Minutes of Meeting

Ministry of Energy and Water Resources (MEWR)and JICA Expert Team

4 -8 November 2019 (Barbados)

Date and Time: 4 Nov-8 Nov 2019

Location: MEWR and Grenada

Participants:

1) Ministry of Energy and Water Resources (MEWR)
   - Ms. Francine Blackman, Permanent Secretary
   - Ms. Debra Dowridge, Deputy Permanent Secretary
   - Mr. Horace Archer, Senior Technical Officer
   - Mr. Tyrone White, Electrical Engineer

2) BL&P
   - Mr. Roger Blackman (MD)
   - Mr. Johann Greaves (Director, Operation),
   - Ms. Joan Bourne (Engineering Manager, Planning/Projects)
   - Mr. Rohan Seale (Director, Asset Management Dept)
   - Mr. Cori King (Manager)

3) JICA Expert Team (JET)
   - Mr. Masaaki Ebina, Sub Team Leader/Power System
   - Mr. Yasuhiro Sakamoto, Energy Efficiency
   - Ms. Yuka Nakagawa, Renewable Energy
   - Mr. Hiroaki Niimi, Grid Stabilization
   - Ms. Anna Miyaura Human Resource Development
   - Mr. Alex Harewood

The 1st Joint Coordinating Committee (JCC) and Kick-off Workshop in Barbados:

The first JCC Meeting/Kick-off Workshop was held on 7th November at Radisson in Grenada. Agenda and objectives of the JCC are:

1) To confirm the current situations/issues and result of Baseline Survey in the area of Renewable Energy and Energy Efficiency carried out for the last 6 months.
2) To share the revised Project Design Matrix (PDM) and to review the progress measurement indexes in the Monitoring Sheet.
3) To share the overall objectives and goals of the program including, Outputs, Activities, Means of Verification and Schedules

As a result of the JCC, the technical cooperation program by JICA was unanimously agreed upon by MEWR in Barbados.

BL&P, a member of the C/P Team, could not attend the JCC. JET setup meeting separately with Managing Director of BL&P and staffs from relevant departments on 5th November.

Revised PDM was discussed and agreed upon by BL&P. Under the circumstances, MEWR agreed that this meeting was considered as a part of JCC.

Discussions:

< Project Design Matrix (PDM) >

Project Design Matrix (PDM) was revised to reflect the outcome of the meetings until the 3rd Mission in August 2019, as shown in red-letters in the Attachment 4.

Major changes from the original PDM would be as follows:

1) Introduction and demonstration of digitized network management system will be additionally included in the training to enhance the "resiliency" which is one of the major concerns among CARICOM countries.
2) Introduction of customized computer modeling for one of the areas in Barbados to examine the Micro-Grid Concept, in view of technological and economical points. This will replace the feasibility study on potential RE sites (originally stipulated in Output 3-1).

MEWR will submit revised PDM to the Cabinet.

<Approach to Introduce Micro-Grid in Coverley Village >

It was agreed to create grid model for "GridSim", grid analysis software and conduct training program, by using existing Coverley Village grid infrastructure, and to examine various scenarios using "what if" approach as follows, but not limited to:

What if:

1) All the houses and shopping mall install roof top PV and EV chargers
2) EV charging station is constructed nearby
3) Airport is connected to the grid and University is also connected to the grid
4) Rent a Car company at the airport is invited and use all EVs
5) Larger PV power generation facilities are constructed nearby

JET is to develop a road map jointly with MEWR and BL&P and examine in view of technological viability/affordability/operational risk/resiliency, and prepare execution plan which might be of the interest of international development organization for funding.

<BL&P>

In order to release proprietary information, BL&P require Non-disclosure Agreement (NDA) with JET. After signing of NDA, BL&P will provide information necessary for modeling power network infrastructure in Coverley Village. The data would include asset data, single line diagram, Grid GIS data, detailed demand profile data, and all other relevant data.

<Statistics of Energy Use in view of Energy Efficiency>

1) EE roadmap will be formulated based on the data provided by MEWR primarily,
2) Long term demand forecast (e.g. up to 2028) is to be provided by BL&P in consideration

with the diffusion of various EE technologies including electric vehicles (EVs).

List of Attachment:

1) JCC Attendance List
2) Presentation slide on Baseline Survey
3) Presentation slide on revised PDM and Monitoring Sheet #1
4) PDM/ PO rev.1

End of the MoM

Ministry of Energy and Water Resources (MEWR)

7st November 2019
Francine Blackman, Acting Permanent Secretary

JICA Expert Team

7st November 2019
Masaaki Ebina, Team Sub Leader

Attendant List

Project: Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Meeting Title: MEWR
Venue: MEWR meeting Room Date: Nov. 4, 2019 Time: 14:30

SN	Name	Organization	Title	Mobile or E-mail	Signature
1	Yuka Nakagawa	JICA Expert Team	Re-Expert	[redacted]	
2	Tyrone White	Electrical Eng. Dept.	C.E.O.		
3	HORACE ARCHER	MEWR	STO		
4	Francine Blackman	MEWR	PS (ag)		
5	Debra Dowridge	MEWR	DPS (Ag.)		D.D.
6	ALEX HAREWOOD	JET	Technical Assistant		
7	ANNA MIYAURA	JET	Expert of Capacity building		宮浦
8	Yasuhiro Sakamoto	"	EE Expert		
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Attendant List

Project: Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Meeting Title: BL&P

Venue: BL&P Date: 5 Nov. 2014 Time: 9:00

SN	Name	Organization	Title	Mobile or E-mail	Signature
1	Yuka Nakagawa	JICA Expert Team	PE Specialist	[redacted]	
2	Joan Bourne	Barbados Light & Power	Planning/Project Engineering Mana		
3	CORI KING	BARBADOS LIGHT AND POWER	MANAGER		
4	JOHANN GREAVES	BLPC.	DIRECTOR OPERATIONS		
5	ROHAN SEALE	BLPC	DIRECTOR ASSET MANAGE		
6	ROGER BLACKMAN	BLPC	MANAGING DIRECTOR		
7	ANNA MIYAURA	JET	Expert of Capacity Building		
8	Yasuhiro Sakamoto	JET	EE Expert		
9	HIROAKI NIIMI	〃	GRID STABILISATION		
10	MASAAKI EBINA	〃	Sub-leader		
11	ALEX HAREWOOD	〃	Technical Assistant		
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Joint Coordinating Committee (JCC) for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Baseline Survey Report

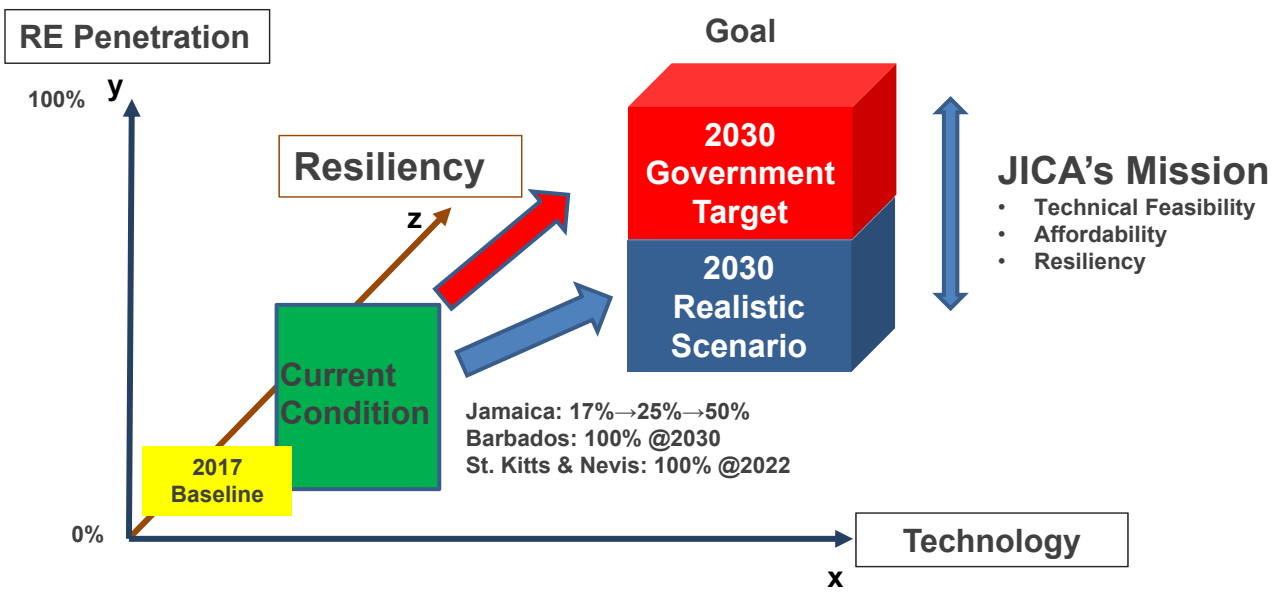
October-November 2019

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

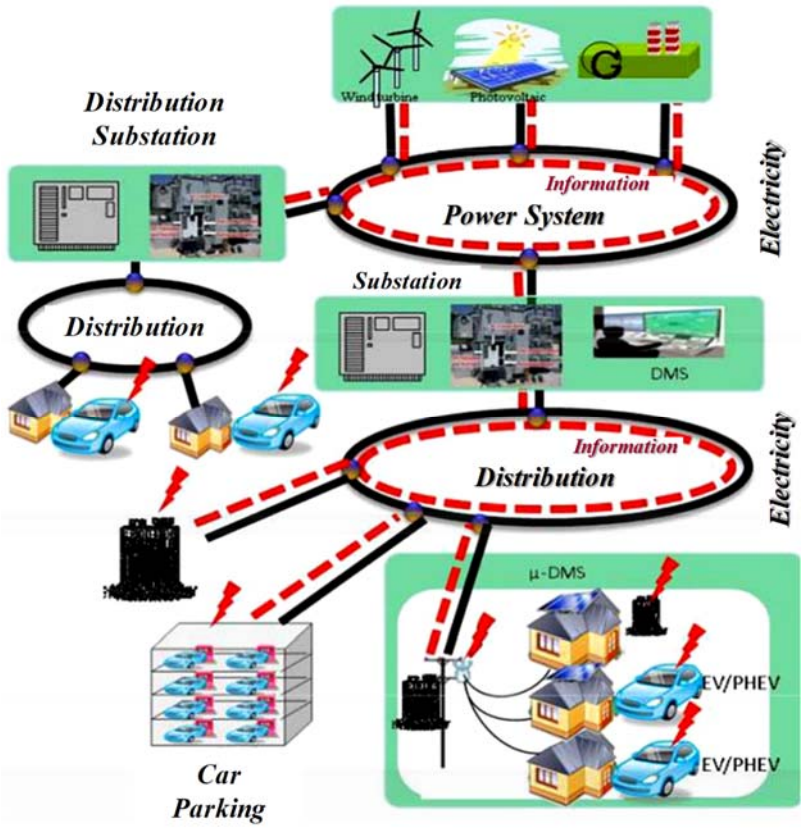
1. Project Outline

JET's Mission Recognition

Three Dimensional Approach is required: RE Penetration %, Technology, and Resilience



Micro-grid Concept



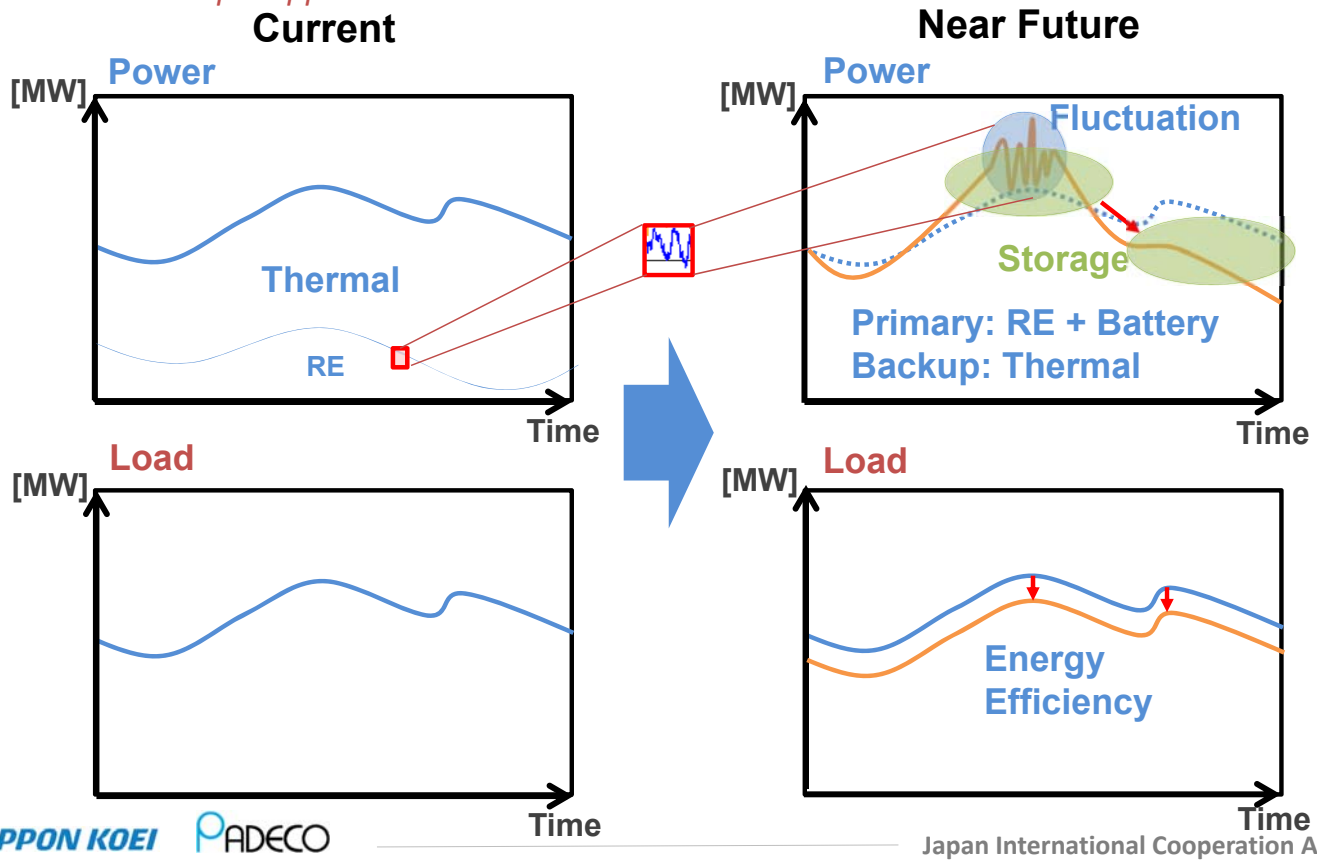
Concept of Micro-grid

- ✓ Respective Micro-grid is connected each other, and each Micro-grid can work independently
- ✓ Local energy production for local consumption
  - ✓ Generation: PV, wind, biomass, DG, GT, battery, etc.
  - ✓ Demand: industry, commercial, home, EV, etc.
- ✓ Less transmission → loss saving
- ✓ With IoT, control system, EMS, demand response, smart meters → Smart energy
- ✓ Enhance resiliency

Source: Smart City Development and Recent trend in Electric Power Network, Waseda Univ.

Challenges

- Fluctuation of VRE and necessity of energy storage and buck-up
-RE and EE multiple approach



Project Period/ Outputs

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	33	34
Phase 1 (Baseline Survey)						Phase 2 (Technical Transfer)																													34 months	
Year 2019									Year 2020												Year 2021												2022		
4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

Output 1
The basic information is confirmed for the capacity building for the introduction of RE

Output 3
The human and institution capacity are enhanced for the mass introduction of RE

Output 2
The basic information is confirmed for the capacity building for the promotion of EE

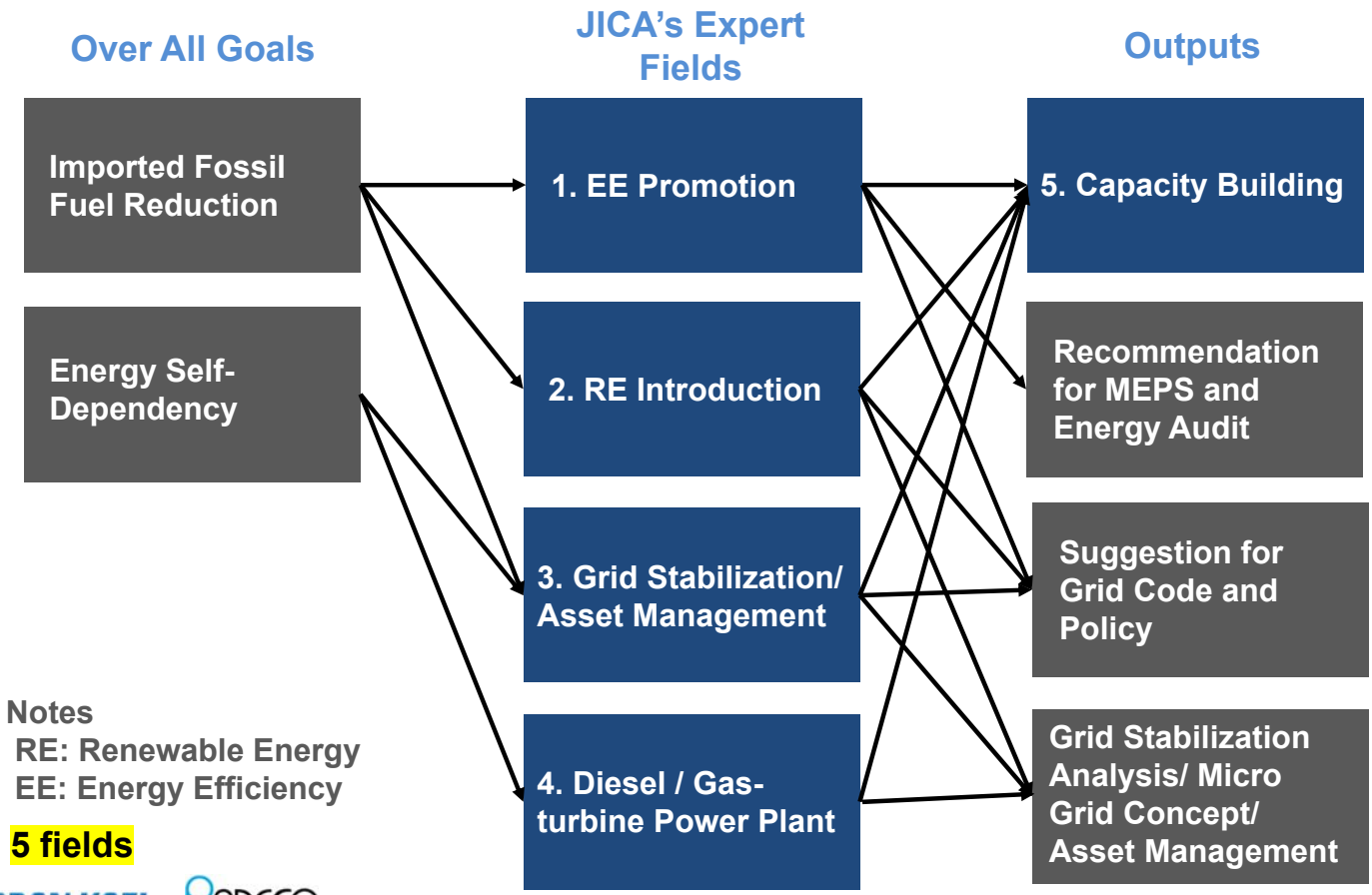
Output 4
The human and institution capacity are enhanced for the promotion of EE

4 outputs

This JCC #1 aims to share the result of Baseline Survey belong to output 1 and 2.

As the result, JET proposed revised work plan and PDM based on discussion on previous meetings for assistance of achieving your goals.

Project Outline/ Contents Outline



Notes
RE: Renewable Energy
EE: Energy Efficiency

5 fields

JICA Expert Team

Team Leader Group/ Power System


1. EE Promotion

5. Capacity Building

2. RE Introduction


3. Grid Stabilization/ Asset Management

4. Diesel / Gas-turbine Power Plant

8 Japanese Experts

NIPPON KOEI PADECO

Contents

2. Baseline Survey Report

Summary

Fields	Findings	Project Activities
1. Energy Efficiency	• Energy Source: Electricity (54%) , Oil (42%) • Load Curve: Bactrian camel type • Annual Peak Demand: about 150MW • Peak Period: 2pm - 3pm, 7pm-8pm	Priority 1: VRF Priority 2: BEMS Priority 3: Optimized operation with inverter
2. Renewable Energy	• 100% RE target incl. fuel by 2030 • 14% RE (generation), 2% of RE (energy base) • Good RE potential, but project plan not concrete • 10MW Trents PV + 12 MW Roof top	Confirmation of affordability and feasibility of 100% RE target Future project IP confirmation Training for grid simulation Micro-grid concept study
3. Grid Stabilization	• 5MW, 20 MWh BESS, 400 USD/MWh • 0.02 Hz with 1MW fluctuation, Ramp Rate 3MW/min • Fuel increase for spinning reserve	
4. O&M of Thermal Power Generation	• Thermal power plant: total 16 units (10 units for base load and 6 units for peak load • Installed Capacity: Total 255.5MW • Predictive Maintenance: Conducted twice a year	-
5. Human Resources and Capacity Building	• MEWE's Energy Conservation and Renewable Energy Unit: 3 employees • Most of capacity building is done by OJT • There is no systematic HR development.	JET experts select topics and develop the most suitable curriculum for technology transfer period

Energy Efficiency

- **Current situation 1-1: Energy consumption outlook by sector and energy source (EE efforts need to be made based on country's Energy Balance prepared properly)**
  - Transportation sector is the largest energy consuming sector (33%) followed by commercial & public services (25%) and residential (20%) sectors.
  - Electricity is the largest energy source (54%) followed by oil (42%).

Energy consumption by sector and energy source on primary energy basis (ktoe)

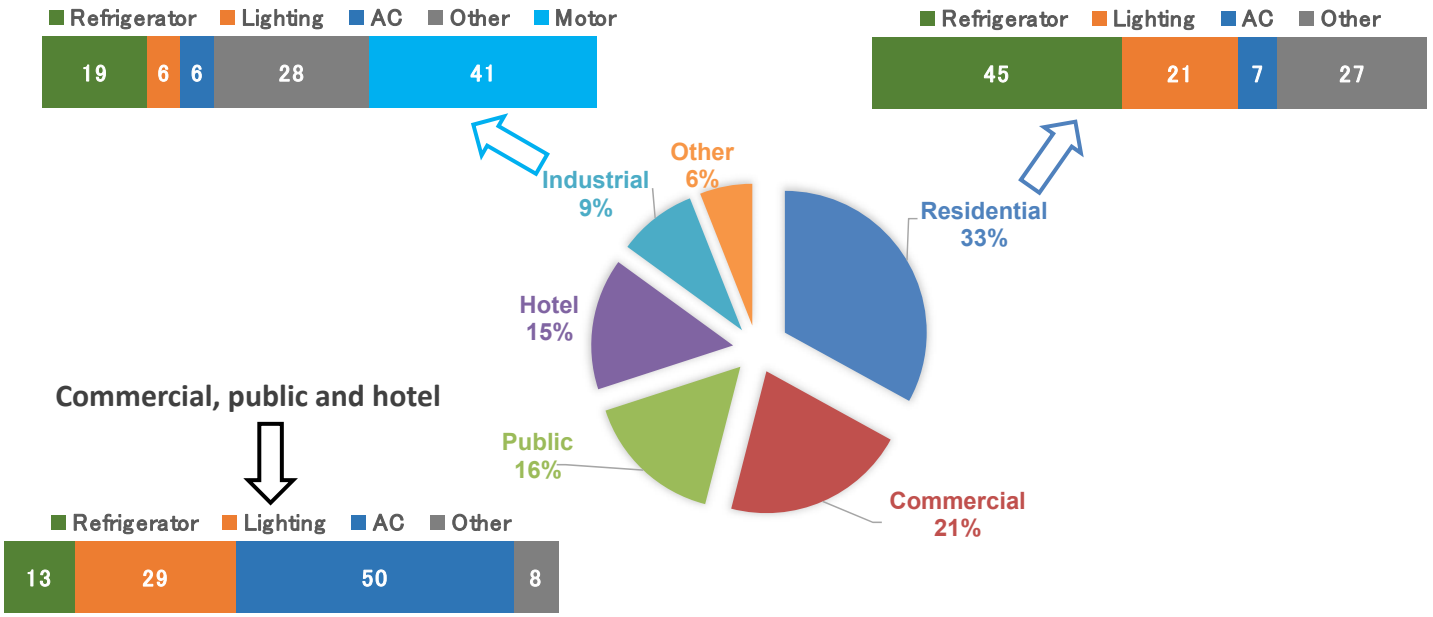
	Industry	Commercial & public	Residential	Other	Transportation	Total
Oil	17	12	8	1	138	175 (42%)
Natural gas	1	7	2	0	0	10 (2%)
Bio/waste	7	0	0	1	0	7 (2%)
Charcoal	0	0	0	0.2	0	0.2 (0%)
Electricity (primary energy basis)	19	84	74	47	0	224 (54%)
Total	43 (10%)	103 (25%)	83 (20%)	48 (12%)	138 (33%)	416 (100%)

Note 1: Primary energy conversion factor of electricity is utilized to evaluate the effect of energy saving by reduction of 1kWh of electricity consumption at demand side.
Note 2: To calculate primary energy consumption of electricity, energy efficiency at end use (36.3%) was used based on the material by Government of Barbados.
Source: JET with reference to energy balances (2016) by United Nations Statistics Division for overall energy balance and the material above mentioned (Note 2) for primary energy conversion factor calculation of electricity.

Energy Efficiency

- **Current situation 1-2: Electricity consumption by sector and end-use**

Electricity sales by demand group (last 10 years) and end-use



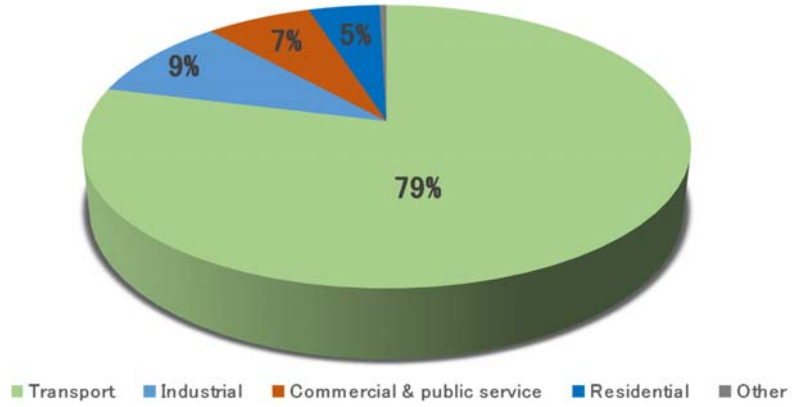
Source: JET with reference to Barbados NATIONAL ENEGY POLICY (2019-2030) and material by the Government of Barbados

Energy Efficiency

- **Current situation 1-3: Oil consumption situation**

  - Excluding oil used for power generation, 79% of oil is consumed by the transport sector (ground transportation) followed by industrial sector (9%) and commercial & public service sectors.

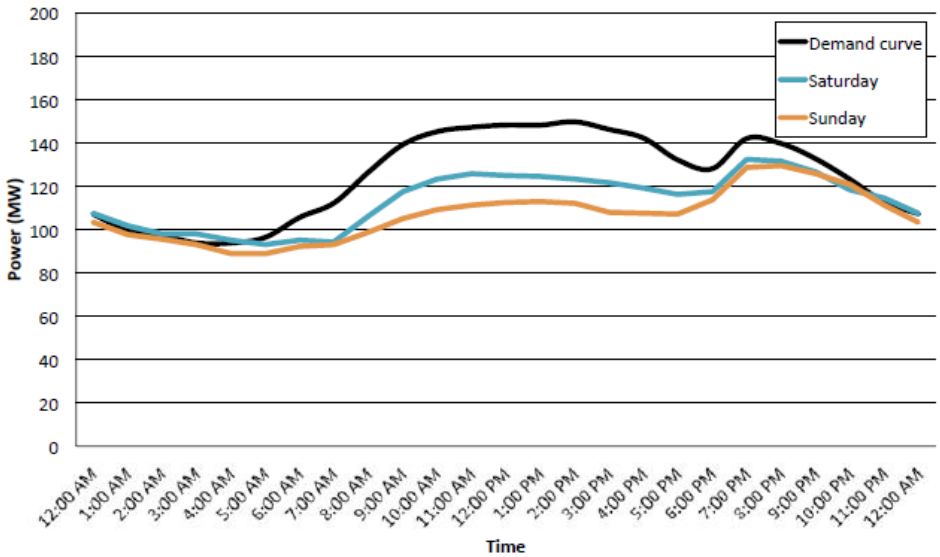
Petroleum consumption by sector excluding power generation use, 2016



Source: JET with reference to energy balances (2016) by United Nations Statistics Division.

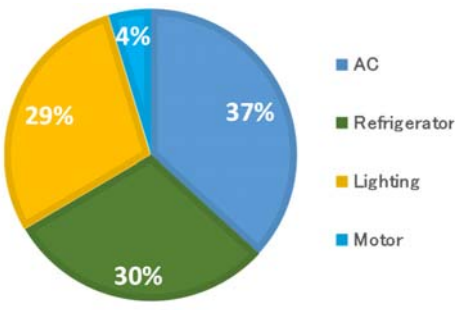
Energy Efficiency

- **Current situation 1-4: Electricity load curve**
  - At present, annual peak demand is considered to be approximately 150MW.
  - As for the load curve, the daily peak demand is generated between 2:00 pm & 3:00 pm, and the demand increase again between 7:00 pm & 8 pm for lighting demand (Bactrian camel type (very common)).



Source: Presentation material by the university of the west indies, Sep.2016

Breakdown of power consumption by end-use (all sectors)



Source: JET based on material by the Government of Barbados

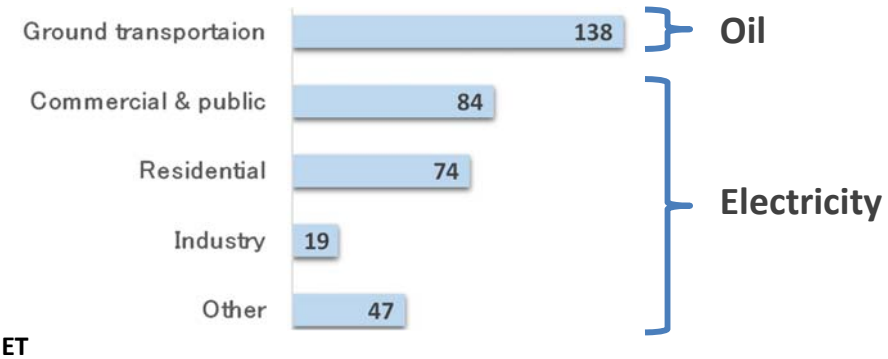
Energy Efficiency

- **Points of studies and proposals on EE measures:** Studies and proposals shall be made with high priority for the energy consumption fields indicated **in red**.
- The **coverage ratio of high priority EE fields = 89%** (362/408)

(ktoe)

	Oil	Electricity	Natural gas	Charcoal	Bio/Waste	Total
Primary energy consumption	175	224	10	0.2	(7)	408
Industry	17	19	1		(7)	19
Residential	8	74	2			74
Commercial & public services	12	84	7			84
Other	1	47	0	0.2	(1)	47
Ground transportation	138					138
Primary energy consumption to be studied as to EE measures with high priority	138	224				362

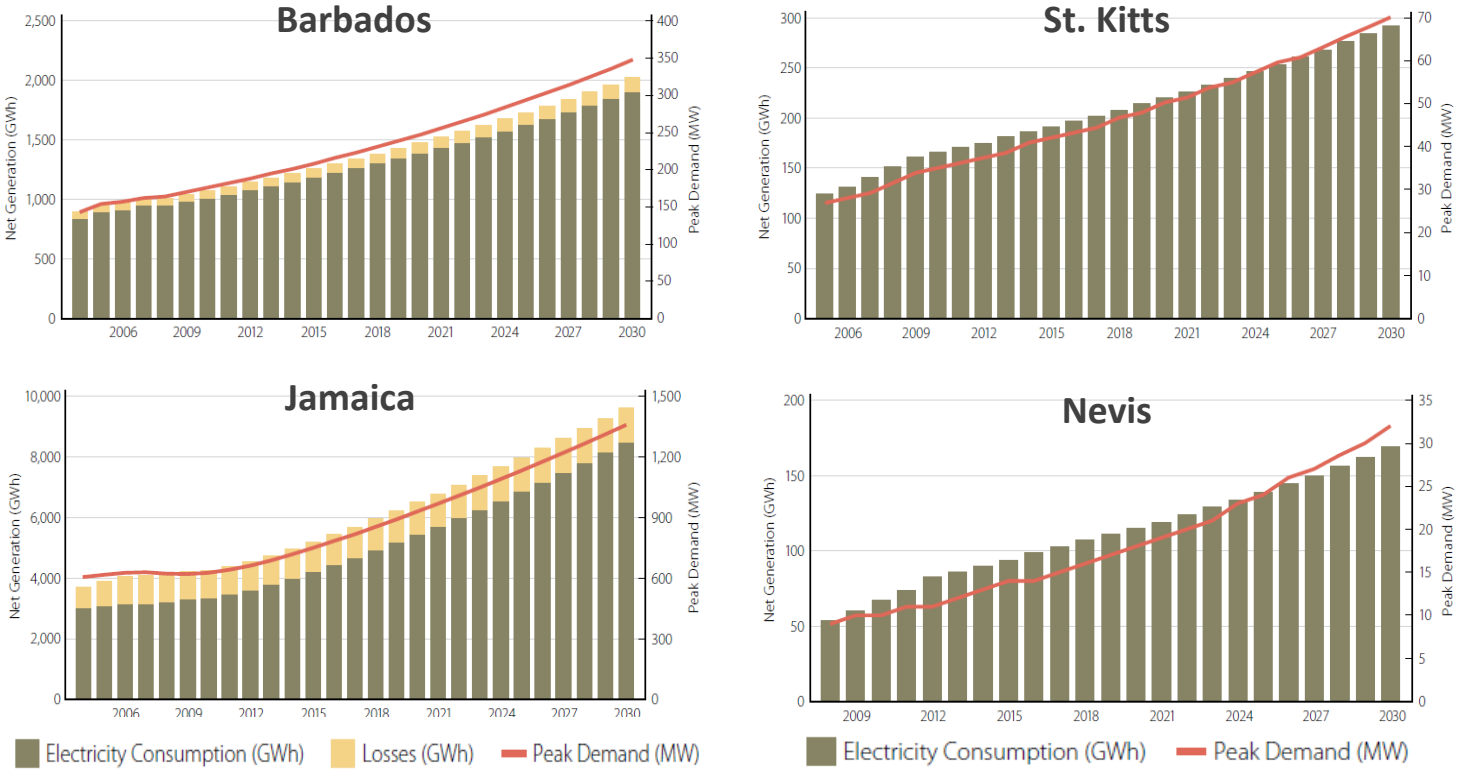
Primary energy consumption by EE high priority field



Source: JET

2-1. Baseline Survey Report- Energy Efficiency

Energy Efficiency



Electricity System Forecast

Source: Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS) (Worldwatch Institute, IDB, GIZ (2015))

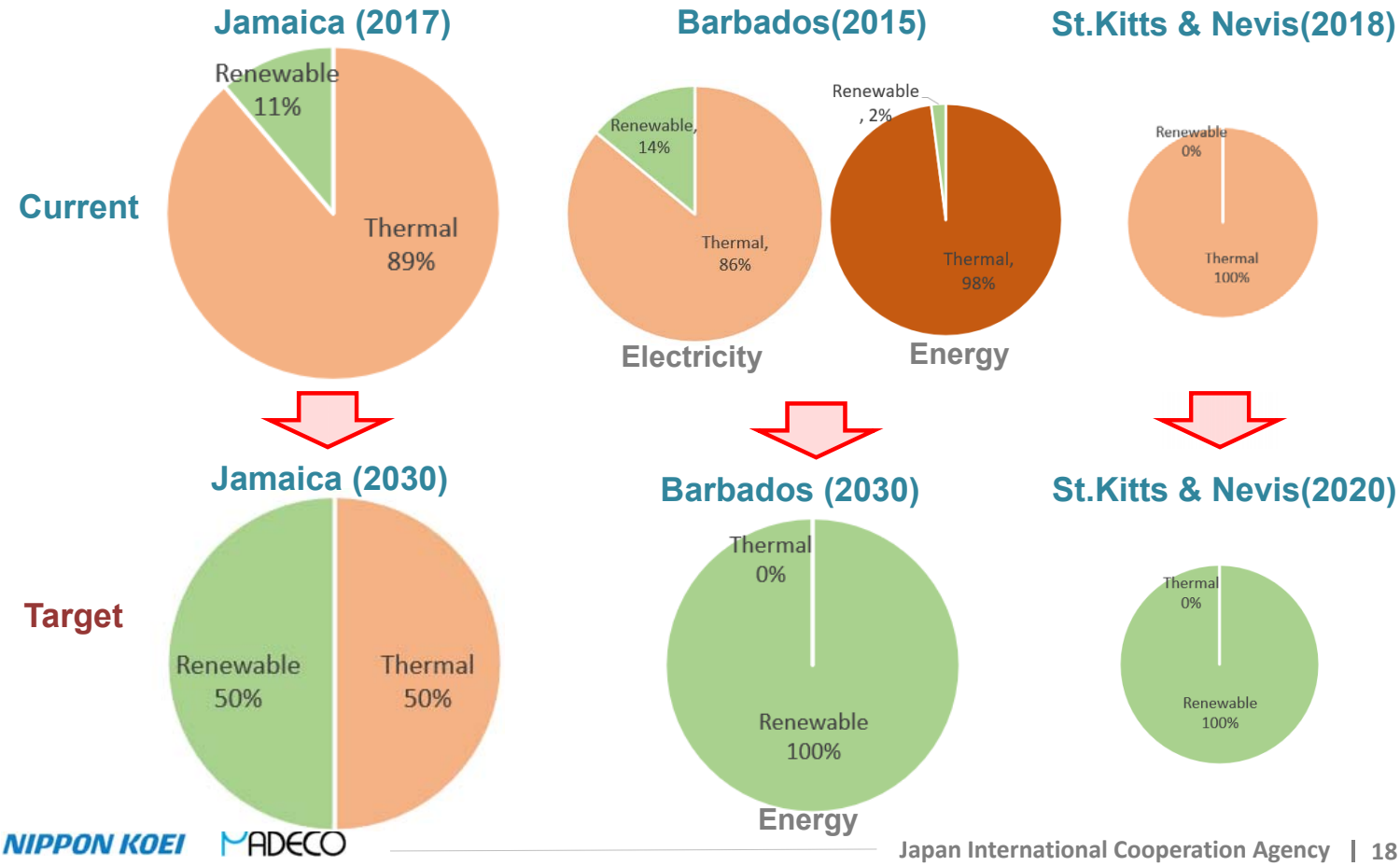
Energy Efficiency

EE technologies summary with priority (needs survey results)

Priority	Barbados	Jamaica	St. Kitts & Nevis
1	VRF (Variable Refrigerant Flow)	BEMS	Optimized operation with inverter
2	BEMS	Mini split AC with inverter	Mini split AC with inverter
3	Optimized operation with inverter	LED	VRF (Variable Refrigerant Flow)
4	(Smart meter)	VRF (Variable Refrigerant Flow)	LED
5	Mini split AC with inverter	Optimized operation with inverter	BEMS
6	Efficient refrigerator incl. inverter type	Efficient refrigerator incl. inverter type	(Smart meter)
7	Efficient motor (IE1 - IE3 level)	Efficient motor (IE1 - IE3 level)	Amorphous metal transformer
8	LED	Heat recovery system (co-gen, heat recovery heat pump)	Efficient motor (IE1 - IE4 level)
9	Heat recovery system (co-gen, heat recovery heat pump)	(Smart meter)	Heat recovery system (co-gen, heat recovery heat pump)
10	Amorphous metal transformer	Amorphous metal transformer	Efficient refrigerator incl. inverter type
New	Electric Vehicle (EV)	Electric Vehicle (EV)	

EE technologies with high priority/needs is consistent with the "points of studies and proposals on EE measures"

RE: Current Status of RE



RE&Grid: Summary of Baseline Survey

Summary of Indicators for RE and Grid

Item	Barbados	Jamaica	St.Kitts & Navis
Access to Electricity	100%	100%	100%
SAIDI (hrs/customers/yr)	3.68	46.7	0.0: 7.5 hrs (2016)
SAIFI (outages/customers/yr)	5.84	19.7	0.0: 3 times (2016)
Composition of power sources, 2018 (Capacity, MW)	Thermal 239 PV10+21(FIT)	Thermal 843.3, Hydro 28.6, VRE 122 Rooftop 20?	Thermal 44.9&18 PV 1.2 & Wind2.2
Pecentage of RE (Electricity)	12.4%	14.9%	2.6%
Power consumption (GWh) including estimation	Total: 950, RE:14% (BNEP) 2%, total energy base	Total 4356, Hydro146, VRE358 estd. RE 12%	Total 208&56 RE: 1 & 5.25 (0 & 9%)
Grid stabiliztion	5MW, 20MWh BESS	21.5 MW, 16.6MWh BESS + 3MW Flywheel	NA
Electricity tariff ($/kWh)	0.28	0.284	0.26
CO2 emission factor (tCO2/MWh)	0.737	0.688	0.691
Grid status (Customer, line length, loss)	130,000 customer TL 169km DL2800km Loss 4.8%	>0.6mil customer 138/69 kV :366/794km MV 11,280 km 43 Substation Loss 26.3%	SKELEC customer 20,815, Loss 12% NEVLEC Loss 14%

RE: Key T/C Activities for RE

Barbados

- Provision of Grid simulation software and training
- Micro-grid concept study at Coverley Village
- Energy source diversity (incl. waste treatment in cement plant)

Jamaica

- Training for grid simulation
- Introduction of network asset management
- Micro-grid concept study at Bogue area

St Kitts &Nevis

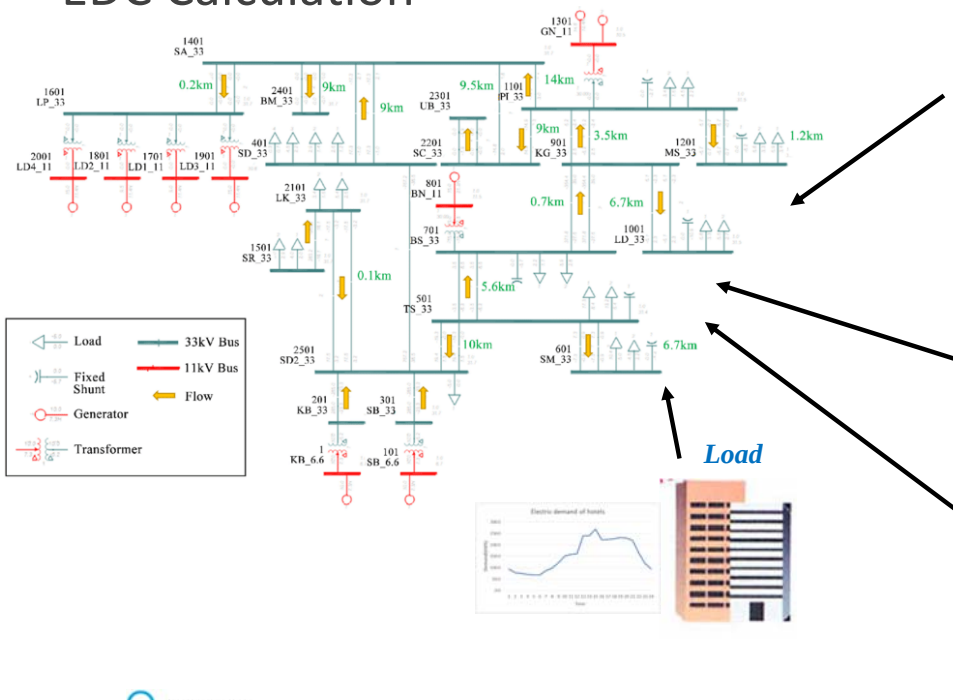
- Provision of Grid simulation software and training
- Introduction of network asset management

✓ **Discussion for grid code**

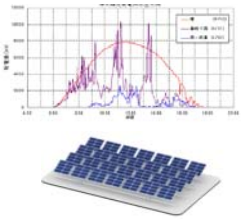
✓ **Suggestion for policy and RE target with reviewing affordability of RE**

Grid Stabilization Simulation

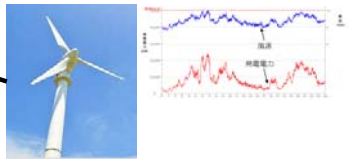
- Simulation of National Grid Model
- Analysis of Issues and Solutions
- EDC Calculation



Photovoltaic Generation

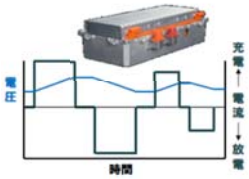


Wind Generator



Load

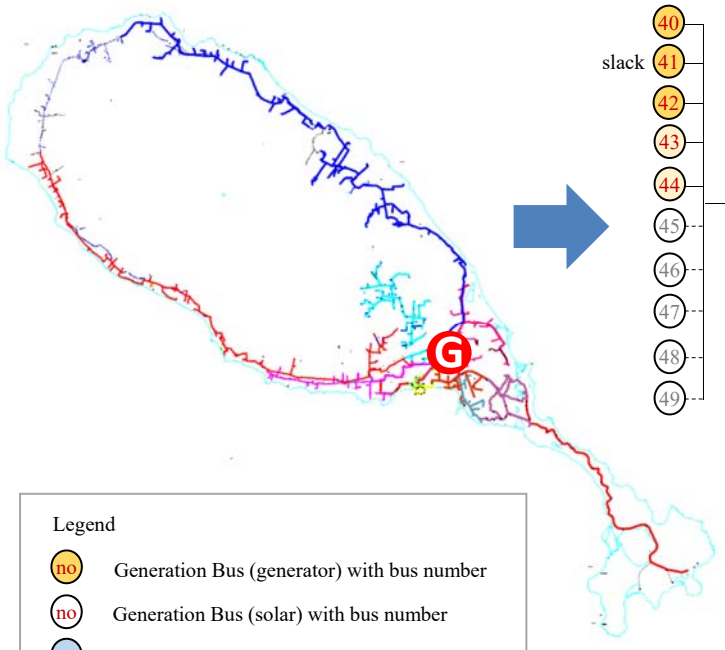
Battery

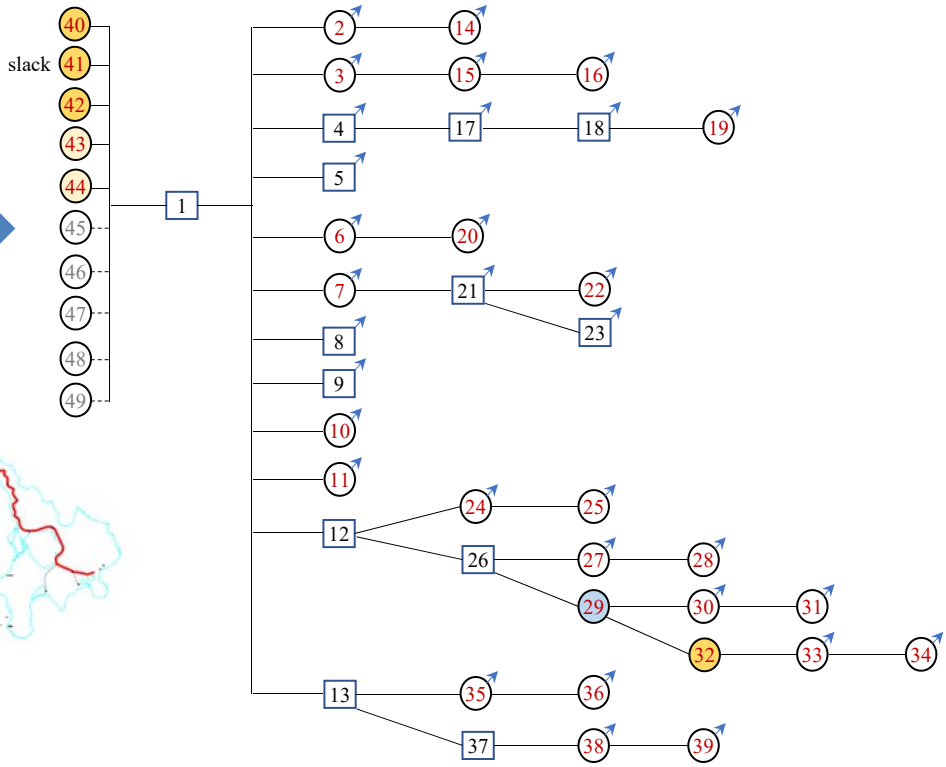


Grid Stabilization Simulation Mod

For St. Kitts & Nevis Only

Schematic view of Grid configuration (11kV)



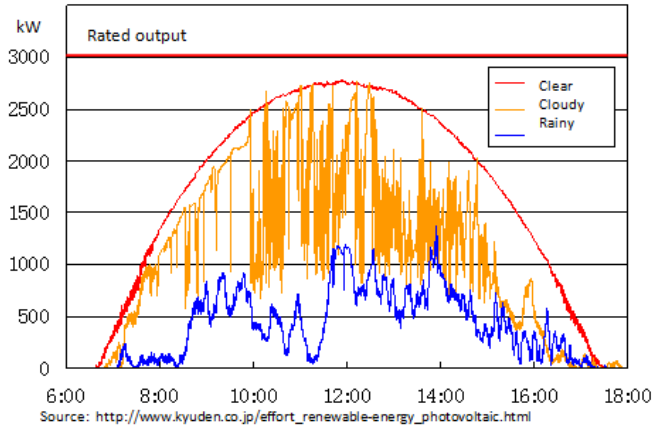


Legend

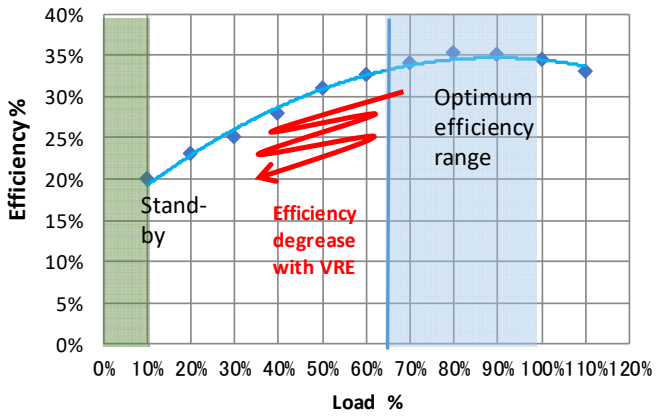
- no — Generation Bus (generator) with bus number
- no — Generation Bus (solar) with bus number
- no — Generation Bus (wind) with bus number
- no — Load/Transit Bus with bus number
- Load

RE: With Large RE Penetration

- VRE causes frequency and voltage fluctuation
- Load shedding due to fluctuation:
- Efficiency reduction
  - 10% DG efficiency reduction offsets 30% RE output in micro-grid without grid stabilization method
  - Increasing fuel consumption

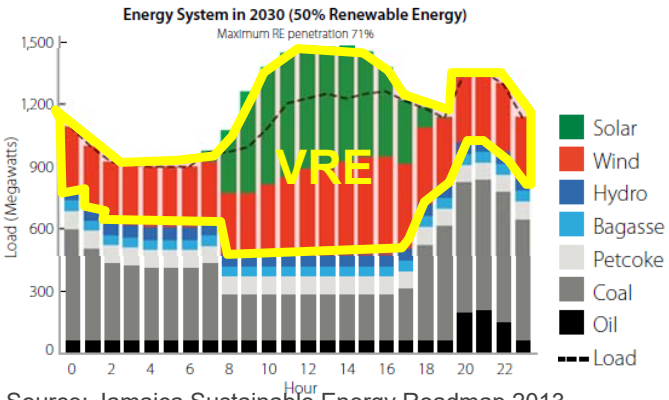


PV output in each whether



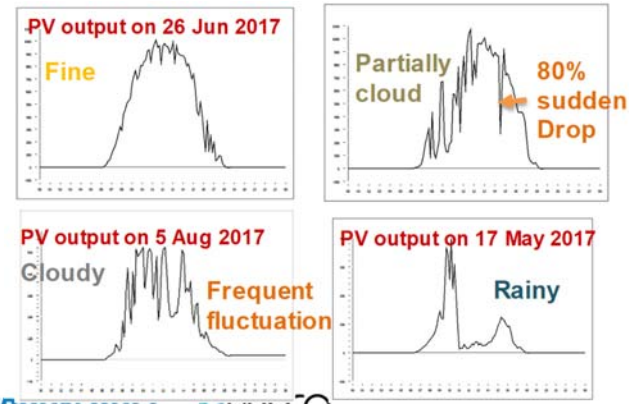
Load and efficiency of typical diesel generator

RE: Instability Caused by VRE



Source: Jamaica Sustainable Energy Roadmap 2013

Spinning reserve is necessary for RE fluctuation.



Grid instability

- Voltage and frequency fluctuation
- Shortage of Inertial power
- High cost for countermeasure

Fuel L/kW increase in diesel generator

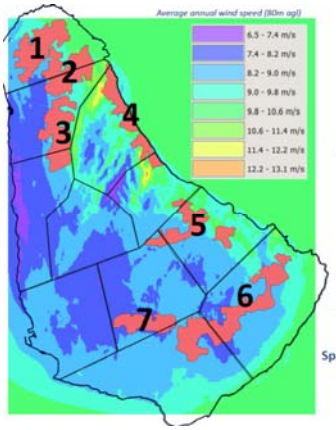
- Low load operation
- Acceleration and deceleration
- Spinning reserve

→ **EMS and Battery Storage are necessary for grid stability and economic operation (expensive)**

→ **It might need to optimize RE%**

VRE %	< 20%	20-60%	> 60%
Issue	Response by thermal poser	Voltage and frequency fluctuation, power failure increase	(in addition to left) harmonic wave, phase balance, synchronization, supplement of reactive power
Equipment needed for grid stabilization	Output restrain by PCS, EMS	EMS and high-speed charge-discharge battery or capacitor, quick-response thermal power	Power factor control PCS is needed. Special arrangement according to site is necessary.
Cost	Low	High (battery replacement is necessary)	Very high. Specific technical arrangement is necessary

RE: Status in Barbados

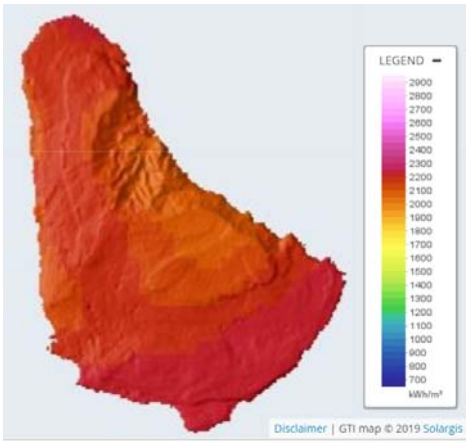


Zone	Area (km²)	No. 2MW turbines	Annual yield (GWh)
1	9.4	34	218.1
2	9.2	33	218.0
3	9.4	30	193.1
4	7.0	34	245.5
5	7.9	27	166.7
6	16.2	58	301.1
7	5.2	20	94.7
	64.2	236	1,437.3

Space for 472MW of wind

Current Barbados electricity demand is ~950 GWh/year!

Measuring and mapping wind energy in Barbados 2016



Source: ESMAP

RE Potential

- ✓ Irradiation 4.4-4.7 kWh/kW, 2050-2240 kWh/m2/yr
- ✓ 472 MW wind potential identified but constrained by land availability

RE Projects

Location/Project	Type	Capacity MW
BL&P Trents	PV	10
Rooftop (FIT)	PV	21
Lambers ?	Wind	10?

Challenges for RE

- ✓ 100% RE target for all energy
- ✓ Grid stability
- ✓ Bottle neck : land availability and environment
- ✓ More options necessary: CSP
- ✓ RE Project pipeline and implementation plan is necessary

RE: Status in Barbados

BNEP Indicators for RE (2015)

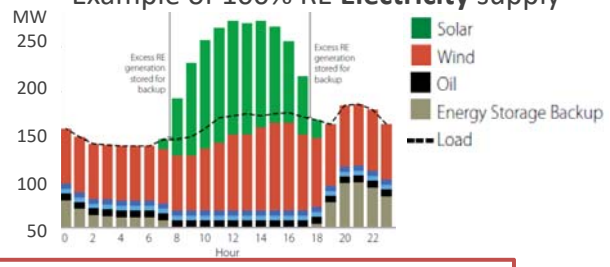
Percentage Share Of The Renewable Energy Supply In The Total Energy Supply For Given Period (%)	2.00%
Percentage Share Of The Solar Supply In The Total Energy Supply For Given Period (%)	0.30%
Percentage Share Of The Biomass Supply In The Total Energy Supply For Given Period (%)	2.10%
Percentage Share Of The Bio-diesel Supply In The Total Energy Supply For Given Period (%)	
Percentage Share Of The Electricity Generated From Renewable Supply In The Total Electricity Generated For Given Period (%)	14.00%
Percentage Share Of The Electricity Generated For Solar Supply In The Total Electricity Generated For Given Period (%)	1.70%
Percent Share Of The Electricity Generated For Biomass Supply In The Total Electricity Generated For Given Period (%)	12.30%
Renewable Energy Intensity (BOE/M$US)	20.782

100%

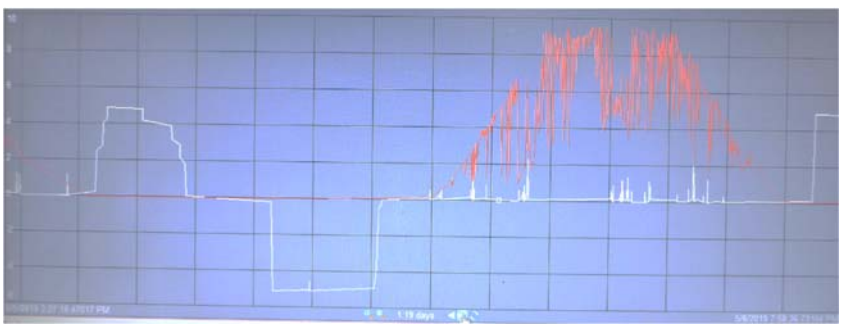
?

