SUPPORT FOR THE DEVELOPMENT OF A COMPREHENSIVE ENERGY PLANNING PROGRAM FOR JAMAICA

Capacity Building in Ministry of Science, Energy and Technology

Inter-American Development Bank

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Contact person:	Malaika Masson	
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Task and objective:

To support the capacities required at MSET to develop and maintain IRP

Prepared by:	Verified by:	Approved by:
C Albero HoS AOM Iberia	C Albero HoS AOM Iberia	JM Marco HoD RA Iberia
A Roark Senior engineer		

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Reference to part of this report which may lead to misinterpretation is not permissible.

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Acronym list

Acronym	Full Description
Bls	Barrels
BOE	Barrels of Oil Equivalent
BoJ	Bank of Jamaica
DSM	Demand Side Management
EE	Energy Efficiency
ESET	Electricity Sector Enterprise Team
EWP	East West Power
GCT	General Consumption Tax
GER	Government Electricity Regulator
GNI	Gross National Income
GoJ	Government of Jamaica
HF	Heavy Fuel
ICT	Information and Communication Technologies
IPP	Independent power producers
IRP	Integrated Resource Plan
JAMALCO	Jamaica Aluminum Company
JEC	Jamaica Energy Council
JEP	Jamaica Energy Partners
JPPC	Jamaica Private Power Company
JPS	Jamaica Public Service Company
LCE	Low Carbon Economy
LNG	Liquefied Natural Gas
MSET	Ministry of Science, Energy and Technology
NECEP	National Energy Conservation and Efficiency Policy
NEP	National Energy Policy
NGCC	Natural Gas Combined Cycle
OUR	Office of Utilities Regulation
PCJ	Petroleum Corporation of Jamaica
Petrojam	PDVSA/PCJ owned company
PIoJ	Planning Institute of Jamaica
PM	Project Manager
PPA	Power Purchase Agreement
PS	Project Sponsor
PSA	Production Sharing Agreement
PV	Photovoltaic
QoS	Quality of Service
RE	Renewable Energies
REP	Rural Electrification Program
RFP	Request for Proposal
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index

T&D	Transmission and Distribution
TFP	Total Factor Productivity
URA	Office of Utilities Regulation Act of 1995
US$	United States Dolars
VAT	Value Added Tax
VRE	variable renewable energy
WACC	weighted average cost of capital
WKPP	West Kingston Power Partners
WTI	West Texas Intermidiate

1 EXECUTIVE SUMMARY

This report aims to address the existing gaps between today's situation and the position in which MSET needs to be in to fulfil all the tasks now assigned to the institution. The two main points addressed herein are human and Information and Communication Technology (ICT) resources; a number of other issues will arise in other areas such as salaries in the private and public sectors, though these will not be covered in this report. Regarding human resources, the most relevant issue is the lack of specific expertise in purely technical areas. There are several roles that were not possible to cover with the profiles provided by MSET such as EE and DSM expert, electricity sales and rates, and T&D Engineer. Reinforcements in these areas should be considered.

Regarding specific issues that have been covered in the report, specific training plans should be designed to fill the technical gaps in all of these areas. Coaching and mentoring should be developed in the short term by PS and PM in order to train staff in these capacities.

In terms of the ICT platform, there are some areas in which new implementations for larger database management should be developed, while in others, the previously used models could be run properly. Benchmark modelling for load and energy forecasting could still be developed by means of MAED modules, and the planning and production cost platforms should be updated to EPIS PLEXOS and continue using WASP to calibrate the results.

PM tools such as MS Project should be implemented, and tailored spreadsheets should be developed for certain areas of overall project planning.

For the project, DNV GL suggested the use of PLEXOS, an Energy Exemplar software tool, which has been used in Integrated Resource Planning efforts in the Caribbean. PLEXOS is used by more than 190 organizations of various types around the world, currently in at least 42 countries spanning Europe, North and South America, Australia, Asia, and increasingly in Africa. PLEXOS is used by a wide variety of organizations in terms of mission as well, including Utilities, Regulators, Independent Power Producers, System Operators, Market Operators, builders of generation and transmission infrastructure, Research Institutes, Consultants, Academics, among others. Appendix A provides information from Energy Exemplar and project references.

2 INTRODUCTION AND BACKGROUND

Jamaica has been one of the most active countries in the Caribbean from an energy policy perspective. Some of the main issues addressed include renewable energy penetration, energy efficiency and conservation, and system losses. Despite these efforts, dependence on energy imports and electricity costs for the consumer remain high; volatile oil markets create uncertainty in prices and deliveries; and adoption of renewable energy to reduce emissions requires planning for these unique resources.[1] Planning for these efforts requires an integrated resource plan to:

- Communicate strategy and implementation thereof
- Coordinate infrastructure requirements
- Notify all interested parties of changes to allow said parties to adapt to the changes
- Determine the scope of potential impacts

In 2009 the energy policy for the 2030 horizon was published. The report described multiple challenges and scenarios that the country needed to address. In order to tackle these issues, **several new institutions were created while other existing institutions were assigned new mandates in the planning process**. The utility providing electric services, Jamaica Public Service (JPS), continues to play the leading role in the electricity system, maintaining a dominant position in the generation and operation while also having monopoly over the transmission and distribution of electricity.

The new framework, based on the new Electricity Act published in 2015, has redistributed responsibilities within the electricity sector, and players such as Ministry of Science, Energy and Technology (**MSET) and the Office of Utilities Regulation (OUR)**, have many new roles to play. This creates an opportunity for these institutions to **strengthen their human and technical capabilities**. This is a must, as these players will strengthen their role as regulator and supervisor of the market, and will need to provide the market with the stability and the regulatory framework to support the compliance of the national policy targets.

In February and March 2016, DNV GL conducted two seminars with MSET to describe in detail the IRP process and to obtain a better understanding of the Ministry's resources and capabilities. As a result of these seminars and an exchange of documentations, the structure of the future planning unit was agreed upon with MSET, and the IRP process and the structure required at MSET were defined so that this process can be properly developed.

[1] Jamaica Energy Policy, http://mstem.gov.jm/sites/default/files/National%20Energy%20Policy.pdf

3 EXISTING RESOURCES AT MSET

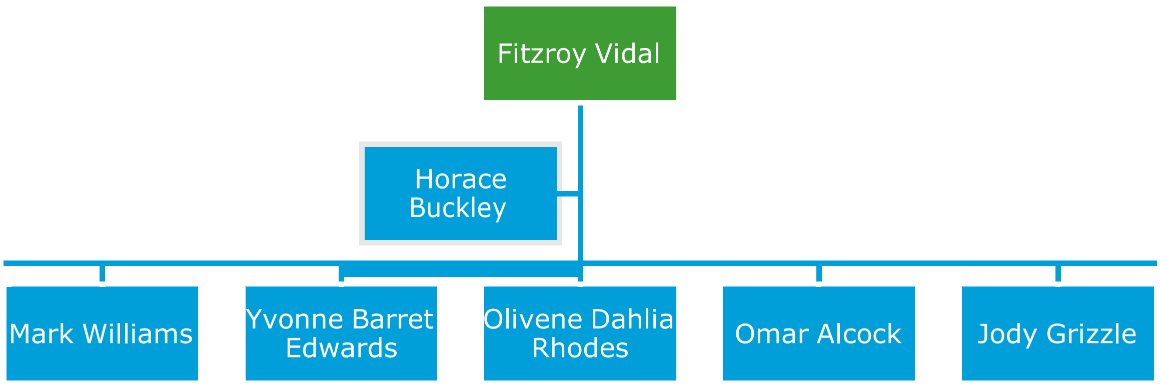
DNV GL has been in contact with MSET for the dimensioning of the resources that the Ministry has available for the development of the planning activity. The resources have been split into Human /1/ and ICT resources /2/, so a separate analysis has been done over the two. Considering the human resources available, DNV GL is aware that the personnel of the Ministry have been developing different tasks apart from the energy system planning. The aim of this report is to evaluate MSET personnel suitability to develop this function, and not to evaluate the implementation of the different resourcing options from the human resources point of view.

3.1 Human Resources

The Ministry comprises several departments, units, divisions and agencies. The focus of this report, however, is towards the development of the Energy Division tasked with the responsibility to do the IRP. The Division itself also has several departments and Units namely the Energy Economics and Planning Unit, the Energy Resources Unit, the Regulatory Affairs Unit, the Government Electricity Regulator (GER), the Project Management Office along with the IDB and World Bank Project Implementation Units.

The MSET IRP Project Team overseeing the current collaboration with IDB and DNV GL is comprised of seven (7) persons. The team diagram could be drawn as follows:

Figure 3-1 MSET Team



The profiles have been classified regarding the experience and versatility within the energy sector. As per the documentation provided, Mr. Vidal has the longest and most relevant experience in the electricity sector, as per his former roles in JPS as Power System Control and Electricity Grid Management in the control centre. This allows Mr. Vidal to have an unparalleled vision of the electricity sector, and he can act as the main coordinator of the team.

Mr. Buckley has been through many different roles that can allow him to assist Mr. Vidal and to be considered as a high-level interlocutor by the different stakeholders that will be involved in the project. His telecommunications background and the wide variety of tasks he has carried out, provide him a wide experience that could be used in different roles.

After the leading roles, the team is introduced, each of them with their own special abilities or experience that could enrich the planning function:

- Mr. Alcock and Mrs. Barrett-Edwards hold experience in energy economics and planning capabilities. In the case of Mrs. Barret Edwards, relevant experience in RE is also valuable for the planning function. Mr. Alcock's abilities to deal with complex Excel data bases and models, is also valuable at this stage.

- Mrs. Grizzle holds experience in project management and the use of analytical tools as the most relevant abilities towards the planning function. An added talent for Mrs. Grizzle is that she has experience in Stakeholders management and this is something that will be certainly needed.
- Mr. Williams is a mechanical engineer with a strong focus on energy activities. This could be a good basis for the OPEX focus needed in the planning units.
- Ms. Rhodes does not have a technical profile but a management one. She has been working in MSET for 15 years and she has a good knowledge of the organisation and the HR area.

