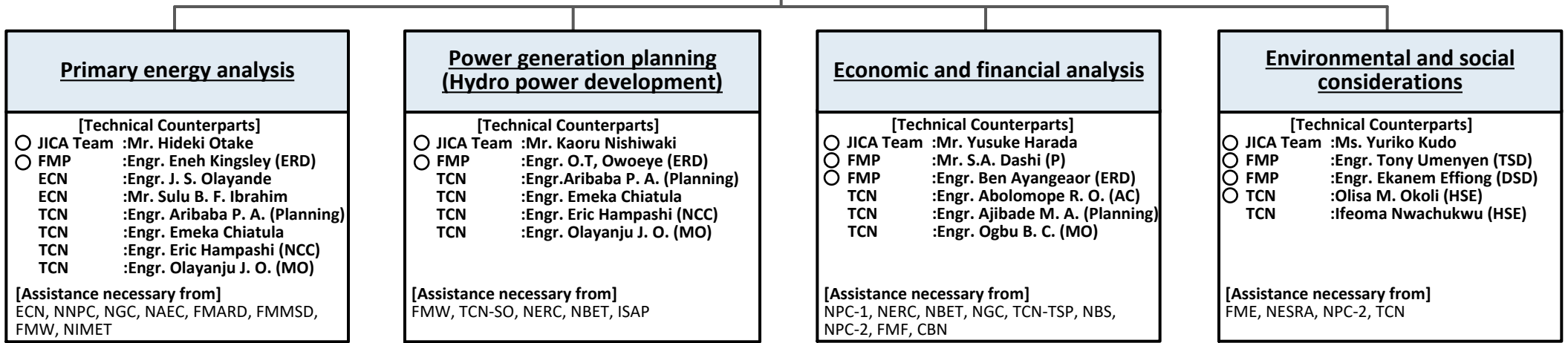
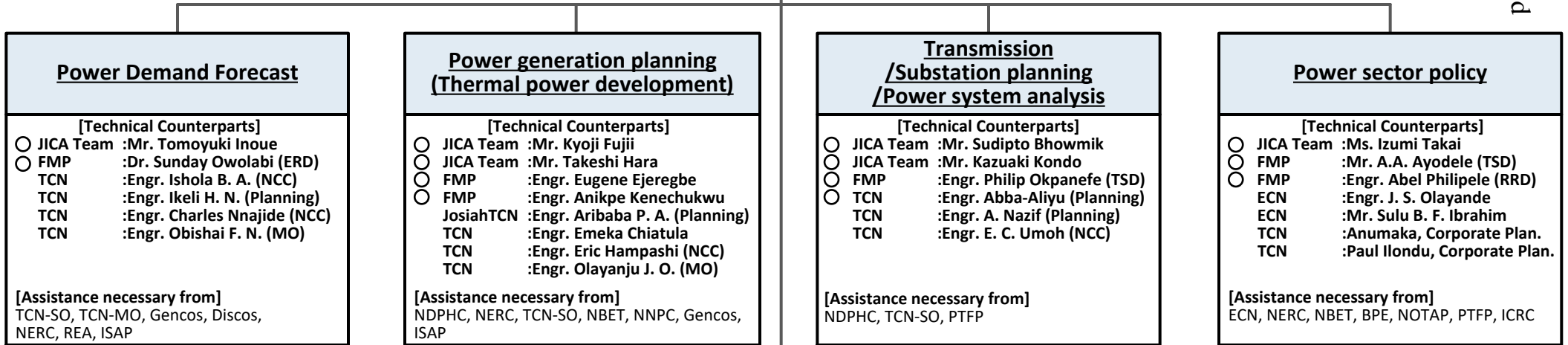
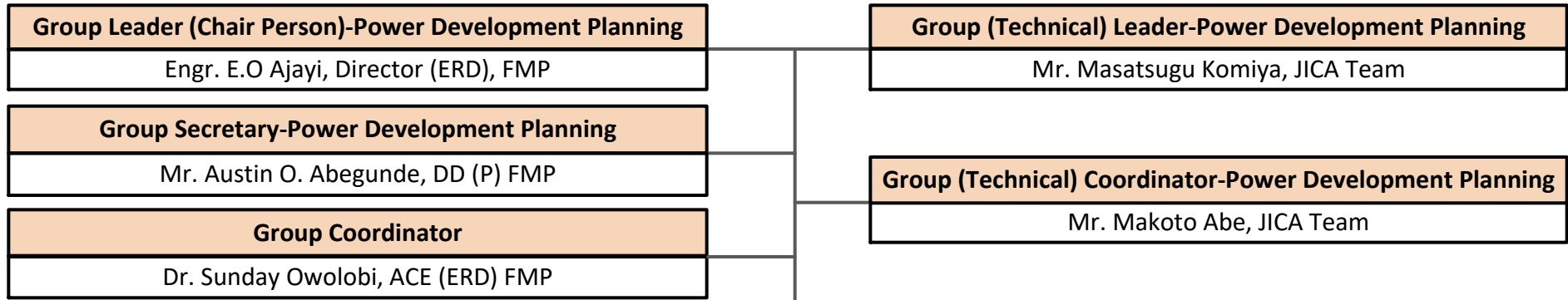


Appendix

A-1 Persons and Organizations Concerned

Details of Technical Working Group



* ○:Main Counterparts

I-1-A

CBN: Central Bank of Nigeria
Discos: Distribution Companies
DSD: Distribution Services Department (FMP)
ECN: Energy Commission of Nigeria
ERD: Energy Resources Department (FMP)
FMARD: Federal Ministry of Agriculture and Rural Development
FME: Federal Ministry of Environment
FMF: Federal Ministry of Finance
FMMSD: Federal Ministry of Mines and Steel Development
FMP: Federal Ministry of Power
FMW: Federal Ministry of Water Resources
Gnenos: Generation Companies
GP D&C: Generation Planning and Data Control (TCN)
ICRC: Infrastructure Concession Regulatory Commission
ISAP: Initial Stakeholder Advisory Panel
NAEC: Nigeria Atomic Energy Commission
NBET: Nigeria Bulk Electricity Trading
NBS: National Bureau of Statistics
NDPHC: Niger Delta Power Holding Company
NERC: National Electricity Regulatory Commission
NESRA: National Environmental standards & Regulations Enforcement Agency
NGC: Nigerian Gas Company Limited
NIMET: Nigerian Meteorological Agency
NNPC: Nigerian National Petroleum Corporation
NOTAP: National Office for Technology Acquisition and Promotion (Ministry of Science and Technology)
NPC-1: National Planning Commission
NPC-2: National Population Commission
PTFP: Presidential Task Force on Power
REA: Rural Electrification Agency
RRD: Renewable and Rural Power Access Department (FMP)
TCN: Transmission Company of Nigeria
TCN-MO: TCN-Market Operation
TCN-SO: TCN-System Operation
TCN-TSP: TCN-Transmission Service Provider
TSD: Transmission Services Department (FMP)

**A-2 PPA Price of GenCo and IPP
and Nominal Tariff of DisCo**

A-2 PPA Price of GenCo and IPP and Nominal Tariff of DisCo

PPA Price of GenCo and IPP

発電所	料金種別	単位	2012	2013	2014	2015	2016	2017	2018	2019
SUCCESSOR GenCo HYDRO										
	Capacity price	NGN/MW	4,571.33	4,739.84	4,456.76	4,677.21	4,677.59	4,677.59	4,677.59	4,677.59
	Energy price	NGN/MWh	1,005.67	1,043.28	994.40	1,069.52	1,070.49	1,070.49	1,070.49	1,070.49
SUCCESSOR GenCo THERMAL										
	Capacity price	NGN/MW	4,174.00	4,327.81	4,068.21	4,267.25	4,267.53	4,267.53	4,267.53	4,267.53
	Energy price	NGN/MWh	5,443.63	5,645.19	6,418.71	7,637.69	7,847.14	8,062.47	8,285.92	8,517.78
OMOTOSHO										
	Capacity price	NGN/MW			4,783.00	5,057.35	5,092.30	5,129.06	5,138.69	5,148.44
	Energy price	NGN/MWh			4,956.00	5,887.21	6,129.11	6,381.15	6,581.48	6,788.84
OLORUNSOGO										
	Capacity price	NGN/MW			4,783.00	5,057.35	5,092.30	5,129.06	5,138.69	5,148.44
	Energy price	NGN/MWh			4,956.00	5,887.21	6,129.11	6,381.15	6,581.48	6,788.84
NIPP THERMAL										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
AGIP OKPAI										
	Capacity price	NGN/MW	4,042.40	4,345.48	3,831.93	4,200.15	4,200.15	4,200.15	4,200.15	4,200.15
	Energy price	NGN/MWh	1,222.50	1,333.08	1,185.85	1,311.31	1,323.02	1,334.95	1,347.09	1,359.45
AFAM VI										
	Capacity price	NGN/MW	3,576.22	3,844.35	3,390.02	3,715.78	3,715.78	3,715.78	3,715.78	3,715.78
	Energy price	NGN/MWh	1,357.79	1,469.74	1,301.57	1,432.81	1,439.09	1,445.48	1,451.99	1,458.62
IBOM POWER										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
OMOKU										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
AES										
	Capacity price	NGN/MW	4,365.42	4,526.11	4,250.26	4,449.78	4,449.78	4,449.78	4,449.78	4,449.78
	Energy price	NGN/MWh								
TRANS AMADI										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,077.36	4,274.25	4,279.83	4,285.51	4,291.30	4,297.18
	Energy price	NGN/MWh	5,443.63	5,706.29	6,482.96	7,686.84	7,933.57	8,188.82	8,452.90	8,726.14
RIVERS IPP										
	Capacity price	NGN/MW	4,174.00	4,336.51	4,303.00	4,494.68	4,502.30	4,510.05	4,517.95	4,525.98
	Energy price	NGN/MWh	5,443.63	5,706.29	6,755.59	8,705.49	8,973.62	9,251.02	9,538.03	9,834.98

Nominal Tariff of DisCo

(NGN/MWh)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Abuja	5,674.62	4,728.01	4,715.69	7,845.89	8,160.99	8,709.53	9,281.45	9,872.81
2	Benin	6,217.67	5,118.44	4,973.61	8,236.07	8,380.88	8,909.50	9,469.09	10,052.47
3	Enugu	6,069.57	5,015.83	4,920.75	8,167.05	8,383.36	8,943.43	9,532.41	10,143.95
4	Ibadan	7,161.95	5,923.00	5,798.89	9,763.89	10,082.92	10,806.63	11,568.95	12,362.95
5	Jos	6,714.11	5,552.06	5,452.62	9,243.31	9,624.66	10,345.79	11,097.09	11,873.00
6	Kaduna	6,977.06	5,691.26	5,542.81	9,229.21	9,511.32	10,093.63	10,702.27	11,331.54
7	Kano	5,355.13	4,440.28	4,457.95	7,361.71	7,711.27	8,233.95	8,773.01	9,324.94
8	Eko	5,788.03	4,831.24	4,766.20	8,140.28	8,513.34	9,196.81	9,905.22	10,633.83
9	Ikeja	4,504.32	3,834.59	3,823.86	6,597.97	6,948.80	7,570.30	8,210.59	8,865.91
10	Port Harcourt	6,368.04	5,226.33	5,174.24	8,585.09	8,927.03	9,504.00	10,102.30	10,717.50
11	Yola	7,140.64	5,873.62	5,917.75	9,649.02	10,061.09	10,753.78	11,479.56	12,232.01
12	Total	6,021.51	4,993.60	4,927.92	8,264.39	8,576.42	9,189.78	9,829.42	10,490.13

**A-3 Nigeria Power System
(Existing and Planning for 2040)**

A-4 Record of JCC and TWG Workshop

4th September 2015
1ST JOINT COORDINATION COMMITTEE
(INCEPTION WORKSHOP)

TIME TABLE FOR 1ST JOINT COORDINATION COMMITTEE (INCEPTION WORKSHOP) ON THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

VENUE: MINISTER'S CONFERENCE ROOM

PLACE: 4TH FLOOR, FEDERAL MINISTRY OF POWER FEDERAL SECRETARIAT

DATE: 4TH SEPTEMBER, 2015.

[General Session]

<i>Time</i>	<i>Event/ Activity</i>	<i>Action by</i>
10:00-10:10	Opening Remarks from the Federal Ministry of Power	PS-FMP
10:10-10:20	Introduction	All
10:20-10:30	Key note address	Chief Representative- JICA Nigeria Office
10:30-10:40	Outline of the Project	Mr. Masatsugu Komiya, Mr. Makoto Abe
10:40-10:55	General discussion	All
10:55-11:00	Closing remarks	PS-FMP

[Technical Session]

<i>Time</i>	<i>Event/ Activity</i>	<i>Action by</i>
11:30-11:40	Opening Remarks from Federal Ministry of Power	Director, ERD-FMP
11:40-11:50	Introduction	All
	~Presentation by JICA Team~	
11:50-12:00	Power Demand Forecasts	JICA Team
12:00-12:10	Power Generation Planning	JICA Team
12:10-12:20	System Planning and System Analysis	JICA Team
12:20-12:30	Environmental and Social Considerations	JICA Team
12:30-12:55	General discussion	All
12:55-13:00	Closing remarks	Director, ERD-FMP

Note:

FMP- Federal Ministry of Power, PS- Permanent Secretary, ERD- Energy Resources

TCN- Transmission Company of Nigeria, MD- Managing Director, SO – System Operations,

MO – Market Operations

Record of Discussion	
Project	The Project for Master Plan Study on National Power System Development in the Federal Republic of Nigeria (The First Field Work)
Venue	4 th floor, Conference Room, Federal Ministry of Power, Federal Secretariat
Date	4 September, 2015 (Fri) 10:00-13:00
Attendance	FMP, JICA, JICA Team, TCN, WB, Refer to the Attendance List UNIDO, FME, NAPTIN, AFD, USAID,

【Contents】
<p>The 1st JCC was opened by Permanent Secretary's (PS) remarks. PS emphasized importance of power sector development and appreciation of assistance from JICA and other donors related to the power sector.</p> <p>After JICA Chief Representative presented a key note address to the invitee, presentations by the team were performed.</p> <p>Points of discussions made among the parties are followings;</p> <p>1 . Outline of the Project</p> <ul style="list-style-type: none"> - Through the presentation, the team emphasized the importance of information sharing and coordination among the stakeholders for comprehensive power system development in Nigeria. - The WB agreed collaboration with the captioned project not only the transmission master plan but also Hydro project and Gas Supply projects. - PS emphasized that the expected peak demand is approx. 12,500MW and the key authority is TCN. Furthermore PS suggested that NCC should be in better position related to acknowledge the peak demand. <p>2 . Power Demand Forecast</p> <p>(1) Regarding the relation between Power system M/P and GHG</p> <p>Q What kinds of countermeasures are considered for the reduction of GHG emission and woods and charcoal consumption in the power system master plan</p> <p>A Regarding woods and charcoal consumption reduction, the consumption has the strong relation to deforestation. Most of the developing countries have some limitation to use woods and charcoal. As substitution energies, the promotion of LPG and coal briquette can be considered. In our model, the woods and charcoal consumption should be reduced.</p> <p>(2) Regarding comparison between SimpleE model and FMP power demand model</p> <p>Q FMP has a power demand forecasting model. Is it possible to compare SimpleE model and FMP power demand model? And how much cost SimpleE software.</p> <p>A We can compare the two models completely. The cost of simple E is around 200USD per a</p>

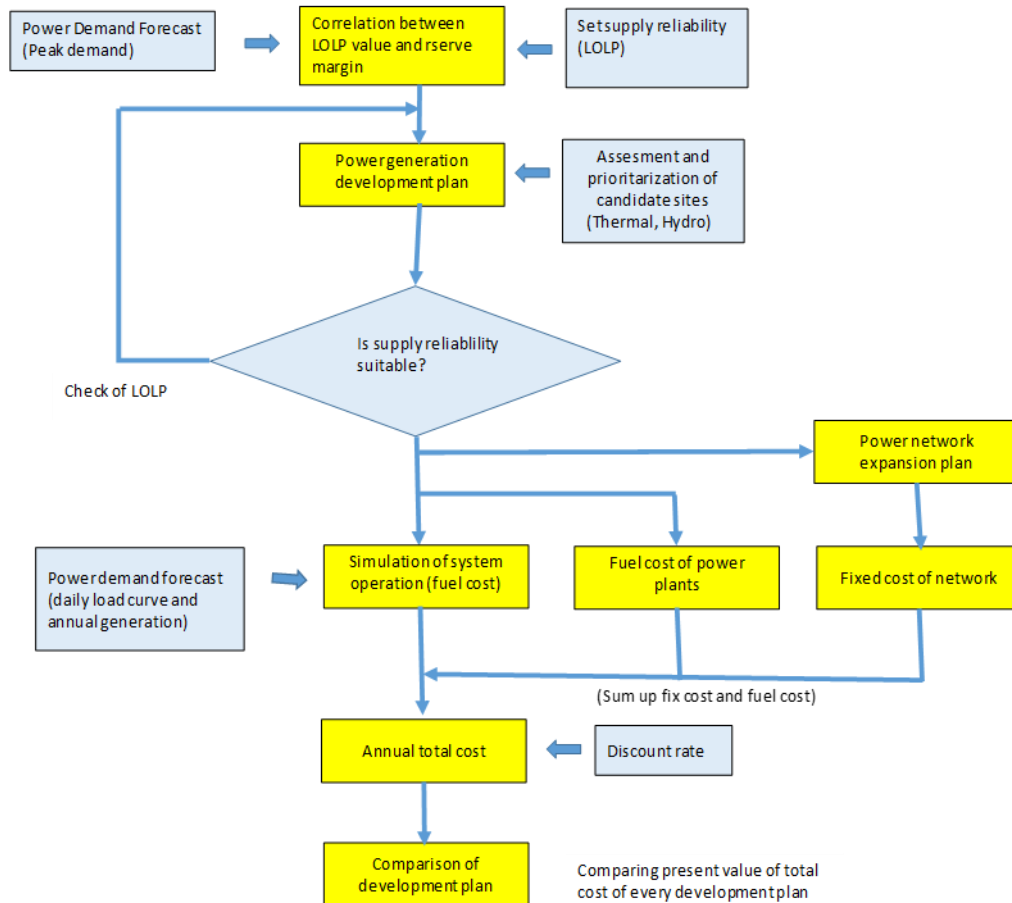
【Contents】
<p>set. The software is established by The Institute of Energy Economics, Japan.</p> <p>(3) Regarding methodology of demand forecasting</p> <p>Q As demand forecasting approach, there is Top down approach and Bottom up approach. Which one is SimpleE?</p> <p>A In Simple E model, the country wise power demand forecasts is implemented under social economic strategies, therefore, it can be said as Top down approach. Other hand, DISCO wise power demand forecasts are implemented accumulatively based on DISCO plans. Therefore, it is bottom up approach. In the case, it is important how to get the data and information from DISCOs.</p> <p>(4) Regarding input and output data</p> <p>Q Explain the input data and output data in Data sheet, Model sheet and Simulation sheet.</p> <p>A The all data in data sheet are input data, however, the back color values in simulation sheet are input data and the red color values are forecasted values. The red color values are calculated internally in the model.</p> <p>(5) Regarding technical transfer on power demand model</p> <p>Q How to implement the technical transfer?</p> <p>A According to my experiences in the similar projects, the technical transfer was implemented for four days. We were required 4 hours a day from 9:00 AM to 1:00 PM. The all members had their PCs and the seminar was in hand on style.</p> <p>3. Power System Development Master Plan</p> <p>(1) Explanation Summary (detail is referred to the presentation paper)</p> <p>1) Flow Chart of Power System Development Planning for preparation of Power System Development Master Plan is shown below, it is very important to coordinate among various fields such as power demand forecast, primary energy policy, generation and network development plan, power system analysis, economic efficiency and environmental impact of power plant candidate sites, financial condition and power development policy.</p> <p>2) The long term power system development plan is established for the coming 25 years by the least cost analysis method. The power plant candidate sites and network system are evaluated from economic and financial aspects. The evaluation results are reflected into the generation and network development plan. The generation and network development planning is carried out by using least cost method.</p> <p>3) In this chart, the generation and network development plan should be drafted in harmony with many fields, such as demand forecasts, power system analyses, and selection of power plant candidates, network system, financial condition and power development policy.</p>

【Contents】

- 4) Therefore, the generation and network development planning is conducted through close contact and discussions with the counterparts and good coordination among the related working groups.
- 5) The scenarios are determined based on the analyses and examinations of the actual power generation records and the actual demand and supply balance under the constraints and conditions.
- 6) Nigeria has to develop ten times capacity as much as existing power plants for the coming 25 years in order to meet the rapid growing demand. In other words, it is necessary to develop power plants of as much as 2,200MW every year.
- 7) Therefore, all necessary power plants cannot be invested and owned by FGN. Some of the power plants will need to be developed through other approaches such as IPP (domestic investors) and BOT (foreign investors), which options has already taken place in thermal power. Since some projects might not be developed in time, the mitigation measures of power shortage due to project delay should be considered in Master Plan. Generally, the new power plant site should be developed considering additional room of expansion of the plant in order to cope with the delay of power development and/or the higher than expected growth of power demand.
- 8) Fuel price with its hikes are set referring to the Nigerian long-term primary energy development plans and international market prices of oil, coal and gas.
- 9) The economic power system operation is simulated and fed back to the economic, social and environmental consideration study in order to clarify feasibility of each power plant development. The simulation is repeated, changing preconditions based on the results of evaluation of preconditions. Thus, the most economic scenario, best fuel mix of power sources, and long-term power development pattern are determined through Master Plan study by the following steps.
 - A) Verification of the data and information of every power plant
 - B) Establishment of the power development scenarios
 - C) Establishment of vision of power generation composition
 - D) Consideration of interconnection with neighboring countries
 - E) Evaluation of power plant candidates
 - F) Review of power development scenarios and vision of power generation composition
 - G) Putting order of priority to the candidates of power development

【Contents】

- H) Establishment of long-term power development plan for the coming 25 years based on the least cost analysis method
- I) Master Plan should be revised every 5 year taking various circumstances into consideration (This is presenter’s recommendation)



(2) Questionnaires etc. from FMP

Q Master Plan should be considered the implementation of nuclear power plants at Akwa Ibom state etc.