100%

Example of 100% RE **Electricity** supply



PV and Battery Operation at Trents 10MW PV &



For 100% RE target:

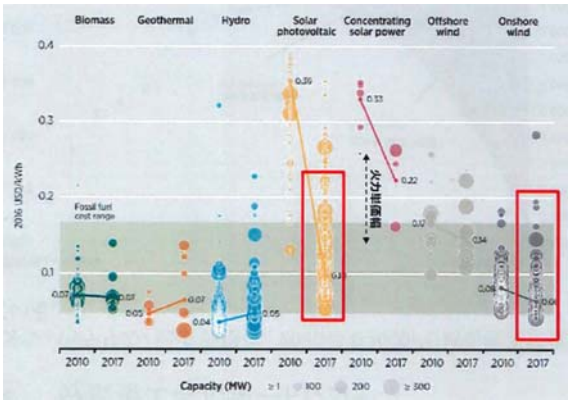
- ✓ Review of affordability and feasibility
- ✓ Additional RE for EV
- ✓ RE project implementation plan
- ✓ Very large scale energy storage
- ✓ Control and cost reduction method
- ✓ Investment cost consideration and fund procurement

RE: Way Forward for Large RE Penetration

Paradigm Shift

- VRE generation itself is low cost, promoted by market
- Grid stabilization is necessary for large scale
- **Inertia** needs to be considered
  - Biomass, Biogas, CSP
- Large cost for energy storage

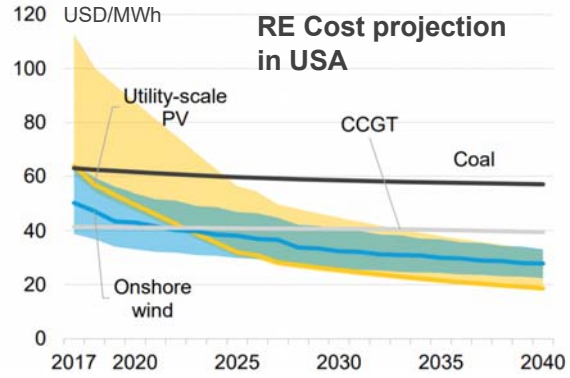
→ **Who owns the stabilization cost?**



Source: Mitsubishi Electrics, IRENA RE cost database

Necessary consideration in project activity

1) Grid Stabilization
2) Cost reduction of energy storage
3) Resiliency
4) Microgrid



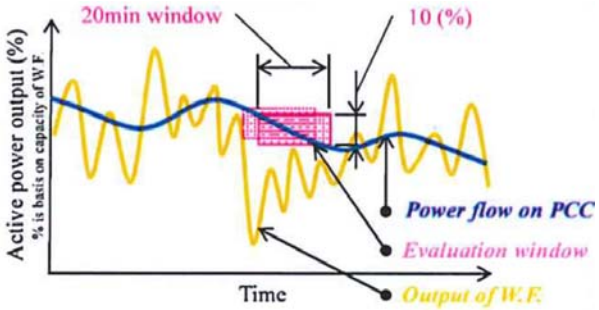
Source: Power Markets Today, Broomberg 2018/ METI, Japan

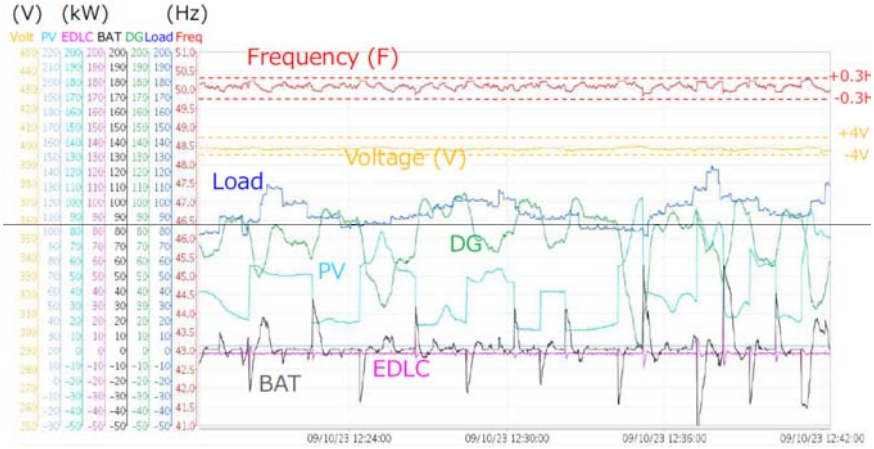
RE: Example of Grid Stabilization with RE and energy storage

For Voltage and Frequency stabilization (below)

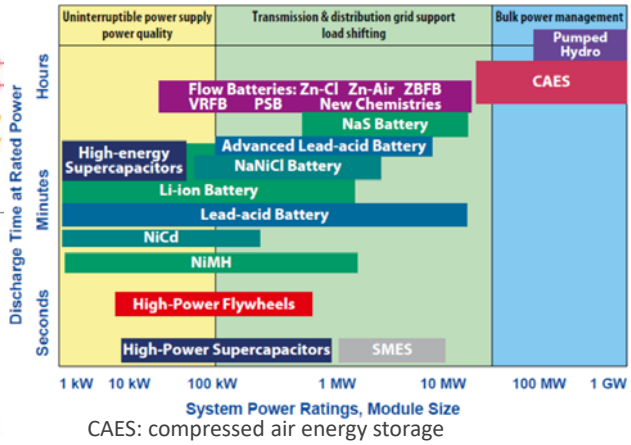
- ✓ Generation: PV, Wind, DG, GT, etc.
- ✓ Energy Storage: Battery (BAT), Capacitor (EDLC)
- ✓ Load /Demand control
- → **Grid Simulation is necessary**
- → **Various energy storage needs to be considered**

Smoothing output





Source: Meidensha, Autonomous Micro-grid Conference, 2019

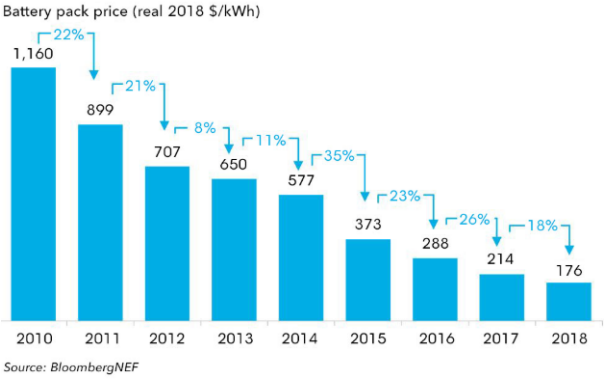


CAES: compressed air energy storage
Source: IRENA, Electricity Storage and Renewables, 2017

RE: Cost consideration of BESS

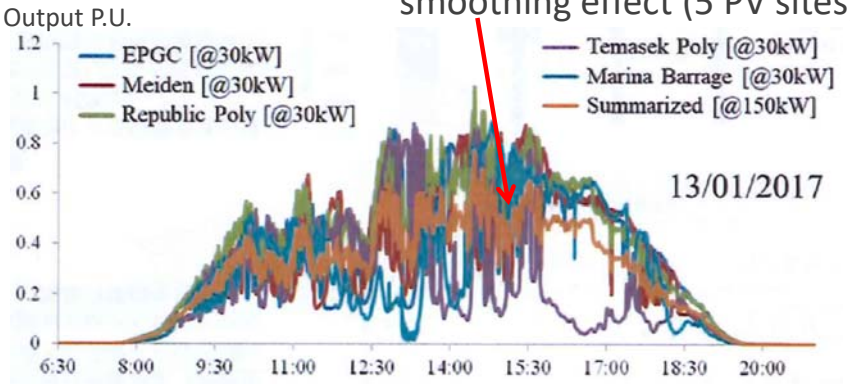
1) Output smoothing by overlaying different PV/wind locations
2) Battery at each site → Centralized battery storage system

Battery cost reduction, but still high cost



Cost reduction Example in Singapore

67% of battery capacity can be reduced by output smoothing effect (5 PV sites)



Source: Meidensha, Autonomous Micro-grid Conference, 2019

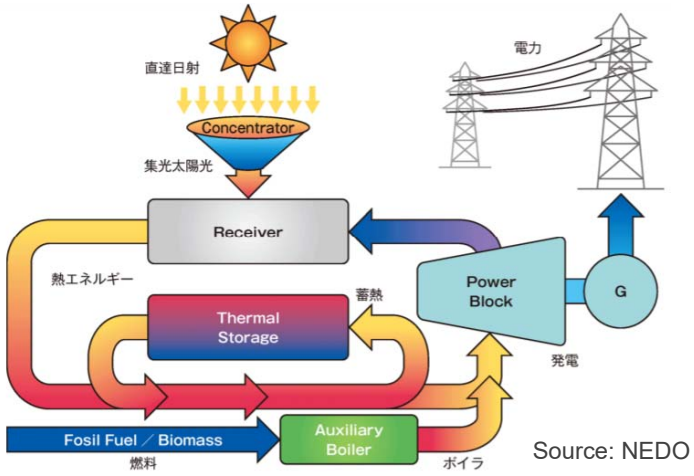
To reduce cost:
- Data analysis with solar irradiation/wind speed short interval necessary at several locations
- Speedy communication system advanced EMS control is necessary

National grid oriented program is necessary

→Battery capacity and EMS cost should be considered in Tariff

RE: Optional Technology : CSP

Concentrating Solar Thermal Power (CSP)



Source: NEDO

- Inertial power can be supplied
- Combination with molten-salt heat storage
- Inertial power can be supplied
- Combination with molten-salt heat storage

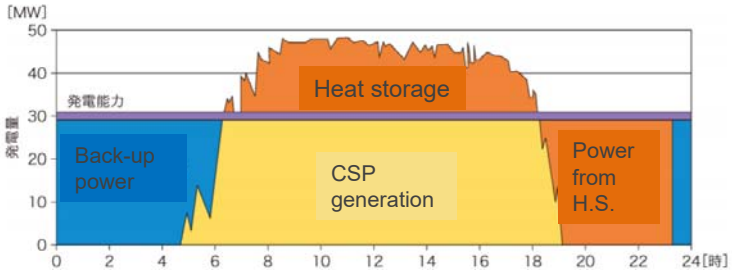
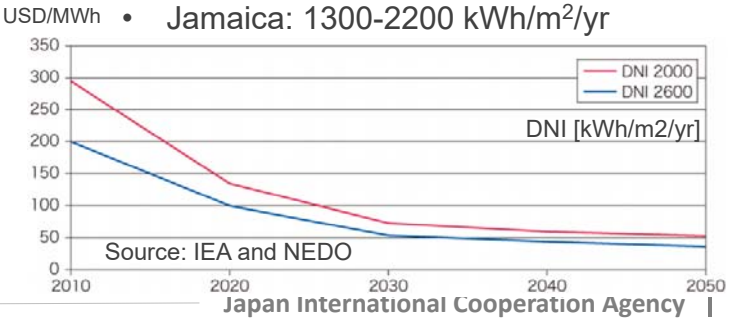


Photo: blog.eco-megane.jp/

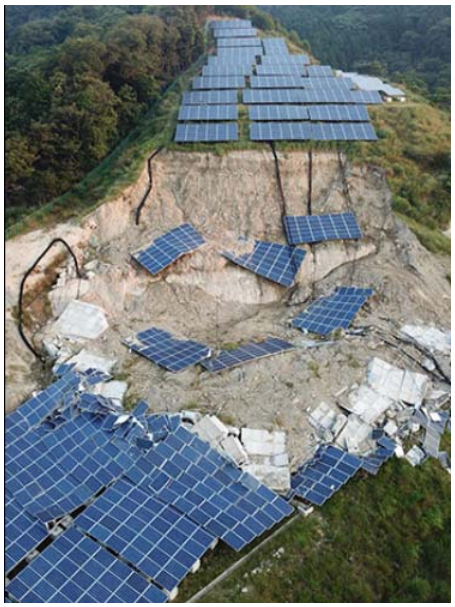
- DNI (Direct normal irradiation)
  - Barbados: 1600-2000 kWh/m²/yr
  - St Kitts&Nevis:1600-2300 kWh/m²/yr
  - Jamaica: 1300-2200 kWh/m²/yr



RE: Resiliency of RE

23 Aug 2018 Awaji, Japan
https://www.sankei.com/west/news/180828/wst1808280043-n1.html
600 kW, Fallen at 25.6m/s wind while 60m/s design
- Additional moment due to Excess of high speed
- Missing control power supply

9 Sep 2019 Kanto, Japan
@kadowaki_kozo
Damage of roof-top structure by high speed wind



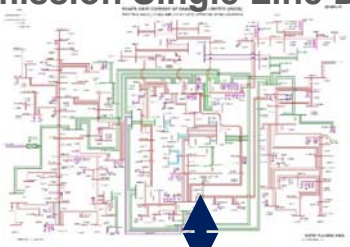
26 Jul 2019 Himeji, Japan
https://www.dailyshincho.jp/article/2018/07260800/?photo=1
Landslide by a heavy rain

For enhancement of resilience:
- ✓ Design Standard with higher rank hurricane
- ✓ Compensation, third party Insurance coverage
- ✓ Safety Education for shock
- ✓ Fast recovery with **GIS and Asset management**
- ✓ **Micro-grid**

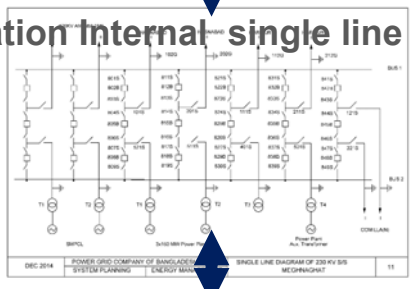
RE: Resiliency Enhancement - Digitalized Network Management System

Linking all asset data on to one data platform

Transmission Single Line Diagram

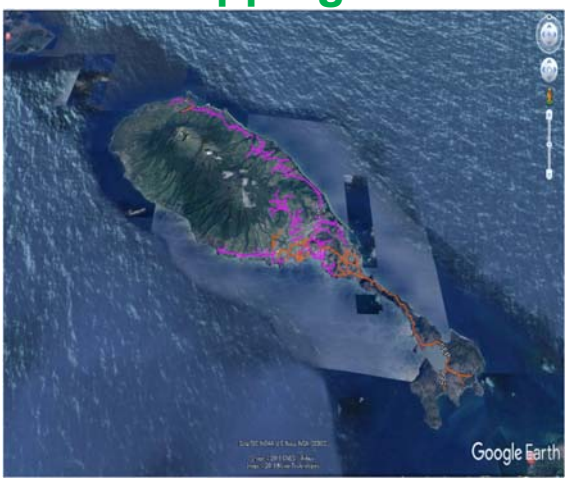


Substation Internal single line diagram



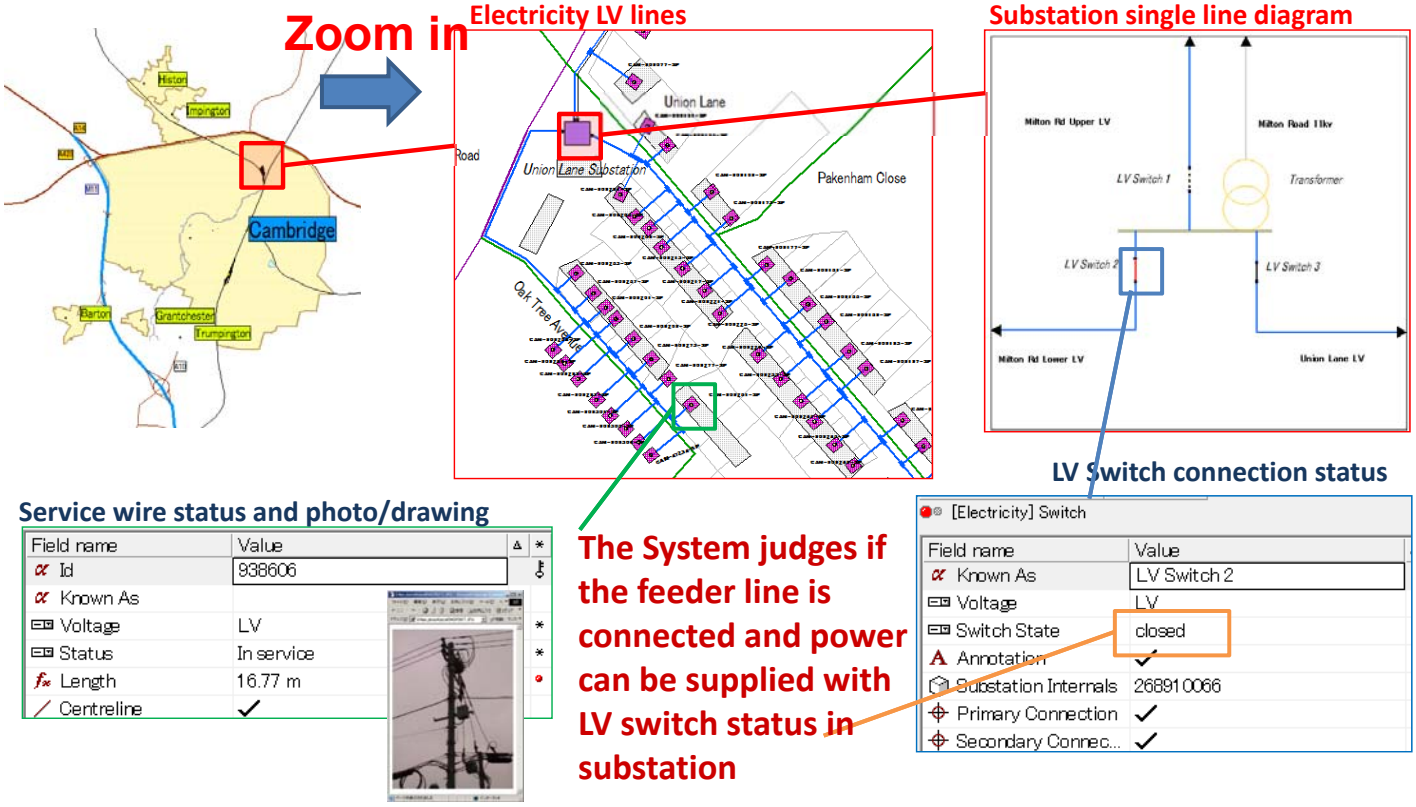
Power distribution network to meter

Power Network Mapping Data



- Visualization of precise location
- Base for fast fault recovery
- Asset management of small VREs
- Database for EE verification

RE: Resiliency Enhancement - Digitalized Data Model

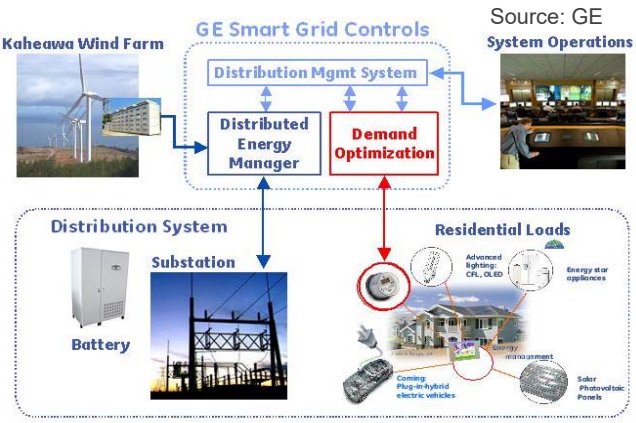


RE: Large RE Example in Islands

40% RE: Hawaii

Hawaiian Electric Company: Expansion of distributed power sources
Nos of customers: 462,225, total 1,795 MW, VRE 673 MW

- Energy storage
- Output suppression of wind and solar
- 15% peak load reduction



100% RE: Samoa (USA)

Source: JICA

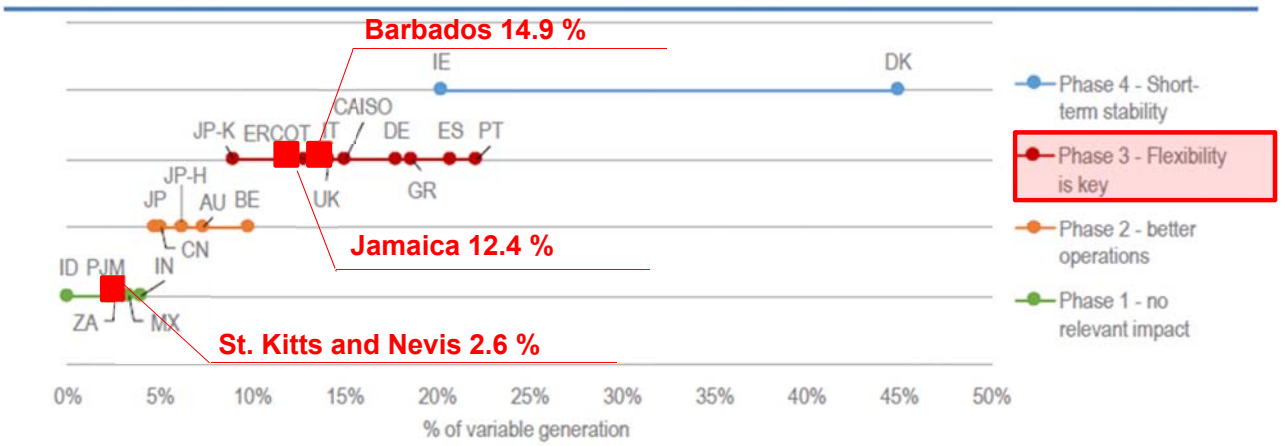
3 villages, 203 household, population 790
Peak **229kW**, Demand1300 MWh/yr, **3.6 MWh/day**)
RE: **1.4 MW PV (6.1 times than peak)**
Battery: **750kW**/**6 MWh** LIB, Tesla 20yrs guarantee
DG: 320kW × 3, 150kW × 1

Mon	Jan	Feb	Mar	Apr	May	Jun
RE%	98.4	97	99	91.2	89.9	99.6

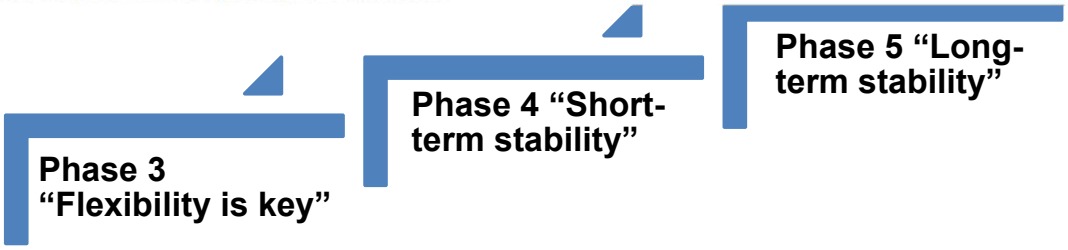
Small demand, but huge RE and Battery
→ **Micro-grid**, Back-up DG is necessary

Current Situation of VRE Generation Share

Annual VRE generation shares in selected counties and correspondence to deferent VRE phases, 2016



Source: Adapted from IEA (2017a), *Renewable 2017.*



Balance

Cost and Benefits, Power and Load, Myths and Reality

Grid Simulation

Photo: Steve Buissinne via Pixabay

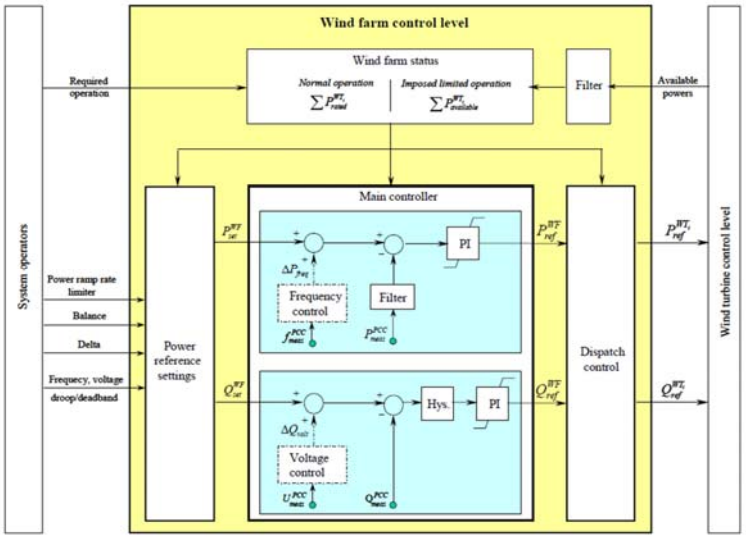
Grid Simulation Software

Country	Current Condition	T/C Activity
Jamaica	Power Factory/DIgSILENT by IRP consultant	GridSim: Montego Bay Area Modeling*
St. Kitts	Data for PSS/E by a past external consultant, currently not available	GridSim: Transmission/Distribution Network Modeling
Navis	--	GridSim: Transmission/Distribution Network Modeling
Barbados	PSS/E, ETAP by BL&P	GridSim: for Coevally Area Modeling and for training of government staff*
CARICOM	--	Requested for other Caribbean countries

***: JET recommended GridSim for technology transfer in the view of transparent and migratable from existing software.**

Solution 1: Revising Grid Code: EU Cases

Active/ real power control

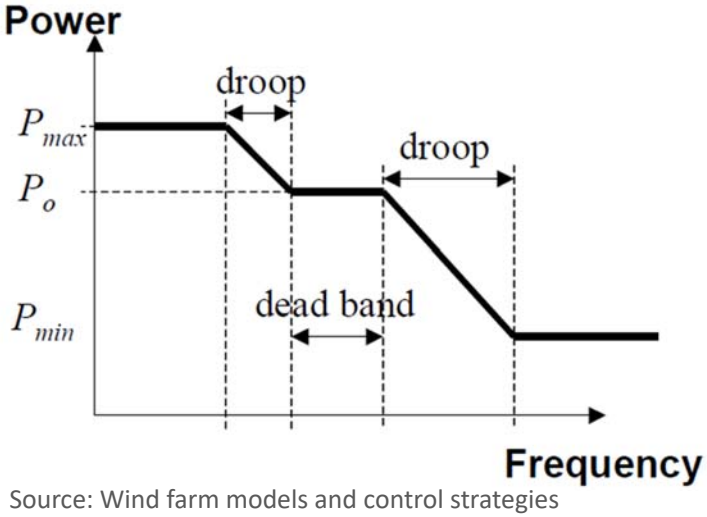


Source: Wind farm models and control strategies

- VRE can be controlled the limitation of active power based on power system condition

Regulated in EU, Germany, UK, Ireland, Denmark etc.

Frequency droop control



Source: Wind farm models and control strategies

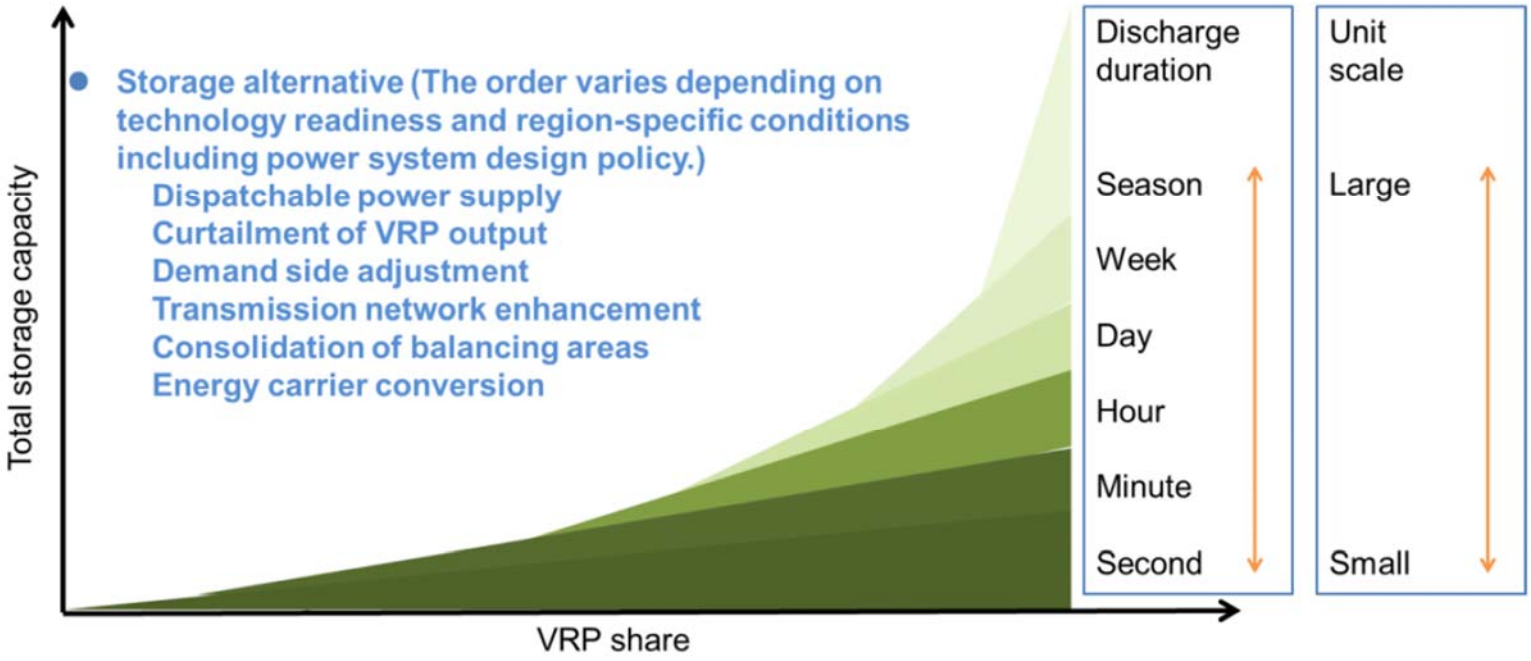
- Same as thermal power plant control
- For frequency stabilization

Regulated in EU, Germany, UK, Ireland, Denmark etc.

Solution 2: Application of Large Capacity Energy Storage System

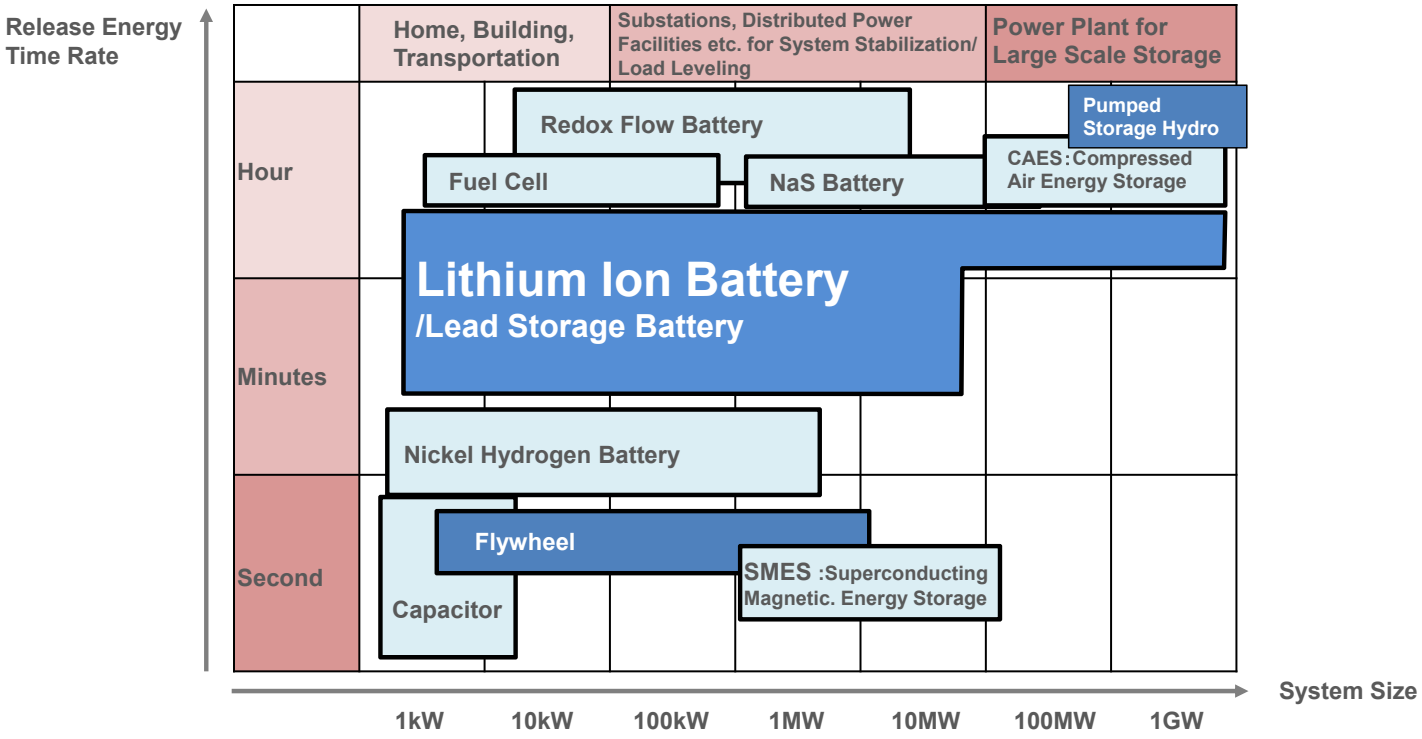
Variable Renewable Energy (VRE) Share and Storage Requirements for Power Systems

(Source: The Institute of Applied Energy)



Source: ICEF2017 Energy Storage Roadmap

Positioning for Energy Storage Technology



Source: NEDO Renewable Energy Technology White Paper Chapter 9

Current Status of Stationary Electric Energy Storage Technology

Technology	Order of Capacity (MWh)	Cycle Efficiency (%)	Energy Density (Wh/l)	Initial Investment Cost (USD/kWh)	Initial Investment Cost (USD/kW)	Maturity*	Discharge Time				
							Sec.	Min.	Hr.	Day	Month /Season
PSH	100-1,000	50-85	0.1-0.2	250-430	500-4,600	H		←	—	→	
CAES**	10-1,000	27-70	2-6	60-130	500-1,500	H		←	—	→	
LAES	10-1,000	55-85	N.A.	260-530	900-1,900	M-H		←	—	→	
Power to Hydrogen	10-1,000	22-50	600***	440-870****	500-750	M-H			←	—	→
Battery	0.1-100	75-95	20-400	290-2,000	300-3,500	M-H		←	—	→	
SMES	0.1-10	90-95	6	700,000	130-520	L-M	←	→			
Flywheel	0.1	90-95	20-80	7,800-8,800	130-500	M		←	—	→	
Capacitor	0.1	90-95	10-20	1,000	130-520	M	←	→			

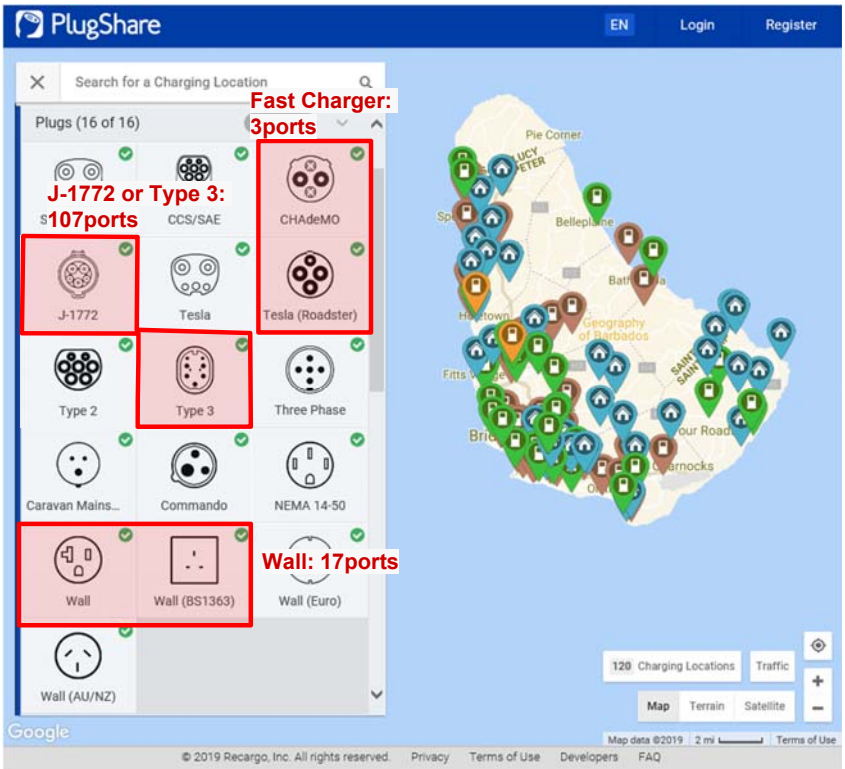
PSH: Pumped-Storage Hydropower
CAES: Compressed Air Energy Storage
LAES: Liquid Air Energy Storage
SMES: Superconducting Magnetic Energy Storage

(notes) * L:Low M:Medium H:High
** Underground Cavern Storage Case
*** 600bar Compressed H_2 Case
**** Hydrogen Production Facility Only

Source: ICEF2017 Energy Storage Roadmap

Current EV Situation

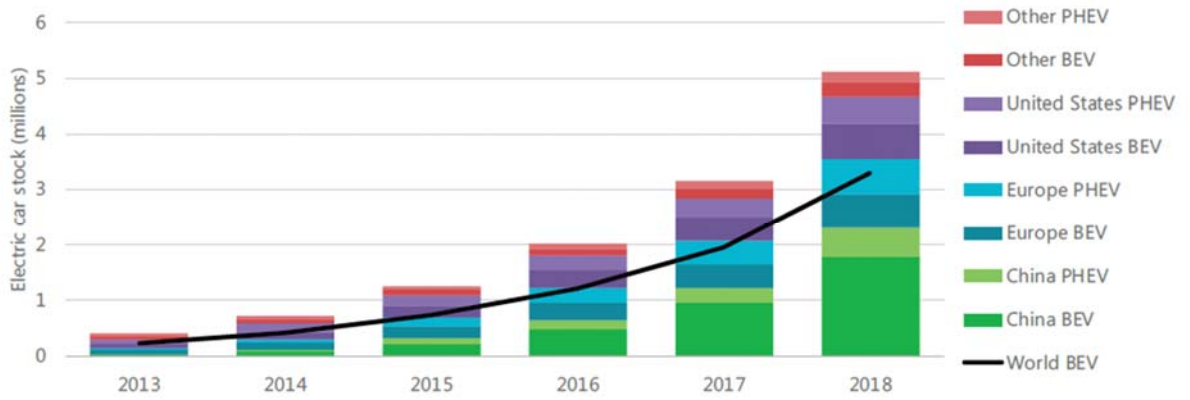
Number of car and motorcycle	Total : **150,000** on July 2011[1] **approximately 100,000**[5] Detail[1] - Private Motor Car 90,400 - Private Motorcycle 2,061 - Hired Vehicle 2,467 - Taxi 1,677 - Route 287 - Omnibus 441 - Tour Coache 98 - Minibus 161 - Max Taxi 676
Number of EV	About 320 cars on May 2018 [1] Increased 37 cars from January 2019 to July 2019[2] Currently little less than **400** cars
EV dealer	Only 1 company (Megapower) on May 2018[1]
Number of Charging port	Total **120** ports including household use[3]
Spec. of Charging Port	**2 Ports; Fast Charger**(CHAdeMO, 50kA)[2] 107 Ports; Type 3 or J-1772[3] 17 Ports: Wall[2]
EV Battery Capacity	average 24kWh[4] cf. Nissan Leaf: 24kWh model
EV Model	More than 200 cars ; **Nissan Leaf**[1] Others ; Unknown



Source
[1] ConPlusUltra GmbH (2018), Barbados Sustainable Energy Industry Market Assessment Report
[2] JET's interview to Megapower [3] PlugShare.com [4] Stacia Howard(2018), Monitoring Energy Efficiency in Barbados
[5] Barbados national energy policy 2019 - 2030

Current EV Situation in the World

Passenger electric car stock in main markets and the top-ten EVI countries



Notes: BEV = battery electric vehicle; PHEV = plug-in electric vehicle. Other includes Australia, Brazil, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand.

Source: IEA Global EV Outlook 2019

Still EV share is 0.25% compared to all the car stock in the World

100% EV Scenario

Assumption Items

- Total vehicle stocks: 100,000 vehicles[1]
- Vehicle utilization rate: 50% (no source)
- Vehicle average driving distance: 23km/day (based on Okinawa case in Japan)[2]
- Battery mileage: 9.5 km/ kWh (Nissan Leaf 24kWh)
- Charge Loss: 15%[3]

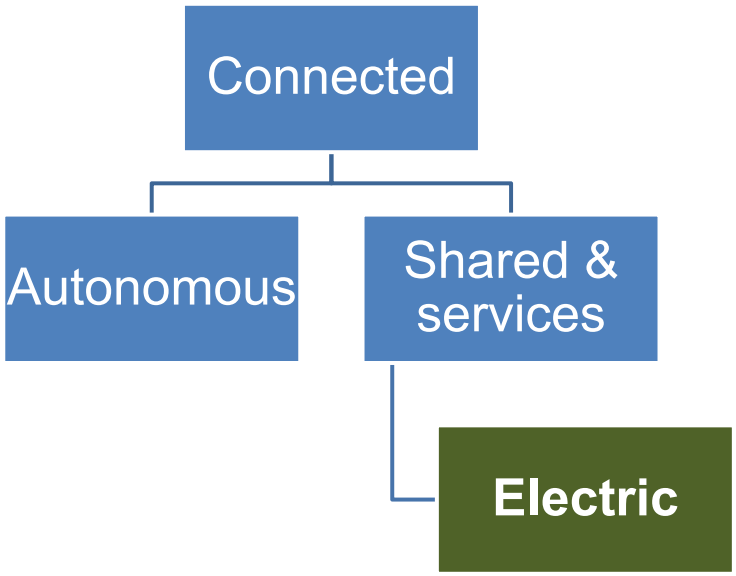
Total kWh/day = 100,000 vehicles * 50% * 23km/day * $(10\ km/kWh)^{-1}$ * $(100\% - 15\%)^{-1}$
$\simeq$ 135,000 kWh/day = 135 MWh/day → 135 / 24h = 5.6

cf. 2018 daily net generation: Approximately 3,000 to 4,000 MWh/day

Source
[1] Barbados national energy policy 2019 – 2030
[2] Automotive fuel consumption survey, 2018, Japan Okinawa pref.
[3] Electric power Consumption Performance of Battery Electric Vehicles, 2019
http://www.jari.or.jp/Portals/0/resource/JRJ_q/JRJ20190402_q.pdf

The Revolution of CASE

Connected to internet
Autonomous
Shared & Services
Electric



JET proposed to consider **all CASE** for fossil fuel reduction and overall optimization connected to expand the introduction of EV.

O&M of Thermal Power Generation

<Maintenance>

- **Preventive(Scheduled) Maintenance based on Manufacture's recommended schedule and practice**
- **Trial of Predictive Maintenance, Data acquisition twice a year for critical equipment. "Meridium by GE" is consider as a platform.**
- **Enrollment of Engineer who has CERTIFIED MAINTENANCE AND RELIABILITY PROFESSIONAL obtained from ANSI (OSHA Standard)**
- **Planning the Maintenance based on BLPC's own database**

Human Resources Development

(1) Outline of HR Development, Certificate Holders, Challenges and Plans

	Ministry of Energy, Water Resources (MEWR), Barbados	Ministry of Science, Energy and Technology (MSET), Jamaica	Ministry of Public Infrastructure (MPI), St. Kitts
Organization & Structure	■ Energy Conservation and Renewable Energy Unit ■ 3 employees (Total No. of employees is 11)	■ Energy Division ■ 14 employees (Total No. of employees was N/A)	■ Energy Division ■ 4 employees (Total No. of employees was N/A)
HR Master Plan	■ None	■ Proposing about EE	■ None
Internal Trainings	■ No in-unit training. (Use external trainings)	■ Division/Department based trainings ■ External 3day basic energy audit training course, awareness building WS, seminars, etc.	■ No division-based trainings (Use external trainings)
Certificate Holders (CEM、CEA)	■ 3 employees (CEM/CEA holder 0)	■ 1 staff (CEM/CEA holder 0)	■ 4 staffs (CEM/CEA holder 0)
HR Dev. Budget	■ Not available	■ Not available	■ Not available
Challenges & Plans on HR Development	■ TBC	■ TBC	■ Energy Unit has only 3 staffs and activities are limited ■ Director wants to focus on business planning and budget requests to expanded their activities ■ HR Management Dept. does not have HR development plan

Human Resources Development

(2) Outline of HR Management

	Ministry of Energy, Water Resources (MEWR), Barbados	Ministry of Science, Energy and Technology (MSET), Jamaica	Ministry of Public Infrastructure (MPI), St. Kitts
Command Order System	■ Deputy Permanent Secretary allocates works of each unit and department head	■ Chief Technical Director allocates works of technical director and others of Energy div.	■ Permanent Secretary allocates works of Director and others
Employment Status	■ Two types of labor contracts - permanent and contract ■ Permanent employees must pass interview by the committee	■ All labor contracts are permanent basis	■ All labor contracts are permanent basis
Promotion & Transfer	■ Possible to reach a certain level of positions (but it takes time…) ■ Possibility to stay in the current position, pass the promotion exam, or move to the same position of other Ministries ■ Possibility of temporary assignment of other Ministries	■ TBC	■ Possible to apply for the upper positions. Possibility of promotion if employees meet duty requirements. ■ Possibility of internal transfer from the Energy Div. to the Water Service Dept. ■ Possibility of temporary assignment to other ministries
Salary	■ Each post has a certain range of salary. Salary is determined by qualification, experiences, skills etc. ■ No bonus	■ TBC	■ Each post has a certain range of salary. Salary is determined by qualification, experiences, skills etc. ■ No bonus
Recruitment	■ When there is a vacant position, announce to newspaper. Sometimes word of mouth recruitment	■ When there is a vacant position, firstly access internal resources. If no candidate, announce internationally.	■ When there is a vacant position, firstly access internal resources. If no candidate, announce to newspaper and social media.

Human Resources Development

(3) Result of Study of HR Development

Challenges of HR Development

- Recruitment of employees is normally done by a replacement of vacant position ⇒ Difficult to strengthen organization capacity by increasing number of employees.
- Most of capacity building is done by On-the-Job-Training (OJT) ⇒ Employees work without systematic knowledge.
- There is no systematic HR development.

Planned Policy of Technology Transfer

- JET experts select topics and develop the most suitable curriculum ⇒ Give essential lectures from policy making to practical activities for renewable energy, energy efficiency… etc.

Planned Training Method

- JET and CP share knowledge and learn each other ⇒ Combine lectures, practical exercises and discussions.

3. Training Program

Training Content

Item	1st domestic training	2nd domestic training	Training in Japan
Period	Five days (Around September 2020)	Four or Five days (Around May 2021)	Approximately 3 weeks (July 2021)
Course	• Conduct energy audit • Learn about technology for energy saving • Apply RE stabilization technology	• Learn about cost evaluation for energy saving • Learn efficient system operations including RE	• Learn the technology that includes system stabilization in the introduction of renewable energy • Obtain knowledge and technology related to energy-saving and the energy-saving planning, policy and dissemination awareness activities
Participant	About 5 members of the Saint Christopher Nevis, about 5 members of Barbados, about 5 members of Jamaica	About 5 members of the Saint Christopher Nevis, about 5 members of Barbados, about 5 members of Jamaica	About 1-4 members from each country, total about 10 people

Trainings in Your Country

Trainings by Japanese Specialists are organized in two phases, 1st training, and 2nd training.

- 1st training plan: 1st day to 3rd day for EE

Dates		Example of classroom and OJT curriculum
1st day (EE)	AM	Significance of energy saving approaches based on energy balances and a long-term supply and demand outlook. Effective approaches/practices with priority toward energy saving realization by sector/end-use.
1st day (EE)	PM	Successful EE policies/regulations and incentive programs. Various EE technologies and EE best practices.
2nd day (EE)	AM	Study on how to develop energy audit reports with reference to international standards and actual reports developed by the expert of JET in the past.
2nd day (EE)	PM	【OJT】 Walk-through survey of public building
3rd day (EE)	AM	Walk-through survey of water pump station
3rd day (EE)	PM	Prepare energy audit reports for facilities of which walk-through surveys have been carried out.

Trainings in Your Country

Trainings by Japanese Specialists are organized in two phases, 1st training, and 2nd training.

- 1st training plan: 4th day to 5th day for RE

Dates		Example of classroom and OJT curriculum
4th day (RE)	AM	Renewable energy technology and cost, Examples of renewable energy projects, operations and issues
4th day (RE)	PM	System stabilization Technology, grid simulation with RE input
5th day (RE)	AM	【OJT】 Grid modeling in simulation software
5th day (RE)	PM	Grid simulation software output analysis

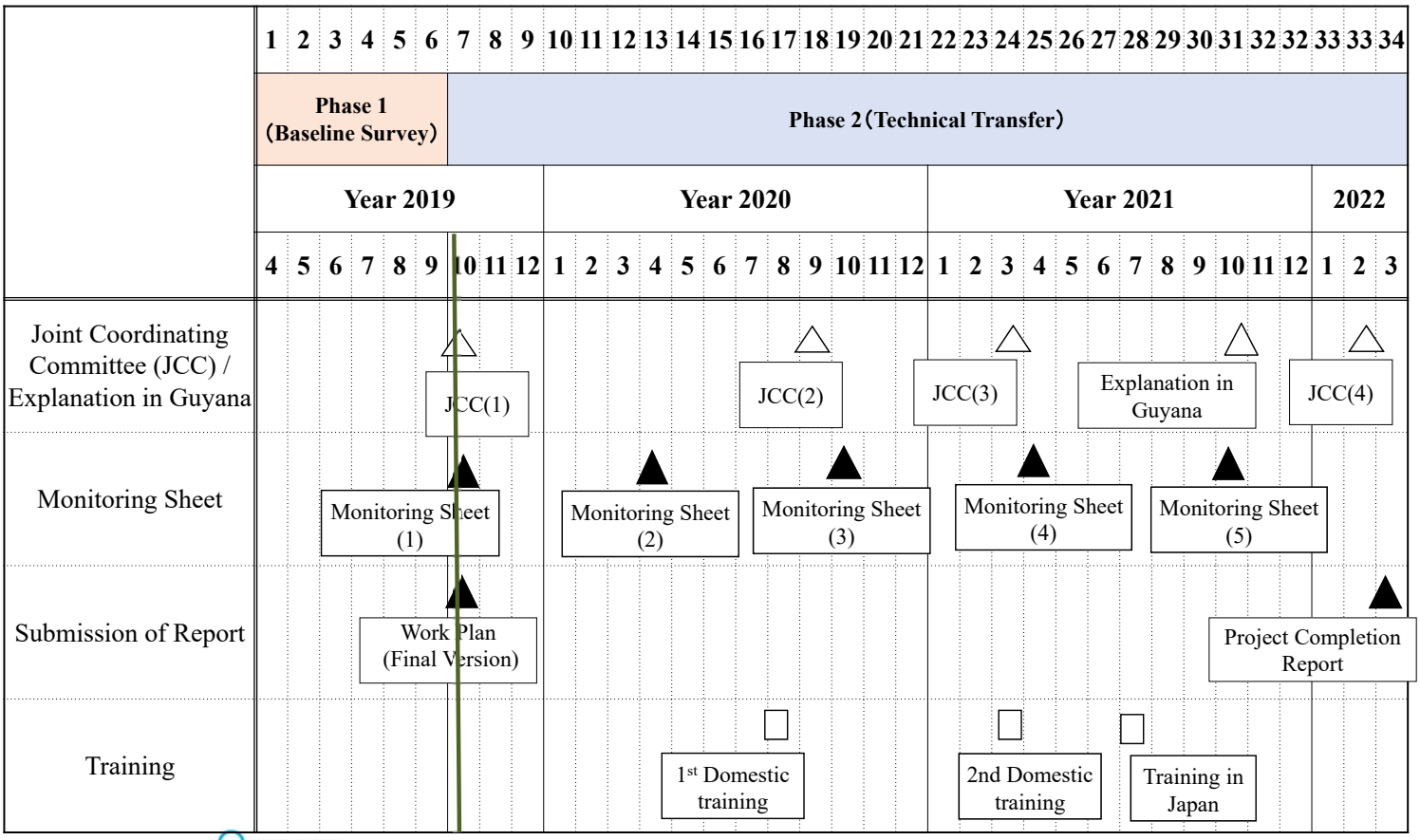
2nd training plan will be adjusted for your demands, situations and feedbacks.

Training in Japan (Provisional)

Days		Itinerary / Theme	Field
Day 1-2	Sat	Move (each country → Tokyo/Narita)	-
Day 3	Mon	Arrive at Tokyo/Narita. PM: Orientation	RE/EE
Day 4	Tue	Manufacturer of solar power, wind power, PCS	RE
Day 5	Wed	RE business, example of grid connection, evaluation of energy production	RE
		Manufacturer of electric automobile, EV battery VPP (virtual power plant)	
Day 6	Thu	Grid stabilization simulation (1):Basic structure, simulator, parameter, data structure	RE
Day 7	Fri	Grid stabilization simulation (2): Data model, input, case study	RE
Day 8	Sat	Reporting work, etc.	RE
Day 9	Sun	Move (Tokyo → Miyakojima Island)	RE
Day 10	Mon	Tour for Miyakojima island type smart community and EMS	RE
Day 11	Tue	Move (Miyakojima Island → Tokyo)	RE
		Ancillary service, balance of supply and demand, quality of power	RE
Day 12	Wed	Introduction RE Planning, asset management, evaluation, example of policy	RE
Day 13	Thu	Policy for EE and awareness building activities for popularity	EE
Day 14	Fri	EE actions by electric power companies in isolated islands, example of building EE	EE
Day 15/16	Sat Sun	Reporting work, etc.	EE
Day 17	Mon	High efficient transformer, BEMS	EE
Day 18	Tue	Example of introduction of large inverter, ESCO business	EE
Day 19	Wed	Large and high efficient refrigeration machine / heat recovery machine, example of introduction of high efficient boiler, High efficient air conditioning equipment, EE for lighting equipment	EE
Day 20	Thu	Market research of home appliances, Wrap-up meeting	EE
Day 21-22	Fri	Move (Tokyo/Narita → each country) Arrive at each country	-

4. Way Forward and Schedule

Schedule of the Project



Way Forward and Requests

#	Item	Description	Schedule
1	Selection of participants for the training	Engineers to have a key technical role in the organization, with electrical engineering or mechanical engineering BSc or MSc background - (1) Senior/chief/managing engineer, working experience 15-30 years - (2)engineer or/and assistant engineer, working experience 5-15 years	By End of Mar 2020
2	Arrange of place and participants for domestic training	First domestic training is scheduled around September 2020. Please cooperate to determine the arrangement of venue and the schedule considered P/D, P/M and C/P staffs.	By End of Mar 2020
3	Access permission to areas where it is necessary to enter for the survey	Such as power station, substation, and important faculties for energy saving	Project period
4	Comment on PDD/PO	For revise of PDD, PD please provide comments.	By end of Nov 2019
5	Property selection for OJT of energy audit	First domestic training is scheduled around September 2020. Please cooperate to select the objective property. - (1) Large energy consumer - (2) Equipment list can be shared to OJT participants	By End of Mar 2020

Appendix

O&M of Thermal Power Generation(Barbados)

<List of Thermal Power Unit>

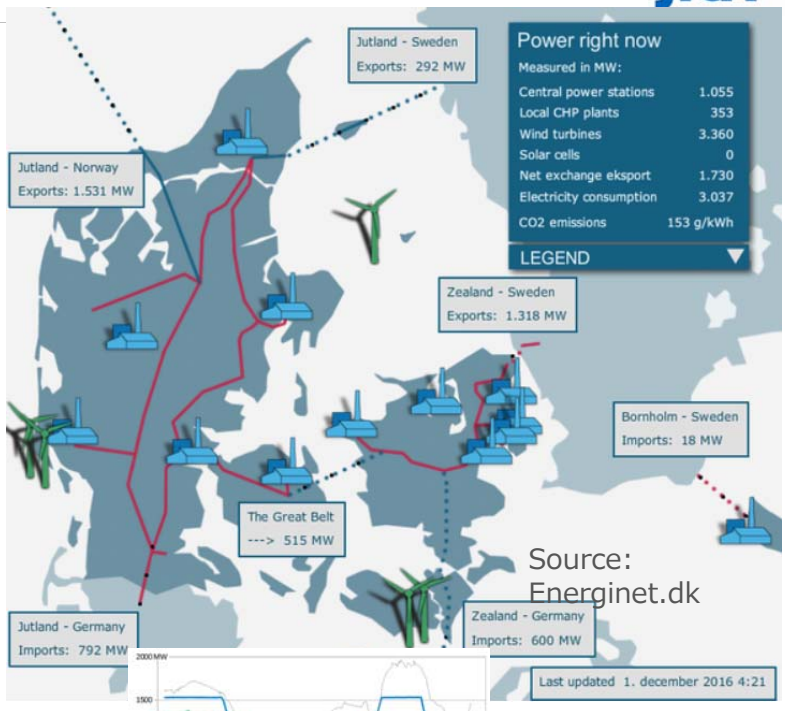
Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
Barbados	Spring Garden	D10(Unit A)	LSD	HFO	MAN	1982	Base	12.0
		D11(Unit A)	LSD	HFO	MAN	1982	Base	12.0
		D12(Unit A)	LSD	HFO	MAN	1987	Base	12.0
		D13(Unit A)	LSD	HFO	MAN	1990	Base	12.5
		CG01	ST	heat from unit A	Peter Brotherhood	1985	Base	1.5
		D14(Unit B)	LSD	HFO	MAN	2005	Base	30.0
		D15(Unit B)	LSD	HFO	MAN	2005	Base	30.0
		CG02	ST	heat from unit B	SHINKO	2005	Base	2.0
		Unit S1	ST	HFO	GEC	1976	Base	20.0
		Unit S2	ST	HFO	GEC	1976	Base	20.0
			Olympos GT	Jet Fuel/ Diesel	CURTISS WRIGHT	1969-1970	Peak	17.5
	Garrison	G02	GT	Diesel	ABB	1990	Peak	13.0
	Seawell	G03	GT	Diesel	ABB	1996	Peak	13.0
		G04	GT	Jet Fuel	ABB	1999	Peak	20.0
		G05	GT	Jet Fuel	ABB	2001	Peak	20.0
		G06	GT	Jet Fuel	ABB	2002	Peak	20.0

Total: 255.5MW

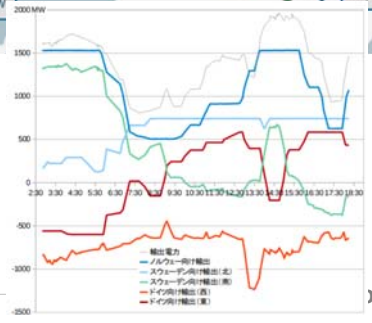
RE: Why Large RE penetration possible for Denmark?

5475 MW wind, 14.8 TWh, 44% of domestic electricity by VRE

	Denmark Condition	For Caribbean
1	Dynamic Interconnection with Norway (large pump storage), Sweden, and Germany	**Not possible**
2	Different places of offshore wind (7 locations)+500 MW onshore → fluctuation is levelized	Limited but can be considered → Data necessary
3	Grid code -Power control - Frequency droop control -FRT (fault ride through) -Power change rate limit	Applicable



Source: Energinet.dk



https://www.itmedia.co.jp/smartjapan/articles/1612/19/news085_3.html

- Large inter-connection can not be referred
- Different concept necessary for Caribbean countries → **Microgrid**

Joint Coordinating Committee (JCC) for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Work Plan, PDM and Monitoring Sheet #1

October-November 2019

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Work Plan

Draft Work Plan and the contents were basically agreed.
Changes will be reflected on PDM rev.1.

Revised Project Design Matrix (Draft)

Barbados	BEFORE	AFTER
Output		(Added) Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of power network Resiliency Objectively Verifiable Indicators 5-1. Number of trained staffs 5-2. Textbooks/ manuals 5.3. Number of participants of workshops to disseminate promotion of Resilience to the relevant organizations 5-4. Number of workshops
Narrative Summary Activities for achieving Output 3	3-1 To conduct feasibility studies on potential RE sites already identified under previous surveys carried out in Barbados. The feasibility study should not only focus on financial aspect but should also consider environmental and planning permission issues is it relates to these locations. 3-3 To demonstrate the way to enhance resiliency of the power infrastructure using network asset management system.	3-1.To develop microgrid concept in view of maximizing VRE introduction. 3-3. To consider the use of electric transportation in Barbados and its effects (positive and negative) on the grid and economy.

Revised Project Design Matrix (Draft)

Barbados	BEFORE	AFTER
Activities for achieving Output 5		(Added) 5-1. To demonstrate the way to enhance resiliency of the power infrastructure using network asset management system.
Inputs (Japanese side)	1. Dispatch of the Japanese experts -Chief advisor -Renewable energy -Grid stabilization -Energy efficiency -Coordinator 4. Equipment -measuring instrument for: Potential survey of renewable energy Monitoring operation load of thermal power plants, etc. -software for : Grid Analysis Cost-benefit analysis to compare introduction of long-term storage and output restriction of RE etc.	1. Dispatch of the Japanese experts -Chief advisor/ power system -Renewable energy -Grid stabilization -Energy efficiency -Diesel/ gas-turbine power plant/ coordinator -Human resource development/ monitoring 4. Equipment - Software for: Grid Analysis (Power Flow Analysis Module)

Overall Goals & Target Value/ Barbados

Description	Verifiable Indicator	Target Value
Overall Goals Energy security is ensured through introduction of renewable energy (hereinafter referred to as “RE”) and promotion of energy efficiency (hereinafter referred to as “EE”)	1. Energy self-dependency 2. Imported fossil fuel reduction	1. 100% (100%RE by 2030) 2. 0%

Project Purpose & Target Value/Barbados

Description	Verifiable Indicator	Baseline Value	Target Value
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant	1. PV 10MW +12MW rooftop BESS 5MW, 20MWh	1.XX
	2. Number of public buildings with EE program including BEMS: Building Energy Management System	2. Needs of MERW is very high to promote EE of public buildings.	2.XX
	3. Number of trained staffs for introduction of RE	3. 0	3.XX
	4. Number of trained staffs for promotion of EE	4. 0	4.XX

Outputs 1,2 & Target Value/Barbados

Description	Verifiable Indicator	Baseline Value	Target Value
Output 1 *(Phase 1)* The basic information is confirmed for the capacity building for the introduction of RE	1-1. Assessment of number and qualification of staffs responsible for RE	1-1. Senior technical officer & specialists	1-1. ditto
	1-2. Human resource development plan for the introduction of RE	1-2. N/A	1-2. planned as per PDM
	1-3. Number of training courses for the introduction of RE	1-3. Several external programs.	1-3. planned as per PDM
	1-4. Total capacity of RE	1-4. 22MW	1-4. 22MW
Output 2 *(Phase 1)* The basic information is confirmed for the capacity building for the promotion of EE	2-1. Assessment of number and qualification of staffs responsible for EE	2-1. N/A	2-1. 3 staffs (CEM/CEA:0)
	2-2. Human resource development plan for the introduction of EE	2-2. N/A	2-2. None
	2-3. Number of training courses for the promotion of EE	2-3. N/A	2-3.Organized training: 0
	2-4. Number of facilities conducted energy audit	2-4. N/A	2-4. about 30/80-100 bldg.

Outputs 3,4 & Target Value/Barbados

Description	Verifiable Indicator	Baseline Value	Target Value
Output 3 *(Phase 2)* The human and institution capacity are enhanced for the introduction of RE	3-1. Number of trained staffs	3-1. 0	3-1. 11-15 personnel
	3-2. Textbooks/ manuals	3-2. None	3-2. 3 copies (For trainings in 2 local and 1 Japan)
	3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations	3-3. 0	3-3. XX
	3-4. Number of workshops	3-4. 0	3-4. 2 times (Kickoff, Wrap-up)
Output 2 *(Phase 2)* The human and institution capacity are enhanced for the promotion of EE	4-1. Number of trained staffs	4-1. 0	4-1. 11-15 personnel
	4-2. Textbooks/ manuals	4-2. None	4-2. 3 copies (For trainings in 2 local and 1 Japan)
	4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations	4-3. 0	4-3.Organized training: 0
	4-4. Number of workshops	4-4. 0	4-4. 2 times (Kickoff, Wrap-up)

Outputs 5 & Target Value/Barbados

Description	Verifiable Indicator	Baseline Value	Target Value
Output 5 *(Phase 2)* The human and institution capacity are enhanced for the promotion of power network Resiliency	5-1. Number of trained staffs	5-1. XX	5-1. XX
	5-2. Textbooks/ manuals	5-2. XX	5-2. XX
	5-3. Number of participants of workshops to disseminate promotion of Resilience to the relevant organizations	5-3. XX	5-3. XX
	5-4. Number of workshops	5-4. XX	5-4. XX

Annex 1

Project Design Matrix (PDM)

Project Title: Technical Cooperation to Promote Energy Efficiency in the Caribbean Countries
Project Term: 3 Years, Phase 1: 6 months, Phase 2:30 months
Country: Whole country
Target Area: Barbados
Target Group: MEWR (Ministry of Energy and Water Resources), BLPC (Barbados Light and Power Co., Ltd.)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Energy security is ensured through introduction of renewable energy (hereinafter referred to as "RE") and promotion of energy efficiency (hereinafter referred to as "EE")	1. Energy self-dependency 2. Imported amount of fossil fuel	Data from MEWR annual report	The current relevant policies on promotions of RE and EE are sustained after the Project.
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant 2. Number of public buildings with EE program including BEMS 3. Number of trained staffs for introduction of RE 4. Number of trained staffs for promotion of EE	Project Report	C/P agency continues commitment to the Project by continuing budget allocation as well as assignment of personnel for the post- Project activities.
Output Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	1-1. Assessment of number and qualification of staffs responsible for RE 1-2. Human resource development plan for the introduction of RE 1-3. Number of training courses for the introduction of RE 1-4. Total capacity of RE	Project Report	
Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	2-1. Assessment of number and qualification of staffs responsible for EE 2-2. Human resource development plan for the introduction of EE 2-3. Number of training courses for the promotion of EE 2-4. Number of facilities conducted energy audit	Project Report	

Annex 1

<table>
<tr><td>Output 3 (to be achieved in Phase 2)
The human and institution capacity are enhanced for the introduction of RE</td><td>3-1. Number of trained staffs
3-2. Textbooks/ manuals
3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations
3-4. Number of workshops for CARICOM region</td><td>Project Report</td><td></td></tr>
<tr><td>Output 4 (to be achieved in Phase 2)
The human and institution capacity are enhanced for the promotion of EE</td><td>4-1. Number of trained staffs
4-2. Textbooks/ manuals
4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations
4-4. Number of workshops for CARICOM region</td><td>Project Report</td><td></td></tr>
<tr><td>Output 5 (to be achieved in Phase 2)
The human and institution capacity are enhanced for the promotion of power network resiliency</td><td>5-1. Number of trained staffs
5-2. Textbooks/ manuals
5.3. Number of participants of workshops to disseminate promotion of Resilience to the relevant organizations
5-4. Number of workshops</td><td>Project Report</td><td></td></tr>
<tr><td rowspan="3">Activities
Activities for achieving Output 1
1-1. To verify human and institutional capacities for the introduction of RE

Activities for achieving Output 2
2-1. To verify the fundamental indicators on promotion of EE for the electricity demand side, e.g. electric power consumption unit requirement, final energy consumption, etc.
2-2. To verify the existing conditions in promotion of EE, relevant policies/ national plans
2-3. To carry out a review of the current maintenance practices for thermal power plants and these practices to international best practices.
2-4. To verify human and institutional capacities for the promotion of EE

Activities for achieving Output 3
3-1. To develop microgrid concept in view of maximizing VRE introduction.</td><td colspan="2">Inputs
(Japanese side)
1. Dispatch of the Japanese experts in respect of following:
-Chief advisor/ power system
-Renewable energy
-Grid stabilization
-Energy efficiency
-Power network asset management**
-Diesel/ gas-turbine power plant/ coordinator
-Human resource development/ monitoring

2. Training in Japan
-Micro Grid system including Grid Stabilization Technology in small island (e.g. Okinawa, Tokyo and other cities)
-Policies and technologies for promotion of EE (Energy load labelling, policies, regulations and incentives) (Tokyo and other

(Barbados side)
1. Assignment of C/Ps
-Project Director (P/D)
-Project Manager (P/M)
- Other C/Ps

2. Facilities and equipment for the Project office
-To allocate office space with furniture for experts during their stay in Barbados (desks, chairs, meeting tables, copy machine, etc)

3. Recurrent costs
Project Director, Project Manager and Project Administrator’s salaries will be met by DET</td><td>Most of the trained C/Ps continues commitment to the Project activities.

Preconditions
Contents of the current relevant policies on promotion of RE and EE are not largely changed.</td></tr>
</table>

Annex 1

3-2. To model microgrid concept in the agreed area carry out case studies using own computer simulator as part of capacity building. 3-3. To consider the use of electric transportation in Barbados and its effects (positive and negative) on the grid and economy. 3-4. Review of the effectiveness of the existing Government policies on RE and propose changes to the existing policies to promote the uptake of electric vehicles. 3-5. To prepare the necessary training plan for doing the above Activities '3-1' through '3-4' 3-6. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '3-5' 3-7. To review the training plan though monitoring of the training conducted in Activity '3-6' 3-8. To provide advice on realization of the RE projects 3-9. To provide recommendations on design of the policy/ legal system proposed in Activity '3-4' 3-10. To share the project output with other recipient countries	cities) -Site visit in Japan 3. Training/Workshop in each recipient country -Trainings/Workshops for project counterparts in each recipient country 4. Equipment - Software for: Grid Analysis (Power Flow Analysis Module)		
Activities for achieving Output 4 4-1. To consider and propose the EE goals through cost-benefit analysis on introduction of the facilities contributing to EE, e.g. Green Wall, Green roofs, thermal insulations, LED lighting etc. 4-2. To consider and propose the EE facilities necessary for achieving the EE goals 4-3. To consider and propose necessary technologies for achieving EE goals, including building energy management system (BEMS) for public sector, etc. 4-4. To carry out a review of the current methods of operation and load dispatch and compare to international best practices for thermal power plants 4-5. To consider and propose measures to improve the maintenance system for thermal power plants, including measures to do periodic maintenance and overhaul and procurement of spare parts 4-6. To consider and propose the necessary policy and/or regulatory frameworks for achieving EE initiatives such as introduction of energy service company (ESCO) and energy management service and items mentioned in '4-1'. 4-7. To prepare the necessary training plan for doing the above Activities '4-1' through '4-6' 4-8. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '4-7' 4-9. To review the training plan though monitoring of the training conducted in Activity '4-8' 4-10. To provide advice on realization of the EE projects 4-11. To provide recommendation on design of the policy/ legal system proposed in Activity '4-6' 4-12. To share the project output with other recipient countries			
Activities for achieving Output 5 5-1. To demonstrate the way to enhance resiliency of the power infrastructure using power network asset management system. *			

Note: * Subject to budgetary approval by JICA

** Subject to budgetary approval by JICA. Assignment of task can be either in a form of expert assignment or sub-let basis.

Annex 2

Tentative Plan of Operaion (PO)

Project Title: Technical Cooperation to Promote Energy Efficiency in the Caribbean Countries
Project Term: 3 Years, Phase 1: 6 months, Phase 2: 30 months
Country: Barbados
Target Area: Whole country
Target Group: MEWR (Ministry of Energy and Water Resources), BLPC (Barbados Light and Power Co., Ltd.)