As a general comment for the whole team, the foundations of it are solid, as the STEM (Science, Technology, Engineering and Maths) profiles prevail. These profiles are requested in these kinds of units although a higher specialisation is needed to develop the different tasks in the planning function. This will be analysed.

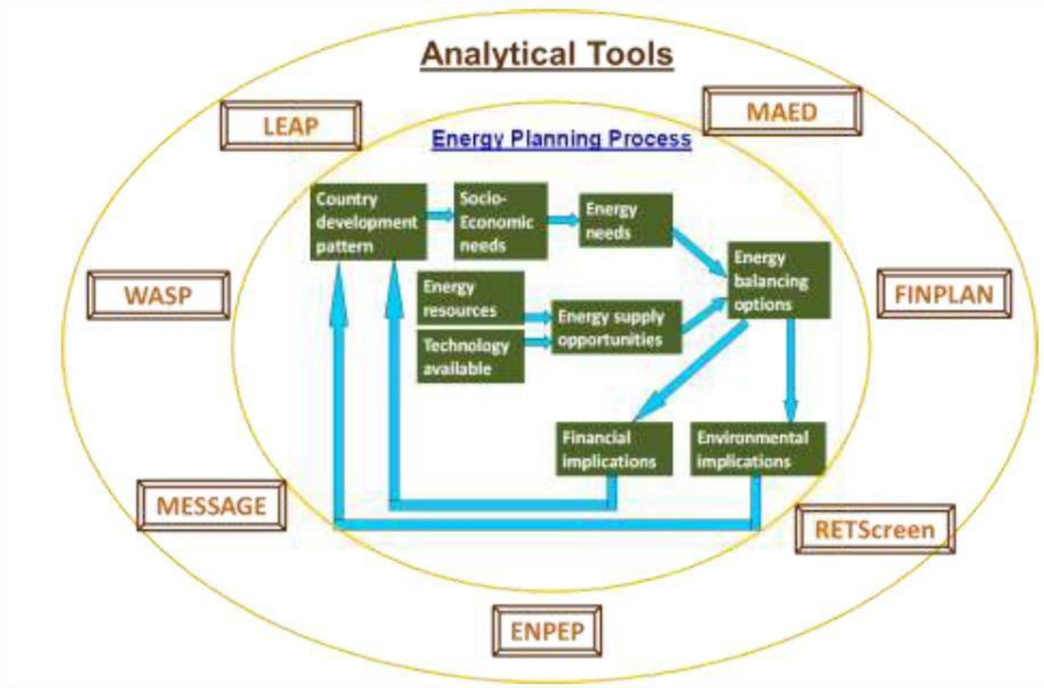
3.2 Current Software Inventory

Current software tools related to integrated resource planning are described in the document *A Synopsis of our Experience with Energy Modeling Tools, Prepared by the Energy Division, Ministry of Science, Technology, Energy and Mining, February 22, 2016.*

The Energy and Power Evaluation Programme (ENPEP) has various modules which balance energy supply and demand across the islands. The program is modular with various connections between each sub-module. A market share algorithm allocates various energy alternatives to end use purposes. The model is currently used for Energy Policy Analysis, Energy Market Projections, Natural Gas Market Analysis, Carbon and other Air Pollutant Emissions Projections and conducting "what-if" scenarios for various policy studies on taxes, subsidies, energy import quotas, etc.).

The following figure summarizes the tools used:

Figure 3-2 Summary of the planning tools used



A brief summary of each application is explained below:

3.2.1 Energy and Power Evaluation Programme (ENPEP)

The ENPEP model itself has various sub-modules with the ENPEP-BALANCE. This program allows for energy demand and supply linkages with environmental impact and implications of different energy strategies. ENPEP-BALANCE is a nonlinear equilibrium model that matches the demand for energy with available resources and technologies. Its market-based simulation approach allows ENPEP-BALANCE to determine the response of various segments of the energy system to changes in energy prices and demand levels. The model relies on a decentralized decision-making process in the energy sector and can be calibrated to the different preferences of energy users and suppliers.

Basic input parameters include information on the energy system structure, base-year energy statistics including production, and consumption levels and prices, projected energy demand growth, and any technical and policy constraints.

3.2.2 Financial Analysis of Electric Sector Expansion Plans (FINPLAN) Model

FINPLAN helps to assess the financial viability of plans and projects. It takes into account different financing sources — including export credits, commercial loans, bonds, equity, and modern instruments like swaps — and calculates projected cash flows, balance sheet, financial ratios, and other financial indicators.

Nowadays, Weighted Average Cost of Capital (WACC) is the most common indicator, and provides better competence idea between the parties depending on their risk appetite and financing capabilities.

3.2.3 Long-Range Energy Alternative Planning System (LEAP)

This model is applied primarily by the Ministry of Water, Land, Environment and Climate Change (MWLECC) as the analytical tool for preparing the Jamaican National Communication for the United Nations Framework Convention on Climate Change (UNFCCC).

The main features of the LEAP are as follows:

- Supports a range of simulation methods for modelling both capacity expansion and plant dispatch.
- Includes a built-in Technology and Environmental Database (TED) containing data on the costs, performance and emission factors for over 1,000 energy technologies.
- Can be used to calculate the emissions profiles.
- Can create scenarios of non-energy sector emissions and sinks (e.g., from cement production, landuse change, solid waste).
- Includes features designed to make creating scenarios, managing and documenting data and assumptions and viewing results reports as easy and flexible as possible (e.g., c reates an editable hierarchical tree).
- The Results View is an extremely powerful report generator capable of generating thousands of reports as charts or tables.

3.2.4 Model for Analysis of Energy Demand (MAED)

The following represent some key characteristics of the model:

- Written using a series of Excel macros.
- Evaluates future energy demands based on medium to long term scenarios.
- Relies on data inputs from all spheres impacting energy demand:
    - Examines the socioeconomic, technological and demographic development.
- Depends on disaggregated energy demand:
    - Details end-use categories corresponding to different goods and services in different sectors
    - Model built based on efficiencies of end-use appliances
    - Model scenarios driven by economic factors to give future energy demand growth

3.2.5 Model of Energy Supply Systems and their General Environmental Impacts (MESSAGE)

The following represent some key characteristics of the model:

- Used to formulate and evaluate alternative energy supply strategies (examples include new investment limits, market penetration rates for new technologies, fuel availability and trade and environmental emissions).
- Assesses capacity expansion and energy production policies.
- Relies on a technology rich description of the energy system.
- Used to analyse energy/electricity markets and climate change issues.
- Optimizes the system expansion and operation to meet the demands for energy service specified.
- Provides qualitative ideas on future energy system development.
- Framework to quantitatively assess their implications for the energy supply system.

In summary, MESSAGE is used to formulate and evaluate alternative energy supply strategies for a country or region. The model finds the optimal energy supply strategy for user defined constraints. The model is extremely flexible and can also be used to analyse energy/electricity markets and climate change issues.

3.2.6 Renewable Energy Technology Screen (RETScreen)

RETScreen is a Clean Energy Project Analysis Software developed by Natural Resources Canada and used across the world. It is a decision analysis tool used by energy professionals in Jamaica to evaluate the financial viability of renewable projects. In addition, energy efficiency, cogeneration projects, project cost accounting, emissions reductions, and financial risks are also evaluated using this tool.

RETScreen models both new and conventional technologies which allows for comparisons between technology options. The software can also specifically be used to evaluate benefits from clean energy.

3.2.7 Wien Automatic System Planning (WASP)

WASP is used in Jamaica for modeling the electricity sector. It is used primarily by the Office of Utilities Regulation (OUR) and the main power company, the Jamaica Public Service Company Limited (JPS). Its use is mainly for analyzing the least-cost generating system expansion plan that adequately meets demand for electrical power. It further uses probabilistic simulation to calculate production costs for a large number of possible future system configurations.

3.2.8 Summary Table

As a summary of the previous descriptions, the following table is depicted:

Table 3-1 Summary of the software tools at MSET

Tool	Scope	Methodology
ENPEP Balance	Integrated Energy/Environment Analysis	Market-based simulation
FINPLAN	Financial analysis of energy systems	Physical Accounting
LEAP	Integrated Energy/Environment Analysis	Physical Accounting, Simulation
MAED	Energy demand analysis	Physical Accounting, Simulation
MESSAGE	Energy supply system analysis & strategy	Optimization
RETScreen	R.E. technology evaluation and financial modelling	Physical Accounting
WASP-IV	Power system analysis	Optimization (least cost expansion)

3.3 Conclusions and Recommendations

Based upon conversations with MSET during DNV GL workshops, the following description characterizes the software tools required for Integrated Resource Planning

- ***Build versus Buy? Buy***. MSET recognized the advantages of buying large software solutions rather than building functionality internally. The time to implement, cost to build, software development capability is daunting. Further, the publicly available software vendors support products.

- ***"Best in Class" versus Integrated Solution: "Best in Class".*** While many integrated solutions reduce the amount of time and effort required to interface separate solutions, Integrated Resource Planning requires an emerging set of requirements which require updating functionality. For example, distributed electricity resources, distribution planning and load as a resource requires re-thinking many traditional tools.

- ***Upgrade existing platform/software versus purchasing new software? Purchase new software.*** To accommodate the changes in IRP participants, technologies and operating paradigms, it is assumed that new solutions can be implemented alongside any existing software.

- ***Modular with Interfaces (manual or automatic) versus Fully Integrated System: Modular with Interfaces***. To be able to adjust to required technology changes, incorporatenew model logic and utilize modules efficiently for small and large projects, solutions suggested are focused upon modules with interfaces to existing platforms.

4 BEST CASE PLANNING UNIT IN JAMAICA

Relative to best practices in Electricity Integrated Resource Planning, DNV GL has identified the following resources required to conduct an Integrated Resource Plan. In the first section a review of MSET responsibilities in the Inter-Agency Electricity Integrated Resource Planning effort is discussed. Based upon MSET responsibilities, DNV GL describes the skill set required and roles and responsibilities for each position required in MSET. For ICT and software, DNV GL describes ICT and software available and recommends developing requirements, short listing of vendors and select a vendor based upon criteria consistent with MSET ICT Policy.

