The Malaysian Electricity Supply Industry (MESI) - Stakeholders
CISB413 Malaysian Electricity & Power Landscape

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1. Power System Review
2. Malaysian Electricity Supply Industry
3. Governance & Institutional Framework
4. Smart Grid and New Technologies
5. IPPs and PPAs
Part 1: Power System Review
Electricity Characteristics

What’s so special about electricity?

- Electricity is an essential (public?) service
  - guarantee of supply & price are politically sensitive issues

- Electricity cannot be easily stored, i.e. delivery is practically instantaneous
  - Generation & demand are permanently in balance

- Supply of electricity requires networks, where electricity is injected or retrieved but cannot be traced
  - Network duplication does not make economic sense

- Also (not so special)
  - Large & dedicated investments
  - Complex decision making under much uncertainty
  - Predictable cyclical variations in demand
Illustration of Power Delivery

500kV Lines
Long Distance Bulk Power Transfer

33kV, 11kV, 415V cables
Distribution line
Power Transfer

132kV cables
Sub transmission line
Power Transfer

Step up Tx
33kV/500kV

Step down Tx
500kV/275kV

Step down Tx
275kV/132kV

Step down Tx
132kV/33kV/11kV

Distribution network
LOAD
LOAD
LOAD
LOAD
LOAD
Illustration of Generation Sources

Installed generation capacity of 11 GW
- 2 Coal-fired stations: ~ 4.4 GW
- 6 Gas-fired stations: ~ 4.7 GW
- 3 Hydro schemes: ~1.9 GW

~55% of total national power generation capacity

Additional 1.6 GW due online by 2015
- 1 Coal-fired unit: 1 GW
- 2 Hydro schemes: 0.6 GW

*All figures are approximations*
Part 2: Malaysian Electricity Supply Industry
Evolution of the MESI

- AC Unbundling/Preparation for IBR 2011
- First electricity supply in Malaysia by private concerns
- National Green Technology Policy launched
- Public enterprises through Municipalities and state departments
- Separation of commercial & operations
- Fragmented
- Energy Commission Operationalised
- 1894
- Integrated
- Five Fuel Policy
- 1949
- LLS privatized as SESB and taken over by TNB
- Malayanisation: Name change to NEB
- Public Listing of TNB & Introduction of IPPs
- Two Oil Shocks Rural Electrification
- TNB Corporatisation JBE&G established
- Consolidation of Industry Four Fuel Policy
- 1984
- Consolidation
Evolution of the MESI (cont)

1. 1894 – First private supply of electricity to Rawang by Loke Yew and Thamboosamy Pillai
2. 1904 – First public supply inaugurated in Penang
3. 1905 – First public supply to KL from the Ulu Gombak HEP
4. 1928 – Commissioning of 18MW Malim Nawar Station by Perak River Hydro. KED established
   – 27MW Chendeho HEP commissioned
5. 1937-1949 The Electricity Department
6. 1949-1964 The Central Electricity Board established
7. 1953 – 1958 – Connaught Bridge and Malacca Power Station commissioned
8. 1963 - Cameron Highlands HEP commissioned
9. 1965 – CEB renamed as National Electricity Board
10. 1982 – Takeover of PRHEP and KED by NEB
11. 1986 – 275Kv loop completed, forming the National grid
12. 1990 – NEB corporatised and privatised as TNB
Introduction to Tenaga Nasional Berhad
Three Major Utilities in Malaysia

PENINSULAR MALAYSIA

SABAH

SARAWAK

Sabah Electricity Sdn Bhd
(A 83% TNB Subsidiary)

Tenaga Nasional Bhd
(TNB)

MD: 16,901MW

21,060MW*

11,506MW

11,506MW

SINGAPORE

21,060MW*

1,237MW

1,141MW*

1,237MW

695MW

11,506MW

WE’VE GOT THE POWER
-to serve, to deliver, to excel'

* Includes IPPs

<table>
<thead>
<tr>
<th></th>
<th>FY’09</th>
<th>FY’10</th>
<th>FY’11</th>
<th>FY’12</th>
<th>1HFY’13</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNB -Peninsula Installed Capacity (MW)</td>
<td>11,530</td>
<td>11,530</td>
<td>11,530</td>
<td>11,462</td>
<td>11,462</td>
</tr>
<tr>
<td>Total units sold (GWh)</td>
<td>87,780</td>
<td>95,197</td>
<td>97,888</td>
<td>102,132</td>
<td>52,129</td>
</tr>
<tr>
<td>Total customers (million)</td>
<td>7.59</td>
<td>7.87</td>
<td>8.11</td>
<td>8.36</td>
<td>8.47</td>
</tr>
<tr>
<td>Total employees</td>
<td>29,149</td>
<td>30,535</td>
<td>31,935</td>
<td>33,568</td>
<td>34,353</td>
</tr>
<tr>
<td>Total assets (RM billion)</td>
<td>71.4</td>
<td>75.9</td>
<td>79.1</td>
<td>88.5</td>
<td>88.3</td>
</tr>
</tbody>
</table>
Customer VS Sales

Sectoral Sales Analysis (Gwh)

- Shift from Industrial-based to Service-based economy
- Increasing market share from Commercial sector
- Commercial sector contributes the highest electricity sales margin