Year		Three years (36 months)																																		
Phase		Phase 1						Phase 2																														
Output 1 Activities		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1-1.	To verify human and institutional capacities for the introduction of RE.																																				
Output 2 Activities																																					
2-1.	To verify the fundamental indicators on promotion of EE for the electricity demand side, e.g. electric power consumption unit requirement, final energy consumption, etc.																																				
2-2.	To verify the existing conditions in promotion of EE, relevant policies/ national plans.																																				
2-3.	To carry out a review of the current maintenance practices for thermal power plants and these practices to international best practices.																																				
2-4.	To verify human and institutional capacities for the promotion of EE.																																				
Output 3 Activities																																					
3-1.	To develop microgrid concept in view of maximizing VRE introduction.																																				
3-2.	To model microgrid concept in the agreed area carry out case studies using own computer simulator as part of capacity building.																																				
3-3.	To consider the use of electric transportation in Barbados and its effects (positive and negative) on the grid and economy.																																				
3-4.	Review of the effectiveness of the existing government policies on RE and propose changes to the existing policies to promote the uptake of electric vehicles.																																				
3-5.	To prepare the necessary training plan for doing the above Activities '3-1' through '3-4'.																																				
3-6.	To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '3-5'.																																				
3-7.	To review the training plan though monitoring of the training conducted in Activity '3-6'.																																				
3-8.	To provide advice on realization of the RE projects.																																				
3-9.	To provide recommendations on design of the policy and/or regulatory framework proposed in Activity '3-4'.																																				
3-10.	To share the project output to other recipient countries.																																				
Output 4 Activities																																					
4-1.	To consider and propose the EE initiatives through cost-benefit analysis on introduction of the facilities contributing to EE, e.g. Green Wall, Green roofs, thermal insulations, LED lighting etc.																																				
4-2.	To consider and propose the EE initiatives necessary for achieving the EE goals.																																				
4-3.	To consider and propose necessary technologies for achieving EE goals, including building energy management system (BEMS), for public sector etc.																																				
4-4.	To carry out a review of the current methods of operation and load dispatch and compare to international best practices for thermal power plants.																																				
4-5.	To consider and propose measures to improve the maintenance system for thermal power plants, including measures to do periodic maintenance and overhaul and procurement of spare parts.																																				
4-6.	To consider and propose the necessary policy and/or regulatory framework for achieving EE initiatives such as introduction of energy service company (ESCO) and energy management service, etc.																																				
4-7.	To prepare the necessary training plan for doing the above Activities '4-1' through '4-6'.																																				
4-8.	To conduct training including OJT, training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '4-7'.																																				
4-9.	To review the training plan though monitoring of the training conducted in Activity '4-8'.																																				
4-10.	To provide advice on realization of the EE projects.																																				
4-11.	To provide recommendation on design of the policy and/or regulatory framework proposed in Activity '4-6'.																																				
4-12.	To share the project output to other recipient countries.																																				
Output 5 Activities																																					
5-1.	To demonstrate the way to enhance resiliency of the power infrastructure using power network asset management system. *																																				
△: JCC								△											△					△												△	
▲: Training in Japan																													▲								
◇ : Seminer(for RE, EE and CARICOM regional)																		◇						◇													

Note:* Subject to budgetary approval by JICA

Minutes of Meeting

Energy Division, Ministry of Public Infrastructure (MPI) and JICA Expert Team

28 Oct-01 Nov 2019 (St. Kitts and Nevis)

Date and Time: 28 Oct - 01 Nov 2019

Location: Energy Division, Ministry of Public Infrastructure (MPI)

Participants:

1) Ministry of Public Infrastructure (MPI)
   - Mr. Glenn Amory (Permanent Secretary (Acting))
   - Dr. Bertill Blowne, Director, Energy Unit, MPI

2) Navis Island Administration (NIA)
   - Ms. Michelle Walters, Energy Commissioner

3) SKELEC
   - Mr. Kevin Bennett (Power Station Manager)
   - Mr. Rhondel Philip (Renewable Energy and Special Project)
   - Mr. Gaston Dixon (Power Station Operation Engineer)
   - Mr. Clement J. Williams (Acting GM of SKELEC),
   - Mr. Collin Brown (T&D Dept),
   - Mr. Dwyer Edmeade (IT Officer)

4) NEVLEC
   - Mr. Gilroy Pultie (GM)
   - Mr. Ian Ward (T&D Manager)
   - Mr. Earl Springetne (Generation)
   - Mr. Stare France, (Planning Officer)
   - Mr. Jervan Swanston (HR Manager)

5) JICA Expert Team (JET)
   - Mr. Masaaki Ebina, Sub Team Leader/Power System
   - Mr. Yasuhiro Sakamoto, Energy Efficiency
   - Ms. Yuka Nakagawa, Renewable Energy
   - Mr. Hiroaki Niimi, Grid Stabilization
   - Ms. Anna Miyaura Human Resource Development
   - Mr. I-Ronn Audain

The 1st Joint Coordinating Committee (JCC) and Kick-off Workshop in St. Kitts and Nevis:

The first JCC Meeting/Kick-off Workshop was held on 29th October in MPI Office, St. Kitts, attended by Mr. Glenn Amory, Senior Assistant Secretary, MPI and Mr. Katsutaka Kikkawa, Project Formulation Advisor of JICA in Saint Lucia, and representatives from relevant organizations including MPI, NIA, SKELEC, NEVLEC WSD, WSN.

Agenda and objectives of the JCC was:

1) To confirm the current situations/issues and result of Baseline Survey in the area of

Renewable Energy and Energy Efficiency carried out for the last 6 months.

2) To share the revised Project Design Matrix (PDM) and also review the progress measurement indexes in the Monitoring Sheet.
3) To share the overall objectives and goals of the program including, Outputs, Activities, Means of Verification and Schedules

As a result of the JCC, the technical cooperation program by JICA was unanimously agreed upon by all the relevant members and stake holders in St. Kitts and Nevis .

Discussions:

< Project Design Metrix or PDM>

Project Design Metrix (PDM) was revised to reflect the outcome of the meetings until the 3rd Mission in August 2019, as shown in red-letters in the Attachment 1).

Major changes from the original PDM would be as follows:

1) Introduction and demonstration of power network asset management system will be additionally included in the training to enhance the "resiliency" which is one of the major concerns among CARICOM countries.
2) Introduction of customized computer modeling for grid analysis to examine issues associated with large penetration of VRE in St. Kitts.

<34 MW PV IPP in St. Kitts>

Construction of large scale PV power plant is underway, project overview and status are as follows:

1) IPP Company is Laclanche (Swiss Company). PPA is signed for 16 MW with sealing of 18 MW as a maximum. 34 MW PV Installed Capacity, 44MWh Storage Capacity. JET will apply this condition for grid simulation training.
2) Grid stability analysis is carried out by Leidos, consultant company, hired by SKELEC. The report has not been completed yet and will be shared with JET to review once it is completed.
3) Site preparation has started recently. EIA is in progress. Construction will be starting shortly, after clearance of EIA. Construction site is located adjacent to SKELEC Needsmust Power Plant.

<Simulator for Grid Stability Analysis>

Grid modeling and stability analysis for RE projects has been carried out by outside consultant on contract basis. Both SKELEC and NEVLEC have no analytical software to trace the report prepared by contractor.

Both SKELEC and NEVLEC wishes to own and use "GridSim" for capacity building and grid planning and nominated officers to be trained.

<Network Asset Management>

Both SKELEC and NEVLEC have recognized the importance of Power Network Asset Management which needs to be in place to enhance the resiliency of the power system, which can be extended to outage control, disaster management, and long-term maintenance.
Both SKELEC and NEVLEC wish JET to implement the capacity building program immediately. In addition to SKELEC, NEVLEC is also ready to send any information to be used for system modeling.
Both SKELEC and NEVLEC nominated officers to be trained.

<Statistics of Energy Use in view of Energy Efficiency>

Following SKELEC and NEVLEC data will be used to formulate EE roadmap.

- Past 10 years records of power consumption classified by customer class (e.g. residential, commercial, public, industrial).
- Energy consumption data classified by customer class and by end use (e.g. percentage in refrigerator out of residential customer power consumption).
  Note: The utilities would give suggestion in the event that there is no data available on this matter.
- Long term demand forecast (e.g. up to 2028)

List of Attachment:

1) JCC Attendance List
2) JCC and Kick-off Workshop Agenda
3) Presentation slide on Baseline Survey
4) Presentation slide on revised PDM and Monitoring Sheet #1
5) Keynote speech slide by Dr. Bertill Browne, Director, Energy Unit, MPI
6) PDM/ PO rev.1

End of the MoM

Ministry of Public Infrastructure (MPI)

Bertill Browne 1st November 2019
Dr. Bertill Browne, Director, Energy Unit, MPI

JICA Expert Team

蝦名雅幸 1st November 2019
Masaaki Ebina, Team Sub Leader

Attendant List

Project: Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Meeting Title:

Venue: Conference room at MPI Date: 29th Oct. 2019 Time: 9:00~

SN	Name	Organization	Title	Mobile or E-mail	Signature
1	HIROAKI NIIMI	JICA EXPERT TEAM	GRID STABILISATION (2)/POWER STORAGE	[redacted]	
2	ANNA MIYAURA	〃	CAPACITY BUILDING		
3	Yasuhiro Sakamoto	〃	Energy Efficiency expert		
4	MASAAKI EBINA	〃	SUB LEADER OF THE P.J.		
5	YUKA NAKAGAWA	JICA EXPERT TEAM	RE Expert		
6	IAN WARD	NEVLEC	T&D MANAGER		
7	Clyphton Wilson	WATER Department	Head of Water Production		
8	I-Ronn Andrin	JICA Expert Team	COCA/ AGENT		
9	KATSUTAKA KIKKAWA	JICA ST.LUCIA	Project Formulation Advisor		
10	Jamal Hugg	SKNIS	Media		
11	Anthony Norford	SKNIS	Media		
12	Glenn Amory	MIN OF Public Fnt	Sr. Asst Secretary		
13	Charles Harris	Public Infrast.	Assistant water Engineer.		巴夏禮 Charles Harris
14	Easton Dixon	SKELEC	Operations Engineer		
15	Alonzo Phillip	SKELEC	Renewable Energy Project Eng.		
16	BERTIL BRAUN	MPI	DIRECTOR		
17	Michelle Walker	NIA	COMMISSIONER OF Energy		Comm't Injured Sign Hand.
18	Clement Williams	SKELEC	GM (Ag.)		
19					
20					

Japan Technical Cooperation Project for
The Project to Promote Energy Efficiency in Caribbean Countries

The 1st Joint Coordination Committee (JCC) / Kick off Work Shop Program in St. Kitts and Nevis

Date: Tuesday, October 29, 2019 **Venue : Conference room at MPI**

Purpose of The 1st JCC	◎ To confirm the current situations and result of baseline survey for EE and RE ◎ To share the outputs, activities, means of verification, challanges, and schedule for the Project to promote RE and EE ◎ To share revised Project Design Matrix (PDM) and start the Project monitoring report based on the PDM Rev.1.

9:00-9:05	Opening Remarks for JCC	Mr. Glenn Amory	Project Director
9:05-9:10	Greeting by JICA St. Lucia	Mr. Katsutaka Kikkawa	Project Formulation Advisor (JICA Saint Lucia Office)
9:10-10:55	Baseline Survey Report with Current Situation and Capacity Assessment (Q&A to be included)	Member of JET	Member of JET
10:55-11:05	Break Time		
11:05-11:25	Keynote presentation on policies, and/or current issues/challenges in energy sector in St Kitts and Nevis (Q&A to be included)	Mr. Bertill Browne	Project Manager
11:25-11:50	The Work Plan and Project Design Matrix (PDM)/ Monitoring Sheet #1	Mr. Masaaki Ebina	Subchief and Advisor/Power System (2)
		Ms. Anna Miyaura	Human Resource Development / Monitoring
11:50-11:55	Closing Remarks	Mr. Glenn Amory	Project Director

Joint Coordinating Committee (JCC) for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Baseline Survey Report

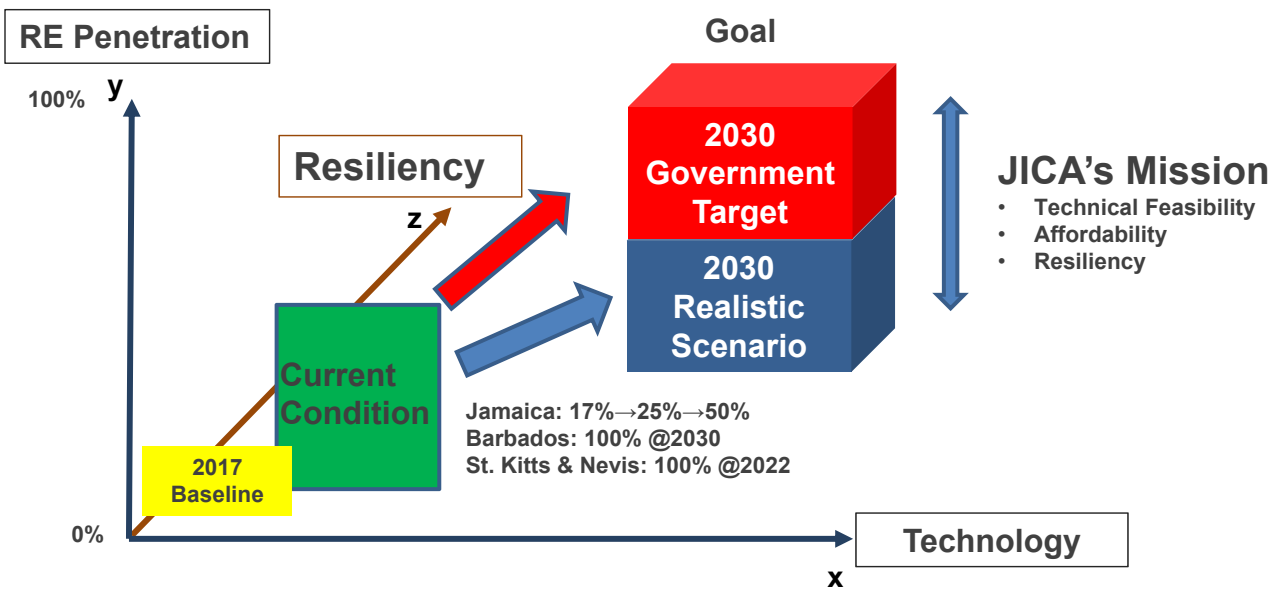
October-November 2019

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

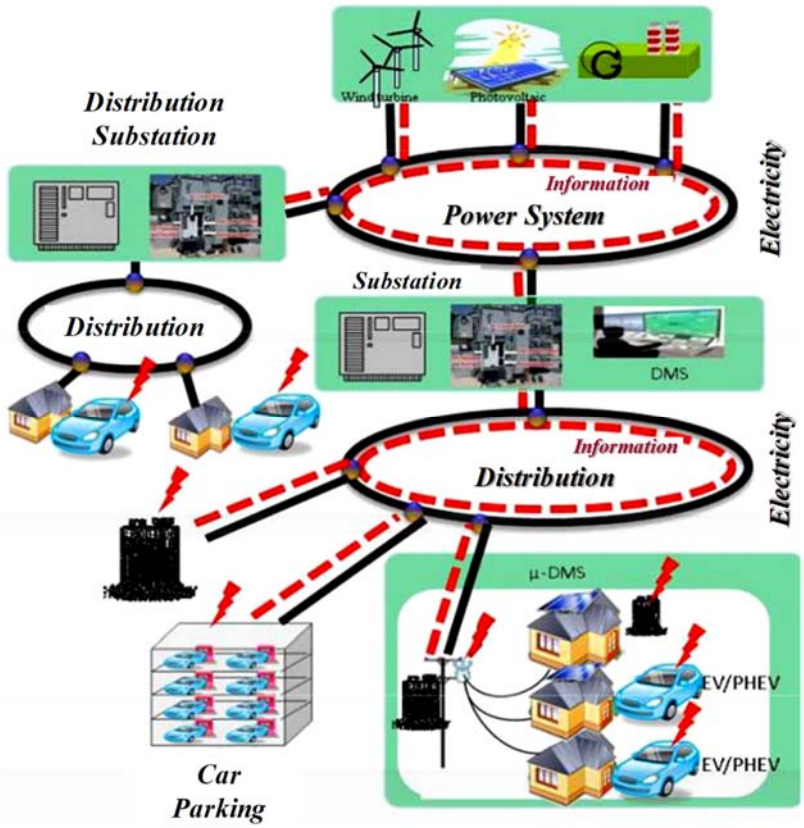
1. Project Outline

JET's Mission Recognition

Three Dimensional Approach is required: RE Penetration %, Technology, and Resilience



Micro-grid Concept



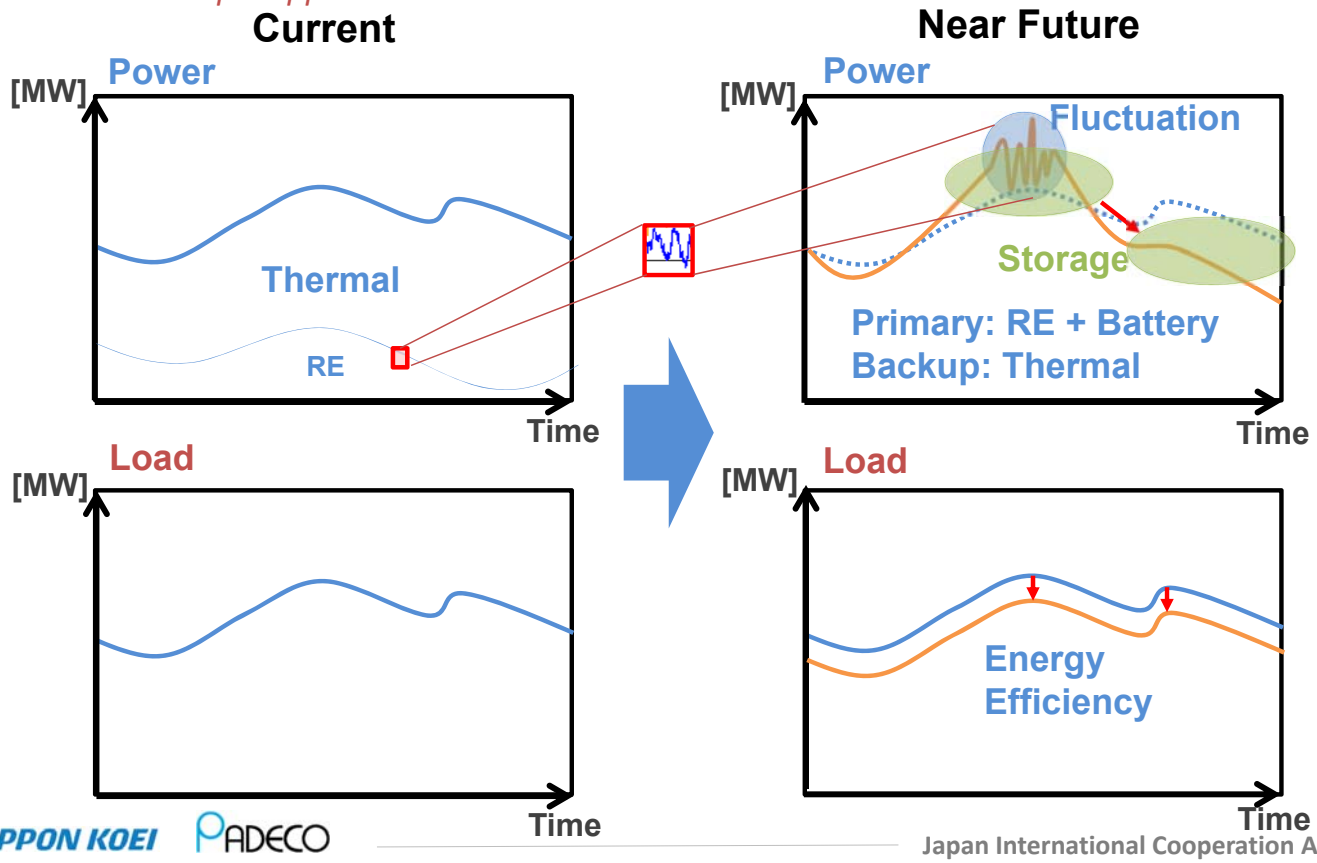
Concept of Micro-grid

- ✓ Respective Micro-grid is connected each other, and each Micro-grid can work independently
- ✓ Local energy production for local consumption
  - ✓ Generation: PV, wind, biomass, DG, GT, battery, etc.
  - ✓ Demand: industry, commercial, home, EV, etc.
- ✓ Less transmission → loss saving
- ✓ With IoT, control system, EMS, demand response, smart meters → Smart energy
- ✓ Enhance resiliency

Source: Smart City Development and Recent trend in Electric Power Network, Waseda Univ.

Challenges

- Fluctuation of VRE and necessity of energy storage and buck-up
-RE and EE multiple approach



Project Period/ Outputs

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	33	34
Phase 1 (Baseline Survey)						Phase 2 (Technical Transfer)																													34 months	
Year 2019									Year 2020												Year 2021												2022		
4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

Output 1
The basic information is confirmed for the capacity building for the introduction of RE

Output 3
The human and institution capacity are enhanced for the mass introduction of RE

Output 2
The basic information is confirmed for the capacity building for the promotion of EE

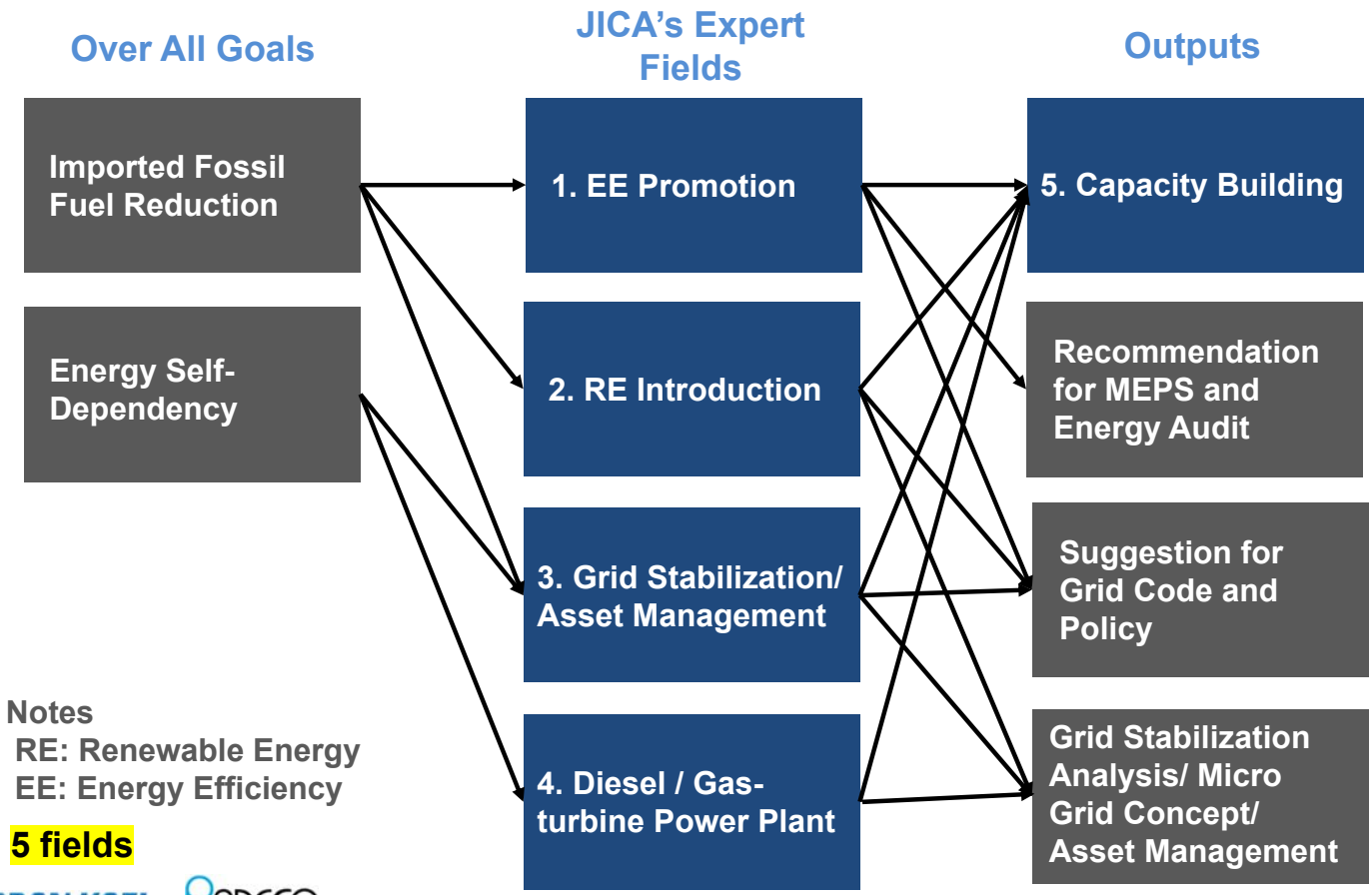
Output 4
The human and institution capacity are enhanced for the promotion of EE

4 outputs

This JCC #1 aims to share the result of Baseline Survey belong to output 1 and 2.

As the result, JET proposed revised work plan and PDM based on discussion on previous meetings for assistance of achieving your goals.

Project Outline/ Contents Outline



Notes
RE: Renewable Energy
EE: Energy Efficiency

5 fields

JICA Expert Team

Team Leader Group/ Power System


1. EE Promotion

5. Capacity Building

2. RE Introduction


3. Grid Stabilization/ Asset Management

4. Diesel / Gas-turbine Power Plant

8 Japanese Experts

NIPPON KOEI PADECO

Contents

2. Baseline Survey Report

Summary

Fields	Findings	Project Activities
1. Energy Efficiency	• Energy Source: Electricity (63%) , Oil (37%) • Load Curve: Bactrian camel type • Annual Peak Demand: about 25MW (St. Kitts) about 9MW (Nevis) • Peak Period: around 11am, 6pm-8pm (St. Kitts) around 12am, 6pm-8pm (Nevis)	Priority 1: Optimized operation with inverter Priority 2: Mini split AC with inverter Priority 3: VRF
2. Renewable Energy	• 100% RE target by 2020 • PV 2MW, Wind 2.2MW, RE 2.6% of grid	Recommendation for 100% RE target Micro-grid concept study Training for grid simulation
3. Grid Stabilization	• "RE is a Nightmare!" • Grid stabilization analysis is needed for new PV project	
4. O&M of Thermal Power Generation	• Thermal power plant: total 13 units (St. Kitts), total 9 units (Nevis) • Installed Capacity: total 44.9MW (St. Kitts) total 20.3 MW (Nevis) • Preventive(Scheduled) Maintenance	-
5. Human Resources and Capacity Building	• MPI's Energy Division: 4 employees • Most of capacity building is done by OJT • There is no systematic HR development.	JET experts select topics and develop the most suitable curriculum for technology transfer period

Energy Efficiency

- **Current situation 1-1: Energy consumption outlook by sector and energy source**
  - Other sector (residential, commercial & public service ,etc.) is the largest energy consuming sector (48%) followed by transportation (31%) and industrial (21%) sectors.
  - Electricity is the largest energy source (63%) followed by oil (37%).

Energy consumption by sector and energy source on primary energy basis (ktoe)

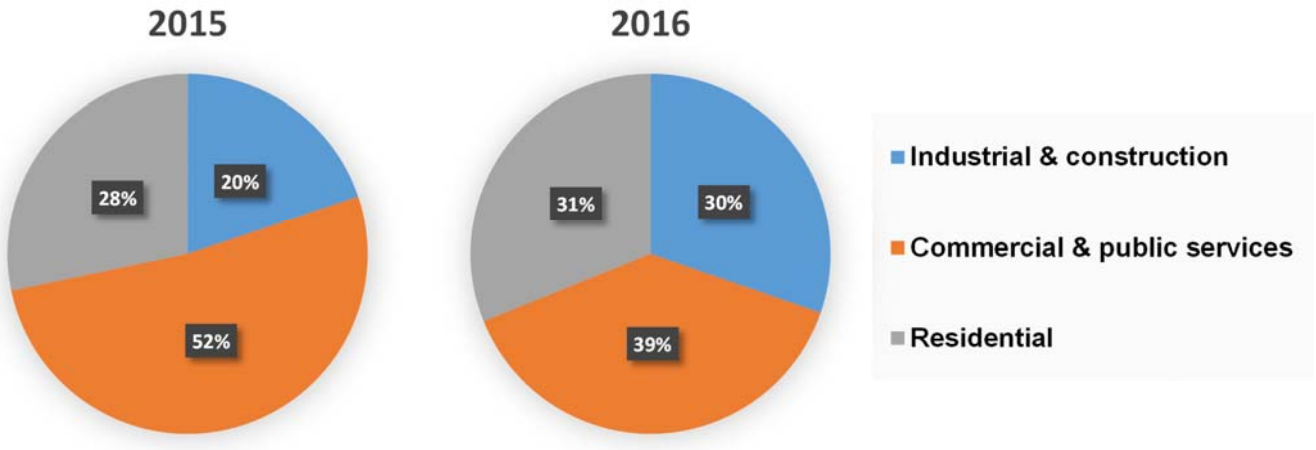
	Industry	Other	Transportation	Total
Oil	1	3	25	29 (37%)
Electricity (primary energy basis)	15	35	0	50 (63%)
Total	16 (21%)	38 (48%)	25 (31%)	79 (100%)

Note 1: Primary energy conversion factor of electricity is utilized to evaluate the effect of energy saving by reduction of 1kWh of electricity consumption at demand side.
Note 2: To calculate primary energy consumption of electricity, energy efficiency at end-use (30.0%) was used based on energy balances (2016) by United Nations Statistics Division. SKELEC provided overall loss is approximately 20% including in-house loss at thermal power plants and transmission & distribution loss. JET considers end use efficiency (30.0%) is appropriate level in light of thermal efficiency of diesel generators and overall loss.
Source: JET with reference to energy balances (2016) by United Nations Statistics Division and above information mentioned in Note 2.

2-1. Baseline Survey Report- Energy Efficiency

Energy Efficiency

- **Current situation 1-2: Electricity consumption by sector**
  - Commercial & public services sector is the largest electricity consumer (39-52%) followed by residential customers (approximately 30%) and industrial customers (20-30%).



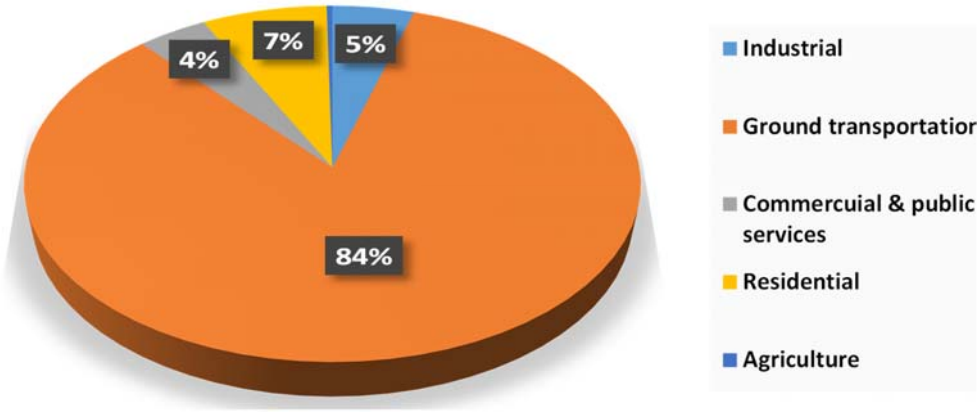
Source: JET with reference to energy balances and electricity profile (2015, 2016) by United Nations Statistics Division.

Energy Efficiency

- **Current situation 1-3: Oil consumption situation**

  - Excluding oil used for power generation, 84% of oil is consumed by the transport sector (ground transportation) followed by residential sector (7%) and commercial & public service sectors.

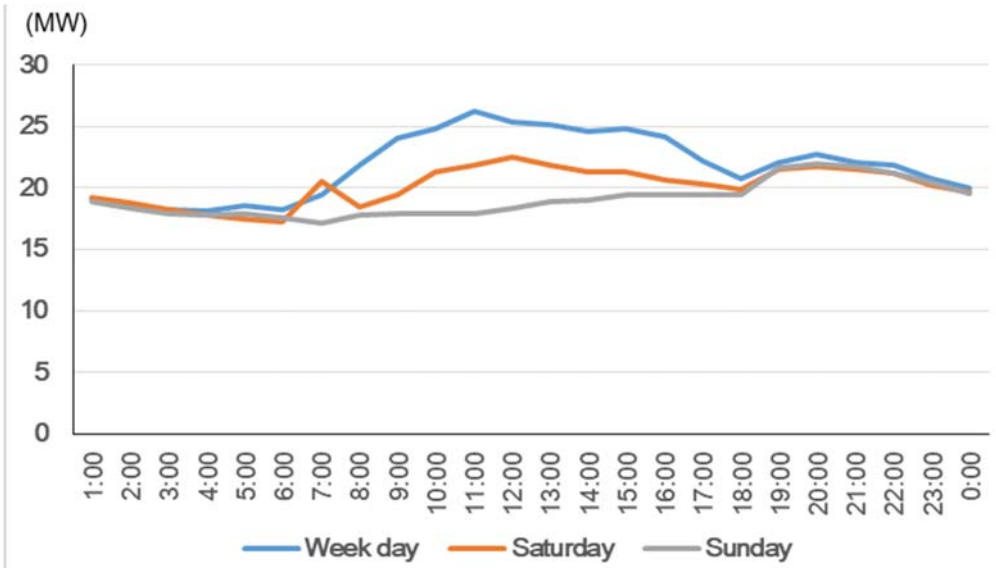
Petroleum consumption by sector excluding power generation use, 2015 & 2016



Source: JET with reference to energy balances (2015 & 2016) by United Nations Statistics Division.

Energy Efficiency

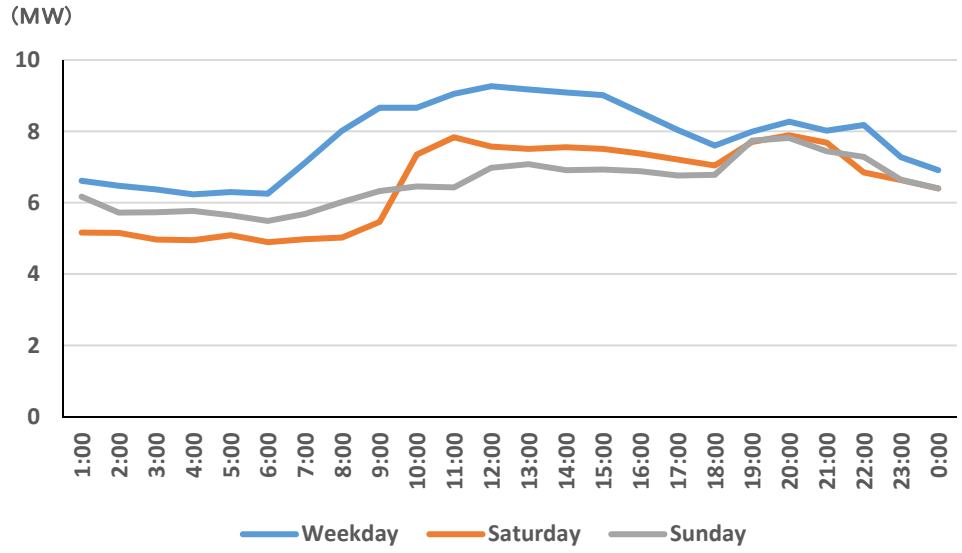
- **Current situation 1-4: Electricity load curve (SKELEC)**
  - Annual peak demand: Approximately 25MW.
  - As for the load curve, the daily peak demand is generated at around 11:00 am, and the demand increase again between to 6:00 pm & 8pm for lighting demand (Bactrian camel type (very common)).



Source: JET with reference to ST. KITTS AND NEVIS RENEWABLE ENERGY POLICY (draft), MINISTRY OF PUBLIC INFRASTRUCTURE, POST, URBAN DEVELOPMENT AND TRANSPORT

Energy Efficiency

- **Current situation 1-5: Electricity load curve (NEVLEC)**
  - Annual peak demand: Approximately 10MW or more.
  - As for the load curve, the daily peak demand is generated at around 12:00 pm, and the demand increase again between to 6:00 pm & 8pm for lighting demand (Bactrian camel type (very common)).

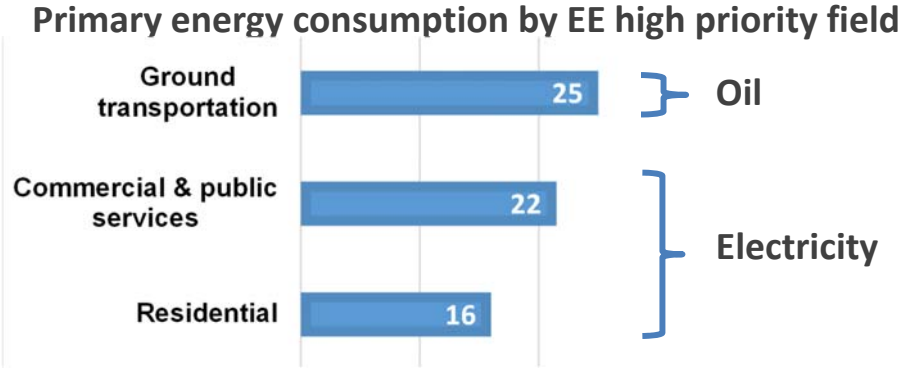


Source: JET with reference to ST. KITTS AND NEVIS RENEWABLE ENERGY POLICY (draft), MINISTRY OF PUBLIC INFRASTRUCTURE, POST, URBAN DEVELOPMENT AND TRANSPORT

Energy Efficiency

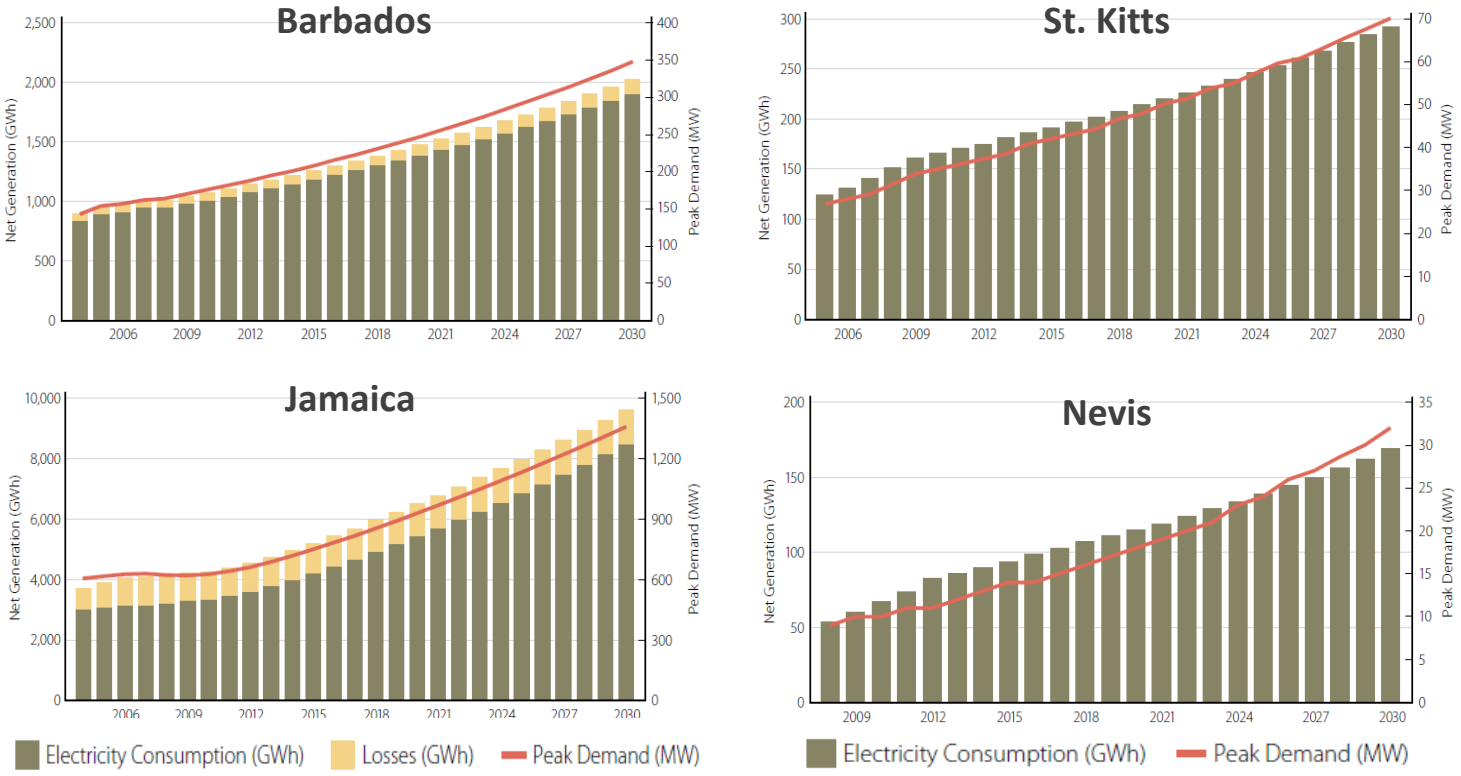
- **Points of studies and proposals on EE measures:** Studies and proposals shall be made with high priority for the energy consumption fields indicated **in red**.
- The **coverage ratio of high priority EE fields = 76%** (60/79)

	Oil	Electricity	Total
Primary energy consumption	29	50	79
Industry	1	15	16
Ground transportation	25	0	25
Residential	3	16	35
Commercial & public services		19	
Primary energy consumption to be studied as to EE measures with high priority	25	35	60



Source: JET

Energy Efficiency



Electricity System Forecast

Source: Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS) (Worldwatch Institute, IDB, GIZ (2015))

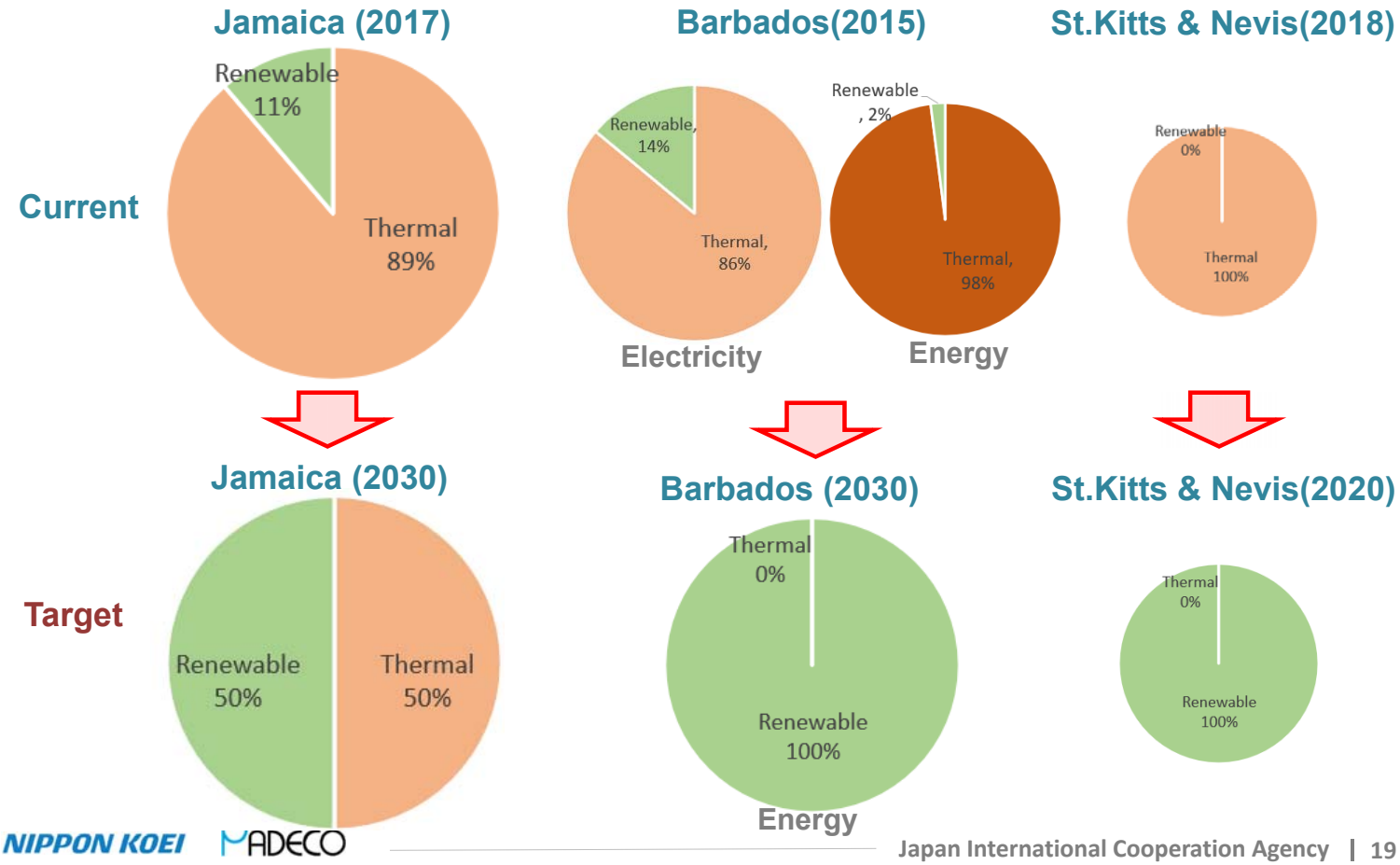
Energy Efficiency

EE technologies summary with priority (needs survey results)

Priority	Barbados	Jamaica	St. Kitts & Nevis
1	VRF (Variable Refrigerant Flow)	BEMS	Optimized operation with inverter
2	BEMS	Mini split AC with inverter	Mini split AC with inverter
3	Optimized operation with inverter	LED	VRF (Variable Refrigerant Flow)
4	(Smart meter)	VRF (Variable Refrigerant Flow)	LED
5	Mini split AC with inverter	Optimized operation with inverter	BEMS
6	Efficient refrigerator incl. inverter type	Efficient refrigerator incl. inverter type	(Smart meter)
7	Efficient motor (IE1 - IE3 level)	Efficient motor (IE1 - IE3 level)	Amorphous metal transformer
8	LED	Heat recovery system (co-gen, heat recovery heat pump)	Efficient motor (IE1 - IE4 level)
9	Heat recovery system (co-gen, heat recovery heat pump)	(Smart meter)	Heat recovery system (co-gen, heat recovery heat pump)
10	Amorphous metal transformer	Amorphous metal transformer	Efficient refrigerator incl. inverter type
New	Electric Vehicle (EV)	Electric Vehicle (EV)	Electric Vehicle (EV) for St. Kitts

EE technologies with high priority/needs is consistent with the "points of studies and proposals on EE measures"

RE: Current Status of RE



RE&Grid: Summary of Baseline Survey

Summary of Indicators for RE and Grid

Item	Barbados	Jamaica	St.Kitts & Navis
Access to Electricity	100%	100%	100%
SAIDI (hrs/customers/yr)	3.68	46.7	0.0: 7.5 hrs (2016)
SAIFI (outages/customers/yr)	5.84	19.7	0.0: 3 times (2016)
Composition of power sources, 2018 (Capacity, MW)	Thermal 239 PV10+21(FIT)	Thermal 843.3, Hydro 28.6, VRE 122 Rooftop 20?	Thermal 44.9&18 PV 1.2 & Wind2.2
Pecentage of RE (Electricity)	12.4%	14.9%	2.6%
Power consumption (GWh) including estimation	Total: 950, RE:14% (BNEP) 2%, total energy base	Total 4356, Hydro146, VRE358 estd. RE 12%	Total 208&56 RE: 1 & 5.25 (0 & 9%)
Grid stabiliztion	5MW, 20MWh BESS	21.5 MW, 16.6MWh BESS + 3MW Flywheel	NA
Electricity tariff ($/kWh)	0.28	0.284	0.26
CO2 emission factor (tCO2/MWh)	0.737	0.688	0.691
Grid status (Customer, line length, loss)	130,000 customer TL 169km DL2800km Loss 4.8%	>0.6mil customer 138/69 kV :366/794km MV 11,280 km 43 Substation Loss 26.3%	SKELEC customer 20,815, Loss 12% NEVLEC Loss 14%

RE: Key T/C Activities for RE

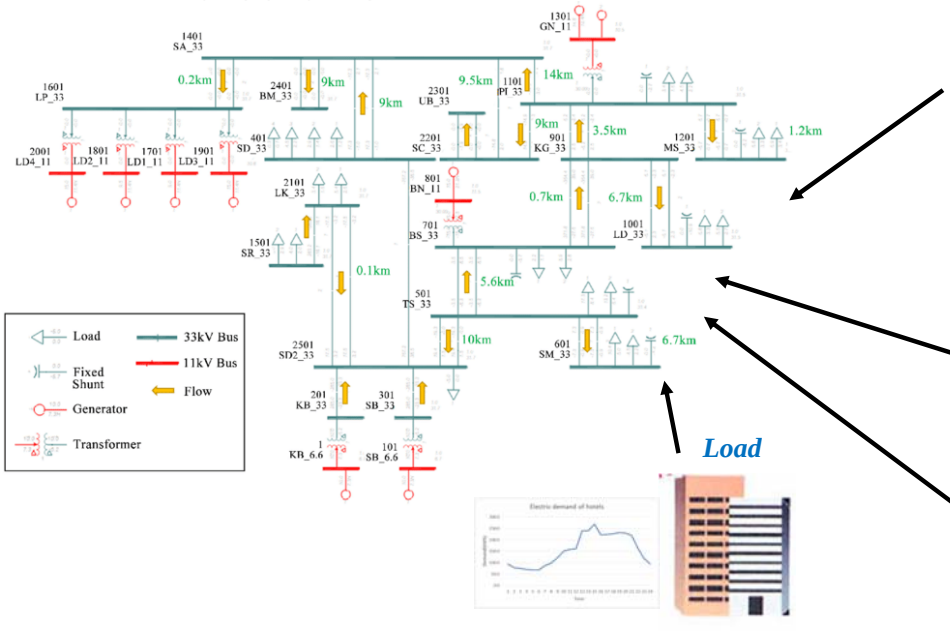
Barbados	Jamaica	St Kitts &Nevis
• Provision of Grid simulation software and training • Micro-grid concept study at Coverley Village • Energy source diversity (incl. waste treatment in cement plant)	• Training for grid simulation • Introduction of network asset management • Micro-grid concept study at Bogue area	• Provision of Grid simulation software and training • Introduction of network asset management

✓ **Discussion for grid code**

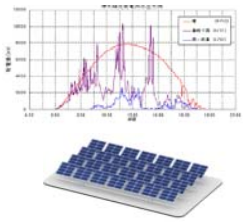
✓ **Suggestion for policy and RE target with reviewing affordability of RE**

Grid Stabilization Simulation

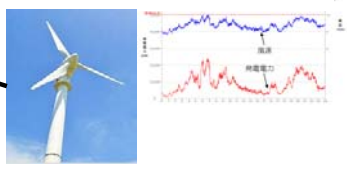
- Simulation of National Grid Model
- Analysis of Issues and Solutions
- EDC Calculation



Photovoltaic Generation

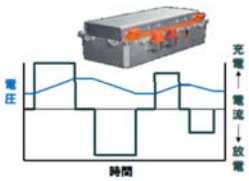


Wind Generator

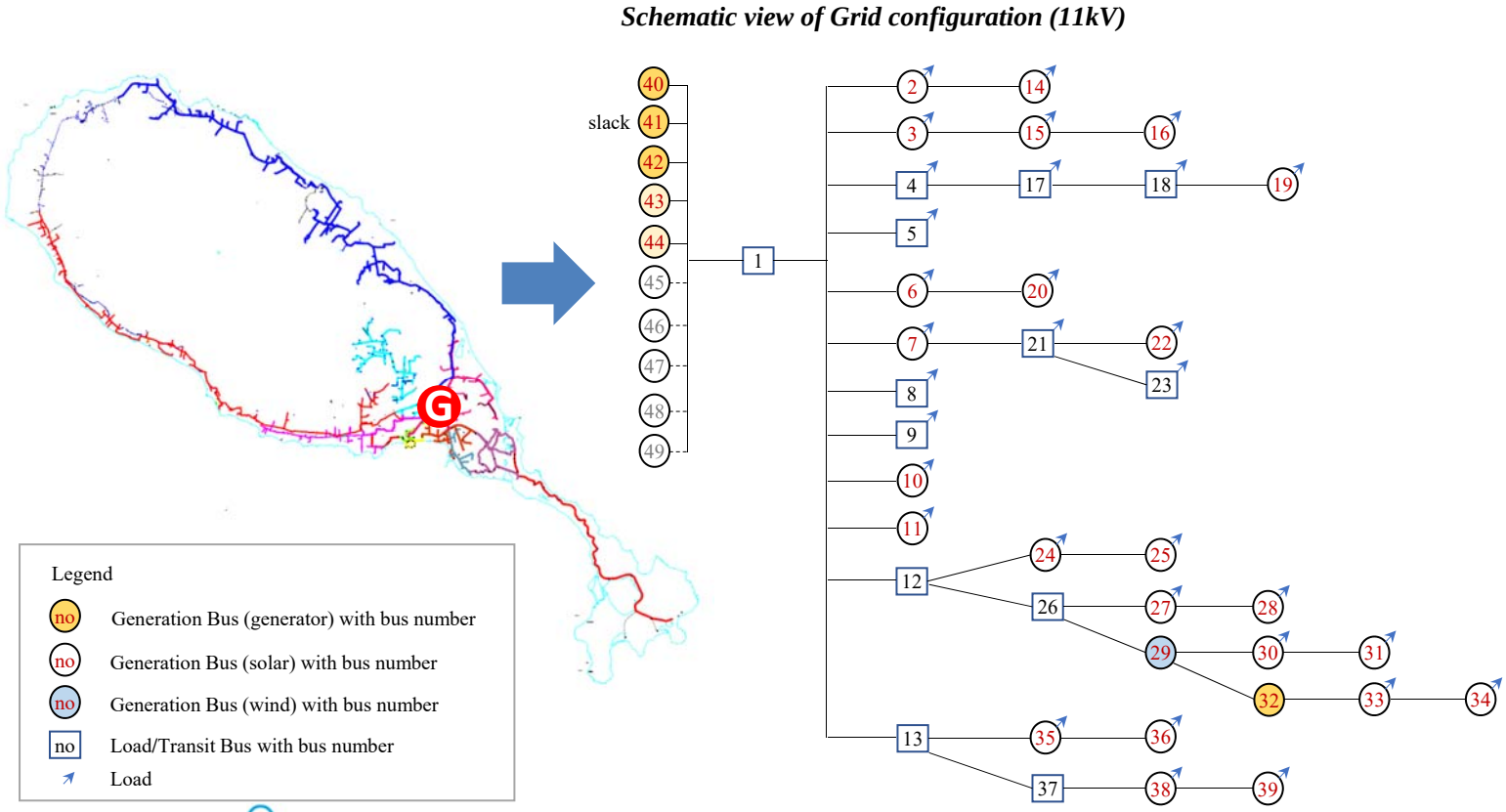


Load

Battery

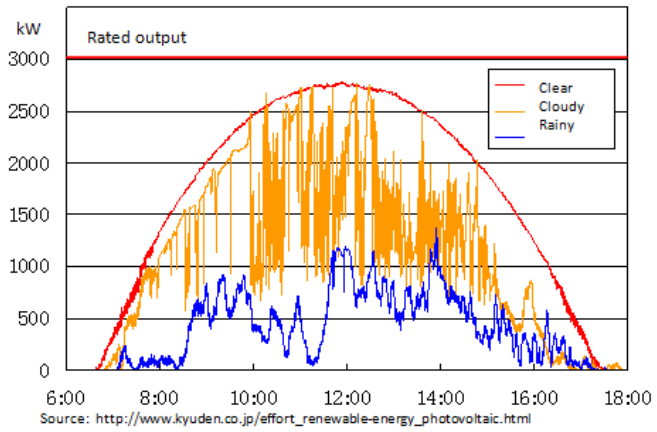


Grid Stabilization Simulation Modeling

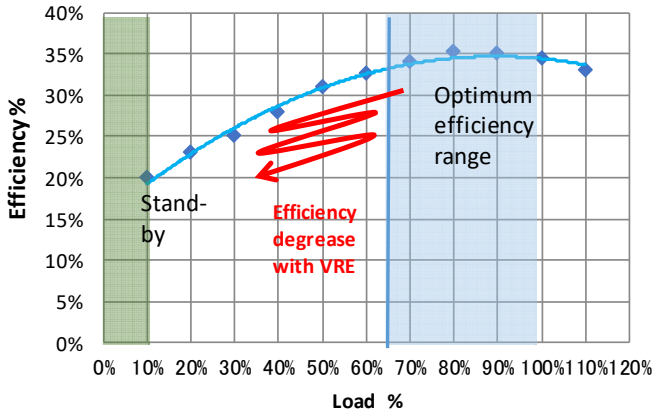


RE: With Large RE Penetration

- VRE causes frequency and voltage fluctuation
- Load shedding due to fluctuation:
- Efficiency reduction
  - 10% DG efficiency reduction offsets 30% RE output in micro-grid without grid stabilization method
  - Increasing fuel consumption

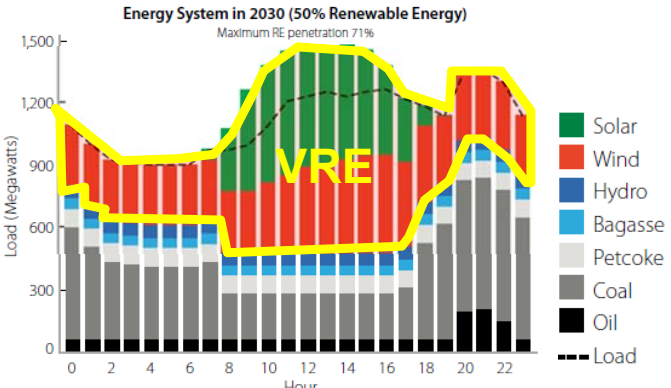


PV output in each whether



Load and efficiency of typical diesel generator

RE: Instability Caused by VRE



Source: Jamaica Sustainable Energy Roadmap 2013

Grid instability

- Voltage and frequency fluctuation
- Shortage of Inertial power
- High cost for countermeasure

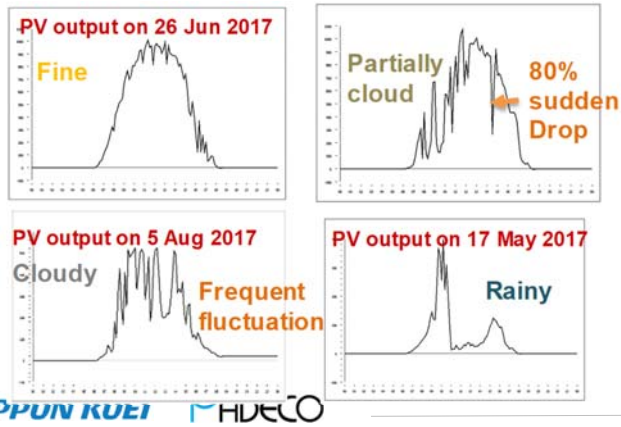
Fuel L/kW increase in diesel generator

- Low load operation
- Acceleration and deceleration
- Spinning reserve

→ **EMS and Battery Storage are necessary for grid stability and economic operation (expensive)**

→ **It might need to optimize RE%**

Spinning reserve is necessary for RE fluctuation.

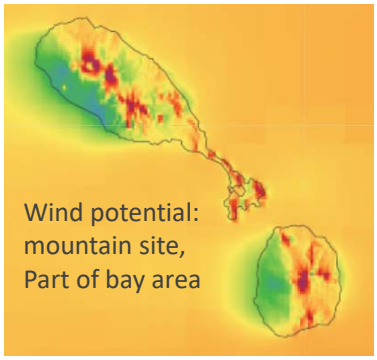


VRE %	< 20%	20-60%	> 60%
Issue	Response by thermal poser	Voltage and frequency fluctuation, power failure increase	(in addition to left) harmonic wave, phase balance, synchronization, supplement of reactive power
Equipment needed for grid stabilization	Output restrain by PCS, EMS	EMS and high-speed charge-discharge battery or capacitor, quick-response thermal power	Power factor control PCS is needed. Special arrangement according to site is necessary.
Cost	Low	High (battery replacement is necessary)	Very high. Specific technical arrangement is necessary

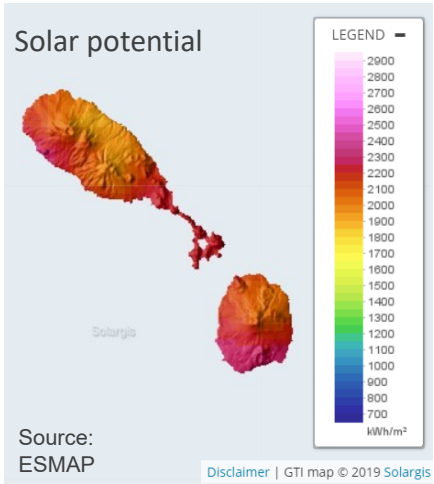
RE: Status in St.Kitts & Nevis

RE Projects in St. Kitts and Navis

Location/Project	Type	Capacity MW	Generation GWh estimated	Year	Tariff USc/kWh
S: SCASPA	PV	0.7	NA	2013	Self
S: SKELEC	PV	0.5	1	2015	Self
N: Windwatt	Wind	2.2	5.25	2011	NA
N: NREI Geothermal	Geo	10	NA	2020	16-17
S: Leclanche	PV	35	43.8	2020	
S: Bellevue	Wind	5.7	NA	NA	
S: NW Geothermal	Geo	18-36	NA	NA	



Source: ESMAP



Source: ESMAP

Necessary consideration for future RE

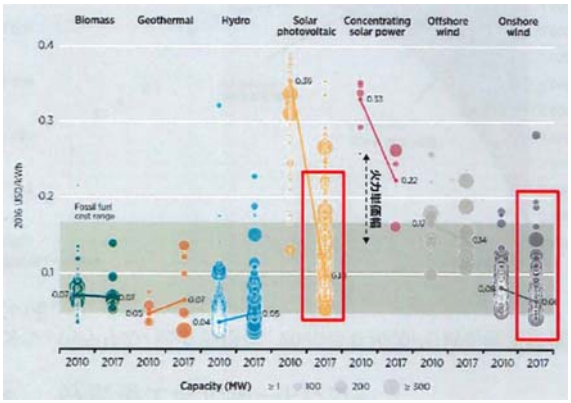
1) Grid stability analysis for new 35MW PV system
2) Update of geothermal development
3) Interconnection?

