Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Seminar on Grid Stability and Large RE
List of Participants for Physical Attendance (18 and 19, Jan 2023)
Venue: Courtyard by Marriott Bridgetown, Barbados

No	Name	Agency	Positionn
1	Bertill Conroy Browne	MPI	Director
2	Denasio Frank	MPI	Energy Officer
3	Curtis Morton	NIA	Electrical Inspector
4	Deora Raoul Pemberton	NIA	Dept. Physical Planner
5	Haniff Woods	SKELEC	Operations Engineer
6	Collin Williams	SKELEC	Meter Manager
7	Rhondel Philip	SKELEC	Engineer
8	Claricia Langley-Stevens	SKELEC	Safety Manager
9	Nelson Horatio Ald Junior Stapleton	NEVLEC	Distribution Manager
10	Starett France	NEVLEC	Planing Officer
11	Resean Maynard	NEVLEC	Linesman II
12	Clayon Everton	NEVLEC	Linesman II
13	Gavin Walters	NWD	Electrical Tech II
14	Sharma Browne	NWD	Electrical Tech II

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Seminar on Grid Stability and Large RE in 18-19 Jan 2023 (B St.Kitts&Nevis): Q&A

No	Type	Question	Name	Answer	Further Notes
1	Question	Can inverter be the source of black start ?	Dr. Bertill, MPI	If GFM is connected with PV and Battery, it can be source of the black start. With GFM, PV and battery can be the source for excitation of generator.	IEEE general meeting paper will provide detailed information.
2	Question	Is Hydrogen used in Japan? How much is the hydrogen demand in Japan?	Mr. Sterret, NEVLEC	The highest demand of hydrogen in Japan is in power sector for generation, followed by fuel cell for automobile.	
3	Question	Do we visit site in Japan?	Mr. Sterret, NEVLEC	FREA in Fukushima has Hydro QBiC system, where we will visit in the Program in Japan.	
4	Question	Does car company manufacture fuel cell vehicle?	SKELEC	Major car company such as Toyota, Honda, Nissan, Mitsubishi, Suzuki are developping Hydrogen car. Toyota Mirai model, for example.	
5	Question	LiB has disadvantage for hire. How safe is hydrogen storage?	NIA	Depends on method for storage. Ventilation is necessary when treating liquidated H2. Hydrogen deteriorates brittleness of metal. Specific material should be applied for pipe and valve infrastructure and plant. Regulatory framework and standard will be necessary.	
6	Question	Nevis has excess geothermal source. How is it practical for export H2 and NH3?	Dr. Bertill, MPI	At this moment Japan has technology for liquid hydrogen but is under development. Cost is expensive. Implementation is still experimental, but Japan will be a candidate for consumer.	
7	Question	(from JET) Does SKELEC and NELVEC have regulation about harmonic?	Dr. Bertill, MPI	(Answer from MPI) StKN does not have regulation about harmonics but consultant suggests it should be less than 5%.	
8	Question	Is there any time schedule for geothermal in St. Kitts?	Nakagawa	(Answer from MPI) There is no specific timeline. It is under exploration stage.	
9	Question	What is the capacity of PV for desalination plant?	Nakagawa	(Answer from MPI) 0.75 MW.	
10	Question	Is any Var compensator or capacitor installed?	Taoka	(Answer from MPI) No var compensator is installed. For wind project it will need voltage control and technical study is being conducted.	
11	Question	Does PV emit CO2? Is RE really emission free?	NEVLEC?	According to NERL report, 50 gCO2/kWh is emitted. It is much smaller than fossil fuel, such as 800 gCO2/kWh for diesel oil.	
12	Question	Is there resource limitation for battery?	SKELEC?	At present, consumption of Li for LiB is increased. Considering current consumption hike for EV, resource limitation of Li is concerned and alternative battery method such as CASE, gravitational battery, Mg-Air, etc., will need to be considered.	
13	Question	(From JET) Voltage compensator is recommended around Lodge village. Is there substation around there?	Mr. Collin, SKELEC	There is a disconnector near in Frola Plant factory.	
14	Question	In Japan there are two frequency system. How power consumer cope with when move from one area to another.	Mr. Bertill, MPI	In many appliance can cope with both 50Hz and 60 Hz there is switch for frequency.	
15	Question	Why Japan has two different frequency system?	Mr. Collin, SKELEC	Because western side and eastern side separately installed system at the fist time of generator installation, western system applied USA system and eastern system applied Germany system.	
16	Question	(from JET) Did you study about 33 kV upgrade, not 66 kV? Why 66 kV was proposed for integration?	SKELEC & NEVLEC	Because we also consider interconnection with another Caribbean countries such as Montserrat, Antigua Barbuda and Anguilla.	
17	Question	(from JET) How many do you install capacitor in Nevis system?	NEVLEC	There are two Capacitors in Nevis. In addition near Hillside farm shown in GIS, other one is at near Islander Watersports.	
18	Question				

Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Seminar on Grid Stability and Large RE in 18-19 Jan 2023 (B St.Kitts&Nevis): Feedback

SN	Your Title and Organization	What kind of roles/responsibilities are you engaged in your organization?	Please input questions that you would like to know more details in the seminar components.	Please kindly describe how the overall components of the seminars on Grid Stability and Large RE contributed to enhance your organizational capacity, if any.	Please kindly describe how the overall components of the seminars on Grid Stability and Large RE contributed to enhance your organizational capacity, if any.	Please provide details if you have any particular projects that you would like to request to Japan for future project concerning RE and grid stability.	Please input important matters that should to be included in the policy and/or grid code	Please input comments to JICA Team about overall program for this Project and recommendations, if any.
1	Skelec	Operations Engineer		Grid stability and future grid		BESS for spinning reserve	N/A	N/A
2	Linesman 2 NEVLEC	crew chief	how green is green energy in regards to waste and waste mangement	overall some valuable information was recieved which we would consider intergrating into our existing grid				
	Electrical Inspector (NIA)	Inspection of electrical being carried out in new residential and commercial structures and to help in the creation of policies of what is acceptable in the island of Nevis as it has to do with electrical standards.	Hydrogen Storage possibilities	It has provided much more knowledge into renewables and the application of renewables to the island	It has provided much more knowledge into renewables and the application of renewables to the island		Disposability of Batteries and solar panels. Disposal options.	
	Meter Manager, SKELEC	Customer Consumption Metering	Battery Storage (Customer), Business and Utility	Load Flow Analysis, Battery Storage decision	Assist us in our review of the contract for the 34MW Solar Plant	Hydrogen storage feasibility from geothermal, Microgrids for communities	Energy Efficiency Standards, Better data collection for load flow analysis and RE deployment & Grid Stability	Visit to St. Kitts & Nevis to assist us in closing data collection and management gaps

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	NWD (NIA)	Electrical Technician 1						it was informative maybe a little toomuch to grasp withing one week needs an over spread atleast two weeks and less hours in the day time so that information presented wont fall on deaf ears due to strayed attention also proper translation to the listening audience is highly recommended for maximum participation and interaction
	Safety and Security Manager, SKELEC	Ocuppational Health and Safety and Security	Other JICA Energy Visits	Better positioned to set and meet targets set by management	Learning curve	Poly and Procedural processes	JICA Funding and Energy saving appliances support programme	Great job in the Caribbean. keep doing your best.
	Energy Officer - Ministry of Public Infrastructure (GOSKN)	Policy and Initiatives for energy industry		It will allow me access to critical data to make policy decisions.		Feasibility study on the impact of a Renewable Energy tariff for St. Kitts and Nevis, feasibility study for integration of electric vehicles.		
	Nevlec	Planning	Microgrid Designer and Operation	Good experience and effort	Motivated to use the load flow calculation	study for Hydrogen		Very grateful to JICA Team for the opportunity
	NEVLEC	Transmission and Distribution	Grid Modeling, Geothermal, Hydrogen Production, Grid forming Inverters,	Sessio was very informative. The presentation on Hydrogen really stood out.				
	Linesman #2 / Nevlec	crew chief/ responsible for mentenanace and contruction of new and exist (T&D) Transmition and distribution lines...						

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	SKELEC	Engineer	More details on Mcrogrids	it helps/enhances my organzations capacity for grid development based on increasing demand		Asset management system		
	Electrical Technician — Nevis Water Department	My current role is Electrical Technician 2 with responsibilities in ensuring all electrical equipment is operating as effective and efficiently as possible. Both Vertical centrifugals, Submersible pumps, Generator etc.	Hopefully in the next seminar the requirements necessary for an even more effective training session.	The session was well informative participants needed to be a little more informed of the necessary equipment needed	Both were well effectively especially in regards to the implementation of the geothermal plant on the island in Nevis with inter connecting both islands in regards to transmitting power to st. Kitts and the neighboring islands	I would love to see the type of equipment used within the water utility in regards to promoting energy efficiency with your various organization.		The presentation was well put together but hoping to get some more time and more information relating the use of the simulation so everyone could use at the same time.
	Director, Dept of Physical Planning, NIA	Overall Management of the operations of the Department		the content was sometimes not easily understood because my background is in civil engineering. However, the content was good.	The Department of Physical Planning, NIA is responsible for outlining the Government's policies. The Department will work closely with NEVLEC to ensure that the policies are properly outlined.			very thorough, technical and educating

Minutes of Meeting
Energy Division, Ministry of Science, Energy and Technology (MSET)
and JICA Expert Team
22- 25 Oct 2019 (Jamaica)

Date and Time: 22-25 Oct 2019

Location: Energy Division, Ministry of Science, Energy and Technology (MSET)

Participants:

1) Ministry of Science, Energy and Technology (MSET)
   - Mr. Horace Buckley, Director, Project Management, Energy Division

2) IRP Team
   - Mr. Steve Dixon, Transmission and Distribution
   - Mr. Omar Stewart, Energy Resource Development and Economic Impact Analysis

2) 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 Simulation
   - Ms. Anna Miyaura Human Resource Development
   - Mr. Kevin Douglas

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

The first JCC Meeting/Kick-off Workshop was held on 23rd October at Auditorium of PCJ in Kingston, attended by Mr. Fizroy Vidal, Principal Director of Energy Division, MSET and Mr. Takeshi Takano, Resident Representative of JICA in Jamaica, and representatives from relevant organizations including MSET, PCJ, NESOL, BSJ, JPS, Wigton, UNDP, and academia such as U-tech and CMU.

Agenda and objectives of the JCC is:

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 Matrices (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, 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 Jamaica.

Discussions:

< Project Design Metrices or PDM>

Project Design Metrices (PDM) was revised to reflect the outcome of the meetings up to the 3rd Mission in

August 2019, as shown in red-letters in the Attachment 1). Major changes from the original PDM will be as follows:

1) Introduction of demonstration of power network asset management system to be additionally included in the training to enhance the Resiliency which is a one of the major concerns of CARICOM countries.
2) Micro-Grid concept study in the selected area to investigate the optimized configuration in view of higher penetration of RE, resiliency, and affordability.

<Involvement of Academia>

Considering the requirement of capability for advanced and cutting-edge analysis to manage the complex issues of RE and EE, it was agreed that academia also be invited to the local training program. It was requested to focus more on graduate student education to bring up the engineer in the next generation. JICA Expert Team (JET) agrees to include them in the planned JICA's training.

<Statistics and Target Value Clarification>

Followings are clarified in the meeting with MSET and PCJ in 23-25th October.

1) Monitoring Sheet was revisited, and the Target Values were finalized as attached. MSET will provide further data for the items subject to their confirmation.
2) JET visited JPS on 23rd after the JCC and confirmed that peak demand in 2018 in Jamaica was approximately 655 MW. JPS also indicated that annual growth rate would be 2% in light of GDP growth in Jamaica. Meanwhile, IRP team indicated annual average growth rate (AAGR) was 0.5%. Hence, Option-1 with 1% and Option-2 with 1.5% as AAGR toward 2030 would be considered for EE simulation to be used to formulate EE roadmap.
3) According to IRP Team, the tentative plan for introduction of additional RE is in total 350 MW. MSET noted it needs to review the figure considering demand increase. JET will finalize the target of RE capacity in PDM after the official approval of IRP.

<Collaboration with IRP Team>

Follow-up meeting was held between JICA Expert Team (JET) and IRP Team on 24rd October at the MSET Office and followings are discussed and agreed upon

1) IRP Report is scheduled to be completed by the end of 2019 after revising according to comments from organizations. The copy will be shared via. MSET for JET to review.
2) Candidate area for application of Micro-Grid concept can be either Orange Bay Area in Hanover or Ocho Rios Area in St Ann which both suffer from low power voltage in MV lines. Orange Bay Area can be the first pick from the list.

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) Presentation speech from MSET by Mr. Horace Buckley

End of the MoM

Ministry of Science, Energy and Technology (MSET)

25th October 2019

Mr. Horace Buckley, Director, Project Management, Energy Division

JICA Expert Team

25th October 2019

Masaaki Ebina, Team Sub Leader

Attendant List

Project: (JICA) Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Meeting Title: 1st Joint Coordinating Committee (JCC) & Kick-off Workshop

Venue: PCJ Auditorium Date: 23. Oct. 2019 Time: 9:00 - 12:30

SN	Name	Organization	Title	Mobile or E-mail	Signature
1	Yuka Nakagawa	JICA Expert (Team)	PE Specialist	[redacted]	
2	KEVIN DOUGLAS	JICA EXPERT TEAM	LOCAL COORDINATOR		
3	Kimberley Stanbury	MSET	Project Coordinator		
4	Yasuhiro Sakamoto	JICA EXPERT TEAM	EE Specialist		
5	Todd Johnson	PCJ	Manager, RE & EE Department		
6	JODY GREIZZE	MSET	PROJ COOR		
7	Terry Daley	UNDP	PROJECT Manager		
8	Michelle Chin Lenn	Wigton Windfarm Ltd	Project Manager		
9	Raymond Brown	NESOL	Design Supervisor		
10	Stephen Rhoda	CMU	Associate Vice President		
11	Fitzroy Vidal	MSET	Principal Dir.		
12	Vilton Caydd	JPS	Engineer		
13	Mark William	MSET	Snr Energy Officer		
14					
15					
16					
17					
18					
19					
20					

Attendant List

Project: (JICA) Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

Meeting Title: 1ST Joint Coordinating Committee (JCC) & Kick-off - Workshop

Venue: JCI Auditorium Hall Date: 23-Oct 2019 Time: 9:00 - 12:30

SN	Name	Organization	Title	Mobile or E-mail	Signature
1	MASAAKI EBINA	JICA EXP. TEAM	SUB PJ LEADER	[redacted]	
2	HIROAKI NIIMI	"	GRID STABILISATION(2)/POWER STORAGE SYSTEM		
3	Kimberley Stanbury	MSET.	Project Coordinator		
4	Takeshi Takano	JICA	Res Rep		
5	Kunihiro Butsuen	JICA	Project Formulation Advisor		
6	Horace Bubbs	MSET	Director Project		
7	Ornet Stennett	MSET	Director Regulatory Affairs		
8	Steve Dixon	MSET.	T & D Consultant		
9	RUTH POTOPSINGH	UTech Ja	AVP - Sustainable Energy		
10	Garfield Morgan	BSJ	Manager Electrical/Electronic Building		
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Japan Technical Cooperation Project for
The Project to Promote Energy Efficiency in Caribbean Countries

The 1st Joint Coordination Committee (JCC) / Kick off Work Shop in Jamaica Program

Date: Wednesday, October 23, 2019 **Venue : Auditorium Hall at PCJ**

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. Fitzroy Vidal	Project Director
9:05-9:10	Greeting by JICA Jamaica	Mr. Takeshi Takano	Resident Representative (JICA Jamaica 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 Jamaica (Q&A to be included)	Mr. Horace Buckley	Project Manager
11:25-11:50	The Work Plan and Project Design Matrix (PDM)/ Monitoring Sheet #1	Mr. Masaaki Ebina	Subchief
		Ms. Yuka Nakagawa	Renewable Energy
11:50-11:55	Closing Remarks	Mr. Fitzroy Vidal	Project Director

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

Baseline Survey Report

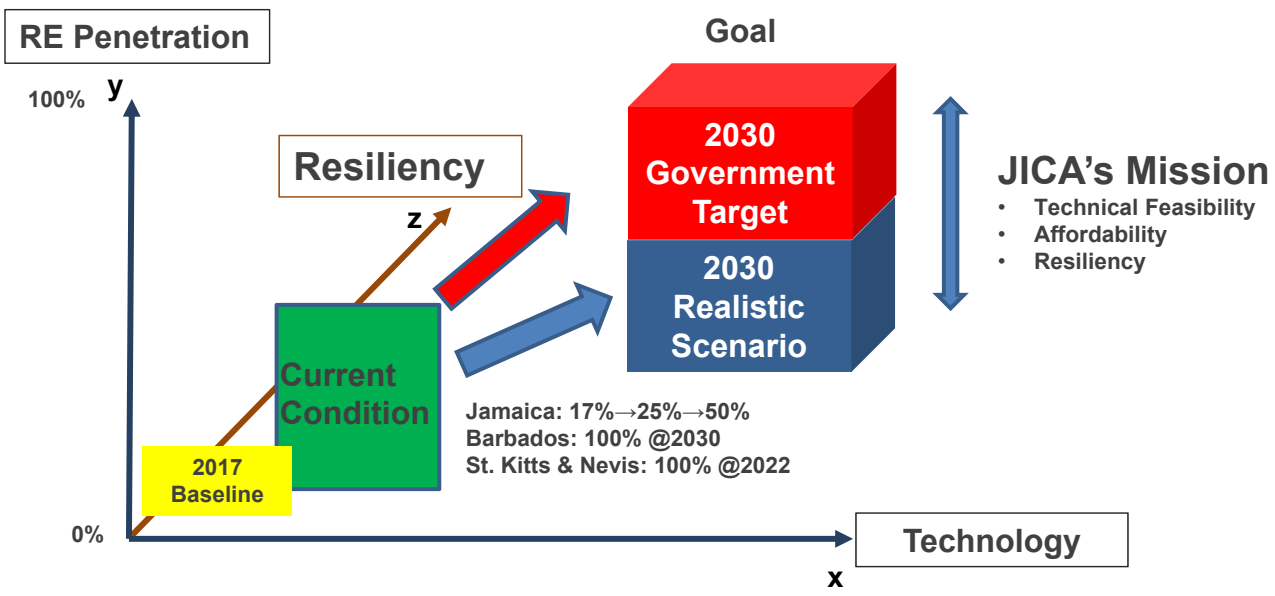
October-November 2019

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

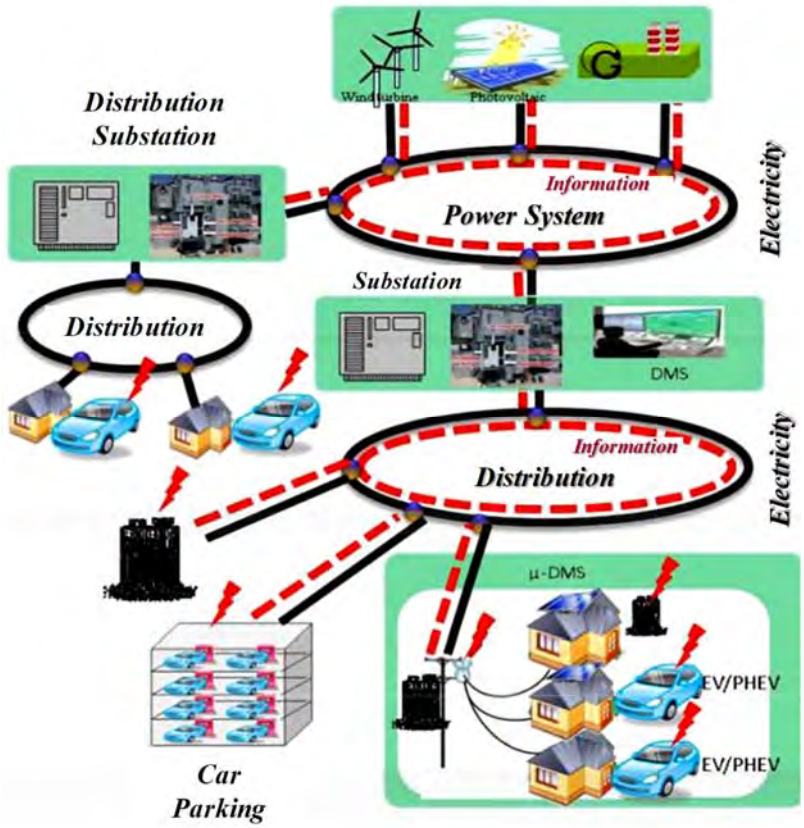
1. Project Outline

JET's Mission Recognition

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



Micro-grid Concept



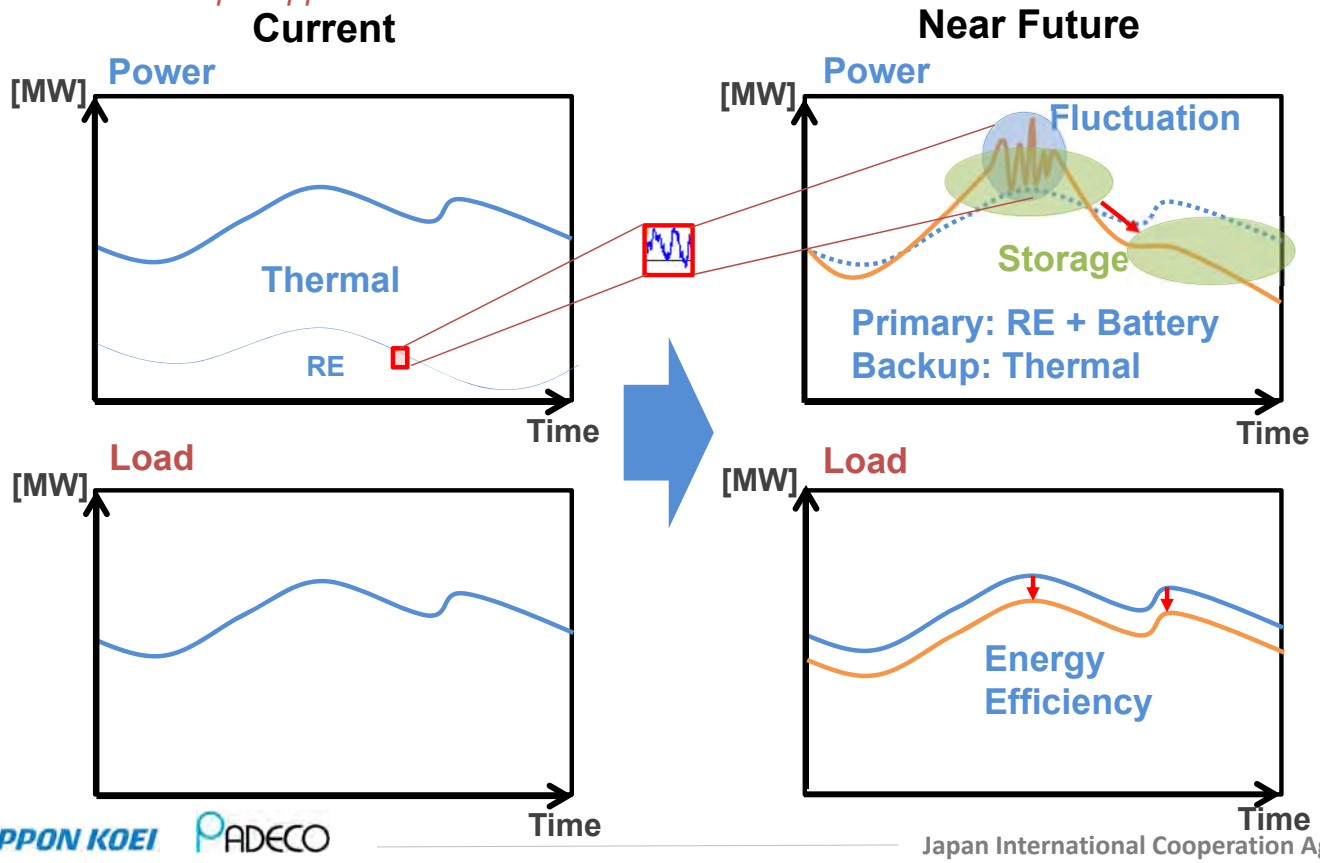
Concept of Micro-grid

- ✓ 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

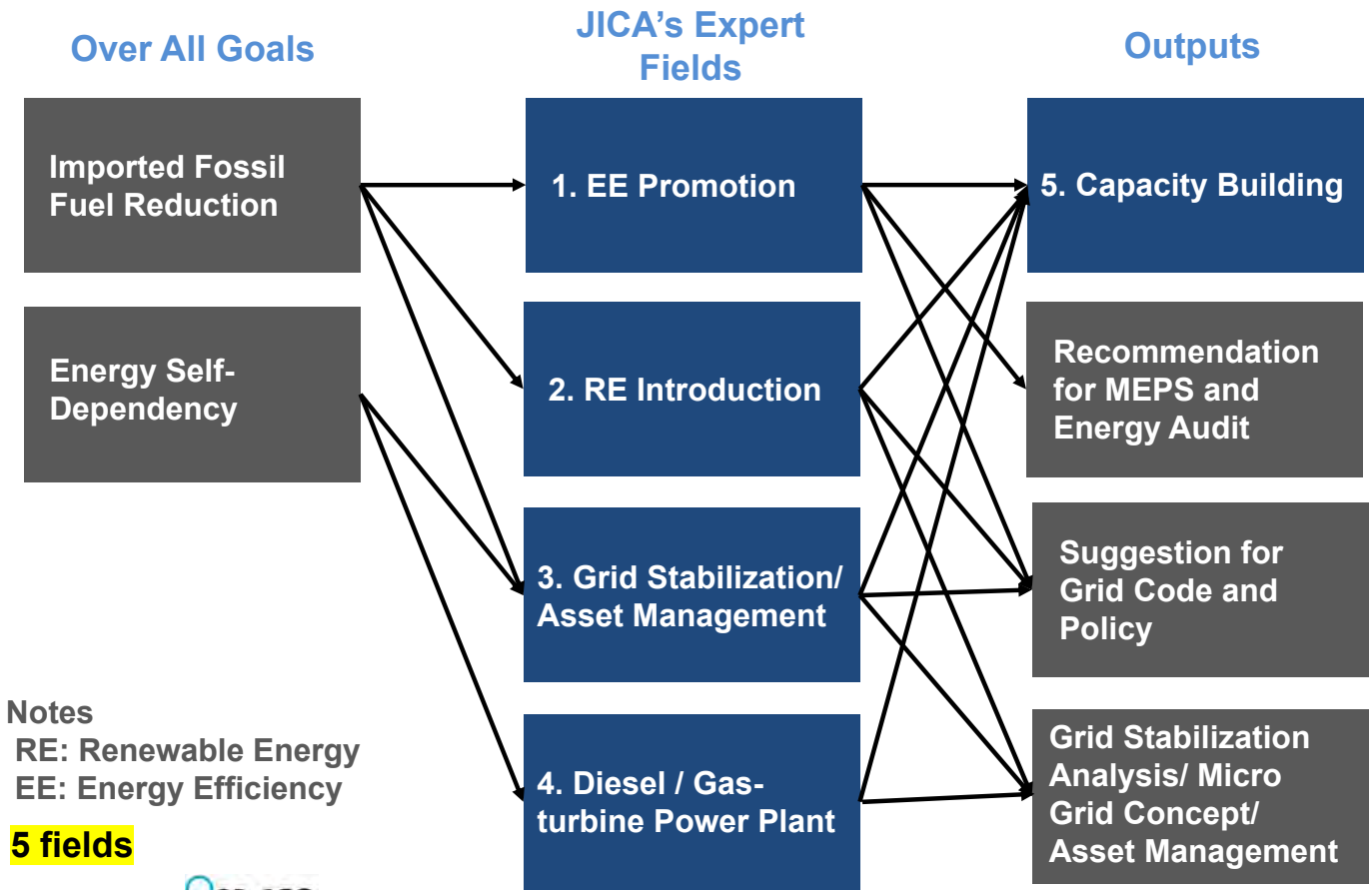
Output 4
The human and institution capacity are enhanced for the promotion of EE

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

1. Project Outline
2. Baseline Survey Report
   2-1. Energy Efficiency
   2-2. Renewable Energy and Grid Stabilization
   2-3. O&M of Thermal Power Generation
   2-4. Human Resources and Capacity Building
3. Training Program
   - Regional Training
   - Training in Japan
4. Way Forward and Schedule

2. Baseline Survey Report

Summary

Fields	Findings	Project Activities
1. Energy Efficiency	• Energy Source: Oil (53%) , Electricity (39%) • 2018 Peak Demand: 654.5MW (Jul. 17th) • Peak Period: 6:30pm - 8:30pm	Priority 1: BEMS Priority 2: Mini split AC with inverter Priority 3: LED
2. Renewable Energy	• 50% RE target by 2030 • Hydro 28.6 MW, VRE 122MW, RE 15% of grid • Rooftop 20MW?	Recommendation for 50% RE target Micro-grid concept study
3. Grid Stabilization	• "RE is a Nightmare!" • JPS 21.5MW/16.6MWh Li BESS +3MW flywheels	Introduction of asset management
4. O&M of Thermal Power Generation	• Thermal power plant: total 20 units including IPP • Installed Capacity: Total 1036.5MW including GTCC in Old Harbour P/S (190MW) • Predictive Maintenance: Considering to apply	-
5. Human Resources and Capacity Building	• MSET's Energy Division: 14 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)**
  - Industry is the largest energy consuming sector (49%) followed by transportation (27%) and residential (15%) sectors.
  - Oil is the largest energy source (53%) followed by electricity (39%).

Energy consumption by sector and energy source on primary energy basis

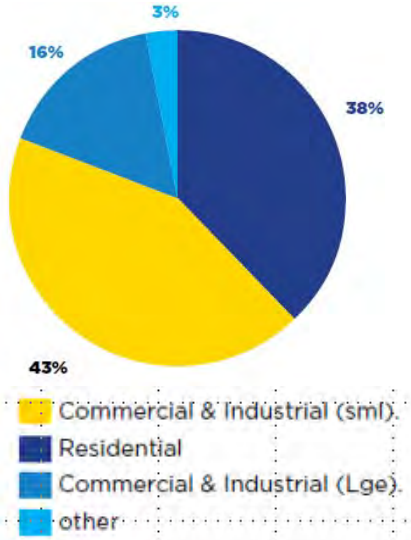
	Industry	Commercial & public	Residential	Transportation	Agriculture / forestry non-use	Total
Oil	565	104	24	679	27	**1399 (53%)**
Coal	51	0	0	0	0	**51 (2%)**
Bio/waste	52	70	32	34	0	**188 (7%)**
Electricity (primary energy basis)	625	59	342	0	0	**1026 (39%)**
Total	**1293 (49%)**	**233 (9%)**	**398 (15%)**	**713 (27%)**	**27 (1%)**	**2664 (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 electricity on primary energy basis, energy efficiency at end use of 26.9% has been assumed.
Source: JET with reference to energy balance (2017) by International Energy Agency.

Energy Efficiency

- **Current situation 1-2: Electricity consumption by sector**
  - Commercial & industrial small customers is the largest electricity consumer (43%) followed by residential customers (38%).
  - Annual average growth rate (AAGR) has been 0-2% in past 5 years throughout all customer classes.

Energy sales share in 2017



Energy sales by customer class

(MWh)

	2012	2017	AAGR (%)
Residential	1,035,377	1,068,594	0.6
C&I (small)	1,383,296	1,381,376	0.0
C&I (large)	615,314	646,669	1.0
Other	99,979	110,500	2.0
Total	3,133,966	3,207,139	0.5

Number of customer by class

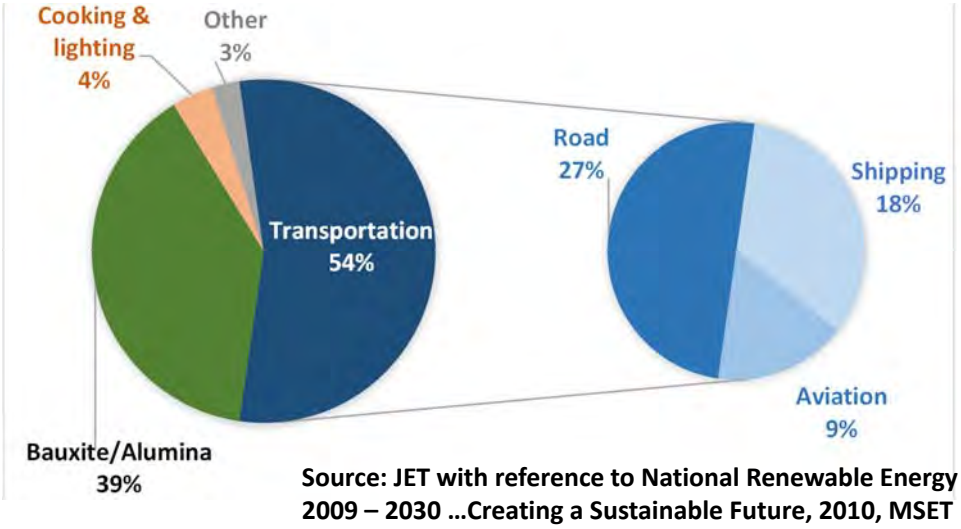
	2012	2017	AAGR (%)
Residential	531,827	574,458	1.6
C&I (small)	63,740	67,874	1.3
C&I (large)	151	162	1.4
Other	253	450	12.2
Total	595,971	642,944	1.5

Source: JET with reference to annual report 2012 and 2017 of JPS

Energy Efficiency

- **Current situation 1-3: Oil consumption situation**
  - Excluding oil used for power generation, more than 90% of oil is consumed by the transport sector and the bauxite/alumina industry.
  - Regarding breakdown of oil consumption in the transportation sector, ground transportation accounts for half, followed by shipping and aviation.

Petroleum consumption by activity excluding power generation use, 2008

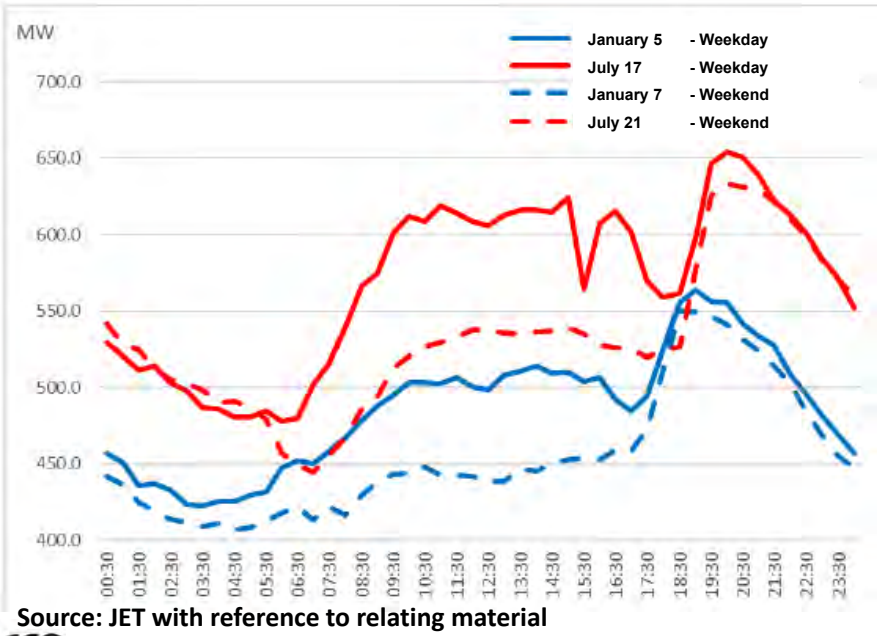


Source: JET with reference to National Renewable Energy Policy 2009 – 2030 …Creating a Sustainable Future, 2010, MSET

2-1. Baseline Survey Report- Energy Efficiency

Energy Efficiency

- **Current situation 1-4: Electricity load curve**
  - 2018 Peak Demand: 654.5MW (Jul. 17th) (Maximum Demand:671MW (2017))
  - Peak hour is between 6:30pm & 8:30pm → lighting peak demand is assumed to be considerable amount (e.g. 50MW or more).
  - Power supply from Solar does not contribute to peak demand.