4.1 Assumptions about Inter-Agency Roles and Responsibilities

As shown in Table 4-1, the Inter-Agency roles are used to define both Human Resources and ICT/Software requirements.

Table 4-1: Inter-Agency Roles and Responsibilities

Responsibility	MSET	JPS	OUR (Rates)
Objectives and Metrics	Develop	Inform	Inform
Transmission & Distribution Planning Studies	Approve	Develop	Review for rates
Load Forecasting: Assumptions/Inputs supplied by MSET	Approve	Develop	Inform
Stakeholder Process: communication & policy	Develop	Inform	Inform
Supply Technologies and Feasibility Studies	Develop	Approve	Review for rates
Third Party Supply/Demand Contracts	Approve	Develop	Approve Rates
Sales Forecasting	Approve	Develop	Approve Rates
Energy Efficiency and Demand Programs	Develop	Inform	Approve Rates
Policy Action Plans	Develop	Inform	Inform
Environmental Impacts – NEPA compliance management interface with JPS	Develop	Inform	Inform

As shown in table above, objectives and metrics of the Integrated Resource Plan are the responsibility of MSET to develop and communicate to JPS and OUR. Transmission and Distribution Planning studies are developed by JPS and approved for use by MSET with rates impacts analysed by OUR.

JPS has responsibilities to develop Load Forecasting projections; MSET would develop assumptions and inputs for use in the Load Forecast. OUR is informed of Load projections. MSET is responsible for all stakeholder communications; informing both JPS and OUR of status and outcomes. Supply Technologies modelled within the study and Feasibility Studies used to determine viable technologies are the responsibility of MSET. JPS approves the integration of any technologies for operational purposes and contracting for resources; OUR will review rates impacts. MSET will approve contracting for third party resources to ensure consistency with Integrated Electricity Planning results.

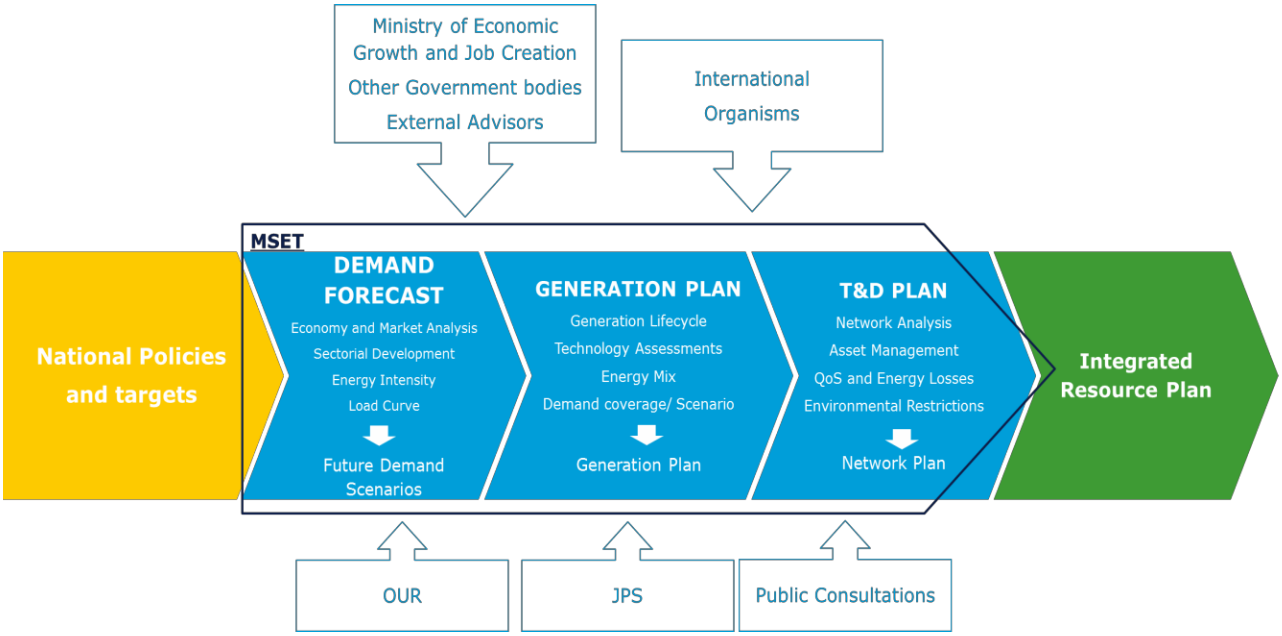
Sales forecasts used in Integrated Resource Planning (including kWh energy sales and rates applied) are developed by JPS (with rates approved by OUR) and approved for use in Electricity Integrated Resource Planning efforts by MSET. Energy efficiency and Demand Side Management Programs are developed and approved by MSET; JPS is informed and OUR will approve rates.

Policy Action Plans associated with the Electricity Integrated Resource Planning efforts are the responsibility of MTEM; with both JPS and OUR being informed. MSET will manage the environmental process, ensuring NEPA compliance with activities. JPS and OUR are informed.

4.2 Human Resources

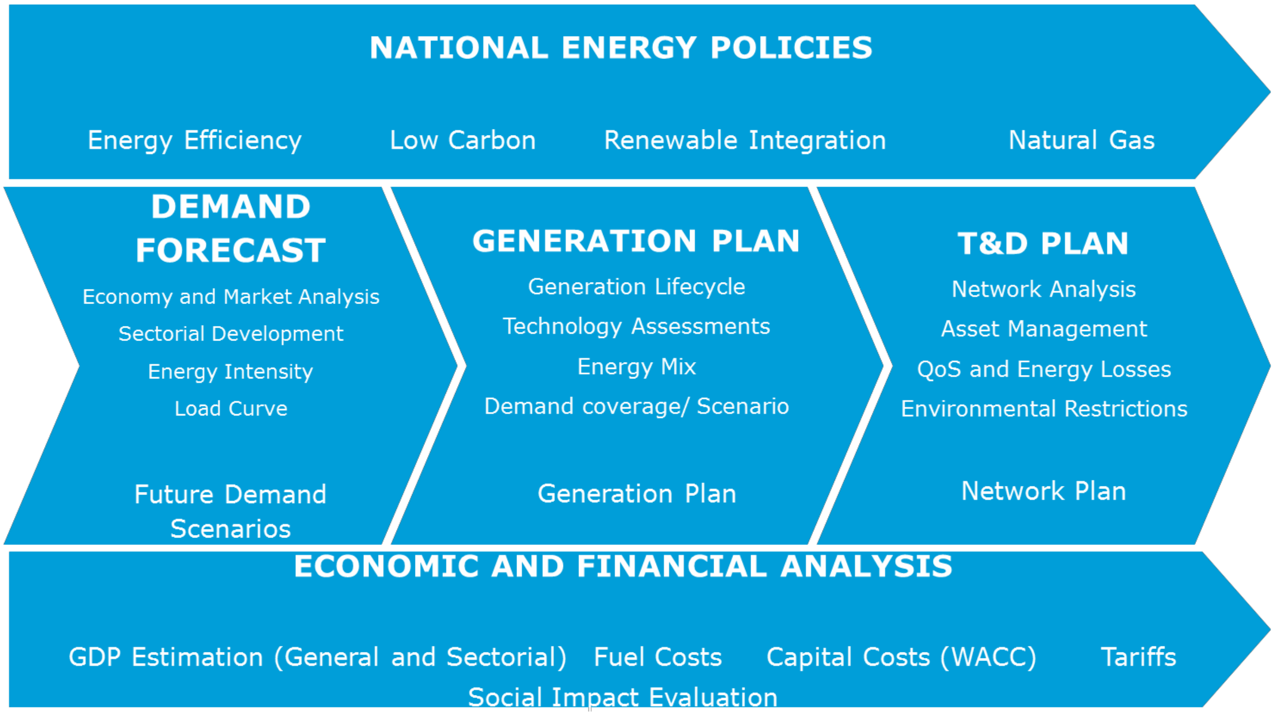
In terms of human resources, DNV GL has considered the planning unit regarding the electricity sector as currently stated in legislation, although some other responsibilities have also been considered owing to DNV GL's knowledge of the Jamaican energy sector. The development of this planning unit will not only be influenced by the planning unit itself, but also by the relationships and roles of other stakeholders. A summary of the process is presented in the figure below.

Figure 4-1 Overall planning and stakeholders of energy process



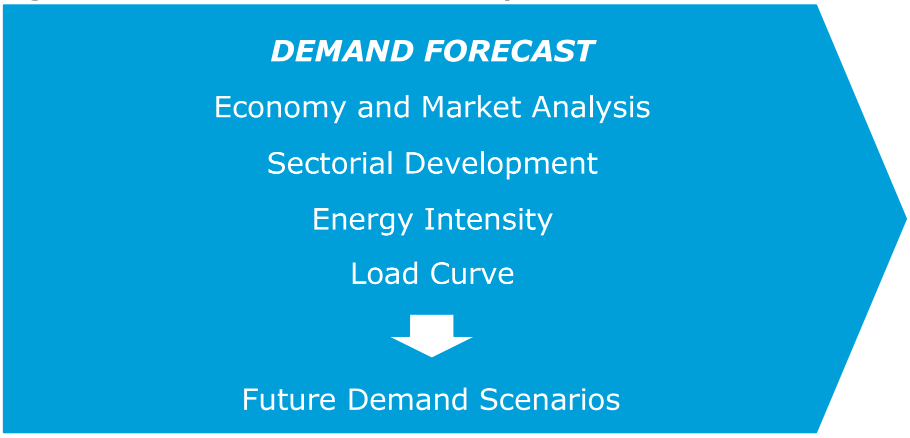
The most important elements of the planning lie in the centre of the flowchart above; DNV GL will analyse these steps in the following sections based on the following figure.