RE: Way Forward for Large RE Penetration

Paradigm Shift

- VRE generation itself is low cost, promoted by market
- Grid stabilization is necessary for large scale
- **Inertia** needs to be considered
  - Biomass, Biogas, CSP
- Large cost for energy storage

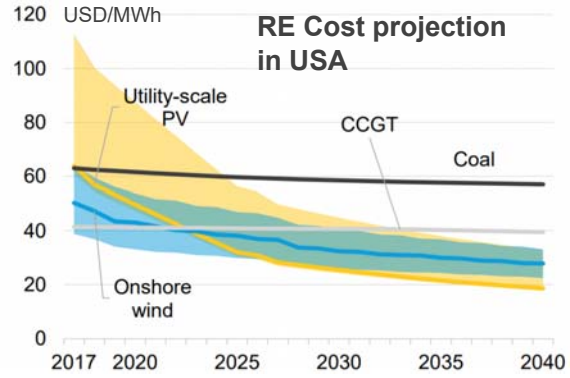
→ **Who owns the stabilization cost?**



Source: Mitsubishi Electrics, IRENA RE cost database

Necessary consideration in project activity

1) Grid Stabilization
2) Cost reduction of energy storage
3) Resiliency
4) Microgrid



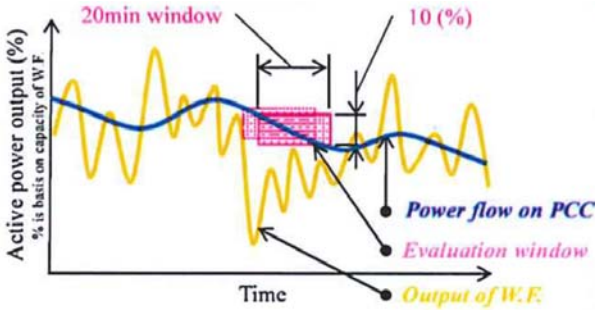
Source: Power Markets Today, Broomberg 2018/ METI, Japan

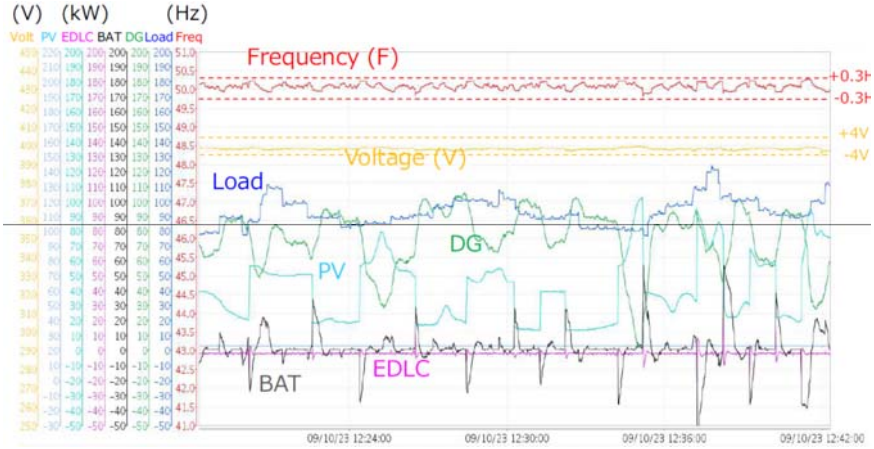
RE: Example of Grid Stabilization with RE and energy storage

For Voltage and Frequency stabilization (below)

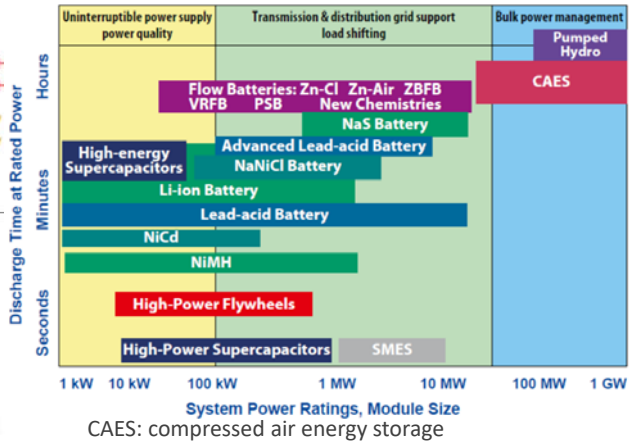
- ✓ Generation: PV, Wind, DG, GT, etc.
- ✓ Energy Storage: Battery (BAT), Capacitor (EDLC)
- ✓ Load /Demand control
- → **Grid Simulation is necessary**
- → **Various energy storage needs to be considered**

Smoothing output





Source: Meidensha, Autonomous Micro-grid Conference, 2019

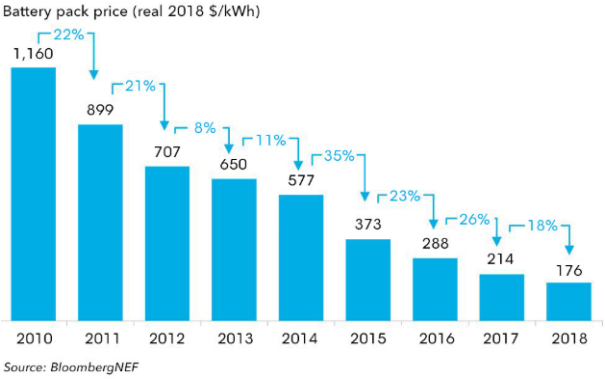


CAES: compressed air energy storage
Source: IRENA, Electricity Storage and Renewables, 2017

RE: Cost consideration of BESS

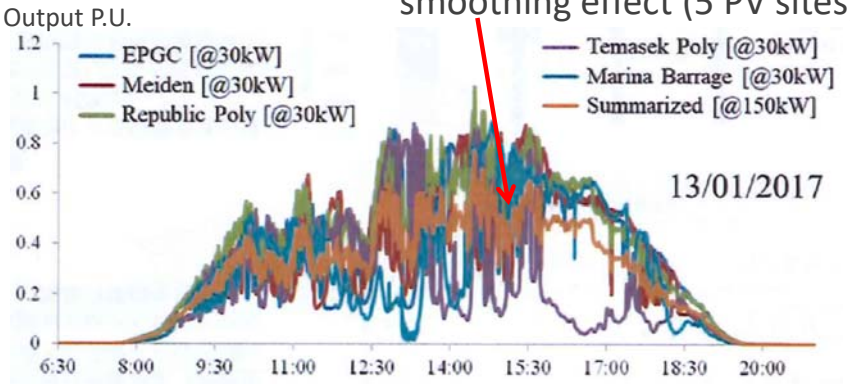
1) Output smoothing by overlaying different PV/wind locations
2) Battery at each site → Centralized battery storage system

Battery cost reduction, but still high cost



Cost reduction Example in Singapore

67% of battery capacity can be reduced by output smoothing effect (5 PV sites)



Source: Meidensha, Autonomous Micro-grid Conference, 2019

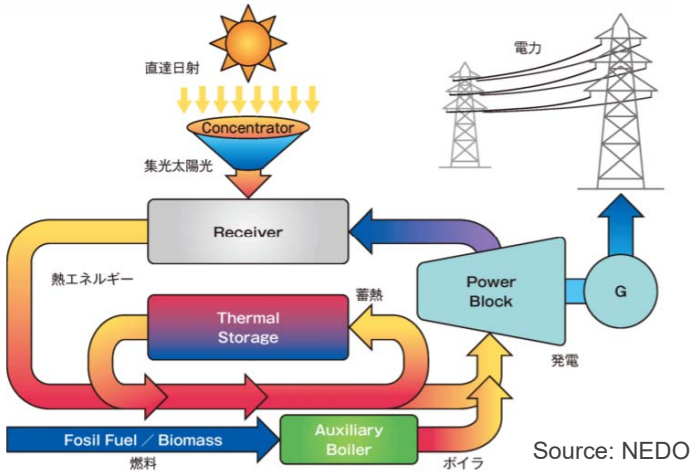
To reduce cost:
- Data analysis with solar irradiation/wind speed short interval necessary at several locations
- Speedy communication system advanced EMS control is necessary

National grid oriented program is necessary

→Battery capacity and EMS cost should be considered in Tariff

RE: Optional Technology : CSP

Concentrating Solar Thermal Power (CSP)



Source: NEDO

- Inertial power can be supplied
- Combination with molten-salt heat storage
- Inertial power can be supplied
- Combination with molten-salt heat storage

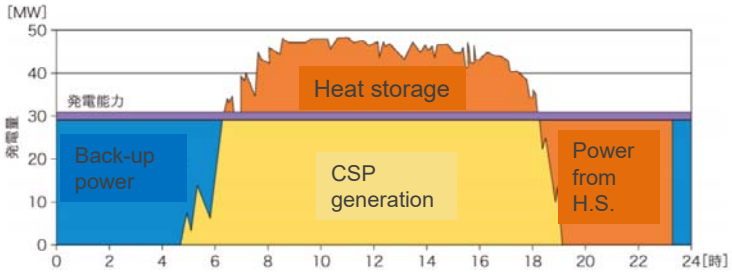
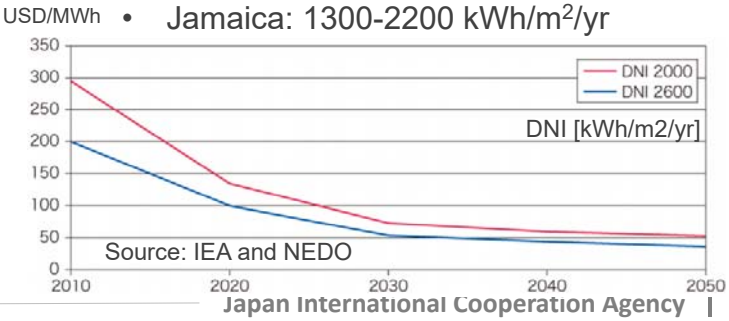


Photo: blog.eco-megane.jp/

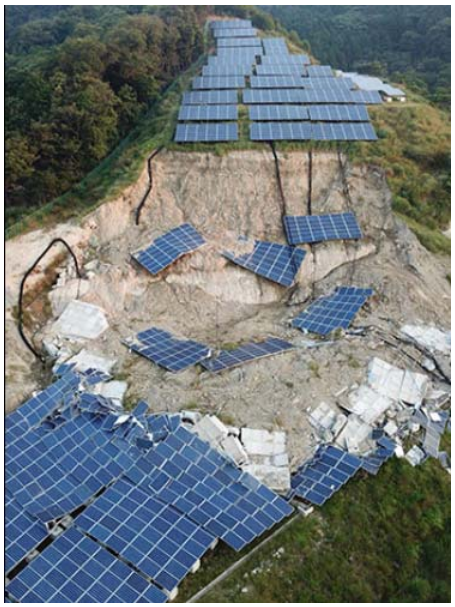
- DNI (Direct normal irradiation)
  - Barbados: 1600-2000 kWh/m²/yr
  - St Kitts&Nevis:1600-2300 kWh/m²/yr
  - Jamaica: 1300-2200 kWh/m²/yr



RE: Resiliency of RE

23 Aug 2018 Awaji, Japan
https://www.sankei.com/west/news/180828/wst1808280043-n1.html
600 kW, Fallen at 25.6m/s wind while 60m/s design
- Additional moment due to Excess of high speed
- Missing control power supply

9 Sep 2019 Kanto, Japan
@kadowaki_kozo
Damage of roof-top structure by high speed wind



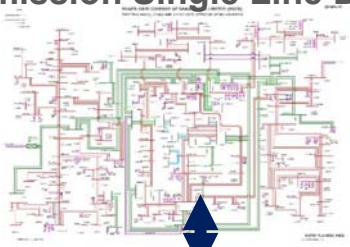
26 Jul 2019 Himeji, Japan
https://www.dailyshincho.jp/article/2018/07260800/?photo=1
Landslide by a heavy rain

For enhancement of resilience:
- ✓ Design Standard with higher rank hurricane
- ✓ Compensation, third party Insurance coverage
- ✓ Safety Education for shock
- ✓ Fast recovery with **GIS and Asset management**
- ✓ **Micro-grid**

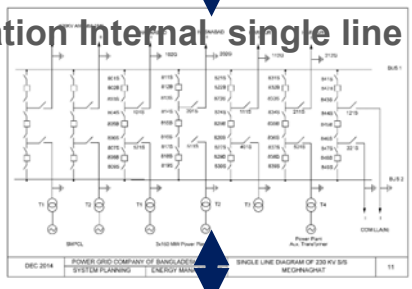
RE: Resiliency Enhancement - Digitalized Network Management System

Linking all asset data on to one data platform

Transmission Single Line Diagram

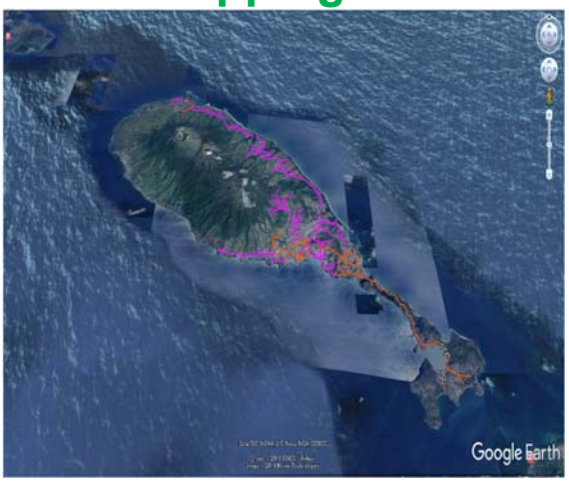


Substation Internal single line diagram



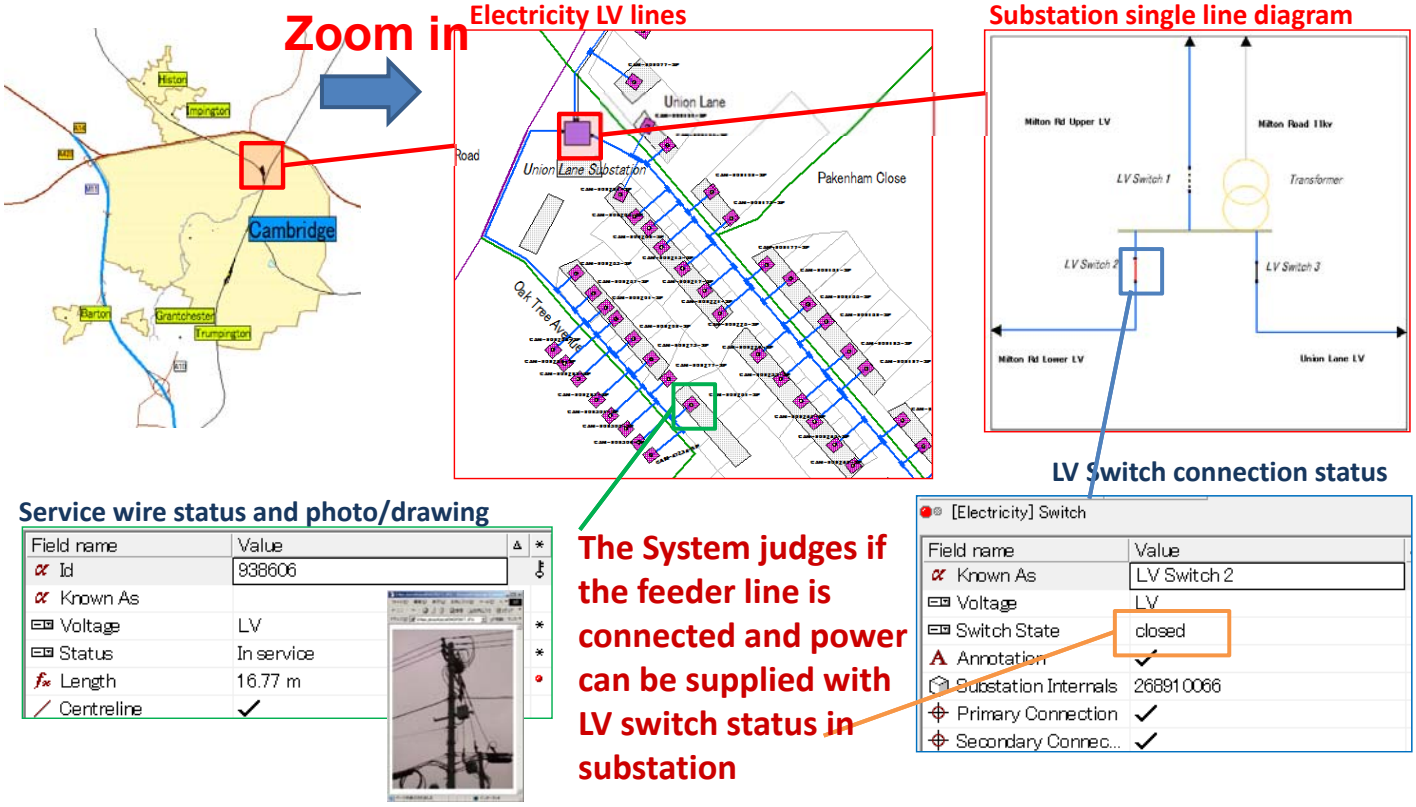
Power distribution network to meter

Power Network Mapping Data



- Visualization of precise location
- Base for fast fault recovery
- Asset management of small VREs
- Database for EE verification

RE: Resiliency Enhancement - Digitalized Data Model

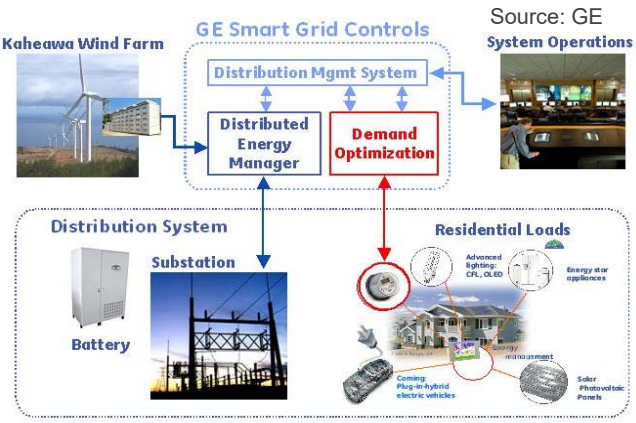


RE: Large RE Example in Islands

40% RE: Hawaii

Hawaiian Electric Company: Expansion of distributed power sources
Nos of customers: 462,225, total 1,795 MW, VRE 673 MW

- Energy storage
- Output suppression of wind and solar
- 15% peak load reduction



100% RE: Samoa (USA)

Source: JICA

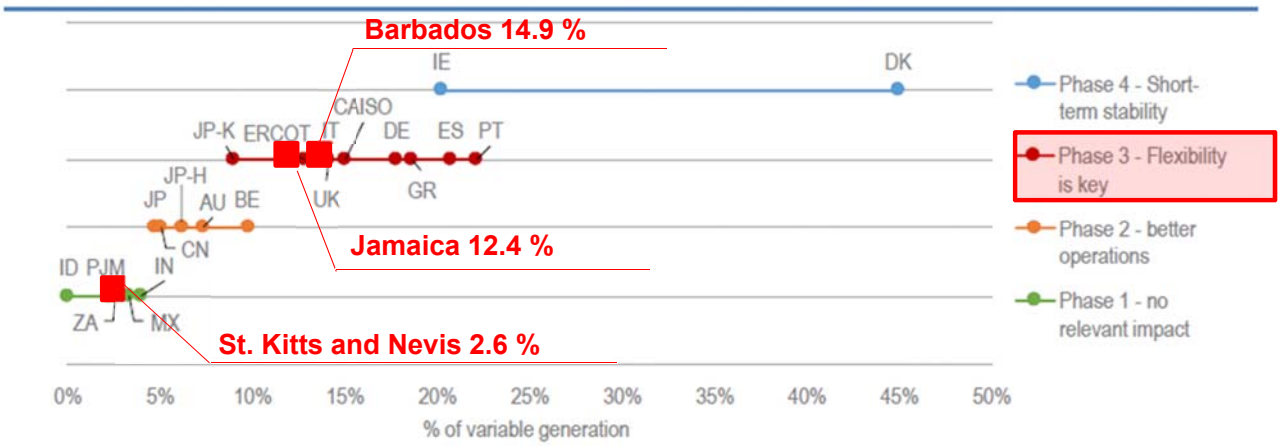
3 villages, 203 household, population 790
Peak **229kW**, Demand1300 MWh/yr, **3.6 MWh/day**)
RE: **1.4 MW PV (6.1 times than peak)**
Battery: **750kW**/**6 MWh** LIB, Tesla 20yrs guarantee
DG: 320kW × 3, 150kW × 1

Mon	Jan	Feb	Mar	Apr	May	Jun
RE%	98.4	97	99	91.2	89.9	99.6

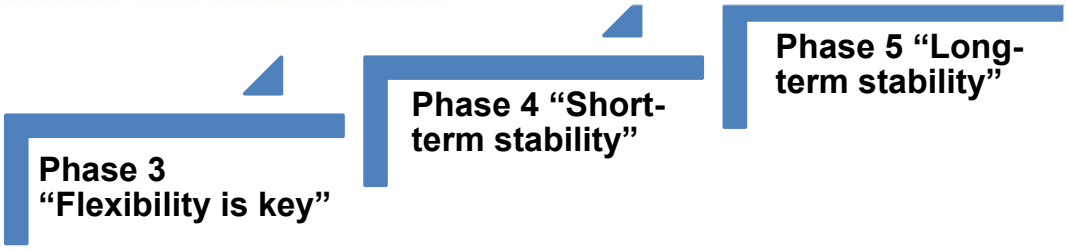
Small demand, but huge RE and Battery
→ **Micro-grid**, Back-up DG is necessary

Current Situation of VRE Generation Share

Annual VRE generation shares in selected counties and correspondence to deferent VRE phases, 2016



Source: Adapted from IEA (2017a), *Renewable 2017.*



Balance

Cost and Benefits, Power and Load, Myths and Reality

Grid Simulation

Photo: Steve Buissinne via Pixabay

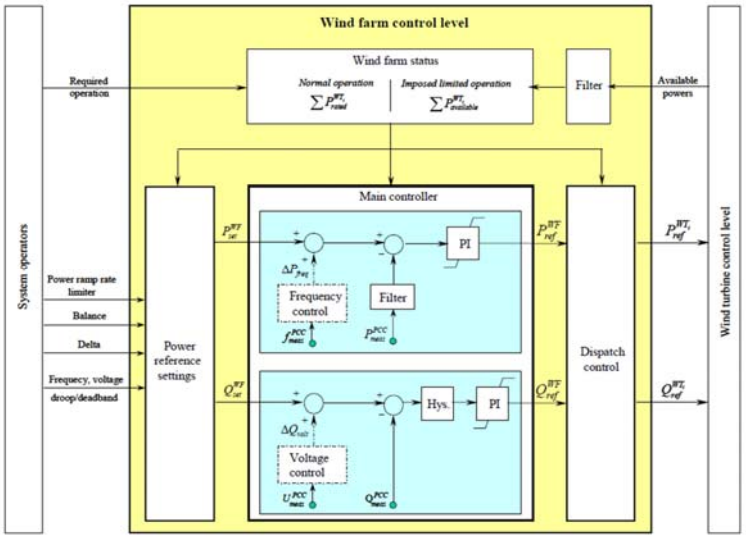
Grid Simulation Software

Country	Current Condition	T/C Activity
Jamaica	Power Factory/DIgSILENT by IRP consultant	GridSim: Montego Bay Area Modeling*
St. Kitts	Data for PSS/E by a past external consultant, currently not available	GridSim: Transmission/Distribution Network Modeling
Navis	--	GridSim: Transmission/Distribution Network Modeling
Barbados	PSS/E, ETAP by BL&P	GridSim: for Coevally Area Modeling and for training of government staff*
CARICOM	--	Requested for other Caribbean countries

***: JET recommended GridSim for technology transfer in the view of transparent and migratable from existing software.**

Solution 1: Revising Grid Code: EU Cases

Active/ real power control

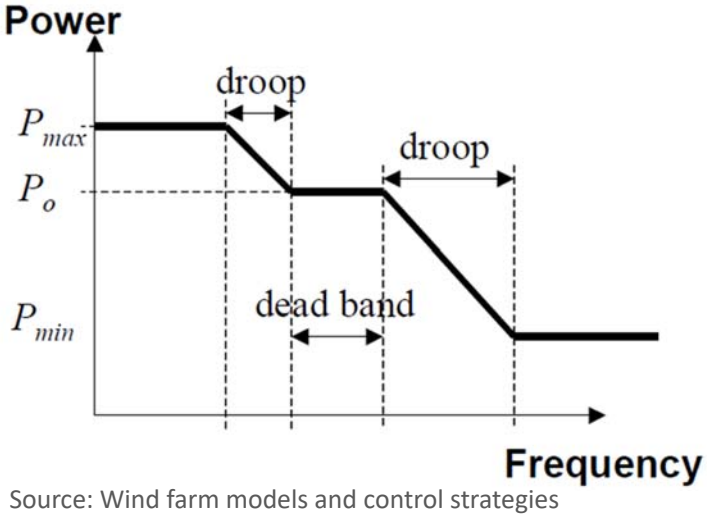


Source: Wind farm models and control strategies

- VRE can be controlled the limitation of active power based on power system condition

Regulated in EU, Germany, UK, Ireland, Denmark etc.

Frequency droop control



Source: Wind farm models and control strategies

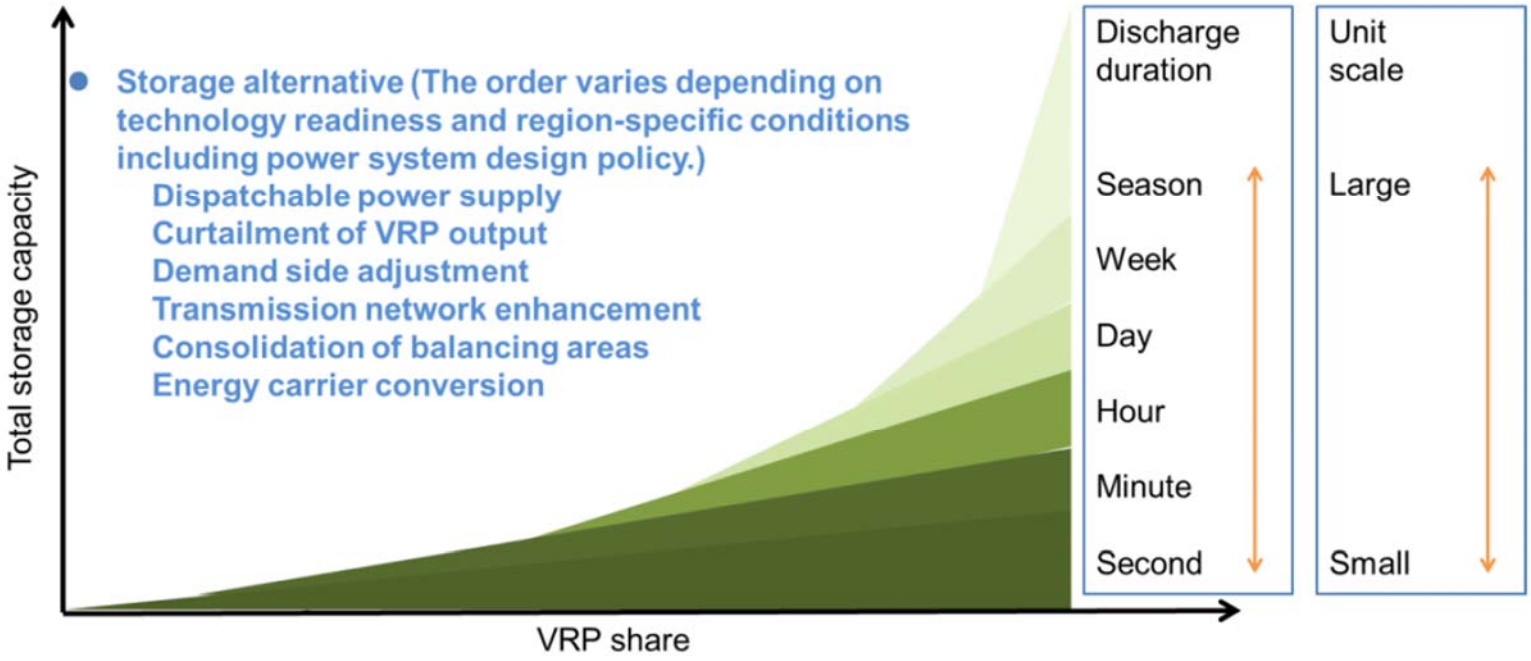
- Same as thermal power plant control
- For frequency stabilization

Regulated in EU, Germany, UK, Ireland, Denmark etc.

Solution 2: Application of Large Capacity Energy Storage System

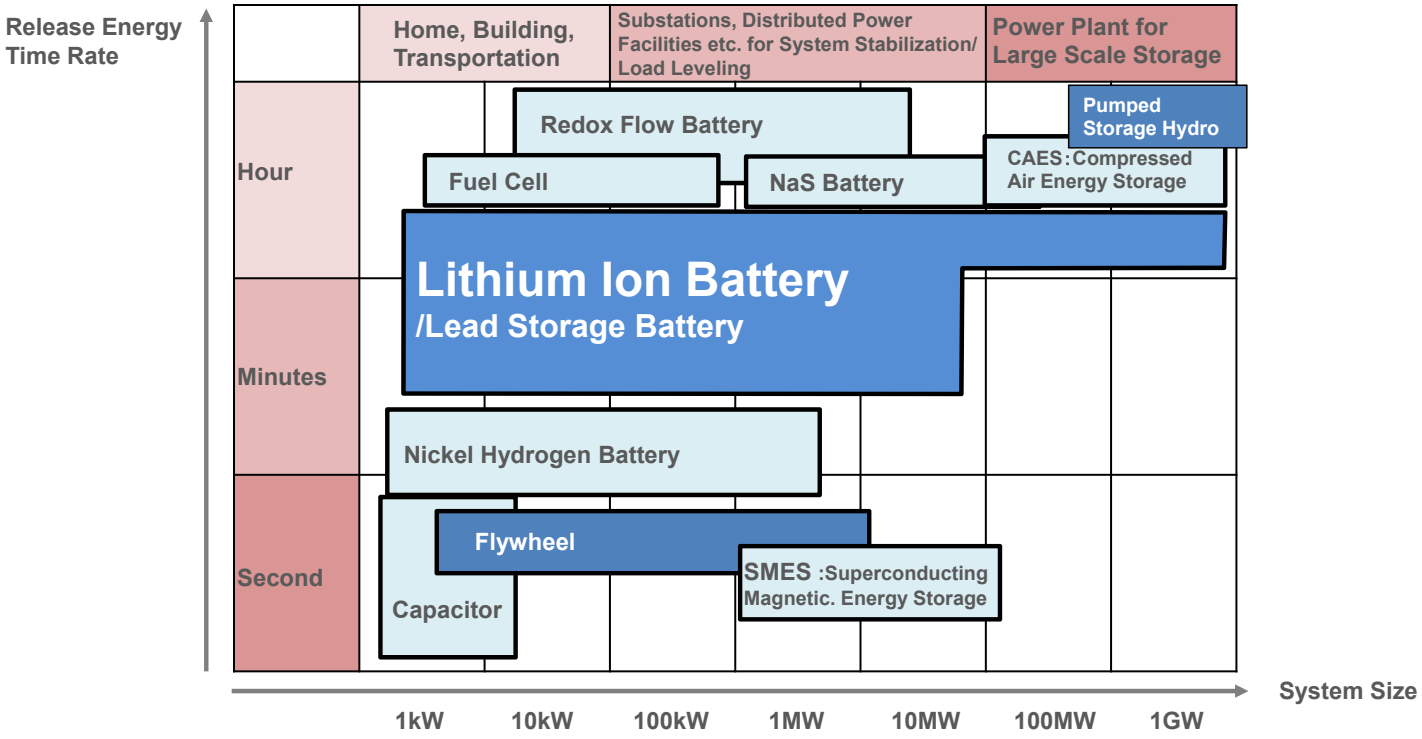
Variable Renewable Energy (VRE) Share and Storage Requirements for Power Systems

(Source: The Institute of Applied Energy)



Source: ICEF2017 Energy Storage Roadmap

Positioning for Energy Storage Technology



Source: NEDO Renewable Energy Technology White Paper Chapter 9

Current Status of Stationary Electric Energy Storage Technology

Technology	Order of Capacity (MWh)	Cycle Efficiency (%)	Energy Density (Wh/l)	Initial Investment Cost (USD/kWh)	Initial Investment Cost (USD/kW)	Maturity*	Discharge Time
							Sec. / Min. / Hr. / Day / Month /Season
PSH	100-1,000	50-85	0.1-0.2	250-430	500-4,600	H	Min. – Day
CAES**	10-1,000	27-70	2-6	60-130	500-1,500	H	Min. – Day
LAES	10-1,000	55-85	N.A.	260-530	900-1,900	M-H	Min. – Day
Power to Hydrogen	10-1,000	22-50	600***	440-870****	500-750	M-H	Hr. – Month /Season
Battery	0.1-100	75-95	20-400	290-2,000	300-3,500	M-H	Sec. – Day
SMES	0.1-10	90-95	6	700,000	130-520	L-M	Sec. – Min.
Flywheel	0.1	90-95	20-80	7,800-8,800	130-500	M	Sec. – Min.
Capacitor	0.1	90-95	10-20	1,000	130-520	M	Sec. – Min.

PSH: Pumped-Storage Hydropower
CAES: Compressed Air Energy Storage
LAES: Liquid Air Energy Storage
SMES: Superconducting Magnetic Energy Storage

(notes) * L:Low M:Medium H:High
** Underground Cavern Storage Case
*** 600bar Compressed H_2 Case
**** Hydrogen Production Facility Only

Source: ICEF2017 Energy Storage Roadmap

O&M of Thermal Power Generation

<Maintenance(St. Kitts)>

- Preventive(Scheduled) Maintenance based on Manufacture's recommended schedule and practice
- Invite Manufacture Supervisor when Overhaul Maintenance
- Inhouse Training for Maintenance and Creating a Maintenance Manual

<Maintenance(Nevis)>

- Preventive(Scheduled) Maintenance based on Manufacture's recommended schedule and practice
- Invite Manufacture Supervisor when Overhaul Maintenance
- Inhouse Training for Maintenance and Creating a Maintenance Manual
- Dispatching the employee overseas and Receiving a Maintenance Training (Miami, Finland and England)

Human Resources Development

(1) Outline of HR Development, Certificate Holders, Challenges and Plans

	Ministry of Energy, Water Resources (MEWR), Barbados	Ministry of Science, Energy and Technology (MSET), Jamaica	Ministry of Public Infrastructure (MPI), St. Kitts
Organization & Structure	■ Energy Conservation and Renewable Energy Unit ■ 3 employees (Total No. of employees is 11)	■ Energy Division ■ 14 employees (Total No. of employees was N/A)	■ Energy Division ■ 4 employees (Total No. of employees was N/A)
HR Master Plan	■ None	■ Proposing about EE	■ None
Internal Trainings	■ No in-unit training. (Use external trainings)	■ Division/Department based trainings ■ External 3day basic energy audit training course, awareness building WS, seminars, etc.	■ No division-based trainings (Use external trainings)
Certificate Holders (CEM、CEA)	■ 3 employees (CEM/CEA holder 0)	■ 1 staff (CEM/CEA holder 0)	■ 4 staffs (CEM/CEA holder 0)
HR Dev. Budget	■ Not available	■ Not available	■ Not available
Challenges & Plans on HR Development	■ TBC	■ TBC	■ Energy Unit has only 3 staffs and activities are limited ■ Director wants to focus on business planning and budget requests to expanded their activities ■ HR Management Dept. does not have HR development plan

Human Resources Development

(2) Outline of HR Management

	Ministry of Energy, Water Resources (MEWR), Barbados	Ministry of Science, Energy and Technology (MSET), Jamaica	Ministry of Public Infrastructure (MPI), St. Kitts
Command Order System	■ Deputy Permanent Secretary allocates works of each unit and department head	■ Chief Technical Director allocates works of technical director and others of Energy div.	■ Permanent Secretary allocates works of Director and others
Employment Status	■ Two types of labor contracts - permanent and contract ■ Permanent employees must pass interview by the committee	■ All labor contracts are permanent basis	■ All labor contracts are permanent basis
Promotion & Transfer	■ Possible to reach a certain level of positions (but it takes time…) ■ Possibility to stay in the current position, pass the promotion exam, or move to the same position of other Ministries ■ Possibility of temporary assignment of other Ministries	■ TBC	■ Possible to apply for the upper positions. Possibility of promotion if employees meet duty requirements. ■ Possibility of internal transfer from the Energy Div. to the Water Service Dept. ■ Possibility of temporary assignment to other ministries
Salary	■ Each post has a certain range of salary. Salary is determined by qualification, experiences, skills etc. ■ No bonus	■ TBC	■ Each post has a certain range of salary. Salary is determined by qualification, experiences, skills etc. ■ No bonus
Recruitment	■ When there is a vacant position, announce to newspaper. Sometimes word of mouth recruitment	■ When there is a vacant position, firstly access internal resources. If no candidate, announce internationally.	■ When there is a vacant position, firstly access internal resources. If no candidate, announce to newspaper and social media.

Human Resources Development

(3) Result of Study of HR Development

Challenges of HR Development

- Recruitment of employees is normally done by a replacement of vacant position ⇒ Difficult to strengthen organization capacity by increasing number of employees.
- Most of capacity building is done by On-the-Job-Training (OJT) ⇒ Employees work without systematic knowledge.
- There is no systematic HR development.

Planned Policy of Technology Transfer

- JET experts select topics and develop the most suitable curriculum ⇒ Give essential lectures from policy making to practical activities for renewable energy, energy efficiency… etc.

Planned Training Method

- JET and CP share knowledge and learn each other ⇒ Combine lectures, practical exercises and discussions.

3. Training Program

Training Content

Item	1st domestic training	2nd domestic training	Training in Japan
Period	Five days (Around September 2020)	Four or Five days (Around May 2021)	Approximately 3 weeks (July 2021)
Course	• Conduct energy audit • Learn about technology for energy saving • Apply RE stabilization technology	• Learn about cost evaluation for energy saving • Learn efficient system operations including RE	• Learn the technology that includes system stabilization in the introduction of renewable energy • Obtain knowledge and technology related to energy-saving and the energy-saving planning, policy and dissemination awareness activities
Participant	About 5 members of the Saint Christopher Nevis, about 5 members of Barbados, about 5 members of Jamaica	About 5 members of the Saint Christopher Nevis, about 5 members of Barbados, about 5 members of Jamaica	About 1-4 members from each country, total about 10 people

Trainings in Your Country

Trainings by Japanese Specialists are organized in two phases, 1st training, and 2nd training.

- 1st training plan: 1st day to 3rd day for EE

Dates		Example of classroom and OJT curriculum
1st day (EE)	AM	Significance of energy saving approaches based on energy balances and a long-term supply and demand outlook. Effective approaches/practices with priority toward energy saving realization by sector/end-use.
1st day (EE)	PM	Successful EE policies/regulations and incentive programs. Various EE technologies and EE best practices.
2nd day (EE)	AM	Study on how to develop energy audit reports with reference to international standards and actual reports developed by the expert of JET in the past.
2nd day (EE)	PM	【OJT】 Walk-through survey of public building
3rd day (EE)	AM	Walk-through survey of water pump station
3rd day (EE)	PM	Prepare energy audit reports for facilities of which walk-through surveys have been carried out.

Trainings in Your Country

Trainings by Japanese Specialists are organized in two phases, 1st training, and 2nd training.

- 1st training plan: 4th day to 5th day for RE

Dates		Example of classroom and OJT curriculum
4th day (RE)	AM	Renewable energy technology and cost, Examples of renewable energy projects, operations and issues
4th day (RE)	PM	System stabilization Technology, grid simulation with RE input
5th day (RE)	AM	【OJT】 Grid modeling in simulation software
5th day (RE)	PM	Grid simulation software output analysis

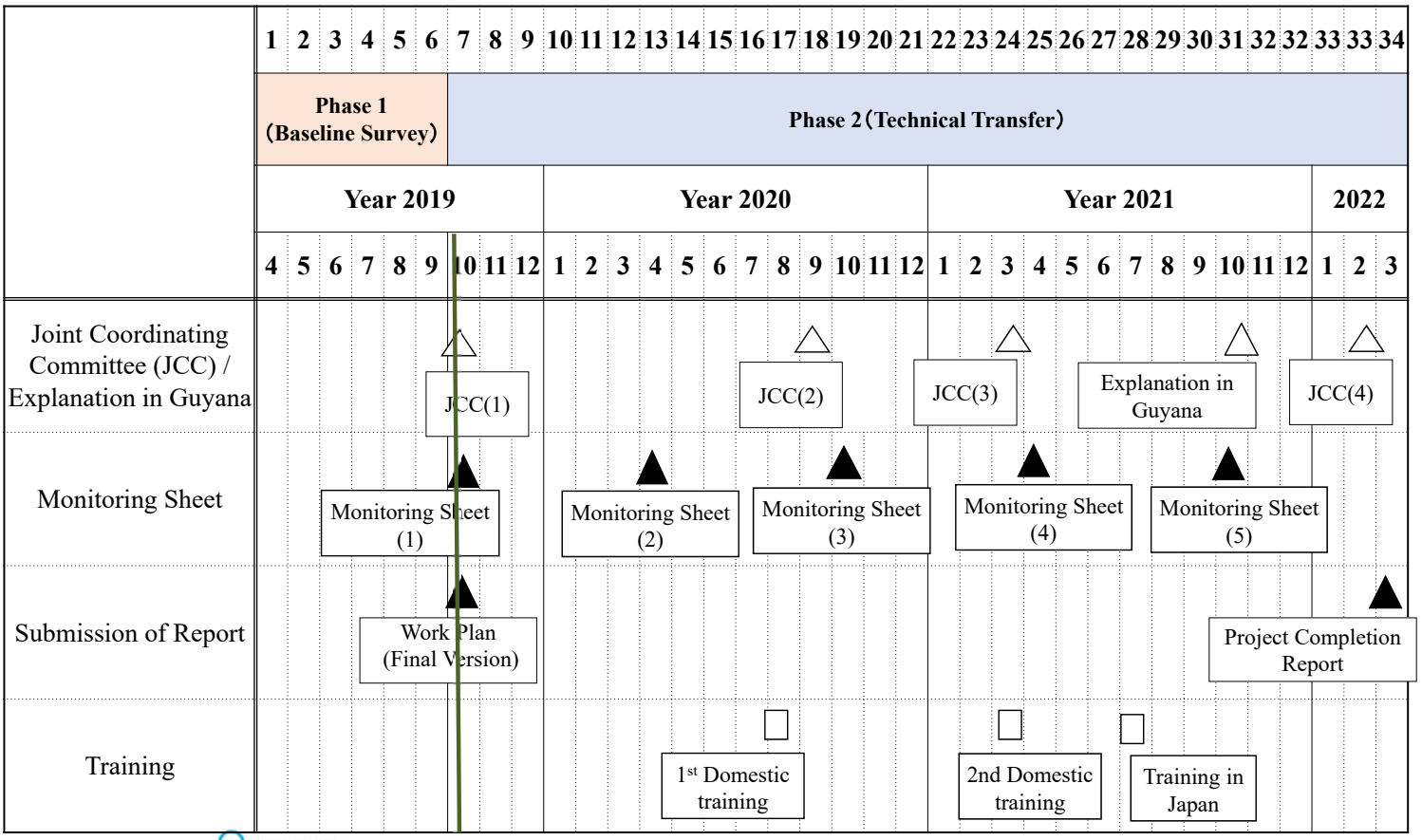
2nd training plan will be adjusted for your demands, situations and feedbacks.

Training in Japan (Provisional)

Days		Itinerary / Theme	Field
Day 1-2	Sat	Move (each country → Tokyo/Narita)	-
Day 3	Mon	Arrive at Tokyo/Narita. PM: Orientation	RE/EE
Day 4	Tue	Manufacturer of solar power, wind power, PCS	RE
Day 5	Wed	RE business, example of grid connection, evaluation of energy production	RE
		Manufacturer of electric automobile, EV battery VPP (virtual power plant)	
Day 6	Thu	Grid stabilization simulation (1):Basic structure, simulator, parameter, data structure	RE
Day 7	Fri	Grid stabilization simulation (2): Data model, input, case study	RE
Day 8	Sat	Reporting work, etc.	RE
Day 9	Sun	Move (Tokyo → Miyakojima Island)	RE
Day 10	Mon	Tour for Miyakojima island type smart community and EMS	RE
Day 11	Tue	Move (Miyakojima Island → Tokyo)	RE
		Ancillary service, balance of supply and demand, quality of power	RE
Day 12	Wed	Introduction RE Planning, asset management, evaluation, example of policy	RE
Day 13	Thu	Policy for EE and awareness building activities for popularity	EE
Day 14	Fri	EE actions by electric power companies in isolated islands, example of building EE	EE
Day 15/16	Sat Sun	Reporting work, etc.	EE
Day 17	Mon	High efficient transformer, BEMS	EE
Day 18	Tue	Example of introduction of large inverter, ESCO business	EE
Day 19	Wed	Large and high efficient refrigeration machine / heat recovery machine, example of introduction of high efficient boiler, High efficient air conditioning equipment, EE for lighting equipment	EE
Day 20	Thu	Market research of home appliances, Wrap-up meeting	EE
Day 21-22	Fri	Move (Tokyo/Narita → each country) Arrive at each country	-

4. Way Forward and Schedule

Schedule of the Project



Way Forward and Requests

#	Item	Description	Schedule
1	Selection of participants for the training	Engineers to have a key technical role in the organization, with electrical engineering or mechanical engineering BSc or MSc background - (1) Senior/chief/managing engineer, working experience 15-30 years - (2)engineer or/and assistant engineer, working experience 5-15 years	By End of Mar 2020
2	Arrange of place and participants for domestic training	First domestic training is scheduled around September 2020. Please cooperate to determine the arrangement of venue and the schedule considered P/D, P/M and C/P staffs.	By End of Mar 2020
3	Access permission to areas where it is necessary to enter for the survey	Such as power station, substation, and important faculties for energy saving	Project period
4	Comment on PDD/PO	For revise of PDD, PD please provide comments.	By end of Nov 2019
5	Property selection for OJT of energy audit	First domestic training is scheduled around September 2020. Please cooperate to select the objective property. - (1) Large energy consumer - (2) Equipment list can be shared to OJT participants	By End of Mar 2020

Appendix

O&M of Thermal Power Generation(St. Kitts)

<List of Thermal Power Unit>

Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
St. Kitts	Needsmust	G1	MSD	Diesel	MAN(Mirlees Blackstone)	1999	Manual	6.1
		G2	MSD	Diesel	MAN	2009	Manual	3.9
		G3	MSD	Diesel	MAN	2008	Manual	3.9
		G4	MSD	Diesel	MAN	2007	Manual	3.9
		Mobile set 1	MSD	Diesel	Caterpillar	2017	Manual	2.0
		Mobile set 2	MSD	Diesel	Caterpillar	2018	Manual	2.0
		Mobile set 3	MSD	Diesel	Caterpillar	2017	Manual	2.0
		Mobile set 4	MSD	Diesel	Caterpillar	2018	Manual	2.0
		G9	MSD	Diesel	MAN(Mirlees Blackstone)	1987	Manual	3.5
		G10	MSD	Diesel	MAN	2010	Manual	3.9
		G11	MSD	Diesel	MAN	2010	Manual	3.9
		G12	MSD	Diesel	MAN	2011	Manual	3.9
		G14	MSD	Diesel	MAN	2011	Manual	3.9

Total: 44.9MW

O&M of Thermal Power Generation(Nevis)

<List of Thermal Power Unit>

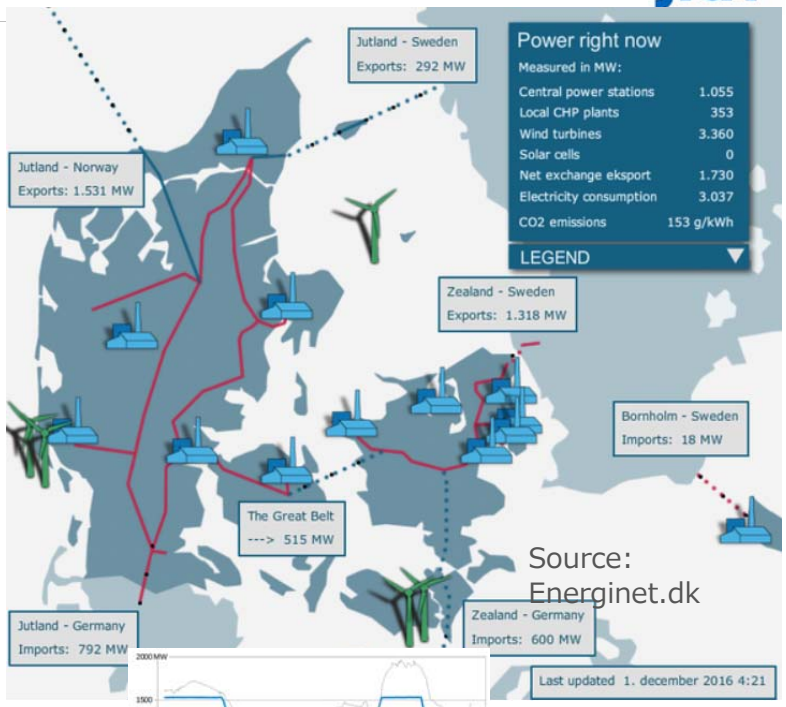
Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
Nevis	Prospect	G3	MSD	Diesel	MAN(Mirlees Blackstone)	1985	Manual	0.9
		G4	MSD	Diesel	MAN(Mirlees Blackstone)	1990	Manual	2.0
		G5	MSD	Diesel	MAN(Mirlees Blackstone)	1996	Manual	2.2
		G6	MSD	Diesel	MAN(Mirlees Blackstone)	1996	Manual	2.2
		G7	MSD	Diesel	Detroit Diesel	1997	Manual	2.5
		G8	MSD	Diesel	Wartila	2002	Base	2.7
		G9	MSD	Diesel	Cummins	2012	Manual	1.5
		G10	MSD	Diesel	Detroit Diesel	2016	Manual	2.5
		G11	MSD	Diesel	Wartila	2017	Base	3.8

Total: 20.3MW

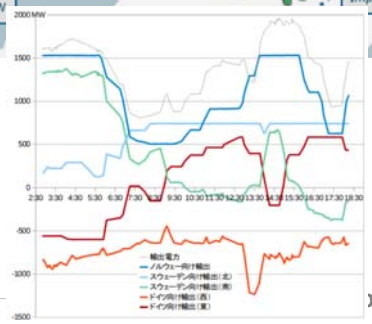
RE: Why Large RE penetration possible for Denmark?

5475 MW wind, 14.8 TWh, 44% of domestic electricity by VRE

	Denmark Condition	For Caribbean
1	Dynamic Interconnection with Norway (large pump storage), Sweden, and Germany	**Not possible**
2	Different places of offshore wind (7 locations)+500 MW onshore → fluctuation is levelized	Limited but can be considered → Data necessary
3	Grid code -Power control - Frequency droop control -FRT (fault ride through) -Power change rate limit	Applicable



Source: Energinet.dk



https://www.itmedia.co.jp/smartjapan/articles/1612/19/news085_3.html

- Large inter-connection can not be referred
- Different concept necessary for Caribbean countries → **Microgrid**

Joint Coordinating Committee (JCC) for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Work Plan, PDM and Monitoring Sheet #1

October-November 2019

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Work Plan

Draft Work Plan and the contents were basically agreed.
Changes will be reflected on PDM rev.1.

Revised Project Design Matrix (Draft)

St. Kitts and Nevis	BEFORE	AFTER
Output Output 5		(Added) Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency Objectively Verifiable Indicators 5-1. Number of trained staffs 5-2. Textbooks/ manuals 5.3. Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations 5-4. Number of workshops
Narrative Summary Activities for achieving Output 3	3-2.To consider and propose the appropriate penetration of RE (PV, Wind, Biomass etc.) in consideration of the necessary cost for grid stabilization	3-2.To introduce computer modelling for grid analysis and examine issues associated with a large penetration of VRE in St. Kitts.

Revised Project Design Matrix (Draft)

St. Kitts and Nevis	BEFORE	AFTER
Activities for achieving Output 5		(Added) 5-1. To demonstrate the way to enhance resiliency by use of power network asset management system.
Inputs (Japanese side)	1. Dispatch of the Japanese experts -Chief advisor -Coordinator -Renewable energy -Grid stabilization -Energy efficiency -Diesel/ gas-turbine power plant 4. Equipment -measuring instrument -software (e.g. grid-modeling)	1. Dispatch of the Japanese experts -Chief advisor/ power system -Renewable energy -Grid stabilization -Energy efficiency -Power network asset management -Diesel/ gas-turbine power plant/ Coordinator -Human resource development/ monitoring 4. Equipment --Software for grid analysis (Power Flow Analysis Module)

Overall Goals & Target Value /St.Kitts & Nevis

Description	Verifiable Indicator	Target Value
Overall Goals Energy security is ensured through introduction of renewable energy (hereinafter referred to as “RE”) and promotion of energy efficiency (hereinafter referred to as “EE”)	1. Energy self-dependency 2. Imported fossil fuel reduction	1. 100% (100%RE by 2020) (to be revised at the end of 2020) 2. 2% of total fuel import

Project Purpose & Target Value/St.Kitts&Nevis

Description	Verifiable Indicator	Baseline Value	Target Value
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant	1. PV 1.2MW(St. Kitts), Wind 2MW(Nevis)	1.PV 35MW by 2020, Wind 5MW, BESS 44.2MWh(St. Kitts), Geothermal power 9MW (Nevis)
	2. Number of public buildings with EE program including BEMS: Building Energy Management System	2. Needs of MPI is very high to promote EE of public buildings. (Current : 0)	2. 1 Proposal by JET will be prepared for the BEMS introduction
	3. Number of trained staffs for introduction of RE	3. 0 staff on this Project (Numbers of trainings by international agencies provided)	3. 10 staffs
	4. Number of trained staffs for promotion of EE	4. 0 staff on this Project (Numbers of trainings by international agencies provided)	4. 10 staffs

Outputs 1,2 & Target Value/St.Kitts&Nevis

Description	Verifiable Indicator	Baseline
Output 1 *(Phase 1)* The basic information is confirmed for the capacity building for the introduction of RE	1-1. Assessment of number and qualification of staffs responsible for RE	1-1. Director and officials, 2 in MPI, 1 in NIA, 2 in SKELEC, 1 in NEVLEC
	1-2. Human resource development plan for the introduction of RE	1-2. N/A
	1-3. Number of training courses for the introduction of RE	1-3. N/A
	1-4. Total capacity of RE	1-4. 6 MW (3MW in St. Kitts, 3MW in Nevis)
Output 2 *(Phase 1)* The basic information is confirmed for the capacity building for the promotion of EE	2-1. Assessment of number and qualification of staffs responsible for EE	2-1. Director and officials, 2 in MPI, 1 in NIA, 2 in SKELEC, 0 in NEVLEC (CEM/CEA: 0)
	2-2. Human resource development plan for the introduction of EE	2-2. N/A
	2-3. Number of training courses for the promotion of EE	2-3. N/A
	2-4. Number of facilities conducted energy audit	2-4. 8 in public buildings, 13 in pumping stations (in St. Kitts) 9 in public buildings, 7 in pumping stations (in Nevis)

Outputs 3,4 & Target Value/St.Kitts&Nevis

Description	Verifiable Indicator	Baseline Value	Target Value
Output 3 *(Phase 2)* The human and institution capacity are enhanced for the introduction of RE	3-1. Number of trained staffs	3-1. 0	3-1. 10 personnel
	3-2. Textbooks/ manuals	3-2. None	3-2. 3 programs (2 domestic trainings and 1 training in Japan)
	3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations	3-3. 0	3-3. Kick-off W/S: 9 Final W/S: 10
	3-4. Number of workshops	3-4. 0	3-4. 2 times (Kickoff, Final)
Output 4 *(Phase 2)* The human and institution capacity are enhanced for the promotion of EE	4-1. Number of trained staffs	4-1. 0	4-1. 10 personnel
	4-2. Textbooks/ manuals	4-2. None	4-2. 3 programs (2 domestic trainings and 1 training in Japan)
	4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations	4-3. 0	4-3. Kick-off W/S: 9 Final W/S: 10
	4-4. Number of workshops	4-4. 0	4-4. 2 times (Kickoff, Final)

Outputs 5 & Target Value/St.Kitts&Nevis

Description	Verifiable Indicator	Baseline Value	Target Value
Output 5 *(Phase 2)* The human and institution capacity are enhanced for the promotion of Power Network Resiliency	5-1. Number of trained staffs	5-1. 0	5-1. 10 personnel
	5-2. Textbooks/ manuals	5-2. None	5-2. 3 programs (2 domestic trainings and 1 training in Japan)
	5-3. Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations	5-3. 0	5-3. Kick-off W/S: 9 Final W/S: 10
	5-4. Number of workshops	5-4. 0	5-4. 2 times (Kickoff, Final)

Policies, Issues and Challenges in the St. Kitts-Nevis Energy Sector

Presented by:

Bertill Browne
Director
Energy Unit
Ministry of Infrastructure, Post, Urban Development and Transport
St. Kitts-Nevis

Tuesday October 29, 2019

Energy Legislations, Policies & Actions

Electricity Supply Act (amendment) Bill

- Provide for the establishment of a legal framework ruling the electricity sector, to make provisions for the promotion of renewable energy sources and for matters connected thereto

Nevis Geothermal Resources Development Ordinance

- **Promote** the **exploration** for, and **development** of, its **Geothermal Resources** in such a manner as to assure the supply of energy necessary for the economic growth and general welfare of the people of Nevis and to decrease the dependency of Nevis on non-renewable resources.
- Encourage and **promote the discovery, development, production and disposal of Geothermal Resources in Nevis in such manner as will safeguard the natural environment** and the public welfare and at the same time will encourage private enterprise to provide the necessary services, financing and technology.

National Energy Policy

- Vision is to become an island nation with a sustainable energy sector where reliable, renewable, clean and affordable energy services are provided to all its citizens, where energy efficiency and the replacement of fossil energy by renewable energy sources will be promoted in all sectors of the economy
- 100% of the electricity supplied in the country will be produced from renewable energy sources".

Renewable Energy Policy

- Support the Energy Policy
- Provide a framework to promote the integration of renewable energy into the grid
- Ensure a transparent, inclusive, coherent and informed process with respect to the integration of renewable energy into the grid

Energy Legislations, Policies & Actions (cont'd)

Energy Unit

- An Energy Unit was formed within the Ministry of Public Infrastructure, Post, Urban Development and Transport
- Energy Unit Formed on Nevis
- Purpose is to develop and implement energy policies, strategies and action plans to ensure energy security, access to affordable energy and protection of the environment

Renewable Energy Infusion Study

- **A study to determine the maximum amount of intermittent renewable energy that can be added to the grid without destabilizing it.**
- **Found 5.4 MW**
- **After this limit it would require mitigating measures such as increased spinning reserves or storage**

Energy Related Projects

- Completed SCASPA and SKELEC solar farms, in conjunction with the Republic of China on Taiwan, Wind farm on Nevis
- Geothermal, wind, waste-to-energy and solar PV projects under consideration
- EV, Energy Audit, LED street & playfield lighting, REEBC, Partially solar powered desalination plant, Grid Code, Storage Study

Electrical System

Load

- 28 MW peak in St. Kitts
- 10 Mw peak in Nevis
- 16 MW base in St. Kitts
- 5 MW base in Nevis

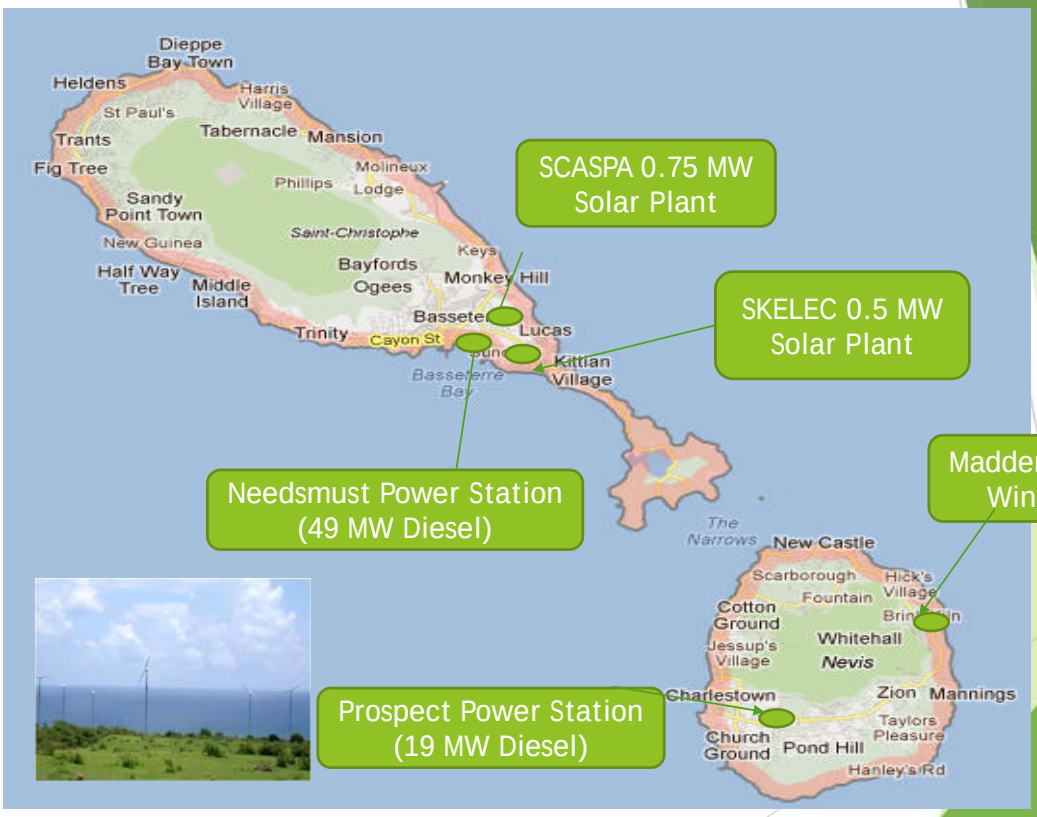
Supply configuration

- 60 Hz
- Generate at 11 KV
- Transmit at 11 KV, 3-phase, DELTA
- Distribute and supply customers at 400 V, 4-wire, 3-phase, WYE or 230 V, 1-phase, 2-wire
- Most homes have transformer to convert to 208/120 V.

