

**Japan International Cooperation Agency**

**Data Collection Survey for Energy  
Transition and Carbon Neutral Society  
Final Report**

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**Pacific Consultants Co., Ltd.**

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### List of Abbreviations

Abbreviation	Formal Name
3E+S	Energy security, Economic efficiency, Environment, and Safety
3R	Reduce, Reuse, Recycle
ADB	Asian Development Bank
AEM	Advanced Energy Metering
AEPC	Alternative Energy Promotion Centre (Nepal)
AETI	Asia Energy Transition Initiative
AF	Asia Foundation
AFD	Agence Française de Développement
AGT	Automated Guideway Transit
AI	Artificial Intelligence
AoS	Academy of Science of Uzbekistan
ASEAN	Association of South East Asian Nations
ASEI	Asian solar energy initiative
BAU	Business as Usual
BBIN	The Bangladesh, Bhutan, India, Nepal
BECCS	Bioenergy with Carbon Capture and Storage
BR	Biennial Report
BRT	Bus Rapid Transit
C/P	Counterpart
CCGT	Combined Cycle Gas Turbine
CCS	Carbon dioxide Capture and Storage
CCU	Carbon dioxide Capture, Utilization
CCUS	Carbon dioxide Capture, Utilization and Storage
CDM	Clean Development Mechanism
CHP	Combined Heat & Power
CN	Carbon Neutral
CNG	Compressed Natural Gas
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
COP26	The 26th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change
CRTN	Centre for Rural Technology Nepal

CSR	Corporate Social Responsibility
CTCN	Climate Technology Centre & Network
DEEP	Department of Energy Efficiency Promotion (Laos)
DEESD	Department of Energy Efficiency and Sustainable Development (Vietnam)
DEPP	Department of Energy Policy and Planning (Laos)
DHUP	Department of Housing and Urban Planning (Laos)
DOT	Department of Transportation (Nepal)
EBRD	European Bank for Reconstruction and Development
EDL	Electric Du Laos
EDL-Gen	EDL-Generation Public Company
EE	Energy Efficiency
EMR	Electricity Market Regulator (Uzbekistan)
EMS	Energy Management Systems
EPC	Engineering, Procurement and Construction
ERC	Nepal Electricity Regulatory Commission
ERIA	Economic Research Institute for ASEAN and East Asia
ESCO	Energy Service Company
ET	Energy Transition
ETM	Energy Transition Mechanism
EU	European Union
EV	Electric Vehicle
EVN	Vietnam Electricity
FCDO	Foreign, Commonwealth and Development Office
FOLU	Forestry and Other Land Use
F-REDD	Sustainable Forest Management and REDD+ Support Project
FS	Feasibility Study
GACMO	The Greenhouse Gas Abatement Cost Model
GB/T	Guo jia Biao zhun
GC	Grid Code
GCF	Green Climate Fund
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit

GL	Guideline
GoN	Government of Nepal
GoV	Government of Vietnam
GRID	Green, Resilient, Inclusive Development
GTCC	Gas Turbine Combined Cycle
HPP	Hydro Power Plant
ICT	Information and Communication Technology
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IPPU	Industrial Processes and Production Use
ISEI	International Solar Energy Institute, Uzbekistan
ITMOs	Internationally Transferred Mitigation Outcomes
JCM	Joint Crediting Mechanism
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KOICA	The Korea International Cooperation Agency
LEAP	Low Emission Analysis Platform
LED	light-emitting diode
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LPP	Laos Pilot Program
LRT	Light Rail Transit
LTS4CN	Long-term Strategy for Carbon Neutrality (Cambodia)
LULUCF	Land Use, Land Use Change and Forestry
MAF	Ministry of Agriculture and Forestry (Laos)
MDM	Meter Data Management
MEM	Ministry of Energy and Mines (Laos)
MHCS	Ministry of Housing and Communal Services (Uzbekistan)
MIFT	Ministry of Investments and Foreign Trade of Uzbekistan
MOA	Ministry of Agriculture (Uzbekistan)
MOAL	Ministry of Agriculture and Livestock Development
MOE	Ministry of Energy (Uzbekistan)
MOEDPR	Ministry of Economy Development and Poverty Reduction (Uzbekistan)

MOEF	Ministry of Forest and Environment (Nepal)
MOEWRI	Ministry of Energy, Water Resources and Irrigation (Nepal)
MOF	Ministry of Finance
MOFAGA	Ministry of Federal Affairs and General Administration (Nepal)
MOIC	Ministry of Industry and Commerce (Laos)
MOICS	Ministry of Industry, Commerce and Supplies (Nepal)
MOID	Ministry of Innovative Development (Uzbekistan)
MOIT	Ministry of Industry and Trade (Vietnam)
MONRE	Ministry of Natural Resources and Environment
MOPE	Ministry of Population and Environment (Nepal)
MOPIT	Ministry of Physical Infrastructure and Transport (Nepal)
MOPWT	Ministry of Public Works and Transport (Laos)
MOT	Ministry of Transport (Uzbekistan)
MoU	Memorandum of Understanding
MOUD	Ministry of Urban Development (Nepal)
MOWS	Ministry of Water Supply and Sewage (Nepal)
MPH	Ministry of Public Health (Laos)
MPI	Ministry of Promotion and Investment (Laos)
MRV	Measurement, Reporting and Verification
MST	Ministry of Science and Technology (Laos)
NAFRI	National Agriculture and Forest Research Institute (Laos)
NAMA	Nationally Appropriate Mitigation Actions
NC	National communication
NDC	Nationally Determined Contribution
NEA	Nepal Electricity Authority
NEGU	National Electricity Grid of Uzbekistan
NGO	Non-Governmental Organizations
NIRES	National Scientific Research Institute of Renewable Energy Sources (Uzbekistan)
NLTS	Nepal's Long-Term Strategy for Net-zero Emissions
NOC	Nepal Oil Corporation
NPC	National Planning Commission (Nepal)
NPT	National Power Transmission Corporation (Vietnam)
NSEDP	9th National Socio-economic Development Plan (Laos)

NSP	New Suspension Pre-heater
NZ	New Zealand
NZL REF	New Zealand Laos Renewable Energy Facility
O&M	Operation & Maintenance
PDP8	The National Power Development Plan VIII (Vietnam)
PMO	Prime Minister Office
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PtG	Power to Gas
PV	Photovoltaic
RDF	Refuse Derived Fuel
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and the Role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks in Developing Countries
REDS	Renewable Energy Development Strategy (Vietnam)
REPN	Regional Electric Power Networks
RHC	Rural Health Clinic (Uzbekistan)
RIEM	Research Institute Energy and Mines (Laos)
RPF	Refuse Paper & Plastic Fuel
R&D	Research & Development
SAF	Sustainable aviation fuel
SATREPS	Science and Technology Research Partnership for Sustainable Development
SCADA	Supervisory Control And Data Acquisition
SCEEP	State Committee for Ecology and Environmental Protection
SDGs	Sustainable Development Goals
TCFD	Task Force on Climate-related Financial Disclosures
TPP	Thermal Power Plant
UE	Uzbekenergo Joint Stock Company
UJICY	Uzbek-Japan Innovation Centre of Youth
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change

UNIDO	United Nations Industrial Development Organization
UNPN	Uzbekistan National Power Networks
USAID	United States Agency for International Development
USTDA	United State Trade Development Agency
V2H	Vehicle to Home
VLEEP	Vietnam Low Emission Energy Program
VNEEP	National Energy Efficiency Programme (Vietnam)
WAM	With Additional Measures
WB	World Bank
WECS	Water and Energy Commission Secretariat (Nepal)
WEM	With Existing Measures
WS	Workshop
WtE	Waste to Energy
ZEB	Net Zero Energy Building
ZEH	Net Zero Energy House
ZEV	Zero Emission Vehicle



# **Chapter 1. Business Overview**

## **1.1 Business Background**

Following the Paris Agreement in December 2015, efforts to achieve a low-carbon, decarbonized society are in full swing worldwide. At the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (November 2021), to accelerate climate change action, discussions were held on significantly revising the Nationally Determined Contribution (NDC) targets and establishing a carbon value trading system. Ratifying countries, including developing countries, in order to fulfill their common but differentiated responsibilities for greenhouse gas reduction, should make maximum efforts toward Carbon Neutral (CN).

In addition, in the context of discussions on achieving CN, the importance of Energy Transition (ET) is recognized worldwide. In particular, in Asia where energy demand growth is significant along with economic growth, ET is essential to achieving CN. Regarding Japan, at the “ASEAN-Japan Business Week” in May 2021, the Ministry of Economy, Trade and Industry (METI) announced the "Asia Energy Transition Initiative" to support ET in the Asian region, and in October of the same year the status of support for roadmap formulation, etc., was shared at the "First Asia Green Growth Partnership Ministerial Meeting." In addition, in Europe, the EU-ASEAN Business Advisory Committee in August 2021 has published a report on ET in the region, "Powering ASEAN's Energy Transition." As during COP26, the Energy Transition Council, attended by twenty-one countries and international organizations including Japan, Vietnam, and Laos, agreed on international cooperation toward ET, and as well the Asian Development Bank (ADB), together with Indonesia and the Philippines, launched a partnership to establish an Energy Transition Mechanism and so forth, there is a growing movement toward ET on a global scale.

The Japan International Cooperation Agency (JICA) has been working on CN in developing countries, and to promote ET toward this end, the program is supporting the formulation of policy systems and development plans, such as the promotion of “renewable energy” and energy use efficiency (Energy Conservation) improvements, to contribute to this goal. In the future, the support needs of developing countries for ET and CN are expected to increase. In order to formulate and implement effective projects to meet these needs in a timely manner, it is necessary to accurately grasp the current situation and issues in the target countries, which have various characteristics, in terms of country size, stage of development, energy supply and demand structure, demand outlook, etc., and to build close relationships with relevant government agencies to provide support for the promotion of ET to the achievement of CN. Particularly, in achieving ET and CN, while ensuring stable energy supply and economic efficiency in the target countries, it is important to work on developing feasible scenarios.

Also, to support sustainable development, JICA developed the "Global Agenda", which is an issue specific business strategy consistent with the SDGs, and a "Cluster Business Strategy" that allocates focused resources under each agenda. In climate change, one item of the Global

Agenda, two fields were set up, “Promotion of implementation of the Paris Agreement” as well as “Co-benefit-oriented climate change measures,” and JICA has set forth priority issues to be addressed including:

- (1) Promoting low-carbon, decarbonized, climate resilient urban development and infrastructure investment
- (2) Improving climate change policy and institutions in developing countries,
- (3) Strengthening climate risk assessment and countermeasures,
- (4) Strengthening conservation and management of forests and natural ecosystems.

## **1.2 Purpose of the Work**

Based on the above understanding, this project was carried out in Vietnam, Laos, Nepal, and Uzbekistan (the "Surveyed Countries") for the purpose of considering the optimal cooperation programs and so forth, and as well to gather basic information necessary to identify issues and discussion points for the realization of ET and CN socio-economics, while also taking into account the effectiveness of existing projects by the organization and trends of other donors, etc., regarding the current status and outlook of low-carbonization and decarbonized energy as part of the JICA's global agenda for business management.

## Chapter 2. Method of Conducting the Work

### 2.1 Survey implementation policy

The survey was summarized by conducting a desktop review and on-site interviews under the following policies.

- ✓ Gathering information and identifying issues needed to propose the cooperation program plan

To propose a concrete and realistic cooperation program proposal that can contribute to achieving CN from ETs in the surveyed countries, it is necessary to collect and analyze information in advance, interview local officials, identify issues through field surveys, and provide concrete back data to support the proposal. To this end, in this survey, the following steps were taken, the proposed cooperation program was examined by collecting and analyzing sufficient information in advance, formulating a hypothesis using this information, verifying this hypothesis through field surveys, and revising and reinforcing this hypothesis using information obtained in the field.

- ✓ Accurate understanding of local needs

After developing hypothetical plans for proposed development scenarios and cooperation programs, these hypothetical plans were reinforced by examining the results of existing projects of JICA in the surveyed countries, the latest climate change policies and measures in each country, trends in cooperation projects by other donors, energy statistics in the surveyed countries, papers and reports on ET and CN in each country, and conducting a survey of energy use potential for ET and CN in the surveyed countries. Then, interviews were conducted in the surveyed countries to verify the hypothetical plan and to identify priority issues, support and technical needs, and potential for cooperative projects.

- ✓ Synergistic effects with ET and CN support policies of the Japanese government and private sector trends

Proposed development scenarios and cooperation programs were examined that are consistent with the foreign cooperation policy of Japan in the energy and environment sector and contribute to deploying technologies possessed by Japanese companies that contribute to ET and CN. Consideration was given in particular to policies and technologies (hydrogen, storage batteries, carbon recycling, etc.) in the energy and environment sector of the Overseas Infrastructure Export Strategy and international deployment and cooperation policies of the Paris Agreement Long-Term Growth Strategy, while also paying attention to trends of the Asian Energy Transition Initiative, and to achieving synergistic effects of these policies. In addition, consideration was also given to proposed development scenarios and cooperation program proposals that would contribute to the business development of private companies engaged in activities that contribute to climate change mitigation in the surveyed countries through the

projects of JICA and others.

✓ Considering development scenarios for ETs and CNs with an awareness of the global agenda

To realize ET and CN, it is not only necessary to develop technical aspects but also soft aspects such as policies and systems to promote realization of ET and CN and finance at the same time, and to build the response capacity of concerned organizations and parties in the surveyed countries. In addition, in developing countries with many development issues, it is effective and efficient to implement "co-benefit-oriented climate change measures" that contribute to solving development issues by implementing measures for ET and CN. Therefore, in addition to examining proposed development scenarios for ET and CN in terms of both hardware and software, a development scenario was designed to maximize the co-benefit effects.

✓ Considering a proposed cooperation program that maximizes effectiveness of the existing cooperation of Japan

In studying the proposed cooperation program, while making maximum use of the results of past development assistance of JICA in the surveyed countries, it was attempted to harmonize the program with the foreign cooperation policy of Japan in the energy and environment field, the country-specific policies of the Ministry of Foreign Affairs, and the country-specific support policies of JICA. In addition, in examining the proposed cooperation program, the vision of the proposed cooperation program for ET and CN was clarified, the project groups that constitute the program were examined, and the outputs and outcomes to be achieved through implementing the proposed cooperation program were considered.

✓ Quantitative evaluation of project effectiveness in ET and CN development scenarios

In studying the proposed development scenarios for ET and CN, assumptions were clarified based on the economic conditions of the surveyed countries, including 3E+S (environment, stable energy supply, economic efficiency, and safety in short and long term), international trends after COP26 including carbon trading, etc., and trends in transition finance in the surveyed countries, including ASEAN.

When considering multiple options for the assumptions, a proposed development scenario was examined for each of them. In addition, in the study of the proposed development scenario, a comprehensive evaluation was made from various aspects such as cost and environmental impact. Furthermore, in examining the proposed cooperation program based on the proposed development scenarios, using publicly available materials and field surveys, etc., based on the local situation to the extent possible, the cost-effectiveness was estimated based on the assumed amount of CO<sub>2</sub> reduction and the amount of renewable energy introduced, the amount of energy saving potential, and the projected cost of technology and products, etc., and as much as possible the results were examined together with quantitative evaluations.

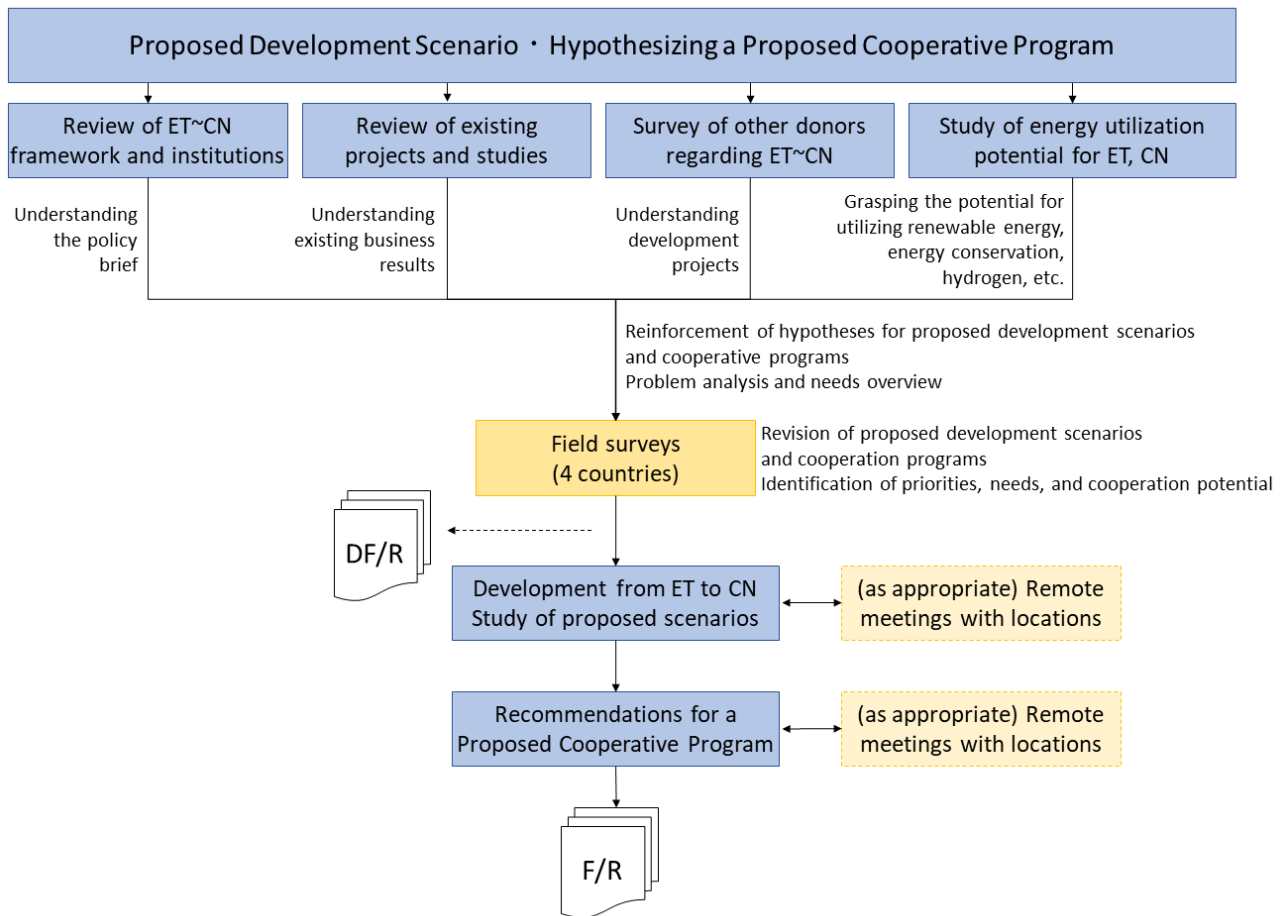


Figure 2-1 Image of the overall work implementation flow <sup>1</sup>

<sup>1</sup> Since the work content differs from country to country, this is shown as an image of the overall work implementation flow.

## 2.2 Survey implementation structure

The survey was conducted by Pacific Consultants Co., Ltd. under the following structure.

Table 2-1 Survey implementation structure

No.	Name	Responsibility
1	Daiki NOSE	Leader / Strategy for energy transition to carbon neutral - 1
2	Akifumi NISHIHATA	Sub-leader / Strategy for energy transition to carbon neutral - 2
3	Yoshihiro MIZUNO	Climate change framework, Carbon trading, Economic assessment
4	Noriko ISHIBASHI	Renewable energy, electrification, hydrogen
5	Yasuko ARAKAWA	Policy, institution
6	Ayu HORIUCHI	Energy saving

## 2.3 Survey schedule

The survey was conducted between February 2022 and September 2022.

## 2.4 Onsite survey schedule and survey structure

The field survey was conducted under the following structure and schedule.

Table 2-2 Onsite survey schedule and survey structure

Country	Schedule	Members
Lao PDR	May 18, 2022 - June 12	Daiki NOSE, Yasuko ARAKAWA, Ayu HORIUCHI
Uzbekistan	June 15, 2022 – 30 June	Akifumi NISHIHATA, Noriko ISHIBASHI, Yasuko ARAKAWA
Nepal	June 18, 2022 – 30 June	Daiki NOSE, Yoshihiro MIZUNO, Ayu HORIUCHI
Vietnam	July 31, 2022 – August 6	Yoshihiro MIZUNO, Noriko ISHIBASHI

# Chapter 3. Current Status on Energy Transition and Carbon Neutrality

## 3.1 Energy Transition Carbon Neutral Overview

### 3.1.1 Energy Transition and Carbon Neutrality

Climate change is already affecting the entire world, and measures to mitigate its impacts, including to reduce anthropogenic greenhouse gas ("GHG") emissions to reach the global peak as soon as possible, decarbonization efforts in all parts of society and the economy to date need to begin reducing GHG emissions as soon as possible. The IPCC Sixth Assessment Report WG3 Report, Mitigation of Climate Change, published in April 2022, states that net GHG emissions continue to increase (WG3 Report, Climate Change Mitigation, April 2022) (Figure 3-1), with CO<sub>2</sub> emissions from both energy sources and the land use, land-use change and forestry (LULUCF) sector accounting for approximately 75% of GHGs. In the breakdown of global GHG emissions by sector (Figure 3-2), about 70% of GHG emissions are from the combustion of fossil fuels consumed in the power generation, industrial, commercial, transport, and consumer sectors. In other words, there is a need to promptly reduce or decarbonize the energy sources consumed in the social economy globally.

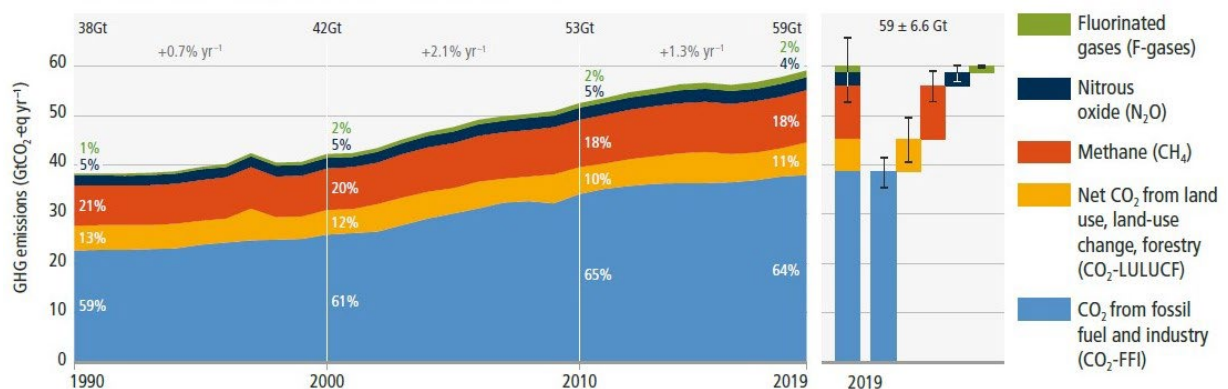
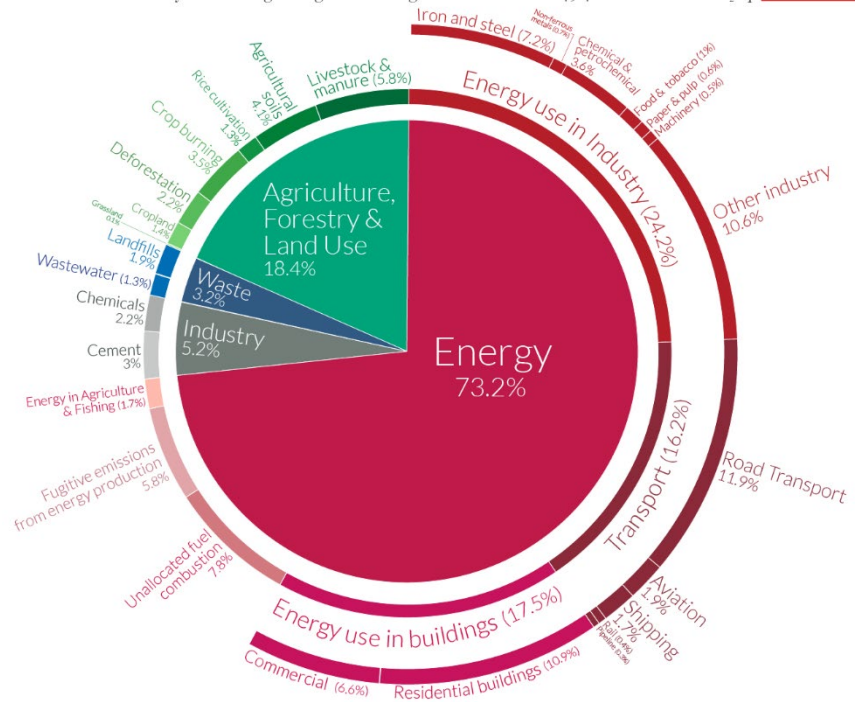


Figure 3-1 Global net anthropogenic GHG emissions (1990-2019) <sup>2</sup>

<sup>2</sup> IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

# Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO<sub>2</sub>eq.



OurWorldinData.org – Research and data to make progress against the world's largest problems. Source: Climate Watch, the World Resources Institute (2020). Licensed under CC-BY by the author Hannah Ritchie (2020).

Figure 3-2 Global GHG by sector (2016) <sup>3</sup>

On the other hand, since it is difficult to completely eliminate GHG emissions, it will become increasingly important to achieve a balance between GHG emissions from GHG emission sources and GHG absorption or fixation by GHG sinks to achieve net zero GHG emissions. The term "carbon neutral" used in this study means "zero net GHG emissions".<sup>4</sup> In this study, ET and CN in the surveyed countries are covered.

### 3.1.2 Overview of technologies related to energy transition and carbon neutrality

Achieving energy transition and carbon neutrality depends primarily on shifting energy sources from fossil fuels to renewable energy and promoting reductions in energy consumption (energy efficiency). As shown in Figure 3-3, to reach a decarbonized society, it is necessary to promote discontinuous innovation and introduce technologies that contribute to energy transition towards a decarbonized society to maximize GHG emissions reductions, as not all industries can jump from a fossil fuel-consuming economy to a decarbonized society.

<sup>3</sup> Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

<sup>4</sup> Strictly speaking, "carbon neutral" refers to zero net emissions of CO<sub>2</sub>, a GHG, while "net zero" refers to zero net GHG emissions (IPCC, 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 541-562, doi:10.1017/9781009157940.008.). In practice, however, it is often used in a similar sense.



Also, as shown in Figure 3-4, there are two types of energy use: electric power and non-electric power (e.g., heat use), and it is necessary to promote energy conservation and decarbonization of power sources for electric power, and energy conservation and fuel switching for non-electric power to reduce CO2 emissions, while also examining the possibilities for developing negative emission technologies to capture and store CO2. In FY2021, the Ministry of Economy, Trade and Industry (METI) held the "Study Session on Establishing a Roadmap for Promoting Transition Finance in the Economic and Industrial Sector"<sup>5</sup> and formulated a roadmap for transitions in the electricity, gas, oil, steel, chemical, pulp and paper, and cement sectors. The technologies listed in these roadmaps are summarized by sector in Table 3-1..

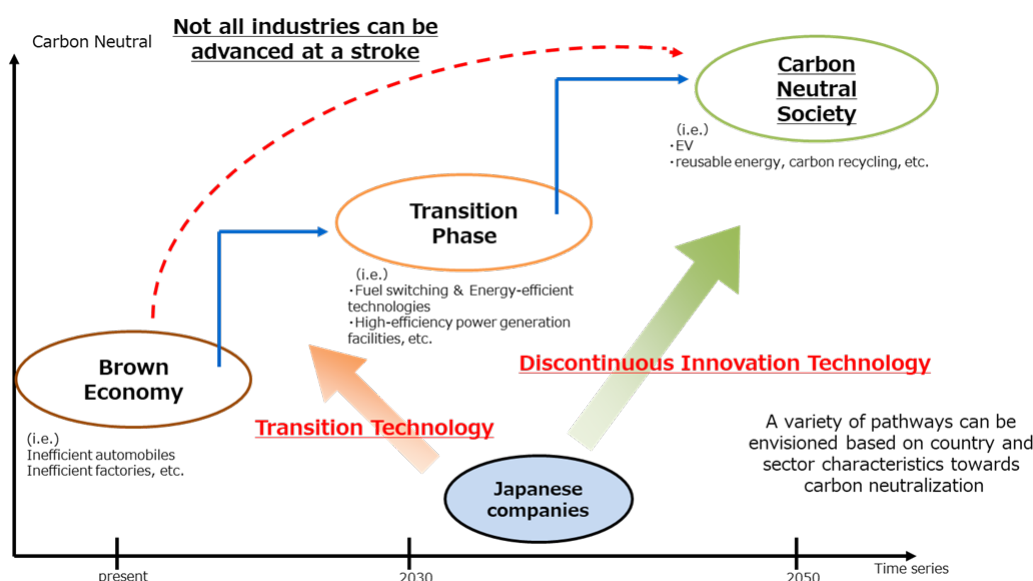


Figure 3-3 Image of reaching a decarbonized society from energy transition<sup>6</sup>

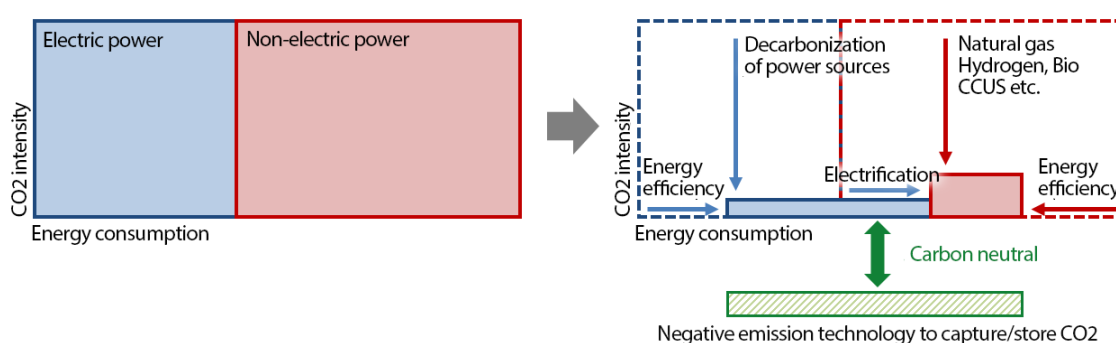


Figure 3-4 Image of CO2 emission reduction<sup>7</sup>

<sup>5</sup> Study Group to Develop a Roadmap for Promoting Transition Finance in the Economy and Industry Sector [https://www.meti.go.jp/shingikai/energy\\_environment/transition\\_finance\\_suishin/index.html](https://www.meti.go.jp/shingikai/energy_environment/transition_finance_suishin/index.html) Accessed July 6, 2022

<sup>6</sup> Transition Finance (Ministry of Economy, Trade and Industry) [https://www.meti.go.jp/english/policy/energy\\_environment/transition\\_finance/index.html](https://www.meti.go.jp/english/policy/energy_environment/transition_finance/index.html) July 1, 2022, Access

<sup>7</sup> What is "carbon neutrality" all about? (Part 2) - Why does Japan aim to realize it? (March 16, 2021, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry) [https://www.enecho.meti.go.jp/en/category/special/article/detail\\_167.html](https://www.enecho.meti.go.jp/en/category/special/article/detail_167.html) Accessed July 1, 2022

Table 3-1 List of main technologies contributing to ET and CN <sup>8</sup>

Field	Technology	Outline	Implementation year
<b>Electric power</b>			
Decarbonated power supply	Ammonia mono fuel	Ammonia mono-firing in boilers and gas turbines	2030s
	Hydrogen mono fuel	Mono-firing by hydrogen turbine	2030s
	CCUS	Promotion of technological development, demonstration, introduction, and commercialization of CO2 capture and storage technologies	2030s
	Re-energy and nuclear power	Introduction of renewable and nuclear energy	Already in place
	Suspension and discontinuation of thermal power supply	Suspension and decommissioning of existing thermal power sources	Already in place
Transition power supply	Ammonia co-firing	Co-firing of ammonia with coal	Late 2020s
	Hydrogen mixing and burning	Hydrogen co-firing with gas fired power plants	Late 2020s
	Biomass co-firing	Biomass co-firing with coal fired power plants	Already in place
Other	Strengthening and upgrading of power transmission and distribution networks	Reinforcement of power transmission and distribution networks, etc. to expand the introduction of renewable energies	Already in place
	Promotion of demand response, electrification, etc.	Demand-side decarbonization initiatives, electrification, etc.	Already in place
	Storage batteries, pumped water, distributed energy	Introduction of storage batteries and distributed energy resources that contribute to grid stabilization, etc.	Already in place
<b>Gas</b>			
Natural gas	Energy conservation in the city gas production process	Energy saving by cooling/heating equipment, etc.	Already in place
	Development of natural gas supply network	Strengthening supply infrastructure to expand use of natural gas	Already in place
	Fuel conversion	(Installation, etc. of facilities, etc. necessary for demand-side fuel conversion)	Already in place

<sup>8</sup> Based on roadmaps for each sector from the Study Group on Roadmap Development for Promoting Transition Finance in the Economy and Industry Sector [https://www.meti.go.jp/shingikai/energy\\_environment/transition\\_finance\\_suishin/index.html](https://www.meti.go.jp/shingikai/energy_environment/transition_finance_suishin/index.html) Accessed July 6, 2022

Field	Technology	Outline	Implementation year
	Advanced utilization of natural gas	Energy conservation through energy measurement, high-efficiency boilers, etc.	Already in place
	Distributed energy system	Energy conservation through the spread and expansion of smart energy networks (energy use in all areas), cogeneration, fuel cells, etc.	Already in place
	Conversion of city gas feedstock from natural gas to synthetic methane	Converting city gas feedstock to synthetic methane to reduce CO2 emissions from city gas use to zero	2030s
Synthetic methane	Methanation (Sabatier reaction)	Methane synthesis from hydrogen and CO2	2030s
	Methanation (Innovative technology)	Innovative technologies to synthesize methane more efficiently than methanation by the Sabatier reaction (e.g., co-electrolysis)	2040s
	Establishment of domestic and overseas supply chain	Combined use of synthetic methane in existing infrastructure such as liquefaction terminals, LNG carriers, receiving terminals, pipelines, etc.	2030s
LP gas	Promotion of energy conservation and fuel conversion	Spread of high-efficiency gas hot-water supply equipment and household fuel cells, energy conservation at LP gas import terminals, etc., and LP gas boilers and LP gas-fueled ships	Already in place
	Rationalization of transmission and distribution	Spread of smart meters and centralized monitoring equipment	Already in place
Green LP gas	Synthetic LP gas	Methanol from hydrogen and CO2, LP gas production by indirect synthesis method via Di-Methyl Ether	2030s
Hydrogen	Water electrolysis (manufactured overseas and in Japan)	Hydrogen produced by electrolyzing water	Late 2020s
	Transportation from overseas (liquefied hydrogen carriers and liquid hydrocarbons as carriers)	Transported by liquefied hydrogen carriers or by using methylcyclohexane and other substances as carriers	Late 2020s
	Local hydrogen network	Development of domestic hydrogen supply network	2030s
	Hydrogen combustion equipment, etc.	Use of hydrogen in industrial furnaces, cogeneration, fuel cells, etc.	Before 2030

Field	Technology	Outline	Implementation year
	Hydrogen station	Social implementation of hydrogen production from city gas at low cost	Already in place
Biogas	Biogas	Utilization of biomass fermentation-derived gas	Already in place
Ammonia	Ammonia	On-site utilization of ammonia	Late 2020s
CCUS	Separation and recovery of CO2 from exhaust gas, etc.	Captures and utilizes CO2 emitted from city gas appliances. Collection, utilization and storage	Early 2020s
		CO2 emitted from steel mills, power plants, chemical plants, etc. is turned around.	2030s
	DAC	Direct capture of CO2 from the atmosphere	2040s
<b>Petroleum</b>			
Crude oil processing	Strengthening energy-saving measures	Effective use of heat, introduction of advanced control and high-efficiency equipment, improvement of power system efficiency, large-scale improvement and upgrading of processes, etc.	Already in place
	Promotion of fuel conversion	Conversion from petroleum-based fuels to natural gas, etc.	Already in place
	Transition to decarbonized fuels	Conversion from fossil fuels to CO2-free hydrogen and other decarbonized fuels	2030s
	Promote the use and development of renewable energy and zero-emission power sources	Greening electricity in the petroleum refining process	Already in place
	Refining process transformation	Decarbonization of refining processes by utilizing CO2-free hydrogen	2030s
	CCS/CCU	CO2 recovery from refining processes, etc. Production of fuels, materials (carbonates), etc. from recovered CO2 Introduction of CCS	2030s
	Improvement and more efficient use of existing fuels	Chemical recycling of waste plastics	Waste plastics are converted into oil and then chemically recycled using oil refining equipment to produce fuels and chemical raw materials.
New fuels that contribute to improved fuel efficiency of internal combustion engines		Emission reductions through optimization of future innovative engine combustion methods and fuel combinations, etc.	Late 2020s

Field	Technology	Outline	Implementation year
Hydrogen, Ammonia	Establishment of CO <sub>2</sub> -free hydrogen and ammonia supply chain	Highly efficient manufacturing and transportation technology Dehydrogenation and storage using refinery facilities Domestic supply and in-house use (for power generation, automobile fuel, raw materials, etc.)	2030s
	Development of hydrogen stations, etc.	Hydrogen supply for fuel cell vehicles, etc.	Already in place
Biofuels, etc.	Biofuels, etc. (bioethanol, biodiesel, SAF, chemical raw materials, etc.)	Production of liquid fuels and chemical raw materials from plants and waste materials	Partially already implemented (SAF manufacturing technology implemented around 2030)
Synthetic fuels, etc.	Synthetic fuels, etc. (automotive fuels, SAF, chemical raw materials, etc.)	Production of liquid fuels and chemical feedstock from hydrogen and CO <sub>2</sub>	2030s
<b>Iron and Steel</b>			
Blast furnace related	Energy saving and high efficiency	[Upstream process] Utilization of next-generation coke Exhaust heat and byproduct gas recovery Introduction of high-efficiency power generation equipment Plastic recycling in coke ovens, etc. Scrap utilization Highly efficient production through the introduction of AI, ICT, etc. Improvement of heat transfer efficiency Coke oven refurbishment to improve efficiency [Downstream process] Process consolidation and improvement waste heat recovery Burner improvement, introduction of high-efficiency equipment	Already in place
	Fellow coke (carbon fuel)	Utilizing coke produced by effectively utilizing low-grade iron ore and coal that cannot be utilized in the conventional ironmaking process (fellow coke)	2020s

Field	Technology	Outline	Implementation year
	CO2 Separation and recovery	Utilization of CO2 capture technology using unused waste heat in steel works	Late 2020s
	Utilization of hydrogen in the plant	Reduction technology of iron ore by utilizing hydrogen in the plant	Late 2020s
	Utilization of reduced iron	Reduced iron utilization to reduce coke	2020s
	Biomass utilization	Biomass utilization as a substitute for coke	2040s
	Use of recovered CO2	Utilization technology for reductant (synthetic methane), CO2 recycling ironmaking system, CO2 reduction technology, etc.	2040s
	Utilization of external hydrogen	Hydrogen reduction technology in blast furnaces utilizing external hydrogen	2040s
Continuous casting and rolling	Improved heat transfer efficiency and power saving	Reducing costs during manufacturing by promoting energy conservation through improvements in heat transfer efficiency in melting and rolling processes, etc.	Late 2020s
	Heating electrification	Electrification of heating reduces CO2 emissions in the reheating process during rolling	Late 2020s
Electric furnace related	Energy saving and high efficiency in electric furnaces	Introduction of high-efficiency arc furnace Waste heat recovery	Already in place
	Impurity removal and scaling technology in electric furnaces	Impurity removal required for high-grade steel production and larger scale production of pig iron for mass production of pig iron	2030s
Direct reduction relation	Partial hydrogen direct reduction	Hydrogen reduction technology using a direct reduction furnace (technology in which hydrogen is used as part of the reductant)	Year 2030
	100% direct hydrogen reduction	Hydrogen reduction technology using a direct reduction furnace (technology in which 100% of the reduction material is hydrogen)	2040s
<b>Chemistry</b>			
End product	Highly efficient production technology	In the production of functional chemicals, the flow method is used for continuous production instead of the conventional batch method.	2020s

Field	Technology	Outline	Implementation year
	Lightweight reinforced materials (cellulose nanofibers, etc.)	Manufacture of lightweight reinforced materials for automobiles and other applications using versatile cellulose nanofibers composite technology. Technology that contributes to the reduction of petroleum-derived materials, etc.	2020s
	N2O suppression technology	N2O control technology in waste gas/semiconductor gas treatment, wastewater/sludge/waste/biomass, treatment, agriculture, etc.	2035s
Recycle	Material recycling	Production of plastic products from waste plastic, etc.	Some already in place
	Chemical recycling (waste plastic)	Producing olefin from waste plastic by gasification, oilification, pyrolysis, etc.	2030s
	Chemical recycling (waste rubber)	Producing olefin from waste rubber by gasification, oilification, pyrolysis, etc.	2040s
Gas industry	Best practice	Energy-saving and high-efficiency technologies: Introduction of high-efficiency deep-cooling separators, etc., use of inverters for pumps, compressors, etc., review of delivery bases, etc.	Already in place
Soda electrolysis	Best practice	Energy-saving and high-efficiency technologies: Advanced control / Renewal and high-efficiency of facilities / Introduction of zero-cap electrolyzer / Introduction of double-station electrolyzer / Heat recovery of concentration facilities, etc.	Already in place
Steam for captive use, Electricity for captive use, etc.	Best practice	Downsizing of boilers, operation management, energy-saving distillation technology, expansion of the scope of application of energy-saving steam traps, cogeneration, heat pumps, etc.	Already in place
	Fuel conversion to natural gas	Conversion from coal and heavy oil to natural gas for private power and steam	Already in place
	Fuel conversion to biomass	Biomass co-firing, dedicated burning, etc.	Already in place
	Fuel conversion to hydrogen, ammonia, etc.	Hydrogen power generation, ammonia co-firing, and ammonia mono-firing technology in gas turbines, etc.	2020s and beyond

Field	Technology	Outline	Implementation year
	Electrification	Producing steam by electric heating Introduction of renewable energy (solar cells, hydroelectric power, etc.)	-
	Separation and recovery of CO <sub>2</sub> from exhaust gas, etc.	CO <sub>2</sub> capture from natural gas fired power plants, chemical processes, incineration, etc. Chemical absorption, chemisorption, physical absorption, membrane separation, etc. Introduction of CCS	2030s
<b>Paper and Pulp</b>			
Manufacturing process	Energy saving and high efficiency	Review of manufacturing processes (integration, shortening, etc.) Thorough energy management (introduction of energy management systems, review of management methods, etc.) Renewal of aging facilities for energy conservation and higher efficiency, adoption of LED lighting	Already in place
	Highly efficient pulp manufacturing, etc.	Chemical pulp produced by steaming is washed with steam instead of water, etc.	2020s
	Decarbonizing the kiln	Electrification of lime burning process in pulp production New kiln-free chemical recovery technology	2030s
	Dry sheet forming	Reduces energy consumption in the drying process by using air instead of water. Wastewater reduction is also possible.	2030s
	Highly efficient press technology	Energy-saving technologies such as reducing heat demand during drying by pressing using heat and combining mechanical and pneumatic pressure	2030s
	High density papermaking	This technology increases the concentration of raw material at the inlet of the paper machine from the conventional 0.5-1% to around 3%, which contributes to improved forming speed and energy saving in the pressing process.	2030s
	Electrification of paper machine dryer	Electrification of drying facilities using fossil fuels in the papermaking process (assuming CN power supply)	2030s



Field	Technology	Outline	Implementation year
	Highly efficient drying technology	Efficiency-enhancing technologies such as mechanical dehydration using heat and pressure and drying under high-pressure conditions. Some of these technologies contribute to improved product quality and productivity.	2030s
	Gas drying	Gas produced by gas combustion is used instead of steam to improve energy efficiency. In some cases, this can contribute to improved productivity.	2030s
Raw fuel production	Lignin isolation	Lignin is separated from wood, etc., and used as biofuel (can also be used for chemicals)	2020s
	Black liquor gasification	Efficient energy recovery by gasifying black liquor, a byproduct of the pulping process	-
	Smart forestry	Development of ICT production management systems and other systems that are consistent with automated machinery and forest cloud computing, and the use of sensing technology to reduce the cost and labor of afforestation work	Some already in place
Private power generation and steam	Energy saving and high efficiency	Introduction of high-efficiency power generation equipment and CHP Introduction of energy management systems, etc.	Already in place
	Fuel conversion to natural gas	Conversion of fuel to natural gas (co-firing and dedicated burning)	Already in place
	Fuel conversion to biomass	Conversion of fuels to biomass (co-firing and dedicated burning)	Already in place
	Energy use of waste	Utilization of waste energy from plastics, tires, RPF, RDF, etc.	Already in place
	Conversion to solar power	Switching to solar power for private power generation	Already in place
	Fuel conversion to hydrogen, ammonia, etc.	Hydrogen power generation, ammonia co-firing, and dedicated ammonia firing in coal boilers and gas turbines	2020s and beyond
	Direct electric heating	Generates heat from an electric boiler	2030s
	Exhaust heat recovery in heat pumps	Recovers waste heat from the process and converts it to medium temperature (around 160°C)	2030s
Recovery and absorption	Separation and recovery of CO <sub>2</sub> from exhaust gas, etc.	CO <sub>2</sub> recovery from natural gas and biomass combustion, etc. Introduction of CCS/CCUS, etc. (including BECCS, etc.)	2020s

Field	Technology	Outline	Implementation year
	CO2 absorption from the atmosphere (fast-growing trees and elite trees)	Development of superior tree species that are highly adaptable, grow quickly, and absorb more CO2 (1.5 times or more), and afforestation of these trees Direct absorption of CO2 from the atmosphere	Already introduced in some areas
<b>Cement</b>			
Manufacturing process	Energy saving and high efficiency	Waste heat power generation High efficiency clinker cooler Introduction of vertical coal mill Vertical type blast furnace slag mill NSP kiln Introduction of IoT and automated operations	Already in place
	Lower combustion temperature	Contribute to a reduction of about 2.6% in energy intensity by lowering the calcination temperature through the use of mineralizing agents	2020s
Raw materials	Reduction of clinker ratio	Reduce the ratio of clinker in cement and reduce emissions by ✓ Increased use of mixed materials by increasing the amount of tricalcium aluminate ✓ Increase in the amount of blast furnace slag added to blast furnace cement Class B	Some already in place
	Substitution of raw materials by waste	Contributing to the reduction of process-derived CO2 emissions by using waste as part of the raw materials	Already in place
	Recycling of concrete fines	Utilization of fine powder from concrete production as raw material for clinker	2030s
	Development of new low-carbon materials	Contribute to the reduction of non-energy emissions by developing materials with new compositions (e.g., materials with low CO2 emissions during production, new binding agents similar to limestone, etc.) to replace existing binding materials	2040s
Fuel conversion	Energy use of waste	Utilization of waste plastics, sludge, wood waste, etc. from various industries, as a substitute for heat energy	Already in place
	Use of biomass, etc.	Reducing the use of fossil fuels by using biomass for combustion, thereby contributing to the reduction of energy-derived CO2 emissions.	Already in place

Field	Technology	Outline	Implementation year
	Use of hydrogen, ammonia, etc.	Contributing to the reduction of energy-derived CO2 emissions by using hydrogen and ammonia, which do not emit CO2 during combustion	2030s
CCUS	Separation and recovery of CO2 from exhaust gas, etc.	Separation and recovery of CO2 from exhaust gas emitted outside the plant using existing technologies such as chemical absorption methods	2020s
	CO2 Capture manufacturing process	Recovery of process-derived CO2 from inside the pre-heater by utilizing the existing cement manufacturing process	2030s
	Carbonate formation	CO2 is captured and fixed in a calcium source, which is stored and utilized as carbonate and contributes to the reduction of CO2 emissions.	2030s
	Generation of carbon recycled cement	Technology to produce cement from CO2-fixed carbonate contributes to CO2 emissions reduction	2030s
	Generation and utilization of synthetic methane	Contributing to the reduction of CO2 emissions in cement production by capturing CO2 in exhaust gas and generating and utilizing synthetic methane	2030s

In addition, as shown in Figure 3-2, the agriculture, forestry and land use sectors account for about 18% of global GHG emissions, and it is important to reduce GHG emissions and enhance GHG absorption in the agriculture and forestry sectors to achieve CN. Examples of major technologies that contribute to ET and CN in the agriculture and forestry sectors are shown below.

Table 3-2 List of main technologies contributing to ET and CN in agriculture and forestry <sup>9</sup>

Field	Technology	Outline
<b>Agriculture and Forestry</b>		
Reduction of greenhouse gas emissions from agriculture and livestock production	Increased soil carbon content in agricultural land	Increase the amount of organic inputs such as compost, crop residues, and green manure. Slow decomposition of soil organic matter through no-till and reduced tillage cultivation. Application of biochar increases carbon sequestration into the soil.
	Methane reduction from	Reduce methane emissions by

<sup>9</sup> Prepared by Pacific Consultants with referring to Kenji YAMAJI ed. (2022) "Carbon Neutral 2050 Outlook", Nihon Denki Kyokai Shinbunbu.

Field	Technology	Outline
	rice paddies	shortening the duration of waterlogging (promoting the ancient Japanese practice of Nakaboshi). <sup>10</sup> Plowing rice fields in autumn after summer harvesting promotes aerobic decomposition of rice straw.
	N <sub>2</sub> O reduction from fertilizer	Use of fertilizers containing nitrification inhibitors to improve the efficiency of nitrogen fertilizer absorption by crops and reduce the number of fertilizer applications.
	Reduction of N <sub>2</sub> O and methane by fermentation in livestock digestive tract and livestock waste management	Reduced emissions per output by improving milk and meat production. Inhibits fermentation by microorganisms in the stomach of ruminants. Reduce N <sub>2</sub> O by reducing total nitrogen excretion with amino acid-added low protein feed. N <sub>2</sub> O is reduced by attaching microorganisms to carbon fiber carriers to reduce nitrite and nitrate ions in sewage.

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<sup>10</sup> Temporary suspension of waterlogging about one month after rice planting.

## 3.2 International Trends Towards Energy Transition and Carbon Neutrality

### 3.2.1 International trend

#### 3.2.1.1 Sinks and Carbon Trading in the Paris Agreement

The Paris Agreement, adopted at COP21 in Paris in December 2015, sets a long-term goal of "keeping the global average temperature increase well below 2°C above pre-industrial levels and striving to limit it to 1.5°C," and all 196 countries of the United Nations Framework Convention on Climate Change (UNFCCC) agreed to participate with targets and actions for reduction and absorption. emission reduction and absorption targets and actions. As one of the measures to promote the GHG emission reduction and absorption actions, the utilization of sinks and market mechanisms are stipulated in Articles 5 and 6, respectively.

Article 5 provides, in paragraph 1, for the conservation and enhancement of forests and other sinks and, in paragraph 2, for encouraging actions to implement and support REDD+, which is a results-based payment framework for measures undertaken by developing countries. Paragraph 2 also mentions encouraging benefits other than GHG emission reductions from REDD+ activities, but is not clear on how to do so.

Article 6.1 states its objective as "Parties recognize that some Parties may choose to cooperate on a voluntary basis to enable more ambitious action on mitigation and adaptation, and to promote sustainable development and the conservation of the environment, in the implementation of nationally determined contributions. Article 6 of the Kyoto Protocol provides that "the Parties shall choose to cooperate on a voluntary basis to promote sustainable development and environmental protection" and uses the phrase "make ambitious" to indicate that emission reduction targets should be deepened. Article 6 contains three concepts, as follows

- ✓ Article 6.2 and 6.3 (hereafter 6.2): market mechanisms involving the transfer of international allowances or credits implemented under a cooperative approach between countries (e.g. JCM, CORSIA, etc.)
- ✓ Article 6.4-7 ("6.4"): UN-administered market mechanism (successor to the CDM)
- ✓ Article 6.8-9 ("6.8"): support through non-market approaches such as mitigation, adaptation, finance and capacity building

In particular, it is the mitigation outcomes called Internationally Transferred Mitigation Outcomes (ITMOs) generated under the cooperative approach in Section 6.2 that are expected to play a role in helping countries achieve their CNs, as the ITMOs will be In order to participate in Section 6.2, countries are required to prepare and maintain NDCs, establish recordkeeping and management systems for the use and reporting of ITMOs, apply equivalent adjustments, and submit updated GHG inventory reports. In order to meet these requirements, countries need to promote the necessary infrastructure development and capacity building. On the other hand, paragraph 6.4 stipulates reductions generated by the Clean Development Mechanism (CDM) or its successor mechanisms, which are market mechanisms managed by the United Nations, as mechanisms that contribute to sustainable development. Under the Paris Agreement, it is clarified that emission reductions generated from this mechanism cannot be

used to achieve a host country's national target if they are used to achieve another party's national target. However, many countries are opposed to the transfer of CDM credits generated by the CDM so far, and it depends on the future course of negotiations. If the transfer of pre-2020 credits is allowed, some estimates suggest that the amount of CDM credits supplied by CDM projects registered after 2013 will amount to about 340 million tons.

At COP26 held in Glasgow, UK, in November 2021, agreement was reached on important agenda items such as this Paris Agreement Article 6 Implementation Guidelines, and the Paris Rulebook was completed. It is expected that various initiatives related to Article 6.2, including JCM, will be promoted in the future.

### 3.2.1.2 Asian Energy Transition Initiative (AETI)

The Asia Energy Transition Initiative (AETI) was announced at the ASEAN-Japan Business Week held from 24 to 28 May 2021. AETI will propose concrete support measures in the following five areas.

- ✓ Support for the development of an energy transition roadmap toward carbon neutrality
- ✓ Presentation and dissemination of the Asian version of the transition finance concept
- ✓ 10 billion in financing support for renewable energy, energy conservation, CCUS, and other projects
- ✓ Support for technology development and demonstration using the results of the Green Innovation Fund
- ✓ Human resource development, knowledge sharing, and rule making on decarbonization technologies

Approximately one year after the announcement, the following support efforts are currently underway.

Table 3-3 Summary of Support in AETI

Item	Embodiment
Support for Energy Transition Roadmap Development	The Economic Research Institute for ASEAN and East Asia (ERIA) and the Institute of Energy Economics, Japan (IEEJ) have developed country-specific roadmaps (model analyses) that utilize all energy sources and technologies based on cost minimization models, while assuming the carbon neutrality target years for ASEAN countries. The roadmap (model analysis) was developed for each country that utilizes all energy sources and technologies based on the cost minimization model, while assuming the carbon neutrality target years for each ASEAN country. Implemented in Thailand, Vietnam, and Indonesia. Individual meetings are being held with other ASEAN countries.

Presentation and dissemination of the Asian version of the transition finance concept	The Asia Transition Finance (ATF) Study Group, led by Mitsubishi UFJ Financial Group and led by financial institutions in Japan, Asia, Europe and the United States, was established to conduct discussions on finance for energy transitions in Asia. The study group will formulate guidelines and make recommendations to Asian governments in order to financially support transitions in Asia, with an interim report to be released in April 2022 and deliverables in September.
10 billion dollar financing support for renewable energy, energy conservation, LNG and other projects	The Ministry of Economy, Trade and Industry (METI) and industry (Global Energy Conservation Promotion Council) have established five business groups ((1) Distributed Power Generation Using Renewable Energy, (2) Decarbonized Electricity System, (3) Electricity and Heat Management, (4) ZEB, (5) Geothermal) to promote public-private cooperation, including standardization for the introduction of Japanese technologies. As the Renewable Energy and Energy Management Deployment Project (tentative name), the project will identify issues in each country, establish and review systems, conduct joint public-private sector missions, and provide verification and financial support.
Support for technology development and demonstration using the results of the Green Innovation Fund	<Utilization of ammonia as fuel> Malaysia: FS study for ammonia co-firing is underway (techno-economic evaluation of the entire supply chain including blue/green ammonia production, verification of application of ammonia co-firing technology to coal-fired power plants in Southeast Asia, etc.) Indonesia: FS study on ammonia co-firing at a coal-fired power plant is scheduled to start. < Zero Emission Thermal Power Deployment Project in Asia> Developing projects such as the Asia Green Growth Project, the introduction of hydrogen and fuel ammonia and the establishment of a system for securing suitable sites for CCUS, and international demonstration projects for Japanese technologies that contribute to more efficient energy consumption, etc.
Human resource development, knowledge sharing, and rule making on decarbonization technologies	Through the Asia CCUS Network, we contribute to knowledge sharing, human resource development, and business environment improvement for CCUS utilization in Asia. Currently, a total of 14 countries from the ASEAN 10 countries are participating as members, in addition to Japan, the United States, Australia, and India.

### 3.2.1.3 ADB Energy Transition Mechanism Partnership

At the 26<sup>th</sup> Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2021, the ADB announced the launch of a new partnership with Indonesia and the Philippines to create the Energy Transition Mechanism (ETM).

The ETM is a blended financing approach aimed at accelerating the shutdown of existing coal-fired power plants and replacing them with clean generation facilities. The mechanism includes a Carbon Reduction Facility to accelerate the shutdown or conversion of coal-fired power plants and a Clean Energy Facility to promote investment in new clean and renewable energy sources such as power generation, storage, and transmission and distribution system upgrades. Both public and private sources of funding are envisaged for these funds, including international financial institutions, private institutional investors, philanthropic organizations, and long-term investors. In fact, the Japanese government has announced an initial seed money grant of \$25 million for the mechanism to coincide with the launch of the partnership between Indonesia and the Philippines. The ETM is considering a variety of investment approaches to achieve a quick shutdown of thermal power plants. For example, the owner of a coal-fired power plant will sell the plant to the Fund, and the Fund will take measures to promote the introduction of renewable energy while implementing the shutdown of the plant ahead of schedule.<sup>11</sup>

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11 Japan Announces \$25 Million for ADB-Led Energy Transition Mechanism in Southeast Asia (ADB, Nov 2021) <https://www.adb.org/ja/news/japan-announces-25-million-adb-led-energy-transition-mechanism-southeast-asia> Accessed 16 Aug.





### ETM to leverage public/private finance to develop a pilot Coal Reduction Facility of ~ \$3bn

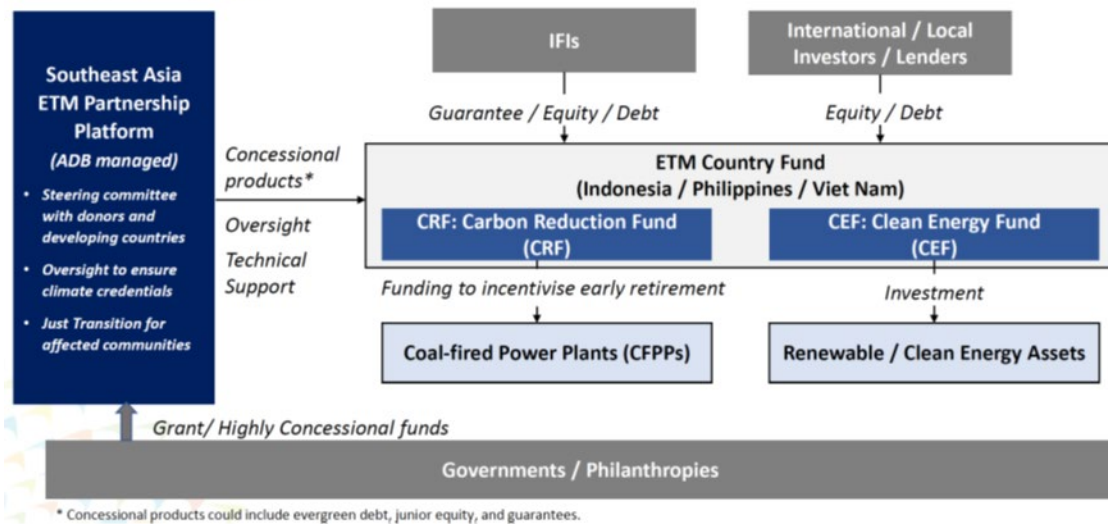


Figure 3-5 ADB's Energy Transition Mechanism Model <sup>12</sup>

In July 2022, Indonesia also announced the launch of a country platform as part of its ETM initiative. ADB's ETM is expected to be implemented in Indonesia, the Philippines and Vietnam, and then expanded to other regions and countries. The ADB ETM will be implemented in Indonesia, the Philippines, and Vietnam. Currently, the study of the ETM financing structure has been completed, the shortlist of coal-fired power plants for the pilot program has been narrowed down and feasibility studies have been completed, and a full-scale feasibility study for implementation is underway.

<sup>12</sup> Dr. Pradeep Tharakan, Unit Head, Sovereign Energy Operations, Greater Mekong Subregion, Southeast Asia Energy Division, Energy Transformation Mechanism (ETM) of the Asian Development Bank (February 2022) Available at: [https://www.iges.or.jp/sites/default/files/inline-files/2\\_Tharakan\\_ETM%20Introductory%20Presentation%20External%20Feb%202022\\_IGES\\_Tharakan.pdf](https://www.iges.or.jp/sites/default/files/inline-files/2_Tharakan_ETM%20Introductory%20Presentation%20External%20Feb%202022_IGES_Tharakan.pdf) Accessed August 3, 2022

### 3.2.2 Japan

In 2021, Japan revised the Act on Promotion of Global Warming Countermeasures <sup>13</sup> with the aim of achieving a decarbonized society by 2050. Subsequently, in the "The Long-term Strategy under the Paris Agreement" (October 2021) <sup>14</sup>, Japan formulated strategies for GHG emission reductions in the energy, industry, transportation, and community and lifestyle sectors, and set a milestone for 2050 of reducing GHG emissions by 46% from the 2013 level by 2030.

To achieve CN in 2030, existing technologies will be utilized to the maximum extent to achieve the 2030 reduction target, and to achieve CN in 2050, efforts toward the 2030 target will be further expanded and deepened while developing and disseminating decarbonization technologies that have not been implemented in society at the moment. On the other hand, it is difficult to accurately predict the success or failure of various technological developments and innovations for 2050 at this point, and therefore, while setting the target of CN for 2050, the priority of measures and technological developments will be determined based on the latest information. The main action plans are shown in the table.

Table 3-4 Examples of Action Plans in the Long-Term Strategy as a Growth Strategy under the Paris Agreement

Sector	Item	Outline
Energy	Renewable energy	<ul style="list-style-type: none"> <li>• Maximum introduction will be pursued under the principle of giving the highest priority as the main power source in 2050.</li> <li>• Promote the development of innovative technologies such as next-generation solar cells and floating offshore wind turbines.</li> </ul>
	Nuclear power	<ul style="list-style-type: none"> <li>• Reduce dependence on nuclear power as much as possible.</li> </ul>
	Hydrogen, Ammonia, CCS, CCU/Carbon Recycling	<ul style="list-style-type: none"> <li>• Decarbonization of thermal power generation will be achieved by converting the fuel itself to hydrogen and ammonia, and by capturing, storing and reusing the carbon dioxide emitted.</li> <li>• Development and demonstration of technologies for the construction of an international hydrogen supply chain and establishment of hydrogen power generation technologies.</li> <li>• For CCS, establish technology, reduce costs, develop suitable sites and improve the environment</li> </ul>

<sup>13</sup> Act on Promotion of Global Warming Countermeasures <https://elaws.e-gov.go.jp/document?lawid=410AC000000117> Accessed July 6, 2022

<sup>14</sup> The Long-Term Strategy under the Paris Agreement (Cabinet Decision of October 22, 2021) <https://www.env.go.jp/earth/ondanka/keikaku/chokisenryaku.html> Accessed on July 6, 2022

		<p>for commercialization.</p> <ul style="list-style-type: none"> <li>• For CCU, promote technology development and social implementation for cost reduction and application development, as well as international deployment.</li> </ul>
Industry	CO2 reduction measures	<ul style="list-style-type: none"> <li>• Pursue policy measures that combine regulation and support.</li> </ul>
	Measures to reduce CFC substitutes	<ul style="list-style-type: none"> <li>• Expand the use of green refrigerant equipment, prevent leakage of CFCs when refrigeration and air-conditioning equipment is used, recover and properly dispose of CFCs from refrigeration and air-conditioning equipment, and promote international cooperation.</li> </ul>
	Decarbonization management	<ul style="list-style-type: none"> <li>• Continue to promote industry-based initiatives to set voluntary reduction targets and promote measures.</li> </ul>
Transportation	Promotion of transportation and logistics services using electric vehicles, etc.	<ul style="list-style-type: none"> <li>• To improve fuel efficiency of new vehicles and promote the spread of next-generation vehicles in buses, trucks, taxis, etc. for commercial use.</li> <li>• Promote the introduction of new transportation systems through automation, including the social implementation of automated driving technology, including the use of electric vehicles.</li> </ul>
	Promotion of social implementation of urban and road infrastructure compatible with the electrification of automobiles	<ul style="list-style-type: none"> <li>• Promote the development of charging facility information signs and conduct social experiments on the installation of EV chargers on public roads.</li> </ul>
	Reinforcing the power supply function during disasters, etc., using electrically powered vehicles	<ul style="list-style-type: none"> <li>• Promote the spread of V2H (a system that supplies electricity from EVs, etc. to residences).</li> </ul>
	Road traffic flow	<ul style="list-style-type: none"> <li>• Promote consideration of the introduction of areal</li> </ul>

	countermeasures from both soft and hard aspects	congestion countermeasures including toll measures for traffic demand adjustment utilizing ICT, AI, etc.
	Promote the use of public transportation and bicycles	<ul style="list-style-type: none"> <li>Promote the use of public transportation by improving its convenience through reorganization of regional transportation networks and promotion of barrier-free access, etc., and introduce LRT, BRT, etc.</li> </ul>
	Promoting green logistics	<ul style="list-style-type: none"> <li>Promote more efficient truck transportation by making the entire supply chain more efficient and energy-efficient, building a joint transport and delivery system, and reducing redelivery of parcel deliveries.</li> <li>The project will work to make logistics facilities low-carbon, put drone logistics into practical use, and further promote modal shifts, etc.</li> </ul>
	Decarbonizing rail, shipping and aviation	<ul style="list-style-type: none"> <li>In railways, promote energy-efficient rolling stock and advanced energy-saving equipment. Promote the development of fuel cell railcars fueled by hydrogen.</li> <li>In terms of ships, promote the technical development, demonstration, and introduction promotion of ships utilizing innovative energy-saving technologies, digital technologies, etc., including LNG-fueled ships, hydrogen fuel cell ships, and EV ships.</li> <li>In aviation, promote the introduction of sustainable aviation fuel (SAF).</li> </ul>
	Promote the formation of carbon neutral ports (CNPs)	<ul style="list-style-type: none"> <li>Promote the formation of carbon neutral ports, including the introduction of power supply to ships at anchor to stop idling ships and the introduction of stand-alone hydrogen and other power sources.</li> </ul>
Consumer	Life	<ul style="list-style-type: none"> <li>Promote the use of ICT in homes and buildings and the spread of ZEH/ZEB, etc.</li> </ul>
	Community	<ul style="list-style-type: none"> <li>Promote the creation of an independent and decentralized society through smart mobility and decentralized grids, CN town planning in urban areas, and CN farming, forestry and fishing villages through energy-saving equipment and ICT.</li> </ul>

		<ul style="list-style-type: none"> <li>Reduce energy demand through optimization of production volume and timing, etc. using AI. Reduce food waste throughout the supply chain and promote 3R initiatives.</li> </ul>
Sink	Forest	<ul style="list-style-type: none"> <li>Secure and enhance forest absorption through appropriate thinning of planted forests, etc.</li> </ul>
	Agricultural land	<ul style="list-style-type: none"> <li>Promote carbon sequestration in agricultural soil through the development of new biochar and other resources.</li> </ul>
	City	<ul style="list-style-type: none"> <li>Comprehensive promotion of urban greening, including rooftop and wall greening of public and private facilities, through public-private partnerships.</li> </ul>
	Nature	<ul style="list-style-type: none"> <li>Enhance the ability of healthy ecosystems to absorb CO<sub>2</sub> by promoting the conservation and regeneration of forests, grasslands, peat bogs and other wetlands, soils, coastal areas and other ecosystems.</li> </ul>
	Direct CO <sub>2</sub> capture from the atmosphere	<ul style="list-style-type: none"> <li>The project aims to develop technologies for highly efficient CO<sub>2</sub> capture from the atmosphere, to achieve cost reduction, and to put them into practical use by 2050.</li> </ul>

### 3.2.3 United States

In the United States, "The Long-term Strategy of the United States Pathways to Net-Zero Greenhouse Gas Emissions by 2050"<sup>15</sup> was published by the Executive Office of the President in November 2021. This strategy is based on the Net Zero Greenhouse Gas Emissions by 2050. This strategy aims to achieve Net Zero emissions by 2050, with a target of 26-28% reduction in 2025 and 50-52% reduction in 2030 compared to GHG emissions in 2005.

<sup>15</sup> THE LONG-TERM STRATEGY OF THE UNITED STATES Pathways to Net-Zero Greenhouse Gas Emissions by 2050 (The United States Department of State & the United States Executive Office of the President, 2021) <https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf> Accessed July 6, 2022

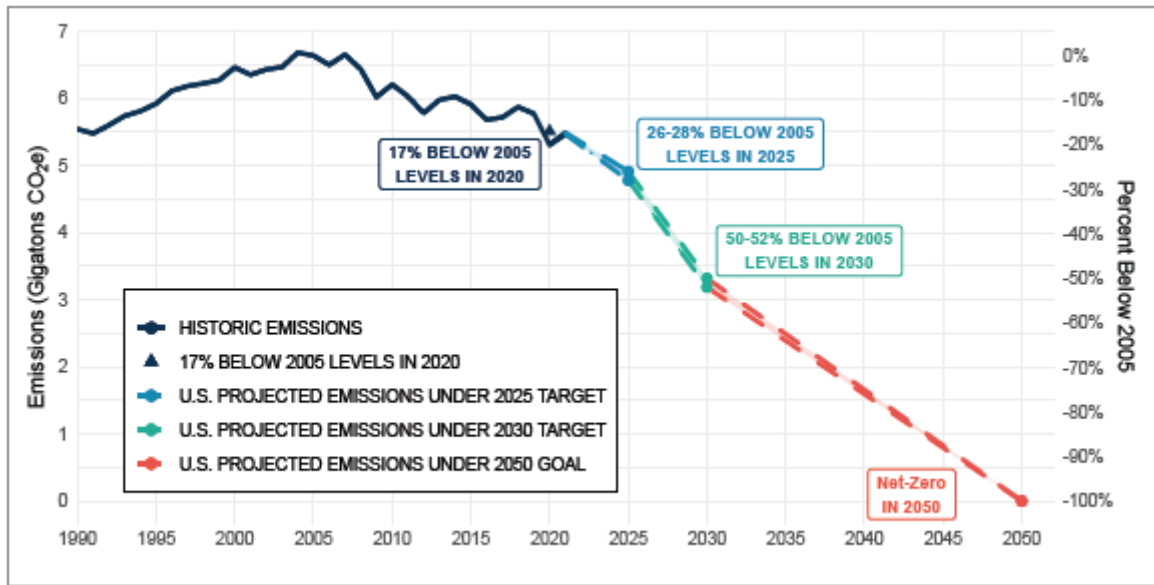


Figure 3-6 United States Historic Emissions and Projected Emissions Under the 2050 Goal for Net-Zero <sup>16</sup>

The strategy pays particular attention to the electricity sector, with a target of 100% zero carbon emissions electricity supply by 2035. A key element of all net zero scenarios is the rapid decarbonization of electricity and the expansion of the use of this decarbonized electricity to as many applications as possible. This section presents measures, initiatives and action plans to achieve the goals of the strategy.