Figure 4-2 Summary of major responsibilities of the planning office



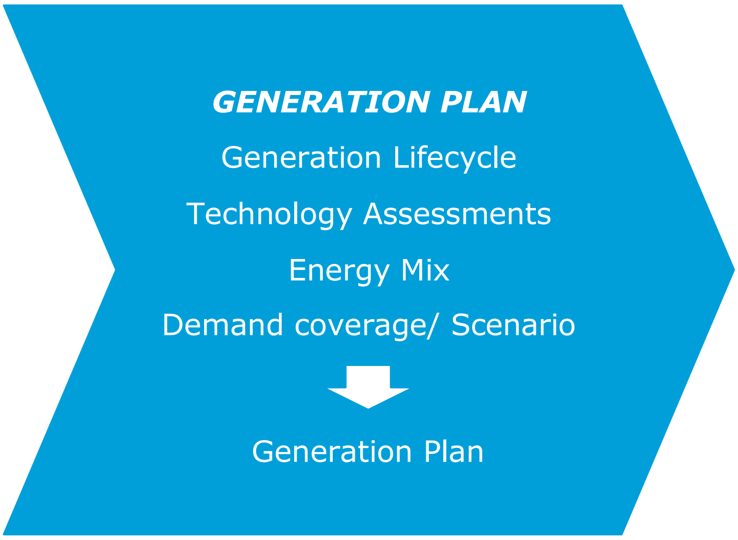
The National Electricity Plan is a key component of the Energy Policies and a basic driver to ensure their implementation. In this specific area, the planning unit is responsible for delivering these policies to the government or at least being aware of them in order to enforce them. Once these policies have been defined, the impacts on the technical and financial side have to be evaluated and different scenarios considered. DNV GL recommends defining a specific Program for each of the most relevant Policies such as Energy Efficiency, LCE, Renewable Integration, or Natural Gas penetration and to ensure proper coordination between them. Energy Efficiency will be a key input for the Demand Forecast Analysis, as well as to define specific targets for Energy Demand (overall and per economic sector), Energy Intensity and Load Curve.

Figure 4-3 Demand forecast decision process



The first step of the Planning Process is the Demand Forecast, as its relationship with the growth of the country's economy and more specifically with the GDP forecast needs to be established. Demand Forecast is the key issue in any country, as it marks the pace for new installations to take place or for the capacities of existing units to be pushed to the limit. Sectorial development will be critical, with direct impacts on total demand, energy intensity and the load curve. Different scenarios will be defined in accordance with different assumptions ranging from more conservative to more aggressive growth scenarios (requiring higher investments). Risk Assessment methodologies can be used to contemplate the different levels of uncertainty.

Figure 4-4 Generation plan



Once the different scenarios have been agreed upon, the next question should be how to cover the demand and a generation plan should be developed accordingly: addressing issues such as the type and age of installed units, security of the fuel mix, foreign fuel imports, and demand coverage scenarios. The main input will be the evaluation of the current Generation Portfolio and the expected pending lifetime of the generation fleet together with the evolution of associated costs. At this stage, comprehensive insight is required into the different technologies available on the market, their costs, performance and requirements in addition to the desired energy mix, as it will be mainly affected by the different National Policies (renewable integration, natural gas, environmental policies). For each of the Demand Scenarios, the most efficient Demand Coverage will be defined, including details of the new Generation Plants needed.

Figure 4-5 Transmission and Distribution plan

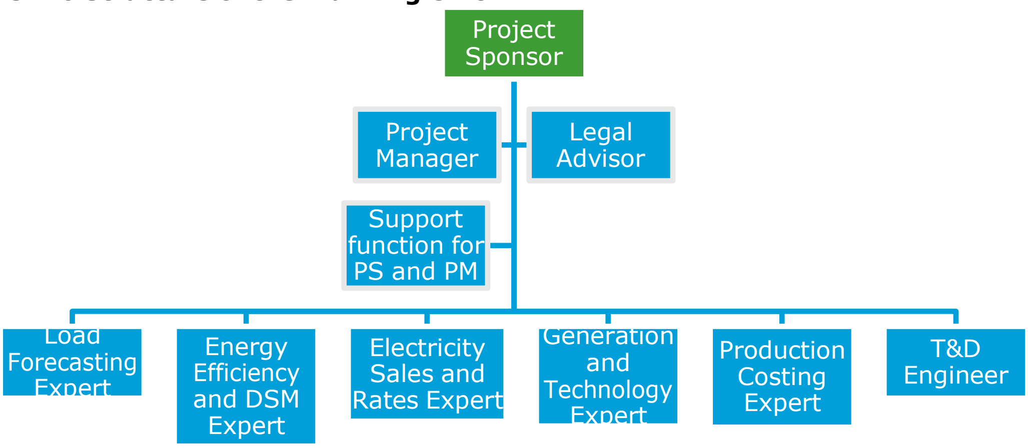
The Network Plan will be the final step and will include the integration of the new Generation and Demand scenarios. Based on the locations of the generation units and grid infrastructure, the

Transmission and Distribution scenario needs to be addressed. Network analysis, including updated inventory of the grid and congestion analysis will be the basic activity. At both the transmission level (examining the interconnections of the major substations and energy lines) and distribution level (examining the feeder and end consumers), several scenarios regarding network analysis and asset conditions need to be considered. For this kind of evaluation, Asset Management methodologies (including Load and Health indices) as well as Risk Assessments should be considered. In addition to pure network layout details, key inputs for the planning process will be the desired Quality of Service and the Energy Losses level, together with Environmental considerations.

The picture for the planning unit will not be complete unless project economics are considered. These inputs will be critical during the Energy Planning Process. In this area, a direct relationship needs to be established between MSET and remaining stakeholders. A specific component of this evaluation is the GDP evolution due to its specific link between the increase in electricity demand and the increase in the GDP itself. This relationship should be considered in a global perspective as well as for each relevant segment of the economic activity. The planning unit should also be aware of the cost evolution of the main technologies and associated fuels as well as Weighted Average Capital Costs (WACC) and other financial inputs that will be relevant when selecting technologies to be deployed in the mix. Last but not least, regulatory impacts of the Energy Plan (Electric Tariffs) warrant ongoing coordination with the OUR.

The integrated resource plan is intended to govern the entire process to be structured; therefore, the human resources that develop the IRP should be the same as those who will update, modify and execute the resulting plan, i.e., the MSET's core planning team. Thus, the leading roles of the planning unit are defined in the following sections based on DNV GL's understanding of the IRP process and the Ministry's technical needs. The main structure is presented in the figure below.

Figure 4-6 Structure of the Planning Unit



4.2.1 Project Sponsor

The Project Sponsor has the overall responsibility for Electricity Integrated Resource Planning on behalf of MSET. This includes selecting and appointing the Project Manager and may include the selection of other resources to support Integrated Resource Planning efforts.

During the Electricity Integrated Resource Planning effort, the Project Sponsor champions the project with other agencies. This includes serving as the spokesperson about the project to gather support throughout Jamaica agencies and stakeholders. The Project Sponsor describes inter-agency benefits of coordinating Integrated Resource Planning.

For issues that are beyond the control of the Project Manager, the Project Sponsor serves as an escalation path. The Project Sponsor is also involved in other important issues such as authorizing changes in scope and phase-end reviews beyond the agreed upon project plan established by the Project Manager. Commensurate with these responsibilities, the Project Sponsor is normally a Director level position within MSET.

Responsibilities:

- Support the Project Manager in handling of contractual matters related to contract work orders, change orders beyond the project plan and coordination with other Jamaican agencies.
- Ensure that the Electricity Integration Resource Planning is done within the context of a National Energy Integrated Resource Plan and that the Electricity Integrated Resource Planning project deliverables are verified by qualified personnel.
- Attend important meetings with other agencies, as agreed with the Project Manager.
- Approve the Electricity Integrated Resource Planning project management plan and budget.
- Review the project on a periodic basis with the Project Manager. The Project Sponsor shall decide how the periodic review shall be conducted, e.g., by dialogue, review by a team or by other means.
- Monitor inter-agency and third party feedback throughout the Integrated Resource Planning Project and ensure that feedback is provided to the Electricity Integrated Resource Planning Team.
- Ensure that Integrated Resource Planning Team members keep abreast of new developments, techniques and methods in Electricity Integrated Resource Planning and support team member involvements in workshops and training (when applicable).
- Approve project close-out, ensuring that all learnings and ideas for improvement are captured for broader internal communication and use in later projects.
- Support the Project Manager by making decisions in matters having contractual implications and /or budgetary consequences.
- Define Integrated Electricity Planning goals for Project Team Members development of professional capabilities.

4.2.2 Project Manager

The Project Manager's role is to manage Electricity Integrated Resource Planning efforts according to the project plan approved by the Project Sponsor. The Project Manager is the primary contact person for all Integrated Resource Planning efforts and has the operational responsibility for running the project to meet the defined goals, milestones and budget according to approved project plan. The Project Manager also has a responsibility for compliance with Jamaica regulations, team building and being a source of inspiration for Project Team Members. The Project Manager is appointed by the Project Sponsor.

Responsibilities:

- Prepare and update the Integrated Resource Project Plan which includes definition of tasks, deliverables, budgets, identification of risks and contingency plans, resources and schedules for each part of the project.
- Identification of Electricity Integrated Resource project milestones and communication of status to project members and the Project Sponsor.
- Establish the project organisation and organise the project work.

- In case of project roadblocks with third parties or agencies, proactively communicate this to the Project Sponsor and agree on adequate actions.
- Follow-up work execution, and facilitation of the successful completion of assigned tasks with project team members and subcontractors.
- Evaluate effects of Integrated Resource Planning project changes (scope changes), including impact on deliverables, schedule and budget, and, if approved by the Project Sponsor, negotiate contractual agreement with customer on these impacts.
- Monitor the performance of personnel and other resources allocated to the project, take corrective actions as needed, and provide feedback on performance to the Project Sponsor.
- Regularly describe and discuss project Integrated Resource Planning progress with Stakeholders.
- Promote third party vendor security and confidentiality requirements as part of the project.