Source: JET with reference to relating material

Energy Efficiency

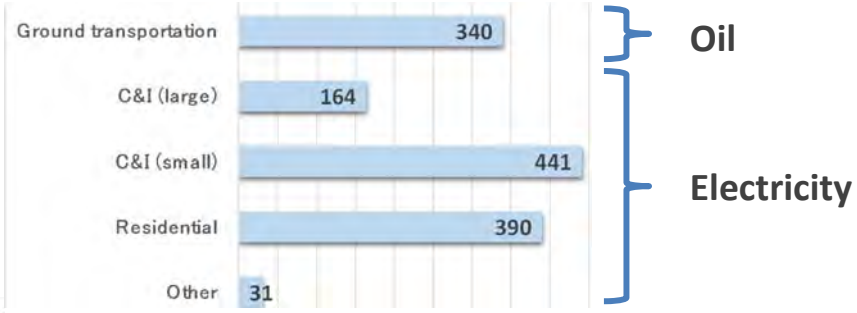
- **Points of studies and proposals on EE measures:** Studies and proposals shall be made with high priority for the energy consumption fields indicated **in red.**

- The **coverage ratio of high priority EE fields = 55%** (1366/2476)

(ktoe)

	Oil	Electricity	Coal	Bio/Waste	Total
Primary energy consumption	1399	1026	51	(188)	2476
Industry	565		51	(52)	
Ground transportation	**340**				
Shipping	226			(34)	**340**
Aviation	113				
Residential		**390**			
C&I (small)	128	**441**		(102)	**1026**
C&I (large)		**164**			
Other		**31**			
Agriculture / forestry / non-use	27				
Primary energy consumption to be studied as to EE measures with high priority	**340**	**1026**			**1366**

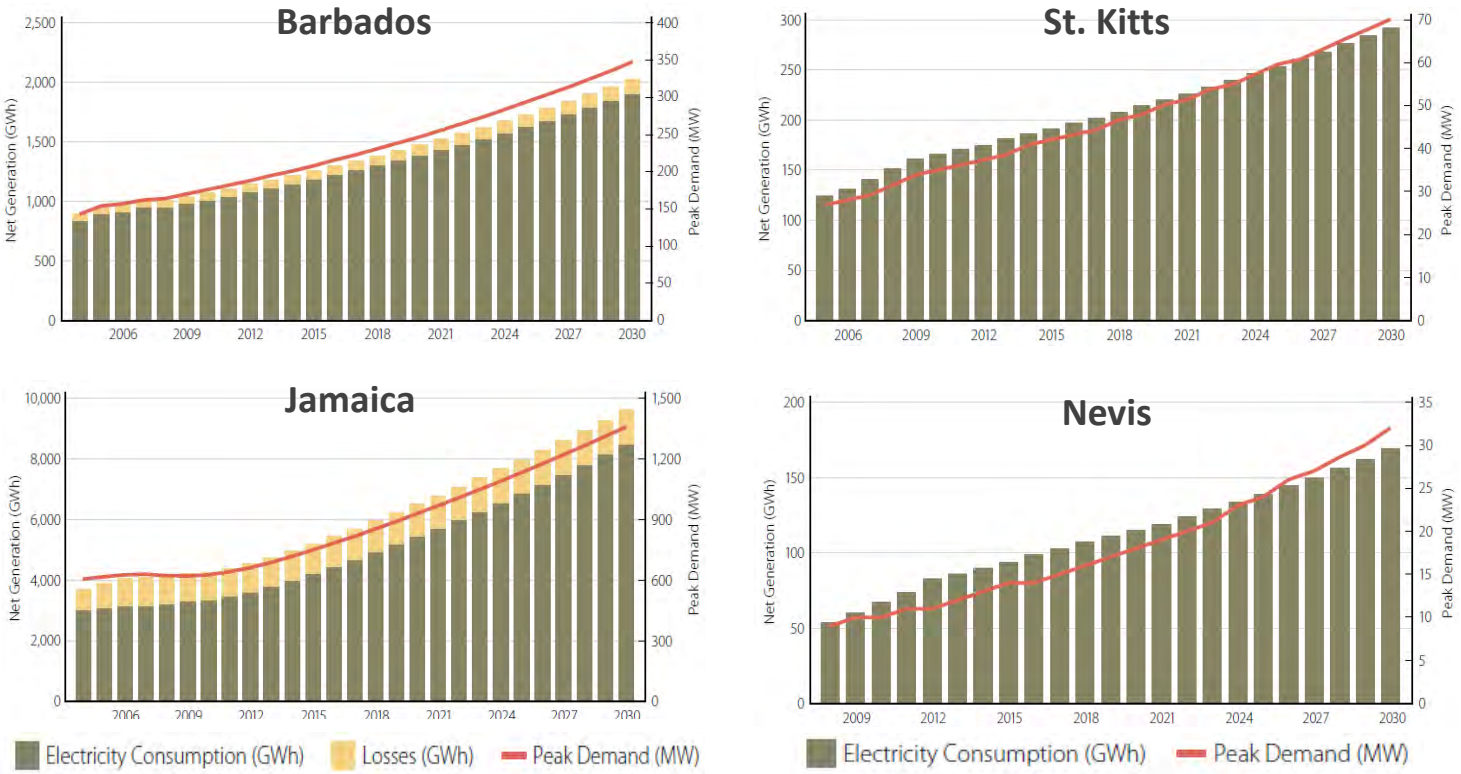
Primary energy consumption by EE high priority field



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))

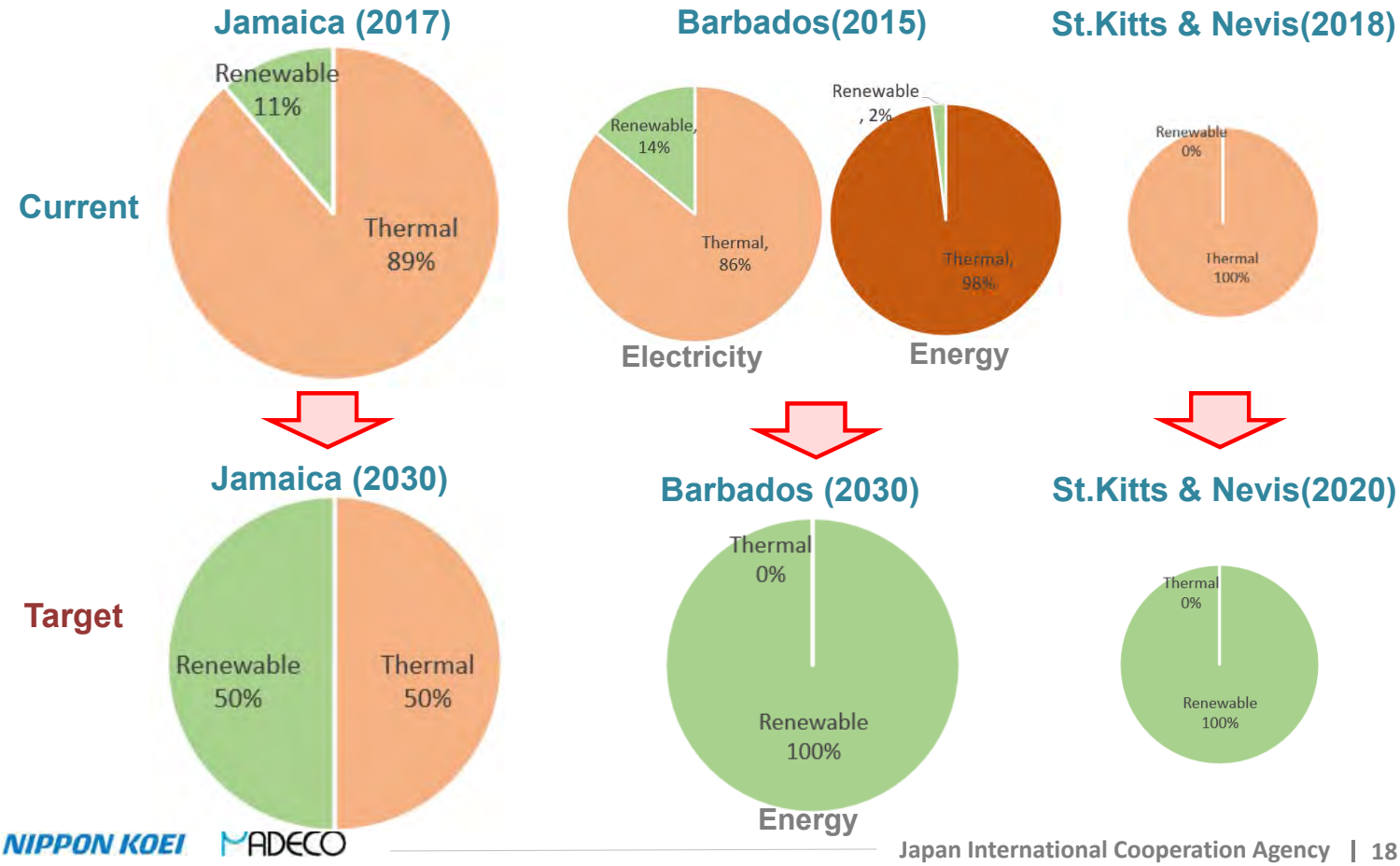
Energy Efficiency

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 almost 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

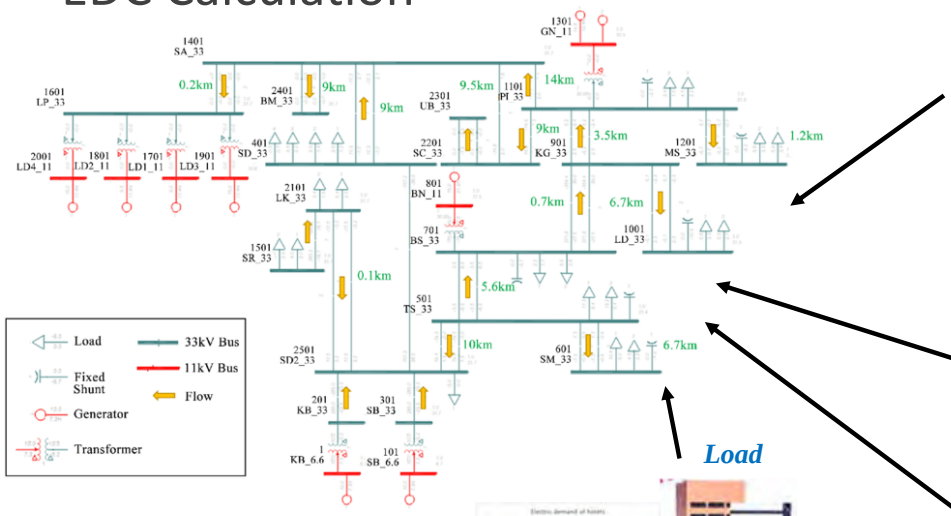
- Provision of Grid simulation software and training
- Introduction of network asset management

✓ **Discussion for grid code**

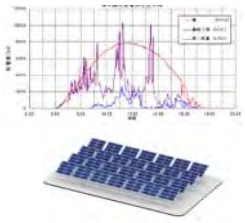
✓ **Suggestion for policy and RE target with reviewing affordability of RE**

Grid Stabilization Simulation

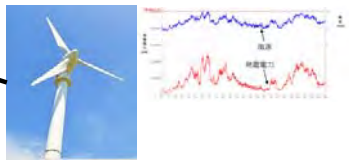
- Simulation of National Grid Model
- Analysis of Issues and Solutions
- EDC Calculation



Photovoltaic Generation

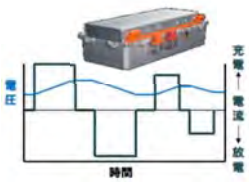


Wind Generator



Load

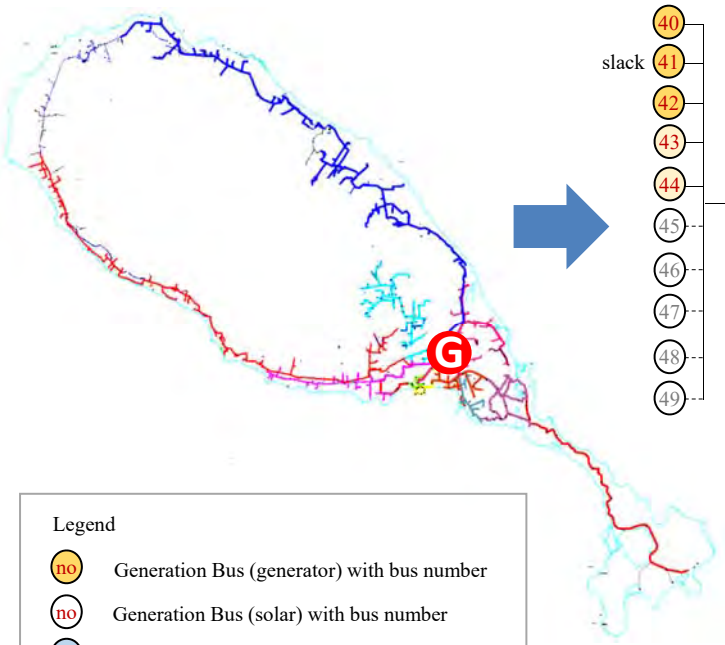
Battery

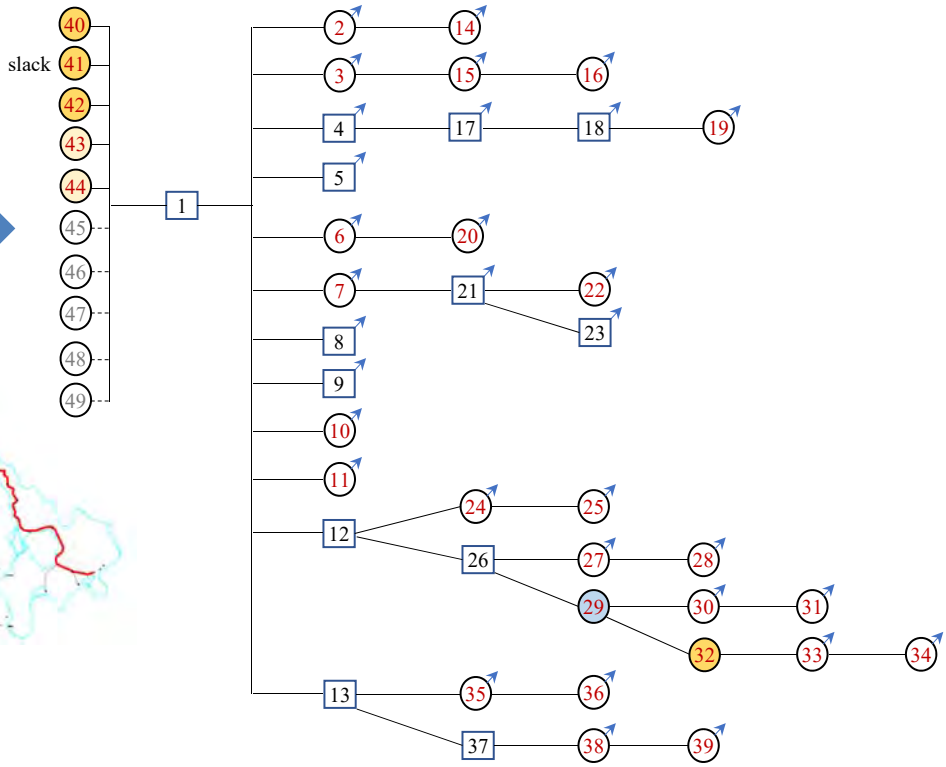


Grid Stabilization Simulation Mod

For St. Kitts & Nevis Only

Schematic view of Grid configuration (11kV)



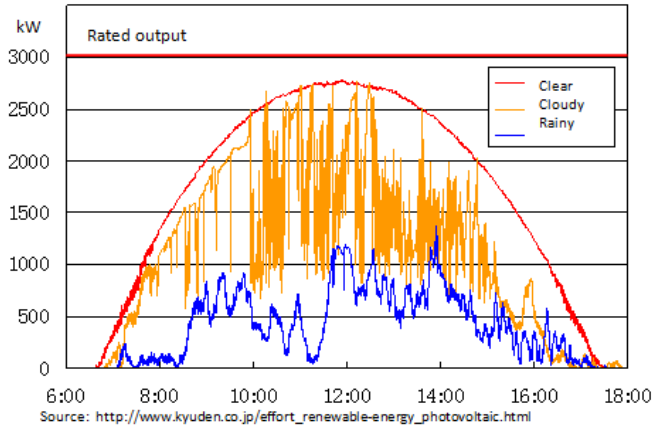


Legend

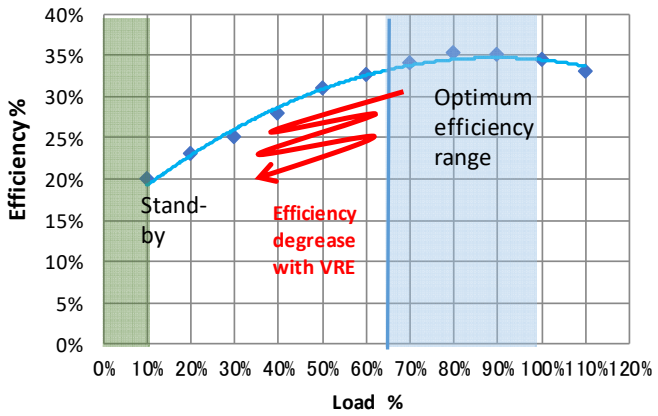
- no — Generation Bus (generator) with bus number
- no — Generation Bus (solar) with bus number
- no — Generation Bus (wind) with bus number
- no — Load/Transit Bus with bus number
- Load

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

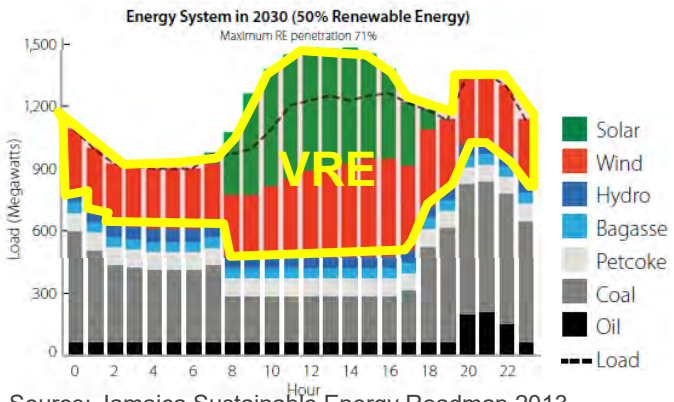


PV output in each whether



Load and efficiency of typical diesel generator

RE: Instability Caused by VRE



Source: Jamaica Sustainable Energy Roadmap 2013

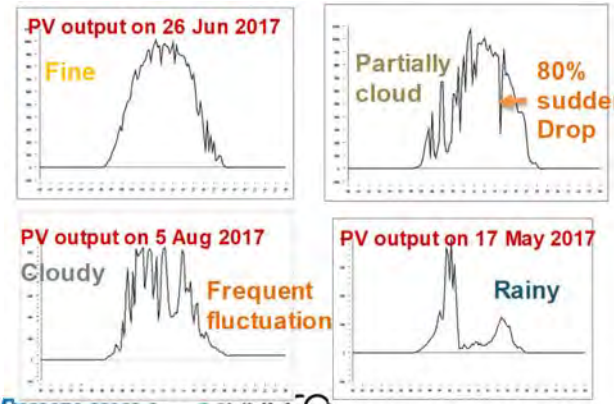
Grid instability
- Voltage and frequency fluctuation
- Shortage of Inertial power
- High cost for countermeasure

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.



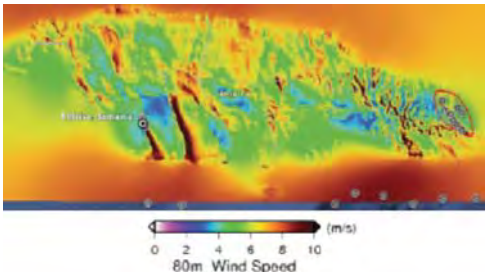
VRE %	< 20%	20-60%	> 60%
Issue	Response by thermal poser	Voltage and frequency fluctuation, power failure increase	(in addition to left) harmonic wave, phase balance, synchronization, supplement of reactive power
Equipment needed for grid stabilization	Output restrain by PCS, EMS	EMS and high-speed charge-discharge 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 Jamaica

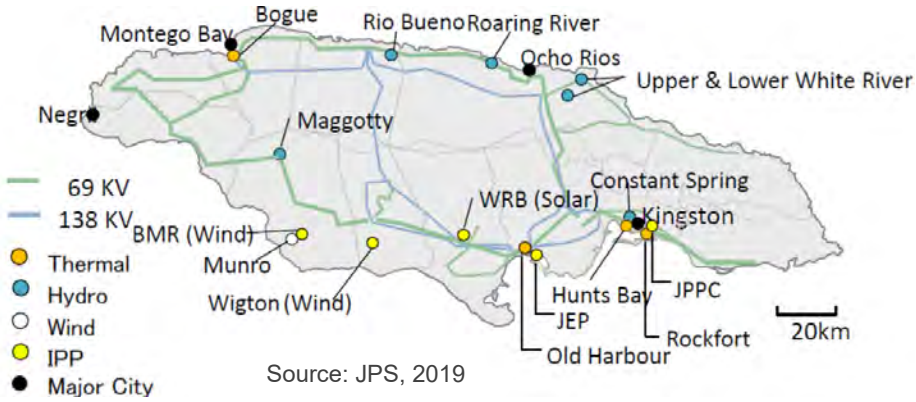
Challenges for RE:

- ✓ Grid stability issue and power cut :Feeder cut at 49.5 Hz
- ✓ 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

VRE Projects in Jamica

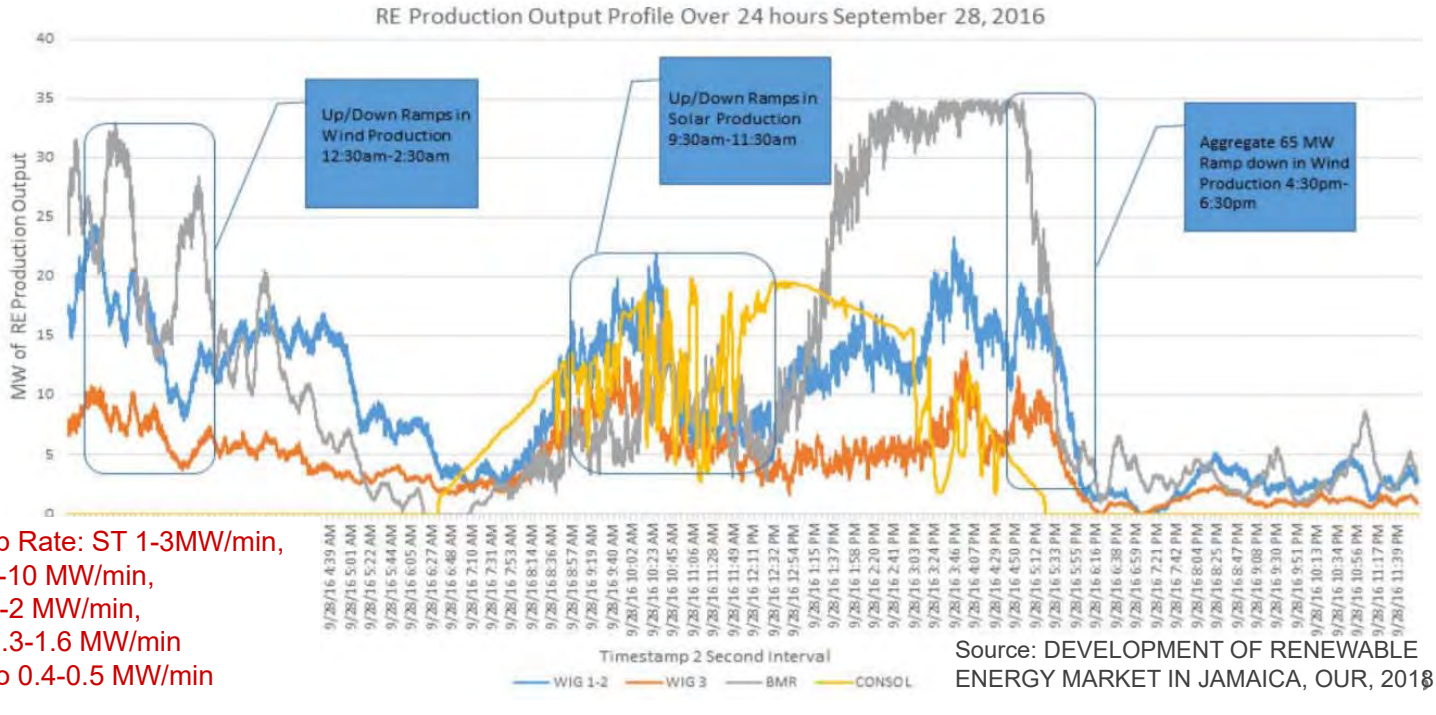
Location/Project		Capacity MW	Generation GWh estimated	Year	Tariff USc/kWh	Investment mil USD
Wigton I	Wind	20.7	52	2004	10.21	26
Wigton II	Wind	18	47	2010	10.723	45
Wigton III	Wind	24	63	2016	13.4	46.5
Munro	Wind	3	10.5	2010	(JPS)	
BMR Wind	Wind	36.3	120	2016	12.9	90
Content Solar (WRB)	PV	20	34	2016	18.8	65
Independent roof-top	PV	20?			--	
Eight River (EREC)	PV	33.1		2019	8.5	
Wigton IV	Wind	34		?		
VRE under operation		**142**	**326.5**			

Source: Prepared by JET with several data sources

RE: Grid Stability Issue with VRE in Jamaica

Grid Stability issues due to significant VRE fluctuation

- Limitation of generating units, unable to ramp fast to counter rapid variations in VRE
- Adverse effect on Heat Rate (Efficienc) and increase of production cost
- Part-load operation of generating units, increasing emissions and reducing operating life of equipment
- Impacts System reliability, security, stability and power quality



Ramp Rate: ST 1-3MW/min,
GT 5-10 MW/min,
CC 1-2 MW/min,
DG 0.3-1.6 MW/min
Hydro 0.4-0.5 MW/min

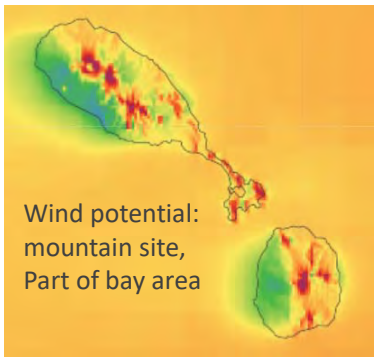
Source: DEVELOPMENT OF RENEWABLE ENERGY MARKET IN JAMAICA, OUR, 2018

RE: Status in St.Kitts & Nevis

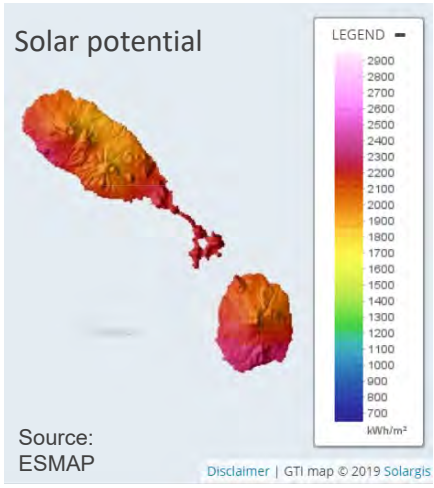
For St. Kitts & Nevis Only

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



Necessary consideration for future RE

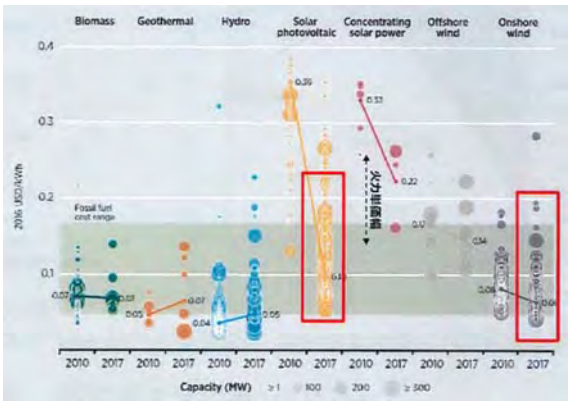
1) Grid stability analysis for new 35MW PV system
2) Update of geothermal development
3) Interconnection?

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

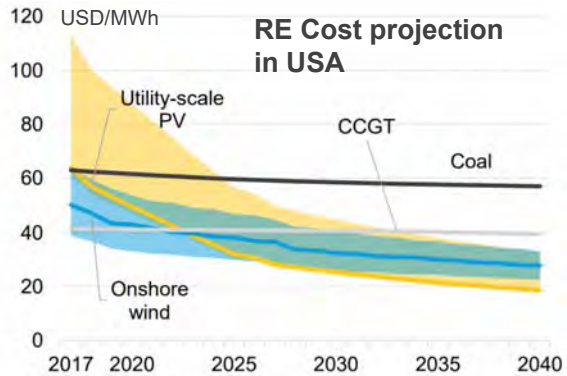
→ **Who owns the stabilization cost?**



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



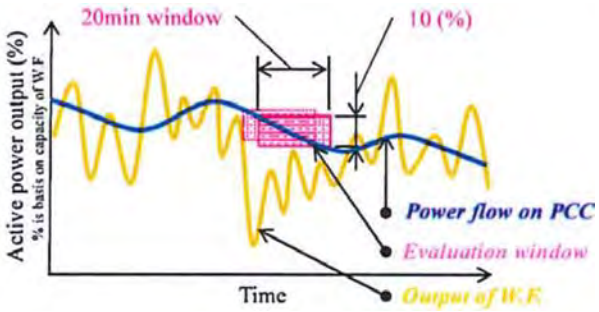
Source: Power Markets Today, Broomberg 2018/ METI, Japan

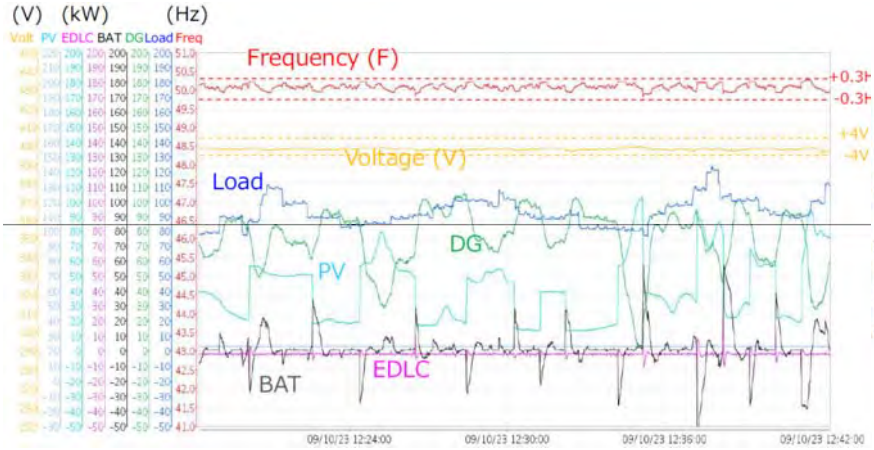
RE: Example of Grid Stabilization with RE and energy storage

For Voltage and Frequency stabilization (below)

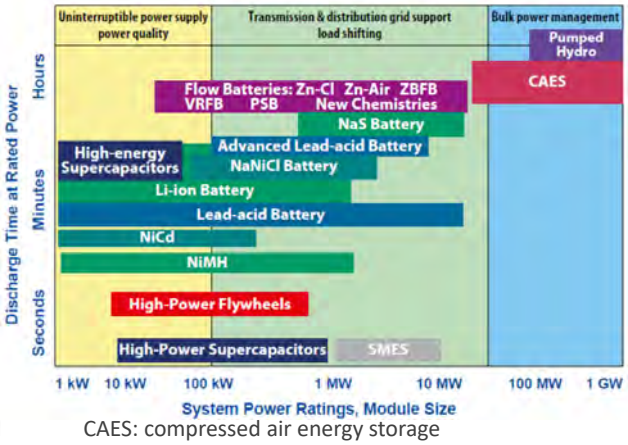
- ✓ Generation: PV, Wind, DG, GT, etc.
- ✓ Energy Storage: Battery (BAT), Capacitor (EDLC)
- ✓ Load /Demand control
- → **Grid Simulation is necessary**
- → **Various energy storage needs to be considered**

Smoothing output





Source: Meidensha, Autonomous Micro-grid Conference, 2019



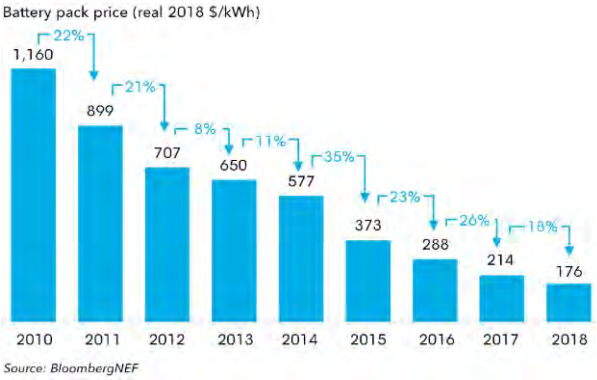
CAES: compressed air energy storage

Source: IRENA, Electricity Storage and Renewables, 2017

RE: Cost consideration of BESS

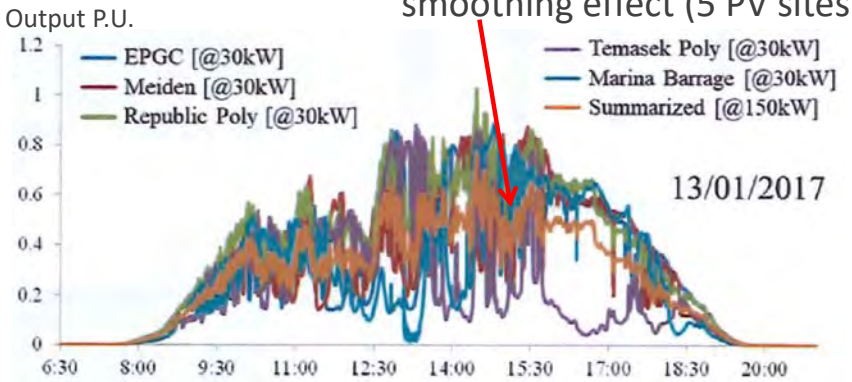
1) Output smoothing by overlaying different PV/wind locations
2) Battery at each site → Centralized battery storage system

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:

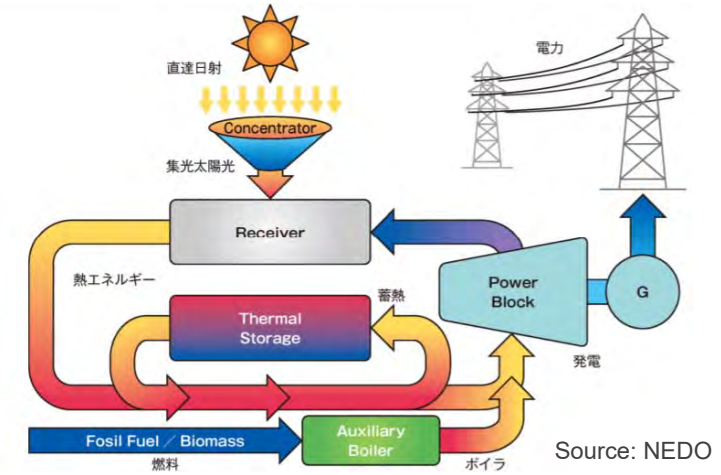
- Data analysis with solar irradiation/wind speed short interval necessary at several locations
- Speedy communication system advanced EMS control is necessary

National grid oriented program is necessary

→Battery capacity and EMS cost should be considered in Tariff

RE: Optional Technology : CSP

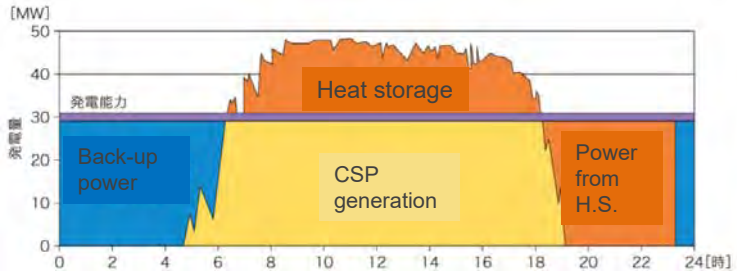
Concentrating Solar Thermal Power (CSP)



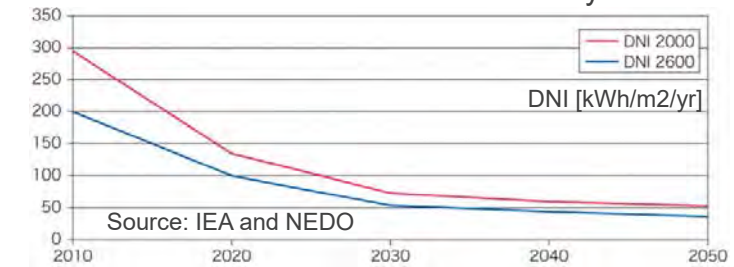
Source: NEDO

Photo: blog.eco-megane.jp/

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



- DNI (Direct normal irradiation)
  - Barbados: 1600-2000 kWh/m^2/yr
  - St Kitts&Nevis:1600-2300 kWh/m^2/yr
  - Jamaica: 1300-2200 kWh/m^2/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

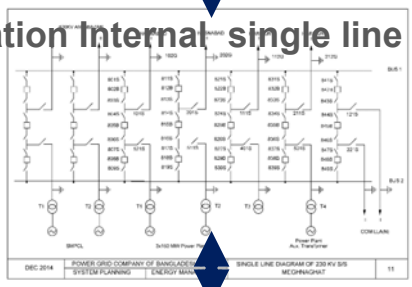
For enhancement of resilience:
- ✓ Design Standard with higher rank hurricane
- ✓ Compensation, third party Insurance coverage
- ✓ Safety Education for shock
- ✓ Fast recovery with **GIS and Asset management**
- ✓ **Micro-grid**

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

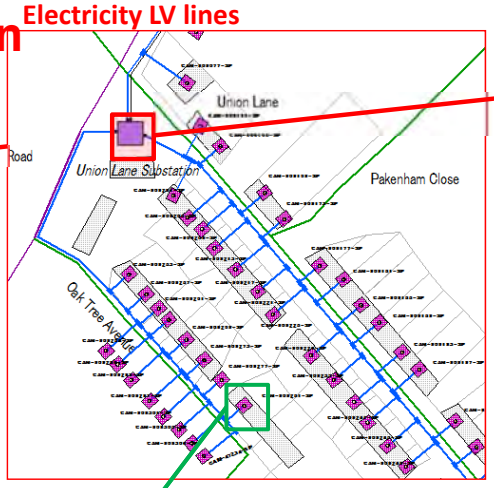
Power Network Mapping Data

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

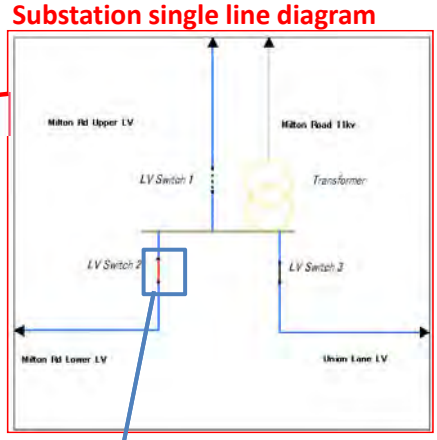
RE: Resiliency Enhancement - Digitalized Data Model

Zoom in

Electricity LV lines



Substation single line diagram



Service wire status and photo/drawing

Field name	Value
Id	938606
Known As	
Voltage	LV
Status	In service
Length	16.77 m
Centreline	✓

The System judges if the feeder line is connected and power can be supplied with LV switch status in substation

LV Switch connection status

[Electricity] Switch

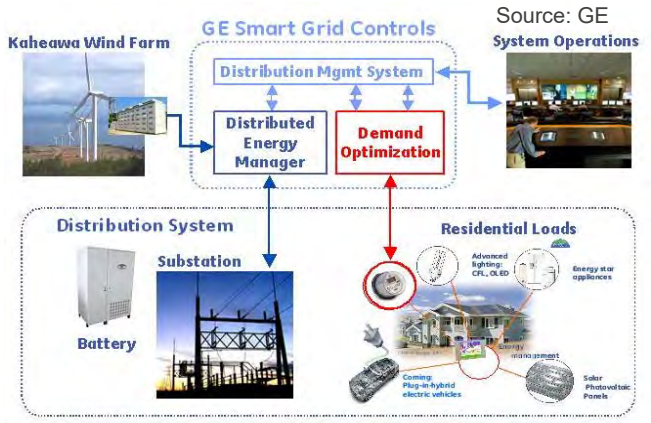
Field name	Value
Known As	LV Switch 2
Voltage	LV
Switch State	closed
Annotation	✓
Substation Internals	26891 0066
Primary Connection	✓
Secondary Connec...	✓

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

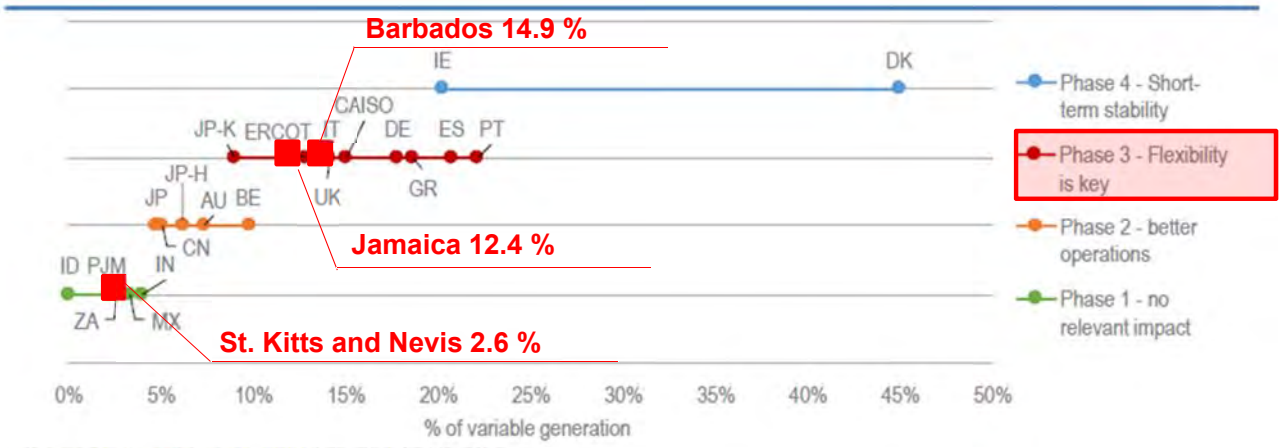
3 villages, 203 household, population 790
Peak **229kW**, Demand1300 MWh/yr, **3.6 MWh/day**)
RE: **1.4 MW PV (6.1 times than peak)**
Battery: **750kW/6 MWh** LIB, Tesla 20yrs guarantee
DG: 320kW × 3, 150kW × 1

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.*

Phase 3 "Flexibility is key"

Phase 4 "Short-term stability"

Phase 5 "Long-term stability"