Master plan should be taken countermeasures of greenhouse gas emission reduction into consideration.

Nigeria has been exporting power to neighboring countries with interconnection lines.

A Greenhouse gas emission reduction is political matter. Target value such as 25% reduction compared to 2005 shall be flagged as governmental policy. We shall reflect the governmental policy in the Master Plan study.

【Contents】
<p>(3) Transmission Planning and Analysis</p> <p>In the presentation, necessity of coordination with TCN's 20 year Master Plan supported by WB is emphasized and following case studies were proposed.</p> <ol style="list-style-type: none"> i. 2020 : Near term plan ii. 2030 : Mid term plan iii. 2040 : Long term plan <p>by taking WAPP (West African Power Pool) study into consideration.</p> <p>(4) Environmental and social consideration: Summary of the presentation</p> <ol style="list-style-type: none"> 1) Explanation of the JICA's Environmental and Social Consideration Guidelines <ul style="list-style-type: none"> ● It's applied to all JICA's projects. ● In the development of the master plan, SEA is implemented. ● Stakeholder meetings are very important in the JICA's guidelines. 2) The basics of SEA and overall process <ul style="list-style-type: none"> ● Information gathering at the early stage of the project, such as baseline data and laws, regulation, and policies (including climate change strategy) in terms of environmental and social aspects. ● IEE level survey for a hydropower pre-F/S. ● Multiple scenarios are compared to search for the best alternatives. ● Relevant cumulative impacts are investigated. ● Scoping of the environmental and social impacts is carried out. ● Stakeholder meetings are held as needed. <p>Attachment: JCC Program, Attendance List</p>

The Project for Master Plan Study
on National Power Development
in
The Federal Republic of Nigeria

Outline of the Project

September 2015

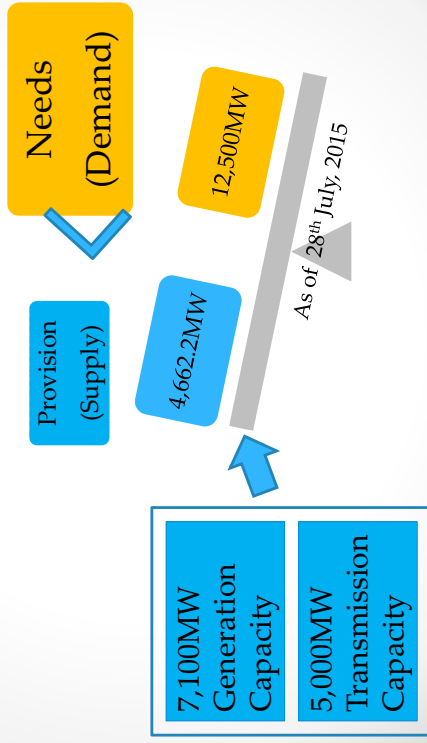
Team Leader: Masatsugu Komiya

Dep. Team Leader/Project Coordinator: Makoto Abe

• 1

1. Background of the Project

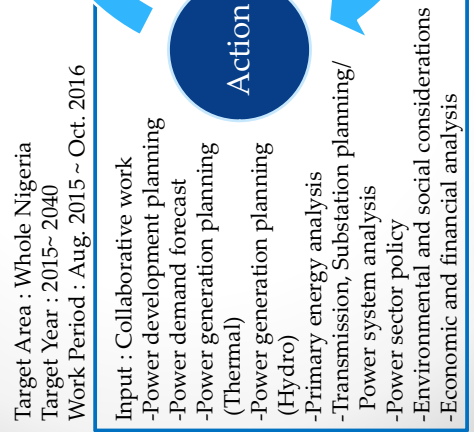
Population: 170 Million
National Electrification: 45%~50%



• 3

A-4 Record of JCC and TWG Workshop

2. Project Overview



Target Area : Whole Nigeria
Target Year : 2015~ 2040
Work Period : Aug. 2015 ~ Oct. 2016

Input : Collaborative work
-Power development planning
-Power demand forecast
-Power generation planning (Thermal)
-Power generation planning (Hydro)
-Primary energy analysis
-Transmission, Substation planning/
Power system analysis
-Power sector policy
-Environmental and social considerations
-Economic and financial analysis

• 4

Contents

1. Background of the Project
2. Project Overview
3. Basic policy in project implementation
4. Project Organization
5. Joint Coordination Committee(JCC)
6. Technical Working Group(TWG)
7. Assistance from Stakeholders
8. Details of TWG
9. Overall Schedule

• Abbreviation

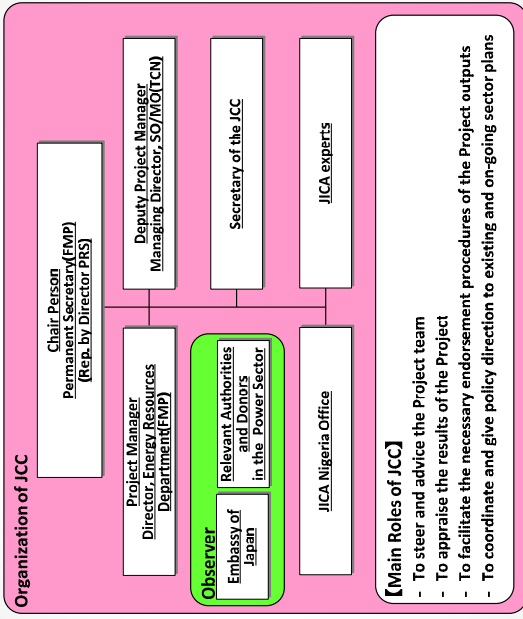
• 2

3. Basic policy in project implementation

- Policy 1: Consistency with Nigeria's development plan and energy policy
- Policy 2: Corporation and Coordination with other Relevant Authorities and donors
- Policy 3: Emphasis of Technical Transfer
- Policy 4: Coordination with Transmission System Expansion Plan

• 5

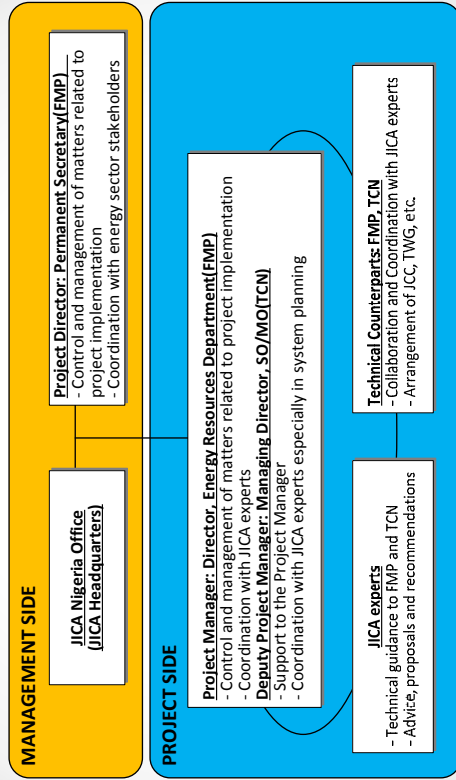
5. Joint Coordination Committee(JCC)



FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
 PRS: Planning, Research and Statistics, JCC: Joint Coordination Committee
 SO: System Operator, MO: Market Operation

• 7

4. Project Organization

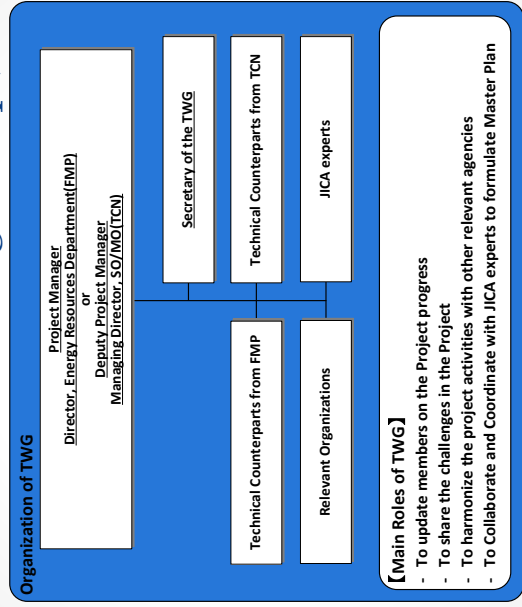


FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
 SO: System Operator, MO: Market Operation
 JCC: Joint Coordination Committee, TWG: Technical Working Group

• 6

A-4 Record of JCC and TWG Workshop

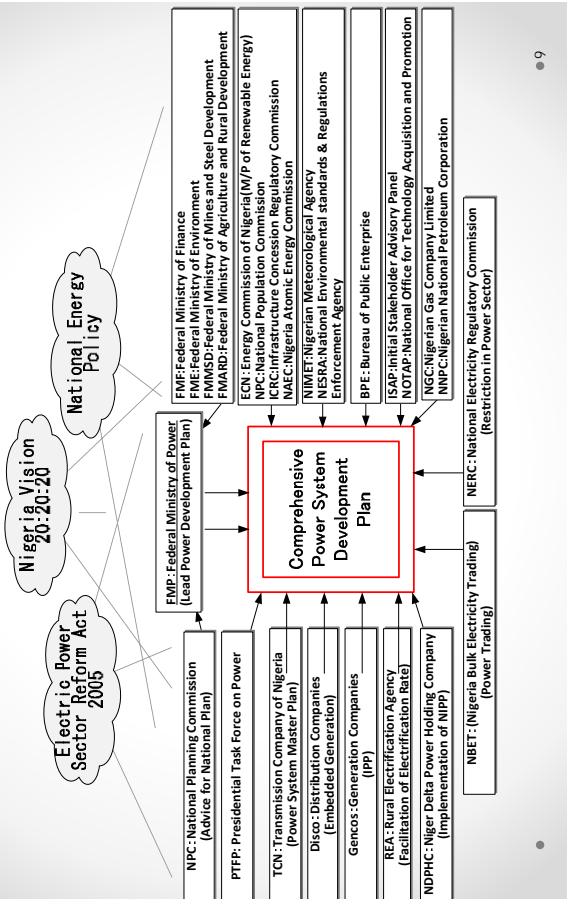
6. Technical Working Group(TWG)



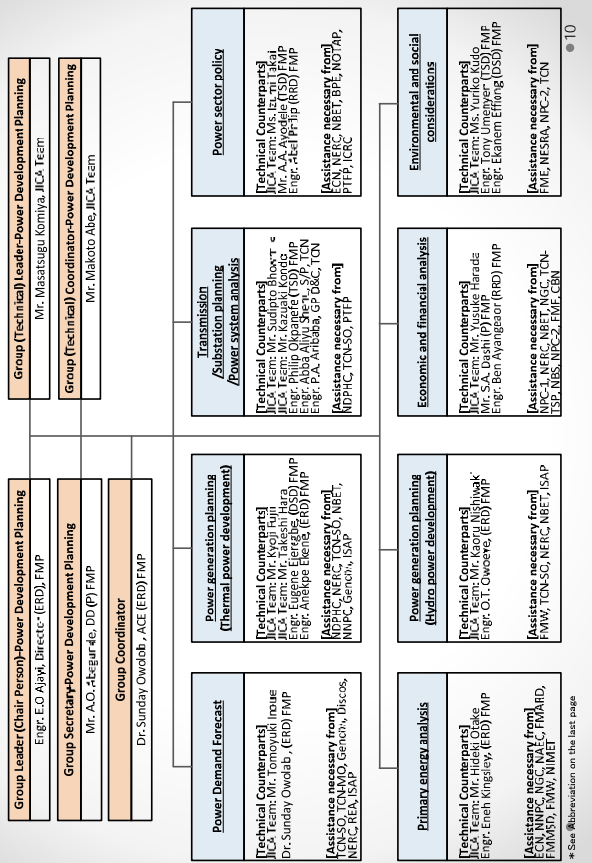
FMP: Federal Ministry of Power, TCN: Transmission Company of Nigeria
 PRS: Planning, Research and Statistics, TWG: Technical Working Group
 SO: System Operator, MO: Market Operation

• 8

7. Assistance from Stakeholders



8. Details of TWG



9. Overall Schedule

Assignment	Name	Year 2015												Year 2016															
		8	9	10	11	12	1	2	3	4	5	6	7	8	9	10													
Team Leader	Mr. Masatsugu Komiya	(10)																											
Power Development / Policy Team Leader	Mr. Masato Abe	(2)																											
Power Demand Forecast	Mr. Tomoyuki Inoue	(15)																											
Generation Expansion Planning	Mr. Takashi Hira	(2)																											
Generation Expansion Planning	Mr. Kyoji Fujii	(15)																											
Generation Expansion Planning	Mr. Kazuaki Ohike	(2)																											
Primary Energy Analysis	Mr. Sudioke Bhooyt	(2)																											
Transmission Network Expansion Planning	Mr. Sudioke Bhooyt	(2)																											
Power System Analysis	Mr. Sudioke Bhooyt	(2)																											
Power Sector Policy	Ms. Yuriko Kudo	(14)																											
Environmental and Social / Civil and Economic Analysis	Mr. Kazuaki Ohike	(14)																											
Financial and Economic Analysis	Mr. Kazuaki Ohike	(14)																											
Substation Planning	Mr. Kazuaki Ohike	(2)																											

A-4 Record of JCC and TWG Workshop

Abbreviation

- CBN:** Central Bank of Nigeria
Disco: Distribution Companies
DSD: Distribution Services Department (FMP)
ECN: Energy Commission of Nigeria
ERD: Energy Resources Department (FMP)
FMA RD: Federal Ministry of Agriculture and Rural Development
FME: Federal Ministry of Environment
FMMSD: Federal Ministry of Finance
FMP: Federal Ministry of Power
FMV: Federal Ministry of Water Resources
Gencos: Generation Companies
GP D&C: Generation Planning and Data Control (TCN)
ICRC: Infrastructure Concession Regulatory Commission
ISAP: Initial Stakeholder Advisory Panel
NAEC: Nigeria Atomic Energy Commission
NBET: Nigeria Bulk Electricity Trading
NBS: National Bureau of Statistics
NDPHC: Niger Delta Power Holding Company
NERC: National Electricity Regulatory Commission
NESRA: National Environmental Standards & Regulations Enforcement Agency
NGC: Nigerian Gas Company Limited
NIMET: Nigerian Meteorological Agency
NNPC: Nigerian National Petroleum Corporation
NOTAP: National Office for Technology Acquisition and Promotion (Ministry of Science and Technology)
NPC-1: National Planning Commission
NPC-2: National Population Commission
PTFP: Presidential Task Force on Power
REA: Rural Electrification Agency
TCN: Renewable and Rural Power Access Department (FMP)
TCN-MO: Transmission Company of Nigeria
TCN-SO: TCN-System Operation
TCN-TSP: TCN-Transmission Service Provider
TSD: Transmission Services Department (FMP)

Power Demand Forecasts

Contents

1. Overviews on Power demand forecasts (page 2)
2. Methodologies of Power demand model (page 6)
3. Joint works between C/P and Study team (page 12)

September 2015

1

(2) The required information to Power demand forecasts

The power demand forecasts are required when establishing Power system master plan. Especially, the followings are important.

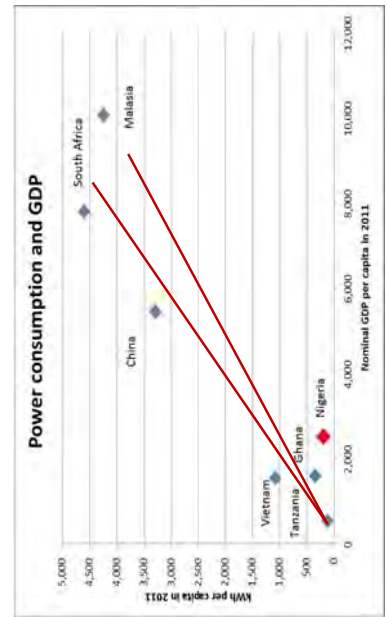
Important information	Forecasting	Comments
Power demand	2015 to 2040	The whole country, Sector and DISCO wise
Peak demand	2015 to 2040	The whole country and DISCO wise
Generation	2015 to 2040	Main producers and Auto producers (generators for Independent grid)
Transmission & Distribution loss	2015 to 2040	The whole country and DISCO wise
Fuel source consumption	2015 to 2040	Oil products, Natural gas and Coal
Primary energy supply	2015 to 2040	The above + Import oil + Hydro + Bio + Renewable
GDP per capita	2015 to 2040	Nigeria, Ghana, Tanzania, South-Africa Saudi-Arabia, Malaysia, China, Japan
Power consumption per capita	2015 to 2040	Nigeria, Ghana, Tanzania, South-Africa Saudi-Arabia, Malaysia, China, Japan

3

1. Overviews

(1) Current Nigeria Power Consumption

- Nigerian power consumption per capita is 200 kWh in 2011, it is lower than other countries.
- As other countries, there are Ghana 344 kWh, Vietnam 1,080 kWh in 2011.



2

A-4 Record of JCC and TWG Workshop

(3) Consistency to the other Strategies and Plans

For keeping the consistency among the related strategies and plans in Nigeria, The followings are studied by the JICA team and C/P.