4.2.3 Electricity Load Forecasting Subject Matter Expert

The Load Forecasting Subject Matter Expert works with the Project Manager and is responsible for developing inputs to JPS Load Forecast; reviewing outputs and ensuring consistency with MSET Electricity Integrated Resource Planning efforts. This resource provides inputs to both the long-term and short-term load econometric forecasts; ensure that a half hour pattern is developed by JPS and determines consistency for feeder level forecast for distributed energy net load forecasts in the Electricity Integrated Resource Plan.

Responsibilities:

- Validate monthly half hour shaping of aggregated Jamaica electricity load.
- Perform hindsight metrics of half hour long term load forecast performance.
- Provide analysis to identify long term forecast variance drivers and improve the overall accuracy of month ahead forecast.
- Make recommendations to improve overall forecasting capabilities.
- Prepare clear and accurate documentation support for inputs and results of any long term load forecast.
- Support and develop improvements to the forecast accuracy of the feeder forecast.
- Provide modeling support for all the weather sensitive, weather insensitive, lighting and real time models using regression analysis.
- Interface with various databases to gather needed information for appropriate functions as well as interfacing with personnel who maintain these various systems.
- Ensure accuracy of the load forecasting results.
- Perform back-cast metrics of forecast performance.
- Understand the factors that influence the load across different customer segments.
- Recommend process and systems improvements.
- Prepare and present analysis on load forecast variance and performance.
- Work with third parties and other agencies to develop solutions to their issues.

Experience:

- Electrical or Mechanical engineer with experience on energy market regulation for at least 5 years.
- Minimum 4 years of work experience or equivalence required in load forecasting/modelling or electricity sales or electricity operations.
- Good understanding of electricity markets is strongly preferred.
- Excellent modeling skills, detail oriented and able to produce accurate work products.
- Demonstrate ability to work with and analyze large volumes of data.
- Good Analytical skills using Excel pivot tables, graphs, macros.

Additional Knowledge, Skills, and Abilities:

- Advanced analytical/quantitative skills to conduct forecast variance analysis is preferred.
- A high degree of initiative and capability to work independently and cross-functionally is a required aspect of this job as well as strong interpersonal communication skills.
- Superior attention to detail in analytical assessments; thrives on developing and maintaining high quality reports and assessments and considers effects of decision in upstream or downstream information flows.
- Demonstrates ability and desire to master integration of model results and load forecasting data/metrics.
- Collaborative approach to issues and problems.

4.2.4 Electricity Energy Efficiency/Demand Side Management (DSM) Subject Matter Expert

The Energy Efficiency/Demand Side Management Program Manager works with the Project Manager and is responsible for identifying, developing and planning for energy efficiency initiatives that focus on commercial, institutional, and governmental entities using electricity across Jamaica.

Responsibilities:

- Assess the existing energy efficiency market for Jamaica and in other islands for new opportunities that can be used to advance the Electricity Integrated Resource Planning goals.
- Design and determine whether new energy efficiency programs are feasible including, but not limited to, making incentive recommendations, developing program documentation, and overseeing the program implementation process.
- Provide technical review of grant and/or loan proposals, evaluating technical and financial feasibility.
- Interface with contractors helping Jamaica implement energy programs.
- Determine appropriate cost estimates, implementation timeline, effectiveness and data collection to support the use of Energy Efficiency or Demand Side Management programs in Jamaica’s Integrated Resource Planning efforts.
- Review energy efficiency legislation during the annual legislative session to determine impacts on Jamaica Integrated Resource Planning efforts.
- Analyze data submitted by third parties.

- Collect and enter other data such as building characteristics and spot diagnostic measurements.

Experience:

- Two years developing and implementing energy efficiency programs focused on commercial, institutional, industrial, and governmental entities.

Additional Knowledge, Skills, and Abilities:

- Master's degree in energy or engineering related field.
- Experience working with utility-run energy efficiency programs as either a program implementer or as an installation contractor.
- Experience managing national grant programs, ideally energy-focused.
- Experience working with residential energy efficiency and/or renewable energy technologies.
- Energy-related certifications (e.g., CEM).
- Strong writing, presentation and analytical skills.
- Strong facility with Microsoft Excel.

4.2.5 Electricity Sales and Rates Subject Matter Expert

The Electricity Sales and Rates Subject Matter Expert works with the Project Manager to ensure that customer rates and sales are appropriate in Integrated Resource Planning efforts. The Sales and Rates Subject Matter Expert works with OUR and JPS to provide inputs for, review methodology and assumptions used in rates and sales forecasts.

Responsibilities:

- Determine inputs for rates and sales forecast analysis consistent with Integrated Resource Planning efforts.
- Determine if new rates, alternate rates, tariffs or subsidies are required in concert with new generation technologies or energy efficiency/demand side management programs.
- Leading or participating in highly complex special projects and studies involving cost-of-service analysis, rate design, and service rules.
- Providing oral or written responses to JPS and OUR regarding rates, tariffs and/or subsidies.
- Provide inputs into Electricity Sales forecasts, bad debt and cost of capital discussions.
- Developing and maintaining standard analytical tools and spreadsheets for assumptions used, methodology used and outcomes of OUR conducting cost of service analysis and rate design.
- Maintaining utility tariff filings.
- Leading or participating in highly complex special projects and studies involving cost allocation, rate design, and emerging energy industry trends such as renewable energy, distributed generation, and utility industry restructuring.

Experience:

- Electrical engineer with financial background (MBA or similar).
- Two years in electricity sales forecasting and/or rate analytics.

Job Knowledge, Skills and Abilities:

- Strong quantitative and qualitative methods of analysis.
- Microsoft Office and Excel.
- Skill in the creation and use of computerized database systems for research and analysis, including experience designing spreadsheet models and database queries.
- Written communication skills, including the ability to clearly explain complex technical and policy materials to diverse audiences including Commissioners, water utilities, stakeholders, policy-makers, and the general public.
- Oral communication skills, including the ability to present complex technical and policy material in the form of speeches, discussion groups, and phone calls to diverse audiences such as Commissioners, water utilities, media, stakeholders, policy-makers, and the general public.
- Ability to work collaboratively and effectively in a multi-disciplinary team environment.

4.2.6 Electricity Generation Technology Subject Matter Expert

The Electricity Generation Technology expert works with the Project Manager and is responsible for reviewing feasibility and implementation studies for central plant and distributed resources, requesting data and determining operating characteristics for all electricity supply technologies.

Responsibilities:

- Plan, organize, and direct supply vendors submittals for the Electricity Integrated Planning Effort.
- Determine operating feasibility and compliance with environmental and water use regulations as used in the Integrated Resource Planning effort.
- Populate the database and ensure confidentiality of planning estimates used in the IRP study.
- Evaluating alternative generation methods, analyzing distributed energy resource planning and developing solicitations that complement utility technology demonstrations.
- Assess the ability of existing, new and emerging energy generation technologies to be designed, developed, and deployed to utilize in Integrated Resource Planning efforts.
- Identify methods, models, and techniques to evaluate energy generation system impacts on the transmission and distribution systems.
- Plan, organize, assist and/or participate in meetings with other JPS and OUR staff, consultants, contractors, and other parties active in energy-related research and development.
- Lead research efforts to analyze and evaluate alternative generation technologies and systems and their impacts to Jamaica’s electric grid infrastructure.
- Review and analyze new and emerging energy generation technologies to ensure conformance to distributed energy resource planning.
- Reviewing proposals to determine how well the proposals address the scope of the solicitation criteria including, but not limited to: the extent the project will advance science or technology, address market issues and needs, meet specified target goals and objectives; and move the results into the marketplace.

- Oversee the completion of complex project reports, fact sheets, and other documents to disseminate research results and lessons learned to stakeholders in the Integrated Resource Planning efforts that provides significant public benefits to California and meets the state's energy policies and goals.

Experience:

- Two years in Power generation engineering.

Job Knowledge, Skills and Abilities:

- Excellent interpersonal skills and expected to work within a large team environment.
- Ability to communicate complicated information in a simple, consumer-friendly manner.
- Ability to coordinate interdisciplinary projects.
- Strong written and verbal communication skills.

4.2.7 Electricity Production Costing Subject Matter Expert

The Electricity Production Costing Subject Matter expert works with the Project Manager and is responsible for modelling, methodology and estimating production cost impacts using MSET software for a variety of different technologies and implementation studies for central plant and distributed resources. Work closely with the Generation Technology Subject Matter Expert.

Responsibilities:

- Identify current and future load/resource balances; prepare analysis and recommendations for managing forecasted electricity imbalances.
- Conduct detailed energy resource planning studies and provide analysis of electricity price trends and data.
- Prepare, analyze, and estimate the impacts of power supply contracts and agreements; evaluate technical, economic, and regulatory feasibility of contracts and projects.
- Develop, modify, maintain, and use computer based models related to power production costs, current market transactions, forecasts of need and supply; and anticipated procurement costs.
- Validate model assumptions and address needed changes in the model planning process, and software installation/maintenance, as appropriate.
- Make presentations on results to a variety of organizations and agencies on power resource planning, including pooling, contracts, distribution and transmission lines, demand side resources, and regulatory compliance and changes.
- Prepare written analysis of complex forecasts for use by Integrated Resource Planning stakeholders; prepare and make oral presentations related to production costing results.

Experience:

- One year in production costing for electric utilities.

Job Knowledge, Skills and Abilities:

- Principles and practices of mathematical and statistical analysis and modeling.
- Principles and methods of decision analysis, including cost/benefit analysis.
- Techniques of data analysis and related software and computer interfacing.

- Modern office systems and equipment, including specialized computer applications for forecasting and modeling.
- Technical report writing procedures and techniques.
- Learn power systems optimization methodologies, including related software programs.

4.2.8 Electricity Transmission and Distribution Engineer

The Electricity Transmission and Distribution Engineer works with the Project Manager and is responsible for determining impacts of Integrated Resource Planning on transmission and distribution reliability.