Balance

Cost and Benefits, Power and Load, Myths and Reality

Grid Simulation

Photo: Steve Buissinne via Pixabay

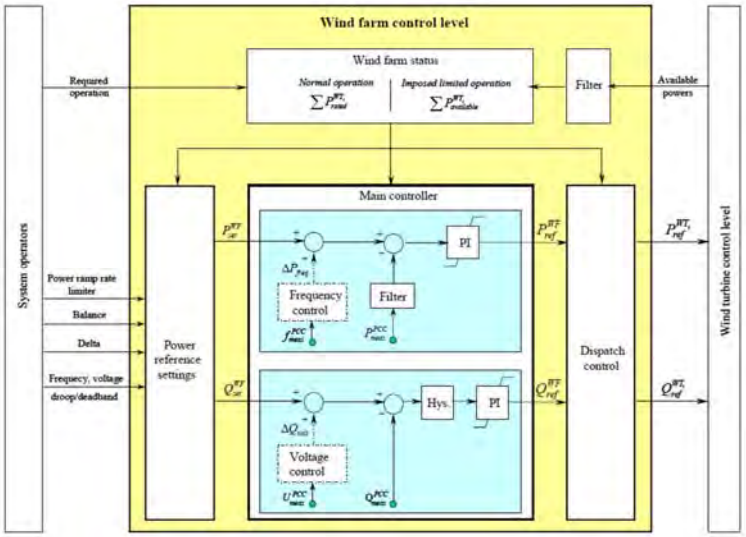
Grid Simulation Software

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

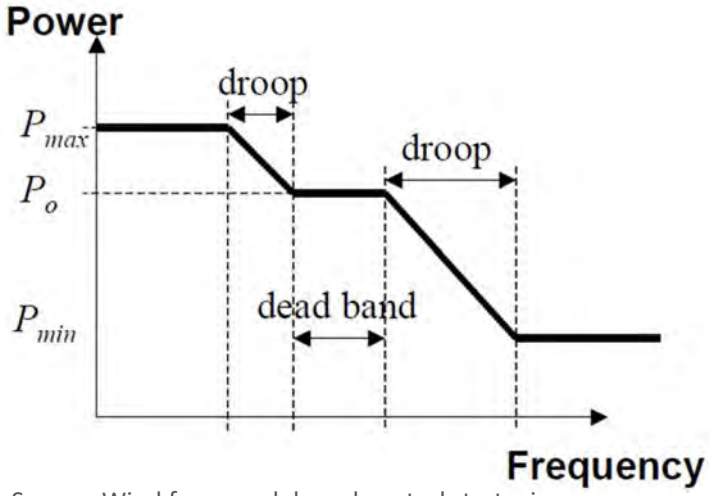


Source: Wind farm models and control strategies

- 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

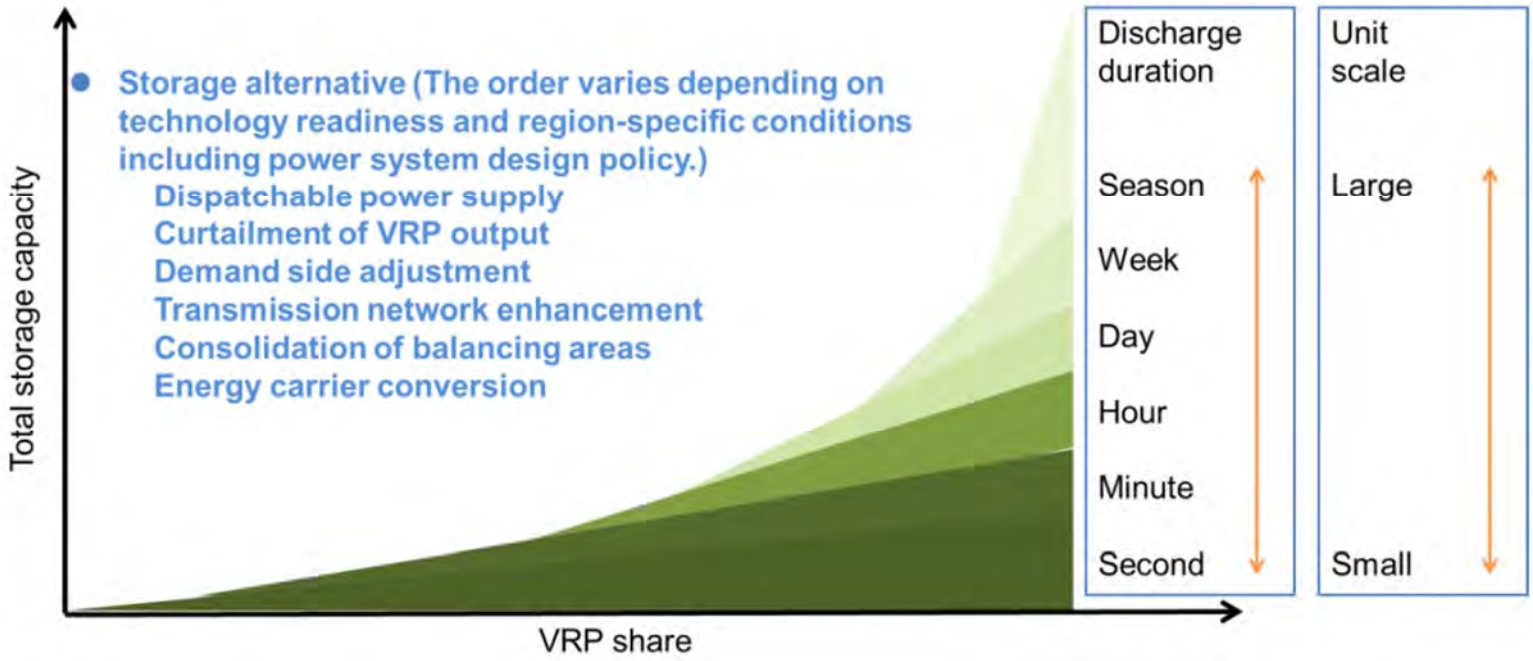
- Same as thermal power plant control
- For frequency stabilization

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

Solution 2: Application of Large Capacity Energy Storage System

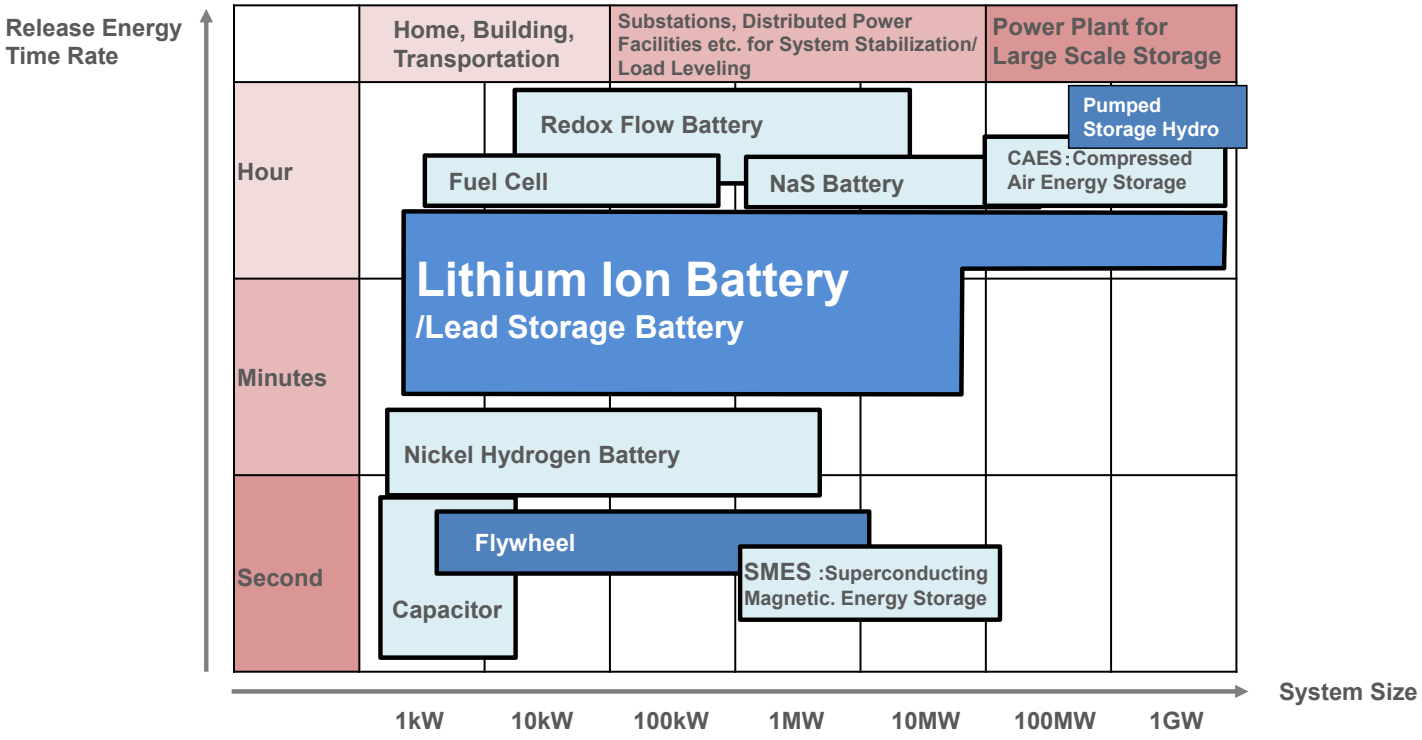
Variable Renewable Energy (VRE) Share and Storage Requirements for Power Systems

(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>

- **Preventive(Scheduled) Maintenance based on Manufacture's recommended schedule and practice**
- **Invite Supervisors from Manufactures in case of major maintenance**
- **Considering introduction of Predictive Maintenance but cost merit basis**
- **OSHA based management system**

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

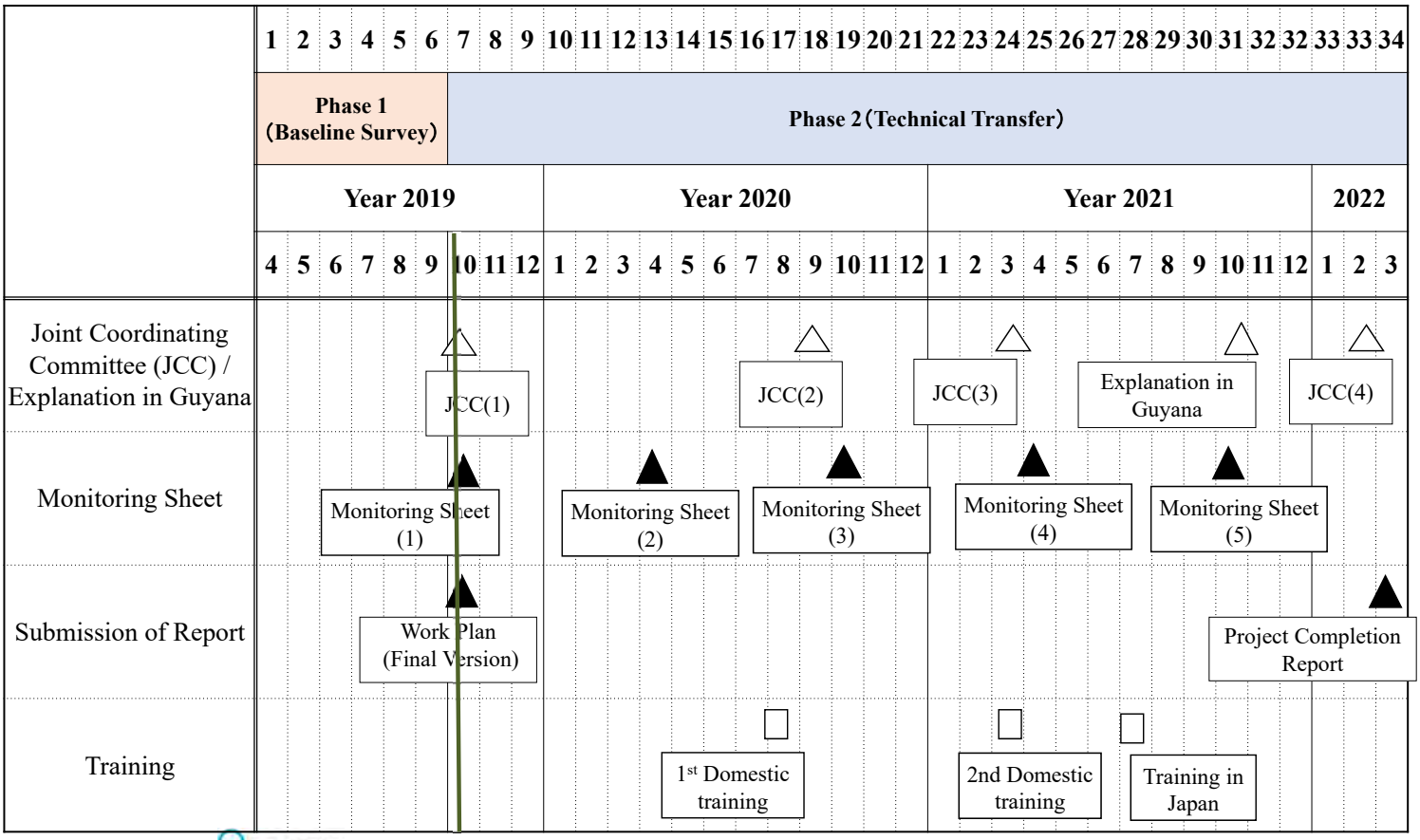
2nd training plan will be adjusted for your demands, situations and feedbacks.

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(Jamaica)

<List of Thermal Power Unit>

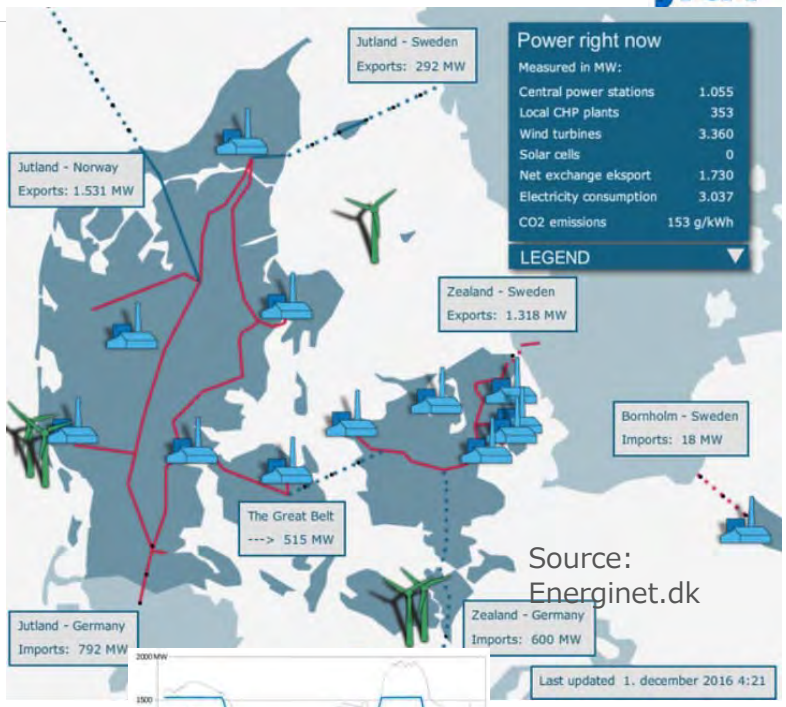
Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
Jamaica	Bogue	GT3	GT	Diesel	GE	1972	unknown	21.5
		GT6	GT	Diesel	PRATT & WHITNEY	1990	unknown	18.0
		GT7	GT	Diesel	PRATT & WHITNEY	1990	unknown	18.0
		GT8	GT	Diesel	PRATT & WHITNEY	1992	unknown	14.0
		GT9	GT	Diesel	PRATT & WHITNEY	1992	unknown	20.0
		GT11	GT	Gas/Diesel	GEC	2001	unknown	25.0
		CC	GTCC	Gas	GE	2002	unknown	114.0
	Old Harbour	Unit 2	ST	HFO	unknown	unknown	unknown	60.0
		Unit 3	ST	HFO	unknown	unknown	unknown	65.0
		Unit 4	ST	HFO	unknown	unknown	unknown	68.5
		CC (under construction)	GTCC	Gas	GE	2019	Base	190.0
	Hunts Bay	Unit B6	ST	HFO	GE	1976	Base	68.5
		GT10	GT	Diesel	GE	1993	Peak	32.5
		GT5	GT	Diesel	GE	1974	Peak	21.5
	Rockfort	Unit 1	LSD	HFO	MHI(Sulzer)	1985	Base	20.0
		Unit 2	LSD	HFO	MHI(Sulzer)	1985	Base	20.0
	JEP(IPP)		MSD	HFO	unknown	unknown	unknown	124.0
	WKPP(IPP)		MSD	HFO	unknown	unknown	unknown	65.0
	JPPC(IPP)		LSD	HFO	unknown	unknown	unknown	60.0
	Jamalco(IPP)		Cogen	HFO	unknown	unknown	unknown	11.0

Total: 1036.5MW
including the output of GTCC in Old Harbour

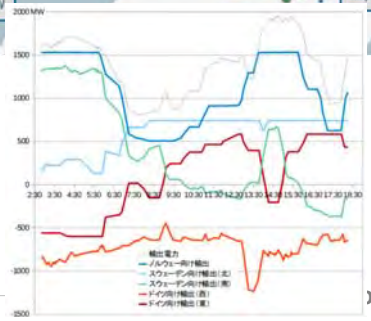
RE: Why Large RE penetration possible for Denmark?

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**

NIPPON KOEI PADECO

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)

Jamaica	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 Resilience 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 Resilience to the relevant organizations 5-4. Number of workshops
Narrative Summary Activities for achieving Output 3	3-2.To prepare the necessary training plan for achieving the RE goals in Jamaica	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.

Revised Project Design Matrix (Draft)

Jamaica	BEFORE	AFTER
Activities for achieving Output 5		(Added) 5-1. To demonstrate the way to enhance resiliency of power infrastructure using Power Network Asset Management System.
Inputs (Japanese side)	1. Dispatch of the Japanese experts -Chief advisor -Renewable energy -Grid stabilization -Energy efficiency -Diesel/ gas-turbine power plant -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 for reginal coordination -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 for Training Purpose (Power Flow Analysis Module)

Overall Goals & Target Value/ Jamaica

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. 50% (50%RE by 2030) 2. To 80% (20% by RE in energy base)

Project Purpose & Target Value/Jamaica

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. Hydro 28.6 MW, VRE 162MW (total 191 MW) Rooftop 20MW? BESS 20MW+ FH3MW	1.To be set according to IRP
	2. Number of public buildings with EE program including BEMS: Building Energy Management System	2. BEMS 11(completed), 3 (planned)	2. EE program in total for 44 facilities in next 4 yrs
	3. Number of trained staffs for introduction of RE	3. Several Officers under MSET/PCJ took local trainings but no specialized staffs to RE	3. total Local: 20-30 Japan: 1-4 MSET/PCJ: 6
	4. Number of trained staffs for promotion of EE	4. 0 (External 3day Basic Energy Audit Training Course : Total No.150, Awareness building WS, seminars, etc.: Total No. 745)	4. Local: 20-30 Japan: 1-4 MSET/PCJ: 4

Outputs 1,2 & Target Value/Jamaica

Description	Verifiable Indicator	Baseline 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. Several staffs under MSET, 6 in REEED of PCJ
	1-2. Human resource development plan for the introduction of RE	1-2. IRP capacity building provided
	1-3. Number of training courses for the introduction of RE	1-3. Conducted in some external programmes
	1-4. Total capacity of RE	1-4. 191 MW as of Sep 2019
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. 2 staffs CEM/CEA:0 (MSET) 4 EE staffs,7 CEM (PCJ)
	2-2. Human resource development plan for the introduction of EE	2-2. Proposing EE Plan
	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. 60 Govt. facilities

Outputs 3,4 & Target Value/Jamaica

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. MSET/PCJ: 6
	3-2. Textbooks/ manuals	3-2. None	3-2. 3 courses (For 2 local 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: 15 Final W/S: 20-30
	3-4. Number of workshops	3-4. 0	3-4. 2 times (Kickoff W/S, Final W/Ss)
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. MSET/PCJ: 4
	4-2. Textbooks/ manuals	4-2. None	4-2. 3 courses (For 2 local 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: 15 Final W/S: 20-30
	4-4. Number of workshops	4-4. 0	4-4. 2 times (Kickoff, Final)

Outputs 5 & Target Value/Jamaica

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. MSET/PCJ: 6
	5-2. Textbooks/ manuals	5-2. None	5-2. 2 courses (For 1 local trainings and 1 training in Japan)
	5-3. Number of participants of workshops to disseminate promotion of Power Network Resilience to the relevant organizations	5-3. 0	5-3. Kick-off W/S: 15 Final W/S: 20-30
	5-4. Number of workshops	5-4. 0	5-4. 2 times (Kickoff, Final)

Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

In April 2017 Jamaica Information Service reported the following:

- Jamaica has moved 74 places up on the World Economic Forum's Global Energy Architecture Performance Index.
- Jamaica's improved ranking placed it among the 127 countries making significant strides in energy sector performance since 2009, moving from 166 to 92 for 2017.

Background

Vision 2030 Jamaica - National Development Plan is the 'roadmap' for making "Jamaica, the place of choice to live, work, raise families and do business".

Four National Goals

- **Goal** 1: **Jamaicans** are empowered to achieve their fullest potential.
- **Goal** 2: The **Jamaican** society is secure, cohesive and just.
- **Goal** 3: **Jamaica's** economy is prosperous.
- **Goal** 4: **Jamaica** has a healthy natural environment.

Goal 3: **Jamaica's** economy is prosperous - Outcome #10 of the (NDP) Vision 2030, Energy Security and Efficiency gave rise to the National Energy Policy (NEP 2009-2030).

The National Energy Policy is a commitment of the Jamaican Government through the Ministry of Science Energy & Technology to ensure that by 2030 Jamaica achieves: A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework. This Policy

document represents the revision to the Energy Policy Green Paper 2006- 2020 based on national consultations and comments received by a wide cross-section of society as well as current realities facing Jamaica and in keeping with the country's long term plan to achieve developed country status by 2030 as articulated in Vision 2030 Jamaica – National Development Plan. This Strategic Framework– the goals and strategies underpinning this National Energy Policy – is comprehensive and is expected to be durable to 2030 and beyond, yet be flexible and adaptable to meet new challenges and opportunities as they arise. This Strategic Framework also addresses both supply and demand energy issues the country faces and as such places priority attention on seven key areas:

1. Security of Energy Supply through diversification of fuels as well as development of renewables
2. Modernizing the country's energy infrastructure
3. Development of renewable energy sources such as solar and hydro
4. Energy conservation and efficiency
5. Development of a comprehensive governance/regulatory framework
6. Enabling government ministries, departments and agencies to be model/leader for the rest of society in terms of energy management
7. Eco-efficiency in industries

Giving due consideration to the seven priority areas listed above, the National Energy Policy will ensure that the country minimizes the effects of volatile and rising crude oil prices, takes advantage of renewable resources and promotes conservation and efficiency in the use of energy resources amongst all sectors of the society. The ultimate outcome of achieving the seven goals of this policy will be the provision of more affordable energy supplies to Jamaican consumers, an

improved competitive base for the country, as well as sustainable growth and development of the nation.

The Jamaican Context

The Jamaican energy landscape is dominated by the Jamaica Public Service company (JPSCo), which has a monopoly on transmission and distribution and is the largest energy supplier. The industry is regulated by the Office of Utilities Regulation (OUR), who sets the rates and service standards to ensure a transparent and equitable representation for all stakeholders and MSET is responsible for Energy Policy in addition to Planning through the promulgation of the Electricity Acts 2015. This New Electricity Act 2015 Governs the, Generation, Transmission, Distribution, Economic Dispatch and Supply of Electricity and replaces the 1890 Electric Lighting Act and other related Legislations. The new Act also supports self generators of energy through Net Billing, Power Wheeling and Auxiliary Connections.

The Jamaican economy is characterized by high energy intensity and low efficiency and still depend on imported fuels. Petroleum consumption is concentrated in three areas, namely: bauxite/alumina, power generation and transport. The recent cycle of oil price volatility and the global emphasis on environmental issues have re-focused energy supply security and the environmental sustainability agendas for both energy import-dependent and exporting economies. Uncertainty of oil prices is prompting developing economies such as ours to rethink the fundamentals of our energy policies. Access to energy at affordable prices has thus become the focus of the energy security agendas of oil import-dependent economies. A comprehensive

and continuous program of efficiency improvement and energy diversification is required for Jamaica to provide high-quality, affordable, environmentally-friendly energy and to reduce the country's dependence on high-cost imported oil. Energy diversification has started and involve moving from an almost total dependence on petroleum to a strategic mix of other sources, including natural gas, since 2016, renewable energy such as solar, wind, and biofuels. In the short to medium term, natural gas would be the fuel of choice for generation of electricity and the production of alumina. This diversification will require an enabling regulatory and legislative environment and development of institutional capacity, which is on the way. In the longer term more sustainable and cheaper fuel options must, and will be identified and developed. Jamaica's National Energy Policy support Vision 2030, Jamaica National Development Plan, provide the enabling environment for the achievement of the national outcome of "a secure and sustainable energy supply for our country" as articulated in the Plan and the implementation of the two national energy strategies: to diversify the energy supply and to promote energy efficiency and conservation. It would also provide support for the achievement of two other national strategies articulated in the Plan, namely "adaptation to climate change" and "to contribute to the effort to reduce the global rate of climate change". The Energy Policy will ensure that linkages are established with other sectors such as agriculture, transport, construction, bauxite, and finance to achieve policy coherence and fulfil the country's energy goals.

The Strategic Framework underpinning this National Energy Policy is comprehensive and will be sustained to 2030 and beyond yet be flexible and adaptable to meet new challenges and opportunities as they arise. The framework includes the short- to medium-term as well as long-term strategic directions for the government, private sector and industry as well as civil society.

The draft Renewable Energy Policy further emphasises the NEP strategic objectives on Renewable Energy.

Details

Renewable Energy Relationships

Jamaica consumes approximately 23 Million Barrels of Oil Equivalent, 7% of which is Renewables (Energy). Excluding Eight Rivers 37MW Solar Plant, renewables 14.8%, LNG 11.8% and Petroleum 73.4% in Electricity Generation (installed capacity). Between 2016– 2019, 154 MW of renewable capacity was installed in Jamaica – Electricity.

Renewable Energy plays a key role in Jamaica achieving its Climate Change commitments as Jamaica is a signatory to a number of Treaties and Agreements to include the Paris Agreement, which seeks to limit the rise of the global temperature below 2°Celsius. The United National Framework Convention on Climate Change seeks to regulate Greenhouse Gas Emissions. It is estimated that Renewable Energy capacity of 154 MW will reduce annual CO_2 emissions per year by 450,000 metric tonnes.

Energy Efficiency

The long-term strategic vision of the NEP is built on ten (10) fundamental elements. Energy efficiency is directly reflected in the following three elements:

1. An energy sector that is supported by greater awareness by the Jamaican public of the importance of energy and its use in their daily lives and the contribution that each can make to the responsible and efficient use of this vital commodity
2. An energy sector that is driven by private sector investment within a policy and regulatory framework that fosters investments, competition, efficiency, a level playing field and transparency.
3. An energy sector that reflects a sustained improvement in the ways in which energy is used, through greater energy efficiency, reduced energy intensity and better energy conservation and management.

Energy Efficiency Indicators Improvement

- Reduction in Energy Intensity Index
- Reduction of T & D systems losses in public electricity supply
- Reduction in energy consumption by National Water Commission (NWC)
- Reduction in households' income spent on energy
- Increase in fuel efficient vehicles on the road

The four goals underpinning the National Energy Conservation and Efficiency Policy draft (sub-policy) address the following areas:

1. Assisting households and businesses to aggressively adopt energy conservation and efficiency practices towards a reduced carbon footprint.
2. Reducing and/or eliminating barriers to the uptake of energy conservation and efficiency projects, technologies etc.
3. Government leading the way in energy conservation and efficiency efforts and working in partnership with the private sector and civil society.
4. The efficiency of the energy plants that supply energy to all sectors of the economy.

NEP 2015 implementation translate into a number of programmes and projects, for example

Energy Efficiency and Conservation Programme (EECP)

This programme seeks to enhance Jamaica's energy efficiency and conservation potential through design and implementation of EE and EC cost saving measures in the public sector by focussing on the following objectives

1. The implementation of EE and EC investment measures in the public sector namely; *Air-Conditioning and Building Envelope Retrofits.*

2. Undertake activities to increase awareness among the public and private sectors regarding EE and EC cost and benefits.
   - workshops and seminars on EE procurement and EE management

  - Education and dissemination of information on the main lessons learnt nationally and regionally
- The Development of an Energy Efficiency and Conservation Standard Manual for the public sector.
- The development of National Guidelines for the Management of Hazardous Waste arising from EE/EC interventions in the Public Sector is also being done.

Energy savings of the public sector (kWh/year) **Total savings from January 2013 to August 2019 is** 9,913,506.12 kWh

Cumulative savings from January 2013 to August 2019 (kWh) 3,569,265.40 kWh

Total savings from January 2013 to August 2019 7,892.14 tonnes CO_2 and Cumulative **savings from January 2013 to August 2019 (kWh)** 2,841.49 tonnes CO_2
(July 2019: 2,911.01 tonnes CO2)

Additionally we have EMEP, Energy management and Efficiency program

Component 1 - Retrofitting of GOJ Facilities (Budget - US$30.87 Million)

Component 2 - Urban Traffic Management System (Budget - US$3.5 Million)

Component 3 - Electricity & Energy Planning (Budget - US$2.03 Million)

Prior to the new electricity Act, the utility plants did not have a set retirement date. This issue has now been corrected under the new Act and all generating plants will have a set economic retirement date. IRP will dictate the need for additional Generating capacity, Transmissions and Distribution which could include for generation, Biomass in the form a Waste to Energy plant. In implementing the energy policy, seeking to ensure Jamaica's energy security, diversification and to reduce our overall dependence on crude oil, Jamaica introduced LNG into its energy mix in 2016. 120 MW of the electricity generation capacity was converted to use LNG in 2016 and another 190 MW is nearing completion in 2019.

Several consultation with stakeholders has been held looking at the various implication for the introduction of electric vehicles. Additional renewable energy capacity will be needed to meet the RE targets of the policy, electric vehicles will create additional demand for RE Renewable Energy and will play a significant part in the future of energy in Jamaica.

Jamaica Public Service Company, JPS, has being commissioning a US$25 million storage facility in phases this year as a safeguard against power outages. The 24.5 megawatt plant, the first of its kind for Jamaica, is being installed at the company's Hunt's Bay power station in Kingston.

Renewables as a source of electricity, both generated by JPS and its independent power providers, have been incorporated into the national grid since 2016. The result was cleaner fuel but fluctuating power during low periods. The storage facility will allow the company to maintain consistent power supply and curtail the power fluctuations. Peak energy usage in Jamaica occurs between 6.30 p.m. and 9.30 p.m., which matches the time that solar plants reduce power generation. The energy at the new facility would be brought into play at peak periods, utilising the power already stored.

MSET through the NEP is ensuring a *modern, efficient, diversified and sustainable energy sector.*

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		
9					
10					
11					
12					
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19					
20					

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

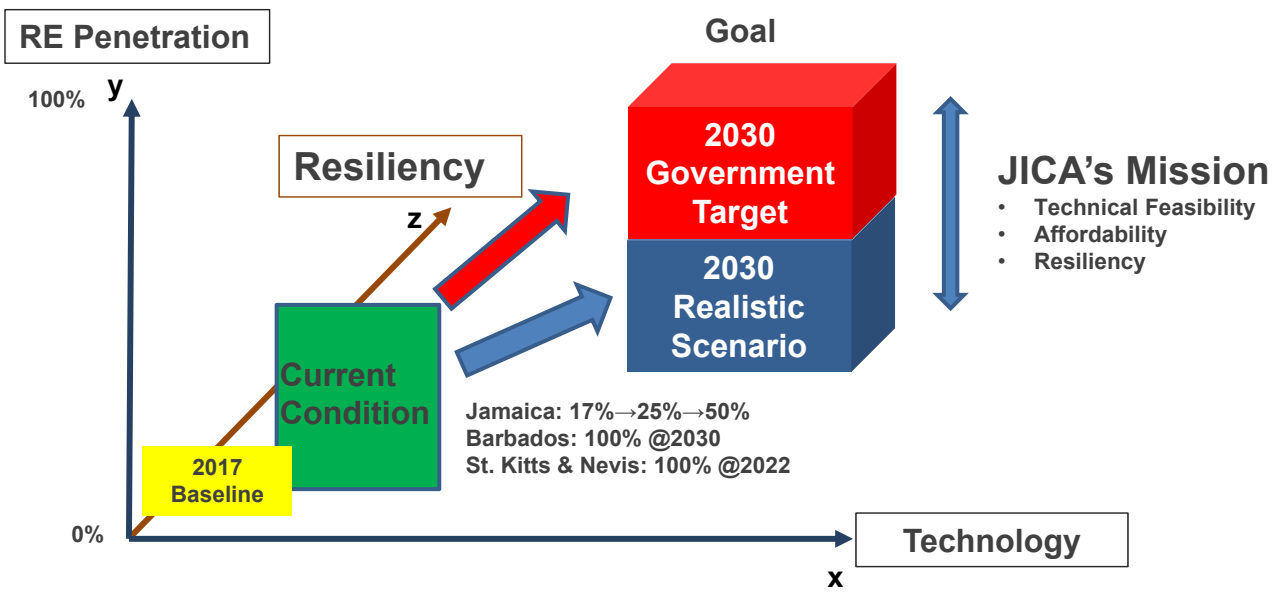
October-November 2019

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

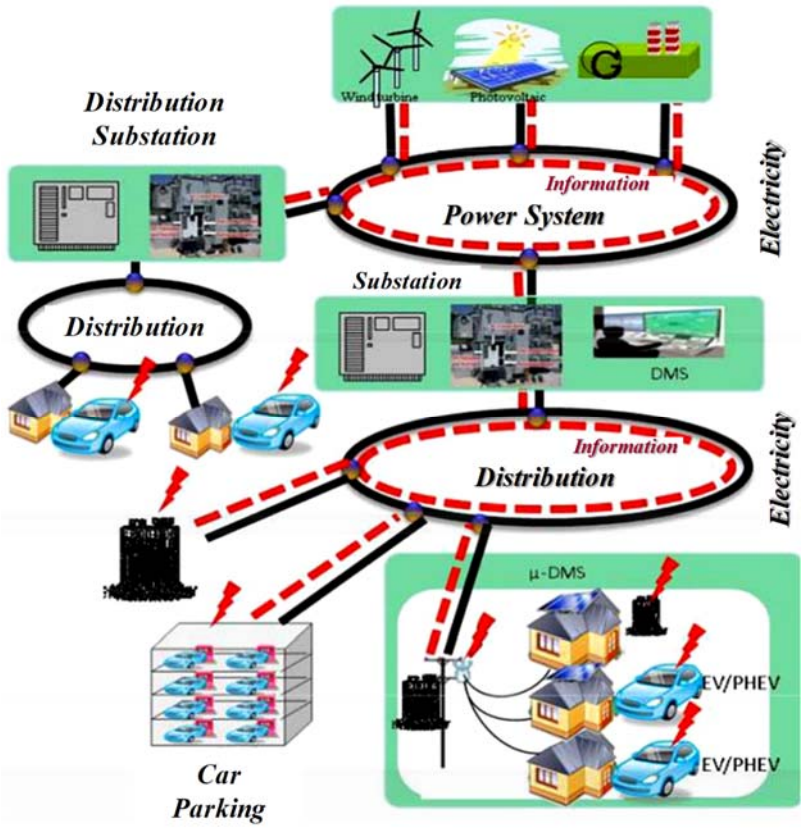
1. Project Outline

JET's Mission Recognition

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



Micro-grid Concept



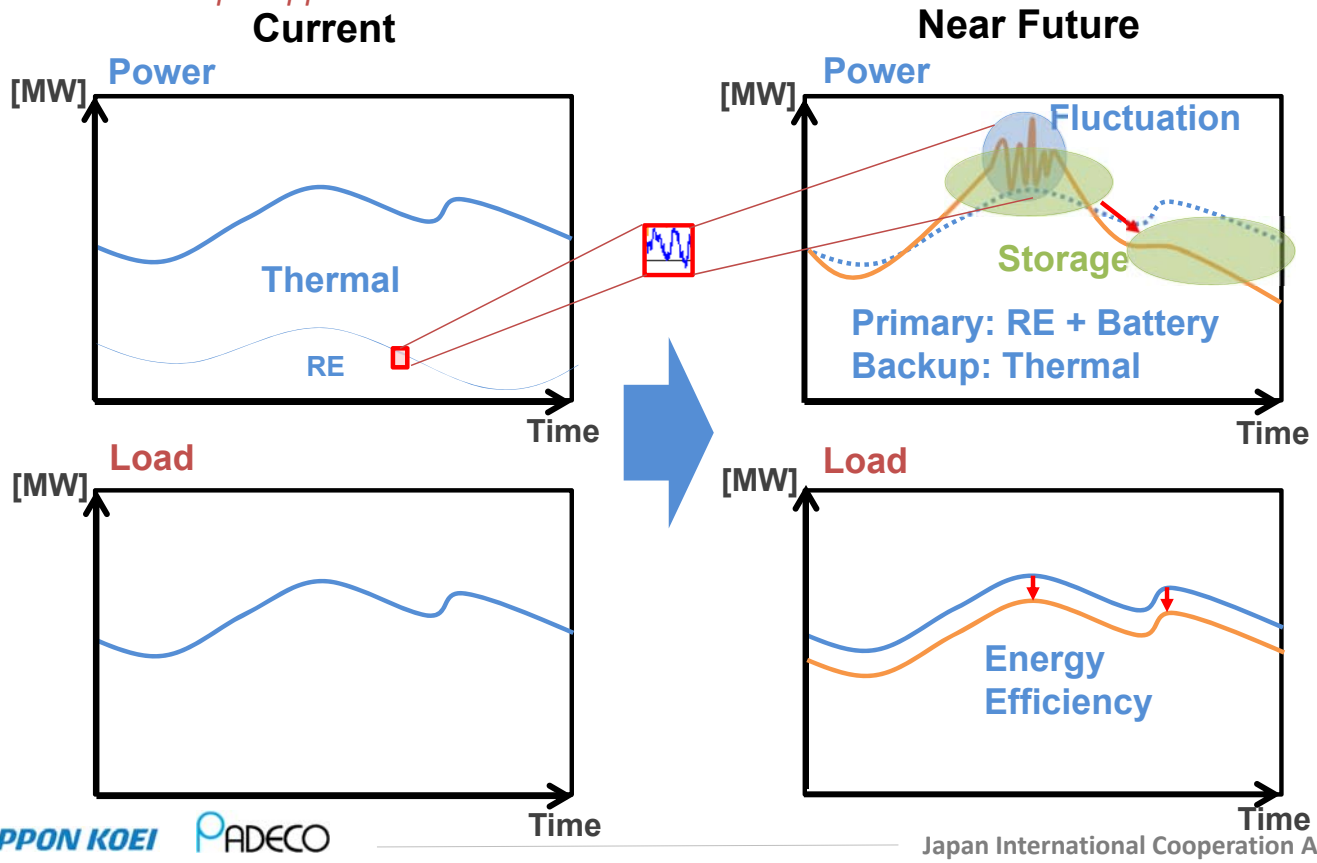
Concept of Micro-grid

- ✓ 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

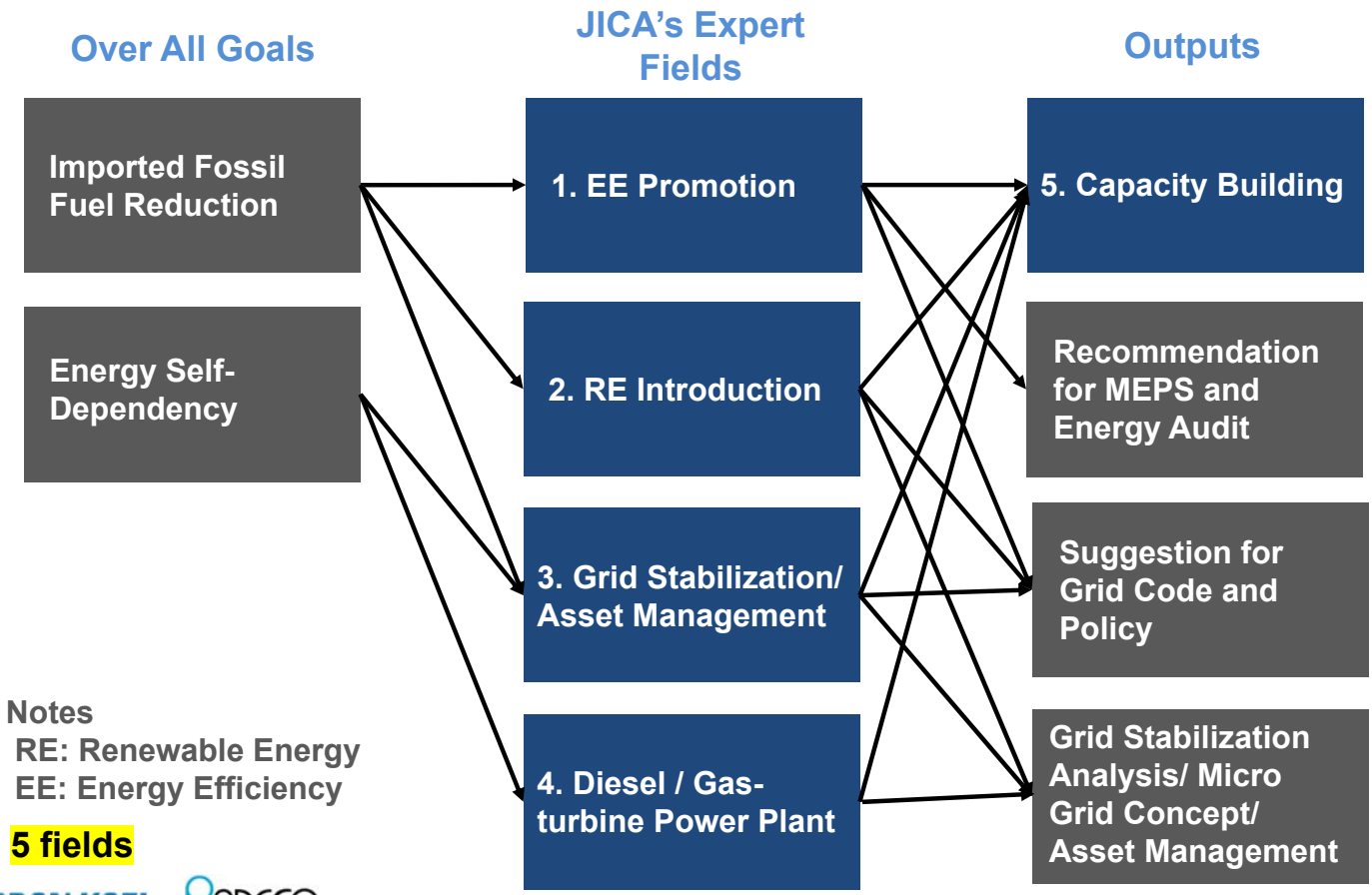
Output 4
The human and institution capacity are enhanced for the promotion of EE