<sup>16</sup> Same as footnote15.

Table 3-5 Examples of Action Plans in the 2050 Net Zero Long-Term Strategy

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>• Supply 100% zero carbon emission electricity by 2035.</li> <li>• Develop incentives and standards to reduce GHG emissions from power plants; invest in technologies that increase the flexibility of the electricity system, including transmission, energy efficiency, energy storage, smart buildings, and green fuels; and leverage carbon capture and storage (CCS) and nuclear power.</li> <li>• Facilitate the transition to an affordable electricity system with no carbon emissions through research, development, demonstration, and deployment.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• The transportation sector is the largest source of GHG emissions in the United States, so promote electric vehicles and transition to low-carbon or carbon-free biofuels and hydrogen for applications such as long-haul and air transportation.</li> <li>• Half of all light-duty vehicles sold in 2030 will be zero-emission vehicles, and 3 billion gallons of Sustainable Aviation Fuel will be produced by 2030.</li> </ul>
Building	<ul style="list-style-type: none"> <li>• Improve energy efficiency and increase the sales share of clean and efficient electric appliances such as heat pumps for air conditioning, heat pump water heaters, induction stoves, and electric clothes dryers.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>• Promote energy efficiency improvements, industrial electrification, use of low carbon fuels and industrial CCS.</li> <li>• Low- and medium-temperature process heat facilitates the use of industrial heat pumps, electric boilers, or electromagnetic heating processes.</li> <li>• Technology development and process innovation to address emissions from the industrial sector, including hot heat and process emissions from steel, petrochemical and cement production.</li> <li>• To address methane emissions, set strict standards for oil and gas production and prevent leaks from coal, oil and gas mines and wells.</li> </ul>
Agriculture, Forestry and Land Use	<ul style="list-style-type: none"> <li>• Promote continuous expansion of forest area, extension of crop rotation periods, protection of forest area, expansion of climate-friendly agricultural practices, and rotational grazing on agricultural lands.</li> <li>• Reduce methane and N<sub>2</sub>O emissions through improved livestock manure management and improved farmland nutrient management.</li> <li>• Increase investment in forest protection and management to reduce the extent and intensity of wildfires and work to restore fire-damaged forest lands.</li> </ul>

### 3.2.4 United Kingdom

In the UK, the government has set out a "Net Zero Strategy: Build Back Greener"<sup>17</sup> for 2021. This strategy aims to achieve carbon neutrality by 2050, with targets to reduce GHG emissions by 55% by 2025, 68% by 2030 and 78% by 2035 compared to 1990 levels.

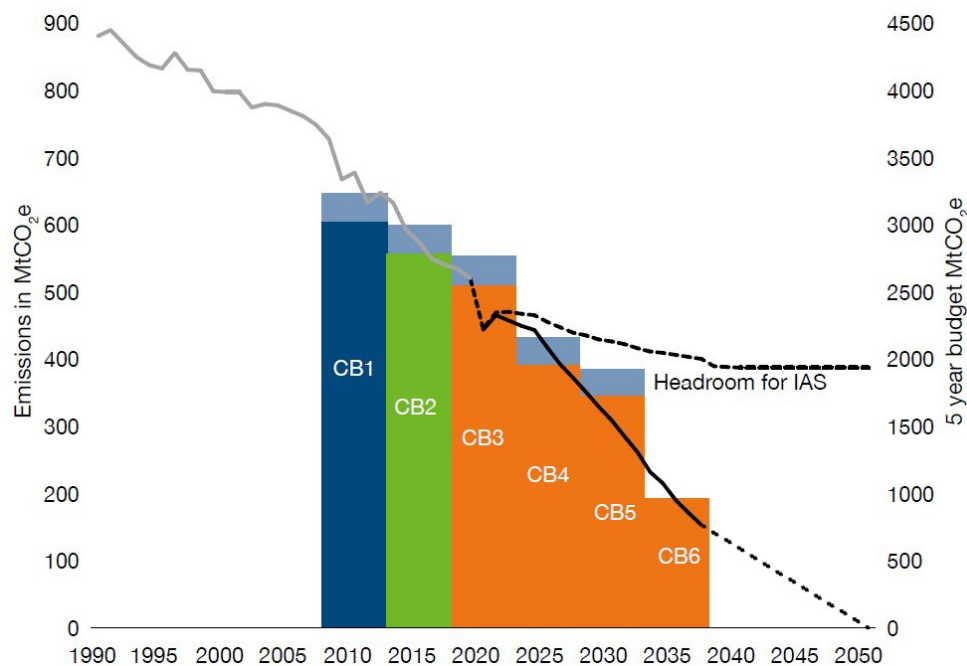


Figure 3-7 Indicative Emissions Reductions to Meet UK Carbon Budgets and NDC<sup>18</sup>

The strategy aims to reduce GHG emissions in the power sector by 80-85% from 1990 levels by 2035, and in the fuel switching sector by 53-60% from 1990 levels by 2035 through the replacement of oil and gas with electricity. In the industrial sector, the project aims to reduce GHG emissions by 63-76% from 1990 levels by 2035 through energy conservation, fuel switching, and the use of CCUS. In the heat and building sectors, the goal is to reduce GHG emissions by 47-62% from 1990 levels by 2035 through the use of low-carbon heating systems and more efficient energy use. In the transportation sector, the government aims to reduce GHG emissions by 47-59% by 2035 through measures such as expanding the use of zero-emission vehicles (ZEVs) and stopping the sale of new gasoline and diesel vehicles. In the area of natural resources, the strategy aims to reduce GHG emissions by 39-51% by 2035 through afforestation and other measures. The measures, efforts, and action plans to achieve the targets of the Strategy are shown below.

<sup>17</sup> Net Zero Strategy: Build Back Greener (UK Government, 2021) <https://unfccc.int/sites/default/files/resource/UK%20Net%20Zero%20Strategy%20-%20Build%20Back%20Greener.pdf> Accessed 6 July 2022

<sup>18</sup> Same as footnote 17.



Table 3-6 Examples of Action Plans in the Net Zero Strategy in UK

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>• Fully decarbonize energy by 2035.</li> <li>• Launch of the Nuclear Power Realization Fund.</li> <li>• Develop 40 GW of offshore wind and other renewable energy by 2030; promote 1 GW of floating offshore wind power generation by 2030.</li> <li>• Establish Industrial Decarbonization and Hydrogen Revenue Support. It will also secure 250MW of hydrogen production capacity.</li> <li>• Introduce new climate compatibility checkpoints for licensing in the oil and gas sector and regulate the oil and gas sector to curb GHGs.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>• Contribute £315 million through the Industrial Energy Transition Fund to create jobs through this.</li> <li>• Grow new industries such as CCUS and hydrogen.</li> </ul>
Building	<ul style="list-style-type: none"> <li>• End the sale of new gas boilers by 2035. Provide subsidies for low carbon heating systems to bring their cost burden in line with that of current gas boilers.</li> <li>• Funding for pioneering heat pump technology, with a target of 600,000 installations per year by 2028.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• Promote subsidies for zero-emission vehicles and EV infrastructure development.</li> <li>• Sales of new gasoline and diesel vehicles will end by 2030.</li> <li>• Introduce 4,000 zero-emission buses, and phase out diesel locomotives by 2050.</li> <li>• Support the development of SAF plants with the goal of providing 10% SAF by 2030.</li> </ul>
Natural resources	<ul style="list-style-type: none"> <li>• Restore peat and enhance forestation and management.</li> </ul>
GHG removal	<ul style="list-style-type: none"> <li>• Increased investment in GHG removal technologies will facilitate private sector investment and transfer from engineering technology in the UK oil and gas sector.</li> </ul>
Other	<ul style="list-style-type: none"> <li>• Supporting over £40 billion of investment through the UK Infrastructure Bank to mature and scale up the low carbon technology sector.</li> <li>• Develop a Net Zero Research &amp; Innovation Framework to present key research and innovation issues for the next 5-10 years.</li> </ul>

### 3.2.5 Germany

In Germany, the "Climate Action Plan 2050" <sup>19</sup> was presented in 2016 by the then Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety). This strategy aims to achieve net zero emissions in 2050 with a target of 55% reduction by 2030, based on the EU target of 80-95% reduction in GHG emissions by 2050 compared to 1990 levels. No specific sector-by-sector description for 2050 was found.

The strategy includes the following reduction targets for each sector:

- energy sector from 358 MtCO<sub>2</sub>e to 175-183 MtCO<sub>2</sub>e (61-62% reduction),
- building sector from 119 MtCO<sub>2</sub>e to 70-72 MtCO<sub>2</sub>e (66-67% reduction)
- transportation sector from 160 MtCO<sub>2</sub>e to 95-98 MtCO<sub>2</sub>e (40-42% reduction),
- industrial sector from 181 MtCO<sub>2</sub>e to 40-143 MtCO<sub>2</sub>e (49-51% reduction),
- agriculture sector from 72 MtCO<sub>2</sub>e to 58-61 MtCO<sub>2</sub>e (31-34% reduction),
- in other areas the figure was reduced from 12 MtCO<sub>2</sub>e to 5 MtCO<sub>2</sub>e (87% reduction).

Measures, initiatives, and action plans to achieve the targets of the strategy are presented as follows.

Table 3-7 Examples of Action Plans in the German Net Zero Strategy

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>• Expand renewable energy in line with The 2017 Renewable Energy Sources Act.</li> <li>• Increasing interactions between energy and other sectors (sectoral coupling) to allow flexibility in dealing with the instability of solar and wind power.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>• Lengthen the consumption cycle of products by extending their useful life.</li> <li>• Innovative research and development in the field of CO<sub>2</sub> utilization (CCU) by the Federal Ministry of Education and Research (BMBF).</li> <li>• Develop a circular economy.</li> </ul>
Building	<ul style="list-style-type: none"> <li>• The zero-energy building standard will be in operation from 2021 to promote energy conservation and the use of renewable energy in new buildings.</li> <li>• Provide incentives to install new heating systems.</li> <li>• Sector coupling will link up with the transport and industrial sectors. For example, electricity from buildings will be used to charge electric vehicles, and waste heat from the industrial sector will be used to heat buildings.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• Regularly review funding measures for electric mobility.</li> </ul>

<sup>19</sup> Climate Action Plan 2050 (then Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 2016) <https://www.bmuv.de/en/publication/climate-action-plan-2050-en> Accessed 3 August 2020

	<ul style="list-style-type: none"> <li>• Enhance rail transport by coordinating connections between mainline and regional rail passenger transport.</li> <li>• Continue to update the National Rideway Plan (NRVP) after 2020, and continue to build bikeways.</li> <li>• Promote the electrification of power sources and the use of biofuels in air and sea transport.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Further reduction of nitrogen fertilizers to achieve the German Sustainable Development Strategy target of 70 kg N/ha between 2028 and 2032.</li> <li>• Promote the expansion of organic farming acreage.</li> <li>• As a significant proportion of greenhouse gas emissions from agriculture come from animal-based food production, research efforts will be undertaken to develop more climate-smart livestock production in areas such as feed, breeding and farm management.</li> </ul>
Land Use and Forests	<ul style="list-style-type: none"> <li>• Promote forest conservation and sustainable management at home and abroad, including negotiating bilateral agreements by 2040 to import timber only from forests managed in a legal and sustainable manner.</li> <li>• Increase the rigor of land acquisition and reduce the increase in land development for settlement and transport infrastructure (land acquisition) to 30 hectares per day in accordance with the Sustainable Development Strategy.</li> </ul>
Other	<ul style="list-style-type: none"> <li>• Work to end subsidies that harm the environment and expand climate-friendly investments and markets.</li> </ul>

### 3.2.6 France

In France, the "National low carbon strategy" <sup>20</sup> was presented by the Ministère de la Transition écologique et solidaire (Ministry of the Environment and Solidarity) in 2020. This strategy sets a target of 40% reduction in GHG emissions in 2030 and 11.5MtCO<sub>2</sub>e reduction every year after 2031, compared to 1990 GHG emissions, and aims to achieve net zero emissions by 2050 by reducing national GHG emissions to 80MtCO<sub>2</sub>e and absorbing the same amount of GHGs.

<sup>20</sup> National low carbon strategy (Ministry of Environment, Solidarity and Transition, 2020)  
[https://unfccc.int/sites/default/files/resource/en\\_SNBC-2\\_complete.pdf](https://unfccc.int/sites/default/files/resource/en_SNBC-2_complete.pdf)  
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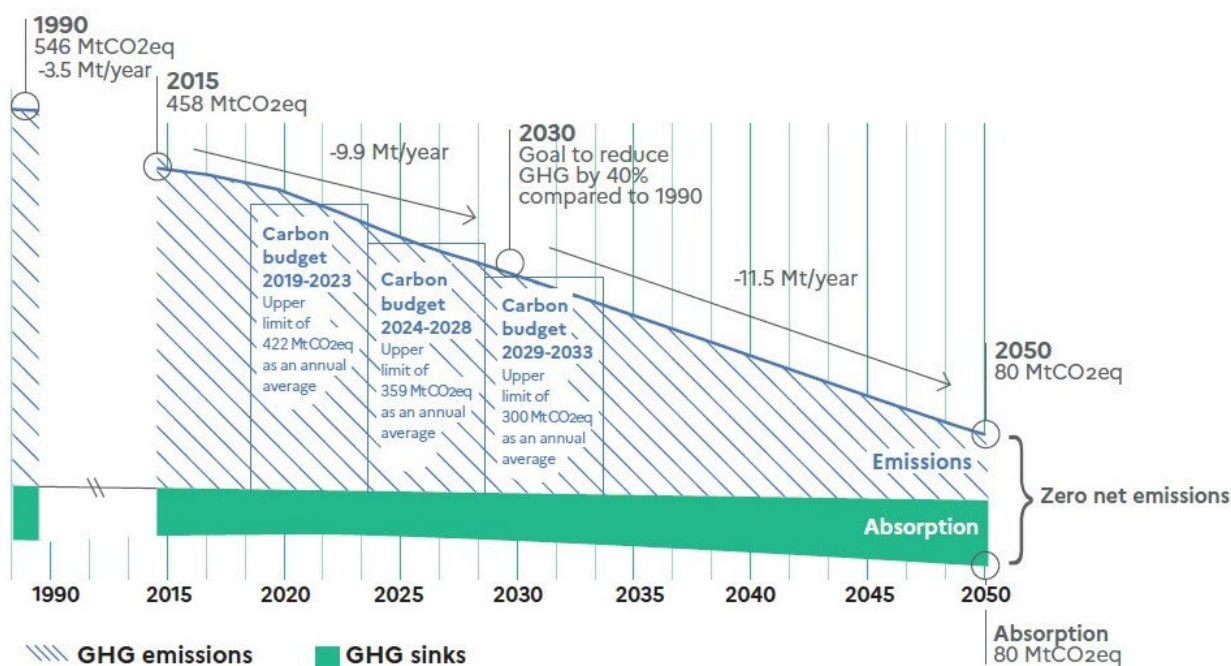


Figure 3-8 Evolution of GHG Emissions and Sinks on French Territory between 1990 and 2050 <sup>21</sup>

The strategy aims to fully decarbonize energy production by 2050 and to use biomass, geothermal, heat pumps and other renewable energy sources as energy sources. It also aims to significantly reduce energy consumption in all sectors by significantly improving energy efficiency and promoting electricity conservation through lifestyle changes. In terms of GHGs from non-energy sources, the target is to reduce GHG emissions from the agricultural sector by 38% from 2015 levels by 2050, and by 60% in the industrial sector. On the other hand, regarding GHG sinks, the strategy aims to double the carbon sinks by 2050 compared to the time when the strategy was formulated. The measures, efforts, and action plans to achieve the targets of the Strategy are shown below.

Table 3-8 Examples of Action Plans in France's Net Zero Strategy

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>Managing energy demand through energy efficiency and conservation.</li> <li>Decarbonize and diversify the energy mix through the promotion of renewable energy and the phase-out of coal use in power generation and heat production (from 2022).</li> </ul>
Industry	<ul style="list-style-type: none"> <li>Support the transition to low-carbon production systems (e.g., development of decarbonization roadmaps, financing instruments).</li> <li>Strengthen research and development of low-carbon manufacturing</li> </ul>

<sup>21</sup> National low carbon strategy (Ministry of Environment, Solidarity and Transition, 2020) [https://unfccc.int/sites/default/files/resource/en\\_SNBC-2\\_summary\\_4-pages.pdf](https://unfccc.int/sites/default/files/resource/en_SNBC-2_summary_4-pages.pdf) Accessed July 6, 2022

	<p>processes.</p> <ul style="list-style-type: none"> <li>• Significantly improve energy efficiency and the use of carbon-free energy sources.</li> <li>• Develop a circular economy.</li> </ul>
Building	<ul style="list-style-type: none"> <li>• Use the best carbon-free energy source for the type of building.</li> <li>• The introduction of new environmental regulations for new buildings and renovations in 2020 on the energy efficiency of buildings, with the goal of implementing 500,000 renovations per year.</li> <li>• More moderate energy consumption behavior of people.</li> <li>• Promote products and equipment for construction and renovation that have a low carbon footprint (circular economy or bio) and high energy and environmental performance throughout their life cycle.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• Improve the energy performance of light-duty and heavy-duty vehicles to achieve the target of 25 km/liter of fuel efficiency for internal combustion engine vehicles for private use by 2030.</li> <li>• Decarbonize the energy consumed by cars, develop infrastructure, and increase the number of new passenger cars sold that run on electricity or hydrogen to 35% by 2030 and 100% by 2040.</li> <li>• Promote telecommuting, car sharing, short-distance travel, and optimizing car use to curb the growth in transportation demand.</li> <li>• Encourage a shift to passenger and freight transport modes (public transport, rail) with lower GHG emissions and support the use of bicycles and other means of transport.</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Prevent waste generation from the product design stage.</li> <li>• Promote circular economy, product reuse and repair on the consumer side.</li> <li>• Improve waste collection and management and facilitate recovery.</li> <li>• Improve the efficiency of wastewater and organic and non-hazardous waste treatment systems.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Develop agroecology, agroforestry and precision agriculture, especially for minimizing nitrogen fertilizer surpluses.</li> <li>• Develop a bioeconomy to provide energy and materials with low GHG emissions.</li> <li>• Reduce food waste by directing demand towards quality and organic foods.</li> </ul>
Forest	<ul style="list-style-type: none"> <li>• Increase carbon sequestration in agricultural soils by changing agricultural practices.</li> <li>• Promote sustainable forest management that enables the conservation</li> </ul>

	<p>of carbon stocks in forest ecosystems.</p> <ul style="list-style-type: none"> <li>• Expand afforestation and reduce deforestation through land clearing.</li> <li>• Maximize carbon sequestration in wood products and use wood products in long-life applications such as construction.</li> <li>• Reduce artificial cover of soil (soil artificialization).</li> </ul>
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### 3.2.7 China

"China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy" in 2021"<sup>22</sup> was presented by the Chinese government in 2021. This strategy is based on the Chinese government's stated goal in 2020 to peak out CO<sub>2</sub> emissions by 2030 and strive to achieve carbon neutrality by 2060, and to reduce CO<sub>2</sub> per GDP by at least 65% from 2005 levels by 2030. It also indicates that by 2030, China will increase the share of non-fossil fuels in primary energy consumption to about 25%, increase forest cover by 6 billion m<sup>3</sup> from 2005 levels, and increase the combined installed capacity of wind and solar power generation to at least 1.2 billion kW.

The measures, initiatives and action plans in the ten areas addressed in the Strategy are shown below.

Table 3-9 Examples of Action Plans in China's Low Carbon Growth Strategy

Sector	Outline
Fostering a green, low-carbon, circular economic system	<ul style="list-style-type: none"> <li>• The economic structure will be adjusted, to change the development mode, promote the development of new low-carbon technologies, new products, new industries, new models, new business forms and the creation of a new economy, foster a green, low-carbon and circular economic system, and strive to continuously improve the quality and efficiency of development.</li> </ul>
Building a clean, low-carbon, safe and efficient energy system	<ul style="list-style-type: none"> <li>• To promote the energy production and consumption revolution, improve energy use efficiency, accelerate the transformation of the energy structure towards a clean and low-carbon direction, ensure energy security of supply, and meet the domestic demand for the sustainable development of the national economy and the continuous improvement of people's living standards.</li> </ul>
Building an industrial system with low greenhouse gas	<ul style="list-style-type: none"> <li>• Focusing on improving the efficiency of resource and energy use and the level of green production, promoting energy conservation, clean production and green technology innovation, adjusting the energy structure and form of industry, deepening the</li> </ul>

<sup>22</sup> China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy (Government of China, 2021) <https://unfccc.int/documents/307765> Accessed August 3, 2022

emissions	implementation of green manufacturing projects, building a comprehensive green manufacturing system and promoting the green and low-carbon development of key industries.
Promotion of green and low-carbon buildings in urban and rural areas	<ul style="list-style-type: none"> <li>Accelerate the establishment of a green and low-carbon innovation system in the building sector. Optimize the energy structure of end-uses, curb the total energy consumption of the building sector and improve the energy efficiency of buildings at the same time, while meeting the growing energy demand of the building sector in line with economic development.</li> </ul>
Establishment of a low-carbon integrated transportation system	<ul style="list-style-type: none"> <li>Focusing on the optimization of supply and demand, accelerate the construction of a green and low-carbon comprehensive transportation system by demonstrating the comparative advantages and efficiency of various means of transportation.</li> </ul>
Achieve significant reductions in greenhouse gas emissions other than carbon dioxide	<ul style="list-style-type: none"> <li>Coordinate the management and control of GHG emissions other than CO<sub>2</sub> in sectors such as energy, industrial production processes, agriculture, and waste management; strengthen the coordinated management of GHG emissions and air pollutant emissions; subject GHG emissions other than CO<sub>2</sub> to stepwise quantitative management and control; and establish a statistical system.</li> </ul>
Implementing nature-based solutions	<ul style="list-style-type: none"> <li>Adhere to the harmonious coexistence of humans and nature, strive to harness the potential of "nature-based solutions" in reducing GHG emissions and increasing carbon sinks, and enhance the resilience of terrestrial and marine ecosystems to climate change.</li> </ul>
Inspiring low emission innovation	<ul style="list-style-type: none"> <li>To strengthen research and development and international cooperation, and accelerate technological innovation. Develop and promote sustainable energy consumption technologies, including energy conservation and energy efficiency.</li> </ul>
Creating new patterns of national participation	<ul style="list-style-type: none"> <li>Position the development of green and low-carbon lifestyles as a key indicator for raising the standard of social civilization.</li> </ul>
Promote modernization of climate governance systems and governance capacity	<ul style="list-style-type: none"> <li>Promote institutional transformation and accelerate the establishment of a climate governance system. Strive to establish and build legal, policy, market and support systems for climate governance. At the same time, promote the establishment of science-based mechanisms to reduce GHG emissions from international shipping and international aviation.</li> </ul>

### 3.2.8 (South) Korea

In Korea, "2050 Carbon Neutral Strategy of The Republic of Korea"<sup>23</sup> is presented by the Korean government in 2020. In this strategy, the target for 2030 is based on the NDC, which is to reduce GHG by 24.4% by 2030 compared to 2017, and the goal is to achieve carbon neutrality by 2050. In the energy sector, the strategy calls for reducing coal-fired power generation and promoting renewable energy, with plans to cover 20% of total electricity supply by 2030 and 30-35% by 2040 from renewable energy.

The Strategy also includes the reduction of fossil fuel use, especially in the power generation sector, the promotion of energy saving in industry, buildings and transport, the promotion of digital transformation, hydrogen production/supply/utilization, and the introduction of CCUS as steps towards achieving carbon neutrality. The measures, initiatives and action plans to achieve the goals of the Strategy are presented as follows.

Table 3-10 Examples of Action Plans in Korea's Carbon Neutral Strategy

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>Promote expansion of renewable energy, development of electricity supply-demand forecasting systems, support for the introduction of energy storage systems and hydrogen fuel cells for auxiliary power sources, and the phasing out of coal-fired power generation.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>Promote the transition to low-carbon processes in the steel and cement industries, etc.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>Promote the use of public transport, expand shared mobility, build traffic demand management and advanced road transport systems, encourage the commercial use of automated vehicles to reduce energy consumption, and promote a modal shift from road to rail.</li> </ul>
Building	<ul style="list-style-type: none"> <li>Promote all public buildings constructed after 2020 to be zero-energy buildings, subsidize renovation to clean homes, etc.</li> </ul>
Waste	<ul style="list-style-type: none"> <li>Promote recycling throughout the lifecycle and phase-out of plastics, etc.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>Smart Farming using ICT to promote reduction of energy, fertilizer, and water consumption, etc.</li> </ul>
Carbon sink	<ul style="list-style-type: none"> <li>Promote the improvement of aging forests and afforestation on underutilized land.</li> </ul>

<sup>23</sup> 2050 Carbon Neutral Strategy of The Republic of Korea (Government of Korea, 2020) <https://unfccc.int/documents/267683> accessed 3 August 2022



### 3.2.9 Singapore

In Singapore, "Charting Singapore's Low-Carbon and Climate Resilient Future" <sup>24</sup> was presented by the Prime Minister's Office in 2020. The Strategy sets a target of peaking out at 65 MtCO<sub>2</sub>e around 2030, reaching 33 MtCO<sub>2</sub>e by 2050 and net zero by the late 2050s. The strategy lays out six main sectors for mitigation, based on the pillars of transforming industry, economy and society, strengthening adaptation measures, and promoting international cooperation. The following section presents measures, initiatives and action plans to achieve the goals of the Strategy.

Table 3-11 Examples of Action Plans in Singapore's Carbon Neutral Strategy

Sector	Outline
Energy (Electricity)	<ul style="list-style-type: none"> <li>Utilize natural gas, solar, local power grids, and non-carbon-emitting alternative energy sources.</li> <li>Expand the introduction of solar power generation, including floating, offshore, and building-integrated solar power generation methods. The target for PV deployment is 2 GWp by 2030. Work on energy storage systems and solar power forecasting to resolve the intermittent nature of solar power generation.</li> <li>Research will be conducted into low and zero-carbon alternative energy sources, including the use of regional power grids and the production and supply of hydrogen from solar power generation.</li> </ul>
Industry	<ul style="list-style-type: none"> <li>Reduce GHG emissions by decarbonizing electricity. Work with industry to ensure that industry is world class in energy and carbon efficiency.</li> <li>Strengthen grant schemes to help businesses improve energy efficiency and achieve sector-wide efficiency gains.</li> <li>Research and development of new technologies such as CCUS and hydrogen that promote the decarbonization of industrial processes.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>Capping the increase in private cars and motorcycles to zero from 2018 onwards. Major investment in public transport infrastructure, with the aim of completing the majority of peak journeys by walking, cycling or electric scooters by 2040.</li> <li>Eliminate internal combustion engine vehicles by 2040.</li> <li>All new public buses to be purchased shall be electric or hybrid vehicles.</li> <li>Provide rebates on new EV purchases for three years beginning in January 2021 to encourage the adoption of cleaner vehicles.</li> </ul>

<sup>24</sup> Charting Singapore's Low-Carbon and Climate Resilient Future (Prime Minister's Office, 2020) <https://unfccc.int/documents/212914> accessed 3 August 2022

	<p>Significantly expand public EV charging infrastructure.</p> <ul style="list-style-type: none"> <li>• Tuas Port, to be completed in the 2040s, will consolidate Singapore's container operations and implement more efficient cargo handling and transportation. Changi Airport will continue its efforts to improve energy efficiency and electrification, and the new Terminal 5 will be designed and built according to strict energy efficiency standards.</li> </ul>
Building	<ul style="list-style-type: none"> <li>• The goal is to green 80% of buildings on a gross floor area basis by 2030; as of March 2020, more than 40% of buildings have been greened.</li> <li>• Increase minimum energy performance standards for all new and existing buildings undergoing major retrofits to support energy efficient building efforts. Publish building energy performance data annually to encourage retrofits to improve building energy efficiency.</li> </ul>
Civil (Home)	<ul style="list-style-type: none"> <li>• Minimum Energy Performance Standards and Mandatory Energy Labelling Scheme for common household appliances have been introduced to reduce energy consumption in the household sector. These standards will be reviewed periodically to promote the adoption of more energy efficient appliances. In addition, a campaign will be launched to encourage the switch to energy efficient appliances and to raise public awareness of energy efficiency and conservation.</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Launch of the Zero Waste Master Plan, developed in 2019 to promote a circular economy in which waste is a resource. Resource Sustainability Act Goals: 30% reduction in the amount of daily waste sent to landfill by 2030.</li> </ul>

### 3.2.10 Thailand

In Thailand, "Mid-century, Long-term Low Greenhouse Gas Emission Development Strategy"<sup>25</sup> was presented by the Thai government in 2021. This strategy sets a scenario to peak out at 370 MtCO<sub>2</sub>e in 2030 and to achieve net zero in 2090, and also sets a target to achieve net zero CO<sub>2</sub> in 2065.

<sup>25</sup> Mid-century, Long-term Low Greenhouse Gas Emission Development Strategy (Government of Thailand, 2021) <https://unfccc.int/documents/307950> Accessed August 3, 2020

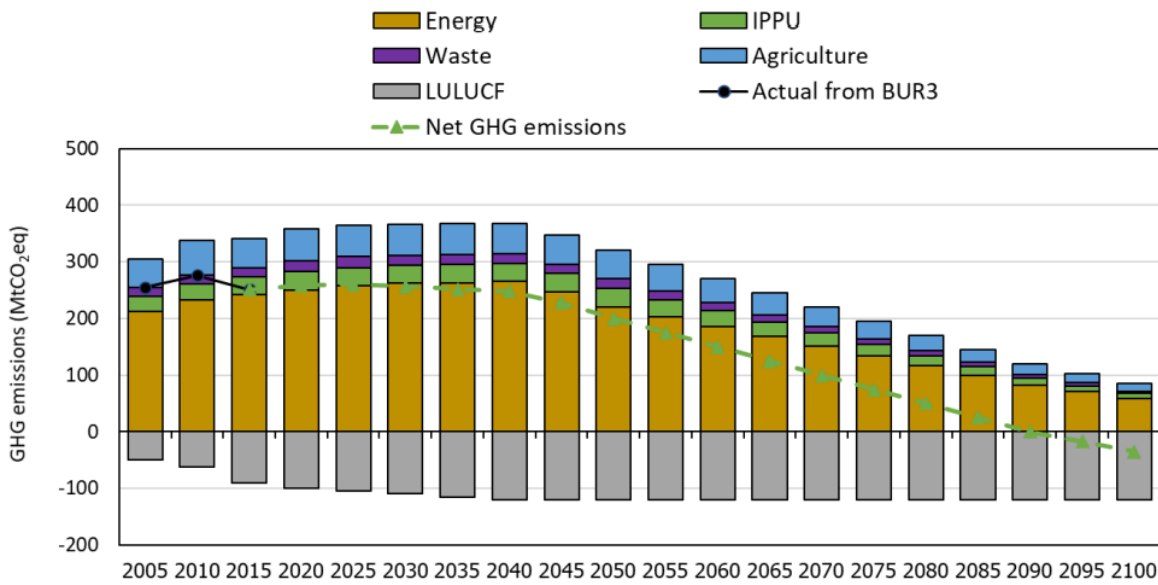


Figure 3-9 Thailand's GHG emissions and sequestration pathway to 2100 <sup>26</sup>

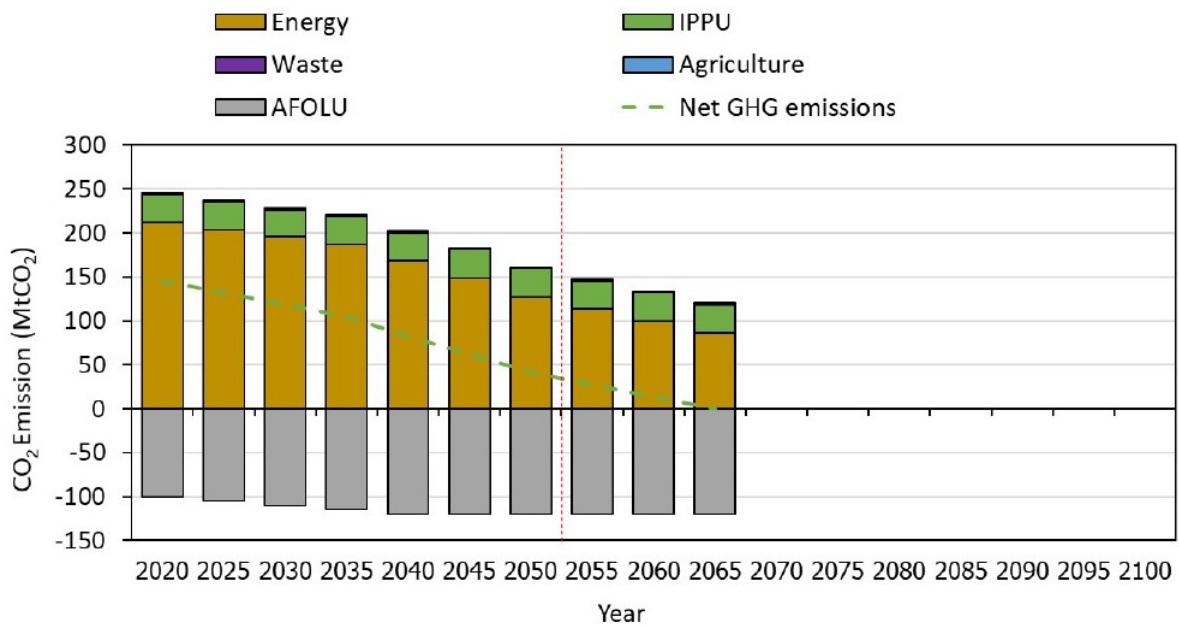


Figure 3-10 Thailand's CO<sub>2</sub> emissions and sequestration pathway to achieve net zero by 2065 <sup>27</sup>

The measures, initiatives, and action plans to achieve the goals of the Strategy are presented as follows.

<sup>26</sup> Same as footnote25

<sup>27</sup> Same as footnote25

Table 3-12 Examples of Action Plans in Thailand's Low Carbon Growth Strategy

sector	outline
Energy (power generation)	<ul style="list-style-type: none"> <li>• The introduction of natural gas-fired and coal-fired power plants with CCS will increase energy efficiency to 43% in 2050 compared to current technology.</li> <li>• Increase the share of renewable energy in electricity generation to 33% by 2050; consider biomass power plants with CCS.</li> </ul>
Industry (including industrial processes)	<ul style="list-style-type: none"> <li>• Increase the energy efficiency of electrical equipment up to 77%.</li> <li>• Heating systems will increase the share of renewable energy to about 46% of final energy consumption in 2030 and 50% in 2050.</li> <li>• The introduction of CCS in the industrial sector will play an important role in the chemical and non-metallic industries, with an estimated 18 MtCO<sub>2</sub>e of CO<sub>2</sub> to be captured in 2050.</li> <li>• Industrial process changes, including clinker replacement and refrigerant substitution, and increased biogas production from industrial wastewater through methane recycling.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• The goal is to improve energy efficiency by changing behavior, improving road surfaces, and improving engine performance.</li> <li>• Improve energy efficient vehicles in the transport sector to 68% of final energy consumption by 2050.</li> <li>• Increase the share of biofuels from 8% in 2030 to 34% of final energy consumption in 2050.</li> </ul>
Building (commercial building)	<ul style="list-style-type: none"> <li>• By 2050, energy efficiency of energy equipment in commercial buildings will be increased to 33% of final energy consumption.</li> <li>• Solar water heaters will be widely used in hotels, condominiums, hospitals, etc., and increase to 5% of final energy consumption in 2050.</li> </ul>
Consumer	<ul style="list-style-type: none"> <li>• Improve energy efficiency of household appliances to 29% of final energy consumption by 2050.</li> <li>• Increase the share of renewable energy use in households to 49% of final energy consumption by 2050.</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Promote waste reduction, landfill gas, WtE, semi-aerobic landfill, composting, anaerobic digestion and mechanical biological treatment.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Promote measures with mitigation effects in livestock enteric fermentation measures and manure management, which are part of the adaptation measures. Likewise, promote adaptation measures with mitigation effects in rice cultivation and agricultural soil management.</li> </ul>
Land Use,	<ul style="list-style-type: none"> <li>• Increase carbon sequestration by increasing and conserving the area</li> </ul>

Land Use Change and Forests	of primary and regenerating natural forests, increasing the area of economic forests, increasing and conserving the area of agricultural land, and reducing biomass burning.
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### 3.2.11 Cambodia

In Cambodia, the "Long-term Strategy for Carbon Neutrality (LTS4CN)"<sup>28</sup> was developed by the Ministry of Environment in 2021 with the support of international organizations such as UNEP. The CN scenario to 2050 assumes that CN will be achieved by the absorption of 50MtCO<sub>2</sub>e by the agriculture, forestry and other land use (FOLU) sector. In 2050, the energy sector will be the largest GHG emitter with 28 MtCO<sub>2</sub>e, followed by the agriculture sector with 19 MtCO<sub>2</sub>e. The waste sector and IPPU (industrial processes and product use) sectors are projected at 1.6 MtCO<sub>2</sub>e and 1.2 MtCO<sub>2</sub>e, respectively.

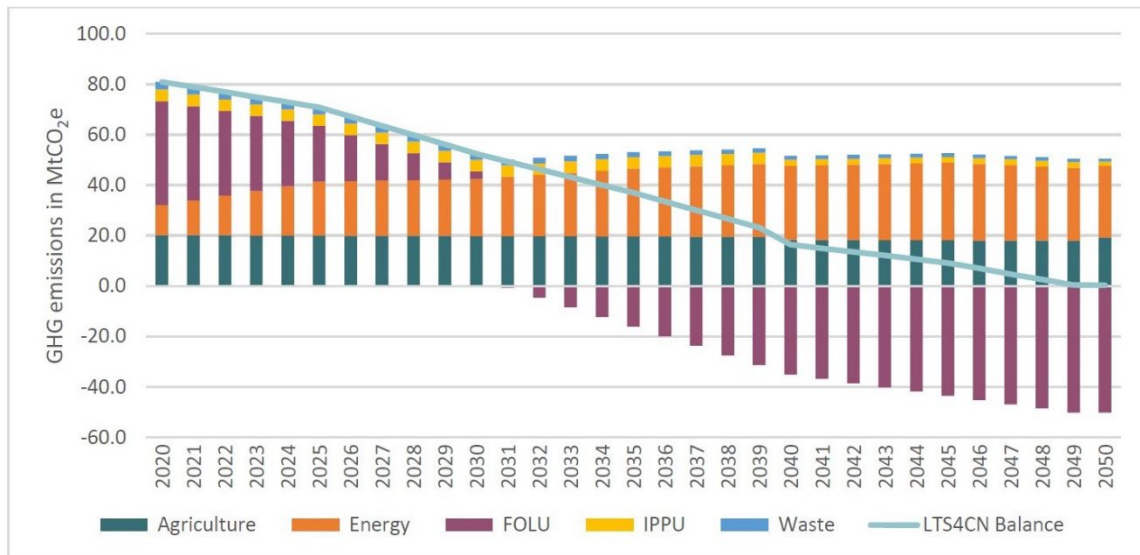


Figure 3-11 Sectoral GHG emission projections for Cambodia under the LTS4CN scenario<sup>29</sup>

The measures, initiatives and action plans to achieve the goals of the strategy are shown as follows.

Table 3-13 Example of Action Plan in LTS4CN in Cambodia

Sector	Outline
Energy	<ul style="list-style-type: none"> <li>Stop the development of new coal-fired power generation except for projects already underway.</li> </ul>

<sup>28</sup> Long-term Strategy for Carbon Neutrality (LTS4CN) (Ministry of Environment et al, 2021) <https://ncsd.moe.gov.kh/resources/document/cambodia-LTS4CN-En> accessed 6 July 2022

<sup>29</sup> Same as footnote 28

	<ul style="list-style-type: none"> <li>• Use natural gas for ET.</li> <li>• Promote investment in liquefied natural gas imports, storage and infrastructure.</li> <li>• Increase renewable energy to 35% of the installed power generation mix by 2050, of which 12% will be solar power.</li> <li>• Invest in power grid modernization, increased flexibility, and energy storage facilities.</li> <li>• Promote energy efficiency measures in buildings and industry.</li> <li>• Promote the switch to electricity for cooking fuel.</li> <li>• Promote the use of alternative energy sources to coal in the industrial sector.</li> </ul>
Industrial Processes and Product Use (IPPU)	<ul style="list-style-type: none"> <li>• Facilitate clinker substitution in cement production.</li> <li>• Promote CCS in cement kilns.</li> <li>• Promote recycled aggregate concrete.</li> <li>• Promote the use of refrigerants with low global warming potential.</li> <li>• Promote periodic inspections of refrigeration and air conditioning equipment and recovery of used refrigerant.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• 30% modal share of public transport in urban areas by 2050.</li> <li>• By 2050, 70% of motorcycles and 40% of cars and urban buses will be electric vehicles.</li> <li>• By 2050, 80% of interregional buses and 80% of trucks will be CNG-fueled vehicles.</li> <li>• Improve fuel efficiency of internal combustion engine vehicles.</li> <li>• Promote the use of railways.</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Increase garbage collection rate to 85% by 2050 and reduce wildland fires.</li> <li>• Implement the 3R (reduce, reuse, recycle) strategy.</li> <li>• Promote proper management of landfill gas.</li> <li>• Promote composting of organic waste.</li> <li>• Promote anaerobic treatment and proper wastewater treatment.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Develop rice varieties with low methane load.</li> <li>• Direct seeding will be implemented.</li> <li>• Implement the alternate wetting and drying method.</li> <li>• Promote organic fertilizers and deep fertilization techniques.</li> <li>• Promote improved feed additives for cattle.</li> <li>• Promote improved feed management.</li> <li>• Introduce composting technology.</li> </ul>
Forestry and other land uses	<ul style="list-style-type: none"> <li>• Reduce deforestation rate to 50% by 2030.</li> <li>• Halt deforestation by 2045.</li> </ul>

	<ul style="list-style-type: none"><li>• Promote afforestation, improved forest management and forest restoration.</li><li>• Promote agroforestry and commercial afforestation.</li><li>• Aim to fully implement the REDD+ investment plan by 2050.</li></ul>
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### 3.3 Current Status of Energy Transition and Carbon Neutrality in the Countries under Assessment

#### 3.3.1 Vietnam

##### 3.3.1.1 Summary of Greenhouse Gas Emissions and NDC

The latest official GHG inventory by the Vietnamese government is the 2016 GHG inventory as shown in the third Biennial Report (BUR3)<sup>30</sup> published in 2020. It shows that total GHG emissions were 354.2 million tCO<sub>2</sub>e in 2016, with the energy sector accounting for 58%, IPPU 13%, agriculture, forestry and other land use 23% and waste 6% (Figure 3-12), net GHG emissions are 299.5 million tCO<sub>2</sub>e when GHG absorption by forests and other sectors is subtracted from the GHG emissions. The GHGs covered in the inventory are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and HFCs, which are among the seven GHGs specified by IPCC.<sup>31</sup> BUR3 also summarizes the GHG emissions of each subsector, with the top five largest GHG emitters amounting to 219.2 million tCO<sub>2</sub>e (about 62% of total GHG emissions) (Table 3-14). Therefore, in order to achieve ET/CN in Vietnam, GHG emission reduction measures are mainly important in energy manufacturing in the energy sector, industry and construction, transport and transportation, cement manufacturing in the IPPU sector, and rice farming in the agricultural sector (Figure 3-13 Figure 3-14).

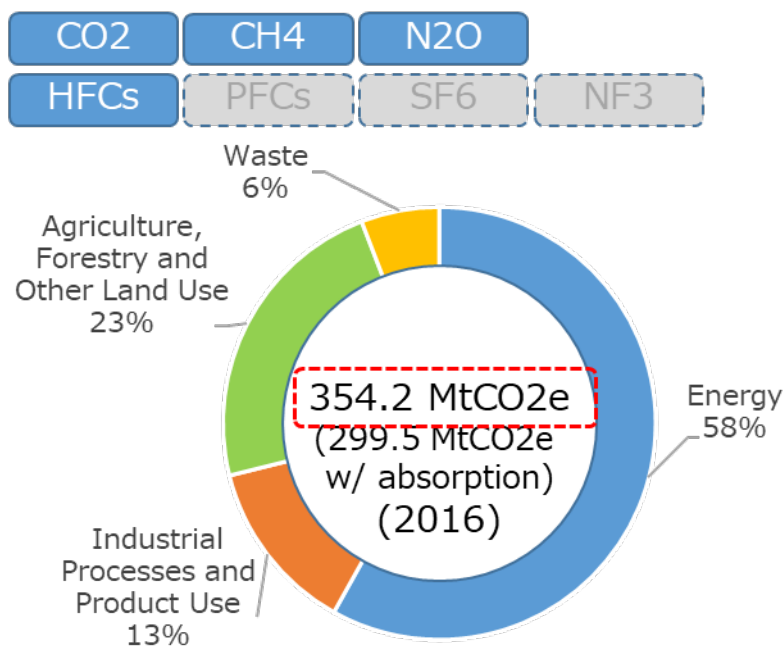


Figure 3-12 Vietnam's GHG inventory (2016)<sup>32</sup>

<sup>30</sup> Viet Nam Third Biennial Updated Report (Ministry of Natural Resources and Environment, 2020) [https://unfccc.int/sites/default/files/resource/Viet%20Nam\\_BUR3.pdf](https://unfccc.int/sites/default/files/resource/Viet%20Nam_BUR3.pdf) Accessed 16 July 2022

<sup>31</sup> Developing countries that are non-Annex I countries are required to report CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O, but other GHGs are to be reported to the extent possible. (Reference: Greenhouse Gas Inventory Office, National Institute for Environmental Studies, <https://www.nies.go.jp/gio/faq/faq1.html#Q1-1> accessed July 16, 2022)

<sup>32</sup> Prepared by Pacific Consultants based on BUR3



Table 3-14 GHG Emissions by Sub-sector in Vietnam <sup>33</sup>

Sector	Sub-sector		ktCO2e
Energy	Fuel Combustion	-Energy Industries	91,005
		-Manufacturing and Construction	38,248
		-Transport	35,845
		-Others	18,153
	Fugitive Emissions	-Solid Fuel	3,007
		-Oil and Natural Gas	19,574
Industrial Processes and Product Use	Mineral Industries	-Cement Production	36,773
		-Lime Production	3,824
		-Grass Production	319
	Chemical Industries	-Ammonia Production	1,272
		-Nitric Acid Production	24
	Metal Industries	-Iron and Steel Production	3,858
Product uses as substitutes for ODS	-Fire Protection	23	
Agriculture, Forestry, and Other Land Use (AFOLU)	Livestock	-Enteric Fermentation	12,422
		-Manure Management	6,092
	Land	-Forest Land	-54,658
		-Cropland	3,638
		-Grassland	1,384
		-Wetland	1,047
		-Settlements	1,919
		-Other Land	7,179
	Aggregate sources and non-CO2 emissions sources on land	-Biomass Burning	1,624
		-N2O from managed soils and manure management	11,729
		-Rice Cultivation	49,693
		-Others	2,002
Waste	Solid Waste Disposal		10,439
	Biological Treatment of Solid Waste		109
	Incineration and open burning of Waste		1,241
	Wastewater Treatment and Discharge		8,949

\*The main types of GHG emissions in GHG emissions are shown in black: CO2, red: CH4, blue: N2O, and green: HFCs.

\*Negative (-) in GHG emissions indicates GHG absorption.

\*Yellow highlights indicate the top five GHG emitters.

## 5 Major Emission category

Sector	Key emission category	ktCO2e	
Energy	Fuel combustion for electricity generation	88,483	CO2
AFOLU	Rice Cultivation	49,693	CH4
IPPU	Cement Production	36,773	CO2
Energy	Road Transportation	29,861	CO2
Energy	Non-Metallic Minerals	14,403	CO2

33 Prepared by Pacific Consultants based on BUR3. In the GHG inventory submitted to the UN, GHG emissions are organized by sub-sector (Table 3-14 Upper row), GHG emissions are further broken down by each subsector (Table 3-14 lower). The GHG inventories for Lao PDR, Nepal, and Vietnam, which are the same that apply to Laos, Nepal, and Uzbekistan, which are discussed below.

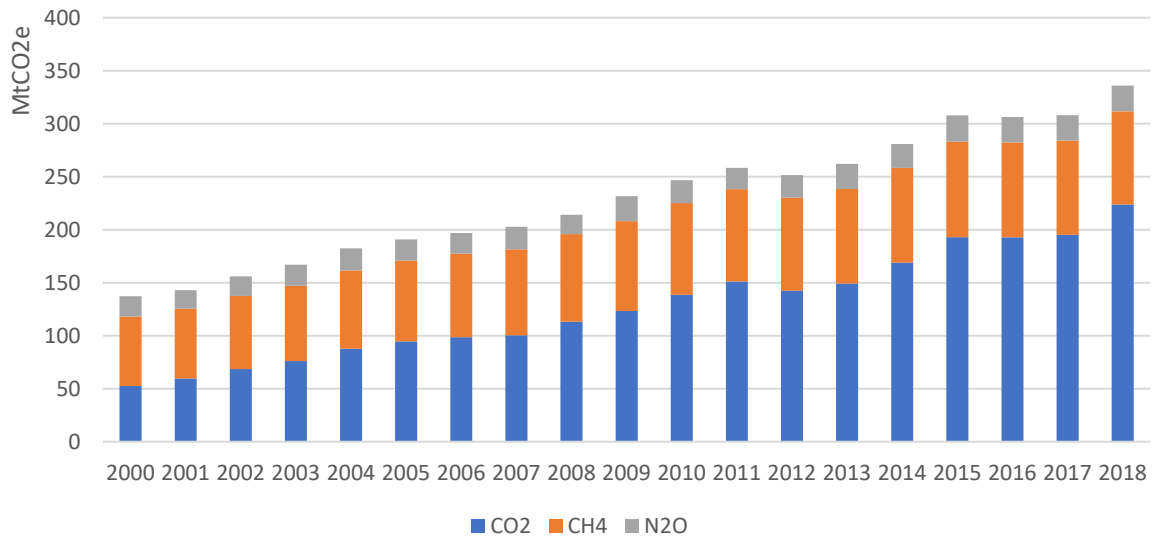
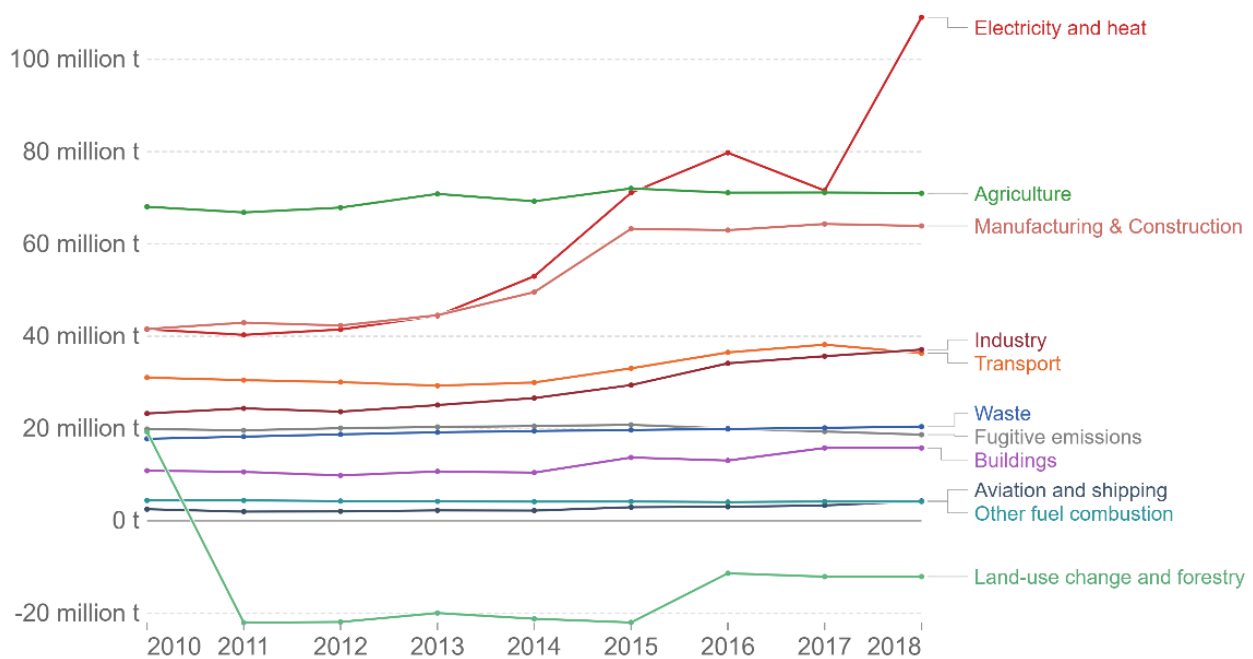


Figure 3-13 Change in GHG Emissions in Vietnam Over Time (2010-2018) <sup>34</sup>

### Greenhouse gas emissions by sector, Vietnam



Emissions are measured in carbon dioxide equivalents (CO2eq). This means non-CO2 gases are weighted by the amount of warming they cause over a 100-year timescale.



Source: CAIT Climate Data Explorer via Climate Watch OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY  
 Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.

Figure 3-14 Vietnam's GHG Emissions by Sector <sup>35</sup>

34 Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

35 Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

Vietnam presented its revised NDC <sup>36</sup> in 2021, which projects baseline GHG emissions of 927.9 million tCO<sub>2</sub>e by 2030 under a moderate economic development scenario. In contrast, the GHG reduction target is 9% by 2030 through own efforts (Unconditional) and 27% under international support (Conditional) (Figure 3-15). The revised NDC shows GHG reduction measures for each sector under national efforts and international support, and the reduction target by international support in the energy sector (104.3 million tCO<sub>2</sub>e reduction) is particularly large, while the GHG reduction target by international support in the agriculture sector and waste sector have large potentials (Table 3-15). The revised NDC also identifies challenges and measures to achieve the target from the perspectives of "energy security," "finance," "MRV," "SMEs," and "waste," and mainly cites the lack of policies and institutions, technology, and financial mechanisms as challenges (Table 3-16). In addition, given the Vietnamese government's goals at COP26 of "achieving net zero emissions by 2050" <sup>37</sup> and "reducing coal-fired power generation to 30% by 2030 and phasing it out in the 2040s" <sup>38</sup>, the development of high-efficiency coal-fired power generation, which is cited as an energy security measure, will be reviewed.

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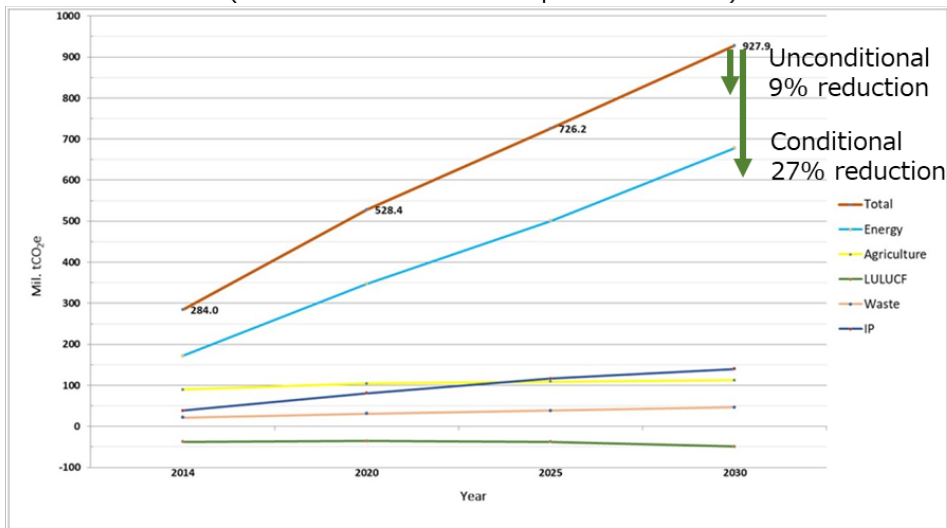
36 Updated Nationally Determined Contribution (NDC) (The Socialist Republic of Viet Nam, 2020)

[https://unfccc.int/sites/default/files/NDC/2022-06/Viet%20Nam\\_NDC\\_2020\\_Eng.pdf](https://unfccc.int/sites/default/files/NDC/2022-06/Viet%20Nam_NDC_2020_Eng.pdf) Accessed 16 July 2022

37 Viet Nam - High-level Segment Statement COP 26 <https://unfccc.int/documents/308938> accessed 2 August 2022

38 Vietnam Coal Pledge at COP26 - A New PDP8 and Net-Zero by 2050 <https://energytracker.asia/vietnam-coal-cop26/> accessed 2 August 2022

Baseline Scenario (Medium Economic Development Scenario)



Year	Energy	Agriculture	LULUCF	Waste	IP	Total
2014	171.6	89.8	-37.5	21.5	38.6	284.0
2020	347.5	104.5	-35.4	31.3	80.5	528.4
2025	500.7	109.2	-37.9	38.1	116.1	726.2
2030	678.4	112.1	-49.2	46.3	140.3	927.9

About 4 times (73% total) on About 1.2 times About 2.2 times About 3.6 times About 3.3 times

Figure 3-15 Projected GHG Emissions in Vietnam's NDCs to 2030 <sup>39</sup>

Table 3-15 Targets for Mitigation Measures in Vietnam's NDCs by 2030 <sup>40</sup>

Sector	Unconditional Mitigation Target (2020-2030)	Target (MtCO2e/y) Uncond 9%/Cond 27%	
Energy	Energy savings and energy efficiency	▼51.5	▼104.3
	Renewable energy		
	Transportation: energy efficiency, modal shift in freight, public transportation and fuel shift		
	Improving construction materials		
	Reducing clinker in cement production		
Agriculture	Management of cultivation and husbandry, improving diet for animals, shifting crop production structures, changing land-use method	▼6.8	▼25.8
LULUCF	Sustainable use of forest, reforestation, agroforestry	▼9.3	▼11.9
Waste	Management of solid waste, industrial solid waste	▼9.1	▼24
IP	Improving cement production process using by-products	▼7.2	▼0.8
	Reducing HFCs		

39 Additions made by Pacific Consultants to the revised NDC for Vietnam.

40 Prepared by Pacific Consultants for Vietnam's revised NDC.

Table 3-16 Challenges and Measures to Achieve the Targets in Vietnam NDC <sup>41</sup>

Problem	Countermeasure	
Energy Security	<ul style="list-style-type: none"> <li>• Insufficient domestic supply of energy</li> <li>• Low energy use efficiency</li> <li>• Lack of technical standards in the energy industry</li> <li>• Delays in building competitive energy markets</li> </ul>	<ul style="list-style-type: none"> <li>• Diversification of primary energy</li> <li>• Developing sustainable power sources</li> <li>• Maximize hydropower generation</li> <li>• Ensuring system safety while prioritizing wind and solar power development</li> <li>• Maximize biomass and gas power generation and establish a support system</li> <li>• Development of high-efficiency coal-fired power generation</li> <li>• Improve the financial sector and promote investment in power development</li> <li>• Introduction of a competitive electricity market</li> </ul>
Finance	<ul style="list-style-type: none"> <li>• The high cost of mitigation measures is an upfront investment</li> <li>• Limited energy efficiency markets and renewable energy technologies</li> <li>• Insufficient financial support for firms to take mitigation measures</li> </ul>	<ul style="list-style-type: none"> <li>• Formulate mechanisms and policies to attract domestic and foreign investment</li> <li>• Cooperation with development partners</li> <li>• Coordination for the development of the Mekong Delta</li> <li>• Improving the policy framework for energy efficiency and renewable energy development</li> <li>• Identification of public and private investment needs and gaps</li> <li>• Development and application of financial instruments such as green bonds and green funds</li> </ul>
MRV	<ul style="list-style-type: none"> <li>• Lack of MRV system</li> <li>• Lack of strict regulations on technical standards and labeling</li> </ul>	<ul style="list-style-type: none"> <li>• Establishment of MRV systems at national and sectoral levels</li> <li>• National Committee on Climate Change coordinates among relevant</li> </ul>

<sup>41</sup> Prepared by Pacific Consultants for Vietnam's revised NDC.

	<ul style="list-style-type: none"> <li>• Lack of awareness of energy efficiency, renewable energy and mitigation</li> </ul>	ministries and agencies
Measures for Small and Medium Enterprises	<ul style="list-style-type: none"> <li>• Lack of specific policies and mechanisms for mitigation</li> </ul>	<ul style="list-style-type: none"> <li>• Develop a list of high-potential mitigation measures and green growth projects to mobilize private and international funding</li> </ul>
Waste management	<ul style="list-style-type: none"> <li>• Insufficient or overlapping policies, systems and support</li> <li>• Discrepancies between central and local responses</li> <li>• underinvestment</li> </ul>	<ul style="list-style-type: none"> <li>• Revision of the taxation system, including the natural resources tax and the environmental protection tax</li> <li>• Promoting the 3Rs, efficient use of natural resources, and application of environmentally friendly waste treatment technologies</li> </ul>

### 3.3.1.2 Policy Framework and Institutions

Vietnam is considered one of the countries most affected by climate change in the world and has taken many measures to cope with climate change, starting with the National Climate Change Strategy in 2011 and through the formulation and implementation of Prime Minister's Decision No. 1670/QĐ-TTg issued in 2017 and the Green Growth Strategy. At the same time, the country is one of the largest energy consumers in ASEAN and according to the Ministry of Natural Resources and Environment, Vietnam will be the second largest GHG emitter<sup>42</sup> in ASEAN in 2021 after Indonesia. Therefore, at COP26 in 2021, the Vietnamese government has set an ambitious target to achieve carbon neutrality by 2050, and accordingly, the relevant policy framework is currently under review. The following is a summary of key policies related to energy transition and carbon neutral.

<sup>42</sup> Status of Vietnam's efforts to become carbon neutral (JETRO, 2022)  
<https://www.jetro.go.jp/world/reports/2022/01/2cdcfeb62193c5a8.html> Accessed May 6 2022

Table 3-17 Policy framework and institutions  
contributing to ET and CN in Vietnam <sup>43</sup>

(in chronological order)

No.	Policy/Regulation	Year of issue	Issuing Authority	Relevance to ET/CN
1	Master Plan on National Energy Development for the Period of 2021 - 2030, with a Vision to 2050	Pending approval	MOIT	Direction of the future energy mix
2	The Draft of Power Development Master Plan for Period 2021-2030, with a Vision to 2045 (PDP8)	Pending approval	Government	Long-term power supply development plans, including renewable energy and LNG development plans
3	The National Green Growth Strategy for the 2021-2030 Period, with a Vision to 2050 (Decision No. 1658/QD-TTg)	2021	Government	Reducing fossil fuels and promoting renewable energy
4	Orientation of Vietnam's National Energy Development Strategy by 2030, with a Vision to 2045 (The Resolution 55 NQ/TW)	2020	Central Committee of the Communist Party of Vietnam	Renewable Energy Development Strategies
5	Promulgation of the Government's Action Program for Implementing the Resolution No. 55-NQ/TW dated 1/02/2020 of Politburo Regarding Orientations of the Vietnamese National Energy Development Strategy until 2030, with a Vision to 2045 (Resolution No. 140/ NQ-CP)	2020	Government	Action Plan to implement Resolution 55 Program
6	National Energy Efficiency Program (VNEEP) for the Period 2019-2030 (Prime Minister's	2019	Government	Targets are set to reduce final energy consumption compared

<sup>43</sup> Prepared by Pacific Consultants based on the websites of Vietnamese ministries and interviews.

	Decision 280/QD-TTg)			to the business-as-usual baseline.
7	Gas Industry Development Plan up to 2025 in Vietnam and Prospects up to 2035 (Prime Minister No. 60 / QD-TTg)	2017	Government	Direction of efforts to develop natural gas, LNG and other gas industry development
8	Viet Nam's Renewable Energy Development Strategy up to 2030, with a Vision to 2050 (Prime Minister's Decision 2068/QD-TTg)	2015	Government	Setting Renewable Energy targets in the energy and power sector. Support systems for Renewable Energy development

An outline of each measure is as follows.

1. Master plan on national energy development for the period of 2021 - 2030, vision of 2050 (Pending approval at Aug 2022)

This Master Plan is a master plan that sets out an energy development plan to meet energy demand and supply in a manner consistent with national socio-economic development objectives, in light of the growing demand for energy and the increasing trend from energy exports to imports. This Master Plan has been developed with the following objectives

- ✓ Exploit and efficiently use domestic energy resources and implement rational energy import and export
- ✓ Actively produce key equipment in the energy sub-sector and develop and build an advanced and modern power transmission and distribution network
- ✓ Promote activities related to energy efficiency and encourage the development of renewable energy sources
- ✓ Develop a plan for the current and projected socio-economic development, energy demand assessment for 2011-2018, and projected energy demand based on fuel types and economic subsectors for 2021-2030 and 2031-2050

2. The Draft of Power Development Master Plan for Period 2021-2030 with vision to 2045 (PDP8)) (Pending approval at Aug 2022)

The Eighth National Electricity Master Plan (PDP8), Vietnam's domestic power development plan, was drafted by the Ministry of Industry and Trade in September 2021, but following the commitment to carbon neutrality by 2050 announced at COP26, PDP8 has had to be revised and has not been approved as of July 2022. The new PDP8, submitted to the government in April 2022, aims to minimize the development of coal-fired power sources to achieve carbon neutrality by 2050, and to reduce dependence on fuel imports. It therefore plans to increase the share of renewable energy even further than in the draft, reaching more than 50% of total



generation capacity. The following table shows the percentage of power generation capacity by 2045.

Table 3-18 Power Supply Capacity Composition Ratio from 2025 to 2045

Units: %.

Target/Year	2025	2035	2045
Coal power/biomass/ammonia	29.3	17.7	9.6
LNG, switching to LNG/hydrogen	11.1	7.0	3.8
Gas turbine using LNG, new hydrogen	3.6	14.8	8.0
Hydrogen-powered thermal power	0.0	3.0	7.2
Coal power, oil-fired gas turbine	0.6	0.0	0.0
Hydropower (including small hydropower)	27.2	15.9	9.0
Wind power on shore, near shore	13.8	12.6	14.3
Offshore wind power	0	8.5	17.0
Large-scale solar power	8.9	11.8	19.4
Biomass electricity, other renewable energy	1.0	1.5	1.3
Stored hydropower, storage battery	0.0	3.6	7.5
Import	4.5	3.7	2.8

3. The National Green Growth Strategy for the 2021-2030 period, vision to 2050 (The Decision No. 1658/QD-TTg) (2021)

This strategy sets out the nation's green growth policy and follows on from the National Green Growth Strategy, which was developed in 2011. The Strategy aims to contribute to the achievement of a green and carbon neutral economy and the prevention of global warming, with the aim of achieving economic prosperity and sustainable environmental and social equality. Specific numerical targets have been set in this Strategy and the key numerical targets are as follows.

Table 3-19 Numerical Targets in the National Green Growth Strategy

Achievement goal	Year 2030	2050
Ratio of renewable energy to total primary energy supply	15-20%.	25-30%.
Percentage reduction in greenhouse gas	Reduction of more than	Reduction of more

emissions intensity per unit of GDP	15% compared to 2014	than 30% compared to 2014
Increase in public transportation usage	Special Cities: 20% or more First Class Cities: 5% or more	Special Cities: 40% or more First Class Cities: 15% or more
Increase in clean fuel buses	Special Cities: 15% or more First Class Cities: 10% or more	Special Cities: 100% First Class Cities: 40% or more
Municipal solid waste collection rate	95%.	100%.
Forest cover	42-43%.	N/A

#### 4. Orientation of Vietnam's National Energy Development Strategy by 2030, with a vision towards 2045 (The Resolution 55 NQ/TW) (2020)

The Strategy sets out perspectives, targets and measures for the future energy transition in Vietnam to promote energy transition from traditional energy sources and fossil fuels to clean energy and renewable energy for sustainable economic development and adaptation to climate change. As the national energy development strategy, the following specific targets have been set under the overall objectives of:

- (1) National energy security,
- (2) High quality and affordable energy supply,
- (3) Environmental protection,
- (4) Upgrading of advanced infrastructure in the ASEAN region,
- (5) Effective development of energy sources, and
- (6) Transparent and competitive market.

Table 3-20 Specific targets in the National Energy Development Strategy

Achievement goal	Year 2030	2050
Primary energy supply	Approx. 175 to 195 million TOE	Approx. 320 to 350 million TOE
Total power supply output	Approx. 125-130 GW	N/A
Electricity production	Approx. 500 to 600 billion kWh	N/A
Share of renewable energy in primary energy supply	Approx. 15-20%	Approx. 25-30%
Total final energy consumption	Approx. 105 to 115 million TOE	Approx. 160 to 190 million TOE
Primary energy intensity	420-460 kgOE /1,000	375-410 kgOE /1,000

	USD GDP	USD GDP
Reliability of power supply	Joined ASEAN's top 4 countries	N/A
Power access index	Joined ASEAN's top 3 countries	N/A
Liquefied natural gas (LNG) imports	Approx. 8 billion cubic meters	Approx. 15 billion cubic meters
Ratio of energy savings to total final energy consumption	Approx. 7%.	Approx. 14%.
Percentage reduction in greenhouse gas emissions generated by energy development	15%.	20%.