Responsibilities:

- Serves as a lead project engineer on complex, long range projects involving major electrical equipment and systems concerning planning and design phase of maintenance and improvement projects.
- Prepares electrical designs and cost estimates covering the new, repair, maintenance, and improvement of all electric, electronic, and electro-mechanical equipment and systems.
- Prepares justifications, supporting data, requisitions, technical reports and correspondences.
- Performs technical review of designs and documents prepared by others.
- Provides engineering leadership and consulting services on the design, production of equipment, installation, testing and operation.

Experience:

- Electrical Engineering Degree.

4.2.9 Legal (Contracting) Subject Matter Expert

The Legal (Contracting) Subject Matter Expert works with the Project Manager and is responsible for reviewing legal and contracting issues for the Integrated Resource Planning effort. The purpose of this position is to serve as senior contract administrator for PPA’s most complex power or non-tariff transmission contracts particularly those involving non-standard customer transactions. The incumbent also serves as a recognized technical expert in contract administration, providing expert advice in compliance with Jamaica’s laws and regulations.

Responsibilities:

- Provide advice on the viability of complex power or non-tariff transmission contracts particularly those involving non-standard customer transactions.
- Provide leadership within the group by proactively identifying contract administration weaknesses in processes, places where standards and policies do not exist or are not being followed, procedures that need to be in place and areas of work responsibility that need additional emphasis and direction.

Requirements:

- Part time, as needed, during inputs portion of Integrated Resource Planning phase.

4.2.10 Public Consultations

This will be a major task for the team, as the interaction between the Ministry and the different stakeholders will be through meetings and public consultations, this should be covered by the team members. This is not a pure technical aspect, but a professional approach has to be taken into account in this issue; public communications as part of the IRP process can impact the Ministry. This has also been considered in the assembly of the team.

4.3 MSET Software or Third Party Solutions for IRP Work

Currently MSET has experience with energy balancing software to conduct impact analysis. As part of its Integrated Resource Planning function, the following software application and functions are required. Some of these are recommended to be deployed by MSET and others by JPS.

4.3.1 Load Forecasting

4.3.1.1 Requirements and Current Capabilities

The IRP function requires a software application or third party consultancy capable of providing half hourly resolution in both short term and long term. Longer run forecasts may require monthly peak and energy estimates for up to 20 years.

For distributed forecasts, the IRP would need feeder load granularity to compare the impacts of distributed resources to central station; to determine the effectiveness of demand side management and energy efficiency programs on net feeder load and to determine the impacts of customer outage (both frequency and duration).

Currently MSET uses the Model of Analysis of Energy Demand (MAED) component of the ENPEP integrated model. This module uses economic, demographic and technology data inputs to build hourly electric load duration curves and is built around appliance saturation models. As a long term energy planning construct, this load module is deployed by several agencies. Most utilities that DNV GL consults with uses more granular, feeder level or detailed sector (residential, commercial and industrial) models to which forecasts are calibrated.

MSET has expertise with several system demand forecasting techniques, including ARIMA, multivariate econometric regression, artificial intelligence/neural networks, and error correction models. There is experience with linear regression models. It is also desired that the prospective software application or third party consultancy service be capable of quantifying uncertainty in demand forecasts by using either scenarios or simulation techniques.

4.3.1.2 Load Forecasting Tools and Third Party Services Used in IRP Analysis

- Global Insight (Third Party Service)
- EViews (Third Party Service)
- International Energy Association and US Energy Information Agency (Limited Energy Forecasts)
- Areva (Models)
- Argonne Labs –MAED- (Models)
- AspenTech (Model platforms)
- Itron (Model platforms)
- SAS (Model platforms)

- SPSS (Model platforms)
- ABB/Nostradamus (Models)
- Internal Spreadsheets (Model platforms)
- Matlab programmed Model platforms
- "R" programmed Models

4.3.1.3 Recommendations

As part of the IRP, DNV GL recommends incorporating half hourly load shapes and feeder level granularity into forecast capabilities. While many of the model platforms will accomplish this objective, spreadsheets are common platforms which can be used and shared. A re-usable spreadsheet model can be developed to update capabilities into this area and be used to benchmark the MAED modules.

- DNV GL has found that spreadsheets developed internally or by external vendor are flexible and can be adapted, shared and used for multiple purposes.
- Many of the platforms and models require some time to get acquainted with logic, interfaces and results and may require multiple installations to use.
- The existing MAED tool can still be used to coordinate energy policy efforts, but can be calibrated to a spreadsheet tool and methodology.

4.3.2 Energy Efficiency/Demand Side Management Software

4.3.2.1 Requirements and Current Capabilities

As part of the ENPEP platform, two sub-modules are used at MSET to conduct energy efficiency analysis: MAED, discussed above, and LOAD, the modules forecasting hourly load duration curves. Both modules examine scenario based demands.

For Integrated Resource Planning, load shapes are impacted by specific Energy Efficiency/Demand Side Management (EE/DSM) programs. For example, demand response programs can alter peak loads, reducing the amount of energy required to meet demand at those times. Driven by these EE/DSM programs, most Integrated Resource Planning efforts include the capability to alter load shapes over time to determine the cost savings of such programs. Smart Grid meters record consumption of electric energy in real time while communicating the information back to the utility (or end user) for monitoring and billing purposes.

Measuring the impact of these programs requires analytics for EE/DSM potential under a variety of policy directives, price trends and building mixes. The methodology is required to capture engineering, economic, customer behaviour and market impacts.

Required outputs from the analysis include assessment of EE/DSM potential for uncertainty or range of savings potential and cost effectiveness. The outputs of these models provide policy guidance and impact analysis for utility management and regulators.

To calibrate the model used, there is a variety of field and survey data collected as part of the process including:

- Baseline levels.
- Saturation of key end-uses and energy intensity by segments and geographic regions.
- Calibration to billing, sales and load shape data.
- Identification of the full range of energy efficiency and demand response options.

- Development of initial cost-effectiveness estimates used for measure bundles and program portfolio.
- Forecast of energy savings, demand reduction, costs, and cost-effectiveness of programs developed and specified.

Results assess the performance and cost-effectiveness of candidate programs under different planning scenarios with varying energy costs, regulatory regimes, and growth rates.

4.3.2.2 Recommendations

Given the specific nature of energy efficiency programs, DNV GL recommends the use of an initial survey by external vendors to collect detailed information on program data and design interfaces to integrated resource planning efforts. Most of the IRP efforts are conducted outside of existing programs where inputs can be modified and conducted with the assistance of JPS.

Once established, data parameters can be interfaced to and calibrated with existing programs that MSET has.

4.3.3 Energy Price Forecasting

Key energy price inputs for Integrated Resource Planning include fuels, equipment costs, capital and operating parameters as well as economic and demographic variables (such as Gross Domestic Product, inflation, etc.). The requirements for the forecast variables are that they are publicly available, there is general agreement about the trend of the forecast and that there is broad agreement associated that various high, low and base case assumptions reflect potential ranges of outcomes.

DNV GL deploys publicly available forecasts which contain high, medium and low scenarios to investigate a range of possible outcomes for Integrated Resource Planning. Energy Information Association forecast or those from third party vendors are the most commonly used sources. While DNV GL has worked with energy planning agencies using models such as ENPEP to develop price forecasts for key variables, DNV GL has found that internally developed models require significant time to produce results which detract from IRP activities.

4.3.4 Project Management Tracking Software

The key requirements for Project Management software to track the project status, internal and external vendor and consulting budgets and to discern actions required to meet budget and timeline constraints. There are many potential software solutions for this activity; DNV GL uses a common software platform called MS Project to provide consistency and ease of use.

4.3.5 Database Management for IRP Results and Assumptions

4.3.5.1 Requirements and Current Capabilities

For this project, no MSET database structures were reviewed.

Database management systems interact with the user, other applications, and the database itself to capture and analyze data. Energy database management systems are repositories of IRP work, confidential vendor information and require definition, creation, querying, update, and administration of databases.

4.3.5.2 Tools and Third Party Services Used in IRP Analysis

The following tools and platforms are common enterprise databases used by energy firms and agencies to coordinate business data flows:

- Access
- Adabas
- Adaptive
- Advantage
- Datacom
- DB2
- Filemaker
- IDMS
- Ingres
- Interbase
- MySQL
- NonStop
- Pervasive.SQL
- Progress
- Quadbase
- R:Base
- Rdb
- Red
- SQL
- SQLBase
- SUPRA
- Teradata
- YARD-SQL
- TimesTen
- Model
- UniData
- UniVerse
- Cache'
- Cloudscape
- Informix
- Oracle
- PointBase
- PostgreSQL
- SharePoint
- UniSQL
- Jasmine
- Object
- Objectivity
- POET
- Versant
- Raima
- Velocis
- Db.linux
- Db.star
- IMS

4.3.5.3 Recommendations

To initiate the database requirements, DNV GL recommends a SharePoint site. Later, more advanced databases are required as history in IRP planning is developed. Well-known database management tools include MySQL, PostgreSQL, Microsoft SQL Server, Oracle, Sybase and IBM DB2 are often used as IRP and data needs grow.

4.3.6 Supply Technologies Database and Ranking Criteria

4.3.6.1 Requirements and Current Capabilities

MSET currently uses RETSCREEN for renewable and conventional fossil generation supply configurations. Data requirements for the new technologies include, but are not limited to: capital expenditure (total cost of developing and constructing a plant, excluding any grid-connection charges); operating expenditure (variable and fixed operating expenditures); capacity factor for operations, heat rate ranges for operation, maintenance and outage information. Much of this information is provided within RETSCREEN. Most IRP efforts require site specific feasibility studies conducted to study long term planning impacts. Further, there is usually vendor specific information regarding costs and operating parameters which require confidentiality.