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

1. Project Outline
2. Baseline Survey Report
   - 2-1. Energy Efficiency
   - 2-2. Renewable Energy and Grid Stabilization
   - 2-3. O&M of Thermal Power Generation
   - 2-4. Human Resources and Capacity Building
3. Training Program
   - Regional Training
   - Training in Japan
4. Way Forward and Schedule

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)

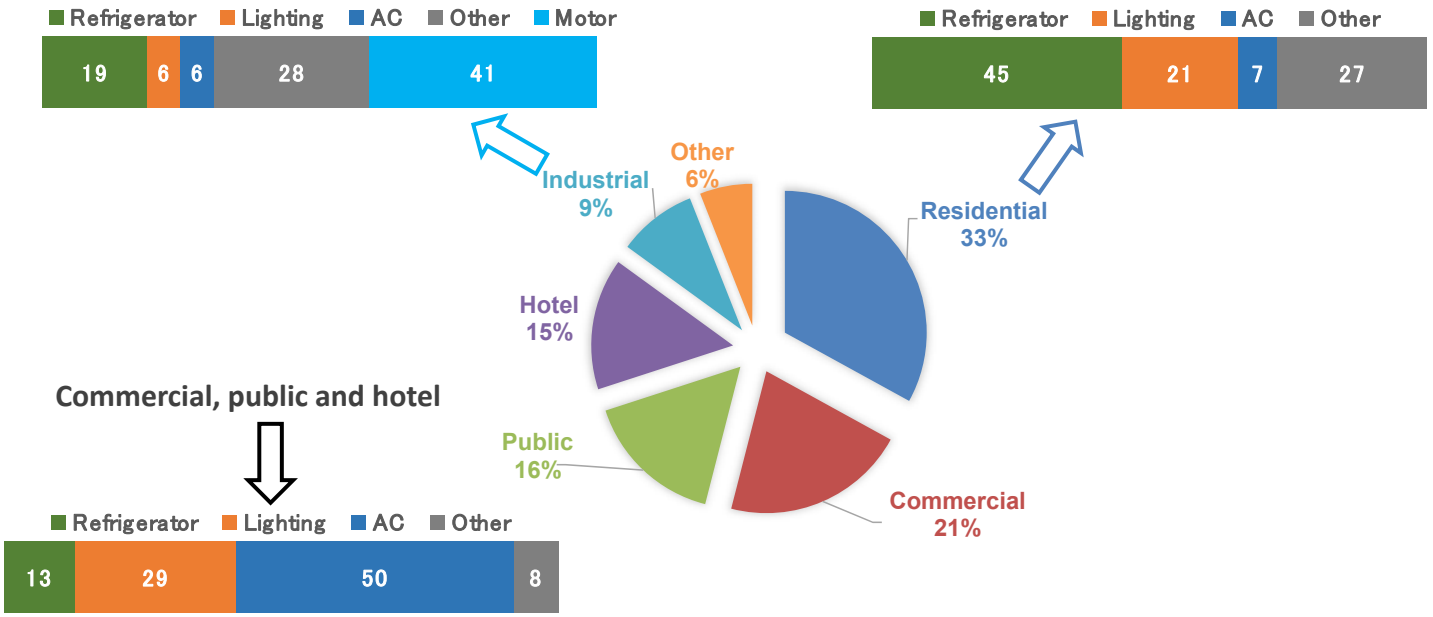
	Industry	Commercial & public	Residential	Other	Transportation	Total
Oil	17	12	8	1	138	175 (42%)
Natural gas	1	7	2	0	0	10 (2%)
Bio/waste	7	0	0	1	0	7 (2%)
Charcoal	0	0	0	0.2	0	0.2 (0%)
Electricity (primary energy basis)	19	84	74	47	0	224 (54%)
Total	43 (10%)	103 (25%)	83 (20%)	48 (12%)	138 (33%)	416 (100%)

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



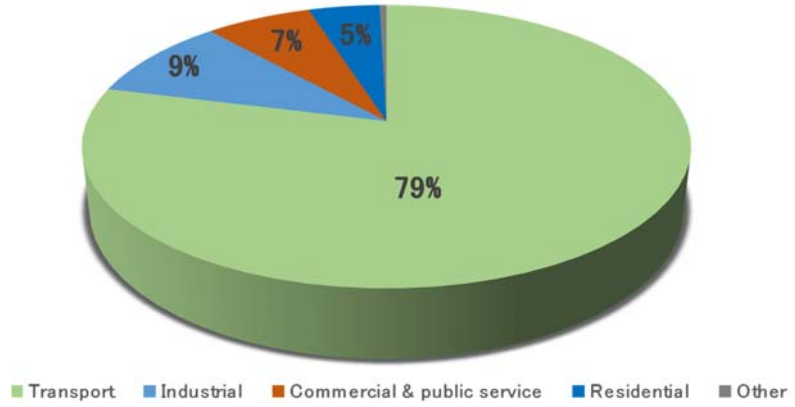
Source: JET with reference to Barbados NATIONAL ENEGY POLICY (2019-2030) and material by the Government of Barbados

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.

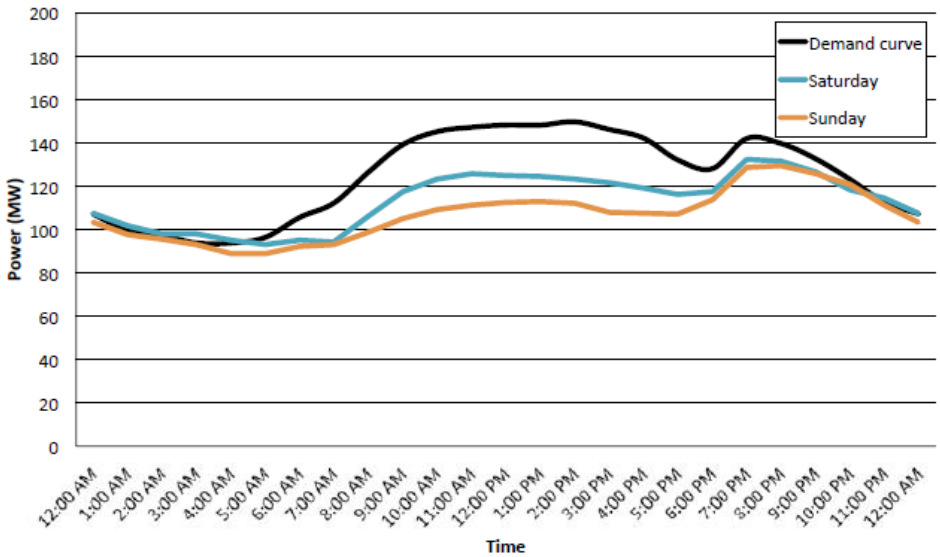
Petroleum consumption by sector excluding power generation use, 2016



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

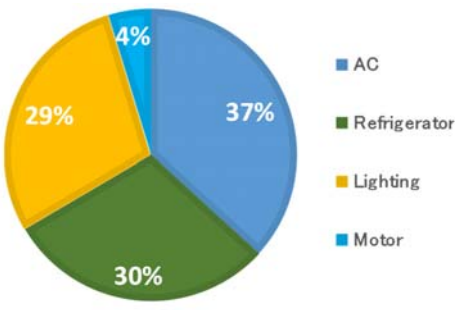
Energy Efficiency

- **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

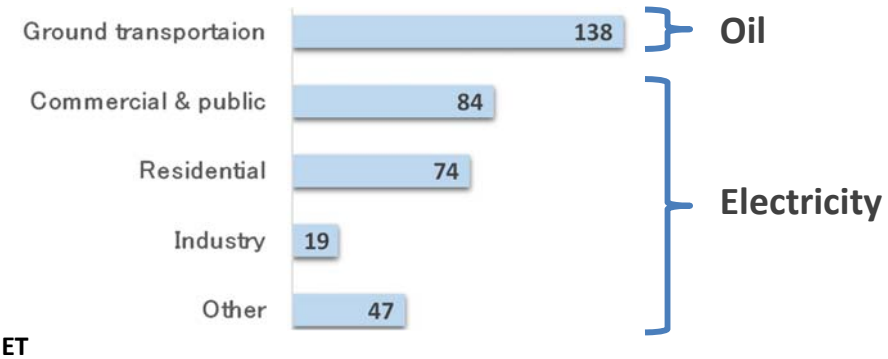
Energy Efficiency

- **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

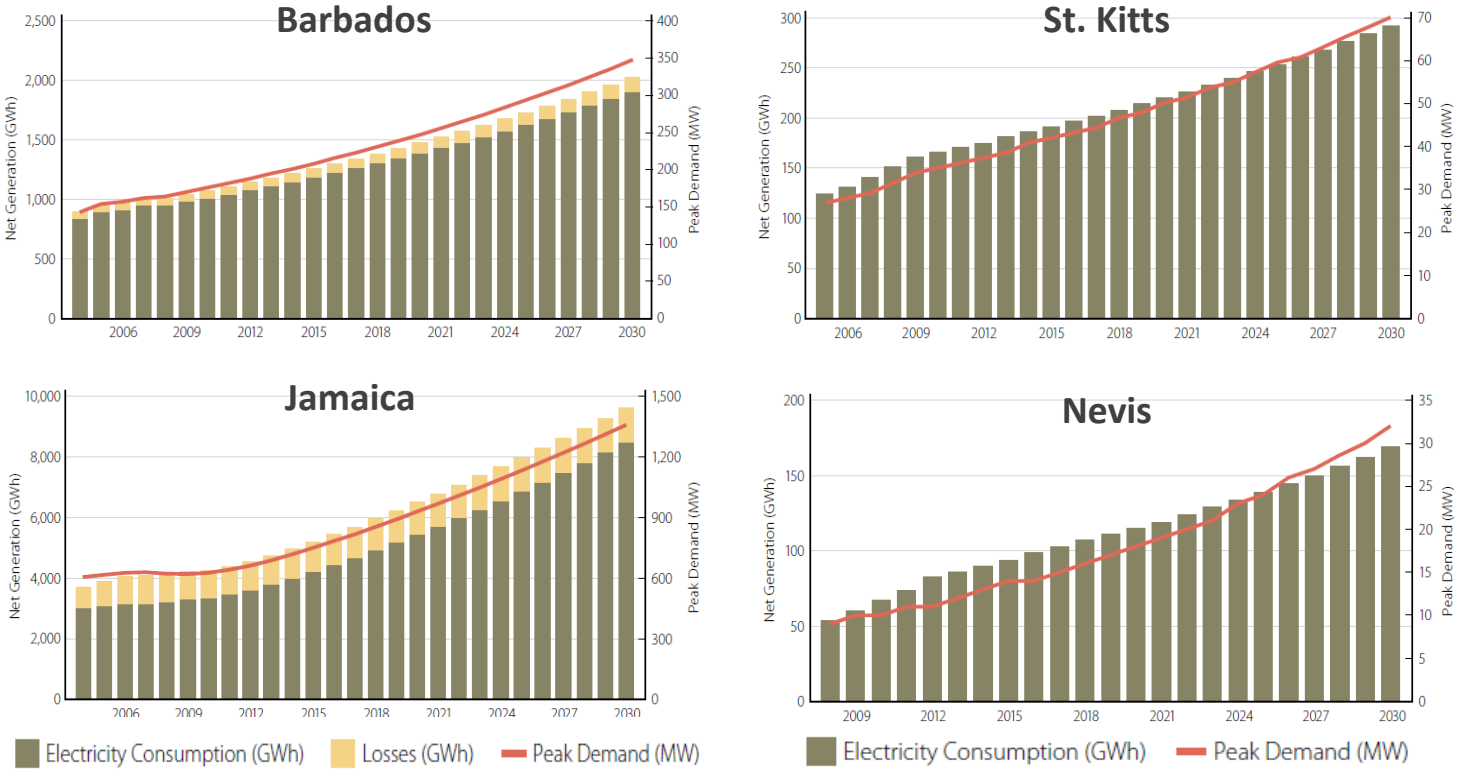
Primary energy consumption by EE high priority field



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))

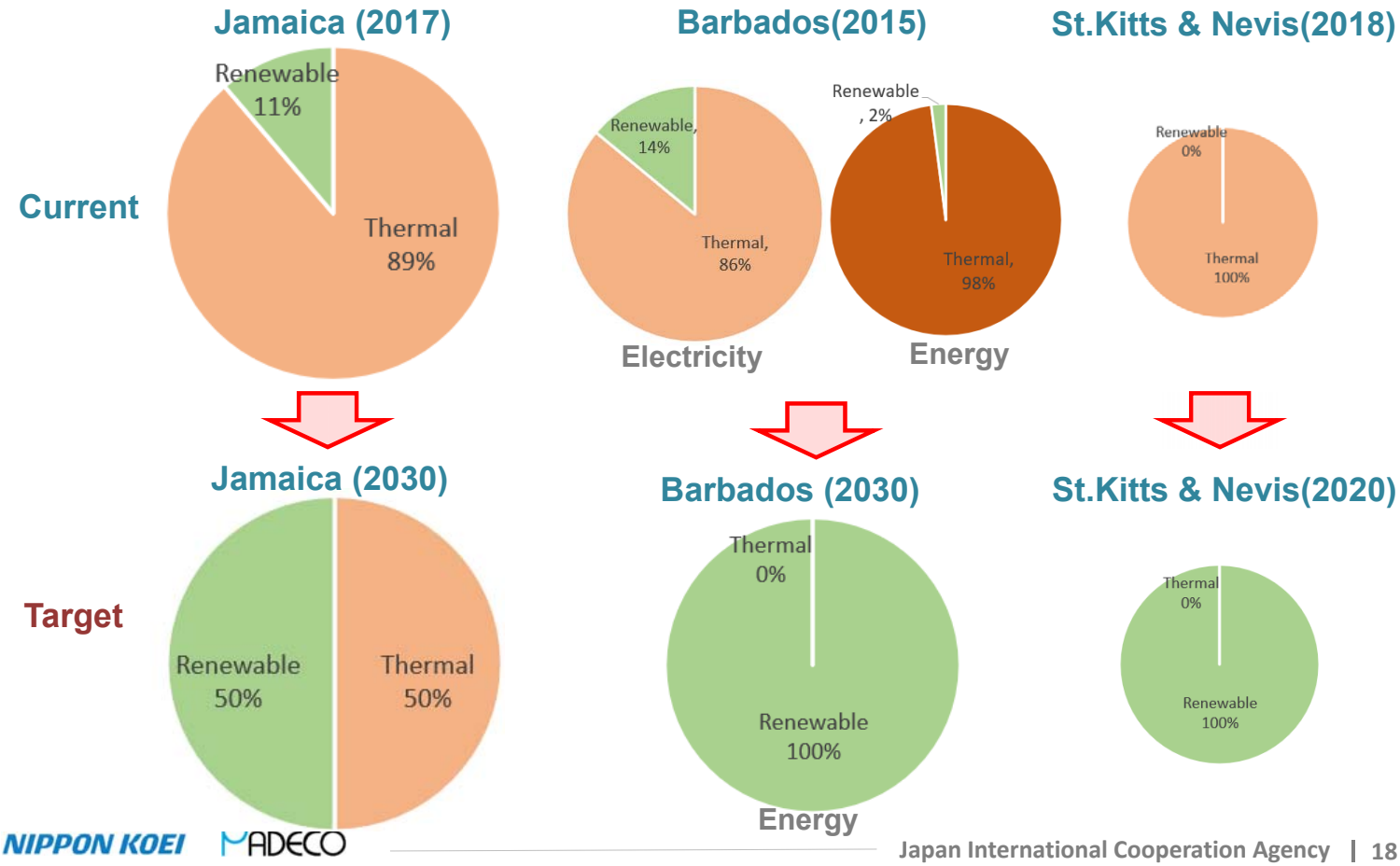
Energy Efficiency

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

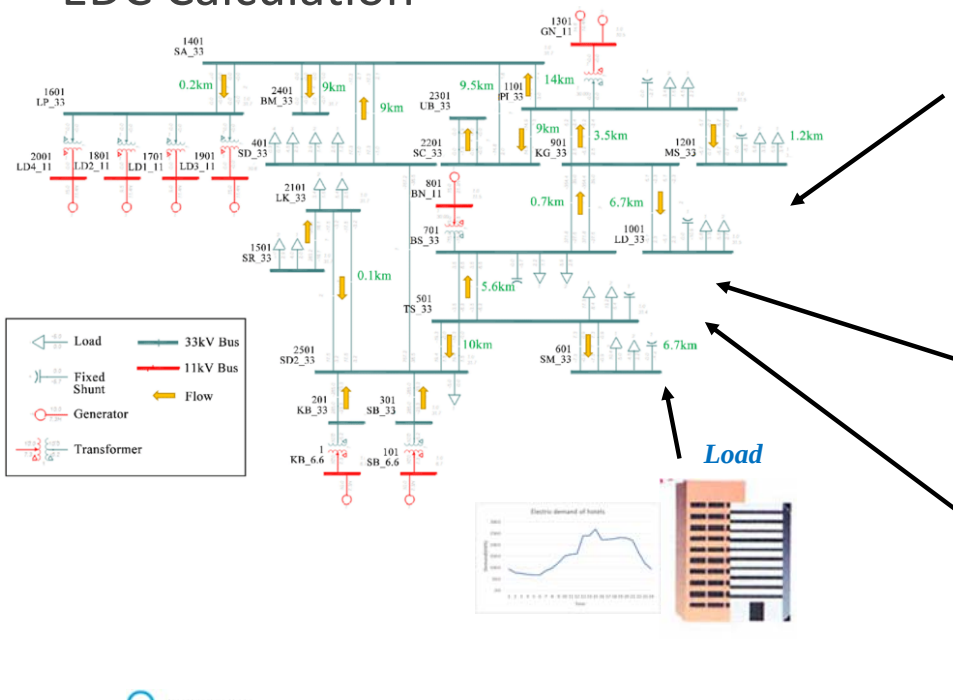
- Provision of Grid simulation software and training
- Introduction of network asset management

✓ **Discussion for grid code**

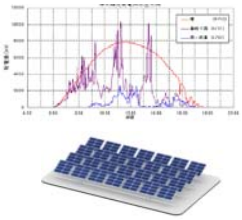
✓ **Suggestion for policy and RE target with reviewing affordability of RE**

Grid Stabilization Simulation

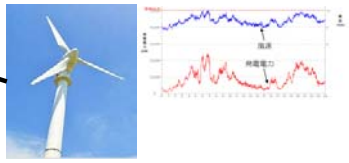
- Simulation of National Grid Model
- Analysis of Issues and Solutions
- EDC Calculation



Photovoltaic Generation

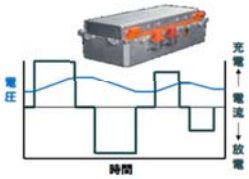


Wind Generator



Load

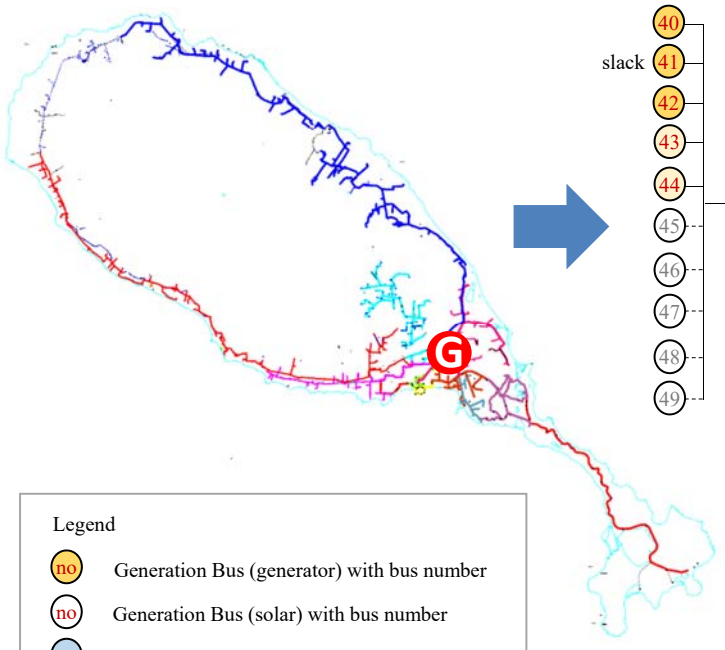
Battery

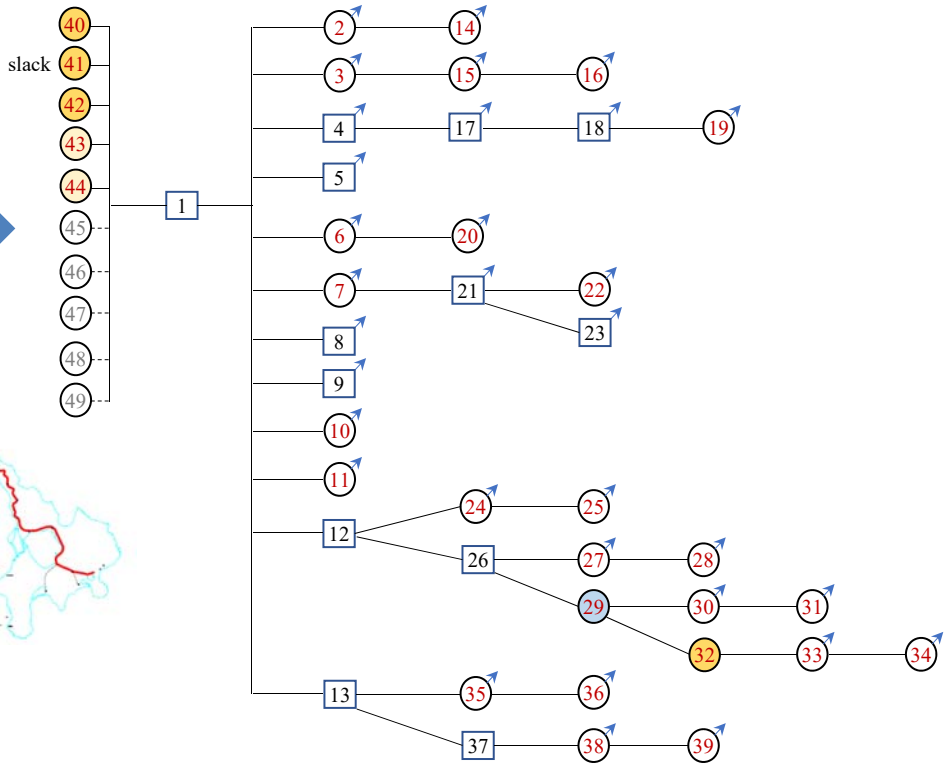


Grid Stabilization Simulation Mod

For St. Kitts & Nevis Only

Schematic view of Grid configuration (11kV)



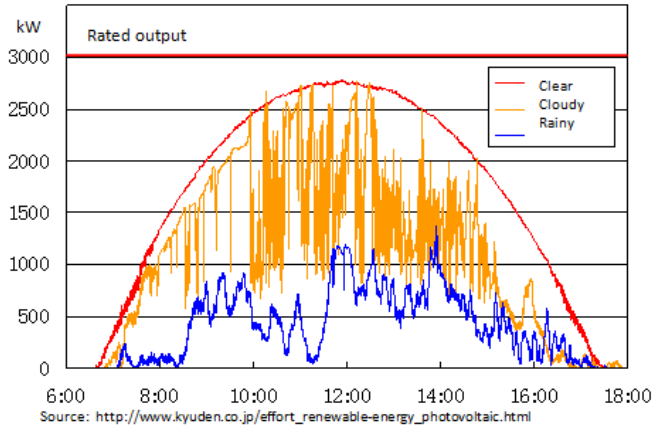


Legend

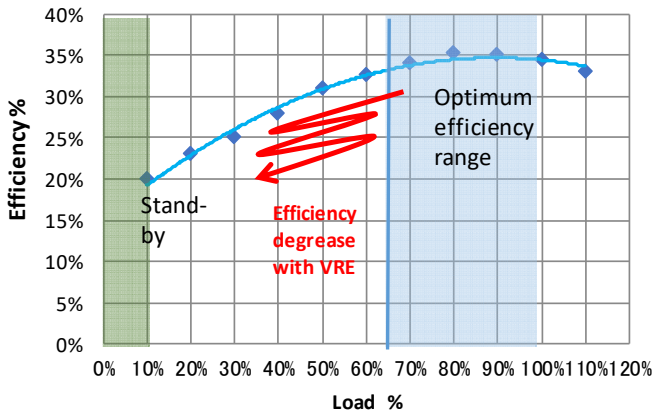
- no — Generation Bus (generator) with bus number
- no — Generation Bus (solar) with bus number
- no — Generation Bus (wind) with bus number
- no — Load/Transit Bus with bus number
- Load

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

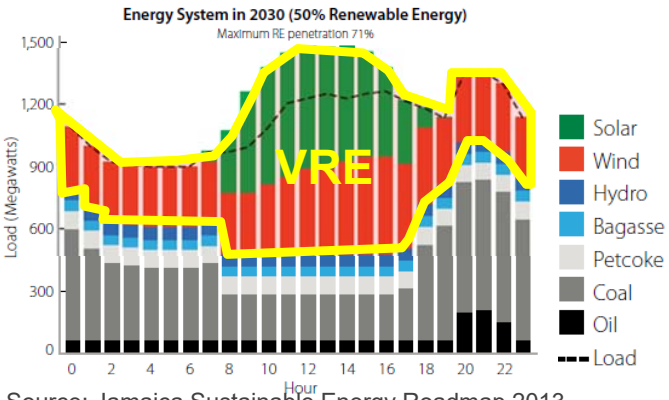


PV output in each whether



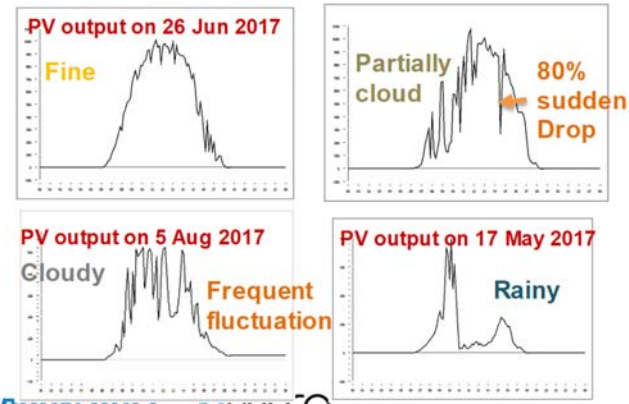
Load and efficiency of typical diesel generator

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

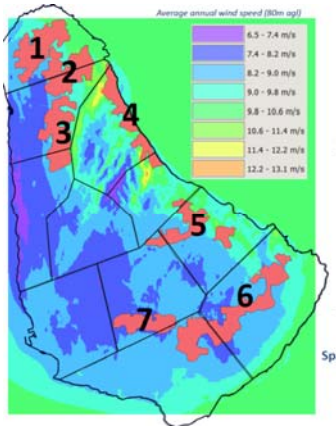
- Low load operation
- Acceleration and deceleration
- Spinning reserve

→ **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

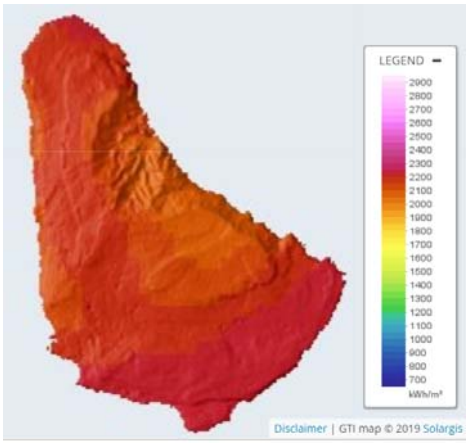


Zone	Area (km²)	No. 2MW turbines	Annual yield (GWh)
1	9.4	34	218.1
2	9.2	33	218.0
3	9.4	30	193.1
4	7.0	34	245.5
5	7.9	27	166.7
6	16.2	58	301.1
7	5.2	20	94.7
	64.2	236	1,437.3

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)

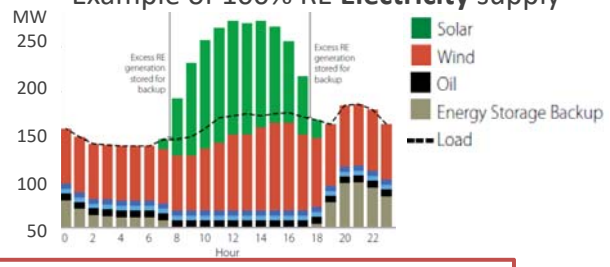
Percentage Share Of The Renewable Energy Supply In The Total Energy Supply For Given Period (%)	2.00%
Percentage Share Of The Solar Supply In The Total Energy Supply For Given Period (%)	0.30%
Percentage Share Of The Biomass Supply In The Total Energy Supply For Given Period (%)	2.10%
Percentage Share 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%

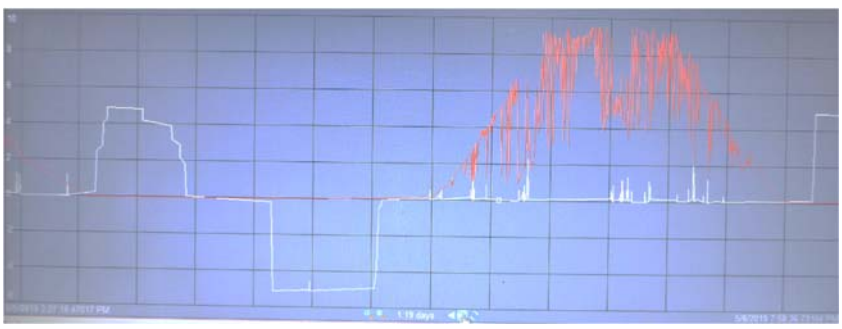
?

100%

Example of 100% RE **Electricity** supply



PV and Battery Operation at Trents 10MW PV &



For 100% RE target:

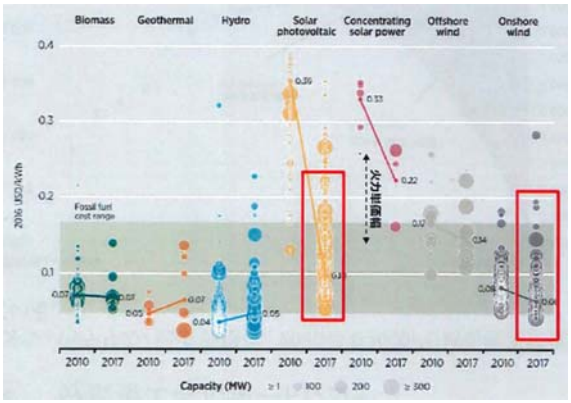
- ✓ Review of affordability and feasibility
- ✓ Additional RE for EV
- ✓ RE project implementation plan
- ✓ Very large scale energy storage
- ✓ Control and cost reduction method
- ✓ Investment cost consideration and fund procurement

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

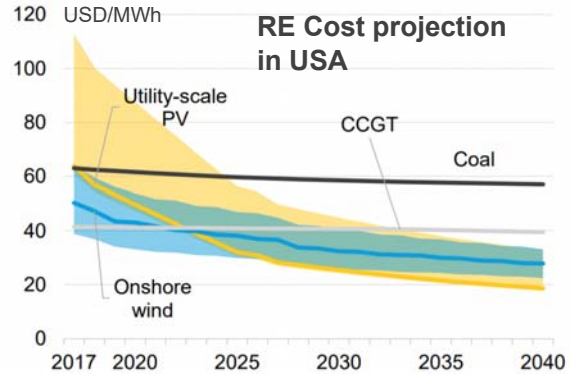
→ **Who owns the stabilization cost?**



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



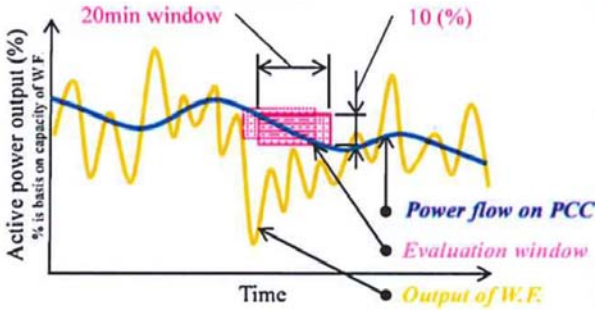
Source: Power Markets Today, Broomberg 2018/ METI, Japan

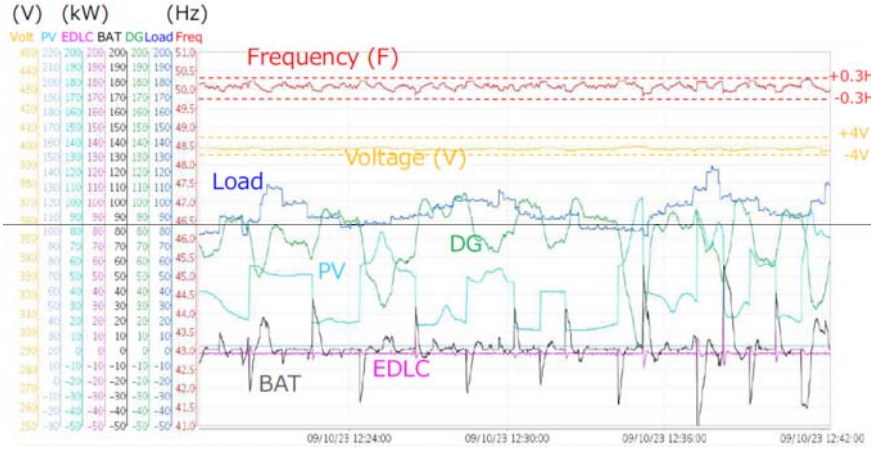
RE: Example of Grid Stabilization with RE and energy storage

For Voltage and Frequency stabilization (below)

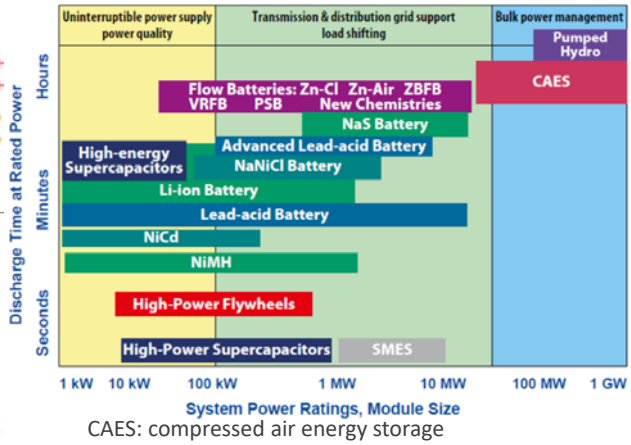
- ✓ Generation: PV, Wind, DG, GT, etc.
- ✓ Energy Storage: Battery (BAT), Capacitor (EDLC)
- ✓ Load /Demand control
- → **Grid Simulation is necessary**
- → **Various energy storage needs to be considered**

Smoothing output





Source: Meidensha, Autonomous Micro-grid Conference, 2019

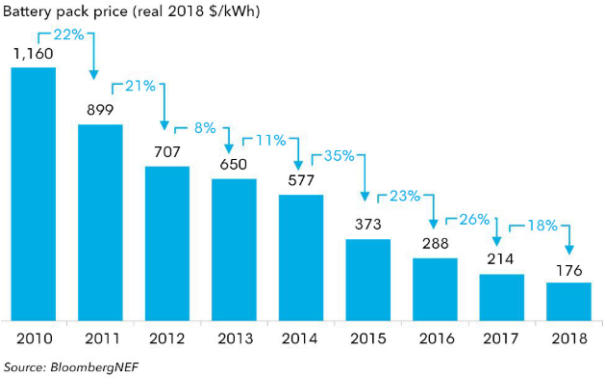


CAES: compressed air energy storage
Source: IRENA, Electricity Storage and Renewables, 2017

