Options for Fossil Fuel Systems

The purpose of this presentation is to look at, as titled " Options for Fossil Fuel System". As we are all aware, the bulk of our electrical energy comes from fossil fuel sources. It is therefore, think that one of the best way of looking at this is to look at the impact that existing and future fossil fuel power generating plants are having , on the delivery of electricity to consumers.

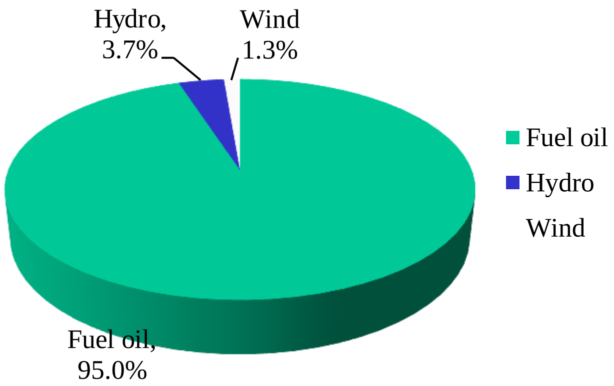
To best illustrate this, we will be looking at:

- System demand profile
- Generation systems
- Transmission and
- Distribution systems

In light of the above, we will take the opportunity to look at the proposed LNG fired 360 MW in 2014 and 120 by 2016 and their impact

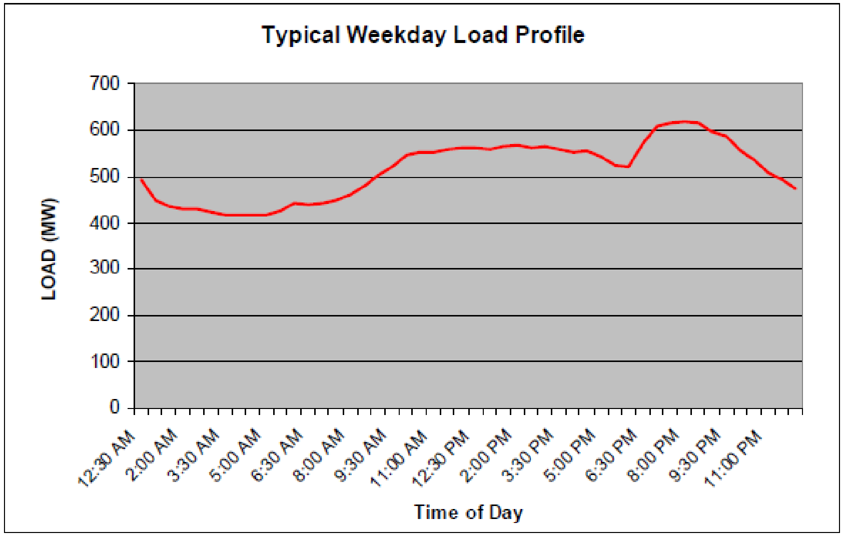
Electricity Production by Fuel Type

- At present, about 95% of our electricity comes from fossil fuel sources:
  - Bunker C, Heavy Fuel Oil (HFO, No. 2)
  - Automotive Diesel Oil (ADO, No. 2)
  - The remainder is provided by small hydro power plants and the Wigton Wind Farm (3 MW Munro wind farm was recently commissioned)

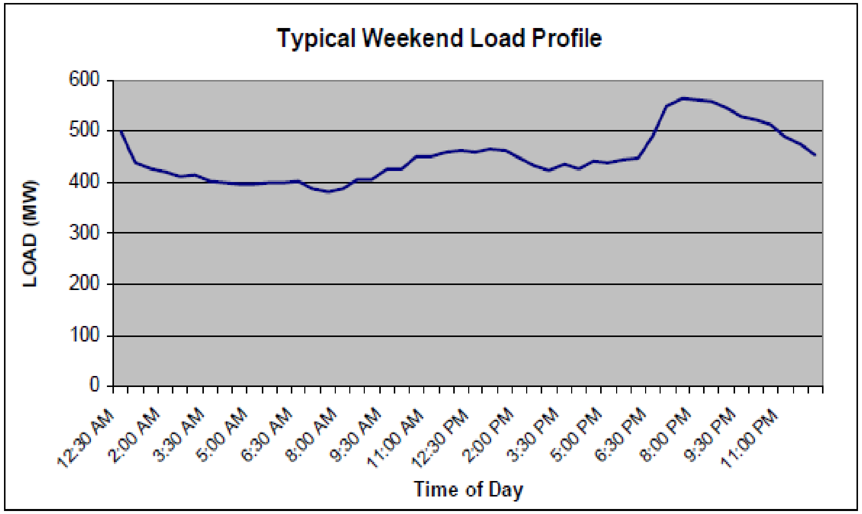


System Demand Profile and Generation Mix

Typical Weekday Load



Typical Weekend Load



Demand and Generation cont'd

- The slide below shows a typical weekday and weekend demand profile for the system
- Considering a 620 MW for a typical weekday:
- Just about 400MW of continuous demand, is provided by what we call baseload capacity, and the contributions are as follows:
  - Hydro power plant – 23 MW
  - Steam turbine – 292 MW
  - Jamaica Private Power Company (JPPC) – 60 MW
  - Jamalco – 11 MW
  - The remainder, being provided by the Jamaica Energy Partner (JEP) Bogue combine cycle plant (BCC) – 14 MW
- The other 220 MW will a mix between JEP, BCC and if required will be provided by gas turbines

Demand and Generation cont'd

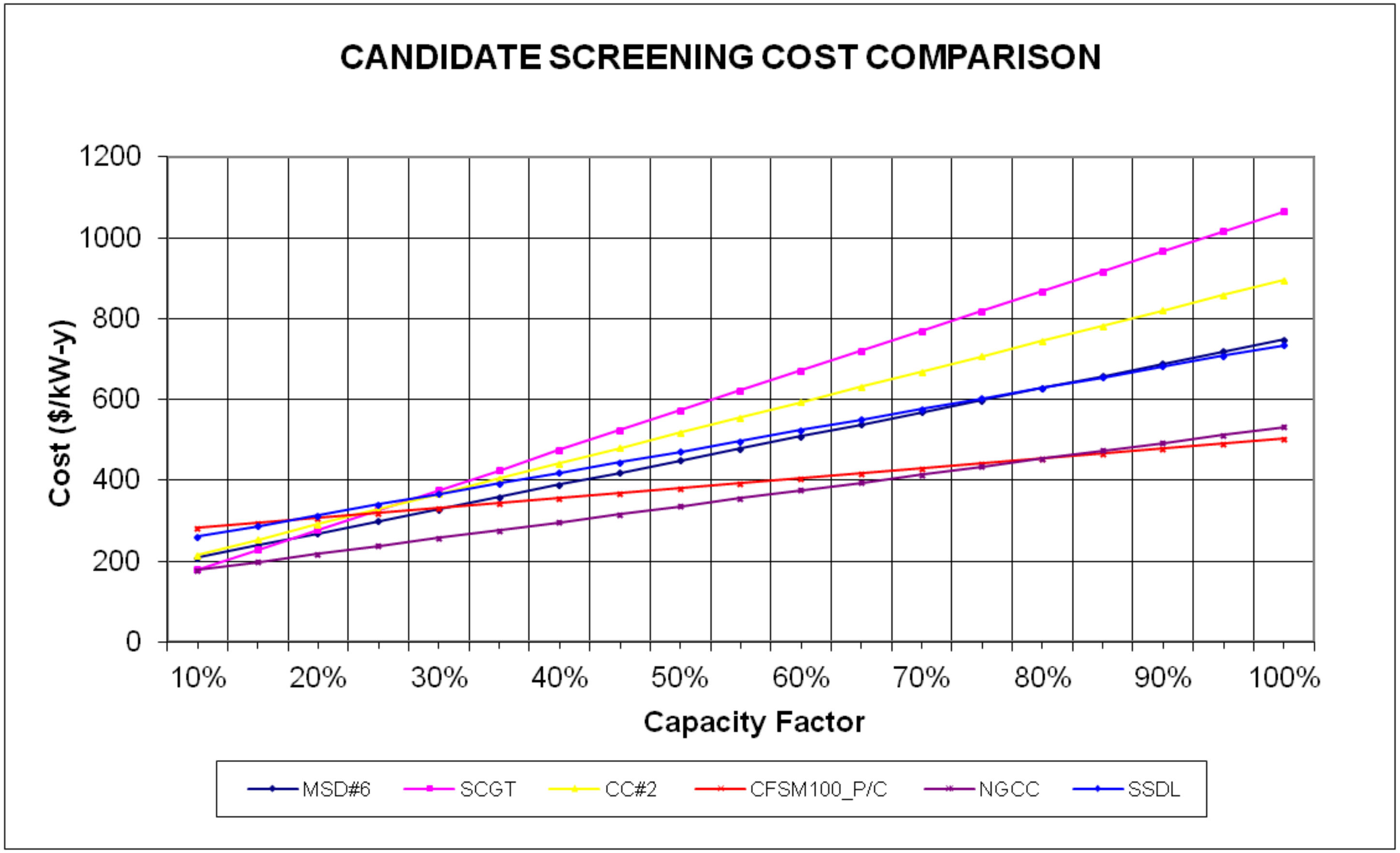
- **Baseload plant** – always online and are only taken off for either planned or forced maintenance. Future candidate plants are steam turbines provided by HFO, coal petcoke and NGCC. At present SSD and MSD provide this function
- **Intermediate plant –** adjust their outputs according to the tem demand (load following), and are able to be taken offline or bring online accordingly, BCC, MSD
- **Peaking –** quick start gas turbines that are brought online for short time, usually to meet the peak demand

Demand and Generation cont'd
Screening Curve

- The diagram below gives the screen curve for the appropriate usage of various generation technologies, based on their capacity factors
- Capacity Factor – Is a percentage ratio of energy output of a power plant over a given period, to it potential output over the same time period
- Designation for plants in the screening curve are:
  - MSD#6 – Medium Speed Diesel, using No. 6 fuel
  - SCGT - Single Cycle Gas Turbine
  - CC#2 - Combine Cycle plant, using No. 2 fuel
  - CFSM100_P/C – Coal Fired Steam, Pulverized Coal
  - NGCC – Natural Gas Combine Cycle plant and
  - SSDL – Slow Speed Diesel, using No. 6 fuel

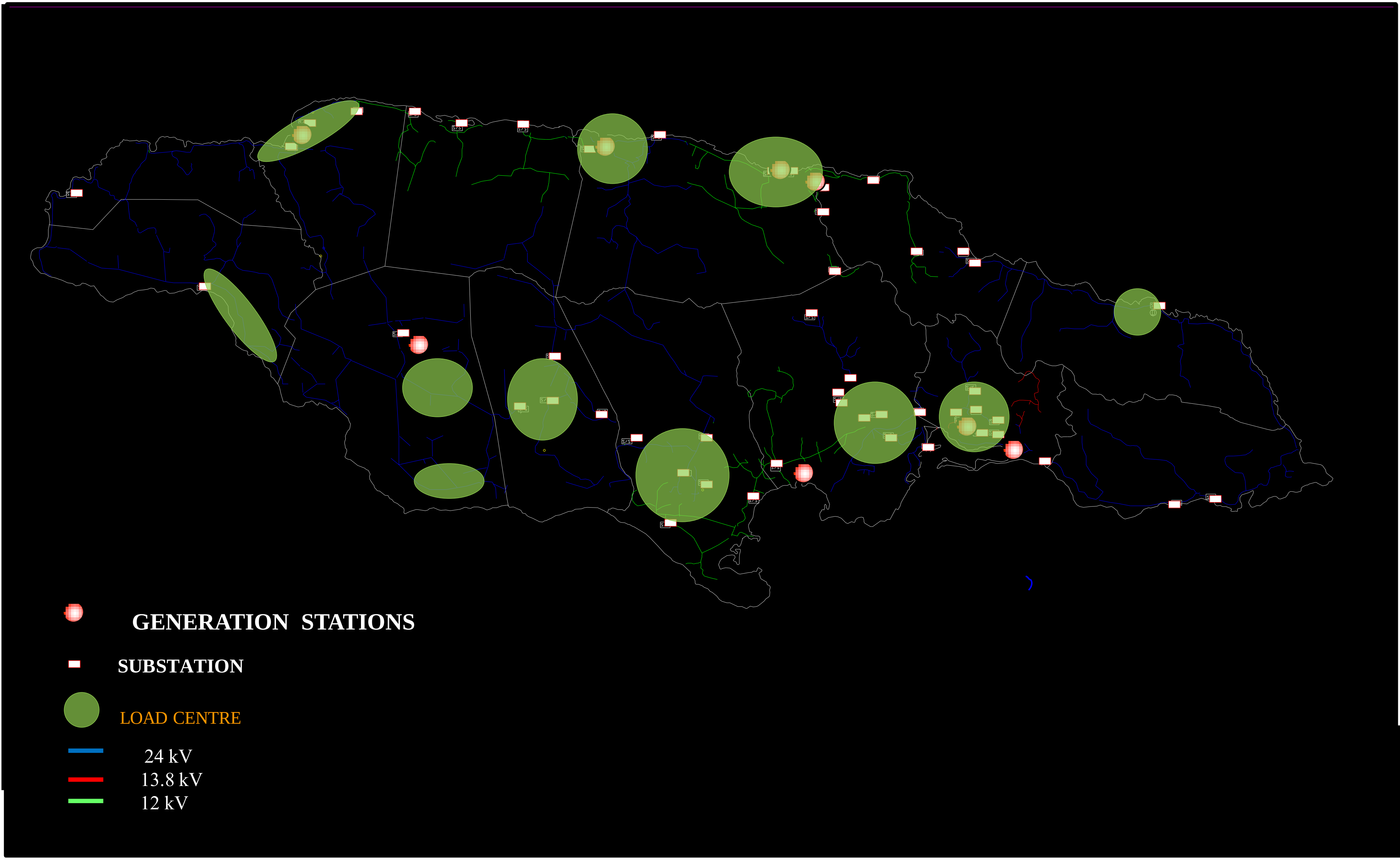
Demand and Generation cont'd

Typical Screening Curve



JPS Distribution System

- The diagram below gives an outline of the JPS:
  - Primary distribution systems
    - 24 kV
    - 13.8 kV
    - 12 kV
  - Power generating stations (conventional and small hydros)
  - Substations
  - Load centres


GENERATION STATIONS
SUBSTATION
LOAD CENTRE
24 kV
13.8 kV
12 kV

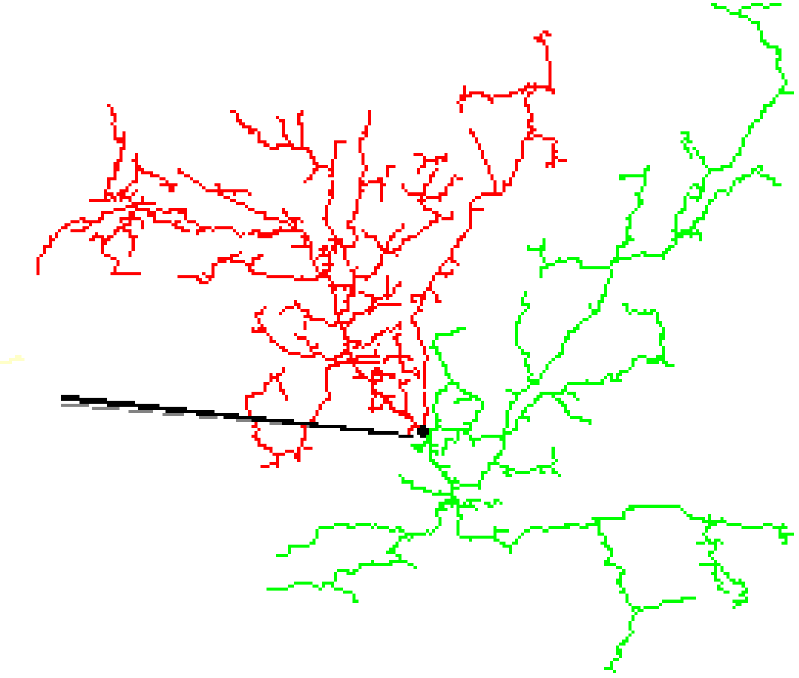
Distribution System Planning and Operation

- This 620 MW demand for example, is a accumulation of substation loads, that are carried by primary distribution circuits, closer to the point of demand:
- The distribution system can be categorized as primary
  - 13.8 and 24 kV in the Corporate Area (CA) and
  - 12 kV for rural communities/area

- Secondary - that which comes into the homes
  - 110 V and
  - 220 V

Distribution System Planning and Operation

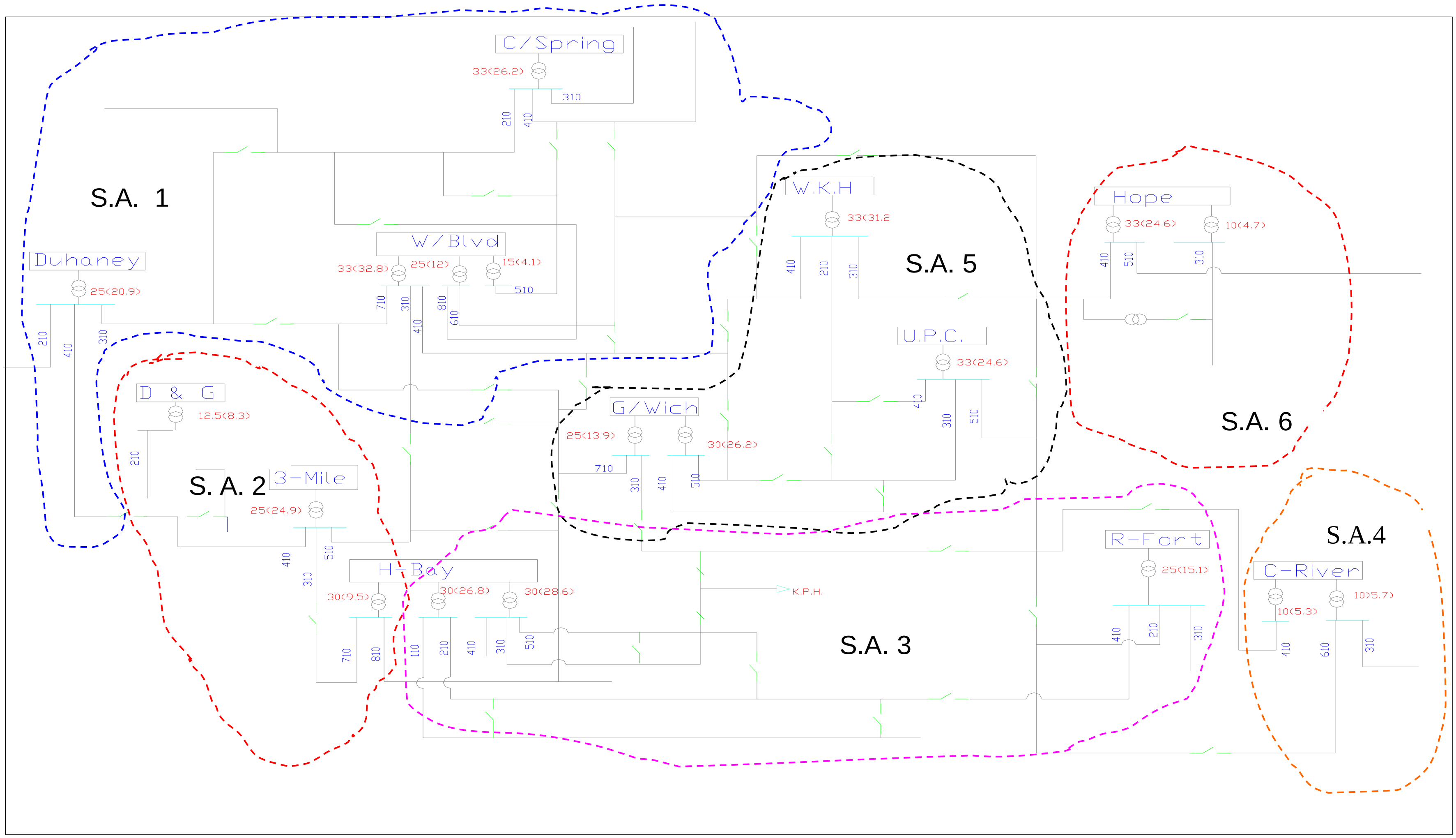
- Feeders are radial - supply comes from one point
- Feeder analysis can be done by considering individual feeder, or a group of them that are in close proximity
- On the JPS distribution system, only two source of Distributed Generation exist (DG)
  - ➢ A 700 KW hydro power plant is on the Constant Spring feeder
  - ➢ A 3 MW wind turbine on the Maggotty feeder at Munro
- DG are power generating plants that are connected to the distribution system



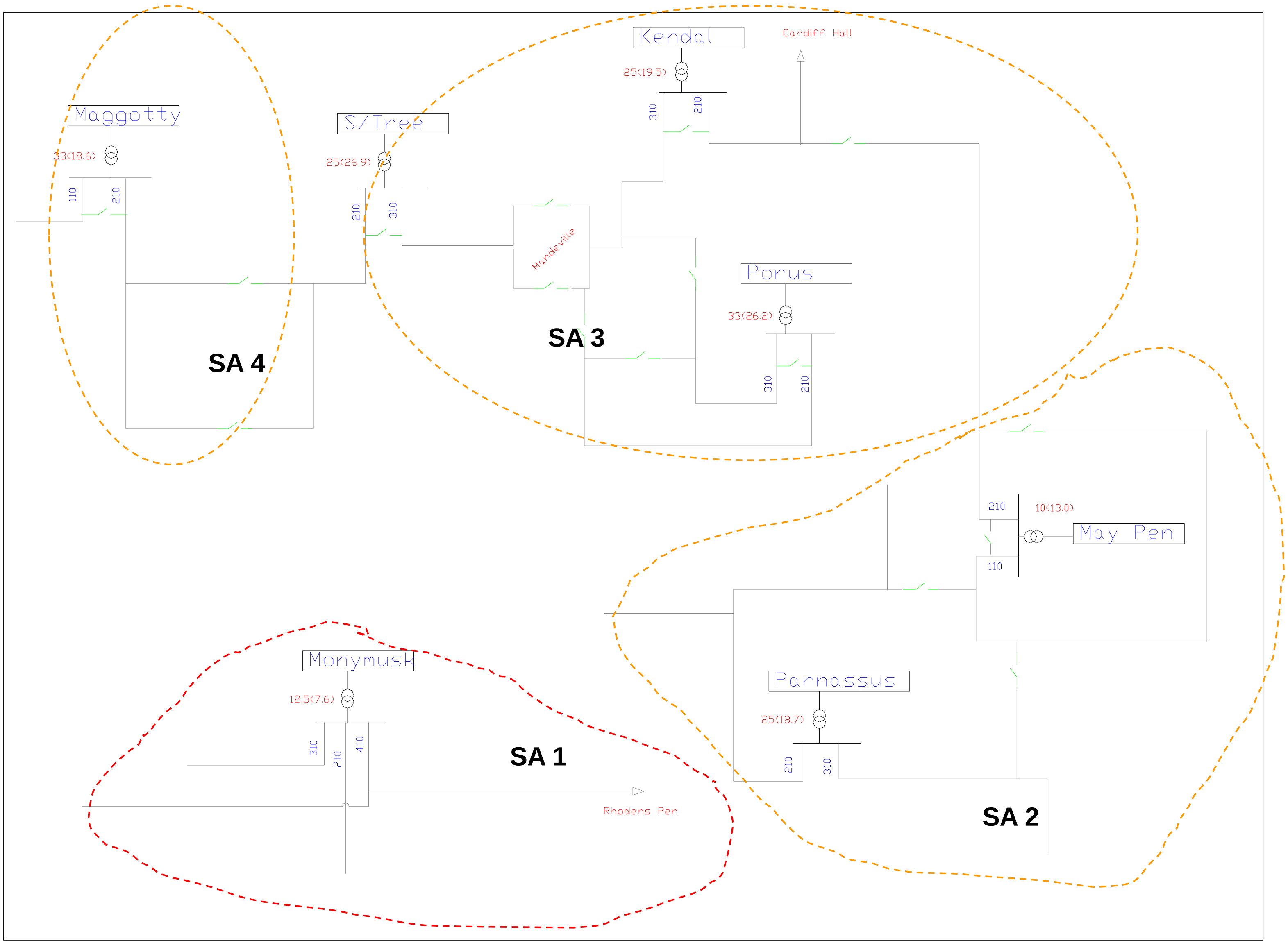
Distribution System Planning and Analysis

- In order to improve reliability. Utilities does including JPS, adopt what is known as the Service Area Concept (SAC).
- The idea behind which is to maintain, 100% supply in the shortest possible time following the loss of a major equipment. As such a minimum of two substations are required in the service area.
- Within the CA, bordering Cane River, Papine, Constant Spring Duhaney. SAC con be realize, though will take some time.
- Outside of CA, with the exception of business districts of Spanish Town, Ocho Rios, Montego Bay

Corporate Area Service Area System



Southwest Jamaica Swervice Area System



Solving Rural Area Distribution System Problem

- Conventional generation and conventional means of supply, over time will not be able to adequately meet the needs of remote rural communities
- Additional means such as DG will be required, be it renewable or otherwise. However, such requirements will have to have firm capacity

Service Area Comparison

Corporate Area

- Feeders are usually short
- Multiple load points for load transfer exist
- 100% load transfer possible
- No significant voltage drop issue

Southwest

- Usually very long
- Limited amount of points for load transfer
- Not able to transfer 100% of the load. In some situation, no point exist for load transfer
- Voltage drops becomes an issue
- Technical loss issue will arise in some cases

Transmission System

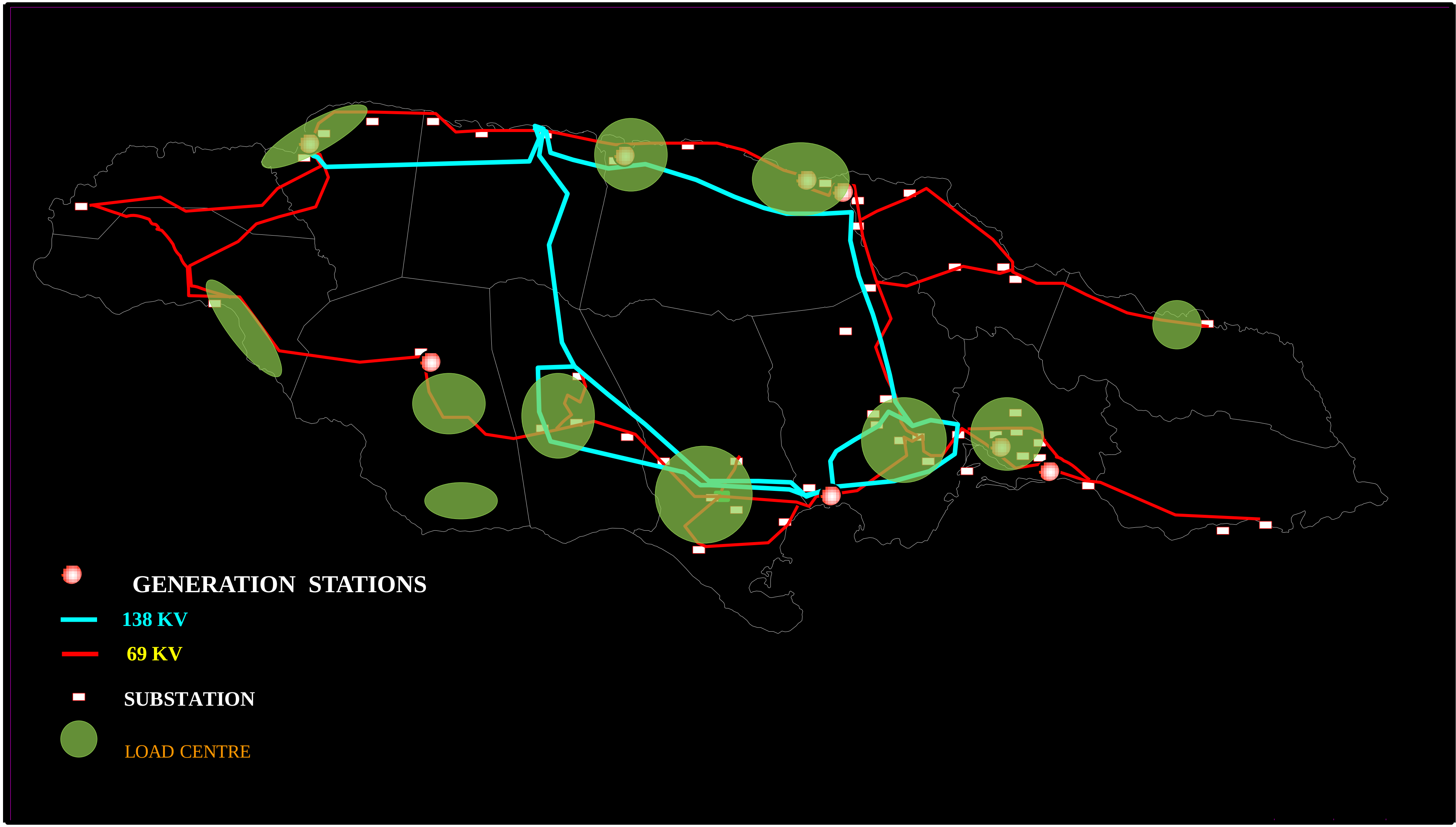
- This is the corridor by which bulk electric power is taken from conventional generation sourcse, to the point of distribution
- It is closely coupled to the generation system and vise veras
- The transmission systems or the power grid in general is a relative loop/mesh system, with few radial circuits. A simple way to put it is that it is like a rectangular box with all sources of generation and demand connected to it.
- JPS grid voltages are
  - 69 kV and
  - 138 kV

  With the 138 kV circuit forming the backbone of the system

In the past the term power grid was used with reference to the transmission network. But with generation being added to the distribution network, this could also include the distribution network

JPS Transmission System

- The diagram below gives an outline of the JPS:
  - Load centre
  - Substations
  - 69 kV transmission lines
  - 138 kV transmission lines
  - Power generating stations (conventional and small hydros)


GENERATION STATIONS
138 KV
69 KV
SUBSTATION
LOAD CENTRE

Economic Disptaching of Generating Units

- One rule of thumb in dispatching generating units, is to disptach the most economical unit first, followed the next unit in the ranking or merit order
- The table below give the merit order of units for 2007 and 2012
- With the addition of new of the 360 MW of proposed LNG fired combined cycle plant in 2014 and another 120 MW in 2016 as new generation comes online, the older plants will be pushed further down the order. This will have implications for the transmission network.
- Lets consider the options here:
  - 360 MW at Old Harbour in 2014 and 120 MW in 2016
  - 360 MW at Old Harbour in 2014 and 120 MW at Bogue in 2016

Merit Order of Generating Plants

Year: 2007		Year: 2010	
Unit	Cost ($/MWH)	Unit	Cost ($/MWH)
RF1	75.62	Jamalco	118.82
RF2	75.62	RF1	162.32
JPPC	89.18	JPPC	162.67
OH4	91.65	RF2	165.04
OH3	92.04	JEP	171.84
HBB6	93.24	HBB6	222.69
Jamalco	96.46	BCC	227.65
JEP	101.26	OH3	236.02
OH2	104.99	OH2	240.57
BCC	110.24	OH4	241.99
OH1	115.12	OH1	N/A

Capacity Factor for Bogue Combine Cycle (BCC)

Capacity Factor

Years	Capacity Factor (%)
2007	36.69
2008	47.41
2009	56.77
2010	64.37
2011	71.36
2012	**2.59**
2013	**4.51**
2014	**1.01**
2015	**2.76**
2016	**0.67**

- The table give a projection of the Capacitor Factor (CF) of the unit. Running on ADO
- Note that, after new generations additions proposed for 2012, the CF decreases significantly
- Similar situation will exist with the commissioning of new plants in 2014 and 2016. From 2014 the CF of BCC will be low – for most of the time, the plant will be off-line
- This significantly impact the system in a number ways

Options for Generation Expansion

- Option 1 – 360 MW at Old Harbour and 120 MW at Bogue
- Option 2 – 480 MW Old Harbour
- Comparing both options and the benefits that are derived from having generation at Bogue, option 2 will provide the following disadvantages to the transmission grid:
  - Transmission losses will approximately increase about 2% of total generation
  - Ability to manage system voltages under normal system condition, will become difficult

Options for Generation Expansion Cont'd

- Loss of either
  - The Tredegar to Bellevue 138 kV line – line running from Tredegar in St. Catherine to Bellevue in St. Anns
  - The Kendal to Duncan 138 kV line – line running from Kendal in Manchester to Duncans in Trelawny
  - Interbus transformers at Bellevue or Duncans substatioins

  Will result in voltage collapse along the north coast. From Portland to Hanover, going into Westmoreland. If corrective actions are not taken, the entire JPS power system can collapse

- The addition of 360 MW in 2014 and another 120 MW by 2016 will have serious implications for taking power into the Corporate Area (CA)
- Over 60% of the system demand is consumed in this area

Options for Generation Expansion Cont'd

- Only two bulk power 138 kV transmission lines takes power into the area
  - Old Harbour to Duhaney 138 kV line and
  - Old Harbour to Tredagar 138 kV line
- Loss of either lines will likely overload the other line. resulting in a system separation – creating two electrical island. One CA and the other the remainder of the island. CA will collapse, because of insufficient generation
- In order to meet the new generation expansions additional transmission infrastructure may have to be put in place, to ensure system security, among others.
- A inadequately planned transmission system can sirgnificantly impact cost. Outages of
  - Generating plant
  - Transmission lines or
  - A combination of both

  Can cause operational planners to sub – optimal dispatch out of merit – dispatching more expensive units though

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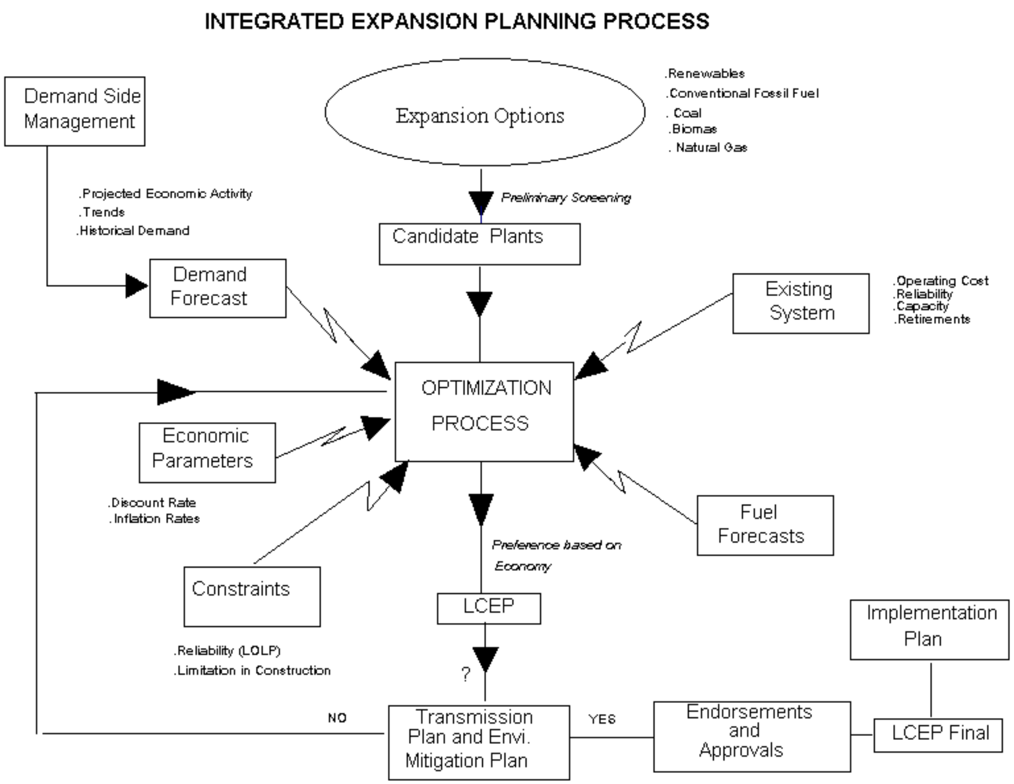
Optimally Planned System Expansion Process

- An optimally planned system expansion Planning process, would be in iterative process, taking into consideration:
  - Demand Side Management – Energy conservation and energy auditing
  - Generation planning – giving considerations where distributed generation may be required
  - Transmission system planning

Optimally Planned System Expansion Process



Conclusion

- Central/conventional generation as it is will not be able to provide overall solutions to the distribution network problem overtime with regards to:
  - Power quality
  - Technical losses
  - Load transfers

Unless significant, but uneconomical investments are made in the transmission infrastructure, with regards to the building of more transmission lines and substations

- DGs with firm capacity (renewable or otherwise), can provide solutions in some of these cases
- In this regard, the avoided cost of energy should challenge in pricing the cost of these generation. Provided DGs are meeting the planning criteria that convention plants are failing to meet, with regards to the network

Conclusion cont'd

- Bulk power generation – conventional or otherwise, will continue to be an efficient means of supplying providing power to major load centre such as CA
- LNG will have to provided to BCC in order of it to be competitive against the new NGCC plant, during dispatching. Otherwise the plant will have to be dispatched out of merit, at a cost to consumers
- The means by which LNG will reach BCC will be a matter of concern, and information need to be provided as to how BCC will be supplied either by:
  - ➢ Building pipelines, from Old Harbour to Bogue – this can be a costly exercise, in addition to the delay in accessing easement and environmental implication
  - ➢ Building a LNG terminal in Montego Bay

Conclusion cont'd

- The Optimal Expansion Planning Process, though included in the OUR reports and other previous JPS reports, were never adopted in developing the, generation expansion plans

- If this was done, then the reports would have included components for:
  - Demand Side Management
  - Transmission system expansion

Thank You

THE END