Much of the traditional fossil supply resource information is already available from existing JPS sources or vendor quotes available from JPS. Common electricity generating turbines driving an electric generator modelled in IRP studies include biomass, wind, water, steam or burning gas. The turbine drives an electric generator. Inverter based generators modelled in IRP efforts include fixed panel solar thermal energy, solar parabolic troughs and solar power towers concentrate sunlight to heat a heat transfer fluid, which is then used to produce steam. For some islands, geothermal resources create steam under pressure emerges from the ground and drives a turbine or hot water evaporates a low boiling liquid to create vapor to drive a turbine.

Reciprocating engines are among the most common configurations used in island systems. Reciprocating engines burn heavy fuel oil, diesel, biogas, liquid petroleum gas or natural gas. In addition, smaller or isolate loads use diesel engines for back up generation, usually at low voltages.

Within Integrated Resource Planning, a variety of emerging supply and demand resource technologies should be anticipated such as storage devices and fuel cells. Storage devices have been modelled as renewable balancing, voltage control and distribution feeder upgrade deferrals. Unlike batteries, fuel cells require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these inputs are supplied. They inherently displace the need for natural gas turbines, and are ideally used for stationary power generation or large passenger vehicles such as buses (especially at energy- dense future iterations of the technology). Advances in materials technology is enabling the advance of high energy Li-air batteries which promise an energy density that rivals gasoline, offering a five-fold increase compared to traditional Li-Ion batteries. By using atmospheric oxygen instead of an internal oxidizer, these batteries could dramatically extend electric vehicle range. Thermal storage is used in conjunction with active solar collectors or with combined heat and power plants, and transferred to insulated repositories for use later in various applications, such as space heating, domestic or process water heating. Meters can be used for remote load-balancing such as disabling non-essential devices at peak usage. Tidal turbines convert tidal energy into electricity. Currently used in small scale, with the potential for great expansion. Second-generation biofuels technologies, such as cellulosic ethanol and biodiesel from microalgae, promise to produce conventional fuel-compatible energy at low or zero greenhouse gas emissions.

4.3.6.2 Recommendations

Much of the data for use in IRP studies is available through site specific feasibility studies. It is highly recommended to utilize these sources of information.

4.3.7 Capacity Expansion and Production Costing Software

4.3.7.1 Requirements and Current Capabilities

Integrated Resource Planning involves both longer term capacity planning and short run production costing/dispatch software to conduct various planning scenarios. The most commonly used IRP tools involve optimization, simulation, and decision analysis. Optimisation refers to linear programming, decomposition methods, dynamic programming, and stochastic programming techniques to solve for time paths according to one or more objectives. Simulation refers to system dynamics, scenario analysis, sensitivity analysis, and probabilistic risk analysis which focus upon various market and operational settings. Decision analysis uses decision trees and other decision theoretic techniques to explicitly incorporate uncertainty into various decisions. Assuming that JPS has responsibility for optimizing operations of assets, DNV GL focuses only simulation requirements, since these are relevant to this review.

MSET requires the use of simulation tools to determine the financial, economic and operational impacts of various supply and demand technologies in Jamaica. The simulation tool requires a set of generation units or demand side resources with constraints, areas with requirements and constraints, and a detailed nodal transmission model. Specific requirements include the ability to model maintenance and forced outages and forecast errors. Study horizons of interest are annual to twenty years.

The key attribute for IRP efforts is to combine efficient production cost modeling including unit commitment capabilities with a transmission and distribution constrained economic dispatch engine using linear programming solution techniques. The software should be capable of at least one-year simulation of Jamaica with half hourly resolution, minimally producing as outputs such as costs, generation dispatch outputs, and flows on transmission lines. IRP simulation software requires support from a market simulation software vendor.

An integrated software tool for all planning time horizons, including long-term portfolio assessment includes the following capabilities:

- Residual net short/long assessment.
- Resource valuation.
- Portfolio valuation.
- Risk assessment.

The software should be able to capture uncertainty in underlying inputs as well as the produced results.

MSET has two modules which provide both capacity expansion and production costing capabilities. Message evaluates different scenarios and WASP provides detailed production costing estimates based upon load duration curves.

4.3.7.2 Tools and Third Party Services Used in IRP Analysis

The list of vendor support offerings used in IRP is large. The most common that DNV GL reviews on behalf of clients include:

- ABB Strategist/PROMOD/Gridview
- Argonne Labs APEX
- General Electric MAPS and suite of tools
- Energy Exemplar PLEXOS
- EPIS Aurora
- Spreadsheet tools

4.3.7.3 Recommendations

Given these criteria, the two most frequent choices include the ABB suite and Energy Exemplar's PLEXOS. There are advantages and disadvantages of both. WASP provides capacity planning capabilities which can be utilized, but there are no interfaces between WASP and other solutions. DNV GL recommends having a consultant set up a simulation model for Jamaica within PLEXOS and leverage that tool in IRP work.

Integrated Resource Plans involve a series of resource scenarios which are simulated and compared against multiple objectives. Two common objectives could be to minimize production cost subject to various resource adequacy and reliability constraints.

There are usually three steps used:

- Long-term capacity planning;
- Mid-term maintenance and outage management (resource adequacy measured in reserve margins); and
- Short term economic dispatch with security constraints to ensure against valid contingencies.

While DNV GL has used many solutions which captures one or two of these steps, PLEXOS is a convenient tool which conducts all three steps during one simulation. We have found it to be efficient and cost effective in our projects, capturing new resource technologies such as Demand Side Management programs which may shift hourly load resources.

4.4 JPS & OUR Software and Third Party Resources

The following IT and Software requirements are owned by other agencies. Inputs from these systems are utilized in the IRP systems. MSET must develop capabilities and skills in how these tools operate in the IRP.

- (JPS) Sales Forecasting and Revenue Management Tools.
- (JPS) Half hourly load shape tools.
- (JPS) Distribution Feeder Outage Management System.
- (OUR) Rates Model to incorporate alternative technologies and Demand Side Management Programs.
- (JPS) Distributed Planning Study Tools.
- (JPS) Transmission Planning Software.
- (JPS) Asset Management Software (maintenance and status).

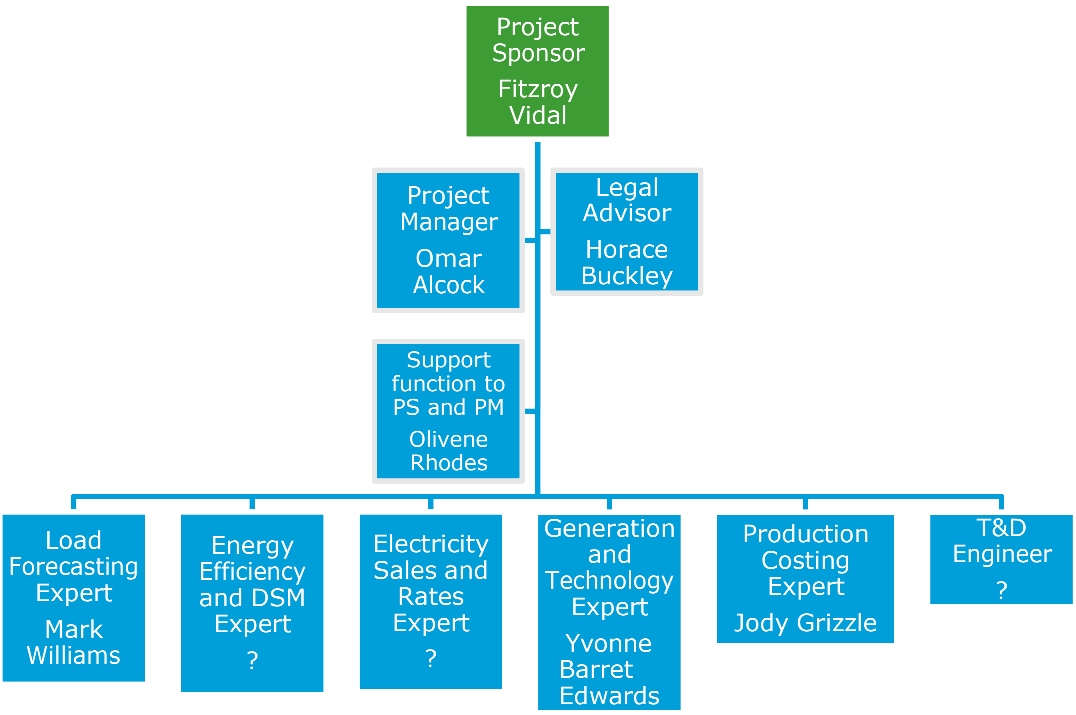
5 GAPS IDENTIFIED

5.1 Human Resources

In terms of human resources, the most relevant issue is the lack of specific expertise in the areas that are purely technical. Although the MSET team is quite experienced in project management, there is a lack of expertise required to build a planning unit such as that described above. DNV GL's philosophy regarding training is based on a 70:20:10 philosophy, i.e., 70% is learnt on the job on a day-by-day basis; 20% is learnt by mentoring and coaching actions which should be continuously developed by the managers of the unit; and, lastly, 10% is learnt through specific courses that are delivered internally or externally. Combining the proposed structure with the MSET team results in the flowchart depicted below.

In this case, specific training is needed in the areas of expertise, and although these roles can be assigned to different individuals within the team, specific training actions should be conducted, as described in the paragraphs below.

Figure 5-1 Draft team for IRP and planning unit



There are a few roles that could not be covered with the profiles provided by MSET such as EE and DSM expert, electricity sales and rates, and T&D Engineer. Reinforcements in these areas should be considered.

Regarding the specific issues that have been covered in this report, specific training plans should be designed to fill the technical gaps in all of these areas. Coaching and mentoring should be developed in the short term by PS and PM in order to train staff in these capacities.

As a major learning scheme, the 70:20:10 philosophy could be applied. These rates are considered to be the learning rates at work situations. 70% of the learning should take place on the job, 20% is learned through mentoring and coaching activities, and 10% is learned through specific classroom activities. The mentoring and coaching role of the most experienced members of the team should be delivered through vis-à-vis to the rest of the unit. In light of his background, it is recommended that the senior roles supervise the coaching and training plan of the unit so that the entire team can benefit from his experience. This activity only takes some time from the senior team, but should be delivered timely when needed.