RE: Cost consideration of BESS

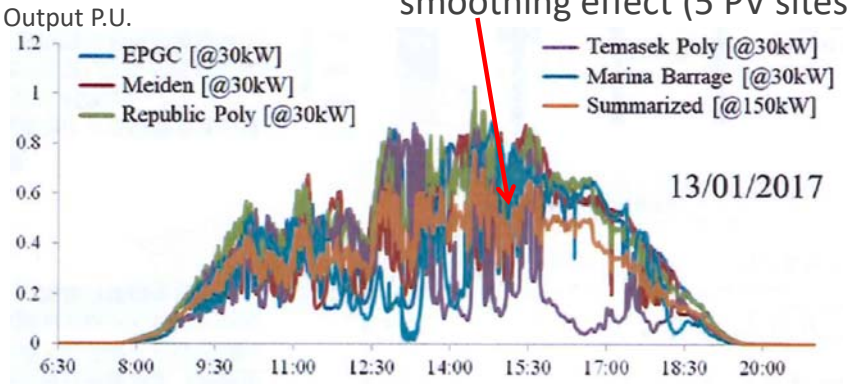
1) Output smoothing by overlaying different PV/wind locations
2) Battery at each site → Centralized battery storage system

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

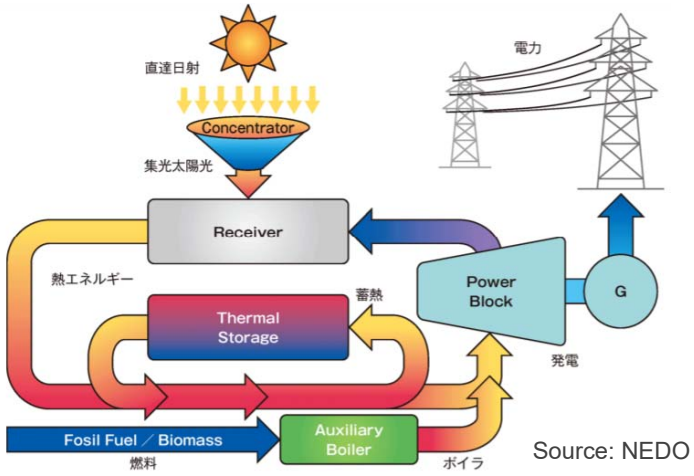
To reduce cost:
- Data analysis with solar irradiation/wind speed short interval necessary at several locations
- Speedy communication system advanced EMS control is necessary

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

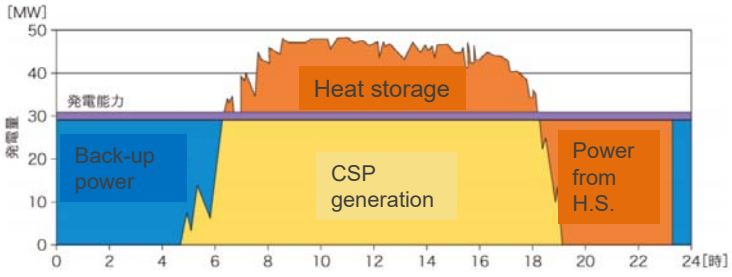
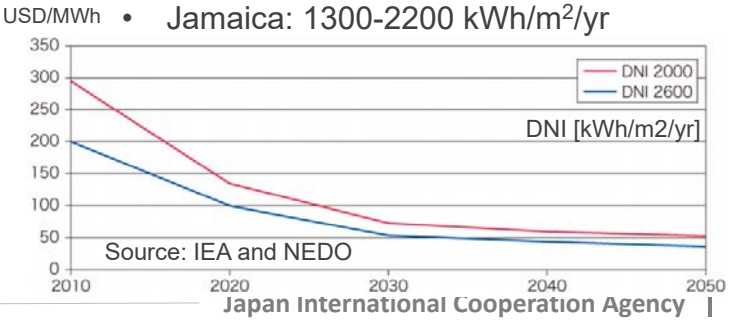


Photo: blog.eco-megane.jp/

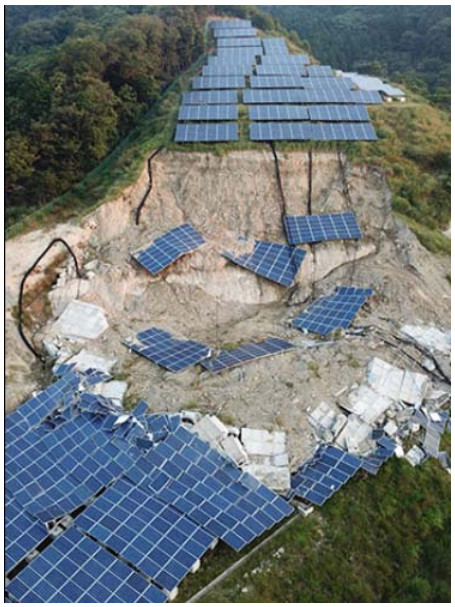
- DNI (Direct normal irradiation)
  - Barbados: 1600-2000 kWh/m²/yr
  - St Kitts&Nevis:1600-2300 kWh/m²/yr
  - Jamaica: 1300-2200 kWh/m²/yr



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



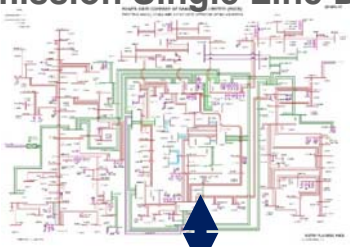
26 Jul 2019 Himeji, Japan
https://www.dailyshincho.jp/article/2018/07260800/?photo=1
Landslide by a heavy rain

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**

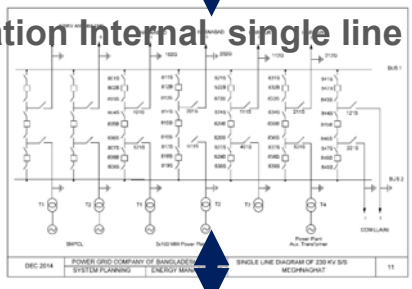
RE: Resiliency Enhancement - Digitalized Network Management System

Linking all asset data on to one data platform

Transmission Single Line Diagram

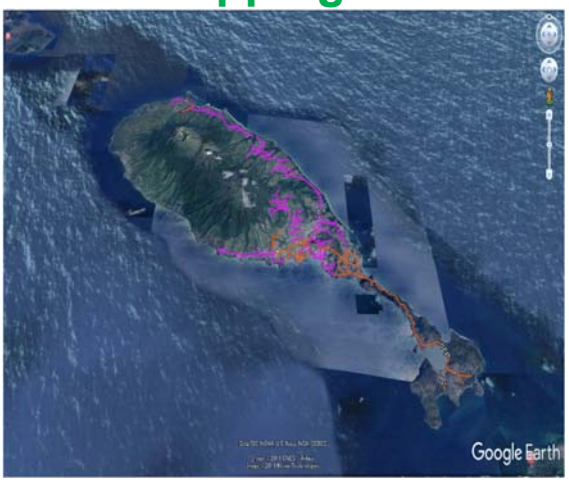


Substation Internal single line diagram



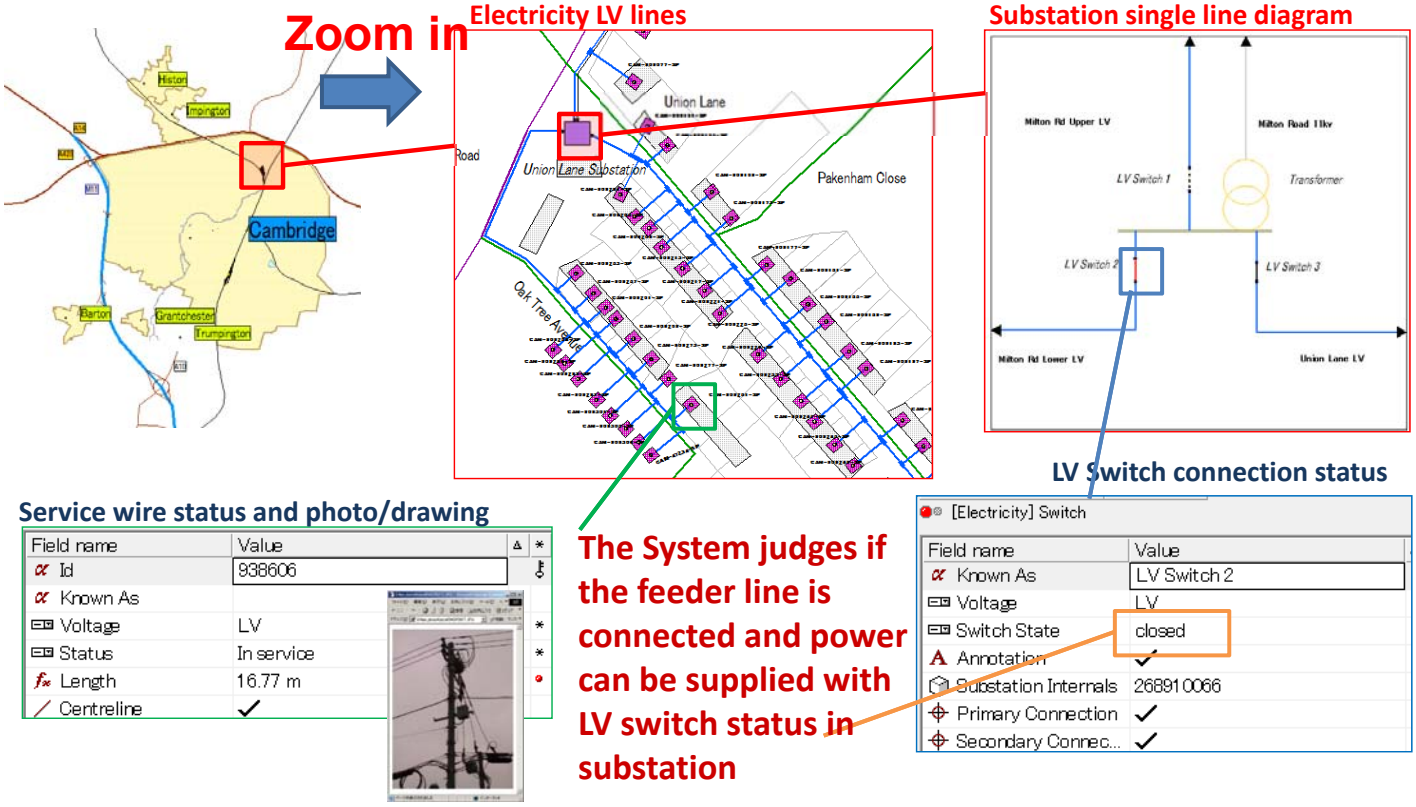
Power distribution network to meter

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

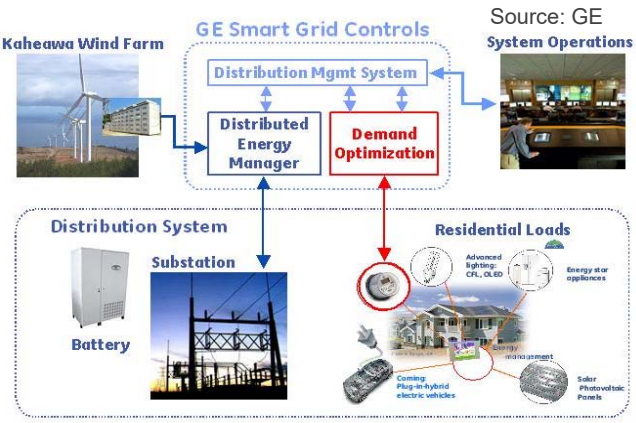


RE: Large RE Example in Islands

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

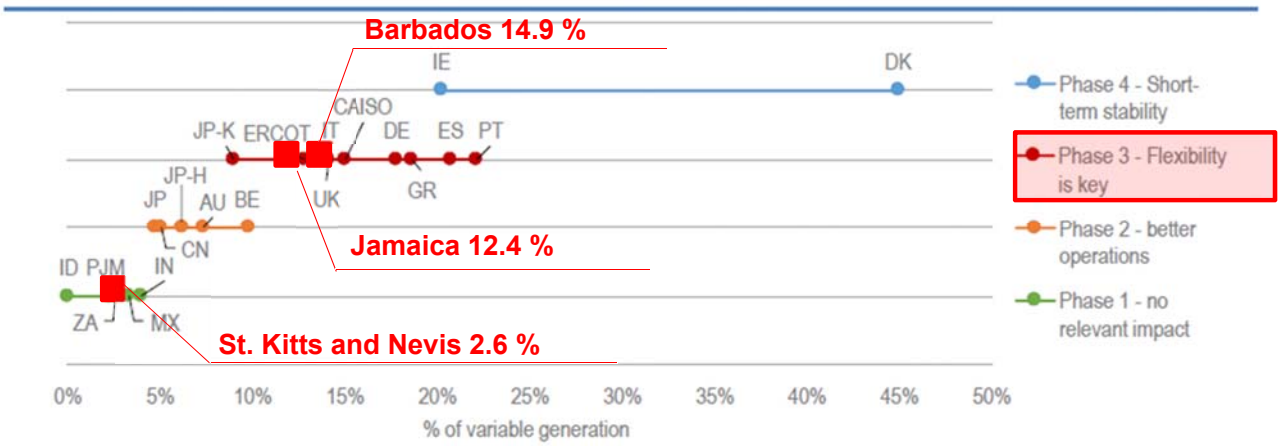
3 villages, 203 household, population 790
Peak **229kW**, Demand1300 MWh/yr, **3.6 MWh/day**)
RE: **1.4 MW PV (6.1 times than peak)**
Battery: **750kW**/**6 MWh** LIB, Tesla 20yrs guarantee
DG: 320kW × 3, 150kW × 1

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

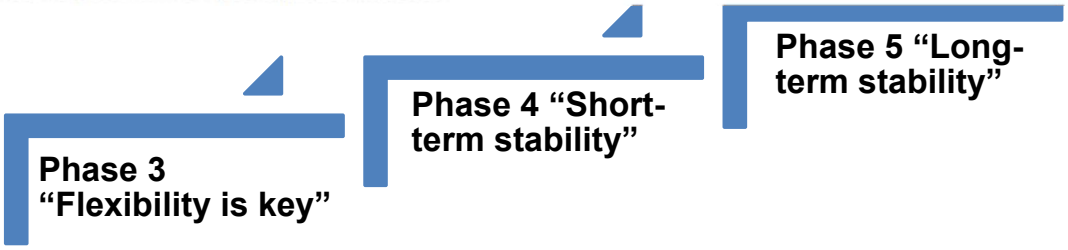
Small demand, but huge RE and Battery
→ **Micro-grid**, Back-up DG is necessary

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

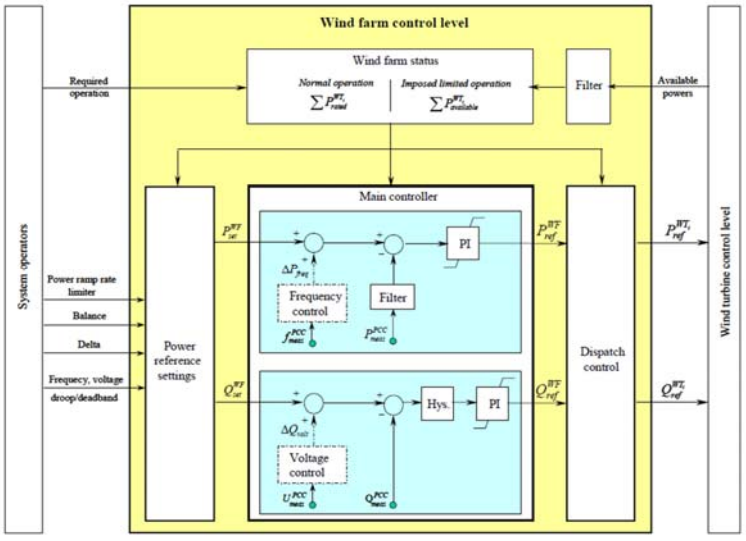
Grid Simulation Software

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

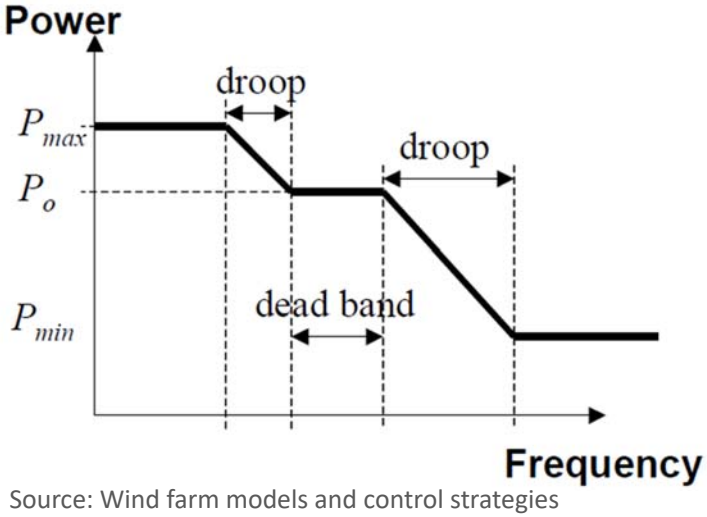


Source: Wind farm models and control strategies

- 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

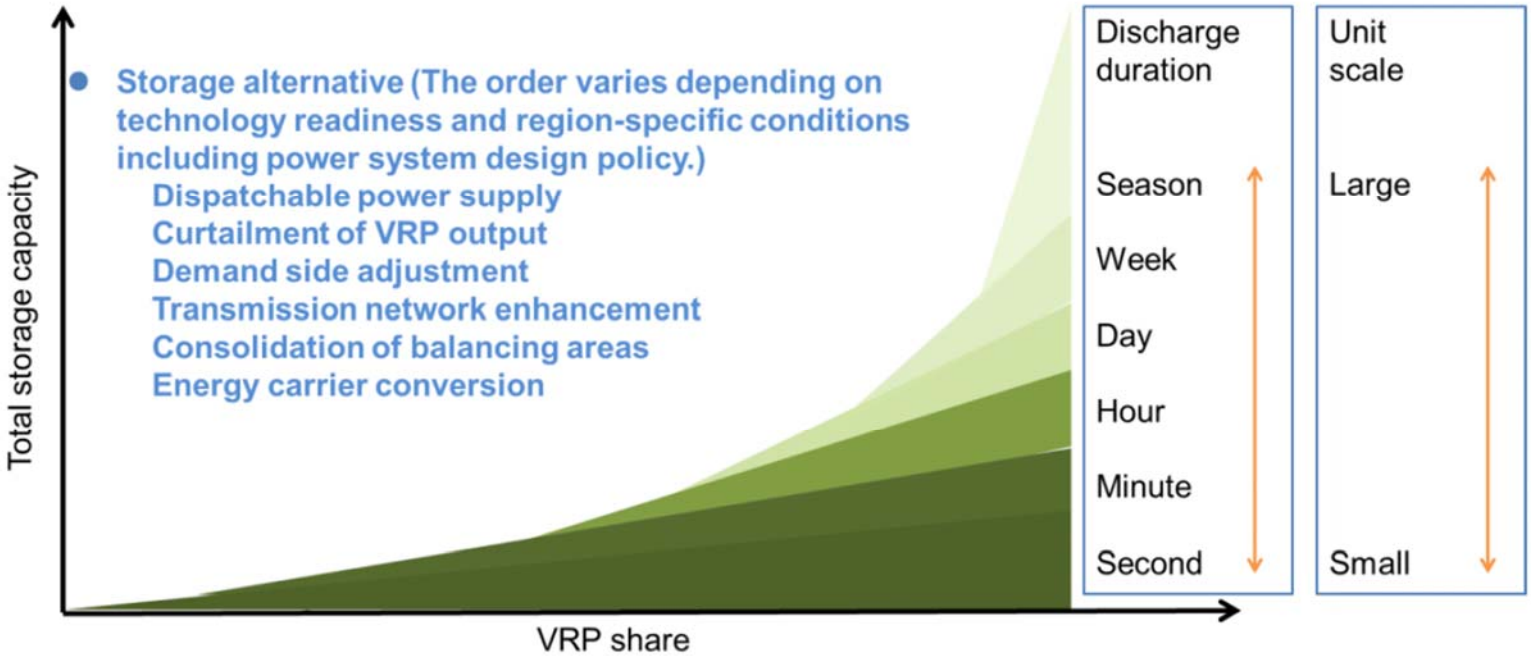
- Same as thermal power plant control
- For frequency stabilization

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

Solution 2: Application of Large Capacity Energy Storage System

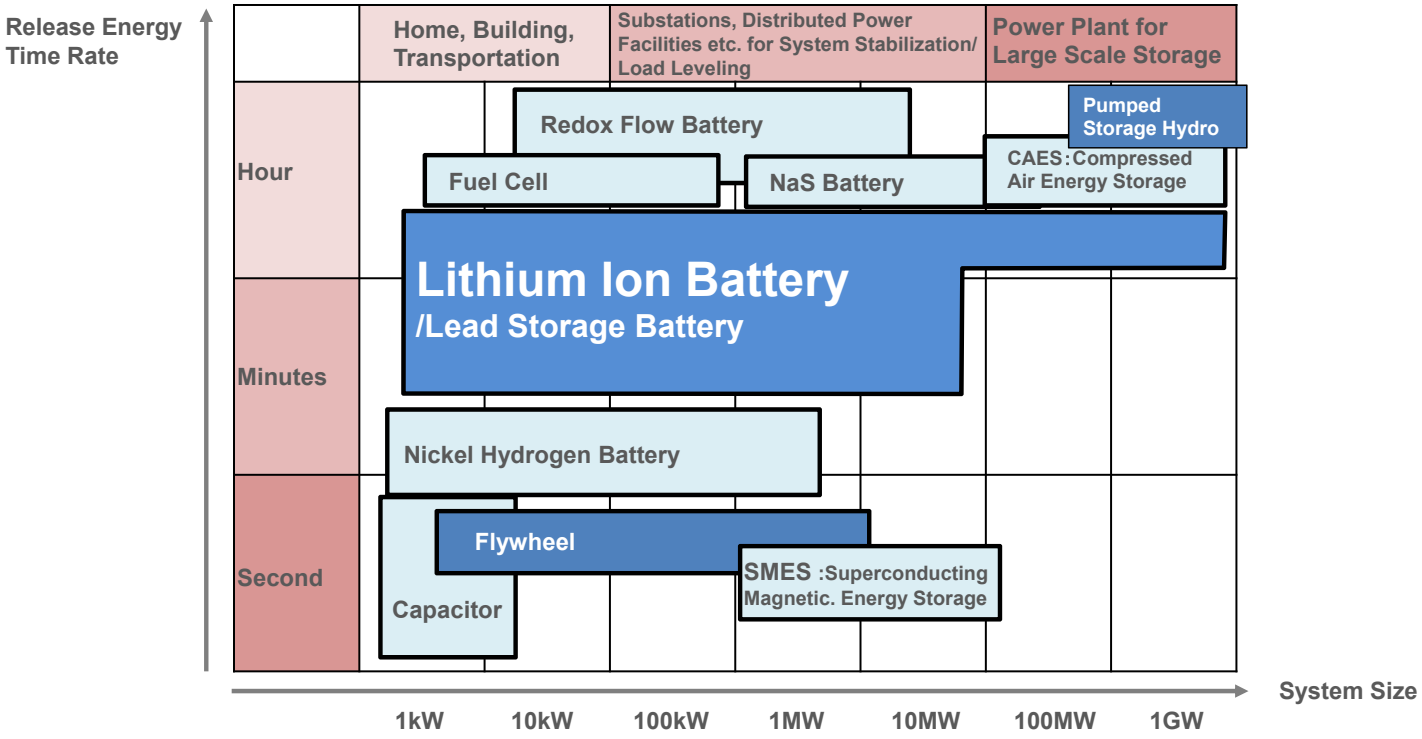
Variable Renewable Energy (VRE) Share and Storage Requirements for Power Systems

(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	←	→			

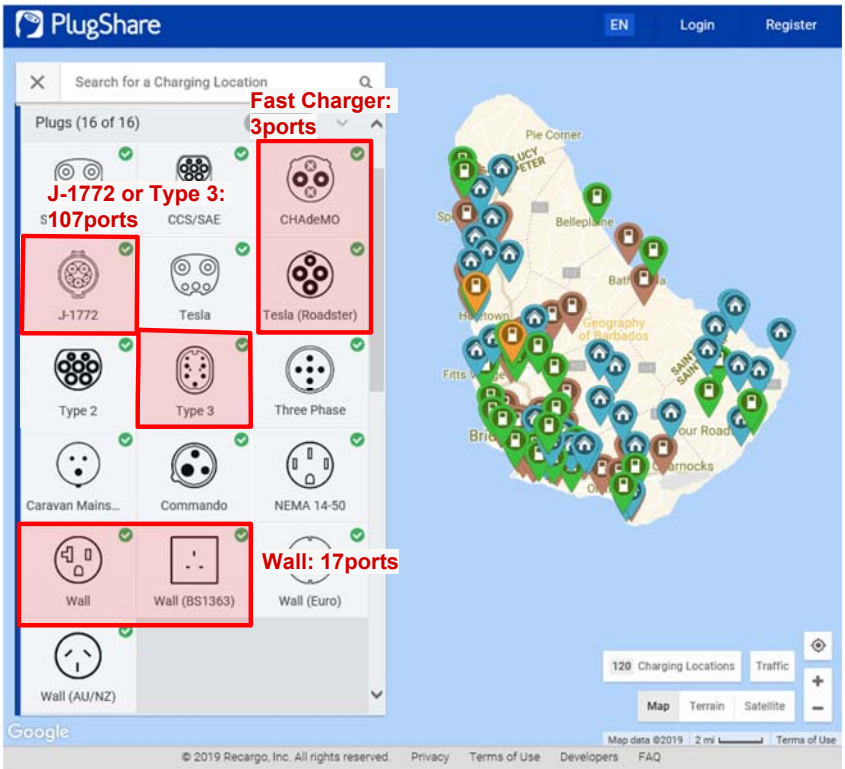
PSH: Pumped-Storage Hydropower
CAES: Compressed Air Energy Storage
LAES: Liquid Air Energy Storage
SMES: Superconducting Magnetic Energy Storage

(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

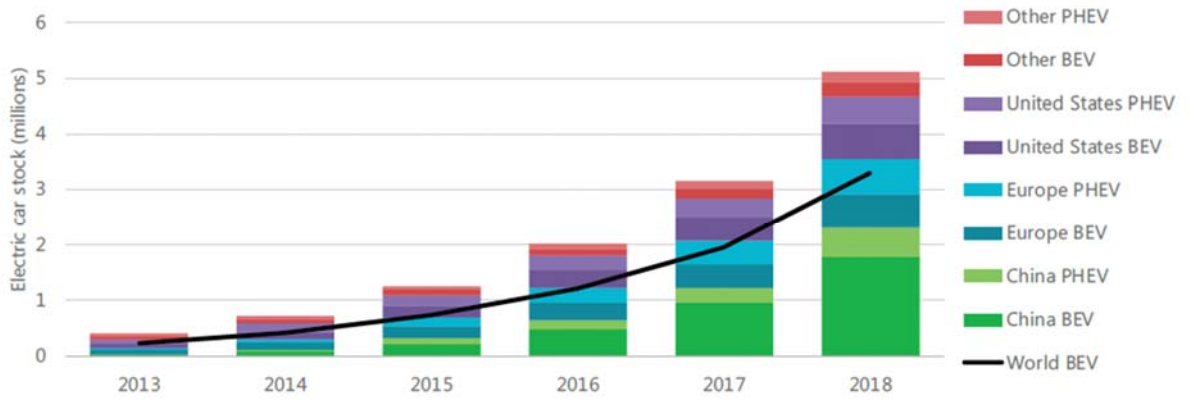
Number of car and motorcycle	Total : **150,000** on July 2011[1] **approximately 100,000**[5] Detail[1] - Private Motor Car 90,400 - Private Motorcycle 2,061 - Hired Vehicle 2,467 - Taxi 1,677 - Route 287 - Omnibus 441 - Tour Coache 98 - Minibus 161 - Max Taxi 676
Number of EV	About 320 cars on May 2018 [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]

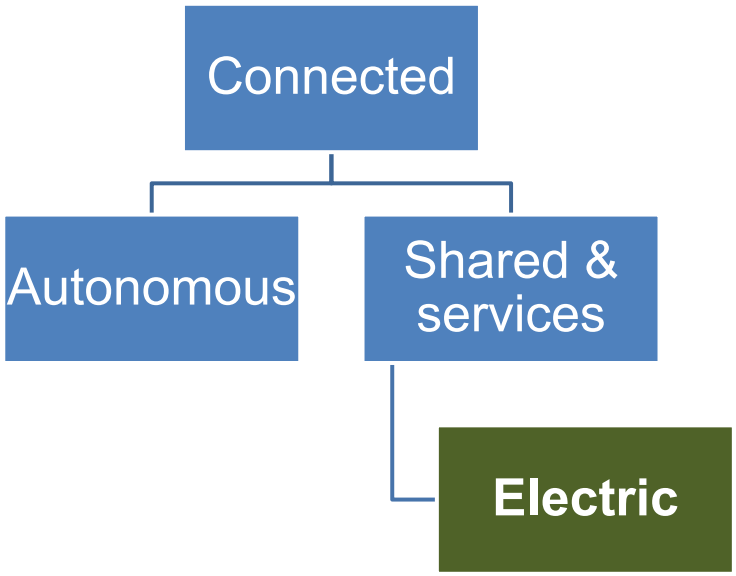
Total kWh/day = 100,000 vehicles * 50% * 23km/day * $(10\ km/kWh)^{-1}$ * $(100\% - 15\%)^{-1}$
$\simeq$ 135,000 kWh/day = 135 MWh/day → 135 / 24h = 5.6

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

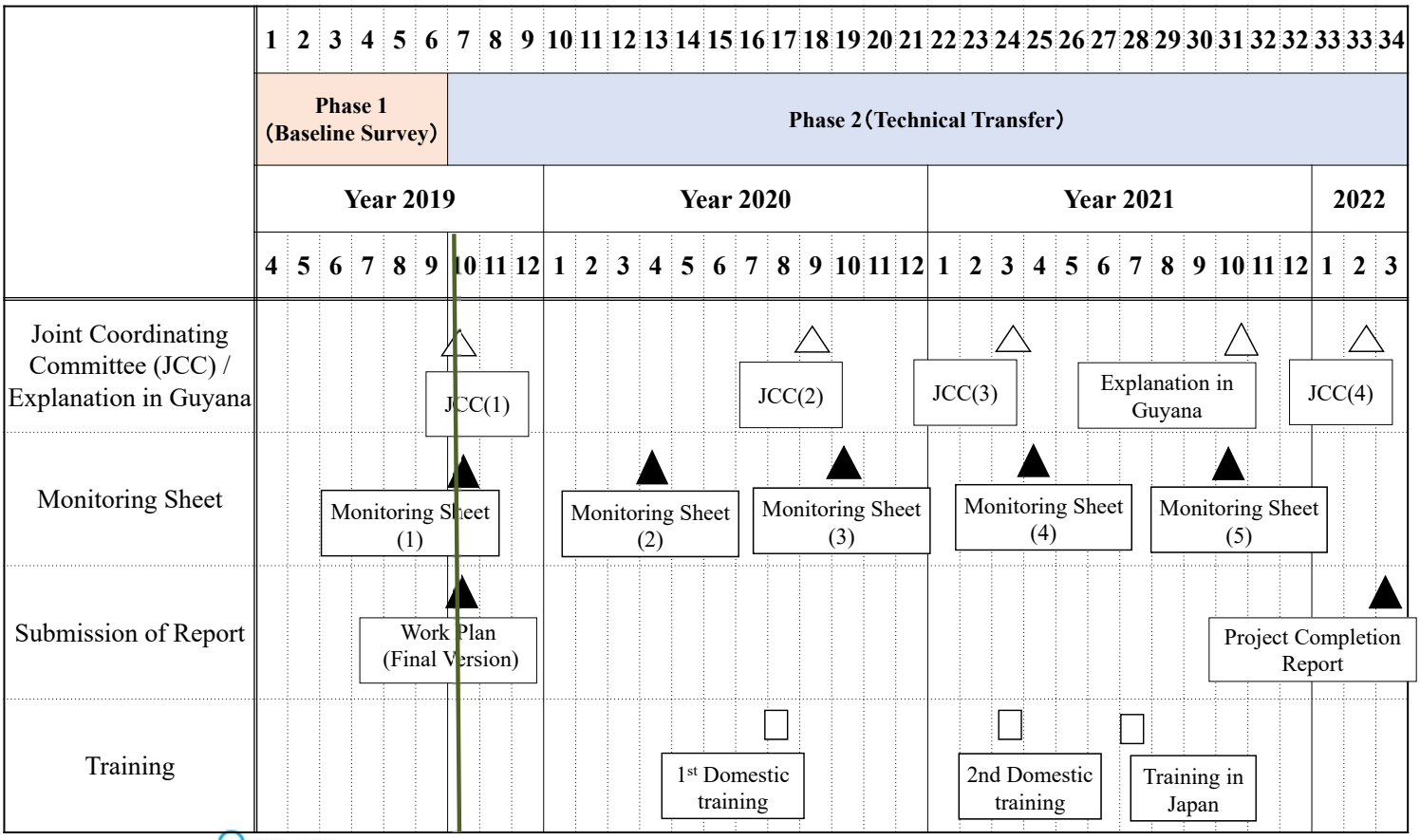
2nd training plan will be adjusted for your demands, situations and feedbacks.

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>

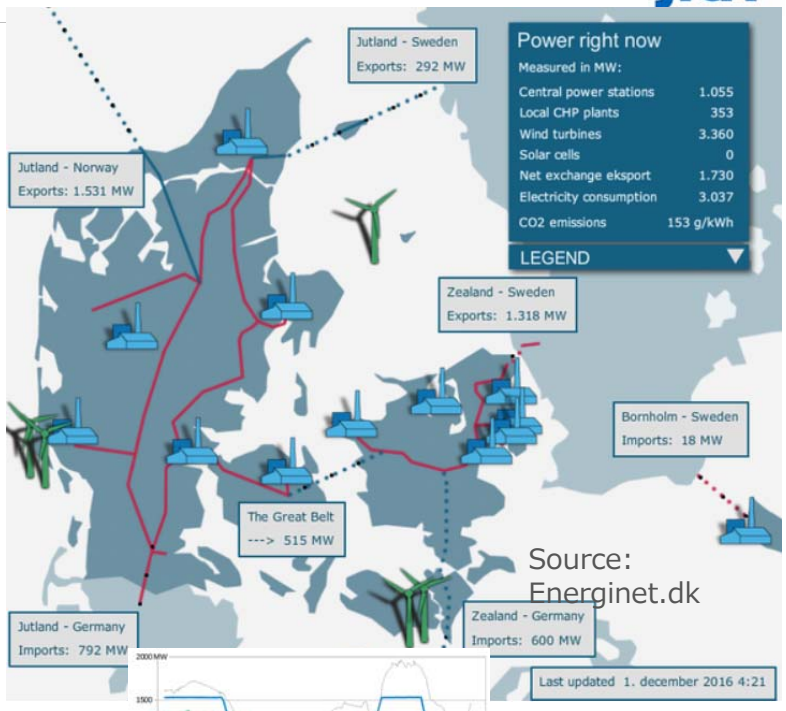
Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
Barbados	Spring Garden	D10(Unit A)	LSD	HFO	MAN	1982	Base	12.0
		D11(Unit A)	LSD	HFO	MAN	1982	Base	12.0
		D12(Unit A)	LSD	HFO	MAN	1987	Base	12.0
		D13(Unit A)	LSD	HFO	MAN	1990	Base	12.5
		CG01	ST	heat from unit A	Peter Brotherhood	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

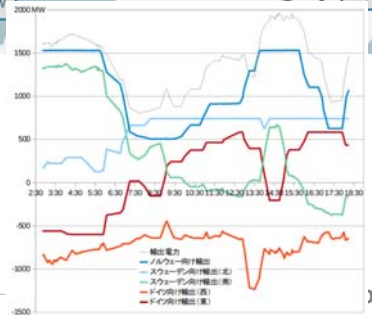
RE: Why Large RE penetration possible for Denmark?