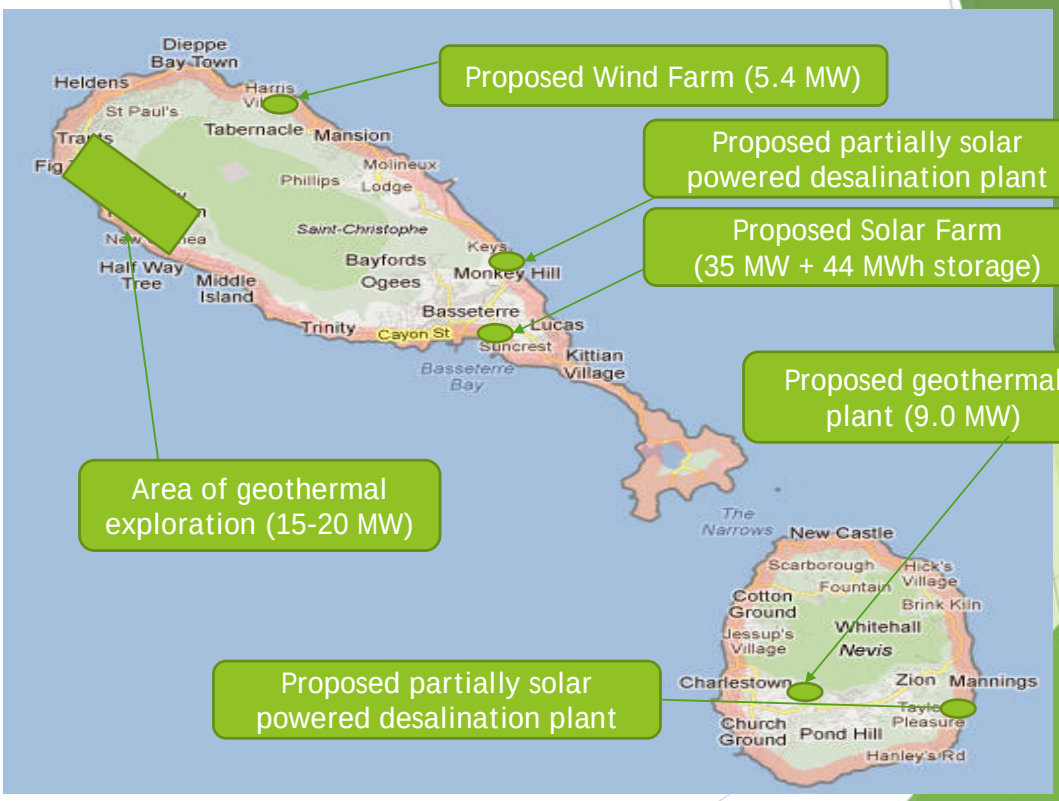
Commercial

- Approximately 18,000 customers in St. Kitts
- Approximately 8, 0000 customers in Nevis
- St. Kitts 2016 sales: 133 GWh.
- Nevis 2017 sales: 60 GWh

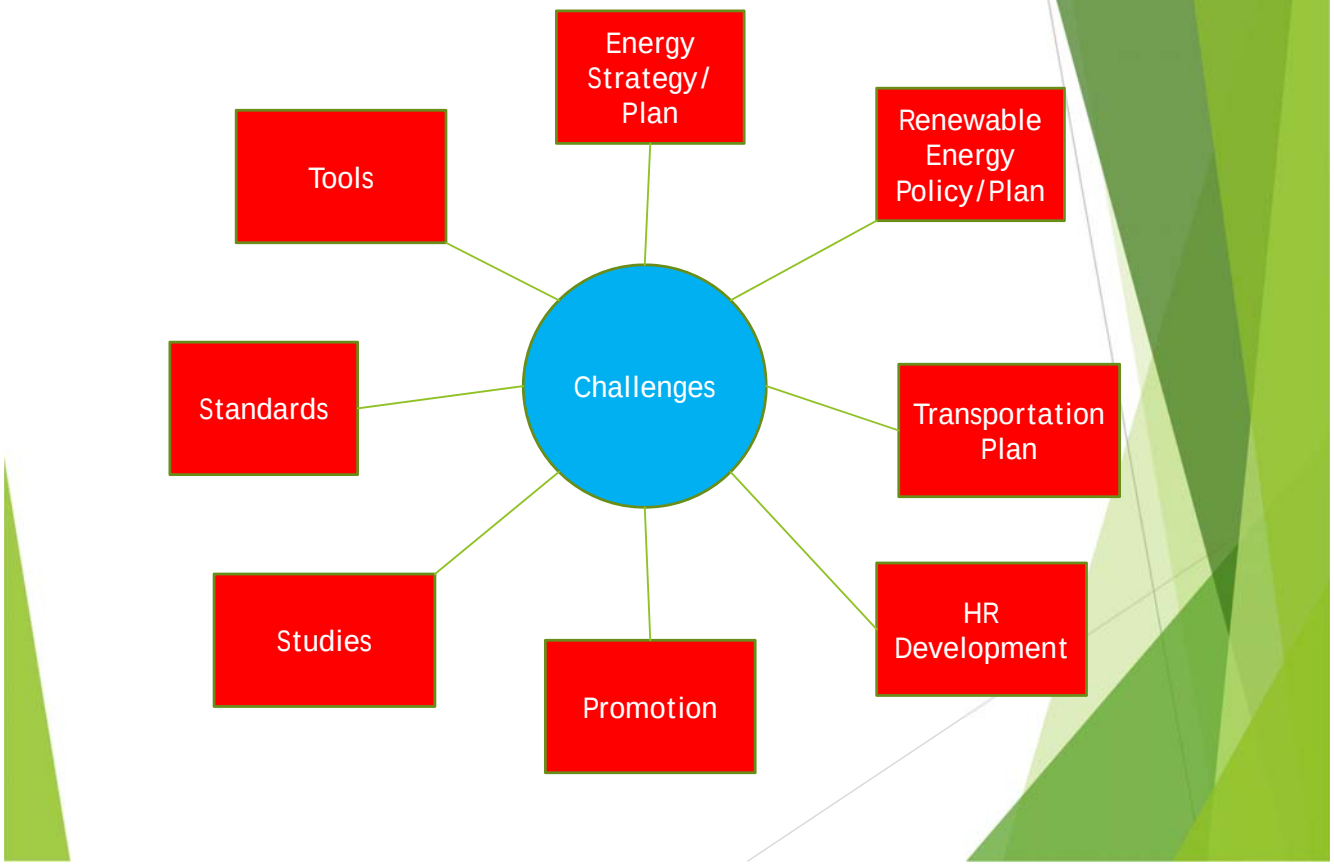
Installed Generation



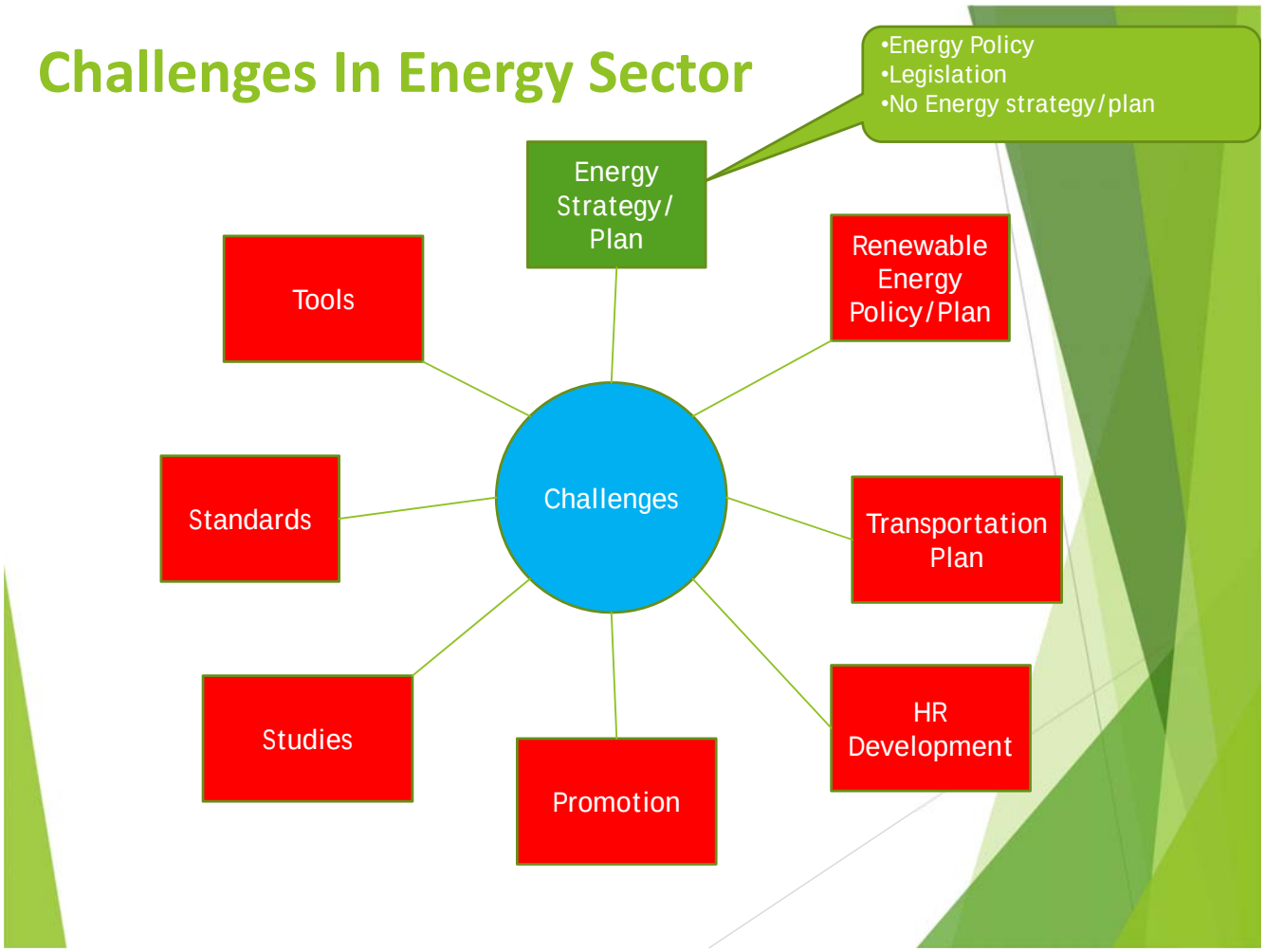
Pending Generation



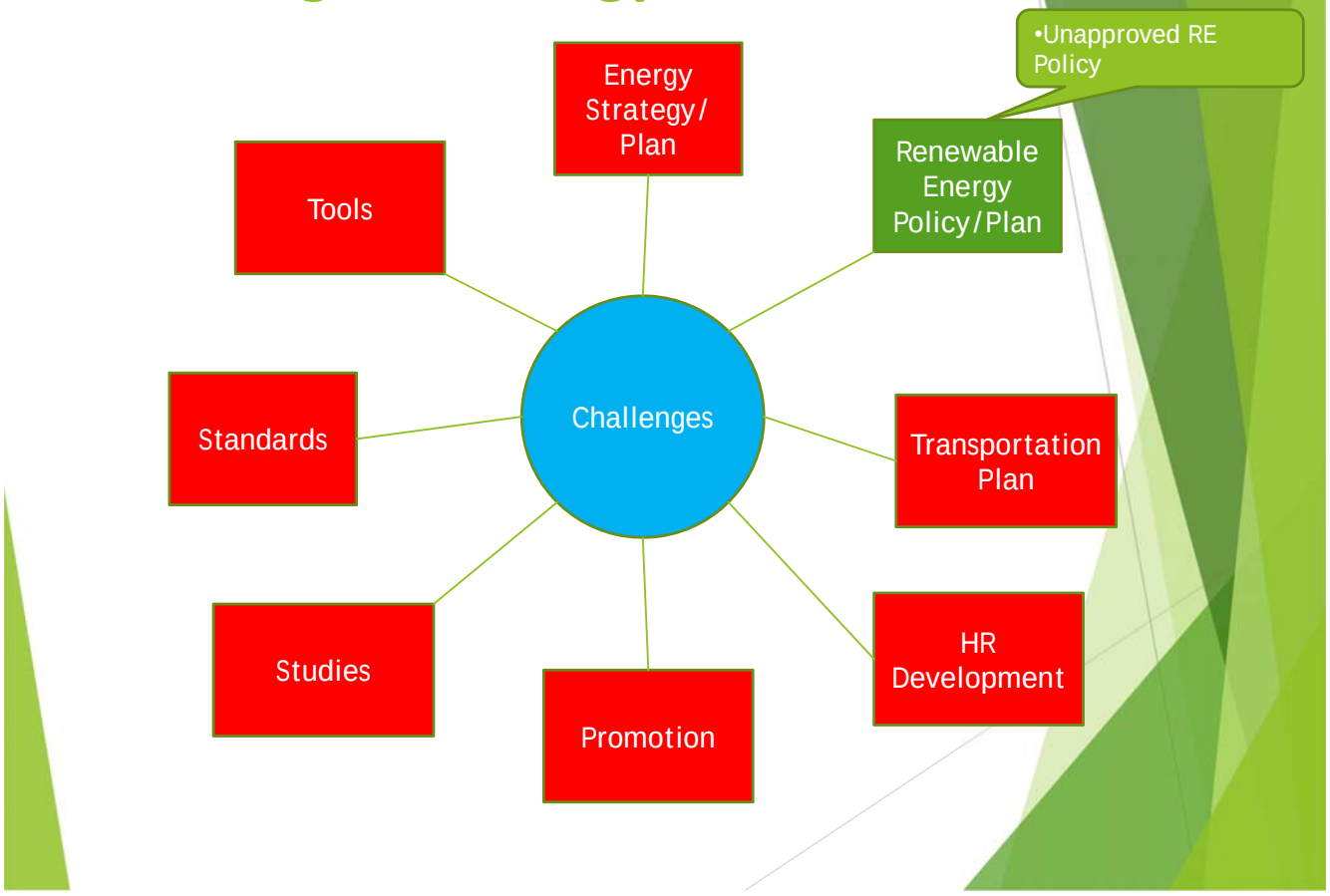
Challenges In Energy Sector



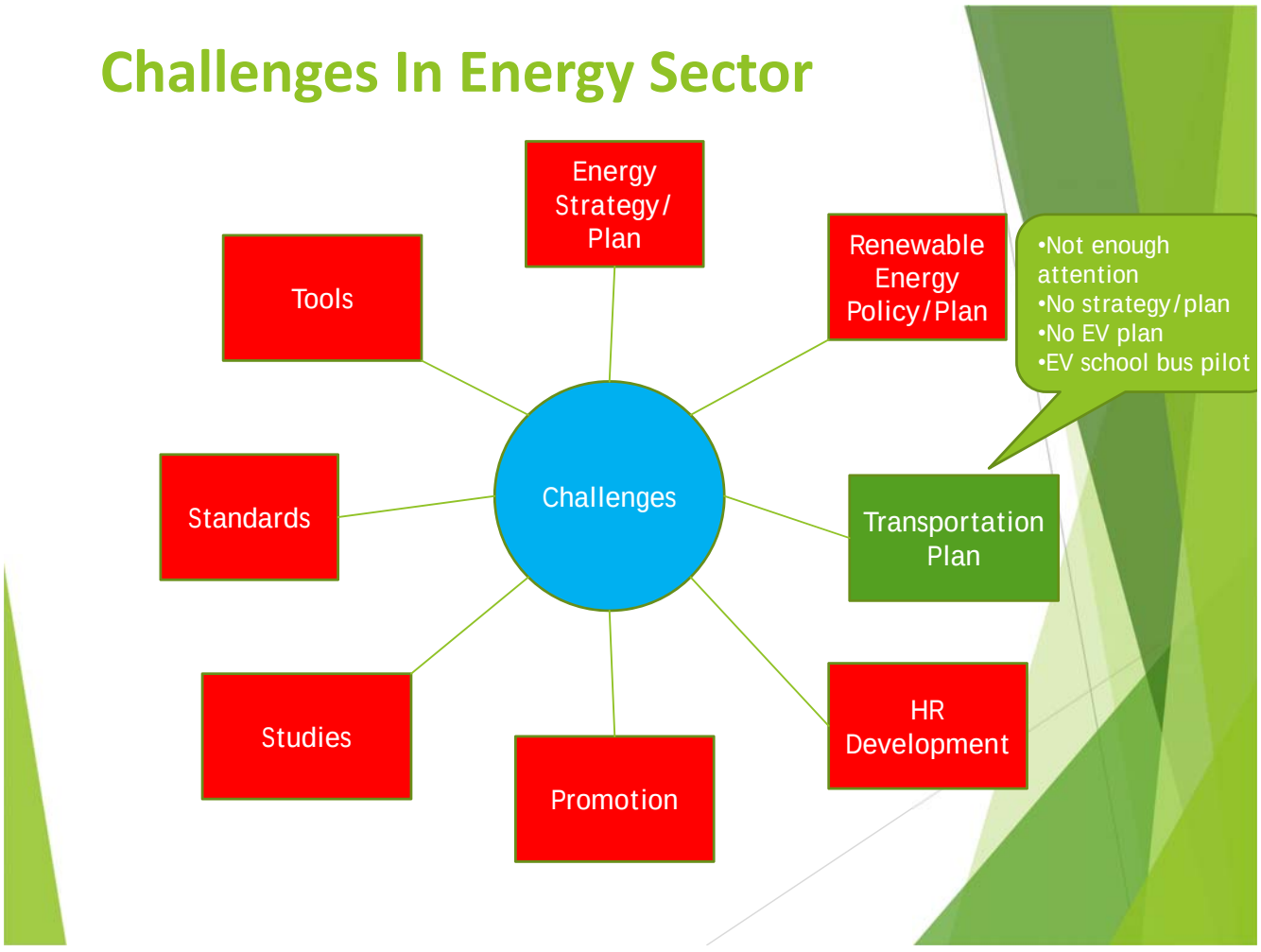
Challenges In Energy Sector



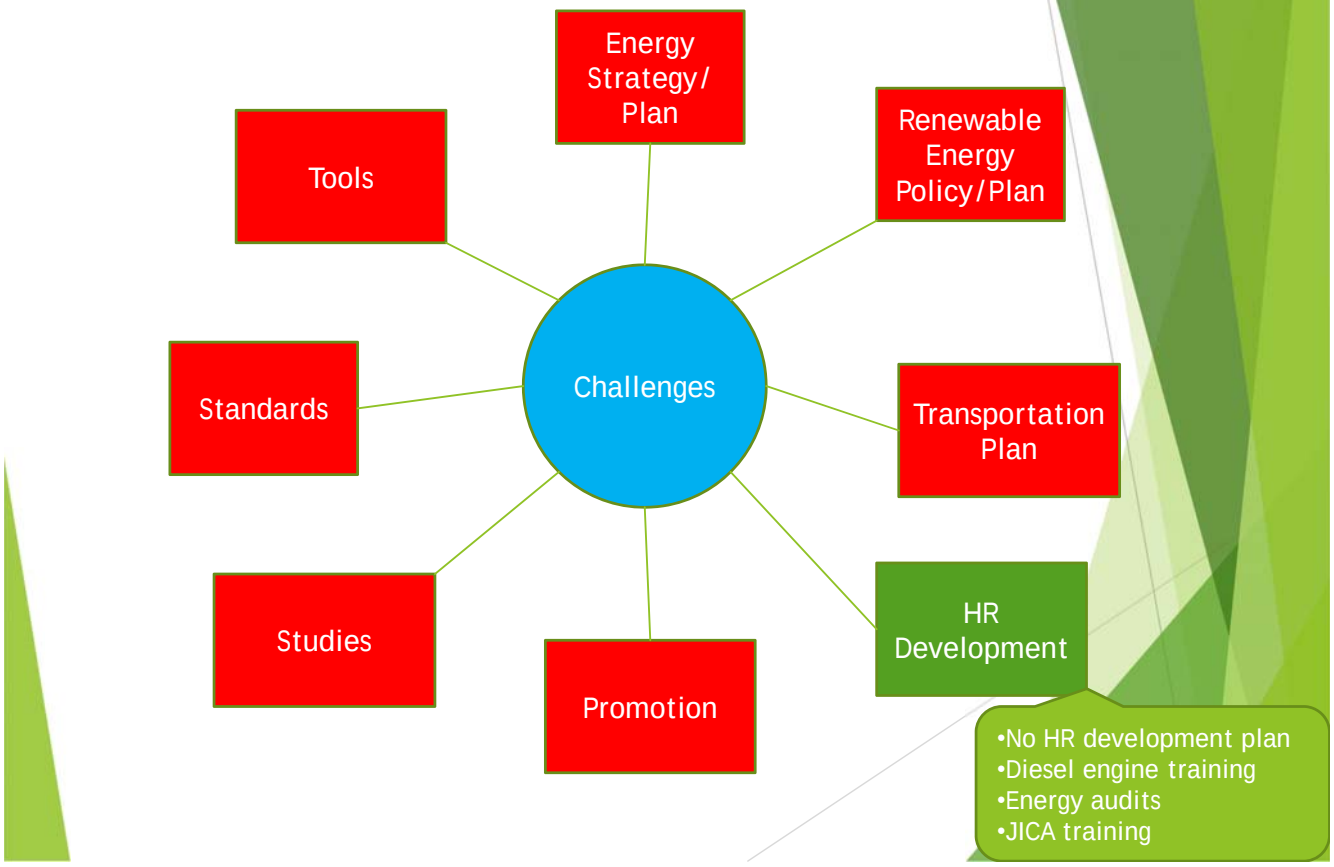
Challenges In Energy Sector



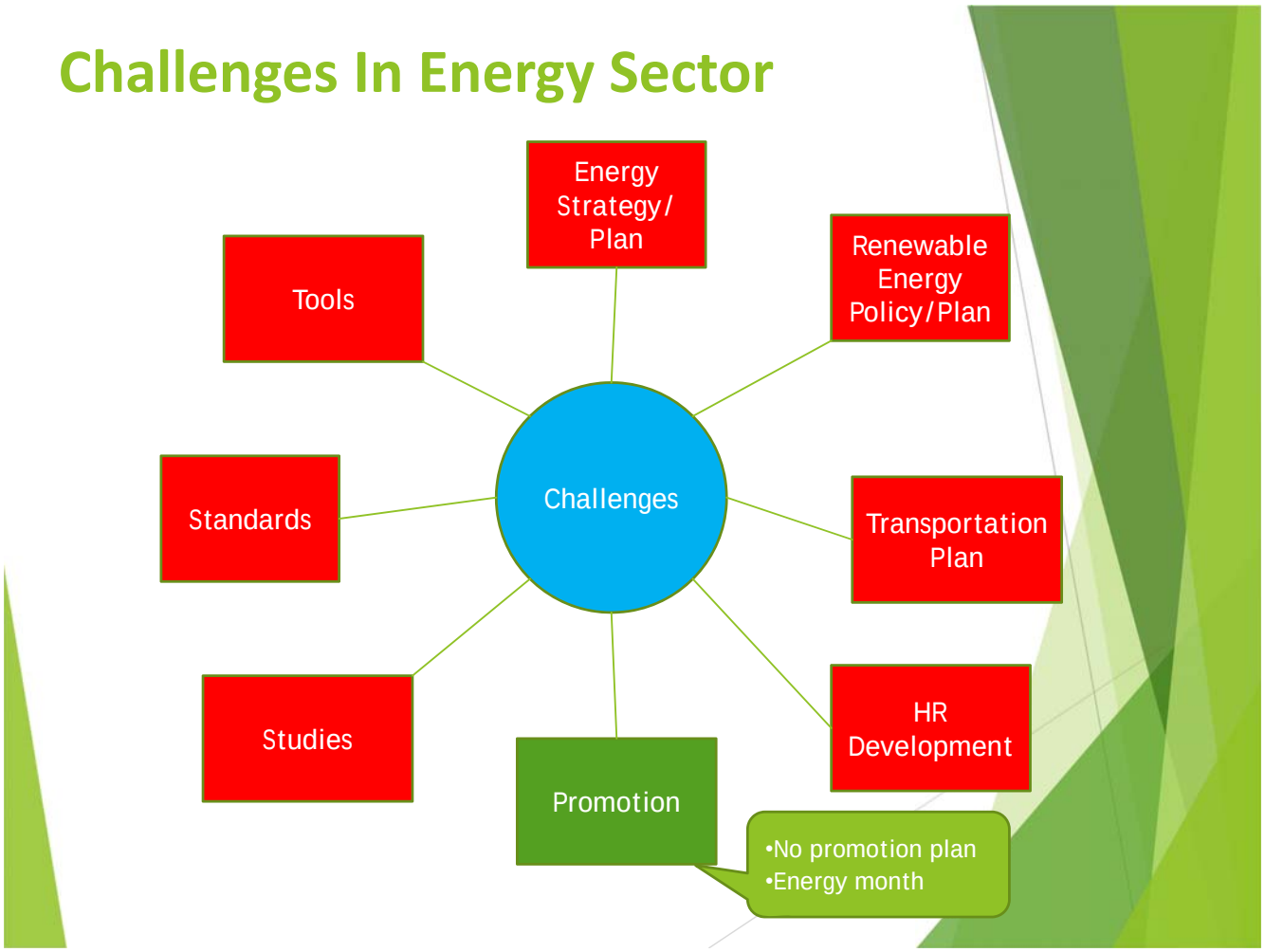
Challenges In Energy Sector



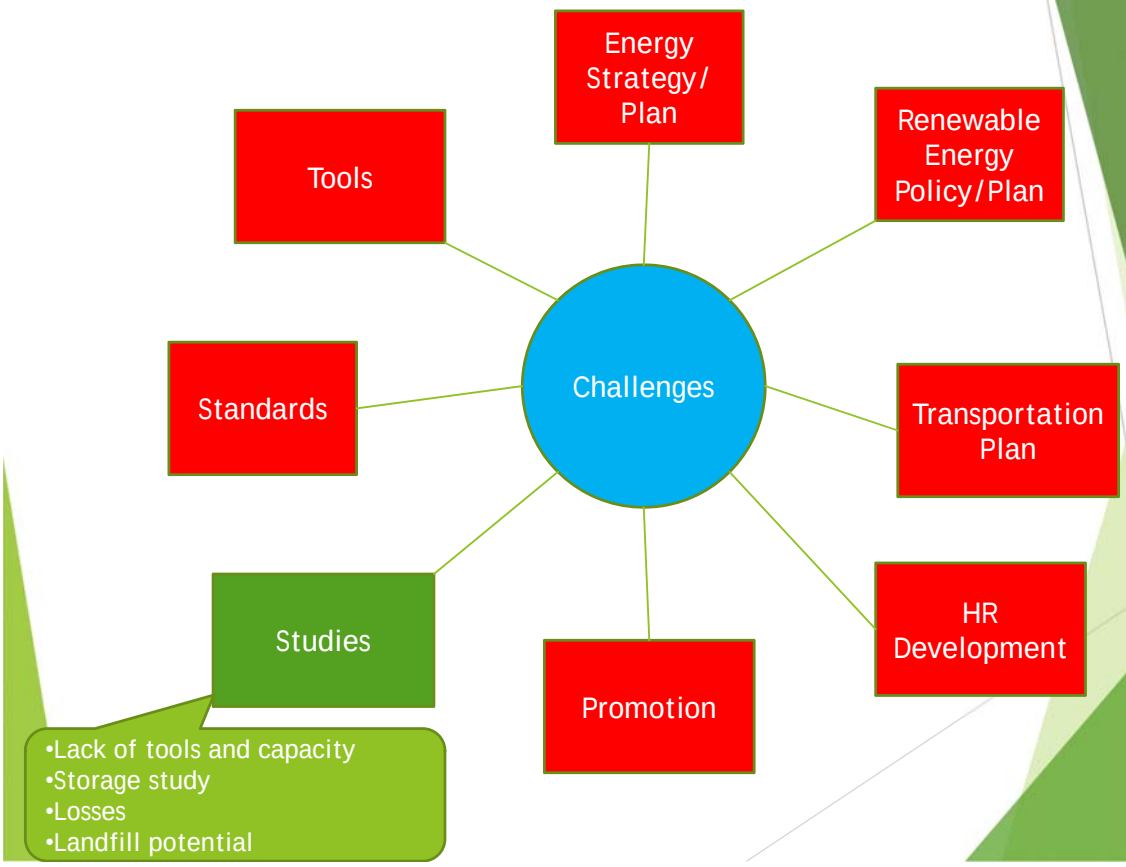
Challenges In Energy Sector



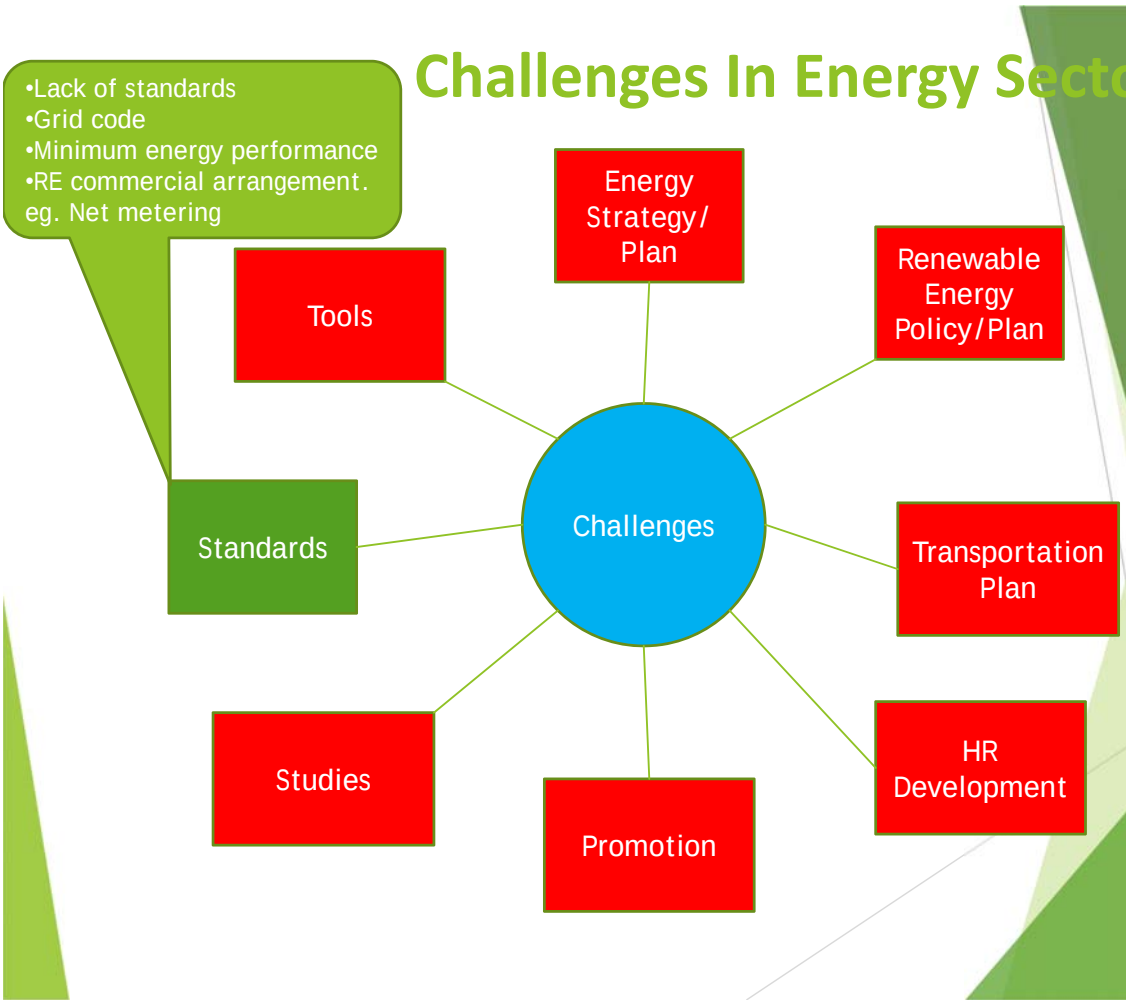
Challenges In Energy Sector



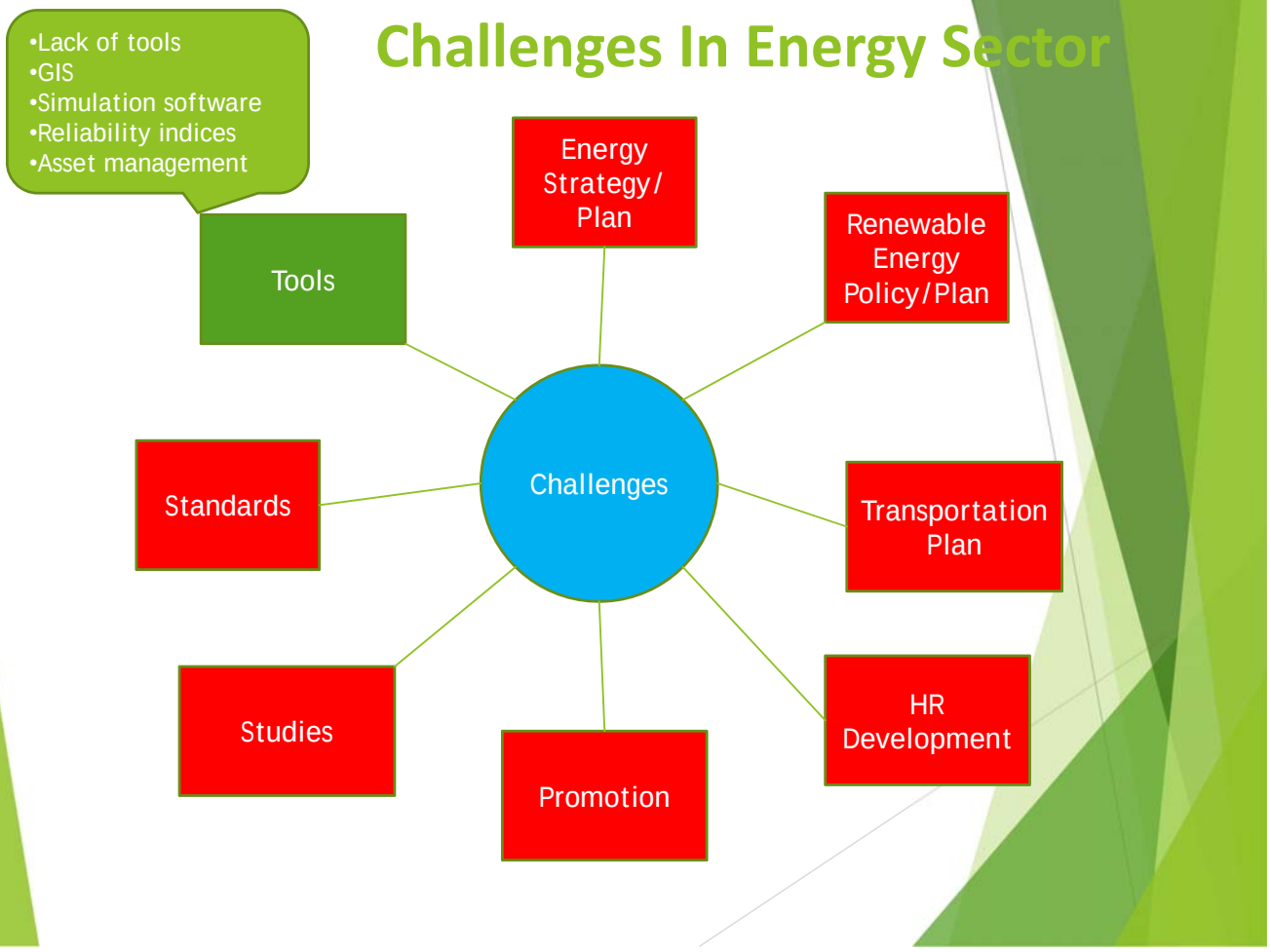
Challenges In Energy Sector



Challenges In Energy Sector



Challenges In Energy Sector



Thanks

Annex 1

Project Design Matrix (PDM)

Project Title: Technical Cooperation to Promote Energy Efficiency in the Caribbean Countries
Project Term: 3 years, Phase1:6 months, Phase2 :30 months
Country: Saint Christopher and Nevis
Target Area: St. Kitts and Nevis
Target Group: MPI (Ministry of Public Infrastructure, Post, Urban Development and Transport), NIA (Nevis Island Administration), SKELEC (St.Kitts Electricity Company Ltd.), NEVLEC (Nevis Electricity Company Ltd.)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Energy security is ensured through introduction of renewable energy (hereinafter referred to as "RE") and promotion of energy efficiency (hereinafter referred to as "EE")	1. Energy self-dependency 2. Imported amount of fossil fuel	Data from MPI annual report	The current relevant policies on promotions of RE and EE are sustained after the Project.
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant 2. Number of public buildings with EE program including BEMS 3. Number of trained staffs for introduction of RE 4. Number of trained staffs for promotion of EE	Project Report	C/P agency continues commitment to the Project by continuing budget allocation as well as assignment of personnel for the post- Project activities.
Outputs Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	1-1. Assessment of number and qualification of staffs responsible for RE 1-2. Human resource development plan for the introduction of RE 1-3. Number of training courses for the introduction of RE 1-4. Total capacity of RE	Project Report	
Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	2-1. Assessment of number and qualification of staffs responsible for EE 2-2. Human resource development plan for the introduction of EE 2-3. Number of training courses for the promotion of EE 2-4. Number of facilities conducted energy audit	Project Report	

Annex 1

Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	3-1. Number of trained staffs 3-2. Textbooks/ manuals 3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations 3-4. Number of workshops	Project Report	
Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	4-1. Number of trained staffs 4-2. Textbooks/ manuals 4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations 4-4. Number of workshops	Project Report	
Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	5-1. Number of trained staffs 5-2. Textbooks/ manuals 5-3. Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations 5-4. Number of workshops	Project Report	
Activities Activities for achieving Output 1 1-1. To verify the fundamental indicators for the power supply side, e.g. access to electricity (electrification rate), cost (composition of power sources, electricity tariff), low carbon (CO_2 emission coefficient) and power system reliability (SAIDI/SAIFI), etc. 1-2. To verify the existing situations in introduction of the technologies of grid stabilization and relevant policies/ national plans pertaining to RE 1-3. To verify human and institutional capacities for the introduction of RE	**Inputs** **(Japanese side)** 1. Dispatch of the Japanese experts -Chief advisor/ power system -Renewable energy -Grid stabilization -Energy efficiency -Power network asset management** -Diesel/ gas-turbine power plant/ Coordinator -Human resource development/ monitoring 2. Training in Japan -Micro Grid system including Grid Stabilization Technology in small island (e.g. Okinawa) -Policies and technologies for promotion of EE (Energy load labelling, policies, regulations and incentives) -Site visit in Japan 3. Workshop -for project counter parts	**(Saint Christopher and Nevis side)** 1. Assignment of C/Ps -Project Director (P/D) -Project Manager (P/M) - Other C/Ps 2. Facilities and equipment -Project office 3. Recurrent costs -C/Ps' wages and allowances	Most of the trained C/Ps continues commitment to the Project activities.
Activities for achieving Output 2 2-1. To verify the fundamental indicators on promotion of EE for the electricity demand side, e.g. electric power consumption unit requirement, final energy consumption, etc. 2-2. To verify the existing conditions in promotion of EE, relevant policies/ national plans 2-3. To verify the existing conditions to carry out maintenance work for thermal power plants 2-4. To verify the existing conditions of transmission and distribution system losses 2-5. To verify human and institutional capacities for the promotion of EE			**Preconditions** Contents of the current relevant policies on promotion of RE and EE are not largely changed.
Activities for achieving Output 3 3-1. To conduct the potential survey of RE (PV, Wind, Biomass etc.) 3-2. To introduce computer modelling for grid analysis and examine issues associated with			

Annex 1

a large penetration of VRE in St. Kitts. 3-3. To consider and propose the necessary technologies for achieving the RE goals, including battery applications for grid stabilization, for improvement of load following capability and load operation of thermal power plants 3-4. To consider and propose additional policy/ legal system for achieving RE goals 3-5. To prepare the necessary training plan for doing the above Activities '3-1' through '3-4' 3-6. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '3-6' 3-7. To review the training plan though monitoring of the training conducted in Activity '3-6' 3-8. To provide advice on realization of the RE projects 3-9. To provide recommendations on design of the policy/ legal system proposed in Activity '3-4' 3-10. To share the project output among other CARICOM member states	4. Equipment -Software for grid analysis (Power Flow Analysis Module)		
Activities for achieving Output 4 4-1. To consider and propose the EE goals through cost-benefit analysis on introduction of the facilities contributing to EE 4-2. To consider and propose the EE facilities necessary for achieving the EE goals 4-3. To consider and propose necessary technologies for achieving EE goals, including building energy management system (BEMS), etc. 4-4. To consider and propose the necessary measures for efficient operation of thermal power plants, including introduction of economic load dispatching control (EDC), etc. 4-5. To consider and propose measures to improve the maintenance system for thermal power plants, including measures to do periodic maintenance and overhaul and procurement of spare parts 4-6. To consider and propose the necessary policy/ legal system for achieving EE goals such as introduction of energy service company (ESCO) and energy management service, etc. 4-7. To prepare the necessary training plan for doing the above Activities '4-1' through '4-6' 4-8. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '4-7' 4-9. To review the training plan though monitoring of the training conducted in Activity '4-8' 4-10. To provide advice on realization of the EE projects 4-11. To provide recommendation on design of the policy/ legal system proposed in Activity '4-6' 4-12. To share the project output among other CARICOM member states			
Activities for achieving Output 5 5-1. To demonstrate the way to enhance resiliency by use of power network asset management system. *			

Note: * Subject to budgetary approval by JICA

** Subject to budgetary approval by JICA. Assignment of task can be either in a form of expert assignment or sub-let basis.

Annex 2

Tentative Plan of Operaion (PO)

Project Title: Technical Cooperation to Promote Energy Efficiency in the Caribbean Countries
Project Term: 3 years, Phase 1: 6 months, Phase 2: 30 months
Country: Saint Christopher and Nevis
Target Area: St. Kitts
Target Group: MPI (Ministry of Public Infrastructure, Post, Urban Development and Transport), NIA (Nevis Island Administration), SKELEC (St.Kitts Electricity Company Ltd.), NEVLEC (Nevis Electricity Company Ltd.)

Year		Three years (36 months)																																			
Phase		Phase 1						Phase 2																															
Output 1 Activities		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1-1.	To verify the fundamental indicators for the power supply side, e.g. access to electricity (electrification rate), cost (composition of power sources, electricity tariff), low carbon (CO_2 emission coefficient) and power system reliability (SAIDI/SAIFI), etc.																																				
1-2.	To verify the existing situations in introduction of the technologies of grid stabilization and relevant policies/ national plans pertaining to RE																																				
1-3.	To verify human and institutional capacities for the introduction of RE																																				
Output 2 Activities																																					
2-1.	To verify the fundamental indicators on promotion of EE for the electricity demand side, e.g. electric power consumption unit requirement, final energy consumption, etc.																																				
2-2.	To verify the existing conditions in promotion of EE, relevant policies/ national plans																																				
2-3.	To verify the existing conditions to carry out maintenance work for thermal power plants																																				
2-4.	To verify the existing conditions of transmission and distribution system losses																																				
2-5.	To verify human and institutional capacities for the promotion of EE																																				
Output 3 Activities																																					
3-1.	To conduct the potential survey of RE (PV, Wind, Biomass etc.)																																				
3-2.	To introduce computer modelling for grid analysis and examine issues associated with a large penetration of VRE in St. Kitts.																																				
3-3.	To consider and propose the necessary technologies for achieving the RE goals, including battery applications for grid stabilization, for improvement of load following capability and load operation of thermal power plants																																				
3-4.	To consider and propose additional policy/ legal system for achieving RE goals																																				
3-5.	To prepare the necessary training plan for doing the above Activities '3-1' through '3-4'																																				
3-6.	To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '3-5'																																				
3-7.	To review the training plan though monitoring of the training conducted in Activity '3-6'																																				
3-8.	To provide advice on realization of the RE projects																																				
3-9.	To provide recommendations on design of the policy/ legal system proposed in Activity '3-5'																																				
3-10.	To share the project output among other CARICOM member states																																				
Output 4 Activities																																					
4-1.	To consider and propose the EE goals through cost-benefit analysis on introduction of the facilities contributing to EE																																				
4-2.	To consider and propose the EE facilities necessary for achieving the EE goals																																				
4-3.	To consider and propose necessary technologies for achieving EE goals, including building energy management system (BEMS), etc.																																				
4-4.	To consider and propose the necessary measures for efficient operation of thermal power plants, including introduction of economic load dispatching control (EDC), etc.																																				
4-5.	To consider and propose measures to improve the maintenance system for thermal power plants, including measures to do periodic maintenance and overhaul and procurement of spare parts																																				
4-6.	To consider and propose the necessary policy/ legal system for achieving EE goals such as introduction of energy service company (ESCO) and energy management service, etc.																																				
4-7.	To prepare the necessary training plan for doing the above Activities '4-1' through '4-6'																																				
4-8.	To conduct training including OJT, training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '4-7'																																				
4-9.	To review the training plan though monitoring of the training conducted in Activity '4-8'																																				
4-10.	To provide advice on realization of the EE projects																																				
4-11.	To provide recommendation on design of the policy/ legal system proposed in Activity '4-6'																																				
4-12.	To share the project output among other CARICOM member states																																				
Output 5 Activities																																					
5-1.	To demonstrate the way to enhance resiliency by use of power network asset management system. *																																				
△: JCC								△											△					△												△	
▲: Training in Japan																												▲									
◇ : Seminer(for RE, EE and CARICOM regional)																		◇						◇													

Note:* Subject to budgetary approval by JICA

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Minutes of Meeting
of
Joint Coordination Committee #2
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MSET, JICA, and JICA Expert Team

February 3, 2022

Ministry of Science, Energy and Technology (MSET)

Mrs. Olive Wilson Cross, Director Programme Management

Japan International Cooperation Agency (JICA), Tokyo

久下 勝也

Dr. Katsuya KUGE, Senior Director, Team 2, Energy and Mining Group

Japan International Cooperation Agency, Jamaica Office

for (TOGAWA Toru, Acting Resident Representative)

Mr. Takeshi TAKANO, Resident Representative

JICA Expert Team (JET)

小川 良輔

Mr. Ryosuke OGAWA, Team Leader

Date and Time:

February 3, 2022, 8:30am (in Jamaica), 10:30pm (in Japan)

Location:

Online (Virtual Meeting by Teams)

Participants:

1) Ministry of Science, Energy and Technology (MSET)

- Mrs. Olive Wilson Cross, Director Programme Management
- Mr. Todd Johnson, Principal Director, Energy Division
- Mr. Horace Buckley, Director, Project Management, Energy Division Frank Branch
- Mr. Brian Richardson, Manager, Oil & Gas
- Mr. Steve Dixon, Consultant, Transmission & Distribution Expert, IRP

2) Japan International Cooperation Agency (JICA), Tokyo

- Dr. Katsuya KUGE, Senior Director, Team 2, Energy and Mining Group
- Mr. Takeshi NAITO, Special Advisor (Energy & Mining Group)

3) Japan International Cooperation Agency (JICA), Jamaica Office

- Mr. Takeshi TAKANO, Resident Representative
- Mr. Hiroyuki OKAZAKI, Project Formulation Advisor
- Ms. Maragh Sauna, Program Officer

4) JICA Expert Team (JET)

- Mr. Ryosuke OGAWA, Team Leader
- Mr. Masaaki EBINA, Sub Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Dr. Hiroshi SUZUKI, Electrical Grid Expert
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Ms. Anna MIYAURA, Human Resource Development
- Mr. Kevin Douglas, Technical Assistant

Discussions:

<Looking Back the Current Status of Project>

- The JET explained the summary of the current project status to the MSET Team by the presentation material. (Attachment 1). This included summary of baseline survey result about Energy Efficiency (EE) and Renewable Energy (RE) via presentation slides.
- The JET also outlined the original schedule of the project, which was slated to end March 2022 (but was disrupted by the COVID-19 Pandemic) as well as putting forward the need for an extension of the agreement.
- The JET proposed a one-year extension of the project to March 2023 as well as presented a revised schedule of activities.
- The MSET outlined that there have been some organizational changes locally, with the closure and winding up of the Petroleum Corporation of Jamaica (PCJ). The MSET now has portfolio responsibility for some key activities that were previously being undertaken by the PCJ.
- The MSET indicated that the change of the PCJ status will not impact project implementation going forward, as anyone from the PCJ that was previously involved in the project and is now in the Ministry can be reassigned if necessary. The JET expressed no difficulty with a change in project structure.

<Resuming Onsite Visit to Jamaica>

- The JET highlighted the difficulties in implementing project activities (such as technical transfers) remotely and therefore outlined plans to visit the region up to four (4) times for EE and RE project activities, if possible, for a duration of five working days each visit and to wrap-up the project early in 2023.
- The MSET expressed satisfaction with the project extension as well as the revised schedule. However, the MSET cautioned that they may not be willing to facilitate face to face discussions, depending on the COVID-19 situation locally. The MSET emphasized that the JET is free to visit Jamaica but may be limited to virtual meetings with local stakeholders.
- The MSET declared that they are willing and able to restart the project, however JICA needs to formally apply to the Planning Institute of Jamaica (PIOJ) of the extension of the technical cooperation, after which official signing of the extension will follow.
- The JICA will therefore prepare amended Record of Discussion (R/D) and discuss with PIOJ, and share with the MSET. The PIOJ and other relevant government ministries will need to be formally informed and involved in the extension process.

- The Plan of Operation (PO) and Organization Structure, which are the attachment to R/D, will also need to be revised. The PO needs to include the project extension and other pertinent information. The organizational chart which previously included the PCJ needs revision. The JET will prepare the revised PO and organization structure and send to the JICA. The JICA will take action for signing of revised R/D with PIOJ. The MSET will assist with this task.

<Update on Activities in Jamaica>

- The JET asked the MSET about the progress of the Integrated Resource Plan (IRP) Project. Mr. Steve Dixon indicated that the first revision of the IRP was completed, and a second revision is now being done, focused heavily on resilience, including micro and distribution grids.
- The JET inquired if the IRP report as of Jan 2020 currently uploaded in MSET website is the final version. The MSET indicated that the draft IRP now available on their website, can be treated as the final version, as there were very few changes made based on feedback from stakeholders.
- The JET also inquired about the progress of the work on grid stability. The MSET shared that there are recommendations for the provision of additional batteries, however there are plans to see how the grid can accommodate greater stability. For example, new IPP developers to establish wind and solar projects will be asked to propose improved energy storage for better stability as part of their proposals. This may be more cost effective.
- The MSET highlighted that the ministry has a non-disclosure agreement with the Jamaica Public Service (JPS) and encouraged the JICA and the JET to have similar discussions with the utility company to establish the same one, because the sharing of information is a major component of the project. The JET committed to pursue and finalize this with JPS.

<Others details of meeting>

- The MSET emphasized that EE remains a major objective of the Ministry and the wider government of Jamaica and that they are very pleased with the move for the re-engagement of the project and that the topics of focus are still very relevant.
- The MSET underscored that the national energy policy forms a basis for this technical agreement extension, and it is therefore welcomed.
- Mr. Buckley of MSET is to research the parties of the original agreement in order to ensure all are appraised and involved in the extension process.

List of Attachments:

1) Presentation Slides on February 3, 2022 (PowerPoint)

End of the MoM

Joint Coordinating Committee (JCC) #2 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries [Jamaica]

February 3, 2022
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

10 min.	Participants and Introduction
3 min.	Opening Remarks [by JICA]
5 min.	Project Outline and Necessity of Extension of Project
15 min.	Current Status and Further Activity of the Project
5 min.	Relevant Restrictions against Implementation of the Project
15 min.	Constrains in Project Schedule and Discussion
3 min.	Closing Remarks [by MSET]

Participants and Introduction

Today's Participants (1/2) (Jamaica)

Jamaica	• MSET (Ministry of Science, Energy and Technology)
JICA	• JICA HQ in Tokyo, Japan • JICA Jamaica Office
JET	• Japanese Experts • Local Expert

Today's Participants (2/2) (Jamaica)

Jamaica

Organization	Name and Title
MSET (Ministry of Science, Energy and Technology)	Ms. Olive Wilson Cross, Director Programme Management Mr. Todd Johnson, Principal Director, Energy Division Mr. Horace Buckley, Director, Project Management, Energy Division Mr. Brian Richardson, Manager, Oil & Gas Mr. Steve Dixon, Consultant, Transmission & Distribution Expert, IRP

JICA

Organization	Name
JICA HQ, Tokyo	Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group Mr. Takeshi NAITO
JICA Jamaica Office	Mr. Takeshi TAKANO, Resident Representative Mr. Hiroyuki OKAZAKI, Project Formulation Advisor

JET

Name and Position (some of members may be absent in this meeting)
Mr. Ryosuke OGAWA, Team Leader
Mr. Masaaki EBINA, Sub Team Leader/Power System
Mr. Yasuhiro SAKAMOTO, Energy Efficiency
Ms. Yuka NAKAGAWA, Renewable Energy
Dr. Hiroshi SUZUKI, Electrical Grid Expert
Dr. Hisao TAOKA, Electrical Grid Expert (additional)
Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator (new)
Ms. Anna MIYAURA, Human Resource Development
Mr. Kevin Douglas, Technical Assistant

Opening Remarks [by JICA]

Project Outline and Necessity of Extension of Project

Project Outline (1/2)

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration
- Originally 3 Years from March 2019 to March 2022.

Expert Team
- JICA Expert Team (JET), which is the consultant team employed by JICA, is conducting the project.

Project Outline (2/2)

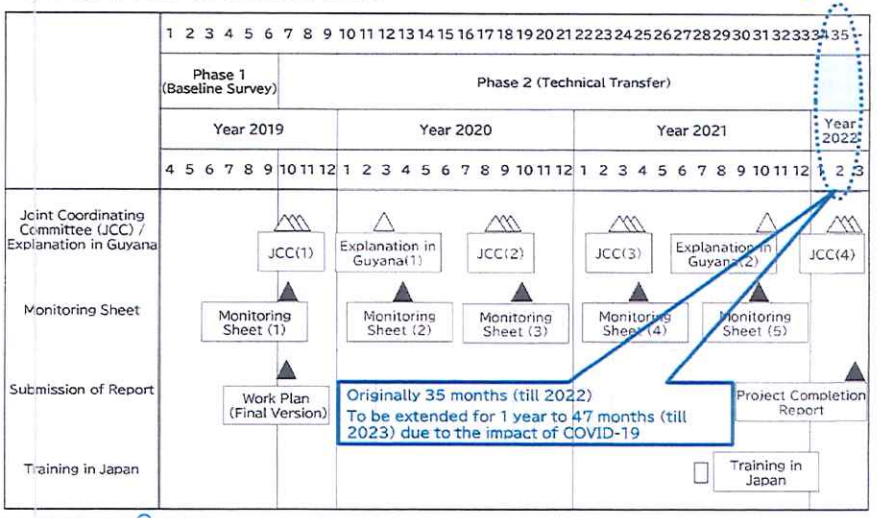
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

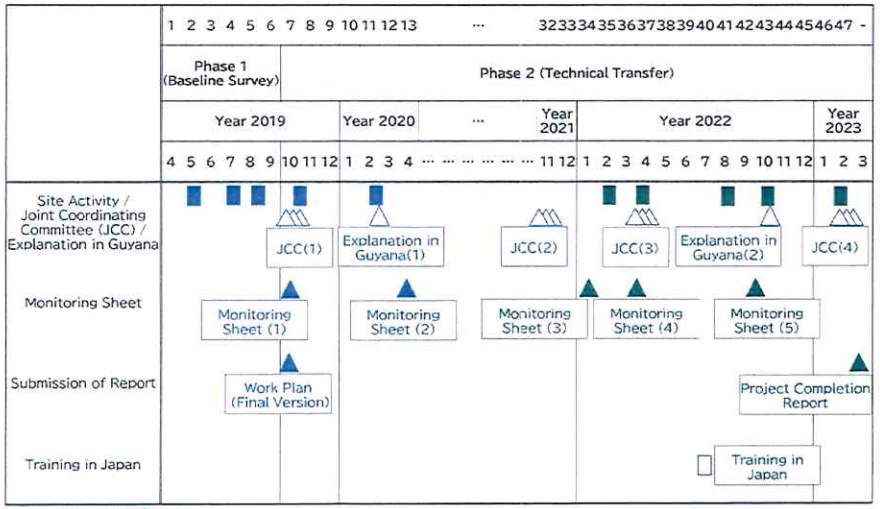
Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE.
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.

Original Schedule



Revised Schedule (Draft)



Necessity of Extension (1/2)

- This project starts in April 2019.
- "Baseline Survey" has been completed and we are at the initial stage of "Technical Transfer" as of March 2020.
- Activities at the site are suspended due to restrictions caused by COVID-19 after March 2020.

- It is not realistic to implement the activities for "Technical Transfer" including usage of instrument and software by online (remote).

Necessity of Extension (2/2)

- Now, JICA and JET seeking possibilities to resume the site activity to complete the project within the extended project duration (35 to 47months) since the restrictions have been slightly relaxed.

- Today, we would like to reach a consensus of the new timeline of this project with necessary revision of R/D (for extension of the project duration and any other issue if necessary).

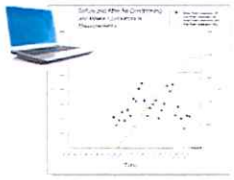
Current Status and Further Activity

Current Status (1/3) (EE, Jamaica)

Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (data logger, software) are to be provided through this project.



Source: Data logger catalogue of HIOKI E.E. CORPORATION

Current Status (2/3) (RE, Jamaica)

Baseline Survey (RE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

RE Installation (2020):

- 50% RE penetration target by 2030.
- 35% RE in 2030, 40% in 2037 (IRP2020)
- Current RE: 14% (hydro 28.7MW, VRE 179MW)
- Roof-top 20MW? Need statistic.
- Wind in valley place
- IRP additional 513.5MW by 2025

Grid Stability:

- Capacity 1,071MW, Peak demand 654.5 MW
- Sales 4,227MWh (JPS2020AR)
- USD0.31/kWh, 26.9% loss (JPS2020AR)
- JPS 21.5MW/16.6MWh Li BESS +3MW Flywheels
- Fuel increase for spinning reserve, Feeder cut at 49.5 Hz. **"VRE is a Nightmare"**

Challenges:

- RE gap of present vs target(15% vs 50%)
- Voltage/frequency fluctuation → Grid stability with 50% VRE
- Cost of energy → Rooftop PV management
- RE project implementation plan
- Wind and PV potential unevenly distributed → No smoothing

Needs:

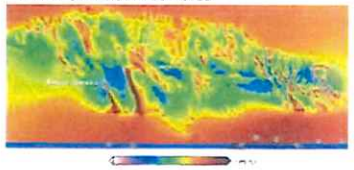
- Capacity building of grid simulation with software
- Proposal for grid code revision
- Enhancement of resilience → Microgrid concept

Current Status (3/3) (RE, Jamaica)

Challenges for RE:

- Increasing RE capacity >15%. Grid stability and power cut issue
  - ✓ Feeder cut at 49.5Hz
- High Pilferage and losses
- Large number of independent power, no statistics
- Wind and PV potential unevenly distributed → no smoothing

Wind Potential in Jamaica



Source: Sustainable Energy Roadmap 2013

Source: JPS, 2019

Year	Consumption (MWh)	Assumed RE (MWh)	Percentage of RE
2020	4,227	564	14%
2030	5,453	1,913	35%
2037	5,939	3,435	41%

Source: 2020: Assumed from table below, 2030 2037: IRP2020 draft

Location/Project	Type	Capacity MW	Generation GWh estimated	Year	Tariff USc/kWh	Investment mil USD	USD/ MW
Wigton I	Wind	20.7	52	2004	10.21	26	1,256
Wigton II	Wind	18	45	2010	10.723	45	2,500
Wigton III	Wind	24	60	2016	13.4	46.5	1,938
Munro	Wind	3	10.5	2010	(IPS)		
BMR Wind	Wind	36.3	120	2016	12.9	90	2,479
Content Solar (WRB)	PV	20	34	2016	18.8	65	3,250
Eight River (EREC)	PV	37	59.2	2019	8.5		
Hydro	Hydro	28.67	152.2				
Independent roof-top	PV	267	30.6		--		
Wigton IV	Wind	34		?			
RE under operation		**207.67**	**564**				

Source: Prepared by JET with several data sources

Further Activity (EE)

Year 2021 ● Online Activities

- Prepared for online presentations as additional activities planned:
  - Current & future situation on EE&C (Energy Efficiency and Conservation) in Japan & the world including effects derived from COVID-19.
    - EE policy, Outlook of power demand, CO_2 reductions ,etc.
    - Introduction of IEA's publications including "Energy Technology Perspectives 2020" and "Energy Efficiency 2020", and progress of EE targets up to 2030 in Japan.
- Activities originally planned at site:
  - Collaboration activities to draft EE activities/roadmap based on energy balance in each country.

Year 2022 ● Site Activity (Technical Transfer)

Review of S&L (Standards and Labeling) program	On site energy auditing	Preparation of EE roadmap
Possibilities of ESCO business	Energy auditor / manager	Delivery of power consumption measurement device (data logger)
Review of building code	Examination of EE pump system	

Further Activity (RE)

	By Mar 2022 (Online Activity (was planned))	After Apr 2022 (Site Activity)
Additional Activity	● COVID19 impact on RE plan, operation, investment ● RE tends after COVID-19	
Grid Stability	● Lecture on grid simulation (basic, concept, methodology) ● Simulation model ● Energy storage and equipment	● Exercise on grid simulation using software
Microgrid	● Microgrid examples and Japanese experiences (system component, benefit, cost, challenges)	● Data collection and concept formulation
Resilience, Asset Management	● Mitigation measurement for RE to enhance resilience ● Introduction of asset management concept	● Demonstration of asset management
Policy Recommendation	● Example of grid code with large RE penetration (frequency / voltage stability, Inertia, speed regulation, etc.)	● Discussion/recommendation for future application of grid code

Relevant Restrictions against Implementation of the Project

Restrictions (General)(1/2)

Flights
- There is some difficulty for scheduling due to limited number of routes and flights, and availability of air tickets with reasonable price.

Quarantine
- Depending on the country, however negative certificate of COVID-19 is generally required "home quarantine" is also required after arriving a country in some country.

Meeting Restriction
- In most of countries, remote (virtual) meetings are recommended instead of face-to-face meetings.

Restrictions (General)(2/2)

Previously ···
- Day 1-2(Sat, Sun): from Japan via Canada(Toronto)
- Day 3-7(Mon to Fri): Barbados
- Day 10-14(Mon to Fri): St. Kitts and Nevis
- Day 17-21 (Mon to Fri): Jamaica
- Day 22-24 (Sat to Mon): to Japan
- Mainly travel days are Saturday and Sunday.

Currently ··· Flight Schedule as of February 2022
- Between Barbados and St. Kitts and Nevis by LIAT Twice a week (daily flight in 2019)
- Between Barbados and Jamaica by Caribbean Air Twice a week (previously 5 flights/week (direct or one-stop flights) in 2019)

Restriction (Country Specific)

Jamaica
- In case of business travel (Category 3), no quarantine for fully vaccinated traveler having negative certificate of COVID-19 (RT-PCR)

Barbados
- No quarantine for fully vaccinated traveler having negative certificate of COVID-19 (RT-PCR)
- Selected traveler are to be tested upon arrival.

St. Kitts and Nevis
- No quarantine for fully vaccinated traveler having negative certificate of COVID-19 (RT-PCR)
- However, there is a travel restriction by JICA.

Constrains in Project Schedule and Discussion

Constrains in Project Schedule (1/2)

Schedule and Constrains

- Four (04) times visits are expected each for EE and RE. (05 working days/time)
- Wrap-up is expected in early 2023.
- There are still the limitation of flights and requirement for entry of the country.
- The circumstance is still uncertain for international trip and face-to-face meeting.

Constrains in Project Schedule (2/2)

Discussion

- Revision of R/D (Record of Discussion) for project extension for one (01) year
- Confirmation of counterpart organization of this project in Jamaica (It was originally MSET and PCJ)
- Reality of the schedule under current situation and availability of personnel for site activity (acceptable or not by Jamaican side)
- Timing/season of site activity and program in Japan (subject to regulation to enter Japan)
- Possibility of face-to-face meeting/activity

Thank you.

Closing Remarks [by MSET]

Minutes of Meeting
of
Joint Coordination Committee #2
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MESBE, JICA, and JICA Expert Team

November 25, 2021

Ministry of Energy, Small Business and Entrepreneurship (MESBE)

Mr. Andrew Gittens, Permanent Secretary

Japan International Cooperation Agency (JICA), Tokyo

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Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group

Japan International Cooperation Agency, St. Lucia Office

Mr. Hiroyasu TONOKAWA, Chief Representative

JICA Expert Team (JET)

Mr. Ryosuke OGAWA, Team Leader

Date and Time:

November 25, 2021 8:30am (in Barbados), 9:30pm (in Japan)

Location:

Online (Virtual Meeting by Zoom)

Participants:

1) Ministry of Energy, Small Business and Entrepreneurship (MESBE)

- Mr. Andrew Gittens, Permanent Secretary
- Mr. Horace Archer, Senior Technical Officer
- Mr. Frank Branch,Technical Officer

2) Japan International Cooperation Agency (JICA), Tokyo

- Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group
- Mr. Takeshi NAITO

3) Japan International Cooperation Agency (JICA), St. Lucia Office

- Mr. Hiroyasu TONOKAWA, Chief Representative
- Ms. Hitomi URUSHIHATA
- Mr. Terumasa MATSUZAKI

4) JICA Expert Team (JET)

- Mr. Ryosuke OGAWA, Team Leader
- Mr. Masaaki EBINA, Sub Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Ms. Anna MIYAURA, Human Resource Development
- Mr. Alex Harewood, Technical Assistant

Discussions:

<Looking Back the Current Status of Project>

- JET explained the summary of current project status by presentation material. (Attachment 1).

- JET has plans to visit the region in 2022 up to four (4) times each for EE and RE if possible, for a duration of five working days each visit. The project is expected to wrap-up in early 2023.
- JET also explained about the further activities of EE and RE both in presentation slides.

<Resuming Onsite Visit to Barbados>

- The revised schedule shown in slides including visits timing is no problem for Barbados side. MESBE agreed the restarting of site activities in early 2022, however MESBE can only say, "Depends on the situation", at this moment.
- JICA indicated this project was planned to finish by the end of March 2022 originally, but JICA would like to extend 1 more year. The procedure to extend the project will be informed later by email. MESBE agreed with this proposal for this project extension.

<Update on Activities in Barbados>

- JET asked MESBE about the progress of natural gas project brings the gas from Trinidad Tobago to Barbados, and its effect to achieve the 100% RE. MESBE mentioned it hasn't progressed yet.
- Moreover, the government main policy of Barbados is to achieve the 100% RE by 2030, so the discussions and activities are ongoing. MESBE shared recent activities as below.

    1) To bring solar and different sources (ex. wind) of energy is recently approved.
    2) Solar power of roof of top and pumping project is continued.
    3) Use facilities on shore (ocean energy) is under the cabinet discussion but not started actual action yet.
    4) Discussion to finalize standard of ocean energy is occurred.
    5) BLPC discussion is also done with the whole stakeholder.

<Area for Technical Assistance >

- JET agreed following items.

    1) To give lectures by specialist how to use systems. Regarding application of grant roots project, grid stability is supported by academia, and university's joint venture company. They will give a lecture as a specialist.
    2) To discuss about the percentage of energy source. Total energy consumption will be increased 30%, and the amount of power consumption has been changed. JET would like to share the percentage changing of energy source in Japan and discuss it during next field visit.

3) To give the latest information of fossil fuel free vehicle's market and technical matters in Japan. Barbados is also interested in the fossil fuel free vehicles for moving to such as EV, because Japan is already more focus on HV, EV etc. and trying to hydrogen car more.

List of Attachments:

1) Presentation Slides on November 25, 2021(PowerPoint)

End of the MoM

Joint Coordinating Committee (JCC) #2 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries [Barbados]

November 25, 2021
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

3 min.	Today's Participants
3 min.	Opening Remarks from JICA
5 min.	Project Outline and Current Status
10 min.	Further Activity
5 min.	Relevant Restrictions against the Implementation of the Project
20 min.	Constrains in Project Schedule and Discussion
3 min.	Closing Remarks from Barbados Side

Today's Participants

Today's Participants (1/2) (Barbados)

Barbados	• MESBE (Ministry of Energy, Small Business and Entrepreneurship)
JICA	• JICA HQ • JICA St. Lucia Office
JET	• Japanese Experts • Local Expert

Today's Participants (2/2) (Barbados)

Barbados

Organization	Name and Title
MESBE (Ministry of Energy, Small Business and Entrepreneurship)	Mr. Andrew Gittens, Permanent Secretary Ms. Debra Dowridge, Deputy Permanent Secretary Mr. Horace Archer, Senior Technical Officer

JICA

Organization	Name
JICA HQ in Tokyo	Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group Mr. Takeshi NAITO
JICA St. Lucia Office	Mr. Hiroyasu TONOKAWA, Chief Representative Mr. Terumasa MATSUZAKI Ms. Hitomi URUSHIHATA

JET

Name and Position (some of members are absent in this meeting)
Mr. Ryosuke OGAWA, Team Leader
Mr. Masaaki EBINA, Sub Team Leader/Power System
Mr. Yasuhiro SAKAMOTO, Energy Efficiency
Ms. Yuka NAKAGAWA, Renewable Energy
Dr. Hiroshi SUZUKI, Electrical Grid Expert
Dr. Hisao TAOKA, Electrical Grid Expert (additional)
Mr. Hiroaki NIIMI, Grid Stabilization/Coordinator (former)
Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator (new)
Ms. Anna MIYAURA, Human Resource Development
Mr. Alex Harewood, Technical Assistant

Opening Remarks

Project Outline and Current Status

Project Outline

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration

- Originally 3 Years from March 2019 to March 2022.

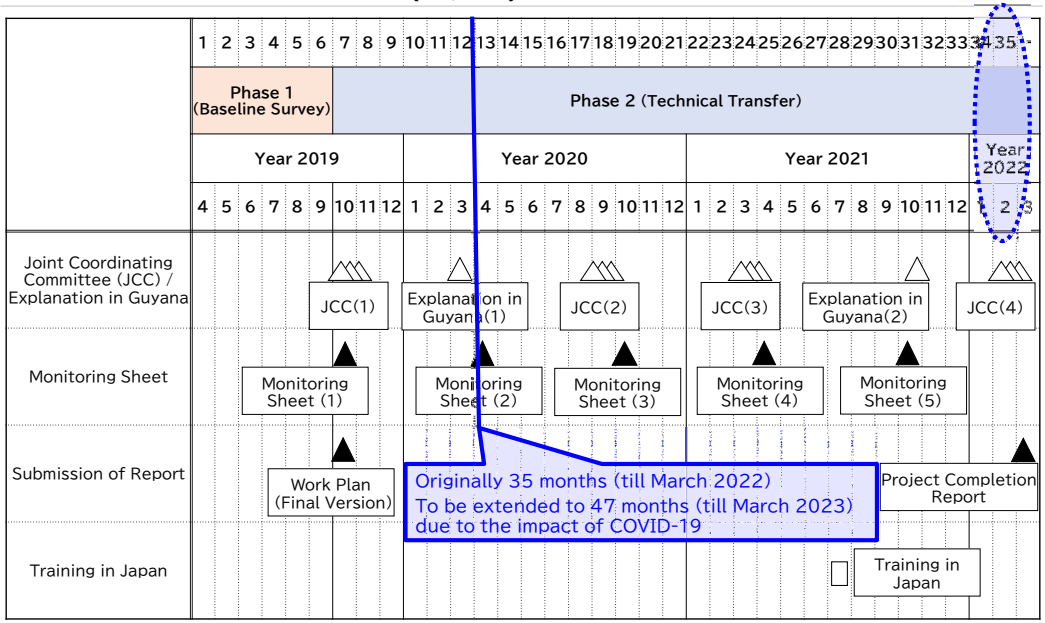
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE.
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.

Current Status (1/5)



Current Status (2/5) (Barbados)

Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In EE, in addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (logger, software) are to be provided through this project.

Current Status (3/5) (Barbados)

Baseline Survey (RE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

RE Installation (2019):

- 100% RE target incl. fuel by 2030
- 14% RE (generation capacity), 2% of RE (energy base) of 950GWh/year
- Good RE potential, but detailed project plan need confirmation
- CO_2 emission 0.737 tCO_2/MWh
- 10MW Trents PV + 21MW Roof top
- Good potential (472MW wind identified, 4.4-4.7kWh/kW PV)

Grid Stability:

- 5MW, 20MWh BESS
- 0.02Hz with 1MW fluctuation, Ramp Rate 3MW/min
- Fuel increase for spinning reserve

Challenges:

- 100% RE target for all energy (incl. EV)
- Grid stability with 100% VRE
- Bottle neck: Land availability and environment
- More options necessary: CSP
- RE project pipeline and implementation plan

Needs:

- Capacity building of grid simulation with software in academic field
- Proposal for grid code revision
- Microgrid concept (Coverley Villages)
- Design of enhanced resilience for PV and Wind

Current Status (4/5)

Current Status

- Activities at the site are suspended from March 2020, due to restrictions caused by COVID-19.
- All remained activities are postponed for one year and online (remote) activities are to be added.
- "Baseline Survey" has been completed and currently the initial stage of "Technical Transfer".

- JICA and JET considers that it takes some more time to resume the activities due to the restrictions (till the end of Year 2021 or March 2022).
- It is not realistic to implement the activities for "Technical Transfer" by online (remote).