Strategy and plan fields	Study items
National Strategies	Nigeria Vision 20: 2020
Economic development strategy	Nigeria Economic Review and Outlook (2015-2017)
Power sector plan	(1) Electrification plan: 56% → ?? (2) Loss reduction plan: 9% ? (3) Shedding reduction plan: 20% → ?? (4) Auto generation estimation: 27% → ?? (5) Grid connection plan : Independent grid to TCN
Energy plan	National Energy Master plan 2014 By Ministry of Science and Technology
Renewable energy plan	National Renewable Energy and Energy Efficiency Policy (NREEEP) by Ministry of Science and Technology
Environment plan	Woods and charcoal consumption estimation

4

(4) Review of the Existing Power Demand Forecast

Existing Power Demand	Items	Study items
National Load	Published	TCN April 2009
Demand Study	Forecasted	2010 to 2033
	Power demand	Potential demand by national & region
	Methodology	Social & economic scenario approach
Analysis Of Nigeria's National Electricity Demand Forecast	Published Forecasted Power demand Methodology	Mr. Ezennaya, others 2013 to 2030 Residential, Industry and Commercial Time Series Analysis
African Energy Outlook	Published Forecasted Power demand Methodology	International Energy Agency Forecast 2014 to 2040 TCN + Auto generation consumption Unknown

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2. Methodologies

(1) Technologies for demand forecasting models

- Model methodologies used in World wide
 - Time-series forecasting model
 - Elasticity approach model
 - Econometric model
 - Social economic scenario model
- Model building engine of the Study team
 - Simple .E : developed by The Institute of Energy Economics, Japan
 - Used OS/Soft : Windows XP, Vista, 7 and 8, MS-EXCEL add in Soft
- Experiences of the model building by Simple. E

Year	Country	Project title
2015	Pakistan	Power system Master Plan
2015	Bangladesh	Power system Master Plan
2014	Tanzania	Power system Master plan
2012	Oman	EE&C Master plan project
2011	Kazakhstan	EE&C project finding survey project
2011	Serbia	EE&C Master plan project
2010	Syria	Power system Master plan
2010	Vietnam	Power system Master plan
2008	Saudi Arabia	EE&C Master plan project
2007	Vietnam	Energy Master pan

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(2) Model flows of the Study team

Economic block

- Social economic indices
 - Population
 - GDP
 - Prices and foreign exchange
- Production activities
 - Agriculture & forestry GDP
 - Industrial GDP
 - Commercial & Service GDP
- Energy prices
 - Crude oil price
 - Electricity tariffs
 - Petroleum product prices
- Precondition values
 - T/D loss
 - Own use
 - Load factor
 - Electrification rate
- Power supply plan
 - Import
 - Renewable/ Hydro power

Energy demand block

- Power demand by sector
 - Residential
 - Commercial
 - T/D loss
 - Others
- Power net demand
 - Net electric energy demand
 - Net peak demand
 - Renewable energy
- Energy source in Power sector
 - Coal
 - Gas
 - Others
- Power consumption per capita
 - Nigeria
 - Ghana
 - Malaysia
 - South Africa
 - Tanzania
 - Others
- Primary energy demand by energy
 - Coal
 - LPG
 - Jet fuel
 - Diesel
 - Power
 - Natural gas
 - Gasoline
 - Kerosene
 - Fuel oil
 - Renewable energy

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A - 4 Record of JCC and TWG Workshop

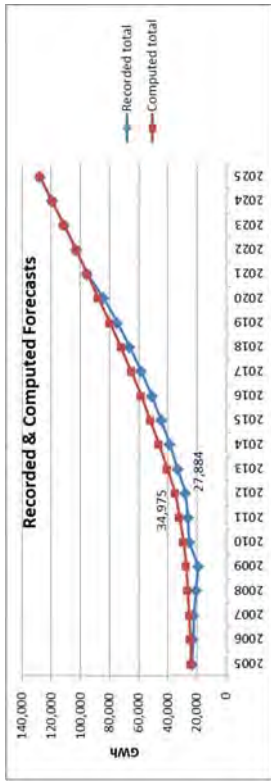
(3) Building procedures of power demand forecasting model

Data sheet:	Model sheet:	Simulation sheet:
Population growth	Elasticity calculation	Actual term
Economic Growth	$\ln(Y) = a * \ln(\text{GDP}) - b * \ln(\text{Tariff}) + c$	2000-2013
Power tariff	Forecasting equation	Forecasting term
Residential power dem	$Y_t = Y_{t-1} * (1 + a * \text{GDP}) * (1 + b * \text{tariff}) * (1 + \text{EE\&C})$	2014-2040
Industry power dem		
LNG power dem		
Commercial power dem		
Public power dem		
T/D loss		

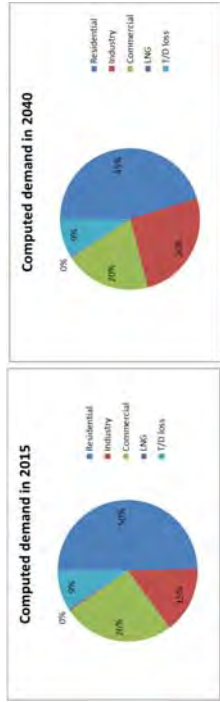
Net power demand		
Generation		
Peak demand		
Growth sht	Compare sht	DISCO sht
		Primary sht

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(4) Recorded & Computed power demand Forecasting

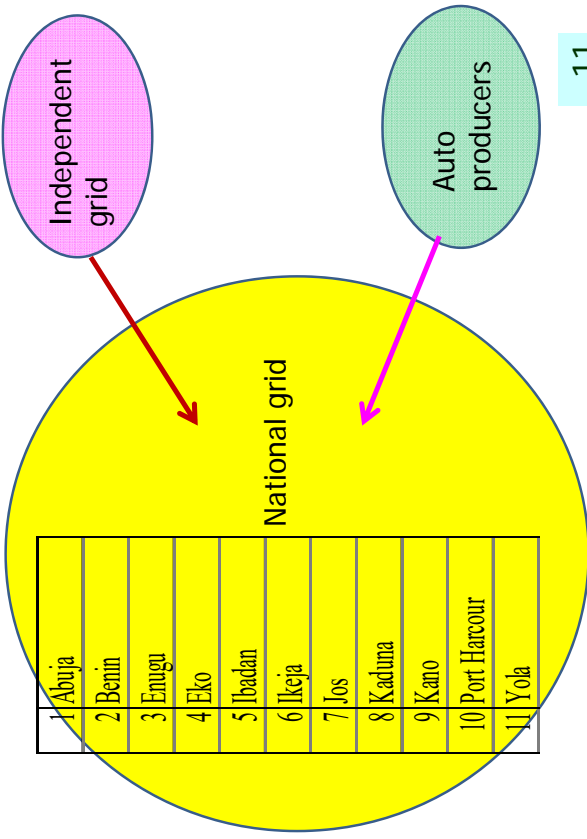


Source : Actual values are estimated by the Study team and , future values are tentative forecasted by the Study team



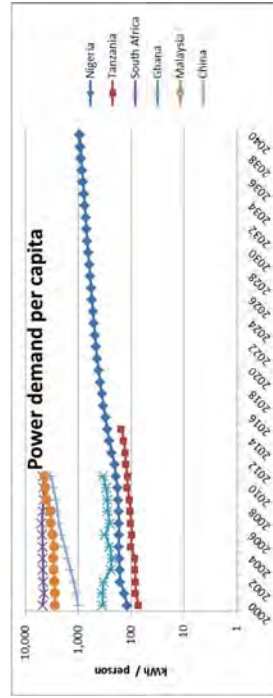
9

(6) Power demand by DISCO



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(5) Power comparison between Nigeria and Selected countries



	2000	2005	2010	2015	2020	2025	2030	2035	2040
Nigeria	120	173	183	283	418	533	654	791	949
Tanzania	73	102	119	153	0	0	0	0	0
South Africa	4,681	4,660	4,571	0	0	0	0	0	0
Ghana	346	259	299	0	0	0	0	0	0
Malaysia	2,720	2,857	4,136	0	0	0	0	0	0
China	993	1,784	2,944	0	0	0	0	0	0

Source : World Bank Database , future values of Nigeria are tentative forecasted by the Study team

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A - 4 Record of JCC and TWG Workshop

3. Joint works

(1) Collection of power demand data & strategies

Type	Data and information as sample	Periods
Power data	Power consumption and Power tariff	2000-2014
	Power generation , Own use and T/D loss	2000-2014
	Load factor, Peak load and Reserve margin	2010-2014
Off grid	Off grid by region	2000-2014
DISCO data	Power consumption and number of customers by DISCO	2000-2014
	Peak demand & Load factor by DISCO	2000-2014
Future plan	Industry development Plans	
	Off grid to main grid and Renewable energy plans	

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(2) Discussing the results of power demand forecasts

Type	Data and Information as sample
Power demand	Computed & Recorded power demand forecasts
	Sector wise contribution of power demand
	Future load factor, Peak load
Energy demand	Sector and energy wise contribution of the demand
	Future energy supply availability
Future images	Comparison of power consumption per GDP
	Comparison of power consumption per capita

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Thank you

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(3) Schedule on the Power Demand

M / Y	Contents
Sep 2015	(1) Collection of power demand data & strategies (2) Discussing the methodology (3) Discussing the strategies on Power demand
Jan 2016	(1) Building the demand model (2) Discussing the preconditions of the forecasts (3) Discussing the results of the forecasts (4) Explaining the results to stakeholders
May 2016	(1) Collection of fuel energy demand data & strategies (2) Discussing the methodology (3) Building the fuel energy demand model (4) Discussing the preconditions on the fuel energy forecasts (5) Discussing the fuel energy demand forecasts (6) Explaining the results to stakeholders

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A - 4 Record of JCC and TWG Workshop

Appendix 1 : Power demand forecast items (tentative)

		2015	2020	2025	2030	2035	2040
Computed demand	Net demand(Energy)	51,989	88,467	136,018	203,988	289,292	392,776
	Net peak demand(Power)	8,638	15,537	23,888	35,825	50,807	68,981
	Shedding at peak demand	1,037	0	0	0	0	0
	TCN peak demand	6,046	10,876	18,343	29,390	43,745	61,562
	Auto producer's peak demand	2,591	4,661	5,545	6,435	7,061	7,419
Recorded demand	Recorded peak demand	7,601	15,537	23,888	35,825	50,807	68,981
	TCN peak demand	5,010	10,876	18,343	29,390	43,745	61,562
	Auto producer's peak demand	2,591	4,661	5,545	6,435	7,061	7,419

		2015	2020	2025	2030	2035	2040
Capacity	Peak *1.2	10	19	29	43	61	83
	GW						

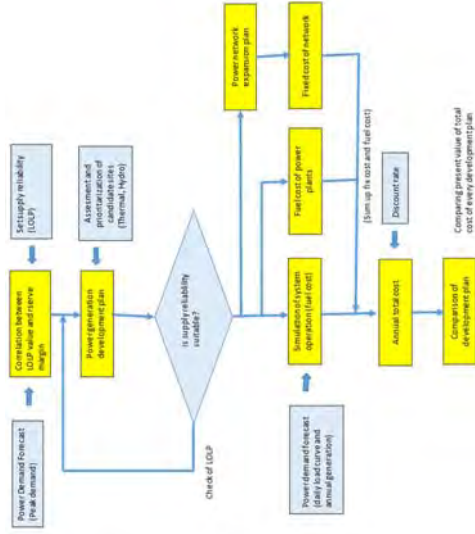
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Appendix 2 : Indicators of Power demand (tentative)

		2015	2020	2025	2030	2035	2040
Social economic data	Population	183,523	210,158	239,874	273,120	310,125	350,720
	GDP (2005 price US\$)	218	306	429	602	844	1,184
	Nominal GDP (US\$)	628	1,027	1,697	2,751	4,431	7,135
	Electric energy Demand	51,989	88,467	136,018	203,988	289,292	392,776
	Power demand	8,638	15,537	23,888	35,825	50,807	68,981
	GDP (2005 price US\$) / capita	1,188	1,456	1,789	2,203	2,721	3,375
Indicator	Nominal GDP (US\$) / capita	3,421	4,887	7,076	10,073	14,286	20,345
	Power demand / rGDP at 2005	0.238	0.289	0.317	0.339	0.343	0.332
	Power demand / Nominal GDP	0.083	0.086	0.08	0.074	0.065	0.055
	Power demand / capita	283	421	567	747	933	1,120
	Power demand / Household	0.264	0.414	0.558	0.735	0.917	1.101

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Master Plan Flow Chart



1) Verification of the data and information of every power plant

- Actual records of power generation and system operation,
- List of planned power plants including IPP and BOT,
- Plans of power exchange with neighboring countries,
- Plans for abolition and replacement of power plants and so on.

Power Generation Development Plan

K.NISHIWAKI

2) Establishment of the power development scenarios

- Demand forecast scenarios (High, Base, Low)
- Limitation of capacity of transmission lines
- Delay of development
- Water flow fluctuation of hydropower stations
- Conformity with energy resources development and supply plan
- Power exchange with neighboring countries through interconnections
- Fuel price hike
- Constraint and condition of IPP and BOT plant operation

4) Consideration of interconnection with neighboring countries

- Interconnection with neighboring countries will be planned for implementation taking the study on interconnection plan among WAPP countries into account.

3) Establishment of vision of power generation composition

- The most economic composition is sought by changing the development ratios of various types of fuel (coal-fired thermal, combined cycle thermal and hydropower etc.) with which new development is deemed feasible, and comparing the total annual costs, consisting of fixed costs and variable (fuel) costs, in the various development ratios of each power source.
- The power generation composition with the least cost operation is determined by finding out the most economic combination of power sources among the various power development scenarios also based on the results of risk study of each scenario.

5) Evaluation of power plant candidates

- Selection of sites
The information for economic evaluation is collected and put in order, such as location, available capacity of units (kW), types of fuel, development period, construction cost, fuel cost and so on.
- Economic evaluation
Comprehensive economic evaluation is carried out by comparing cost of power generation of each development site.

6) Review of power development scenarios and vision of power generation composition

- The power development scenarios and vision of power generation composition are reviewed.

8) Establishment of long-term power development plan for the coming 25 years

- The least cost power development plan for the coming 25 years is determined to achieve the appropriate power source composition or best fuel mix in the year of 2040.

7) Putting order of priority to the candidates of power development

- The candidates are prioritized considering the economic efficiency, diversification and security of primary energies, conditions of existing power plants and interconnection with neighboring countries.

9) Master Plan should be revised every 5 year taking various circumstances into consideration

- Achievement ratio of power development shall be delayed.
- Circumstances alter cases such as fuel price, new development procedures and change of economic fabric etc.
- Budget and business situation

Schedule of Transmission planning

1. Project Mobilization and Data collection
2. Establishment of Base Case Data Sets from TCN and Osogbo
3. Data cleanup and verification for clean base case
4. Coordination with TCN transmission master plan from World Bank
5. Coordination with Generation, Load forecast and Substation group

Thank you, see you again.

A – 4 Record of JCC and TWG Workshop

Schedule of Transmission planning

1. Inputs from NERC and NBET regarding project completion probability
2. Preliminary presentation of Data collection
3. Creation of 3 future case studies
 - i. 2020 : Near term plan
 - ii. 2030 : Mid term plan
 - iii. 2040 : Long term plan
4. Inclusion of WAPP plans



Objective

- Development of the Transmission System for 25 years timeline in order to support the “Master plan study” being developed by JICA
- The primary focus is Generation adequacy
- Coordinate with the plan operation based TCN’s 20 year master plan (World Bank).
- All analysis will be carried out using PSS@E
- Any additional developmental need for transmission upgrades will take into consideration feasibility and reliability

Data Request

- Power Flow data for present and future year in PSS/E format
- Detailed generator data
- Detailed data regarding voltage control devices and schedule
- Definition and limits of the power transmission interfaces.
- Contingencies: definition and their corresponding limits
- Reports on historically observed Transmission and Voltage problems and their associated data

Relevant Organizations

1. **TCN:** Bulk of simulation data including Transmission upgrade queues , their probability and priority
2. **NERC:** Relevant Generation upgrades
3. **NBET :**Relevant Generation upgrades
4. **World Bank:** Data verification and coordination
5. **NDPHC:** Transmission upgrades

Data Request 2

- Recent/Planned transmission or generation upgrades
- Restrictions on sites for installation or transmission upgrades
- System load forecasts
- System diagrams (existing)
- Information on transmission upgrades probability
- Current Grid codes and operating procedures, for both national and regional systems.

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT

Environmental and Social
Considerations (ESC)

Sept. 4, 2015 Yuriko Kudo

1

JICA ENVIRONMENTAL AND SOCIAL GUIDELINES

Basic Principles in the Guidelines

1. A wide range of impacts must be addressed.
2. Measures for environmental and social considerations must be implemented from an early stage to a monitoring stage.
3. JICA is responsible for accountability when implementing cooperation projects.
4. JICA asks stakeholders for their participation.
5. JICA discloses information.
6. JICA enhances organizational capacity.
7. JICA makes serious attempts at promptness.



The Master Plan applies:

- SEA (Strategic Environmental Assessment)
- IEE (Initial Environmental Examination) for pre-F/S (Hydropower)
- Stakeholder meetings

OUTLINE

1. Principles of JICA's Environmental and Social Guidelines
2. What is Strategic Environmental Assessment (SEA) ?
3. How to integrate Environmental and Social Consideration (ESC) into the Plan
4. Schedule of the study: SEA and IEE
5. Strategy for ESC
6. JICA's Checklist for ESC

2

WHAT IS STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)?

Analytical and participatory approach that aims to integrate environmental considerations into policies, plans, and programs, and evaluate the inter linkages with economic and social considerations.”

OECD/DAC: "Applying Strategic Environmental Assessment: good practice guidance for development cooperation" (2006)

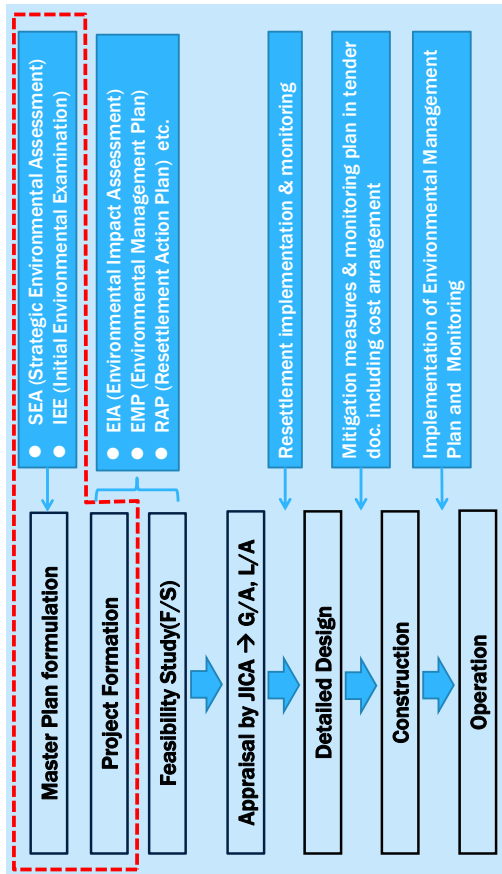
A good quality SEA process ...

- Informs planners, decision makers and affected public on the sustainability of strategic decisions
- Facilitates the search for the best alternative
- Ensures democratic decision making process
- Enhances the credibility of decisions
- Leads to more cost- and time-effective EIA at the project level

IAIA, SEA Performance Criteria (2002)

4

HOW TO INTEGRATE ESC INTO THE PROJECTS (JICA REQUIREMENTS)



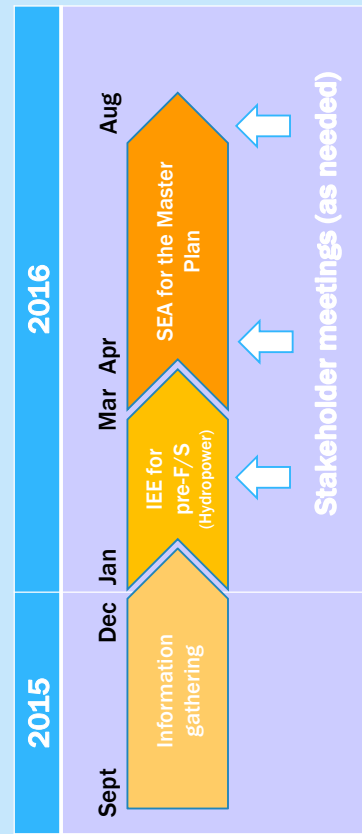
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STRATEGY FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

- Confirm contents and means of conducting SEA with C/P
- IEE level investigation for pre-F/S (Hydropower)
- Overall process for SEA:
 1. Investigate multiple scenarios to be compared
 2. Investigate relevant cumulative impacts
 3. Scoping of environmental and social impacts
 4. Stakeholder meetings (as needed)

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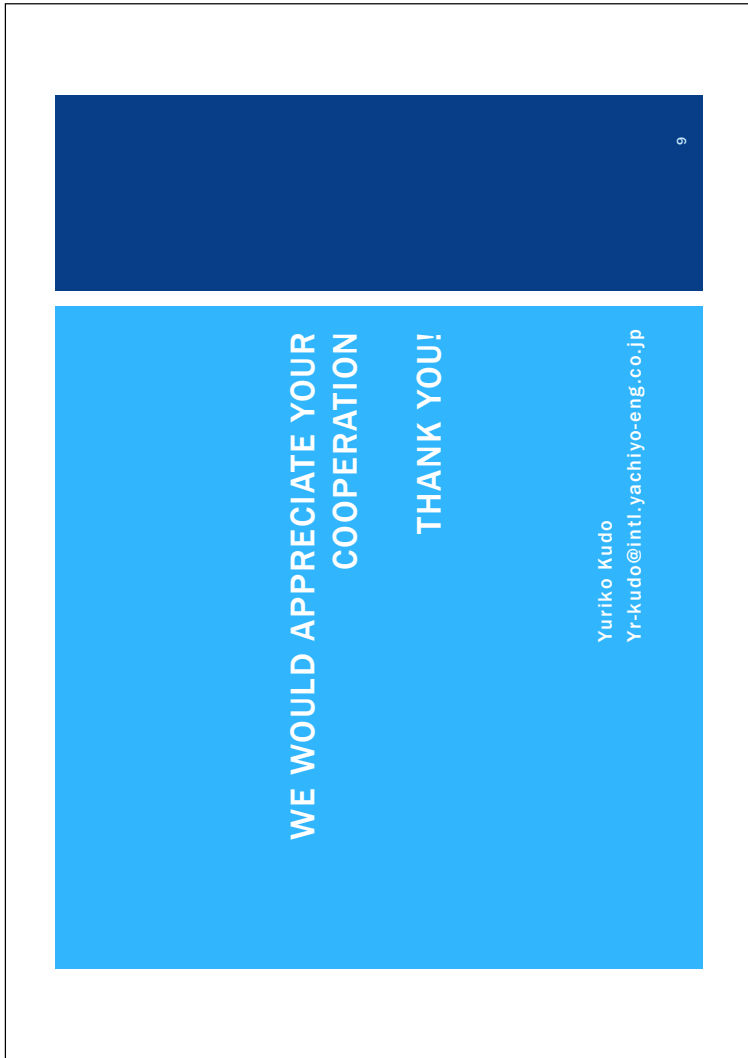
SCHEDULE OF THE STUDY: SEA AND IEE



JICA'S CHECKLIST FOR ESC THERMAL POWER STATION, HYDROPOWER, TRANSMISSION LINES

Category	Major Environmental Items (Impacts)
Permits and Explanation	(1) EIA & Environmental Permits (2) Explanation to local stakeholders (3) Examination of Alternatives
Pollution Control	(1) Air Quality (2) Water Quality (3) Waste (4) Soil contamination (5) Noise & Vibration (6) Subsidence (7) Odor
Natural Environment	(1) Protected Areas (2) Ecosystem (3) Hydrology (4) Topography and Geology
Social Environment	(1) Resettlement (2) Living & Livelihood (3) Heritage (4) Landscape (5) Ethnic Minorities and Indigenous Peoples (6) Working Conditions
Others	(1) Impacts during Construction (2) Monitoring (2) Impacts on Global Environmental Issues (e.g. global warming)

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4th February 2016
1ST TECHNICAL WORKING GROUP
(PROGRESS WORKSHOP)

TIME TABLE FOR 1ST TECHNICAL WORKING GROUP (PROGRESS WORKSHOP) ON THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

VENUE: BOARD ROOM (ROOM 510), 5TH FLOOR, CORPORATE HEADQUARTERS, TRANSMISSION COMPANY OF NIGERIA

PLACE: PLOT 441, ZAMBEZI CRESCENT, MAITAMA, ABUJA

DATE: 4th FEBRUARY, 2016.