The role of Legal Advisor has been assigned to Mr Buckley due to his vast experience in PM. It is assumed that a specific legal advisor, whether from the Ministry or an external service, will be supporting him.

5.2 Training program options

Training options should be considered mainly in two areas:

- In-house training. Once the ICT structure is in place, spend time with the users, and complementing their knowledge in the areas where they should have this expertise according to their roles. In house training allows a close contact between trainees and trainers so an enriching exchange of experiences and market situation is fostered.
- On Line training. Once the personal contact has taken place, the second half of the training could be delivered via webinar or on-line presentations. These presentations could complete the vis-a-vis sessions in specific aspects of the training.

The timing for this is considered to be 6-months.

5.3 Software and ICT Resources

To summarize recommendations, DNV GL proposes the following additional software or ICT resources:

- Load and energy forecasts based upon spreadsheet models and benchmark MAED modules.
- Energy efficiency and Demand Response programs interfaced with load and energy forecasts, preferable in a spreadsheet model.
- Economic and energy fuel prices from publicly available forecast with Jamaica specific delivery costs. Existing and publicly accepted high, medium and low scenarios are required.
- Project tracking software such as Microsoft Project.
- Start initially with SharePoint, but collect requirements for a larger database from common platforms such as MySQL, PostgreSQL, Microsoft SQL Server, Oracle, Sybase and IBM DB2 as IRP and data needs grow.
- Utilize site specific feasibility studies whenever possible. Existing tools provide a sanity check for these estimates.
- Utilize common capacity planning/production cost software platforms such as EPIS PLEXOS and continue to use WASP to calibrate results.

6 SCOPE OF WORK FOR IRP CAPACITY BUILDING IN JAMAICA

DNV GL provides this work scope as part of our IRP capacity building tasks with Jamaica's MSET. The activities described include:

- Training (with specific modules hosted by other DNV GL experts on-line), described in Section 6.1.
- Document current state and proposed future state of IRP coordination with JPS and OUR. This description includes processes, roles and responsibilities and identified systems described in Section 6.1.1.
- Systems integration with new tools and interfaces with legacy systems is described in Section 6.1.2.
- High level budget estimation is described in Section 6.1.3.

6.1 Training scope and budget

Week 1: Mobilization Meeting, initial project planning training and stakeholder outreach training:

- During the mobilization, capacity building for project planning for Integrated Resource Planning. This is a series of meetings to review the project steps involved, coordinate resources, project duration, time steps and deliverables. Portions of this training could be conducted on line after initial meetings. ***Deliverable: project schedule in MS Project for the IRP meeting.***

Week 2: Stakeholder Outreach, databases and Communication Plan.

- Stakeholder outreach and facilitation. Stakeholder outreach is one of the most critical components in IRP efforts. This is a training program to ensure that third party stakeholders concerns are met. This includes meeting facilitation; database requirements; responses to intervener questions; notices for public comment and third party vendor or Independent Power Producer management. ***Deliverable: Communication and Stakeholder Outreach Program.***

Week 3 and 4: Load and Energy Forecasting models, approaches and systems.

- Load and energy forecasting techniques. Update awareness of current fundamental (economic driven forecasts, emphasizing income and price elasticity components) and technical techniques (such as artificial intelligence and neural networks) for half hourly forecasts and simulations. Training should include net load at the meter (distributed meter data management), ability to model and induce demand side management programs as part of forecasts/simulations. ***Deliverable: system and data requirements associated with Load and energy forecasting.***

Week 5 and 6: Energy Efficiency programs, approaches and systems.

- Energy efficiency and Demand Side Management program modelling describes various programs available, methodologies in capturing benefits and modelling those programs to compare against supply side resources. ***Deliverable: programs for IRP; discussions with Stakeholders.***

Week 7 and 8: Rates models for IRP

- Rates and fuel adjustment mechanisms provides an overview of the components of rate calculations, billing determinants, financing, credit and cost of capital used in calculating rates. Of importance are independent power production rates, distribution feed-in tariffs, net metering and other related issues of importance to the IRP effort. ***Deliverable: models and inputs for IRP to discuss with stakeholders.***

Weeks 9, 10 and 11: Supply side feasibility study and generation planning

- Supply side generation asset feasibility study review, components to model and drivers for both utility and independent power producer drivers. This training should include Power Production Agreements, credit and cash flow drivers, outages and reserves, and interconnection standards for siting generation across merchant and reliability reasons. The training is usually offered by generation configuration and prime mover (fuel) for central station. Normally this includes both renewable and fossil generation types. ***Deliverable: fuels assumptions as inputs to IRP.***
- Generation Planning involves modelling interconnections, outages, start-up, operations and maintenance, emissions and efficiencies for IRP planning. ***Deliverable: IRP central station supply options.***
- Fossil fuel market training, contracting for alternative fuels (including renewables); forecasting and fuels management; and contracting for alternative fuels. Included are fossil fuels from the refinery (Liquid Petroleum Gases, Gasoline, Diesel/gasoil, and residual fuel) as well as biomass. Topics should include specifications for common combustion turbines and reciprocating engines with considerations for combined cycles. ***Deliverable: Modelling fuel assumptions in the IRP.***

Weeks 11 and 12 Distributed Generation and Reliability Modelling in IRP:

- Distributed generation options and distribution outage management training alternatives are focused upon resource at the distribution voltage level. The training by technology type should include Micro-grid operations, Combined Heat and Power, small renewables, electric energy storage and small engine generators. The reliability modelling uses baseline outage statistics of existing systems and will consider operations of distributed resources to provide customer reliability under grid outage events. Portions of this training may be conducted on line. ***Deliverable: Modelling distributed supply resources in the IRP.***

Week 13 and 14:

- Transmission and Distribution planning incorporates power delivery concepts at a high level, components of the system, definitions of reliability and economics and planning estimates. Service and standards for interconnection are part of this training. The training includes elements of transmission and distribution software offerings and vendors. Parts of this course can be conducted on-line. ***Deliverable: Transmission and Distribution planning in the IRP.***

Week 15, 16 and 17: Dispatch, Production Costing procedures and Systems

- Production costing, dispatch, unit commitment and simulation techniques used in IRP efforts reviews current methodologies, contrasts of approach and vendor supported demonstration of up to two tools. Parts of this course can be conducted on-line. ***Deliverable: Specifications and requirements for capacity planning and production costing in IRP.***

Week 18: Policy implications and next steps

- Policy implications regarding IRP conclusions. As the IRP develops and certain scenarios are defined, tax, user charges, rebates, low income assistance and various policy implications should be promulgated. ***Deliverable: Anticipated policy parameters and trade-offs to measure in the IRP.***

6.1.1 Coordination of IRP processes

While on site, DNV GL will begin facilitation of current state process at MSET and identify appropriate JPS and OUR interfaces. Throughout the training sessions, meetings with representatives at JPS and OUR will be held to discuss organization, roles and responsibilities and systems. The outcome of these coordination efforts are shared roles and responsibilities and system associated with IRP efforts.

6.1.2 Coordination of IRP Systems

Throughout the capacity building updates and training, DNV GL will work with JPS, OUR and MSET on system requirements, interfaces with existing systems and new tools/systems required. The end result is documentation for IRP efforts to leverage currently and in future work.

6.1.3 High level financial estimation

DNV GL has done a high level financial estimation based on the described scope. This estimation is around 550,000 USD. Final adjustments should be done to this figure based on the final scope of work and travel costs.

6.2 Software scope and budget

DNV GL has done a high level financial estimation based on the described requirements in Section 4.3. The following software should be considered for MSET to conduct IRP analysis:

- Load forecasting: custom model in spreadsheet $40k and one time interfaces to MAED Jamaica load forecasting (pull only).
- Database for supply side options, SQL server.
- Project Management Software: 4 licenses for MS Project.
- Capacity Expansion/Production Costing: Energy Exemplar/PLEXOS $155k/year. Interfaces to WASP.

The following are proprietary tools used in consulting engagements. I'm not aware of other companies that offer these tools for commercial license:

- Energy Efficiency/Demand Side Management: DSMAssyst proprietary software not available for commercial license.
- Distribution reliability analysis tool to compare distributed generation to station power plant expansion: Proprietary DNV GL software not available for commercial license.
- Supply side evaluations: These are usually custom spreadsheets based upon existing data supplied by vendors and RETSCREEN (already in house at MSET).

Other existing software tools used in IRP engagements that are usually specific to JPS:

- Distribution planning software (either PSS/E or Synergi). Synergi license at JPS is probably easiest to renew.
- JPS half hourly load analysis spreadsheets from EMS/SCADA data.
- JPS Feeder distribution outage management system.
- JPS Asset Maintenance programs.

For OUR, software includes rate base models.

6.2.1 Bottom line

It is considered that MSET will need to spend $400k during the first year and $200k for renewals.

Third party consulting as part of IRP arrangement is about $110k as part of IRP project.

A. Appendix A: PLEXOS descriptions and references

In two companion documents to this description, Energy Exemplar has provided descriptions of PLEXOS software and applications. (See EnergyExemplar_Applications_Web.pdf and EnergyExemplar_ProductsAndServices_16Page_Web_Letter.pdf).

In addition, MSET requested two references for companies using PLEXOS for Integrated Resource Planning efforts:

Rachell S. Roullet
Director, Innovation and Resource Planning
FortisTCI Limited
P.O. Box 132
1030 Leeward Highway
Providenciales
TKCA 1ZZ Turks and Caicos Islands
Tel: 649-946-4313 Ext: 2566
Direct: 649-941-2340
Mobile: 649-331-2801
RRoullet@fortistci.com

Barbados Integrated Resource Planning

Reference: Steven Broad
Business Development Manager, North America
3013 Douglas Blvd, Suite 120
Roseville, CA 95661
916 462 8658
steven.broad@energyexemplar.com

REFERENCES

/1/ Profile List from MSET personnel sent on 19th February 2016 by Olivene Rhodes

/2/ Energy Modeling Experiences - Feb 2016 update sent on 22nd February 2016

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener