Electricity
Wheeling/Transmission Pricing
Framework for Jamaica
Training Seminar
PPA Energy
3rd December 2012
## Schedule of Activities

<table>
<thead>
<tr>
<th>Jamaica Wheeling Charges including cost of service study</th>
<th>Week Commencing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22-Oct 1</td>
</tr>
<tr>
<td></td>
<td>29-Oct 2</td>
</tr>
<tr>
<td></td>
<td>05-Nov 3</td>
</tr>
<tr>
<td></td>
<td>12-Nov 4</td>
</tr>
<tr>
<td></td>
<td>19-Nov 5</td>
</tr>
<tr>
<td></td>
<td>26-Nov 6</td>
</tr>
<tr>
<td></td>
<td>03-Dec 7</td>
</tr>
<tr>
<td></td>
<td>10-Dec 8</td>
</tr>
<tr>
<td></td>
<td>17-Dec 9</td>
</tr>
<tr>
<td></td>
<td>24-Dec 10</td>
</tr>
<tr>
<td></td>
<td>31-Dec 11</td>
</tr>
<tr>
<td></td>
<td>07-Jan 12</td>
</tr>
<tr>
<td></td>
<td>14-Jan 13</td>
</tr>
</tbody>
</table>

1. Review of Regulatory documents and other data
   1.1 Review relevant documents
   1.2 JPS data review
   1.3 Obtaining and review of documents for cost of service study
   1.4 Inception report

2. Review of Wheeling Charge Methods and Recommendation
   2.1 Compare wheeling charge methodologies
   2.2 Examine cost implications of congestion
   2.3 Examine time of day implications
   2.4 Consider distribution wheeling charges
   2.5 Recommend a wheeling charge methodology

3. Methodological report
   3.1 Prepare methodological report

4. Training Session #1
   4.1 Prepare training session material
   4.2 Deliver training session on wheeling methodologies
   4.3 Approval from OUR on wheeling methodology
   4.4 Regulatory framework discussions
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>Registration</td>
</tr>
<tr>
<td>9:30</td>
<td>Introduction and Aims</td>
</tr>
<tr>
<td>9:45</td>
<td>Introduction to Transmission Prices / wheeling</td>
</tr>
<tr>
<td>10:00</td>
<td>Wheeling Charge Methodologies</td>
</tr>
<tr>
<td>11:00</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>11:30</td>
<td>Discussion: Issues specific to Jamaican system</td>
</tr>
<tr>
<td>12:30</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>14:00</td>
<td>Recommended approach for Jamaica</td>
</tr>
<tr>
<td>15:00</td>
<td>Tea Break</td>
</tr>
<tr>
<td>15:30</td>
<td>Workshop discussion/break out groups</td>
</tr>
<tr>
<td>16:30</td>
<td>Conclusion</td>
</tr>
<tr>
<td>17:00</td>
<td>End</td>
</tr>
</tbody>
</table>
Outline

• Objectives

• Transmission pricing – Principles

• Transmission pricing methodology – Types

• Review of international practices

• Key influencing factors for Jamaica

• Recommendations
Objectives

• Develop a fair and practical framework for the provision of wheeling services on Jamaica’s transmission and distribution network and

• Facilitate regulatory capacity building in relation to wheeling charge methodologies and the computation of transmission and distribution network fees.
The network context

Jamaica All Island Electricity Grid

Keys: LOAD CENTRES, GENERATION STATIONS

Lines: 138 KV, 69 KV, 24 KV, 12 KV, 13.8 KV
Transmission pricing – Principles

- Promote efficiency
- Recover costs
- Be transparent, fair and predictable
- Be non-discriminatory
Promotes efficiency

• Appropriate price signals to generation and demand

• Incentives for appropriate investment – locational signals

• Promotes competition
Recovers cost

- Security in cost recovery  ➔  Lowered cost of capital
- Incentives for appropriate investment
  – if recovery of cost for appropriate investments is assured
- Different methods available for cost computation
- Historic cost, Future cost (nodal pricing)
- Transmission prices can recover
  – capital costs,
  – O&M costs,
  – losses
  – congestion
Be transparent, fair and predictable

• Encourage new market participants

• Fair

• Stable- immune to ‘price shocks’

• Clear and straightforward to apply
Be non-discriminatory

• Treat the network users equally in non discriminating nature.

• Residual costs are allocated in a fair manner
  – Key issue: balance between user-specific and “socialised” costs
Transmission pricing methodology - Types

- Historic cost
  - Postage Stamp
  - Contract paths
  - MW-km (distance)
  - MW-km (load flow)

- Future cost
  - Short run (SRIC & SRMC)
  - Long run (LRIC & LRMC)

Nodal pricing
Historic costs - Postage stamp

**Method**
- Costs allocation based on the basis of their share of total peak load on the system

**Advantages**
- Full historic cost recovery
- Clear, simple, stable charges
- Suitable for non congestion systems, with generation and demand fairly equally spaced

**Disadvantages**
- Does not take into account of utilisation of system, lack of incentive for system users
- Discriminates low cost users in favour of high cost users
Example: Generation at Montego Bay, Demand at Kingston
Postage Stamp Pricing
Historic costs- Contract paths

- **Method**
  - Costs based on the specific path agreed for an individual wheeling transaction.

- **Advantages**
  - Full historic cost recovery encouraging efficient level of investment
  - Simple, stable charges
  - An improved ability to signals the costs of decisions of individuals

- **Disadvantages**
  - Does not take into account of utilisation of system, lack of incentive for system users
  - Potentially discriminates between users
  - Low economic efficiency as it may lead to investments out of contract path as well.
Contract paths
Contract paths
Contract paths
Historic costs- MW-km (distance based)

• **Method**
  • Distance travelled by the energy in a specific transaction (MW-km) in relation to the total MW-km in the system

• **Advantages**
  • An improved version of postage stamp and contract path approaches.

• **Disadvantages**
  • Does not take into account of system costs and actual operation in the system.
  • Does not provide accurate economic signals to users.
MW-km (distance based)
Historic costs- MW-km (load flow based)

• **Method**
  - Uses power flow model, hence reflects to a better extent, the actual use of the system.
  - Transmission prices reflect the proportion of system use.

• **Advantages**
  - An improved version of postage stamp and contract path approaches.
  - Simple, clear, stable charges
  - System congestion is starting to be taken into account

• **Disadvantages**
  - As power flows are less than circuit capacity fails to recover full capital costs.
  - Does not provide correct economic signals to users for future investments.
MW-km (flow-based)
### Forward looking – Short run pricing

<table>
<thead>
<tr>
<th><strong>SRIC (Short Run Incremental Cost)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>– Short run incremental operating cost</td>
</tr>
<tr>
<td>– Uses a model of optimal power flows</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SRMC (Short Run Marginal Cost)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>– The marginal cost of extra use of transmission system</td>
</tr>
<tr>
<td>– The marginal operating cost of an extra MW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Disadvantages of short run methods</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>– Difficult to estimate the operating cost of a single transaction while multiple transactions are occurring simultaneously</td>
</tr>
<tr>
<td>– Requires future forecasting, the accuracy of which can become increasingly accurate</td>
</tr>
<tr>
<td>– Data volatility in the short run can result in under investment</td>
</tr>
<tr>
<td>– Additional disadvantages of SRMC method</td>
</tr>
</tbody>
</table>
Forward Looking – Long run pricing

• LRIC and LRMC (Long Run Incremental Cost and Long Run Marginal Cost)
  – Both take into account of investment cost, in addition to incremental operating cost
  – Full long term costs including new investments
  – More stable prices compared to short run

• Disadvantages of long run methods
  – Difficult to estimate the operating cost of a single transaction while multiple transactions are occurring simultaneously
  – Double counting of investment requirements
Nodal pricing

• Method
  – Nodal charges vary at nodes depending on marginal cost of losses and congestion at that node

• Advantages
  – Economically ideal transmission prices
  – Ensures optimal dispatch thus maximizing allocative and dynamic efficiency

• Disadvantages
  – Possible under recovery of fixed costs due to marginal pricing
  – Requires constant real time information about loads, generators, bids and condition of the equipment.
  – Potential Instability and complexity in methodology implementation
Nodal pricing
Congestion management

Market Splitting to manage congestion constraint between areas A & B

ZONE A
Solve this market with interconnector at full *export*

ZONE B
Solve this market with interconnector at full *import*

Price A (low price)

Transfer Volume

Price B (high price)

Congestion Price = (Price B – Price A)

Congestion Rent = Congestion Price * Transfer Volume
Transmission pricing - International examples

- Nord Pool
- Ireland
- Southern African Power Pool (SAPP)
- Great Britain
- United states: PJM
- New Zealand
- Brazil
Nord pool transmission zones
International examples: **Nord Pool**

- Nord pool covers six countries in Europe: **Denmark, Finland, Sweden, Norway, Estonia and Lithuania.**
- Each country has its own TSO and often has more than one market areas.
- Nord pool spot market operates 14 market areas in six countries.
- Nord pool has Point or stamp tariff system
- Producers and consumers pay a fee for the kWh injected or drawn.
- Distance between the countries does not impact the prices.
- Each country has its own transmission tariff for within the country transactions. i.e in Norway, transmission charges include fixed, load and energy components.
- Each country has a different way of allocating charges between consumers and producers.
- Transmission losses (Elspot) – recovered by a standard trading fee Eur/MWh, paid by both buyers and sellers
Ireland-All Island transmission system
International examples: Ireland

- Eirgrid is the TSO for Republic of Island (RoI) and SONI is the System Operator for Northern Ireland (NI)

- SEMO (Single Electricity Market Operator) operates the centralised gross pool/wholesale market.

- Transmission costs allocated 25:75 between generation and demand

- All island generator transmission tariff recovers 30% from locational element and 70% from a postage stamp element.

- Losses allocated to generators and interconnectors by Transmission Loss Adjustment Factors (TLAF)
SAPP transmission system
International examples: SAPP

• SAPP includes utilities and ministries in energy use in 11 countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zaire, Zimbabwe and South Africa.

• In 2003, SAPP moved from postage stamp to MW-km (load flow) methodology.

• In 2005, Plans to move to Nodal pricing did not go ahead due to various factors.

• Sophisticated Day Ahead Market (DAM) facilitates trading across interconnectors in real time.

• SAPP region is split into market zones that can split as constraints become binding on the interconnectors.
International examples: Great Britain

• National Grid is the System Operator in Great Britain (England, Scotland and Wales)
• GB transmission system is divided into 14 demand zones and 20 generation zones
• Transmission charges based on nodal pricing that uses DCLF (Direct Current Load flow) ICRP (Investment cost Related Pricing)
• Charges reflect the incremental cost in addition to locational factor
• Transmission costs are allocated at 27:73 split between generation and demand
• Transmission losses recovered via energy market, through loss factor application
## Great Britain – Demand zones

<table>
<thead>
<tr>
<th>Demand Zone</th>
<th>Zone Area</th>
<th>Demand Tariff (£/kW)</th>
<th>Energy Consumption Tariff (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Northern Scotland</td>
<td>10.741418</td>
<td>1.481661</td>
</tr>
<tr>
<td>2</td>
<td>Southern Scotland</td>
<td>16.001744</td>
<td>2.260958</td>
</tr>
<tr>
<td>3</td>
<td>Northern</td>
<td>19.662769</td>
<td>2.720973</td>
</tr>
<tr>
<td>4</td>
<td>North West</td>
<td>22.838742</td>
<td>3.310579</td>
</tr>
<tr>
<td>5</td>
<td>Yorkshire</td>
<td>23.180244</td>
<td>3.216258</td>
</tr>
<tr>
<td>6</td>
<td>N Wales &amp; Mersey</td>
<td>23.639502</td>
<td>3.392395</td>
</tr>
<tr>
<td>7</td>
<td>East Midlands</td>
<td>25.451532</td>
<td>3.602558</td>
</tr>
<tr>
<td>8</td>
<td>Midlands</td>
<td>27.358246</td>
<td>3.936288</td>
</tr>
<tr>
<td>9</td>
<td>Eastern</td>
<td>25.952047</td>
<td>3.633328</td>
</tr>
<tr>
<td>10</td>
<td>South Wales</td>
<td>25.257265</td>
<td>3.368021</td>
</tr>
<tr>
<td>11</td>
<td>South East</td>
<td>28.248124</td>
<td>3.987297</td>
</tr>
<tr>
<td>12</td>
<td>London</td>
<td>31.174616</td>
<td>4.169758</td>
</tr>
<tr>
<td>13</td>
<td>Southern</td>
<td>30.613447</td>
<td>4.343659</td>
</tr>
<tr>
<td>14</td>
<td>South Western</td>
<td>31.062748</td>
<td>4.226735</td>
</tr>
</tbody>
</table>
## Great Britain - Generation zones

<table>
<thead>
<tr>
<th>Zone</th>
<th>Zone Name</th>
<th>Tariff (£/kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>North Scotland</td>
<td>21.958097</td>
</tr>
<tr>
<td>2</td>
<td>Peterhead</td>
<td>20.113140</td>
</tr>
<tr>
<td>3</td>
<td>Western Highland &amp; Skye</td>
<td>22.051017</td>
</tr>
<tr>
<td>4</td>
<td>Central Highlands</td>
<td>17.560345</td>
</tr>
<tr>
<td>5</td>
<td>Argyll</td>
<td>14.187889</td>
</tr>
<tr>
<td>6</td>
<td>Stirlingshire</td>
<td>14.227364</td>
</tr>
<tr>
<td>7</td>
<td>South Scotland</td>
<td>12.787463</td>
</tr>
<tr>
<td>8</td>
<td>Auchencrosh</td>
<td>10.504012</td>
</tr>
<tr>
<td>9</td>
<td>Humber &amp; Lancashire</td>
<td>6.078531</td>
</tr>
<tr>
<td>10</td>
<td>North East England</td>
<td>8.426476</td>
</tr>
<tr>
<td>11</td>
<td>Anglesey</td>
<td>7.099147</td>
</tr>
<tr>
<td>12</td>
<td>Dinorwig</td>
<td>6.355495</td>
</tr>
<tr>
<td>13</td>
<td>South Yorks &amp; North Wales</td>
<td>4.605096</td>
</tr>
<tr>
<td>14</td>
<td>Midlands</td>
<td>2.392870</td>
</tr>
<tr>
<td>15</td>
<td>South Wales &amp; Gloucester</td>
<td>2.031854</td>
</tr>
<tr>
<td>16</td>
<td>Central London</td>
<td>-13.350709</td>
</tr>
<tr>
<td>17</td>
<td>South East</td>
<td>2.324187</td>
</tr>
<tr>
<td>18</td>
<td>Oxon &amp; South Coast</td>
<td>-1.108129</td>
</tr>
<tr>
<td>19</td>
<td>Wessex</td>
<td>-1.708422</td>
</tr>
<tr>
<td>20</td>
<td>Peninsula</td>
<td>-5.676387</td>
</tr>
</tbody>
</table>
PJM transmission zones
International examples: US (PJM)

- PJM, a Regional Transmission Organisation (RTO) manages the interconnection between 13 states and District Columbia and a market operator.
- Uses Locational Marginal Pricing (LMP) – reflects value of energy at the specific location and the time of delivery
- Demand pays 100% transmission costs
- PJM Day ahead market – Forward market- Hourly LMPs are calculated based on generation offers, demand bids and scheduled bilateral transactions.
- PJM Real time market- Spot market –real time LMPs calculated at 5 min intervals.
- FTR (Financial Transmission Rights) traded separately from transmission service.
- Cost of transmission losses are reflected in the energy market prices.
New Zealand transmission system
International examples: New Zealand

- TransPower is the system operator covering north and south islands.
- Uses LMP and based on full nodal pricing to calculate transmission costs.
- Loads pay the interconnection charges- weighted average of the regional coincident peak demand
- 100% transmission costs are allocated to the loads.
- NZEM, New Zealand electricity Market operates whole sale electricity market.
- Long term bilateral contracts known as contracts market
- Spot market
- Transmission losses are reflected in the half hourly energy prices.
Brazil transmission system
International examples: Brazil

• ONS is the National System Operator in Brazil

• Transmission costs are allocated at 50:50 split between generation and demand.

• Cost recovery- 20% from flow-based calculation and 80% from peak usage charges

• Self producers are charged on nodal basis and charges depends on connection point location and reflect an element of socialised system service charges

• Transmission losses are reflected through the loss factors adjustment. Energy prices reflect marginal loss component.
Methodologies - Trade off between Efficiency and Simplicity

- Nodal Pricing
- Forward Looking Cost / LRMC/SRMC
- Historic cost / MW-km
- Postage Stamp

Indicative Only
International examples - Trade off between Efficiency and Simplicity

Nodal Pricing

- United States
- New Zealand
- Great Britain
- Brazil
- Ireland
- SAPP
- Nord pool

Forward Looking Cost / LRMC/SRMC

Historic cost / MW-km

Postage Stamp

Indicative Only
## Comparison of wheeling methodologies

<table>
<thead>
<tr>
<th>Method</th>
<th>Efficiency</th>
<th>Cost recovery</th>
<th>Transparency</th>
<th>Stability</th>
<th>Non-discrimination</th>
<th>Ease of application</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage Stamp</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>2</td>
</tr>
<tr>
<td>Contract Path</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>0</td>
</tr>
<tr>
<td>MW-km (distance)</td>
<td>-</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>1</td>
</tr>
<tr>
<td>MW-km (flow-based)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Nodal Pricing</td>
<td>✓</td>
<td>-</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>-1</td>
</tr>
<tr>
<td>SRIC</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✗</td>
<td>✓</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>LRIC</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>4</td>
</tr>
</tbody>
</table>
Influencing factors

• **Electricity trading rules:**
  – spot market/gross pool vs. bilateral contracts
  – identification of trading counterparties
  – entry/exit charges vs. contract based
  – restriction to self-generators at present

• **Congestion management:**
  – market rules linkage
  – value of signal through T charges
  – importance of significant locational component
  – medium/long term signals of the availability of transmission
Influencing factors

• **Losses:** under all of the methods other than the nodal pricing approach, treated separately from the application of network charges themselves.
  – via a “postage-stamp” approach, allocating the overall cost of losses across all system users; or
  – by identifying the costs arising from the incremental effect of losses arising from specific wheeling transactions.

• **Ancillary Services Costs:** impact of generation required to:
  – balance the network
  – maintain supply quality and security standards
  – provide top-up/standby electricity

• **Cost recovery:**
  – to “socialise” the costs; or
  – include in specific the wheeling agreements
Discussion: Characteristics of Jamaican Power Sector

Impact on charging methodology
Discussion: System Characteristics

- Wheeling asset definitions – what is the wheeling network?
  - voltages, differentiation from connection assets

- Generation and network flows
  - capacities, locations of generation; dominant flow patterns

- Market conditions
  - how many bilateral wheeling trades initially?
  - capacities/volumes/firm access vs. non-firm

- Time of year/time of day
  - effects on power flows

- Congestion
  - areas of networks affected, what is the impact?

- Distribution
  - voltages of connection, connection configurations
## JPS Generation (GWh)

<table>
<thead>
<tr>
<th></th>
<th>Old Harbour 6</th>
<th>Hunts Bay 6</th>
<th>Rockfort 6</th>
<th>Hunts Bay 2</th>
<th>Bogue 2</th>
<th>Renewables</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-11</td>
<td>75.2</td>
<td>35.5</td>
<td>14.5</td>
<td>9.4</td>
<td>75.4</td>
<td>13.8</td>
<td>223.8</td>
</tr>
<tr>
<td>Feb-11</td>
<td>76.9</td>
<td>30.3</td>
<td>19.2</td>
<td>2.7</td>
<td>61.1</td>
<td>11.2</td>
<td>201.4</td>
</tr>
<tr>
<td>Mar-11</td>
<td>81.2</td>
<td>16.7</td>
<td>27.2</td>
<td>11.4</td>
<td>76</td>
<td>12.7</td>
<td>225.2</td>
</tr>
<tr>
<td>Apr-11</td>
<td>65.1</td>
<td>35.6</td>
<td>24.9</td>
<td>14.3</td>
<td>68.3</td>
<td>11.7</td>
<td>219.9</td>
</tr>
<tr>
<td>May-11</td>
<td>65.3</td>
<td>34.1</td>
<td>24.2</td>
<td>12.8</td>
<td>77.6</td>
<td>13.1</td>
<td>227.1</td>
</tr>
<tr>
<td>Jun-11</td>
<td>66.4</td>
<td>31.4</td>
<td>23.6</td>
<td>11.3</td>
<td>67.8</td>
<td>14.4</td>
<td>214.9</td>
</tr>
<tr>
<td>Jul-11</td>
<td>86</td>
<td>35.5</td>
<td>25.4</td>
<td>6.1</td>
<td>69.3</td>
<td>14.7</td>
<td>237.0</td>
</tr>
<tr>
<td>Aug-11</td>
<td>82.4</td>
<td>34</td>
<td>27.2</td>
<td>6.7</td>
<td>72.8</td>
<td>14.8</td>
<td>237.9</td>
</tr>
<tr>
<td>Sep-11</td>
<td>85.8</td>
<td>36.1</td>
<td>26.2</td>
<td>16</td>
<td>65.3</td>
<td>12.6</td>
<td>242.0</td>
</tr>
<tr>
<td>Oct-11</td>
<td>77.7</td>
<td>36.4</td>
<td>25.2</td>
<td>12.3</td>
<td>80</td>
<td>11.7</td>
<td>243.3</td>
</tr>
<tr>
<td>Nov-11</td>
<td>67.9</td>
<td>35.1</td>
<td>26</td>
<td>11.8</td>
<td>79</td>
<td>9.4</td>
<td>229.2</td>
</tr>
<tr>
<td>Dec-11</td>
<td>68.6</td>
<td>34.4</td>
<td>25.9</td>
<td>7.6</td>
<td>75.1</td>
<td>12</td>
<td>223.6</td>
</tr>
<tr>
<td>Total</td>
<td>898.5</td>
<td>395.1</td>
<td>289.5</td>
<td>122.4</td>
<td>867.7</td>
<td>152.1</td>
<td>2725.3</td>
</tr>
</tbody>
</table>
## IPPs/Self Generation (GWh)

<table>
<thead>
<tr>
<th></th>
<th>JAMALCO</th>
<th>JPPC</th>
<th>JEP</th>
<th>WIGTON</th>
<th>ROPECON</th>
<th>JABROILERS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-11</td>
<td>0.05</td>
<td>37.9</td>
<td>72</td>
<td>5.8</td>
<td>0</td>
<td>1.9</td>
<td>117.65</td>
</tr>
<tr>
<td>Feb-11</td>
<td>0.037</td>
<td>35.8</td>
<td>62.8</td>
<td>7.8</td>
<td>0</td>
<td>2.6</td>
<td>109.037</td>
</tr>
<tr>
<td>Mar-11</td>
<td>0.047</td>
<td>33.4</td>
<td>73.7</td>
<td>8.4</td>
<td>0</td>
<td>3.3</td>
<td>118.847</td>
</tr>
<tr>
<td>Apr-11</td>
<td>0.018</td>
<td>34.2</td>
<td>74.8</td>
<td>5.7</td>
<td>0</td>
<td>1.8</td>
<td>116.518</td>
</tr>
<tr>
<td>May-11</td>
<td>0.001</td>
<td>38.7</td>
<td>81.7</td>
<td>3.9</td>
<td>0</td>
<td>2.3</td>
<td>126.601</td>
</tr>
<tr>
<td>Jun-11</td>
<td>0.002</td>
<td>37</td>
<td>76.5</td>
<td>14.9</td>
<td>0</td>
<td>3.5</td>
<td>131.902</td>
</tr>
<tr>
<td>Jul-11</td>
<td>0.041</td>
<td>37.9</td>
<td>70.9</td>
<td>13.9</td>
<td>0.1</td>
<td>2.4</td>
<td>125.241</td>
</tr>
<tr>
<td>Aug-11</td>
<td>0.45</td>
<td>42.7</td>
<td>70</td>
<td>7.9</td>
<td>0.087</td>
<td>1.8</td>
<td>122.937</td>
</tr>
<tr>
<td>Sep-11</td>
<td>0.55</td>
<td>23.5</td>
<td>76.7</td>
<td>4.8</td>
<td>0.083</td>
<td>1.8</td>
<td>107.433</td>
</tr>
<tr>
<td>Oct-11</td>
<td>1.1</td>
<td>28.2</td>
<td>69.4</td>
<td>6.8</td>
<td>0.068</td>
<td>1.8</td>
<td>107.368</td>
</tr>
<tr>
<td>Nov-11</td>
<td>0.63</td>
<td>40.3</td>
<td>66.3</td>
<td>4</td>
<td>0.094</td>
<td>1.8</td>
<td>113.124</td>
</tr>
<tr>
<td>Dec-11</td>
<td>0.7</td>
<td>37.9</td>
<td>66.9</td>
<td>7.3</td>
<td>0.082</td>
<td>1.9</td>
<td>114.782</td>
</tr>
<tr>
<td></td>
<td>3.626</td>
<td>427.5</td>
<td>861.7</td>
<td>91.2</td>
<td>0.514</td>
<td>26.9</td>
<td>1411.44</td>
</tr>
</tbody>
</table>

Potential Wheeling energy per annum: 122.24 GWh
Total Energy delivered per annum: 4136.74 GWh
Wheeling volume: 3%
With IPPs: 34%
Network characteristics

• Transmission system: 69kV ring, with a central 138kV ring superimposed

• Combination of wheeling routes possible, so power-flow based pricing is likely to be desirable.

• Network is not highly meshed, and limited difference likely in transmission prices at adjacent nodes.

• Distribution networks primarily radial
  – Further work is required to determine the locations within these networks of the typical loads (or indeed generators) that require wheeling services. Because of the radial nature of distribution, however, relatively simplistic pricing of this element of network use is possible.
Network characteristics
Comments on Specific Methods

Historic cost
- Postage Stamp
- Contract paths
- MW-km (distance)
- MW-km (load flow)

Future cost
- Short run (SRIC & SRMC)
- Long run (LRIC & LRMC)

Nodal pricing

- Transparent
- Cost-reflective
- Cost recovery
- Straightforward to implement
- Non-discrimination/fairness
- Stability
Recommended Wheeling Methodology
Recommended methodology for Jamaica

- Taking account of...
  - Network characteristics
  - Regulatory context
  - Electricity market background in Jamaica (focus on self-generators)
  - International experience
  - Characteristics of different theoretical methods
  - Tradeoffs in economic efficiency/simplicity

- ...then the MW-km (Flow based) method is recommended

- Advantages:
  - Transparency
  - Assurance of cost recovery of existing asset base
  - Gives locational signals to future wheeling parties
  - Based on actual network flows to measure use of assets
MW-km (flow-based)
Compatibility with regulations

• Key documents reviewed:
  – The OUR Act
  – The All-Island Electric Licence
  – 2009-2014 OUR Tariff Determination Report
  – 2004 Generation Market Study
Key findings

• The proposed methodology is compatible with the high level objectives of the OUR Act
  – particularly promotion of competition in generation
• JPS All-Island Electric Licence requires non-discrimination in connection/use of system
  – a clear and transparent wheeling charge structure will assist this
• JPS Licence also requires wheeling charges to be developed that are:
  – cost reflective
  – consistent with tariffs (and must therefore avoid under/over-recovery
  – guided by a Cost of Service study
• Need to confirm that locational variation of charges is permissible
Key implementation issues

- Distinction between connection and use of system charges – where are the boundaries?
- Incorporate appropriate depreciation rates into treatment of assets
- Share of costs between generators and consumers?
- Agree approach to network constraints
- Adjustment of charges to ensure full revenue recovery
- Confirm that reserves etc. (covered by Q-factor) are outside the scope of the wheeling charges
- Metering, top-up and standby pricing arrangements
**MW-km Methodology implementation**

**Flow diagram**

1. Define a set of transmission network assets – asset base
2. Define the value of asset base
3. Choose system load flow scenarios and their weighting
4. Define entry and exit point sets
5. Load flow studies to take identify power flows/losses associated with wheeling
6. Evaluate proportion of asset capacity used by wheeling transactions
7. Develop generic models of relevant distribution network
8. Compute complete localised wheeling charges
Specific steps

1. Define transmission network assets to be included in wheeling methodology
2. Define asset values – obtain JPS asset register, carry out cost of service assessment
3. Agree load flow scenarios: mix of peak, off peak and shoulder scenarios
4. Define entry and exit points for wheeling based on current transactions
5. Run load flow studies to account for power flows and losses at transmission level
6. Apply asset costs in proportion to wheeling power flows – ratings?
7. Derive net transmission wheeling costs (1)
8. Develop distribution network generic model that is part of the wheeling
9. Add the cost of distribution wheeling costs (2) to transmission costs (1)
10. Calculate final locational wheeling charges as costs per MW or costs per MWh.
Wheeling model components

- Wheeling Transactions
- Load Flow Model
- Charge calculation algorithm
  - Depreciated asset values
  - Transaction-specific charges
  - • Congestion costs
  - • Losses
  - • Distribution
  - • Other costs
<table>
<thead>
<tr>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>•</strong> Consultants visit/Training seminar – 3 December</td>
</tr>
<tr>
<td><strong>•</strong> OUR agreement on wheeling charge methodology</td>
</tr>
<tr>
<td><strong>•</strong> JPS to supply load flow studies information in several iterations as required</td>
</tr>
<tr>
<td><strong>•</strong> Consultation on proposed charging methodology</td>
</tr>
<tr>
<td><strong>•</strong> PPA Energy will develop detailed spreadsheet model</td>
</tr>
<tr>
<td><strong>•</strong> PPA Energy to develop distribution cost model</td>
</tr>
<tr>
<td><strong>•</strong> PPA Energy to complete cost of service component, to sufficiently differentiate between wheeling costs and network costs</td>
</tr>
<tr>
<td><strong>•</strong> PPA Energy to complete and submit a final wheeling charge model to the OUR</td>
</tr>
<tr>
<td><strong>•</strong> PPA Energy to draft outline content for regulations for wheeling charge implementation</td>
</tr>
<tr>
<td><strong>•</strong> Training seminar- Final wheeling charge model</td>
</tr>
<tr>
<td><strong>•</strong> Project Completion</td>
</tr>
</tbody>
</table>
# Project programme – next steps

## Schedule of Activities

<table>
<thead>
<tr>
<th>Jamaica Wheeling Charges including cost of service study</th>
<th>Week Commencing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22-Oct</td>
</tr>
<tr>
<td>5 Cost of Service Study</td>
<td></td>
</tr>
<tr>
<td>5.1 Develop cost of service spreadsheet</td>
<td></td>
</tr>
<tr>
<td>5.2 Provide cost input to wheeling model</td>
<td></td>
</tr>
<tr>
<td>6 Develop Wheeling Charge Model</td>
<td></td>
</tr>
<tr>
<td>6.1 High level data review</td>
<td></td>
</tr>
<tr>
<td>6.2 Develop wheeling model</td>
<td></td>
</tr>
<tr>
<td>6.3 Populate and test model</td>
<td></td>
</tr>
<tr>
<td>6.4 Prepare User Manual</td>
<td></td>
</tr>
<tr>
<td>7 Develop regulatory framework</td>
<td></td>
</tr>
<tr>
<td>7.1 Develop regulatory framework</td>
<td></td>
</tr>
<tr>
<td>8 Draft Report</td>
<td></td>
</tr>
<tr>
<td>8.1 Prepare draft final report including cost of service study</td>
<td></td>
</tr>
<tr>
<td>9 Training Session #2</td>
<td></td>
</tr>
<tr>
<td>9.1 Prepare training session #2</td>
<td></td>
</tr>
<tr>
<td>9.2 Deliver training session on wheeling model and reg. framework</td>
<td></td>
</tr>
<tr>
<td>9.3 OUR feedback / approval of draft final report and model</td>
<td></td>
</tr>
<tr>
<td>10 Final Report</td>
<td></td>
</tr>
<tr>
<td>10.1 Prepare final report including cost of service study</td>
<td></td>
</tr>
</tbody>
</table>

## Deliverables

- Inception report
- Methodological report
- Training Session #1 - Wheeling methodology
- Tariff wheeling model and instruction material
- Draft final report including cost of service study
- Training Session #2 - Wheeling model and regulatory framework
- Final report (to include cost of service study)
Questions and discussion

Impact on charging methodology
Thank you!
Our Contacts

PPA Energy (UK)
1 Frederick Sanger Road
Surrey Research Park
Guildford, Surrey
GU2 7YD, UK
www.ppaenergy.co.uk
Tel: +44 (0) 1483 544944
Fax: +44 (0) 1483 544955

PPA Energy Pty. Ltd. (South Africa)
1 Eastgate Lane
Bedfordview
Johannesburg
2007
South Africa
www.ppaenergy.co.za
Tel: +27 (0)11 615 3403