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

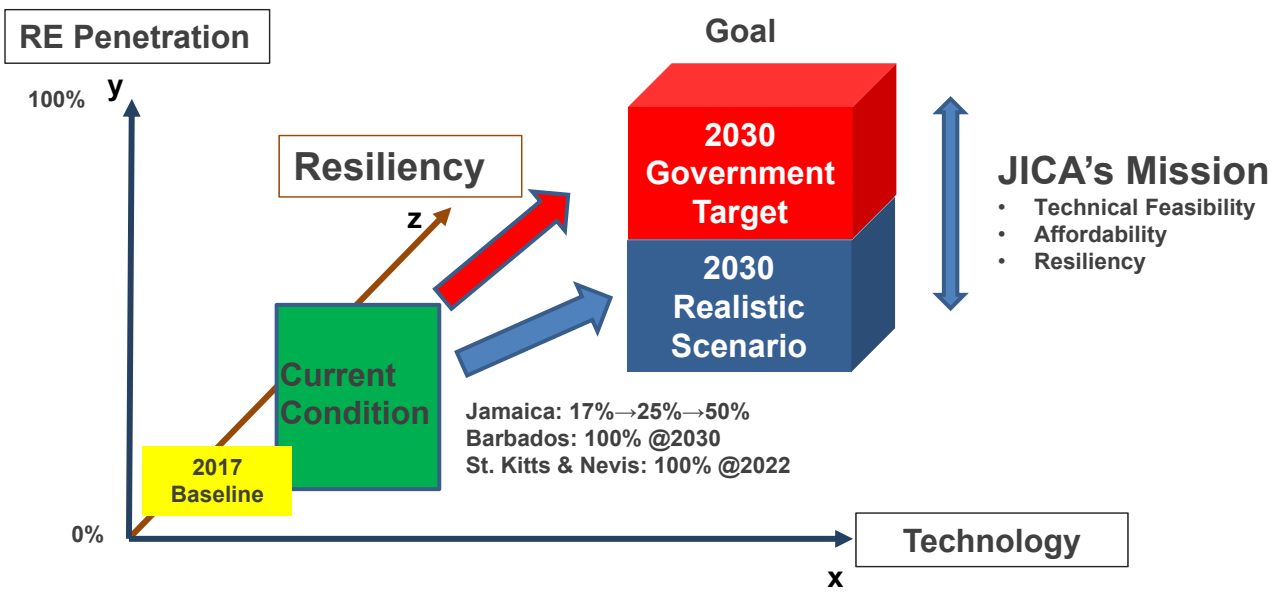
October-November 2019

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

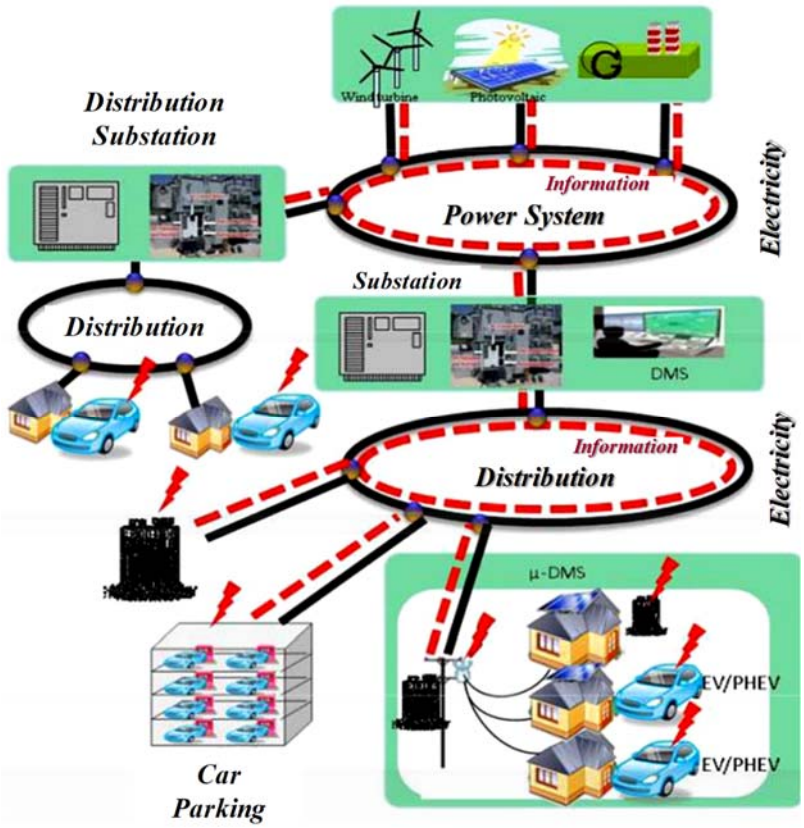
1. Project Outline

JET's Mission Recognition

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



Micro-grid Concept



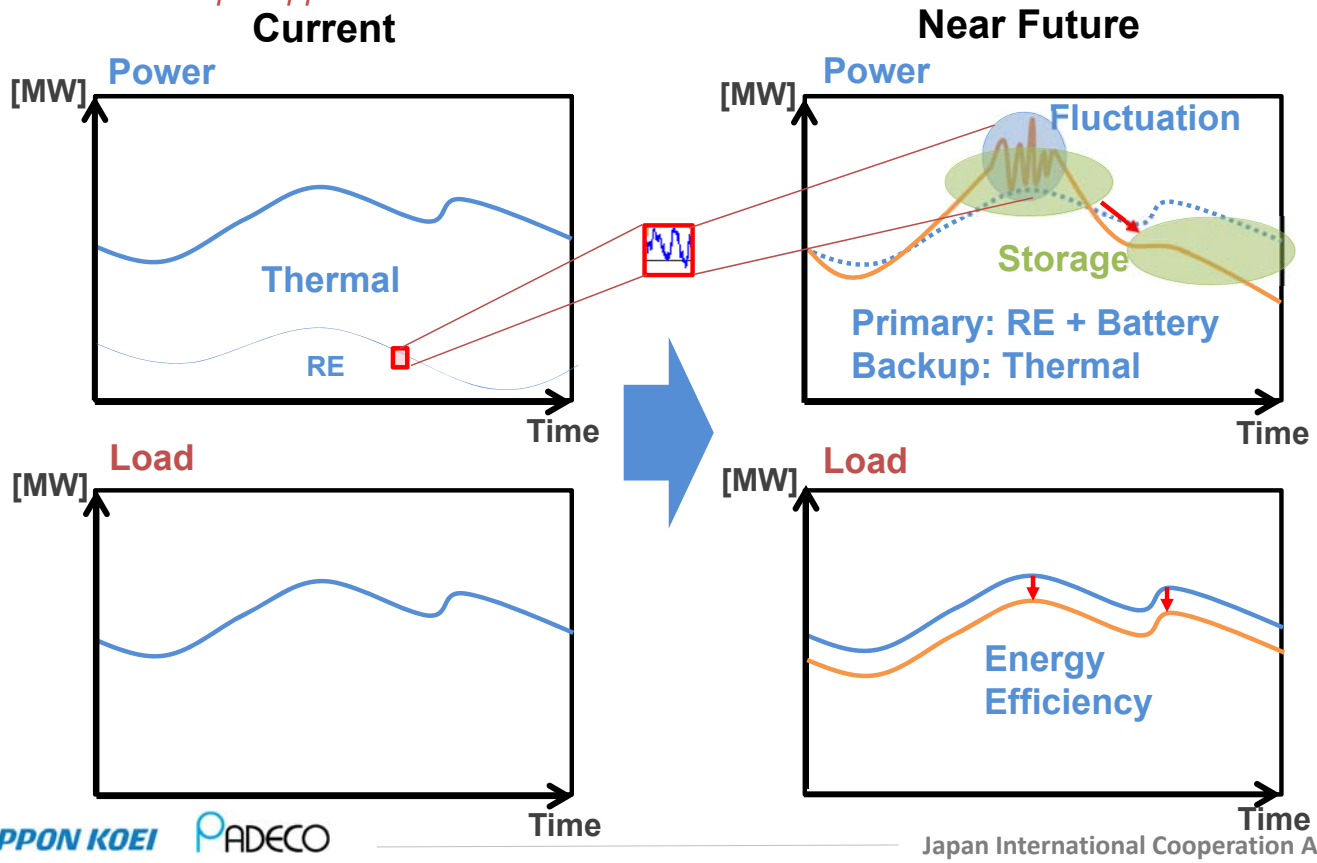
Concept of Micro-grid

- ✓ 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

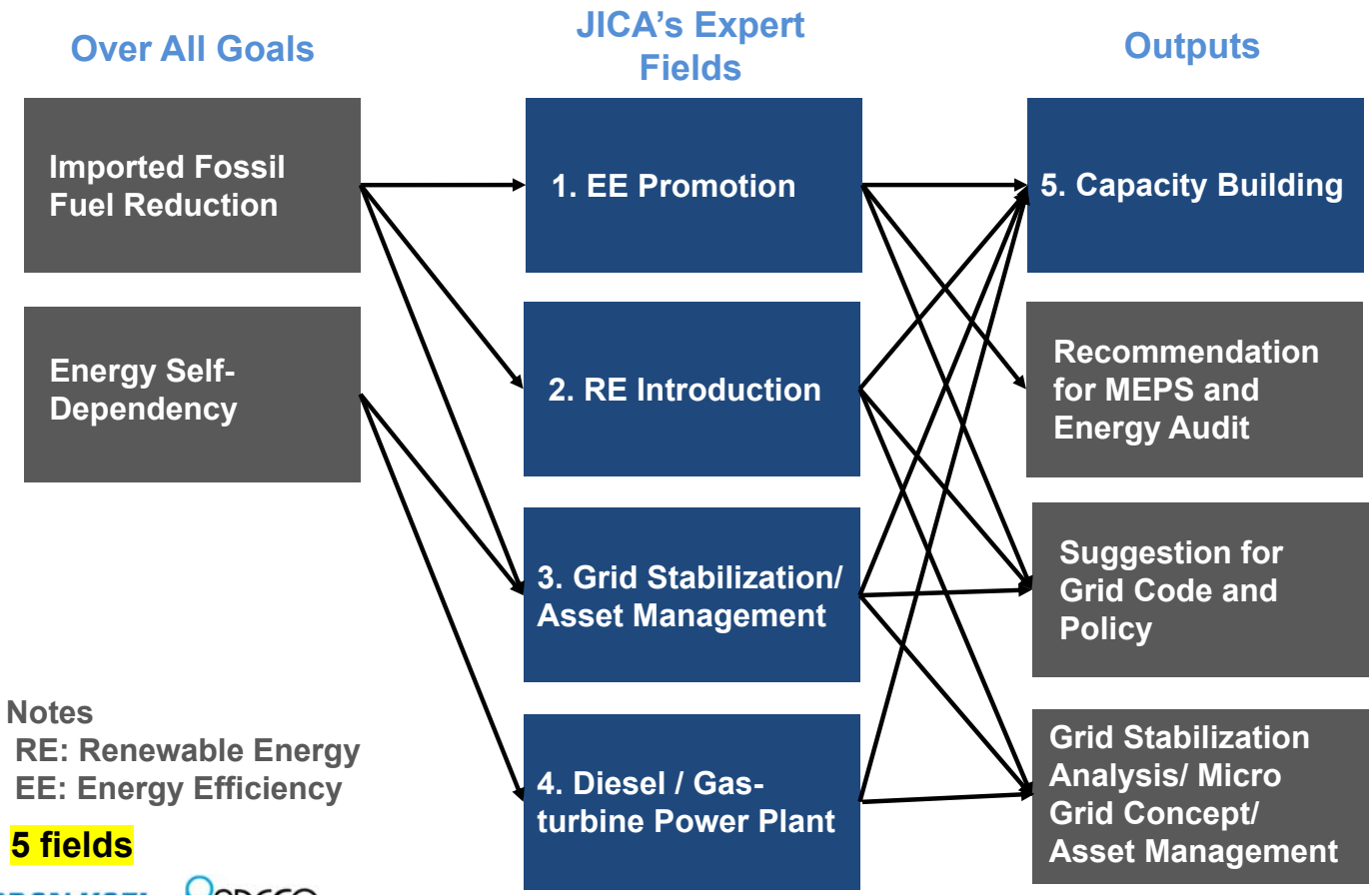
Output 4
The human and institution capacity are enhanced for the promotion of EE

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

1. Project Outline
2. Baseline Survey Report
   - 2-1. Energy Efficiency
   - 2-2. Renewable Energy and Grid Stabilization
   - 2-3. O&M of Thermal Power Generation
   - 2-4. Human Resources and Capacity Building
3. Training Program
   - Regional Training
   - Training in Japan
4. Way Forward and Schedule

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)

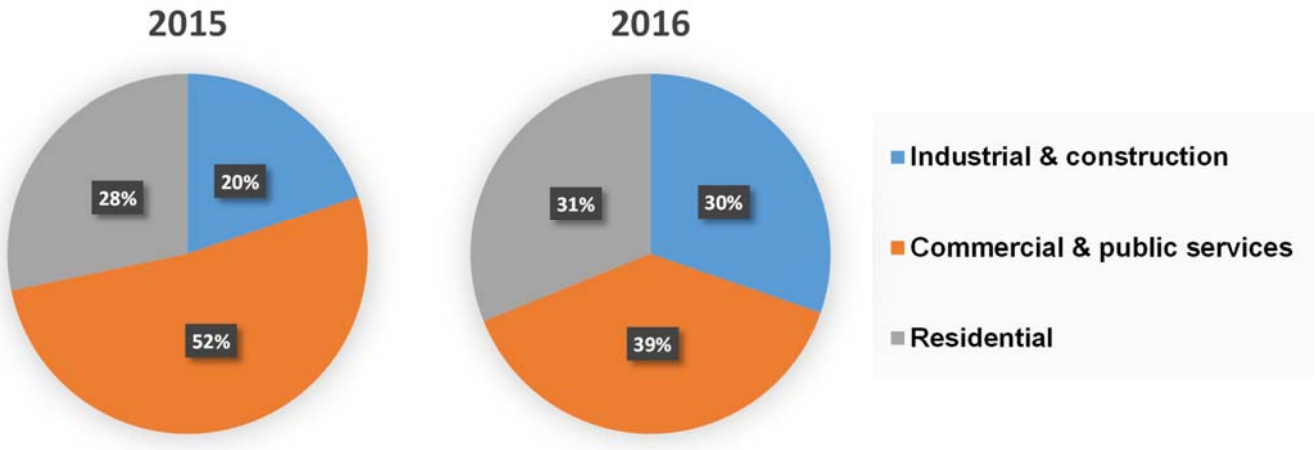
	Industry	Other	Transportation	Total
Oil	1	3	25	29 (37%)
Electricity (primary energy basis)	15	35	0	50 (63%)
Total	16 (21%)	38 (48%)	25 (31%)	79 (100%)

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%).



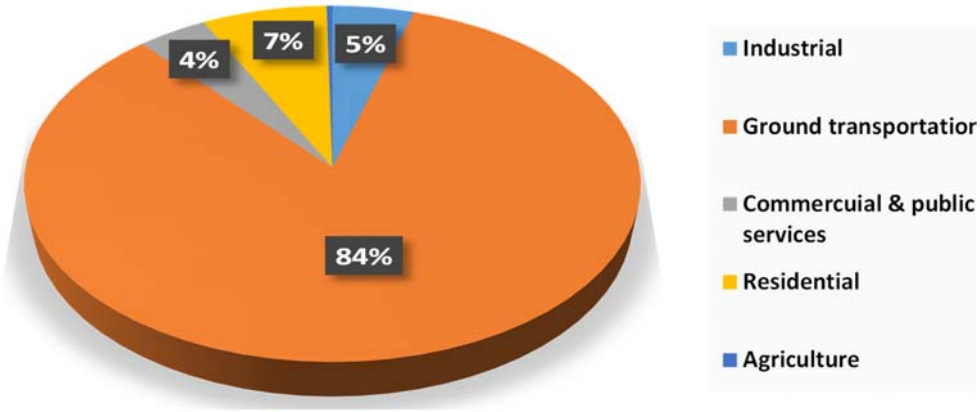
Source: JET with reference to energy balances and electricity profile (2015, 2016) by United Nations Statistics Division.

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.

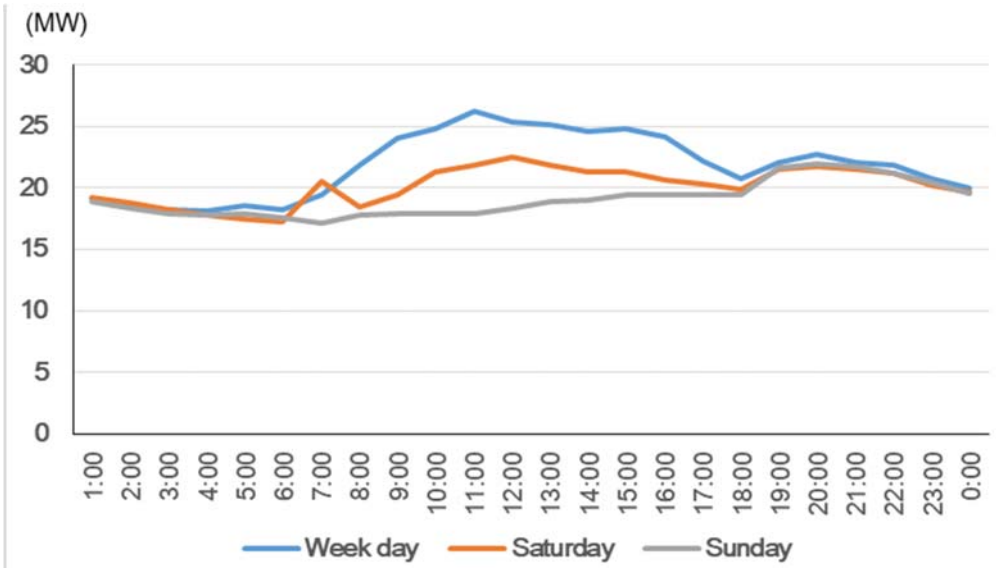
Petroleum consumption by sector excluding power generation use, 2015 & 2016



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

Energy Efficiency

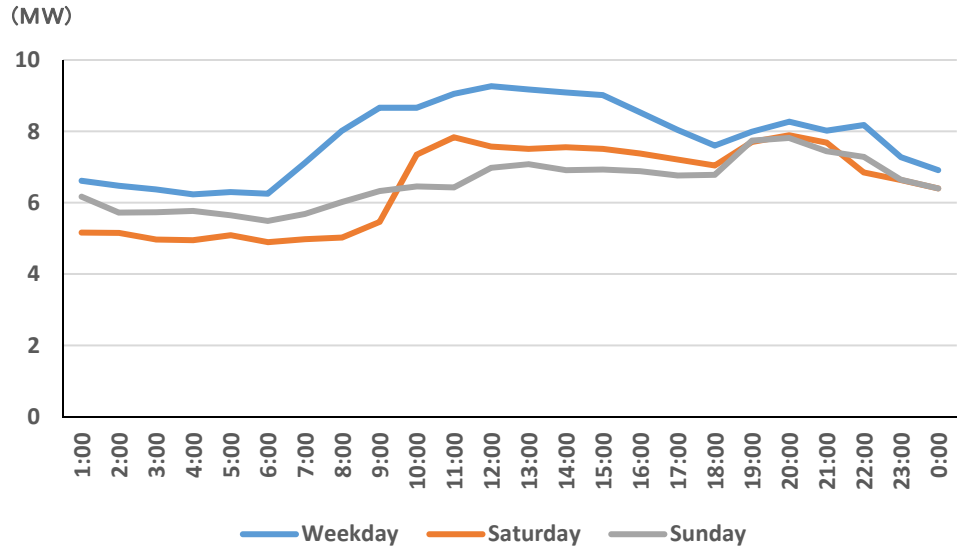
- **Current situation 1-4: Electricity load curve (SKELEC)**
  - Annual peak demand: Approximately 25MW.
  - As for the load curve, the daily peak demand is generated at around 11:00 am, and the demand increase again between to 6:00 pm & 8pm for lighting demand (Bactrian camel type (very common)).



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)).

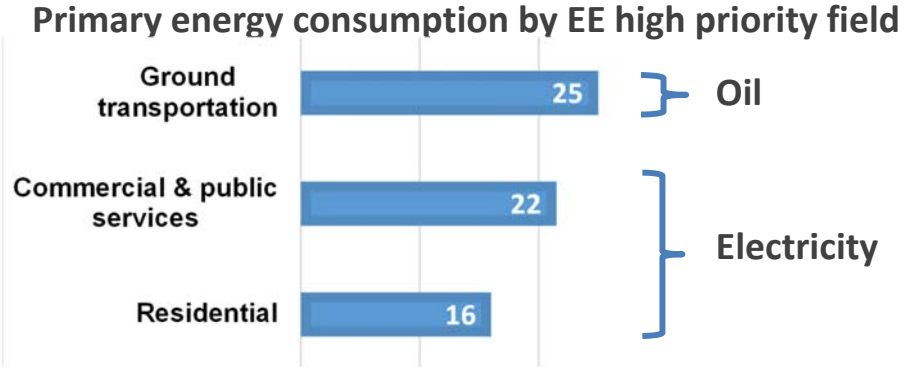


Source: JET with reference to ST. KITTS AND NEVIS RENEWABLE ENERGY POLICY (draft), MINISTRY OF PUBLIC INFRASTRUCTURE, POST, URBAN DEVELOPMENT AND TRANSPORT

Energy Efficiency

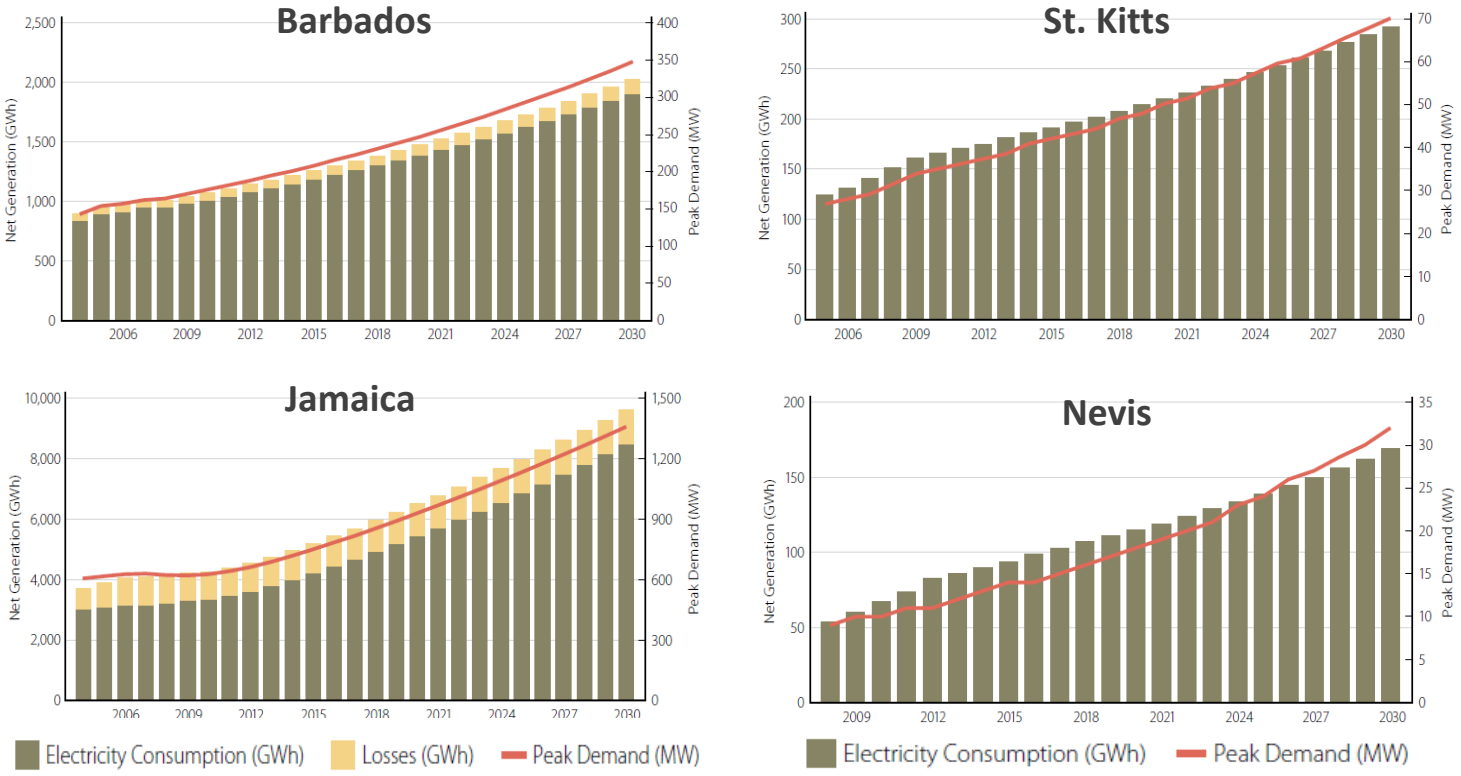
- **Points of studies and proposals on EE measures:** Studies and proposals shall be made with high priority for the energy consumption fields indicated **in red**.
- The **coverage ratio of high priority EE fields = 76%** (60/79)

	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))

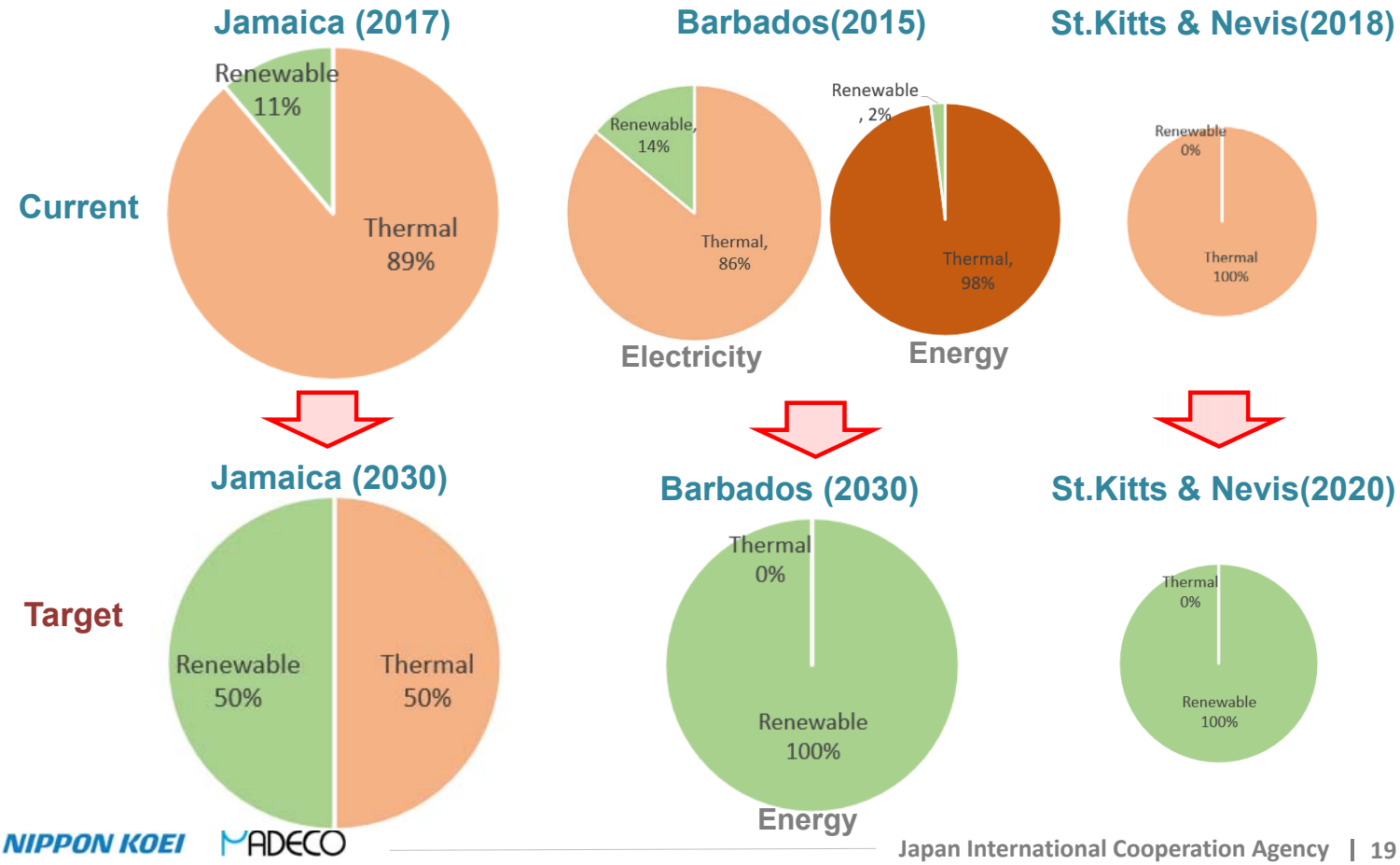
Energy Efficiency

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

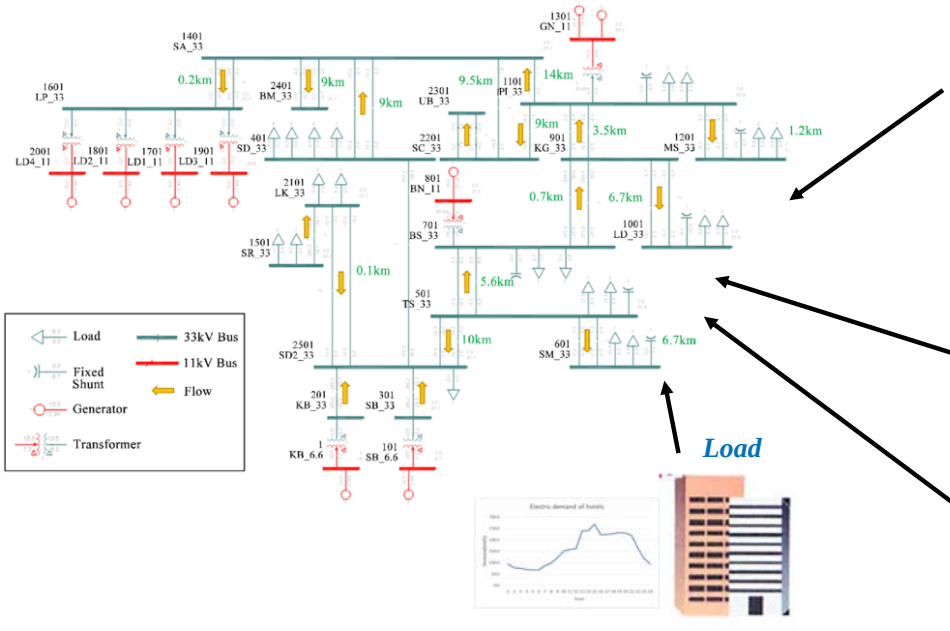
Barbados	Jamaica	St Kitts &Nevis
• Provision of Grid simulation software and training • Micro-grid concept study at Coverley Village • Energy source diversity (incl. waste treatment in cement plant)	• Training for grid simulation • Introduction of network asset management • Micro-grid concept study at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

✓ **Discussion for grid code**

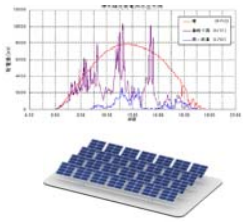
✓ **Suggestion for policy and RE target with reviewing affordability of RE**

Grid Stabilization Simulation

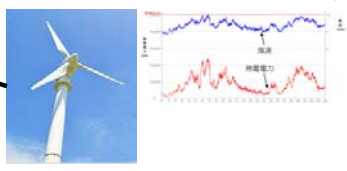
- Simulation of National Grid Model
- Analysis of Issues and Solutions
- EDC Calculation



Photovoltaic Generation

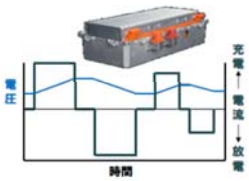


Wind Generator

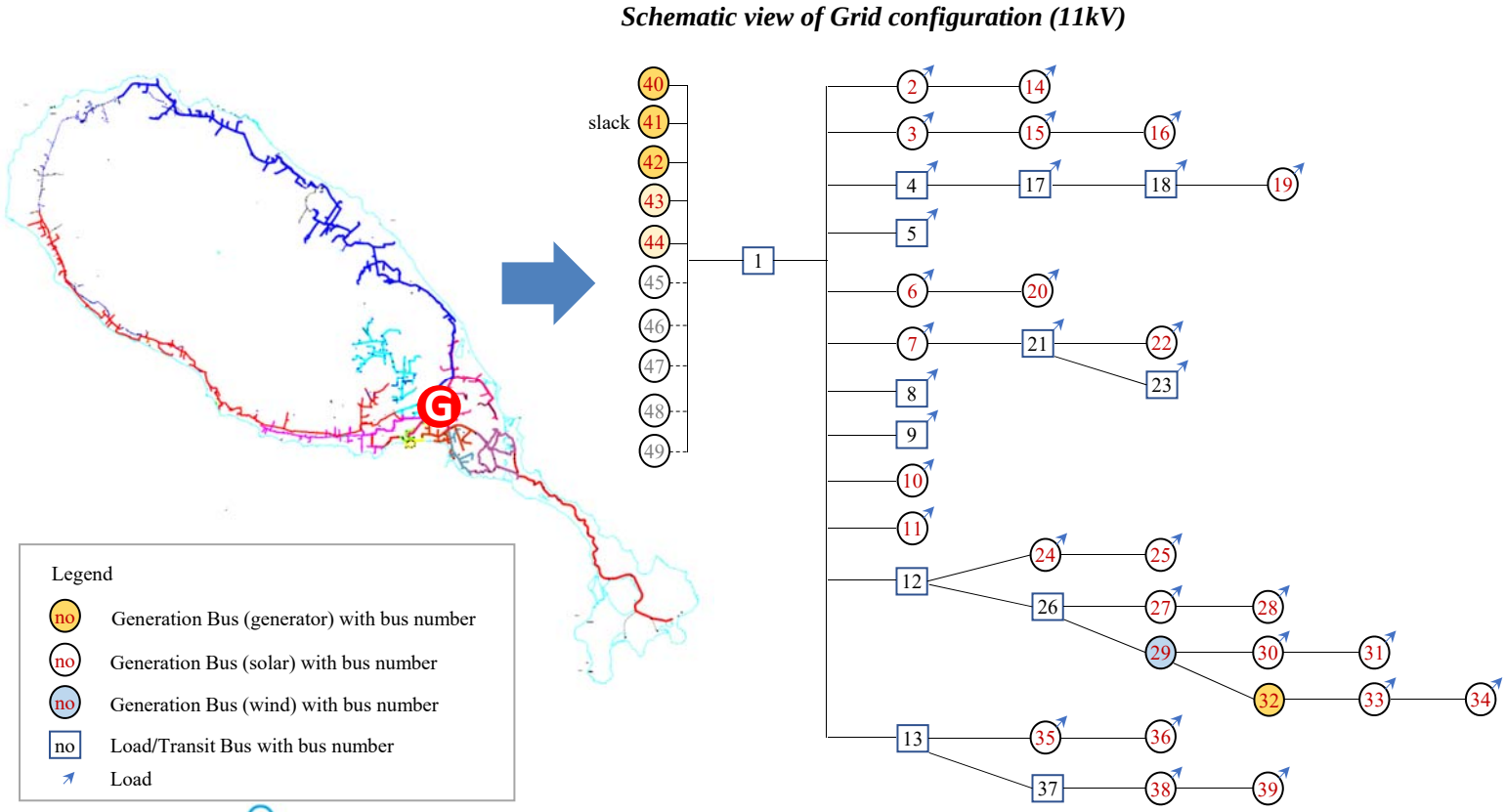


Load

Battery

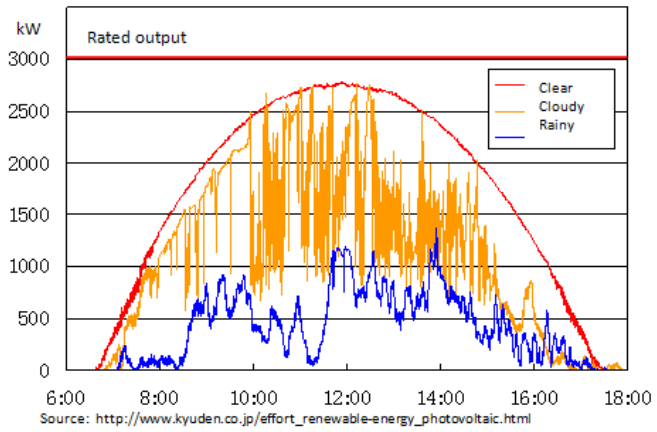


Grid Stabilization Simulation Modeling

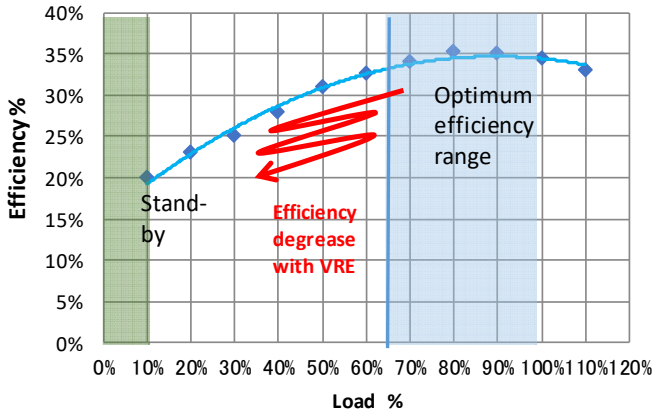


RE: With Large RE Penetration

- 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

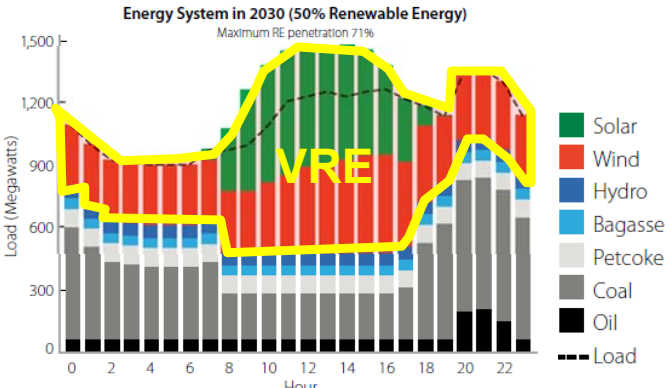


PV output in each whether



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

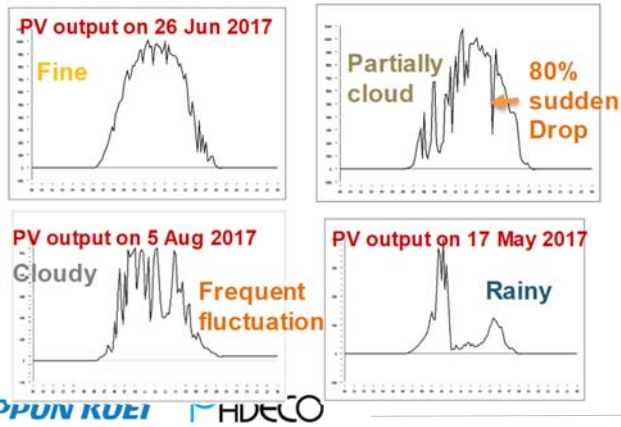
Fuel L/kW increase in diesel generator

- 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.

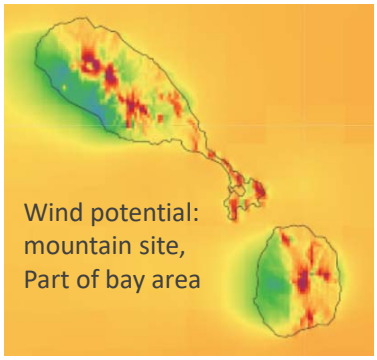


VRE %	< 20%	20-60%	> 60%
Issue	Response by thermal poser	Voltage and frequency fluctuation, power failure increase	(in addition to left) harmonic wave, phase balance, synchronization, supplement of reactive power
Equipment needed for grid stabilization	Output restrain by PCS, EMS	EMS and high-speed charge-discharge 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

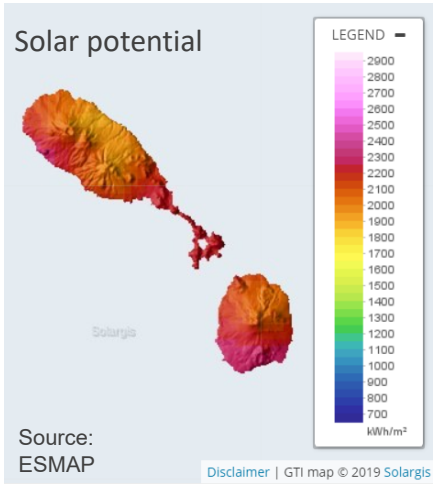
RE: Status in St.Kitts & Nevis

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

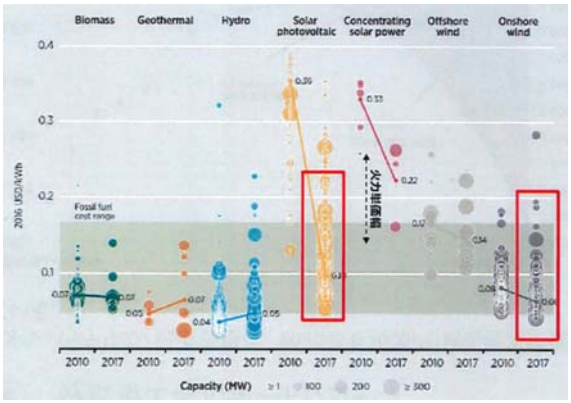
1) Grid stability analysis for new 35MW PV system
2) Update of geothermal development
3) Interconnection?