Current Status (5/5)

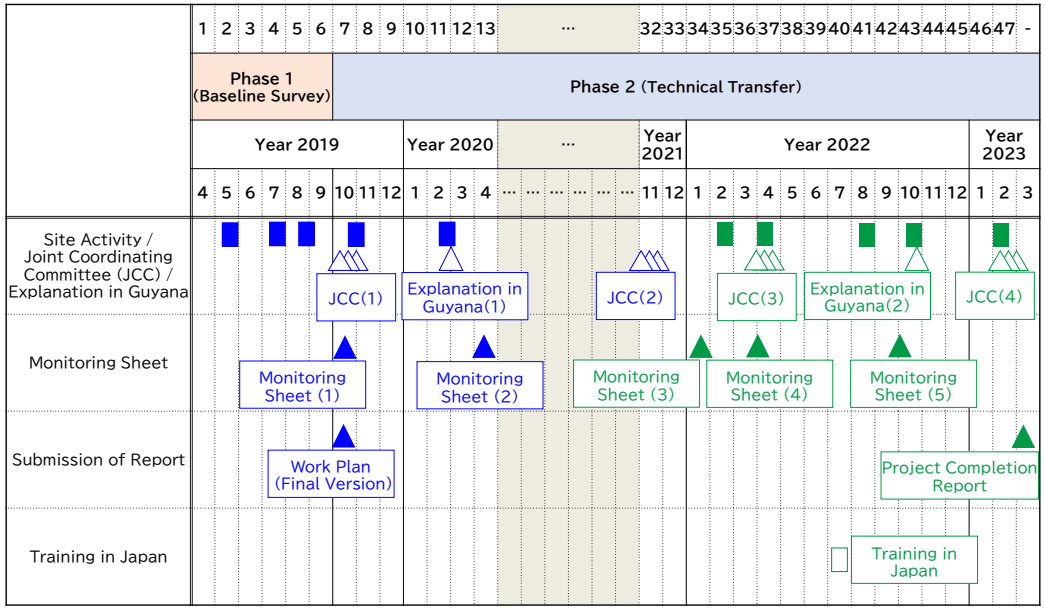
Further Schedule

- Now, JICA and JET seeking possibilities to resume the site activity to complete the project within the extended project duration (47months) since the restrictions have been slightly relaxed.

- With necessary revision of R/D (for extension of the project duration and any other issue if necessary), we would like to reach a consensus of the new timeline of this project.

Further Activity

Revised Schedule (Draft)



Outline of Further Activity (EE)

Year 2021 ● Online Activity

- Additional activities:

  Current & future situation on energy efficiency & conservation in Japan & the world including effects derived from COVID-19.

  - EE policy, Outlook of power demand, CO_2 reductions ,etc.

- Activities originally planned at site:

  - Collaboration activities to draft EE activities/roadmap based on energy balance in each country.

Year 2022 ● Site Activity (Technical Transfer)

Review of S&L program	On site energy auditing	Preparation of EE roadmap
Possibilities of ESCO business	Energy auditor / manager	Delivery of power consumption measurement device (data logger)
Review of building code	Examination of EE pump system	

Outline of Further Activity (RE)

	Year 2021 (Online Activity)	Year 2022 (Site Activity)
Additional Activity	● COVID19 impact on RE plan, operation, investment ● RE tends after COVID-19, fuel price forecasts	
Grid Stability	● Lecture on grid simulation (basic, concept, methodology) ● Simulation model ● Energy storage and equipment	● Exercise on grid simulation using software ● RE scenario setting
Microgrid	● Microgrid examples and Japanese experiences (system component, benefit, cost, challenges)	● Data collection and concept formulation
Resilience, Asset Management	● Mitigation measurement for RE to enhance resilience ● Introduction of asset management concept	● Demonstration of asset management
Policy Recommendation	● Example of grid code with large RE penetration (frequency/voltage stability, Inertia, speed regulation, etc.)	● Discussion/recommendation for future application of grid code

Relevant Restrictions against the Implementation of the Project

Restrictions (General)(1/2)

Flights

- There is some difficulty for scheduling due to limited number of routes and flights, and availability of air tickets with reasonable price.

Quarantine

- Depending on the country, however negative certificate of COVID-19 is generally required “home quarantine” is also required after arriving a country in some country.

Restrictions (General)(2/2)

Previously …

- Day 1-2(Sat, Sun): from Japan via Canada(Toronto)
- Day 3-7(Mon to Fri): Barbados
- Day 10-14(Mon to Fri): St. Kitts and Nevis
- Day 17-21 (Mon to Fri): Jamaica
- Day 22-24 (Sat to Mon): to Japan
- Mainly travel days are Saturday and Sunday.

Currently … Flight Schedule as of January 2022

- Between Barbados and St. Kitts and Nevis by LIAT Twice a week (daily flight in 2019)
- Between Barbados and Jamaica by Caribbean Air Twice a week (previously 5 flights/week (direct or one-stop flights) in 2019)

Restriction (Country Specific)

Barbados
- No quarantine for fully vaccinated traveler. (Selected traveler are to be tested upon arrival.)

Jamaica
- In case of business travel (Category 3), no quarantine for fully vaccinated traveler after obtaining negative test result of test conducted upon arrival

St. Kitts Nevis
- Quarantine till obtaining negative result test conduced within 24 hours after arrival in case of fully vaccinated traveler
- However, there is a travel restriction by JICA.

Constrains in Project Schedule and Discussion

Constrains in Project Schedule

Schedule
- Four (04) times each in 2022 are expected for EE and RE. (05 working days/time)
- Wrap-up is expected in early 2023.

Constrains and Discussion
- Revision of R/D (Record of Discussion) for project extension
- Reality of the schedule under current situation and availability of personnel for site activity
- Timing (season) of site activity
- Timing of program in Japan

Thank you.

Closing Remarks

Minutes of Meeting
of
Joint Coordination Committee #2
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MPI, NIA, NEVLEC, SKELEC, JICA, and JICA Expert Team

November 22, 2021

Ministry of Public Infrastructure, Post, Urban Development, and Transport (MPI)

Bertill Browne

Dr. Bertill Browne

Nevis Island Administration (NIA)

Ms. Michelle Walters

St. Kitts Electricity Company Limited (SKELEC)

Mr. Jonathan Kelly, Engineering Manager

Nevis Electricity Company Limited (NEVLEC)

Mr. Albert Gordon, General Manager

Japan International Cooperation Agency (JICA), Tokyo

久下 勝也

Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group

Japan International Cooperation Agency, St. Lucia Office

殿川 弘康

Mr. Hiroyasu TONOKAWA, Chief Representative

JICA Expert Team (JET)

小川 良輔

Mr. Ryosuke OGAWA, Team Leader

Date and Time:

November 22, 2021 9:00am (in St. Kitts and Nevis), 10:00pm (in Japan)

Location:

Online (Virtual Meeting by Zoom)

Participants:

1) Ministry of Public Infrastructure, Post, Urban Development, and Transport (MPI)

- Dr. Bertille Browne, Director of the Energy Unit (absent)

2) Nevis Island Administration (NIA)

- Ms. Michelle Walters, Energy Commissioner (absent)

3) St. Kitts Electricity Company (SKELEC)

- Mr. Jonathan Kelly, Engineering Manager
- Mr. Kenrod Roberts, Maintenance Engineer

4) Nevis Electricity Company (NEVLEC)

- Mr. Albert Gordon, General Manager
- Mrs. Roma Merchant, Financial Controller
- Mr. Jervan Swanston, System Planning and Projects Manager
- Mr. Ian Ward, Chief Engineer
- Mr. Naftalie Errar, Planning Engineer
- Mr. Starett France, Planning Officer
- Mr. Nelson Stapleton, T&D Manager

5) Japan International Cooperation Agency (JICA), Tokyo

- Mr. Takeshi NAITO

6) Japan International Cooperation Agency (JICA), St. Lucia Office

- Mr. Hiroyasu TONOKAWA, Chief Representative
- Ms. Hitomi URUSHIHATA
- Mr. Terumasa MATSUZAKI

7) JICA Expert Team (JET)

- Mr. Ryosuke OGAWA, Team Leader

- Mr. Masaaki EBINA, Sub Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Ms. Anna MIYAURA, Human Resource Development
- Mr. I-Ronn Audain, Technical Assistant

Discussions:

<Looking Back the Current Status of Project>

- JET explained the summary of current project status by presentation material. (Attachment 1).
- JET has plans to visit the region in 2022 up to four (4) times each for EE and RE if possible, for a duration of five working days each visit. The Project is expected to wrap-up in early 2023.
- JET also explained about the further activities of EE and RE both in presentation slides.

<Resuming Onsite Visit to St. Kitts and Nevis>

- JICA indicated this project was planned to finish by the end of March 2022 originally, but JICA would like to extend 1 more year. The procedure to extend the project will be informed later by email. MPI, NIA, SKELEC and NEVLEC agreed with this proposal for this project extension.
- JICA indicated JET cannot visit St. Kitts & Nevis, due to JICA restriction, until March 2022 or later, and JICA cannot say when JET can resume field activities at the moment.
- JICA also indicated that specific conditions, especially medical information, and institutions, must be met for the visits to occur. Although there is no JICA office or Embassy of Japan in St. Kitts & Nevis, JICA St. Lucia office has started information collection. They will gather more information and make an assessment on whether to approve visits to St. Kitts and Nevis going forward.
- No objection to the visits in 2022 was raised by the St. Kitts and Nevis participants. However, NEVLEC local team propose that, in order to keep the project moving toward completion, assistance from JET remotely for a while would be greatly appreciated.

<Update on Activities in St. Kitts and Nevis>

- NEVLEC and SKELEC have procured the Generation Software PLEXOS and NEVLEC has procured the grid modeling software, ETAP. Both utilities have procured software

at a significant discount for the first few years. SKELEC intends to procure grid modeling software within Q1 of 2022.

- NEVLEC is in the process of purchasing an asset management software, ESRI. SKELEC will also be acquiring this software within Q1 of 2022.
- Both NEVLEC and SKELEC have base models in PLEXOS to commence learning remotely with JET's supports. Both utilities can prepare for the basic knowledge for the effective use of the software.
- Both NEVLEC and SKELEC are ready to receive training on power system design and implementation using JET's training platforms and software tools
- Nevis' geothermal project will receive equity from a private developer and CDB (Caribbean Development Bank) will provide funding for the first phase. Contracts will be signed on December 2021. Funding will be needed for the second phase, which will involve the production of hydrogen and ammonia.
- St. Kitts: the Leclanche 35MW PV project is to be installed and commissioned in the second quarter of 2023, with the specifications remaining the same as before COVID-19. Battery installation is also planed the second quarter of 2023.

<Area for Technical Assistance >

- JET agreed to the following items.

  1) To assist in capacity building in relation to grid modeling and simulation, explanation of asset management and "QGIS" software, which is open source one.
  2) To share the basic knowledge about how to use software, hydrogen project and future possibilities remotely. JET has an expert to explain the use of system to students for education purpose.
  3) To provide fundamental training in high voltage submarine cable installation and maintenance. JET can give basic level lecture for plans to place high voltage submarine cable between St. Kitts and Nevis.
  4) To evaluate whether a study can be conducted in relation to the production of hydrogen and/or ammonia from the Nevis geothermal site.

- NEVLEC mentioned the deliberative of hydrogen as below.

  1) NEVLEC is looking to develop 90 MW of geothermal energy source in the medium term. Peak electricity demand is just over 9 MW. Excess capacity would be used for export and production of hydrogen and/or ammonia.
  2) Looking to develop additional capacity for manufacturing, agriculture tourism and other areas of the economy based on geothermal resources. Application is being

made for 15 million Euros of financing to support the production of hydrogen and/or ammonia.

3) Mixture of energy sources and hydrogen projects also need to be supported. For hydrogen, looking for offshore opportunities for export.

List of Attachments:

1) Presentation Slides on November 22, 2021(PowerPoint)

End of the MoM

Joint Coordinating Committee (JCC) #2 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries [St. Kitts and Nevis]

November 22, 2021
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

3 min.	Opening Remarks from JICA
5 min.	Introduction of Participants
3 min.	Project Outline and Current Status
10 min.	Further Activity
5 min.	Relevant Restrictions against the Implementation of the Project
15 min.	Constrains in Project Schedule and Discussion
3 min.	Closing Remarks from St. Kitts and Nevis Side

Today's Participants

Today's Participants (1/2) (St. Kitts and Nevis)

St. Kitts and Nevis	• Ministry of Public Infrastructure, Post, Urban Development, and Transport (MPI) • Nevis Island Administration (NIA) • SKELEC • NEVLEC
JICA	• JICA HQ • JICA Office (JICA St. Lucia Office)
JET	• Japanese Experts • Local Expert

Today's Participants (2/2) (St. Kitts and Nevis)

St. Kitts and Nevis

Organization	Name and Title
MPI	Mr. Daryll Lloyd- Permanent Secretary Dr. Bertille Browne- Director of Energy Mr. Denasio Frank- Energy Officer
NIA	Mr. Wakely Daniel- Permanent Secretary Ms. Michelle Walters- Energy Officer
NEVLEC	Mr. Albert Gordon – General Manager Ms. Roma Merchant - Financial Controller Mr. Jervan Swanston - Strategic Planning Manager Mr. Ian Ward – Chief Engineer Mr. Naftalie Errar - Planning Engineer Mr. Starett France - Planning Officer Mr. Nelson Stapleton - T&D Manager
SKELEC	Mr. Clement Williams – General Manager Ms. Pearl Williams- Financial Controller Ms. Inga Rogers – Human Resource Manager Mr. Jonathan Kelly – Engineering Manager Mr. Kenrod Roberts – Maintenance Engineer

JICA

Organization	Name
JICA (Tokyo)	Dr. Katsuya KUGE, Director, Team 2, Energy and Mining Group Mr. Takeshi NAITO
JICA (St. Lucia Office)	Mr. Hiroyasu TONOKAWA, Chief Representative Mr. Terumasa MATSUZAKI Ms. Hitomi URUSHIHATA

JICA Expert Team Member

JET

Name and Position
Mr. Ryosuke OGAWA, Team Leader Mr. Masaaki EBINA, Sub Team Leader/Power System Mr. Yasuhiro SAKAMOTO, Energy Efficiency Ms. Yuka NAKAGAWA, Renewable Energy Dr. Hiroshi SUZUKI, Electrical Grid Expert Dr. Hisao TAOKA, Electrical Grid Expert (additional) Mr. Hiroaki NIIMI, Grid Stabilization/Coordinator (former) Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator (new) Ms. Anna MIYAURA, Human Resource Development Mr. I-Ronn Audain, Technical Assistant

Project Outline and Current Status

Project Outline

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration

- Originally 3 Years from March 2019 to March 2022.

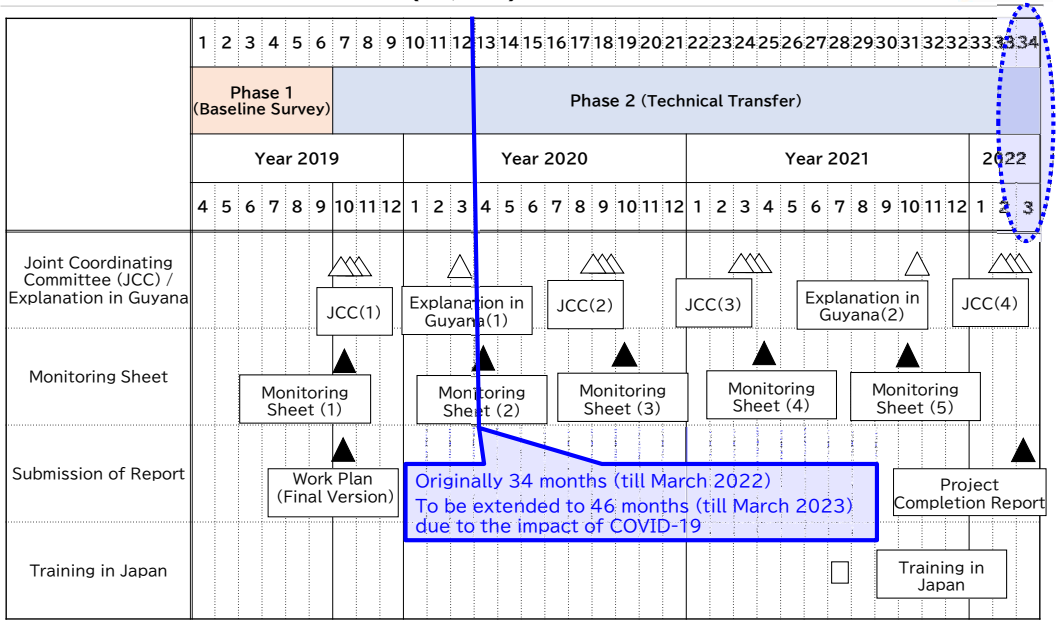
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE.
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.

Current Status (1/5)



Current Status (2/5) (St. Kitts and Nevis)

Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In EE, in addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (logger, software) are to be provided through this project.

Current Status (3/5) (St. Kitts and Nevis)

Baseline Survey (RE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

RE Installation:

- 100% RE by 2020 target
- 0.7+0.5 MW PV (St. Kitts)
- 2MW wind operated at 1.1 MW (Nevis)
- Bellevue 5.4MW wind, Leclanche 35MW PV to be installed
- Nevis Geothermal plan (10-30 MW + potential

Grid Stability:

- 6MW-34MWh BESS planned for 35MW PV
- Output suppression conducted in NEVLEC

Needs for:

1) Modeling for existing transmission and distribution network
2) Provision of grid simulation software and training and grid analysis with 35 MW PV
3) Proposal for grid code revision
4) Introduction of network asset management
5) Additional request of hydrogen utilization study (from NEVLEC, 2021)

Current Status (4/5)

Current Status

- Activities at the site are suspended from March 2020, due to restrictions caused by COVID-19.
- All remained activities are postponed for one year and online (remote) activities are to be added.
- "Baseline Survey" has been completed and currently the initial stage of "Technical Transfer".

- JICA and JET considers that it takes some more time to resume the activities due to the restrictions (till the end of Year 2021 or March 2022).
- It is not realistic to implement the activities for "Technical Transfer" by online (remote).

Current Status (5/5)

Further Schedule

- Now, JICA and JET seeking possibilities to resume the site activity to complete the project within the extended project duration (46months) since the restrictions have been slightly relaxed.

- With necessary revision of R/D (for extension of the project duration and any other issue if necessary), we would like to reach a consensus of the new timeline of this project.

Further Activity

Outline of Further Activity (EE)

Year 2021 ● Online Activity

◆ Additional activities:

Current & future situation on energy efficiency & conservation in Japan & the world including effects derived from COVID-19.

- EE policy, Outlook of power demand, CO_2 reductions ,etc.

◆ Activities originally planned at site:

- Collaboration activities to draft EE activities/roadmap based on energy balance in each country.

Year 2022 ● Site Activity (Technical Transfer)

Review of S&L program	On site energy auditing	Preparation of EE roadmap
Possibilities of ESCO business	Energy auditor / manager	Delivery of power consumption measurement device (data logger)
Review of building code	Examination of EE pump system	

Outline of Further Activity (RE)

	Year 2021 Online Activity	Year 2022 Site Activity
Additional Activity	● COVID19 impact on RE plan, operation, investment ● RE tends after COVID-19, fuel price forecasts	
Grid Stability	● Lecture on grid simulation (basic, concept, methodology) ● Simulation model ● Energy storage and equipment	● Exercise on grid simulation using software ● RE scenario setting
Microgrid	● Microgrid examples and Japanese experiences (system component, benefit, cost, challenges)	● Data collection and concept formulation
Resilience, Asset Management	● Mitigation measurement for RE to enhance resilience ● Introduction of asset management concept	● Demonstration of asset management
Policy Recommendation	● Example of grid code with large RE penetration (frequency/voltage stability, Inertia, speed regulation, etc.)	● Discussion/recommendation for future application of grid code ● Hydrogen utilization possibility with Geothermal

Relevant Restrictions against the Implementation of the Project

Restrictions (General)(1/2)

Flights

- There is some difficulty for scheduling due to limited number of routes and flights, and availability of air tickets with reasonable price.

Quarantine

- Depending on the country, however negative certificate of COVID-19 is generally required "home quarantine" is also required after arriving a country in some country.

Restrictions (General)(2/2)

Previously …

- Day 1-2(Sat, Sun): from Japan via Canada(Toronto)
- Day 3-7(Mon to Fri): Barbados
- Day 10-14(Mon to Fri): St. Kitts and Nevis
- Day 17-21 (Mon to Fri): Jamaica
- Day 22-24 (Sat to Mon): to Japan
- Mainly travel days are Saturday and Sunday.

Currently … Flight Schedule as of January 2022

- Between Barbados and St. Kitts and Nevis by LIAT Twice a week (daily flight in 2019)
- Between Barbados and Jamaica by Caribbean Air Twice a week (previously 5 flights/week (direct or one-stop flights) in 2019)

Restriction (Country Specific)

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St. Kitts Nevis

- Quarantine till obtaining negative result test conduced within 24 hours after arrival in case of fully vaccinated traveler
- However, there is a travel restriction by JICA.

Constrains in Project Schedule and Discussion

Constrains in Project Schedule

Schedule

- Four (04) times each in 2022 are expected for EE and RE. (05 working days/time)
- Wrap-up is expected in early 2023.

Constrains

- Possibility of availability for project activity
- Preferred timing (season)
- Program in Japan

Thank you.

Minutes of Meeting
of
Joint Coordination Committee #3
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MSET, JICA, and JICA Expert Team

March 30, 2023

Ministry of Science, Energy and Technology (MSET)

Mrs. Olive Wilson Cross, Chief Technical Director, Programme Implementation

Japan International Cooperation Agency, Jamaica Office

Mr. Mitsuyoshi KAWASAKI, Resident Representative

JICA Expert Team (JET)

Mr. Tomoyasu FUKUCHI, Team Leader

Date and Time:

March 30, 2023, 10:00 a.m. (in Jamaica), 12:00 a.m. (in Japan)

Location:

Virtual Meeting by Zoom

Participants:

1) Ministry of Science, Energy and Technology (MSET)

- Mrs. Olive Wilson Cross, Chief Technical Director, Programme Implementation
- Mr. Horace Buckley, Project Engineer
- Mr. Steve Dixon, IRP Consultant (T&D Expert)
- Mr. Todd Johnson, Principal Director, Energy Division
- Ms. Leneka Rhoden, Director of Energy Systems and Conservation

2) Japan International Cooperation Agency (JICA), Tokyo

- Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group

3) Japan International Cooperation Agency (JICA), Jamaica Office

- Mr. Mitsuyoshi KAWASAKI, Resident Representative
- Mr. Hiroyuki OKAZAKI, Project Formulation Advisor

4) Caribbean Community (CARICOM), Guyana

- Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

5) JICA Expert Team (JET)

- Mr. Tomoyasu FUKUCHI, Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Dr. Hisao TAOKA, Electrical Grid Expert
- Ms. Anna MIYAURA, Human Resource Development
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Ms. Christina Francis (Representing Mr. Kevin Douglas, Technical Assistant)

oc

Discussions

<Looking Back Over all the Project>

- JICA Expert Team (JET) explained the project was originally from March 2019 to March 2022, however, due to the COVID-19 pandemic, it was extended to May 2023.

<Activities of Phase 1 for Renewable Energy (RE)>

- JET explained that the Phase 1 baseline survey indicated that before 2019 the former RE target in Jamaica was 35% by 2030 and 40% by 2037. This was accelerated to 50% RE by 2030. The fluctuation due to Variable RE such as PV and wind had caused issues on the grid, but the Jamaica Public Service (JPS) installed hybrid energy storage systems which improved the fluctuation conditions.
- JET mentioned that to achieve the 50% RE, additional grid stability measurements will be necessary. In addition, enhancement of resilience for climate change is an issue. Accordingly, JET summarized that the parties had agreed that the technical transfer stage will mainly focus on grid stability and microgrid concept to enhance resilience.

<Activities of Phase 1 for Energy Efficiency (EE)>

- Baseline survey was conducted on Phase 1 as planned while the additional activity was proposed through Phase 1 to hand over the data collection devices (data logger and its software) to figure out the energy consumption ratio at households, etc. to formulate effective EE policies/regulations. Two data loggers were provided to Jamaica (MSET and BSJ).

<Achievement of Phase 2 "Technical Transfer">

- Activities of Phase 2 for RE:
  - JET explained that Seminars on Large RE and Grid Stability were conducted in three sessions (1st seminar on 12 Oct 2022, 2nd seminar on 30 Nov 2022, and 3rd seminar on 8 Feb 2023). The key focus was on Grid Stability and how this is affected by large amounts of VRE on the grid as this is of high importance for the government, JPS, and other key stakeholders to enable 50% RE target.
  - JET stated that the load flow analysis was conducted and that the grid model comprising of the open data of Jamaica's grid system was prepared. A simplified model has been prepared for exercise in the seminar making it easier for participants to understand the concept.

- JET also stated that a simulation scenario was developed based on seminar feedback for trial, and JET highlighted the importance of grid simulation with one example that a line section was overloaded according to PV increase in future.
- A concept for microgrid was also prepared with the selection criteria of target location based on remote, high transmission loss, area with voltage drop and fluctuation and area with high solar and wind potential. JET stated that, Hagley Gap in St. Andrew, meets the criteria. JET noted that all information presented on the area is based on desktop survey and detailed design will be necessary based on actual site data.
- JET stated that a grid model was created for the Hagley Gap microgrid, and grid analysis was conducted, and indicated that grid forming inverter (GFM) will be necessary when PV and wind percentage is increased. A provisional cost estimation for Hagley Gap microgrid was also done based on assumptions.
- JET made some recommendations for grid stability and revision of grid code:
  1. Spinning reserve to compensate variable RE (VRE) fluctuation should be kept.
  2. Reactive power compensation should be provided according to VRE installation.
  3. For grid stability, the Short Circuit Ratio (SCR) (= AC power in grid / Power from inverter based resource (PV and wind) should be kept more than 3.0.
  4. In case SCR will be less than 3.0, Grid Forming Inverter (GFM) should be applied, once GFM becomes available in the market.
  5. If the VRE will be installed more than 1 MW, a BESS with minimum 80% capacity and 4hrs duration should be installed.
- JET summarized policy recommendations for future RE for Jamaica, such as approval of investment for grid stability, sharing responsibility of grid stability with IPP and consumers, and promotion of microgrid.

- Activities of Phase 2 for EE
  - JET explained the workshops that were conducted, and that stakeholders were receptive to the knowledge shared.
  - JET stated that data loggers were handed over to Jamaica, BSJ: 1 (November 2022) and MSET: 1 (March 2023).
  - Major contents presented from JET are as follows.
    1. Energy Management & Energy Audit (International Standards and introduction of successful practices).

2. EE&C Roadmap with Country Energy Balance and efficient technologies (residential & commercial sector integration).
3. EE Building Code including Okinawa & Hawaii Situation and EE&C Evaluation Study.
4. Report on Energy Audits Results including Walk Through Survey.
5. Demonstration: Data Logger and its Software.
6. EE policy in Japan.

<Confirmation of Project Design Matrix (PDM)>

- To confirm the achievement of Overall Goal in PDM, JET stated that the first indicator is the energy self-dependency and confirmed current percentage of the total RE generation as of March 2023 in GWh. MSET indicated that at present it is 12.4%.
- JET also asked for data on the imported amount of fossil fuel in energy base for March 2023 as the indicator. MSET will provide the data by the time of training in Japan in April 2023.
- To confirm the achievement of Project Purpose, JET requested the provision of data about the total capacity MW of distributed PV, utility scale PV and battery as of March 2023. MSET will also provide the data before the training in Japan.
- JET also asked for data on the number of public buildings which were implemented or introduced in EE programs including BEMS introduction as of March 2023. The information was not available at the time but would be provided. With regard to BEMS, JET requested data covering all public buildings from MSET. MSET stated that there are several projects under other institutions that are implementing similar programs and that it would not be possible to provide an answer at the time; however, MSET confirmed that as far as possible, any data available will be provided.
- As for the Achievement for other Project Purpose and Outputs, Mr. Horace Buckley of the MSET reconfirmed the ones which were confirmed in the 1st JCC in 2019 and agreed. Mrs. Olive Wilson Cross of MSET stated that some achievements from the activities done after 2019 should be confirmed later.

<Training in Japan>

- JET gave a brief overview of the training program that will be held in Japan from departure to arrival.
- JET also mentioned the necessities to carry, ideal clothing, the procedure of purchasing a sim card and immigration entry procedures.

List of Attachment:

Attachment – 1: Presentation Material for 3rd JCC

Attachment – 2: Presentation Material for Training in Japan

End of the MoM

Joint Coordinating Committee (JCC) #3 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

March 30, 2023
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

5 min.	Opening Remark from JICA
5 min.	Introduction of Participants
5 min.	Project Outline and Recap of Project
30 min.	Detail of Activities in Phase 2
30 min.	Confirmation of PDM (Project Design Matrix)
10 min.	Discussion
5 min.	Closing Remark from Jamaica Side

Opening Remarks from JICA

Today's Participants

Today's Participants (1/4)

Jamaica
- MSET

JICA
- JICA HQ in Tokyo, Japan
- JICA Jamaica Office

JET
- Japanese Experts
- Local Expert

Today's Participants (2/4)

Jamaica

Organization	Name and Title
MSET	Dr. Olive Wilson Cross, Director Programme Management

Today's Participants (3/4)

JICA

Organization	Name
HQ, Tokyo	Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group, Infrastructure Management Department
Jamaica Office	Mr. Mitsuyoshi KAWASAKI, Resident Representative Mr. Hiroyuki OKAZAKI, Project Formulation Advisor

CARICOM

Organization	Name
HQ	Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

Today's Participants (4/4)

JET

Name	Position
Mr. Tomoyasu FUKUCHI	Team Leader/Power System
Mr. Masaaki EBINA	Sub Team Leader/Power System
Mr. Yasuhiro SAKAMOTO	Energy Efficiency
Ms. Yuka NAKAGAWA	Renewable Energy
Dr. Hisao TAOKA	Electrical Grid Expert
Ms. Anna MIYAURA	Human Resource Development
Mr. Tomoaki TSUJI	Grid Stabilization/Coordinator
Mr. Kevin DOUGLAS	Technical Assistant

Project Outline and Recap of Project

Project Outline

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration

- Originally 3 Years from March 2019 to March 2022.
- >>> Extended until Jun 2023.

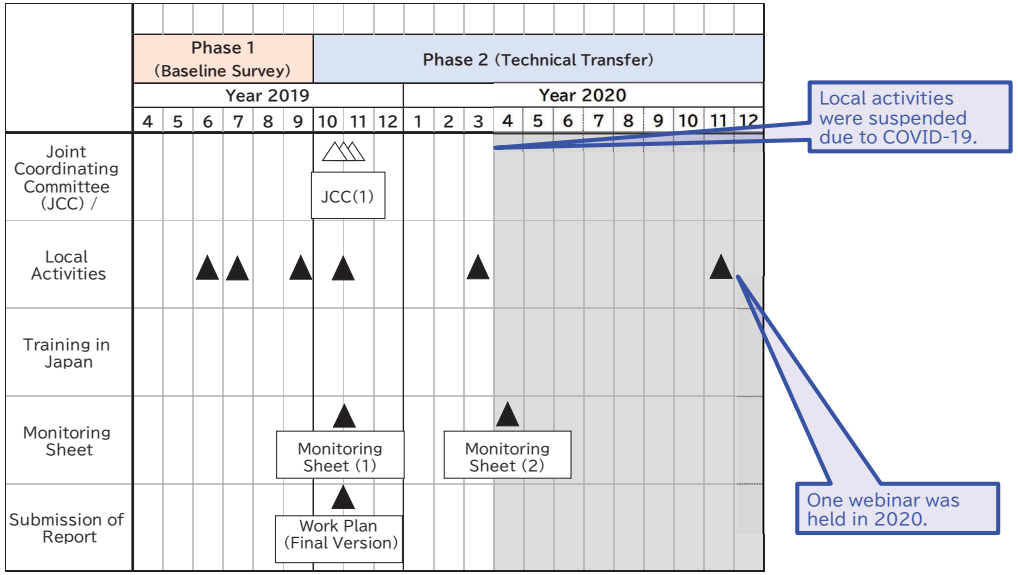
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

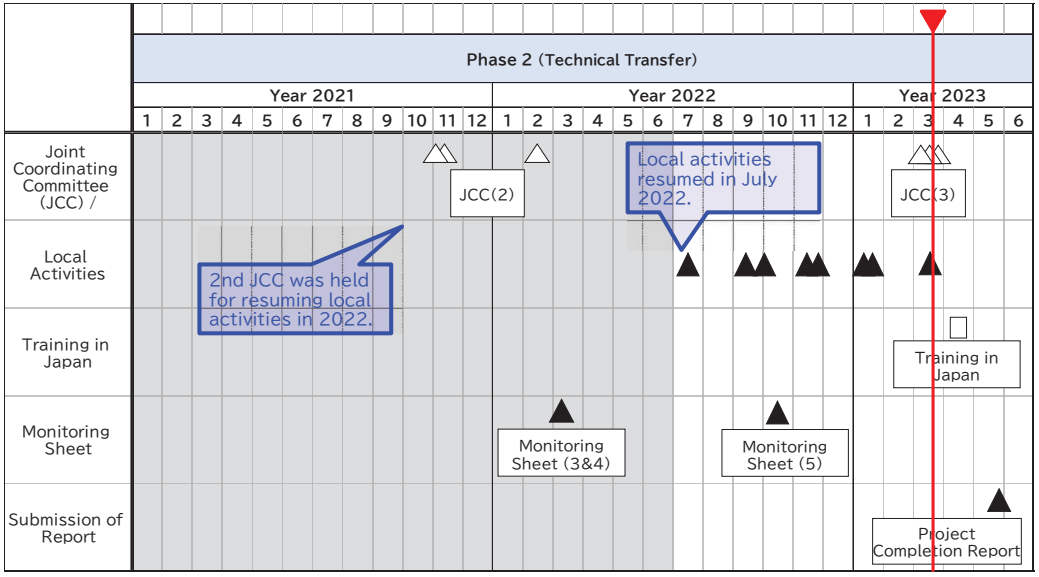
Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE. (Phase 1: from Mar to Sep 2019)
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.
  (Phase 2: from Oct 2019 to Jun 2023)

Recap of Project (1/6)



Recap of Project (2/6)

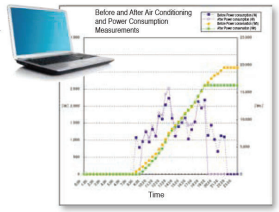


Recap of Project (3/6)

Phase1 Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (data logger, software) are to be provided through this project.



Source: Data logger catalogue of HIOKI E.E. CORPORATION

Recap of Project (4/6)

Phase1 Baseline Survey (RE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

RE Installation (2020):

- 50% RE penetration target by 2030,
- 35% RE in 2030, 40% in 2037 (IRP2020)

→ Target acceleration, 50% RE by 2030

- Current RE: 14% (hydro 28.7MW, VRE 179MW)
- Roof-top 20MW? Need statistics.
- Wind in valley place
- IRP additional 513.5MW by 2025

Grid Stability:

- Capacity 1,071MW, Peak demand 654.5 MW
- Sales 4,227MWh (JPS2020AR)
- 0.31 UScent/kWh, 26.9% loss (JPS2020AR)
- JPS 21.5MW/16.6MWh Li BESS +3MW Flywheels
- Fuel increase for spinning reserve. Feeder cut at 49.5 Hz. "VRE is a Nightmare"

Challenges:

- RE gap of present vs target(15% vs 50%)
- Voltage/frequency fluctuation → Grid stability needed with 50% VRE
- Cost of energy → Rooftop PV increase
- RE project implementation plan
- Wind and PV potential unevenly distributed → Less smoothing

Needs:

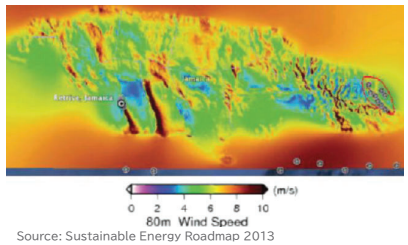
- Capacity building of grid planning Proposal for grid code revision
- Enhancement of resilience → Microgrid concept

Recap of Project (5/6)

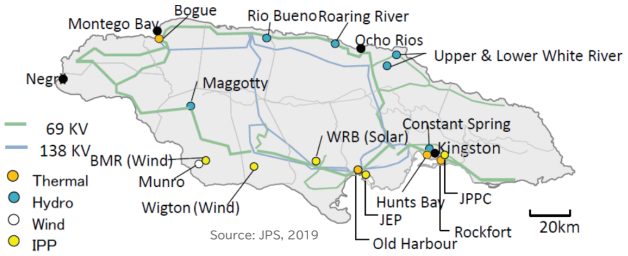
Challenges for RE:

- ✓ Increasing RE capacity >20%, RE generated energy >14%.
- ✓ Future increase of RE with stability
- ✓ System losses 26.3%(2018) →28.3%(2021)
- ✓ Large number of distributed PV → need database management
- ✓ Wind & PV potential unevenly distributed →less smoothing

Wind Potential in Jamaica



Source: Sustainable Energy Roadmap 2013



Source: JPS, 2019

Year	Comsumption (MWh)	Assumed RE (MWh)	Percentage of RE
2020	4,227	564	14%
2030	5,453	1,913	35%
2037	5,939	2,435	41%

Source:
2020: Assumed from table below.
2030/2037: IRP2020 draft

Location/Project	Type	Capacity MW	Generation GWh estimated	Year	Tariff USc/kWh	Investment mil USD	USD/ MW
Wigton I	Wind	20.7	52	2004	10.21	26	1,256
Wigton II	Wind	18	45	2010	10.723	45	2,500
Wigton III	Wind	24	60	2016	13.4	46.5	1,938
Munro	Wind	3	10.5	2010	(JPS)		
BMR Wind	Wind	36.3	120	2016	12.9	90	2,479
Content Solar (WRB)	PV	20	34	2016	18.8	65	3,250
Eight River (EREC)	PV	37	59.2	2019	8.5		
Hydro	Hydro	28.67	152.2				
Independent roof-top	PV	207	30.6		--		
Wigton IV	Wind	34		?			
RE under operation		**207.67**	**564**				

Source: Prepared by JET with several data sources

Recap of Project (6/6)

Phase 2 Technical Transfer

- JET conducted capacity building related to RE and EE based on baseline survey.
- Seminar or Workshop were held online
  - 3 RE and Grid Stability Seminar
  - 2 EE Workshop
- The following equipment was also provided from JET
  - EE: Data Loggers
- The only remaining activity is the training in Japan, April 2023.

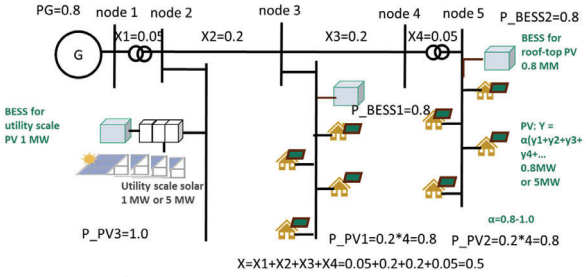
Detail of Activities in Phase 2

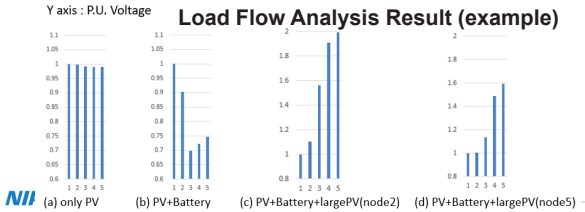
Activity and Achievement (RE)

Basics of Load Flow Analysis with simplified model

Load Flow Analysis with Grid Model for Exercise

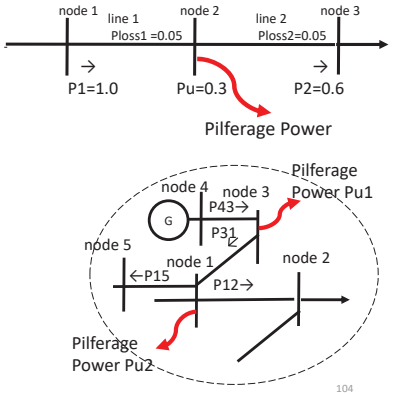
- Case study: 1 or 5 MW PV's, 1 MW BESS, total 0.8 or 5 MW roof-top PV + 0.8 MW BESS per a feeder
- Unbalanced voltage will be problem BESS capacity/ location is suggested from the result.





State Estimation method

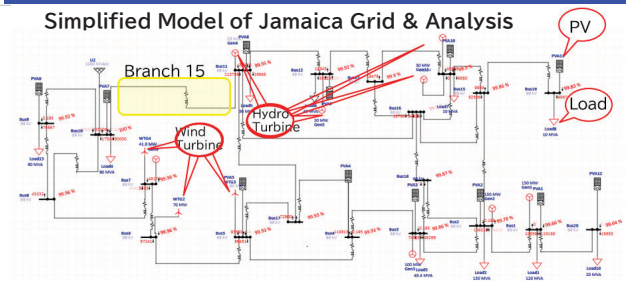
- System loss:
26.5% in 2018 → 28.3% in 2021
- State Estimation in the grid analysis, method to specify the location and amount of stolen electric energy, was introduced in seminars



Activity and Achievement (RE)

Grid Modeling and Analysis with Future Scenario

Simplified Model of Jamaica Grid & Analysis



Category	Capacity factor 2020 Jamaica	Capacity factor IRP2020	Capacity factor IRENA	2021 GWh	GWh target %	2030 GWh	2030 MW	2030 MW %
Fossil Fuel	44%	54%	41%	4,092	50%	2,689	748.6	33%
Total RE				640	50%	2,689	1,537	67%
Hydro	37%	61%	52%	136	10%	538	118.0	5%
Solar	11%	21%	15%	124	30%	1,613	1,227.6	54%
Wind	23%	38%	32%	280	10%	538	191.8	8%
Bioenergy	25%	95%	80%	100	0%	0	0.0	0%
Total				4,732	100%	5,377	2,286	100%

This is the typical case proposed in the 2nd seminar's feedback data.

Load and at generation at nodes

Node ID (Up to 4 characters)	Fossil Fuel (pu)	Hydro (pu)	Bioenergy (pu)	Load (pu)	PV (pu)	Battery (pu)	Wind (pu)	1pu= 100MW
1	1.5			1.2	1.5			
2	1.5			1.3	1.5			
3	1			0.494	1			
4					1			
5	1				1		0.8	
6							0.7	
7		0.3					0.418	
8								
9				0.8	1			
10	2			0.8	1			
11		0.28		0.3	1			
12		0.3		0.3	1			
13								
14	0.486	0.3		0.1	1			
15								
16								
17								
18								
19				0.1	0.276			
20				0.2	1			
(Total pu)	7.486	1.18	0	5.594	12.276	0	1.918	

Simulation scenario case prepared based on seminar feedback for trial

- 69kV as base voltage
- GWh Energy base: 30%PV, 10%Wind, 10% hydro, 50% thermal.

→ Output 54%PV, 8% wind, 5% hydro (capacity factor need to be reviewed)

- Over current at low demand area at Feeder 15 (Rio Bueno)

→ Depends on scenario, it needs to re consider PV location and/or line enhancement

Activity and Achievement (RE)

Microgrid Concept: Hagley Gap

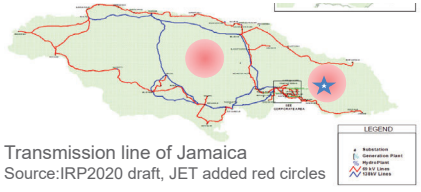
The data used in this plan is based on assumption, and it needs site confirmation and review .

Hagley Gap and Perlyne Castle

Wind Speed of the Area

Selection Criteria:

- Remote, high transmission loss
- Area with voltage drop and fluctuation
- Area with high solar and wind potential



Transmission line of Jamaica

Source:IRP2020 draft, JET added red circles

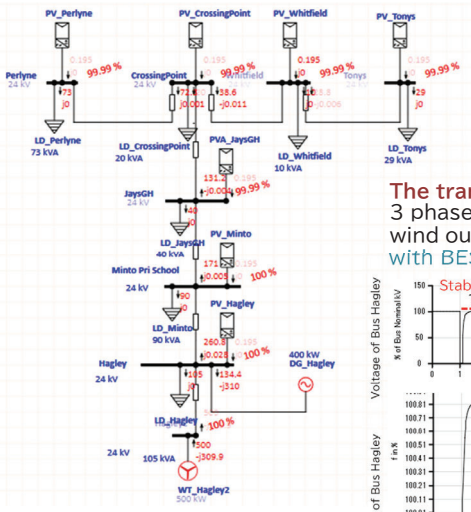
→ Target area: around Hagley Gap in St. Andrew

Total residential consumer	166	hh*1
Max daily energy consumption	7,029	kWh/day*2
Peak load	367.2	kW*2
Hagley Gap mean wind speed	7.6	m/s @10mH*3
Wind rated output	500	kW
Wind average output	301	kW
Hagley Gap solar irradiation	4314	kWh/kWp/day
Total Solar PV output	105	kWp
Diesel Generator	400	kW

*1 This count is not accurate and need to be reviewed.
*2 Assumed from 1.5 kW /hh, 30kW/facility. It needs to be reviewed by accrual data of the area. *3 Wind speed at available road. Better wind speed may be obtained at hilltop, but road construction will be necessary.

Activity and Achievement (RE)

Transient Stability Analysis of Hagley Gap Micro Grid

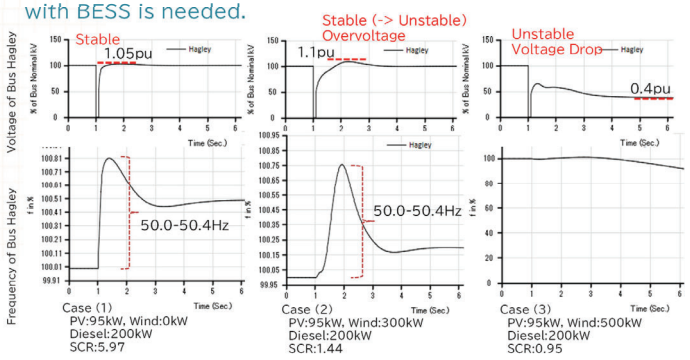


Model of Hagley Gap Microgrid

Source: Prepared by JET with ETAP

Load Flow Analysis:
(a) PV95kW, Wind500kW, Diesel400kW
(b) PV95kW, Wind500kW (c) Wind500kW (d) Wind500kW, Diesel400kW (e)Wind500kW, Diesel100kW
→ Case (a)-(e): Load flow analysis has no problem about voltage and load.

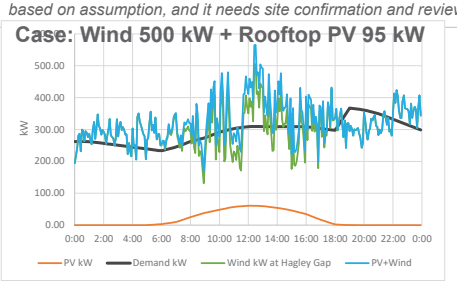
The transient stability analysis : with condition of 100 msec 3 phase grounding fault at Hagley Node→ unstable when wind output is more than 300 kW → Grid forming inverter with BESS is needed.



Activity and Achievement (RE)

Provisional Cost Estimation for Hagley Gap Micro Grid

This is NOT Feasibility Study. The data used in this plan is based on assumption, and it needs site confirmation and review.



- The estimation is just trial, based on assumptions, which need to be reviewed.
- Feasibility is much depending on wind speed.
- Both PV & wind has fluctuation. BESS or DG is necessary to absorb fluctuation and levelized output.
- Initial cost : DG < BESS
- GFM is necessary for stability.
- Cost of DG needs fuel cost. BESS needs consideration of replacement and cycle life.

With BESS, 260 kW-1.05 MWh

Item	Amount	unit	Remark
Unit cost of PV	1000	USD/kW	
Rated Output of PV	95	kW	
Cost of PV installation	94,700	USD	
Unit cost of Wind	2,500	USD/kW	
Rated output of Wind	500	kW	
Cost of Wind	1,250,000	USD	
Unit cost of 24 kV system	400,000	USD/km	
Length of 24 kV	0.3	km	
Cost of 24 kV system	120,000	USD	
Requirement of SCO	149	kVA	25% of PV+Wind output
Unit cost of SCO	200	USD/kVA	
Cost of SCO	29,735	USD	
Unit cost of Diesl Generator	300	USD/kW	
Capacity of Diesel Generator	400	kW	
Cost of Diesel Generator	120,000	USD	
Total Cost	**1,913,918**	**USD**	

With Diesel Generator, without BESS

Item	Amount	unit	Remark
Unit cost of PV	1000	USD/kW	
Rated Output of PV	95	kW	
Cost of PV installation	94,700	USD	
Unit cost of Wind	2,500	USD/kW	
Rated output of Wind	500	kW	
Cost of Wind	1,250,000	USD	
Unit cost of 24 kV system	400,000	USD/km	
Length of 24 kV	0.3	km	
Cost of 24 kV system	120,000	USD	
Requirement of SCO	149	kVA	25% of PV+Wind output
Unit cost of SCO	200	USD/kVA	
Cost of SCO	29,735	USD	
Unit cost of Diesl Generator	300	USD/kW	
Capacity of Diesel Generator	400	kW	
Cost of Diesel Generator	120,000	USD	
Total Cost	**1,614,435**	**USD**	**+ Fuel Cost**

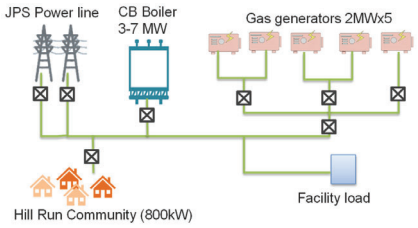
Activity and Achievement (RE)

Sharing of Good Practice of Jamaica in Caribbean Countries

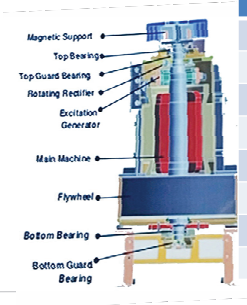
To cope with >140MW VRE for 650 MW peak grid in 2016, JPS took following measurement:

1. Application of 24.5 HESS Demand projection >99% accuracy → base for efficient operation in System Control Center
2. AWS installed for weather projection and output forecast of PV and wind, utilizing satellite image → 90% accuracy. Remaining 10% is covered by spinning reserve.
3. Microgrid with CHP for Caribbean Boiler and Hill Run community (800kW)
4. Establishment of **training school for Caribbean countries**

Microgrid with CHP for Caribbean Boiler



HESS for Stabilization



Item	Flywheel
System integrator	ABB RE+
Manufacturer	Pillar Germany
Capacity	3MW, 16.5 MWs
Speed	1800-3600 rpm
Bearing life	8yrs
Response speed	100 ms
Efficiency	>96%
BESS	LG Chem, 21 MWh

Activity and Achievement (RE)

Seminars on Large RE and Grid Stability

JCC: Joint Coordinating Committee

Team	Country	Oct (2022)	Nov (2022)	Dec (2022)	Jan (2023)	Feb (2023)	Mar (2023)	Apr (2023)
RE&Grid	Barbados						JCC	Program in Japan
	St.Kits&Nevis (at Barbados)		1st Seminar	2nd seminar		3rd Seminar		
	Jamaica							

Title	Date	Objective	Contents
1st Seminar	12 Oct 2022	To share basic technical knowledge for grid analysis with large RE	Overview of Power system, per unit method, modeling, asset management, load flow analysis, introduction of method, software and tools
2nd Seminar	30 Nov 2022	To conduct and exercise grid modeling and analysis	Grid modeling, Microgrid, example, Load flow analysis and stability analysis, evaluation
3rd Seminar	8 Feb 2023	Review and exercise of grid analysis with scenario cases	Detailed system and countermeasures, protection, Exercise of tools for grid analysis with various RE scenarios
Final JCC	Mar 2023	To confirm outcome of project and way	Review of TC activity output, policy recommendation, Program in Japan

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (1)

Seminar	Agenda of 1st Seminar	Participants
1st Seminar 12 Oct 2022	**Overview if challenges of large RE and Grid analysis** 1. Activity and overall project schedule 2. RE target, challenges, and activity of Technical Assistance 3. Grid with large RE penetration& Microgrid Concept for resilience 4. Proposed Contents for Workshop No.1 and No.2 5. Suggestion for countermeasure to non-technical loss	32 nos in total (MSET: 3, OUR 4, JPS and other: 25)
2nd Seminar 30 Nov 2022	**Grid Stability, Grid Analysis, and Microgrid** 1. Project Outline, RE and Microgrid Concept 2. Review and Feedback of 1st seminar 3. Why Grid Stability is necessary - Grid Modelling for Jamaica - Basics of Power System Engineering for Grid Stability Simulation 4. Load Flow Analysis and its Evaluation 5. Transient Stability Analysis and Evaluation of Stability 6. State Estimation for Multi-point Pilferage 7. Discussion for future grid and RE in Jamaica	45 nos in total (MSET:6, OUR:2, JPS and other: 57)

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (2)

Seminar	Agenda of 1st Seminar	Participants
3rd Seminar 8 Feb 2023	1. Opening Remark 2. Project outline, Review and Feedback of 2nd Seminar 3. Grid Scenario proposed and stability analysis 4. Development Status of Grid Forming Inverter and its Safety : Current Status, Blackout with GFM & Black Start using BESS 5. Transmission lines and Remedial Action Schemes : Special Protection System, PV/Wind Turbine Trip 6. Microgrid planning 7. Technology options 8. Policy recommendation 9. Discussion, sharing good practice of Jamaica, and way forward	29 nos in total (MSET:6, OUR:3, JPS and other: 20)

Activity and Achievement (RE)

Recommendations for Grid with Large RE

Need of Spinning Reserve:
- stand-by thermal generation source should be kept to absorb output fluctuation of VRE

Reactive Power Compensation:
- Reactive power is necessary to establish and maintain the electromagnetic field in the grid and keep voltage. VRE can lead to voltage fluctuations and instability. Reactive power compensation should be installed.

Provision of Sufficient Synchronous generator and Inertia in grid:
- In case VRE generates more than 1/3 of the grid capacity, insufficient synchronous generator and inertia will be a problem.

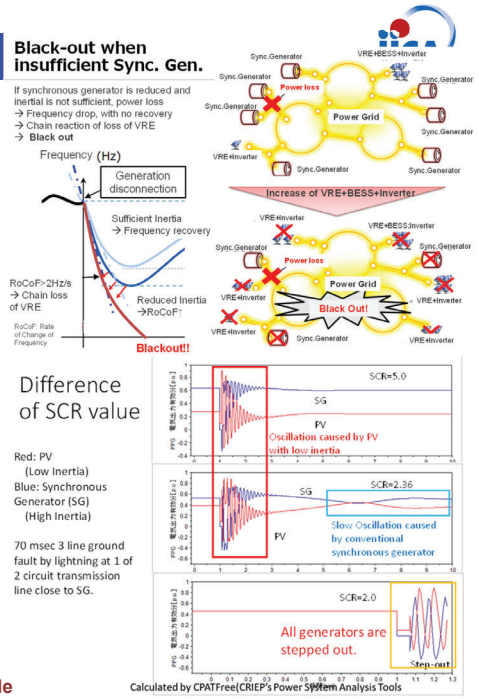
SCR (short circuit ratio):
- SCR = AC in grid / IBR power. Keep SCR>3.0

IEEE Std 1204-1997(R2003) IBR: Inverter based resource (PV & wind)

BESS: VRE more than 1 MW should mandate to install BESS, more than 80% of VRE, 4hrs

Application of Grid Forming Inverter (GFM):
- To keep SCR >3.0 with VRE, apply GFM with BESS and PV and wind as soon as it can be procured in the market

→ **Discussion with Fair Trade Commission (FTC) will be important**



Activity and Achievement (RE)

Recommendation for Future RE and Grid for 50%RE by 2030

Item	Description
Energy Storage for smoothing &peak shift	- Mandatory installation of BESS, for example, more than 80% of Peak MW and 4hrs storage for utility scale VRE
Investment to secure inertia and spinning reserve for grid	- Maintaining sufficient synchronous generator for spinning reserve - Introduction of Grid Forming Inverter (GFM) for VRE once available, application of Weather projection system
Investment for voltage and reactive power compensation	- Capacitor bank/ STATCOM / Synchronous condenser where needed. - Mandatory application of inverter with reactive power compensation for Wind/Solar IPP
Sharing responsibility of grid stability among utility, IPP, consumers	- **Utility**: maintaining transmission and distribution line frequency and voltage stability, ancillary service, -**VRE IPP**: installation of inverter with reactive power compensation & energy storage - **Consumer**: demand response, ToU setting& EV charging, peak shift
Option for storage (especially with inertia)	- In addition to BESS, options for future ex. consideration of V2G, hydrogen, pumped storage, Compressed Air Energy Storage (CAES) and Gravity Storage to be considered
Microgrid	- To promote microgrid to strengthen resiliency
Data management	- GIS for distributed PV, Database management, Asset management
Recycle/disposal	- Consideration for disposal/recycling of battery &PV panel
Finance	- Use of climate finance, international finance cooperation for RE&stability
"Best-Mix" Energy	- Gas for fluctuation mitigation as intermittent measurement. - Multiple alternative for RE and storage, not a single source (Solar/CSP/Wind/Biomass, BESS/Thermal/new storage, etc.)

Activity and Achievement (EE): #1 Workshop

Year 2022

1. Dates and venue

Feb.9-10 (2days), Zoom

2. Participants

Participated relevant entities(Jamaica)		
Name of entity		# of participants (3 persons in total)
MSET	Ministry of Science, Energy and Technology	1 persons
OUR	Office of Utilities Regulation	2 persons

Activity and Achievement (EE): #1 Workshop

3. Workshop program

Day-1 Feb. 9 (Thu)

Time	Contents	Speaker	Session Time (min.)
9:00	<Presentation> Energy Management & Energy Audit (International Standers and introduction of successful practices)	JET	90
10:30	<Presentation> Battery VS Hydrogen Storage	JET	30

Day-2 Feb. 10 (Fri)

Time	Contents	Speaker	Session Time (min.)
9:00	<Presentation> Report on Energy Audits Results	JET	60
10:00	<Presentation> Market Study of EV	JET	60

Activity and Achievement (EE): #2 Workshop

1. Dates and venue

Mar.28, ZOOM

2. Participants

Participated relevant entities(Jamaica)		
Name of entity		# of participants (8 persons in total)
MSET	Ministry of Science, Energy and Technology	5 persons
BSJ	Bureau of Standards, Jamaica Technology	3 persons

Activity and Achievement (EE): #2 Workshop

3. Workshop program

Time	Contents	Speaker	Session Time (min.)
10:00	<Presentation> Organizational Management and Q&A	JET	50
10:50	Break Time	-	10
11:00	<Presentation> Energy balance, energy efficiency and conservation roadmap	JET	30
11:30	<Presentation> Energy Efficiency Policy in Japan	JET	20
11:50	Q&A	-	10
12:00	Lunch Time	-	60
13:00	<Presentation> Part-1 Energy Efficiency Building Code (Including Okinawa Situation and EE&C Evaluation Study)	JET	50
13:50	Break Time	-	10
14:00	<Presentation> Part- Energy Efficiency Building Code (Including Okinawa Situation and EE&C Evaluation Study)	JET	50
14:50	Q&A	-	10
15:00	Closing	-	-

Activity and Achievement (EE): Workshop Summary

1. Summary of Workshops Contents

	Contents of Workshops	WS, etc.
I	Energy Management & Energy Audit (International Standards and introduction of successful practices)	#1WS
II-a	EE Roadmap with Country Energy Balance and efficient technologies (residential sector)	#2WS
II-b	EE&C Roadmap with Country Energy Balance and efficient technologies (Res & Com sector integration)	#2WS
III-a	Introduction of EE Building Code in Japan	#2WS
III-b	EE Building Code (Including Okinawa & Hawaii Situation and EE&C Evaluation Study)	#2WS
IV	Report on Energy Audits Results including Walk Through Survey	#1WS
V-a	Demonstration: Data Logger & Software	To BNSI: Pre-Conducted
V-b	Demonstration: Software	To MSET: #1WS
V-c	Demonstration: Data logger	To MSET: #2WS
VI	EE policy in Japan	#2WS

Activity and Achievement (EE): Workshop Summary

2. Feedback from Participants of #1 EE Workshop

On a 5-point scale, participants were asked to rate the content of the workshop.

✓ Was JICA experts' explanation clear and easy to understand?	5
✓ Were training materials well organized and easy to understand?	5
✓ Was the content of lecture enough to understand?	4
✓ Were JICA experts maximize participants' opportunities?	4

Activity and Achievement (EE): Workshop Summary

2. Feedback from Participants of #2 EE Workshop

On a 5-point scale, participants were asked to rate the content of the workshop.

✓ Was JICA experts' explanation clear and easy to understand?	3.5
✓ Were training materials well organized and easy to understand?	3.5
✓ Was the content of lecture enough to understand?	3.5
✓ Were JICA experts maximize participants' opportunities?	5

Activity and Achievement (EE): Data Loggers

- **Demonstration was conducted and data loggers were handed over to Jamaica**
  - MSET: 1 data logger (This mission)
  - BSJ: 1 data logger (Mission in last November)

Demonstration using a kettle @ BSJ

Demonstration using a fan @ MSET

Confirmation of PDM (Project Design Matrix)

Overall Goals & Achievement

Description	Verifiable Indicator	Achievement
Overall Goal Energy security is ensured through introduction of renewable energy	1. Energy self-dependency Target Value: **50%** **(50% RE by 2030)** 2. Imported amount of fossil fuel Target Value: **To 80%** **(20% by RE in energy base)**	1. As of March 2023, RE generation accounts for 12.4% of total generation. 2. As of March 2023, imported amount of fossil fuel is ??% in energy base. (MSET will inform to JET)

Project Purpose & Achievement (1)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant Target Value: **To be set according to IRP**	1. As of Mar 2023, Utility Scale PV Total ?? MW, Distributed PV Total ?? MW, (If possible) Wind Total ??MW, Battery Total ??MW etc. (MSET will inform to JET)

Project Purpose & Achievement (2)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	2. Number of public buildings with EE program including BEMS Target Value: **EE program in total for 44 facilities in next 4 years)**	2. As of Mar 2023, number of public buildings which are implemented or introduced EE program is ??. (MSET will inform to JET)

Project Purpose & Achievement (3)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**3.** Number of trained staffs for introduction of RE Target Value: - **Domestic trainings: 20-30 personnel** - **Training in Japan: 1-4 personnel**	**3.** In total, number of participants (accumulated total) was 115 personnel **Average (Domestic):** 115/3 = 38.9 personnel/time - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was 39 personnel 1 officer engaged in RE will participate in the training in Japan.

Project Purpose & Achievement (4)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**4.** Number of trained staffs for promotion of EE Target Value: - **Domestic trainings: 20-30 personnel** - **Training in Japan: 1-4 personnel**	**4.** In total, number of participants (accumulated total) was 19 personnel **Average:** 19/3 = 6.3 personnel/time - Demonstration on EE roadmap program etc. in Feb 2020 was 8 personnel - 1st Workshop in Feb 2023 was 3 personnel - Final (2nd) Workshop in Mar 2023 was 8 Personnel 1 officer engaged in EE will participate in the training in Japan.

Output 1 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	**1-1.** Assessment of number and qualification of staffs responsible for RE **1-2.** Human resource development plan for the introduction of RE **1-3.** Number of training courses for the introduction of RE **1-4.** Total capacity of RE	**1-1.** Confirmed **1-2.** Confirmed **1-3.** Confirmed **1-4.** Confirmed *** Achievement of Output 1 was already confirmed when 1st JCC which was held in Nov 2019**

Output 2 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	**2-1.** Assessment of number and qualification of staffs responsible for EE **2-2.** Human resource development plan for the introduction of EE **2-3.** Number of training courses for the promotion of EE **2-4.** Number of facilities conducted energy audit	**2-1.** Confirmed **2-2.** Confirmed **2-3.** Confirmed **2-4.** Confirmed *** Achievement of Output 2 was already confirmed when 1st JCC which was held in Nov 2019**

Output 3 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-1.** Number of trained staffs Target Value: **MSET/PCJ: 6 personnel** **3-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**3-1.** In total, number of participants (accumulated total) was **115 personnel** **Average: 38.9 personnel/time** **3-2.** In total, **3 (4) materials** were prepared. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Nov 2022 and Feb 2023. - 1 training material for training in Japan (Available next month)

Output 3 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-3.** Number of participants of workshops to disseminate introduction of RE to the relevant organizations Target Value: - **Kick-off workshop: 15 personnel** - **Final workshop: 20 - 30 personnel**	**3-3.** - Kick-off workshop in Nov 2019 was **8 personnel** - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was **39 personnel**

Output 3 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**3-4.** In total, **4 times** - Kick-off workshop was conducted in Nov 2019 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Nov 2022 - Final (3rd) Seminar was conducted in Feb 2023

Output 4 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-1.** Number of trained staffs Target Value: **MSET/PCJ: 4 personnel** **4-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**4-1.** In total, number of participants (accumulated total) was **19 personnel** **Average: 6.3 personnel/time** **4-2.** In total, **2 (3) materials** were prepared. - 2 training materials about 'Energy Efficiency Workshop' for domestic training in Feb and Mar 2023. - 1 training material for training in Japan in Apr 2023. (Available next month)

Output 4 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-3.** Number of participants of workshops to disseminate promotion of EE to the relevant organizations Target Value: - **Kick-off workshop: 15 personnel** - **Final workshop: 20 -30 personnel**	**4-3.** - Kick-off workshop in Nov 2019 was 8 personnel - 1st Workshop in Feb 2023 was 3 personnel - Final (2nd) Workshop in Mar 2023 was 8 personnel

Output 4 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**4-4.** In total, 3 times - Kick-off workshop was conducted in Nov 2019 - 1st workshop was conducted in Feb 2023 - Final (2nd) workshop was conducted in mar 2023

Output 5 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-1.** Number of trained staffs Target Value: **MSET/PCJ: 6 personnel** **5-2.** Textbooks/ manuals Target Value: **2 programs** (1 domestic trainings and 1 training in Japan)	**5-1.** In total, number of participants (accumulated total) was 115 personnel **Average: 38.9 personnel/time** **5-2.** In total, 3 (4) materials were prepared. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan (Available next month)

Output 5 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-3.** Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations Target Value: - **Kick-off workshop: 15 personnel** - **Final workshop: 20 - 30 personnel**	**5-3.** - Kick-off workshop in Nov 2019 was 8 personnel - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was 39 personnel

Output 5 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**5-4.** In total, 4 times - Kick-off workshop was conducted in Nov 2019 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Nov 2022 - Final (3rd) Seminar was conducted in Feb 2023

Discussion

Closing Remarks

Thank you.