5. Promulgation of the Government's Action Programme for Implementing the Resolution No. 55-NQ/TW dated 1/02/2020 of Politburo regarding orientations of the Vietnamese National Energy Development Strategy until 2030, with a vision till 2045 (Resolution No. 140/ NQ-CP) (2020)

The following is a summary of the responsibilities of the key sectors involved in the ETCN.

- Oil and Gas Exploration and Development Industry
  - Active research and exploration of coal gas, tight gas, shale gas, gas hydrates, etc.
  - Incentivize the development of oil and gas infrastructure and solutions for enhanced oil recovery
  - Promotion of natural gas extraction and transportation projects
  - Promote investment and construction of infrastructure for LNG import ports, storage facilities, and distribution facilities
- Renewable energy
  - Research and development of new laws on renewable energy
  - Research and planning of regions and municipalities with advantages in renewable energy, and study of preferential treatment schemes
  - Development of technologies in line with global trends, establishment of production test projects, and promotion of hydrogen use
- Power sector
  - Proposal for an appropriate bidding and auction mechanism for renewable and new energy investment projects for the period 2020-2022
  - Proposed incentive mechanisms for the development of biogas power generation between 2020 and 2022
  - Study and development of policies and mechanisms for offshore wind power development

- Consideration and development of incentive mechanisms to encourage the development of renewable energy for own consumption (with priority given to rooftop solar PV)
- Study and Development of Incentive Mechanisms for the Development of Floating Photovoltaic Power Generation
- Research and proposal of policies related to the development and production of hydrogen
- Prioritizing the use of domestic gas sources and promoting the development of gas-fired power generation using LNG
- Develop mechanisms and policies to encourage investment in renewable energy storage devices/technologies
- Establishment of a mechanism for direct power purchase agreements between renewable energy developers and major electricity consumers
- Improved energy consumption, energy efficiency
  - Development of mechanisms, policies, etc. to facilitate the development of smart grids
  - Development of standards and regulations to control electricity consumption intensity and solar panel performance
  - Sanctions for energy use in energy-intensive industries; development of mandatory standards and regulations
  - Promote the application of renewable and clean fuels (e.g., CNG, LPG, LNG, biofuels, electric energy and other potential energy sources) to replace conventional fuels in transportation vehicles and equipment and promote new technologies to improve the energy efficiency of transportation vehicles and equipment

Research and development of technical standards and regulations for energy consumption in buildings.

#### 6. National Energy Efficiency Programme (VNEEP) for the period of 2019-2030 (Prime Minister's Decision 280/QD-TTg) (2019)

VNEEP is a national energy conservation program aimed at reducing energy intensity in the industrial and economic sectors towards the goals of green growth and sustainable development, and the VNEEP announced in Prime Ministerial Decision No. 280 is the third phase covering the period 2019-2030 (VNEEP3), which aims to reduce national energy use by 5-7% by 2025 and 8-10% by 2030, with savings of 50-60 million tons of oil equivalent (TOE). The required budget is expected to consist of VND 600 billion each from state and local finances, VND 500 billion from various domestic and foreign organizations, and VND 100 billion from other sources. In addition, numerical targets for the years 2025 and 2030 have been set as shown in the following table.

Table 3-21 Main numerical targets in VNEEP3

Items	2025	Year 2030
Power loss reduction	6.5%.	6% or less
Industrial Sector Energy Saving Targets (vs. average energy consumption in 2015-2018)		
Steel industry	3-10%.	5-16.5%
Chemical industry	7% or more	10% or more
Plastics manufacturing	18-22.46%.	21.55-24.81%.
Cement industry	7.5% or more	10.89% or more
Textile and Garment Industry	5% or more	6.8% or more
Alcohol, Beer and Beverage Industry	3-6.88%.	4.6-8.44%.
Paper (manufacturing) industry	8-15.8%	9.9-18.48%.
Number of green certified buildings	80 buildings	150 buildings
Percentage of gasoline savings in the transportation sector	N/A	5%.
Training for energy managers/auditors	3,000 people	5,000 people

7. Gas industry development plan up to 2025 in Vietnam and prospects up to 2035 (Prime Minister's Decision No. 60/QD-TTg, 2017) (2017)

This Master Plan has been developed to develop gas development, gathering, transportation, processing, storage, distribution, import and export lines across the country to achieve natural gas production of 17-21 billion cubic meters per year between 2026 and 2035. The master plan mainly addresses the following.

- ✓ Continued development of gas-fired power plants that use 70-80% of total production (including LNG imports)
- ✓ Developing the petrochemical sector from gas
- ✓ Increased investment in deep processing of natural gas to add value to gas products
- ✓ To produce materials and fuel for domestic industrial production with the aim of increasing exports and reducing the rate of the trade deficit
- ✓ To continue to maintain and expand the gas supply system for industry, transportation and urban households for the purpose of protecting the environment and increasing the value of gas use
- ✓ To develop gas supply systems for transportation and to develop low-pressure and compressed natural gas supply systems.

In addition, the gas industry aims to develop a gas market of 23-31 billion cubic meters between 2026 and 2035, and to achieve this goal, the following development policies have been established nationwide.

- ✓ North: To enhance gas supply capacity to industrial customers in the region, measures to enhance gas recovery from dispersed small-scale oil fields will be

considered. In addition, LNG import infrastructure will be considered and deployed in a phased manner to maintain gas availability to industrial customers in the region. Other measures include the development of LNG-based power plants in accordance with the power plan approved by the Prime Minister.

- ✓ Central: To enhance and develop infrastructure systems to collect, transport and process gas from the Blue Whale field to supply the region's gas-fired power plants, in accordance with the power plan approved by the Prime Minister. The plan also includes the development of a petrochemical industry from the gas from the Shilonagas Whale gas to fully meet the gas demand of the power plants, and the development of a low-pressure gas distribution system and the production of small CNG/LNG to supply industrial consumers in the region.
- ✓ Southeast: To intensify exploration and exploitation activities and oil field development to sustain the region's gas demand, develop storage and port systems for LNG imports to supplement the depletion of domestic gas resources and supply power plants as per the power plan approved by the Prime Minister.
- ✓ Southwest: To develop infrastructure for gas gathering and transportation, develop infrastructure for LNG imports to maintain gas supplies to customers, and develop new power plants using LNG.

8. Prime Minister's Decision No.2068/QD-TTg/Viet Nam's Renewable Energy Development Strategy up to 2030 with an outlook to 2050 (2015)

This Strategy aims to develop and use renewable energy development in a way that contributes to the development of a sustainable environment and green economy. The numerical targets set out in this Strategy are as follows.

Table 3-22 Numerical targets in the Renewable Energy Development Strategy

Achievement goal	Year 2030	2050
Percentage reduction in greenhouse gas emissions relative to the BAU scenario	Approximately 25%	Approx. 45%
Reduction in fuel imports for energy use	Coal: approx. 40 million tons, Petroleum products: approx. 3.7 million tons	150 million tons of coal and 10.5 million tons of petroleum products
Renewable electricity as a percentage of total national production	32%.	43%.
Percentage of households with solar water heaters	26%.	50%.
Construction area to expand the application of biogas technology	Approximately 60 million m <sup>3</sup>	Approx. 100 million m <sup>3</sup>

Biofuel production volume	3.7 million TOE (equivalent to 13% of transportation sector fuel demand)	10.5 million TOE (equivalent to 25% of transportation sector fuel demand)
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### 3.3.1.3 Review of similar studies by international development cooperation organizations, etc.

Major donors implementing ET~CN related programs in Vietnam include the World Bank (WB), United States Agency for International Development (USAID), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Asian Development Bank (ADB).

The WB is mainly focusing on renewable energy development in Vietnam, such as solar and offshore wind power, transparent equipment procurement support, and legal support. The WB is also providing support for bidding for renewable energy, energy efficiency and conservation projects in the industrial sector, market development for ESCO-type projects, and MRV for GHG emissions. In the transport sector, the WB is working with GIZ to support the development of business models for the transport sector. In addition, the WB has been providing long-term support with MOIT as a counterpart, and is planning to implement projects in the energy sector, including decarbonization, renewable energy, circular economy, and recycling using innovative technologies. In addition, the WB plans to support FS studies for the development of LNG power plants and projects to improve power transmission lines and substations.

The USAID is supporting the deployment of rooftop solar power generation, EVs, and waste power generation under the Vietnam Urban Energy Security Project, and is also providing guidance to factories to improve their energy efficiency and conservation knowledge. In addition, the USAID launched the Innovation Challenge Fund to support energy efficiency and conservation, and is currently supporting several energy efficiency and conservation projects in the industrial sector. In addition, the Vietnam Low Emission Energy Program (VLEEP) is setting energy efficiency and conservation standards in industrial parks, supporting monitoring, and strengthening MRV capacity. In addition, support is also being provided for the formulation of a legal system for EVs, support for the introduction of EVs in the public and private sectors, and assistance in studying the introduction of recharging facilities. In the area of electricity market reform, the USAID is reviewing the structure of electricity rates. In the area of renewable energy, in addition to rooftop solar power, policy support and private sector support are being provided for green hydrogen production from offshore wind power generation.

The United State Trade Development Agency (USTDA) is conducting transmission line FS and Smart Grid Roadmap development. The USTDA is interested in clean energy, and is providing support for solar and wind power generation, where U.S. companies have particular strengths. The USTDA has a policy of not providing support for fossil fuels, including LPG, except for existing projects.

The GIZ has been providing support and capacity building on renewable energy such as solar

PV and biomass, smart grid development, technical advice on the introduction of energy efficiency and conservation regulations, and energy audit reviews. Currently, the GIZ is supporting the development of long-term energy transition scenarios and grid development scenarios, as well as strengthening the capacity of clean energy engineers, particularly wind power engineers, and providing support to EVNs on the introduction of rooftop solar power generation.

In addition, the Danish government, with MOIT as a counterpart, is supporting the development of long term energy planning scenarios, capacity building for offshore wind power development, assistance in connecting renewable energy to the power grid, and the development of energy efficiency and conservation regulations in the industrial and industrial sectors.

Agence Française de Développement (AFD) includes supports photovoltaic and hydroelectric power generation, and improvements to the power distribution network and substations. The ADB mainly provides loans for the construction and operation of wind farms. Innovation Norway supports Norwegian companies involved in renewable energy, the circular economy, and fisheries and aquaculture businesses, etc. The EU is supporting rural electrification and the National Energy Efficiency Program for the period of 2019-2030 (VNEEP3), and the Renewable Energy Development Strategy (REDS), etc.

In addition to donor and other activities, Vietnam has implemented two mitigation projects under the Green Climate Fund (GCF) of the UNFCCC: Scaling Up Energy Efficiency for Industrial Enterprises in Vietnam (No. FP071), for which IBRD and IDA is the accredited entity<sup>44</sup>, and Improving the resilience of vulnerable coastal communities to climate change related impacts in Viet Nam, which is accredited by UNDP (No. FP013)<sup>45</sup>. The former is the provision of technical assistance and financial tools to expand Vietnam's energy efficiency market, while the latter is a program aimed at planting and rehabilitating mangrove forests in coastal areas and reducing climate risks for the community people.

Table 3-23 summarizes the activities of major international donors.

Table 3-23 Projects contributing to ET-CN of international donors in Vietnam

The underlined and italicized parts indicate ongoing and future projects.

Donor	CP	Technical cooperation			Financial support
		Policy/Institution	Capacity building	Pilot	
World Bank	Ministry of Industry and Trade (MoIT)	<ul style="list-style-type: none"> <li><u><i>Support for the development of decarbonization roadmaps and pilot implementation plans for energy-intensive</i></u></li> </ul>	<ul style="list-style-type: none"> <li><u><i>Establishment of a low-carbon technology database</i></u></li> <li><u><i>Capacity building on energy audits, evaluation and monitoring of EE/RE projects in the</i></u></li> </ul>		<ul style="list-style-type: none"> <li>Two-step loans for financing renewable energy projects of 30 MW or less</li> </ul>

44 Scaling Up Energy Efficiency for Industrial Enterprises in Vietnam <https://www.greenclimate.fund/project/fp071> accessed 3 August 2022

45 Improving the resilience of vulnerable coastal communities to climate change related impacts in Viet Nam <https://www.greenclimate.fund/project/fp013> Accessed August 3, 2022



		<p><u>industries such as cement, steel, and chemicals</u></p> <ul style="list-style-type: none"> <li>• Support for the development of EE strategies and action plans in energy-intensive sectors</li> <li>• Regulatory development support for grid-connected generation of renewable energy of 30 MW or less</li> </ul>	<p><u>industrial sector, GHG emissions quantification methodologies, etc. (for the industrial sector, ESCOs, banks, etc.)</u></p> <ul style="list-style-type: none"> <li>• <u>Support for the introduction of a competitive bidding program for solar power generation</u></li> <li>• Knowledge and expertise development support for EE investment incentives and identification and evaluation of EE financing projects for financial institutions</li> <li>• Strengthening the capacity of electricity regulators and relevant government agencies for grid-connection of renewable energy</li> </ul>		
	Vietnam Electricity				<ul style="list-style-type: none"> <li>• Grid Capacity Enhancement for Renewable Energy Grid Integration</li> </ul>
	National Power Transmission Corporation (NPT)		<ul style="list-style-type: none"> <li>• NPT Management Improvement, Power Reform Capacity Enhancement</li> </ul>		<ul style="list-style-type: none"> <li>• Reinforcement of 220kV and 500kV transmission lines and substations</li> <li>• Modernization of monitoring, control and protection facilities for 220kV and 500kV substations</li> </ul>
USAID	Government of Vietnam (GOV)	<ul style="list-style-type: none"> <li>• <u>Support for the development of legal systems for the introduction of EVs</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Renewable Energy Grid Integration, Power Distribution</u></li> <li>• <u>Women Energy Professional Development Program</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Develop mechanisms for direct PPA, strengthen procurement, monitoring</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>2000MW renewable energy, 1000MW CCGT construction</u></li> </ul>

		<ul style="list-style-type: none"> <li>• <u>Support for Improvement of Electricity Rate System Design</u></li> </ul>		<u>and evaluation capacity</u>	
	Others (Da Nang and other cities)		<ul style="list-style-type: none"> <li>• <u>Establishment and monitoring of energy efficiency and conservation standards in industrial parks</u></li> </ul>		
GIZ	MoIT	<ul style="list-style-type: none"> <li>• <u>Develop long-term scenarios for energy transitions and grid development scenarios</u></li> <li>• Support for improving laws and regulations related to energy conservation and renewable energy (biomass energy, support for establishing a solar power generation FIT system, grid connection regulations for renewable energy, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• <u>Department of Energy Efficiency and Sustainable Development (DEESD) capacity strengthening (e.g., support for energy efficiency and conservation database development)</u></li> <li>• Creation of energy audit handbook</li> <li>• Support for the construction of energy-saving networks for private companies</li> <li>• <u>Improvement of technical and management capacity of electricity supply in the context of increasing solar power generation by Electricity of Vietnam (EVN)</u></li> </ul>		
ADB	MoIT		<ul style="list-style-type: none"> <li>• Support for formulating energy-saving building standards</li> <li>• Training on energy conservation management standards for energy-intensive industries</li> <li>• ESCOs capacity enhancement</li> </ul>	<ul style="list-style-type: none"> <li>• Energy audits for energy-intensive industries</li> </ul>	
	Other (IPP, etc.)				<ul style="list-style-type: none"> <li>• <u>Construction of 144MW Wind Power Plant in Quang Chi Province</u></li> </ul>

					<ul style="list-style-type: none"> <li>• <u>Construction of 50MW solar power generation and transmission line in Tay Ninh Province</u></li> <li>• <u>47.5MWp water solar power construction</u></li> <li>• Construction of 500kV/220kV high voltage transmission lines and substations</li> </ul>
EU	MoIT		<ul style="list-style-type: none"> <li>• Strengthening Energy Sector Governance</li> </ul>		
	Danang Province	<ul style="list-style-type: none"> <li>• Support for policy/regulatory development related to solar energy</li> </ul>		<ul style="list-style-type: none"> <li>• Solar power generation system pilot model installed</li> </ul>	
AFD	Vietnam Electricity			<ul style="list-style-type: none"> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Sesan 49MWp solar power construction</li> <li>• Distribution line and substation reinforcement</li> </ul>

### 3.3.2 Laos

#### 3.3.2.1 Summary of Greenhouse Gas Emissions and NDC

The latest official GHG inventory by the Government of Lao PDR is the 2014 GHG inventory as shown in the Biennial Report (BR)<sup>46</sup> published in 2020. It shows that total GHG emissions were 39.5 million tCO<sub>2</sub>e in 2014, with the energy sector accounting for 10%, IPPU 3%, agriculture, forestry and other land use 86% and waste 1% (Figure 3-16), net GHG emissions after subtracting GHG absorption by forests and other sectors from GHG emissions are 24.1 million tCO<sub>2</sub>e. The inventory covers CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O, which are among the seven GHGs specified by the IPCC. The BR also summarizes the GHG emissions of each subsector, with the top five largest GHG emitters amounting to 29.66 million tCO<sub>2</sub>e (about 75% of total GHG emissions) (Table 3-24). One of the characteristics of GHG emissions in Lao PDR is that about four-fifths of the GHG emissions come from agriculture, forestry and other land use sectors. Four out of the top five categories are related to agriculture, forestry and other land use, and the remaining one is emissions from transportation in the energy sector (emissions from gasoline and diesel). However, the official GHG inventory is as of 2014, and given that a 1,876 MW Hongsa coal-fired power plant has been in operation in Lao PDR since 2015, GHG emissions from the energy sector have increased rapidly (Figure 3-17 Figure 3-18), and the share of the energy sector in GHG emissions is also expected to increase. Therefore, GHG emission reduction measures, mainly from energy production in the energy sector and livestock management, land use and biomass use in the transport and transportation and agriculture, forestry and other land use sectors are important to achieve ET and CN in Lao PDR.

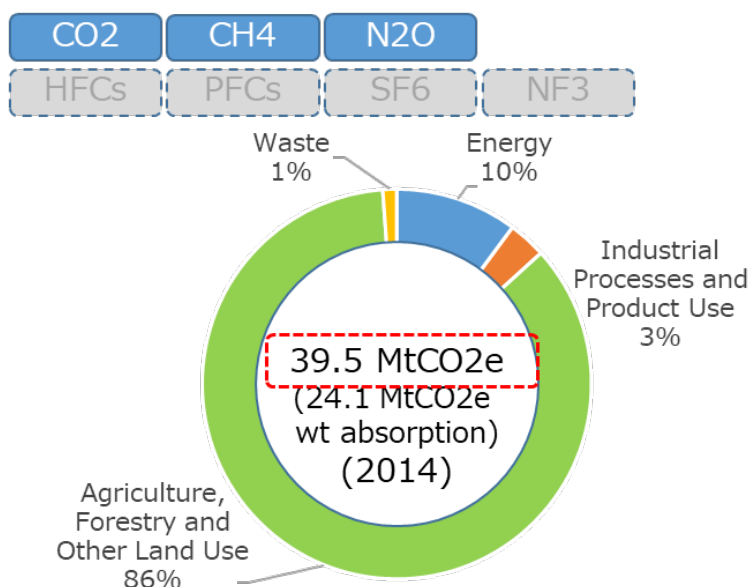


Figure 3-16 Lao PDR GHG Inventory (2014)<sup>47</sup>

<sup>46</sup> The First Biennial Updated Report of the Lao PDR (Ministry of Natural Resources and Environment, 2020) [https://unfccc.int/sites/default/files/resource/The%20First%20Biennial%20Update%20Report-BUR\\_Lao%20PDR.pdf](https://unfccc.int/sites/default/files/resource/The%20First%20Biennial%20Update%20Report-BUR_Lao%20PDR.pdf) Accessed 16 July 2022

<sup>47</sup> Prepared by Pacific Consultants based on BR of Lao PDR.

Table 3-24 GHG Emissions by Sub-sector in Lao PDR <sup>48</sup>

Sector	Sub-sector		ktCO2e
Energy	Fuel Combustion	-Energy Industries	335
		-Manufacturing and Construction	27
-Transport		2,322	
-Others		1,042	
	Fugitive Emissions	-Solid Fuel	2
Industrial Processes and Product Use	Mineral Industries	-Cement Production	1,090
		-Lime Production	3
	Metal Industries	-Iron and Steel Production	62
Agriculture, Forestry, and Other Land Use (AFOLU)	Livestock	-Enteric Fermentation	3,211
		-Manure Management	756
	Land	-Forest Land	-12,662
		-Cropland	19,315
		-Grassland	8
		-Settlements	92
		-Other Land	2,341
	Aggregate sources and non-CO2 emissions sources on land	-Biomass Burning	967
		-N2O from managed soils and manure management	1,768
		-Rice Cultivation	1,148
-Others		26	
Other	-Harvested Wood Product	1,824	
Waste	Solid Waste Disposal		55
	Wastewater Treatment and Discharge		368
	Other		2

\*Black: CO2, red: CH4, blue: N2O are shown as the main types in GHG emissions.

\*Negative (-) in GHG emissions indicates GHG absorption.

\*Yellow highlights indicate the top five GHG emitters.

## 5 Major Emission Source

Sector	Sub-Sector	ktCO2e	
AFOLU	Land converted to cropland	20,057	CO2
AFOLU	Enteric fermentation	3,211	CH4
AFOLU	Land converted to other land	2,341	CO2
Energy	Road transportation	2,229	CO2
AFOLU	Harvested wood product	1,824	CO2

48 Prepared by Pacific Consultants based on BR.

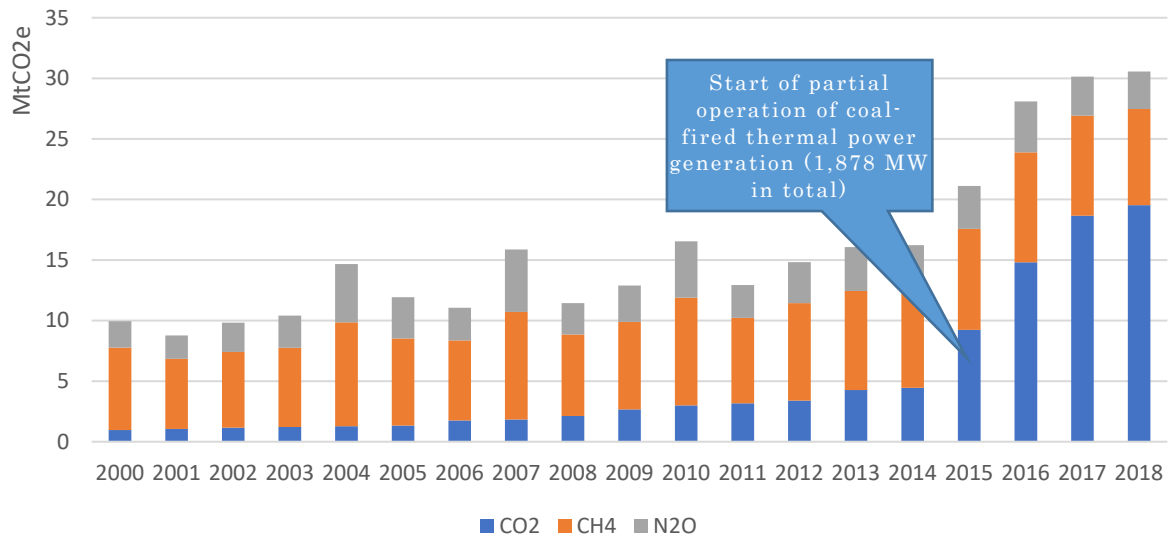
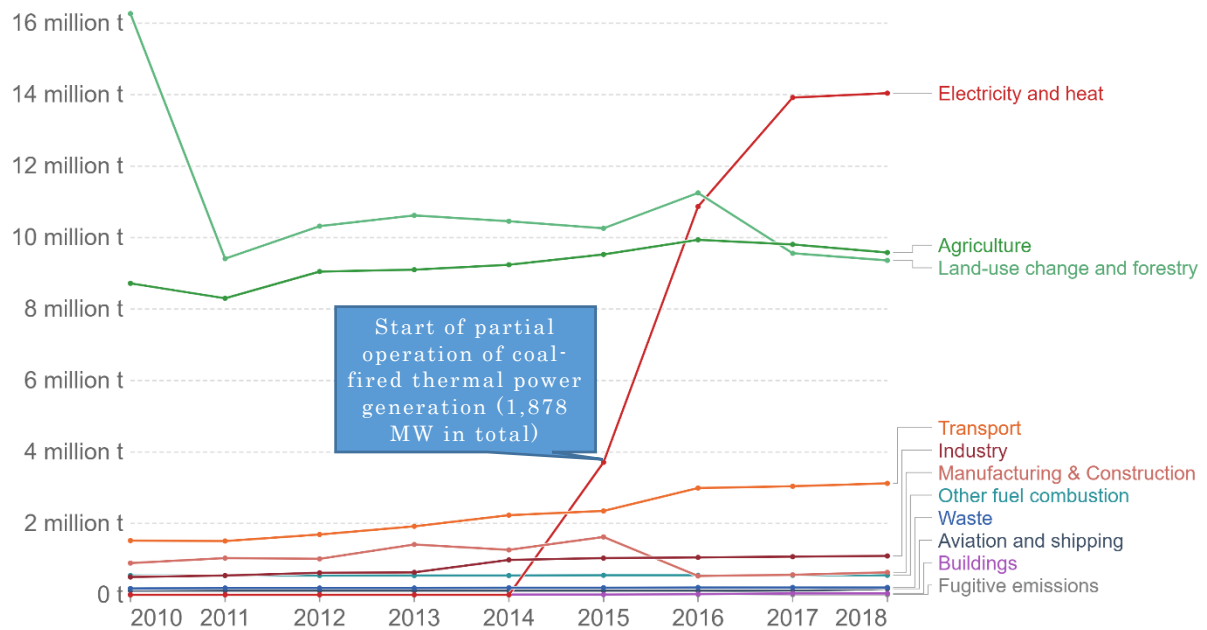


Figure 3-17 Change in GHG Emissions in Lao PDR Over Time (2000-2018) <sup>49</sup>

### Greenhouse gas emissions by sector, Laos



Emissions are measured in carbon dioxide equivalents (CO2eq). This means non-CO2 gases are weighted by the amount of warming they cause over a 100-year timescale.



Source: CAIT Climate Data Explorer via Climate Watch OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY  
 Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.

Figure 3-18 Lao PDR GHG Emissions by Sector <sup>50</sup>

<sup>49</sup> Prepared by Pacific Consultants based on Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

<sup>50</sup> Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource] with PCKK additions.

Lao PDR presented its revised NDC <sup>51</sup> in 2021, which projects baseline GHG emissions of 104 million tCO<sub>2</sub>e in 2030 and over 120 million tCO<sub>2</sub>e in 2050. In contrast, the GHG reduction target is 60% reduction by 2030 through own efforts (Unconditional) (Figure 3-19). The revised NDC updates the reduction targets in the 2015 NDC and presents GHG reduction measures under national efforts and international support for each sector. Under the homegrown efforts, the GHG reduction target from hydropower development is significant, especially in the energy sector, while the GHG reduction target from forest cover restoration measures is significant under the international support. Furthermore, under international support, GHG reductions are shown to be achieved through solar, wind and biomass power generation, EV penetration, biofuel penetration, energy conservation, water management in rice cultivation and waste disposal measures (Figure 3-20).

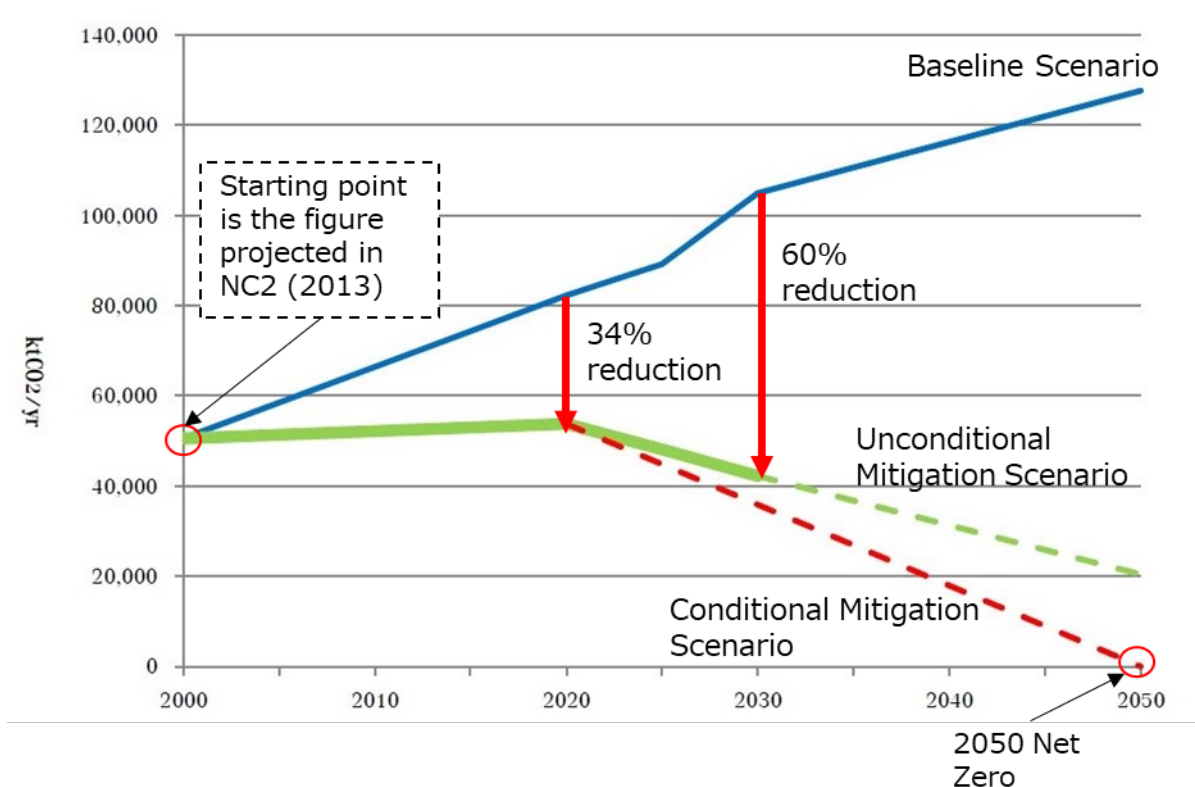


Figure 3-19 Projected GHG emissions in NDCs in Lao PDR <sup>52</sup>

51 Nationally Determined Contribution (NDC) (Lao People's Democratic Republic, 2021) Available at: <https://unfccc.int/sites/default/files/NDC/2022-06/NDC%202020%20of%20Lao%20PDR%20%28English%29%2C%2009%20April%202021%20%281%29.pdf> Accessed 16 July 2022

52 Based on the revised NDC of Lao PDR with additions by Pacific Consultants.

2015 First NDC Measures	Year	Progress
Increase forest cover to 70% land area	2020	58% (2015)
30% RE excluding large hydro	2025	Not on Track
Share of biofuels to meet 10% of transport fuels	2025	Not on Track
90% households electrified	2020	93.79% (2018)
Transport NAMA	2025	Not Started
Expansion of large hydro to 5,500 MW (2020)	2020	<4,500MW (2018)
20,000 MW (2030)	2030	On Track

Sector	Unconditional Mitigation Target (2020-2030)	Target (ktCO2e/y)
LUCF	Reduce Deforestation and Forest Degradation, Enhance Forest Carbon Stocks (*1)	1,100
Energy	13GW Total Hydropower Capacity (Domestic and Export) (*2)	2,500
	Introduction of 50,000 Energy Efficient Cook Stove (Vientiane, Savannakhet, Champasack)	50
Replace	BRT in Vientiane and Non-Motorized Transport	25
	Lao-China Railway	300
Sector	Conditional Mitigation Target (2020-2030)	Target (ktCO2e/y)
LUCF	Increase forest cover to 70%	45,000
Energy	Solar and Wind: 1GW Total Installed Capacity	100
	Update Biomass: 300MW Total Installed Capacity	84
	30% EV for 2-Wheelers, Passengers' Cars	30
	Biofuels to meet 10% of Transport Fuels	29
	10% Reduction of Final Energy Consumption Compared to BAU	280
Agriculture	50,000 hectares adjusted water management practices in lowland rice cultivation	128
Waste	Implementation of 500 tons/day sustainable municipal solid waste management project	40

Revised edition NDC

Figure 3-20 GHG emission reduction measures in NDCs in Lao PDR <sup>53</sup>

In addition, other technical needs to achieve the goals include the following.

- ✓ Support for the design of innovative financial mechanisms that can blend public and private capital
- ✓ Support to ongoing administrative, legal, technical and institutional capacity building for NDC implementation. This includes MRV, refinement of GHG inventories, GHG emission and climate models, and support for the establishment of carbon trading schemes
- ✓ Legal and technical assistance to avoid conversion of forest lands outside of the certified

<sup>53</sup> Prepared by Pacific Consultants based on the revised NDC.



forest lands to other land uses

### 3.3.2.2 Policy Framework and Institutions

While Lao PDR is rich in energy resources such as hydropower and biomass, rapid population growth, economic development, and motorization over the past two decades have increased the country's dependence on fossil fuel imports. Since fossil fuel imports not only put pressure on government finances but also increase GHG emissions, the Lao government is working to develop a policy and regulatory framework to achieve its 2050 net-zero goal through "Energy Transition" and "Carbon Neutral" initiatives. Among the key policies, those related to ET-CN are listed below.

Table 3-25 Policy Frameworks and Institutions Contributing to ET and CN in Lao PDR (in chronological order) <sup>54</sup>

No.	Policy/regulation	Year of issue	Issuing agency	Relevance to ET/CT
1	National Strategy on Climate Change (draft)	2022	MONRE	Strategy on Climate, Change of the Lao PDR(2010) update
2	Resolution on Endorsement of Policy on Electricity Vehicle Use	2021	MEM, MPWT	Promotion of EV Use
3	9 <sup>th</sup> National Socio-economic Development Plan	2021	GoL	Renewable energy development strategy, electrification of transportation systems, promotion of EVs, energy conservation
4	Energy Policy of Lao PDR	2021	MEM	Renewable energy development strategy, electrification of transportation systems, promotion of EVs, energy conservation
5	National Power Development Plan of Lao PDR	2021	MEM	Increase the share of renewable energy (hydro, solar, wind, biomass) in the energy mix
6	National Forestry Strategy	2021	MAF	Strategy to achieve 70% forest coverage in 2025
7	Decree on Energy Efficiency and Conservation	2020	MEM	Promotion of energy conservation to reduce GHG emissions
8	Strategy on Promotion of Clean Energy for Transport	2020	MEM, MPWT	Development of biofuels and EV utilization for decarbonization

<sup>54</sup> Prepared by Pacific Consultants based on Lao Ministry websites and interviews.

	Sector-Plan for 2025, strategy for 2030, and vision for 2050			Promotion of Clean Energy for Transport Sector-Plan for 2025, strategy for 2030, and vision
9	Decree on Climate Change	2019	MOMRE	Climate Change Response Strategy
10	National Green Growth Strategy of the Lao PDR	2018	MONRE	Strategy for the development of renewable and alternative energy for sustainable development
11	Decree on Biodiesel	2016	MEM	Promotion of biodiesel production to reduce fossil fuel use and carbon emissions
12	Regulation for Generic Standard on Clean Cookstove in Lao PDR	2015	MEM	Regulation on biomass use and carbon emission reduction
13	Sustainable Hydropower Development	2015	MEM	Sustainable Hydropower Development
14	Climate Change Action Plan	2013	MONRE	Climate change mitigation and adaptation strategies, including renewable energy development, energy efficiency, and use of alternative energy sources in the transportation sector
15	Renewable Energy Development Strategy	2011	MEM	Strategy to promote renewable energy for sustainable development
16	Strategy on Climate Change of the Lao PDR	2010	MONRE	Strategy for applying climate change measures to development strategies and programs in key sectors

A summary of each policy is as follows:

1. National Strategy on Climate Change (draft) (2022)

This Strategy updates the Strategy on Climate Change of the Lao PDR (2010), which is a draft version in Lao as of May 2022. Besides outlining changes in the national policy and regulatory framework and international agenda related to environmental and climate change impacts and future development directions since 2010, the Strategy sets a goal of achieving net zero by 2050 and outlines the following targets:

- ✓ Integrate the climate change agenda into national policies, strategies, programs, and

projects in sectors that may be exposed to climate change impacts and risks.

- ✓ Increase the resilience of urban and rural communities, infrastructure, production services, and ecosystems to cope with climate change and reduce vulnerabilities and risks associated with climate change and natural disasters.
- ✓ Reduce GHG emissions to 60% BAU level.
- ✓ Reduce the impact on the economy and GDP to less than 0.2%, less than 120,000 people, and per capita GHG emissions to less than 1.2t/capita/year, as well as to increase forest area to cover 70% of the country's land area and 30% of energy consumption to be covered by renewable energy.

## 2. Resolution on endorsement and promulgation of Policy on EV Use (2021)

This resolution, published in October 2021, sets the goal of increasing the EV rate to at least 1% by 2025 and 30% by 2030 in order to reduce imports of petroleum products and foreign currency outflows, reduce costs for automobile users, and reduce environmental pollution caused by gasoline-powered vehicles. The resolution outlines an action strategy to promote EVs by providing the following incentives and directs the ministries and agencies to take the following measures.

- ✓ Preferential treatment for imports and sales under the Law on Investment Incentives, Customs Law, and Tax Administration Law
- ✓ Incentives for production and assembly, such as incentives for investment in EV parts manufacturing and assembly plants, and reductions in tariffs and tax rates on imports of EV assembly parts.
- ✓ Preferential investment in charging stations and preferential electricity prices for charging stations.
- ✓ Preferential treatment for EV users, such as free meters for installation of EDL EV charging systems in residences and offices, preferential road usage fees, and preferential parking.
- ✓ The government will take the lead in the use of EVs, and when government makes a new purchase for a car for official use, it shall be an EV.

It also calls on the ministries and agencies to implement the following coordination

- ✓ Ministry of Energy and Mining: to coordinate policies related to EV use, legislation related to charging stations, and the electricity tariff structure for charging.
- ✓ Ministry of Public Works and Transport: conducts research on technical safety standards and technical standards for import and assembly.
- ✓ Ministry of Finance: coordinate on taxes, duties and fees related to EVs, charging stations and components.
- ✓ Ministry of Natural Resources and Environment: Develop guidelines for the proper disposal of waste related to EVs and storage batteries.

### 3. 9<sup>th</sup> National Socio-economic Development Plan (2021)

The 9th National Socio-economic Development Plan (NSEDP) recommends the promotion of EVs using clean energy sources such as hydropower and solar power, and the development of biofuels for the transportation and industrial sectors to reduce fossil fuel imports and GHG emissions. The NSEDP also promotes the development of green infrastructure and technologies related to renewable energy, such as hydro, solar, and wind power, and energy efficiency in homes and public buildings. In addition, the NSEDP addresses the need for the sector to develop energy conservation policies and regulations for factories, buildings, and electrical and energy equipment. The main goals for ET and CN as outlined in the NSEDP are listed below.

Table 3-26 ET- and CN-related targets in the 9th NSEDP of Lao PDR

Sectors	Sector Target (2021-2025)
Electrification	To make national electrification rate 98%. In this 98 %, expand grid systems by 2.26% (28,000 households) and off-grid systems by 0.74% (over 9,000 households).
	To expand power grid in the three provinces with the lowest electricity consumption rate in the country (North: Phongsaly, Huaphan, and South: Sekong)
Energy/ Transportation	To promote the development of biofuel plants from palm oil and cassava and methane (CH <sub>4</sub> ) production demonstration projects for the transportation and industrial sectors to reduce fossil fuel imports and use and GHG emissions.
	To implement strategies to promote the use of clean energy in the transportation sector, aiming for a 14% clean energy utilization rate.
	To build at least 100 charging stations/biofuel stations throughout the country (20 in the northern region, 50 in the central region, and 30 in the southern region).
Climate Change	To promote GHG emission reductions in accordance with the NDC.
Waste	To build/improve at least 5 standardized landfills in major cities.
Land Use /Forest	To increase forest area to be at least 70% of the national land and elevate forest coverage
	To reduce GHG emissions from deforestation to about 30 million tCO <sub>2</sub> e and sell forest carbon credits worth at least US\$95 million.
	To convert 5 national protected forest areas into national parks by 2025 (Xe Pian, Dong Hua Sao, Phu Khao Kuay, Nam Kan and Nam Kading conservation forests)

	To plant trees on 200,000 ha of land for supplying commercial and industrial sectors raw materials
	To construct at least 9 air quality monitoring stations throughout the country.

#### 4. Energy Policy of Lao PDR (2020)

Developed by MEM in 2020, this policy aims to reduce Lao PDR's dependence on imported oil and gas, reduce GHG emissions from the transportation sector, and promote the use of renewable energy. In the transportation sector, the report outlines strategies to promote electrification of transportation systems and EVs, promote energy conservation, electrify railroads, and promote the use of public transportation. It also encourages the use of biogas for small and large household use. For renewable energy, it sets ambitious targets to achieve a 30% share of renewable energy in the country's total energy mix by 2025. For electricity, the target is set at 65% hydropower, 30% coal-fired power, and 5% non-hydropower renewable energy. This target setting considers the possibility of lower reservoir levels in the dry season at many hydropower plants, which would reduce power generation. The main targets for ET and CN as presented in the policy are listed below.

Table 3-27 Goals in Lao PDR Energy Policy

Hydroelectric power generation	To achieve an installed capacity of 12,000 MW in 2025 and 20,000 MW in 2030.
	To expand reservoir hydropower projects to 70% of total hydropower capacity to ensure stable power generation during peak dry season.
	To Implement the “Sustainable Hydropower Development Policy of Lao PDR (2015)”
Coal-fired power generation	To control emitted pollutants according to national environmental standards.
	To apply clean coal technology in pre-combustion, combustion, and post-combustion processes.
Renewable Energy	To connect solar and wind power generation to the existing power grid.
	To increase Biofuels up to 10% of total energy fuel demand.
	To increase the share of renewable energy in entire energy mix to 30% by 2025.
Electrification	To increase the electrification rate from 95% in 2020 to 98% in 2025 and 100% in 2030.
	To expand the power grid nationwide.
	To establish a state-owned power transmission company.
Energy Security	To promote and develop energy efficiency and conservation policies,

	formulate mechanisms to support the implementation of relevant regulations and policies.
	To set a reserve ratio as 15% for peak electricity demand. To prepare a 90-day fuel and oil surplus supply for emergencies (natural disasters, etc.) for the period of 2020- 2030.
Energy Export	To export 9,000 MW of electricity to Thailand and 5,000 MW to Vietnam and other countries by 2020.
Energy Saving	To reduce 10% of total energy consumption by 2030.
Implementation Strategy	To develop guidelines and medium-term action plans (2020-2025) for Lao energy policy to support cross-sectoral coordination on energy demand and consumption, regional and international energy integration and cooperation, national energy security development, institutional capacity building, and information sharing.
	To develop medium-term action plans (2025-2030) for energy policy of Lao PDR.
	To review existing energy policies and develop a long-term action plan (2030-2050) for continuous improvement of national energy policy.

#### 5. National Power Development Plan of Lao PDR (2021)

For the power sector, the goal is to achieve energy mix of 65% hydro, 30% coal-fired, and 5% other renewable energy sources. In the transportation sector, the plan includes the promotion of a cross-country high-speed rail system, EVs, and vehicles powered by renewable energy sources. In relation to these goals, the Lao government has set targets to increase hydropower capacity in the power sector to 12,000 MW and 20,000 MW by 2025 and 2030, respectively, and in the transportation sector, to develop technologies to replace 10% of total fuel consumption in the transportation sector with biofuels by 2025. In the area of transportation, the plan calls for the development of technology to replace 10% of total fuel consumption in the transportation sector with biofuels by 2025, and the establishment of EV infrastructure, battery charging fees, and tax incentives. It also aims to achieve a 10% reduction in energy consumption by 2030 by promoting energy efficiency and conservation in an environmentally sustainable manner.

#### 6. National Forestry Strategy (2021)

The quantitative target for forest cover by 2020 is to increase forest cover from 41.5% in 2002 to 58% in 2015 and 62% in 2020. The Strategy aims to improve the quality of forests in the future and to have 70% of the country's land covered by forests by 2025, and has three main programs and implementation plans: "Management of Forest Resource Use," "Conservation of

Forest Resources," and "Forest Development and Related Action Plans.

7. Decree on Energy Efficiency and Conservation (2020)

This resolution was developed by MEM to update the 2016 National Policy on Energy Efficiency and Conservation. This resolution covers factories, public buildings, housing, transportation, and other products.

1) Factories

Factories are classified as designated factories and non-designated factories. While the latter are only required to take general energy conservation actions, they are also required to provide relevant information for external inspections and to conduct monitoring inspections of the energy efficiency and conservation status of their factories and report regularly to MEM. Designated factories are those that meet one or more of the following requirements.

- i. Factories that have installed at least one set of transformers with a cumulative capacity of 1,000 kW or 1,175 kVA or higher
- ii. Factories using more than 20 million MJ of boiler heat or more than 478 tons of oil equivalent energy per year.

Designated factories must implement energy conservation under the requirements in Table 3-28, and new factories must meet MEM's Energy Conservation Standards and receive approval. In addition, they are required to assign energy conservation managers/persons in charge of energy conservation at the direction of MEM, establish a department in charge of energy conservation in the factory, conduct inspections of internal energy use and submit a report to MEM about the results based on such inspections every March, provide relevant information when there is an external inspection, and provide information on social and environmental impacts in relevant sectors. The company is required to bear the costs of monitoring and inspections.

Table 3-28 Energy Saving Measures in Lao PDR Factories

Factories	Improving fuel combustion efficiency for power equipment in manufacturing processes
	Improving production processes in manufacturing facilities
	Improving cold/heat production processes, including conversion of heat to mechanical power
	Reduction of energy loss in power and electrical equipment
	Reuse of residual energy in manufacturing processes
	Improving heat to power conversion processes

	Replacing it with more efficient energy
	Use of energy-efficient equipment and devices
	Use of renewable energy

## 2) Buildings

Buildings are classified by designated buildings and non-designated buildings. The latter are required to provide energy data and regularly monitor energy use in the building, although they only promote general energy conservation. Designated buildings are those that meet one or more of the following requirements, and any new building must have an energy conservation plan approved by MEM.

- i. Buildings with a cumulative capacity of 1,000 kW or 1,175 kVA or more of installed transformers.
- ii. Buildings that use 20 million MJ of boiler heat or 478 tons of oil equivalent energy per year or more.
- iii. Buildings with a total building floor area of 20,000 square meters or more.

Designated buildings are required to assign an energy conservation manager/person in charge, set up a department in charge of energy conservation in the building, conduct inspections of energy use in the building and submit a report of the results to MEM annually based on the inspections, provide relevant information for external inspections, and provide information on social and environmental impacts of the relevant sectors under the direction of MEM monitoring, and bearing the costs of the inspections. Among the designated buildings, public buildings will be subject to energy conservation under the requirements in Table 3-29.

Table 3-29 Energy Conservation Measures in Buildings in Lao PDR

Buildings	Design lighting systems in accordance with MEM standards, technologies, and regulations
	Installation and use of high-efficiency lighting fixtures in compliance with national and international standards
	Installation of automatic control systems in public buildings
	Regular maintenance of lighting systems in public buildings
	Use of appropriate renewable energy sources for lighting systems in public buildings

## 3) Transportation and traffic

Energy efficiency and conservation measures in the transportation and traffic sector are shown in Table 3-30.



Table 3-30 Energy Saving Measures in Transportation and Traffic in Lao PDR

Transportation	Improvement and promotion of public transportation
	Improvement of vehicles and management of appropriate traffic routes to increase energy efficiency.
	Reduce energy consumption by developing and implementing regulations for vehicle maintenance
	Use of technology and energy management
	Identifying and implementing energy conservation and efficiency measures

In addition, the Government of Lao PDR has announced that it will promote the following efforts.

- i. Promote the development of effective transport systems through the improvement of transport infrastructure.
- ii. Promote and develop alternative modes of transportation (fuel cells, hydrogen and EVs) and encourage the use of public transportation.
- iii. Promote the use of environmentally friendly energy sources such as biofuels, fuel cells, hydrogen and electricity.

The following are the measures that should be undertaken by each ministry to implement these policies.

- i. MPWT:
  - ✓ Develop regulations related to effective, low-energy vehicle management.
  - ✓ Apply energy efficiency and energy conservation standards in transportation.
  - ✓ Cooperation with relevant sectors to issue standards and licenses for energy efficiency of vehicles.
  - ✓ Proposing improvements in vehicle energy use to transport operators.
  - ✓ Encouraging further investment in the use of public transport systems, especially rail system.
  - ✓ Regular inspections of vehicle
- ii. MOIC:
  - ✓ Control the production and importation of vehicles to ensure compliance with standards and technologies related to their use.
- iii. MST (at the mentioned time):
  - ✓ Define national standards for energy efficiency and environmental friendliness of vehicles, in cooperation with relevant authorities and sectors.

#### 4) Power and power equipment

Energy efficiency and conservation measures in motive power and electric power equipment are shown in Table 3-31. It states that energy performance standards to minimize energy use should be revised every 5 years.

Table 3-31 Energy Efficiency and Conservation Measures in Power and Electric Power facilities in Lao PDR

Power and electric power equipment	Establish and implement measures and standards to minimize energy use.
	Attach energy efficiency labels to each facility.
	Disseminate information on energy efficiency of facilities to the public.

8. Strategy on Promotion of Clean Energy for Transport Sector-Plan for 2025, strategy for 2030, and vision for 2050 (2020)

Through this policy developed under the MEM and MPWT in 2020, the Government of Lao PDR aims to increase the share of EVs in the total vehicle fleet to 14% by 2025<sup>55</sup>, 30% by 2030, and 50% by 2050. To promote EVs, including electric motorcycles, 200 battery charging stations will be installed at gas stations, shopping centers, and office buildings, and service centers will be established for EV users. It will also encourage domestic and foreign investors to develop biofuel production capable of producing 400,000 liters of diesel and 200,000 liters of gasoline per day by 2030. In addition, the policy states that the use of public transportation will be promoted to reduce traffic congestion and GHG emissions. The implementation of this policy will reduce fossil fuel imports by the equivalent of \$1 billion per year. The action plan to achieve these goals is as follows.

- ✓ Develop and implement a policy framework for vehicles powered by renewable energy sources available in Laos.
- ✓ Introduce economic incentives for EV businesses, such as lower import taxes and tariffs, lower electricity and road use fees, and an easy payment system for battery charging.
- ✓ Expand the EV market and encourage competition among EV service providers.
- ✓ Conduct educational activities to make EVs more accessible to as many people as possible and to raise their interest.

9. Decree on Climate Change (2019)

This is a ministerial decree that is the top-level climate change measure in each ministry. This Prime Ministerial Decree states the need for climate change-related measures and adaptation strategies to be integrated into development policies, strategies, plans, programs and projects in all sectors, at national and local levels.

<sup>55</sup> In No. 2 Resolution on endorsement and promulgation of Policy on EV Use (2021), the figure is revised to 1% in 2025.

The main measures to reduce GHG emissions and address climate change issues are:

- ✓ Dissemination of information on climate change
- ✓ Reducing GHG emissions in the agricultural sector by promoting reforestation and reducing slash-and-burn cultivation practices
- ✓ Development of environmentally friendly industrial technologies in the industrial sector and access to climate resilient industrial infrastructure
- ✓ Development and promotion of renewable energy sources
- ✓ Research, development, and promotion of environmentally friendly alternative energy sources such as biofuels
- ✓ Implementation of climate change policies and regulations

#### 10. National Green Growth Strategy of the Lao PDR (2018)

This strategy, developed by MONRE in 2018, presents an action plan for ET and CN measures in each sector, including achieving 70% forest coverage by 2020. In the industrial sector, it includes the promotion of energy-saving, low-carbon, and other environmentally friendly technologies, improvement of public transportation services to increase conversion to public transportation use, and promotion of EVs and other vehicles using renewable energy to reduce fossil fuel imports and GHG emissions. It also sets a goal of achieving 98% electrification of all households in Laos while accelerating the development of renewable energy and reducing the use of biomass energy such as firewood and charcoal for cooking to reduce GHG emissions and promote energy conservation. Examples of specific strategies in these are as follows:

- ✓ Establishment of a National Steering Committee for Green Growth, chaired by the Deputy Prime Minister and with ministers from relevant ministries and agencies as members.
- ✓ Establishment of a Lao National Green Growth Promotion Center, chaired by the Director of the National Economic Research Institute, vice-chaired by the Deputy Minister of Planning and Investment, and with deputy ministers of relevant ministries and agencies as members.
- ✓ Improve the early warning system to be more efficient and effective to reduce loss of life and property due to natural disasters caused by climate change.
- ✓ Establish and expand the Emergency Relief Reserve Fund at the national, provincial, district, and village levels to provide relief to victims of natural disasters in an efficient, effective, and timely manner.
- ✓ Encourage economic growth that reduces GHG emissions by promoting advanced technologies that use efficient, effective, low-waste, energy-efficient, clean, and environmentally friendly energy, and by promoting the protection and expansion of GHG sinks such as forests and soil.
- ✓ Increase forest cover to 70% of the national land area by 2020 through the implementation of laws, regulations and mechanisms for the sustainable protection and use of forests. Develop a number of laws, regulations and mechanisms for the sustainable protection and use of forests, including Law on Forest, Decree No. 95/PM on ceasing the export of timbers,

Policy on the decrease of slash-and-burn cultivation practices, etc.

- ✓ Promote the production, importation, and use of domestically available clean energy transportation vehicles, such as hydropower and solar-powered EVs, in order to reduce import and use of fossil fuels and reduce GHG emissions.
- ✓ Comprehensively expand the power grid (transmission system) to ensure connectivity to all regions of the country and rural electrification of 98% of the country's households.
- ✓ Increase the efficiency of clean energy use and energy conservation by promoting the use of energy-saving materials, production equipment, transportation vehicles, and technologies, and restricting the import of energy-wasting materials, production equipment, transportation vehicles, and technologies.

#### 11. Decree on Biodiesel (2016)

This Decree, enacted by the MEM, defines principles, regulations, and standards for the development, production, import/export, use, and management of biofuels in Lao PDR. Contents include crop plantations for biofuels, development of biofuel production technologies, domestic and international investment, technology and capacity development, marketing and pricing, access to loans, and product quality standards.

#### 12. Regulation for Generic Standard on Clean Cookstove in Lao PDR (2015)

This regulation, established by the MEM in 2015, aims to reduce the consumption of biomass fuels (firewood and charcoal) for cooking in households and promote the use of cookstoves in terms of GHG emissions, energy savings, and health risks. It provides technical guidance and standards for the production of environmentally friendly cookstoves, energy efficiency of the products, and their commercial use.

#### 13. Sustainable Hydropower Development (2015)

The objective of this policy is to promote sustainable hydropower development in Laos. The policy outlines a wide range of management measures for hydropower development, including inter-sectoral coordination, environmental and social impact assessment, social protection for project-affected communities and others, information disclosure, stakeholder coordination, and benefit sharing.

#### 14. Climate Change Action Plan (2013)

This Action Plan was developed to complement the Strategy on Climate Change of the Lao PDR (2010) and outlines priority strategies and measures to be addressed by each relevant agency as shown in Table 3-32 below.

Table 3-32 Climate Change Action Plan for Lao PDR

Priorities	Key Ministries
Establish and strengthen technical capacity for planning and implementing activities related to climate change	MONRE and other relevant ministries
National management and coordination on climate change	MONRE
Develop a climate change strategy and action plan	MONRE and other relevant ministries
Strengthen financial management in response to climate change	Ministry of Finance, MONRE and other relevant ministries
Promote climate resilient agriculture	MAF
Promote climate resilient agricultural infrastructure	MAF
Strengthen technical capacity in agriculture	MAF
Promote climate change adaptation technologies	MAF
Promoting Appropriate Agricultural Land Use	MAF
Promote climate resilient forest production and forest ecosystems	MAF, MONRE
Promote capacity building in the forest sector	MAF
Strengthen water resources information systems	MONRE
Flood management	MONRE
Climate resilient watershed and wetland management	MONRE
Promote climate resilient water resources infrastructure	MONRE and other relevant ministries
Promote climate resilience in the water resources sector	MONRE and other relevant ministries
Promote resilience of energy and transportation infrastructure	MEM and other relevant ministries
Promote climate resilient industrial sectors	MOIC and other relevant ministries
Promote climate resilient urban development	MPWT
Promote climate resilient water supply systems in rural areas	MPH and other relevant ministries
Promote climate resilient public health services	MPH and other relevant ministries
Management of GHG emissions in agriculture	MAF and other relevant ministries
Capacity building in forest management	MONRE, MAF
Promote clean energy to reduce GHG emissions	MEM and other relevant ministries
Promote carbon management in urban areas	MPWT,

	MONRE and other relevant ministries
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### 15. Renewable Energy Development Strategy (2011)

The strategy aims to increase the share of renewable energy in the national energy mix to 30% by 2025, and to replace 10% of imported fossil fuels with biofuels. It cites the promotion of the development of renewable energy sources such as biofuels, small hydropower, solar, wind, and biomass heat in the public and private sectors, as well as alternative fuels in the transportation sector. However, the Strategy focuses on the development of renewable energies with a focus on energy self-sufficiency and connection to off-grid areas to achieve rural electrification.

### 16. Strategy on Climate Change of the Lao PDR (2010)

The Strategy considers the reduction of GHG emissions as one of the government's priorities and outlines measures to accelerate the reduction of GHG emissions, including the eradication of slash-and-burn cultivation practices to achieve a forest cover of 70% of the country's land area. Specifically, it includes reducing the use of firewood for household cooking by strengthening rural electrification, managing forest fires, participating in carbon credit markets, developing renewable energy, raising public awareness of energy conservation, promoting low-carbon transportation, and strengthening the Clean Development Mechanism (CDM). This Strategy will be revised in Draft No. 1 National Strategy on Climate Change Management (2022).

#### 3.3.2.3 Review of similar studies by international development cooperation organizations, etc.

Major donors implementing ET/CN related programs in Lao PDR include the Global Green Growth Institute (GGGI), the New Zealand (NZ) Government, the WB and USAID.

The GGGI Lao PDR Office has mainly focused on supporting urban areas, and most of the support is related to transportation and energy. MOIC has also conducted simple energy audits at 25 factories in the three main industrial sectors of construction materials, garments, and food processing. In the future, discussions are underway with the Department of Housing and Urban Planning (DHUP) to support energy efficiency and conservation in the private sector. The office also provides education and other training related to ESCOs in the area of energy conservation. In addition, the office has been involved in the development of a strategy for solid waste management in Vientiane in collaboration with the Korea International Cooperation Agency (KOICA) and has supported the provision of municipal solid waste collection vehicles and the establishment of a composting facility in Vientiane. Regarding EVs, MPWT, is used as a counterpart to provide support for the adaptation of existing regulations for conventional vehicles to EVs, including proposals for vehicle inspections, vehicle registration, and other

legal and regulatory aspects, as well as standards for plugs and charging stations. In the future, GGGI plans to implement strategies to raise public awareness of EVs and provide financial support for EV purchases and is in discussions with car dealers and banks.

USAID is considering a project on EV promotion and a project on energy security with MEM's DEEP as a counterpart; and the project on EV promotion will support the review of regulatory standards for charging stations, inspection and certification of charging stations, and tariff design, and is expected to start in 2022. The Energy Security Project is part of the U.S.-Laos Comprehensive Partnership (now part of the U.S.-ASEAN Economic Framework) and will improve energy planning and EDL capacity building with MEM and EDL as counterparts, and the MoU is currently under discussion. The Clean Power Asia program, which ended in March 2021, included energy demand forecasting, etc. The follow-up to Clean Power Asia, Southeast Asia's Smart Power Program <sup>56</sup>, is a project to improve energy efficiency in the industrial sector, etc.

The NZ Laos Renewable Energy Facility is supporting the revision of the Renewable Energy Development Strategy established in 2011, capacity building on dam safety for EDL staff, and English language training for EDL and MEM. Future projects include technical advice to MEM on dam safety and support to EDL on power system operation, and in the area of energy conservation, the establishment of an energy consumption database and support for the establishment of an energy manager system are being considered.

Although ADB's support to the energy sector has been limited in recent years due to the financial situation of the EDL and the Lao PDR as a whole, it has provided support to the hydropower company at Nam Theun 2 Dam, the Greater Mekong Subregion Northern Power Transmission Project, policy support for EVs and energy efficiency and conservation, a transmission line strengthening project, and support for charging stations under the BRT project.

The Asia Foundation, an international NGO based in the United States, provides advice to MEMs on electricity sales contracts. It is also planning to implement a project to conduct financial analysis of solar power generation, and is considering an assistance program on energy transition in cooperation with the Australian Embassy. <sup>57</sup>

The Climate Technology Centre & Network (CTCN), established under the UNFCCC, was providing support to Lao PDR to develop a Power to Gas (PtG) Master Plan until March 2022. The implementing agency is the Global Environment Centre (GEC), a public interest incorporated foundation in Japan. In Lao PDR, there is almost no use of gas as an energy source, and therefore, there are no gas-related regulations or infrastructure, which makes it impossible to plan for commercial use of hydrogen and synthesis gas. This project proposes a master plan that organizes the items to be developed to solve these issues. <sup>58</sup>

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<sup>56</sup> USAID Southeast Asia's Smart Power Program <https://www.usaid.gov/asia-regional/fact-sheets/usaids-southeast-asia-smart-power-program> Accessed July 16

<sup>57</sup> Details unknown at the time of this study.

<sup>58</sup> The text is not available at the time of this study.

In addition to donor and other activities, Lao PDR has implemented two mitigation projects under the Green Climate Fund (GCF) of the UNFCCC: the Green Recovery Program (No. FP156), for which ADB is the accredited entity <sup>59</sup>, and the Sustainable Forest Management (No. FP117) <sup>60</sup>, which is accredited by GIZ. The former is a financing program aimed at stimulating low-carbon investments in target countries to support economic recovery after COVID-19, while the latter is a program aimed at creating an enabling environment for REDD+ implementation.

Table 3-33 summarizes the main international donor activities.

Table 3-33 International Donors' Cooperation Projects Contributing to ET-CN in Lao PDR

\*Italicized descriptions with underlines are projects under consideration

Energy

Donor	C/P	Policy	Regulation	Tax system	Fundraising	Pilot	Capacity building
USAID (Energy Security Project)	MEM EDL	<u>Support for the development of a work plan for the implementation of the EV strategy</u>	<u>Support for development of power distribution grid code</u>		<u>1 mUSD Grant for Private Sector</u>	<u>Pre-FS of PV hybrids in hydropower</u> <u>Pre-FS of renewable energy storage technology on the grid</u>	<u>Integrated Resource and Resilience Planning Support Power System Planning Support for building internal and external coordination capacity of MEM staff Support for consultation on improving the local power grid Development of Rural Electrification Support Tools EDL Technical Capacity Enhancement Support</u>
GGGI	-	None in particular.					

59 ASEAN Catalytic Green Finance Facility (ACGF): Green Recovery Program <https://www.greenclimate.fund/project/fp156> accessed 3 August 2022

60 Implementation of the Lao PDR Emission Reductions Programme through improved governance and sustainable forest landscape management <https://www.greenclimate.fund/project/fp117> Accessed August 3, 2022



NZL REF	MEM EDL- Gen	Support for Revision of the Renewable Energy Strategy					Advice on dam safety <u>Improve EDL's power system management capabilities</u>
GIZ	-	None in particular.					
Asia Foundatio n, Australia	MEM	<u>Proposed Support Program for Energy Transition</u>					Legal advice on PPAs, etc.
UNESCA P	-	None in particular.					
UNFCCC CTCN	MEM	PtG Master Plan Proposal					

#### EV Promotion

Donor	C/P	Policy	Regulation	Tax system	Fundraisin g	Pilot	Capacity building
USAID	MEM	<u>Developing a strategy for public charging stations Electricity rate design for EVs Policy/Market/Progr am Design</u>	<u>Charging Station Regulatory Standards Review Charging station inspection and certificati on support</u>				Electricity rate design support Support for EV- related equipment standards
GGGI	MPW T	Policy analysis and recommendations on imports, vehicle registration, taxation, etc. <u>Policy Recommendations for EV Conversion</u>	Proposals for Technical Standards for Charging Plugs, Charging Stations, etc. <u>Vehicle inspection, vehicle registratio n and legal maintenan ce Proposal of Vehicle Disposal Scheme</u>		<u>Preferenti al interest rate financing for EVs (200 mUSD)</u>	Motorcycle Battery Sharing Pre (BBS) FS <u>BBS demonstrati on</u>	Training at the Vehicle Inspection Center Improved EV Recogniti on

NZL REF	MEM	Revision of the Renewable Energy Strategy					
GIZ	-	No cooperative program on EVs is currently being implemented. The company intends to hold a WS in the future to understand the needs of Laos.					
Asia Foundation	-	None in particular.					
UNESCO P	-	Policies and strategies on EVs are being implemented for Laos, Nepal, and other countries. No specific activities in Laos at this time. We are considering launching the Electric Mobility Initiative for Asia and the Pacific in the future.					

#### Energy conservation

Donor	C/P	policy	regulation	tax system	fundraising	pilot	capacity building
USAID	-	None in particular.					
GGGI UNIDO	MOI C	Establishment of a public-private steering committee Support for the Formulation of Green Industrial Policy			Based on a simple energy audit, an investment of 20-30mUSD	Energy efficiency and conservation audits at 25 factories	Energy Management System Training Training on ESCO
NZL REF	MEM		<u>Establishment of an energy manager system</u>				Support for collection of energy consumption data from large-scale energy consumers Support for formulating energy conservation indices <u>Development of Energy Consumption Database</u>
GIZ	MOI C		Establishment of eco-labels for products				
Asia Foundation	-	None in particular.					

UNESCA P	-	None in particular.
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### 3.3.3 Nepal

#### 3.3.3.1 Summary of Greenhouse Gas Emissions and NDC

The latest official GHG inventory by the Government of Nepal is the 2011 GHG inventory as shown in the National Communication 3rd Edition (NC3) <sup>61</sup> published in 2021. It shows that total GHG emissions were 45.2 million tCO<sub>2</sub>e in 2011, with the energy sector accounting for 33%, IPPU 1%, agriculture, forestry and other land use 64% and waste 2% (Figure 3-21), net GHG emissions are 28.2 million tCO<sub>2</sub> after subtracting GHG sequestration by forests and other sectors from GHG emissions. Note that the GHGs covered in the inventory are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs, and SF<sub>6</sub> among the seven GHGs specified by the IPCC. NC3 also summarizes GHG emissions for each subsector, with the top five largest GHG emission categories amounting to 38.2 million tCO<sub>2</sub>e (about 84% of total GHG emissions) (Table 3-34). One of the characteristics of GHG emissions in Nepal is that about three-fifths of the GHG emissions come from agriculture, forestry and other land use sectors. Three out of the top five categories are related to agriculture, forestry and other land use, while the remaining two are CO<sub>2</sub> emissions from biomass use (methane) in the energy sector and from brick manufacturing. However, the official GHG inventory is outdated as of 2011, and CO<sub>2</sub> emissions from the transport sector have increased in Nepal in recent years due to the rapid increase in the number of cars and from the construction materials industry during reconstruction after the 2015 earthquake (Figure 3-22 Figure 3-23).

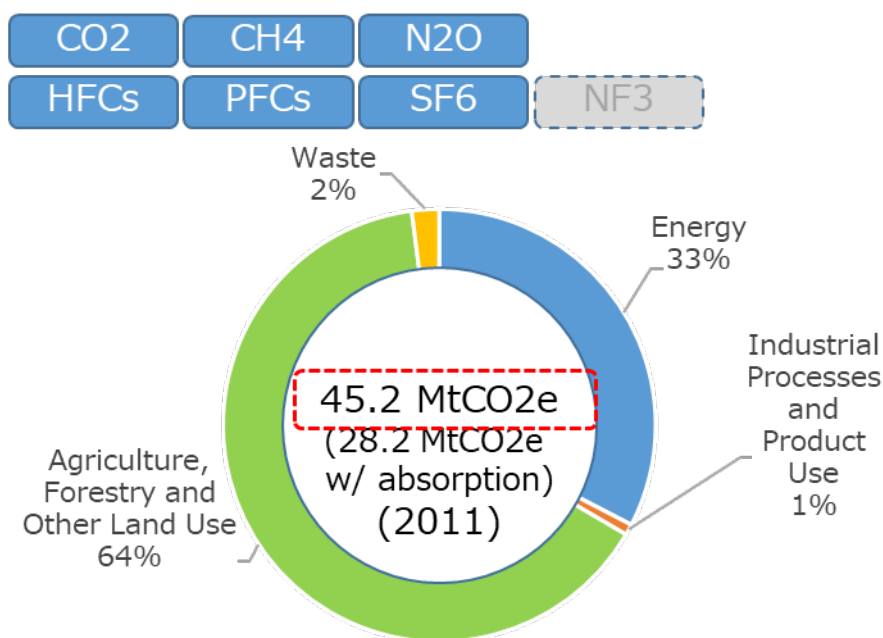


Figure 3-21 GHG Inventory of Nepal (2011) <sup>62</sup>

<sup>61</sup> National communication (NC3) (Ministry of Forest and Environment, 2021) [https://unfccc.int/sites/default/files/resource/TNC%20Nepal\\_Final\\_v2.pdf](https://unfccc.int/sites/default/files/resource/TNC%20Nepal_Final_v2.pdf)

<sup>62</sup> Prepared by Pacific Consultants based on NC3 of Nepal.

Table 3-34 GHG Emissions by Sub-sector in Nepal <sup>63</sup>

Sector	Sub-sector		ktCO2e
Energy	Fuel Combustion	-Energy Industries	2.38
		-Manufacturing and Construction	2,256.2
		-Transport	1,739.5
		-Others (e.g., non-CO2 from biomass combustion in other sector)	10,753.5
Industrial Processes and Product Use	Mineral industries	-Cement Production	350.2
		Non-energy products from fuels and solvent use	5.2
	Product uses as substitutes for ozone depleting substances		13.0
Agriculture, Forestry, and Other Land Use (AFOLU)	Livestock	-Enteric Fermentation	16,218.5
		-Manure Management	1,446.6
	Land	-Forest Land	-17,077.8
		-Non-forest land	35.4
	Aggregate sources and non-CO2 emissions sources on land	-Rice cultivations	3,974.9
	-Other (e.g., indirect N2O from manure management)	7,524.7	
Waste	Solid Waste Disposal	Biological Treatment of Solid Waste	4.5
		Open burning of Waste	12.7
		Wastewater Treatment and Discharge	644.8
			261.6

\*The main types of GHG emissions in GHG emissions are shown in black: CO2, red: CH4, blue: N2O, and green: HFCs.

\*Negative (-) in GHG emissions indicates GHG absorption.

\*Yellow highlights indicate the top five GHG emitters.

## 5 Major Emission category

Sector	Key emission category	ktCO2e	
AFOLU	Enteric Fermentation	16,218.5	CH4
Energy	Non-CO2 from biomass combustion in other sector	10,753.5	CH4
AFOLU	Indirect N2O from manure management	5,760.3	N2O
AFOLU	Rice Cultivation	3,974.6	CH4
Energy	Brick manufacturing	1,493.3	CO2

63 Prepared by Pacific Consultants based on NC3 of Nepal.

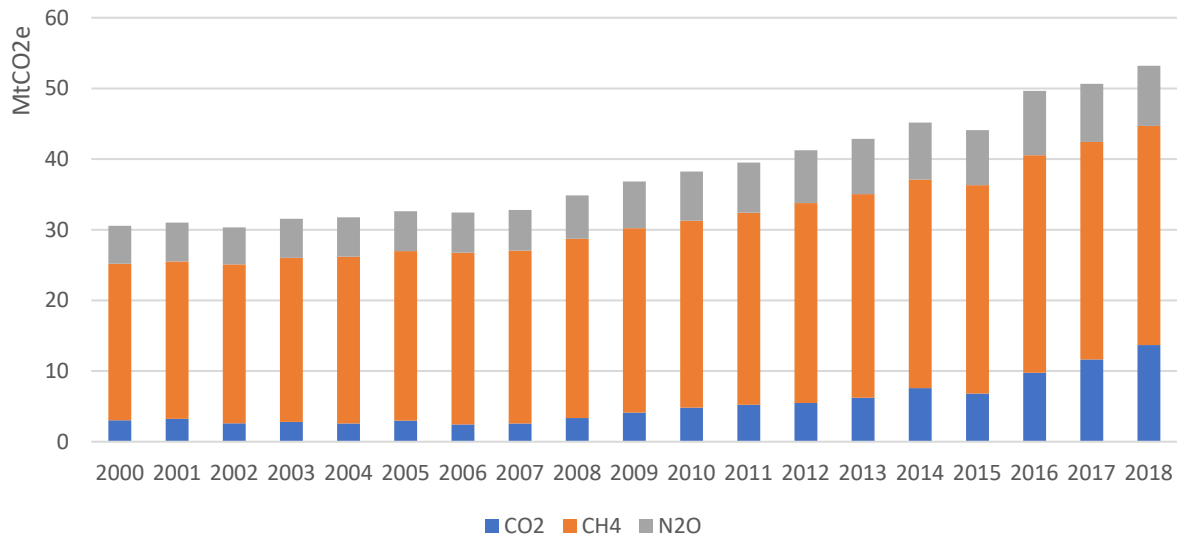
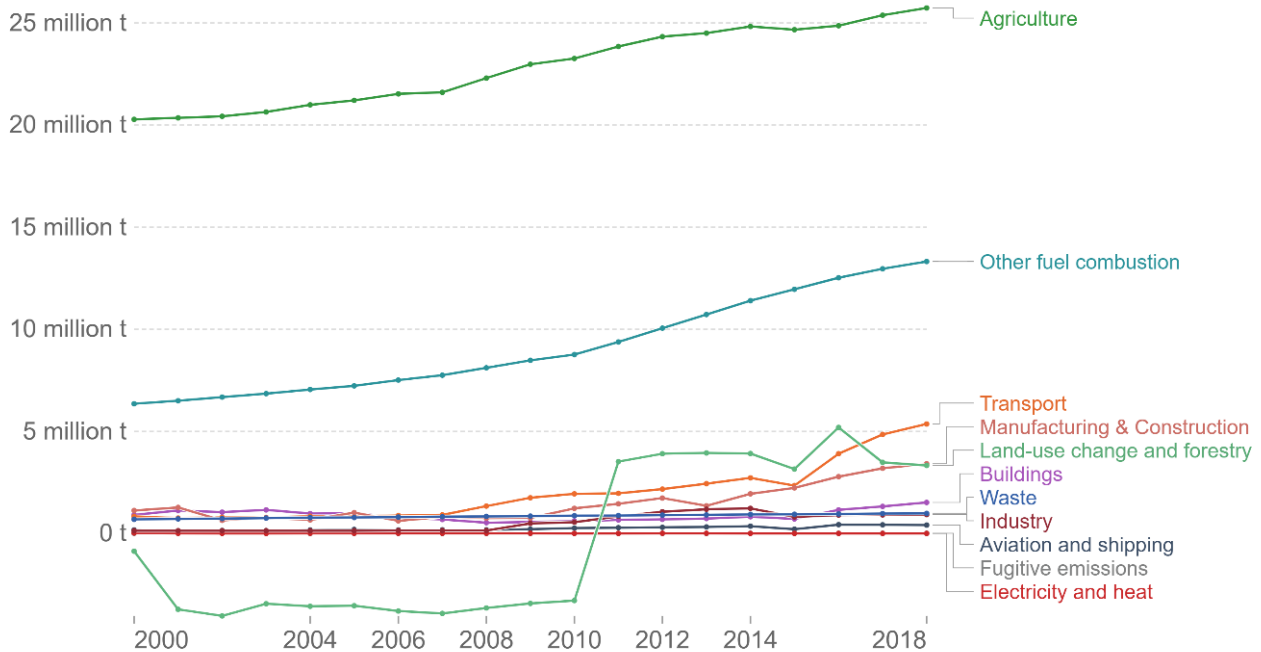


Figure 3-22 Change in GHG Emissions in Nepal Over Time (2010-2018) <sup>64</sup>

### Greenhouse gas emissions by sector, Nepal

Emissions are measured in carbon dioxide equivalents (CO2eq). This means non-CO2 gases are weighted by the amount of warming they cause over a 100-year timescale.



Source: CAIT Climate Data Explorer via Climate Watch

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.

Figure 3-23 GHG emissions by sector in Nepal <sup>65</sup>

64 Prepared by Pacific Consultants based on Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

65 Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

Nepal issued its revised NDC (NDC2) <sup>66</sup> in 2020, which presented mitigation measures and targets in energy, agriculture and forestry and other land use and waste sectors (Table 3-35). According to the NDC, the development of 5,000 MW of renewable energy, such as hydropower, is listed as a mitigation measure through national efforts. On the other hand, under the international support, the development of 8,600 MW of renewable energy, the penetration of EVs, the penetration of electric cookers, the restoration of forest cover, REDD+, and the improvement of waste and wastewater treatment are mentioned.

Table 3-35 GHG Emission Reduction Measures in Nepal's NDC2 <sup>67</sup>

Sector	Mitigation Target (2021-2030)	Target. Unconditional (left), Conditional (right)	
Energy	By 2030, expand clean energy from 1,400MW to 15,000MW (5-10%: micro-hydro, solar, wind, bioenergy)	5,000 MW	8,600 MW
	By 2030, 15% of the total energy demand is supplied from clean energy sources	-	-
	By 2025, 25% of private vehicle, 20% of public vehicle sales are EV	-	▼ 253 ktCO <sub>2</sub> in 2025
	By 2030, 90% of private vehicle, 60% of public vehicle sales are EV	-	▼ 1,021 ktCO <sub>2</sub> in 2030
	By 2030, develop 200km electric rail network	-	200km rail
	By 2030, 25% households use electric stoves for cooking	-	▼ 225 ktCO <sub>2</sub> in 2025
	By 2025, install 500,000 improved cookstoves in rural areas	-	▼ 465 ktCO <sub>2</sub> in 2030
	By 2025, install 200,000 household biogas plants and 500 large scale biogas plants (institutional/industrial/municipal/community)	-	
Agriculture, forestry and land use	By 2030, maintain 45% forest cover	-	45%.
	By 2030, manage 50% of Tarai and Inner Tarai forests*, 25% of middle hills and mountain forests sustainability, including through the use of funding from REDD+ initiative	-	-
Waste	By 2030, treat 380 million liters/day of wastewater before being discharged, and manage 60,000 m <sup>3</sup> /y of fecal sludge.	-	300 million/d of wastewater 60,000 m <sup>3</sup> /y of fecal sludge ▼ 258 ktCO <sub>2</sub>

66 Second Nationally Determined Contribution (NDC) (Government of Nepal, 2020) <https://unfccc.int/sites/default/files/NDC/2022-06/Second%20Nationally%20Determined%20Contribution%20%28NDC%29%20-%202020.pdf> 2022 Access ed 16 July

67 Prepared by Pacific Consultants based on NDC2 of Nepal.

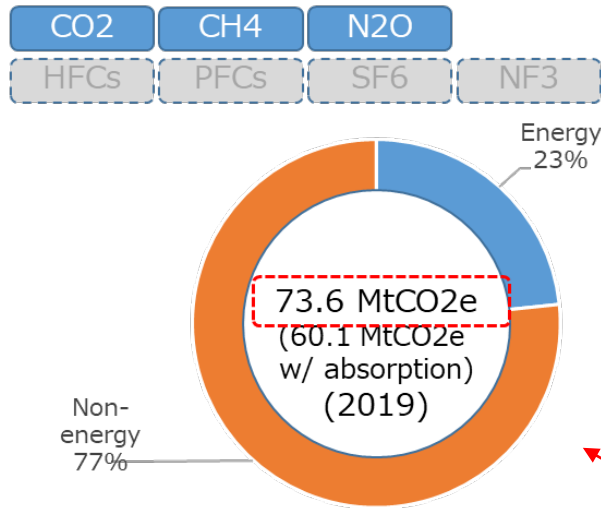
Nepal's "Nepal's Long-Term Strategy for Net-zero Emissions" (NLTS) <sup>68</sup>, is a net-zero strategy to 2050 in addition to the NDC. The strategy uses GHG emissions in 2019, calculated using the LEAP model <sup>69</sup>, as a starting point and projects CO2 emissions to 2050. It also projects the CO2 emission pathways for each "With Existing Measures" (WEM: existing mitigation measures) and "With Additional Measures" (WAM: additional mitigation measures) (CH4 and N2O are not considered). According to those projections, CO2 emissions of 23 million tCO2 in 2019 would increase to 42 million tCO2 in 2030 and 79 million tCO2 in 2050 (of which 54% would come from the energy sector) under the reference scenario, but could be reduced to 1.5 million tCO2 in 2030 and 29 million tCO2 in 2050 under the WEM scenario, and 4 million tCO2 in 2030, net zero in 2045, and -6 million tCO2 in 2050 under the WAM scenario, which is net negative. (Figure 3-25). In the WAM scenario, it is possible to achieve the national target of net-zero in 2045, and it is effective to consider active implementation of mitigation measures considered in the WAM scenario to actually achieve net-zero in 2045. The mitigation measures for each sector in the WAM scenario are summarized in the following Table 3-36.

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68 Nepal's Long-Term Strategy for Net-zero Emissions" (Government of Nepal, 2021) <https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf> Accessed July 16, 2022

69 Low Emission Analysis Platform (formerly Long-range Energy Alternatives Planning System) is a tool for energy and mitigation planning developed by the Stockholm Environment Institute.





Sector	Sub-sector	CH4	N2O	CO2	ktCO <sub>2</sub> e
Energy	Residential	0.41	3.57	2.09	6.07
	Transport	0.40	0.01	4.73	5.15
	Industrial	0.02	0.02	4.45	4.49
	Commercial	0.01	0.13	0.54	0.69
	Agriculture	0.01	0.00	0.78	0.78
Non-Energy	IPPU	0.00	0.00	1.87	1.87
	Agriculture	1.39	26.3	0.17	27.86
	Waste	0.00	4.73	0.00	4.73
	LULUCF (emissions)	0.00	0.00	21.93	21.93
LULUCF	Removals	0.00	0.00	-13.5	-13.5

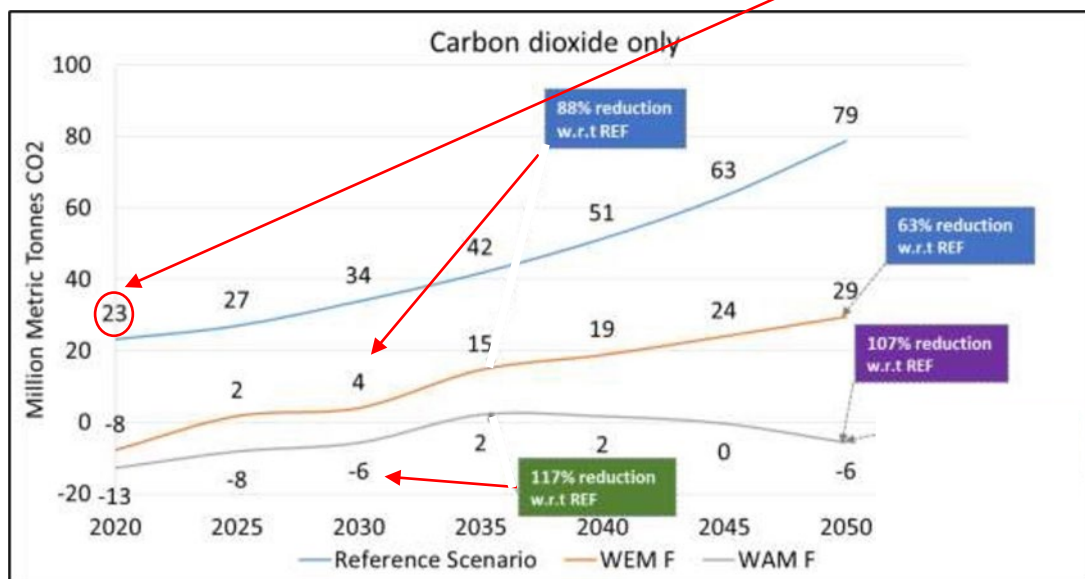
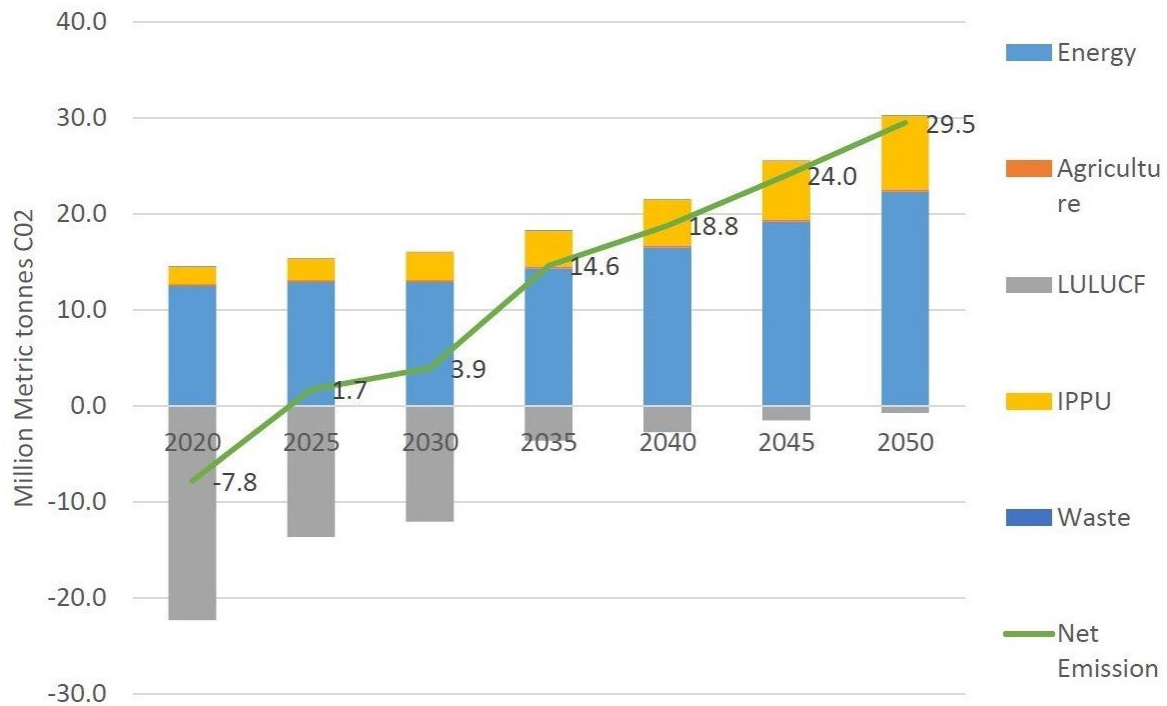
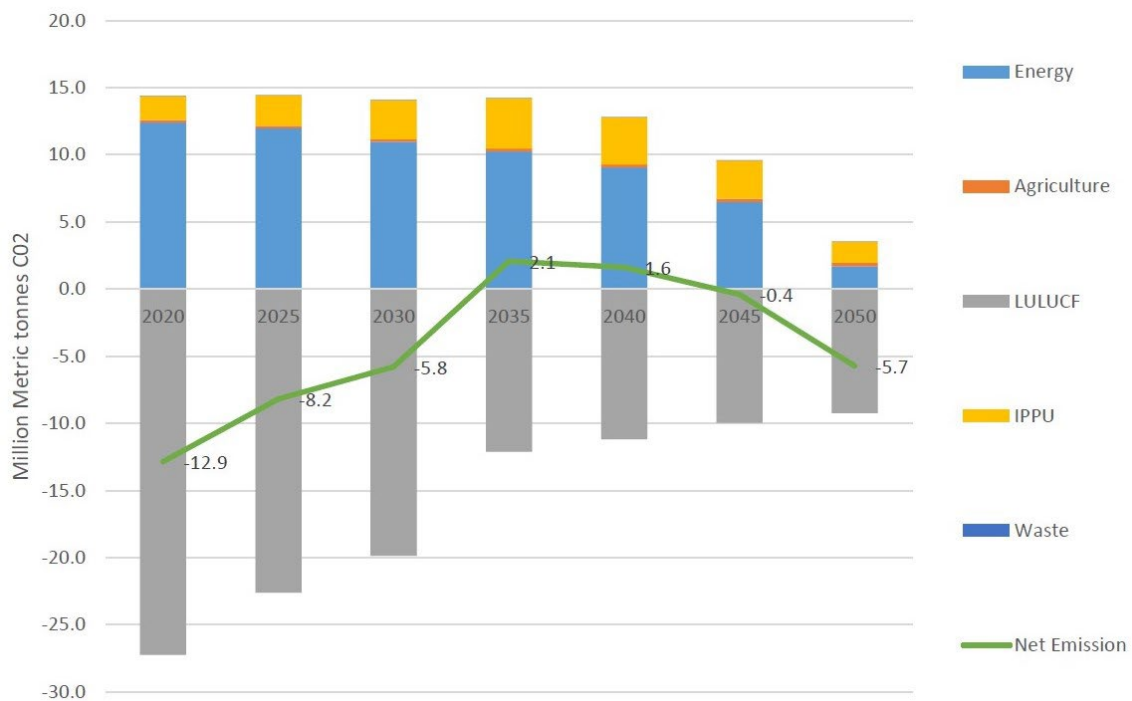


Figure 3-24 Projected CO<sub>2</sub> Emissions in Nepal's NLTS to 2050 <sup>70</sup>

<sup>70</sup> Prepared by Pacific Consultants based on NLTS.



CO2 emission pathways in the WEM scenario



CO2 emission pathways in the WAM scenario

Figure 3-25 CO2 Emission pathways for WEM (upper) / WAM (lower) Scenarios in Nepal's LTS <sup>71</sup>

<sup>71</sup> Nepal's Long-Term Strategy for Net-zero Emissions" (Government of Nepal, 2021) <https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf> Accessed July 16, 2022

Table 3-36 Mitigation measures in Nepal's LTS <sup>72</sup>

Sector	Subsector	Mitigation measure	Milestones in the WAM scenario
Energy	Generation (e.g., power)	<ul style="list-style-type: none"> <li>• Development of Hydroelectric Power Generation</li> <li>• Development of renewable energy and its integration into the power grid</li> <li>• Scaling up distributed energy resources</li> <li>• Develop policies on regional power sector integration and grid flexibility</li> </ul>	<ul style="list-style-type: none"> <li>• By 2050, 50 GW hydropower, 2.1 GW grid-connected solar PV, 1.1 GW off-grid renewable energy</li> </ul>
	Consumer	<ul style="list-style-type: none"> <li>• Electrification of end-consumer services in urban areas</li> <li>• Promoting Clean Cookstoves in Rural Areas</li> <li>• Electrification of cooking, heating, hot water and lighting in rural areas</li> <li>• Promoting efficient technology in end-consumer services</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 1.7 MtCO<sub>2</sub>e in 2030 and 4.45 MtCO<sub>2</sub>e in 2050</li> </ul>
	Industry	<ul style="list-style-type: none"> <li>• Expanding efficient and clean production technologies</li> <li>• Electrification of process heat, boilers and power in all industries</li> <li>• Replacement of brick kilns with improved brick kilns (zigzag kilns, electric tunnel kilns)</li> <li>• Introduction of CCUS in the cement industry</li> <li>• Introduction of green fuels (electricity, waste, hydrogen) in thermal processes</li> <li>• Introduction of electrical technology in process heat in heavy industry (metal, cement, brick)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 3.3 MtCO<sub>2</sub>e in 2030 and 19.8 MtCO<sub>2</sub>e in 2050</li> </ul>
	Transportation	<ul style="list-style-type: none"> <li>• Promotion of electrification of mass passenger transport</li> <li>• Conversion to clean fuels (electricity, fuel cells, synthetic fuels, biofuels)</li> <li>• Electrification of freight transport</li> <li>• Expand installation of charging stations</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 2.1 MtCO<sub>2</sub>e in 2030 and 19.5 MtCO<sub>2</sub>e in 2050</li> </ul>
	Trade	<ul style="list-style-type: none"> <li>• Achieve full electrification in all commercial sectors</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 1.2 MtCO<sub>2</sub> by 2030</li> </ul>
	Agriculture	<ul style="list-style-type: none"> <li>• Electrification of agricultural and pumping facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 0.4 MtCO<sub>2</sub>e in 2030</li> </ul>

<sup>72</sup> Prepared by Pacific Consultants based on NLTS.

		<ul style="list-style-type: none"> <li>Promotion of pumps using solar power generation</li> </ul>	and 2.8 MtCO <sub>2</sub> e in 2050
Agriculture	Fermentation	<ul style="list-style-type: none"> <li>GHG-aware gene selection and breeding</li> <li>Optimization of feed formulation</li> <li>Use of animal feed additives</li> <li>Use of feed grain processing to improve digestibility</li> <li>Improved animal health monitoring and disease prevention</li> <li>Improvement of livestock production efficiency technology</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of 0.4 MtCO<sub>2</sub>e in 2030 and 2.8 MtCO<sub>2</sub>e in 2050</li> </ul>
	Soil Management	<ul style="list-style-type: none"> <li>Promotion of anaerobic manure treatment</li> <li>Effective use of nutrients from livestock</li> <li>Application of nitrification inhibitors to pasture grasses</li> <li>Promotion of technologies to improve livestock production efficiency</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of 0.12 MtCO<sub>2</sub>e in 2030 and 0.5 MtCO<sub>2</sub>e in 2050</li> </ul>
	Nutrition/Manure management	<ul style="list-style-type: none"> <li>Improvement of water management in paddy fields</li> <li>Widespread use of dry direct sowing in rice cultivation</li> <li>Improvement of rice straw management</li> <li>Promotion of selection of optimum rice varieties</li> <li>Improvement of paddy rice fertilization</li> <li>Expansion of low-tillage and no-tillage cultivation</li> <li>Reduction of excessive nitrogen fertilization</li> <li>Promotion of variable fertilizer application</li> <li>Implementation of nitrogen fixation rotation</li> <li>Improved timing of fertilizer application</li> <li>Use of controlled-release fertilizers and stabilized fertilizers</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of 1.5 MtCO<sub>2</sub>e in 2030 and 6.5 MtCO<sub>2</sub>e in 2050</li> </ul>
	Livestock management	<ul style="list-style-type: none"> <li>Methane recovery</li> <li>Increase in incineration</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of 1.4 MtCO<sub>2</sub>e in 2030 and 6.4 MtCO<sub>2</sub>e in 2050</li> </ul>
Forestry	Countermeasures against deforestation	<ul style="list-style-type: none"> <li>Prevent land cover conversion</li> <li>Promoting afforestation</li> <li>Promotion of private forestry</li> </ul>	<ul style="list-style-type: none"> <li>Zero forest degradation by 2030</li> <li>Double the amount of absorption by afforestation.</li> </ul>

	Forest degradation countermeasures	<ul style="list-style-type: none"> <li>• Reduction of degradation due to fire, illegal logging, etc.</li> <li>• Reduction of unsustainable grazing</li> <li>• Promoting the use of alternative energy sources for cooking and heating</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce deforestation by 90% and forest fires by 75% by 2030</li> </ul>
	Utilization of wood	<ul style="list-style-type: none"> <li>• Promoting the use of harvested timber</li> <li>• Promotion of agriculture and forestry producing wood products</li> <li>• Improvement of logging techniques</li> <li>• Promotion of wood technology (e.g., composite wood)</li> </ul>	<ul style="list-style-type: none"> <li>• Self-sufficient in wood products</li> </ul>
	Adoption of integrated systems	<ul style="list-style-type: none"> <li>• Balancing development and infrastructure improvement</li> <li>• Compensation for forest land reduced by development</li> </ul>	<ul style="list-style-type: none"> <li>• Complement targets for forest loss and increase</li> </ul>
	Sustainable forest management	<ul style="list-style-type: none"> <li>• Formulation of directives and guidelines</li> <li>• Implement systems that promote forest growth</li> <li>• Promoting sustainable forest management</li> </ul>	<ul style="list-style-type: none"> <li>• 75% of forests in the Terai and 75% of forests in the mid-hills between 2030 and 2050</li> </ul>
	Forest research and development	<ul style="list-style-type: none"> <li>• Capacity building for information processing such as forest statistics</li> <li>• Establishment of an observation system for GHG emissions</li> <li>• Enhanced forest baseline data</li> </ul>	<ul style="list-style-type: none"> <li>• Compilation of statistics on annual soil coverage changes</li> <li>• Enhancing forest emissions-related information</li> </ul>
Waste	Promotion of WtE	<ul style="list-style-type: none"> <li>• Methane recovery from landfills</li> <li>• Incineration heat utilization and power generation</li> <li>• Methane utilization from anaerobic treatment of wastewater</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of 1.6 MtCO<sub>2</sub>e in 2030 and 5.7 MtCO<sub>2</sub>e in 2050</li> </ul>

### 3.3.3.2 Policy Framework and Institutions

While Nepal is rich in energy resources such as hydropower and biomass, over the past two decades rapid population growth, economic development and motorization have increased the country's dependence on fossil fuel imports. Fossil fuel imports are not only putting pressure on government finances but also increasing GHG emissions, and the Nepalese government is working on developing a policy and regulatory framework to achieve the net zero target for 2045 through ET-CN initiatives. Among the key policies, those related to ET-CN are as follows.

Table 3-37 Policy Framework and Institutions Contributing to ET and CN in

Nepal (in chronological order) <sup>73</sup>

No.	Policy/Regulation	Year of Issue	Issuing Authority	Relevance to ET/CT
1	Budget Speech of Fiscal Year 2022/23	2022	MoF	Budget policy on renewable energy, energy-saving initiatives, promotion of EVs, use of hydrogen energy, etc.
2	Environmentally Friendly Local Government Framework	2021	MoFAGA	Framing local government environmental policy, including climate change action measures
3	Industrial Enterprises Act	2020	MoICS	Reduction of GHG emissions in the industrial sector
4	Environment Protection Regulation	2020	MoFE	GHG emission reduction, EV promotion, energy saving
5	National Environment Policy	2019	MoFE	GHG emission reduction, biomass use reduction, EV promotion, electrification, energy saving
6	Environment Protection Act	2019	MoFE	GHG emission reduction
7	National Climate Change Policy	2019	MoFE	GHG emission reduction, electrification, EV promotion, forest management
8	The Fifteenth Plan (Fiscal Year 2019/20 - 2023/24)	2019	NPC	Reduction of GHG emissions, promotion of renewable energy, reduction of biomass use, promotion of EVs, electrification, energy conservation
9	White paper on energy and water	2018	MoEWRI	Renewable energy dissemination, etc.
10	Nepal National REDD + Strategy (2018 -2022)	2018	MoFE	Spread of renewable energy, electrification, biogas, and electric cookers
11	National Energy Efficiency Strategy	2018	MoEWRI	Energy conservation and energy efficiency
12	The Biomass Energy Strategy	2017	MoPE (at the time)	Promotion of sustainable biomass use
13	National Urban Development Strategy	2017	MoUD	Renewable energy dissemination, etc.
14	Renewable Energy Subsidy Policy	2016	MoPE (at the time)	Renewable energy dissemination
15	Constitution of Nepal	2015	Constituent Assembly	Renewable energy dissemination
16	Agriculture Development Strategy (2015-2035)	2015	Ministry of Agricultural Development (at the time)	Rural electrification, promotion of renewable energy, promotion of biogas use

73 Prepared by Pacific Consultants based on Nepal's ministry websites and interviews.

17	Nepal Sustainable Development Goals Status and Roadmap: 2016 -2030	2015	NPC	Renewable energy dissemination, etc.
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An outline of each measure is as follows.

1. Budget Speech of Fiscal Year 2022/23 (2022)

The Ministry of Finance made a speech on the Government Budget for 2023<sup>74</sup> on May 29, 2022. It listed 10 priorities, which included agrarian reforms, infrastructure development and expansion of power infrastructure.

Notable policies related to ET and CN are described below.

- ✓ Develop an initiative to establish a chemical fertilizer plant using green hydrogen and green ammonia technologies
- ✓ Large-scale infrastructure projects led by the government will use green bonds
- ✓ Conduct FS for Kathmandu Metro
- ✓ Establish an energy consumption plan and set annual electricity consumption per person at 400 kWh.
- ✓ Utilize renewable energy sources such as small-scale hydropower and solar power to supply electricity to 25,000 off-grid households
- ✓ Select reservoir type for more than 50% of hydropower projects
- ✓ NEA operates 50 EV charging stations in Nepal
- ✓ Encourage the installation of charging stations at private fueling stations
- ✓ Replacing energy sources in the brick industry with electricity
- ✓ To reduce LPG consumption, subsidies for LPG will be phased out and subsidies for electricity will be increased
- ✓ Begin the work necessary to make hydrogen energy commercially available.
- ✓ 40% income tax exemption for five years for EV-related industries such as new EV assembly plants
- ✓ Import duty on electric three-wheeled and two-wheeled parts to be 1%.

2. Environment Friendly Local Government Framework (2021)

The Framework developed by MoFAGA is to promote environmental policies in local government and build an environmentally friendly society. The four main objectives are as follows.

- ✓ Mainstreaming and localizing environmental protection, sanitation, waste management, biodiversity protection, climate change adaptation, and disaster management in local planning processes
- ✓ Clarification of responsibilities, roles, etc. at the household level in the areas of climate change adaptation, disaster management, environmental protection and waste management

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<sup>74</sup> The financial year in Nepal is from July 15 to July 14 of the following year.

✓ Encouraging environmentally sustainable development in local communities and households through positive feedback

✓ Cooperation among stakeholders in environmental protection and sustainable development

It sets indicators for the implementation of environmental policies by municipalities, which include the use of clean energy, the use of electric stoves, water source management and waste reduction.

### 3. Industrial Enterprises Act (2010)

The act stipulates that the industrial sector must conduct initial environmental studies and take action to mitigate environmental impacts.

### 4. Environment Protection Regulation (2020)

The regulation indicates that priority will be given to clean energy, EVs and energy-saving technologies to reduce GHG emissions. Target sectors are energy, industry, forestry, land use, and waste, and measures to reduce GHG emissions are provided. It also states that government agencies, organizations, and private companies can sell credits for GHG emission reductions in domestic and international carbon markets through the government and other entities.

### 5. National Environment Policy (2019)

The policy aims to reduce and prevent environmental pollution through waste management in the household, industrial and commercial sectors and by increasing the area of green space. Specifically, the policy aims to reduce GHG emissions from households through the use of biomass energy, solar cookers, electric stoves and improved cook stoves. It also aims to promote energy efficient buildings. The policy also focuses on promoting alternatives to fossil fuel vehicles such as EVs, hybrids and hydrogen-fueled vehicles and consumption of eco-labelled products to promote clean energy in Nepal. In addition, the policy will also focus on promoting the construction of biogas plants at the regional level to promote the use of bioenergy and organic fertilizers, and the use of renewable energy, particularly through the promotion of bicycle lanes and sidewalk infrastructure and the introduction of EVs to reduce GHG emissions from vehicles that consume fossil fuels. This policy will be renewed every five years.

### 6. Environment Protection Act (2019)

This stipulates, among other things, the submission of environmental reports to be handled by implementers of development projects and commercial activities in general that emit pollutants. It also provides for GHG emission reduction measures for development projects implemented by central and local governments, including the provision of information from the Ministry on periodic GHG emissions calculations and for the government to conduct calculations and determine impacts as necessary. It also states that the government may participate in carbon trading markets established with other governments and the private sector.



## 7. National Climate Change Policy (2019)

On mitigation, the promotion of technology development to reduce black carbon and GHG emissions is indicated. On the financial side, the report states that funding will be obtained through bilateral and multilateral international financial mechanisms such as REDD+, the Green Climate Fund, the Global Environment Facility, the Adaptation Fund, the Climate Investment Fund (CIF) and carbon trading, with over 80% of the funds used for program implementation at the local level. As for private finance, the MoFE recommends the use of green bonds and carbon trading. The MoFE will also develop a Low Carbon Economic Development Strategy and a National Strategy for Carbon Trade.

The main mitigation-related policies in each sector are as follows.

- ✓ Agriculture: Use of efficient irrigation technologies. Promotion of agroforestry on uncultivated land. Promotion of low carbon and energy saving technologies in the production, collection, processing and storage processes of agricultural products and in livestock production.
- ✓ Forests: Enhancing GHG fixation capacity through the adoption of sustainable forest management. Promoting agroforestry in slopes and low quality forest areas; attracting funding through REDD+ and CDM.
- ✓ Water resources and energy: Ensure water and energy security by promoting cascading use of water resources and renewable energy.
- ✓ Rural and urban development: Incorporate low carbon technologies into development plans.
- ✓ Industry, transport and infrastructure: Develop mitigation standards and identify sources of emissions in the industry and transport sectors. Promote the application of energy-saving technologies and electricity consumption; promote EVs; encourage GHG emission reductions in the private sector through CSR activities; and encourage the use of energy-efficient technologies in the transport sector. Phase-out of vehicles after a certain number of years of use.
- ✓ Tourism: Aim for zero emissions at tourist attractions using renewable energy and energy-saving technologies.
- ✓ Waste: Household waste is separated and biodegradable waste is encouraged to be used as alternative energy at the household level.

## 8. The Fifteenth Plan (Fiscal Year 2019/20 - 2023/24) (2019)

It is a five-year plan for socio-economic development and serves as a high-level plan that forms the basis for the policies of the ministries and agencies. Its vision is to achieve rapid and balanced economic development, prosperity, good governance and well-being of the people. The Plan also aims to move Nepal from a Least Developed Country to a Developing Country by 2022 and to raise it to the level of a middle-income country by 2030 through the achievement of the SDGs.

The specific targets in the energy sector in this plan are as follows.

- ✓ Increase hydropower capacity to 5,000 MW.

- ✓ Achieve 100% electrification rate.
- ✓ Increase the share of renewable energy in total energy consumption from 7% to 12%.
- ✓ Extend the total length of 66kV and above transmission lines to 8,000km, 33kV lines to 7,300km and 11kV lines to 43,352km.
- ✓ To earn income from carbon trading, a total of 500 large-scale biogas plants will be installed to reduce LPG imports by 40,000 tons.
- ✓ Solar power generation from 33 MW in FY 2018-19 to 160 MW by the end of 2024.

The following targets have been set for the transport and transportation sector.

- ✓ Promote the use of environmentally sustainable vehicles.
- ✓ Automotive testing facilities were established to measure vehicle emissions.
- ✓ Focus on the promotion of EVs.

In the industrial sector, the government will promote the use of clean energy under the green growth concept.

In the consumer sector, the following targets have been identified to increase electricity consumption by making the distribution system more efficient and reliable to improve energy efficiency and to expand access to electricity.

- ✓ Hydroelectric power will replace fossil fuels to realize the "Smokeless Kitchen" concept.
- ✓ Establish an appropriate rate structure for electricity used for cooking.
- ✓ "Every Home, Energy Home" concept to promote energy efficiency programs and rooftop solar PV connection to the grid based on net metering and net payments.
- ✓ Develop and implement energy conservation standards for electric heaters and electronic equipment.

Others include the implementation of GHG emissions monitoring from transport and transportation, industry and commerce, agriculture, forestry and energy sectors; community-based forest management to maximize carbon fixation; human resource capacity building to address climate change; and climate change education in about 90% of schools. It also indicates that access to modern and sustainable energy will be facilitated by promoting carbon trading markets with the help of financial institutions.

#### 9. White paper on energy and water (2018)

This is a white paper on MoEWRI's development policy for the energy and water resources sector, and the policies and objectives are as follows

- ✓ Power projects of 3,000 MW in 3 years, 5,000 MW in 5 years and 15,000 MW in 10 years (including 10,000 MW for domestic supply) will be developed by the Government, NEA and private companies.
- ✓ Under the "One Province, One MW Project" program, at least one hydro and solar power project will be constructed in each province.

- ✓ At least one medium-sized hydropower project will be constructed at the expense of the provincial/local government.
- ✓ Under the slogan "Every House, Energy House", launch a campaign on energy conservation programs for rooftop photovoltaics connected to the grid at home through net metering and net payments.
- ✓ The Electricity Utilities Act and the Electricity Corporation of Nepal Act will be amended and the Renewable Energy Development Act will be enacted. The Electricity Regulatory Commission will be completed in accordance with the Electricity Regulatory Commission Act, 2017.
- ✓ Increase per capita annual electricity consumption to 700 kWh over the next five years and 1,500 kWh over the next 10 years.
- ✓ Improve energy efficiency.
- ✓ Implement the necessary programs to increase the use of energy generated through waste-to-energy conversion.
- ✓ Modernize and consolidate the power distribution infrastructure.
- ✓ Improve the existing power distribution network in major cities including Kathmandu.
- ✓ Expand and strengthen industrial transmission lines and substations to provide reliable power services to industrial zones and special economic zones.
- ✓ To improve the power system, smart meters and smart grid systems will be introduced.
- ✓ Take the necessary legal, technical and administrative measures to reduce and more effectively manage electrical leakage.

#### 10. Nepal National REDD+ Strategy (2018 -2022) (2018)

The Strategy aims to analyze the impacts of climate change on forest ecosystems and integrate them into forest management plans. It also states that the role and importance of forest conservation in mitigating climate change will be incorporated into education. The Strategy also addresses the energy sector, focusing on promoting the use of sustainable energy sources such as biogas, solar and wind power, enhancing rural people's access to sustainable and affordable alternative energy sources, as well as promoting the use of electric stoves and improved biomass stoves. Others include developing measures to facilitate access to alternative energy and energy saving technologies for poor and rural people dependent on forests and biomass use, and implementing programs to promote natural, protected, community, private and agroforestry forests through sustainable forest management.

#### 11. National Energy Efficiency Strategy (2018)

The Strategy promotes the use of energy efficient equipment in the transport and industrial sectors to reduce energy imports and GHG emissions and air pollution by promoting clean energy use and energy conservation. The goal is to double the average rate of improvement in energy efficiency in Nepal from 0.84% per annum in 2000-2015 to 1.68% per annum in 2030. The specific targets are as follows.

- ✓ Establish an organization dedicated to energy efficiency and conservation advocacy, development, and implementation.
- ✓ Strengthen MoEWRI's existing energy efficiency measures and implement various energy efficiency related initiatives.
- ✓ Conduct surveys and research on energy efficiency and the demand side, and develop technologies related to energy efficiency.
- ✓ Formulate a national energy conservation action plan to institutionalize energy conservation.
- ✓ Set minimum energy performance standards for equipment used in different sectors.
- ✓ Conduct energy conservation campaigns targeting the industrial, commercial, and transportation sectors.
- ✓ Encourage the use of energy efficient equipment in the transport and industrial (manufacturing) sectors.
- ✓ Implement initiatives to help farmers learn about energy efficient agricultural equipment and how to use it.
- ✓ Conduct awareness-raising activities in the consumer sector to stimulate energy conservation awareness from consumers to policy makers.

#### 12. The Biomass Energy Strategy (2017)

The Ministry of Population and Environment (then MoFE, now MoFEM) has developed this Strategy to promote the use of biomass as an affordable and sustainable energy source. The strategy aims to enhance the production of sustainable biomass energy from organic wastes in agriculture and forests and to provide financial support for the development of affordable biomass energy technologies (biogas, improved cook stoves (ICS), briquettes, pellets, combined heat and power, waste to energy, etc.), including feasibility, quality control, emission standards and financial support for technology development and to increase the efficiency of biomass energy consumption. Furthermore, it states that all households will have access to clean cookstoves by 2022 and all households using biomass will have access to modern clean energy by 2030. The specific targets are as follows.

- ✓ 3 million improved cook stoves will be made available to households using conventional biomass.
- ✓ About 600,000 household biogas systems using livestock manure will be installed.
- ✓ 20,000 tons of pellets and briquettes will be produced per year.
- ✓ Provide sufficient financial incentives (such as tariff and VAT exemptions) for the production, processing and distribution of biodiesel and bioethanol, as well as subsidies and credit facilities.

#### 13. National Urban Development Strategy (2017)

The policy of this strategy is to provide sustainable and sufficient energy supply or 100% electricity access for all urban activities, with the goal of providing a stable energy source to

households across the country using alternative energy sources within 15 years.

#### 14. Renewable Energy Subsidy Policy (2016)

It aims to promote cost reduction and use of alternative energy sources in rural Nepal through research on renewable energy technologies. The policy will provide subsidies for a range of renewable energy technologies, including hydro, solar, biogas, biomass and wind. The amount of subsidy will be calculated based on cost per output and will generally be around 40% of the total cost.

#### 15. Constitution of Nepal (2015)

The Constitution provides for the reliable supply and proper use of energy through the development of renewable energy sources.

#### 16. Agriculture Development Strategy (2015-2035) (2015)

The Strategy focuses on rural electrification, enhancement of renewable and alternative energy sources and sustainable agriculture through the promotion of biogas and biomass. The main action plans that will contribute to GHG emission reductions are as follows.

- ✓ Income tax incentives to encourage investment in crops, machinery and irrigation infrastructure
- ✓ Promoting Green Technology
- ✓ Rural electrification and increased use of renewable energy
- ✓ Promotion of good practices integrating soil and plant condition management, pest management and livestock management to promote sustainable agriculture and the use of renewable energy based on biogas and biomass utilization
- ✓ Encouraging local forestry groups to use alternative energy sources and energy conservation measures

#### 17. Nepal Sustainable Development Goals Status and Roadmap: 2016 -2030 (2015)

Target 7.1 of the SGDs aims to ensure access to affordable, reliable, sustainable and modern energy for all. Goal 7.a. states that international cooperation will be strengthened by 2030 to make clean energy research and technologies, including renewable energy, energy efficiency and clean fossil fuel technologies, more accessible and to promote investment in energy infrastructure and clean energy technologies. This roadmap sets out quantitative targets based on these goals as follows.

- ✓ The percentage of the population with access to electricity will be 99% by 2030, up from 74% in 2015.
- ✓ Increase per capita final energy consumption from 16 GJ in 2015 to 24 GJ by 2030.
- ✓ Increase electricity consumption from 80 kWh in 2015 to 1,500 kWh by 2030.
- ✓ Reduce the number of households dependent on firewood for cooking
- ✓ Reduce energy use per GDP from 3.20 toe/mRs in 2015 to 3.14 toe/mRs by 2030

- ✓ Increase the share of renewable energy in final energy consumption from 11.9% in 2015 to 50% by 2030.
- ✓ Increase hydropower installed capacity from 782 MW in 2015 to 15,000 MW by 2030.

### 3.3.3.3 Review of similar studies by international development cooperation organizations, etc.

Major donors implementing renewable energy and climate change-related programs in Nepal include the WB, ADB, and GGGI. The following is a summary of trends in related projects and support by other donors for ET and CN.

WB is providing development policy loans under the Green, Resilient, Inclusive Development (GRID) project. It is also preparing a project related to power distribution network upgrading and development.

ADB is focusing on strengthening the stable supply of electricity and energy and energy security. In particular, it is working to strengthen and expand the power supply system, supporting the construction of more than 200 km of transmission lines and substations along the Kaligandaki corridor. In addition, GGGI is implementing projects to promote the efficient use of biomass, developing micro/mini-hydropower and mini-PV in rural areas, developing micro/mini-grids, publicizing EV charging stations, and assisting in the development of strategies to promote EVs.

GGGI has provided various support for the development of Nepal's revised NDC released in 2021 and is considering support for the next revised version. In particular, GGGI has been continuously cooperating with MOEF by providing consultancy services on a regular basis. Currently, GGGI is mainly focusing on e-mobility, and is implementing the NAMA project on e-mobility from 2021.<sup>75</sup> Furthermore, GGGI is implementing projects in partnership with Kathmandu University and NEA for the production of green hydrogen, green ammonia, and fertilizer using green ammonia.

Through the Urja Nepal program, USAID is implementing energy-related assistance projects, including support for the formulation of policy frameworks, support for energy conservation and EV promotion policies, and technical assistance to NEA regarding purchase agreements for energy developed by the private sector and electricity sharing with India. For the promotion of EVs, the impact of E-bus (Sajha Yatayat) recharging on electricity demand is being analyzed. In the future, they plan to support grid code development.

The UK's Foreign, Commonwealth and Development Office (FCDO) is funding the evaluation and implementation of distributed renewable energy projects for small and medium enterprises, hospitals, schools, etc. It is provided through the Sustainable Energy Challenge Fund established under AEPC's Central Renewable Energy Fund. It aims to mitigate implementation risks through cost-sharing to make PPP energy projects by local governments, renewable energy

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<sup>75</sup> Nepal - Electric Transportation, <https://www.nama-facility.org/projects/nepal-electric-transportation/> Accessed Aug 3, 2022.

projects for household and irrigation uses in rural areas, mini-grids, and other projects feasible.

NGOs (Practical Action Nepal, Centre for Rural Technology Nepal) are working with APEC and others to promote electric stoves and improved biomass stoves in households, mainly in rural areas. The project supports the introduction of high-tier stoves to encourage conversion from traditional biomass stoves to more environmentally friendly improved biomass stoves and electric stoves, and also supports negotiations with rural electric stove suppliers, discount campaigns for electric stove cookers, demand stimulation, and the development of an app that allows people to check how they use electric products and their electricity bills.

In addition to the activities of donors, Nepal is implementing three projects using UNFCCC GCF. Clean cooker dissemination (Program No. FP172) is a mitigation project for which AEPC is the certifying agency <sup>76</sup>. Ecosystem improvement in Gandaki river basin (No. FP131) is a cross-cutting project for which the International Union for Conservation of Nature is the certifying agency <sup>77</sup>. The Food and Agriculture Organization of the United Nations is the accredited agency for the project of building resilience in the Churia region (No. FP118) <sup>78</sup>. The clean cooker dissemination includes installation of electric cookers, improved biomass cookers and biogas plants and municipal capacity building in the Terai region of the country. The ecosystem improvement in Gandaki river basin and building resilience in Churia region programs are mainly aimed at restoring and maintaining the natural environment and ecosystems.

Table 3-38 summarizes the activities of major international donors.

Table 3-38 International donors' cooperative projects contributing to ET-CN in Nepal

\*Italicized descriptions with underlines are projects under consideration

#### Energy

Donor	C/P	Policy	Regulation	Tax system	Fundraising	Pilot	Capacity building
Global Green Growth Institute (GGGI)	MOFE	<u>Support for NDC formulation</u>					
	MoEWRI, NEA, Kathmandu University, etc.						Research on Hydrogen, Ammonia and Fertilizer Production and their Use for Greening

76 Mitigating GHG emissions through modern, efficient and climate friendly clean cooking solutions (CCS) <https://www.greenclimate.fund/project/fp172> Accessed 3 August 2022

77 Improving Climate Resilience of Vulnerable Communities and Ecosystems in the Gandaki River Basin, Nepal <https://www.greenclimate.fund/project/fp131> Accessed August 3, 2022

78 Building a Resilient Churia Region in Nepal (BRCRN) <https://www.greenclimate.fund/project/fp118> Accessed 3 August 2022

							the Socio-Economy
Foreign, Commonwealth and Development Office (FCDO)	AEPC				Investment in the Sustainable Energy Challenge Fund (SECF) of AEPC's Renewable Energy Fund		
ADB Nepal	AEPC NEA, etc.					Improvement of power transmission and distribution network Distributed energy development in rural areas	
WB Nepal	GoN				Development Policy Financing in Green, Resilient, Inclusive Development (GRID)		
	-					<i>Improvement of power transmission and distribution network</i>	
USAID	NEA					Improvement of power transmission and	Purchasing support for import and export of



						distributi on network	electric power Support for financial analysis and demand forecasting for hydropower generation
	ERC		Assistance in developing regulations and guidelines				
	-		<u>Grid Code Developme nt</u>				
GIZ	MoEWRI					Rural electrifica tion, creation of clean cooker market	

#### EV Promotion

Donor	C/P	Policy	Regulati on	Tax syste m	Fundraisin g	Pilo t	Capacity building
GGGI *In the NAMA Facility (E- Transportation) , GIZ is the budget management body and GGGI is one of the implementing entities along with NEA, DoT and others.	MOFE, MOPIT , MOF	EV promotion policy at the NAMA Facility, support for the development of EV guidelines, funding for electric buses and charging stations, etc.					
ADB Nepal	MPIT	Promotion of charging stations and support for formulating EV promotion strategies					
USAID	Sajha Yatayat						Electricit y Demand

							Impact Analysis of E-Bus Charging
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Energy Conservation

Donor	C/P	Policy	Regulation	Tax system	Fundraising	Pilot	Capacity building
USAID	NEA						Support for evaluation of electrification promotion measures
GIZ	MoEWRI, AEPC (-2017)	<u>Improve energy efficiency policies</u>					Promote energy efficiency market, energy saving human resource development

### 3.3.4 Uzbekistan

#### 3.3.4.1 Summary of Greenhouse Gas Emissions and NDC

The latest official GHG inventory by the Government of Uzbekistan is the 2017 GHG inventory as presented in the Biennial Report 1st Edition (BR)<sup>79</sup> published in 2021. It shows that total GHG emissions were 189.2 million tCO<sub>2</sub>e in 2017, with the energy sector accounting for 76%, IPPU 5%, agriculture, forestry and other land use 18% and waste 1% (Figure 3-26); net GHG emissions and absorption are only 180.6 million tCO<sub>2</sub> and 8.6 million tCO<sub>2</sub>e, respectively, when GHG absorption by forests and other sectors is subtracted from GHG emissions. The inventory covers CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and HFCs, which are among the seven GHGs specified by IPCC. The BR also summarizes the GHG emissions of each subsector, with the top five largest GHG emission subsectors amounting to 132.5 million tCO<sub>2</sub>e (about 70% of total GHG emissions) (Table 3-39). A distinctive feature of GHG emissions in Uzbekistan is that about four-fifths of GHG emissions come from the energy sector. Four out of the top five categories are related to energy, especially fugitive emissions from pipelines and CO<sub>2</sub> emissions from the energy industry, and the remaining one is CH<sub>4</sub> emissions from fermentation of livestock in agriculture, forestry and other land use. The reason for the large emissions from the energy sector is thought to be that Uzbekistan delivers and consumes its own natural gas through aging pipelines, power generation and heat production equipment. In addition, although there is no significant change in GHG emissions in Uzbekistan, there is an increasing trend in emissions from the electricity and heat use, agriculture, and transportation sectors. (Figure 3-27 Figure 3-28)

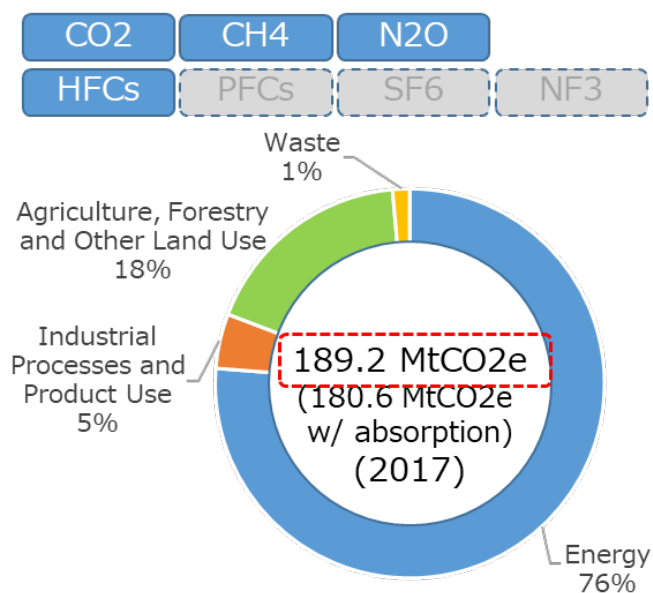


Figure 3-26 GHG Inventory of Uzbekistan (2017)<sup>80</sup>

<sup>79</sup> First Biennial Update Report of The Republic of Uzbekistan (Government of Uzbekistan, 2021) <https://unfccc.int/sites/default/files/resource/FBURUZeng.pdf> Accessed July 16, 2022

<sup>80</sup> Prepared by Pacific Consultants based on BR.

Table 3-39 GHG Emissions by Sub-sector in Uzbekistan <sup>81</sup>

Sector	Sub-sector		ktCO2e
Energy	Fuel Combustion	-Energy Industries	31,900
		-Manufacturing and Construction	21,200
		-Transport	16,100
		-Commercial	6,100
		-Residential	19,600
	-Agriculture	50	
	Fugitive Emissions		49,370
Industrial Processes and Product Use	Mineral Industries		3,455.5
	Chemical Industries		3,616.7
	Metal Industries		1,041
	Use of HFCs		269.7
	Lubricant use		84.2
Agriculture, Forestry, and Other Land Use (AFOLU)	Livestock	-Enteric Fermentation	19,446.3
		-Manure Management	3,093.8
		-N2O from managed soils	10,943.4
		Rice cultivation	168.8
	Forestry and other land use	Forest land	-12,207.7
		Pasture	5,024.2
	Cropland	-1,448.7	
Waste	Solid waste landfills		2,171
	Industrial wastewater		95.5
	Domestic wastewater		413.1

\*The main types of GHG emissions in GHG emissions are shown in black: CO<sub>2</sub>, red: CH<sub>4</sub>, blue: N<sub>2</sub>O, and green: HFCs.

\*Negative (-) in GHG emissions indicates GHG absorption.

\*Yellow highlights indicate the top five GHG emitters.

## 5 Major Emission category

Sector	Key emission category	ktCO2e	
Energy	Natural gas	47 185.2	CH <sub>4</sub>
Energy	Power generation, gaseous fuels	27 557.8	CO <sub>2</sub>
Energy	Process industry and construction, gaseous fuels	20 838.2	CO <sub>2</sub>
AFOLU	Internal fermentation	19 446.3	CH <sub>4</sub>
Energy	Residential sector, gaseous fuels	17 521.8	CO <sub>2</sub>

81 Prepared by Pacific Consultants based on NC3.

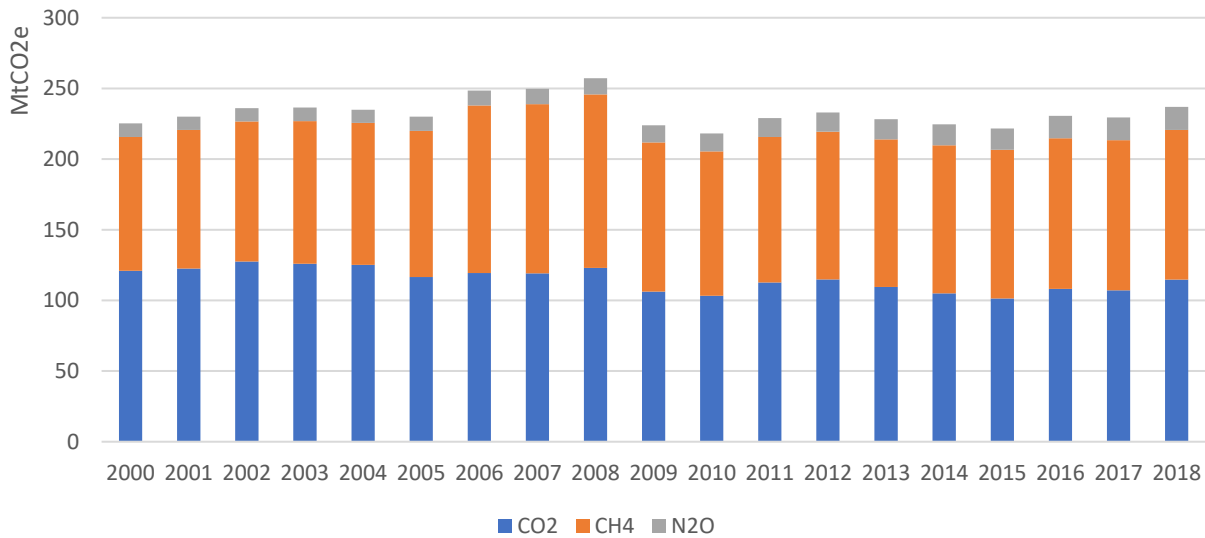
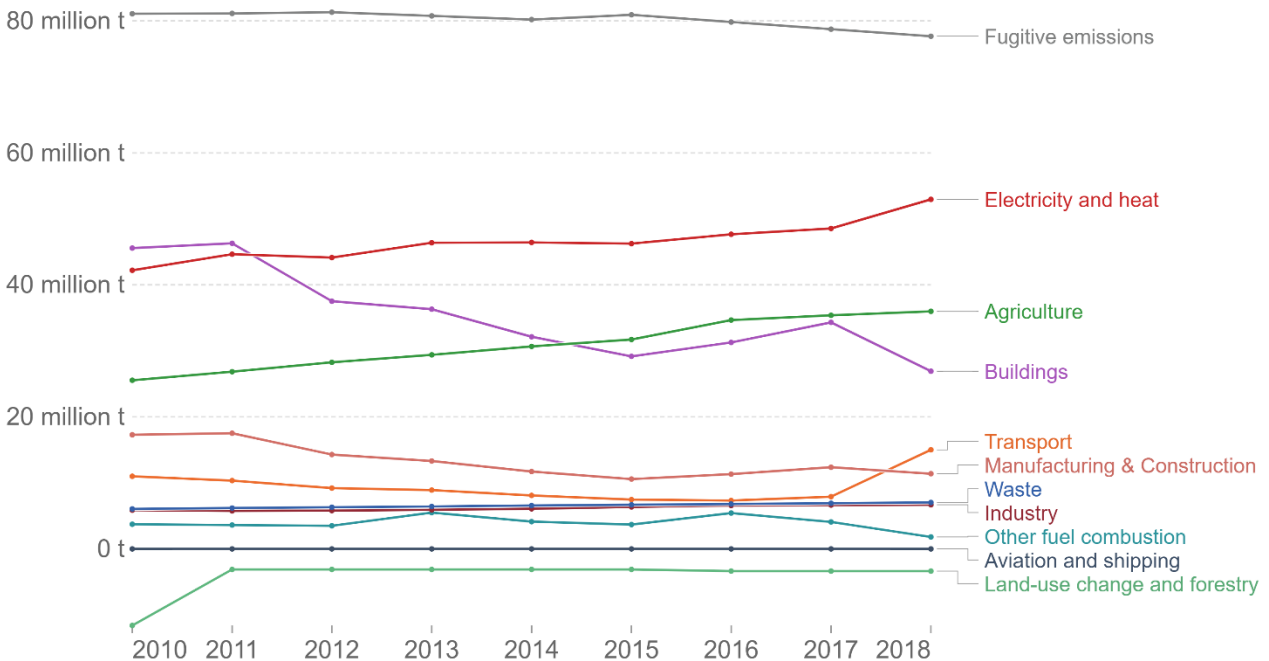


Figure 3-27 Change in GHG emissions in Uzbekistan Over Time (2000-2018) <sup>82</sup>

### Greenhouse gas emissions by sector, Uzbekistan



Emissions are measured in carbon dioxide equivalents (CO2eq). This means non-CO2 gases are weighted by the amount of warming they cause over a 100-year timescale.



Source: CAIT Climate Data Explorer via Climate Watch

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.

Figure 3-28 GHG emissions in Uzbekistan by sector <sup>83</sup>

82 Prepared by Pacific Consultants based on Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

83 Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "CO<sub>2</sub> and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

Uzbekistan's revised NDC (NDC2)<sup>84</sup> in 2021 states a 35% reduction by 2030 compared to 2010 GHG emissions per GDP, with mitigation measures and targets in the energy, agriculture, other land use and forestry, waste and other sectors (Table 3-40).

Table 3-40 GHG Emission Reduction Measures in NDC2 in Uzbekistan<sup>85</sup>

Sector	Mitigation Target (2020-2030)
Energy	Increase the share of renewable energy in power generation to 25%, through solar, wind and small hydro
	Further introduce energy-saving technologies in industry, construction, agriculture and other sectors of the economy
	Introduce alternative fuels in transportation
	Introduce effective incentives for resource mobilization
Agriculture	Improve productivity of agricultural land
	Improve the water management system (improve energy efficiency of pumping system)
LULUCF	Expand forest areas
Waste	Improve the solid waste management system
Other	Other measures and actions reflected in the Strategy for Transition to a Green Economy until 2030 (PP-4477 dated 04.10.2019), which is currently under revision and is to be extended until 2050

Uzbekistan also presented emission projections to 2030 in its 2021 Biennial Report<sup>86</sup> (Figure 3-29). The forecast uses the GHG Abatement Cost Model (GACMO)<sup>87</sup> to project GHG emissions (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) to 2030 based on 2019 GHG emissions. It shows that even the most “ambitious scenario” with the most emission reductions in 2030 will result in a 111.5% increase from 2019 levels. The projections also forecast increases in GHG emissions in the energy, IPPU, agriculture and waste sectors, resulting in an increase only in the energy sector (Table 3-41). The measures for the energy sector in the ambitious scenario are shown in Table 3-24.

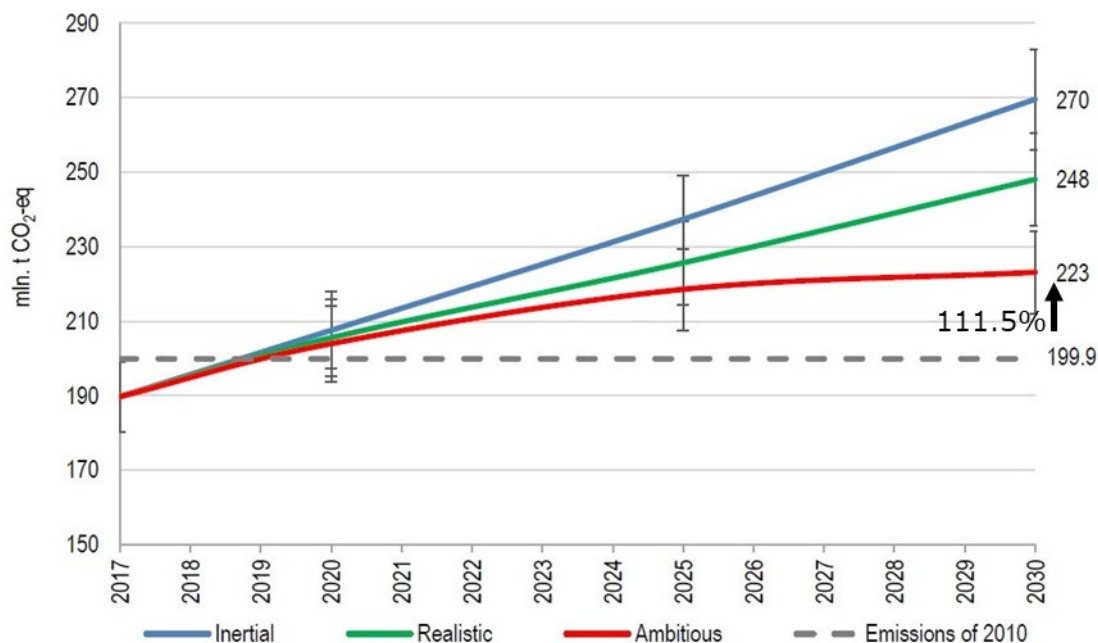
84 Updated Nationally Determined Contribution (NDC) (Government of Uzbekistan, 2020) [https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan\\_Updated%20NDC\\_2021\\_EN.pdf](https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf) Accessed 16 July 2022

85 Prepared by Pacific Consultants based on NDC2.

86 First Biennial Update Report of The Republic of Uzbekistan (Government of Uzbekistan, 2021) <https://unfccc.int/sites/default/files/resource/FBURUZeng.pdf> Accessed 16 July 2022

87 A GHG emission reduction forecasting model developed by UNEP and the Technical University of Denmark. Reference: The Greenhouse Gas Abatement Cost Model (GACMO)

<https://unepdtu.org/publications/the-greenhouse-gas-abatement-cost-model-gacmo/> Accessed July 16, 2022



Inertial: Current GHG emission and energy consumption trends will continue.

Realistic: Mitigation measures in progress or scheduled to be implemented for which funding has been committed will reduce the rate of increase in GHG emissions.

Ambitious: Realize the full reduction potential of the energy sector with international support.

Figure 3-29 Projected GHG Emission Pathways in Uzbekistan

Table 3-41 Sectoral Emissions in the GHG Emission Pathway Projection for Uzbekistan <sup>88</sup>

Inertial Scenario	2017	2020	2025	2030
Energy	145.0	159.4	182.7	207.1
IPPU	8.5	8.9	9.6	10.4
Agriculture	33.7	36.6	42	48.4
Waste	2.7	2.7	3.0	3.6
<b>Total</b>	<b>189.8</b>	<b>207.5</b>	<b>237.4</b>	<b>269.6</b>
Realistic Scenario	2017	2020	2025	2030
Energy	145.0	157.4	171.0	185.6
IPPU	8.5	8.9	9.6	10.4
Agriculture	33.7	36.6	42	48.4
Waste	2.7	2.7	3.0	3.6
<b>Total</b>	<b>189.8</b>	<b>205.5</b>	<b>225.7</b>	<b>248.1</b>
Ambitious Scenario	2017	2020	2025	2030
Energy	145.0	155.8	163.9	160.6
IPPU	8.5	8.9	9.6	10.4
Agriculture	33.7	36.6	42.0	48.4
Waste	2.7	2.7	3.0	3.6
<b>Total</b>	<b>189.8</b>	<b>204.0</b>	<b>218.5</b>	<b>223.1</b>

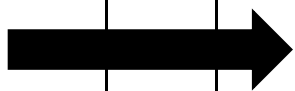
<sup>88</sup> Prepared by Pacific Consultants based on BR of Uzbekistan.

Table 3-42 Energy Sector Measures in the Ambitious Scenario in Uzbekistan's BR <sup>89</sup>

Ambitious Scenario	Mitigation measures	Period	Reduction MtCO <sub>2</sub> e/y
Energy generation	Implementation of new thermal power plants (3,800MW), expanding existing thermal power plants through the construction of CCGT, GTU (additional 4,100MW)	2020-2030	8.5
	Construction of 35 HPP (1,537MW) and modernization of 27 existing HPP (additional 186MW)	2020-2030	1.9
	Construction of solar PV (5,000MW 9.9billion kWh/y)	2020-2030	5.2
	Construction of wind power plants (3,000MW 8.6billion kWh/y)	2020-2030	4.6
	Construction of nuclear power plants (2,400MW 18billion kWh/y)	2022-2028	7.1
	Reducing fugitive emissions in the oil and gas sector	2021-2030	1.0

Furthermore, in Uzbekistan, the Ministry of Energy, in cooperation with the European Bank for Reconstruction and Development (EBRD), has developed recommendations and a roadmap for achieving carbon neutrality in the electricity sector by 2050 <sup>90</sup>, with particulars in Table 3-43. The roadmap to 2050 in the EBRD report is shown in Figure 3-30.

Table 3-43 EBRD Recommendations for Achieving Carbon Neutrality in Uzbekistan's Electricity Sector by 2050 <sup>91</sup>

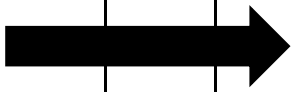
Priority item	Outline	Contents	Organizations concerned (involved)	1-2 years	3-5 years	>5 years
1. Infrastructure improvement	Continued development of efficient, low-carbon power generation infrastructure and grids	Continue the reform of the grid to make power generation sources more efficient and low-carbon and to accommodate the massive introduction of	Department of Energy			

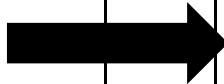

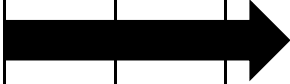
<sup>89</sup> Prepared by Pacific Consultants based on BR.

<sup>90</sup> A carbon-neutral electricity sector in Uzbekistan: summary for policymakers (Ministry of Energy of the Republic of Uzbekistan, 2021) <https://minenergy.uz/en/lists/view/131> Accessed 16 July 2022

<sup>91</sup> Prepared by Pacific Consultants based on A carbon-neutral electricity sector in Uzbekistan: Summary for policymakers (Ministry of Energy of the Republic of Uzbekistan, 2021).