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

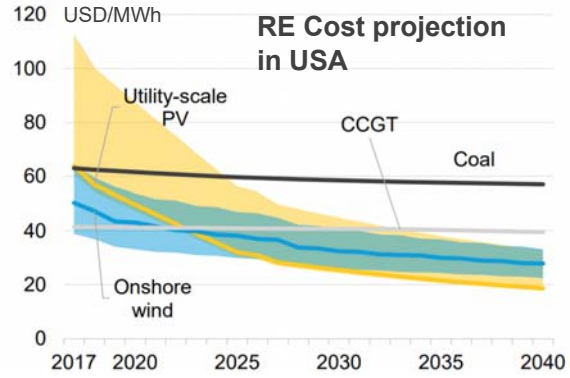
→ **Who owns the stabilization cost?**



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



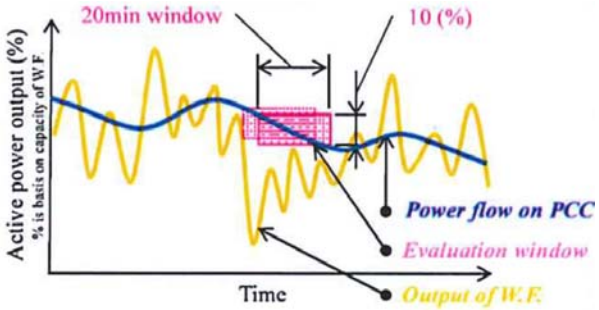
Source: Power Markets Today, Broomberg 2018/ METI, Japan

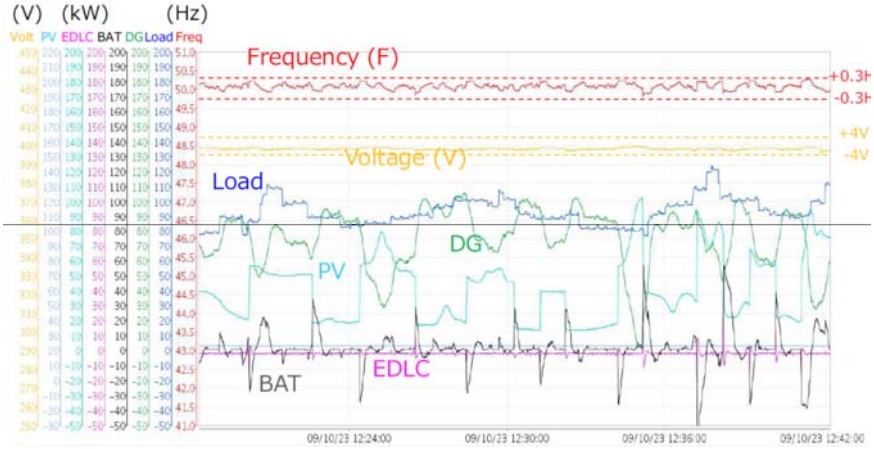
RE: Example of Grid Stabilization with RE and energy storage

For Voltage and Frequency stabilization (below)

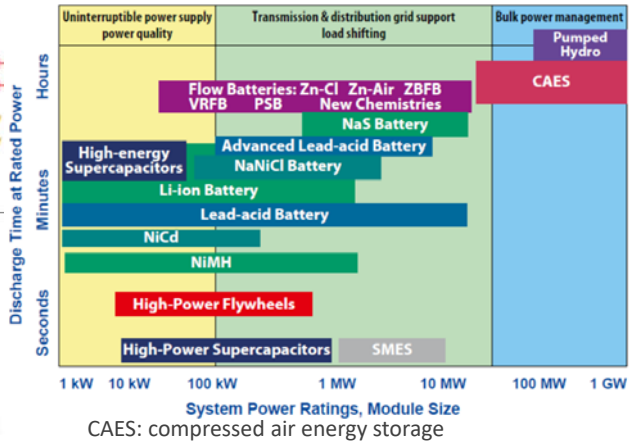
- ✓ Generation: PV, Wind, DG, GT, etc.
- ✓ Energy Storage: Battery (BAT), Capacitor (EDLC)
- ✓ Load /Demand control
- → **Grid Simulation is necessary**
- → **Various energy storage needs to be considered**

Smoothing output





Source: Meidensha, Autonomous Micro-grid Conference, 2019

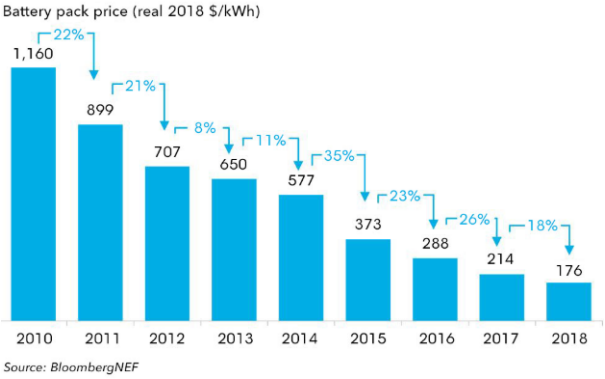


CAES: compressed air energy storage
Source: IRENA, Electricity Storage and Renewables, 2017

RE: Cost consideration of BESS

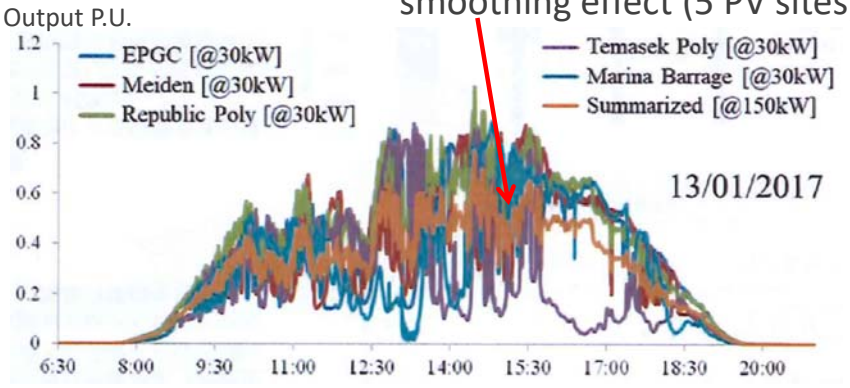
1) Output smoothing by overlaying different PV/wind locations
2) Battery at each site → Centralized battery storage system

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

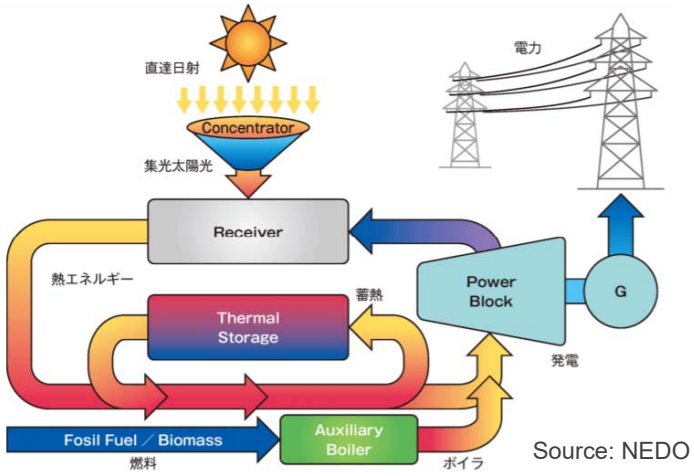
To reduce cost:
- Data analysis with solar irradiation/wind speed short interval necessary at several locations
- Speedy communication system advanced EMS control is necessary

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

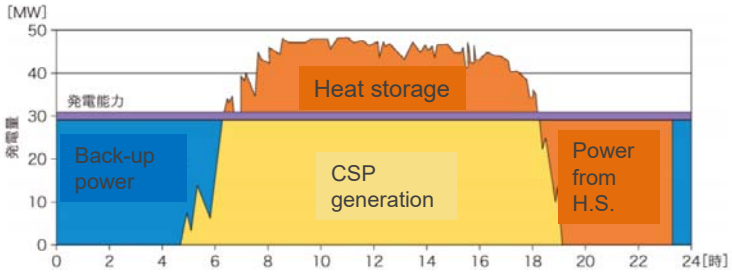
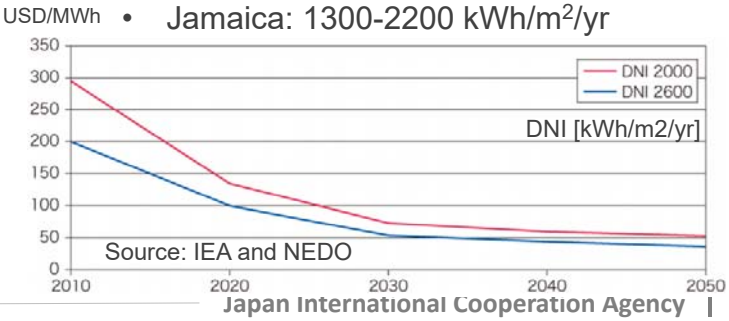


Photo: blog.eco-megane.jp/

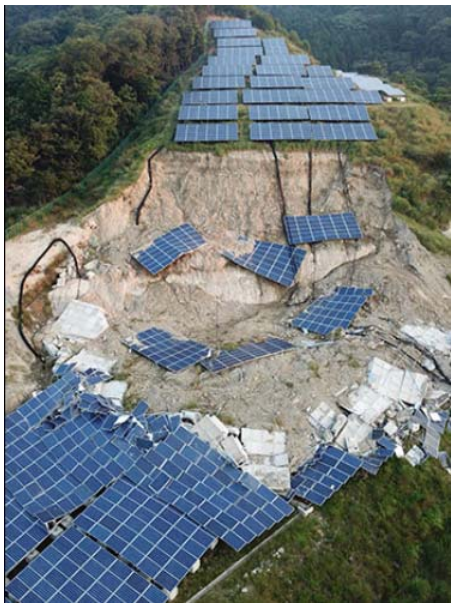
- DNI (Direct normal irradiation)
  - Barbados: 1600-2000 kWh/m²/yr
  - St Kitts&Nevis:1600-2300 kWh/m²/yr
  - Jamaica: 1300-2200 kWh/m²/yr



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



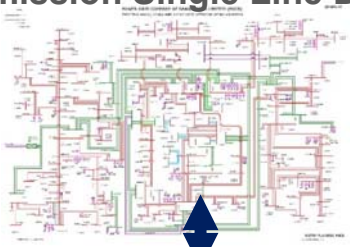
26 Jul 2019 Himeji, Japan
https://www.dailyshincho.jp/article/2018/07260800/?photo=1
Landslide by a heavy rain

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**

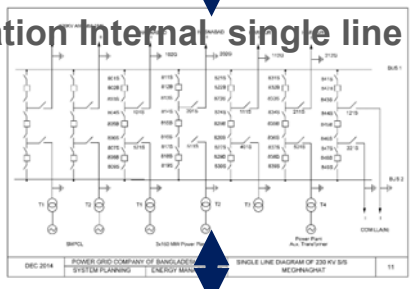
RE: Resiliency Enhancement - Digitalized Network Management System

Linking all asset data on to one data platform

Transmission Single Line Diagram

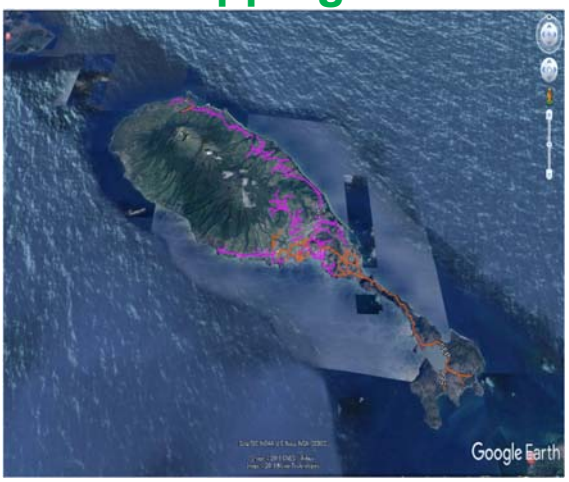


Substation Internal single line diagram



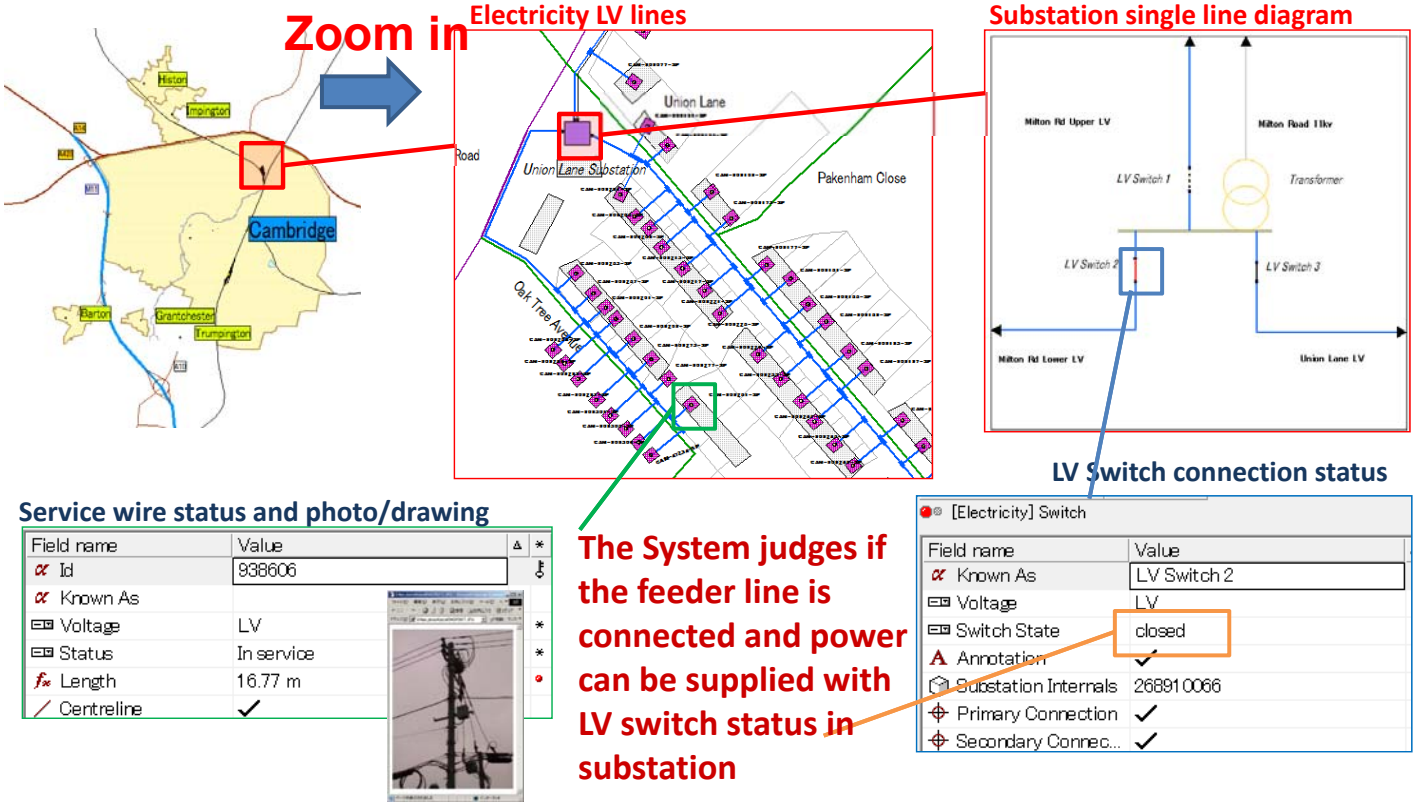
Power distribution network to meter

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

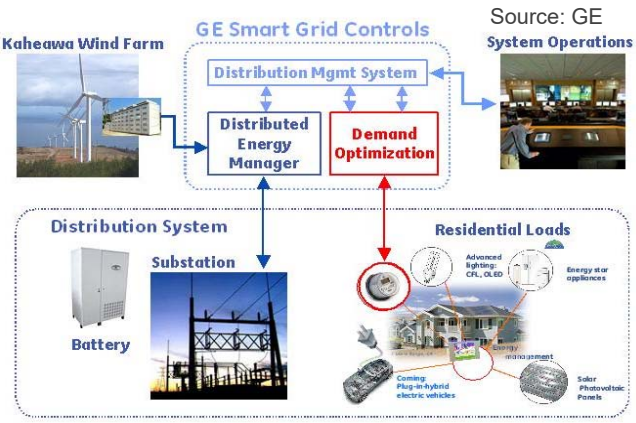


RE: Large RE Example in Islands

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

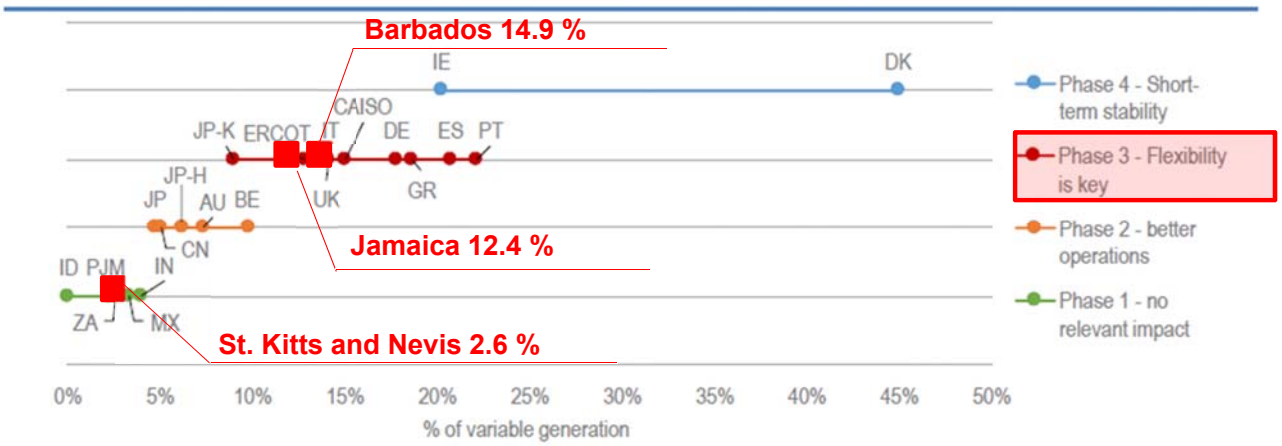
3 villages, 203 household, population 790
Peak **229kW**, Demand1300 MWh/yr, **3.6 MWh/day**)
RE: **1.4 MW PV (6.1 times than peak)**
Battery: **750kW**/**6 MWh** LIB, Tesla 20yrs guarantee
DG: 320kW × 3, 150kW × 1

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

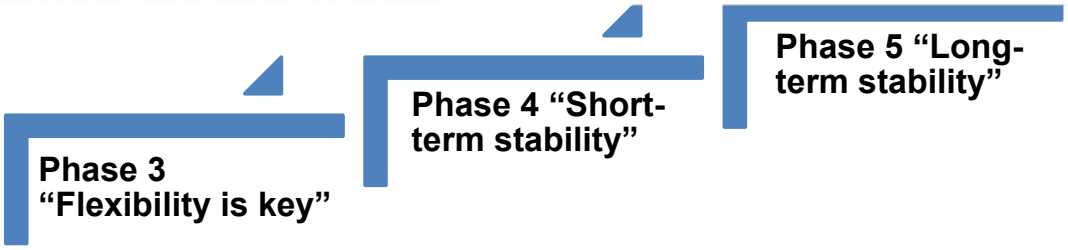
Small demand, but huge RE and Battery
→ **Micro-grid**, Back-up DG is necessary

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

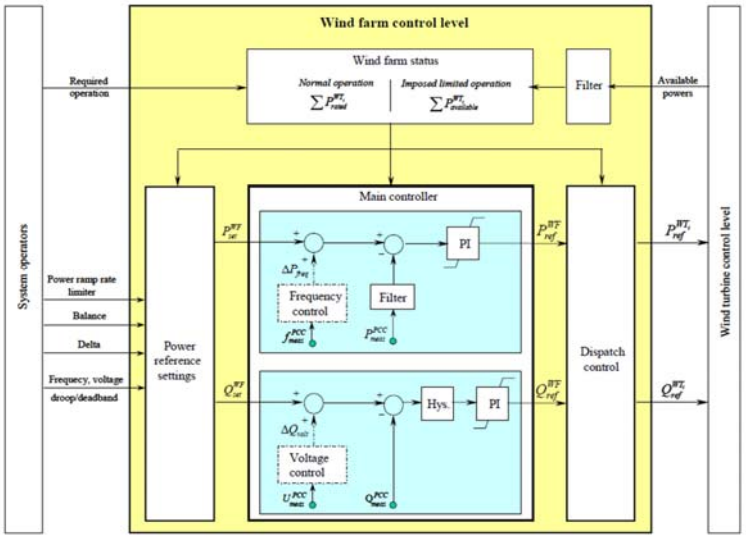
Grid Simulation Software

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

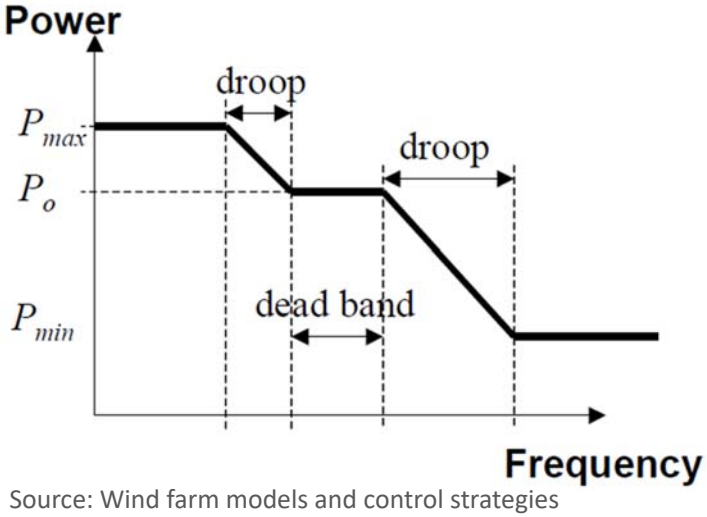


Source: Wind farm models and control strategies

- 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

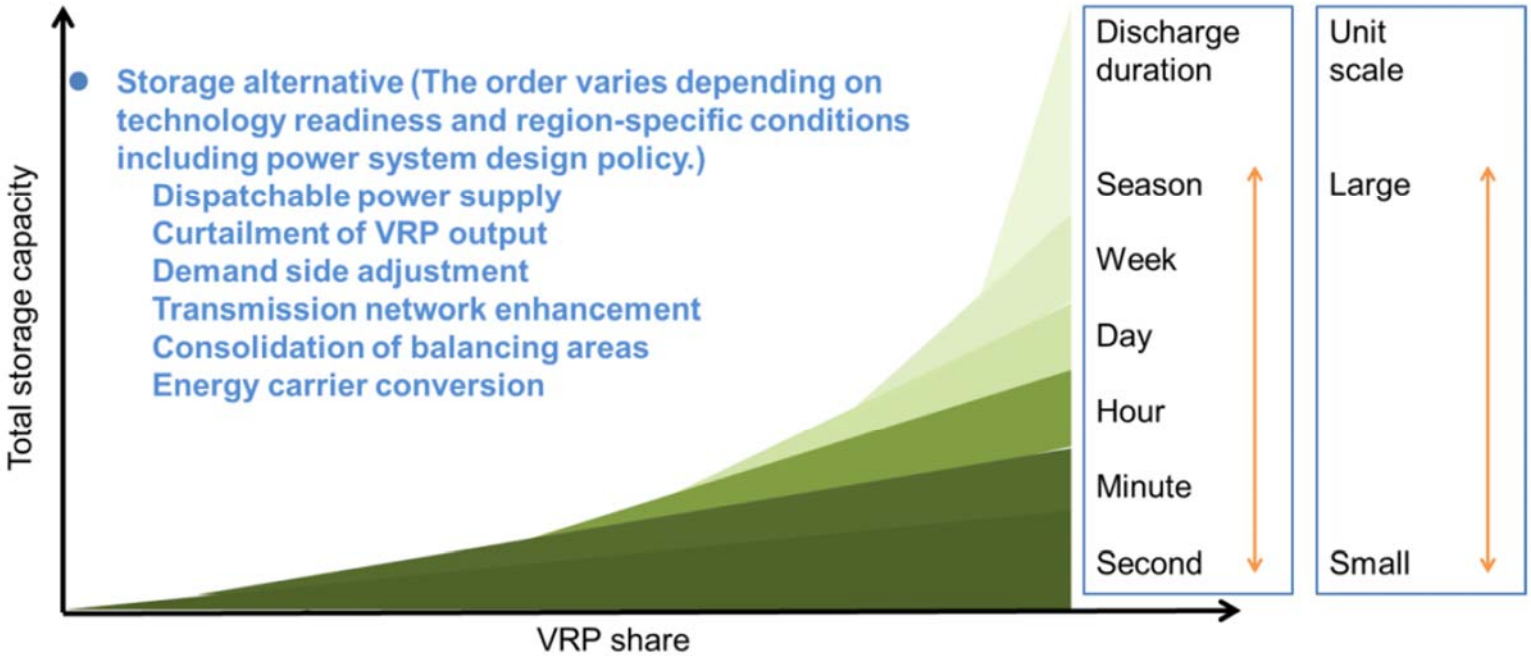
- Same as thermal power plant control
- For frequency stabilization

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

Solution 2: Application of Large Capacity Energy Storage System

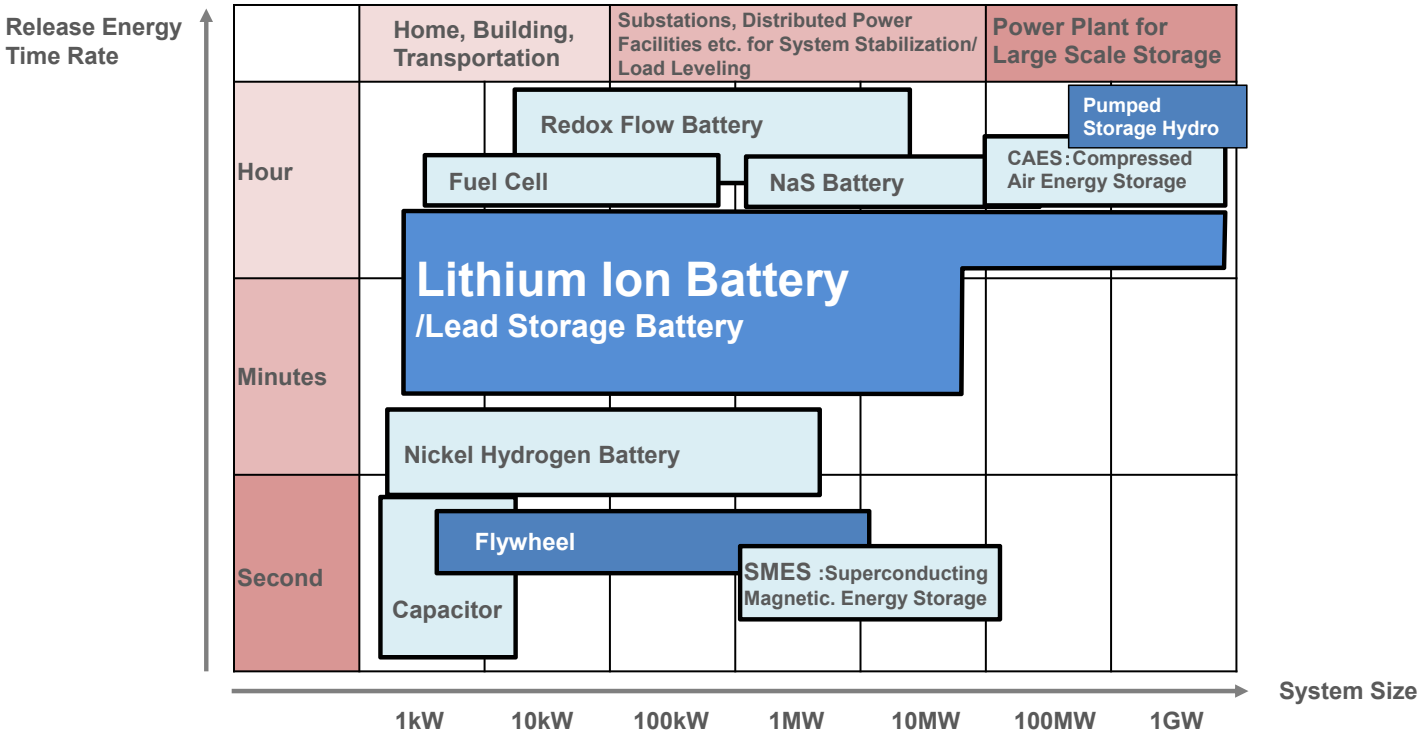
Variable Renewable Energy (VRE) Share and Storage Requirements for Power Systems

(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

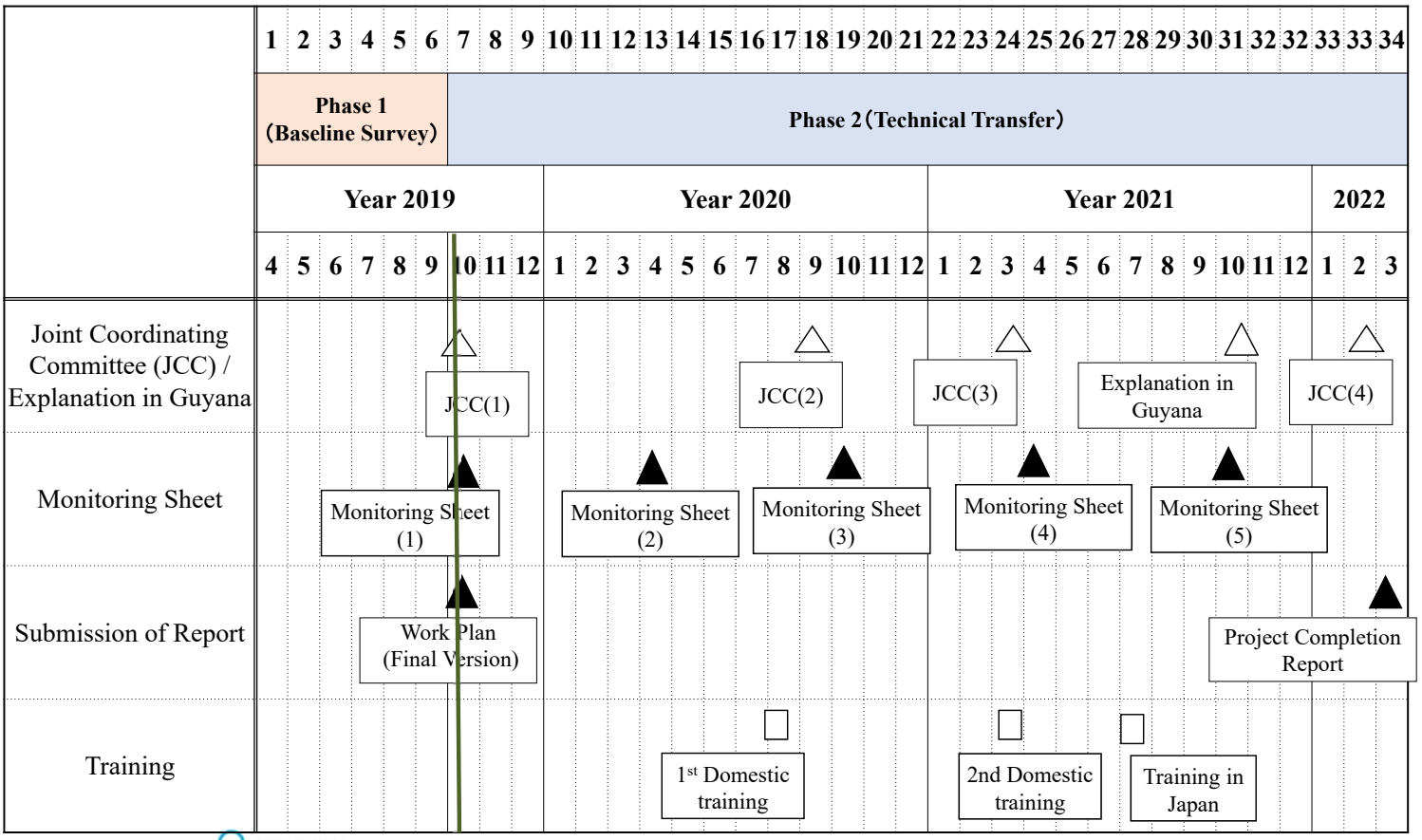
2nd training plan will be adjusted for your demands, situations and feedbacks.

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>

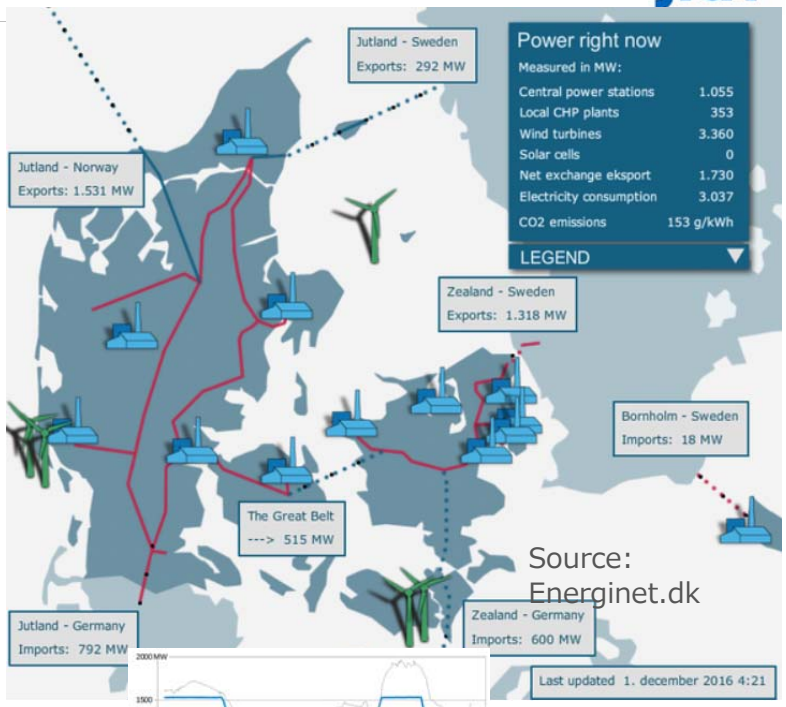
Country	Plant	Unit	Type	Fuel	Manufacture	Year Installed	Load	Rating Capacity(MW)
Nevis	Prospect	G3	MSD	Diesel	MAN(Mirlees Blackstone)	1985	Manual	0.9
		G4	MSD	Diesel	MAN(Mirlees Blackstone)	1990	Manual	2.0
		G5	MSD	Diesel	MAN(Mirlees Blackstone)	1996	Manual	2.2
		G6	MSD	Diesel	MAN(Mirlees Blackstone)	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



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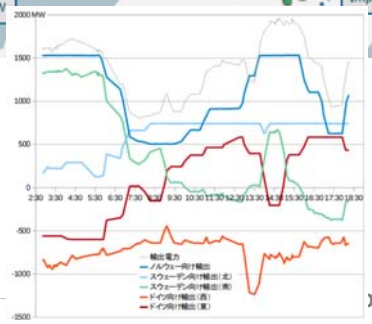


https://www.itmedia.co.jp/smartjapan/articles/1612/19/news085_3.html

- 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

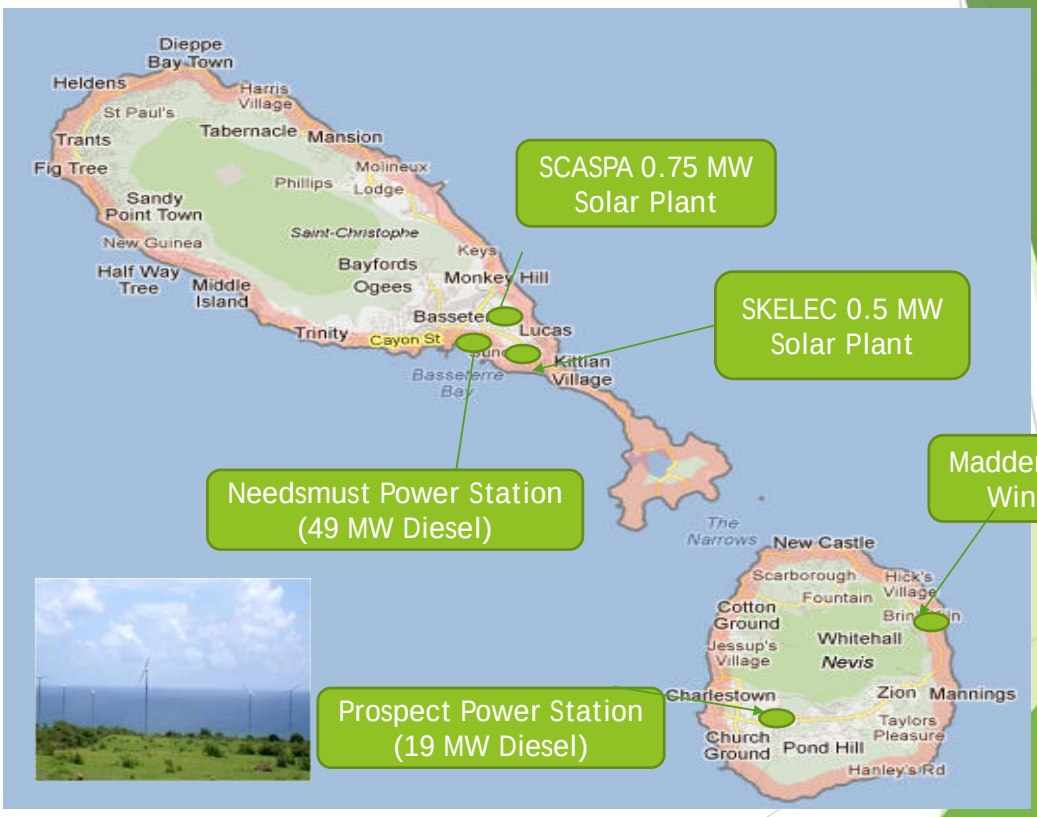
Supply configuration

- 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.

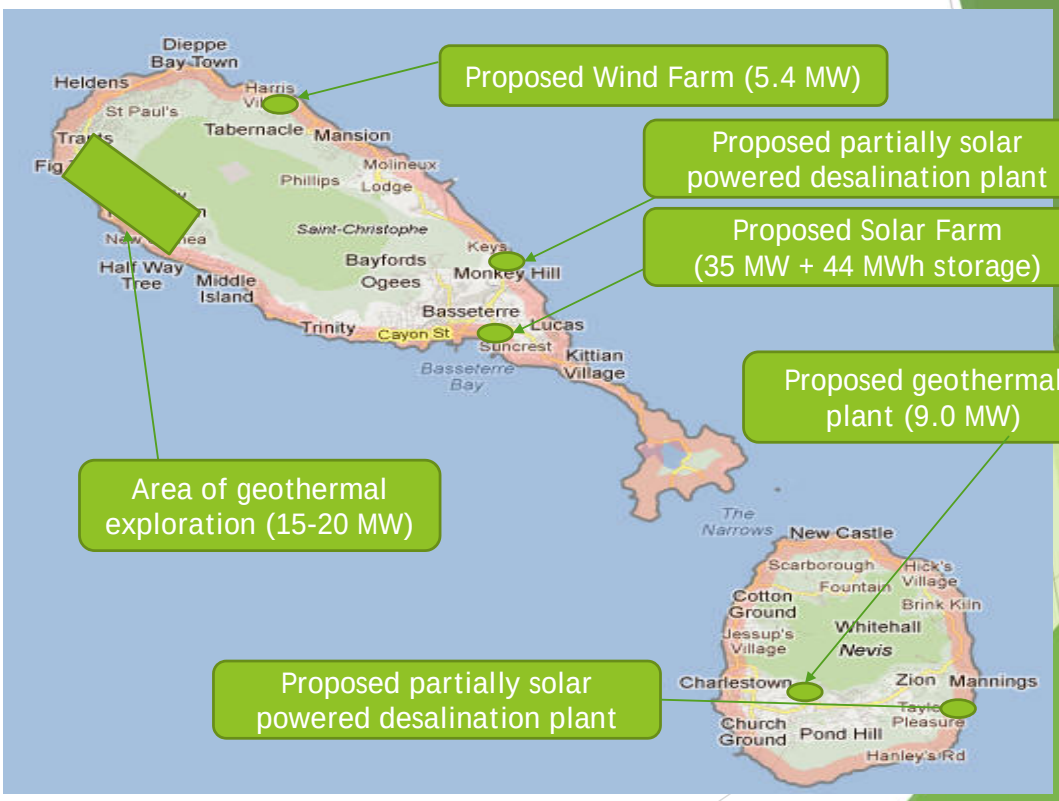
Commercial

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

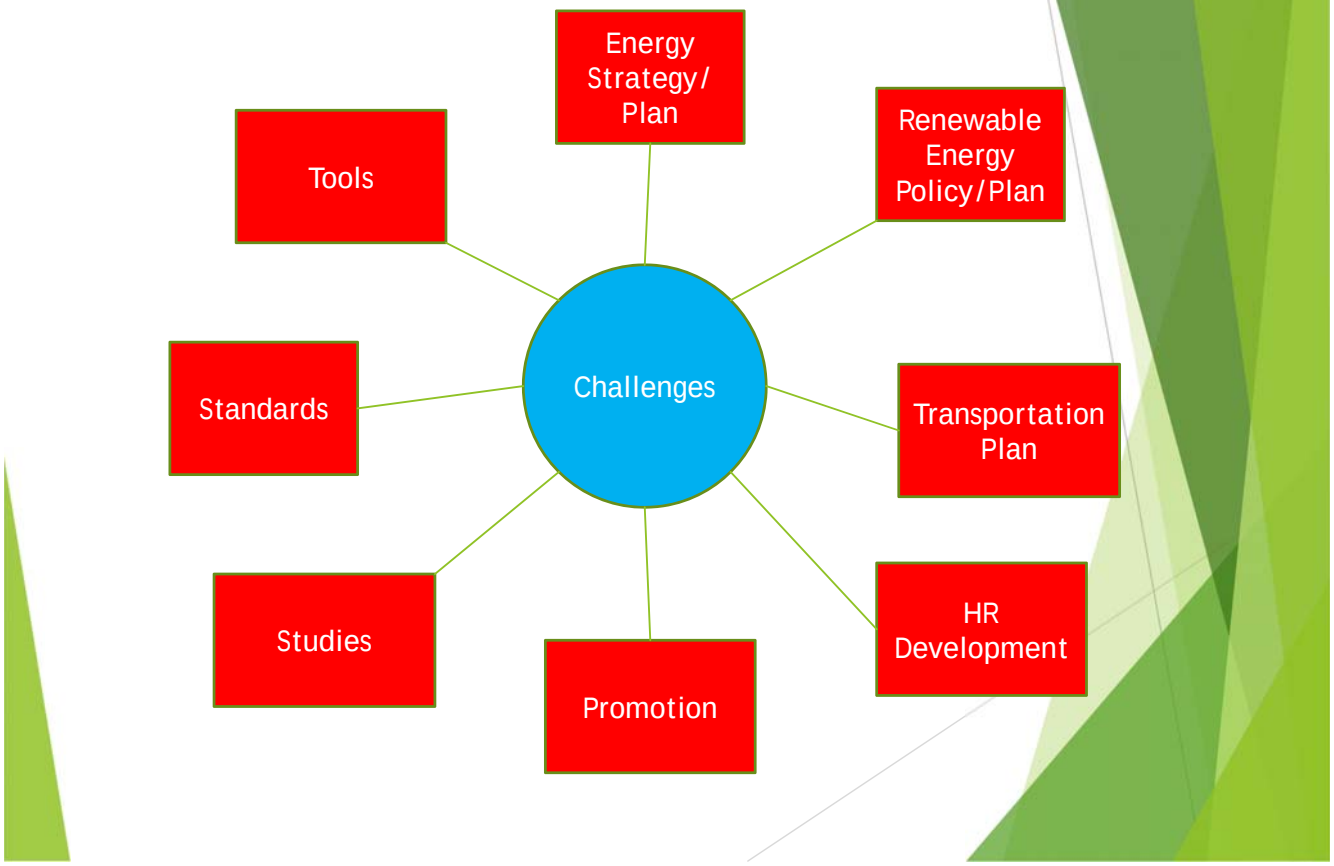
Installed Generation



Pending Generation



Challenges In Energy Sector



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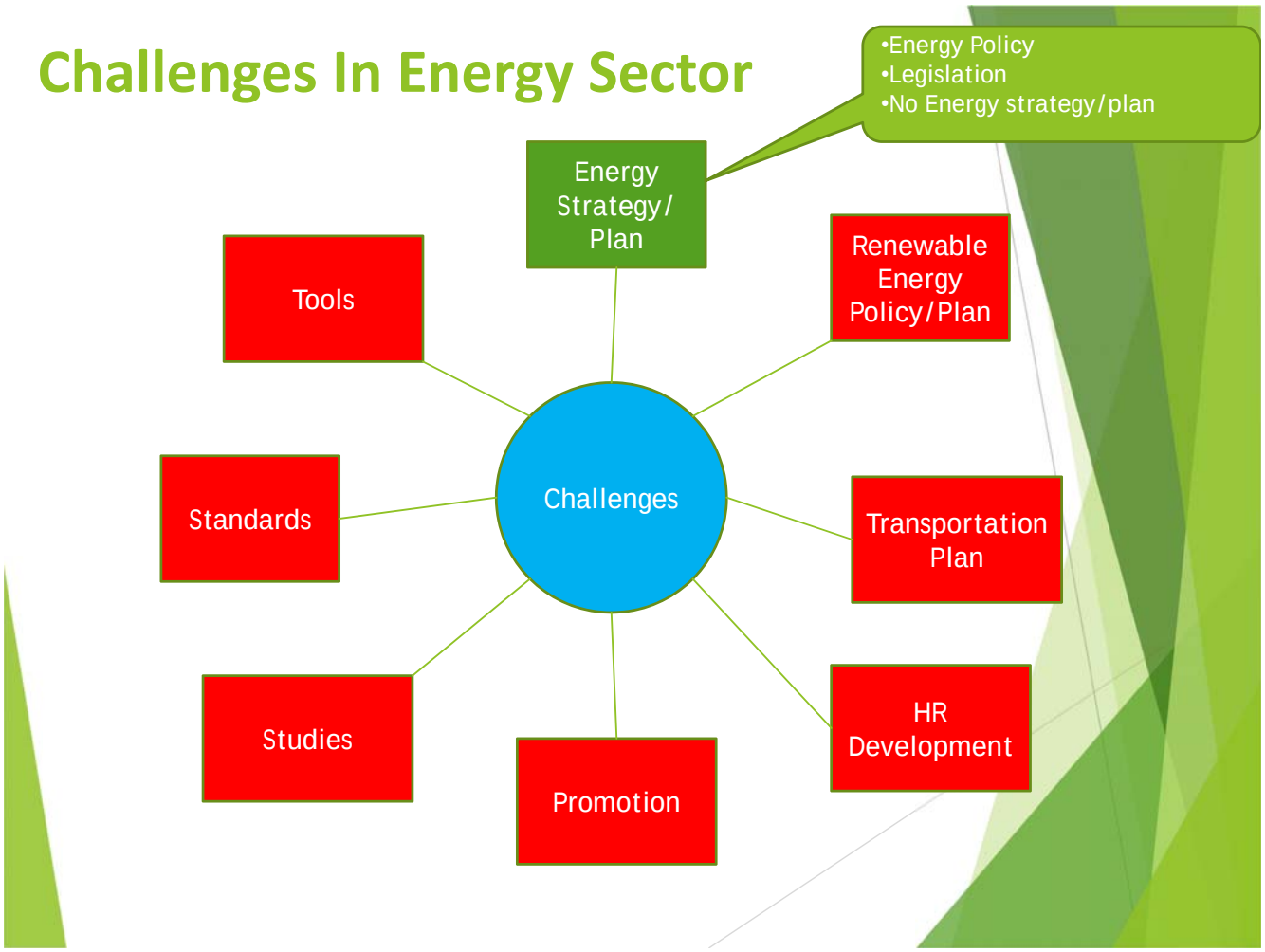

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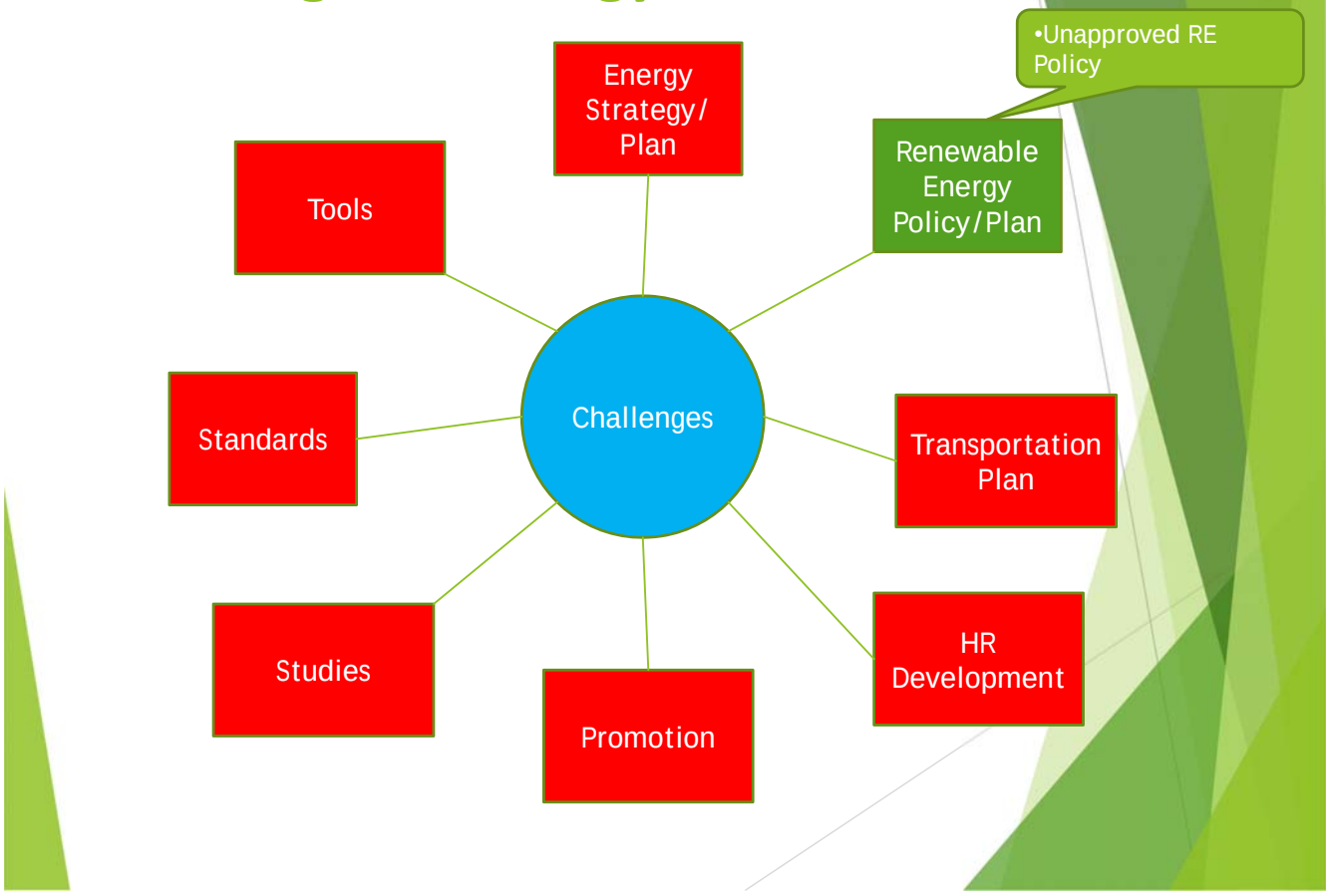

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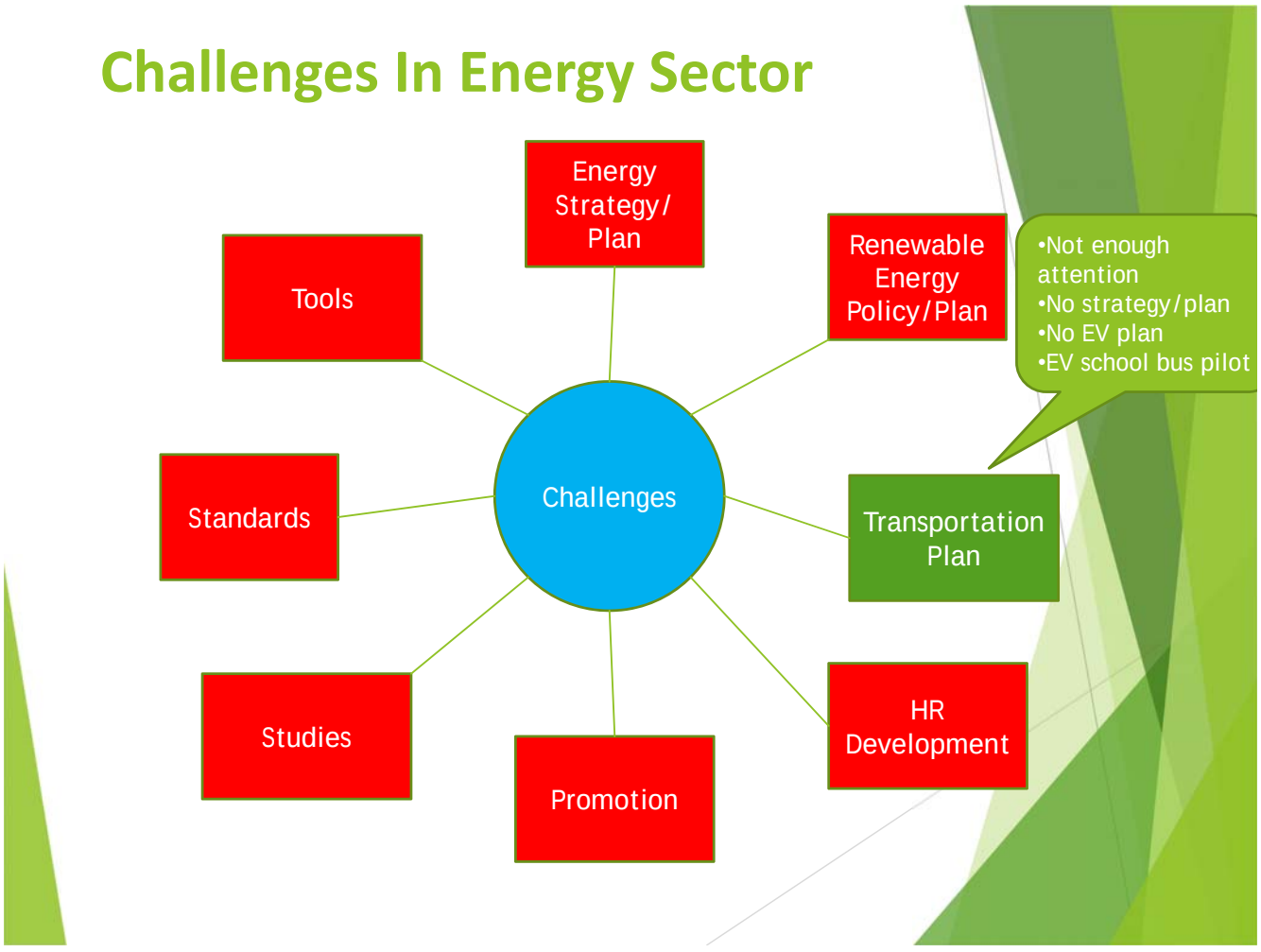

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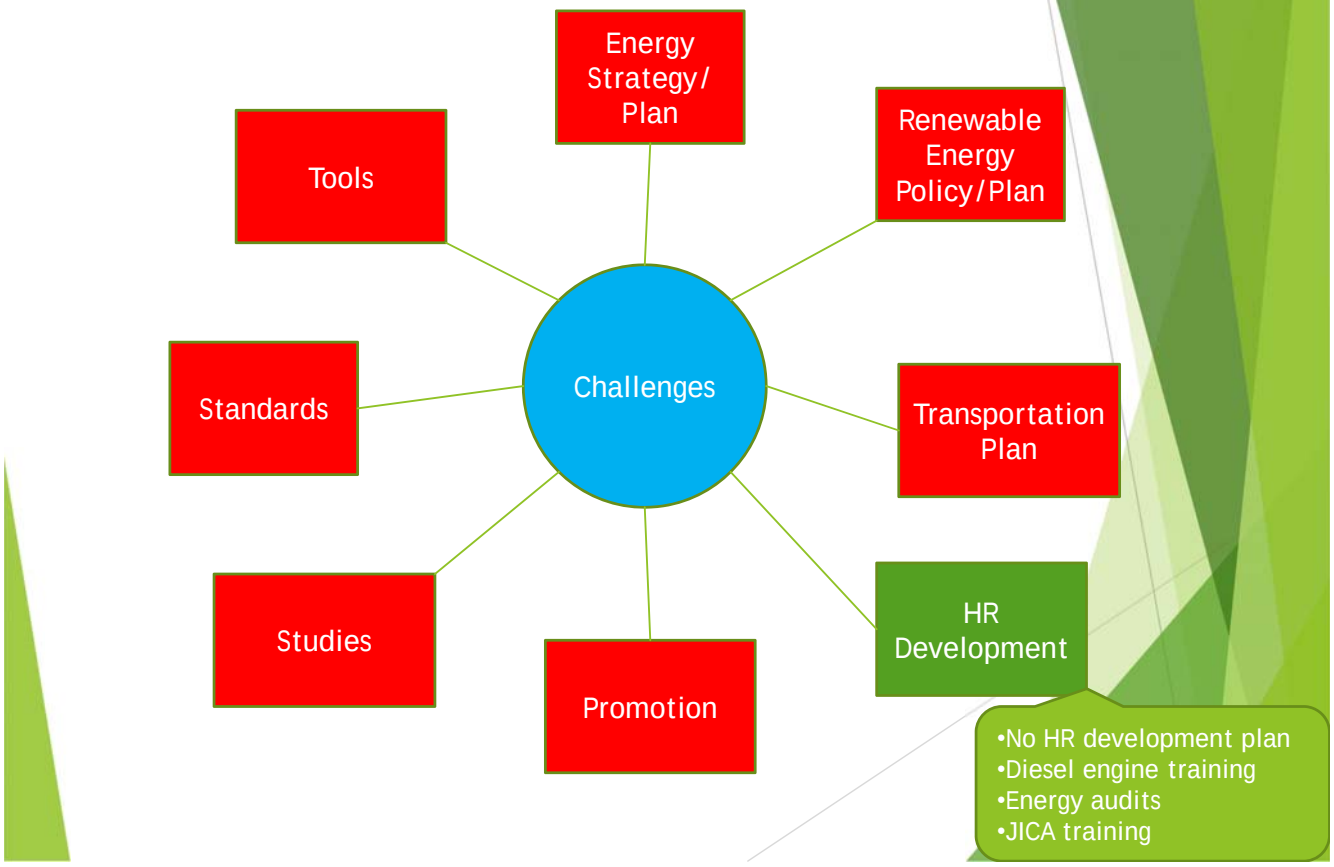

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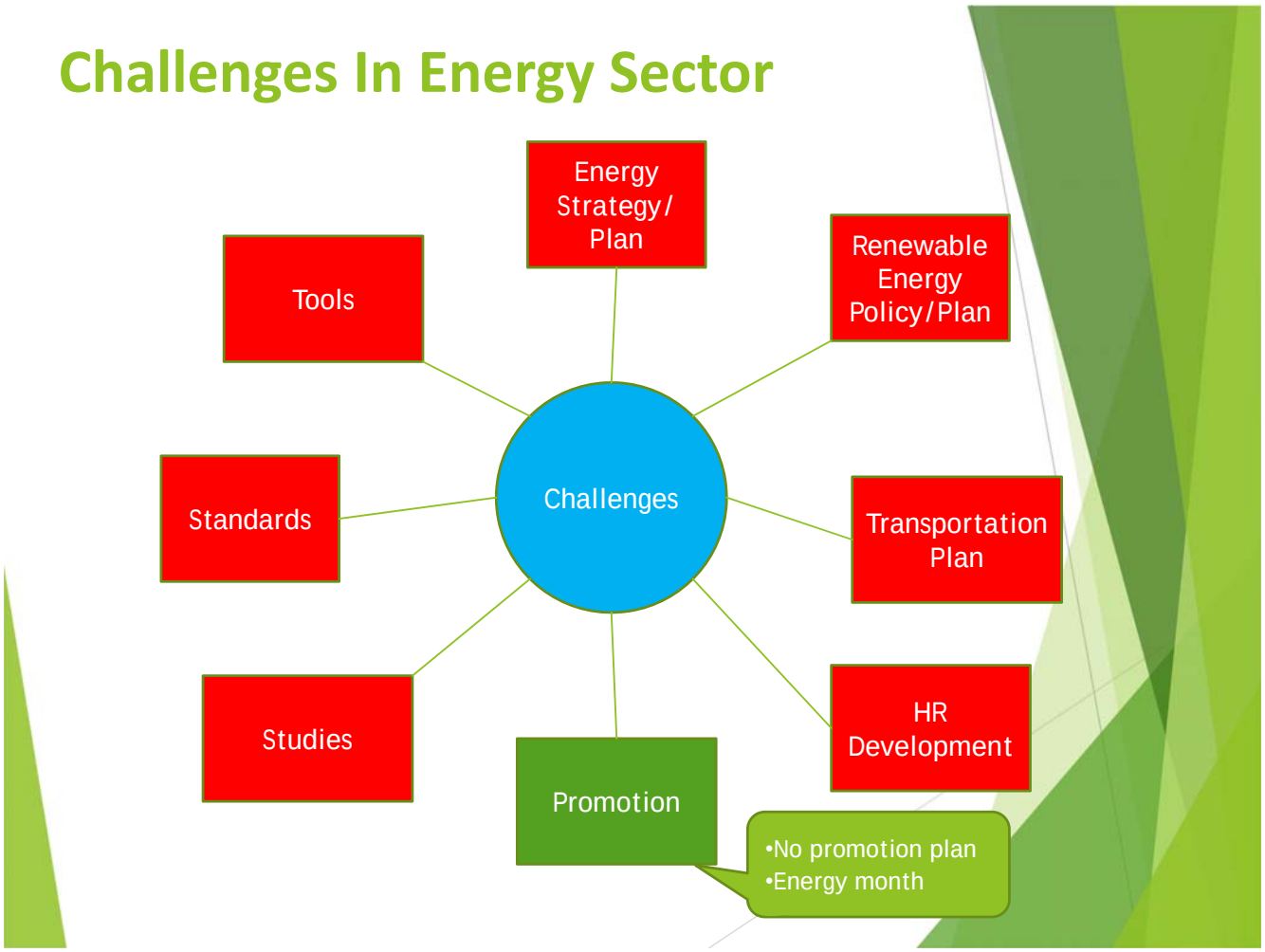
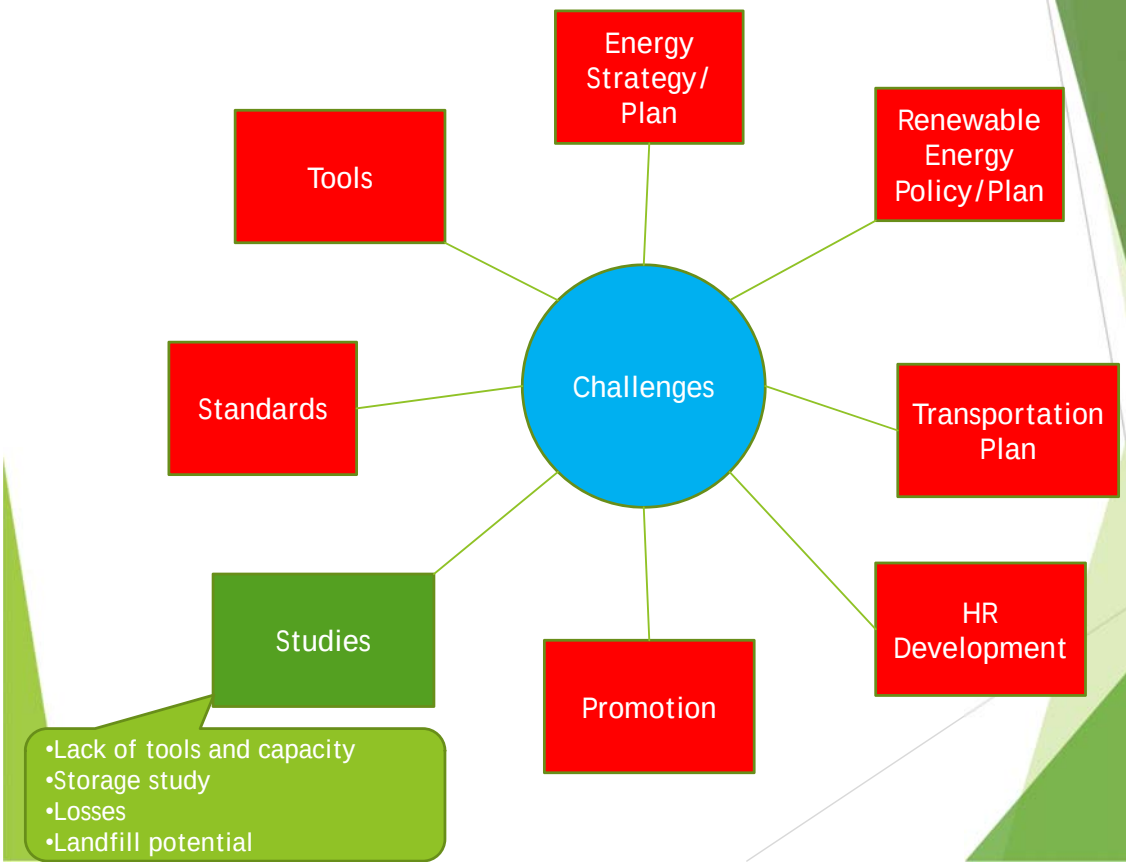
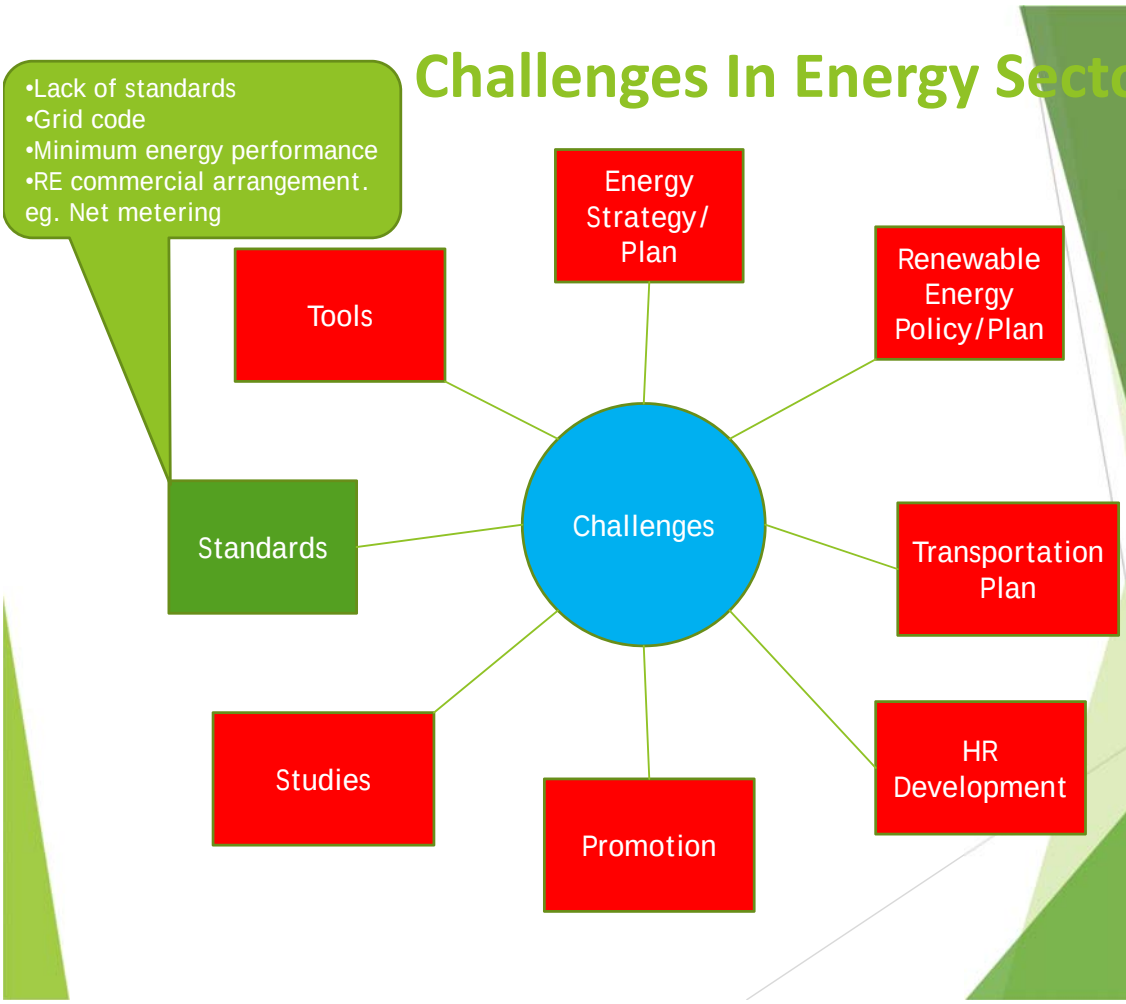


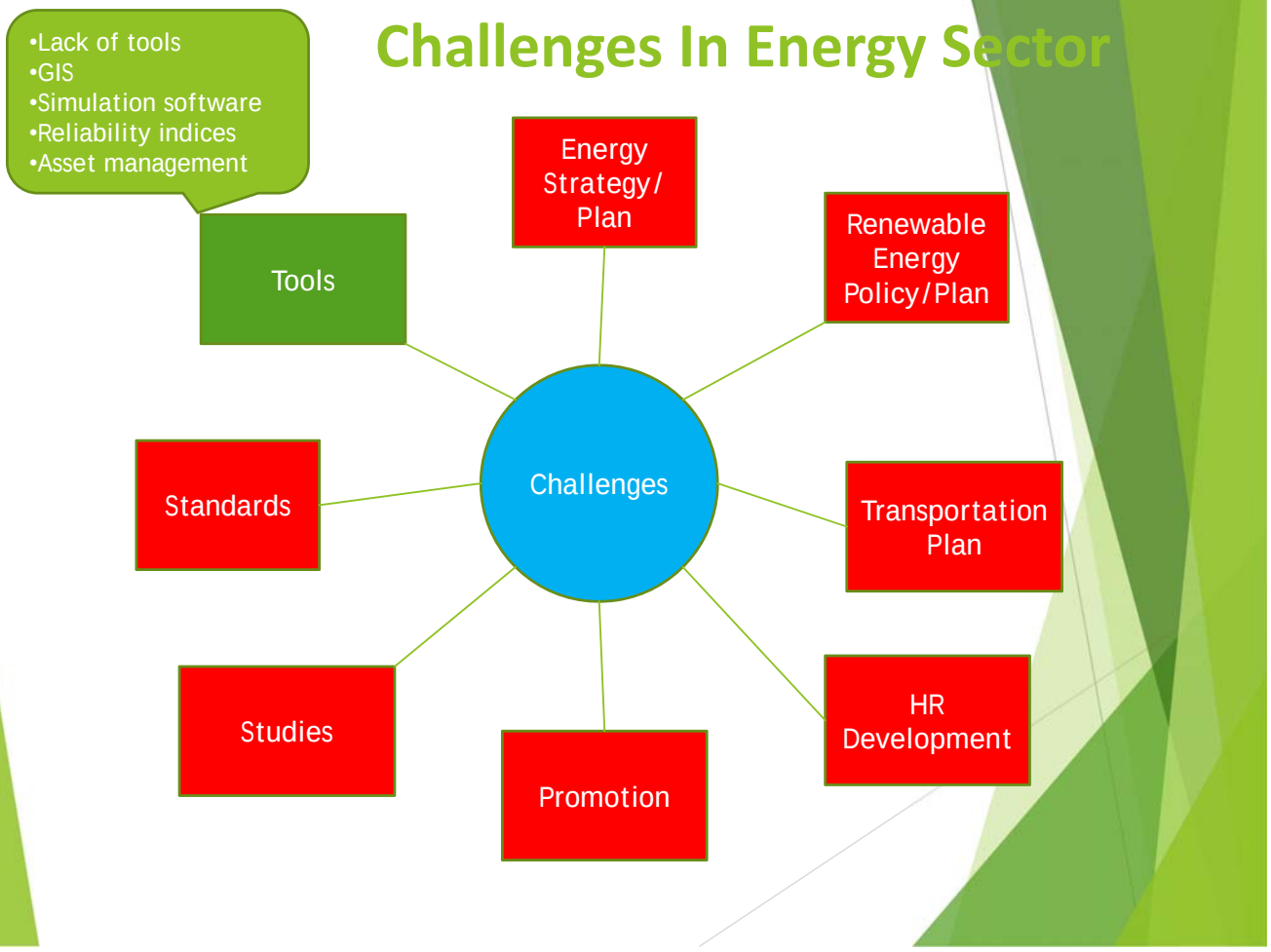
Challenges In Energy Sector



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)

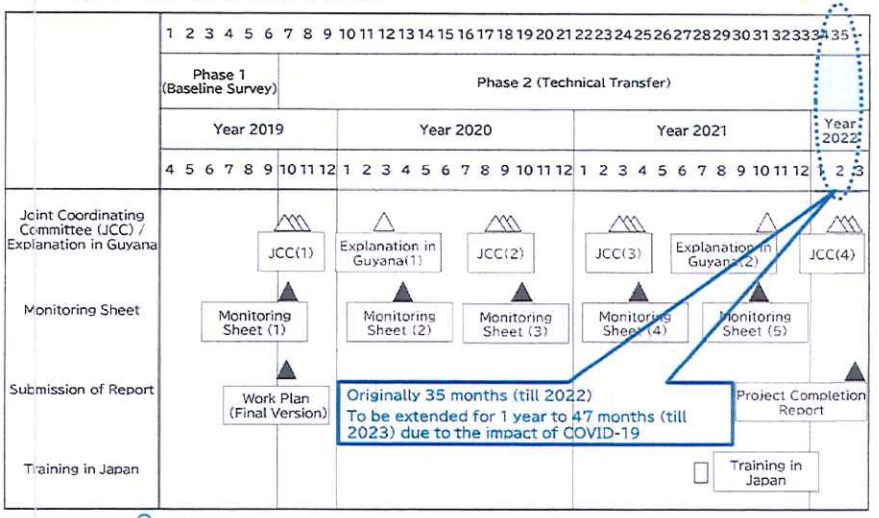
Purpose

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

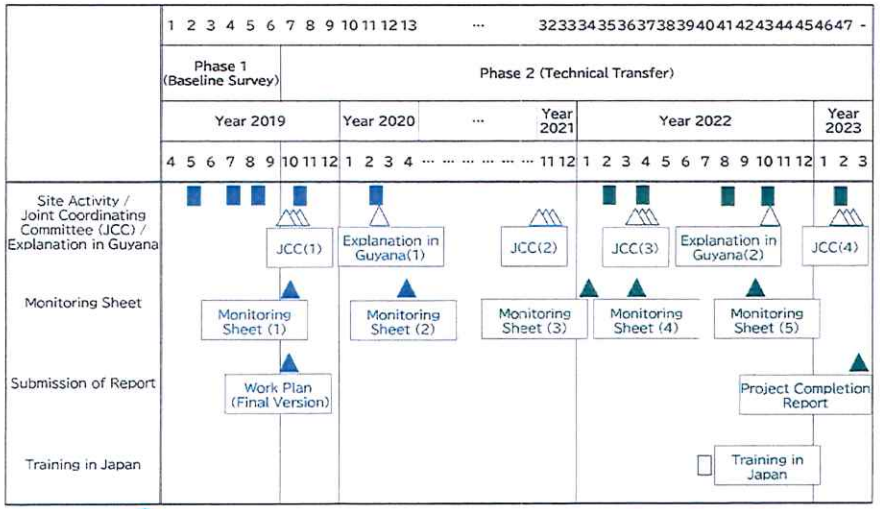
Output

- 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).

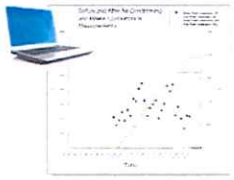
Current Status and Further Activity

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:

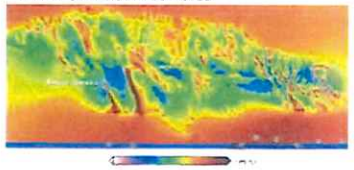
- Capacity building of grid simulation with software
- Proposal for grid code revision
- Enhancement of resilience → Microgrid concept

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

久下 勝也

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.

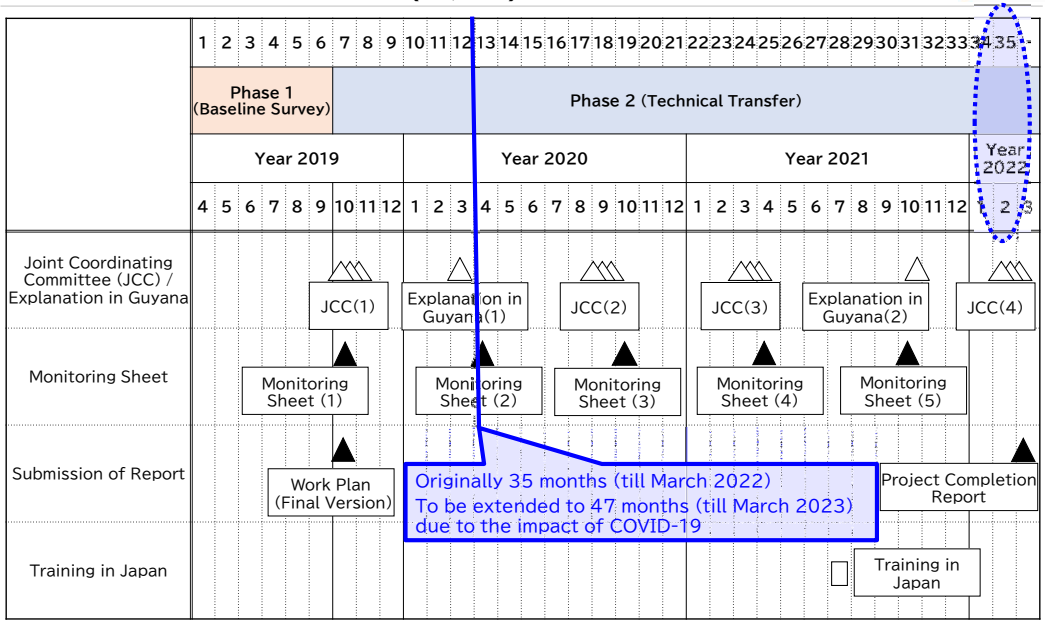
Purpose

- 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)

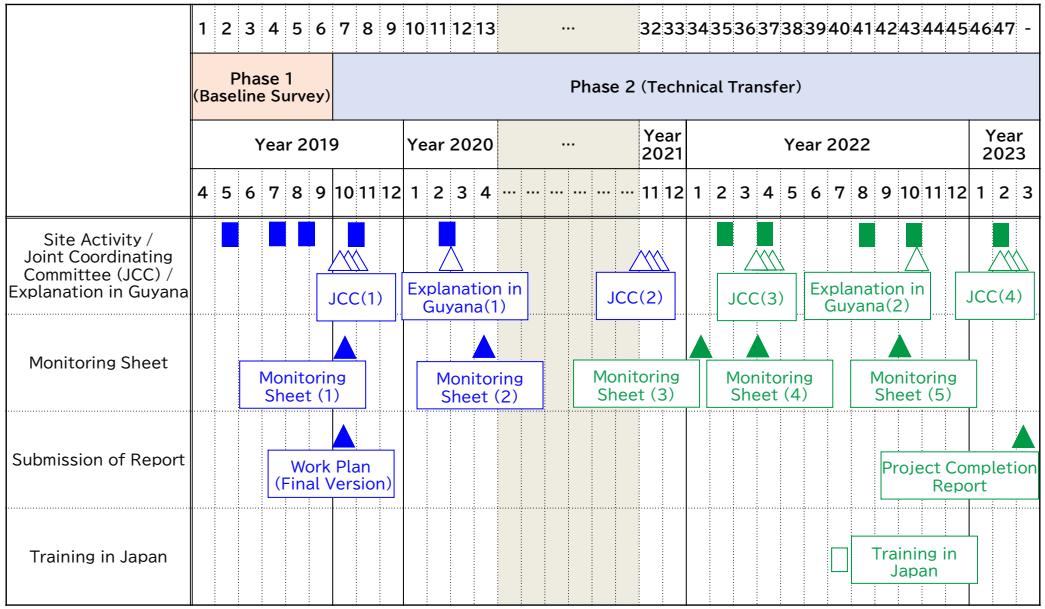
Further Schedule

- 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