Minutes of Meeting
of
Joint Coordination Committee #3
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MEB, JICA, and JICA Expert Team

March 27, 2023

Ministry of Energy and Business (MEB)

Ms. Debra Dowridge, Deputy Permanent Secretary

Japan International Cooperation Agency, St. Lucia Office

Japan International Cooperation Agency, St. Lucia Office

JICA Expert Team (JET)

Mr. Tomoyasu FUKUCHI, Team Leader

Date and Time:

March 27, 2023, 10:00am (in Barbados), 11:00pm (in Japan)

Location:

Hybrid: Face to Face and Online (Virtual Meeting by Zoom)

Participants:

1) Ministry of Energy and Business (MEB)

- Ms. Debra Dowridge, Deputy Permanent Secretary
- Mrs. Frances Scantlebury, Administrative Officer
- Mr. William Hinds, Chief Energy Conservation Officer
- Mr. Horace Archer, Senior Technical Officer
- Mr. Frank Branch, Technical Officer
- Mr. Terry Neblett, Licensing Officer

2) Japan International Cooperation Agency (JICA), Tokyo

- Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group

3) Japan International Cooperation Agency (JICA), St. Lucia Office

- Mr. Ichiro MIMURA, Chief Representative
- Ms. Hitomi URUSHIHATA, Programme Formulation Advisor
- Dr. Ayodele Hippolyte, Project Officer

4) Caribbean Community (CARICOM), Guyana

- Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

5) JICA Expert Team (JET)

- Mr. Tomoyasu FUKUCHI, Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Dr. Hisao TAOKA, Electrical Grid Expert
- Ms. Anna MIYAURA, Human Resource Development
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Mr. Alex Harewood, Technical Assistant

Discussions:

<Looking Back at the Overall Project>

- JICA Expert Team (JET) explained the project was originally from March 2019 to March 2022, however, due to the COVID-19 pandemic, it was extended to June 2023.
- Activities of Phase 1 for Renewable Energy (RE)
  - Baseline survey was conducted, and JET summarized RE potential in Barbados, existing/planned RE projects, and challenges for achieving 100% RE including grid stability resilience.
  - Accordingly, JET modified the capacity building program to be conducted in Phase 2 to include training for grid stability analysis and microgrid concept.
- Activities of Phase 1 for EE
  - Baseline survey was conducted.
  - JET also recapped Energy Efficiency (EE) background and potential for Barbados as the reduction of energy consumption is fundamental to achieve the 100% RE by 2030.
  - JET revealed with their analysis that approximately half of primary energy is used by residential and commercial sector; and the bulk of EE measures should target these areas in Barbados. The energy saving potential utilizing the proposed JET EE Roadmap with increasing MEPS is estimated to be over 50% by 2036.

<Achievement of Phase 2 "Technical Transfer">

- The activities of JET in the Caribbean region were resumed in July 2022 for Phase 2.
- The capacity building activities were conducted through seminars and workshops based on the baseline survey in the areas of RE and EE.
- JET expressed appreciation for the continuous attendance from MEB and other organizations. Four seminars on Large RE and Grid Stability and two workshops on EE were conducted by a combination of face to face and online methods from Oct 2022 to Jan 2023.
- JET reported about the equipment provision that (i) the power flow analysis software "Microgrid Designer" were handed over to Barbados, and (ii) the power

consumption data collection device (logger, software) was handed over to MEB and BNSI.

- Activities of Phase 2 for RE:
  - JET explained the hybrid seminar series in four sessions where the key focus was on Grid Stability and how this is affected by large amounts of RE on the grid as this is of high importance for the government, the BLPC, and other key stakeholders.
  - JET explained the training sessions were well attended, and the information shared will assist the policy makers and engineers as they seek to achieve 100% RE. JET indicated that the need for spinning reserve, reactive power compensation, and inertia are crucial to ensure grid stability with large penetration of RE in the grid.
  - JET made some recommendations for grid stability and revision of grid code:
    1. Spinning reserve to compensate variable RE (VRE) fluctuation should be kept.
    2. Reactive power compensation should be provided.
    3. For grid stability, the Short Circuit Ratio (SCR) (= AC power in grid / Power from inverter based resource (PV and wind)) should be kept more than 3.0
    4. In case SCR will be less than 3.0, Grid Forming Inverter (GFM) should be applied, once GFM is available in the market.
    5. If the VRE will be installed more than 1 MW, a BESS with minimum 80% capacity and 4hrs duration should be installed.
  - JET summarized recommendations for future RE and grid plans for Barbados.
  - For the enhancement of resilience, JET recommended microgrid application, and reported on case study of Microgrid at Coverley with 100% RE including EV demand. The proposed system includes 3 MW rooftop PV, 7 MW utility scale PV, and 16 MW wind in Long Bey with 33 MWh BESS for135 MWh/day demand, and recommended to apply GFM for stable supply by RE.
- Activities of Phase 2 for EE
  - JET demonstrated data logger and software use to BNSI before handing over.
  - JET demonstrated the data logger and set up the refrigerator to collect power consumption data at the MEB following the request of MEB after handing over.

- JET explained the workshops that were conducted, and stakeholders were receptive to the knowledge shared. The participants voiced the need for a battery standard for safety and performance, along with EE standards for housing in Barbados for cooling.
- Major contents presented from JET are as follows.
    1. Energy Management & Energy Audit (International Standards and introduction of successful practices).
    2. EE&C Roadmap with Country Energy Balance and efficient technologies (residential & commercial sector integration).
    3. EE Building Code including Okinawa & Hawaii Situation and EE&C Evaluation Study.
    4. Report on Energy Audits Results including Walk Through Survey.
    5. Demonstration: Data Logger and its Software.
    6. EE policy in Japan.

<Confirmation of Project Design Matrix (PDM)>

- JET explained the goals of the projects and discussed the achievements in terms of the number of personnel trained in RE and EE, the number of training sessions and the number of training manuals.
- For achievement items of Overall Goal (energy self-dependency and imported amount of fossil fuel), MEB indicated that they will provide the updated data in early April 2023 and will discuss during training in Japan.
- As for the achievement of Project Objective, for RE, JET requested MEB to review the existing project list presented in JCC. MEB will provide the result in early April 2023. For EE, MEB indicated that there are two public buildings with EE program including BEMS (one is National Insurance and the other is regional university (UWI)).
- MEB was in agreement with the result of activities by JET, except the part of under confirmation above.

<Training in Japan>

- JET presented the content of the training experience in Japan, including what to wear, the places that will be visited and any pertinent information key to the visit. MEB asked about sim cards and JET stated that additional information, including any other questions, can be sent forward by 06 April for clarification.

- Participants were also informed about the immigration entry procedures for entering Japan.

List of Attachment:

Attachment-1 Presentation Material for 3rd JCC

Attachment-2 Presentation Material for Training in Japan

End of the MoM

Joint Coordinating Committee (JCC) #3 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

March 27, 2023
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

5 min.	Opening Remark from JICA
5 min.	Introduction of Participants
5 min.	Project Outline and Recap of Project
30 min.	Detail of Activities (Phase 2)
30 min.	Confirmation of PDM
10 min.	Discussion
5 min.	Closing Remark from Barbados Side

Opening Remarks

Today's Participants

Today's Participants (1/4)

Barbados
- MEB

JICA
- JICA HQ
- JICA Office (JICA St. Lucia Office)

JET
- Japanese Experts
- Local Expert

Today's Participants (2/4)

Barbados

Organization	Name and Title
MEB	◆ **Administration** - Mr. Andrew Gittens, Permanent Secretary - Mrs. Debra Dowridge, Deputy Permanent - Mrs. Frances Scantlebury, Administrative Officer I ◆ **Energy Conservation and Renewable Energy Unit** - Mr. William Hinds, Chief Energy Conservation Officer - Horace Archer, Senior Technical Officer - Frank Branch, Technical Officer - Terry Neblett, Licensing Officer

Today's Participants (3/4)

JICA

Organization	Name
HQ, Tokyo	Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group, Infrastructure Management Department
Saint Lucia Office	Mr. Ichiro MIMURA, Chief Representative Ms. Hitomi URUSHIHATA, Programme Formulation Advisor Dr. Ayodele HIPPOLYTE, Project Officer

CARICOM

Organization	Name
HQ	Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

Today's Participants (4/4)

JET

Name	Position
Mr. Tomoyasu FUKUCHI	Team Leader/Power System
Mr. Masaaki EBINA	Sub Team Leader/Power System
Mr. Yasuhiro SAKAMOTO	Energy Efficiency
Ms. Yuka NAKAGAWA	Renewable Energy
Dr. Hisao TAOKA	Electrical Grid Expert
Ms. Anna MIYAURA	Human Resource Development
Mr. Tomoaki TSUJI	Grid Stabilization/Coordinator
Mr. Alex HAREWOOD	Technical Assistant

Project Outline and Recap of Project

Project Outline

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration

- Originally 3 Years from March 2019 to March 2022.
- >>> Extended until Jun 2023.

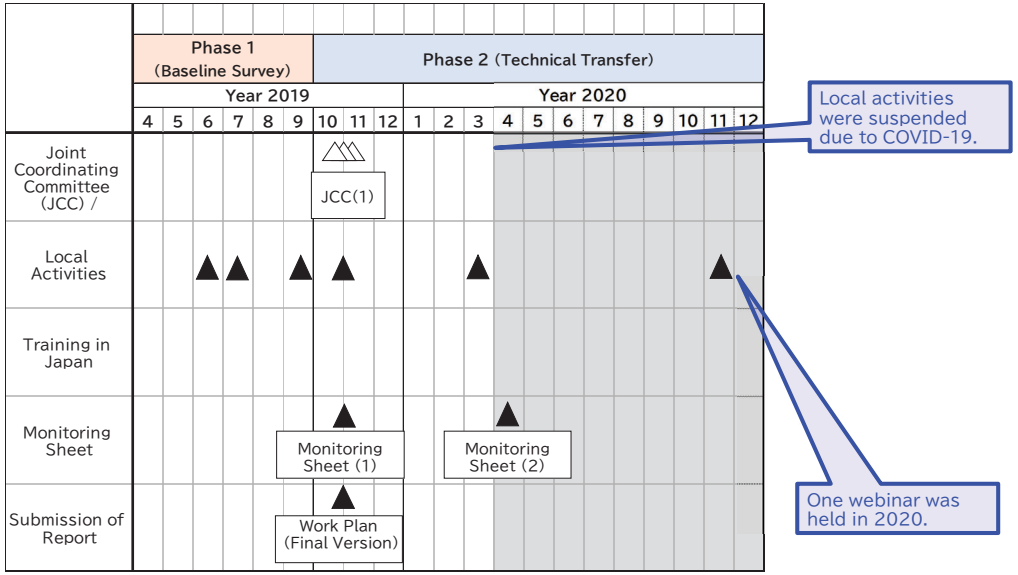
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

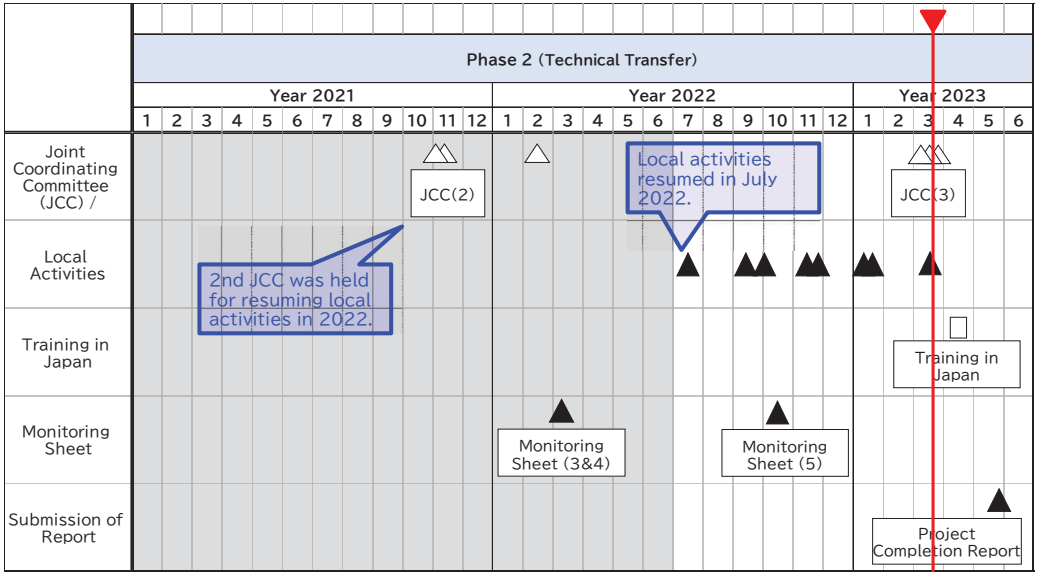
Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE. (Phase 1: from Mar to Sep 2019)
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.
  (Phase 2: from Oct 2019 to Jun 2023)

Recap of Project (1/5)



Recap of Project (2/5)



Recap of Project (3/5)

Phase1 Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In EE, in addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (logger, software) are to be provided through this project.

Recap of Project (4/5)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

Baseline Survey and Challenges

Fields	Baseline Findings
RE	• 100% RE target incl. fuel by 2030 • 14% RE (generation), 2% of RE (energy) in 2018 • Good RE potential, but project plan not concrete • 10MW Trents PV + Rooftop PV 12 MW (2018) →>70 MW (Jan 2023)
Grid Stability	• Annual Peak Demand: about 150MW • 5MW, 20 MWh BESS • PV curtailment required • VRE Fluctuation → stability issue • Fuel increase for spinning reserve

Barbados National Energy Policy (BNEP) 2019-2030

- 52% RE by 2030
- 100% RE by 2030 (energy base)
- 10 Visionary goals: Diversity, Efficiency, Affordability, Reliability, Capacity&Collabolation, Entrepreneurship, Environment, Regulation, Innovation, Economic enfranchisement

Importance on Resilience, Integrated Resource and Resilience Plan (IRRP)

RE and Grid Stability activity is to:
- propose the way to enhance resiliency → Microgrid
- introduce micro-grid concept in one of the agreed areas and develop modelling
- introduce computer modelling for grid analysis and examine issues associated with a large penetration of VRE
- consider and propose the technologies for achieving the RE goals, including grid stabilization,
- consider and propose additional policy and legal system for achieving RE goals
- Prepare training (seminar) plan
- provide recommendations on design of the policy/ legal system

Recap of Project (5/5)

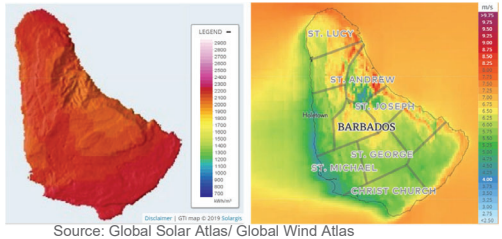
Phase 2 Technical Transfer

- JET conducted capacity building related to RE and EE based on baseline survey.
- Seminar or Workshop were held online or face to face in Barbados
  - 4 RE Seminars on Large RE and Grid Stability
  - 2 EE Workshops
- The following equipment was also provided from JET
  - RE: Grid Analysis Software
  - EE: Data Loggers
- The only remaining activity is the training in Japan, April 2023.

Detail of Activities (Phase 2)

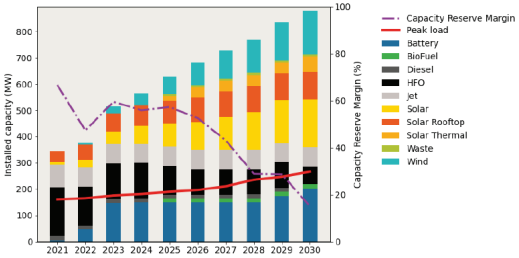
Activity and Achievement (RE)

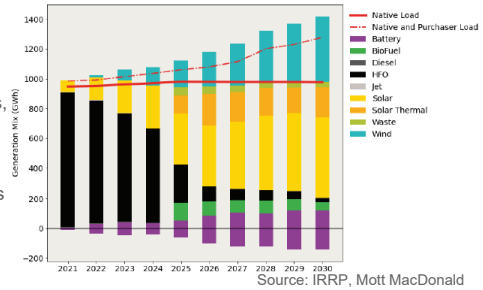
RE Potential and Plan



Source: Global Solar Atlas/ Global Wind Atlas

Solar and Wind Potential in Barbados





Source: IRRP, Mott MacDonald

Capacity and Generated Energy in IRRP Scenario-3

Barbados has overall high solar and local wind potential

- High Solar potential :2,000-2,200 kWh/m2 (5.5-6.2 kWh/m2/day)
- Rapid increase of distributed PV
- Wind potential is relatively high in the eastern part , 6-8 m/s, due to winds from the east of the Atlantic Ocean
- Wind potential of 472 MW, estimated by UWI

IRRP Scenario-3 plans to install:

- PV: 100.13 MW distributed, 176.75 MW IPP, 9.4 MW Trents
- Biomass: 23 MW + 34 MW MSD (biofuel?)
- Wind166.35 MW, CSP: 60 MW
- BESS: 203.37MW

→ Detailed location of VRE is not clear. Grid capacity and stability according to VRE location needs to be assessed.

Activity and Achievement (RE)

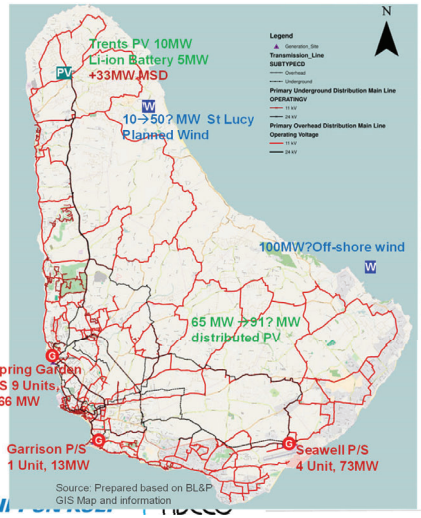
VRE Mapping and Grid Modeling

Challenges:

- Grid capacity enough for Feeder Wise PV / Wind location ?
- Necessary measurement for Grid stability with VRE fluctuation?

→ GIS Mapping of planned PV location and feeder arrangement was done

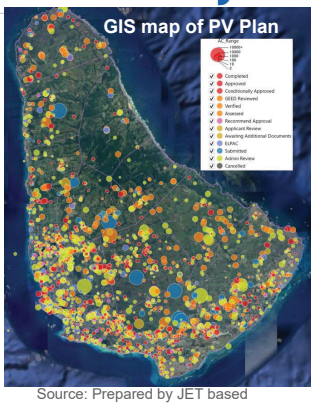
→ Modeling and grid analysis was conducted.



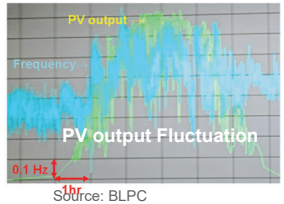
Grid and Generation of Barbados

	Location	MW/u	Qy	MW	Remark
	Existing				
Total thermal power				225	
	Spring Garden Total		9	166	LDS, ST, GT
	Garrison	13	1	13	Gas Tubine
	Seawell	13	1	13	Gas Tubine
	Seawell	20	0	0	GT (Retire)
	Trents	8.3	4	33	MSD Engine
Total PV				75.6	
	Trents	10	1	10	PV
	Distributed PV		LS	65.6	PV
Total Wind				1	
	Ashford	1	LS	1	Wind
Total Battery				5	
	Trents	1	LS	5	BESS
	Planned				
Total Planned RE				248.5	
	St Lucy	50	1	50	Wind Planned
	Northeast	100	1	100	Off-shore wind
	St Tomas	30	1	30	Vaucluse Biomass
	PV	13	1	13	PV 52 MW+hydrogen
	Distributed PV		LS	25.5	Licensed yet installed
	PV IPP's		LS	30	IPP's by 2025

Source: Based on information from MEB and BLPC, as of Jan 2023



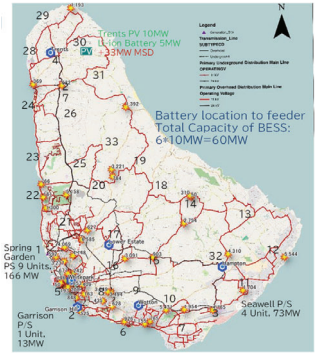
Source: Prepared by JET based on MEB database



Source: BLPC

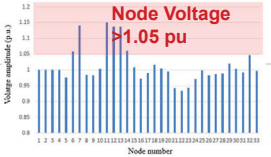
Activity and Achievement (RE)

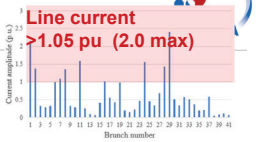
Grid Model and Analysis



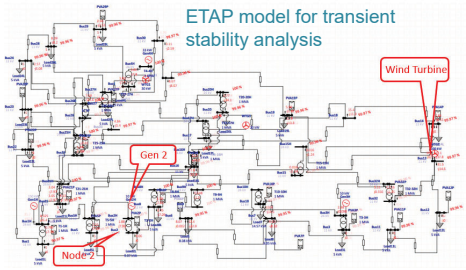
(1) Power flow analysis (Load flow analysis) result with discharge of BESS Discharge (10MW x 6 nos BESS + 143.37MW BESS at new PV/Wind site)

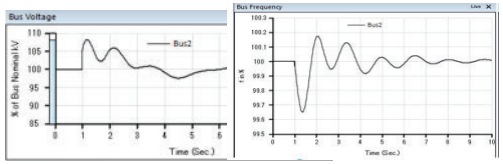
(2) Transient stability analysis with a case 100 MW wind trips





→ Need to enhance grid by such as larger conductor material constructing 2 circuits, voltage upgrade,





→No problem found in transient stability analysis

- Capacity in 2030 from IRRP Report

Power Resources	Capacity [MW]	Node
– Thermal Generator	102.7*	1,2,3,4
– WH	3.7*	2
– Distributed Solar	100.13	1~33
– Utility Scale Solar	186.16	3,7,11
– Biomass and WtE	57.04*	25
– Onshore Wind	166.35	29
– Solar CSP	60.00*	11
– Battery	203.37	2, 4, 5, 9, 17, 32 +others
• Total	879.45	

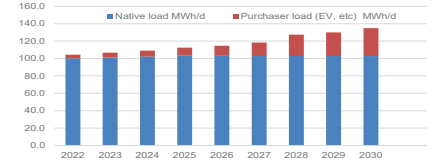
Source: Prepared by JET

Activity and Achievement (RE)

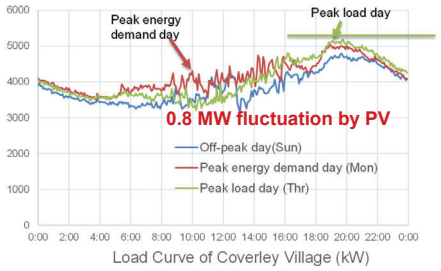
Microgrid Study in Coverley Village

Coverley Village Microgrid Plan with:

- 99MWh→135 MWh/d demand with EV in 2030
- 3 kW rooftop PV/hh
- 5-7 MW additional utility PV BESS and EMS
- 8-16 MW wind at Long Bey



Demand Increase of Coverley Village



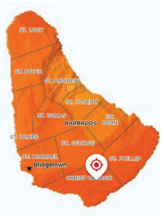
Load Curve of Coverley Village (kW)

Source: Prepared by JET using Google Earth

Location of Coverley Village

Example of system

Nos of houses	1026	nos
Roof area for PV	30	m2/house
Commercial/official roof	300	m2 (6 facilities)
Total rool area	31080	m2
Rooftop PV Capacity	3108	kWp
Specific PV Generation	4.917	kWh/kW/day
PV Generation by Rooftop	15,282	kWh/day
Current peak demand	5191	kW
Current energy demand	99,637	kWh/day

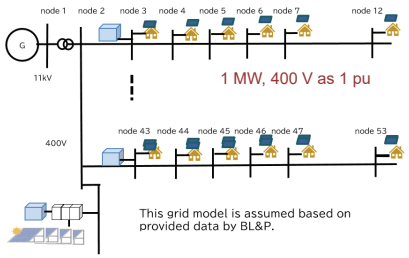


Source: Prepared by JET with Global Solar Atras

Source: Prepared by JET based on BLPC data

Activity and Achievement (RE)

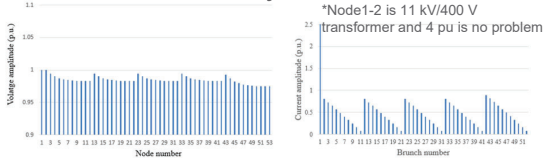
Coverley Village Microgrid Modeling and Analysis



Source: Prepared by JET

Result of Power Flow Analysiss

*Node1-2 is 11 kV/400 V transformer and 4 pu is no problem

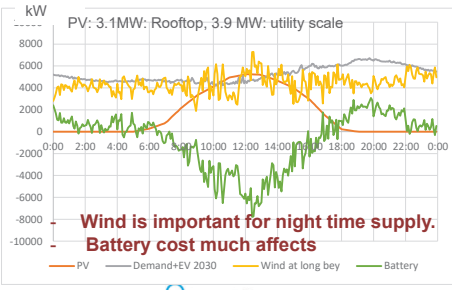


Node Voltage

Line Current

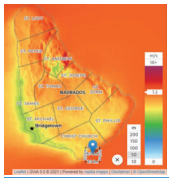
→ No problem in node voltage and line current, since current is small with PV at each house and BESS. Small current from generator (wind or grid)

Case: PV 7 MW + Wind 16 MW, 33 MWh BESS



Provisional Cost Estimation

Item	Amount	unit	Remark
Unit cost of PV	1000	USD/kW	
Rated Output of PV	7,000	kW	
Cost of PV installation	7,000,000	USD	
Unit cost of Wind	1,500	USD/kW	
Rated output of Wind	16,000	kW	
Cost of Wind	24,000,000	USD	
Unit cost of 22 kV system	400,000	USD/km	
Length of 22 kV	5	km	
Cost of 22 kV system	2,000,000	USD	
Requirement of SCO	5,750	kVA	25% of PV+Wind output
Unit cost of SCO	200	USD/kVA	
Cost of SCO	1,150,000	USD	
Unit cost of Battery	400	USD/kWh	
Battery Strorage	32.9	MWh	8 MW, 4.1 hr
Cost of Battery	13,158,725	USD	
Total Cost	**47,308,725**	**USD**	



Source: Prepared by JET

Activity and Achievement (RE)

Plan for Seminars on Large RE and Grid Stability

2022 2023 JCC: Joint Coordinating Committee

Team	Country	Oct	Nov	Dec	Jan	Feb	Mar	Apr
RE&Grid	Barbados	★ 2nd seminar		★ 3rd seminar	★ 4th Seminar		★ JCC	★ Program in Japan
	St.Kits&Nevis (at Barbados)	★		★	★		★	★
	Jamaica	★		★		★	★	★

Title	Date	Objective	Contents
1st Seminar	27 Jul 2022	To confirm present situation and needs for seminar	• RE target and challenges, revise of activity, general issues of grid with large RE penetration • Microgrid Concept for resilience
2nd Seminar	3-5 Oct 2022	To share basic technical knowledge for grid analysis with large RE	Overview of Power system, per unit method, modeling, load flow analysis, introduction of method, software and tools
3rd Seminar	6-7 Dec 2022	To conduct and exercise grid modeling and analysis	Grid modeling, Microgrid, example, Load flow analysis and stability analysis, evaluation
4th Seminar	25-26 Jan 2023	Review and exercise of grid analysis with scenario cases	Detailed system and countermeasures, protection, Exercise of tools for grid analysis with various RE scenarios
Final JCC	Mar 2023	To confirm outcome of project and way forward	Review of TC activity output, policy recommendation, Program in Japan

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (1)

Seminar	Agenda of 1st Seminar	Participants
1st Seminar 27 Jul, 2022	(On-line/Off-line hybrid) **Overview of Large RE Challenge and needs update** 1. Activity and overall project schedule 2. RE target, challenges, and activity of Technical Assistance 3. Grid with large RE penetration 4. Microgrid Concept for resilience 5. Grid Stability: General Session 6. Grid Stability: Special Session	25 nos in total (MEB:3,GEED:1 BLPC:3CCREEE: 2 UWI:1 Other: 15)

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (2)

Seminar	Agenda of 1st Seminar	Participants
2nd Seminar 3, 4, & 5 Oct 2022	<Day-1 on-line only> **Basics of Power System Engineering for Grid Stability** 1. What is Power System?, Three-phase AC, Single line network description 2. Per Unit Method 3. Modeling of Power System Equipment: Transmission Line, Transformer, Generator & Load 4. Active Power & Frequency: Frequency control, Area requirement 5. Reactive Power & Voltage: P-V Curve, Reactive power resource 6. Practice of Modeling of Grid	Day-1: 61 nos in total (Day-1: 61 nos in total (joint with St. Kitts & Nevis) MEB:7, GEED:2, BPLC:1 BREA and other: 51
	<Day2 online/off-line hybrid > **Basics and Exercise for Load Flow Analysis** 1. Overview of Load Flow Analysis: Purpose, Methods, Modeling of grid 2. Newton-Raphson Method: Theory, Characteristics 3. DC Flow Method: Theory, Simple method to solve load flow manually 4. Exercise of DC Flow Method 5. Practice on Microgrid/VPP Designer 6. Load Flow Analysis & Evaluation of sample Grid	Day-2: 44 nos (joint with St. Kitts & Nevis) MEB:11, GEED:1, CCREEE:3, BLPC:2, BREA:1, Other:26
	<Day-3 on-line/off-line hybrid> **Analysis of Grid Stability and LFC/ELD** **Overview of Stability: Definition, Methods, Swing equation** 1. Stability Model: Simplified grid model, Equivalent circuit of synchronous generator 2. Equal Area Criterion: Theory, Simple method to solve stability manually 3. Available Transmission Capacity & Spinning Reserve 4. Exercise of Equal Area Criterion 5. Practice on Microgrid/VPP Designer and LFC/ELD 6. Discussion for Interconnection, RE and Grid Stabilization in St. Kitts&Nevis	Day-3: 48 nos (joint with St .Kitts & Nevis) MEB:11, GEED:1, CCREEE:3 BLPC:2 BREA:1, Other:26

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (3)

Seminar	Agenda of 2nd Seminar	Participants
3rd Seminar 6 Dec (full day)	<Day-1 on-line >: **Preparation for Exercise and Grid Modeling** 1. Opening Remarks. 2. Project Outline, Feedback of 2nd seminar, Microgrid, Why Grid Stability is necessary 3. Grid Modeling 4. Basics of Power System Engineering, 5. Load Flow Analysis and its Evaluation 6. Transient Stability Analysis and Evaluation of Stability. 7. Discussion	Day-1: 45 nos (joint with St. Kitts & Nevis) MEB:9 GEED:2, CCREEE:3 BLPC:5 BREA:4, Other: 22
8, Dec 2022 (Half day	<Day-2 on-line/off-line hybrid >**Exercise for Grid Analysis** 1. Evaluation of Load Flow Analysis by Microgrid Designer 2. Evaluation of Load Flow Analysis & Transient Stability by ETAP 3. Discussion for 100% RE achievement 4. Closing Remarks	Day-2:11 nos MEB:4 CCREEE:2 BLPC:1 BREA:2, Other: 2

Team for exercise of grid analysis

Power Flow analysis tool "Microgrid Designer" was handed over to MEB.

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (4)

Seminar	Agenda of 3rd Seminar	Participants
4th Seminar 24-25, Jan 2023 (All full day)	<Day-1 on-line only> **Scenario Cases, Protection, and Technologies** 1. Introduction for the Seminar, Power system, Review &feedback 2. Microgrid Planning with Large RE 3. Development Status of Grid Forming Inverter and its Safety: Current Status, Blackout with GFM & Black Start using BESS 4. Battery & Hydrogen as an Electricity Storage, cost comparison 5. Special Protection System including Load Shedding, PV/WT Trip 6. Scenario cases of modified IRRP, Simulation Cases for Exercise 7. Cost of stability and Sharing Responsibility for stability 8. Harmonics and filtering 9. Inverter, Grid Code 10. A Sample of Other Countries Situations of Grid and RE 11. Investment of MW and MWh of Energy Storage for VRE	Day-1:13 nos MEB:3 UWI:1 CCREEE:3 GEED:2 BLPC:2 BREA:2
	<Day-2 on-line/off-line hybrid > **Exercise for analysis with Microgrid** 1. Introduction of Microgrid Designer and Transient Analysis 2. - Role of Tools for Power System Analysis, - Load Flow Analysis 3. - Transient Stability Analysis for Operation and Control 4. Microgrid model with Coverley Village example 5. Exercise on simple model and Microgrid : Design &Operation Planning, Load Flow Analysis, Transient Stability Analysis 6. Exercise on Future Grid and IRRP Scenario: Design and Operation Planning, Load Flow Analysis, Transient Stability Analysis 7. Analysis Result and Countermeasure of Grid Stability 8. Discussion and Way forward 9. 9. Conclusion and Closing Remarks	Day-1:8 nos MEB:3 GEED:1 BLPC:2 BREA:2

Activity and Achievement (RE)

Recommendations for Grid with 100%RE

Need of Spinning Reserve:

- stand-by thermal generation source should be kept to absorb output fluctuation of VRE

Reactive Power Compensation:

- Reactive power is necessary to establish and maintain the electromagnetic field in the grid and keep voltage. VRE can lead to voltage fluctuations and instability. Reactive power compensation should be installed.

Provision of Sufficient Synchronous generator and Inertia:

- In case VRE generates more than 1/3 of the grid capacity, insufficient synchronous generator and inertia will be a problem.

SCR (short circuit ratio):

- SCR = AC in grid / IBR power. Keep SCR>3.0

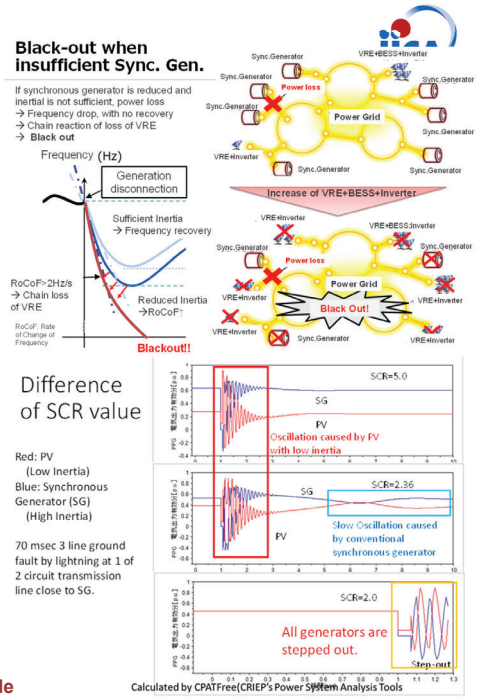
IEEE Std 1204-1997(R2003) IBR: Inverter based resource (PV & wind)

BESS: VRE more than 1 MW should mandate to install BESS, more than 80% of VRE, 4hrs

Application of Grid Forming Inverter (GFM):

- To keep SCR >3.0 with VRE, apply GFM with BESS and PV and wind as soon as it can be procured in the market

→ Discussion with Fair Trade Commission (FTC) will be important



Activity and Achievement (RE)

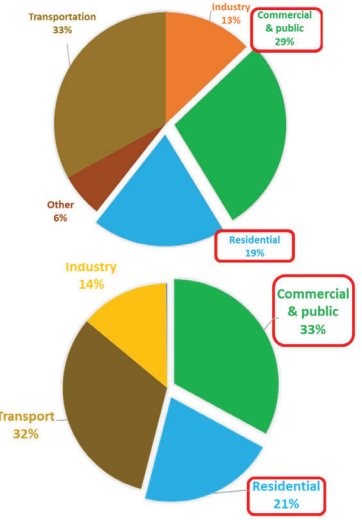
Recommendation for Policy and Regulation

Item	Description
Storage for smoothing output and peak shift	- Mandatory installation of BESS, for example, more than 80% (or 100%) of Peak MW and 4hrs storage for utility scale VRE
Investment to secure inertia and spinning reserve for grid	- Maintaining sufficient synchronous generator for spinning reserve - Introduction of Grid Forming Inverter (GFM) for VRE once available, application of Weather projection system
Investment for voltage and reactive power	- Mandatory application of Inverter with reactive power compensation for Wind/Solar IPP
Microgrid	- To promote microgrid to strengthen resiliency
Sharing responsibility of grid stability among utility, IPP, consumers	- Utility: maintaining transmission and distribution line frequency and voltage stability, ancillary service - IPP of VRE: installation of inverter with reactive power compensation and energy storage - Consumer: demand response, ToU setting& EV charging, peak shifting
Option for storage (especially with inertia)	- In addition to BESS, consideration of V2G, hydrogen, (pumped storage), Compressed Air Energy Storage (CAES) and Gravity Storage based on cost analysis and future development
Data management	- Database management, update plans based on implementation status
Recycle/disposal	- Consideration for disposal and recycling of battery and PV panel
"Best-Mix" Energy	- Multiple alternative for RE and storage, not a single source (Solar/CSP/Wind/Biomass, BESS/Thermal/new storage, etc.)

Year 2022

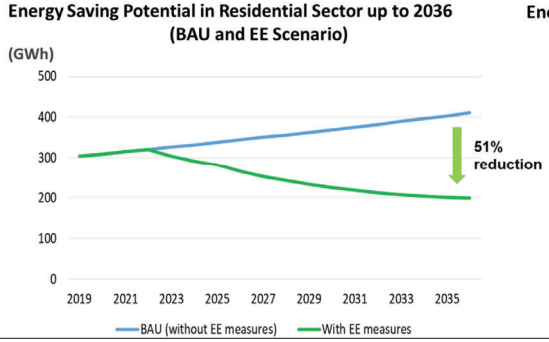
Activity and Achievement (EE): Visits in Sep.2022

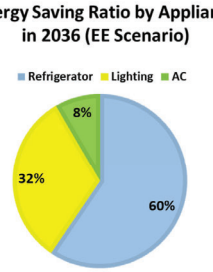
Items	Technology transfer/sharing contents in Sep.2022
E&CE roadmap／MEPS & labeling program (S&L)	▪ Reported Primary Energy (PE) consumption analysis based on national energy balance. [Barbados] ➢ 48% of PE is used for non-industrial sector (Res&Com). ➢ PE consumption has been reduced by approx. 6% in last 10 years. [SKN] ➢ 54% of PE is used for non-industrial sector (Res&Com). ➢ PE consumption has increased by approx. 6% in last 10 years. ▪ Based on above analysis, EE&C should be promoted with priority given to non-industrial sector.



Activity and Achievement (EE): Visits in Sep.2022

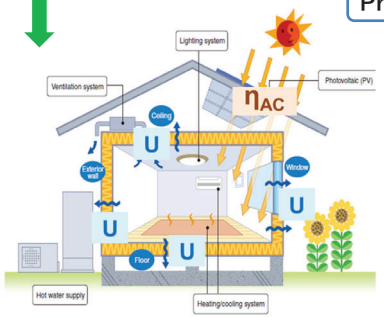
Items	Technology transfer/sharing contents in Sep.2022
EE&C roadmap／MEPS & labeling program (S&L)	▪ Introduced the method of creating EE&C roadmap. ▪ Reported the developed roadmap for residential sector assuming MEPS introduction as well as periodical increasement of MEPS targeting to refrigerators, air conditioners, and lighting). ➢ Energy saving potential was estimated to be 51% in 2036. ➢ Refrigerator has the highest energy-saving potential (60%).

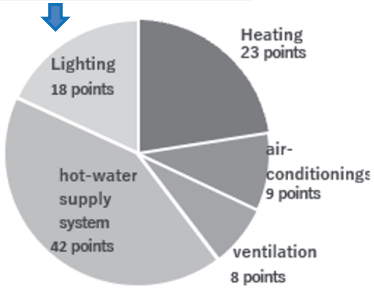




Activity and Achievement (EE): Visits in Sep.2022

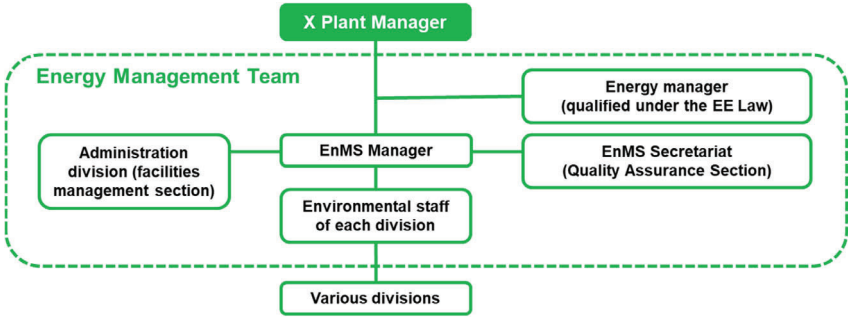
Items	Technology transfer/sharing contents in Sep.2022
Building code	▪ Introduced the Japanese building code situation in Japan (residence) and a simple evaluation method. 【EE standards】 Envelope performance (U value, η value) Primary energy consumption



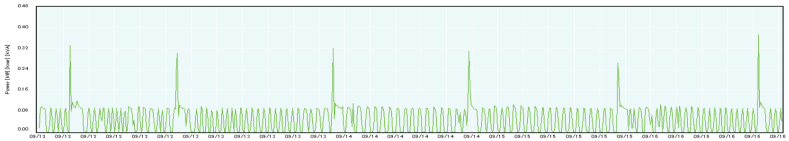


Activity and Achievement (EE): Visits in Sep.2022

Items	Technology transfer/sharing contents in Sep.2022
Energy Management (EnMS) ／Energy Audit	▪ EnMS methods based on ISO 50001 were shared. ▪ Good practices of acquiring the ISO certificate was introduced. (the figure below is an example of the EnMS team of a Japanese company). • Energy audit methods based on ISO 50002 were shared. • Good practices of energy audits were introduced.



Activity and Achievement (EE): Visits in Sep.2022

Items	Technology transfer/sharing contents in Sep.2022
Power consumption measurement/analysis using a data logger	▪ Explained how to use data logger, accessories (for current/voltage measurement), and software, including demonstrations. ▪ Proposed it is essential to use actual power consumption data for each device when formulating EE&C policies. ▪ Delivered data loggers and its software to Barbados (MEB). **Measured Power Consumption Data of Refrigerator in MEB Office (Sep.12 – 16, 2022)**  

Activity and Achievement (EE): #1 Workshop

1. Dates and venue

Nov.24 (2days), Meeting Room in Dover Beach Club Hotel, Barbados

2. Participants

Participated relevant entities(Barbados)		
Name of entity		# of participants (5 persons in total)
BL&P	Barbados Light and Power Company Limited	1 persons (on site)
BNSI	Barbados National Standards Institution	2 persons (on site)
UWI	University of West Indies	2 persons (on site)

Activity and Achievement (EE): #1 Workshop

3. Workshop program

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Opening Remarks	Barbados Light & Power	10
10:10	<Presentation> Energy Management & Energy Audit (International Standers and introduction of successful practices)	JET	50
11:00	Q&A	-	15
11:15	Break Time	-	15
11:30	<Presentation> Energy Efficiency Roadmap with country energy balance and efficient technologies	JET	45
12:15	Q&A	All	15
12:30	Lunch Time	-	60
13:30	<Presentation> EV and Storage Battery Market Trends	JET	60
14:30	Q&A	All	15
14:45	Closing	-	-

Activity and Achievement (EE): #2 Workshop

1. Dates and venue

Jan.23-24(2 Days),COURTYARD BRIDGETOWN, BARBADOS

2. Participants

Participated relevant entities(Barbados)		
Name of entity		# of participants (10 persons in total)
MEB	Ministry of Energy and Business	3 persons (on site)
BNSI	Barbados National Standards Institution	4 persons (on site)
BREA	Barbados Renewable Energy Association	1 persons (on site)
CCREEE	Caribbean Centre for Renewable Energy and Energy Efficiency	2 persons (on site)

Activity and Achievement (EE): #2 Workshop

3. Workshop program (Day 1: Jan.23 (Mon))

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Opening Remarks	MEB	10
10:10	<Presentation> Energy balance, energy efficiency and conservation roadmap (Residential & commercial sector integration) Including break time and Q&A session <Presentation (additional)> Energy Efficiency Policy in Japan	JET	110
12:00	Lunch Time	-	60
13:00	<Presentation> Energy Efficiency Building Code (Including Okinawa Situation and EE&C Evaluation Study * Including break time and Q&A session	JET	120
15:00	Closing	-	-

Activity and Achievement (EE): #2 Workshop

3. Workshop program (Day 2: Jan.24 (Tue))

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Recap of First Day	JET	10
10:10	<Presentation> Report on Energy Audits Results <Presentation (additional)> Energy Audit Best Practice at Aquarium & Amusement Park in Japan	JET	80
11:30	Break Time	-	15
11:45	<Demonstration> Data Logger Software	JET	15
12:00	Lunch Time	-	60
13:00	<Presentation> Lecture on Organizational Collaboration	JET	60
14:00	Break Time	-	15
14:15	<Free Discussion Time>	All	20
14:35	Closing Remarks	MEB	10
14:45	Photo Session	All	15
15:00	Closing	-	-

Activity and Achievement (EE): Workshop Summary

1. Summary of Workshops Contents

	Contents of Workshops	WS, etc.
I	Energy Management & Energy Audit (International Standards and introduction of successful practices)	#1WS
II-a	EE Roadmap with Country Energy Balance and efficient technologies (residential sector)	#1WS
II-b	EE&C Roadmap with Country Energy Balance and efficient technologies (Res & Com sector integration)	#2WS
III-a	Introduction of EE Building Code in Japan	Conducted in Sep visit
III-b	EE Building Code (Including Okinawa & Hawaii Situation and EE&C Evaluation Study)	#2WS
IV	Report on Energy Audits Results incl. Walk Through Survey	#2WS
V	Demonstration: Data Logger & Software	To MEB: conducted in Sep visit To BNSI: conducted in Nov visit
VI	EE policy in Japan	#2WS

Activity and Achievement (EE): Workshop Summary

2. Comments from Participants

Comments collected after #2 EE Workshop Day-1
✓ The industry increase when compared to the overall energy use is quite small. The commercial decrease can be attributed to decrease in economic activity in that sector.
✓ It takes about 3 joules of fossil fuel produces only 1 joule of electricity.
✓ There are examples of inefficient LED installations in Barbados that needs to suit the Street lighting application.
✓ Passive Cooling is something we as Barbadians should look into, primarily insulation of roofs.
✓ Large eaves can't work in Barbados as we are in the Hurricane Belt, so we can use paints etc.
✓ There is still a need to ensure the EE measures are done correctly in Barbados, despite the lack of resources.

Activity and Achievement (EE): Workshop Summary

2. Comments from Participants

Comments collected after #2 EE Workshop Day-2
✓ For companies renting buildings, there is no incentives to invest in energy savings as this doesn't benefit the landlord. If there is a mechanism where the tenant and landlord both benefit.
✓ EE building certifications can be used to incentivize EE measures including LED.
✓ There are about 4 buildings that are focused on EE in Barbados and use this as a selling point for their tenanted buildings.
✓ The office of the MEB can have a reduction in lighting requirements as the light levels are about 900 Lux.
✓ The temperature variation is the highest from late night till midday. If we utilize the variations in temperature during the night and weather variations, we can boost energy efficiency in cooling in Barbados. (night parge)
✓ The avoidance of being dazzled by several possibilities is one key measure BNSI takes to progress the national standards.

Activity and Achievement (EE): Workshop Summary

2. Comments from Participants

Topics you would like us to cover at next training (after #2 EE workshop)
✓ Need to introduce an EE Standard for houses in Barbados.
✓ The CREEBC is very complex, and Japanese approach is simple and easy to use.
✓ Battery storage integration into utility grid. Standards for safety and performance.
✓ Infrastructure for Electric Vehicles

Activity and Achievement (EE): Data Loggers

Demonstration @ Pantry in MEB Building

- Demonstration was conducted and data loggers were handed over to Barbados
  - MEB: 1 data logger
  - BNSI: 1 data logger

Confirmation of PDM (Project Design Matrix)

Overall Goals & Achievement

Description	Verifiable Indicator	Achievement
Overall Goal Energy security is ensured through introduction of renewable energy	**1.** Energy self-dependency Target Value:**100%** **(100%RE by 2030)** **2.** Imported amount of fossil fuel Target Value: **To 0% by 2030**	**1.** - **2.** -

Project Purpose & Achievement (1)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**1.** Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant Target Value: - **PV 10 MW (BLPC)** **+ 25 MW (Other)** **+ Wind 10 MW**	**1.** -

Project Purpose & Achievement (2)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**2.** Number of public buildings with EE program including BEMS Target Value: **TBC**	**2.** -

Project Purpose & Achievement (3)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**3.** Number of trained staffs for introduction of RE Target Value: **6 personnel** **(MEB:3, BLPC:3)** **and others**	**3.** In total, number of participants (accumulated total) was **36 personnel (MEB and BLPC)** **MEB: around 3 personnel** **BLPC: 2-4 personnel** - Remote training in Dec 2020 was 4 personnel (MEB: 4) - 1st Seminar in Jul 2022 was 4 personnel (MEB: 2, BLPC: 2) - 2nd Seminar in Oct 2022 was 33 personnel (MEB: 12, BLPC: 3) - 3rd Seminar in Dec 2022 was 19 personnel (MEB: 4, BLPC: 4) - Final (4th) Seminar in Jan 2023 was 13 personnel (MEB: 3, BLPC: 2)

Project Purpose & Achievement (4)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	4. Number of trained staffs for promotion of EE Target Value: **7 personnel**	4. In total, number of participants (accumulated total) was 35 personnel **Average:** 35/4 = 8.5 personnel/time - Demonstration on EE roadmap program etc. in Feb 2020 was 15 personnel - Remote training in Dec 2020 was 4 personnel - 1st Workshop in Nov 2022 was 5 personnel - Final (2nd) Workshop in Jan 2023 was 11 personnel

Output 1 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	**1-1.** Assessment of number and qualification of staffs responsible for RE **1-2.** Human resource development plan for the introduction of RE **1-3.** Number of training courses for the introduction of RE **1-4.** Total capacity of RE	**1-1.** Confirmed **1-2.** Confirmed **1-3.** Confirmed **1-4.** Confirmed *** Achievement of Output 1 was already confirmed when 1st JCC which was held in Nov 2019**

Output 2 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	**2-1.** Assessment of number and qualification of staffs responsible for EE **2-2.** Human resource development plan for the introduction of EE **2-3.** Number of training courses for the promotion of EE **2-4.** Number of facilities conducted energy audit	**2-1.** Confirmed **2-2.** Confirmed **2-3.** Confirmed **2-4.** Confirmed *** Achievement of Output 2 was already confirmed when 1st JCC which was held in Nov 2019**

Output 3 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-1.** Number of trained staffs Target Value: **6 personnel (MEB, BLPC)** **3-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**3-1.** In total, number of participants (accumulated total) was 36 personnel MEB: 3 personnel/time BLPC: 2 – 4 personnel/time **3-2.** In total, 6 (7) materials were prepared. - 1 manual for simulation software of system analysis. - 1 training material for remote training in Dec 2020. - 4 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan (Available next month)

Output 3 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-3.** Number of participants of workshops to disseminate introduction of RE to the relevant organizations Target Value: - **Kick-off workshop: 10 personnel** - **Final workshop: 10 - 15 personnel**	**3-3.** - Kick-off workshop in Nov 2019 was 9 personnel - Remote training about 'impact of COVID-19 on RE' in Dec 2020 was 4 personnel - 1st Seminar in Jul 2022 was 4 personnel - 2nd Seminar in Oct 2022 was 33 personnel - 3rd Seminar in Dec 2022 was 19 personnel - Final (4th) Seminar in Jan 2023 was 13 personnel

Output 3 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**3-4.** In total, 6 times - Kick-off workshop was conducted in Nov 2019 - Remote training about 'impact of COVID-19 on RE' in Dec 2020 - 1st Seminar was conducted in Jul 2022 - 2nd Seminar was conducted in Oct 2022 - 3rd Seminar was conducted in Dec 2022 - Final (4th) Seminar was conducted in Jan 2023

Output 4 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-1.** Number of trained staffs Target Value: **6 personnel** **4-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**4-1.** In total, number of participants (accumulated total) was 35 personnel **Average: 8.5 personnel/time** **4-2.** In total, 3 (4) materials were prepared. - 1 training material for remote training in Dec 2020. - 2 training materials about 'Energy Efficiency Workshop' for domestic training in Nov 2022 and Jan 2023. - 1 training material for training in Japan in Apr 2023. (Available next month)

Output 4 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-3.** Number of participants of workshops to disseminate promotion of EE to the relevant organizations Target Value: - **Kick-off workshop: 10 personnel** - **Final workshop: 10 - 15 personnel**	**4-3.** - Kick-off workshop in Nov 2019 was 9 personnel - Demonstration on EE roadmap program and power consumption measurement was conducted in Feb 2020 was 15 personnel - Remote training in Dec 2020. Number of participants was 4 personnel - 1st Workshop in Nov 2022 was 5 personnel - Final (2nd) Workshop in Jan 2023 was 11 personnel

Output 4 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**4-4.** In total, 5 times - Kick-off workshop was conducted in Nov 2019 - Demonstration on EE roadmap program and power consumption measurement in Mar 2020 - Remote training about 'impact of COVID-19 on EE' in Dec 2020 - 1st workshop was conducted in Nov 2022 - Final (2nd) workshop was conducted in Jan 2023

Output 5 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-1.** Number of trained staffs Target Value: **6 personnel** (MEB, BLPC) **5-2.** Textbooks/ manuals Target Value: **2 programs** (1 domestic trainings and 1 training in Japan)	**5-1.** In total, number of participants (accumulated total) was 36 personnel **MEB: 3 personnel/time** **BLPC: 2 – 4 personnel/time** **5-2.** In total, 4 (5) materials were prepared. - 1 training material for remote training in Dec 2020. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan (Available next month)

Output 5 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-3.** Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations Target Value: - **Kick-off workshop: 10 personnel** - **Final workshop: 10 – 15 personnel**	**5-3.** - Kick-off workshop in Nov 2019 was 9 personnel - Remote training about 'impact of COVID-19 on RE' in Dec 2020 was 4 personnel - 1st Seminar in Jul 2022 was 4 personnel - 2nd Seminar in Oct 2022 was 33 personnel - 3rd Seminar in Dec 2022 was 19 personnel - Final (4th) Seminar in Jan 2023 was 13 personnel

Output 5 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**5-4.** In total, 6 times - Kick-off workshop was conducted in Nov 2019 - Remote training about 'impact of COVID-19 on RE' in Dec 2020 - 1st Seminar was conducted in Jul 2022 - 2nd Seminar was conducted in Oct 2022 - 3rd Seminar was conducted in Dec 2022 - Final (4th) Seminar was conducted in Jan 2023

Discussion

Closing Remarks

Thank you.

Minutes of Meeting
of
Joint Coordination Committee #3
of
Technical Cooperation to Promote Energy Efficiency in Caribbean Countries
among
MPI, JICA, and JICA Expert Team

March 21, 2023

Ministry of Public Infrastructure, Post, Urban Development, and Transport (MPI)

Bertill Browne

Dr. Bertille Browne, Director of Energy unit

19/4/23

Japan International Cooperation Agency, St. Lucia Office

Mr. Ichiro MIMURA, Chief Representative

JICA Expert Team (JET)

Mr. Tomoyasu FUKUCHI, Team Leader

Date and Time:

March 21, 2023, 9:30am (in St. Kitts and Nevis), 10:30pm (in Japan)

Location:

Online (Virtual Meeting by Zoom)

Participants:

1) Ministry of Public Infrastructure, Energy, and Utilities (MPI)

- Dr. Bertille Browne, Director of the Energy Unit
- Mr. Denasio Frank, Energy Officer, Energy Unit

2) Nevis Island Administration (NIA)

- Ms. Michelle Walters, Energy Commissioner

3) St. Kitts Electricity Company (SKELEC)

- Mr. Jonathan Kelly, Engineering Manager

4) Nevis Electricity Company (NEVLEC)

- Mr. Ian Ward, Chief Engineer

5) Nevis Water Department (NWD)

- Mr. Clychawn Wilson, Water Technician

6) Japan International Cooperation Agency (JICA), Tokyo

- Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group

6) Japan International Cooperation Agency (JICA), St. Lucia Office

- Mr. Ichiro MIMURA, Chief Representative
- Ms. Hitomi URUSHIHATA, Programme Formulation Advisor
- Dr. Ayodele HIPPOLYTE, Project Officer
- Ms. Elvinette Wilson

7) Caribbean Community (CARICOM), Guyana

- Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

8) JICA Expert Team (JET)

- Mr. Tomoyasu FUKUCHI, Team Leader/Power System
- Mr. Yasuhiro SAKAMOTO, Energy Efficiency
- Ms. Yuka NAKAGAWA, Renewable Energy
- Dr. Hisao TAOKA, Electrical Grid Expert
- Ms. Anna MIYAURA, Human Resource Development
- Mr. Tomoaki TSUJI, Grid Stabilization/Coordinator
- Mr. I-Ronn Audain, Technical Assistant

Discussions:

<Looking Back Over all the Project>

- JET explained that the project is a technical cooperation project by JICA and that the project was originally from March 2019 to March 2022 however due to the COVID-19 pandemic it was extended to June 2023.

- JET explained that the purpose of the project is to enhance the human and institutional capacity of St. Kitts and Nevis in the areas of Renewable Energy (RE) and the promotion of Energy Efficiency (EE). At the first phase of the project, which went from March to September of 2019, JET confirmed the baseline of the country by gathering the information to be able to develop a plan for the capacity building of the participants for the introduction of the RE and the promotion of the EE. The second phase, from October 2019 to June 2023 concentrated on developing the human and institutional capacity by workshop and seminars.

- Activities of Phase 1 for EE

  - Baseline survey was conducted.
  - A recommendation was made by JET that it was necessary to collect the end user energy consumption data by equipment as it would help to shape future (EE) policies.
  - JET decided to provide two data loggers and the necessary software, one for each island. This was to facilitate the collection of the power consumption data.

- Activities of Phase 1 for RE

  - Baseline survey was conducted, and sector challenges were identified as RE plans, standards, and tools of grid analysis. This information was used to determine the capacity building plan, which include: (i) Modeling of existing power line network, (ii) Provision of grid simulation software and training and grid analysis with 35 MW PV and 6 MW wind, (iii) Recommendation for grid code revision, and (iv) introduction of network asset management.
  - NEVLEC requested a hydrogen/ammonia utilization study with geothermal, which was to be included in seminar agenda.

- JET explained that activities in St. Kitts and Nevis till March 2020, after which local activities were suspended until November 2020 of the same year when an online webinar was conducted. In November 2021 a second JCC was conducted to determine the way forward for 2022.

<Achievement of Phase 2 "Technical Transfer">

- The capacity building activities were conducted through seminars and workshops based on the baseline survey in the areas of RE and EE. The activities of JET in Caribbean region were resumed in Jul 2022, however, due to travel restriction of JET, officers of St, Kitts and Nevis were requested to attend workshops and seminars in Barbados. JET expressed appreciation for their several times travel management to attend. Three seminars on Large RE and Grid Stability and two workshops on EE were conducted by combination of face to face and online method from Oct2022 to Jan 2023.

- JET reported about the equipment provision that (i) the power flow analysis software "Microgrid Designer" were handed over to St. Kits and Nevis, (ii) the asset management system with SKELEC data were installed in a PC of SKELEC for demonstration purpose, and (iii) power consumption data collection device (logger, software) was handed over to each island.

- Activities of Phase 2 for RE,

  • JET presented about (i) the result of grid modeling and analysis and recommendation for St. Kitts and Nevis with current plan and future interconnection with geothermal development in Nevis, (ii) demonstration of asset management, and (iii) hydrogen/ammonia study with geothermal power.

  • JET made some recommendations for grid stability:

  1. There is a need for a spinning reserve to compensate variable RE (VRE) fluctuation.
  2. There should be reactive power compensation
  3. For grid stability, the Short Circuit Ratio (SCR) (= AC power in grid / Power from inverter based resource (PV and wind)) should be kept more than 3.0
  4. In case SCR will be less than 3.0, Grid Forming Inverter (GFM) should be applied.
  5. If the VRE will be installed more than 1 MW, a BESS should be installed

• JET summarized recommendations for future RE and grid plans for St. Kitts and Nevis.

- Activities of Phase 2 for EE,
  • Major contents presented from JET are as follows.
  1. Energy Management & Energy Audit (International Standards and introduction of successful practices).
  2. EE&C Roadmap with Country Energy Balance and efficient technologies (residential & commercial sector integration).
  3. EE Building Code including Okinawa & Hawaii Situation and EE&C Evaluation Study.
  4. Report on Energy Audits Results including Walk Through Survey.
  5. Demonstration: Data Logger and its Software.
  6. EE policy in Japan.

<Confirmation of Project Design Matrix (PDM)>

- JET explained the goals of the projects and discussed the achievements in terms of the number of personnel trained in RE and EE, the number of training sessions and the number of training manuals. In each area all the goals were surpassed.

- Mr. Browne of MPI agreed that the goals of the project as explained by JET was correct.
  * Note:
  After the JCC, JICA and JET requested MPI to provide further information on the achievements described in the material but not discussed in detail during the JCC.

<Training in Japan>

- JET explained the detailed schedule training in Japan to be held in April 2023. It was informed that the duration of the training is 14 days, but they would be out of St. Kitts and Nevis for 17 days. Participants were given a preliminary tip such as how to deal with issues such as jet lag, clothing, SIM card, etc.

- Participants were also informed about the immigration entry procedures for entering Japan.

List of Attachment:

Attachment-1 Presentation Material for 3rd JCC

Attachmetn-2 Presentation Material for Training in Japan

End of the MoM

Joint Coordinating Committee (JCC) #3 for Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

March 21, 2023
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

Contents and Timetable

5 min.	Opening Remark from JICA
5 min.	Introduction of Participants
5 min.	Project Outline and Recap of Project
30 min.	Detail of Activities in Phase 2
30 min.	Confirmation of PDM (Project Design Matrix)
10 min.	Discussion
5 min.	Closing Remark from MPI

Opening Remarks from JICA

Today's Participants

Today's Participants (1/4)

St. Kitts and Nevis

- Ministry of Public Infrastructure, Post, Urban Development, and Transport (MPI)
- Nevis Island Administration (NIA)
- SKELEC
- NEVLEC
- Nevis Water Department (NWD)

JICA

- JICA HQ
- JICA Office (JICA Saint Lucia Office)

JET

- Japanese Experts
- Local Expert

Today's Participants (2/4)

St. Kitts and Nevis

Organization	Name and Title
MPI	Mr. Daryll Lloyd, Permanent Secretary Dr. Bertille Browne, Director of the Energy unit Mr. Denasio Frank, Energy Officer
NIA	Ms Michelle Walters, Energy Commissioner
SKELEC	Mr. Clement J Williams, General Manager Mr. Jonathan Kelly, Engineering Manager
NEVLEC	Mr. Albert Gordon, General Manager Mr. Ian Ward, Chief Engineer
NWD	Mr. Clychawn Wilson, Water Technician

Today's Participants (3/4)

JICA

Organization	Name
HQ, Tokyo	Mr. Kentaro KUNIKATA, Special Advisor, Team 2, Energy and Mining Group, Infrastructure Management Department
Saint Lucia Office	Mr. Ichiro MIMURA, Chief Representative Ms. Hitomi URUSHIHATA, Programme Formulation Advisor Dr. Ayodele HIPPOLYTE, Project Officer

CARICOM

Organization	Name
HQ	Mr. Tatsuya MORITA, CARICOM Advisor (Dispatched from JICA)

Today's Participants (4/4)

JET

Name	Position
Mr. Tomoyasu FUKUCHI	Team Leader/Power System
Mr. Masaaki EBINA	Sub Team Leader/Power System
Mr. Yasuhiro SAKAMOTO	Energy Efficiency
Ms. Yuka NAKAGAWA	Renewable Energy
Dr. Hisao TAOKA	Electrical Grid Expert
Ms. Anna MIYAURA	Human Resource Development
Mr. Tomoaki TSUJI	Grid Stabilization/Coordinator
Mr. I-Ronn AUDIN	Technical Assistant

Project Outline and Recap of Project

Project Outline

This project is a technical cooperation project by Japan International Cooperation Agency (JICA), which is a governmental agency of Japan.

Duration

- Originally 3 Years from March 2019 to March 2022.
- >>> Extended until Jun 2023.