		<p>renewable energy, as outlined in the Ministry of Energy Concept for 2020-2030. In particular, natural gas-fired power generation is expected to play a role in regulating the variability of renewable energy. National grid interconnections will also play an important role in dispersing and absorbing renewable energy variability.</p>					
<p>2. Establishment of a framework for promoting renewable energy</p>	<p>Implement regulatory and institutional reforms to promote renewable energy development</p>	<p>Implement regulatory and institutional reforms to enable and support the development of renewable energy resources and mobilize domestic and foreign investment in renewable energy, which will also contribute to the creation of green jobs. Decarbonize the energy sector by revising the legal framework for governance of energy-related state-owned enterprises, and also to encourage private sector participation.</p>	<p>MoE, State Commission for Ecology and Environmental Protection (SCEEP), Electricity Market Regulator (EMR), Ministry of Finance (MoF), Ministry of Investment and Trade (MIFT)</p>				

3. Subsidy Reform and Carbon Pricing	Elimination of schemes and subsidies that support highly carbon-intensive energy sources and creation of fair competition through the development of a final carbon pricing system	Phasing out subsidies for carbon intensive energy and introducing compensation for affected businesses. Gas should be fully liberalized to show the true cost to the market. Eventually introduce carbon pricing.	MoE, SCEEP, MoF, MIFT, Ministry of Economic Development and Poverty Reduction (MoDPR)			
4. Awareness raising campaign to create public support	Ensure social acceptability and sustainability of the changes being introduced	Support the social acceptability and sustainability of the transformation through measures to protect consumers vulnerable to energy prices (e.g., compensation for price increases, subsidies for energy efficiency and renewable energy deployment, transparency in electricity prices, and refund of revenues from carbon pricing).	MoE, SCEEP, MoDPR			
5. Environmental protection	Protecting the environment with a view to mitigating climate change and improving resilience and reducing other adverse environmental impacts	Monitor the biodiversity and environmental impacts of the project and improve environmental laws; climate risk assessment and disclosure in line with TCFD recommendations	MoE, SCEEP, MIFT			

		is important to understand the impacts of climate change on power generation assets.				
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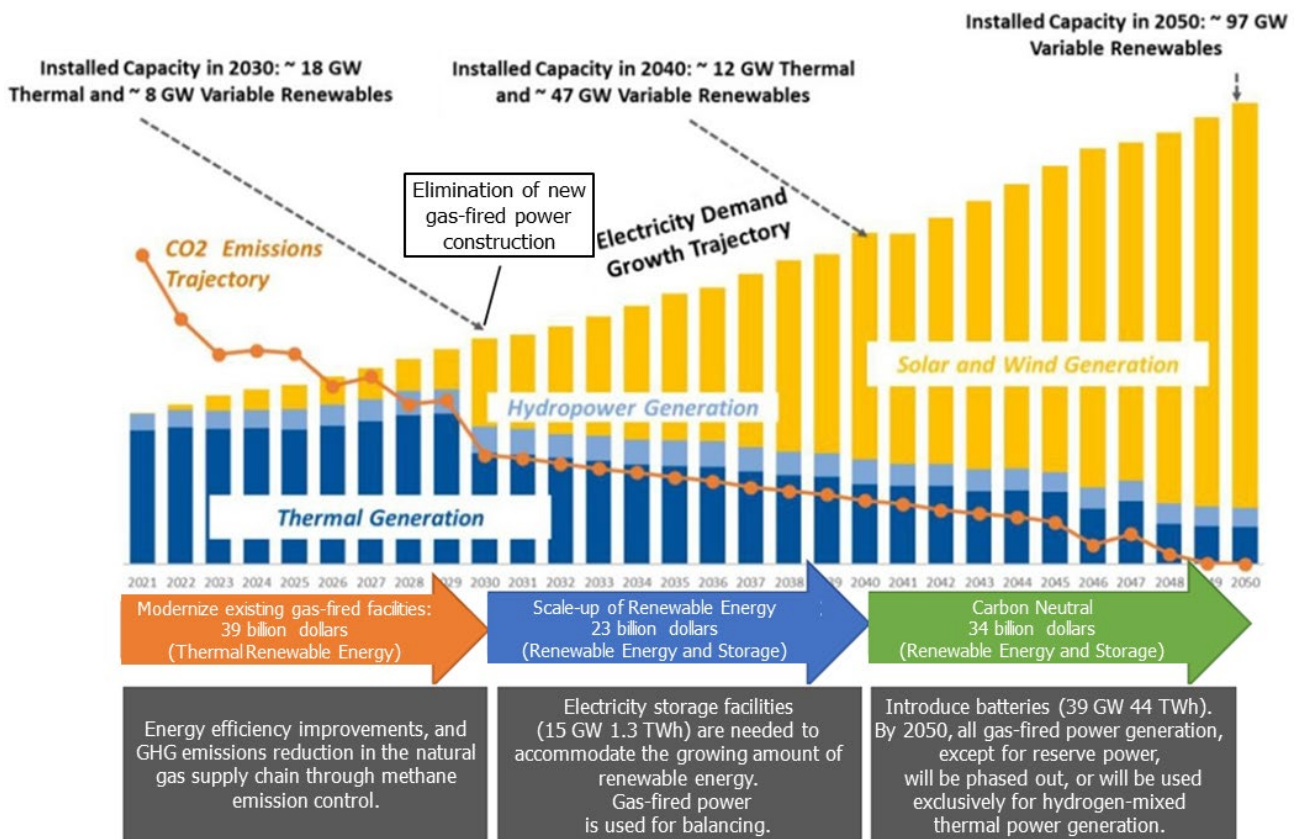


Figure 3-30 Change in Generation Mix and CO2 Emissions under the Carbon Neutral Scenario <sup>92</sup>

### 3.3.4.2 Policy Framework and Institutions

President Mirziyoyev has been actively engaged in political reforms, including the establishment of a new Ministry of Energy, and structural reforms of state energy companies, and, like the former Karimov administration, has made increasing oil and gas production, increasing natural gas exports, and expanding foreign direct investment the basic policies of his government. Below is a summary of the policies and institutions related to renewable energy and hydrogen utilization.

<sup>92</sup> Prepared by Pacific Consultants based on A carbon-neutral electricity sector in Uzbekistan: Summary for policymakers (Ministry of Energy of the Republic of Uzbekistan, 2021).

Table 3-44 Policy Framework and Institutions Contributing to ET-CN in Uzbekistan <sup>93</sup>

No.	Legal system name	Year of entry into force	Issuing authority	Relevance to ET-CN
	laws and ordinances			
1	No.539: Use of Renewable Energy	2019	Parliament	Definition of renewable energy and provisions for preferential treatment, etc.
2	No.412: Rational Use of Energy	2020	Parliament	Implementing rational energy use and energy conservation
	Presidential decree			
3	PP4422: Development of renewable energies and introduction of energy-saving technologies and accelerated measures in improving energy efficiency in economic and social sectors	2019	Government	Setting targets for the introduction of renewable energy and energy conservation
4	PP4477: Strategy for the transition to a green economy 2019-2030	2019	Government	Transition Strategy to a Green Economy by 2030
5	PP4779: Additional Measures to Reduce the Dependence of Economic Sectors on Fuels and Energy Products by Increasing the Energy Efficiency of the Economy and Leveraging Existing Resources	2020	Government	Establishment of an energy conservation fund, energy conservation targets for major energy providers, roadmaps for energy conservation, etc.
6	PP5063: Measures for renewable energy and hydrogen energy development	2021	Government	(Promotion of the Development of Renewable Energy and Hydrogen Energy)
7	No640: Approval of the Regulation on Intersectoral Energy Saving Fund (Fund) by the Budget of the	2020	Government	Regulations on the duties, rights and obligations, use of funds, etc., relating to

93 Prepared by Pacific Consultants based on Uzbekistan's ministry websites and interviews.

	Ministry of Energy of the Republic of Uzbekistan			the Energy Conservation Fund under PP 4779.
	Strategy & Policy			
8	UP-60: Development Strategy of New Uzbekistan 2022-2026	2022	Government	National Development Strategy for 2022-2026
9	A National Low-Carbon Energy Strategy <sup>94</sup>	2020	MOE	Transition Strategy to a Low Carbon Energy Society
10	The concept note for the supply of electric power 2020-2030	2019	MOE	Sustainable Electricity Supply Plan to 2030
11	A carbon-neutral electricity sector in Uzbekistan: Summary for policymakers	2021	MOE	Carbon neutral roadmap for the power generation sector to 2050

#### 1. No.539 Use of Renewable Energy (2019)

This Decree provides the definition of renewable energy, the powers of the implementing entities for production and use, the rights and obligations of producers and equipment manufacturers, and preferential measures.

As for preferential measures, manufacturers of renewable energy installations will be exempted from all taxes for five years from the registration of the enterprise, and property tax on the installation of renewable energy installations and land tax in the area occupied by such installations (with a rated capacity of 0.1 MW or more) will be exempted for 10 years from the date of commissioning. In addition, for personal land tax, it is stipulated that the use of renewable energy on residential premises completely disconnected from the existing energy network will be exempted from land tax for three years from the month of commencement of such use, among others.

#### 2. No.412 Rational Use of Energy (2020)

The Act provides that the Ministry of Energy is empowered to implement a unified national policy on rational energy use applicable to all economic sectors and social facilities. The Ministry of Energy is required to establish mechanisms to promote the introduction of energy-efficient and energy-saving technologies, including in production processes, and to monitor them as appropriate.

#### 3. PP4422: Accelerated measures in the development of renewable energies and the introduction of energy-saving technologies and the improvement of energy efficiency in economic and social sectors (2019)

This sets energy efficiency and conservation targets up to 2022 and provides for government

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<sup>94</sup> The original text was not available and was reviewed by Pacific Consultants from a variety of sources.

subsidies and clarification of where responsibility lies within the government. The Presidential Decree acknowledges that the existing energy efficiency and conservation laws and regulations, the tax exemption system based on the Presidential Decree and the installation of energy efficiency and conservation equipment in public facilities and residences are not fully functional, and specifies that the heads of government organizations and local governments are to take "personal responsibility" for promoting energy efficiency and conservation. The measures include setting up a "combined program" to be implemented in 2019-2022, and in the area of energy conservation, it states that low-efficiency gas stoves used by individuals and corporations should be replaced with energy-efficient models.

In addition, the following targets have been indicated for renewable energy:

- ✓ Increase the share of renewable energy, which accounts for 10% of total electricity generation, to 25% by 2030
- ✓ Promote the installation of solar panels (average 2kW) and solar water heaters (average capacity 200L) in private homes
- ✓ Replacement of low-efficiency gas stoves used by individuals and corporations with energy-efficient models
- ✓ Installation of solar panels and solar water heaters at designated facilities

From January 2020, the government budget has been allocated to subsidize 30% of the purchase cost of solar panels and solar water heaters, as well as the interest on bank loans.

#### 4. PP4477: Strategy for the transition to a green economy 2019-2030 (2019)

To transition Uzbekistan to a green economy in the period 2019-2030, GHG emissions are to be reduced by 10% from 2010 levels, renewable energy is to account for at least 25% of total electricity generation, and industrial infrastructure is to be modernized and energy efficiency improved by at least 20%. The country is also committed to achieving these goals. To achieve these goals, the report also sets priorities for each sector to address. The following is a list of priorities in key areas.

##### Power Field

- ✓ Rebuild and modernize the generating capacity of existing power plants by introducing high efficiency technologies to combined cycle and gas turbine units
- ✓ Modernization of the electricity grid and implementation of organizational and technical measures
- ✓ Reduced electricity consumption for transport and distribution
- ✓ Installation of power consumption system equipment with automatic control and measurement devices

##### Thermal Power Generation

- ✓ Introduction of new technologies such as cogeneration in gas boilers and coal steam turbines with supercritical steam
- ✓ Reconstruction and modernization of the heating network

### Oil and Gas

- ✓ Modernization of compressor stations and piping network for low and medium pressure gas, introduction of SCADA
- ✓ Introduction of alternative energy sources at oil and gas production facilities
- ✓ Waste heat recovery for power generation

### Renewable Energy Sources

- ✓ Establishment of long-term targets for renewable energy development and annual determination of potential sites for renewable energy production
- ✓ Improved policy on tariffs
- ✓ Establishment of a modern and transparent competitive bidding method for selecting potential investors for renewable energy projects
- ✓ Modernization and restructuring of the electricity supply system through the introduction of distributed generation systems based on renewable energy sources
- ✓ Development of a national project on the installation of solar energy systems for the generation of electrical and thermal energy in rural and remote areas

### Construction and building operations

- ✓ Implementation of national projects to improve multi-family and individual home energy efficiency
- ✓ Establish a system to review building codes and building standards every five years and to manage and monitor compliance with the standards
- ✓ Establishment of a building energy certification system
- ✓ Revision of insulation standards and application of new standards
- ✓ Developing a tariff structure to create incentives for energy conservation
- ✓ Widespread use of closed systems in central heating
- ✓ Efficient use of local boilers for heating and hot water in individual houses, apartment buildings and public buildings
- ✓ Introduction of air conditioning with heat pump function
- ✓ Installation of solar panels as a source of energy supply
- ✓ Use of high-efficiency lamps

### Transportation

- ✓ Production and use of energy-efficient vehicles and electric and hybrid vehicles that meet or exceed Euro-4 emission standards
- ✓ Development of incentives to replace older vehicles with environmentally friendly ones
- ✓ Phase out fossil fuels and promote electric transportation systems

5. PP4779: Additional measures to reduce the dependence of economic sectors on fuels and energy products by increasing the energy efficiency of the economy and using existing resources (2020)

The presidential decree establishes an energy conservation fund, energy conservation targets for major energy providers, a roadmap for energy conservation, and a list of providers that will

be required to conduct energy audits. The energy savings will save 3.3 billion kWh of electricity, 2.6 billion m<sup>3</sup> of natural gas, and 16.5 thousand tons of petroleum products.

In addition to the decision to introduce a guaranteed purchase price for electricity from new renewable energy sources (solar, wind and biogas power plants and small hydropower plants with an installed capacity of up to 1 MW) from 1 August 2020, it has also been decided to introduce a system of guaranteed purchase prices for renewable energy projects of 1 MW or more (excluding hydropower ), and it has been decided to introduce a system of bidding in auctions to determine potential investors. With regard to energy audits, a mechanism will be introduced to require energy audits for energy intensive companies based on data obtained from the energy system, which the Ministry of Energy plans to put into operation at the end of 2021.

#### 6. PP5063: Measures for renewable energy and hydrogen energy development (2021)

In order to increase the effectiveness of scientific and practical research in the field of renewable energy and hydrogen energy and to introduce innovative technologies in their production, the establishment of the National Research Institute of Renewable Energy Sources <sup>95</sup> and the Center for Hydrogen Energy under the Ministry of Energy and the creation of an interdepartmental Commission for the Development of Renewable and Hydrogen Energy, composed of the Ministry of Energy and other relevant ministries is provided for, with a roadmap for the organization of the institute and the center.

The Interdepartmental Committee is also assigned the following main tasks

- ✓ Preparing a draft national strategy and regulatory law on the development of renewable energy and hydrogen energy and ensuring the implementation of promising projects in these sectors
- ✓ Human resource development in the field of renewable energy and hydrogen energy, and support to relevant ministries and agencies to conduct research
- ✓ Creation of the conditions necessary to carry out research and projects, including support for the introduction of research and development projects in the fields of renewable energy and hydrogen energy

In addition, in order to efficiently organize the institutes and centers, the Ministry of Energy is charged to develop a national strategy on renewable energy and hydrogen energy by 2021 together with the Ministry of Innovative Development and the Ministry of Economic Development and Poverty Reduction. Furthermore, the Ministry of Energy, the Ministry of Economic Development and Poverty Reduction, the Ministry of Innovation, and other ministries are required to develop human resources and open courses in higher education institutions related to hydrogen.

#### 7. No640: Approval of the Regulation on Intersectoral Energy Saving Fund (Fund) by the

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<sup>95</sup> International Solar Energy Laboratory modified



### Budget of the Ministry of Energy of the Republic of Uzbekistan (2020)

Based on the content of the establishment of the Energy Fund as stipulated in PP 4779, with the aim of attracting investments in energy conservation projects, the rules on the Energy Savings Fund, including its duties, rights and obligations, and the use of the Fund, have been established. An overview of the Fund's uses is summarized below.

- ✓ Preparation of FS studies for energy efficiency improvements, such as the introduction of energy-saving technologies and renewable energy to buildings and housing complexes, and energy audits
- ✓ Establishment of a training center for the development of experts in energy saving and renewable energy
- ✓ Support for start-up companies such as for heat pumps and renewable energy equipment
- ✓ Conducting energy audits of businesses
- ✓ Improving the energy efficiency of urban transport

### 8. No. UP-60: Development Strategy of New Uzbekistan 2022-2026 (2022)

This Strategy is the second development strategy for the period 2022-2026, following the 2017-2021 Development Strategy. In the previous five years of development, about 300 laws and more than 4,000 Presidential Decisions were adopted under the strategy of action in five priority areas:

- 1) State and public construction,
- 2) Rule of law,
- 3) Economic development,
- 4) Social sectors, and
- 5) Security and implementation of mutually beneficial and constructive foreign policy.

The Strategy for 2022-2026 consists of the following seven priority areas:

- 1) To build a people's state by promoting human dignity and a free civil society,
- 2) To establish the principles of justice and the rule of law as the most fundamental and important conditions for the development of the country,
- 3) To develop a strong national economy that enables rapid growth,
- 4) To pursue fair and impartial public policy and development of human resources,
- 5) To develop institutions that manage the spiritual values of the country,
- 6) To tackle global challenges from the perspective of national interests, and
- 7) To strengthen security and defense capabilities and pursue an open, pragmatic and proactive foreign policy.

Among the priorities identified in the Development Strategy for 2022-2026, particular emphasis is placed on areas such as further liberalization of the economy, improving competition, eliminating monopolies, attracting foreign investment, price stability and decentralization, and in the economic area, increasing GDP per capita by 1.6 times over the

next five years and increasing per capita income to USD 4,000 by 2030, as important goals that are prerequisites for entering the category of "upper-middle income countries. Another important goal is to ensure macroeconomic stability and to gradually reduce the annual inflation rate to 5 percent by 2023. In the energy sector, as part of the transformation process, the monopoly of electricity supply will be abolished and market mechanisms will be introduced, as well as the following plans.

- ✓ Attract extensive private investment in the energy sector and introduce social consumption standards to protect vulnerable groups in society.
- ✓ Increase natural gas processing from 8% to 20%, achieving up to \$2 billion in chemical production.
- ✓ Stable supply of electricity, active introduction of green economy technologies in all sectors, and a 20% increase in the energy efficiency of the economy.
- ✓ Increase power generation by 30 billion kWh by 2026, bringing total generation capacity to 100 billion kWh.
- ✓ Increase the share of renewable energy to 25% by 2026 and reduce natural gas by up to 3 BCM.
- ✓ Promote the production and use of electric vehicles and reduce harmful gas emissions to the atmosphere per unit of GDP in economic sectors by 10%.

#### 9. A National Low-Carbon Energy Strategy (2020)

The strategy was developed by the Ministry of Energy with EBRD support to support the transition to low-carbon energy production and to meet growing energy demand. It follows the publication of a 10-year plan for electricity supply in Uzbekistan, developed jointly with the Asian Development Bank and the World Bank, which aims to add up to 30 million kW of generating capacity by 2030, of which 5 million kW will come from solar power, 3.8 million kW from hydroelectric power, 2.4 million kW from nuclear power and 3 million kW from wind power. Priority activities to be implemented include:

- ✓ Modernization and reconstruction of existing power plants,
- ✓ Construction of new power generation facilities using energy-efficient power generation technologies,
- ✓ Improvement of the power measurement system,
- ✓ Diversification of fuels and development of renewable energy (especially solar energy), and
- ✓ Improvement of the tariff structure and amend legislation to support the transition to a wholesale market.

Through these measures, the Ministry aims to reduce greenhouse gas emissions by 10% (compared to 2010 levels) by 2030.

## 10. The Concept Note for the Supply of Electric Power 2020-2030 (2019)

This Concept Note has been developed with the objective of ensuring that the power sector in Uzbekistan is able to supply electricity in an adequate, secure and sustainable manner. The document defines medium- and long-term goals and directions for the development of the power sector in Uzbekistan, including priorities, benchmarks, and arrangements to ensure the achievement of the planned objectives.

The main objectives of this document are:

- 1) Modernization and rehabilitation of existing power plants,
- 2) Construction of new power plants using energy efficient generation technologies,
- 3) Improvement of electricity metering systems,
- 4) Fuel diversification,
- 5) Development of renewable energy sources to meet the increasing demand for electricity at competitive prices, and
- 6) Dynamic development of the power sector. dynamic development of the power sector.

In addition, the following main directions for the development of the power sector in Uzbekistan up to 2030 are presented in this document.

Thermal power generation:

- ✓ Tenders have been issued for the construction of two new power plants in the Shirdaria region in 2020. The power plants will use state-of-the-art CCGTs of 650-750 MW with a total capacity of 2,600-3,000 MW.
- ✓ Expansion of the Navoi TPP.
- ✓ The third 650 MW CCGT is scheduled to come on stream in 2023-2024 and the fourth 650 MW CCGT in 2024-2025.
- ✓ A regulated power plant with a total generation capacity of approximately 1,200 MW is scheduled to come on stream between 2021 and 2023.
- ✓ 150MW coal IPP and modernization of existing coal power plants.
- ✓ CHPP provision over the next two years.

Renewable Energy:

- ✓ Development of 5 GW of solar power and 3 GW of wind power.
- ✓ From 2020 to 2022, competitive bidding will be conducted together with international financial institutions to find investors on a Build-Own-Operate basis and conclude long-term (up to 25 years) power purchase agreements for the supply of solar power.
- ✓ 2020-2030, with a particular focus on solar PV development. Photovoltaic projects are solely financed by IPPs.
- ✓ Solar power plants of 100-500 MW are mainly concentrated in the south-central regions (Jizzakh, Samarkand, Bukhara, Kashkadarya and Surkhandarya regions), while 50-200 MW

solar power plants will be built in other regions. Large-scale solar power plants (with an overall capacity of 300 MW or more) will gradually be equipped with industrial-scale power storage systems to stabilize power generation and regulate peak loads.

- ✓ Regarding wind power development, priority will be given to large-scale wind power plants of 100-500 MW per site, mainly in the northwest (Republic of Karakalpakstan and Navoi region).

#### 11. A carbon-neutral electricity sector in Uzbekistan: Summary for policymakers (2021)

This roadmap was developed by the Ministry of Energy, with the support of the EBRD and the Government of Japan, and commissioned a consortium of international experts to develop a roadmap exploring the potential for the power generation sector to become carbon neutral by 2050. While the Ministry of Energy's "The Concept Note for the Supply of Electric Power 2020-2030" has already outlined an ambitious renewable energy development program, this roadmap builds on that concept note and extends the analysis and provides insights into the policies, technologies and investments needed to achieve a Carbon Neutral electricity generation sector by 2050. The specific recommendations and scenarios for achieving Carbon Neutral are summarized in Table 3-43 and Figure 3-30 in the previous section, but it is concluded that it is technically and economically feasible to move Uzbekistan's electricity sector to CN by 2050.

##### 3.3.4.3 Review of similar studies by international development cooperation organizations, etc.

The major donors implementing renewable energy and climate change related programs in Uzbekistan are the WB, ADB, EBRD, etc. In the power sector, the WB is mainly supporting the transmission system, while the ADB and EBRD are supporting the distribution system. The trends of projects and support by other donors for ET-CN are summarized below.

The WB's program in Uzbekistan as of 2022 consists of 28 projects supporting economic and social reforms and modernization in various sectors, with total commitment of \$5.26 billion. The program also focuses on private sector development and growth, including providing guarantees for the construction and operation of a 1,500 MW Greenfield Combined Cycle Gas Turbine (CCGT) power plant in the Shirdaria region and the first privately developed and operated 100 MW solar power plant in the Navoi region.

In the power system, the project mainly provides support for the power transmission system, including installation of SCADA/EMS and communication facilities at the National Dispatch Center of the National Electricity Grid of Uzbekistan (NEGU), projects to improve the power system including new 500kV transmission lines and substations for integration of renewable energy, and support for the preparation of Grid Codes.

With regard to energy efficiency and conservation, support is mainly targeted at the industrial sector, with loans provided to six commercial banks as two-step loans to facilitate investment

in energy efficiency and conservation equipment in the industrial sector, with the commercial banks financing the industrial sector. Most recently, a new energy efficiency project was launched in June 2022, which will implement energy efficiency improvements in hospitals, schools and other public buildings.

As for policy support, the WB is supporting the preparation of a master plan for the MoE and CN, which is expected to be finalized around July 2022. The WB study is a master plan for CN for the entire energy-related sectors including transportation and industrial sectors. In the Master Plan, three scenarios were developed to reach CN in 2040, 2050 and 2060, and the projects will be developed according to the scenarios selected by the Government of Uzbekistan.

Regarding cooperation on hydrogen, a research study is being conducted jointly with the MoE to examine the feasibility of developing blue hydrogen starting in 2021, and a roadmap is being prepared for Uzbekistan to become a hydrogen-producing country in the future. The roadmap also examines the feasibility of blue hydrogen production, and also includes consideration of green hydrogen initiatives.

Since Uzbekistan joined the ADB in 1995, the Bank has provided more than \$10 billion in loans, concessions and technical assistance to support the country's development. The ADB's support to the energy sector is the largest, accounting for about 21% of the total amount of assistance provided, or about USD 2.49 billion. The ADB's support for the energy sector is wide-ranging and includes the construction of thermal and renewable energy power plants and the enhancement of power distribution systems, as well as support for the gas sector.

In the area of power supply development, the ADB is constructing two gas turbine combined cycle (GTCC) power plants in Talimarjan through co-financing with JICA and a 100 MW solar power plant in Samarkand. The modernization and enhancement of the power distribution system and the reduction of transmission losses are also underway, including the construction of transmission lines and the construction and rehabilitation of substations.

In 2012, the ADB supported the establishment of the International Solar Energy Institute (ISEI) as a regional research center for research and development of solar energy, accumulation of knowledge, and human resource development. The ADB, in its "Asia Solar Energy Initiative" (ASEI) announced in May 2010, has been supporting the Asian Solar Energy Initiative (ASEI) to increase solar power generation capacity in developing countries in the Asia-Pacific region to 3,000 MW by 2013. The ADB is providing investment and other support, and has indicated that it will actively support the development of renewable energy in Uzbekistan as well.

The EBRD has identified the promotion of green energy and resource solutions across sectors as a priority in Uzbekistan's Country Strategy for 2018-2023. In terms of renewable energy power source development support, the EBRD is financing the construction and operation of a 500 MW wind power pilot project and a pilot project for solar power with an installed capacity of 100 MW to be set up in the Navoi region. In terms of power system support, the project includes financing for the construction of high-voltage and 500 kV transmission lines. In terms

of financial support, to promote green technology, a two-step loan is being provided for financing by commercial banks in Uzbekistan to suppliers and vendors of this technology. In addition, as described in the previous section, the government has also provided financial support to the project. In addition, as described in the previous section, at the request of the Ministry of Energy, the EBRD and Japanese funds are supporting the preparation of a roadmap to make the power generation sector carbon neutral by 2050.

In addition to the activities of donors, Nepal is implementing three projects using UNFCCC GCF. " High Impact Programme for the Corporate Sector" (Program No. FP140) is a mitigation project for which EBRD is the accredited entity <sup>96</sup>. " Sustainable Renewables Risk Mitigation Initiative (SRMI) Facility " (No. FP163) is a mitigation project for which the IBRD and IDA is the accredited entity <sup>97</sup>. The former is an investment program to promote the adoption of low-carbon technologies in energy-intensive industries, the mining sector, etc., while the latter is a program that provides risk mitigation instruments to encourage private financing to invest in renewable energy.

Table 3-45 summarizes the activities of major international donors.

Table 3-45 Projects contributing to international donors' ET-CN in Uzbekistan

The underlined and italicized parts indicate ongoing and future projects.

Donor	CP	Technical cooperation			Financial support
		Policy/Institution	Capacity building	Pilot	
World Bank	Ministry of Energy (MoE)	<ul style="list-style-type: none"> <li>• <u>Support for the creation of an energy CN roadmap</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Environmental enhancement and market development support for clean energy investments in the buildings sector</u></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Revolving financing mechanisms for clean energy investments in the buildings sector</u></li> </ul>	
	JSC "National Electric Grid of Uzbekistan (NEGU)"		<ul style="list-style-type: none"> <li>• <u>NEGU Organizational Development</u></li> </ul>		<ul style="list-style-type: none"> <li>• <u>Improve transmission system capacity and reliability</u></li> <li>• <u>Navoi Photovoltaic Power Construction (IPP)</u></li> <li>• <u>Digitalization of power transmission</u></li> </ul>

96 High Impact Programme for the Corporate Sector <https://www.greenclimate.fund/project/fp140> Accessed 3 August 2022

97 Sustainable Renewables Risk Mitigation Initiative (SRMI) Facility <https://www.greenclimate.fund/project/fp163> Accessed August 3, 2022

					<u>sector (SCADA/EMS)</u>
	JSC "Uzbekistan National Power Networks (UNPN)"		<ul style="list-style-type: none"> <li>Strengthening Corporate Governance of Uzbekenergo Joint Stock Company (UE)</li> </ul>		<ul style="list-style-type: none"> <li>Transmission substation upgrades</li> </ul>
	Ministry of Economic Development and Poverty Reduction (MoEDPR)				<ul style="list-style-type: none"> <li><u>Industrial Sector Energy Saving 2 Step Loan</u></li> </ul>
	Ministry of Housing and Communal Services (MoHCS)		<ul style="list-style-type: none"> <li><u>Strengthening project operational management capacity for MHCS, district heating and cooling companies, and others</u></li> </ul>		<ul style="list-style-type: none"> <li><u>Gas meter installation</u></li> <li><u>District heating and cooling system upgrade</u></li> <li><u>Heat meter installation for buildings</u></li> <li><u>Repair of aged boiler and heat transport pipe</u></li> </ul>
ADB	JSC "NEGU"	<ul style="list-style-type: none"> <li><u>Support for the development of sector strategies for distributed solar power generation systems</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Planning, design, implementation and operational capacity enhancement of distributed solar power generation systems</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Demonstration of the installation of a 20kW distributed solar power generation system</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Construction of 220kV transmission line in Horems, Karakalapakstan</u></li> <li><u>Karakalapakstan, Horems Substation Reinforcement</u></li> </ul>
	JSC "Regional Electric Power Networks (REPN)"	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Support for Development of PPP Methodology in the Power Distribution Sector</li> <li>Installation of Meter Data Management (MDM) system, capacity enhancement for loss reduction</li> </ul>	<ul style="list-style-type: none"> <li>Pilot installation of roof-mounted solar panels at the Rural Health Clinic (RHC)</li> </ul>	<ul style="list-style-type: none"> <li>Samarkand 100MW solar power construction</li> <li>Advanced Energy Metering (AEM) System Extension</li> </ul>

	JSC "Uzbekenergo".		<ul style="list-style-type: none"> <li>Strengthening Uzbekenergo's project management capabilities</li> </ul>	<ul style="list-style-type: none"> <li>SCADA system introduction F/S</li> </ul>	<ul style="list-style-type: none"> <li><u>Distribution System Modernization/Upgrading</u></li> <li>Namangan 500kV transmission line, substation construction</li> <li><u>Construction of 450 MW CCGT in Tari Marjan</u></li> </ul>
	Uzbekneftegaz		<ul style="list-style-type: none"> <li><u>Uzbekneft Gas O&amp;M Services, Corporate Management Enhancement</u></li> </ul>		<ul style="list-style-type: none"> <li><u>Improvement of gas transportation network</u></li> </ul>
	Uztransgaz			<ul style="list-style-type: none"> <li>Support for Preparation of SCADA System Installation in Gas Transmission Grid</li> </ul>	
	the others (IPPs, research institutes, etc.)	<ul style="list-style-type: none"> <li>Support for the development of a solar energy roadmap</li> </ul>	<ul style="list-style-type: none"> <li>Strengthening solar energy testing and research capabilities</li> </ul>		<ul style="list-style-type: none"> <li><u>Navoi 100MW solar power construction</u></li> <li>International Solar Energy Research Institute established.</li> </ul>
EBRD	MoE	<ul style="list-style-type: none"> <li><u>Support for CN roadmap development in the power sector</u></li> </ul>			
	JSC "NEGU"			<ul style="list-style-type: none"> <li><u>Construction and operation of the Navoi 500MW wind power pilot project</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Support for implementation of 2GW wind power bidding</u></li> <li><u>Construction of 500kV power transmission line in Blach</u></li> <li><u>Navoi high voltage power line construction</u></li> </ul>
	JSC Uzbekenergo				<ul style="list-style-type: none"> <li><u>Construction of Tari Marjan CCGT</u></li> </ul>
	Other (IPP, etc.)				<ul style="list-style-type: none"> <li><u>Construction and operation of 100MW wind</u></li> </ul>



					<p><u>power generation</u></p> <ul style="list-style-type: none"> <li>• <u>Samarkand 100MW solar power construction and operation</u></li> <li>• <u>Green Technology Facilitated 2-Step Loan</u></li> </ul>
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## Chapter 4. Issue Analysis in Surveyed Countries

### 4.1 Vietnam

#### 4.1.1 Organizing existing ET-CN related JICA projects

JICA has been implementing development assistance projects in various sectors in Vietnam which would result in ET-CN, as shown in Table 4-1. The issues from these projects are summarized in the following Table 4-2.

Table 4-1 JICA projects contributing to ET/CN in Vietnam (about the past 10 years) <sup>98</sup>

No.	Type	Project	Period
<b>Energy</b>			
1	Technical cooperation	Project for the Construction of a Local Energy Circulation System Integrating Highly Efficient Fuel Cells and Recycled Biogas	April 2015 - March 2020
2	Technical cooperation	Preliminary Energy Conservation Promotion Master Plan Study	June 2008 - December 2009
3	Loan aid	Taibin Thermal Power Plant and Transmission Line Construction Project (4)	November 2009 - April 2020
4	Loan aid	Taibin Thermal Power Plant and Transmission Line Construction Project (3)	November 2009 - March 2020
5	Loan aid	Second Power Transmission and Distribution Network Improvement Project	March 2015 - April 2018
6	Loan aid	Taibin Thermal Power Plant and Transmission Line Construction Project (2)	November 2009 - April 2020
7	Loan aid	Danim Hydroelectric Power Plant Expansion Project	February 2014 - August 2017
8	Loan aid	Omong Thermal Power Plant Unit 2 Construction Project (2)	March 2004 - October 2017 fixed
9	Loan aid	Guisong Thermal Power Plant Construction Project (3)	March 2007 - February 2016
10	Technical cooperation	Detailed planning study for the project to support the establishment of an energy conservation training center	July 2013 - March 2016
11	Technical cooperation	Project for Strengthening the Operational Structure of the Energy Conservation Labeling Standard Certification System	November 2013 - November 2016

<sup>98</sup> Prepared by Pacific Consultants from preliminary evaluation documents and reports posted on the JICA website. Project titles are provisionally translated by Pacific Consultants.

No.	Type	Project	Period
12	Loan aid	Energy Conservation and Renewable Energy Promotion Project	November 2009 - January 2015
<b>Transportation</b>			
13	Loan aid	Ho Chi Minh City Urban Railway Project (Ben Thanh - Suoi Tien (Line 1)) (3)	March 2007- October 2025 (fixed)
14	Loan aid	Hanoi Urban Railway Project (Line 1) (Ngoc Hoi Train Depot) (1)	March 2008 - August 2021
15	Loan aid	Ho Chi Minh City Urban Railway Project (Ben Thanh - Suoi Tien (Line 1)) (2)	March 2007 - February 2024
16	Technical cooperation	Binh Duong Public Transport Management Capacity Enhancement Project	March 2015 - June 2018
17	Technical cooperation	Da Nang Urban Transport Improvement Project	April 2013 - March 2016
18	Technical cooperation	North-South High-Speed Rail Construction Planning Project	May 2011 - March 2014
<b>Environment &amp; Waste</b>			
19	Technical cooperation	Sustainable Natural Resource Management Enhancement Project Phase 2	May 2021 - May 2025
20	Technical cooperation	Sustainable Natural Resource Management Project	August 2015 - January 2021
21	Technical cooperation	Project to Support the Implementation of Nationally Determined Contributions (NDC) to the Paris Agreement	June 2021 - June 2024
22	Technical cooperation	Green Growth Promotion Project in Halong Bay Area, Quang Ninh Province	November 2016 - November 2019
23	Loan aid	Dong Nai Province Water Infrastructure Development Project	March 2015 - July 2023
24	Technical cooperation	Project for Capacity Improvement of Integrated Municipal Waste Management	March 2014 - March 2018
25	Technical cooperation	Research Project on Multi-beneficial Climate Change Mitigation Strategies through Biomass Energy Development in Vietnam and Indochina Countries	October 2011 - September 2016
26	Technical cooperation	Project for Establishment of Carbon Recycling System Using Natural Rubber	April 2011 - March 2016
27	Loan aid	Phase 2 Ho Chi Minh City Water Environment	March 2006 -

No.	Type	Project	Period
		Improvement Project (4)	June 2024
28	Loan aid	Halong City Sewage Wastewater Treatment Project	July 2015 - June 2027
29	Loan aid	Bien Hoa City Sewage and Wastewater Treatment Plant Project (Stage 1)	August 2017 - January 2026
30	Loan aid	Phase II Ho Chi Minh City Water Environment Improvement Project (3)	March 2006 - October 2021
31	Loan aid	Hanoi En Sa Sewerage Improvement Project (1)	March 2013 - December 2021
32	Loan aid	Southern Binh Duong Province Water Environment Improvement Project (Phase 2)	March 2012 - March 2019
33	Grant aid	Haiphong An Duong Water Treatment Plant Improvement Plan	April 2015 - September 2017
<b>Agriculture</b>			
34	Grant aid	Project for Improvement of Irrigation System in Northern Gueang Province	March 2013 - December 2019
<b>Forest and Land Use</b>			
35	Loan aid	Conservation Forest Plantation and Sustainable Management Project	March 2012 - January 2021

Table 4-2 Summary of main issues related to ET and CN presented in the existing JICA projects in Vietnam

Sector	Problem
Energy	<ul style="list-style-type: none"> <li>When local government organizations promote the "National Target Program for Energy Saving" formulated by the central government, it is essential to clarify the respective functions and roles in addition to the way the project is promoted by of central ministries, local governments, and each implementing agency. (No. 2).</li> <li>In the operation of the energy efficiency and conservation labeling standard certification system, in addition to the commitment to energy efficiency and conservation and the willingness to acquire technology of CP organizations and related parties, it is also important to have the political power to spread the system from the top-down, to have a level of reduction in electricity costs that will affect household or company finances and that consumers can understand this, and the existence of environmental conditions is also important, such as whether consumers' purchasing power has reached a certain level (No. 11).</li> </ul>

	<ul style="list-style-type: none"> <li>• Power supply needs to be increased due to power shortages in industrial areas in the south (No. 7)</li> <li>• Transmission lines will be prioritized for new construction from new power plants, delaying the enhancement of the existing grid. (No. 5)</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• Urban transport in Hanoi, Ho Chi Minh City and other cities is challenged by increasing traffic demand and private transport such as private cars, but roads and parking lots lack capacity (No. 14).</li> <li>• In cities with low public transport traffic sharing ratio, transport policy should first be changed so that buses become the main form of public transport (No. 17).</li> </ul>
Environment & Waste	<ul style="list-style-type: none"> <li>• Urban areas lag behind in the development of wastewater treatment facilities, waste is dumped into rivers and lakes, and treatment of water entering from waste landfills is delayed (No. 30).</li> <li>• Lack of urban development management capacity in the implementing agencies of urban development (No.23)</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• In addition to demand for water for agricultural irrigation, demand for industrial water for industrial estates is increasing, but drainage management based on flow data is insufficient (No.34)</li> </ul>
Forest and Land Use	<ul style="list-style-type: none"> <li>• Strengthening the Forest Certification System to Promote Legal Timber Trade (No. 20)</li> <li>• Even if forest coverage is recovering, sustainable forest management is needed to improve forest quality, not area (No. 20)</li> <li>• Forest cover has improved, but recovery of forest quality to target levels has been delayed (No. 35)</li> </ul>

#### 4.1.2 Energy Balance in Vietnam

Looking at the changes in Vietnam's energy production and primary energy supply over time (Figure 4-1), energy production from oil increased rapidly in the 1990s, and energy production from coal and natural gas increased in the 2000s, but has not increased since the beginning of the 2010s. On the other hand, the primary energy supply shows a remarkable increase in coal even after 2010. In terms of demand for petroleum products, demand for middle distillates (mainly kerosene, diesel oil, and heavy oil A) and motor fuels has increased significantly (Figure 4-2). The main applications are considered to be automotive and industrial applications. In terms of the composition of power generation sources, the share of coal-fired power generation increased sharply in the 2010s, with coal and natural gas together accounting for about 50% of power generation (Figure 4-3).

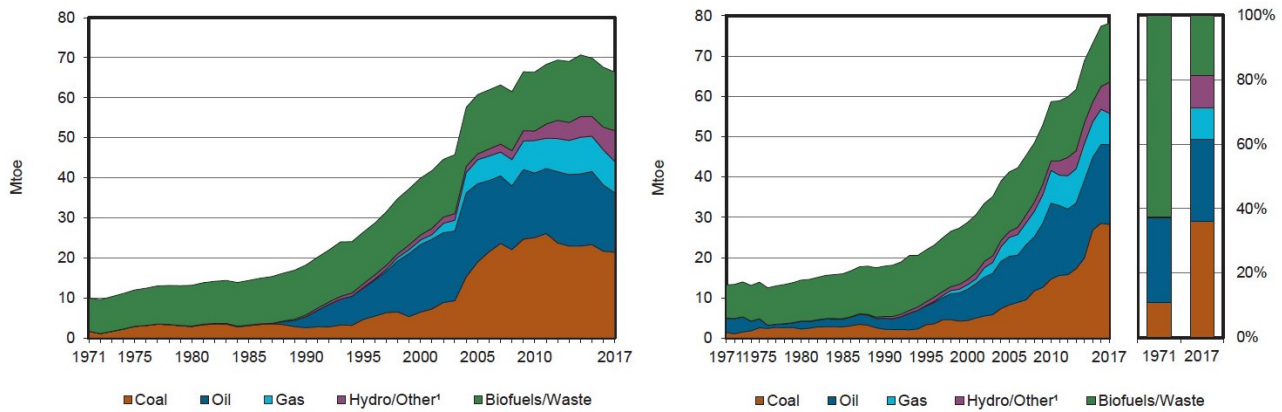


Figure 4-1 Vietnam's energy production (left figure) and primary energy supply (right figure) over time <sup>99</sup>

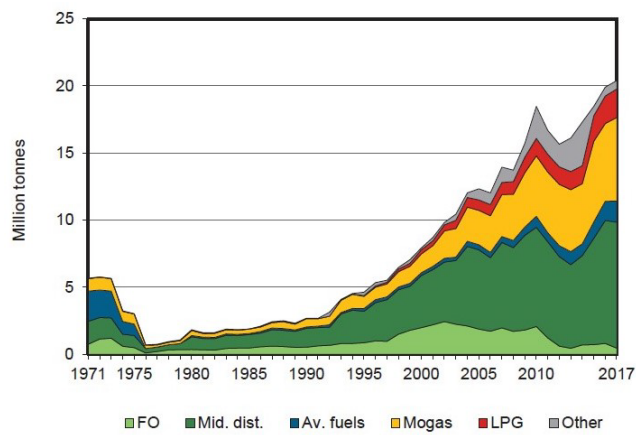


Figure 4-2 Vietnam's demand for petroleum products over time <sup>100</sup>

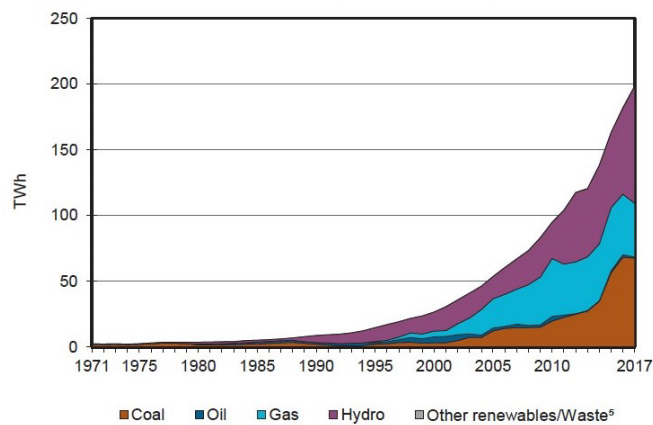


Figure 4-3 Changes in the composition of power generation sources in Vietnam over time <sup>101</sup>

99 World Energy Balances (IEA, 2019)

100 World Energy Balances (IEA, 2019)

101 World Energy Balances (IEA, 2019)

Primary energy supply in Vietnam in 2019 shows that about 47% is coal, 30% is petroleum products, 8% is natural gas and biomass, and 6% is electricity, and to achieve ET-CN, it is necessary to reduce the consumption of coal and petroleum products (Figure 4-4). Looking at final energy consumption, the energy consumed by the industrial sector Coal accounts for 48%, electricity for 30%, petroleum products for 98% in the transport and transportation sector, and electricity for 74% in the civilian sector (Figure 4-5). Thus, these The reduction of fossil fuel consumption in the transportation and transport sector and the promotion of low-carbon power sources will be effective for Vietnam to achieve the ET-CN.

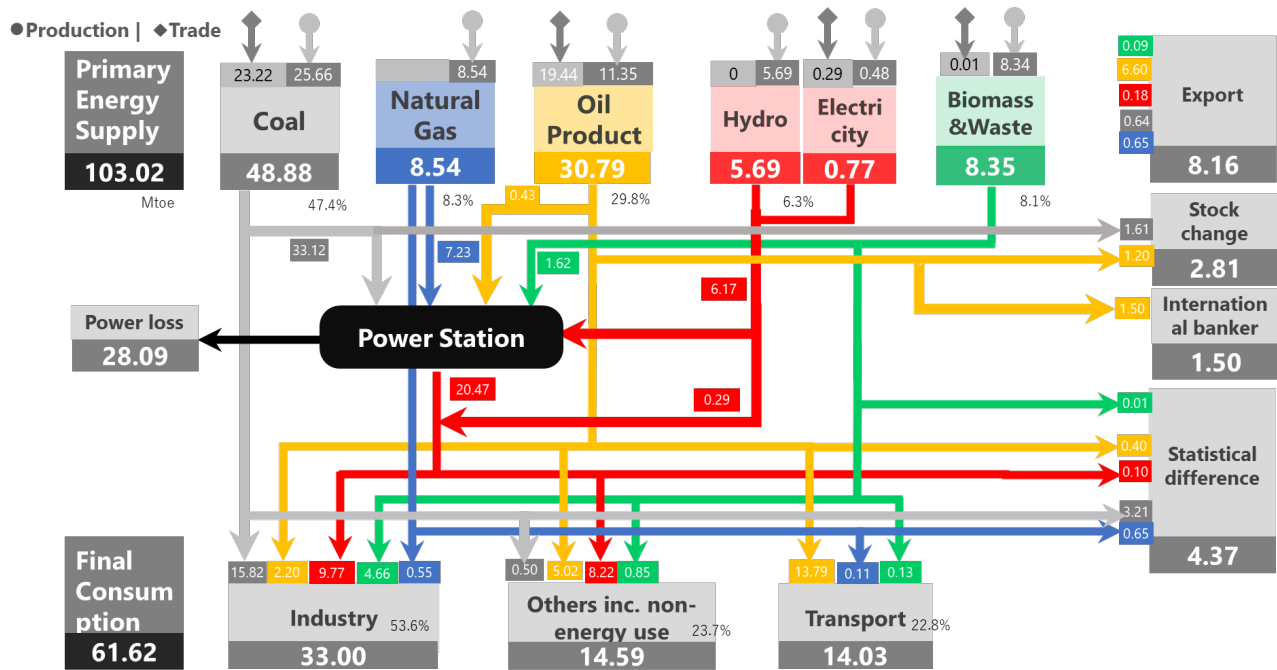


Figure 4-4 Vietnam's energy balance (2019) <sup>102</sup>

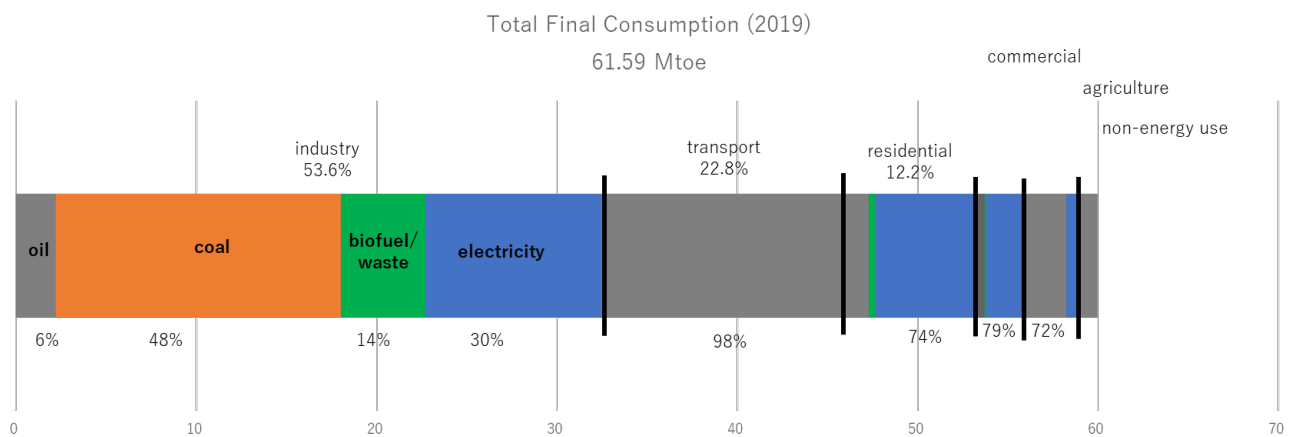


Figure 4-5 Vietnam final energy consumption by sector (2019) <sup>103</sup>

102 Prepared by Pacific Consultants based on information from the IEA website. <https://www.iea.org/sankey/#?c=Viet%20Nam&s=Balance> Accessed August 16, 2022.  
 103 Prepared by Pacific Consultants based on information from the IEA website. <https://www.iea.org/sankey/#?c=Viet%20Nam&s=Balance> Accessed August 16, 2022.

### 4.1.3 Analysis of issues related to LNG and consideration of cooperation possibilities

Based on the results of the review of existing documents and interviews with relevant organizations, issues to be addressed in the deployment of LNG are summarized from institutional, technical and social implementation perspectives.

#### 1) Institutional aspects

While the draft of the Eighth Power Development Plan (PDP8) (released in Apr 2022) sets out the LNG capacity to be installed by 2030, very few projects have been approved by the government and are in the implementation phase. However, it is necessary to wait for the government's approval of the PDP8 and it is important to determine how much capacity will be indicated in the PDP8. As for the institutional aspect of the development of laws and guidelines, although there are laws, not all of the guidelines and technical standards for LNG facilities that are required for the implementation of the laws and regulations have been developed. In addition, MOIT staff needs to acquire technical knowledge of the design and operation of LNG facilities in order to develop these technical standards.

#### 2) Technical side

The use of LNG is a proven technology and the use of LNG has already been deployed in the world overseas, where LNG receiving, storage, transportation, and utilization are already being conducted. Since there is no need for technological development or demonstration studies, the technological aspects were excluded from the scope of this study.

#### 3) Social implementation

Except for the aforementioned awaiting government approval of the PDP8 power development plan including the expected installed capacity of LNG, the main challenge is the financing through project financing for the deployment of LNG using private capital. IPP operators have pointed to the contract terms and conditions set out in the EVN-designated Power Purchase Agreement (PPA), particularly bankability challenges, due to the significant costs involved in setting up LNG facilities.

In addition, although it is considered that there is a domestic demand for LNG gas in the industrial sector, no study has been conducted on the specific volume of demand and the technical infrastructure and financial aspects of LNG gas supply projects for industrial parks, etc., such as business feasibility. In the future, if social implementation through the development of LNG projects utilizing private investment is to be promoted, it will be necessary to conduct surveys on demand and business feasibility in the industrial, transportation, and consumer sectors.

The following figure summarizes only the main points of these issues. The areas where JICA can provide assistance in institutional, technical, and social implementation are shown in gray



(two types of gray: issues in implementation and some issues in implementation). Black indicates that there are issues that are very important for social implementation but cannot be solved with the cooperation of JICA.

Table 4-3 Analysis of LNG-related issues in Vietnam <sup>104</sup>

Large	Institutional	Aspect	Technical	Aspect	Implementation	Aspect
Small Category	National Plans, Policies	Laws & Regulations, Guidelines	R&D	Pre-FS	Feasibility Study	Implement
Color code			-	-	-	
Remarks	- Await PDP8 - LNG power generation IPPs await clarification of their position in the long-term energy transition plan	- Not all the GLs and standards for the operation of the facility are in place. <sup>105</sup> - MOIT needs to develop GLs and standards for implementation, and technical knowledge is required.	N/A	N/A	N/A	- PPAs have bankability issues and funding is a challenge - The amount of domestic demand other than for power generation is not clear

Color code		Overwhelming obstacles which hinder implementation Observed		Obstacles in implementation Observed		Obstacles in implementation Partially observed
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#### 4.1.4 Analysis of Priority Issues Related to Energy Conservation

Based on the results of the review of existing materials and interviews with relevant organizations, issues to be addressed in the further development of energy conservation are summarized from institutional, technological, and social implementation perspectives.

##### 1) Institutional aspects

As in the case of LNG, it is considered that existing energy efficiency and conservation

<sup>104</sup> Prepared by Pacific Consultants based on stakeholder interviews, etc.

<sup>105</sup> Regarding the guidelines and standards for LNG receiving facilities and utilization, some of the technical staff of the MOIT Oil, Gas, and Coal Department commented that they are almost complete. However, according to the interviews with PetroVietnam, which actually operates LNG-related facilities, various guidelines and standards are being developed, but not all of them are in place, and MOIT needs to deepen its level of technical knowledge and develop guidelines, etc. In addition to technical guidelines, guidelines for efficient procurement of LNG from overseas in the future may be required to ensure that large volumes of LNG are procured efficiently.

policies will be followed basically, although the description of the energy efficiency and conservation sector in PDP8 will be important. Although the Energy Conservation Act (2010) exists, MOIT considers it necessary to revise it based on the latest energy efficiency and conservation methods, and has already started preliminary studies with donor support.

## 2) Technical side

Since the main actors implementing energy efficiency and conservation are mainly private enterprises, and energy efficiency and conservation activities are mainly developed by utilizing technologies and products owned by domestic and foreign enterprises, it is considered that there are almost no technical issues such as technological development.

## 3) Social implementation

While there are no technical issues as mentioned above, and although private companies are obliged to report their energy consumption on a regular basis, MOIT recognizes that energy conservation activities have not progressed as much as expected, and considers it necessary to conduct activities at the provincial level, such as energy conservation centers that encourage companies to save energy. In order to further develop energy efficiency and conservation in energy-intensive industries and subsectors such as transport and transportation, and consumer and buildings, incentives for private companies to invest in energy efficiency and conservation are considered necessary. Also, there is a need to focus on continuous outreach to the private sector at the provincial level.

In addition to energy efficiency and conservation, institutional efforts such as the development of a decarbonization roadmap for the industrial sector will be a central issue in the future, based on the National Climate Change Strategy (NCCS) For The Period 2021 To 2050 (MONRE, 2022), a decarbonization strategy for the period up to 2050 published at the end of July 2022. Apart from the aforementioned issues related to the deployment of energy efficiency and conservation activities, issues were also analyzed related to the implementation of decarbonization in the industrial sector as shown in (2) in the table.

Under the strategy, MONRE is responsible for leading the overall decarbonization strategy to 2050 while driving implementation by each ministry, while the relevant ministries are responsible for developing decarbonization roadmaps for the sectors under their jurisdiction and implementing GHG emissions reporting systems. In line with this new national strategy, the MOIT needs to develop a roadmap to achieve 2050 decarbonization in the industrial sector as well as energy conservation in the industrial sector, collect data on energy consumption and other data required for GHG emissions accounting and reporting, and continue to implement MRV of GHG emissions.<sup>106</sup>

Under these circumstances, in terms of the system, it is first necessary to establish a roadmap

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<sup>106</sup> The existing accounting and reporting system in Vietnam covers CO<sub>2</sub> emissions and does not cover GHGs other than CO<sub>2</sub>.

for decarbonization in the industrial sector by 2050, GHG emissions calculation, and guidelines for emission reductions. At the same time, while modifying the database of the existing energy consumption reporting system <sup>107</sup> as necessary, the number of companies subject to energy consumption reporting, which was limited to major energy consumers, will be expanded, and a system for measuring, reporting and verifying energy consumption will be established to promote the expansion of reporting targets. There are some hearing results <sup>108</sup> that the energy consumption data input by companies is inaccurate due to many errors caused by input errors, etc. It is highly likely that the improvement of data quality will be an issue in the implementation stage of the calculation and reporting of GHG emissions in the industrial sector. Human resource development in both the public and private sectors is also considered to be necessary.

In terms of technology, since the web-based platform of the existing energy consumption reporting system will be used, some modification of the system will be required, but it is considered that no large-scale technological development, etc. will be necessary.

In terms of implementation, since energy consumption reporting by the private sector will be the basis for calculating GHG emissions, it will be necessary to involve the private sector and consider incentives, especially for the private sector. Efficient checking and correction of input data may be required in the future.

The main points of these issues are summarized in the figure below. The areas where JICA can provide assistance in institutional, technical, and social implementation are shown in gray (two types of gray are shown: issues in implementation and some issues in implementation). Black indicates that there are issues that are very important for social implementation but cannot be solved with JICA's cooperation.

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107 This was established by the Vietnamese Government Protocol No. 06/2022 / ND-CP of January 2022. Prior to this, there was no legal requirement for key energy users to record their greenhouse gas emissions. Private companies report their energy consumption to the government in the form of inputs to a web-based platform.

108 From interviews with the Industrial Promotion and Development Consultancy Center (IDS) Hanoi.

Table 4-4 Analysis of energy conservation-related issues in Vietnam <sup>109</sup>

(1) Energy saving

Large Category	Institutional Aspect		Technical Aspect		Implementation Aspect	
	National Plans, Policies	Laws & Regulations, Guidelines	R&D	Pre-FS	Involving Stakeholders	Implement
Color code			-	-		
Remarks	<ul style="list-style-type: none"> <li>- Waiting for PDP8</li> <li>- May follow existing Energy Conservation policies</li> </ul>	<ul style="list-style-type: none"> <li>- Revision of the Renewable Energy Act. MOIT is considering revision to the law in accordance with the latest situation.</li> <li>- Donor support available</li> </ul>	N/A	N/A	<ul style="list-style-type: none"> <li>- Lack of incentives for the private sector to implement energy conservation</li> <li>- The number of energy efficiency and conservation promotion activities such as energy audits by IDSs under local governments is small due to lack of budget, personnel, and other measures. <sup>110</sup></li> <li>- Inaccurate figures in private sector energy consumption reporting <sup>111</sup></li> </ul>	<ul style="list-style-type: none"> <li>- The private sector's willingness to invest in energy conservation and funding is an issue</li> </ul>

109 Prepared by Pacific Consultants based on stakeholder interviews, etc.

110 From the interview with Industrial Promotion and Development Consultancy Center (IDS) Hanoi. Not only Hanoi, but many IDSs are facing similar issues.

111 The IDS is unable to make corrections because the system does not allow for correction except by company personnel; according to the IDS, there is also no guidance for the private sector on inputting the information.

## (2) Decarbonizing the industrial sector

Large Category	Institutional Aspect		Technical Aspect		Implementation Aspect	
	National Plans, Policies	Laws & Regulations, Guidelines	R&D	Pre-FS	Involving Stakeholders	Implement
Color code			-	-		
Remarks	- Need to develop a decarbonization plan for the industrial sector (roadmap to 2050) in line with the national strategy for decarbonization	- Inaccurate figures reported in private energy consumption reporting schemes <sup>112</sup> - Calculation of GHG emissions in the industrial sector, GLs for emission reductions, etc. not yet formulated (to be formulated in the future)	N/A	N/A	- Energy consumption reporting systems lack incentives for the private sector	- Data quality, including consistency with data from other sources, can be an issue

Color code		Overwhelming obstacles which hinder implementation Observed		Obstacles in implementation Observed		Obstacles in implementation Partially observed
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### 4.1.5 Analysis of Issues Related to Energy Transition and Carbon Neutrality

In Vietnam, the electricity development plan is the national guideline for promoting energy transition and decarbonization. To date, the Vietnamese government has promoted energy transition and decarbonization through the deployment of renewable energy and LNG. Since PDP8 is currently in the process of being approved by the government, we analyze the issues under the assumption that the introduction of renewable energy and the expected introduction of LNG will not change significantly.

The issues are divided into (1) issues related to the stable supply of electricity, (2) issues related to the stabilization of the power system, (3) issues related to the promotion of energy conservation, and (4) other issues related to ET/CN.

<sup>112</sup> Institutional and reporting platforms are in place, but no activities on data quality improvement have been undertaken.

(1) Issues related to addressing stable power supply and (2) Issues related to addressing power system stabilization

In the energy sector, which has the highest GHG emissions, PDP8 proposes to reduce carbon intensity by converting coal-fired power generation to LNG, while at the same time promoting the introduction of more clean energy. However, since GHG emissions will not be reduced to zero by converting to LNG, it is necessary to promote the introduction of more clean energy (see above (1) Issues related to addressing stable electricity supply). In this regard, the Vietnamese government is actively promoting the introduction of solar and wind power generation, but the challenge is to ensure the stability of the power grid (issue (2) above, which relates to addressing power grid stability). However, this problem is expected to be addressed by the introduction of SCADA and equipment to adjust the supply-demand balance by the World Bank and by the modernization of the grid power management system. The remaining challenge is on the institutional side and is the delay in the development of an investment environment to promote private investment in the energy sector (see above (1) Issues related to addressing stable electricity supply).

(3) Issues related to energy conservation promotion

In the area of energy efficiency and conservation, the establishment of a system has been completed, but the challenge is to involve the private sector and, in particular, to create incentives for the private sector to promote energy efficiency and conservation efforts. In terms of understanding energy consumption, at present, only major electricity users enter their own consumption data into a web-based platform in accordance with the Energy Consumption Reporting System. However, it has been pointed out that the data entered on is often incorrect. As the energy consumption reporting system is expected to become an important indicator for decarbonizing the industrial sector in the future, it is conceivable that, for the time being, the government should aim to develop a decarbonization roadmap for the industrial sector and establish and operate a GHG emissions accounting and reporting system, and then work on improving data quality.

(4) Other issues related to ET-CN

In order to promote IPP projects through private investment, it is essential to ensure bankability of PPAs. In addition, it is also considered necessary to develop new market institutions that have begun to be considered, such as the establishment of an electricity market and a relative electricity trading system. In addition, it would be effective to give new meaning to private investment in the energy sector by establishing a carbon trading system. In addition, in order to achieve decarbonization of the energy sector, it is necessary to modernize the grid power management system and develop technologies for energy storage functions and hydrogen and ammonia utilization to support the large-scale introduction of renewable energy. Improvement of these issues can also be associated with important elements in the improvement

of issues (1) and (2).

The second of the other challenges for ET-CN is the challenge of decarbonizing the non-energy sector. In the non-energy sector GHG emissions, methane emissions from the agriculture and livestock sector are the main source of emissions. On the other hand, for the forest sector, which is an important CO<sup>2</sup> sink in Vietnam, the area of forest cover has almost reached the level to achieve the planned values. Therefore, the Vietnamese government has made a policy shift to secure CO<sup>2</sup> sinks by improving forest quality, and measures to reduce GHG emissions from non-energy sectors are gaining relative importance in achieving national decarbonization by 2050, and research and development on methods to reduce methane emissions in the agriculture and livestock sectors is underway.<sup>113</sup> However, continued research and social implementation is needed to bring these production technologies to national deployment.

Even if GHG emissions from energy and non-energy sectors cannot be reduced to zero, a carbon emissions trading system could be used. The Vietnamese government has begun to study carbon pricing initiatives, especially a carbon trading system, from early 2022, and this initiative needs to be put on track.

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113 Of the countries in this study, Vietnam, Nepal, and Uzbekistan are participating in the Global Methane Pledge to reduce global methane emissions by 30% by 2030.

Table 4-5 Analysis of issues related to energy transition and decarbonization in Vietnam <sup>114</sup>

Large Small Category	Institutional		Aspect		Technical	
	National Plans, Policies	Laws & Regulations, Guidelines	R& D	Pre-FS	Involving Stakeholders	Implement
Color code			-			
Remarks	<ul style="list-style-type: none"> <li>- Waiting for PDP8 <sup>115</sup> . Stable supply of cheap electricity, promotion of renewable energy (continued)</li> <li>- Clarification of role of LNG and renewable energy in long-term ET planning <sup>116</sup></li> </ul> <p><b>Issue (1), (4)</b></p> <ul style="list-style-type: none"> <li>- Methods and measures to reduce emissions of methane and air pollutants in the agricultural sector are unknown</li> <li>- Forest area of sinks has almost reached its maximum value</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthening and stabilizing the grid, adjusting the supply-demand balance by region (continued)</li> </ul> <p><b>Issue (2)</b></p> <hr/> <ul style="list-style-type: none"> <li>- Continued energy conservation</li> <li>- No plan in place to decarbonize industry</li> </ul> <p><b>Issues (3)</b></p> <hr/> <ul style="list-style-type: none"> <li>- Delays in creating an environment for private investment in the energy sector</li> </ul> <p><b>Issue (4)</b></p> <hr/> <ul style="list-style-type: none"> <li>- No system in place to promote carbon trading schemes</li> </ul>	N/A	<ul style="list-style-type: none"> <li>- Securing options for supply and demand adjustment valves for maximum utilization of renewable energy <sup>117</sup></li> </ul>	<ul style="list-style-type: none"> <li>- Lack of attractiveness and incentives for investment in the energy sector by the private sector, etc.</li> </ul> <p><b>Issue (4)</b></p>	<ul style="list-style-type: none"> <li>- Insufficient investment environment for private sector investment</li> <li>- Stable operation of grid power <sup>118</sup> (continued)</li> </ul>

Color code		Overwhelming obstacles which hinder implementation Observed		Obstacles in implementation Observed		Obstacles in implementation Partially observed
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114 Prepared by Pacific Consultants based on stakeholder interviews, etc.

115 PDP8 is expected to provide some indication of the power mix, installed capacity, long-term ET and pathway to decarbonization.

116 LNG IPPs are awaiting clarification of their position in the long-term ET plan. Renewable energy is expected to be massively deployed, accounting for about half of total power generation capacity. Existing energy efficiency and conservation policies are expected to continue.

117 In addition to thermal power generation, energy storage facilities and the utilization of hydrogen and ammonia.

118 Electricity interconnections between regions, power source development, energy storage functions, and the development of hydrogen and ammonia utilization technologies, etc.



## 4.2 Lao PDR

### 4.2.1 Organizing existing ET-CN related JICA Projects

JICA has been implementing development assistance projects in various sectors in Lao PDR which would result in ET-CN, as shown in Table 4-6. The issues from these projects are summarized in the following Table 4-7.

Table 4-6 JICA projects contributing to ET and CN in Lao PDR (about the past 10 years) <sup>119</sup>

No.	Type	Project	Period
<b>Energy</b>			
1	Data collection survey	Energy Sector Data Collection Survey	January 2012 - December 2012
2	Loan aid	NamNgum No.1 Hydroelectric Power Plant Expansion Project	May 2013 - January 2019
3	Grant aid	Small Hydro Power Plan	April 2013 - January 2015
4	Technical cooperation	Project on Power System Master Plan	June 2017 - March 2019
5	Technical cooperation	Project for Power Quality Improvement through Upgrading Grid Code and Strengthening its Enforcement System	February 2021 - January 2024
6	Loan aid	Southern Region Power System Improvement Project	March 2012 - August 2017
7	Preparatory Survey for Cooperation	Preparatory Survey for Sekatam Hydro Power Project (PPP Infrastructure Project)	March 2013 - November 2015
8	Feasibility Study (SME Support Type)	Feasibility Study on Running Water Micro Hydro Power Project in Non-electrified and Weakly Electrified Areas	2012
9	Feasibility Study (SME Support Type)	Feasibility Study on Advanced Operation and Maintenance of Hydroelectric Power Plants Using Remote Monitoring Technology	September 2017 - September 2018
<b>Transportation</b>			
10	Technical cooperation	Vientiane Bus Company Capacity Improvement Project Phase	January 2012 - March 2015

<sup>119</sup> Prepared by Pacific Consultants from preliminary evaluation documents and reports posted on the JICA website. Project titles are provisionally translated by Pacific Consultants.

11	Data collection survey	Basic Data Collection Study on Low-Emission Public Transport System in Lao PDR	2012
12	-	Lao PDR Pilot Program (LPP) (Support for Low Pollution Transportation System to Promote Sustainable Urban Development)	March 2013 - February 2014
13	Technical cooperation	Vientiane Bus Company Capacity Improvement Project Phase 2	August 2016 - August 2019
14	Technical cooperation	Sustainable Urban Transport System Capacity Improvement Project	December 2018 - December 2021
15	Dissemination, Demonstration, and Business Development Project (SME Support Type)	Project to promote and demonstrate a low-pollution transportation system using three-wheeled electric vehicles	October 2014 - January 2017
16	Dissemination, Demonstration, and Business Development Project (SME Support Type)	Dissemination and Demonstration Project of Location Information and Traffic Observation System for Urban Traffic Improvement in Vientiane City	May 2015 - October 2016
17	Feasibility Study (SME Support Type)	Feasibility Study on Improvement System for Bus Business in Vientiane	November 2014 - November 2015
18	Dissemination, Demonstration, and Business Development Project (SME Support Type)	Bus Business Improvement System Dissemination and Demonstration Project	June 2016 - February 2019
19	Basic survey	Basic Study on the Introduction and Maintenance Continuity of Bus and Pedestrian Priority Signals in Vientiane City	Not found
<b>Agriculture</b>			
20	Technical cooperation	Clean Agriculture Development Project	November 2017 -

			November 2022
21	Grant aid	Tagong Irrigated Agriculture Improvement Plan	January 2018 - December 2020
22	Basic survey	Basic Study on Local Fertilizer Production Using Surplus Hydropower	May 2021 - August 2022
<b>Forest and Land Use</b>			
23	Technical cooperation	Sustainable Forest Management and REDD+ Support Project (Reducing Emissions from Deforestation and forest Degradation)	October 2014 - September 2021
<b>Environment &amp; Waste</b>			
24	Grant aid	Waste Management Improvement Plan for Environmentally Sustainable Cities	April 2014 - January 2016
25	Technical cooperation	Vientiane Urban Water Environment Improvement Project	October 2014 - October 2017
26	Feasibility Study (SME Support Type)	Feasibility Study on Improvement of Hazardous Waste Disposal and Management, especially Medical Waste, in Vientiane City	November 2016 - October 2017
27	Dissemination, Demonstration, and Business Development Project (SME Support Type)	Dissemination and Demonstration Project for Improvement of Hazardous Waste Treatment and Management including Medical Waste in Vientiane City	December 2018 - March 2023
<b>Urban development</b>			
28	Technical cooperation	Urban Development Management Project	September 2013 - March 2017

Table 4-7 Summary of major issues related to ET and CN as indicated by existing JICA projects

Sector	Problem
Energy	<ul style="list-style-type: none"> <li>Rural electrification near the border is covered by electricity imports from neighboring countries, but the average unit price of imported electricity often exceeds the average electricity price in Laos, which is one of the factors putting pressure on EDL's finances. (No. 3)</li> </ul>

	<ul style="list-style-type: none"> <li>• In many power systems in rural areas, power is supplied over distances of several hundred kilometers by medium voltage (22kV) distribution lines, and there are few power supply facilities at the end of the system, which makes it difficult to maintain voltage and causes voltage drops and technical problems such as transmission losses and frequency fluctuations. In addition, because power is supplied over long distances by a single line, the reliability of the power supply is also low, as the effects of an accident can be widespread (No. 3).</li> <li>• Off-grid power sources lack management capacity because local governments and others operate the power plants (No. 3).</li> <li>• The installed capacity of power generation for domestic supply is large compared to the demand, and there is surplus power generation capacity and power surplus in Lao PDR that is not used throughout the year, putting pressure on the finances of EDL, which purchases power from the grid. (No. 4)</li> <li>• The current hydropower-centered development cannot solve the shortage of electricity supply capacity in the dry season, and economic dry season measures are needed, taking into consideration imports from Thailand and renewable energy. (No. 14)</li> <li>• In order to realize the "System to System Interconnection System", which is a wide area interconnection system to interconnect the Lao PDR domestic grid to the power grids of neighboring countries, the EDL needs to develop an effective Grid Code (GC) that is consistent with the GC of neighboring countries while taking the characteristics of the Lao PDR grid into consideration. In addition, it is necessary to strengthen the independent monitoring and control system of the EDL's central feed-in control center, to enhance the operational capacity of transmission and substation facilities, and to strengthen the regulatory function to monitor these (No. 5).</li> <li>• While there are plans to build many hydropower plants, the training of engineers responsible for operation and maintenance has not kept pace (No. 9).</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• It is necessary to define EVs as vehicles and safety standards need to be developed. It is also necessary to develop a tax system, infrastructure, and human resource development to promote EVs (No. 12).</li> <li>• Improving the reliability and convenience of public transport and expanding the public transport network (No. 13)</li> <li>• Insufficient public transport policies to promote modal shift (No. 13)</li> <li>• Improvement of the management system of Vientiane Bus Company (No.</li> </ul>

	17)
Agriculture	<ul style="list-style-type: none"> <li>• Need to improve agricultural productivity, create high value-added commodity crops, address surplus electricity, and create industries that consume electricity (No. 22)</li> </ul>
Forest and Land Use	<ul style="list-style-type: none"> <li>• Strengthening forest management capacity at the local level (No. 23)</li> <li>• Weak infrastructure for forest conservation through REDD+ due to lack of human resources for proper analysis and management of REDD+ related data (No. 23)</li> </ul>
Environment & Waste	<ul style="list-style-type: none"> <li>• A significant increase in the amount of waste collection is expected in cities, and measures such as increasing the number of collection vehicles are necessary (No. 24).</li> <li>• As for Vientiane, the final disposal site is about 32 km away from the city center, so it is necessary to establish a waste transfer station to efficiently transport the increasing amount of collected waste (No.25).</li> <li>• Medical waste exceeding the treatment capacity of the incinerator has been brought in, and medical waste is not being treated properly (No. 25).</li> <li>• Although guidelines exist, separated medical waste is mixed with general waste due to lack of understanding by cleaners and other reasons (No. 27).</li> </ul>
Urban Development	<ul style="list-style-type: none"> <li>• The system to restrict and guide development projects based on the land use plan is not functioning well enough to realize the urban planning master plan (No. 28)</li> <li>• Lack of urban development management capacity in the implementing agencies of urban development (No. 28)</li> </ul>

In particular, on the energy sector issue, the following suggestions are made in the No. 4 report.

- ✓ Regarding the excess capacity of power generation facilities for domestic use, increase in domestic demand for electricity, strengthening of electricity exports, and change of power sources for domestic use to power sources for export
- ✓ Strengthening interconnection line capacity with Thailand to address power supply shortages during the dry season
- ✓ Strengthening Compliance with the Lao PDR Grid Code for the Interconnection of the Greater Mekong Subregion's Power Grid

In response to these issues and proposals, JICA is currently implementing the "Power sector advisory project ", the " Project for Power Quality Improvement through Upgrading Grid Code and Strengthening its Enforcement System " and the " Project for Improvement of Power Utility Management ".

In the promotion of EVs, the "Lao Pilot Program (LPP) (Low Emission Transportation System Support for Sustainable Urban Development)" has presented several issues, among which the development of EV promotion policies, the definition of EVs as vehicles, the development of a preferential taxation system for EVs, and the development of EV infrastructure are included in the Resolution on Endorsement of Policy on Electricity Vehicle Use (2021).

#### 4.2.2 Analysis of issues related to energy transition and carbon neutrality (especially promotion of electrification)

Based on the desktop review of existing policies for ET and CN in Lao PDR and field interviews, the challenges, local needs, and donor support for Lao PDR to achieve ET and CN are organized in the following.

Table 4-8 Main challenges for ET and CN in Lao PDR <sup>120</sup>

Classification	Problem	Requests from the Lao side	Movement of other donors	Countermeasure plan
Energy	<ul style="list-style-type: none"> <li>• Lack of interagency collaboration on overall energy development, including hydropower, coal, renewable energy, biomass, etc. (MEM, MAF, MONRE, etc.)</li> <li>• Solar power has no engineers capable of EPC (AF)</li> <li>• No technical standards for Lao PDR in introducing renewable energy such as solar and wind power (MEM)</li> <li>• Hydroelectric power generation in the north must be linked to the capital city, which is the largest electricity demand area.</li> </ul>	<ul style="list-style-type: none"> <li>• (MEM DEEP/DEPP/DEM/RIEM)</li> <li>• Establishment of technical standards and guidelines for renewable energy</li> <li>• Support for policy formulation from potential studies on hydrogen, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• USAID (proposed to MEM and EDL): policy development support, capacity building, EDL improvement</li> <li>• Asia Foundation (AF): Providing legal and financial capacity building to MEM</li> <li>• Australian Embassy and AF (proposed to MEM): Supporting Energy Transition</li> </ul>	<ul style="list-style-type: none"> <li>• Establish a forum for cross-agency discussion and information sharing around MEM on energy</li> <li>• Support the development of technical guidelines for renewable energy</li> <li>• Supporting a detailed study of hydrogen and ammonia potential</li> <li>• However, it is necessary to demarcate and coordinate with USAID and Australia</li> </ul>

<sup>120</sup> Prepared by Pacific Consultants based on on-site interviews, etc.

	<ul style="list-style-type: none"> <li>• Extension of the power grid is not cost-effective and realistic for electrification of mountainous areas</li> </ul>			
EV Promotion	<ul style="list-style-type: none"> <li>• No specific direction of action to achieve 30% by 2030 (MEM, etc.)</li> <li>• US standard was recommended in a study of charging facilities conducted by the US, but it does not fit the Lao context (MEM RIEM)</li> <li>• Charging plugs are expected to be CCS-Type2 only, but must include Chinese standard GB/T to achieve 30% (LOCA)</li> </ul>	<p>(MPWT DoT)</p> <ul style="list-style-type: none"> <li>• Capacity building on the design of taxation and environmental taxes to promote EVs</li> </ul>	<ul style="list-style-type: none"> <li>• USAID (in discussion with MEM): Study on charging infrastructure standards and dissemination strategies</li> <li>• GGGI (MPWT, completed): Study on business models for EV diffusion, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Establish a forum to discuss technical standards, industrial development, electricity rates, taxation, and other issues in an integrated manner, and to compile actions to promote EVs.</li> <li>• MEM has requested each ministry to establish a cross-sectoral WG for relevant ministries and agencies under the EV Promotion No. 8, and we believe that this can be appropriated.</li> </ul>
Energy Conservation	<ul style="list-style-type: none"> <li>• There is no system, procedure, or guideline for third-party inspection and certification of energy-saving performance of air conditioners, etc. (MEM)</li> <li>• No energy consumption data by industry type (MEM)</li> </ul>	<p>(MEM)</p> <ul style="list-style-type: none"> <li>• A system for third-party inspection and certification of energy efficiency and conservation performance</li> </ul>	<ul style="list-style-type: none"> <li>• NZ-Laos REP (MEM and implementation): support energy data collection and energy management capacity building in line with energy conservation legislation</li> <li>• GGGI (underway with MOIC): clean industry strategy development, financing</li> </ul>	<ul style="list-style-type: none"> <li>• Establish procedures and guidelines for third-party certification of energy efficiency and conservation performance.</li> <li>• Promote energy data collection systems from industrial, commercial, and consumer sectors, etc.,</li> </ul>

				and set up a forum to discuss effective energy efficiency and conservation measures (in cooperation with NZLREF).
Other	<ul style="list-style-type: none"> <li>• Continuous awareness raising on REDD is needed. Insufficient budget for solar sharing. Lack of capacity to address emissions from agriculture and livestock, and crop modelling. (MAF)</li> <li>• Deforestation in mountainous areas is due in part to slash-and-burn agriculture. (MoAF)</li> </ul>	<ul style="list-style-type: none"> <li>• Financial support and staff capacity building for emission reductions from the AFOLU sector</li> </ul>	<ul style="list-style-type: none"> <li>• none in particular</li> </ul>	<ul style="list-style-type: none"> <li>• Separate support could be provided by SATREPS and JCM funds from the Ministry of the Environment of Japan and other sources.</li> </ul>

In particular, the following issues can be identified from the viewpoint of promoting electrification.

- ✓ Lack of interagency collaboration on overall energy development, including hydropower, thermal power, renewable energy, biomass, etc.
- ✓ The challenge of expanding electrification using hydropower is the need to eliminate the bias in electricity supply and demand areas.
  - The electricity demand in the region is low compared to the hydropower electricity supply in northern Laos, but there is not enough transmission network connecting the northern part of the country to the electricity demand areas, resulting in a surplus of electricity.
  - The establishment of data centers for virtual currency mining by multiple companies is being considered, and large-scale electricity demand is expected. However, since the continuity of the business is not certain, it is necessary to consider measures to deal with surplus electricity while selling electricity to mining companies.
  - Hydrogen, ammonia, and synthetic methane production using surplus electricity and the use of ammonia as a raw material for fertilizer are considered, among which the



use of ammonia as a raw material for fertilizer is being studied mainly by private companies <sup>121</sup>, but there is no legal system or regulation for the use of gas as energy, so it is necessary to improve it.

- ✓ The challenges for the spread of renewable energy lie in the development of technical standards and the training of engineers.
  - At present, for renewable energies such as solar power and wind power, products based on the standards of the producing countries have been introduced, and the technical standards are not unified.
  - The number of domestic engineers capable of EPC for rooftop solar power generation has not been developed, and there is a lack of engineers who can handle rooftop solar power generation even if the implementation of rooftop solar power generation is considered.
- ✓ Extension of the power transmission and distribution network is not realistic from a cost-effectiveness perspective for electrification of mountainous areas and other areas.
  - Distributed renewable energy is effective for electrification of mountainous areas, but there are many problems in transportation and maintenance management.
- ✓ Although the implementation system for transport electrification is making slow but steady progress, the specific direction to achieve 30% in 2030 is not clear.
  - Infrastructure development, such as recharging facilities, is left to the private sector, but progress has been slow due to insufficient incentives for infrastructure development to enable quick recharging, etc., and it cannot be said that the EV policy reflects the wishes of the private sector.

#### 4.2.3 Domestic and regional zero-emission energy potential and utilization methods

Looking at the changes in energy production and primary energy supply in Laos over time (Figure 4-6, it can be seen that energy production from hydropower and coal increased rapidly in the 2010s, with the share of coal replacing biomass in primary energy supply. This is due to the Hongsa coal-fired power plant being commissioned in 2015. In terms of demand for petroleum products, demand for middle distillates (mainly kerosene, diesel oil and heavy oil A) has grown significantly (Figure 4-7), mainly considered to be for automotive and industrial applications.

The "Project on Power System Master Plan" (JICA, 2020) states that the official electricity demand assumption in Lao PDR will reach 5,892 MW in 2030 from 1,728 MW in 2017 in terms of maximum power, while the actual maximum power demand from 2016 to 2017 will remain

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121 For example, "Basic Study on Local Fertilizer Production Using Surplus Hydroelectric Power in Laos" by Tsubame BHB Corporation using the JICA Small and Medium Enterprises and SDGs Business Support Project, and "Demonstration study of a PEM electrolyzer to realize a green ammonia production and supply project in Laos" using the NEDO 2021 International Demonstration Project for Japanese Technologies Contributing to the Efficiency of Energy Consumption by Hitachi Zosen Corporation.  
<https://tsubame-bhb.co.jp/news/press-release/2020-10-22-1644> Accessed August 3, 2022  
[https://www.hitachizosen.co.jp/newsroom/news/release/2021/20211018\\_001426.html](https://www.hitachizosen.co.jp/newsroom/news/release/2021/20211018_001426.html) Accessed August 3, 2022

around 1,000 MW, which is significantly lower than the assumption. According to the Ministry of Energy and Mines' power development plan until 2030 published in 2017, including existing, under-construction, and export power sources, the total output is about 31.5 GW, which is about 4.3 times the 7.4 GW of power sources that were in operation in 2018.<sup>122</sup> On the other hand, The report analyzes the possibility of transmitting power from hydropower plants in northern Laos to the capital area using existing transmission lines, and as a result, the report considers that the existing 230 kV transmission lines are capped at around 300 MW, and the development of grid codes for interconnection between regions, 500 kV with northern Thailand and 1,000 MW. The company is proposing the development of a grid code for interconnection between regions and the enhancement of 500 kV and 1,000 MW interconnection lines with northern Thailand.

Looking at Lao PDR's primary energy supply in 2019, about 45% is coal, 23% is electricity, 20% is biomass, and 12% is petroleum products, and achieving ET-CN will require reducing the use of coal, petroleum products and non-sustainable biomass use that leads to deforestation (Figure 4-8). In terms of final energy consumption, coal accounts for 50% of the energy consumed in the industrial sector, petroleum products account for 100% in the transport and transportation sector, and biomass energy use exceeds 80% in the private, commercial and public service sectors (figure 4-9). Therefore, it is considered that the electrification of these fossil fuel or non-sustainable biomass consuming sectors and processes with hydropower electricity will be effective to achieve ET-CN in Lao PDR.

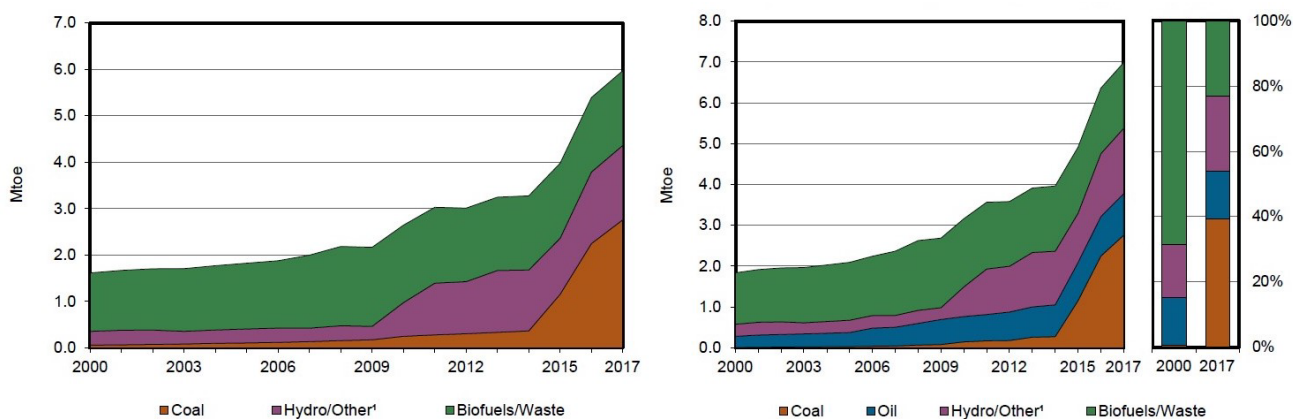


Figure 4-6 Lao PDR energy production (left panel) and primary energy supply (right panel) over time<sup>123</sup>

122 Although several coal-fired power plants are planned to be developed in Lao PDR, the development of coal-fired power plants has stagnated due to the Chinese government's announcement to halt the construction of coal-fired power plants overseas and the global trend to refrain from financing coal-fired power generation. The revised NPDP is expected to significantly reduce the share of coal-fired power generation in the energy mix from 30% (from a field hearing by Pacific Consultants).

123 World Energy Balances (IEA, 2019)

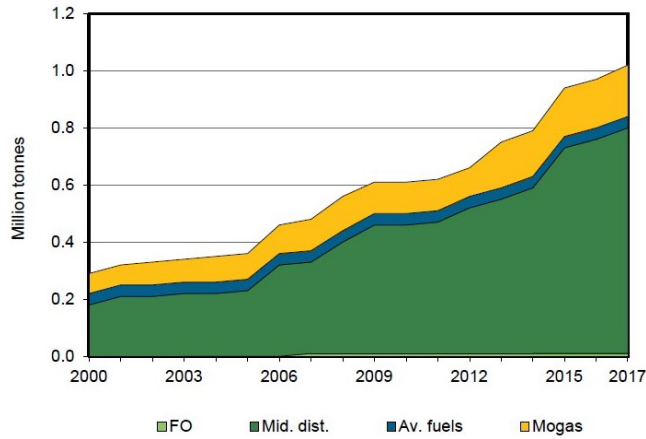


Figure 4-7 Demand for petroleum products in Laos over time <sup>124</sup>

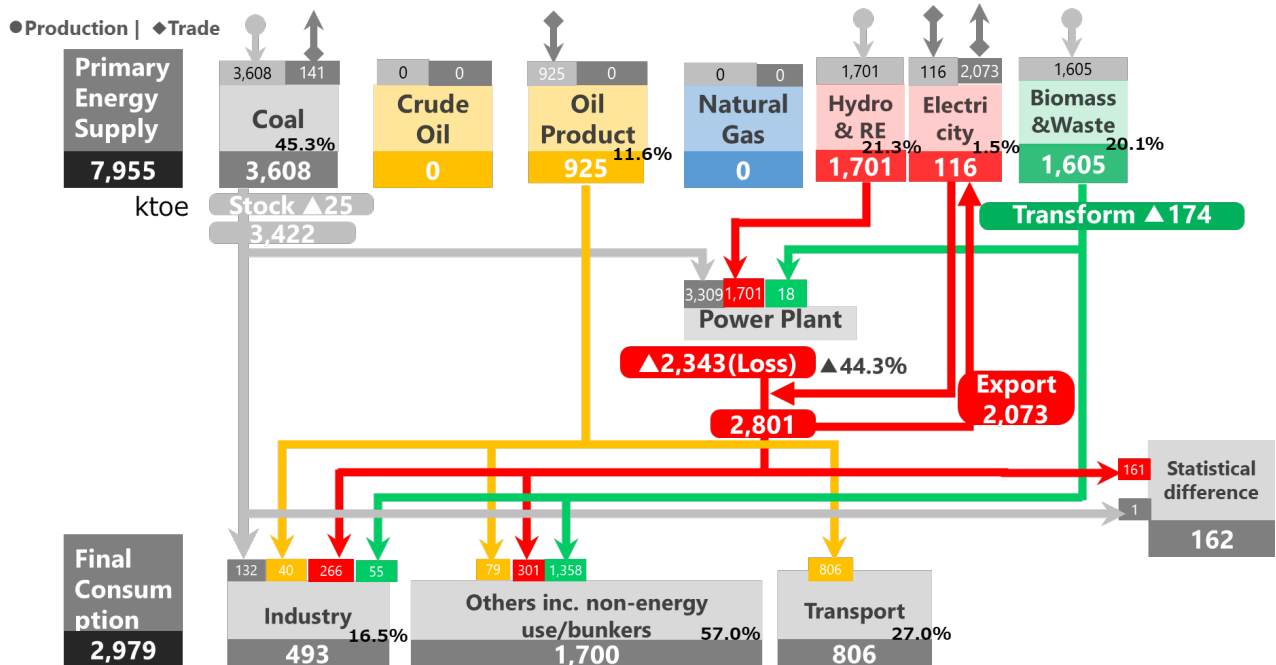


Figure 4-8 Energy balance of Lao PDR (2019) <sup>125</sup>

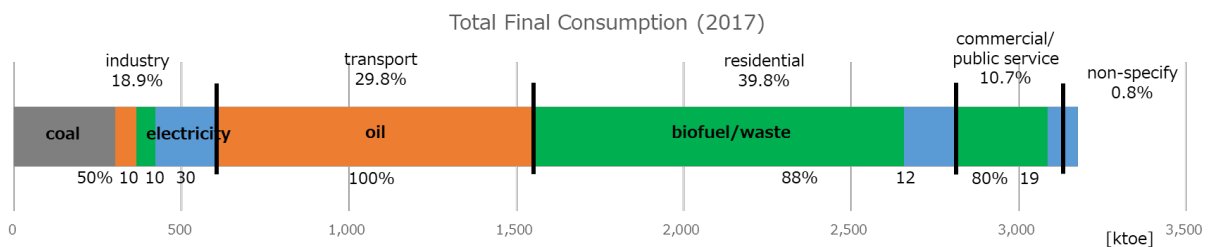


Figure 4-9 Final energy consumption by sector in Lao PDR (2017) <sup>126</sup>

124 World Energy Balances (IEA, 2019)

125 Prepared by Pacific Consultants based on information from the IEA

website. <https://www.iea.org/sankey/#?c=Lao%20People's%20Democratic%20Republic&s=Balance> Accessed 6 May 2022.

126 Prepared by Pacific Consultants based on World Energy Balance (IEA, 2019).

On the other hand, from interviews with the MEM and MOIC in Laos, a detailed statistical database on energy consumption in the industrial sector has not been developed, and it is not possible to accurately grasp the actual situation, such as what energy is consumed in what industries and to what extent.<sup>127</sup> Therefore, the Economic Research Institute for ASEAN and East Asia (ERIA) has reported on the energy consumption of the food processing industry and the energy consumption of the industrial sector. The report ERIA indicates that the food processing and other manufacturing industries<sup>128</sup> consume a large amount of coal, electricity, and fuel oil (Table 4-9), indicating that electrification and fuel conversion of these coal and fuel oil, and energy conservation in electricity consumption are effective in achieving ET-CN. The Final Energy Efficiency Market Assessment Report - LAO PDR (2022) conducted by ADB also states that the sectors with the largest energy saving potential are industry and transportation.

Table 4-9 Estimated energy consumption by industry in Laos<sup>129</sup>

Main activity	Estimated energy consumption (ktoe)	Coal	Biomass	Electricity	Oil			
						LPG	Diesel	Fuel oil
Food processing, beverage and tobacco	182.77	34.44	1.42	38.08	108.83	1.70	3.99	103.13
Textile, cloth, shoes and leather	8.97	0.26	8.24	0.46	0.00	0.00	0.00	0.00
Other manufacturing	240.71	39.34	2.86	184.17	14.35	2.35	11.99	0.00
total	432.45	74.04	12.52	222.71	123.18	4.05	15.99	103.13

GHG reduction measures      ↑ Fuel conversion      ↑ Energy saving      Fuel conversion↑

In the transport sector, it is important to switch to EVs and promote the use of EVs in public transport such as the planned BRT<sup>130</sup>. In the Resolution on Endorsement of Policy on Electricity Vehicle Use in 2021, the ministries are supposed to provide guidelines for the promotion of EVs within 45 days of the promulgation of the resolution. However, according to the results of the field hearing, the work seems to be delayed. However, the MEM is considering the establishment of a working group with the ministries indicated in the Resolution, and the establishment of a system to promote EVs is steadily progressing. International donors, such as USAID and GGGI, are also supporting the development of EV infrastructure and the study of business models for EV promotion.

In the biomass use in the civilian sector, the main use of forest biomass is for charcoal. In addition, one of the factors contributing to deforestation is the development of farmland through

127 When private companies build new factories, they submit information on which energy sources and how much they plan to use to the DoIC, but the database is not yet available, and the actual consumption situation is not understood.

128 Based on interviews with MoIC, the energy intensive industries in Laos are mainly cement manufacturing, metal processing, and brick manufacturing.

129 Prepared by Pacific Consultants based on Lao PDR energy statistics 2018 (ERIA, 2018).

130 EV buses for BRT are expected to be procured under the ADB budget around September 2022 (from local interviews by Pacific Consultants).

slash-and-burn agriculture. Lao PDR aims to achieve 70% forest coverage by 2030, and maintaining a certain amount of GHG absorption through forest conservation is essential to achieve CN by offsetting GHG emissions, which are difficult to reduce in the future. Therefore, it is effective to integrate REDD+ with the provision of incentives to reduce charcoal consumption, especially in rural areas, to promote the spread of alternative methods to slash and burn, to electrify non-electrified areas, and to develop and promote the use of alternative energy sources such as biogas using livestock manure. On the other hand, it is necessary to grasp the number of livestock for the implementation of biogas projects, but since these data have not been developed, it is necessary to grasp various biomass potentials first.

In Laos, there are not many power-consuming industries, and there may be enough cases where surplus electricity is generated by electrification measures such as the spread of EVs, etc. It is desirable to consider the use of surplus electricity for the green hydrogen business that uses electricity for water electrolysis, ammonia production from green hydrogen, and synthetic gas production as an alternative to CNG. It is desirable to consider this as an option. In the country, Japanese companies such as Tsubame BBH Corporation and Hitachi Zosen Corporation are already conducting studies on green ammonia production, and it is necessary to understand the production potential of hydrogen, ammonia, and synthesis gas in conjunction with the estimation of surplus electricity. Hydrogen and ammonia can be used for low-carbon LNG- and coal-fired power generation, so when new coal-fired power plants are planned, the carbon intensity may be lowered by requiring green ammonia co-firing.<sup>131</sup> Green hydrogen and green ammonia produced in Laos could be transported to coal-fired and LNG-fired power plants in neighboring countries to contribute to low carbon emission, but gas pipelines would be required to transport the necessary amount of gas. In the transportation sector, CNG could be substituted for synthetic gas in large commercial vehicles, which are difficult to convert to EVs because they require more driving power than passenger cars, and hydrogen fuel cell vehicles could be substituted for them.

Given these circumstances, it is believed that Japan's areas of cooperation in the energy sector for the achievement of ET-CN in the country will be effective in supporting "the strengthening of the power grid linking northern Laos with electricity demand areas"<sup>132</sup> and "the electrification of the domestic industrial sector and the transport and transportation sectors, and the conversion to green fuels such as green hydrogen".

From the perspective of contribution to Laos' NDC achievement (Figure 3-20), "strengthening the power grid linking northern Laos with domestic and international power demand areas" can contribute to the spread of EVs in urban areas, and "electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transportation sectors" will reduce GHG emissions derived from energy

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<sup>131</sup> The applicability of ammonia co-firing to the existing Hongsa coal-fired power plant should be examined by considering the specifications of the existing facilities and the availability of ammonia storage sites.

<sup>132</sup> Includes international electricity trade between northern Laos and neighboring countries.

consumption, and thus contribute to reducing GHG emissions from final energy consumption in the broad sense.

## 4.3 Nepal

### 4.3.1 Organizing existing ET-CN related JICA Projects

JICA has been implementing development assistance projects in various sectors in Nepal which would result in ET-CN, as shown in Table 4-10. The issues from these projects are summarized in the following Table 4-11.

Table 4-10 JICA projects contributing to ET/CN in Nepal (past 10 years approx.)<sup>133</sup>

No.	Type	Project	Period
<b>Energy</b>			
1	Loan aid	Tanahu Hydroelectric Power Project	March 2013 - October 2021
2	Loan aid	Western Region Small Hydro Improvement Plan	April 2014 - March 2016
3	Technical cooperation	Data Collection Survey for Regional Grid Integration in BBIN	September 2020 - March 2022
4	Technical cooperation	Project on Integrated Power System Development Plan	May 2021 - April 2023
<b>Traffic</b>			
5	Technical cooperation	Kathmandu Basin Urban Transport Improvement Project	July 2014 - December 2015
<b>Agriculture</b>			
6	Technical cooperation	Tarai Plains Irrigated Agriculture Promotion Project	March 2019 - March 2025
7	Technical cooperation	Project for Preparation of a Master Plan for the Promotion and Extension of High Value Agriculture along the Sinzuri Road	April 2011 - March 2014
<b>Consumer</b>			
8	Technical cooperation	Project for Promoting Compliance with Nepalese Building Codes for Safe Building Construction	April 2021 - May 2025

<sup>133</sup> Prepared by Pacific Consultants from preliminary evaluation documents and reports posted on the JICA website. Project titles are provisionally translated by Pacific Consultants.

Table 4-11 Summary of major issues related to ET and CN as indicated by existing JICA projects in Nepal

Sector	Problem
Energy	<ul style="list-style-type: none"> <li>Most of the existing hydropower plants are biased towards the flow-in type of power generation, and only a limited number of reservoir hydropower plants are capable of adjusting the flow rate used for power generation between seasons (No. 1).</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>To relieve traffic congestion caused by the increase in the number of vehicles, radial and ring roads should be constructed avoiding high-density urban areas (No. 5)</li> <li>The increase in traffic demand in the capital cannot be met by road improvement alone, so a modal shift is needed through the introduction of a new track transport system (AGT) and a Bus Rapid transit System (BRT) (No. 5).</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>Management of water use facilities for irrigation, including inadequate maintenance of core and terminal facilities for agricultural irrigation and collection of water use fees for them (No. 6).</li> </ul>

#### 4.3.2 Analysis of issues related to energy transition and carbon neutrality (especially promotion of electrification and energy conservation)

Based on the desktop review of Nepal's existing policies for ET and CN and the field interviews, the main challenges for Nepal to achieve ET and CN are summarized as follows.

Table 4-12 Main challenges for ET-CN in Nepal <sup>134</sup>

Classification	Problem	Nepalese request	Movement of other donors	Examples of countermeasures
Energy	<ul style="list-style-type: none"> <li>The relevant ministries do not fully understand each action of the Long-Term Net Zero Strategy.</li> <li>In power generation, hydropower development is progressing and if all goes well, the country will become a net exporter of electricity within a few years, but</li> </ul>	(NEA, MoEWRI, Parliamentary Committee, etc.) <ul style="list-style-type: none"> <li>The electrification rate of the country as a whole is 95%, but the electrification rate is low in some areas. In rural areas in particular, it is necessary</li> </ul>	(USAID, ADB, WB) <ul style="list-style-type: none"> <li>Projects are progressing in the development of the power transmission and distribution network.</li> <li>(ADB)</li> <li>We are working on micro/mini-hydropower and mini-PV</li> </ul>	<ul style="list-style-type: none"> <li>Seminars and workshops will be held to introduce Japanese technologies in each action of the Net Zero Long-Term Strategy.</li> <li>Conduct basic research on hydrogen and ammonia utilization.</li> </ul>

134 Prepared by Pacific Consultants based on on-site interviews, etc.



	<p>there is a large possibility that development will be delayed due to financial and other issues (MoEWRI, NEA, TEPCO, New Jec, etc.).</p> <ul style="list-style-type: none"> <li>• Electrification rate has reached 95% in the country as a whole, but the quality of electrification is an issue (MoEWRI, NEA, donors and NGOs, etc.).</li> <li>• Rural areas are less stable and reliable in terms of electricity and vulnerable to disasters, so there is a need to strengthen rural electricity distribution networks and resilience (e.g. donors and NGOs).</li> <li>• Distributed generation, such as small-scale hydropower, mainly serves as a bridge until the power grid reaches the area. Once the power grid reaches the area, there is a large possibility that it will not be used (NGO).</li> <li>• If hydroelectric development progresses smoothly, there will be a surplus of several thousand MW in the future, so it is necessary to raise the level of</li> </ul>	<p>to strengthen the power distribution network to ensure a stable supply of electricity. (MoEWRI, Parliamentary Committee, WECS, etc.)</p> <ul style="list-style-type: none"> <li>• It is necessary to strengthen the power distribution network not only in rural areas but also for the increase in domestic demand, measures to cope with peak electricity demand, and electrification of the industrial sector.</li> </ul>	<p>development in rural areas and micro/mini-grid development. (GGGI)</p> <ul style="list-style-type: none"> <li>• The production of hydrogen, ammonia and synthetic methane using surplus and their use to green the socio-economy is being worked on with MoEWRI, NEA, AEPC, NOC and others, led by Kathmandu University. (USAID)</li> <li>• Preparing RFPs for India on the sale and purchase of hydropower and supporting NEA in the bidding process. (Practical Action, CRTN)</li> <li>• Support for the dissemination of improved biomass stoves and electric stoves is being provided.</li> </ul>	<ul style="list-style-type: none"> <li>• Expanding the area of grant assistance on strengthening stable electricity supply in rural areas.</li> <li>• Provide financial support to SECF and TDF by FCDO and AEPC.</li> </ul>
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	electricity demand (Kathmandu University).			
EV Promotion	<ul style="list-style-type: none"> <li>• Currently, there are no EV-specific policies (e.g. MoPIT).</li> <li>• There are incentives such as lower EV import tariffs but no experts in these areas (MoPIT).</li> </ul>	<p>(MoFE)</p> <ul style="list-style-type: none"> <li>• There are currently no guidelines or regulations on EV battery disposal, and these will need to be established in the future.</li> </ul>	<p>(GGGI)</p> <ul style="list-style-type: none"> <li>• EV promotion and support for the development of EV guidelines is underway at the NAMA Facility.</li> </ul> <p>(ADB)</p> <ul style="list-style-type: none"> <li>• The company is engaged in promotional activities for large-scale EV charging stations and support for the formulation of strategies to promote EVs.</li> <li>• A master plan for new road connectivity is currently being developed.</li> </ul>	<ul style="list-style-type: none"> <li>• Support the development of EV-related standards such as EV battery disposal guidelines.</li> </ul>
Energy conservation	<ul style="list-style-type: none"> <li>• The need for energy conservation in the industrial sector is recognized, but efforts are not sufficient (MoICS).</li> <li>• Energy audit guidelines have been developed, but companies are only taking voluntary actions. Energy audits and promotion of energy efficiency and conservation in the manufacturing</li> </ul>	<p>(MoICS, WECS)</p> <ul style="list-style-type: none"> <li>• There is no energy policy targeting the industrial sector, but we believe that energy efficiency improvements and clean energy use in the industrial sector need to be addressed.</li> </ul>	<p>(GIZ)</p> <ul style="list-style-type: none"> <li>• The company had implemented energy conservation programs in the past and conducted basic research on energy consumption in the industrial sector.</li> </ul>	<ul style="list-style-type: none"> <li>• A basic survey on the potential of hydrogen and ammonia utilization in the industrial field will be conducted.</li> <li>• Conduct energy efficiency and conservation audits and pilot projects in the industrial sector (e.g. kiln electrification)</li> </ul>

	<p>industry will eventually be necessary (WECS, MoPIT).</p> <ul style="list-style-type: none"> <li>In the water sector, there is information that the leakage rate is around 40%, but there are no specific initiatives for energy conservation (MoWS).</li> </ul>			<p>in brick factories).</p> <ul style="list-style-type: none"> <li>Conduct an energy conservation study in Kathmandu by reducing the leakage rate of water supply system.</li> </ul>
Other	<ul style="list-style-type: none"> <li>No specific mitigation measures have been implemented in the agricultural sector.</li> </ul>	-	-	<ul style="list-style-type: none"> <li>Cooperate with the newly established Department of Climate Change under the MoA (contents to be discussed).</li> </ul>

In particular, the following issues can be identified from the perspective of promoting electrification and energy conservation.

- ✓ The actions in the Long-Term Net Zero Strategy are not fully understood by the Ministry.
- ✓ The challenge of rural electrification lies in the development of the power distribution network rather than in the development of distributed power sources.
  - In power generation, hydropower development is progressing and if all goes well, the country will become a net exporter of electricity within a few years, but there is a large possibility that development will be delayed due to financial and other issues. Projects by the ADB and the US are making progress in the development of the power grid (but not enough to meet the need). The electrification rate has reached 95% for the country as a whole, but the quality of electrification is an issue. Rural areas have low stability and reliability of electricity and are vulnerable to disasters, so it is necessary to strengthen the distribution network and resilience of rural areas.
  - Distributed generation, such as small-scale hydropower, mainly serves as a bridge until the power grid reaches the area. Once the power grid reaches the area, there is a large possibility that it will not be used.
- ✓ Raising the level of domestic electricity demand is necessary.
  - If hydroelectric development progresses smoothly in line with the power development plan, there will be a surplus of several thousand MW in the future, which will need to be raised to meet domestic electricity demand.

- MoEWRI, NEA, AEPC, NOC and others, led by Kathmandu University, are working on the greening of the socio-economy through fuel switching from fossil fuels, including the production of hydrogen, ammonia and synthetic methane using surplus electricity and the use of ammonia as a fertilizer feedstock <sup>135</sup>, but there is no government policy on the use of alternative fuels like hydrogen. Experts from MoEWRI, WECS and Kathmandu University established the Green Hydrogen Coordination Committee and submitted a proposal on hydrogen strategy to the Minister of MoEWRI <sup>136</sup>, but the document was not publicly available at the time of this study and its contents could not be confirmed.
- ✓ Transport electrification has many challenges
  - With regard to EV promotion, there is no pillar law or policy that conforms to the direction of promotion policy, measures, etc., and no technical guidelines (safety, charging, disposal, etc.) are found. Therefore, in the future, there is a possibility that the technical standards of each country for each imported vehicle will be wildly different in the domestic market.
  - There are incentives such as lower EV import tariffs, but there are no experts in these areas.
  - EV promotion projects are being implemented at the NAMA Facility with GIZ and GGGI. <sup>137</sup>
- ✓ Energy conservation efforts are in the initial stages.
  - MoICS is aware of the need for energy conservation in the industrial sector, but has not seen much action.
  - WECS has established energy audit guidelines, but companies are only taking voluntary actions. Energy audits and promotion of energy conservation in the manufacturing industry will eventually become necessary.
  - In the water sector, there is information that the leakage rate reaches 40%, but there are no specific initiatives for energy conservation.

### 4.3.3 Domestic and regional energy potential

Energy production and primary energy supply in Nepal over time (Figure 4-10), it can be seen that the share of coal and petroleum in primary energy supply has increased rapidly in recent years, although the trend of biofuels and waste-derived energy accounting for the majority has not changed. In particular, there has been a significant increase in demand for petroleum products, with demand for middle distillates (mainly kerosene, diesel and heavy oil A), motor fuels (Mogas) and LPG growing significantly since 1990 (Figure 4-11). Looking at

<sup>135</sup> Nepal Hydrogen Initiative, <https://nhi.ku.edu.np/> accessed 3 August 2022

<sup>136</sup> Urja Khabar, <https://www.urjakhobar.com/news/1802591324?fbclid=IwAR1SvciSmYxfWeEpWIMxYc24EhUGU1ApkfQtsJl8-9bTJPMdRtJBb7K600> August 3, 2022 Accessed on

<sup>137</sup> Nepal - Electric Transportation, <https://www.nama-facility.org/projects/nepal-electric-transportation/> Accessed August 3, 2022

Nepal's primary energy supply in 2019, about 71% is biomass, about 18% petroleum products, 6% coal and 5% electricity (Figure 4-12). All electricity is supplied from domestic hydropower with the exception of imported electricity from India during the dry season. Nepal's energy consumption is characterized by the fact that the largest primary energy sources are biomass and waste-derived, and that the residential sector accounts for about 75% of final energy consumption, with biomass accounting for about 95% of energy consumption in the civilian sector. (Figure 4-13). In other words, to achieve ET-CN in the country, it is first necessary to reduce non-sustainable biomass use that leads to deforestation, as well as effective fuel switching in fossil fuel consuming processes in the industrial sector and transport and transportation sector.

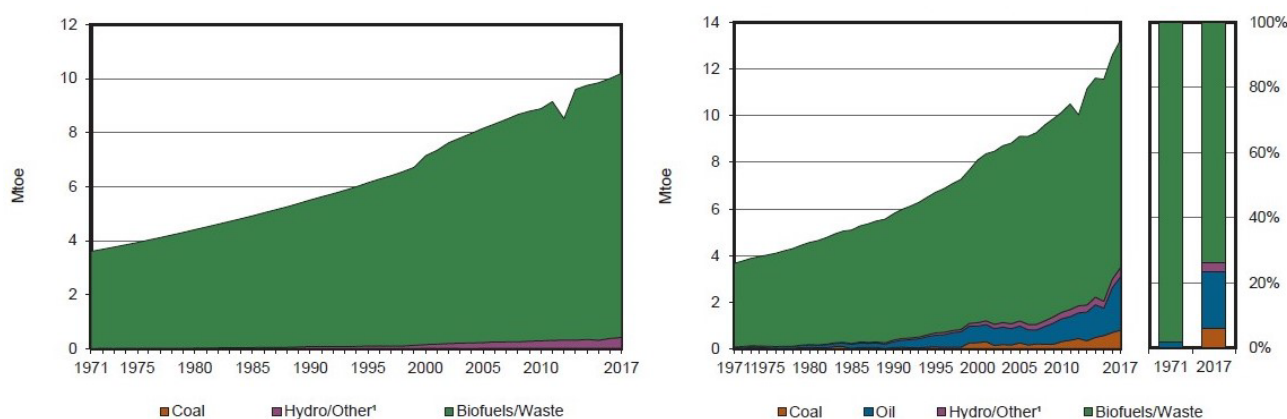


Figure 4-10 Nepal's energy production (left panel) and primary energy supply (right panel) over time <sup>138</sup>

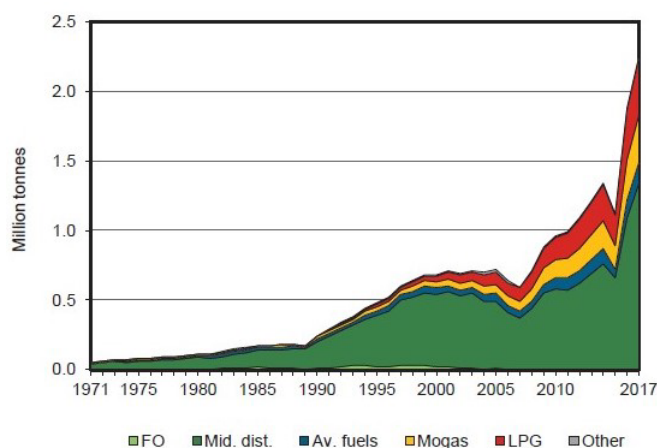


Figure 4-11 Change in demand for petroleum products in Nepal over time <sup>139</sup>

138 World Energy Balances (IEA, 2019)

139 World Energy Balances (IEA, 2019)

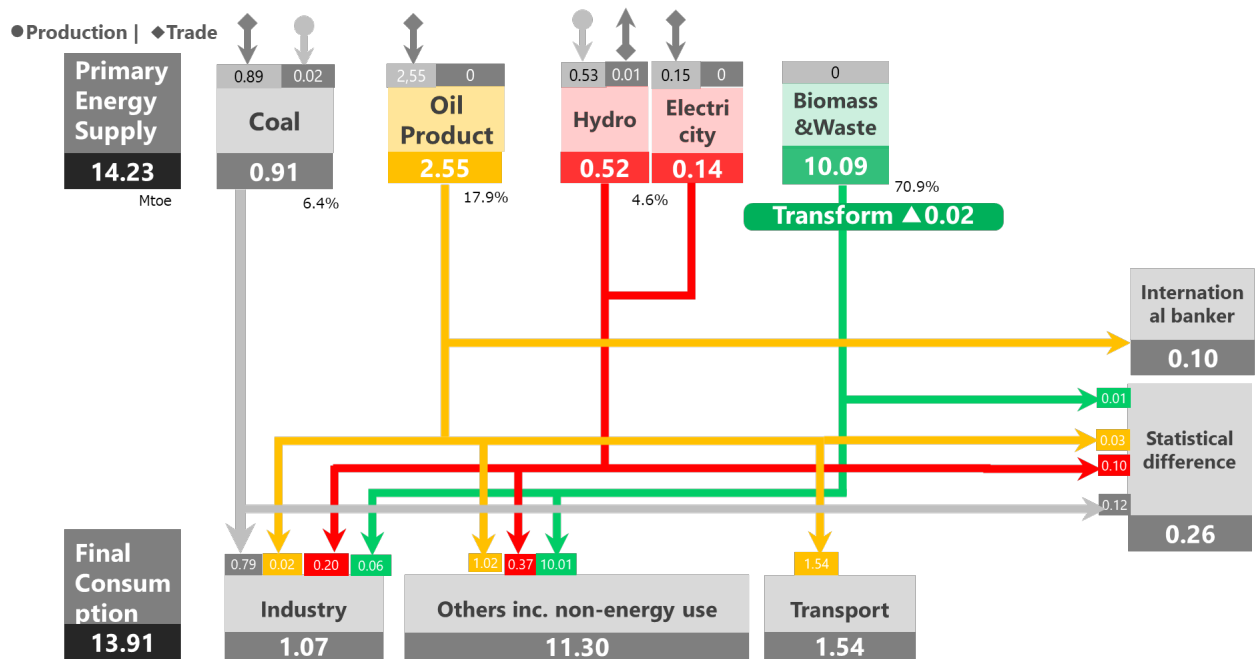


Figure 4-12 Energy balance of Nepal (2019) <sup>140</sup>

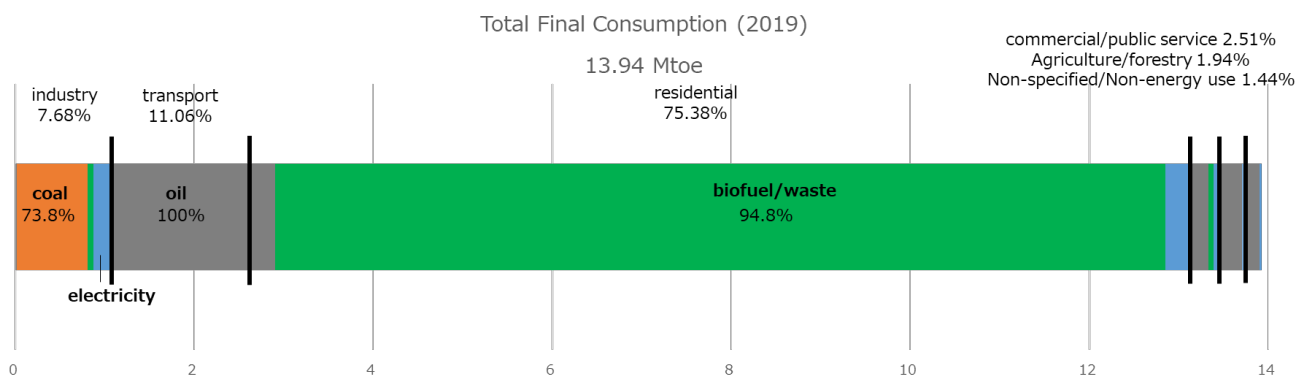


Figure 4-13 Final energy consumption by sector in Nepal (2019) <sup>141</sup>

The civilian use of biomass is mainly for cooking and heating purposes, and from the policy review and field interviews, both institutional and technical support has been implemented, such as improved biomass cooking stoves in the civilian sector, and policies to promote electric stoves and capacity building. Therefore, it is considered that there is no additional support needed at the time of this study. On the other hand, many respondents pointed out that the conversion to electric stoves has not progressed smoothly in some cases, especially in rural areas, because some areas are not electrified and electricity is unreliable due to power outages and other factors. It was also pointed out that in some areas it is difficult to maintain biogas

140 Prepared by Pacific Consultants based on information from the IEA website. <https://www.iea.org/sankey/#?c=Nepal&s=Balance> Accessed 14 June 2022.

141 Prepared by Pacific Consultants based on information from the IEA website. <https://www.iea.org/sankey/#?c=Nepal&s=Final%20consumption> Accessed 14 June 2022

facilities due to the decrease in the number of livestock and the migration of young people to other countries. Therefore, the future development of distributed energy in un-electrified areas is likely to be limited to temporary use until the power grid is extended.

In light of these circumstances, it is believed that Japan's cooperation areas for achieving ET-CN in the country will be effective in supporting "the electrification policy by strengthening and improving the reliability of the local power grid" as well as "electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transportation sectors".

In terms of contribution to Nepal's decarbonization policy, among the energy sector objectives in the NDC (Table 3-35), the development of renewable energy is mainly carried out by NEA and private companies such as IPPs; the promotion of electric vehicles is carried out by MoEWRI, NEA, MoPIT and the NAMA Facility through GIZ and GGGI; and the promotion of high-efficiency cooking equipment and biogas is carried out through GCF projects. On the other hand, with regard to the target of 15% of energy demand to be clean energy, no concrete progress has been made in energy other than electricity at the time of this study, except for the hydrogen project led by Kathmandu University. Under these circumstances, "Electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transport sectors" will contribute to the goal of cleaner energy demand. Furthermore, support for "Promoting electrification policies by strengthening and improving the reliability of rural electricity grids" and "Electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transport sectors" will contribute to Nepal's NLTS (Table 3-36) in the energy sector in "power generation", "civilian", "industrial", "transport and transportation" and "commercial" sectors.

Green hydrogen potentials are calculated by Thapa et al. of Kathmandu University (2021)<sup>142</sup> based on NEA's Annual report (2018/2019)<sup>143</sup>, which points out that there could be a surplus of around 3,000 MW of hydropower capacity by 2030 (Figure 4-14).<sup>144</sup> If 100% of the surplus electricity is used for hydrogen production, about 310,000 tons/year of hydrogen can be produced in 2030 (at a cost of about 6 USD/kg to 13 USD/kg depending on the time of electricity use), which can replace about 1.2 million kL of gasoline. In addition, by converting hydrogen into ammonia, it can be used as an alternative raw material for chemical fertilizers, which are currently imported from India.<sup>145</sup>

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142 Thapa BS et al, Green hydrogen potentials from surplus hydro energy in Nepal, International Journal of Hydrogen Energy, <https://doi.org/10.1016/j.ijhydene.2021.04.096>

143 Nepal Electricity Authority: A year in review-fiscal year 2018/2019 (NEA, 2019)

144 We believe that these include electricity exports to neighboring countries, but since the planned export volumes cannot be ascertained from the NEA Annual Report, we consider them all to be surpluses. In addition, since this figure is lower than the NDC target of installing 13.6 GW of hydropower by 2030, there may be a further surplus if the NDC target is achieved.

145 From the perspective of GHG emission reduction, it is not clear whether replacing imported chemical fertilizers with green ammonia-derived chemical fertilizers produced in Nepal would lead to a reduction in Nepal's GHG emissions. This is because GHG emissions from the manufacturing process of imported chemical fertilizers are accounted for outside Nepal and are not originally considered to be included in Nepal's GHG emissions. Although GHG emissions from imports will be reduced, on the other hand, GHG emissions are likely to arise from the procurement of raw materials for manufacturing in Nepal, so a comparative study is necessary.

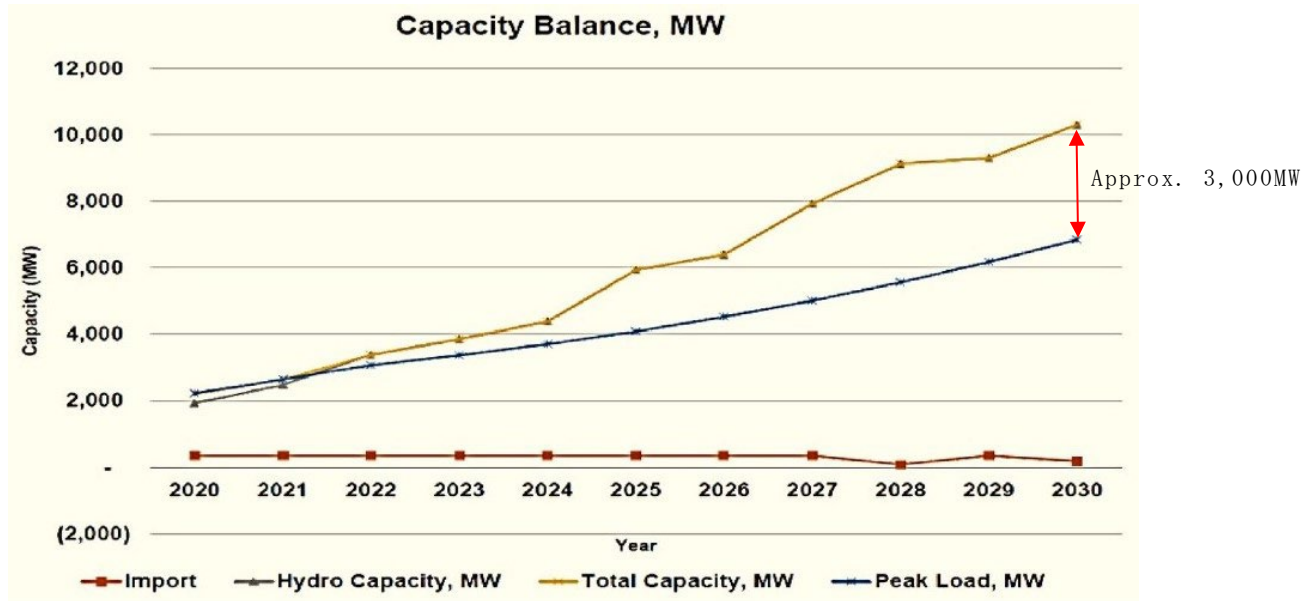


Figure 4-14 Projected balance of installed generation capacity in Nepal (2020-2030) <sup>146</sup>

<sup>146</sup> Nepal Electricity Authority: A year in review-fiscal year 2018/2019 (NEA, 2019) in Thapa BS et al, Green hydrogen potentials from surplus hydro energy in Nepal, International Journal of Hydrogen Energy, <https://doi.org/10.1016/j.ijhydene.2021.04.096>



## 4.4 Uzbekistan

### 4.4.1 Organizing existing ET-CN related JICA Projects

JICA has been implementing development assistance projects in various sectors in Uzbekistan as shown in Table 4-13. The issues from these projects are summarized in the following Table 4-14.

Table 4-13 JICA projects contributing to ET/CN in Uzbekistan (about the last 10 years) <sup>147</sup>

No.	Type	Project	Period
<b>Energy</b>			
1	Loan	Navoi Thermal Power Plant Modernization Project (Phase 2)	December 2019 - April 2031
2	Loan	Power Sector Capacity Enhancement Project (Phase 2)	December 2019 - December 2026
3	Loan	Tashkent Combined Heat and Power Plant Construction Project	October 2015 - August 2021
4	Loan	Power Sector Capacity Enhancement Project	January 2015 - March 2018
5	Loan	Tulaklugan Thermal Power Plant Construction Project	August 2014 - November 2019
6	Loan	Navoi Thermal Power Plant Modernization Project	August 2013 - April 2020
<b>Traffic</b>			
7	Loan	Karsi-Termez railway electrification project	February 2012 - June 2019
<b>Agriculture</b>			
8	Loan	Amvhara Irrigation Facility Rehabilitation Project	December 2014 - December 2020
<b>Education</b>			
9	Technical cooperation	Project for Strengthening the Capacity of Research Activities of Uzbek-Japan Innovation Center of Youth	January 2019 - March 2024

<sup>147</sup> Prepared by Pacific Consultants from preliminary evaluation documents and reports posted on the JICA website. Project titles are provisionally translated by Pacific Consultants.

Table 4-14 Summary of main issues related to ET and CN as indicated by existing JICA projects in Uzbekistan

Sector	Problem
Energy	<ul style="list-style-type: none"> <li>Improvement of power generation efficiency of aging natural gas-fired thermal power plants and construction of new ones to enhance the power supply capacity in the area around the industrial complex (No. 1)</li> <li>The challenge is to improve the power generation efficiency of aging natural gas-fired thermal power plants. It is necessary to improve the efficiency of natural gas-fired thermal power generation by introducing high-efficiency now band cycle gas turbines (No.4), improving the power generation efficiency of thermal power plants, and stabilizing power supply (No. 4, 5, 6).</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>Rail transport capacity needs to be increased to cope with the growing volume of freight transported (No.7).</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>The challenge is improving the efficiency of power from old and aging irrigation pumps (No. 8)</li> </ul>

#### 4.4.2 Analysis of issues related to energy transition and carbon neutrality (especially hydrogen utilization in power generation and other sectors)

Looking at Uzbekistan’s energy production and primary energy supply over time (Figure 4-15), both of which are almost entirely dominated by natural gas, but primary energy supply itself has been declining since 2010. Demand for almost all petroleum products has been continuously declining since 1990 (Figure 4-16). Natural gas is used in all aspects of society, and from field interviews, consumption is particularly high in the heat supply of the residential sector, partly due to losses caused by aging facilities (Figure 4-17 Figure 4-18)

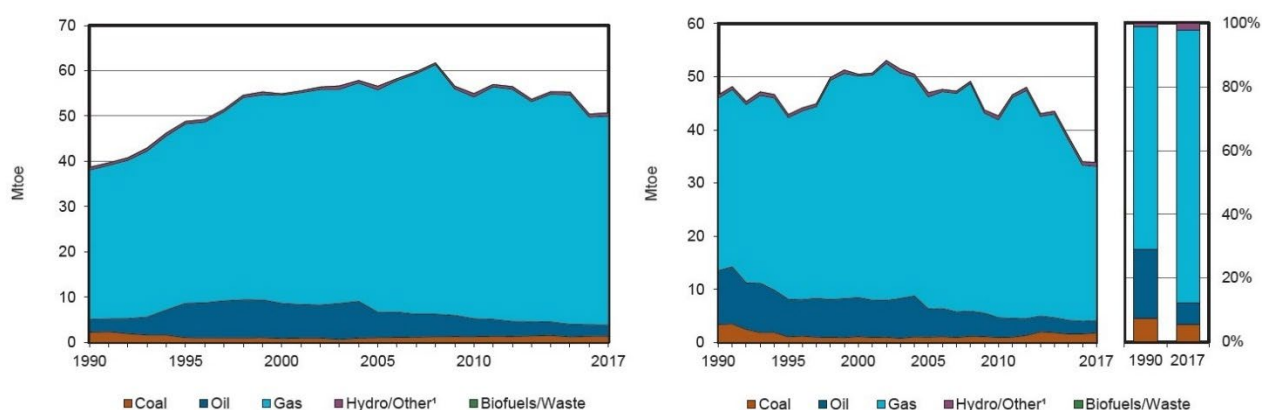


Figure 4-15 Energy production (left figure) and energy supply (right figure) in Uzbekistan over time <sup>148</sup>

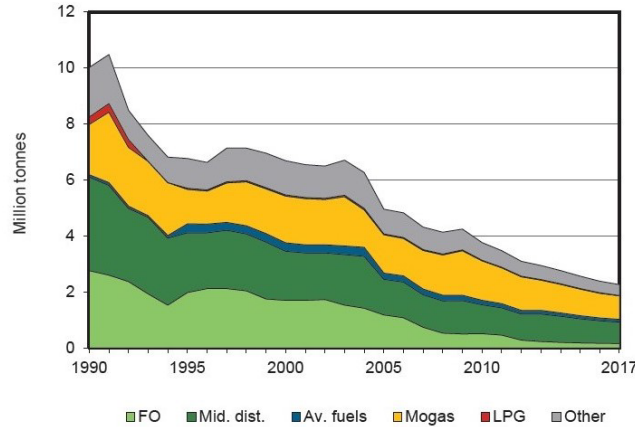


Figure 4-16 Change in demand for petroleum products in Uzbekistan over time <sup>149</sup>

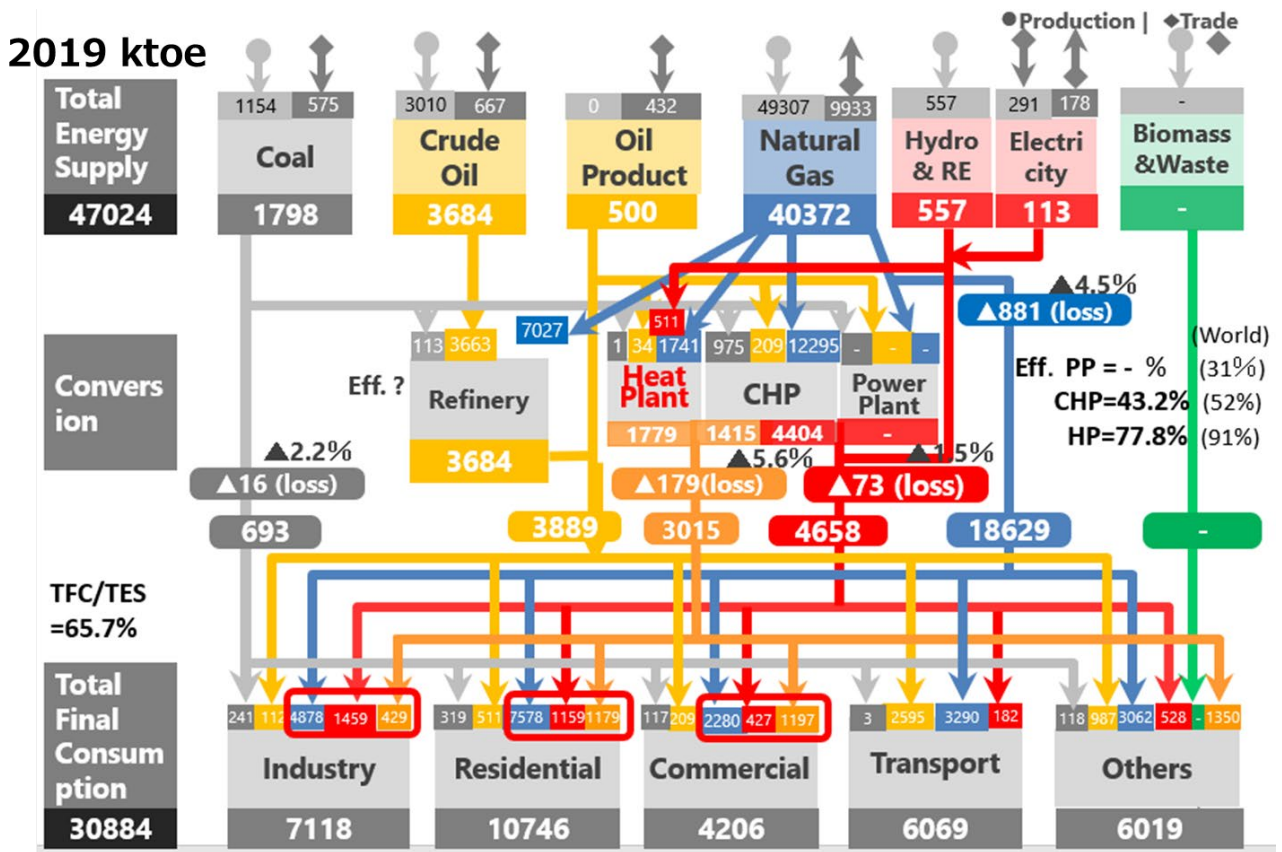


Figure 4-17 Energy balance of Uzbekistan (2019) <sup>150</sup>

149 World Energy Balance (IEA, 2019)

150 Compiled by JICA and Pacific Consultants from IEA World Energy Balances and other sources.

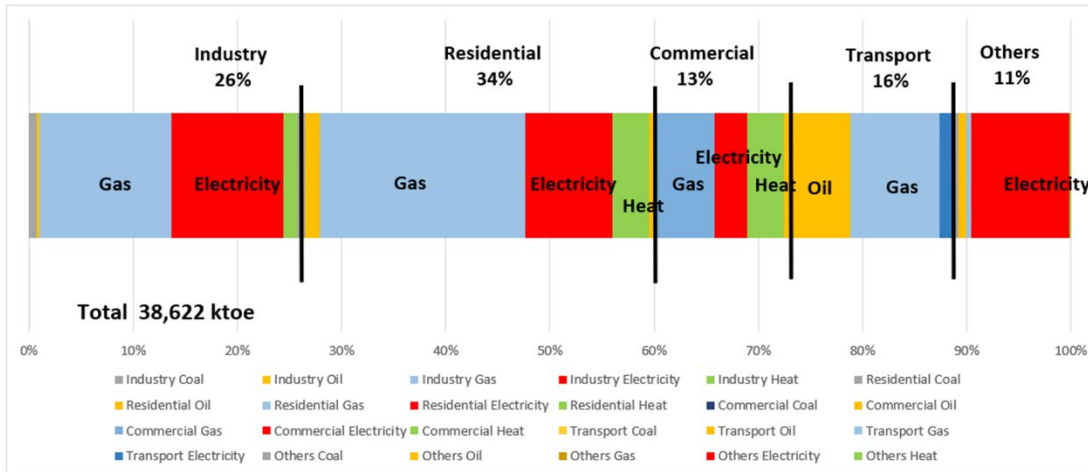


Figure 4-18 Uzbekistan Final Energy consumption by Sector (2019) <sup>151</sup>

Uzbekistan has made a major policy shift from natural gas-fired power generation to the mass introduction of renewable energy, such as solar power and wind power, since 2020, and many new strategies and policies have been approved in the power sector. At the same time, the massive introduction of renewable energy has made the modernization of the power grid a pressing issue. In the power sector, the formulation and implementation of new policies and strategies in the power generation sector and the modernization of the power grid are proceeding simultaneously, and the human resource development of the competent authorities and related organizations is lagging behind. Large-scale renewable energy installations are being promoted through IPPs, and competitive bidding is being conducted by private companies.

The organization in charge of grid management in the region, including domestic and neighboring countries, was also changed around the second quarter of 2022. The Ministry of Energy is now in charge of grid management, and it is necessary to confirm the future grid management policy, etc. as appropriate.

Although several donors are supporting the Government of Uzbekistan in the formulation of the ET-CN strategy, the strategy and direction of the government as a whole is expected to be formulated in the future.

In addition to the energy sector, various new policies are being considered and studied in the industrial, transportation, and residential sectors. In these sectors, the competent authorities are also conducting studies and examinations to establish policies, legal systems and other institutional frameworks, but few policies are at the stage of concrete implementation. In the areas of ET-CN, it is expected that the use of private sector investment and emission trading for net-zero emissions will be on the policy agenda in the future.

Thus, although there is institutional movement toward achieving ET-CN in particular, legislation and guidelines need to be developed before the implementation stage. Furthermore, in order to achieve social implementation of decarbonization technologies, it is necessary to

151 Compiled by JICA and Pacific Consultants from IEA World Energy Balances and other sources.

simultaneously develop human resources in government agencies as well as establish and implement policies and institutions, and the government is required to solve institutional issues with limited human resources for the time being.

Table 4-15 Analysis of issues related to ET-CN in Uzbekistan <sup>152</sup>



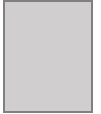
Broad category subclass	Institutional aspects		Technical aspects		Mounting	
	Planning/policy	Legal/GL	R&D	FS	Involvement of stakeholders	Social implementation
Color coding			-			
Description	<ul style="list-style-type: none"> <li>- Stable supply of cheap energy</li> <li>- Policy shift to mass introduction of renewable energy</li> <li>- Long-term ET and decarbonization strategy not yet developed <sup>153</sup></li> <li>- No decarbonization plan in place for industry, transport and residential sector</li> <li>- Methods and measures to reduce methane emissions in the agricultural sector are unclear</li> <li>- Forest area as a sink is decreasing</li> </ul>	<ul style="list-style-type: none"> <li>- Massive introduction of renewable energy, modernization of the grid, and intra-regional supply-demand balance adjustment are proceeding simultaneously, and the same applies to GL, etc.</li> <li>- Lack of relevant human resource development</li> <li>- Need legislation to decarbonize industry, transport and residential life.</li> <li>- Institutionally, hydrogen is not yet recognized as an energy</li> </ul>	N/A	<ul style="list-style-type: none"> <li>- Securing supply and demand adjustment options for maximum use of renewable energy is an issue <sup>154</sup></li> <li>- Prospects for implementation of FSs for hydrogen and ammonia utilization in the industrial, transportation, and residential sectors are</li> </ul>	<ul style="list-style-type: none"> <li>- No structure for import and export of clean energy with neighboring countries</li> <li>- Unclear incentive for private investment in ET-CN for industrial, transport and residential sector</li> </ul>	<ul style="list-style-type: none"> <li>- Emission reductions in non-energy sectors toward net-zero emissions; direction of emissions trading yet to be determined</li> <li>- Unclear how to adjust the electricity supply-demand balance for each region and future energy storage options</li> </ul>

<sup>152</sup> Prepared by Pacific Consultants based on stakeholder interviews, etc.

<sup>153</sup> Donor support is available for the study of energy transition and decarbonization strategies.

<sup>154</sup> In addition to thermal power generation, it will be necessary to conduct FSs for energy storage facilities and hydrogen and ammonia utilization technologies in the future.

				unknown		
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Color code  Overwhelming obstacles which hinder implementation Observed  Obstacles implementation Observed in  Obstacles implementation in Partially observed

In the following, we analyzed the issues regarding the utilization of hydrogen as one of the options for the means of achieving energy ET-CN. As a premise for analyzing the issues, it is necessary to produce hydrogen for use and to transport it to the place of use. However, according to the interview with Ministry of Energy, hydrogen is still in the research stage and is not treated as an energy source. Although the Ministry of Energy is currently formulating a hydrogen strategy, we believe that the method of utilization is also in the study stage. Based on these assumptions, this section analyzes the issues mainly in the institutional and technological development aspects of hydrogen production and the potential for hydrogen use in power generation and other sectors, up to the transportation and social implementation of hydrogen.

### 1. Hydrogen utilization in power generation and other sectors

In the interviews, the use of hydrogen in power generation was mentioned as a method of utilizing hydrogen in order to reduce the carbon intensity of coal-fired power generation, and the use of products such as burners that are capable of hydrogen blending. Although the Uzbek side mentioned plans such as a "hydrogen cluster" to promote the supply and use of hydrogen in transportation and industrial clusters, the hydrogen strategy is still in the formulation stage. In addition, several research institutes for hydrogen research and development were identified.

Under these circumstances, the institutional and organizational aspects are at the stage of investigating and studying the technological development and utilization of hydrogen, and the formulation of a hydrogen strategy is awaited. In addition, if interest in hydrogen production and utilization increases within the country, there is a possibility that the technologies possessed by private companies in the Middle East, Japan and other countries will be introduced. It is assumed that it will eventually become necessary to establish a legal system, guidelines and technical standards for the production and utilization of hydrogen, and the human resource development of ministries and research institutes for the production and utilization technologies of green hydrogen, green ammonia, etc., may become a shared issue.

In terms of technology, the use of hydrogen as energy storage, where electricity is stored as hydrogen through water electrolysis, has not been well understood, and the functions of hydrogen in relation to the use of surplus electricity at the time of mass introduction of renewable energy and the response to seasonal fluctuations in electricity supply and demand through hydrogen power generation have not received attention. On the other hand, some research institutes were interested in the development of hydrogen co-firing technology for thermal power generation and products using hydrogen as an alternative energy source. It

should also be noted in the future that the existing energy prices in Uzbekistan, which are kept low by policy, may pose a pricing challenge when hydrogen is utilized in the industrial and transportation sectors.



## 2. Hydrogen Production

Due to the large amount of water resources required for the commercial scale hydrogen production process, it is considered that there will be competition with water use in the agricultural sector in Uzbekistan. According to the interview survey, the use of water resources such as existing agricultural reservoirs is prioritized for agricultural production, and therefore, securing water resources that do not compete with agricultural water resources is a prerequisite for commercial scale hydrogen production in Uzbekistan.

In terms of institutional and organizational aspects, the use of water resources is under the jurisdiction of the Ministry of Water Resources. In particular, where there is concern about chronic water shortages in the country, it is likely that coordination and cooperation with the Ministry of Energy, Ministry of Water Resources, and other related ministries will be required in the future in order to develop hydrogen production in the country.

In terms of technology, hydrogen production in Uzbekistan is likely to attract attention in the future, but some Middle Eastern companies participating in the EPC and IPP of renewable energy power plants are developing hydrogen-related technology in the Middle East, and there is a possibility that such technology will come from overseas. In addition, if a large amount of water resources is to be extracted from lakes in the country, for example, it will be necessary to confirm the availability of lake water with a high salt content.

Table 4-16 Analysis of issues related to hydrogen utilization <sup>155</sup>

Large category	Organization & Aspect System 		Technology Aspect 		Implementation.	
	Planning/Policy	Laws & Regulations, Guidelines	Technological development	Pre-FS	Demonstration	Social implementation
Color coding	(1) Hydrogen use (power generation) (2) Hydrogen use (transportation, etc.)					
	<b>(3) Hydrogen production</b>					
Description.  1) Hydrogen use in power generation <sup>156</sup> 2) Applications in industry, transportation, and consumer fields	<ul style="list-style-type: none"> <li>- Hydrogen is positioned at the research stage. (Hydrogen development will be carried out depending on the results of studies on the impact on the economy and social environment. <sup>157</sup>)</li> <li>- Hydrogen strategy is being developed at the time of this study</li> <li>- The competent authority for hydrogen as an energy source is unclear.</li> <li>- Unclear the position of stable operation of the grid and energy storage in the renewable energy introduction policy</li> <li>- Energy prices on the user side are kept low by subsidies</li> </ul>	<ul style="list-style-type: none"> <li>- Laws and regulations for hydrogen utilization and GLs have not yet been formulated .</li> <li>- Human resources are needed to understand hydrogen utilization technology and to formulate legal systems, GLs and technical standards.</li> </ul> *Still R & D stage	- Domestic: Utilization technology has not yet been established , but several research institutes are working on it.	N/A	N/A  Private sector (overseas ) has hydrogen utilization technology and products <sup>158</sup>	N/A

155 Prepared by Pacific Consultants based on stakeholder interviews, etc.

156 Hydrogen co-firing technology to reduce the carbon intensity of natural gas fired power plants, and the use of hydrogen as a means of storing surplus electricity from renewable energy sources

157 From an interview with the MoE

158 Development of products that enable production and use of hydrogen is progressing, mainly by overseas companies including Japanese companies. In terms of production, Japanese companies are making efforts, although the cost is high and there are some issues. In the area of hydrogen co-firing in natural gas-fired thermal power generation, Japanese companies and others have hydrogen co-firing power generation technologies and products. In addition, Japanese companies have technologies and products to use hydrogen in vehicles, such as hydrogen FC.



3) Hydrogen production	- Need to coordinate with water resource use policies in the agricultural sector (*Water use for hydrogen production will be subordinated if there is competition with existing agricultural water resource use due to the high water demand during hydrogen production)	- Laws and regulations concerning hydrogen production and GLs have not yet been formulated . - Human resources are needed to understand hydrogen production technology and to develop legal systems, GLs and technical standards.	- Domestic: Hydrogen production method not yet established , several laboratories are researching	N/A Private sector (overseas ) has hydrogen production technology	N/A Private sector (overseas ) has hydrogen utilization technology and products <sup>159</sup>	N/A
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Color code



Overwhelming obstacles which hinder implementation Observed



Obstacles in implementation Observed



Obstacles in implementation Partially observed

<sup>159</sup> Same as footnote 158.

## **Chapter 5. Proposed Development Scenarios for Energy Transition and Carbon Neutrality**

### **5.1 Proposed vision and development scenarios for each country studied**

#### **5.1.1 Vietnam**

Based on Chapter 3.3.1, the analysis of the current status of ET-CN in Vietnam, and Chapter 4.1, the challenges to ET-CN, the proposed vision and development scenarios that would contribute to achieving ET-CN in Vietnam are "building a green energy society centered on the use of LNG, green electricity, and hydrogen to encourage the transition from coal-fired power generation to ET-CN" and "promoting decarbonization through energy conservation, electrification, and renewable energy utilization in the industrial sector and other sectors.

Vietnam aims to achieve the net-zero target by 2050. Considering the current dependence on coal-fired power generation, the outlook and direction of the electricity plan toward 2030 will have a significant impact on the roadmap to achieve net-zero emissions by 2050. The power plan under the draft PDP8 is assumed to replace coal-fired power generation with solar and wind power generation and LNG power generation, which in addition is characterized by a larger installed capacity for renewable energy sources than for LNG. Therefore, a development scenario was studied toward carbon neutrality along this direction. It is observed that the description of energy conservation activities in draft PDP8 is not significantly changed from the existing PDP7, and it is assumed there are no special enhancements to renewable energy activities.

The Vietnamese government expects that renewable energy (solar and wind) power generation projects will be implemented by private IPPs. In the area of LNG, many pipeline projects are also operated by IPPs and the establishment of a power market is being considered as well. Under these circumstances, the new measures include the actions to enable even cheaper electricity supply through trading in the electricity market, while utilizing private investment in renewable energy, LNG, and other applicable resources. Although the industrial sector is still required to conserve energy, priorities should be placed on developing green initiatives on the power generation side as a basic approach, since measures or subsidies to encourage energy conservation through the introduction of high-efficiency equipment are not being considered at present. At the same time, the scenario emphasizes the role of storage technology for renewable electricity, hydrogen, and ammonia.

As such, we assume that LNG power generation projects, which are expected to gain momentum some time before 2030, will also be leveraged as a means to stabilizing the grid from power generation after 2050.

Table 5-1 Draft vision and development scenario for Vietnam: Building a green energy society centered on the use of LNG, green electricity, and hydrogen to support the transition from coal-fired power generation to ET-CN

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	Transition will maximize the use of green power from renewable energy sources while also utilizing LNG power generation. The transition will promote GHG emission reductions in the power generation sector while exploring the possibilities of using energy storage, ammonia, and hydrogen for this purpose. By decarbonizing the power generation sector, it can also contribute to the decarbonization of the industrial sector.
○	International Trends in Climate Change Measures	At COP26, Vietnam signed the "Global Clean Power Transition Statement" to phase out coal-fired power generation. In its Joint Statement for ET Cooperation with MOIT for CN, Japan's Ministry of Economy, Trade and Industry (METI) is promoting investment in clean energy, supporting the development and introduction of hydrogen and other technologies, and supporting the formulation of an ET roadmap in cooperation with ERIA. <sup>160</sup> <sup>161</sup> In addition, the METI is promoting investment in ET through the Asian Future Investment Initiative. <sup>162</sup> ASEAN is formulating its own taxonomy, and the handling of natural gas-fired power generation needs to be closely monitored in conjunction with domestic trends in Vietnam. <sup>163</sup>
○	Energy supply chain	As the amount of renewable electricity generated fluctuates, options for forecasting and balancing electricity supply and demand are essential.

<sup>160</sup> Minister Hagiuda Attends the Japan-Vietnam Investment Conference and Meets H.E. Mr. Pham Minh Chinh, Prime Minister of the Socialist Republic of Vietnam, and H.E. Mr. Nguyen Hong Dien, Minister of Industry and Trade (METI, 2021) [https://www.meti.go.jp/english/press/2021/1125\\_002.html](https://www.meti.go.jp/english/press/2021/1125_002.html) Accessed 19 Aug, 2022.

<sup>161</sup> METI Holds the Fifth Meeting of the Japan-Vietnam Joint Committee on Cooperation in Industry, Trade and Energy (METI, 2022) [https://www.meti.go.jp/english/press/2022/0823\\_001.html](https://www.meti.go.jp/english/press/2022/0823_001.html) Accessed 24 Aug, 2022.

<sup>162</sup> ASIA-Japan Investing for the Future Initiative Announced (METI, 2022) [https://www.meti.go.jp/english/press/2022/0110\\_001.html](https://www.meti.go.jp/english/press/2022/0110_001.html) Accessed 19 Aug, 2022.

<sup>163</sup> ASEAN Taxonomy for Sustainable Finance (ASEAN, 2021) <https://asean.org/book/asean-taxonomy-for-sustainable-finance/> Accessed 23 Aug, 2022.

○	Competitive edge	<p>The unit cost of LNG power generation depends on the LNG procurement price.</p> <p>Solar power is recognized worldwide as the cheapest way to generate electricity. If the private sector can be encouraged to invest in IPP projects, solar and wind power generation will be able to supply electricity at lower cost. However, investment in technologies for stabilize grids such as storage batteries is essential to absorb fluctuations in power generation.</p>
○	National finance	<p>In order to improve the investment environment for renewable energy generation by the private sector, it is highly likely that government guarantees and convertible guarantees will need to be provided.</p>
○	Industrial promotion	<p>By using electricity derived from LNG and renewable energy generation, the export industry can reduce the carbon footprint of its products to a lower level than before. In particular, it can contribute to strengthening the international competitiveness of products in the export industry.</p>
-	Other	-
<b>Impact of the development scenario</b>		<b>Outline</b>
○	Environmental aspect	<p>For LNG facilities, it is necessary to conduct an environmental impact assessment in terms of terminal installation and high-pressure gas management at the port.</p> <p>The construction of solar and wind power generation facilities is not considered to be a major problem unless there are large-scale deforestation and biodiversity protection issues. Generally, power plants are developed in designated areas, and the system is such that financing cannot be obtained from financial institutions without proper implementation of environmental and social studies in advance.</p>
○	Economy and Industry	<p>A stable supply of renewable energy at low cost would be beneficial both economically and for industry. However, stability of the power grid is a prerequisite for this, and in the future it is possible that storage and other functions will be required. In the case of a cluster of</p>

		power plants, the amount of electricity generated will exceed the grid linkage and demand in the target area, and may be subject to temporary supply curbs to stabilize the grid.
○	Society	Large-scale solar and wind power plants are not expected to employ large numbers of workers or provide other benefits compared to other methods of power generation, but they may lead to lower electricity prices. Combined with LNG power generation, it will contribute to stable and inexpensive power supply.

Table 5-2 Draft vision and development scenario for Vietnam: Promoting decarbonization through energy conservation, electrification, and renewable energy utilization in the industrial sector, etc.

Assumptions for development scenarios		
Perspectives for consideration		outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	Promote GHG emission reductions through electrification, use of green power, and energy conservation in the energy consumption of industrial enterprises, which will contribute to building a more sustainable society by achieving decarbonization in the industrial sector by 2050. However, energy saving and electrification require individual capital investment by companies.
○	International Trends in Climate Change Measures	Same as the Table 5-1.
-	Energy supply chain	-
○	Competitive edge	The competitiveness of industrial sectors, especially export industries, requires not only the price of products and services, but also the decarbonization of production and the decarbonization of the value chain from production to sales.
○	National finance	Measures to promote investment in energy efficiency and decarbonization by the private sector are necessary. Generally, large electricity consumers have access to commercial bank loans, etc.

○	Industrial promotion	Energy-saving equipment such as high-efficiency facilities and electrification for decarbonization will increase demand for a variety of high-efficiency products and power generation equipment, contributing to industrial development.
-	Other	-
<b>Impact of the development scenario</b>		<b>Outline</b>
○	Environmental aspect	There is equipment and facilities to be installed within each company's facilities, but it will promote higher efficiency and cleaner energy consumption. It is estimated that environmental issues will not be significant.
○	Economy and Industry	There will be an effect on the economic side due to the investment effect by the private sector. It will contribute to strengthening the competitiveness of industries.
○	Society	Stimulate demand for various equipment, thereby contributing to increased demand for manufacturers and other companies and workers.

### 5.1.2 Lao PDR

Lao PDR aims to achieve net-zero emissions by 2050, and ET-CN will be achieved by promoting hydropower electrification and fuel switching to green fuels derived from hydropower in sectors and processes consuming fossil fuels or non-sustainable biomass in the country. To this end, it is important to develop a transmission network that adequately connects the hydroelectric power supply areas with the demand areas. Although the development of the power grid will require time and money, it is expected to ensure a stable supply of electricity and the proper operation of hydropower facilities, which will in turn help to raise the level of electricity demand in the country as a whole. In Laos, imports of petroleum products have been delayed due to a shortage of foreign currency reserves, and gasoline supply shortages have become a social problem. A development scenario could be constructed with a vision of "building a green energy society centered on the use of green electricity and hydrogen" that promotes fuel conversion using green electricity and hydrogen in the industrial, transportation, and consumer sectors. In addition, "Promotion of the establishment of a carbon neutral society through modernization of the agriculture, forestry, and livestock industries" is considered to be effective as a scenario proposal to strengthen REDD+ to prevent conversion of forest land, the largest emission source in Laos, to cultivated land, and to promote research and implementation with the MoA and the National University of Laos on measures to reduce methane emissions from the agriculture and livestock industries. This is believed to be an effective scenario.

Table 5-3 Draft Vision and Development Scenario for Lao PDR: Strengthening of the power grid linking northern Laos with domestic and international power demand areas

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	<p>The development of the power grid will contribute to the efficient operation of hydropower facilities, increase domestic electricity demand through stable electricity supply, and promote EVs. The promotion of EVs will lead to a reduction in fossil fuel imports in Laos, where foreign currency is scarce, and contribute to improving energy security.</p> <p>The development of international interconnection lines will lead to more efficient operation of hydropower facilities and increased revenues from electricity sales through power exports. In addition, electricity interconnection in the region, including neighboring countries, will lead to improved stability of the regional electricity grid and contribute to improved energy</p>

		<p>security in the region.</p> <p>Neighboring countries that are interconnected to the grid can reduce their own GHG emissions by importing hydroelectric power.</p>
○	International Trends in Climate Change Measures	<p>In its Joint Statement for ET Cooperation with ASEAN for CN, Japan's METI is promoting investment in clean energy, support for the development and introduction of hydrogen and other energy sources, and support for the formulation of an ET roadmap. In addition, METI is promoting investment in ET through the Asian Future Investment Initiative. (refer to the Table 5-1)</p> <p>Electrification with renewable energy power is being promoted globally.</p>
○	Energy supply chain	<p>The development of the power grid will help raise the level of domestic electricity demand.</p> <p>Electricity sharing with neighboring countries is affected by the power development plans of each country.</p>
-	Competitive edge	-
○	National finance	<p>By connecting the demand areas to the grid, the surplus power from hydropower generation can be sold, which will help improve EDL's finances.</p>
-	Industrial promotion	-
-	Other	-
<b>Impact of the development scenario</b>		<b>outline</b>
○	Environmental aspect	<p>If forest lands are to be used for the construction of power transmission and distribution networks, an environmental impact assessment should be conducted.</p> <p>Neighboring countries that will be interconnected with grids of Laos will be able to reduce their own GHG emissions by importing hydropower from Laos.</p>
○	Economy and Industry	<p>The increase in electricity sales in Laos and abroad will lead to an increase in EDL's income from electricity sales.</p>
○	Society	<p>Interconnecting power grids with neighboring countries will lead to improved grid stability and stable energy supply in the region.</p>



Table 5-4 Draft vision and development scenario for Lao PDR: Electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transport sectors

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	Replacing import-dependent petroleum products with home-grown green fuels will lead to a stable energy supply and strengthen energy security. Transitioning from a fossil fuel society to a green fuel society will lead to GHG emission reductions.
○	International Trends in Climate Change Countermeasures	Electrification with renewable energy power is being promoted globally. Transition to green hydrogen-derived fuels.
○	Energy supply chain	Replace import-dependent petroleum products with home-grown hydrogen-derived green fuels. Furthermore, the country could become an exporter of green fuels. However, a study is needed to understand the potential of green fuel demand and supply in Laos as a whole.
○	Competitive edge	The abundant hydropower endowment can be used to supply green fuels at relatively low cost compared to the rest of the world.
○	National finance	Electrification will help strengthen EDL's finances. Substituting the consumption of petroleum products, which is mainly dependent on imports, with home-grown green fuels will reduce import costs and revenue from the sale of green fuels in domestic market. Exporting green fuels will also lead to fiscal revenue.
○	Industrial promotion	Electrification of the transportation sector will lead to the promotion of EV-related industries. Promoting green fuel production and sales will lead to the development of industries related to hydrogen, ammonia, and synthetic gas, as well as the chemical fertilizer industry. However, laws and regulations must be in place for the use of gas as an energy source.
-	Other	-
Impact of the development scenario		Outline
○	Environmental aspect	Electrification with hydropower electricity and substitution of fossil fuels with green fuels are expected

		to reduce GHG emissions and improve air pollution.
○	Economy and Industry	Electrification of the transportation sector will lead to the promotion of EV-related industries. Promoting green fuel production will lead to the development of industries related to hydrogen, ammonia, and synthetic gas, as well as the chemical fertilizer industry. However, laws and regulations must be in place for the use of gas as an energy source.
○	Society	Replacing fossil fuel consumption with hydroelectricity or green fuels improves air quality, which in turn improves health.

Table 5-5 Draft vision and development scenario for Lao PDR: Promoting the establishment of a carbon neutral society through modernization of the agriculture, forestry and livestock industries

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	The spread of methane reduction technologies while maintaining the productivity and quality of agricultural and livestock products will lead to GHG emission reductions together with food supply.
○	International Trends in Climate Change Measures	REDD+ is mentioned in Article 5 of the Paris Agreement, which states that implementation and support for REDD+ will be provided.
-	Energy supply chain	-
-	Competitive edge	-
-	National finance	-
○	Industrial promotion	Modernizing the agriculture, forestry and livestock industries will lead to higher productivity and ultimately higher incomes.
-	Other	
Impact of the development scenario		Outline
○	Environmental aspect	Reduction of GHG emissions such as methane will lead to improvement of the atmospheric environment.
○	Economy and Industry	Modernizing the agriculture, forestry and livestock industries will lead to higher productivity and ultimately higher incomes.

○	Society	Improved productivity in the agriculture, forestry and livestock industries will lead to a stable supply of agricultural, forestry and livestock products.
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### 5.1.3 Nepal

Based on the current situation regarding ET-CN in Nepal in Chapter 3.3.3, and on the analysis of challenges to ET-CN presented in Chapter 4.3, the proposed future vision and development scenarios that will contribute to the achievement of ET-CN in Nepal "Promotion of electrification policy by strengthening and improving the reliability of rural electricity grid" and "Electrification and conversion to green fuels such as green hydrogen in the domestic industrial sector and transport sector" are effective. In addition, with regard to measures to reduce methane emissions from the agriculture and livestock industry, which is the largest source of emissions in the country, it is believed that the "Promotion of the establishment of a carbon neutral society through modernization of the agriculture, forestry and livestock industry" <sup>164</sup>, which will promote research and social implementation with the newly planned special department for climate change measures under the MoA, will be effective. The jurisdiction of this newly planned department is currently unknown, so it will be necessary to discuss this issue with the MoA again in the future.

Table 5-6 Proposed vision/development scenario for Nepal: Promoting electrification policies by strengthening and improving the reliability of rural electricity grids

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	Enhanced rural electrification will reduce non-sustainable biomass consumption for cooking, heating, etc., which will contribute to enhanced GHG reduction and conserve absorption function. It will also lead to improvements in domestic air quality. Improving the vulnerability of the local power grid will lead to improved energy security in the area.
○	International Trends in Climate Change Measures	Electrification with renewable energy power is being promoted globally.
-	Energy supply chain	-
-	Competitive edge	-
○	National finance	NEA, the power utility, will need to invest in infrastructure, but revenues from power sales will increase
○	Industrial promotion	The electrification of rural areas will expand the market for home appliances. In addition, electrification of

<sup>164</sup> The MoA has jurisdiction over agriculture and livestock, while forestry measures are under the jurisdiction of the MoFE.

		agriculture, forestry, livestock, and other industries will lead to higher productivity and, ultimately, higher incomes.
○	Other	In strengthening the electricity grid, climate change adaptation should be considered to improve the energy resilience of the region.
<b>Impact of the development scenario</b>		<b>Outline</b>
○	Environmental aspect	Enhanced rural electrification will reduce non-sustainable biomass consumption for cooking, heating, etc., contributing to enhanced GHG reductions and conservation of sinks. If the use of forest lands, etc. is anticipated as a result of the enhancement of the power grid, an environmental impact assessment should be conducted.
○	Economy and Industry	The electrification of rural areas will expand the market for home appliances. In addition, electrification of agriculture, forestry, livestock, and other industries will lead to higher productivity and ultimately, higher incomes.
○	Society	Stable supply of electricity in rural areas will reduce the effort of biomass extraction. Replacing biomass combustion with electricity will improve indoor air quality, which in turn will contribute to improved health.

Table 5-7 Proposed vision and development scenario for Nepal: Electrification and conversion to green fuels such as green hydrogen in the domestic industrial and transport sectors

Assumptions for development scenarios		
<b>Perspectives for consideration</b>		<b>Outline</b>
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	Replacing fossil fuels (coal and petroleum products) that depend on imports with home-grown green fuels will lead to a stable energy supply and strengthen energy security. Transitioning from a fossil fuel society to a green fuel society will lead to GHG emission reductions.
○	International Trends in Climate Change Measures	Electrification with renewable energy power is being promoted globally. Transition to green hydrogen-derived fuels.

○	Energy supply chain	Oil and LPG, which depend mainly on imports from India, will be replaced by the country's own hydrogen-based green fuels. Furthermore, the country could become an exporter of green fuels. However, a study is needed to understand the demand and supply potential of green fuel in Nepal as a whole.
○	Competitive edge	The abundant hydropower endowment can be used to supply green fuels at relatively low cost compared to the rest of the world.
○	National finance	Electrification will strengthen NEA's finances. Substituting the consumption of coal, petroleum and LPG, which are mainly dependent on imports, with home-grown green fuels will help reduce import costs. Exporting green fuels will also lead to fiscal revenue.
○	Industrial promotion	Electrification of the transportation sector will lead to the promotion of EV-related industries. Promoting green fuel production will lead to the development of industries related to hydrogen, ammonia, and synthetic gas, as well as the chemical fertilizer industry. This will lead to an expansion of the business scope of NOC, which specializes in fossil fuel-related businesses.
-	Other	-
<b>Impact of the development scenario</b>		<b>Outline</b>
○	Environmental aspect	Electrification with hydropower electricity and substitution of fossil fuels with green fuels are expected to reduce GHG emissions and improve air pollution.
○	Economy and Industry	Electrification of the transportation sector will lead to the promotion of EV-related industries. Promoting green fuel production will lead to the development of industries related to hydrogen, ammonia, and synthetic gas, as well as the fertilizer industry. This will lead to an expansion of the business scope of NOC, which specializes in fossil fuel-related businesses.
○	Society	Replacing fossil fuel consumption with hydroelectricity or green fuels improves air quality, which in turn improves health.

Table 5-8 Draft Vision and Development Scenario for Nepal: Promoting a carbon-neutral society through modernization of the agriculture, forestry, and livestock industries

Assumptions for development scenarios		
Perspectives for consideration		outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	The spread of methane reduction technologies while maintaining the productivity and quality of agricultural and livestock products will lead to GHG emission reductions together with food supply.
○	International Trends in Climate Change Measures	Nepal is a participating country in the Global Methane Pledge and has agreed to implement voluntary measures to reduce global methane emissions by at least 30% by 2030. REDD+ is an integral part of Article 5 of the Paris Agreement, which calls for implementation and support.
-	Energy supply chain	-
-	Competitive edge	-
-	National finance	-
○	Industrial promotion	Modernizing the agriculture, forestry and livestock industries will lead to higher productivity and ultimately higher incomes.
-	Other	
Impact of the development scenario		Outline
○	Environmental aspect	Reduction of GHG emissions such as methane will lead to improvement of the atmospheric environment.
○	Economy and Industry	Modernizing the agriculture, forestry and livestock industries will lead to higher productivity and ultimately higher incomes.
○	Society	Improved productivity in the agriculture, forestry and livestock industries will lead to a stable supply of agricultural, forestry and livestock products.

#### 5.1.4 Uzbekistan

Uzbekistan, in its NDC, has set a GHG emission reduction target of 35% per GHG unit of production by 2030 compared to 2010 levels. The National Low Carbon Energy Development Strategy announced in 2020 calls for the additional 30GW of installed capacity from renewable and other energy sources by 2030, modernization of existing gas-fired power plants, energy source diversification, and development of renewable energy (especially solar power). Other national strategies also include reduction of carbon emissions from gas-fired power generation and the introduction of renewable energy generation.

Against this backdrop, based on the EBRD’s recommendation, MOE presented in 2022 a scenario for policymakers to achieve decarbonization by 2050. In this scenario, the percentage of thermal power generation to total installed generation capacity is to be reduced, while using the gas fired thermal power by gas to stabilize the grids, by modernizing the existing gas-fired power plants and introducing renewable energy and eliminating the construction of new gas-fired power plants by 2030, and by providing electricity mainly from scaling up of renewable energy facilities and by storing electricity from renewable energy by 2040. The schedule is to further increase the installed capacity of renewable energy power plants and install large-scale power storage facilities by 2050, while gas-fired power plants will be converted to hydrogen-mixed or hydrogen-power generation.

The scenarios for development towards energy transition and carbon neutrality were examined as follows on the basis of the directions indicated by the various national plans for decarbonization. Modernization of existing gas-fired power generation, introduction of large amounts of renewable electricity, and activities to stabilize the grids will be the main focus until 2050. In addition, as indicated in the MOE scenario, in Uzbekistan, which is rich in renewable energy resources, the installation of equipment such as large-capacity batteries for storing renewable electricity is essential for grid stabilization and achieving carbon neutrality.

Table 5-9 Draft Vision and Development Scenario for Uzbekistan: Promote low-carbon gas-fired power generation and decarbonization through green power and energy storage

Assumptions for development scenarios		
Perspectives for consideration		Outline
○	Policy Framework for Environment, Stable Supply, Economy and Safety (3E+S)	While also utilizing natural gas, maximize the use of green power from renewable energy sources. Promote GHG emission reductions in the power generation sector while exploring the possibility of using energy storage, ammonia, and hydrogen for this purpose. By decarbonizing the power generation sector, also contribute to the decarbonization of the industrial sector.



○	International Trends in Climate Change Measures	Electrification with renewable energy power is being promoted globally. Low-carbon natural gas-fired power generation based on energy transition is being promoted globally.
○	Energy supply chain	As the amount of electricity generated fluctuates, options for forecasting and balancing electricity supply and demand are essential.
○	Competitive edge	The unit cost of natural gas power generation depends on the policy of the government. Solar power is recognized worldwide as the cheapest way to generate electricity. If the private sector can be encouraged to invest in IPP projects, solar and wind power generation will be able to supply electricity at lower cost. However, investment in energy storage is essential to absorb fluctuations in renewable power generation, including R&D for options such as hydrogen and ammonia utilization as an energy storage.
○	National finance	In order to improve the investment environment for renewable energy generation by the private sector, it is highly likely that government guarantees and convertible guarantees will need to be provided.
○	Industrial promotion	By using electricity derived from natural gas and renewable energy generation, the export industry can reduce the carbon footprint of its products to a lower level than before. In particular, it can contribute to strengthening the international competitiveness of products in the export industry.
-	Other	-
<b>Impact of the development scenario</b>		<b>Outline</b>
○	Environmental aspect	If the construction of solar and wind power generation facilities does not involve large-scale deforestation or biodiversity protection issues, there should be no major problems. Generally, power plants are developed in designated areas, and the system is such that financing cannot be obtained from financial institutions without proper implementation of environmental and social studies in advance.

○	Economy and Industry	A stable supply of renewable energy at low cost would be beneficial both economically and for industry. However, grid stability is a prerequisite, and in the future, storage and other functions may be required. In the case of a cluster of power plants, the amount of electricity generated will exceed the grid linkage and demand in the target area, and may be subject to temporary supply curtailment to stabilize the grid.
○	Society	Large-scale solar and wind power plants are not expected to employ large numbers of workers or provide other benefits compared to other methods of power generation, but they may lead to lower electricity prices. Combined with natural gas power generation, it will contribute to stable and inexpensive power supply.

## Chapter 6. Recommendations for a Proposed Cooperative Program

### 6.1 Vietnam

#### 6.1.1 Priority Project Recommendations

As mentioned in Section 5.1.1, we believe that "building a green energy society centered on the use of LNG, green electricity, and hydrogen to encourage the transition from coal-fired power generation to ET-CN" and "promoting decarbonization through energy conservation, electrification, and renewable energy utilization in the industrial and other sectors" will be effective to achieve ET-CN in Vietnam.

According to the Business Development Plan for Socialist Republic of Vietnam (2017) (Table 6-1) by the Ministry of Foreign Affairs, the energy sector is included in Priority 1, Development Agenda 1-3, "Improvement of Economic Infrastructure and Access Services," which states that support for a stable energy supply and utilizing various financial resources, with a view to diversifying the power source mix (LNG, renewable energy, etc.), and cooperation in the energy conservation sector will be pursued in consideration of the Vietnamese government's climate change-related efforts.

Table 6-1 Business Development Plan for the Socialist Republic of Viet Nam  
(2017) <sup>165</sup>

Basic Policy: Based on Vietnam's socio-economic development strategy and plan, the Bank will comprehensively support Vietnam's sustainable growth through strengthening its international competitiveness, overcoming its vulnerable aspects, and building a fair society and country.	
Focus Area 1: Growth and competitiveness	
Development Agenda 1-3: Improvement of Economic Infrastructure and Access Services	Program to Promote Stable Energy Supply and Energy Conservation Support the stable supply of energy to meet the increasing demand for energy to support economic growth.
Focus Area 2: Addressing Vulnerabilities (addressing the negative aspects of growth)	
Priority Area 3: Strengthening Governance	

In the power generation sector, in order to promote energy transition and decarbonization in Vietnam, it is important to establish a system to ensure grid stability and promote private investment to support the introduction of LNG, which will be a key component of energy transition, and a large amount of renewable energy. The use of hydrogen and ammonia will be particularly important in the future for low-carbon coal-fired power generation. Furthermore,

<sup>165</sup> Business Development Plan for the Socialist Republic of Vietnam (Ministry of Foreign Affairs, November 1, 2017) <https://www.mofa.go.jp/mofaj/gaiko/oda/files/000072248.pdf> Accessed August 12, 2022

since energy conservation efforts on the energy consumption side will require steady capital investment by the private sector as its foundation, it will be necessary to build incentives to implement energy saving, especially in terms of funding such as subsidies and making it a necessary requirement for exported products. Since the Energy Conservation Law has not been amended since 2010, the law needs to be amended based on the current state of energy conservation technology and the associated guidelines and technical standards should also be revised.

Stable and affordable energy supply is required on the energy supply side. This will require multifaceted reform in the areas of power supply development and power sectors, including the development of a private investment environment in addition to power generation funded by the national budget, and the future revitalization of the energy market as a whole through the establishment of a carbon market.

Considering the above issues, it is proposed that the project priority will include structural reforms to develop both energy supply and energy conservation using private sector dynamism, energy transitions from coal-fired power to LNG, energy transition to decarbonization such as transition to renewable energy, and cooperation to formulate a long-term roadmap for renewable energy to develop sub-sectors such as cleaner industries from a long-term perspective.

Based on the above, JICA's proposed ET-CN cooperation measures include the following proposed cooperation programs for each of the proposed development scenarios. Projects that should be considered as priorities are noted as "Priority Projects". The feasibility of project implementation will be considered on a case-by-case basis in the future.

Table 6-2 Proposed Cooperation Program on ET-CN in Vietnam

Cooperative Programs		Project	Implementation period	Remarks
<b>Development Scenario 1:</b>				
<b>Building a Green Energy Society Focusing on the Use of LNG, Green Power, and Hydrogen to Support the Shift from Coal-Fired Power Plants to ET-CN</b>				
<b>PG1 Responding to Increased Electricity Demand in Light of the Energy Transition</b>				
Promote energy transition from coal-fired to LNG-fired power generation	1	- Capacity Enhancement for LNG Utilization	From 2023	Priority Projects
	2	- LNG Value Chain Study	From 2024	Priority Projects* Clarification of LNG expansion policy in PDP8 is a prerequisite.
	3	- Study on LNG Demand and Utilization Promotion in Non-Power Sector	From 2024	
Support for the development of a long-term roadmap for decarbonizing thermal power generation	1	- Developing a long-term decarbonization plan for the power generation sector	From 2025	
	2	- Study and demonstration of low-carbon LNG-fired power generation	From 2025	

	3	- Study on low-carbon coal-fired power plants, ammonia co-firing, and demonstration of the introduction of mixed-burning burners	From 2025	
<b>PG2 Strengthening the capacity of power system operation in light of the massive introduction of variable renewable energy supporting the energy transition period</b>				
Grid stabilization and management	1	- Grid stabilization (facility expansion and improvement), SCADA/EMS post-implementation operational support	From 2022	Priority projects (with other donor support)
	2	- Grid supply and demand balancing by region	From 2022	
	3	- Enhanced grid power distribution management	From 2022	
<b>PG3 Other energy transfers / decarbonization</b>				
Hydrogen production and utilization	1	- FS study on hydrogen production using surplus electricity from renewable energy sources - Pilot hydrogen production, transportation, and utilization in the transportation and industrial fields	From 2024	
Carbon trading	1	- Introduction of carbon trading system and business model, promotion of clean energy	From 2024	
Institutional reforms to promote investment by the private sector	1	- Establishment of a bidding system for the electricity market	From 2022	
	2	- Establishment of a system of relative transactions with customers such as Direct PPAs that are not based on PPAs for IPP projects	From 2022	Priority Projects
	3	- Review of PPAs	From 2023	
<b>Development Scenario 2: Promote decarbonization through energy conservation, electrification, and the use of renewable energy in the industrial sector, etc.</b>				
Revision of the Act, GL	1	- Revision of laws, guidelines and technical standards based on the latest energy-saving technologies, etc.	From 2022	(Other donor support available)
	2	- Support for formulating a long-term roadmap for energy conservation (by industry and other sectors)	From 2023	Priority Projects (Components include multiple sub-projects)
industry	1	- Support for the development of a 2050 decarbonization roadmap for the industrial sector, and support for the development and operation of a GHG emissions	From 2023	

		accounting and reporting system		
	2	- Improve incentives for private sector investment in energy conservation, energy conservation implementation	From 2023	
	3	- Conducting energy audits - Strengthening the Energy Conservation Center	From 2023	Priority Projects
	4	- Introduction of energy-saving equipment using JCM scheme (private sector)	being carried out	
Transportation	1	- Improving traffic congestion in urban areas	From 2024	
	2	- Promoting a modal shift to rail and ship	From 2025	
Housing/Urban Development	1	- Promoting decarbonization through mixed-use development of net-zero buildings, zero-emission housing and smart transportation using clean energy	From 2026	

Table 6-3 Summary of proposed priority cooperation projects in Vietnam (1)

Project name (draft)	Capacity Enhancement for LNG Utilization
Assumed C/P	MOIT, PetroVietnam
Assumed scheme	Technical Cooperation Projects
Period of cooperation	About 2 years
Issue	The LNG receiving facility will be operational by the end of 2022, and two LNG power plants will also start operation in the future. However, there are many other related facilities in addition to LNG receiving facilities, and not all of the guidelines and standards for facility operation are available, and in some cases they are established at the facility construction planning stage. Although there is experience in the operation of natural gas related facilities, it is necessary to develop guidelines and standards based on technical considerations specifically for LNG.
Target	Gain comprehensive knowledge of the entire value chain from LNG receiving to the final consumption stage
Details of implementation	<ul style="list-style-type: none"> <li>➤ Enhance LNG network planning and operational capabilities (from receipt to consumption)</li> <li>➤ Present a draft legal and regulatory framework for the introduction of third-party access</li> </ul>

	<p>➤ Deepening understanding of the LNG cold energy business using LNG receiving terminals for high value-added</p>
Output	Gain knowledge of the various technologies and facility operations required from LNG receipt to consumption. Gain a better understanding of measures to improve cost-effectiveness for capital investment.
Outcome	The staff in charge will use the information to develop technical standards and guidelines and to formulate measures for the effective operation of LNG facilities.
Project size	About 300 million yen
Local measures	<p>LNG power generation accounts for about 20% of the total power generation capacity in draft PDP8, and capital investment in LNG is expected in the future.</p> <p>The National Energy Development Strategy (Resolution 55 NQ/TW) and its Action Plan (Resolution No. 140/NQ-CP) and the Gas Master Plan of Prime Minister Decree No. 60/QD-TTg (2017) promote the development and use of LNG-related infrastructure.</p>
Finance	<p>In the case of projects involving the construction of LNG power generation facilities, it may be possible to conduct this as part of METI's FS study.</p> <p>The implementation of LNG power generation in Vietnam is expected to be supported by AETI.</p>
GHG reduction potential and cost-effectiveness	<p>Since this project is assumed to be a technology project for human resource development, no direct GHG emission reduction effect is expected. Therefore, the GHG reduction potential and cost-effectiveness of supporting the introduction of LNG-fired power plants were examined.</p> <p>Based on the FS by the METI <sup>166</sup>, the operation of 4,800 MW LNG-fired power plant (0.4234 tCO<sub>2</sub>/MWh, 31.536 TWh/year) in Long Son, South Vietnam, will reduce CO<sub>2</sub> emissions by 12.3 MtCO<sub>2</sub>/year from the baseline (0.8154 tCO<sub>2</sub>e/MWh). Considering the period until 2030, assuming operation of only 1,600 MW of LNG-fired power generation in the first phase, the reduction would be about 4.1MtCO<sub>2</sub>/year. Since Vietnam's NDC projected GHG emissions in 2030 are 97.9MtCO<sub>2</sub>, considering that 4.1 MtCO<sub>2</sub> will be reduced, about 4.2% will be reduced.</p> <p>According to the FS report, the CAPEX from LNG procurement to operation is 2,398mUSD (in case of 1,600MW), and the cost effectiveness of CO<sub>2</sub> reduction by construction and operation of the 1,600MW LNG-</p>

166 Feasibility Study on Project Implementation for Overseas Development of High-Quality Energy Infrastructure in FY 2018 "Feasibility Study on Integrated LNG Procurement, LNG Receiving Terminal Operation and Gas-fired Combined Cycle Power Plant in Southern Socialist Republic of Viet Nam (Ministry of Economy, Trade and Industry, Japan, 2018) (Japanese only) (Title of the report is provisionally translated by Pacific Consultants) [https://www.meti.go.jp/meti\\_lib/report/H30FY/000208.pdf](https://www.meti.go.jp/meti_lib/report/H30FY/000208.pdf) Accessed August 16, 2022

	fired power plant in Long Son is about 584USD/tCO <sub>2</sub> . Assuming that the construction work will take 5 years and the plant will start operation in the beginning of 2028, the cost effectiveness of CO <sub>2</sub> reduction by 2030 will be about 195USD/tCO <sub>2</sub> .
Major Japanese transition technologies with potential application in the future (From Table 3-1)	<p>[Transition technology in the power sector].</p> <ul style="list-style-type: none"> <li>• CCUS: Promotion of technological development, demonstration, introduction, and commercialization of CO<sub>2</sub> capture and storage technologies</li> <li>• Hydrogen co-firing: Hydrogen co-firing to gas-fired power plants</li> </ul> <p>[Transition technology in the gas field]</p> <ul style="list-style-type: none"> <li>• Energy conservation in the city gas production process (energy conservation through the use of cold heat utilization equipment, etc.)</li> <li>• Strengthening of natural gas supply infrastructure to expand the use of natural gas</li> <li>• Establishment of supply chains in Vietnam and overseas: Liquefaction terminals, LNG carriers, receiving terminals, combined use of synthetic methane in existing infrastructure such as pipelines.</li> <li>• CCUS: Capture and use of CO<sub>2</sub> emitted from city gas appliances</li> </ul>

Table 6-4 Summary of proposed priority cooperation projects in Vietnam (2)

Project name (draft)	LNG Value Chain Study	Study on LNG Demand and Utilization Promotion in Industry, Transportation and Residential Sector
Assumed C/P	MOIT	MOIT
Assumed scheme	Technical Cooperation (Development Study Type), or METI Quality Infrastructure FS Study, etc.	Technical Cooperation (Development Study Type), or METI Quality Infrastructure FS Study, etc.
Period of cooperation	About 1 year	About 0.5 years
Issue	<p>The private sector, including Japanese companies, is expected to participate in IPP projects for LNG power generation, but the construction of facilities requires a large amount of investment.</p> <p>As an upstream of the LNG utilization value chain, it is</p>	<p>Private companies, including Japanese companies, are expected to participate in the IPP business of LNG power generation, but a large amount of investment is required to construct the facilities.</p> <p>The amount of domestic demand for LNG in industry, transportation,</p>



	necessary to examine LNG business models and measures to add value to the overall LNG business.	and residential sector, which are the downstream of the LNG utilization value chain, is not concrete.
Target	Establish an industrial structure that enables stable and economical LNG imports	Stable supply of low-carbon LNG based on demand in the industrial, transportation, and residential sectors
Details of implementation	<ul style="list-style-type: none"> <li>➤ Organize external factors affecting the LNG business model</li> <li>➤ Identify the optimal LNG business model</li> <li>➤ Provide suggestions for improving natural gas policy</li> </ul>	<ul style="list-style-type: none"> <li>➤ Examine the development of gas demand in the industrial sector</li> <li>➤ Examine developing gas demand in the transport sector</li> <li>➤ Examine the development of gas demand in the residential sector</li> </ul>
Output	Identify LNG business models; identify measures to add value to the overall LNG business.	
Outcome	Improve the overall business feasibility of the LNG project and promote the use of investment by the private sector.	
Project size	150 million yen	100 million yen
Local measures	<p>LNG power generation accounts for about 20% of the total power generation capacity in draft PDP8, and capital investment in LNG is expected in the future.</p> <p>The National Energy Development Strategy (Resolution 55 NQ/TW) and its Action Plan (Resolution No. 140/NQ-CP) and the Gas Master Plan of Prime Minister Decree No. 60/QD-TTg (2017) promote the development and use of LNG-related infrastructure.</p>	
Finance	In the case of projects involving the construction of LNG power generation facilities, it may be possible to conduct this as part of METI's FS study.	
GHG reduction potential and cost-effectiveness	Refer to Table 6-3.	
Japan's main applicable in the future Transition technologies (From Table3-1)	<p>[Transition technology in the power sector].</p> <ul style="list-style-type: none"> <li>• CCUS: Promotion of technological development, demonstration, introduction, and commercialization of CO2 capture and storage technologies</li> <li>• Hydrogen co-firing: Hydrogen co-firing to gas-fired power plants</li> </ul> <p>[Transition technology in the gas field]</p>	

	<ul style="list-style-type: none"> <li>• Energy conservation in the city gas production process (energy conservation through the use of cold heat utilization equipment, etc.)</li> <li>• Strengthening of natural gas supply infrastructure to expand the use of natural gas</li> <li>• Establishment of supply chains in Vietnam and overseas: Liquefaction terminals, LNG carriers, receiving terminals, combined use of synthetic methane in existing infrastructure such as pipelines.</li> <li>• CCUS: Capture and use of CO2 emitted from city gas appliances</li> </ul>
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For the proposed projects in the Table 6-3 and Table 6-4 in the transition from coal-fired power generation to LNG-fired power generation (including natural gas-fired power generation) will have CO2 reduction benefits relative to the baseline for the period when the baseline electricity CO2 emission factor is higher than the LNG-fired power generation electricity CO2 emission factor, but in the future if the ratio of coal-fired power generation in Vietnam decreases and the electricity CO2 emission factor of the baseline decreases, the relative CO2 reduction effect of LNG-fired power generation and its cost-effectiveness for the amount of reduction will decrease, and LNG-fired power generation will have a CO2 increase effect relative to the baseline when the CO2 emission factor of LNG-fired power generation is above the electricity CO2 emission factor of the baseline. Therefore, while the introduction of LNG-fired power generation should be considered from various aspects such as stable energy supply, from the perspective of achieving carbon neutrality in 2050, support for LNG-fired power generation should be provided to facilities that will start operation in the 2020s. Alternatively, the specifications should be designed for transition to hydrogen-fired power generation.

Table 6-5 Overview of proposed priority cooperation projects in Vietnam (3)

Project name (draft)	Establishment of a 2050 decarbonization roadmap for the industrial sector and the establishment of a GHG emissions accounting and reporting system	Strengthening the Industrial Promotion and Development Consultancy Center
Assumed C/P	MOIT	DOIT, Industrial Promotion and Development Consultancy Center
Assumed scheme	Technical cooperation	Grant aid (equipment for energy audits, etc.) Technical Cooperation or METI-MOIT Cooperation Framework <sup>167</sup>

<sup>167</sup> According to the Joint Statement for Energy Transition Cooperation towards Carbon Neutrality between the Ministry of Economy, Trade and Industry of Japan and the Ministry of Industry and Trade of Vietnam, 25 November 2021, METI will support renewable energy, energy efficiency, hydrogen and ammonia, etc. through the Asia Energy Transition Initiative (The Ministry of Economy, Trade and Industry (METI) will provide support for renewable energy, energy efficiency, hydrogen and ammonia through the Asian Energy Transition

Period of cooperation	About 3 years	About 1.5 years
Issues	<p>In accordance with the National Decarbonization Strategy to 2050 announced in July 2022, it became necessary to develop an industrial sector decarbonization roadmap under the jurisdiction of MOIT, establish an industrial sector GHG emissions accounting and reporting system, and develop related guidelines.</p> <p>Major energy consumers (companies) in the industrial sector report their energy consumption in accordance with the energy consumption reporting system, but there are many errors in the data.</p>	<p>Although there is the Renewable Energy Act and energy efficiency and conservation standards, there is a lack of incentive on the part of private companies. Energy conservation diagnosis is an effective means to appeal the significance of energy conservation activities.</p>
Target	A GHG emissions accounting and reporting system will be established through the development of a 2050 decarbonization roadmap for the industrial sector.	Build an industrial structure that enables stable and economical LNG imports.
Details of implementation	<ul style="list-style-type: none"> <li>➤ Decarbonization roadmaps will be developed for two or so industry subsectors to achieve 2050 decarbonization. In the process of developing the decarbonization roadmaps, energy efficiency and conservation activities such as development of energy conservation roadmap should be linked.</li> <li>➤ Establish a framework for a GHG emissions accounting and reporting system based on</li> </ul>	<ul style="list-style-type: none"> <li>➤ Provide equipment required for energy efficiency and conservation audits.</li> <li>➤ Conduct training for conducting energy efficiency and conservation audits and training on how to use the equipment.</li> </ul>

	<p>information from the energy consumption reporting system required of major energy consumers.</p> <p>➤ Introduces the equipment, technology, and financing methods required to upgrade to high-efficiency equipment.</p>	
Output	A roadmap will be developed for the industrial sub-sector to save energy and achieve decarbonization.	The capacity of the personnel of the Industrial Promotion and Development Consultancy Center will be strengthened and the environment for conducting energy efficiency and conservation audits will be improved.
Outcome	<p>The institutional framework required for CO2 emission accounting and reporting to MONRE will be established.</p> <p>Energy savings will be implemented by the private sector and awareness will be raised towards decarbonization.</p>	Energy conservation awareness by private companies will be improved.
Project Size	150 million yen	100 million yen
Local measures	<p>Consistent with the implementation of the National Climate Change Strategy (NCCS) For The Period 2021 To 2050 in the industrial sector, implementation of the Energy Conservation Act (2010).</p> <p>It meets the needs of MRV in NDC.</p>	It meets the promotion of energy conservation in VNEEP Phase 3.
Finance	METI-MOIT Cooperation Framework through the AETI; "Project for contributing to the rationalization of energy use in emerging countries, etc. (energy conservation human resource development project)", Agency for	METI-MOIT Cooperation Framework through the AETI; "Project for contributing to the rationalization of energy use in emerging countries, etc. (energy conservation human resource development project)", Agency for

	Natural Resources and Energy, METI	Natural Resources and Energy, METI
GHG reduction potential and cost-effectiveness	<p>Since this project is assumed to be a technical project for planning and human resource development, no direct GHG emission reduction effect is expected. Therefore, we examined the GHG reduction potential and cost-effectiveness of the project, assuming that energy conservation will be achieved by raising awareness of energy conservation in the industrial sector.</p> <p>From IEA (Figure 4-4), the electricity consumption in the industrial sector in Vietnam in 2019 is 9.77 Mtoe. Assuming for convenience that electricity from coal-fired and natural gas-fired generation is consumed, <math>9.77 \text{ Mtoe} \times 0.4</math> (thermal efficiency) <math>\approx 45,450 \text{ GWh}</math> and assuming the baseline electricity CO<sub>2</sub> emission factor is as same as 0.8154 tCO<sub>2</sub>/MWh in Table 6-3, the CO<sub>2</sub> emission from electricity consumption in the industrial sector is about 37 MtCO<sub>2</sub>/year. Therefore, a 1% reduction in electricity consumption in the industrial sector by promoting energy conservation leads to a reduction of 0.37 MtCO<sub>2</sub>/year.</p> <p>If assume that the technical cooperation project is 100 million yen, a 1% reduction in electricity consumption due to energy conservation would be approximately 270 yen/tCO<sub>2</sub>e.</p>	
Major Japanese transition technologies applicable in the future (from Table 3-1)	Depending on the target industry, all transition technologies in the steel, chemical, pulp and paper, and cement fields are applicable.	

## 6.2 Lao PDR

### 6.2.1 Priority Project Recommendations

As described in Section 5.1.2, it is believed that "strengthening the power grid linking northern Laos with electricity demand areas", "electrification and conversion to green fuels such as green hydrogen in the domestic industrial sector and transportation sector", and "promoting the establishment of a carbon neutral society by modernizing the agriculture, forestry and livestock industries" will be effective to achieve ET-CN in Lao PDR.

According to the Business Development Plan for Lao People’s Democratic Republic (2019) of the Ministry of Foreign Affairs, energy is included in Priority 2, Development Agenda 2-2 “Expansion of Stable and Secure Electricity Supply,” which focuses on optimizing power operations, supporting the development of industrial infrastructure through improvement of power transmission and distribution networks, and developing institutional arrangements to promote the export of electricity to the Mekong region. Transportation is included in Priority 2, Development Agenda 2-1 “Improvement of Transportation Networks” and in Priority 4, Development Agenda 4-1 “Improvement of Urban Environment”, which focuses on strengthening regional connectivity through infrastructure development and improving public transport in urban areas, but does not include support for electrification of transportation modes. Support for modernization of agriculture, forestry and livestock industries and REDD+ is provided under Priority 3 Development Agenda 3-3 "Agricultural Development" and Priority 4, Development Agenda 4-2 “Protecting Forests and Mitigating Climate Change”, which includes development of clean agriculture and promotion of REDD+.

Table 6-6 Business Development Plan for the Socialist Republic of Lao PDR (2019) <sup>168</sup>

Basic Policy: Strengthening Economic and Social Infrastructure to Overcome the Challenges of Less Developed Countries	
Priority Area 1: Strengthening governance and addressing cross-cutting issues, including fiscal stabilization	
Priority Area 2: Strengthening hard and soft connectivity with neighboring countries	
Development Agenda 2-1: Improvement of transportation network	<p><u>Traffic and Transportation Network Improvement Program</u></p> <p>In the road sector, cooperation will focus on the maintenance of major roads and bridges, including those in rural areas, while keeping in mind the balance between the maintenance of existing roads and the enhancement of connectivity with ASEAN and other Mekong regions. In addition, the capacity of road and bridge maintenance and management will be strengthened, and policy advisors and others will be utilized to make policy recommendations to secure financial</p>

168 Business Development Plan for the Lao People's Democratic Republic (Ministry of Foreign Affairs, April 2019) <https://www.mofa.go.jp/mofaj/gaiko/oda/files/000072259.pdf> accessed 12 August 2022

	resources. In the aviation sector, cooperation will focus on the expansion of major airports, including Vientiane International Airport in the capital city, and on improving air safety. In addition, we will also work on improving customs clearance procedures as a cross-cutting issue.
Development Agenda 2-2: Expansion of stable and secure power supply	<u>Electricity Maintenance Program</u> The Government will mainly focus on loan aid for the development of domestic backbone transmission lines, distribution and substation facilities, and high-voltage transmission lines for electricity interconnectivity in the Mekong region. As for power supply development, we will examine measures to be taken, focusing on private-sector partnership projects. In addition, with regard to strengthening the capacity of institutions involved in power projects, we will consider measures, mainly technical cooperation, based on the status of efforts on the Laotian side.
Priority Area 3: Diversification of industry and enhancement of competitiveness, and development of industrial human resources for this purpose	
Development Agenda 3-3: Agricultural Development	<u>Agricultural Development Program</u> From the viewpoint of building a value chain that also takes into account distribution and sales, cooperation in human resource development and institutional development will be developed, taking into consideration the possibility of a mutually complementary relationship with the private sector for the dissemination and productivity improvement of commodity crops in light of domestic and international market trends. The development of infrastructure through financial cooperation will also be considered with a view to effectively combining it with soft support.
Priority Area 4: Reducing Disparities through Balanced Urban and Rural Development that Considers Environmental and Cultural Preservation	
Development Agenda 4-1: Urban Environmental Improvement	<u>Urban Environment Improvement Program</u> The Government will systematically work on both soft and hard cooperation on issues related to urban environmental improvement, such as public transport, water supply improvement, waste management, and urban drainage, in Vientiane, the capital city, and other regional core cities, including Luang Prabang, Savannakhet, and Pakseh, according to their respective situations. Cooperation methods such as the formulation of master plans will also be effectively utilized.

Development Agenda 4-2: Forest Conservation and Climate Change	<u>Sustainable Forest Management Program</u> The project will focus on technical cooperation for policy formulation and capacity building of institutions related to forest resources and carbon information development to enable the Lao government to effectively utilize REDD+ and other initiatives.
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Based on the above, JICA's proposed ET-CN cooperation measures include the following proposed cooperation programs for each of the proposed development scenarios. Projects that should be considered as priorities are noted as "Priority Projects". The feasibility of project implementation will be considered on a case-by-case basis in the future.

Table 6-7 Proposed Cooperation Program Recommendations for ET-CN in Lao  
PDR

Cooperative Programs		project	Implementation period	Remarks
<b>Development Scenario 1: Strengthening the Transmission Network Linking Northern Laos and Electricity Demand Areas</b>				
<b>PG1 Strengthening the power grid</b>				
Strengthening the power grid	1	- Preliminary Study for Strengthening Interregional Grid Capacity and Resilience	From 2023	Priority Projects
	2	- Strengthening of inter-regional power transmission and distribution networks	From 2025	
<b>Development Scenario 2: Electrification and conversion to green fuels such as green hydrogen in the domestic industrial sector and transportation sector</b>				
<b>PG1 Electrification of the industrial and transport sectors</b>				
Promotion of electrification in the industrial sector	1	- Research to support electrification of production processes in the manufacturing industry	From 2023	
	2	- Pilot projects for electrification of production processes (e.g., electrification of processing processes in the food processing and manufacturing industries)	From 2025	
<b>PG2 Promote energy conservation in the industrial sector, etc.</b>				
Strengthen energy conservation in industrial and commercial sectors	1	- Establishment of procedures and guidelines for third-party certification of energy efficiency and conservation performance	From 2023	
	2	- Development of energy data collection system from industrial, commercial, and residential sectors, etc.	From 2023	



PG3 Fuel conversion mainly using green hydrogen derived from renewable energy sources such as hydroelectric power generation				
Basic study for building an energy society centered on green hydrogen using renewable energies such as hydroelectric power generation	1	- Investigation of the potential for the production and utilization of green ammonia, fertilizer, and synthesis gas to replace LPG, with a focus on green hydrogen using hydroelectric power generation electricity.	From 2023	Priority Projects
	2	- Investigating the Green Hydrogen Supply Chain	From 2024	
	3	- Pilot project for fuel conversion of industrial processes using green hydrogen (e.g. heat use in processing industry)	From 2025	
	4	- Develop human resources for future deployment of hydrogen, ammonia, etc.	From 2024	
	5	- Synthesis gas production by green hydrogen and CO2 recovery from the cement industry and pilot project for use in commercial vehicles, etc.	From 2025	
	6	- Study on the feasibility of ammonia co-firing in coal-fired power plants, and support for the development of regulations	From 2023	
	7	- Demonstration of ammonia co-firing in coal-fired power plant	From 2025	
	8	- Development of technical guidelines for renewable energy	From 2023	
<b>Development Scenario 3: Promoting the establishment of a carbon neutral society through the modernization of the agriculture, forestry, and livestock industries</b>				
PG1 REDD+ Enhancement				
Continuous forest conservation and expansion/enhancement to other areas	1	- Information development for REDD+ implementation and implementation of REDD+ projects, including linkages with the JCM and GCF	From 2023	
PG2 Response to Agriculture and Livestock				
Cooperation in technological development of low GHG emission rice cultivation	1	- Investigation of methods to reduce methane emissions through appropriate water management in rice cultivation	From 2023	
Cooperation in technological	2	- Investigation of methane reduction methods from	From 2023	

development of low GHG emission livestock industry		ruminants in livestock production		
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The priority projects are outlined below.

Table 6-8 Summary of proposed priority cooperation projects in Lao PDR (1)

Project name (draft)	Strengthening the transmission grid
Assumed C/P	MEM, EDL
Assumed scheme	Preliminary Survey for Cooperation, Grant Aid
Period of cooperation	Preliminary survey: 1 year Grant aid: 2 years and up
Issue	The Lao government is promoting hydropower development, but there is a recurring situation of surplus power, especially in the north.
Target	Optimizing the operation of hydropower facilities by strengthening the power transmission network
Details of implementation	Preliminary Survey for Cooperation ➤ Development of an implementation plan for strengthening the power transmission network Grant Aid ➤ Reinforcement of the power transmission network, construction and strengthening of international linkage lines
Output	Preliminary Survey for Cooperation ➤ Identification of implementation sites and development of implementation plans for strengthening the transmission network Grant Aid ➤ Reinforcement of the power transmission network, construction and strengthening of international linkage lines
Outcome	Improvement of the power transmission network will enable proper operation of hydroelectric power in north and avoid surplus power generation.
Project Size	Preparatory Survey for Cooperation: 0.05 billion yen Grant Aid: (Reference) transmission line 0.61 mUSD/km/2 lines 4 conductors, 37.94 mUSD for substation facilities 500/230 kV 500 MVA/unit <sup>169</sup>
Local measures	The Energy Policy (2020) promotes the expansion of the power grid and the export of electricity to Thailand and Vietnam.

169 From Table 12.6-1 and Table 12.6-2 of the Final Report of the Project for the Development of a Master Plan for the Electricity System in Lao PDR (JICA, 2020)

Finance	Preliminary Survey for Cooperation, Grant Aid
GHG reduction potential and cost-effectiveness	If the grid interconnection to Thailand is enhanced as proposed by the Lao PDR Power System Master Plan Development Project Final Report (JICA, 2020), the CO <sub>2</sub> emission factor of Thailand's grid electricity is 0.394 kgCO <sub>2</sub> / kWh in 2022. <sup>170</sup> Therefore, it can be considered that for every 1,000 GWh of hydropower electricity exported from Laos, Thailand's CO <sub>2</sub> emissions will be reduced by 394 ktCO <sub>2</sub> .
Major Japanese transition technologies applicable in the future (from Table 3-1)	<p>[Transition technology in the power sector].</p> <ul style="list-style-type: none"> <li>• Strengthening and upgrading of power transmission and distribution networks: Reinforcing power transmission and distribution networks to expand the introduction of renewable energy, etc.</li> <li>• Promotion of demand response and electrification, etc.: Efforts toward decarbonization on the demand side, electrification, etc.</li> <li>• Storage batteries, water pumping, distributed energy: Storage batteries contributing to grid stabilization, introduction of distributed energy resources, etc.</li> </ul>

Table 6-9 Summary of proposed priority cooperation projects in Lao PDR (1)

Project name (draft)	Investigation of the potential for the production and utilization of green ammonia, fertilizer, and synthesis gas to replace LPG, with a focus on green hydrogen using hydroelectric power generation electricity.
Assumed C/P	MEM, EDL, MOIC
Assumed scheme	Data collection survey, technical cooperation (development plan study)
Period of cooperation	one year
Issue	<p>The Lao government is promoting the development of hydropower generation, but there is a situation of surplus power on a recurring basis, especially in the northern part of the country, but appropriate measures to deal with the surplus power have not been taken. In addition, the country has low foreign currency reserves, and in recent years there has been some socioeconomic turmoil, including difficulties in importing petroleum products.</p> <p>There has been no energy use of gas in Lao PDR before the past years and there is no legal system and regulation to deal with hydrogen gas and synthetic gas properly.</p>
Target	Proposals for Utilization of Surplus Electricity from Hydroelectric Power Generation and Related Institutional Improvements

<sup>170</sup> Energy policy and Planning Office, Ministry of Energy, Table 9.1-15: CO<sub>2</sub> Emission per kWh <http://www.eppo.go.th/index.php/en/en-energystatistics/co2-statistic> August 2022 Accessed 17 August 2022

Details of implementation	<ul style="list-style-type: none"> <li>➤ Investigation of supply and demand potential of green hydrogen, green ammonia and synthesis gas</li> <li>➤ Identification of relevant schemes for the use of fuel gas</li> <li>➤ Feasibility Study on Green Hydrogen in Industrial Processes</li> <li>➤ Feasibility Study on CO<sub>2</sub> Recovery from Industrial Plants and Demonstration of Synthesis Gas Utilization with Green Hydrogen for Commercial Vehicles</li> <li>➤ Feasibility Study on Green Ammonia for Hongsong Coal Fired Power Plant</li> </ul>
Output	<ul style="list-style-type: none"> <li>➤ Understanding the potential for supply and demand for green fuels</li> <li>➤ Development of a system for the use of gas fuels</li> <li>➤ Identification of potential demonstration sites for conversion to green fuels</li> </ul>
Outcome	Reducing GHG emissions by switching from fossil fuels to green fuels
Project Size	0.5 to 0.8 billion yen
Local measures	<p>At the time of the study, there are no measures to promote green gas fuels such as hydrogen, ammonia or synthetic fuels using surplus electricity in Lao PDR.</p> <p>The 9th NSEDP promotes the demonstration of methane production for transportation and industrial use.</p> <p>The Green Growth Strategy (2018) promotes the use of clean energy vehicles.</p> <p>UNFCCC CTCN has proposed a Power to Gas Master Plan to the MEM.</p>
Finance	Through the improvement of institutional environment by the METI's FS project budget or JICA's data collection survey and technical cooperation for development plan study, preliminary survey for cooperation and/or NEDO's demonstration project could be utilized.
GHG reduction potential and cost-effectiveness	<p>The GHG reduction potential and cost-effectiveness were studied assuming that a part of coal utilization in the manufacturing process (mainly heating process) in the industrial sector is replaced by hydrogen.</p> <p>From IEA (Figure 4-8), the direct consumption of coal in the industrial sector in Lao PDR in 2019 is 132 ktoe (<math>\approx 5.53</math> PJ <math>\approx</math> about 215.1 kt). The CO<sub>2</sub> emission factor of coal is 26.8 gC/MJ if it is anthracite coal, and the CO<sub>2</sub> emission from coal consumption in the industrial sector is about 543.4 ktCO<sub>2</sub>/year. On the other hand, the hydrogen demand equivalent to 215.1 kt of coal is about 45.6 kt (<math>\approx 508</math> million m<sup>3</sup>), and according to The Future of Hydrogen (2019) by IEA, it takes 52 MWh of electricity to produce 1 t of hydrogen by water electrolysis. Therefore, it would take 2,371.2 GWh to produce about 45.6 kt of hydrogen. In addition, according</p>

	<p>to the IEA report, about 9 liters of water is required to produce 1 kg of hydrogen, which means that 0.41 billion liters (410,000 m<sup>3</sup>) of water will be required to produce 45.6 kt of hydrogen. If 30 yen/Nm<sup>3</sup>, which is Japan's 2030 hydrogen production cost target, is applied and 508 million m<sup>3</sup> of hydrogen is produced annually, 17.4 billion yen is required, and the cost effectiveness of CO<sub>2</sub> reduction is about 32,020 yen/tCO<sub>2</sub>.</p>
<p>Major Japanese transition technologies applicable in the future (from Table 3-1)</p>	<p>Transition technology in the gas field</p> <ul style="list-style-type: none"> <li>• Methanation: Synthesizing methane from hydrogen and CO<sub>2</sub></li> <li>• Establishment of supply chains in Japan and overseas: Combined use of synthetic methane in existing infrastructure such as liquefaction terminals, LNG carriers, receiving terminals, pipelines, etc.</li> <li>• Hydrogen: Hydrogen is produced by electrolyzing water</li> <li>• Local hydrogen network: Development of a domestic hydrogen supply network</li> <li>• Hydrogen combustion equipment, etc.: Industrial furnaces, cogeneration, use of hydrogen in fuel cells, etc.</li> <li>• CCUS: Capturing and utilizing CO<sub>2</sub> emitted from industrial facilities</li> </ul> <p>In addition, all transition technologies that use hydrogen, ammonia or syngas in the steel, chemical, pulp and paper, and cement fields are applicable.</p>

## 6.3 Nepal

### 6.3.1 Priority Project Recommendations

As mentioned in Chapter 5.1.3, "Promotion of electrification policy by strengthening and improving the reliability of rural electricity grid", "Electrification and conversion to green fuels such as green hydrogen in domestic industrial and transport sectors", and "Promoting the establishment of a carbon neutral society by modernizing agriculture, forestry and livestock industries" are effective to achieve ET-CN in Nepal.

According to the Business Development Plan for the Republic of Nepal (2021) by the Ministry of Foreign Affairs, energy is included in Priority 1, Development Agenda 1-2 "Electricity and Energy," which focuses on supporting the formulation of policies and plans to achieve a stable electricity supply, developing power distribution networks in urban and remote areas and improving energy efficiency through loans. Transportation is included in Priority 1, Development Agenda 1-1, "Transportation Infrastructure and Connectivity," which focuses on improving urban transit and intercity roads, but does not include support for electrification of transportation modes. Agriculture is included in Priority 1 Development Agenda 1-3 "Agriculture", which means improving productivity and maintaining irrigation systems. From the above, it is considered that the strengthening of rural electricity grids and electrification and conversion to green fuels are in line with the Business Development Plan (2021) from the perspective of strengthening energy supply, but there are no priority issues or development issues that correspond to the modernization of the agriculture and livestock industries for the purpose of climate change mitigation, and further study is required.

Table 6-10 Business Development Plan for Nepal (2021) <sup>171</sup>

Basic Policy: Support for sustainable and balanced economic growth aimed at emerging from the Least Developed Countries	
Focus Area 1: Economic Growth and Poverty Reduction	
Development Agenda 1-1: Transportation Infrastructure and Connectivity	<u>Transportation Infrastructure and Connectivity Program</u> To improve traffic in the Kathmandu Metropolitan Area and enhance transportation capacity and safety on the existing trunk roads extending from the metropolitan area to the east and west. With regard to aviation, contribute to improving operational safety.
Development Agenda 1-2: Electricity and Energy	<u>Power and Energy Programs</u> To increase power generation and transmission/distribution capacity to meet growing electricity demand and improve energy efficiency.
Development Agenda 1-3:	<u>Agriculture and Rural Development Program</u> To improve the productivity of agricultural products for the market

171 Business Development Plan for the Republic of Nepal (Ministry of Foreign Affairs, September 2021) <https://www.mofa.go.jp/mofaj/gaiko/oda/files/000072267.pdf> accessed 12 August 2022

Agriculture	and to maintain and manage irrigation systems in order to improve the livelihood of local people through agriculture and to promote livelihood improvement through stable production and supply of food.
Development Agenda 1-6: Improvement of Urban Environment	<u>Urban Environment Improvement Program</u> To improve access to safe water and to enhance the capacity of water supply, sewage and other environment-related institutions in terms of management, operation and maintenance, and technical guidance.
Priority Area 2: Disaster Prevention and Climate Change	
Development Agenda 2-2: Climate change measures	<u>Climate Change Program</u> To promote institutional arrangements to implement climate change countermeasures and support climate change countermeasures, including the sustainable development of forest resources.

Based on the above, JICA's proposed ET-CN cooperation measures include the following proposed cooperation programs for each of the proposed development scenarios. Projects that should be considered as priorities are noted as "Priority Projects". The feasibility of project implementation will be considered on a case-by-case basis in the future.

Table 6-11 Recommendations for the proposed cooperation program on ET-CN in Nepal

Cooperative Programs		Project	Implementation period	Remarks
<b>Development Scenario 1: Promoting electrification policies by strengthening and improving the reliability of rural electricity grids</b>				
<b>PG1 Strengthening the Rural Electricity Grid</b>				
Reinforcement of the power transmission and distribution network	1	- Strengthening the capacity and resilience of rural electricity transmission and distribution networks	From 2023	Priority Projects
Financial support for local renewable energy projects	2	- Contribute fund to SECF established by AEPC and FCDO.	From 2023	
<b>Development Scenario 2: Electrification and conversion to green fuels such as green hydrogen in domestic industrial and transport sectors</b>				
<b>PG1 Electrification of the industrial and transport sectors</b>				
Promotion of electrification in the industrial sector	1	- Research to support electrification of production processes in the manufacturing industry	From 2023	
	2	- Pilot projects for electrification of production processes (e.g. introduction of electric kilns in the brick industry)	From 2025	

Financial support for transportation infrastructure for electrification	1	- Contributions to the TDF	From 2023	
Development of relevant guidelines to deal with the promotion of EVs	1	- Support for the establishment of a unified EV promotion coordination meeting involving all ministries and agencies related to EV promotion	From 2023	Check progress of NAMA Facility as appropriate
	2	- Support for the development of EV technical standards and battery disposal guideline, etc.	From 2023	
<b>PG2 Promote energy conservation in the industrial sector, etc.</b>				
Strengthen energy conservation in industrial and commercial sectors	1	- Energy conservation diagnosis of factories and commercial buildings	From 2023	
	2	- Support for the development of corporate energy conservation personnel	From 2023	
Reinforcing energy conservation in the water supply system	1	- Kathmandu Water Supply Leakage Prevention Project	From 2023	
	2	- Promoting energy conservation and renewable energy in water and sewage systems	From 2023	
	3	- Developing human resources for energy conservation and renewable energy for water supply companies	From 2023	
<b>PG3 Fuel Conversion Focusing on Green Hydrogen from Hydroelectric Power Generation</b>				
Basic study for building an energy society centered on green hydrogen using hydroelectric power generation	1	- Investigation of the potential for the production and utilization of green ammonia, fertilizer, and synthesis gas to replace LPG, with a focus on green hydrogen using hydroelectric power generation electricity.	From 2023	Priority Projects
	2	- Investigating the Green Hydrogen Supply Chain	From 2024	
	3	- Pilot project for fuel conversion of industrial processes using green hydrogen (e.g. heat use in processing industry)	From 2025	
	4	- Develop human resources for future deployment of hydrogen, ammonia, etc.	From 2024	



	5	- Pilot Project for Syngas Production and Utilization by Green Hydrogen and CO2 Recovery from Cement Industry	From 2025	
<b>Development Scenario 3:</b>				
<b>Promoting establishment of a carbon neutral society through the modernization of the agriculture, forestry, and livestock industries</b>				
<b>PG1 REDD+ Enhancement</b>				
Continuous forest conservation and expansion/enhancement to other areas	1	- Information development for REDD+ implementation and implementation of REDD+ projects, including linkages with the JCM and GCF	From 2023	Horizontal deployment of F-REDD knowledge in Laos
<b>PG2 Response to Agriculture and Livestock</b>				
Cooperation in technological development of low GHG emission rice cultivation	1	- Investigation of methods to reduce methane emissions through appropriate water management in rice cultivation	From 2023	
Cooperation in technological development of low GHG emission livestock industry	2	- Investigation of methane reduction methods from ruminants in livestock production.	From 2023	

The priority projects are outlined below.

Table 6-12 Summary of proposed priority cooperation projects in Nepal (1)

Project name (draft)	Strengthening the capacity and resilience of rural electricity transmission and distribution networks
Assumed C/P	MoEWRI, NEA
Assumed scheme	Preliminary Survey for Cooperation, Grant Aid
period of cooperation	Preliminary survey for cooperation: 1 year, Grant aid: 2 years~
Issue	The Government of Nepal is promoting the replacement of biomass-based cookers with electric cookers through rural electrification. The country's electrification rate has reached 95%, but the electricity grid, especially in rural areas, is poor in some cases, and the electrification of cookers has not progressed sufficiently due to unreliable electricity supply.
Target	Promotion of substitution from biomass use to electricity use by strengthening the local power grid
Details of implementation	➤ Identify areas for grant assistance for rural electrification through a preliminary survey for cooperation.

	➤ The grant aid will be used to extend and expand the capacity of the rural power grid, and will also consider improving the vulnerability of the power grid to climate change impacts.
Output	Achieving a stable supply of electricity and improving electricity demand by strengthening local power grids
Outcome	Reducing GHG emissions by reducing non-sustainable biomass consumption
Project Size	Preliminary Survey for Cooperation: 0.05 billion yen Grant aid: 1 billion yen and up (based on the budget for the 133 kV power transmission and distribution network development plan from the NEA Annual Report for 2020/2021)
Local measures	The 15th Socio-economic Development Plan (2019), the White Paper on Energy and Water (2018) and the SDGs Roadmap (2015) promote hydropower development, strengthening of transmission and distribution infrastructure, rural electrification and reduced biomass fuel use.
Finance	Grant aid
GHG reduction potential and cost-effectiveness	Assuming that 99% of the 10,753.5 ktCO <sub>2</sub> e/year of "Non-CO <sub>2</sub> from biomass combustion in other sector" in NC3 (Table 3-34) comes from the residential sector based on IEA data (Figure 4-12), GHG emissions from biomass are 10,646 ktCO <sub>2</sub> e/year. If electrification with hydropower is assumed to result in 1% reduction of biomass consumption (about 1 Mtoe from Figure 4-13), this leads to a reduction of 106 ktCO <sub>2</sub> e/year. Assuming that the grant aid is 1 billion yen, a 1% reduction would be 9,434 yen/tCO <sub>2</sub> e and a 5% reduction would be 1,887 yen/tCO <sub>2</sub> e.
Major Japanese transition technologies applicable in the future (from Table 3-1)	[Transition technology in the power sector]. <ul style="list-style-type: none"> <li>• Strengthening and upgrading of power transmission and distribution networks: Reinforcing power transmission and distribution networks to expand the introduction of renewable energy, etc.</li> <li>• Promotion of demand response and electrification, etc.: Efforts toward decarbonization on the demand side, electrification, etc.</li> <li>• Storage batteries, water pumping, distributed energy: Storage batteries contributing to grid stabilization, introduction of distributed energy resources, etc.</li> </ul>

Table 6-13 Summary of proposed priority cooperation projects in Nepal (2)

Project name (draft)	Investigation of the potential for the production and utilization of green ammonia, fertilizer, and synthesis gas to replace LPG, with a focus on green hydrogen using hydroelectric power generation electricity.
Assumed C/P	MoEWRI, NEA, Kathmandu University

Assumed scheme	(1) "Feasibility Study on Overseas Development of High-Quality Energy Infrastructure" by the Ministry of Economy, Trade and Industry (METI) or data collection survey or preliminary survey for cooperation by JICA
Period of cooperation	one year
Issue	<p>The Nepalese government is promoting the development of hydropower generation, but there is a possibility that surplus power will be generated on a recurring basis in the future, and it is necessary to consider measures to deal with surplus power as soon as possible. In addition, the recent sharp rise in the price of petroleum products has resulted in huge import costs.</p> <p>Although there have been studies on hydrogen-based energy utilization using surplus electricity mainly by Kathmandu University, MoEWRI, NEA, etc., there has been no detailed study of the supply and demand potential in the country.</p>
Target	Proposal of measures to utilize surplus electricity from hydroelectric power generation, focusing on hydrogen
Details of implementation	<ul style="list-style-type: none"> <li>➤ Investigation of supply and demand potential of green hydrogen, green ammonia and synthesis gas</li> <li>➤ Identification of relevant schemes for the use of fuel gas</li> <li>➤ Feasibility study of green hydrogen application in industrial processes (in Japanese)</li> <li>➤ Feasibility Study of CO2 Recovery from Industrial Plants and Demonstration of Synthesis Gas Utilization with Green Hydrogen for Commercial Vehicles</li> <li>➤ Feasibility study on the application of green ammonia for fertilizer production (Revision of "Study on Urea Fertilizer Plant Project in Kingdom of Nepal" by JICA in 1984)</li> </ul>
Output	<ul style="list-style-type: none"> <li>➤ Understanding the potential for supply and demand for green fuels</li> <li>➤ Development of a system for the use of gas fuels</li> <li>➤ Identification of potential demonstration sites for conversion to green fuels</li> </ul>
Outcome	Reducing GHG emissions by switching from fossil fuels to green fuels
Project size	0.5 to 0.8 billion yen
Local measures	<p>In its budget for 2022-2023, the Nepalese government has set out to promote the use of hydrogen as an energy source and the production of fertilizers using green ammonia.</p> <p>MOEWRI has established a Green Hydrogen Coordination Committee and has submitted recommendations on a hydrogen strategy to the MOEWRI</p>

	Minister.
Finance	Based on METI's FS project budget or JICA's Data collection survey and preliminary survey for cooperation, the institutional environment could be improved through technical cooperation, or NEDO's demonstration project could be utilized.
GHG reduction potential and cost-effectiveness	<p>Since this project is assumed to be a research project, no direct GHG emission reduction effect is expected. Therefore, the GHG reduction potential and cost-effectiveness of the project were examined assuming that a part of coal utilization in the manufacturing process (mainly heating process) in the industrial sector is replaced by hydrogen.</p> <p>From IEA (Figure 4-12), the direct consumption of coal in Nepal's industrial sector in 2019 is 0.79 Mtoe (<math>\approx 33.077</math> PJ <math>\approx</math> about 1,287 kt). However, for example, GlobalEconomy.com<sup>172</sup> for example, Nepal's coal consumption in 2019 is 677.2 kt, which is much lower than the IEA's data. Therefore, in this study, we assume that 677.2 kt (<math>\approx 17.4</math> PJ) of coal consumption in 2019 will be replaced.</p> <p>The CO<sub>2</sub> emission factor of coal is 24.7 gC/MJ, and the CO<sub>2</sub> emissions from coal consumption in the industrial sector is about 1.58 MtCO<sub>2</sub>/year. On the other hand, the hydrogen demand equivalent to 677.2 kt of coal and calorific value is about 143.6 kt (<math>\approx 1.6</math> billion m<sup>3</sup>) According to The Future of Hydrogen (2019) by IEA, 52 MWh of electricity is required to produce 1 t of hydrogen by water electrolysis. Thus, it would take 7,467 GWh to produce about 143.6 kt of hydrogen (which corresponds to about 84% of the total electricity production of 8,878 GWh in 2021). In addition, the IEA report states that approximately 9 liters of water is required to produce 1 kg of hydrogen, which means that producing 143.6 kt of hydrogen will generate a water demand of 1.29 billion liters (1,290,000 m<sup>3</sup>). If Japan's 2030 hydrogen production cost target of 30 yen/Nm<sup>3</sup> is applied and 1.60 billion m<sup>3</sup> of hydrogen is produced annually, 48.0 billion yen is required, and the cost effectiveness of CO<sub>2</sub> reduction is about 30,380 yen/tCO<sub>2</sub>.</p>
Major Japanese transition technologies applicable in the future (from Table 3-1)	<p>Transition technology in the gas field</p> <ul style="list-style-type: none"> <li>• Methanation: Synthesizing methane from hydrogen and CO<sub>2</sub></li> <li>• Establishment of supply chains in Japan and overseas: Combined use of synthetic methane in existing infrastructure such as liquefaction terminals, LNG carriers, receiving terminals, pipelines, etc.</li> <li>• Hydrogen: Hydrogen is produced by electrolyzing water</li> </ul>

172 The GlobalEconomy.com, "Nepal: Coal consumption," [https://www.theglobaleconomy.com/Nepal/coal\\_consumption/](https://www.theglobaleconomy.com/Nepal/coal_consumption/) 8, 2022 Accessed August 16, 2022

	<ul style="list-style-type: none"><li>• Local hydrogen network: Development of a domestic hydrogen supply network</li><li>• Hydrogen combustion equipment, etc.: Industrial furnaces, cogeneration, use of hydrogen in fuel cells, etc.</li><li>• CCUS: Capturing and utilizing CO<sub>2</sub> emitted from industrial facilities</li></ul> <p>In addition, all transition technologies that use hydrogen, ammonia or syngas in the steel, chemical, pulp and paper, and cement fields are applicable.</p>
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## 6.4 Uzbekistan

### 6.4.1 Priority Project Recommendations

As discussed in Section 5.1.4, we believe that "low-carbonization of gas-fired power generation and promotion of decarbonization through green power and energy storage" will be effective in achieving ET-CN in Uzbekistan.

According to the Business Development Plan for the Republic of Uzbekistan (2019) by the Ministry of Foreign Affairs, the energy sector is included in Priority 1, Development Agenda 1-1 "Improve business management and promote efficient use of public utilities," which focuses on creating a foundation for economic development through the development of high-quality infrastructure that will contribute to sustainable economic growth.

Table 6-14 Business Development Plan for the Republic of Uzbekistan  
(2019) <sup>173</sup>

Basic Policy: Providing Support to Promote Economic Growth and Reduce Disparities	
Priority Area 1: Renewal and improvement of economic infrastructure (transport and energy)	
Development Issue 1-1: Improvement of Public Works Management and Promotion of efficient use of Infrastructure Facilities	<u>Energy and Infrastructure Improvement Program</u> The project aims to renew aging power plants and other energy facilities and meet increasing energy demand by introducing state-of-the-art technology to thermal power plants and other facilities. The project will also provide support through training programs for the improvement of power distribution facilities and financial and tariff systems.
Priority Area 2: Support for Human Resource Development and Institution Building for the Promotion of a Market Economy and Economic and Industrial Development	
Priority Area 3: Support for Rebuilding the Social Sector	

In the power generation sector, the development of large amounts of solar and wind power sources is progressing to promote energy transition and decarbonization in Uzbekistan. Existing gas-fired power plants have been modernized and combined cycle power generation has been introduced and expanded.

Currently, plans to implement a large number of renewable energy power plants are underway with donor support, and it is important to ensure the stability of the grid to support the large amount of power received from renewable energy sources. While the system for promoting private investment is driven mainly by donor-led IPP projects for renewable energy generation, it appears that discussions on the stable operation of the grid and how to achieve this have not

<sup>173</sup> Business Development Plan for the Republic of Uzbekistan (Ministry of Foreign Affairs, April 2019) <https://www.mofa.go.jp/mofaj/gaiko/oda/files/000072280.pdf> accessed 12 August 2022

progressed as much as expected, as plans for implementation of large-scale renewable energy projects continue to be developed.

In the future, the use of hydrogen and ammonia will be particularly important as a mechanism for storing surplus electricity from large-scale renewable power generation, while continuing to lower carbon emissions from gas-fired power generation. However, since the target year for decarbonization in the energy sector is 2050, there is a need for hydrogen as a storage for renewable energy generation and its utilization from the implementation of hydrogen production in society should be prepared. In addition, technologies and means for stable operation of the grid will be particularly important.

Furthermore, lower energy payments on the consumer side may have a negative impact on the economic efficiency of the power sector in the future, requiring an adjustment in energy prices.

Based on the above, JICA's proposed ET-CN cooperation measures include the following proposed cooperation programs for each of the proposed development scenarios. Projects that should be considered as priorities are noted as "Priority Projects". The feasibility of project implementation will be considered on a case-by-case basis in the future.

Table 6-15 Recommendations for the proposed cooperation program on ET-CN in Uzbekistan

Cooperation Programs/Sub-Sectors		Priority Projects	Implementation period	Remarks
<b>Development Scenario 1: Promoting low-carbon gas-fired power generation and decarbonization through green power and energy storage</b>				
<b>Responding to Increased Electricity Demand in Light of the PG1 Energy Transition</b>				
Value Chain Study on Hydrogen Utilization	1	- Development of technical personnel for future hydrogen deployment	From 2023	Priority Projects
	2	- Hydrogen production using surplus electricity from renewable energy sources - Research and development for local manufacturing and transportation of energy storage facilities utilizing water electrolysis facilities and fuel cells	From 2023	
Hydrogen Mixed Combustion of Natural Gas Fired Power Plants	1	- Introduction of hydrogen fuel to new and existing thermal power plants, and introduction of mixed-burning burners	From 2025	
Research and development of blue hydrogen production technology	1	Research and development of blue hydrogen production technology using steam reforming reaction in depleted oil and gas fields	From 2023	

PG2 Renewable energy deployment to support the transition from energy transition to decarbonization (supply side)				
Ensure output adjustment function of hydroelectric power generation		- Confirmation of feasibility of introducing pumped storage power generation system, installation of upper adjustment pond and power plant - Ensure output adjustment function	From 2024	
Research and development of hydrogen production and utilization		- Feasibility study on securing water resources as a prerequisite for hydrogen production - Securing water resources that do not compete with agricultural water	From 2024	
		- Pilot hydrogen production, transportation, and utilization in the transportation and industrial fields	From 2025	
Grid stabilization and management		- Power System Design Support for Grid Stabilization - Operational improvement after SCADA/EMS introduction	From 2025	Priority Projects <sup>174</sup>
		- Grid's domestic and intra-regional supply and demand balancing within the Central Asian region	From 2025	
		- Enhanced grid power distribution management	From 2025	
PG3 Improving the electricity market and investment environment to support energy decarbonization				
Improving the management of the electric power business centered on existing thermal power plants		- Appropriate fuel subsidies	From 2025	
		- Investigate business models that support improved management on power company and energy transition	From 2024	

174 The implementation of SCADA and EMS is supported by the World Bank.



The priority projects are outlined below.

Table 6-1 Summary of proposed priority cooperation projects in Uzbekistan (1)

Project name (draft)	Development of technical personnel for future hydrogen deployment
Assumed C/P	Ministries and agencies related to the energy sector, electric power utilities, research institutes
Assumed scheme	Combination of training in Japan and training in a third country
Period of cooperation	About 0.5 to 1 month
Issue	Hydrogen has the potential to play an important role in Uzbekistan, which is working on the massive introduction of renewable energy and the low-carbonization of natural gas-fired power generation. However, Uzbekistan is currently formulating its hydrogen strategy, and although interest in the various functions of hydrogen is increasing among relevant organizations in the energy sector, the value of hydrogen has not yet been recognized, and specific research is still in its early stages. On the other hand, Japanese private companies are conducting FS on hydrogen utilization in various parts of the world, and it is possible to show the series of processes from hydrogen production to utilization, and the functions and potential of hydrogen in building a carbon-neutral society. Under these circumstances, it is necessary to start training technical personnel with a view to hydrogen deployment after 2030. <sup>175</sup>
Target	Acquire basic knowledge of hydrogen production, storage and utilization
Details of implementation	<ul style="list-style-type: none"> <li>➤ Learn about the technology and equipment required for the production, storage and continuous supply of hydrogen</li> <li>➤ Understand the technology of energy storage, power generation, and heat supply systems utilizing hydrogen production by water electrolysis and hydrogen fuel cells</li> <li>➤ To understand the points to be considered in the operation and maintenance of hydrogen supply facilities</li> </ul>
Output	The number of personnel with basic knowledge of hydrogen technology in energy-related ministries and research institutes will increase.
Outcome	Raise awareness among government officials and organizations related to the energy sector that will lead to the consideration of policies and measures for hydrogen production and utilization.

<sup>175</sup> It would also be beneficial to learn about the production and utilization of ammonia at the same time. Some of the countries in Uzbekistan and neighboring countries have long relied on coal- and gas-fired power generation for their power supply structure, and there is a possibility that joint training could be conducted by several countries in Russian language.

Project size	Training in Japan and training in third countries: 0.05 billion yen *Depends on the number of participants.
Local measures	Consistency with the hydrogen strategy currently being developed is key. PP 5063 (2021) on renewable energy and hydrogen energy development promotes research and development of hydrogen energy.
Finance	Technologies that have completed demonstration studies and are in the implementation stage may be implemented as part of the Ministry of Economy, Trade and Industry's feasibility study on high-quality infrastructure exports.
GHG reduction potential	<p>Since this project is a human resource development project, no direct GHG emission reduction effect is expected. Therefore, green hydrogen production using solar-generated electricity and 30% co-firing with natural gas-fired power generation were considered as a case study.</p> <p>According to a press release by Mitsubishi Heavy Industries, Ltd.<sup>176</sup> states that co-firing natural gas-fired power generation with hydrogen at 30% by volume has resulted in a 10% reduction in CO<sub>2</sub> emissions. From Uzbekistan's BR (Biennial Report), CO<sub>2</sub> emissions from natural gas-fired power generation in 2017 were 27.5578 MtCO<sub>2</sub>e.</p> <p>From IEA World Energy Balance (2019), the electricity generated from natural gas power generation in 2017 was 27,433 GWh, and the if the efficiency of natural gas-fired power generation is assumed to be 40% of the IEA constant, 246.9 PJ of natural gas is required. If calorific value is equivalent to 44.8 MJ/m<sup>3</sup> of city gas in Japan, it is about 5.5 billion m<sup>3</sup>. If all natural gas-fired power plants were to burn 30% hydrogen by volume, the annual demand for hydrogen would be 1.65 billion m<sup>3</sup> (about 148.17 kt if hydrogen density is 0.0898 g/10<sup>-3</sup>m<sup>3</sup>).</p> <p>According to the IEA's The Future of Hydrogen (2019), it takes 52 MWh of electricity to produce 1 t of hydrogen by water electrolysis. Therefore, producing about 148.17 kt of hydrogen requires 7,705 GWh (which corresponds to about 28% of natural gas-fired power generation in 2017), and the CO<sub>2</sub> reduction at this time is 2.755 MtCO<sub>2</sub>e, which is considered 10% of 27.5578 MtCO<sub>2</sub>e.</p> <p>If PV power generation is used to supply electricity (assuming PV1MW≈1,000MWh/year), 7,705MW=7.7GW of PV power generation is required. In addition, according to the IEA report, about 9 liters of water is required to produce 1 kg of hydrogen, which means that 1.33 billion liters (1.33 million m<sup>3</sup>) of water is required to produce 148.17 kt of</p>

<sup>176</sup> Successful test of large high-efficiency gas turbine with 30% hydrogen co-firing contributes to CO<sub>2</sub> emissions reduction during power generation (Mitsubishi Heavy Industries, January 2019) <https://power.mhi.com/jp/news/20180119.html> Accessed 17 August 2022.

	hydrogen. If Japan's 2030 hydrogen production cost target of 30 yen/Nm <sup>3</sup> is applied and 1.65 billion m <sup>3</sup> of hydrogen is produced annually, 49.5 billion yen is required, and the cost effectiveness of CO <sub>2</sub> reduction is 17,967 yen/tCO <sub>2</sub> .
Major Japanese transition technologies applicable in the future (from Table 3-1)	<p>Transition technology in the gas field</p> <ul style="list-style-type: none"> <li>• Methanation: Synthesizing methane from hydrogen and CO<sub>2</sub></li> <li>• Hydrogen: Hydrogen is produced by electrolyzing water</li> <li>• Local hydrogen network: Development of a domestic hydrogen supply network</li> <li>• Hydrogen combustion equipment, etc.: Industrial furnaces, cogeneration, use of hydrogen in fuel cells, etc.</li> <li>• CCUS: Capturing and utilizing CO<sub>2</sub> emitted from industrial facilities</li> </ul> <p>In addition, all transition technologies that use hydrogen, ammonia or syngas in the steel, chemical, pulp and paper, and cement fields are applicable.</p>

Table 6-2 Summary of proposed priority cooperation projects in Uzbekistan (2)

Project name (draft)	Training on grid stabilization and management
Assumed C/P	Ministries and agencies related to the energy sector, electric power utilities, research institutes
Assumed scheme	Technical cooperation (combination of training in Japan and training in a third country)
Period of cooperation	About 2 years
Issue	<p>In Uzbekistan, which is working on the massive introduction of renewable energy, the stable operation of the power grid is becoming increasingly important. The National Dispatch Center, which had been in charge of grid management and operation, is now under the Ministry of Energy. In addition, the management and operation of the grid is undergoing rapid change, with donors supporting the development of a 500kV backbone grid, SCADA systems, and EMS for stable grid operation. On the other hand, since the grid system is coordinated within the Central-Asia and Russia region and it is necessary to take measures in cooperation with neighboring countries when problems occur, it is necessary to train human resources who are familiar with the management and technical aspects of stable operation of the grid system.</p> <p>Furthermore, it is necessary to improve the ability to formulate national power development plans and other plans based on medium- to long-term,</p>

	big-picture perspectives, such as appropriate power supply based on future growth in power demand and the massive introduction of renewable energy.
Target	Gain knowledge of stable domestic and intra-Central Asian power system operations
Details of implementation	<ul style="list-style-type: none"> <li>➤ Understand the current status and identify issues of grid management in Uzbekistan and neighboring countries. Learn about grid stabilization efforts by neighboring countries that are promoting the large-scale introduction of renewable energy</li> <li>➤ Understand the basics of normal operation of power supply command and power demand/supply management after SCADA/EMS installation, and also learn countermeasures in case of problems in Uzbekistan and neighboring countries (prevention of widespread blackouts in Central Asia).</li> <li>➤ To consider issues, measures and design for stable operation in grid management in the whole region and in domestic grid management by comparing and examining the methods of adjusting the supply-demand balance within the EU, Russia and Central Asia region.</li> </ul>
Output	The number of personnel with knowledge of the technical and management aspects of stable operation of the grid in light of the massive introduction of renewable energy will increase.
Outcome	<p>Establish a system to be able to respond to normal and problematic situations based on knowledge and technology related to stable operation of the grid within the region and in Uzbekistan.</p> <p>To improve the awareness and capabilities of staff for studying and planning measures for domestic grid operation from a medium- to long-term perspective in light of the massive introduction of renewable energy.</p>
Project Size	Technical cooperation (training in Japan and training in third countries): 0.2 billion yen.
Local measures	<p>The stable operation and management of the power system is under the jurisdiction of the Ministry of Energy.</p> <p>The Transition to a Green Economy Strategy (PP 4477) promotes the modernization of the electricity grid and the enhancement of technological capacity.</p> <p>The MOE's Low Carbon Roadmap for the Electricity Sector (2021), based on the EBRD's proposal, points to the importance of improving the electricity grid and regional grid interconnection.</p>
Finance	-

GHG reduction potential	Although no direct GHG emission reduction effects are expected as this is mainly a human resource development project, the training is expected to contribute to the achievement of CN by strengthening the capacity of staff for the mass introduction of renewable energy.
Major Japanese transition technologies applicable in the future (from Table 3-1)	<p>[Transition technology in the power sector].</p> <ul style="list-style-type: none"> <li>• Strengthening and upgrading of power transmission and distribution networks: Reinforcing power transmission and distribution networks to expand the introduction of renewable energy, etc.</li> <li>• Promotion of demand response and electrification, etc.: Efforts toward decarbonization on the demand side, electrification, etc.</li> <li>• Storage batteries, water pumping, distributed energy: Storage batteries contributing to grid stabilization, introduction of distributed energy resources, etc.</li> </ul>

## Appendix

Appendix 1: Field Survey Schedule

Appendix 2: Collected Materials

## Appendix 1: Field Survey Schedule

### 1. Vietnam

#### (1) Itinerary

Sunday, July 31 - Saturday, August 6, 2022

#### (2) Travelling Team Member

Name	In charge of	period of business trip
Yoshihiro Mizuno	Climate Change Framework, Carbon Trading, Economic Valuation	July 31 - August 6, 2022
Noriko Ishibashi	Renewable energy, electrification, hydrogen	July 31 - August 6, 2022

#### (3) Visiting Institutions and Schedule

No.	Date of visitation	Visiting organization
	Sunday, July 31	Departure from Japan, entry into Vietnam (Hanoi)
1	Monday, August 1	JICA Project Expert, Forestry Sector, JICA Vietnam Office
2	Tuesday, August 2	Meeting of the group
3	Wednesday, August 3	Centre for Energy and Green Growth Research
4		JICA project expert in the field of climate change
5		Industrial Promotion & Development Consultancy Center (Hanoi)
6	Thursday, August 4	Vietnam Electricity (EVN)
7		Energy Efficiency and Sustainable Development Department, Ministry of Industry and Trade (MOIT)
8		MOIT Oil, Gas, and Coal Department, MOIT
9	Friday, August 5	Energy Efficiency and Sustainable Development Department, MOIT (2nd)
10		JICA Vietnam Office
11		Departure from Vietnam
	Saturday, August 6	Returning to Japan

(4) Field survey

	
Hearing with Industrial Promotion and Development Consultancy Center (Hanoi)	Hearing before the Energy Efficiency and Sustainable Development Department, MOIT

2. Laos

(1) Itinerary

Wednesday, May 18 - Sunday, June 12, 2022

(2) Travelling Team Member

Name	In charge of	Period of business trip
Daiki Nose	Chief Operations Officer/ET to CN Strategy 1	May 18 - June 12, 2022
Yasuko Arakawa	Policies and Institutions	May 18 - June 9, 2022
Ayu Horiuchi	Energy conservation	May 18 - June 12, 2022

(3) Visiting Institutions and Schedule

No.	Date of visitation	Visiting organization
	Wednesday, May 18	Departure from Japan, Entry into Laos
	Thursday, May 19	Meeting in the survey team
1	Friday, May 20	Department Energy Efficiency Promotion, Ministry of Energy and Mines (MEM)
2		Department of Energy Policy and Planning, MEM
3	Tuesday, May 24	Department of Climate Change, Ministry of Natural Resources and Environment (MoNRE)
4		Global Green Growth Institute (GGGI)
5	Wednesday, May 25	Department of Transport, Ministry of Public Works and Transport (MoPWT)
6		Department of Forestry, Ministry of Agriculture and Forestry (MoAF)



7		Department of Industry and Handicraft / Department of Import and Export, Ministry of Industry and Commerce (MoIC)
8		Asia Foundation
9	Thursday, May 26	USAID
10	Friday, May 27	National Agriculture and Forest Research Institute (NAFRI), MoAF
11		Forest & Livestock Research Center, MoAF
12		NZ Laos Renewable energy facility
13	Monday, May 30	JICA Vientiane Transport Project
14		F-REDD Project
15	Tuesday, May 31	Loca Laos
16	Wednesday, June 1	ADB
17	Thursday, June 2	Department Energy Efficiency, Department of Energy Policy and Planning, MEM
18		Research Institute Energy and Mines
19	Friday, June 3	EDL
20		Participation in EV Forum
21		Department of Energy Management, MEM
22		MARUHAN Japan Bank
23	Monday, June 6	(Accompanying JICA officials to the consultation) Department of Energy Policy and Planning, MEM Department of Energy Efficiency Promotion, MEM
24		Department of Energy and Mines, Vientiane Capital
25		Investment Promotion Department, Ministry of Promotion and Investment (MPI)
26	Tuesday, June 7	(Accompanying JICA officials to the consultation) Investment Promotion Department, MPI Department of Transport, MoPWT Department of Industry and Handicraft / Department of Import and Export, MoIC
27		Department of Public Works and Transport, Vientiane Capital
28		Customs Department, International Cooperation Division, Ministry of Finance (MoF)
29	Wednesday, June 8	(Accompanying JICA officials to the consultation) MEM
30		Department of Industry and Commerce, Vientiane Capital
31	Thursday, June 9	(Accompanying JICA officials to the consultation) Department of Climate Change, MoNRE

32	Friday, June 10	JETRO Laos
	Saturday, June 11	Departure from Laos
	Sunday, June 12	Returning to Japan

(4) Field survey

	
Hearing to MEM	Hearing on MONRE
	
Hearing with MPWT	Hearing to EDL

3. Nepal

(1) Itinerary

Saturday, June 18 - Thursday, June 30, 2022

(2) Travelling Team Member

Name	In charge of	Period of business trip
Daiki Nose	Chief Operations Officer/ET to CN Strategy 1	June 18 - June 30, 2022
Yoshihiro Mizuno	Climate Change Framework, Carbon Trading, Economic Valuation	June 18 - June 30, 2022
Ayu Horiuchi	Energy conservation	June 18 - June 30, 2022

(3) Visiting Institutions and Schedule

No.	Date and time of visit	Visiting organization
	Saturday, June 18	Departure from Japan, Entry into Nepal
1	Sunday, June 19	Nepal Electricity Authority (NEA)
2		Ministry of Energy, Water Resources and Irrigation (MoEWRI)
3	Monday, June 20	Alternative Energy Promotion Centre (AEPC), MoEWRI
4		Ministry of Forest and Environment (MoFE)
5		Ministry of Physical Infrastructure and Transport (MoPIT)
6	Tuesday, June 21	Department of Transport Management, MoPIT
7		Department of Road, MoPIT
8		Department of Industry, Ministry of Industry, Commerce and Supplies
9		Tokyo Electric Power Company
10	Wednesday, June 22	Ministry of Federal Affairs and General Administration (MoFAGA)
11		Ministry of Urban Development Urban Development Division (MoUD)
12		Department of Urban Development and Building Construction
13		Ministry of Agriculture and Livestock (MoAL)
14		New Jeck et al.
15	Thursday, June 23	Department of Agriculture, MoAL
16		Ministry of Finance (MoF)
17		Parliamentary Committee on Agriculture, Cooperatives and Natural Resources
18	Friday, June 24	Practical Action
18		Global Green Growth Institute (GGGI)
20		Foreign, Commonwealth & Development Office (FCDO), UK Embassy
21	Sunday, June 26	Climate Change Division, MoFE
22		National Planning Commission
23		Town Development Fund, MoUD
24	Monday, June 27	ADB Nepal
25		Department of Water Supply and Sewage, MoWS
26		WB Nepal
27		Centre for Rural Technology Nepal (CRTN)
28	Tuesday, June 28	U.S. Agency for International Development

29		Water and Energy Commission (WECS)
30	Wednesday,	Kathmandu Univ
	June 29	Departure from Nepal
	Thursday, June 30	Returning to Japan

(4) Field survey

	
Hearing with NEA	Hearing with the AEPC
	
Hearing to MoEWRI	Hearing before the Parliamentary Committee

4. Uzbekistan

(1) Itinerary

Wednesday, June 15 - Thursday, June 30, 2022

(2) Travelling Team Member

Name	In charge of	Period of business trip
Akifumi Nishihata	Deputy Operations Manager/ET - CN Strategy 2	June 15 - June 30, 2022
Noriko Ishibashi	Renewable energy, electrification, hydrogen	June 15 - June 30, 2022
Yasuko Arakawa	Policies and Institutions	June 15 - June 30, 2022

(3) Visiting Institutions and Schedule

No.	Date and time of visit	Visiting organization
	Wednesday, June 15	Departure from Japan, Entry into Uzbekistan
1	Thursday, June 16	Department for the Development of Renewable Sources of Energy, Ministry of Energy (MoE)
2		Department for Fuel, Energy and Chemical Development Department for coordinating the implementation of the strategy and programs for the development of the green economy, Ministry of Economic Development and Poverty Reduction (MoEDPR)
3	Friday, June 17	Department for Development of R&D Structures in Sectoral Enterprises, Ministry of Innovative Development (MoID)
4		National Scientific Research Institute of Renewable Energy Sources under the Ministry of Energy (NIREs)
5	Monday, June 20	Public Transport Development Department; International Relations Department; Airports Development Department; Ministry of Transport (MoT)
6	Tuesday, June 21	Uzbek-Japan Innovation Centre of Youth (UJICY)
7		Department of complex development of heating systems, Ministry of Housing and Communal Services (MoHCS)
8	Wednesday, June 22	Institute of Materials Science, Institute of Energy Problems, Thermal Systems Laboratory, Foreign Relations Department, Academy of Science (AoS)
9		Intergovernmental commission for sustainable management, Consolidated information-analytics department, State Committee for Ecology and Environmental Protection (SCEEP)
10	Thursday, June 23	Department of Strategic Development, Relay Protection, Automation Department, IPP Department, NDC Department Joint-Stock Company National Electrical Networks of Uzbekistan (NEGU)

11		Development and International Cooperation; Department of Grants and Intl Finance Institution; Department of Plant Protection and Agrochemistry; Department of Metrology to determine the demand for water in agricultural crops; Department of Organic Production and Development of Optimal Agricultural Practices; Ministry of Agriculture (MoA)
12	Monday, June 27	ADB
13	Tuesday, June 28	WB
14		Department of the Renewable energy source development, MoE
15	Wednesday, June 29	EBRD Departure from Uzbekistan
	Thursday, June 30	Returning to Japan

(4) Field survey

	
Hearing with MoID	Hearing to the MoE
	
Hearing to the MoT	Hearing before the SCEEP

## Appendix 2 List of collected materials

### Material Classification

1-1 Vietnam Collection Materials

1-2 Vietnam interview transcripts (Japanese)

1-3 Vietnam interview materials

2-1 Laos Collection Materials

2-2 Laos interview transcripts (Japanese)

2-3 Laos interview materials

3-1 Nepal Collection Materials

3-2 Nepal interview transcripts (Japanese)

3-3 Nepal interview materials

4-1 Uzbekistan Collection Materials

4-2 Uzbekistan interview transcripts (Japanese)

4-3 Uzbekistan interview materials

1-1 Vietnam Collection Materials

No.	Material	Year	Lang	Issue	URL/paper
1-1-1	The Draft National Power Development Plan VIII (PDP VIII)	Pending approval	En	Prime Minister	<a href="http://vepg.vn/wp-content/uploads/2021/09/5.9.2021-Draft-PDP8_En.pdf">http://vepg.vn/wp-content/uploads/2021/09/5.9.2021-Draft-PDP8_En.pdf</a>
1-1-2	Government Decree No. 06/2022/ND-CP on mitigation of GHG emission and protection of Ozone layer	2022	Vn	Prime Minister	<a href="https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Nghi-dinh-06-2022-ND-CP-giam-nhe-phat-thai-khi-nha-kinh-va-bao-ve-tang-o-don-500104.aspx">https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Nghi-dinh-06-2022-ND-CP-giam-nhe-phat-thai-khi-nha-kinh-va-bao-ve-tang-o-don-500104.aspx</a>
1-1-3	Notice No 30/TB-VPCP on Prime Minister ' s conclusion in the 1st meeting of the National Steering Committee to deploy Vietnam ' s commitments at COP26	2022	En	Government Office	<a href="https://thuvienphapluat.vn/van-ban/tai-nguyen-moi-truong/notification-30-tb-vpcp-2022-the-fulfilment-of-vietnam-s-commitments-on-climate-change-507657.aspx">https://thuvienphapluat.vn/van-ban/tai-nguyen-moi-truong/notification-30-tb-vpcp-2022-the-fulfilment-of-vietnam-s-commitments-on-climate-change-507657.aspx</a>
1-1-4	The National Green Growth Strategy for 2021-2030 period, vision to 2050 (The Decision No. 1658/QD-TTg)	2021	En	Prime Minister	<a href="https://en.baochinhphu.vn/national-green-growth-strategy-for-2021-2030-vision-towards-2050-11142515.htm">https://en.baochinhphu.vn/national-green-growth-strategy-for-2021-2030-vision-towards-2050-11142515.htm</a>
1-1-5	Orientation of Vietnam ' s National Energy Development Strategy by 2030, with a vision towards 2045 ( The Resolution 55 NQ/TW)	2020	Vn	Central Committee of Vietnamese Communist Party	<a href="https://tulieuvankien.dangcongsan.vn/Uploads/2020/2/7/27/55-NQ-phat-trien-nang-luong-quoc-gia.pdf">https://tulieuvankien.dangcongsan.vn/Uploads/2020/2/7/27/55-NQ-phat-trien-nang-luong-quoc-gia.pdf</a>



1-1-	6	Resolution No. 140/ NQ-CP regarding Promulgation of the Government ' s Action Programme for Implementing the Resolution No. 55-NQ/TW dated 1/02/2020 of Politburo regarding orientations of the Vietnamese National Energy Development Strategy until 2030, with a vision till 2045	2020	En	Government of Vietnam	<a href="http://gizenergy.org.vn/media/app/media/140-NQ-CP-Chuong-trinh-hanh-dong-cua-CP-kem-theo-VB-7062-giai-trinh-VPCP-EN.pdf">http://gizenergy.org.vn/media/app/media/140-NQ-CP-Chuong-trinh-hanh-dong-cua-CP-kem-theo-VB-7062-giai-trinh-VPCP-EN.pdf</a>
1-1-	7	Viet Nam Third Biennial Undated Report	2020	En	Ministry of Natural Resources and Environment	<a href="https://unfccc.int/sites/default/files/resource/Viet%20Nam_BUR3.pdf">https://unfccc.int/sites/default/files/resource/Viet%20Nam_BUR3.pdf</a>
1-1-	8	Updated Nationally Determined Contribution (NDC)	2020	En	The Socialist Republic of Viet Nam	<a href="https://unfccc.int/sites/default/files/NDC/2022-06/Viet%20Nam_NDC_2020_Eng.pdf">https://unfccc.int/sites/default/files/NDC/2022-06/Viet%20Nam_NDC_2020_Eng.pdf</a>
1-1-	9	National Energy Efficiency Programme (VNEEP) for the period of 2019-2030 (Prime Minister ' s Decision 280/QD-TTg)	2019	En	Prime Minister	<a href="https://aseanenergy.sharepoint.com/:b:/g/AEDS/EZ5li8_XlnRLilGfV0cT0gMBxryxxIvfVlup57tIlu4rUw?e=OKrM7n">https://aseanenergy.sharepoint.com/:b:/g/AEDS/EZ5li8_XlnRLilGfV0cT0gMBxryxxIvfVlup57tIlu4rUw?e=OKrM7n</a>
1-1-	10	Gas industry development plan up to 2025 in Vietnam and prospects up to 2035 (Prime Minister No. 60 / QD-TTg)	2017	En	Prime Minister	<a href="https://vanbanphapluat.co/decision-60-qd-ttg-approving-plan-development-gas-industry-of-vietnam-by-2025-with-vision-to-2035">https://vanbanphapluat.co/decision-60-qd-ttg-approving-plan-development-gas-industry-of-vietnam-by-2025-with-vision-to-2035</a>
1-1-	11	Prime Minister Decision No. 428/QD-CP on the approval of the revised National Power Development Master Plan for the 2011-2020 period with the vision 2030	2016	Vn	Prime Minister	<a href="https://policy.asiapacificenergy.org/sites/default/files/428.signed.pdf">https://policy.asiapacificenergy.org/sites/default/files/428.signed.pdf</a>

1-1-	12	Viet Nam's Renewable Energy Development Strategy up to 2030 with an outlook to 2050 (Prime Minister's Decision 2068/QD-TTg)	2015	En	Prime Minister	<a href="https://policy.asiapacificenergy.org/node/3447">https://policy.asiapacificenergy.org/node/3447</a>
1-1-	13	LAW ON ECONOMICAL AND EFFICIENT USE OF ENERGY	2010	En	National Assembly	<a href="https://moj.gov.vn/vbpq/en/lists/vn%20bn%20php%20lut/view_detail.aspx?itemid=10481#">https://moj.gov.vn/vbpq/en/lists/vn%20bn%20php%20lut/view_detail.aspx?itemid=10481#</a>

1-2 Vietnam interview transcripts (Japanese)

No.	Materials	Institution	Dates	
1-2-	1	20220601_JICA ETCN ベトナム_USTDA	USTDA	1 June 2022
1-2-	2	20220609_JICA ETCN ベトナム_PetroVietnam ガス	PetroVietnam	9 June 2022
1-2-	3	20220613_JICA ETCN ベトナム_USAID	USAID	13 June 2022
1-2-	4	20220621_JICA ETCN ベトナム_GIZ	GIZ	21 June 2022
1-2-	5	20220623_JICA ETCN ベトナム_Ministry of Industry of Energy	Department of Energy Efficiency and Sustainable Development, Ministry of Industry and Trade	23 June 2022
1-2-	6	20220628_JICA ETCN ベトナム_Ministry of Industry of Energy	Institute of Energy Energy Economic Department, Ministry of Industry and Trade	28 June 2022
1-2-	7	20220628_JICA ETCN ベトナム_ベトナム三菱商事	Mitsubishi Corporation Vietnam	28 June 2022
1-2-	8	20220701_JICA ETCN ベトナム_一般財団法人省エネルギーセンター	The Energy Conservation Center, Japan	1 July 2022
1-2-	9	20220711_JICA ETCN ベトナム_Ministry of Transport	Department of Environment, Ministry of Transport	11 July 2022
1-2-	10	20220713_JICA ETCN ベトナム_Department of Oil, Gas, and Coal (MOIT)	Department of Oil, Gas, and Coal, Ministry of Industry and Trade	13 July 2022
1-2-	11	20220801_JICA ETCN ベトナム_JICA 森林プロジェクト専門家	JICA Expert (Natural resource management)	1 August 2022
1-2-	12	20220802_JICA ETCN ベトナム_Center for Energy and Green Growth Research	Center for Energy and Green Growth Research	2 August 2022

1-2-	13	20220802_JICA ETCN ベトナム _Industrial Promotion and Development Consultancy Center Hanoi	Industrial Promotion and Development Consultancy Center Hanoi	2 August 2022
1-2-	14	20220803_JICA ETCN ベトナム_JICA 専 門家	JICA Expert (NAMA)	3 August 2022
1-2-	15	20220804_JICA ETCN ベトナム _Department of Oil, Gas, and Coal(MOIT)	Department of Oil, Gas, and Coal, Ministry of Industry and Trade	4 August 2022
1-2-	16	20220804_JICA ETCN ベトナム_Energy Efficiency and Sustainable Development Department(MOIT)	Department of Energy Efficiency and Sustainable Development, Ministry of Industry and Trade	4 August 2022
1-2-	17	20220804_JICA ETCN ベトナム_Vietnam Electricity	Vietnam Electricity	4 August 2022
1-2-	18	20220805_JICA ETCN ベトナム_Energy Efficiency and Sustainable Development Department(MOIT)	Department of Energy Efficiency and Sustainable Development, Ministry of Industry and Trade	5 August 2022
1-2-	19	20220810_JICA ETCN ベトナム_東京ガス	Tokyo Gas Co., Ltd	10 August 2022

2-1 Laos Collection Materials

No.	Material	Year	Lang	Issue	URL/paper
2-1-1	National Strategy on Climate Change	2022	Lao	Ministry of Natural Resources and Environment	paper
2-1-2	Energy Policy of Lao PDR	2021	En/Lao	Ministry of Energy and Mines	paper
2-1-3	National Power Development Plan of Lao PDR	2021	Lao	Ministry of Energy and Mines	paper
2-1-4	Nationally Determined Contribution (NDC)	2021	En/Lao	Government of Laos	<a href="https://unfccc.int/sites/default/files/NDC/2022-06/NDC%202020%20of%20Lao%20PDR%20%28English%29%2C%2009%20April%202021%20%281%29.pdf">https://unfccc.int/sites/default/files/NDC/2022-06/NDC%202020%20of%20Lao%20PDR%20%28English%29%2C%2009%20April%202021%20%281%29.pdf</a>
2-1-5	Resolution on Endorsement of Policy on Electricity Vehicle Use	2021	Lao	Ministry of Energy and Mines, Ministry of Public Work and Transport	paper
2-1-6	9th National Socio-economic Development Plan	2021	En	Government of Laos	<a href="https://data.opendevelopmentmekong.net/library_record/9th-five-year-national-socio-economic-develo">https://data.opendevelopmentmekong.net/library_record/9th-five-year-national-socio-economic-develo</a>

						<a href="#">pment-plan-2021-2025</a>
2-1-	7	National Forestry Strategy	2021	Lao	Ministry of Agriculture and Forestry	paper
2-1-	8	Decree on Energy efficiency and Conservation	2020	En/Lao	Ministry of Energy and Mines	paper
2-1-	9	Strategy on Promotion of Clean Energy for Transport Sector-Plan for 2025, strategy for 2030, and vision for 2050	2020	Lao	Ministry of Energy and Mines, Ministry of Public Work and Transport	paper
2-1-	10	The First Biennial Updated Report of the Lao PDR	2020	En/Lao	Ministry of Natural Resources and Environment	<a href="https://unfccc.int/sites/default/files/resource/The%20First%20Biennial%20Update%20Report-BUR_Lao%20PDR.pdf">https://unfccc.int/sites/default/files/resource/The%20First%20Biennial%20Update%20Report-BUR_Lao%20PDR.pdf</a>
2-1-	11	Decree on Climate change	2019	Lao	Ministry of Natural Resources and Environment	<a href="https://data.laos.opendevopmentmekong.net/dataset/decree-on-climate-change-lao-pdr-2019#:~:text=The%20decree%20determines%20the%20principles,properties%2C%20environment%2C%20biodiversity%2C%20and">https://data.laos.opendevopmentmekong.net/dataset/decree-on-climate-change-lao-pdr-2019#:~:text=The%20decree%20determines%20the%20principles,properties%2C%20environment%2C%20biodiversity%2C%20and</a>

2-1-	12	National Green Growth Strategy of the Lao PDR	2018	En/Lao	Ministry of Natural Resources and Environment	<a href="https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database//national_green_growth_strategy_of%20the_Lao_PDR_till_2030_government_of_Lao.pdf">https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database//national_green_growth_strategy_of%20the_Lao_PDR_till_2030_government_of_Lao.pdf</a>
2-1-	13	Lao National Environmental Standards	2017	Lao	Ministry of Natural Resources and Environment	paper
2-1-	14	Decree on Biodiesel	2016	Lao	Ministry of Energy and Mines	paper
2-1-	15	Ministerial Directive for Generic Standard on Clean Cookstove in Lao PDR	2015	Lao	Ministry of Energy and Mines	paper
2-1-	16	Policy on Sustainable Hydropower Development	2015	En/Lao	Ministry of Energy and Mines	<a href="https://policy.asiapacificenergy.org/sites/default/files/Decree%20on%20the%20Approval%20and%20Promulgation%20of%20the%20Policy%20on%20Sustainable%20Hydropower%20Development%20in%20Lao%20PDR.pdf">https://policy.asiapacificenergy.org/sites/default/files/Decree%20on%20the%20Approval%20and%20Promulgation%20of%20the%20Policy%20on%20Sustainable%20Hydropower%20Development%20in%20Lao%20PDR.pdf</a>
2-1-	17	Climate Change Action Plan of Lao PDR for 2013-2020	2013	En/Lo	Ministry of Natural Resources and Environment	paper

2-1-	18	Renewable Energy Development Strategy	2011	En/Lao	Ministry of Natural Resources and Environment	<a href="https://policy.asiapacificenergy.org/sites/default/files/LIRE-Renewable%20Energy%20Development%20Strategy%20in%20Lao%20PDR.pdf">https://policy.asiapacificenergy.org/sites/default/files/LIRE-Renewable Energy Development Strategy in Lao PDR.pdf</a>
2-1-	19	Strategy on Climate Change of the Lao PDR	2010	En/Lo	Ministry of Natural Resources and Environment	paper



## 2-2 Laos interview transcripts (Japanese)

No.		Materials	Institution	Dates
2-2-	1	20220520_JICA ETCN_MEM DEE	Department Energy Efficiency Promotion, Ministry of Energy and Mines (MEM)	20 May 2022
2-2-	2	20220520_JICA ETCN_MEM DEPP	Department of Energy Policy and Planning, MEM	20 May 2022
2-2-	3	20220524_JICA ETCN_GGGI	Global Green Growth Institute (GGGI)	24 May 2022
2-2-	4	20220524_JICA ETCN_MONRE DoCC	Department of Climate Change, Ministry of Natural Resources and Environment (MoNRE)	24 May 2022
2-2-	5	20220525_JICA ETCN_AF	Asia Foundation	25 May 2022
2-2-	6	20220525_JICA ETCN_MoAF DoF	Department of Forestry, Ministry of Agriculture and Forestry (MoAF)	25 May 2022
2-2-	7	20220525_JICA ETCN_MOIC DoI 他	Department of Industry and Handicraft / Department of Import and Export, Ministry of Industry and Commerce (MoIC)	25 May 2022
2-2-	8	20220525_JICA ETCN_MPWT DoT 他	Department of Transport, Ministry of Public Works and Transport (MoPWT)	25 May 2022
2-2-	9	20220526_JICA ETCN_USAID	USAID	26 May 2022
2-2-	10	20220527_JICA ETCN_Forest and Livestock research Center	Forest & Livestock Research Center, MoAF	27 May 2022
2-2-	11	20220527_JICA ETCN_NAFRI	National Agriculture and Forest Research Institute (NAFRI), MoAF	27 May 2022
2-2-	12	20220527_JICA ETCN_NZ	NZ Laos Renewable energy facility	27 May 2022
2-2-	13	20220530_JICA ETCN_F-REDD プロジェクト 江頭様	JICA Expert (F-REDD)	30 May 2022

2-2-	14	20220530_JICA ETCN_TEPSCO,TEPSCO	TEPCO, TEPSCO	30 May 2022
2-2-	15	20220530_JICA ETCN_ビエンチャン都市交通プロジェクト武田様	JICA Expert (Transportation)	30 May 2022
2-2-	16	20220531_JICA ETCN_Loca	Loca Laos	31 May 2022
2-2-	17	20220601_JICA ETCN_ADB	ADB	1 June 2022
2-2-	18	20220602_JICA ETCN_DEEP, DEPP 2nd meeting	Department Energy Efficiency, Department of Energy Policy and Planning, MEM	2 June 2022
2-2-	19	20220602_JICA ETCN_MEM Research Institute Energy and Mine	Research Institute Energy and Mines	2 June 2022
2-2-	20	20220603_EV Forum ラオス	EV Forum	3 June 2022
2-2-	21	20220603_JICA ETCN_EDL	EDL	3 June 2022
2-2-	22	20220603_JICA ETCN_MEM DEM	Department of Energy Management, MEM	3 June 2022
2-2-	23	20220603_JICA ETCN_マルハンジャパン銀行	Maruhan Japan Bank	3 June 2022
2-2-	24	20220606_JICA ETCN_MP IPD	Investment Promotion Department, Ministry of Promotion and Investment (MPI)	3 June 2022
2-2-	25	20220606_JICA ETCN_Vientian Capital DEM	Department of Energy and Mines, Vientiane Capital	6 June 2022
2-2-	26	20220607_JICA ETCN_MOF DOC	Customs Department, International Cooperation Division, Ministry of Finance (MoF)	7 June 2022
2-2-	27	20220607_JICA ETCN_Vientiane Capital_DPWT	Department of Public Works and Transport, Vientiane Capital	7 June 2022
2-2-	28	20220608_JICA ETCN_Vientian Capital DoIC	Department of Industry and Commerce, Vientiane Capital	8 June 2022
2-2-	29	20220610_JICA ETCN_JETRO	JETRO Laos	10 June 2022

### 3-1 Nepal Collection Materials

No.		Material	Year	Lang	Issue	URL/paper
3-1-	1	Budget Speech of Fiscal Year 2022/2023	2022	En/Ne	Ministry of Finance	<a href="https://www.mof.gov.np/site/publication-detail/3185">https://www.mof.gov.np/site/publication-detail/3185</a>
3-1-	2	Third National Communication To The United Nations Framework Convention On Climate Change (2021)	2021	En	Ministry of Forest and Environment	<a href="https://unfccc.int/sites/default/files/resource/TNC%20Nepal_Final_v2.pdf">https://unfccc.int/sites/default/files/resource/TNC%20Nepal_Final_v2.pdf</a>
3-1-	3	Environment Friendly Local Government Framework	2021	Ne	Ministry of Federal Affairs & General Administration	<a href="https://www.dpnet.org.np/resource-detail/506">https://www.dpnet.org.np/resource-detail/506</a>
3-1-	4	Nepal's Long-Term Strategy for Net-zero Emissions	2021	En/Ne	Government of Nepal	<a href="https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf">https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf</a>
3-1-	5	Environment Protection Regulation	2020	Ne	Ministry of Forest and Environment	<a href="https://doind.gov.np/detail/58">https://doind.gov.np/detail/58</a>
3-1-	6	Industrial Enterprises Act 2020/Industrial Policy 2010	2020	En/Ne	Ministry of Industry, Commerce and Supplies	<a href="https://moics.gov.np/uploads/shares/laws/Industrial%20Enterprises%20Act%20%202020.pdf">https://moics.gov.np/uploads/shares/laws/Industrial%20Enterprises%20Act%20%202020.pdf</a>
3-1-	7	Second Nationally Determined Contribution (NDC)	2020	En/Ne	Government of Nepal	<a href="https://climate.mohp.gov.np/attachments/article/167/Second%20Nationally%20Determined%20Contribution%20(NDC)%20-%202020.pdf">https://climate.mohp.gov.np/attachments/article/167/Second%20Nationally%20Determined%20Contribution%20(NDC)%20-%202020.pdf</a>

3-1-	8	National Environment Policy	2019	Ne	Ministry of Forest and Environment	<a href="https://climate.moep.gov.np/downloads/National_Environment_Policy_2076.pdf">https://climate.moep.gov.np/downloads/National_Environment_Policy_2076.pdf</a>
3-1-	9	Environment Protection Act	2019	En/Ne	Ministry of Forest and Environment,	<a href="https://www.lawcommission.gov.np/en/wp-content/uploads/2021/03/The-Environment-Protection-Act-2019-2076.pdf">https://www.lawcommission.gov.np/en/wp-content/uploads/2021/03/The-Environment-Protection-Act-2019-2076.pdf</a>
3-1-	10	National Climate Change Policy 2076	2019	En/Ne	Ministry of Forest and Environment	<a href="http://extwprlegs1.fao.org/docs/pdf/nep199367.pdf">http://extwprlegs1.fao.org/docs/pdf/nep199367.pdf</a>
3-1-	11	The Fifteenth Plan (Fiscal Year 2019/20 - 2023/24)	2019	En/Ne	National Planning Commission	<a href="https://npc.gov.np/images/category/15th_plan_English_Version.pdf">https://npc.gov.np/images/category/15th_plan_English_Version.pdf</a>
3-1-	12	Present Situation and Future Roadmap of Energy, Water Resources and Irrigation Sector (White Paper)	2018	Ne	Ministry of Energy, Water Resources and Irrigation	<a href="https://moewri.gov.np/storage/listies/May2020/white-paper-2075-with-annex02.pdf">https://moewri.gov.np/storage/listies/May2020/white-paper-2075-with-annex02.pdf</a>
3-1-	13	Nepal National REDD + Strategy, (2018 -2022)	2018	En/Ne	Ministry of Forests and Environment	<a href="http://www.redd.gov.np/upload/e66443e81e8cc9c4fa5c099a1fb1bb87/files/REDD_Strategy_Nepal_2018.pdf">http://www.redd.gov.np/upload/e66443e81e8cc9c4fa5c099a1fb1bb87/files/REDD_Strategy_Nepal_2018.pdf</a>
3-1-	14	National Energy Efficiency Strategy 2018	2018	En	Ministry of Energy, Water Resources and Irrigation	<a href="https://www.moewri.gov.np/storage/listies/May2020/national-energy-efficiency-strategy-2075-en.pdf">https://www.moewri.gov.np/storage/listies/May2020/national-energy-efficiency-strategy-2075-en.pdf</a>

3-1-	15	The Biomass Energy Strategy 2017	2017	En	Ministry of Population and Environment	<a href="https://www.aepc.gov.np/uploads/docs/2018-07-29_Biomass%20Energy%20Strategy%202073%20BS%20(2017)%20English.pdf">https://www.aepc.gov.np/uploads/docs/2018-07-29_Biomass%20Energy%20Strategy%202073%20BS%20(2017)%20English.pdf</a>
3-1-	16	National Urban Development Strategy	2017	En/Ne	Ministry of Urban Development	<a href="https://www.moud.gov.np/storage/listies/July2019/NUDS_PART_A.pdf">https://www.moud.gov.np/storage/listies/July2019/NUDS_PART_A.pdf</a>
3-1-	17	Renewable Energy Subsidy Policy, 2073 BS	2016	En	Ministry of Population and Environment	<a href="https://www.aepc.gov.np/uploads/docs/2018-06-19_RE%20Subsidy%20Policy,%202073%20(English).pdf">https://www.aepc.gov.np/uploads/docs/2018-06-19_RE%20Subsidy%20Policy,%202073%20(English).pdf</a>
3-1-	18	Constitution of Nepal	2015	En/Ne	Government of Nepal	<a href="https://www.constituteproject.org/constitution/Nepal_2015.pdf">https://www.constituteproject.org/constitution/Nepal_2015.pdf</a>
3-1-	19	Agriculture Development Strategy (2015-2035)	2015	En/Ne	Ministry of Agriculture and Livestock Development	<a href="https://www.climate-laws.org/geographies/nepal/policies/agriculture-development-strategy-2015-2035#:~:text=The%20Agriculture%20Development%20Strategy%20(AD S,logistics%2Cfinance%2C%20marketing).">https://www.climate-laws.org/geographies/nepal/policies/agriculture-development-strategy-2015-2035#:~:text=The%20Agriculture%20Development%20Strategy%20(AD S,logistics%2Cfinance%2C%20marketing).</a>
3-1-	20	Nepal Sustainable Development Goals Status and Roadmap: 2016 -2030	2015	En	National Planning Commission	<a href="https://policy.asiapacificenergy.org/sites/default/files/Sustainable%20Development%20Goals%20Status%20and%20Roadmap%202016-2030%20%28EN%29.pdf">https://policy.asiapacificenergy.org/sites/default/files/Sustainable%20Development%20Goals%20Status%20and%20Roadmap%202016-2030%20%28EN%29.pdf</a>

3-2 Nepal interview transcripts (Japanese)

No.	Materials	Institution	Dates
3-2-1	20220617_JICA ETCN ネパール_水力発電計画アドバイザー菊川様	JICA Expert (Hydro power)	17 June 2022
3-2-2	20220619_JICA ETCN ネパール_Ministry of Energy Water Resource and Irrigation	Ministry of Energy Water Resource and Irrigation	19 June 2022
3-2-3	20220619_JICAETCN ネパール_Nepal Energy Authority	Nepal Energy Authority	19 June 2022
3-2-4	20220620_JICA ETCN ネパール_Ministry of Forest and Environment	Ministry of Forest and Environment	20 June 2022
3-2-5	20220620_JICA ETCN ネパール_Ministry of Physical Infrastructure and Transport	Ministry of Physical Infrastructure and Transport	20 June 2022
3-2-6	20220620_JICAETCN ネパール_Alternative Energy Promotion Centre	Alternative Energy Promotion Centre	20 June 2022
3-2-7	20220621_JICA ETCN ネパール_Department of Industry	Department of Industry	21 June 2022
3-2-8	20220621_JICA ETCN ネパール_Department of Road	Department of Road	21 June 2022
3-2-9	20220621_JICA ETCN ネパール_Department of Transport Management	Department of Transport Management	21 June 2022
3-2-10	20220622_JICA ETCN ネパール_Department of Urban Development and Building Construction	Department of Urban Development and Building Construction	22 June 2022
3-2-11	20220622_JICA ETCN ネパール_Ministry of Agriculture and Livestock Development	Ministry of Agriculture and Livestock	22 June 2022

			Development	
3-2-	12	20220622_JICA ETCN ネパール_Ministry of Federal Affairs and General Administration	Ministry of Federal Affairs and General Administration	22 June 2022
3-2-	13	20220622_JICA ETCN ネパール_Ministry of Urban Development	Ministry of Urban Development	22 June 2022
3-2-	14	20220622_JICA ETCN ネパール_ニュージェック	Nerjec	22 June 2022
3-2-	15	20220622_JICA ETCN ネパール_東京電力	TEPCO	22 June 2022
3-2-	16	20220623_JICA ETCN ネパール_Department of Agriculture	Department of Agriculture	23 June 2022
3-2-	17	20220623_JICA ETCN ネパール_Ministry of Finance	Ministry of Finance	23 June 2022
3-2-	18	20220623_JICA ETCN ネパール_Parliamentary Committee	Parliamentary Committee	23 June 2022
3-2-	19	20220624_JICA ETCN ネパール_GGGI	GGGI	24 June 2022
3-2-	20	20220624_JICA ETCN ネパール_Practical Action Nepal	Practical Action Nepal	24 June 2022
3-2-	21	20220626_JICA ETCN ネパール_Climate Change Division MOFE	Climate Change Division MOFE	26 June 2022
3-2-	22	20220626_JICA ETCN ネパール_National Planning Commission	National Planning Commission	26 June 2022
3-2-	23	20220626_JICA ETCN ネパール_TDF	TDF	26 June 2022

3-2-	24	20220627_JICA ETCN ネパール_ADB	ADB	27 June 2022
3-2-	25	20220627_JICA ETCN ネパール_Centre for Rural Technology Nepal	Centre for Rural Technology Nepal	27 June 2022
3-2-	26	20220627_JICA ETCN ネパール_Department of Water Supply and Sewege	Department of Water Supply and Sewege	27 June 2022
3-2-	27	20220627_JICAETCN ネパール_WB	WB	27 June 2022
3-2-	28	20220628_JICA ETCN ネパール_FCDO UK	FCDO UK	28 June 2022
3-2-	29	20220628_JICA ETCN ネパール_USAID	USAID	28 June 2022
3-2-	30	20220628_JICA ETCN ネパール_Water and Energy Commission Secretariat	Water and Energy Commission Secretariat	28 June 2022
3-2-	31	20220629_JICA ETCN ネパール_Kathmandu University	Kathmandu University	29 June 2022



## 4-1 Uzbekistan Collection Materials

No.	Material	Year	Lang	Issue	URL/paper
4-1-1	President Decree #60 (dated 28.01.2022) ON THE NEW UZBEKISTAN DEVELOPMENT STRATEGY FOR 2022-2026	2022	Ru/Uz	President Administration	<a href="https://lex.uz/en/docs/5841063">https://lex.uz/en/docs/5841063</a>
4-1-2	President Decree #5063 (dated 09.04.2021) ON MEASURES TO DEVELOP RENEWABLE AND HYDROGEN ENERGY IN THE REPUBLIC OF UZBEKISTAN	2021	Ru/Uz	Office of the President of Uzbekistan	<a href="https://lex.uz/ru/docs/5362035">https://lex.uz/ru/docs/5362035</a>
4-1-3	A carbon-neutral electricity sector in Uzbekistan: Summary for policymakers	2021	En	Ministry of Energy of the Republic of Uzbekistan	<a href="https://minenergy.uz/en/lists/view/131">https://minenergy.uz/en/lists/view/131</a>
4-1-4	First Biennial Update Report of The Republic of Uzbekistan	2021	En	Government of Uzbekistan	<a href="https://unfccc.int/sites/default/files/resource/FBURUZeng.pdf">https://unfccc.int/sites/default/files/resource/FBURUZeng.pdf</a>
4-1-5	THE LAW OF THE REPUBLIC OF UZBEKISTAN ON THE RATIONAL USE OF ENERGY (as amended and supplemented in accordance with the Law of the RUz No. 628 of 14.07.2020 "ON IMPLEMENTATION OF AMENDMENTS AND ADDITIONS TO THE LAW OF THE REPUBLIC OF UZBEKISTAN «ON RATIONAL USE OF ENERGY»")	2020	Ru/Uz	The Legislative Chamber	<a href="https://lex.uz/docs/4895655">https://lex.uz/docs/4895655</a>

4-1-	6	President Decree #4479 (dated 10.07.2020) ON ADDITIONAL MEASURES TO REDUCE THE DEPENDENCE OF ECONOMIC SECTORS ON FUEL AND ENERGY PRODUCTS BY IMPROVING THE ENERGY EFFICIENCY OF THE ECONOMY AND THE USE OF AVAILABLE RESOURCES	2020	Ru/Uz	President Administration	<a href="https://lex.uz/docs/4890075">https://lex.uz/docs/4890075</a>
4-1-	7	Resolution of the Cabinet of Ministers of the Republic of Uzbekistan, No. 640 (dated 09.10.2020) APPROVAL OF THE REGULATION ON EXTRA-BUDGETARY INTERSECTORAL ENERGY SAVING FUND UNDER THE MINISTRY OF ENERGY OF THE REPUBLIC OF UZBEKISTAN	2020	Ru/Uz	THE CABINET OF MINISTERS OF THE REPUBLIC OF UZBEKISTAN	<a href="https://lex.uz/en/docs/5038208">https://lex.uz/en/docs/5038208</a>
4-1-	8	Updated Nationally Determined Contribution (NDC)	2020	En	Government of Uzbekistan	<a href="https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf">https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf</a>
4-1-	9	President Decree #4422 (dated 22.08.2019) ON ACCELERATED MEASURES TO IMPROVE ENERGY EFFICIENCY OF ECONOMIC SECTORS AND THE SOCIAL SPHERE, THE INTRODUCTION OF ENERGY-SAVING TECHNOLOGIES, AND THE DEVELOPMENT OF RENEWABLE ENERGY SOURCES	2019	Ru/Uz	President Administration	<a href="https://lex.uz/ru/docs/4486127">https://lex.uz/ru/docs/4486127</a>

4-1-	10	President Decree #4477 (dated 04.10.2019) ON APPROVAL OF THE STRATEGY FOR THE TRANSITION OF UZBEKISTAN TO A GREEN ECONOMY	2019	Ru/Uz	President Administration	<a href="https://lex.uz/docs/4539506">https://lex.uz/docs/4539506</a>
4-1-	11	The concept note for the supply of electric power 2020-2030	2019	En	Ministry of Energy of the Republic of Uzbekistan	<a href="https://minenergy.uz/en/lists/view/77">https://minenergy.uz/en/lists/view/77</a>
4-1-	12	THE LAW OF THE REPUBLIC OF UZBEKISTAN ON THE USE OF RENEWABLE ENERGY SOURCES	2019	Ru/Uz	the Legislative Chamber of Uzbekistan	<a href="https://lex.uz/docs/4346835">https://lex.uz/docs/4346835</a>

4-2 Uzbekistan interview transcripts (Japanese)

No.		Materials	Institution	Dates
4-2-	1	20220616_JICA ETCN ウズベキスタン_Ministry of Economic Development and Poverty Reduction	Ministry of Economic Development and Poverty Reduction	16 June 2022
4-2-	2	20220616_JICA ETCN ウズベキスタン_Ministry of Energy	Ministry of Energy	16 June 2022
4-2-	3	20220617_JICA ETCN ウズベキスタン_Ministry of Innovative Development	Ministry of Innovative Development	17 June 2022
4-2-	4	20220617_JICA ETCN ウズベキスタン_National Scientific Research Institute of Renewable Energy Sources under the Ministry of Energy	National Scientific Research Institute of Renewable Energy Sources under the Ministry of Energy	17 June 2022
4-2-	5	20220620_JICA ETCN ウズベキスタン_Ministry of Transport	Ministry of Transport	20 June 2022
4-2-	6	20220621_JICA ETCN ウズベキスタン_Ministry of Housing and Communal Services	Ministry of Housing and Communal Services	21 June 2022
4-2-	7	20220621_JICA ETCN ウズベキスタン_UJICY	UZBEK-JAPAN INNOVATION CENTRE OF YOUTH	21 June 2022
4-2-	8	20220622_JICA ETCN ウズベキスタン_Uzbekistan Academy of Sciences	Uzbekistan Academy of Sciences	22 June 2022
4-2-	9	20220622_JICA ETCN ウズベキスタン_State Committee for Ecology and Environmental Protection	State Committee for Ecology and Environmental Protection	22 June 2022
4-2-	10	20220623_JICA ETCN ウズベキスタン_Joint-Stock Company National Electrical Networks of Uzbekistan	Joint-Stock Company National Electrical Networks of Uzbekistan	23 June 2022

4-2-	11	20220623_JICA ETCN ウズベキスタン_Ministry of Agriculture	Ministry of Agriculture	23 June 2022
4-2-	12	20220627_JICA ETCN ウズベキスタン_Asian Development Bank	Asian Development Bank	27 June 2022
4-2-	13	20220628_JICA ETCN ウズベキスタン_Ministry of Energy	Ministry of Energy	28 June 2022
4-2-	14	20220628_JICA ETCN ウズベキスタン_World Bank	World Bank	28 June 2022
4-2-	15	20220629_JICA ETCN ウズベキスタン_EBRD	EBRD	29 June 2022