<i>Time</i>	<i>Event/ Activity</i>	<i>Action by</i>
10:00-10:10	Opening Remarks from the Federal Ministry of Power	Permanent Secretary, Federal Ministry of Power, Works and Housing
10:10-10:20	Introduction	All
10:20-10:30	Key note address	Director, Energy Resources and Development
10:30-10:45	Technical Working Group (TWG) Progress Workshop	Mr. Makoto Abe
10:45-11:00	TWG Workshop on Power Demand Forecasts	Mr. Tomoyuki Inoue
11:00-11:15	Generation Expansion Plan	Mr. Kyoji Fujii
11:15-11:30	Environmental and Social Considerations (ESC)	Ms. Yuriko Kudo
11:30-12:00	Opinion exchange regarding TWG General discussion	TWG members All
12:00-12:10	Closing remarks	Permanent Secretary, Federal Ministry of Power, Works and Housing

Note:

FMP- Federal Ministry of Power, PS- Permanent Secretary, ERD- Energy Resources and Development

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb 4/16. Location: TCN. Board Room - 5th Floor.
 Purpose: Briefing by JICA on 25 yr. West Cost Power Gen. Plan (JICA Power System Master Plan Project (TECHNICAL working group workshop))

No.	Name	Title	Organization
1	Engr. EA. Anumaka	GM/CCP/TSP	TCN
2	Dashu, S.A.	ACAO	FMP
3	Adegboye F.O	PCS	FMP
4	Abegunde A.O	Deputy Director (R&S)	FMP
5	Ayodele, A. A.	Asst Director (Pres)	FMP
6	Ladi M. Orolan	CAO	FMP
7	Miobong Abiaka-Awele	Asst. Director Director	Deputy Director Federal Ministry of Power
8	Anaechi C. Alope	DD (Power)	BPE
9	KYRAN O'SULLIVAN	LEAD ENERGY SPEC	WORLD BANK
10	Nuhu K. Sada	D-PRS	EMRWHT (POWER)
11	DIPAK SARMA	MD SO/MO	TCN
12	HAKE KEST	MD/CEO	TCN
13	MIDEKI OJIKE	TWG PE Analysis, JICA	JICA
14	ANIKPE K. J.	ACEE (EAD) FMP	FMP WTH (POWER)

Attendance List

Date: _____ Location: _____

Purpose: _____

No.	Name	Title	Organization
1	Mrs Foluke Omi	DD (Climate Change)	Min. of Power
2	Maurice Smith	Transmission Advisor	NIAF
3	Dr. Tochi Nwachukwu	Special Assistant to President on Power	Office of Vice President
4	Brokers Jayan	Advisor Power & Market	NIAF
5	Engr. Yusuf Abubakari	Mgr Networks, ES&S	NERC
6	Engr. FARUK YUSUF	AD (BR&D) FMP	FMP
7	Dr Yusuf A.O	PM (REG & D)	NERC
8	Osmond Agidani	Consultant	JICA
9	Adeesji ADEOLA	Sub Prog. Manager	AFD
10	Masaaki Shibano	Project Foundation Advisor	JICA Nigeria
11	Simeon Atakuta	Senior Power Adviser	NIAF
12	Abant O Mould-Shalom	DO (TCN)	BPE
13	ILIYA H VONGJEN	ACEE (TCN LABOUR)	BPE
14	Engr David BEEKER	BEI (JED)	FMP

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb. 4, 2016 Location: TCN Board Room 5th Floor
 Purpose: JICA Power system Master plan project (Technical Working Group Workshop)

No.	Name	Title	Organization
1	Dr. Owolabi Sunday	Asst. Chief Power Engineer	Min. of Power
2	Engr. O.T. Owoeye	Asst. Director	Min. of Power
3	Engr. S.B. AYANFOLAR	Prin. Elect. Engr.	POWER
4	Engr. Abel, Philip	Electrical Engineer	Power
5	Dr. Ogbonnya Montell	Mechanical Engineer	Power
6	Engr. Kabiru M. Adamu	Prin. Ngr. (Tech.)	TCN-MO
7	Dr. Mikanida Z.Y.	CSO	FCN
8	Lucien Agborongojin	IT	FCN
9	Ogunfeyemi Gbadiso	PTO (DSD)	FMO P
10	BASSEY, IIMINIGES	SO U	Min. of Environment
11	CIRIOMAS JOSEPH	GM, TCN-PMU	TCN-PMU
12	KYRAN O'SULLIVAN	TEAM LEADER	WORLD BANK
13	LEKE PETER O'S	ALM(P) PMU	TCN-PMU
14	ABUTU E	PM (Planning)	TCN

The Project for Master Plan Study on National Power System Development in Nigeria
Attendance List

Date: _____ Location: _____

Purpose: _____

No.	Name	Title	Organization
1	Jfiong A. Nwachukwu	Mrs. Mord (ESS)	TCN
2	J.I. Akande	AGM (CR&E)	TCN
3	Odit chibokwu	STO	FMP
4	CHIKWENEM OKWUDIRI	S/O	FMP
5	Eugene Ejerogbe	ACE	FMP
6	Sayo P.A. Arisaba	Acum (Planning)	TCN
7	Christals Chukwura	AM (Gen Plan)	TCN
8	Uyokwu S.E.	AGM (I)	TCN
9	Engr. Ajibade M.A	PM (Planning)	TCN
10	Emeka Ifenkwe	Offr I (PSPD)	TCN
11	Adiji Ibrahim	Offr II (PSPD)	TCN
12	E.M. Okoduwa	PEU	Ministry of Budget and National Planning
13	Adedun O.A	SPO	Ministry of Budget and National Planning
14	Yusiko Kudo	JICA Study Team	YEC

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: Feb 4, 2016 Location: TCN Board Room 5.F
 Purpose: TICA Power System Master Plan Project (Technical Working Group Workshop)

No.	Name	Title	Organization
1	FRED EDIKA	ASS. DIRECTOR	FED. MIN. OF ENVIRONMENT
2	Imobing Abiola-Akofin	Asst Dir	Fed Min of Env.
3	Shehu Abba-Aliyu	Agam (PSP)	TEN/ISO
4	F. CLARK	SPM	PfPR
5	IGBA MATHIAS	HTD.	Fed. Min. of Power.
6	SIBYLLE HAASE	HEAD OF RENEWABLE ENERGY	GIZ (NESP)
7	ADEBITI KUNLE	DIRECTOR (PROC.)	FED. MIN. OF POWER
8	J.O. ENWIERHOMA	DEP. DIR. (POWER)	F.M.O.P
9	Ladi-m. Gboko	CRD	Fmp
10	ANIKPE K.J.	ACEE (ERD)	F.M.O.P W & H
11	Yusuke Hayada	Analyst	JICA Study
12	ADAMU A. SANI	SM (T)	TEN - PMU
13	MURAD OSITEMI	GM	PowerTech
14	Sudipto Bhattacharya	Sr. Consultant	YEC/NEXANT

The Project for Master Plan Study on National Power System Development in Nigeria

Attendance List

Date: 04/02/2016 Location:

Purpose:

No.	Name	Title	Organization
1	Kyoji Fujii	JICA Expert (Generation)	Yachiyo Engineering
2	KAORU NISHIWAKI	Hydro Expert	YEC
3	Makoto Abe		
4			
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THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

TECHNICAL WORKING GROUP (TWG) PROGRESS WORKSHOP

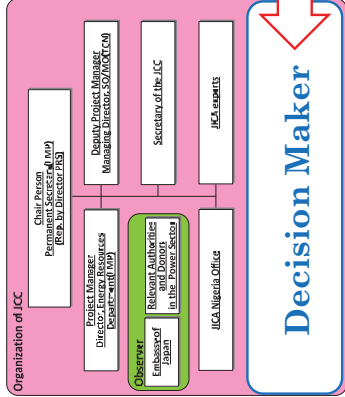
4th February 2016
JICA Study team

CONTENTS

1. JCC and TWG
2. Objectives of TWG
3. Structure of TWG
4. Relative and Flow
5. Tasks of TWG (General)
6. Tasks in TWG (Group)-1
7. Tasks in TWG (Group)-2
8. Tentative Schedule
9. Actual and Assumption
10. Issues to be measured by TWG

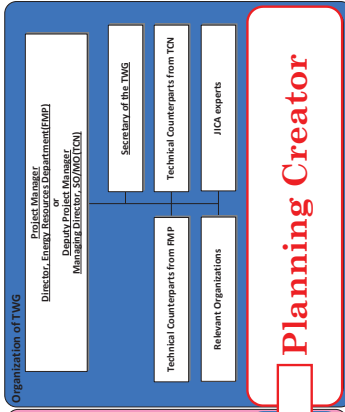
1. ROLES OF JCC AND TWG

Joint Coordination Committee



Decision Maker

Technical Working Group



Planning Creator

JICA: Federal Ministry of Power, IAN: Transmission Company of Nigeria, PRS: Planning, Research and Statistics, JCC: Joint Coordination Committee, SO: System Operator, MCO: Market Operator.

2. OBJECTIVES OF TWG AND JCC

P ⇒ Formulation of National Power Development Plan (JICA+TWG)

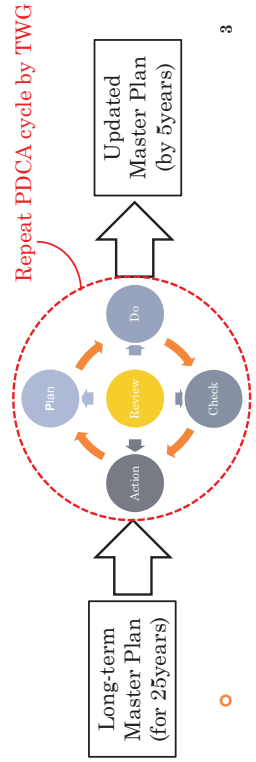
D ⇒ Implementation

C ⇒ Raising Challenges, Difficulties in Groups (TWG)

A ⇒ Countermeasures (TWG)

Decision made (JCC)

P ⇒ Update Master Plan by TWG (TWG)



5. TASKS OF TWG (GENERAL)

Task	JICA Team	Nigerian Counterparts
<ul style="list-style-type: none"> General 		
<ul style="list-style-type: none"> Arrangement with related organizations Data collection 	Combined	Responsibility Collecting
<ul style="list-style-type: none"> Data analysis 	Analysis	Confirmation
<ul style="list-style-type: none"> Basic data for Master Plan 	Data-base	Confirmation
<ul style="list-style-type: none"> Simulation 	Methodology	Technical transfer
<ul style="list-style-type: none"> Formulation of Master Plan 	Formulation	Collaboration
<ul style="list-style-type: none"> Manual for update Master Plan 	To be made	Utilization
<ul style="list-style-type: none"> Review and Update Master Plan 		Continued

6

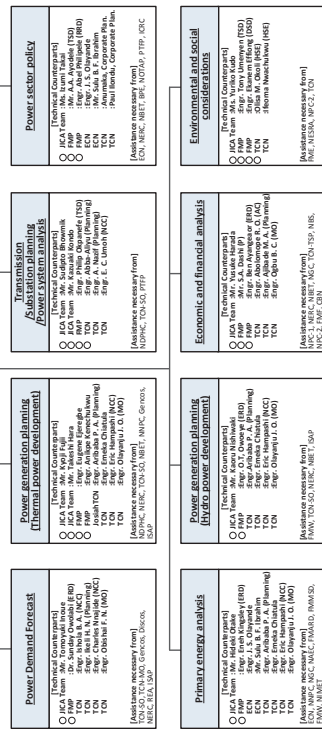
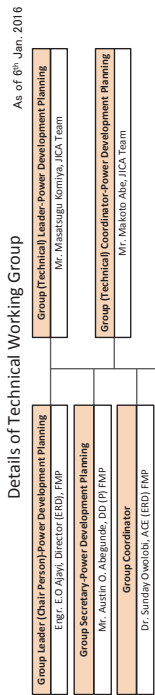
6. TASKS IN TWG (GROUP)-1

Task	JICA Team	Nigerian Technical Counterparts
<ul style="list-style-type: none"> Power Demand Forecast Review of method for power demand forecast Formulation of power demand forecast 	Review Methodology, Formulation	— Formulation, Review, Update
<ul style="list-style-type: none"> Primary energy Energy supply, demand and organizations Energy outlook 	Review Study	Review Study
<ul style="list-style-type: none"> Economic and financial analysis Social and Financial status Investment Plan 	Review Study, Formulation	— Formulation, Review, Update

7

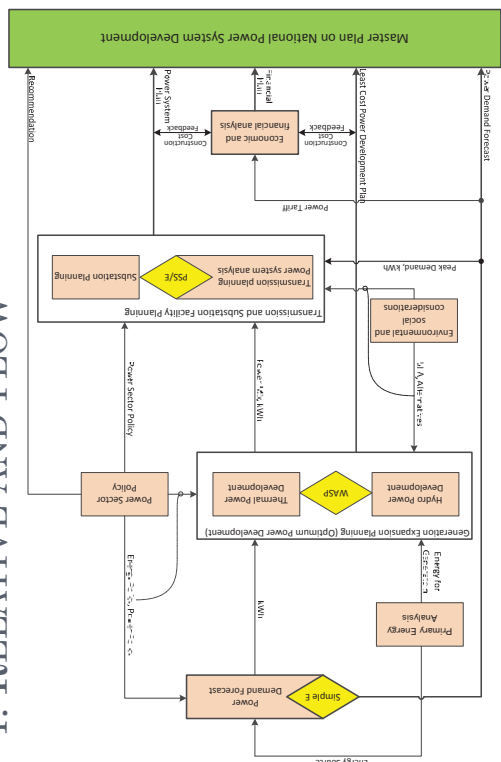
3. STRUCTURE OF TWG

Details of Technical Working Group



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4. RELATIVE AND FLOW



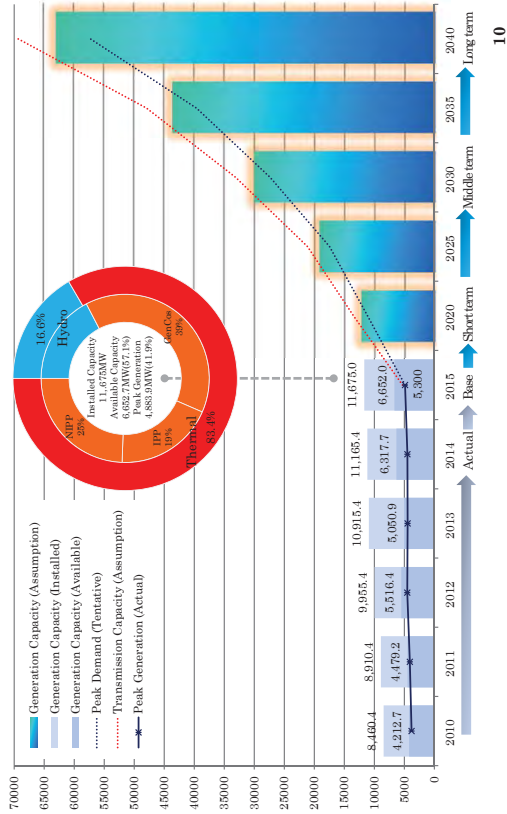
5

7. TASKS IN TWG (GROUP)-2

Task	JICA Team	Nigerian Technical Counterparts
<ul style="list-style-type: none"> Power generation Planning Analysis of existing, planned expansion plan for power plants Study of optimization of power development plan 	Review	—
<ul style="list-style-type: none"> Power system(Transmission, Substations) Analysis of existing, planned expansion plan for power system Simulation 	Simulation	Review, Update
<ul style="list-style-type: none"> Environmental and Social Considerations Regulation framework Implementation of SFA 	Review	—
<ul style="list-style-type: none"> Power Sector Policy Organizational and legal framework, legislation, power tariff and other Power Sector policy 	Assistance	Implementation
	PSS/E Model	Review, Update
	Review	—
	Recommendation	—

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9. ACTUAL AND ASSUMPTION



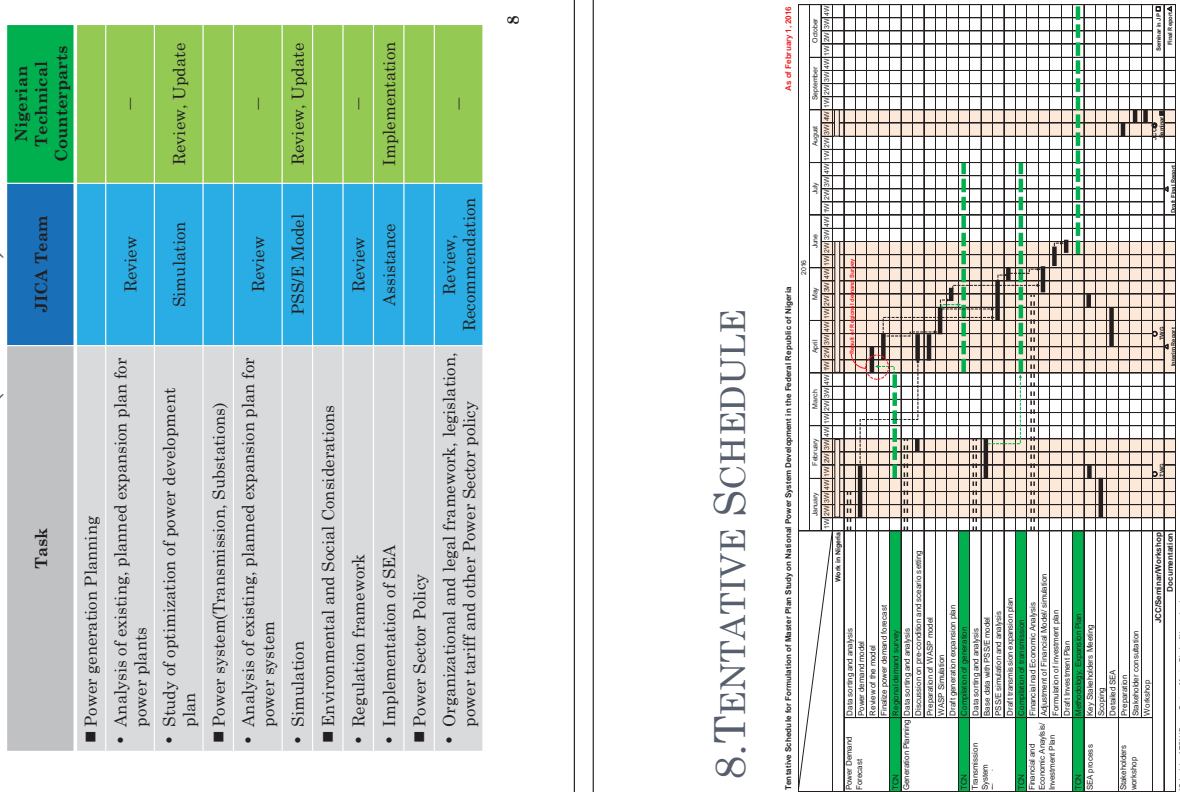
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10. ISSUES TO BE MEASURED BY TWG

- ◆ Information Sharing
- ◆ Adequate Data Management
- ◆ Re-structure TWG (if necessary)
- ◆ Periodical Technical Working Group Meeting
- ◆ Periodical Update of Master Plan

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8. TENTATIVE SCHEDULE



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TWG Workshop on Power Demand Forecasts

January 2016

Contents

1. Procedures of Power Demand Forecasts(P02)
2. Forecasts on Population, GDP and Oil price (P05)
3. Country Wide Power Demand Forecasts (P08)
4. Regional Wise Power Demand Forecasts (P14)
5. Comparison of Nigeria Power Demand (P20)

1

1. Procedures of Power demand forecasts
 - 1.1 Schedule on power demand forecasts

MM /YY	Contents
Sep 2015	(1)Collecting demand data & strategies (2) Discussing methodology (3) Discussing strategies on power demand
Jan 2016	(1)Building Demand model (2)Discussing Preconditions and Results on the forecasts (3)Explaining Tentative results in TWG (4)Implementing Regional survey by end of March
April 2016	(1)Revising DISCO's power demand (2)Discussing DISCO's power demand (3)Explaining Results to Stakeholders

Note : Regional survey is studied by TCN and Fitchner

2

Thank you for your attention

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1.2 Discussing Social Economic & Power demand

Nigerian C/P
FM of Power, Works & Housing
TCN & NCC

JICA
Study Team

	Ministry and Authority	Visited Date
TCN	Ministry and Authority	19 th Jan 2016
REA	Transmission Company of Nigeria	19 th Jan 2016
ECN	Rural Electrification Authority	20 th Jan 2016
NBS	Energy Commission of Nigeria	20 th Jan 2016
MBNP (NPC)	National Bureau of Statistics	21 st Jan 2016
NNPC	Ministry of Budget and National planning	21 st Jan 2016
NERC	Nigerian National Petroleum Corporation	21 st Jan 2016
NBET	Nigerian Electricity Regulatory Commission	27 th Jan 2016
	Nigeria Bulk Electricity Trade	29 th Jan 2016

1.3 Power demand Forecasting schemes

Population & GDP forecasts

Data Sheet	Model sheet	Simulation sheet
Population growth	Elasticity calculation	Actual power demand
Economic Growth	$\ln(Y) = a * \ln(\text{GDP})$	2000-2014
Power tariff	$-b * \ln(\text{Tariff}) + c$	Forecasting period
Residential demand	Forecasting equation	2015-2045
Industry power demand	$Y_t = Y_{t-1}$	Forecasted demand
Commercial demand	$* (1 + a * \text{GDP})$	Sectoral demand
Public power demand	$* (1 + b * \text{tariff})$	Country demand
T/D-loss	$* (1 + \text{EE\&C})$	Country Peak
Net power demand		Regional demand
Generation		Regional peak
Peak demand		

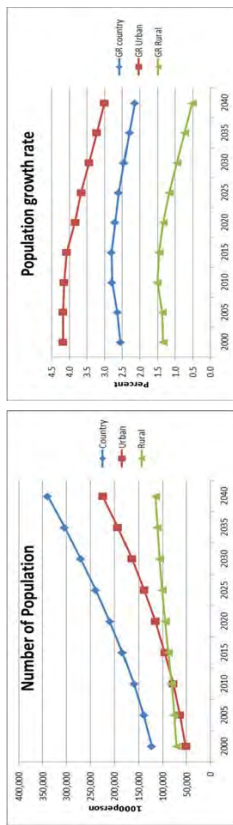
DISCO wise Power demand Forecasts

Note: Methodology is Econometric model

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2. Forecasts on Population, GDP and Oil prices

2.1 Population Forecasts



Source: United Nations : World Population Prospects 2012 Division

- Total population is 340 million in 2040
- Growth rate is 2.80 % in 2015 and it is 2.15 % in 2040.
- Urban share is 52% in 2015 and 66% in 2040.
- Growth rate of population is still high in 2040.

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2.2 GDP growth rate

Scenario of GDP	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040
Base GDP	5.0%	7.0%	7.0%	7.0%	7.0%
High GDP	6.0%	9.0%	9.0%	9.0%	9.0%
Low GDP	4.5%	5.0%	5.0%	5.0%	5.0%

References : Strategy and Economic outlook

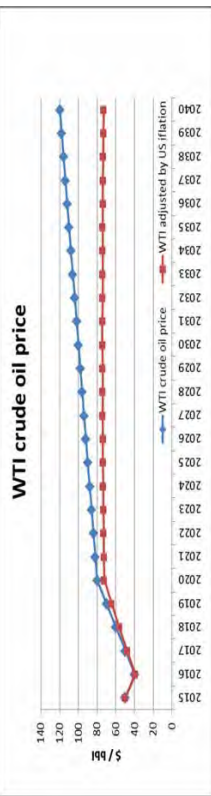
Documents	Organizations	Growth rates	Periods
Vision 20 2020	Nigeria Gov	13% per year	2015 - 2020
GDP outlook	NBS	6% per year	2015 - 2017
GDP outlook	NPC	5% per year	2015 - 2020
Economic outlook 2015	AfDB	7% per year	2015 - 2020
Economic outlook April 2015	IMF	6% per year	2015 - 2020

- Base case growth rate from 2015 to 2020 is forecasted by NPC
- Base case average growth rate from 2020 to 2040 are 7% due to population growth and achieving non oil sector diversification.
- High case is almost implementing Vision 2020.
- Low case is continuing current economic situation.

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2.3 Crude oil price outlook

Organization	Publication	Latest version
International Energy Agency (IEA)	World Energy Outlook (WEO)	2015 version
Organization of the Petroleum Exporting Countries(OPEC)	World Oil Outlook	2014 version
Energy Information Agency (EIA, USA)	International Energy Outlook	2014 version
The Institute of Energy Economics, Japan(IEEJ)	Asia/ World Energy Outlook	2015 version

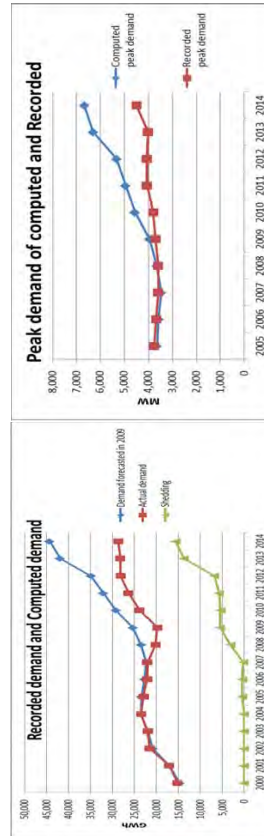


- Source: Actual data from BP statistics.
- Recent data from The Institute of Energy Economics, Japan
- Brent oil price is nearly same to WTI price. (Brent = WTI + \$5/bbl)

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3. Country Wide Power Demand Forecasts

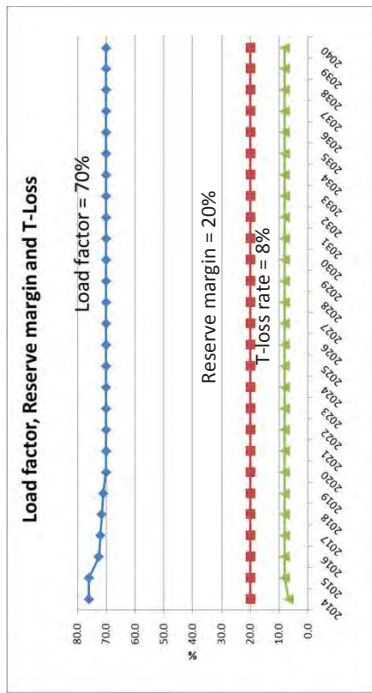
3.1 Recorded demand and Computed demand



- Recorded demand means "With constrain demand" and computed demand is "Without constrain demand".
- "Forecasted demand in 2009" is studied by Tractebel
- Actual demand is 95 % of power generation (Own use is 5%)
- Shedding = Computed demand – Recorded demand
- Power demand in Model is forecasted with Computed demand

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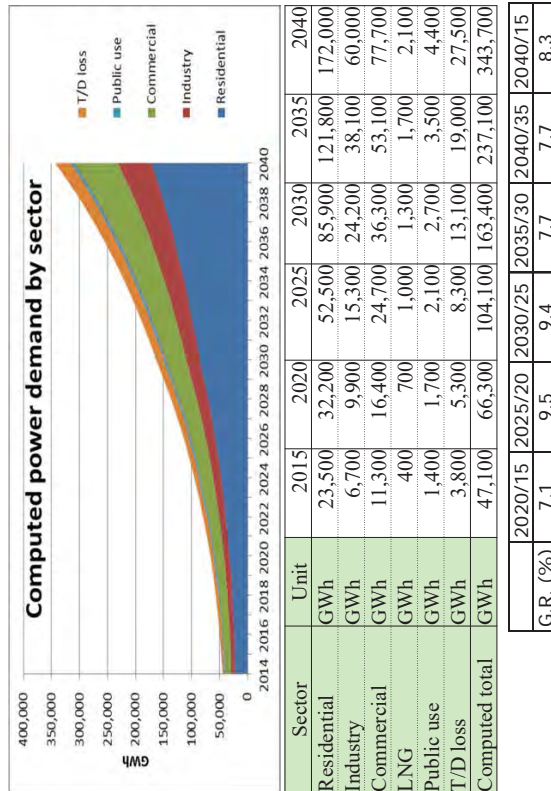
3.2 T- loss, Load factor and Reserve margin



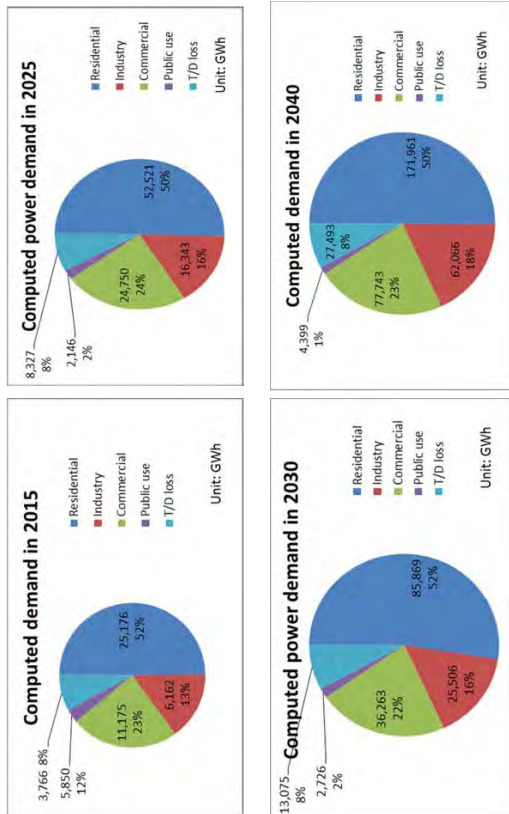
- Source: Preconditions in "MYTO Model 2012"
- Future load factor is 70% to peak demand
- Reserve margin is 20% to peak demand
- T-loss is 8% to power send out.

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3.3 Sectoral power demand (GWh) as JICA forecasts

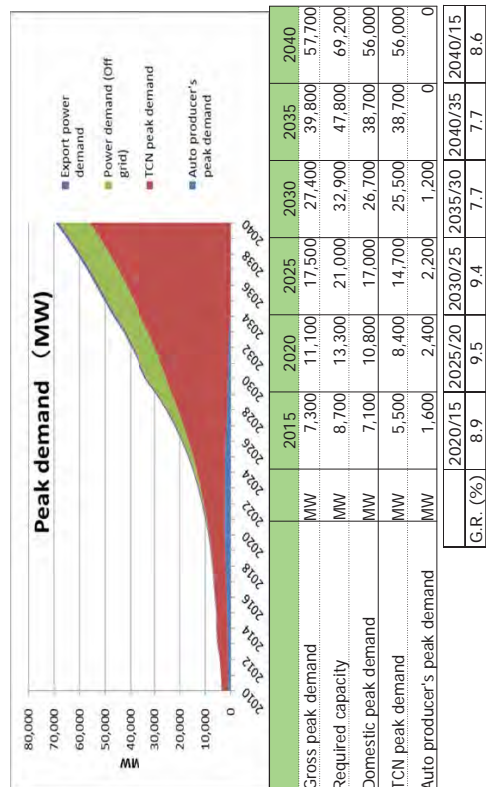


3.4 Sectoral demand shares from 2015 to 2040



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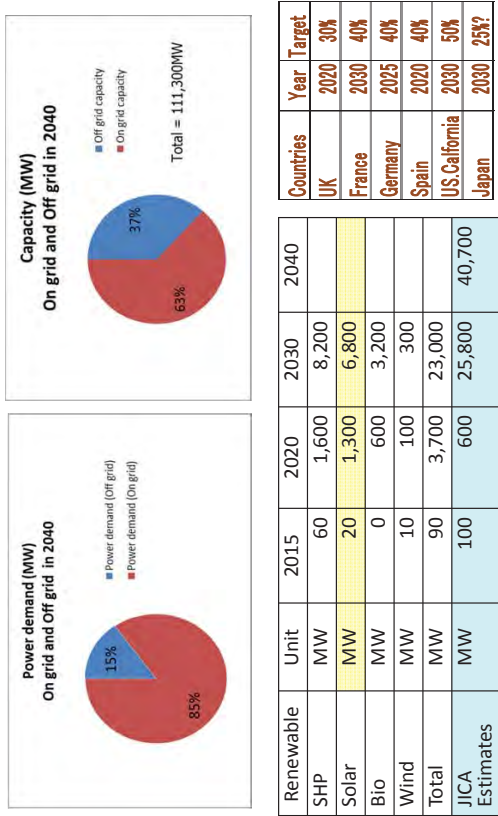
3.5 Peak demand as JICA Forecasts



Source of Off grid power demand : Energy Efficiency Policy 2015
Source of Export : MYTO II MODEL - 2012

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3.6 On grid and Off grid contribution as JICA Forecasts

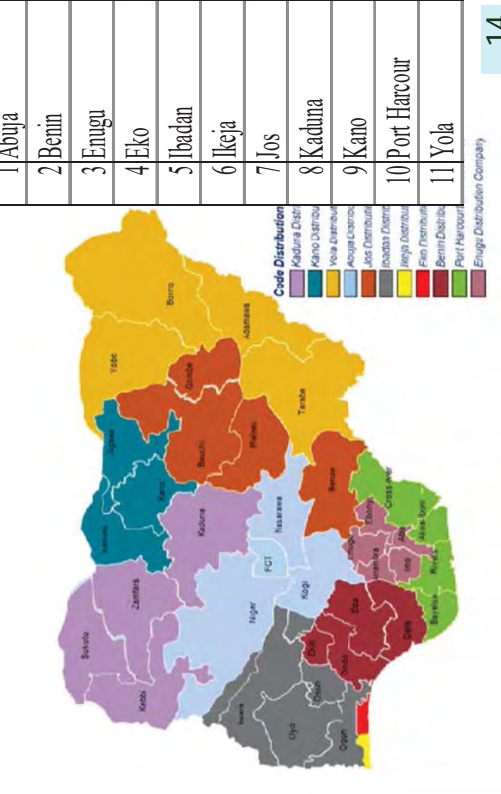


Source : National Renewable Energy and EE&C policy, April 2015 P36

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4. Region wise power demand forecasts

4.1 Distribution companies



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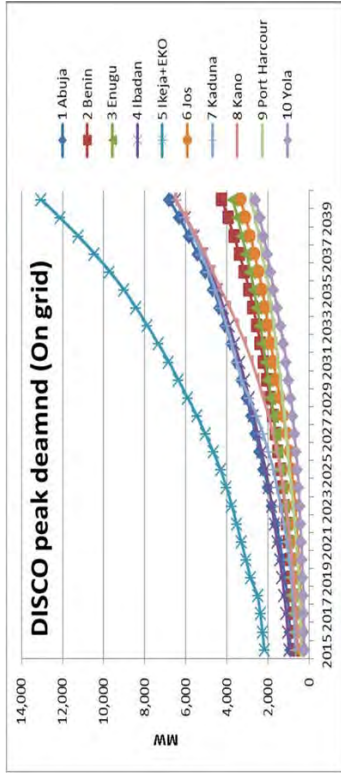
4.2 DISCO wise electrification rate and electrified population

Electrification rate	2014	2015	2020	2025	2030	2035	2040
Abuja	54	57	76	100	100	100	100
Benin	80	82	100	100	100	100	100
Enugu	71	73	86	100	100	100	100
Ibadan	80	81	90	100	100	100	100
Ikeja+EKO	99	99	100	100	100	100	100
Jos	40	42	56	75	100	100	100
Kaduna	41	44	58	76	100	100	100
Kano	36	38	49	62	79	100	100
Port Harcour	61	64	80	100	100	100	100
Yola	30	32	42	56	75	100	100
Total	57	59	71	85	95	100	100
Electrified Population							
Abuja	1000 persons	5,041	5,484	8,331	12,632	14,441	16,463
Benin	1000 persons	13,632	14,337	18,387	23,473	27,000	30,866
Enugu	1000 persons	14,207	14,978	19,530	25,378	28,127	31,069
Ibadan	1000 persons	15,612	16,420	21,059	26,902	30,928	35,437
Ikeja+EKO	1000 persons	11,549	11,895	13,765	15,861	18,234	20,841
Jos	1000 persons	8,943	9,737	14,858	22,608	34,319	38,943
Kaduna	1000 persons	8,532	9,237	13,869	20,715	30,866	34,856
Kano	1000 persons	9,160	9,894	14,499	21,168	30,828	44,753
Port Harcour	1000 persons	10,803	11,647	16,910	24,431	28,065	32,148
Yola	1000 persons	4,497	4,885	7,361	11,072	16,582	24,793
Total	1000 persons	101,977	108,533	148,568	204,242	259,390	310,270

- Current electrification rate is 57% and almost 100% in 2030
- Some DISCOs are 100% up to 2025, and some are 100% in 2030
- Kano and Yola are 100% in 2035

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4.4 DISCO wise peak demand and capacity (On grid)

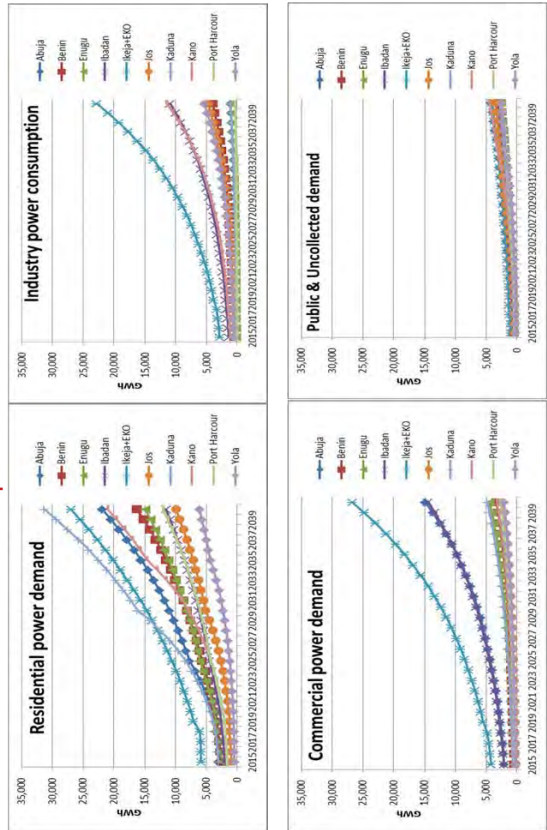


Note : Lagos = Ikeja + Eko

Total(MW)	2015	2020	2025	2030	2035	2040
Peak	7,400	11,000	17,000	27,000	39,000	56,000
Capacity	8,700	14,000	21,000	33,000	48,000	70,000

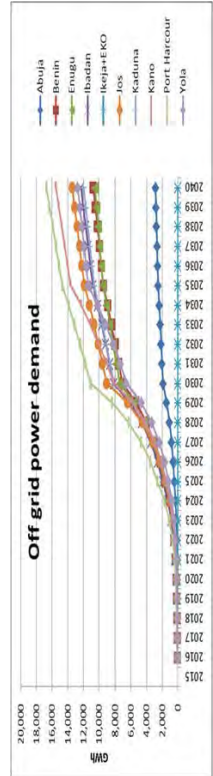
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4.3 DISCO wise sectoral power demand as JICA Forecasts