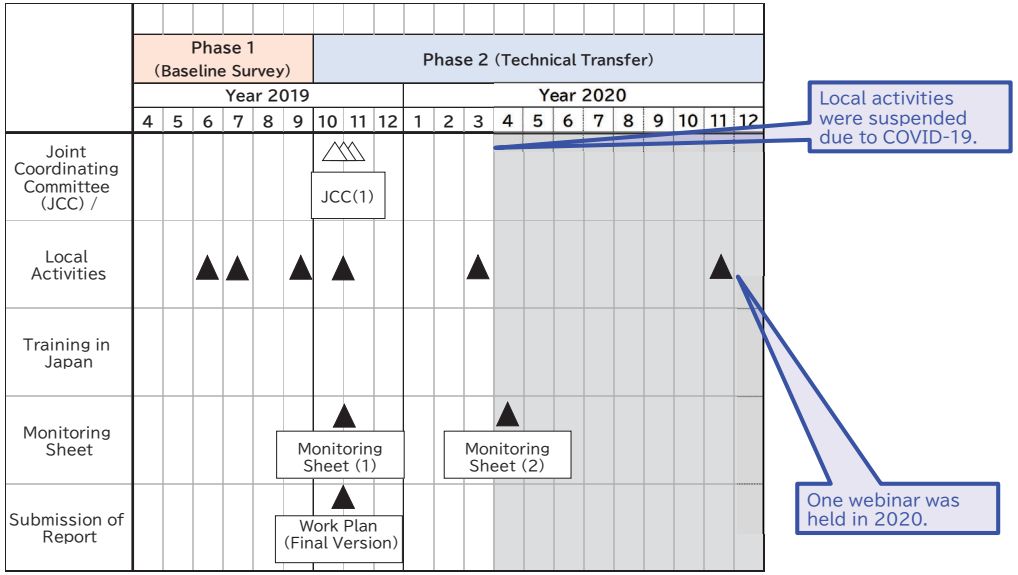
Purpose

- Human and institutional capacities are enhanced for the introduction of Renewable Energy (RE) and the promotion of Energy Efficiency (EE).

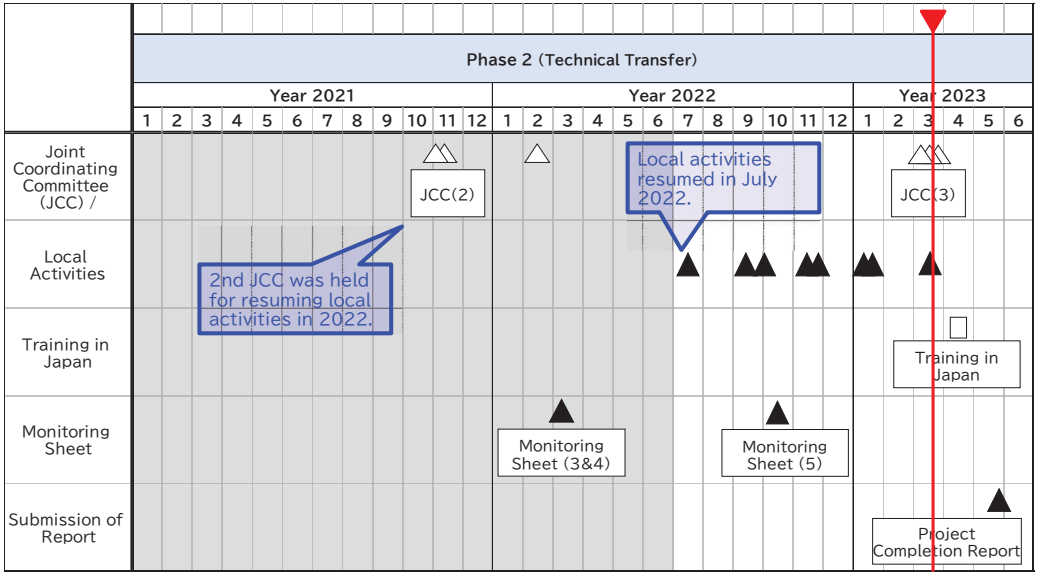
Output

- The basic information is confirmed for the capacity building for the introduction of RE and for the promotion of EE. (Phase 1: from Mar to Sep 2019)
- The human and institutional capacities are enhanced for the introduction of RE and the promotion of EE.
  (Phase 2: from Oct 2019 to Jun 2023)

Recap of Project (1/5)



Recap of Project (2/5)



Recap of Project (3/5)

Phase1 Baseline Survey (EE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

- In EE, in addition to JET's original activities plan, the importance and necessity to collect energy consumption data by end-use/equipment basis has been shared and confirmed with the counterparts toward the formulation of future EE policies.
- Power consumption data collection device (logger, software) are to be provided through this project.

Recap of Project (4/5)

Phase1 Baseline Survey (RE)

- Baseline survey was conducted in 2019 as Phase 1 of this project.

RE Installation:

- 100% RE by 2020 target
- 0.7+0.5 MW PV (St. Kitts)
- 2MW wind operated at 1.1 MW (Nevis)
- Bellevue 5.4MW wind, Leclanche 35MW PV to be installed
- Nevis Geothermal plan (10-30 MW + potential

Grid Stability:

- 34MWh BESS planned for 35MW PV
- Output suppression of wind is conducted in NEVLEC

Needs for:

1) Modeling for existing transmission and distribution network
2) Provision of grid simulation software and training and grid analysis with 35 MW PV
3) Proposal for grid code revision
4) Introduction of network asset management
5) Additional request of hydrogen utilization study (from NEVLEC, 2021)

Recap of Project (5/5)

Phase 2 Technical Transfer

- JET conducted capacity building related to RE and EE based on baseline survey.
- Seminar or Workshop were held online or face to face in Barbados
  - 3 RE and Grid Stability Seminars
  - 2 EE Workshops
- The following equipment was also provided from JET
  - RE: Grid Analysis Software
    Asset management Software (St. Kitts only)
  - EE: Data Loggers
- The only remaining activity is the training in Japan, April 2023.

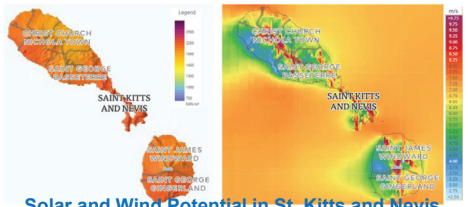
Detail of Activities in Phase 2

Activity and Achievement (RE)

Baseline Study, RE Potential and RE Projects

Challenges: 1% RE in 2019 → 100% RE in 2030

- RE Target: **100% electricity by RE by 2030**, Nationally Determined Contribution (NDC, Oct 2020)
- Sector challenges are: (i) the need for RE plans, (ii) human resource development, (iii) standards, (iv) research, and (v) tools incl. grid analysis
  - Large VRE will be installed in St. Kitts → concern for grid stability
- Solar potential 5.2 to 6.0 kWh/m²/day, mountain and southern peninsula has high wind potential >8m/s
- Geothermal potential at Mt. Liamuiga in St. Kitts and Nevis Peak , >200 MW geothermal potential in Nevis
- Interconnection plan → grid analysis is necessary
- One thermal station in one island → Resilience is concerned.



Solar and Wind Potential in St. Kitts and Nevis

RE Projects in St. Kitts and Nevis

Location	Project and Location	Type	Gapacity	Year
St.Kitts	SCASPA	PV	0.7	2013
St.Kitts	SKELEC	PV	0.5	2015
Nevis	Windwatt	Wind	2.2	2011
St.Kitts	Leclanche	PV	35	2024?
St.Kitts	Bellevue	Wind	5.7	planned
Nevis	N3 Geothermal -Ph2	Geo	30	2025
Nevis	N3 Geothermal -Ph3	Geo	15	proposed
Nevis	N1 Geothermal -Ph4	Geo	15-30	proposed
Nevis	Off-shore wind -Ph4	Wind	50	proposed

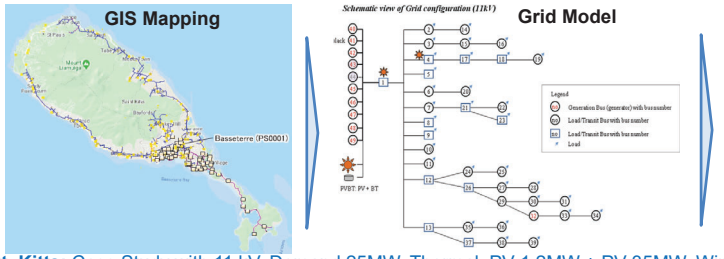
Concept for Geothermal and Grid Development in Nevis

Phase	Nevis Geothermal and Grid Interconnection Plan (provisional)
Phase-1	Power Grid Reinforcement from 11kV to 66kV
Phase-2	Expand 66kV, 30 MW Geothermal at N3, Connect into St. Kitts Power System
Phase-3	Hydrogen Based Project at Long Point, Install 15 MW Geothermal at N3
Phase-4	66KV from Long Point to Camp, Offshore Wind at 50 MW, 4hr BESS, Additional Geothermal from 15MW to 30MW at N1, Expansion of Hydrogen Based Project

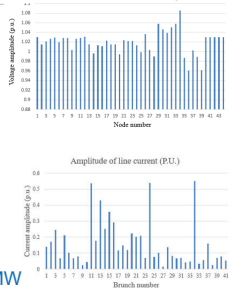
Activity and Achievement (RE)

Grid Modeling for St. Kitts and Nevis

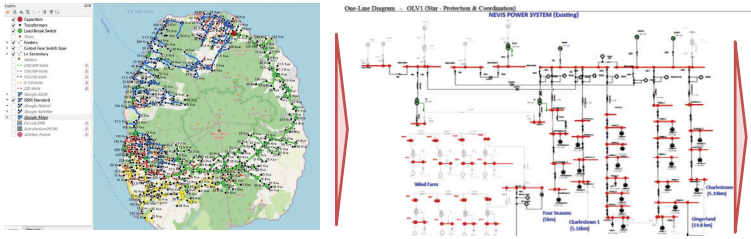
Exercise for grid analysis was conducted with "Microgrid Designer"

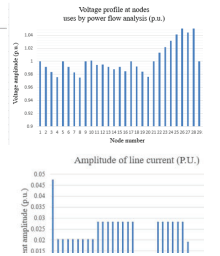


Power Flow Analysis



St. Kitts: Case Study with 11 kV, Demand 25MW, Thermal, PV 1.2MW + PV 35MW, Wind 7 MW
→ **No problem, but reactive power compensation is recommended for future.**





Nevis: Case Study with 11 kV, Demand 10 MW, Thermal, Wind 2 MW
→ **No problem, but reactive power compensation is recommended for future.**

Activity and Achievement (RE)

Grid Modeling for Interconnection of both Islands

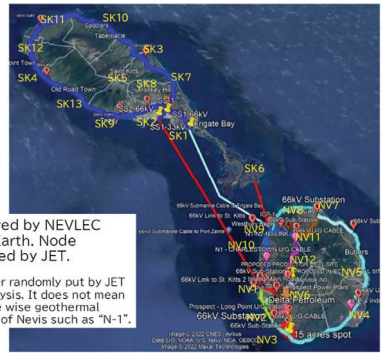
Interconnection is considered to be necessary to achieve 100% RE unless geothermal or further VRE is developed in St. Kitts.

- Nevis will have 100% RE once 10MW geothermal is commenced.
- St. Kitts 35 MW PV + 6 MW Wind will suffice 30-40 % of overall demand. Thermal power is still necessary

→ Grid Analysis was conducted for interconnection.

St. Kitts & Nevis Future Grid

Data is assumed from Google Earth KML file provided from NEVLEC. Both network of St. Kitts and Nevis are connected by 66kV transmission line.



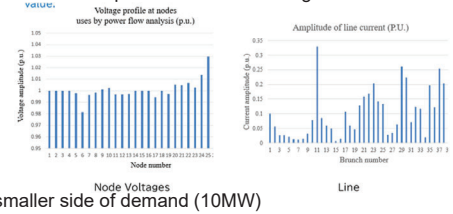
Source: Prepared by NEVLEC using Google Earth. Node Number is added by JET.

"N" is node number randomly put by JET for Nevis grid analysis. It does not mean the name of phase wise geothermal development plan of Nevis such as "N-1".

Assumptions:

- Demand: 25 MW in St. Kitts, 10 MW in Nevis
- 1.2 MW PV, 35 MW PV, 5.7 MW wind, 6 MW charging/discharging BESS in St. Kitts
- 2.2 MW+50MW wind,30 MW geothermal with assumption that 20 MW hydrogen plant

Results: No problem on node voltage and line current



Node Voltages Line

Recommendations:

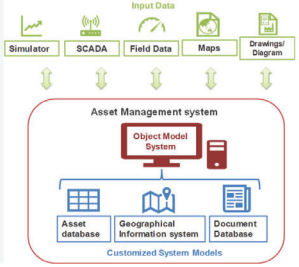
- Maximum interconnection capacity is generally limited to be smaller side of demand (10MW)
- Reactive power compensation is necessary to increase interconnection capacity
- In case full interconnection for St.Kitts (25MW) at all time with stable interconnection, it is recommended to (i) apply DC line to maintain stability, or (ii) use one of 66 kV loop line for exclusive supply to St. Kitts from one geothermal
- Further detailed F/S is recommended with transient stability analysis with local detailed data for optimum operation.

Activity and Achievement (RE)

Demonstration of Asset Management System

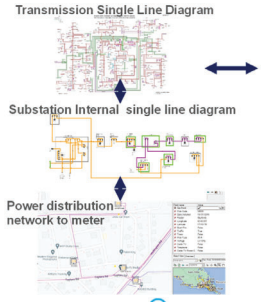
- To Optimize planning
- To Minimize time for recovery from failure with system integration

- ✓ **GIS: Spec. for each facility & equipment on the map**
- ✓ **CAD: analyze each spec. with comprehensive & panoramic view**
- ✓ **SCADA: Real time monitoring on the map**
- ✓ **ERP: liked immediately with updated facility data into ERP**
- ✓ **Others (Simulator, etc.)**

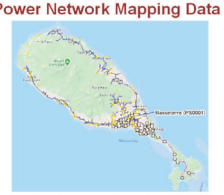


Network asset management system for St. Kitts was demonstrated, as one of the measures of enhancement of resilience

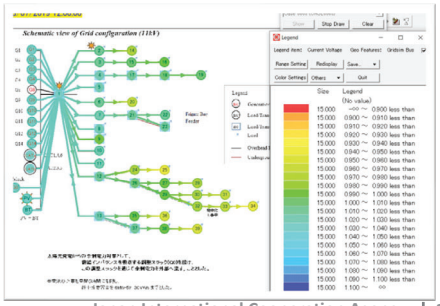
- It has elements of power system equipment for generation, transmission, substation, distribution, meters, switches, etc.
- Power flow analysis result was visualized to find where power cut is likely to occur with future plan
- It can speed up finding and restoration after a failure or disaster when combined with SCADA



Power Network Mapping Data



- Visualization of precise location
- Base for fast fault recovery
- Asset management of small VREs
- Database for EE verification



Activity and Achievement (RE)

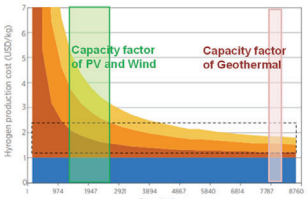
Study for Geothermal Hydrogen/Ammonia

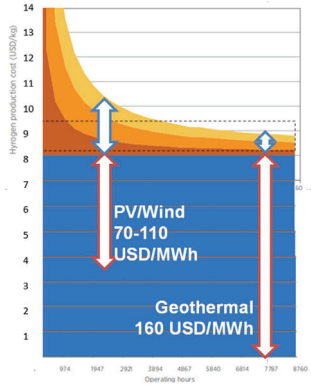
Cost of hydrogen electrolysis is dominated by generation costs than plant factor
- cost of hydrogen production from PV and wind: 7-11 USc/kWh →**7 USD/kg.**
- In case of geothermal generation cost is 16 USc/kW → **9 USD/kg**.
- Ammonia has advantage in transportation, but conversion cost is high.
  - At USD/MJ base, NH3 is 1.4-1.6 times than H2 due to conversion cost

RE Type	Capacity factor	Hour/yr	Electrolyser cost w/o electricity USD/kg*
PV	13-25%	1140-2190	2.8-4.5
Wind	20-30%	1752-2752	2.3-3.3
Geothermal	90-95%	7784-8322	0.8-0.9

*Electrolyser system cost (770USD/kW)

Source: IRENA Green Hydrogen Cost Reduction
Note: Efficiency at nominal capacity is 65% (with an LHV of 51.2 kWh/kg H2),
the discount rate 8% and the stack lifetime 80 000 hours





Cost of Hydrogen, LOHC, NH3 tanker

Geothermal capacity	10 MW
Operation hr	8000 hr/year
Power Production	80,000 MWh/year
Hydrogen efficiency	48.95 MWh/ton
Hydrogen production	1,634 ton/year
LOHC carriage	62 kgH2/t_LOHC
LOHC tanker	15,000 ton/year
H2 by LOHC tanker	930 tonH2/year
nos of tanker	2 tankers/yr

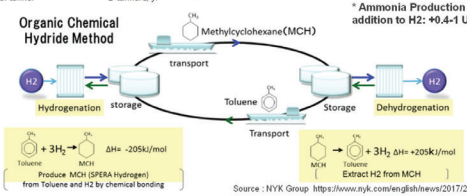
NH3/ LOHC Career cost (USD/kg)

Hydrogen market	km	LHOC/tanker	H2	NH3
Barbados	500	2	2.35	2
Jamaica	1,500	2.05	2.4	2.1
Miami	2,100	2.1	2.5	2.2
New York	3,900	2.2	2.6	2.25
Tokyo	18000	2.5	3.2	2.45

Source : Prepared by JET IEA Global Hydrogen Review

* Ammonia Production cost in addition to H2: +0.4-1 USD/kg

Organic Chemical Hydride Method



Source : NYK Group https://www.nyk.com/english/news/2017/20170727_01.html

Activity and Achievement (RE)

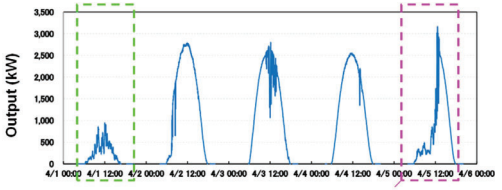
Weather Prediction System

Weather prediction system provides forecast PV/wind output
- Satellite is used for more than 1hour ahead prediction
- The system enables preparation of optimized spinning reserve and contribute stability
- Jamaica JPS applies AWE system

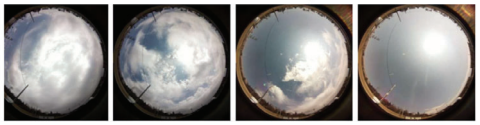
In case of Solcast API
- Analysis on live and forecast data
- The live and forecast data products deliver PV power, irradiance, and weather data globally, with spatial resolution of 2km and data updates every 5 to 15 min

For short time advance prediction, whole-sky camera system will do.
- Weather prediction for 5-30 minutes advance by detection of cloud movement with Whole-Sky Camera
- AI reads image and predict short-term irradiation (ex. SolarMi by Skyperfect JSAT)

Type	Data source	+1 hours ahead error(%)	+3 hours ahead error(%)	+24 hours ahead error(%)
Tropical/Subtropical, Humid (7 sites)	Solcast	(2.4% to 3.8%)	(3.2% to 5.6%)	(4.5% to 7.0%)
	Smart Persistence	(3.0% to 5.3%)	(3.7% to 6.9%)	(3.8% to 8.6%)
	GFS	(4.6% to 8.5%)		



PV output time series variation (1 Apr to 4 Apr9)



Activity and Achievement (RE)

Recommendations for Grid with 100%RE

Need of Spinning Reserve:
- stand-by thermal generation source should be kept to absorb output fluctuation of VRE

Reactive Power Compensation:
- Reactive power is necessary to establish and maintain the electromagnetic field in the grid and keep voltage. VRE can lead to voltage fluctuations and instability. Reactive power compensation should be installed.

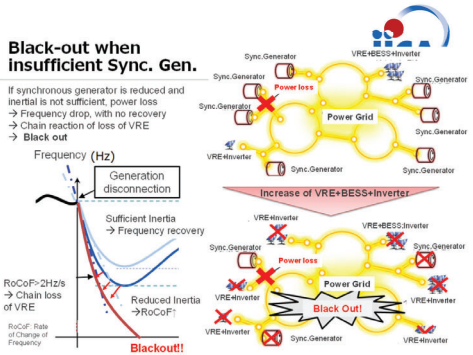
Provision of Sufficient Synchronous generator (thermal or geothermal) and Inertia:
- In case VRE generates more than 1/3 of the grid capacity, insufficient synchronous generator and inertia will be a problem.

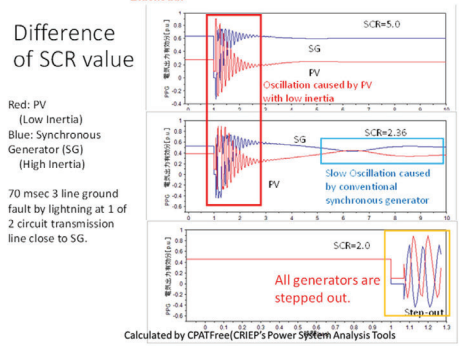
SCR (short circuit ratio):
- SCR = AC in grid / IBR power, Keep SCR>3.0

IEEE Std 1204-1997(R2003) IBR: Inverter based resource (PV & wind)

BESS: VRE more than 1 MW should mandate to install BESS, more than 80% of VRE, 4hrs

Application of Grid Forming Inverter (GFM):
- To keep SCR >3.0 with VRE, apply GFM with BESS and PV and wind as soon as it can be procured in the market





Activity and Achievement (RE)

Recommendation for Future RE and Grid Plan

Item	Description
Interconnection	- St. Kitts and Nevis is recommended to be interconnected by AC or DC 66kV line to achieve stable 100% RE also for resilience. F/S is needed.
Hydrogen/Ammonia	- Hydrogen/Ammonia with geothermal need to be considered with geothermal cost reduction.
Investment to secure inertia and spinning reserve for grid	- Maintaining sufficient synchronous generator for spinning reserve - Introduction of Grid Forming Inverter (GFM) for VRE source - Weather projection system for optimum spinning reserve plan
Investment for voltage and reactive power	- Mandatory application of Inverter with reactive power compensation for and energy storage for Wind/Solar IPP

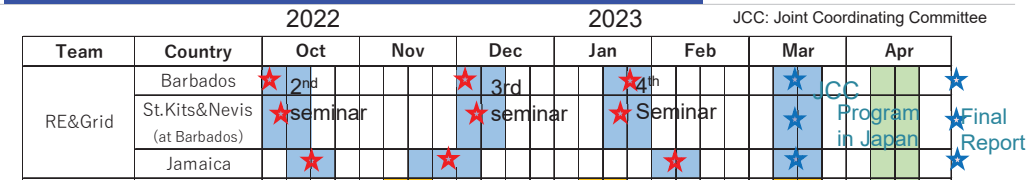
Activity and Achievement (RE)

Recommendation for Future RE and Grid Plan

Item	Description
Sharing responsibility of grid stability among utility, IPP, consumers	- Utility: maintaining transmission and distribution line frequency and voltage stability, ancillary service - IPP of VRE: installation of reactive power compensation and energy storage - Consumer: demand response, ToU setting& EV charging, peak shifting
Option for storage (especially with inertia)	- In addition to BESS, consideration of V2G, hydrogen, (pumped storage), Compressed Air Energy Storage (CAES) and Gravity Storage based on cost analysis and future development
Data management	- Database management, update plans based on implementation status
Recycle/disposal	- Consideration for disposal and recycling of battery and PV panel
"Best-Mix" Energy	- Multiple alternative for RE and storage, not a single source (Solar/CSP/Wind/Biomass, BESS/Thermal/new storage, etc.)

Activity and Achievement (RE)

Schedule and Key Events



Title	Date	Objective	Contents
1st Seminar	27 Jul 2022	To confirm present situation and needs for seminar	• RE target and challenges, revise of activity, general issues of grid with large RE penetration • Microgrid Concept for resilience
2nd Seminar	3-5 Oct 2022	To share basic technical knowledge for grid analysis with large RE	Overview of Power system, per unit method, modeling, load flow analysis, introduction of method, software and tools
3rd Seminar	6-8 Dec 2022	To conduct and exercise grid modeling and analysis	Grid modeling, Microgrid, example, Load flow analysis and stability analysis, evaluation
4th Seminar	18-19 Jan 2023	Review with feedbacks and exercise of grid analysis with scenario cases	Detailed system and countermeasures, protection, Exercise of tools for grid analysis with various RE scenarios
Final JCC	Mar 2023	To confirm outcome of project and way forward	Review of TC activity output, policy recommendation, Program in Japan

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (1)

Seminar	Agenda of 1st Seminar	Participants
1st Seminar 3, 4, & 5 Oct 2022	<Day-1 on-line only> **Basics of Power System Engineering for Grid Stability** 1. What is Power System?, Three-phase AC, Single line network description 2. Per Unit Method 3. Modeling of Power System Equipment: Transmission Line Transformer, Generator & Load 4. Active Power & Frequency: Frequency control, Area requirement 5. Reactive Power & Voltage: P-V Curve, Reactive power resource 6. Practice of Modeling of Grid	Day-1: 61 nos in total (joint with Barbados 2nd Seminar) MPI:3, SKEKEC:10, NEVLEC:3 NIA:1 Other :44
	<Day2 online/off-line hybrid > **Basics and Exercise for Load Flow Analysis** 1. Overview of Load Flow Analysis: Purpose, Methods, Modeling of grid 2. Newton-Raphson Method: Theory, Characteristics 3. DC Flow Method: Theory, Simple method to solve load flow manually 4. Exercise of DC Flow Method 5. Practice on Microgrid/VPP Designer 6. Load Flow Analysis & Evaluation of sample Grid	Day-2: 44 nos (joint with Barbados 2nd seminar) MPI:3, SKEKEC:10, NEVLEC:3 NIA:1, Other :27
	<Day-3 on-line/off-line hybrid> **Analysis of Grid Stability and LFC/ELD** **Overview of Stability: Definition, Methods, Swing equation** 1. Stability Model: Simplified grid model, Equivalent circuit of synchronous generator 2. Equal Area Criterion: Theory, Simple method to solve stability manually 3. Available Transmission Capacity & Spinning Reserve 4. Exercise of Equal Area Criterion 5. Practice on Microgrid/VPP Designer and LFC/ELD 6. Discussion for Interconnection, RE and Grid Stabilization in St. Kitts&Nevis	Day-3: 17 nos MPI:3, SKEKEC:10, NEVLEC:3 NIA:1

Activity and Achievement (RE)

Seminars on Grid Stability and Large RE (2)

Seminar	Agenda of 2nd Seminar	Participants
2nd Seminar 6 Dec (full day)	<Day-1 on-line >: **Preparation for Exercise and Grid Modeling** 1. Opening Remarks. 2. Project Outline, Feedback of 2nd seminar, Microgrid, Why Grid Stability is necessary 3. Grid Modeling 4. Basics of Power System Engineering, 5. Load Flow Analysis and its Evaluation 6. Transient Stability Analysis and Evaluation of Stability. 7. Discussion	Day1: 45 nos (Joint with Barbados) MPI:3, SKEKEC:12, NEVLEC:6
8, Dec 2022 (Half day	<Day-2 on-line> **Exercise for Grid Analysis** 1. Introduction and Schedule 2. Evaluation of Load Flow Analysis by Microgrid Designer, and Transient Stability Analysis 3. Example of LFC and ELD in Microgrid Designer 4. Hydrogen and Ammonia concept with Nevis Geothermal 5. Draft Program of Training in Japan 6. Consideration of Large VRE into Grid, Discussion	Day-2: 21nos MPI:3, SKEKEC:12, NEVLEC:6,

Activity and Achievement (RE)

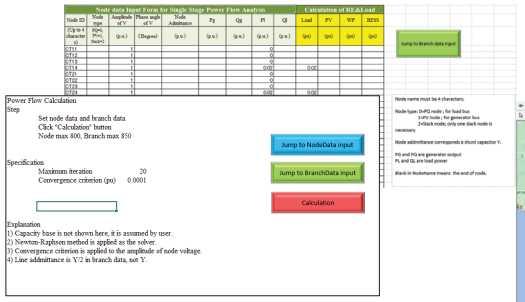
Seminars on Grid Stability and Large RE (3)

Seminar	Agenda of 3rd Seminar	Participants
3rd Seminar 17-18, Jan 2023 (All full day)	<Day-1 on-line only> **Review of grid analysis with scenario cases** 1. Introduction for the Seminar, Review, and feedback 2. RE and Microgrid Planning, 3. Grid Forming Inverter and its Safety - Current Status, Blackout with GFM & Black Start using BESS 1. Battery & Hydrogen as an Electricity Storage, cost comparison 2. Special Protection System including Load Shedding, PV/WT Trip 3. Inter-connection, Simulation Cases for future grid of St. Kitts &Nevis 4. Harmonics and filtering. 5. Measurement Function of Inverter, Grid Code 6. Sample of Other Countries Situations of Grid and RE 7. Demonstration of Asset Management System 8. Presentation from SKELEC and NEVLEC about current status and challenges	Day-2: 14 nos MPI:2, NIA:2, SKEKEC:4, NEVLEC:4, NWD: 2
	<Day-2 on-line/off-line hybrid > **Grid analysis with scenario cases** 1. Introduction of Microgrid Designer and Transient Analysis - Role of Tools for Power System Analysis, - Load Flow Analysis - Transient Stability Analysis for Operation and Control 2. Investment of MW and MWh of Energy Storage for VRE 3. Exercise on simple grid example and Microgrid - Load Flow Analysis, - Transient Stability Analysis 4. Exercise on Future Grid: Design, Operation Planning - Load Flow Analysis, - Transient Stability Analysis 5. Analysis Result and Countermeasure of Grid Stability 6, Discussion, policy recommendation, and Way Forward 7. Conclusion and Closing Remarks	Day-2: 14 nos MPI:2, NIA:2, SKEKEC:4, NEVLEC:4, NWD: 2

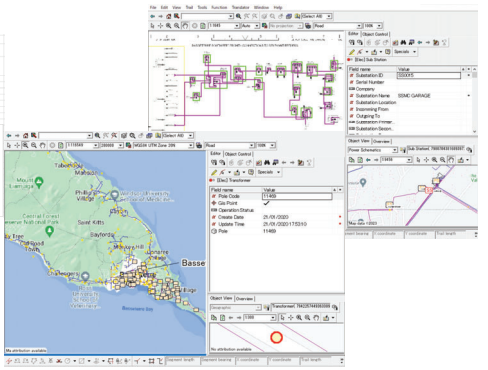
Activity and Achievement (RE)

Provision of Software

- Software for grid analysis “Microgrid Designer” were handed over and training was conducted.
  - *Replacement to new folder to be provided is requested to cope with error.*
- Demonstration of asset management “Smallworld” were provided to SKELEC with software installation.
  - *License is up to Mar 2023, to be extended half year.*



Grid Modeling tool “Microgrid Designer “



Asset Management tool “Smallworld “

Activity and Achievement (EE): #1 Workshop

Year 2022

1. Dates and venue

Nov.14-15 (2days),COURTYARD BRIDGETOWN, BARBADOS

2. Participants

Participated relevant entities(St. Kitts & Nevis)		
Name of entity		# of participants (16 persons in total)
MPI	Ministry of Public Infrastructure	3 persons (online)
NIA	Nevis Island Administration	2 persons (online)
SKELEC	St. Kitts Electricity Company	2 persons (on site)/ 4 persons (online)
NEVLEC	Nevis Electricity Company	2 persons (on site)/ 2persons (online)
NWD	Nevis Water Department	1 person (on site)

Activity and Achievement (EE): #1 Workshop

3. Workshop program (Day 1: Nov.14 (Mon))

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Self-introduction of participants	All	15
10:15	<Presentation> Energy Management & Energy Audit (International Standards and introduction of successful practices)	JET	50
11:05	Q&A	All	20
11:25	Break Time	-	15
11:40	<Demonstration> Data Logger and its Software	JET	15
11:55	Q&A	All	15
12:10	Lunch Time	-	60
13:10	<Presentation> EV and Storage Battery Market Trends	JET	60
14:10	Q&A	All	20
14:30	Closing	-	-

Activity and Achievement (EE): #1 Workshop

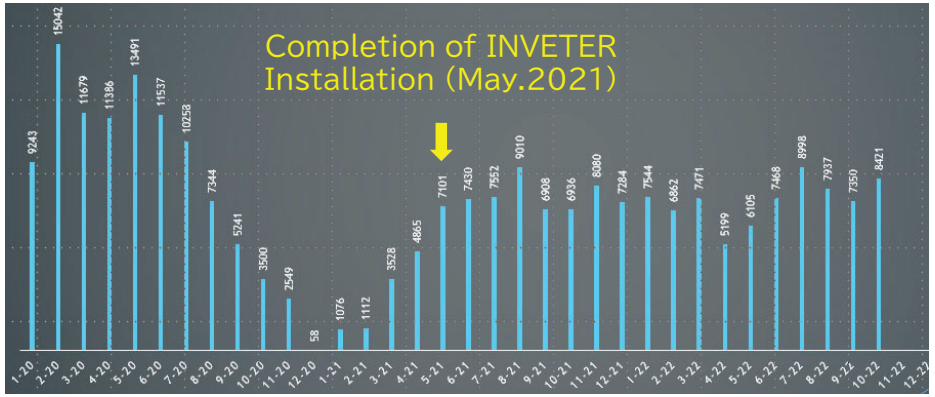
3. Workshop program (Day 2: Nov.15 (Tue))

Time	Contents	Speaker	Session Time (min.)
10:00	<Presentation> Successful implementation in EE improvements at pumping stations	NWD	25
10:25	Q&A	All	15
10:40	Break Time	-	10
10:50	<Presentation> EE Roadmap with country energy balance and efficient technologies (residential sector)	JET	50
11:40	Q&A	All	15
11:55	<Key note speech> EE in St. Kitts and Nevis	MPI	20
12:15	Lunch time	-	60
13:15	<Presentation> Introduction of Energy Efficiency Building Code in Japan	JET	40
13:55	Q&A	All	15
14:10	<Discussion time> *Energy Auditors/Managers system, ESCO business opportunities?*	All	30
14:40	Photo Session - Closing (15:00)	All	20

Activity and Achievement (EE): #1 Workshop

- **Approximately 30% energy savings has been observed** with inverter introduction to 8 water pumps out of 17 pumps (by NWD)

Power Consumption Trend at PADLOCK #1 Pumping Station



Source:: NWD material

Activity and Achievement (EE): #2 Workshop

1. Dates and venue

Jan.16-17 (2days), COURTYARD BRIDGETOWN, BARBADOS

2. Participants

Participated relevant entities(St. Kitts & Nevis)		
Name of entity		# of participants (24 persons in total)
MPI	Ministry of Public Infrastructure	2 persons (on site)
NIA	Nevis Island Administration	2 persons (on site)/ 1 person (online)
SKELEC	St. Kitts Electricity Company	4 persons (on site)/ 6 persons (online)
NEVLEC	Nevis Electricity Company	4 persons (on site)/ 3 persons (online)
NWD	Nevis Water Department	2 persons (on site)

Activity and Achievement (EE): #2 Workshop

3. Workshop program (Day 1: Jan.16 (Mon))

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Opening Remarks	MPI	10
10:10	<Presentation> Part-1 Energy balance, EE&C roadmap (residential & commercial sector integration) Break Time <Presentation> Part-2 Energy balance, EE&C roadmap (residential & commercial sector integration) <Presentation (additional)> Energy Efficiency Policy in Japan Q&A	JET	110
12:00	Lunch Time	-	
13:00	<Presentation> Part-1 EE Building Code (Including Okinawa Situation and EE&C Evaluation Study) Break Time <Presentation> Part-2 EE Building Code (Including Okinawa Situation and EE&C Evaluation Study) Q&A	JET	120
15:00	Closing	-	-

Activity and Achievement (EE): #2 Workshop

3. Workshop program (Day 2: Jan.17 (Tue))

Time	Contents	Speaker	Session Time (min.)
9:30	Reception Start	-	-
10:00	Recap of First Day	JET	10
10:10	<Presentation> Report on Energy Audits Results including Walk Through Survey <Presentation (additional)> Energy Audit Best Practice at Aquarium & Amusement Park in Japan	JET	80
	Q&A		
11:30	Break Time	-	15
11:45	<Demonstration> Data Logger Software	JET	15
12:00	Lunch time	-	60
13:00	<Presentation> Lecture on Organizational Collaboration	JET	60
	Q&A		
14:00	Break Time	-	15
14:15	<Free discussion time: Request and needs during Japan training>	All	20
14:35	Closing Remarks	NIA	10
14:45	Photo Session	All	15
15:00	Closing	-	

Activity and Achievement (EE): Workshop Summary

1. Summary of Workshops Contents

	Contents of Workshops	WS
I.	Energy Management & Energy Audit (International Standards and introduction of successful practices)	#1WS
II-a.	EE Roadmap with Country Energy Balance and efficient technologies (residential sector)	#1WS
II-b.	EE&C Roadmap with Country Energy Balance and efficient technologies (residential & commercial sector integration)	#2WS
III-a.	Introduction of EE Building Code in Japan	#1WS
III-b.	EE Building Code (Including Okinawa & Hawaii Situation and EE&C Evaluation Study)	#2WS
IV.	Report on Energy Audits Results including Walk Through Survey	#2WS
V.	Demonstration: Data Logger Software	#1,2WS

Activity and Achievement (EE): Workshop Summary

2. Comments from Participants

Comments collected after #1 EE Workshop
✓ Great sessions, very informative.
✓ Very informative. I have gain knowledge that I thought was not necessary. This has now broaden my scope.
Comments collected after #2 EE Workshop
✓ the overall training was very informative and education.
✓ There isn't much more to be touched on, I think the facilitators did an excellent job in disseminating the information on hand.
✓ Great Training I look forward to the next one.
✓ Great Presentation. JICA should visit St. Kitts & Nevis.
✓ Very good presentation.
✓ Very informative presentations. Presenters were engaging and offered practical examples.
Topics you would like us to cover at next training (after #2 EE workshop)
Leadership in EE and Management of Resources to support EE

Activity and Achievement (EE): Data Loggers

- **Demonstration was conducted and data loggers were handed over to St. Kitts and Nevis**
  - St. Kitts: 1 data logger
  - Nevis: 1 data logger

Source: https://nia.gov.kn/nevis-government-grateful-for-electrical-equipment-donated-by-japanese-agency/

Confirmation of PDM (Project Design Matrix)

Overall Goals & Achievement

Description	Verifiable Indicator	Achievement
Overall Goal Energy security is ensured through introduction of renewable energy	1. Energy self-dependency Target Value: **100% RE in Power Generation by 2030** 2. Imported amount of fossil fuel Target Value: **2% of total fuel import**	1. Approximately 2 percent 2. Unchanged

Project Purpose & Achievement (1)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant Target Value: - **PV 35MW by 2020** - **Wind 5MW** - **BESS 44.2MWh (St. Kitts)** - **Geothermal power 9MWh (Nevis)**	1. EC$ 25,000 budgeted for RE training in 2023 ＊1 EC $ = about 50 JPY 25,000 ＊ 50 =1,250,000 JPY

Project Purpose & Achievement (2)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	2. Number of public buildings with EE program including BEMS Target Value: **Proposal by JET will be prepared for the BEMS introduction**	2. EC$ 30,000 budgeted for EE promotion in 2023 ＊1 EC $ = about 50 JPY 30,000 ＊ 50 =1,500,000 JPY

Project Purpose & Achievement (3)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	**3.** Number of trained staffs for introduction of RE Target Value:**10 personnel**	**3.** In total, number of participants (accumulated total) was 62 personnel **Average:** 62/4 = 15.5 personnel/time - Remote training in Dec 2020 was 18 personnel - 1st Seminar in Oct 2022 was 11 personnel - 2nd Seminar in Dec 2022 was 19 personnel - Final (3rd) Seminar in Jan 2023 was 14 personnel

Project Purpose & Achievement (4)

Description	Verifiable Indicator	Achievement
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	4. Number of trained staffs for promotion of EE Target Value: **10 personnel**	4. In total, number of participants (accumulated total) was 58 personnel **Average:** 58/4 = 14.5 personnel/time - Demonstration on EE roadmap program etc. in Feb 2020 was 10 personnel - Remote training in Dec 2020 was 18 personnel - 1st Workshop in Nov 2022 was 16 personnel - Final (2nd) Workshop in Jan 2023 was 14 personnel

Output 1 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	**1-1.** Assessment of number and qualification of staffs responsible for RE **1-2.** Human resource development plan for the introduction of RE **1-3.** Number of training courses for the introduction of RE **1-4.** Total capacity of RE	**1-1.** Confirmed **1-2.** Confirmed **1-3.** Confirmed **1-4.** Confirmed *** Achievement of Output 1 was already confirmed when 1st JCC which was held in Nov 2019**

Output 2 & Achievement

Description	Verifiable Indicator	Achievement
Outputs Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	**2-1.** Assessment of number and qualification of staffs responsible for EE **2-2.** Human resource development plan for the introduction of EE **2-3.** Number of training courses for the promotion of EE **2-4.** Number of facilities conducted energy audit	**2-1.** Confirmed **2-2.** Confirmed **2-3.** Confirmed **2-4.** Confirmed *** Achievement of Output 2 was already confirmed when 1st JCC which was held in Nov 2019**

Output 3 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-1.** Number of trained staffs Target Value: **10 personnel** **3-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**3-1.** In total, number of participants (accumulated total) was **62 personnel** **Average: 15.5 personnel/time** **3-2.** In total, **5 (6) materials** were prepared. - 1 manual for simulation software of system analysis. - 1 training material for remote training in Dec 2020. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan (Available next month)

Output 3 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-3.** Number of participants of workshops to disseminate introduction of RE to the relevant organizations Target Value: - **Kick-off workshop: 9 personnel** - **Final workshop: 10 personnel**	**3-3.** - Kick-off workshop in Nov 2019 was **9 personnel** - Remote training about 'impact of COVID-19 on RE' in Dec 2020 was 18 personnel - 1st Seminar in Oct 2022 was 11 personnel - 2nd Seminar in Dec 2022 was 19 personnel - Final (3rd) Seminar in Jan 2023 was **14 personnel**

Output 3 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	**3-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**3-4.** In total, **5 times** - Kick-off workshop was conducted in Nov 2019 - Remote training about 'impact of COVID-19 on RE' in Dec 2020 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Dec 2022 - Final (3rd) Seminar was conducted in Jan 2023

Output 4 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-1.** Number of trained staffs Target Value: **10 personnel** **4-2.** Textbooks/ manuals Target Value: **3 programs** (2 domestic trainings and 1 training in Japan)	**4-1.** In total, number of participants (accumulated total) was **58 personnel** **Average: 14.5 personnel/time** **4-2.** In total, **3 (4) materials** were prepared. - 1 training material for remote training in Dec 2020. - 2 training materials about 'Energy Efficiency Workshop' for domestic training in Nov 2022 and Jan 2023. - 1 training material for training in Japan in Apr 2023. (Available next month)

Output 4 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-3.** Number of participants of workshops to disseminate promotion of EE to the relevant organizations Target Value: - **Kick-off workshop: 9 personnel** - **Final workshop: 10 personnel**	**4-3.** - Kick-off workshop in Nov 2019 was 9 personnel - Demonstration on EE roadmap program and power consumption measurement was conducted in Feb 2020 was 10 personnel - Remote training in Dec 2020. Number of participants was 18 personnel - 1st Workshop in Nov 2022 was 16 personnel - Final (2nd) Workshop in Jan 2023 was 14 personnel

Output 4 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	**4-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**4-4.** In total, 4 times - Kick-off workshop was conducted in Nov 2019 - Remote training about 'impact of COVID-19 on EE' in Dec 2020 - 1st workshop was conducted in Nov 2022 - Final (2nd) workshop was conducted in Jan 2023

Output 5 & Achievement (1)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-1.** Number of trained staffs Target Value: **10 personnel** **5-2.** Textbooks/ manuals Target Value: **2 programs** (1 domestic trainings and 1 training in Japan)	**5-1.** In total, number of participants (accumulated total) was 62 personnel **Average: 15.5 personnel/time** **5-2.** In total, 4 (5) materials were prepared. - 1 training material for remote training in Dec 2020. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan (Available next month)

Output 5 & Achievement (2)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-3.** Number of participants of workshops to disseminate promotion of power network resiliency to the relevant organizations Target Value: - **Kick-off workshop: 9 personnel** - **Final workshop: 10 personnel**	**5-3.** - Kick-off workshop in Nov 2019 was 9 personnel - Remote training about 'impact of COVID-19 on RE' in Dec 2020 was 18 personnel - 1st Seminar in Oct 2022 was 11 personnel - 2nd Seminar in Dec 2022 was 19 personnel - Final (3rd) Seminar in Jan 2023 was 14 personnel

Output 5 & Achievement (3)

Description	Verifiable Indicator	Achievement
Outputs Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	**5-4.** Number of workshops Target Value: **2 times** (Kick-off workshop and Final workshop)	**5-4.** In total, **5 times** - Kick-off workshop was conducted in Nov 2019 - Remote training about 'impact of COVID-19 on RE' in Dec 2020 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Dec 2022 - Final (3rd) Seminar was conducted in Jan 2023

Discussion

Closing Remarks from MPI

Thank you.

PM Form 3-1 Monitoring Sheet Summary

TO CR of JICA JAMAICA OFFICE

Project Monitoring Sheet (Jamaica)

Project Title: The Project to Promote Energy Efficiency in Caribbean Countries
Version of the Sheet: Ver.6（Term: October 2022 – May 2023）

Name: Mrs. Olive Wilson Cross
Title: Director Programme Management
Name: Mr. Tomoyasu Fukuchi
Title: Team Leader
Submission Date: 24th May 2023

I. Summary

1 Progress

1.1. Progress of Inputs

1.1.1. Inputs from the Japan Side

(1) Dispatch of Japanese Experts

- ✓ JICA expert team (JET) postponed its field activities due to continuous travel restrictions caused by COVID-19 from March 2020 by June 2022. Under the circumstance, JET was continuing remote activities in Japan and related research as well as preparation of trainings were conducted. JET has resumed the field activities since July 2022.
- ✓ Actual assignments of JET in this project for three target countries (Jamaica, St. Kitts & Nevis, and Barbados) are shown below.

Assignments of JET in the project (three countries)

No	Technical Area	Total MM (Apr 2019–Apr 2023)		
		Field	Field	Field
1	Chief advisor/ Power System/Diesel/Gas-turbine Power Plant (2)	0.97	0.97	0.97
2	Subchief Advisor/Power system (2)	2.30	2.30	2.30
3	Renewable Energy	4.37	4.37	4.37
4	Energy Efficiency	4.93	4.93	4.93
5	Grid Stabilization	3.26	3.26	3.26
6	Diesel/Gas-turbine Power Plant/Coordinator	1.53	1.53	1.53
7	Human Resources Development/Monitoring	2.57	2.57	2.57
8	Grid Stabilization (2)/ Power Network Asset Management/Coordinator (2)	4.33	4.33	4.33
	Total	**24.26**	**24.26**	**24.26**

(2) Assignment of Local Staff

✓ Local staff was continuously assigned to support JET.

Assignment of Local Staff

No	Name of Local Staff
1.	Mr. Kevin Douglas

(3) Equipment

✓ One power logger was provided to BSJ in November 2022.

✓ One power logger was provided to MSET in March 2023.

1.1.2. Inputs from Jamaica Side

(1) Assignment of Counterparts

✓ Mrs. Olive Wilson Cross, Director Programme Management was assigned.

✓ Project implementation structure of C/P was formed.

1.2. Progress of Activities

✓ JET conducted coordination of business trip schedule as well as whole project schedule during the monitoring period.

✓ JET (RE team) conducted the 6th field visit in Jamaica and Barbados in October 2022. JET

(RE team) conducted the 7th field visit in Jamaica, St. Kitts & Nevis (online), and Barbados in November and December 2022. JET (RE team) conducted the 8th field visit in St. Kitts & Nevis (online) and Barbados in January and February 2023.

- ✓ JET (EE team) conducted the 7th field visit in Jamaica, St. Kitts & Nevis (in Barbados and online), and Barbados in November 2022. JET (EE team) conducted the 8th field visit in St. Kitts and Nevis (online) and Barbados in January and February 2023.
- ✓ JET (RE team and EE team) conducted reporting meeting of the 7th field visit and pre-departure briefings of the 8th field visit in December 2022.
- ✓ JET prepared the 5th and 6th contract change during the monitoring period.
- ✓ JET discussed on the details of the potential program including potential sites for training in Japan.
- ✓ JET submitted Draft Final Report to JICA in February 2023.
- ✓ JET conducted the 3rd JCC with C/Ps in March 2023. (Jamaica: 30th March via online, St. Kitts & Nevis: 21st March via online, and Barbados: 27th March both face to face and via online).
- ✓ JET conducted the 9th field visit in Barbados (RE team) and Jamaica (EE team) in March and April 2023.
- ✓ JET coordinated with C/Ps and JICA regarding invitation for training in Japan. Training in Japan was conducted in April 2023.
- ✓ JET submitted monitoring sheets in October 2022 and May 2023.
- ✓ JET has prepared the Final Report both in English and Japanese for submission in Jun 2023.

1.3. Achievement of Output

(1) Achievement of Outputs

Technical transfer in phase 2 has been implemented for Output 3, Output 4 and Output 5. The status of Achievement of Output is shown below.

Achievement of each Output on PDM (October 2019 – May 2023)

Output	Indicator	Target Value	Achievement
Overall Goal: Energy security is ensured through introduction of RE	1.Energy self-dependency	50% (50%RE by 2030)	As of March 2023, RE generation accounts for 12.4% of total generation.
	2. Imported amount of fossil fuel	To 80% (20% by RE in energy base)	As of March 2023, imported amount of fossil fuel is 87.6% in energy base.
Project Purpose: Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant	To be set according to IRP	PV Total = 57MW; Wind Total = 101MW; Battery Total (plus Fly Wheel) = 24.5MW; Hydro Power Total = 28.6MW
	2. Number of public buildings with EE program including BEMS	EE program in total for 44 facilities in next 4 years	Number of public buildings which are implemented or introduced EE program is approximately 60 since 2015.
	3. Number of trained staffs for introduction of RE	Domestic trainings: 20-30 personnel Training in Japan: 1-4 personnel	In total, number of participants (accumulated total) was 125 personnel
	4. Number of trained staffs for promotion of EE	Domestic trainings: 20-30 personnel Training in Japan: 1-4 personnel	In total, number of participants (accumulated total) was 21 personnel

Output 3: (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	3-1. Number of trained staffs	MSET/PCJ: 6 personnel	In total, number of participants (accumulated total) was 125 personnel
	3.2. Textbooks/ manuals	For 3 programs (2 domestic trainings and 1 training in Japan)	In total, 4 materials were prepared.
	3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations	Kick-off workshop: 15 personnel Final workshop: 20-30 personnel	In total, number of participants (accumulated total) was 123 personnel
	3-4. Number of workshops	2 times (Kick-off workshop and Final workshop)	In total, 4 times.
Output 4: (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	4-1. Number of trained staffs	MSET/PCJ: 4 personnel	In total, number of participants (accumulated total) was 21 personnel
	4-2. Textbooks/ manuals	For 3 programs (For 2 domestic trainings and 1 training in Japan)	In total, 3 materials were prepared.
	4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations	Kick-off workshop: 15 personnel Final workshop: 20-30 personnel	In total, number of participants (accumulated total) was 19 personnel
	4.4. Number of workshops	2 times (Kickoff workshop and Final workshop)	In total, 3 times.

Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	5-1. Number of trained staffs	MSET/PCJ: 6 personnel	In total, number of participants (accumulated total) was 125 personnel.
	5-2. Textbooks/ manuals	For 2 programs (For 1 domestic training and 1 training in Japan)	In total, 4 materials were prepared.
	5-3. Number of participants of workshops to disseminate promotion of Power Network Resilience to the relevant organizations	Kick-off workshop: 15 personnel Final workshop: 20-30 personnel	In total, number of participants (accumulated total) was 123 personnel.
	5-4. Number of workshops	2 times (Kick-off workshop and Final workshop)	In total, 4 times.

(2) Evaluation of Trainings

JET was conducted following trainings and monitoring activities using following questions.

Q.1. Was JICA experts' explanation clear and easy to understand?
Q.2. Were training materials well organized and easy to understand?
Q.3. Was the content of lecture enough to understand?
Q.4. Were JICA experts maximize participants' opportunities?
Q.5. Were training aids and facilities are satisfied?
Q.6. If you have any topics that you would like us to cover next training, please write down.
Q.7. Do you have any other comments?

Overview of each training is shown below.

List of Trainings (October 2022 – March 2023)

Time	Target country	Contents	No. of Participants	Score (*/5)
Jul 2022	Barbados	1st RE grid stability seminar	4	-
Oct 2022	Barbados, St. Kitts & Nevis	2nd RE grid stability seminar for Barbados 1st RE grid stability seminar for St. Kitts & Nevis	44	3.3
Oct 2022	**Jamaica**	**1st RE grid stability seminar**	**31**	**4.3**
Nov 2022	St. Kitts & Nevis	1st EE workshop	12	3.8
Nov 2022	Barbados	1st EE workshop	5	3.7
Dec 2022	**Jamaica**	**2nd RE grid stability seminar**	**45**	**3.9**
Dec 2022	Barbados	3rd RE grid stability seminar	19	3.8
Dec 2022	St. Kitts & Nevis	2nd RE grid stability seminar	19	3.8
Jan 2022	St. & Nevis	2nd EE workshop	11	4.4
Jan 2022	Barbados	2nd EE workshop	11	3.9
Jan 2022	St. Kitts & Nevis	3rd RE grid stability seminar	14	3.8
Jan 2022	Barbados	4th RE grid stability seminar	13	4.1
Feb 2022	**Jamaica**	**1st EE workshop**	**3**	**4.5**
Mar 2022	**Jamaica**	**2nd EE workshop**	**8**	**3.9**

(3) Training in Japan

✓ Training in Japan was conducted in April 2023. 9 participants had lectures, site visits and reporting session. Participants learnt RE and EE efforts in Japan. Details was shown in the report prepared by JET.

1.4. Achievement of the Project Purpose

✓ As mentioned above.

1.5. Changes of Risks and Actions for Mitigation

✓ Travel restrictions caused by COVID-19

✓ Meteorological influence (hurricane etc.)

1.6. Progress of Actions undertaken by JICA

✓ JICA coordinated with C/Ps and JET regarding invitation for training in Japan.

1.7. Progress of Actions undertaken by C/P

✓ C/P timely provided information of travel restrictions caused by COVID-19 in the country to JET.

1.8. Progress of Environmental and Social Considerations (if applicable)

✓ N/A

1.9. Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

✓ N/A

1.10. Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

✓ N/A

2. Delay of Work Schedule and/or Problems (if any)

2.1. Detail

✓ Field activities have been postponed due to COVID-19 since March 2020 to June 2022.

2.2. Cause

✓ Due to JICA's recommendation due to COVID-19 mentioned in 1.6.

2.3. Action to be taken

✓ Project schedule was reviewed in anticipation of resuming field assignments from April 2021 and April 2022. End of project has been extended for 1 year and 3 months by June 2023 from March 2022.

2.4. Roles of Responsible Persons/Organization (JICA, C/P)

✓ N/A

3. Modification of the Project Implementation Plan

3.1. PO

✓ Project schedule was reviewed in anticipation of resuming field assignments from April 2021. End of project has been extended for 1 year and 3 months by June 2023 from March 2022.

3.2. Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

✓ N/A

4. Current Activities of Gov. of Jamaica to Secure Project Sustainability after its Completion

✓ N/A

II. Project Monitoring Sheet I & II

as Attached

Project Monitoring Sheet I (Revision of Project Design Matrix)

Project Title: Technical Cooperation to Promote Energy Efficiency in the Caribbean Countries
Implementing Agency: MSET (Ministry of Science, Energy and Technology)
Target Group: Senior engineer, Engineer, Senior technical officer, Technical officer
Period of Project: 4 Years, Phase 1: 6 months, Phase 2: 42 months
Project Site: Jamaica

Version : 6
Date: 24th May 2023

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
Overall Goal Energy security is ensured through introduction of renewable energy (hereinafter referred to as "RE") and promotion of energy efficiency (hereinafter referred to as "EE")	1. Energy self-dependency ***Target Value**:50% (50%RE by 2030)* 2. Imported fossil fuel reduction ***Target Value**: To 80% (20% by RE in energy base)*	Data from annual report	The current relevant policies on promotions of RE and EE are sustained after the Project.	1. As of March 2023, RE generation accounts for 12.4% of total generation. 2. As of March 2023, imported amount of fossil fuel is 87.6% in energy base.	
Project Purpose Human and institutional capacities are enhanced for the introduction of RE and promotion of EE	1. Number of RE facilities such as PV power station, wind generating facility, battery application, high-efficiency thermal power plant ***Target Value**: To be set according to IRP* 2. Number of public buildings with EE program including BEMS: Building Energy Management System ***Target Value:** EE program in total for 44 facilities in next 4 years)* 3. Number of trained staffs for introduction of RE ***Target Value:** Domestic trainings: 20-30 personnel, Training in Japan: 1-4 personnel* 4. Number of trained staffs for promotion of EE ***Target Value:** Domestic trainings: 20-30 personnel, Training in Japan: 1-4 personnel*	Project Report	C/P agency continues commitment to the Project by continuing budget allocation as well as assignment of personnel for the post- Project activities.	1. PV Total = 57MW; Wind Total = 101MW; Battery Total (plus Fly Wheel) = 24.5MW; Hydro Power Total = 28.6MW 2. Number of public buildings which are implemented or introduced EE program is approximately 60 since 2015. 3. In total, number of participants (accumulated total) was 117 personnel - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was 39 personnel - 2 officers participated in the training in Japan. 4. In total, number of participants (accumulated total) was 21 personnel - Demonstration on EE roadmap program etc. in Feb 2020 was 8 personnel - 1st Workshop in Feb 2023 was 3 personnel - Final (2nd) Workshop in Mar 2023 was 8 Personnel - 2 officers participated in the training in Japan.	
Outputs Output 1 (to be achieved in Phase 1) The basic information is confirmed for the capacity building for the introduction of RE	1-1. Assessment of number and qualification of staffs responsible for RE 1-2. Human resource development plan for the introduction of RE 1-3. Number of training courses for the introduction of RE 1-4. Total capacity of RE	Project Report		1-1. Confirmed 1-2. Confirmed 1-3. Confirmed 1-4. Confirmed	There was an organizational reform of MSET and PCJ. Information of the organizational reform will be updated by JET.
Output 2(to be achieved in Phase 1) The basic information is confirmed for the capacity building for the promotion of EE	2-1. Assessment of number and qualification of staffs responsible for EE 2-2. Human resource development plan for the introduction of EE 2-3. Number of training courses for the promotion of EE 2-4. Number of facilities conducted energy audit	Project Report		2-1. Confirmed 2-2. Confirmed 2-3. Confirmed 2-4. Confirmed	There was an organizational reform of MSET and PCJ. Information of the organizational reform will be updated by JET.
Output 3 (to be achieved in Phase 2) The human and institution capacity are enhanced for the introduction of RE	3-1. Number of trained staffs ***Target Value:** MSET/PCJ: 6 personnel* 3-2. Textbooks/ manuals ***Target Value:** For 3 programs (2 domestic trainings and 1 training in Japan)* 3-3. Number of participants of workshops to disseminate introduction of RE to the relevant organizations ***Target Value:** Kick-off workshop: 15 personnel, Final workshop: 20-30 personnel* 3-4. Number of workshops ***Target Value:** 2 times (Kick-off workshop and Final workshop)*	Project Report		3-1. In total, number of participants (accumulated total) was 125 personnel 3-2. In total, 4 materials were prepared. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Nov 2022 and Feb 2023. - 1 training material for training in Japan 3-3. In total, number of participants (accumulated total) was 123 personnel - Kick-off workshop in Nov 2019 was 8 personnel - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was 39 personnel	

				3-4. In total, 4 times - Kick-off workshop was conducted in Nov 2019 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Nov 2022 - Final (3rd) Seminar was conducted in Feb 2023	
Output 4 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of EE	4-1. Number of trained staffs ***Target Value:*** *MSET/PCJ: 4 personnel* 4-2. Textbooks/ manuals ***Target Value:*** *For 3 programs (2 domestic trainings and 1 training in Japan)* 4-3. Number of participants of workshops to disseminate promotion of EE to the relevant organizations ***Target Value:*** *Kick-off workshop: 15 personnel, Final workshop: 20-30 personnel* 4-4. Number of workshops ***Target Value:*** *2 times (Kick-off workshop and Final workshop)*	Project Report		4-1. In total, number of participants (accumulated total) was 21 personnel 4-2. In total, 3 materials were prepared. - 2 training materials about 'Energy Efficiency Workshop' for domestic training in Feb and Mar 2023. - 1 training material for training in Japan in Apr 2023. 4-3. In total, number of participants (accumulated total) was 19 personnel - Kick-off workshop in Nov 2019 was 8 personnel - 1st Workshop in Feb 2023 was 3 personnel - Final (2nd) Workshop in Mar 2023 was 8 personnel 4-4. In total, 3 times - Kick-off workshop was conducted in Nov 2019 - 1st workshop was conducted in Feb 2023 - Final (2nd) workshop was conducted in mar 2023	
Output 5 (to be achieved in Phase 2) The human and institution capacity are enhanced for the promotion of Power Network Resiliency	5-1. Number of trained staffs ***Target Value:*** *MSET/PCJ: 6 personnel* 5-2. Textbooks/ manuals ***Target Value:*** *For 2 programs (For 1 domestic training and 1 training in Japan)* 5-3. Number of participants of workshops to disseminate promotion of Power Network Resilience to the relevant organizations ***Target Value:*** *Kick-off workshop: 15 personnel, Final workshop: 20-30 personnel* 5-4. Number of workshops ***Target Value:*** *2 times (Kick-off workshop and Final workshop)*	Project Report		5-1. In total, number of participants (accumulated total) was 125 personnel (Domestic training 123 personnel + Training in Japan 2 personnel) 5-2. In total, 4 materials were prepared. - 3 training materials about 'Seminar on Grid stability and RE' for domestic training in Oct, Dec 2022 and Jan 2023. - 1 training material for training in Japan 5-3. In total, number of participants (accumulated total) was 123 personnel - Kick-off workshop in Nov 2019 was 8 personnel - 1st Seminar in Oct 2022 was 31 personnel - 2nd Seminar in Nov 2022 was 45 personnel - Final (3rd) Seminar in Feb 2023 was 39 personnel 5-4. In total, 4 times - Kick-off workshop was conducted in Nov 2019 - 1st Seminar was conducted in Oct 2022 - 2nd Seminar was conducted in Nov 2022 - Final (3rd) Seminar was conducted in Feb 2023	

Activities	**Inputs**		Important Assumptions
Activities for achieving Output 1 1-1. To verify the fundamental indicators for the power supply side, e.g. access to electricity (electrification rate), cost (composition of power sources, electricity tariff), low carbon (CO_2 emission coefficient) and power system reliability (SAIDI/SAIFI), etc. 1-2. To verify the existing situations in introduction of the technologies of grid stabilization and relevant policies/ national plans pertaining to RE 1-3. To verify human and institutional capacities for the introduction of RE	**(Japanese side)** 1. Dispatch of the Japanese experts in respect of following: - Chief advisor/ Power System/Diesel/Gas-turbine Power Plant (2) - Subchief Advisor/Power system (2) - Renewable Energy - Energy Efficiency - Grid Stabilization - Diesel/Gas-turbine Power Plant/Coordinator - Human Resources Development/Monitoring - Grid Stabilization (2)/ Power Network Asset Management/Coordinator (2) 2. Training in Japan -Micro Grid system including Grid Stabilization	**(Jamaica side)** 1. Assignment of C/Ps -Project Director (P/D) -Project Manager (P/M) - Other C/Ps 2. Facilities and equipment for the Project office To allocate office space with furniture for experts during their stay in Jamaica (desks, chairs, meeting tables, copy machines, etc) 3. Recurrent costs -C/Ps' wages and allowances -In-land transportation and allowances	Most of the trained C/Ps continues commitment to the Project activities Preconditions Contents of the current relevant policies on promotion of RE and EE are not largely changed. Issues and countermeasures
Activities for achieving Output 2 2-1. To verify the fundamental indicators on promotion of EE for the electricity demand side, e.g. electric power consumption unit requirement, final energy consumption, etc. 2-2. To verify the existing conditions in promotion of EE, relevant policies/ national plans 2-3. To verify the existing conditions of transmission and distribution system losses 2-4. To verify human and institutional capacities for the promotion of EE			

Activities for achieving Output 3 3-1. To consider and propose additional policy/ legal system for achieving RE goals 3-2. To introduce micro-grid concept in one of the agreed areas and develop computer modelling based on existing grid data. Identify issues in introducing micro-grid concept in the area. 3-3. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '3-1 through to 3-2' 3-4. To review the training plan though monitoring of the training conducted in Activity '3-3' 3-5. To provide advice on realization of the RE projects in Jamaica 3-6. To provide recommendations on design of the policy/ legal system proposed in Activity '3-1' 3-7. To share the project output among other recipient countries	Technology in small island (e.g. Okinawa, Tokyo and other cities) -Policies and technologies for promotion of EE (Energy load labelling, policies, regulations and incentives) (Tokyo and Other cities) -Site visit in Japan 3. Training/Workshop in each recipient country -Training/Workshop for project counterparts in each recipient country 4. Equipment -Power loggers		
Activities for achieving Output 4 4-1. To consider and propose the EE goals through cost-benefit analysis on introduction of the facilities contributing to EE 4-2. To consider and propose the EE facilities necessary for achieving the EE goals 4-3. To consider and propose necessary technologies for achieving EE goals, including building energy management system (BEMS), etc. 4-4. To consider and propose the necessary policy/ legal system for achieving EE goals such as introduction of energy service company (ESCO) and energy management service, etc. 4-5. To prepare the necessary training plan for doing the above Activities '4-1' through '4-4' 4-6. To conduct training including on the job training (OJT), training in Japan, training for preparation of textbooks/ manuals using the training plan prepared in Activity '4-5' 4-7. To review the training plan though monitoring of the training conducted in Activity '4-6' 4-8. To provide advice on realization of the EE projects 4-9. To provide recommendation on design of the policy/ legal system proposed in Activity '4-4' 4-10. To share the project output among other recipient countries			
Activities for achieving Output 5 5-1. To demonstrate the way to enhance resiliency of power infrastructure using Power Network Asset Management System. *			