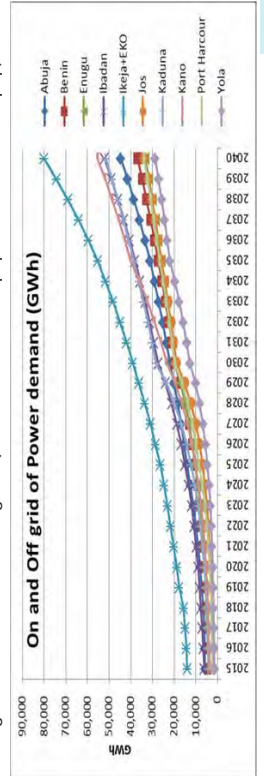
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4.5 DISCO wise power demand (Off grid)



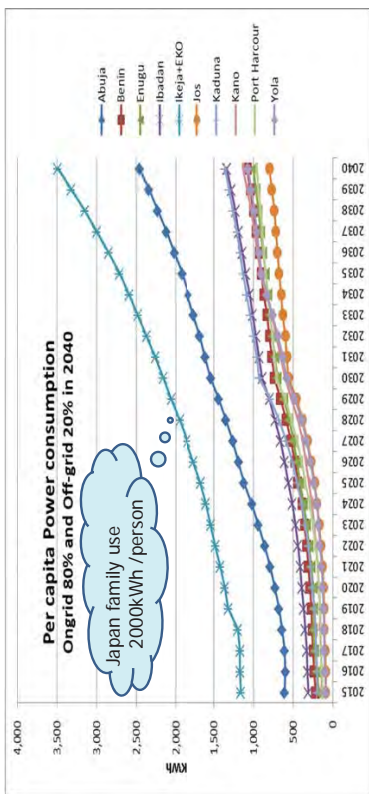
Original Forecasts: National Renewable Energy and EE&C policy, April 2015 P36

Off grid in DISCO = Total off grid * (1 - DISCO electrified pop / Total electrified pop)



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4.6 Per capita power consumption (On+Off grid)

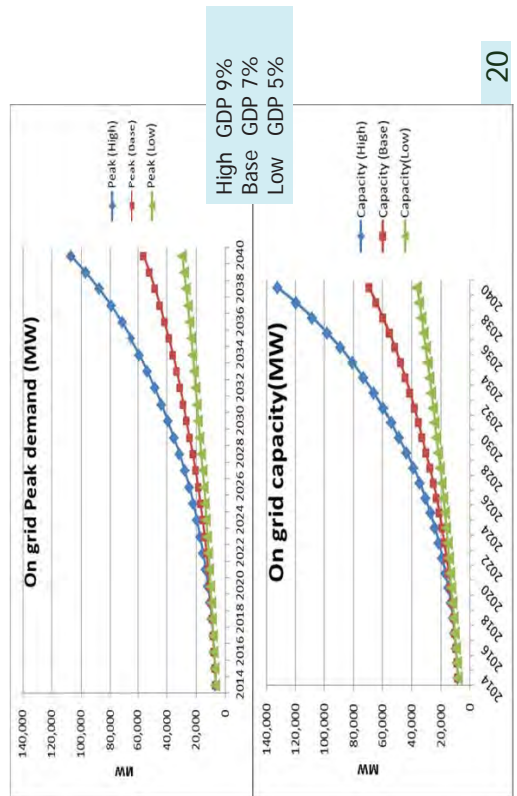


(ON + off grid power consumption) / population

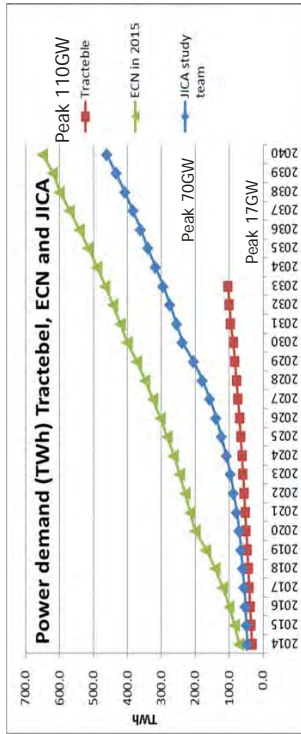
Capacity(MW)	2015	2020	2025	2030	2035	2040
On grid	8,700	14,000	21,000	33,000	48,000	70,000
On & Off	9,200	14,300	27,000	59,000	85,000	111,000

5. Comparison of Nigeria Power Demand

5.1 High, Base, Low cases



5.2 Tractebel, ECN and JICA



Source :

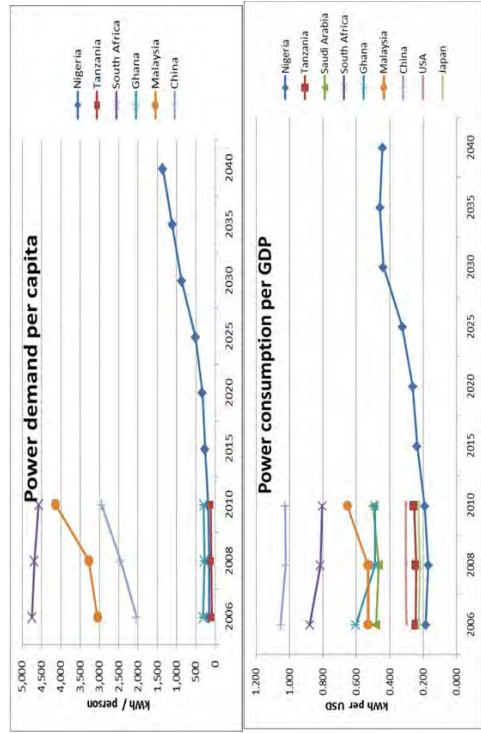
Tractebel: National Load Demand Study in 2009

JICA Study team : Base case (GDP 7% / year) in 2016

ECN 2015: National calculator 2050 published in 2015

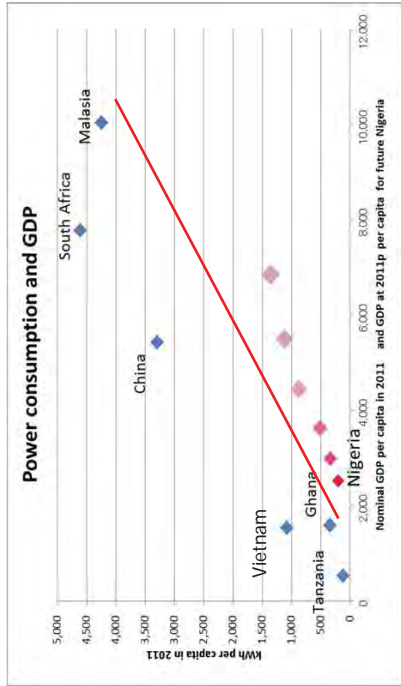
(Greater effort case, GDP 7% / year)

5.3 Per capita power consumption and per capita GDP



Source of Country's data is World Bank data base

5.4 Per capita power demand vs per capita GDP



The points of the countries are at 2011 GDP per capita in all countries are 2011 prices Nigeria points are 2011, 2020, 2025, 2030, 2035 and 2040.

Source of Country's data is World Bank data base

Waiting for the Data

1. Power tariff estimation from NERC. (Already get)
2. Disco wise peak demand from TCN-NCC. (Not yet)
3. Regional power demand survey from Fichtner. (Not yet)

Thank you

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

Generation Expansion Plan

4th February 2016
JICA Study Team

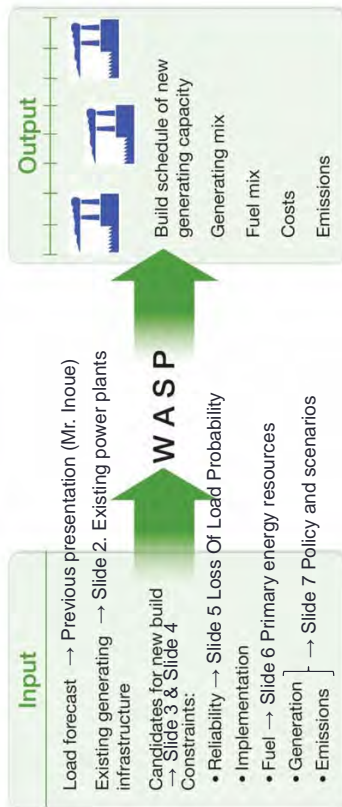
Contents

1. Methodology
2. Existing power plants in Nigeria
3. On-going/planned generation projects
4. Variable candidates for future expansion
5. Reliability criteria-LOLP (Loss of Load Probability)
6. Primary energy resources and availability
7. Power development scenarios

1. Methodology

1.1 Analytical tool used for power development planning

WASP Wien Automatic System Planning Package



Source: IAEA (Aug.2009) "Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments"

1. Methodology

1.2 How WASP works?

- An optimal power development planning software named WASP (Wien Automatic System Planning Package, Version 4.0.3) developed by IAEA is used to seek the least cost power development plan that is a combination of various types of plants and development patterns.
- In WASP, a power development plan that has the least Objective Function (see below for details) within the limitation of LOLP and reserve margin is sought through the calculation.

$$OF = C - SV + O\&M$$

where,

- OF: Objective Function
- C: Construction Cost
- SV: Salvage Value
- O&M: Operation & Maintenance Cost

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2. Existing power plants in Nigeria

Category	Power Plant	Type	Installed Capacity (MW) (On site capacity, * under construction)	Available Capacity (MW)
FGN Successor Companies (Hydro)	Kainji	Dam Hydro	80MWx4, 100MWx2, 120MWx2	444
	Jebba	Dam Hydro	96MWx6	431
	Shiroro	Dam Hydro	600	508
	Sub Total		1,938	1,383
FGN Successor Companies (Thermal)	Egbin	Gas (Steam turbine)	220MWx6	941
	Delia	Gas fired GT	75MWx6, 138MWx2	3
	Sapele	Gas (Steam turbine)	25MWx12, 100MWx6	463
	Gerugu	Gas fired GT	110MWx6	219
	Olorunsogo I	Gas fired GT	138MWx3	328
	Omotesho	Gas fired GT	42MWx8	277
	Sub Total		4,694	2,511
	Olorunshogo	Combined cycle	GT:112.5MWx4, ST:125MWx2	260
	Abaoji	Combined cycle	GT:112.5MWx4, ST:285MWx2	158
	Gerugu	Gas fired GT	145MWx3	159
NIPP	Inovbor	Gas fired GT	112.5MWx4	374
	Omotesho	Gas fired GT	112.5MWx4	306
	Sapele	Gas fired GT	112.5MWx4	184
	Calabar	Gas fired GT	112.5MWx5	234
	Gbarani	Gas fired GT	112.5MWx2	0
	Omoku	Gas fired GT	112.5MWx2	0
	Egbema	Gas fired GT	112.5MWx2	0
	Sub Total		2,935	1,675
	River	Gas fired GT	180MWx1	0
	Omoku (GT)	Gas fired GT	25MWx6	0
ASCO	Gas fired GT	140MWx1	0	
IPP-A (Existing)	Trans-Amadi (GT)	Gas fired GT	100	0
	Okpai	Combined cycle	150MWx3	230
	Ibom	Gas fired GT	112MWx1, 38MWx2	91
	Afam VI	Gas fired GT	150MWx4	587
	AES	Combined cycle	270	175
	Sub Total		2,108	1,083
Grand Total (Thermal + Hydro)		11,675	6,652	

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3. On-going/planned generation projects (Thermal and Renewable)

POWER PLANT	Capacity (MW)	Location	Type of IPP	Fuel Type	Land Evacuation Approval	TCN	Gas/Fuel Supply/Energy Yield Report	ESIA	STATUS
Bresson AS	90	Magboro, Ogun State	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations concluded awaiting regulatory approval
Century Power	495	Ojija, Anambra State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations concluded and IPPs linked (gas supply) issues to be resolved
Proton Energy	150	Sapele, Delta State	GREENFIELD	Gas	YES	YES	NO	NO	Negotiations ongoing, gas supply issues to be resolved
Mobil (Que Ibe IPP)	530	Que Ibe, Akwa Ibom	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations concluded, POA Pending
Ona Power (Geometric)	500	Obasioma, Aba State	GREENFIELD	Gas	YES	YES	NO	YES	Negotiations concluded awaiting regulatory approval
MBH Power (Rockson Energy)	300	Itampole, Ikorodu, Lagos State	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations ongoing
Ethiops Energy	1000	Sapele, Delta State	GREENFIELD	Gas	YES	YES	YES	YES	Negotiations ongoing, gas supply issues to be resolved
Yellowstone	350	Ajokuta, Kogi State	GREENFIELD	Gas	YES	YES	NO	NO	Negotiations ongoing, gas supply issues to be resolved
Ibom Power	191	Ikor-Abasi, Akwa Ibom	BROWNFIELD	Gas	YES	YES	YES	YES	Negotiations concluded awaiting regulatory approval
NOPHC NIPPs	4575	10 projects	BROWNFIELD	Gas	NO	NO	NO	NO	Negotiations ongoing, gas supply issues to be resolved
Zuma Energy (Coal)	1200	Ajokuta, Kogi State	GREENFIELD	Coal	YES	YES	YES	YES	Negotiations Ongoing
Nigeria Solar Capital Partners (NSCP)	100	Bauchi	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Pen Africa Solar	54	Kemilla, Kaduna State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Et Aron Group	100	Gwangwada, F.C.T	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Roop Solar Investment	100	Atakumosa West LGA, Osun State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Roop Solar	90	Kaduna State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
KW Power (Nia) PVT Limited	50	Yabo LGA, Sokoto State	GREENFIELD	Solar	NO	YES	YES	YES	Negotiations Ongoing
Sunrent PowerShare	50	Kaduna	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
Monti Seasphire	1200	Enugu State	GREENFIELD	Solar	YES	NO	NO	NO	Negotiations Ongoing
Gleamorth	281	Kobe State	GREENFIELD	Solar	YES	YES	YES	YES	Negotiations Ongoing
TOTAL	11,406								

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3. On-going/planned generation projects (Hydro)

Project name	Installed capacity (MW)	Type	Location	Status	Expected completion
Kashimbilla	40	Dam	Taraba	Under construction	2015
Gurara-I	30	Dam	Niger	Dam completed Not operable without transmission line	Dam:2011 Transmission: Under planning
Zungeru	700	Dam	Niger	Under construction	2017
Mambilla	3,050	Dam	Taraba	EPC contract signed in 2014	2020
Gurara-II	360	Dam	Niger	Bid preparation	N/A

4. Variable candidates for future expansion

■ Thermal candidates

	Capacity	Efficiency*	Cost**	Plant life
Simple cycle gas turbine	100MW class	30.8%	\$980/kW	30 years
	200MW class	34.7%	\$680/kW	30 years
Combined cycle	300MW class	51.4%	\$980/kW	30 years
	500MW class	54.0%	\$941/kW	30 years
	1,000MW class	55.1%	\$842/kW	30 years
Coal fired conventional	300MW class	40.7%	\$2,500/kW	40 years
	700MW class	42.1%	\$2,000/kW	40 years
	1,000MW class	43.0%	\$2,000/kW	40 years

[Remarks] *: HHV base

[Source] **: "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants" (US-EIA), Gas Turbine World Handbook

■ Hydro candidates

Potential hydro sites which are identified through a study named "Screening for Hydropower Options with Associated Water Resources Development in the Niger Basin" assisted by the World Bank and conducted by Tractebel Engineering will be used for the Project. Out of 64 sites identified by the WB study, 20 to 30 sites which have high ranking scores and large capacity will be selected for hydro candidates for the Project.

5. Reliability criteria-LOLP (Loss of Load Probability)

The LOLP (Loss Of Load Probability) is used as the indicator for evaluating the reliability of power supply, and the power development plan which satisfies the target LOLP will be compiled.

LOLP is defined as probable duration of time when power supply capacity falls short of power demand due to capacity outage as follows.

O_i : Capacity outage amount that causes supply shortage

P_i : Probability that capacity outage of O_i happens

t_i : Time when capacity outage O_i continues

Hence,

$$LOLP = \sum P_i \cdot t_i$$

LOLP is widely applied throughout the world as a standard of power supply reliability: NERC (North American Electric Reliability Corporation) adopts a LOLP of 1 day / 10 years, while PLN in Indonesia adopts 1 day / year, and CEB (Ceylon Electricity Board) adopts 3 days/year.

In this Project, it is intended to adopt LOLP 1 day / year as the target reliability standard.

6. Primary energy resources and availability

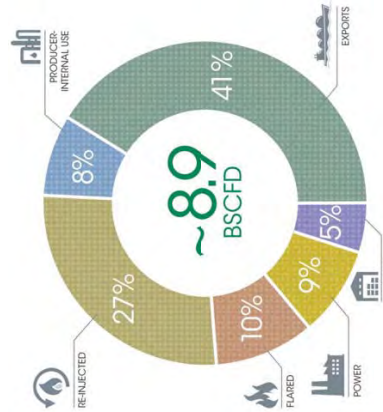
6.1 Natural gas reserve in Nigeria

Proved natural gas reserve in Nigeria is 180.1 Tcf and Reserves-to-Production (R/P) ratio is more than 100 years at end of 2014 (BP Statistical Review 2015).

Natural gas used for power generation accounts for 9% of total gas consumption.

(Nigeria Power Baseline Report)

Still, natural gas is a promising source of power generation in Nigeria.



[Source] "Nigeria Power-Baseline Report" (Sep.2015) Advisory Power Team, Office of the Vice President

6. Primary energy resources and availability

6.2 Coal reserve in Nigeria

S/No	Mine Location	State	Type of coal	Estimated Reserve (Mmt)	Proven Reserve (Mmt)	Depth of Coal (m)	Mining Method(s)
1	Okpara*	Enugu	Sub-bituminous	100	24	180	Underground
2	Ovyeama*	Enugu	Sub-bituminous	150	40	-	Underground
3	Ihoma	Imo	Lignite	40	N/A	20-80	Surface
4	Obovoba	Kogi	Sub-bituminous	427	107	20-100	Surface and underground
5	Ogwashi Azagba Obomkpa	Delta	Lignite	250	63	15-100	Surface and underground
6	Ezimo	Enugu	Sub-bituminous	136	56	30-45	Surface and underground
7	Inyi	Enugu	Sub-bituminous	50	20	25-78	Surface and underground
8	Lafia/Obi	Nassarawa	Bituminous (cokable)	156	21.42	80	Underground
9	Oada/Newei	Anambra	Sub-bituminous	30	N/A	18-38	Underground
10	Afike/Okigwe	Ebonyi/Imo	Sub-bituminous	50	N/A	20-100	Underground
11	Anasiodo	Enugu	Bituminous (cokable)	1,000	N/A	563	Underground
12	Okaba*	Kogi	Sub-bituminous	250	73	20-100	Surface and underground
13	Owika*	Benue	Sub-bituminous	75	57	20-100	Surface and underground
14	Ogugu/Avgu	Enugu	Sub-bituminous	N/A	N/A	N/A	Underground
15	Aiji	Edo	Sub-bituminous	N/A	N/A	N/A	Underground
16	Ute	Ondo	Sub-bituminous	N/A	N/A	N/A	Underground
17	Doho	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
18	Kurumu	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
19	Lamia	Adamawa	Sub-bituminous	N/A	N/A	N/A	Underground
20	Garin Maigun	Gombe	Sub-bituminous	N/A	N/A	N/A	Underground
21	Gardin Akwai	Plateau	Sub-bituminous	N/A	N/A	N/A	Underground
22	Lamato Koji	Kwara	Sub-bituminous	N/A	N/A	N/A	Underground
Total				2,734	461		

7. Power development scenarios

7.1 Energy sector policy in Nigeria

- **National Energy Master Plan 2014**
 - **Chapter 4 Coal and tar sands/Bitumen**
 - The nation shall ensure adequate supply of coal to meet the energy requirements of the country in a cost effective and sustainable manner.
 - **Chapter 5 Nuclear Energy**
 - The nation shall promote the development of nuclear energy and undertake all activities related to peaceful uses of nuclear energy in its entire ramifications.
 - **Chapter 6 Renewable Energy**
 - **Hydro:** The nation shall fully harness the hydropower potential in the country for electricity generation.
 - **Solar:** The nation shall aggressively pursue the integration of solar energy into the nation's energy mix, which should be based on the established potentials and available technologies nationwide.
 - **Wind:** The nation shall commercially develop its wind energy resource and integrate this with other energy resources into a balanced energy mix.
 - **Chapter 8 Electricity**
 - The nation shall pursue measures to **diversify energy sources** for electricity supply.
 - The nation shall **ensure a sustainable supply of gas** for electricity generation.

7. Power development scenarios

7.1 Energy sector policy in Nigeria (cont'd)

NATIONAL RENEWABLE ENERGY AND ENERGY EFFICIENCY POLICY (NREEEP)

➤ Renewable electricity targets

	Short term 2015	Medium term 2020	Long term 2030
Large hydro (MW)	2,121	4,549	4,627
Small hydro (MW)	140	1,607	8,174
Solar (MW)	117	1,343	6,831
Wind (MW)	55	631	3,211
Biomass (MW)	5	57	292
% of Renewables with Large hydro	10%	18%	20%
% of Renewables without Large hydro	1.30%	8%	16%

7. Power development scenarios

7.2 Scenario setting

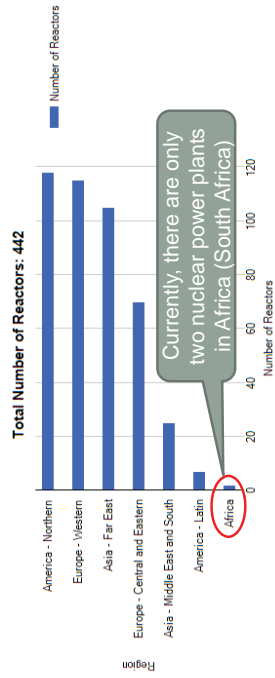
	Capacity Share			Evaluation		
	Gas	Coal	Hydro and Renewable	Cost	Energy Balance	Environment
Scenario-1 (Conservative)	70%	10%*1	20%			
Scenario-2 (More coal)	60%	20%*2	20%			
Scenario-3 (No coal)	75%	0%	25%			

*1: A 1,000MW coal fired power plant consumes 3 million ton of coal for one year, 90 million ton for 30years. Considering the proved reserve of 461million ton, the reserve can accommodate up to 5,000MW coal fired power plants.

*2: More proved coal reserve needs to be identified.

Nuclear power in Nigeria?

◆ Nuclear power plants in the world (as of Jan. 2016, IAEA statistics)



◆ Comparison of unit construction cost

Type	Capacity	Unit Const. Cost
Nuclear	1,100MW	\$ 5,600/kW
Combined cycle	1,000MW	\$842/kW
Coal fired conventional	1,000MW	\$2,000/kW

[Source] "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants" (US-EIA), Gas Turbine World Handbook

THE PROJECT FOR MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT

Environmental and Social Considerations (ESC)

Feb. 3, 2016
JICA Study Team

OUTLINE

1. What is Strategic Environmental Assessment (SEA) ?
2. SEA in power planning
3. Activities in TWG for ESC
4. Scoping of environmental and social impacts
5. Data for SEA
6. Next SEA work plan

WHAT IS STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)?

Analytical and participatory approach that aims to integrate environmental considerations into policies, plans, and programs, and evaluate the inter linkages with economic and social considerations.”

OECD/DAC, "Applying Strategic Environmental Assessment: good practice guidance for development cooperation" (2006)

Overall process for SEA:

- ✓ Investigate multiple scenarios to be compared
- ✓ Investigate relevant cumulative impacts
- ✓ Scoping of environmental and social impacts
- ✓ Stakeholder meetings (as needed)

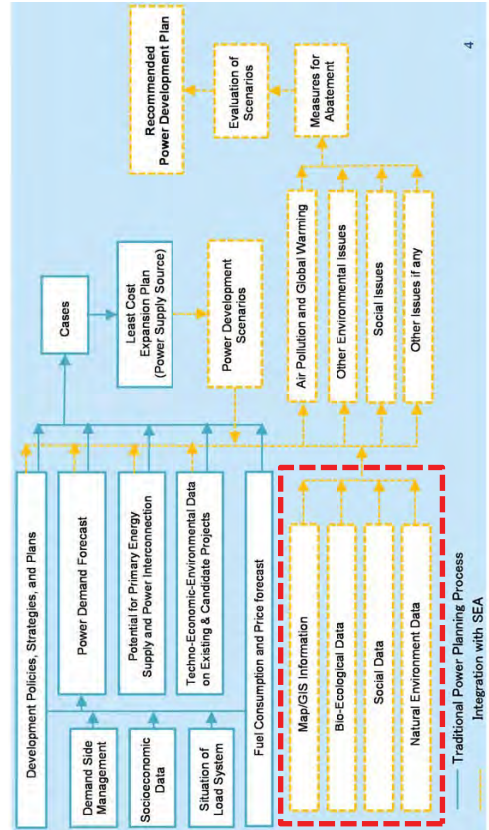
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ACTIVITIES IN TECHNICAL WORKING GROUP (ESC)

- Group Meeting 1 (Jan. 19, 2016)
 - SEA process
 - Stakeholder analysis -1
- Group Meeting 2 (Jan. 25, 2016)
 - Stakeholder analysis -2
 - Scoping discussion

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STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) IN POWER PLANNING



4

SCOPING FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

Potential impacts of the power system development
(Environmental pollution & Natural environment)

A+/-: Significant positive/negative impact C: Positive/negative impact unknown
B+/-: Positive/negative impact to some extent D: No impact

Item	Thermal power	Hydro power	Renewable energy	Transmission lines	Substations
	Gas	Coal	Wind	Solar	
1. Environmental pollution					
Air quality	B-	A-/B-	D	D	D
Water quality	A-/B-	A-/B-	D	D	D
Wastes	B-	A-/B-	D	D	D
Soil contamination	B-	B-	D	D	D
Noise and vibration	A-/B-	A-/B-	B-	D	D
Ground subsidence	C	C	C	C	C
Odour	D	D	D	D	D
Bottom sediment	D	D	D	D	D
2. Natural environment					
Protected areas	B-/D	B-/D	B-/D	B-/D	B-/D
Ecosystem	B-/D	B-/D	B-/D	B-/D	B-/D
Hydrology	B-	B-	D	D	D
Topography and geology	B-/D	B-/D	D	D	B-/D

6

SCOPING FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

Potential impacts of the power system development (Social environment and other issues)

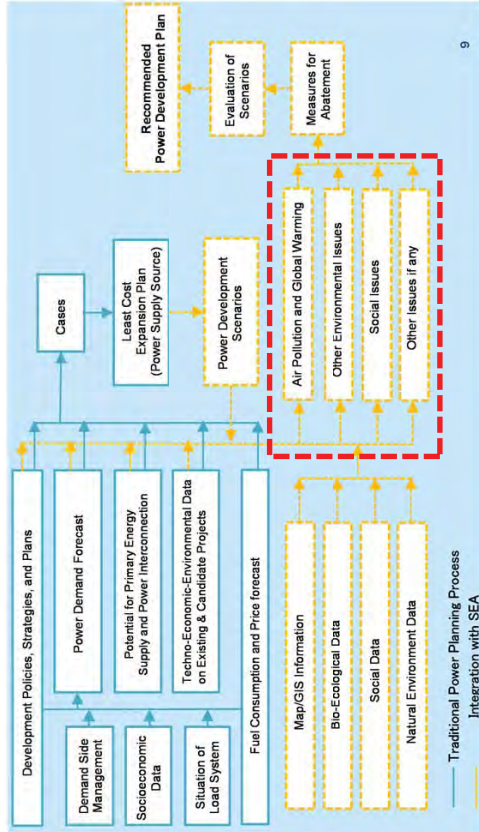
Item	Thermal power		Renewable energy			Transmission lines	Substations
	Gas	Coal	Hydro power	Wind	Solar		
3. Social environment							
Resettlement	B-	B-	A+/B-	B-	B-	B-	B-
Poverty	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Ethnic Minorities/Indigenous People	C	C	C	C	C	C	C
Regional economy	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Land Use/Natural Resources	B-/D	B-/D	A-/B-	B-/D	B-/D	B-	B-
Water Use	B-/D	B-/D	A-/B-	B-/D	B-/D	D	D
Existing Social Infrastructure and Institution	B-/D	B-/D	A-/B-	B-/D	B-/D	B-	B-/D
Misdistribution of Benefit and Damage	B-	B-	B-	B-	B-	B-	B-
Local Conflict of Interest	B-	B-	B-	B-	B-/D	B-/D	B-
Cultural heritage	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D
Landscape	B-	B-	B-	B-	B-	B-	B-
Gender/Children's right	B+/-D	B+/-D	B+/-D	B+/-D	B+/-D	B+/-D	B+/-D
HIV/AIDS and diseases	B-	B-	B-	B-	B-	B-	B-
Working environment	B-	B-	B-	B-	B-	B-	B-
4. Other							
Accidents	B-	B-	B-	B-	B-	B-	B-
Electromagnetic waves	D	D	D	D	D	D	D
Climate change	B-	A-/B-	C	D	D	D	D

DATA FOR STRATEGIC ENVIRONMENTAL ASSESSMENT

- Environmental regulations related to power sector
- CO2: Nigeria's Intended Nationally Determined Contributions in COP21
- Biodiversity and protected area data/maps
 - National parks, internationally protected areas etc.
- ... And more data necessary for detailed SEA

8

NEXT SEA WORK PLAN



WE WOULD APPRECIATE YOUR COOPERATION

THANK YOU!

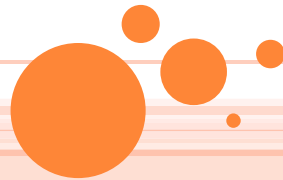
Yuriko Kudo
 yr-kudo@intl.yachiyo-eng.co.jp

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13th February 2017
2nd TECHNICAL WORKING GROUP
(PROGRESS WORKSHOP)

**THE PROJECT FOR MASTER PLAN STUDY
ON NATIONAL POWER DEVELOPMENT
IN
THE FEDERAL REPUBLIC OF NIGERIA

TECHNICAL WORKING GROUP (TWG)
WORKSHOP**



13th February 2017
JICA Study team

1. OUTLINE OF THE STUDY

Item	Description
Objectives	Formulation of National Power System Development for 25 years Technical Transfer to the counterparts of Nigeria
Target Facility	Electric Power generation facilities and power system facilities of not less than 66/33kV substation facilities and transmission system owned by TCN
Implementation Agency	Federal Ministry of Power, Works and Housing
Scope of Work	Formulation of National Power System Development including power demand forecast, power generation development, power system development and investment plan

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2. CONTENTS OF THE STUDY-1

Contents	Outline
1. Review of the Power Sector	<ul style="list-style-type: none"> ■ Review of organizational and legal framework, legislation, power tariff and other policy related to the Power Sector ■ Review and analysis of the current power supply situation ■ Review of the existing power supply facilities
2. Primary Energy Analysis	<ul style="list-style-type: none"> ■ Review of energy policy, energy supply and demand, and organizational structure ■ Review of primary energy as a domestic production ■ Outlook of the primary energy supply and demand
3. Power Demand Forecast	<ul style="list-style-type: none"> ■ Review of method for power demand forecast ■ Formulation of power demand forecast ■ Power demand forecasting up to 2040
4. Study of optimization of power development plan	<ul style="list-style-type: none"> ■ Data collection of the existing power plants ■ Data collection and analysis of planned new / expansion plan for power plants ■ Study of optimization of power development plan
5. Formulation of Power System Development Plan	<ul style="list-style-type: none"> ■ Data collection of the existing power system ■ Data collection and analysis of planned new / expansion plan for transmission and substation facilities ■ Coordination with "Development of Power System Master Plan" ■ Study of power system development plan

3

CONTENTS

1. Outline of the Study
2. Contents of the Study
3. Power Supply flow
4. Master Plan Formulation
5. Schedule of the Study

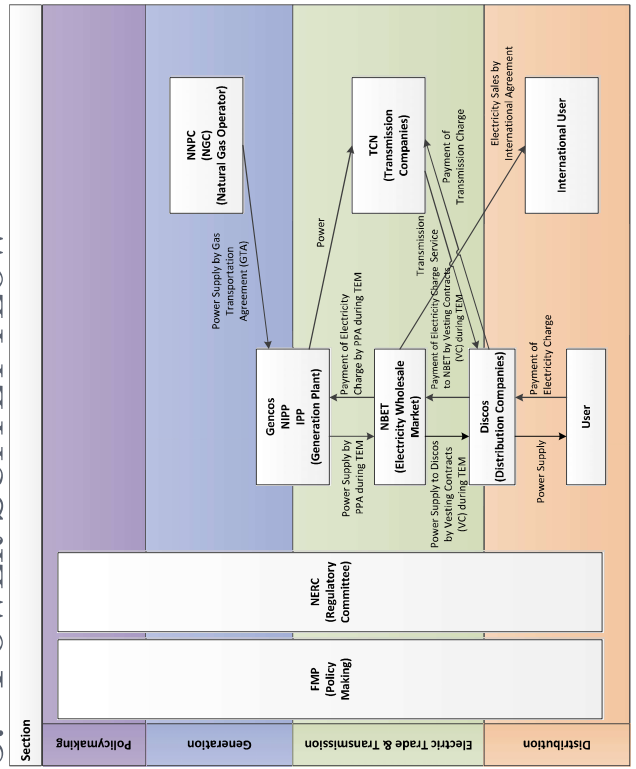
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2. CONTENTS OF THE STUDY-2

Contents	Outline
6. Environmental social considerations	<ul style="list-style-type: none"> Data collection of organizational structure and regulation framework for environmental social considerations Data collection and analysis of prioritized projects Implementation of SEA
7. Formulation of Master Plan on National Power System Development	<ul style="list-style-type: none"> Formulation of optimization of power development plan Formulation of Power System Development Plan Long-term investment plan and economic evaluation Marshaling of the formulation of Master Plan on National Power System Development
8. Policy Recommendation	<ul style="list-style-type: none"> Recommendation of organizational and legal framework, legislation, power tariff and other policy related to the Power Sector shall be made in order to realize the master plan.
9. Technical Transfer	<ul style="list-style-type: none"> The master plan shall be formulated in collaboration work between the study team and the Nigerian counterparts. Classroom training, actual data and software to formulate the master plan shall be utilized in the workshop. How to Update Master Plan
10. Counterpart program in Japan	<ul style="list-style-type: none"> In order to make the master plan public widely and exchange information and opinions, seminar shall be hold in Japan. Introduction of Power sector policy or institutional framework in Japan and facility tour

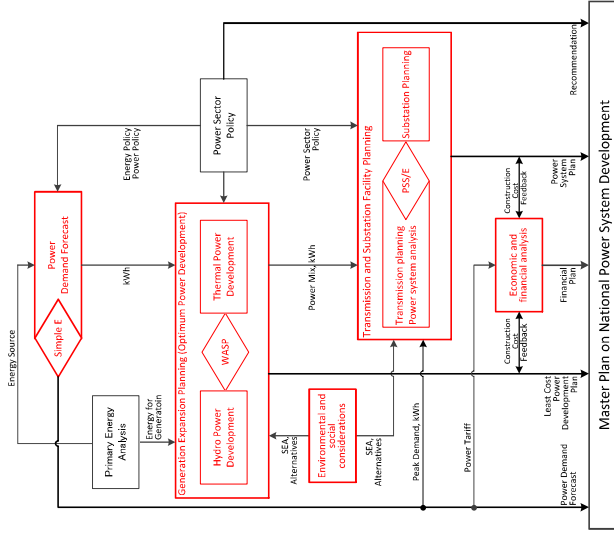
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3. POWER SUPPLY FLOW



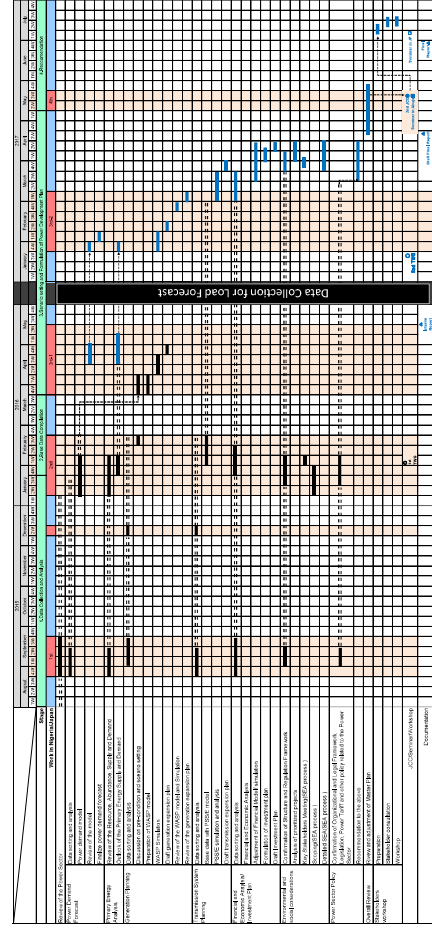
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4. MASTER PLAN FORMULATION



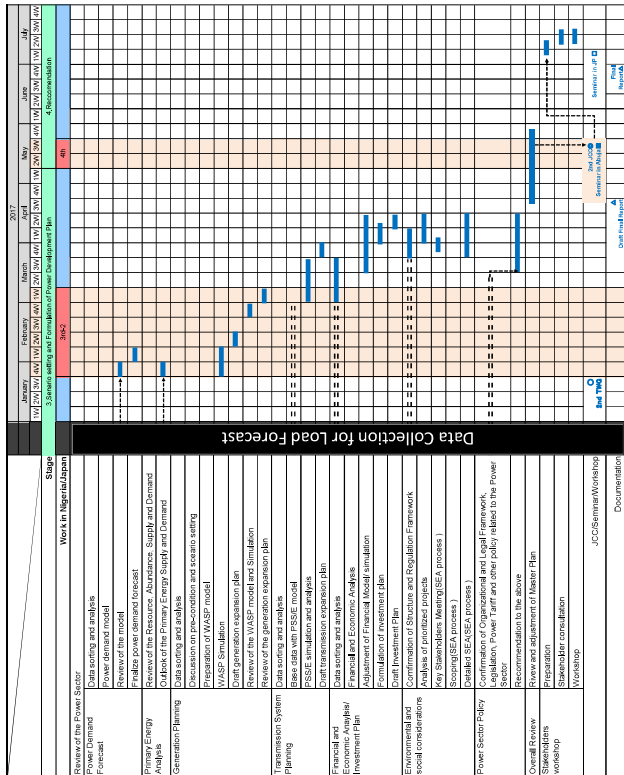
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5. SCHEDULE OF THE STUDY-1



7

5. SCHEDULE OF THE STUDY-2



1 MASTER PLAN STUDY ON NATIONAL POWER SYSTEM DEVELOPMENT IN THE FEDERAL REPUBLIC OF NIGERIA

TWG on Power Demand Forecasts

Feb 2017

Contents

1. Preconditions on Power Demand Forecasts(P02)
2. Country Wide Power Demand Forecasts (P05)
3. Region wise power demand forecasts (P09)
4. Peak demand by GDP Scenario (P14)
5. Update power demand forecasts(P15)

- 2
1. Preconditions on Power demand forecasts
 - 1.1 Discussing Social Economic conditions

Nigerian C/P
FM of Power, Works & Housing
TCN & NCC

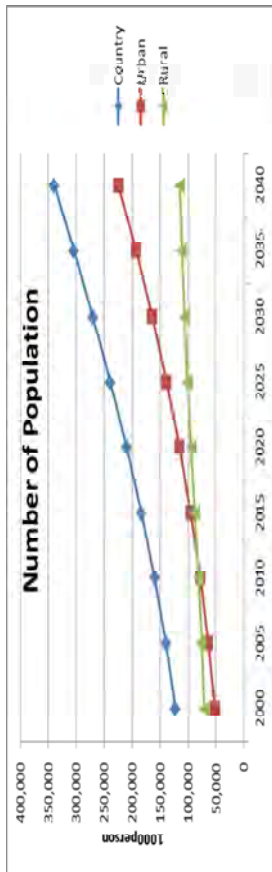
JICA
Study Team

	Ministry and Authority	Visited Date
TCN	Transmission Company of Nigeria	19th Jan 2016
REA	Rural Electrification Authority	19th Jan 2016
ECN	Energy Commission of Nigeria	20th Jan 2016
NBS	National Bureau of Statistics	20th Jan 2016
MBNP (NPC)	Ministry of Budget and National planning	21st Jan 2016
NNPC	Nigerian National Petroleum Corporation	21st Jan 2016
NERC	Nigerian Electricity Regulatory Commission	27th Jan 2016
NBET	Nigeria Bulk Electricity Trade	29th Jan 2016

Thank you for your attention

1.2 Population & GDP Forecasts

3



Source: United Nations : World Population Prospects 2012 Division

< GDP growth rate >

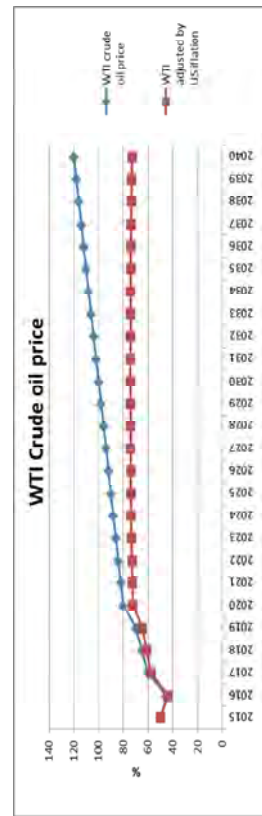
Scenario of GDP	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040
Base GDP	4.3 %	6.5 %	6.5 %	6.5 %	6.5 %
High GDP	4.3 %	8.0 %	8.0 %	8.0 %	8.0 %
Low GDP	4.3 %	5.0 %	5.0 %	5.0 %	5.0 %

Reference: FMBNP, Vision 20 2020 and IMF studies

1.3 Crude oil price outlook

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Organization	Publication	Latest version
International Energy Agency (IEA)	World Energy Outlook (WEO)	2016 version
Energy Information Agency (EIA, USA)	International Energy Outlook	2016 version
The Institute of Energy Economics, Japan(IEEJ)	Asia/ World Energy Outlook	2016 version

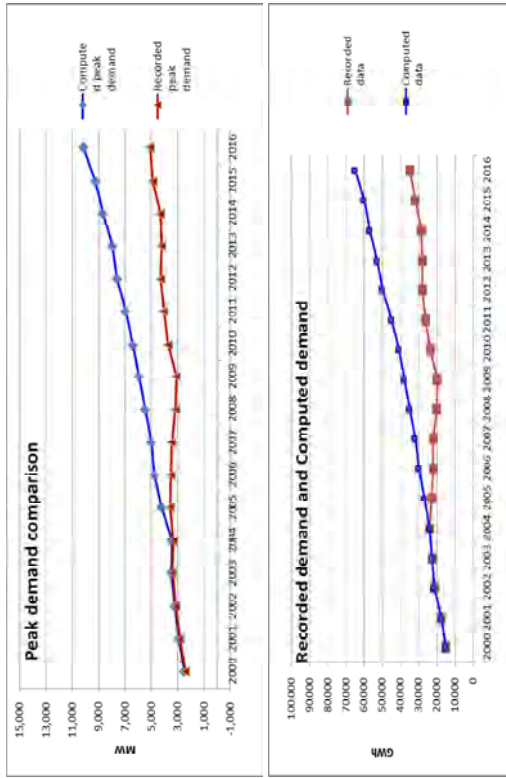


- a. Source: Actual data from BP statistics.
- b. Recent data from The Institute of Energy Economics, Japan
- c. Brent oil price is nearly same to WTI price. (Brent = WTI + \$2/bbl)

2. Country Wide Power Demand Forecasts

5

2.1 Recorded demand and Computed demand



Recorded demand means "With constrain demand" and computed demand is "Without constrain demand".

2.2 Computed and Recorded demand Forecasts

6

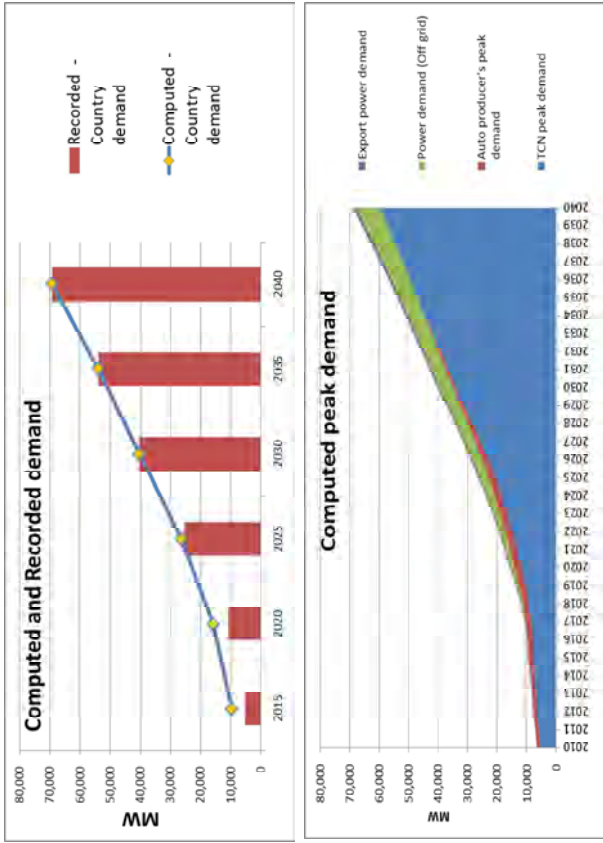
Computed	2015	2020	2025	2030	2035	2040
On grid	9,240	14,070	22,810	35,310	47,140	60,040
Off grid power	160	1,400	3,150	4,340	5,950	8,190
On + Off grid	9,390	15,470	25,960	39,650	53,090	68,230
Export	260	330	500	710	890	1,060
Country power	9,660	15,800	26,460	40,360	53,990	69,290
Recorded						
On grid	4,880	9,140	21,670	35,310	47,140	60,040
Off grid power	160	1,400	3,150	4,340	5,950	8,190
On + Off grid	5,040	10,540	24,820	39,650	53,090	68,230
Export	260	330	500	710	890	1,060
Country power	5,300	10,870	25,320	40,360	53,980	69,290

Note: Off grid demand connected to TCN is increased with real GDP growth rate.
Note: Export is estimated by Elasticity to TCN demand growth rate, the elasticity is 0.7

Computed demand	Unit	2015/10	2020/15	2025/20	2030/25	2035/30	2040/35	2040/15
Energy Demand	%	8.4	7.0	10.2	9.1	6.0	5.0	7.4
Peak demand	%	7.6	8.8	10.2	9.1	6.0	5.0	7.8
Recorded demand	Unit	2015/10	2020/15	2025/20	2030/25	2035/30	2040/35	2040/15
Energy Demand	%	5.3	12.8	18.8	10.3	6.0	5.0	10.4
Peak demand	%	5.6	13.4	18.8	10.3	6.0	5.0	10.6

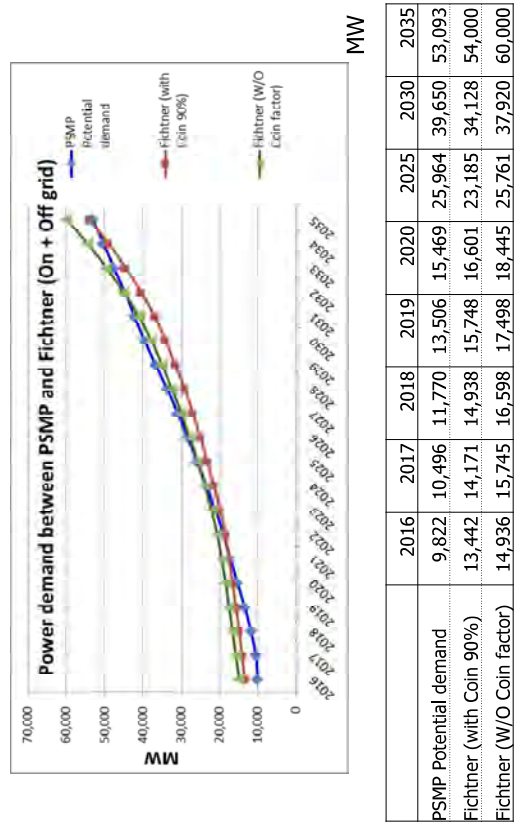
2.3 Comparison Computed and Recorded demand

7



2.4 Load demand comparison of Fichtner study and PSMP

8



Source: PSMP = Power Demand Forecasting Model by PSMP
Fichtner : Regional Survey implemented by TCN and Fichtner

3. Region wise power demand forecasts

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3.1 Regional survey results in 2016

NAME OF DISCO	Unit	C DISCO LOAD DEMAND FROM 2016 FIELD MEASUREMENT	D HISTORIC 33kV PEAK LOAD COLLECTED IN 2016	E DISCO ESTIMATE ON-GRID SUPPRESSED LOAD	F DISCO ESTIMATED OFF-GRID SUPPRESSED (POTENTIAL) LOAD	G Potential demand On grid in 2016	H Potential demand On + Off in Future
AEDC	MW	762	577	270	381	1,033	1,414
BEDC	MW	1,223	777	163	221	1,386	1,607
EEDC	MW	1,027	803	380	287	1,406	1,694
IBEDC	MW	1,286	1,119	184	280	1,470	1,749
IKEDC+EKEDC	MW	2,566	1,834	683	716	3,249	3,965
JEDC	MW	399	416	44	143	443	586
KAEDCO	MW	602	632	93	342	695	1,037
KEDCO	MW	708	514	187	224	895	1,119
PHEDC	MW	948	885	130	230	1,078	1,308
YOLA	MW	280	305	35	365	315	679
TOTAL	MW	9,801	7,861	2,169	3,188	11,969	15,157
Coincident rate 90%	MW	8,821	7,075	1,952	2,869	10,772	13,641

Source: The survey is conducted by TCN and Fichtner

3.2 DISCO wise electrification rate & electrified population

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Electrification rate	2014	2015	2020	2025	2030	2035	2040
Abuja	54	57	76	100	100	100	100
Benin	80	82	90	100	100	100	100
Enugu	71	73	86	100	100	100	100
Ibadan	80	81	90	100	100	100	100
Ikeja+EKO	99	99	100	100	100	100	100
Jos	40	42	56	75	100	100	100
Kaduna	41	44	58	76	100	100	100
Kano	36	38	49	62	79	100	100
Port Harcour	61	64	80	100	100	100	100
Yola	30	32	42	56	75	100	100
Total	57	59	71	85	95	100	100
Electrified Population	5,041	5,484	8,331	12,632	14,441	16,463	18,711
Abuja	13,632	14,337	18,387	23,473	27,000	30,966	35,332
Benin	14,207	14,978	19,530	25,378	28,127	31,069	34,240
Enugu	15,612	16,420	21,059	26,902	30,928	35,437	40,449
Ibadan	11,549	11,895	13,765	15,861	18,234	20,841	23,704
Ikeja+EKO	8,943	9,737	14,858	22,608	34,319	38,943	44,017
Jos	8,352	9,257	13,869	20,715	30,866	34,856	39,222
Kaduna	9,160	9,894	14,499	21,168	30,828	34,753	40,892
Kano	10,803	11,647	16,910	24,431	28,065	32,148	36,653
Port Harcour	4,497	4,885	7,361	11,072	16,582	24,793	27,750
Yola	101,977	108,533	148,568	204,242	259,390	310,270	350,969

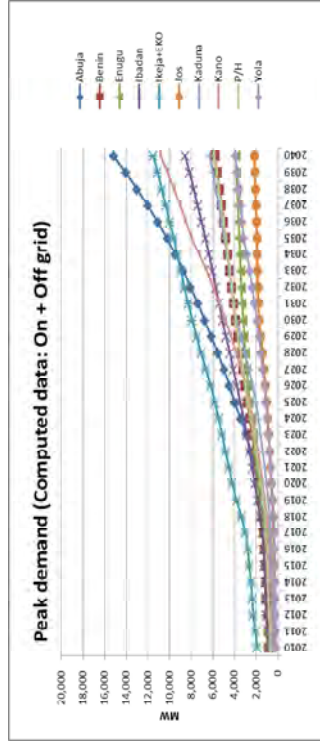
- Current electrification rate is 57% and almost 100% in 2030
- Some DISCOs are 100% up to 2025, and some are 100% in 2030
- Kano and Yola are 100% in 2035

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3.5 Computed growth rate of On+Off grid

%

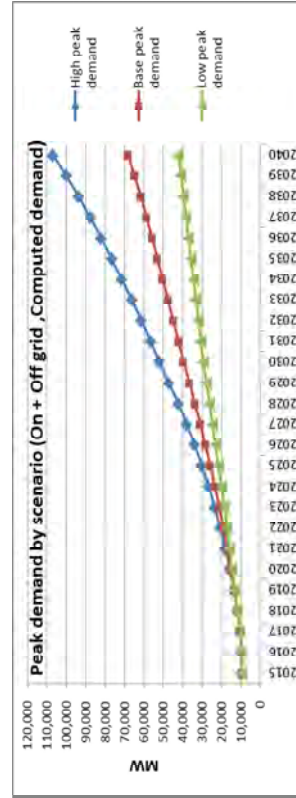
	2020/15	2025/20	2030/25	2035/30	2040/35	2040/15
Abuja	15.0	17.5	11.3	8.7	8.2	12.1
Benin	8.8	9.2	7.0	4.4	3.9	6.6
Enugu	8.2	7.9	4.6	2.3	2.1	5.0
Ibadan	10.8	10.5	8.2	5.6	5.1	8.0
Ikeja+EKO	9.4	7.1	6.7	4.2	3.8	6.2
Jos	10.2	11.1	10.3	2.5	2.2	7.2
Kaduna	12.1	14.1	13.0	5.4	5.0	9.9
Kano	13.0	13.1	12.9	10.3	6.3	11.1
P/H	10.6	12.0	7.1	4.6	4.1	7.6
Yola	16.3	14.0	11.1	9.2	6.0	10.9
Total	10.7	10.9	8.8	6.0	5.1	8.3
Coincident 90%	10.5	10.9	8.8	6.0	5.1	8.3



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4. Peak demand by GDP Scenario

4.1 Peak demand (On + Off) by Scenario



Note: Export is not included

MW

	2015	2016	2017	2018	2019	2020	2025	2030	2035	2040	40/15
High peak	9,393	9,822	10,501	11,784	13,534	15,921	30,236	52,098	76,748	107,015	10.2
Base peak	9,393	9,822	10,496	11,770	13,506	15,469	25,964	39,650	53,093	68,232	8.3
Low peak	9,393	9,820	10,486	11,739	13,184	14,685	21,784	29,437	35,758	42,330	6.2

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3.3 DISCO wise peak demand

Unit: MW

	2015	2020	2025	2030	2035	2040	2040/15
Computed data							
On + Off	885	1,779	3,987	6,806	10,327	15,308	12.1
Abuja	1,189	1,811	3,928	4,871	5,904	6.6	
Benin	1,206	1,786	2,617	3,276	3,668	4,062	5.0
Enugu	1,266	2,106	3,470	5,144	6,754	8,676	8.0
Ibadan	2,786	4,363	6,155	8,500	10,433	12,562	6.2
Ikeja+EKO	380	618	1,045	1,703	1,926	2,149	7.2
Jos	596	1,056	2,045	3,764	4,898	6,249	9.9
Kaduna	767	1,412	2,614	4,792	7,813	10,620	11.1
Kano	924	1,527	2,690	3,790	4,736	5,792	7.6
P/H	270	574	1,107	1,870	2,906	3,582	10.9
Yola	10,263	17,032	28,537	43,574	58,331	74,904	8.3
Total	9,393	15,469	25,964	39,650	53,093	68,232	8.3
Coincided rate 90%							
Country	9,393	15,469	25,964	39,650	53,093	68,232	8.3

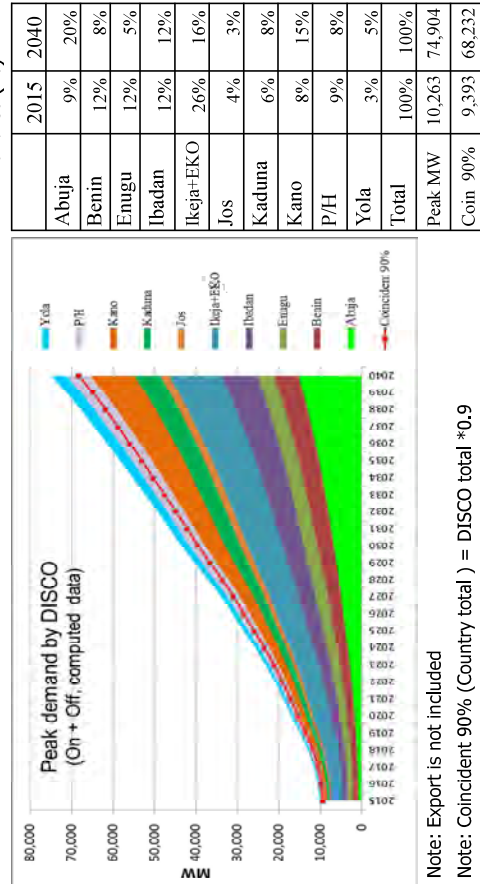
	2015	2020	2025	2030	2035	2040	2040/15
Recorded data							
Abuja	468	1,215	3,807	6,806	10,327	15,308	15.0
Benin	628	1,211	2,677	3,928	4,871	5,904	9.4
Enugu	657	1,205	2,500	3,276	3,668	4,062	7.7
Ibadan	666	1,412	3,310	5,144	6,754	8,676	10.8
Ikeja+EKO	1,472	2,946	5,883	8,500	10,433	12,562	9.0
Jos	201	424	1,000	1,703	1,926	2,149	10.0
Kaduna	315	739	1,960	3,764	4,898	6,249	12.7
Kano	405	952	2,495	4,792	7,813	10,620	14.0
P/H	488	1,028	2,567	3,790	4,736	5,792	10.4
Yola	143	429	1,070	1,870	2,906	3,582	13.8
Total	5,422	11,561	27,270	43,574	58,331	74,904	11.1
Country	4,880	10,545	24,824	39,650	53,093	68,232	11.1

Source: Study team estimation

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3.4 Peak demand shares by DISCO

Shares (%)



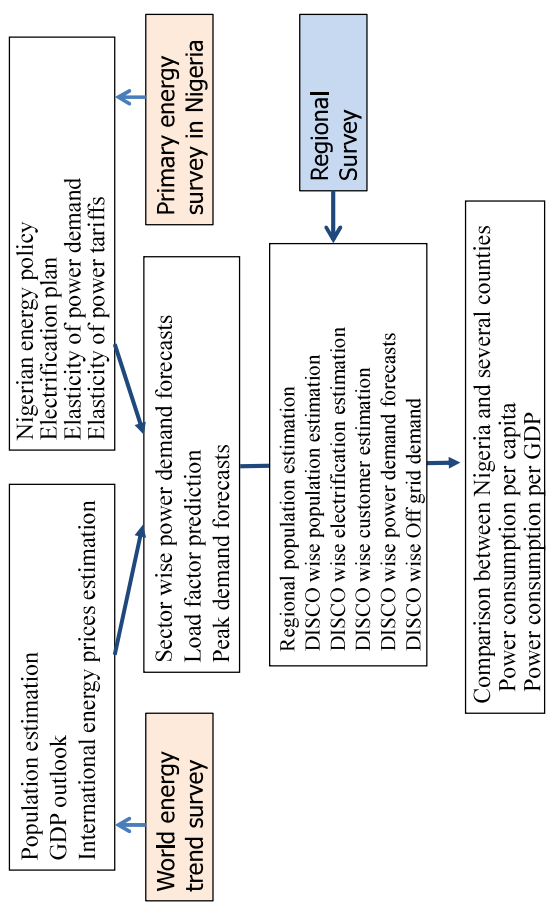
Note: Export is not included

Note: Coincident 90% (Country total) = DISCO total * 0.9

	2015	2040
Abuja	9%	20%
Benin	12%	8%
Enugu	12%	5%
Ibadan	12%	12%
Ikeja+EKO	26%	16%
Jos	4%	3%
Kaduna	6%	8%
Kano	8%	15%
P/H	9%	8%
Yola	3%	5%
Total	100%	100%
Peak MW	10,263	74,904
Coin 90%	9,393	68,232

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5. Update power demand forecasts
5.1 Procedures of Power demand forecasts



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5.2 Social and economic forecasts

Update items	Authorities
Population forecasts	NPopC, NBS
GDP outlook	NPC, NBS
Exchange rate	NPC, MOF, CBN
Inflation rate	NPC, MOF, CBN
Crude oil Price	MPR, NNPC
Power tariff	NERC

NPopC: National Population Committee
MPR: Ministry of Petroleum Resources

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5.3 Power demand forecasts

Update items	Authorities
Residential sector	TCN, NERC, ECN
Commercial sector	TCN, NERC, ECN
Public and Street sector	TCN, NERC, ECN
Transmission loss (T- loss)	TCN, NERC, ECN
Total power demands	TCN, NERC, ECN
Peak demand	TCN, ECN
Generation	TCN, ECN
Required capacity	TCN, ECN
Export	TCN, ECN
Off grid power demand	REA, TCN

5.4 DISCO wise power demand

Update items	Authorities
Regional Survey	TCN ,DISCOS
Sectoral customers	TCN ,DISCOS
Sectoral power demand	TCN ,DISCOS
On + Off grid power demand	TCN ,DISCOS

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5.5 Task force image

Task force	Authorities	Conductors
Social economic forecasts	NPC, MOF, NPopC, NBS, CBN	FMP
Energy supply conditions	ECN, MPR, NNPC	
Power demand forecasts	TCN, NERC	
DISCO power demand forecasts	TCN , DISCOs	
Off grid plans	REA , TCN	

Note: NPopC: National Population Commission
DISCOs: 11 DISCOs