*FY’13 - 1HFY13
Tariffs Comparison

**DOMESTIC**

<table>
<thead>
<tr>
<th>Country</th>
<th>Sen/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>21.83</td>
</tr>
<tr>
<td>TNB (Mar 09)</td>
<td>27.39</td>
</tr>
<tr>
<td>TNB (New)</td>
<td>28.63</td>
</tr>
<tr>
<td>Thailand</td>
<td>34.58</td>
</tr>
<tr>
<td>Singapore</td>
<td>57.50</td>
</tr>
<tr>
<td>Philippines</td>
<td>65.60</td>
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</tbody>
</table>

**COMMERCIAL**

<table>
<thead>
<tr>
<th>Country</th>
<th>Sen/kWh</th>
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<tr>
<td>Indonesia</td>
<td>31.24</td>
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<tr>
<td>TNB (Mar 09)</td>
<td>37.85</td>
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<tr>
<td>TNB (New)</td>
<td>41.01</td>
</tr>
<tr>
<td>Thailand</td>
<td>41.88</td>
</tr>
<tr>
<td>Singapore</td>
<td>52.62</td>
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<tr>
<td>Philippines</td>
<td>57.03</td>
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</table>

**INDUSTRIAL**

<table>
<thead>
<tr>
<th>Country</th>
<th>Sen/kWh</th>
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</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>23.57</td>
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<tr>
<td>TNB (Mar 09)</td>
<td>28.36</td>
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<tr>
<td>TNB (New)</td>
<td>30.94</td>
</tr>
<tr>
<td>Thailand</td>
<td>31.08</td>
</tr>
<tr>
<td>Philippines</td>
<td>31.44</td>
</tr>
<tr>
<td>Singapore</td>
<td>49.75</td>
</tr>
</tbody>
</table>

**Notes:**
1. Singapore - Average reduction of 3.3% from 1st Oct 2010 based on latest fuel cost pass-through.
2. Thailand – Jan-Dec 2010, include fuel adjustment. It has been maintained since Jan 2009.
3. Indonesia (PLN) – 10% tariff increase effective 1st July 2010; Indonesia Govt. subsidy of about US$7.8 billion per year.
4. Philippines (Meralco) – Jan-Dec 2008
5. TNB (New) – average 7.12% increase effective 1st June 2011.

Source: TNB Analysis, ASEAN Utility Data Exchange, SP Services
TYPICAL DAILY LOAD CURVE PATTERN
The apparent increase in FY09/10 might be due to El Niño.
THE POLICY DRIVES THE FUEL MIX EVOLUTION FROM OIL DOMINANT TO GAS DOMINANT OVER A FEW DECADES

Malaysia has been highly dependent on fossil fuels:
- Oil (1970s)
- Natural Gas (1990s to 2000s)
- Coal ??
DEMAND GROWTH FORECAST

2014 17,152 MW
2015 18,697 MW
2016 18,880 MW
2017 19,492 MW
2018

3.18 % 3.31 % 3.27 % 3.24 %

Note: As Approved by the BOD on 29 Jan 2014
Typical Generation-Demand Scenario

Supply / Demand balance

- Share of generation installed capacity
- Share of electricity demand

Inter area power flow

Note: Central area is a nett importer of power
ASEAN Power Grid – Inception under the ASEAN Minister of Energy (AMEM) and implemented under HAPUA

Existing Interconnection
• Peninsular Malaysia – Singapore (1986, 2 x 200 MW)
• Peninsular Malaysia – Thailand
  • HVAC Bukit Ketri – Sadao (1981, 85 MW)
  • HVDC Gurun – Khlong Ngae (2001, 300 MW)

Potential Interconnection
• Peninsular Malaysia – Sarawak (2022)
• Peninsular Malaysia – Sumatera (2018)
• Peninsular Malaysia – Thailand (2015, 2\textsuperscript{nd} 300MW HVDC)
• Rantau Panjang – Sg. Kolok (under discussion)

- Sarawak and Sumatera interconnections are viable options to increase energy security
- The Singapore & Thailand Interconnections enhanced system security for all parties
Part 3:
Governance & Institutional Framework
Current ESI structure remains the same with TNB and IPPs as the key players in the generation sector.

However, the business activities of TNB is segmented into 5 business entities in anticipation of full implementation of Incentive Based Regulation (IBR) in 2015.

The System Operator and Single Buyer are in the process to be ring-fenced to enhance transparency, independence and fair play in generation scheduling and dispatch.

Source:
- Energy Commission’s Peninsular Malaysia Industry Outlook 2013
Industry Regulatory Framework

Prime Minister/Cabinet

Ministry of Energy, Green Technology and Water (KeTTHA)

Empowered by Electricity Supply Act 1990

MyPOWER Corporation

SEDA Malaysia

Special Purpose Agency created to detail out the key reform initiatives of the Malaysian Electricity Supply Industry (MESI), aligned with the Government and Economic Transformation Program (ETP)

Economic Planning Unit (EPU)
- Develops and complements Privatisation Policy
- Evaluates and selects IPPs
- Recommends ESI policies

Energy Commission (Regulator)
- Promote competition
- Protect interests of consumers
- Issue licenses
- Tariff regulation

Policy Maker

Tenaga Nasional Berhad

 IPPs

Consumers

Market Cap (6th) RM27.4bn ($8.9bn)

Holds ‘Golden’ Share
33.78%

Ministry of Finance/Khazanah Nasional Berhad
42.22%

Other Govt. Agencies & Corporations
6.66%

Public

Foreign

Shareholders

17.34%

* Shareholding figures as at Feb ‘13
## Institutions in the Sector

<table>
<thead>
<tr>
<th>Institution</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Planning Unit</td>
<td>Formulates macro national energy policy</td>
</tr>
<tr>
<td>KeTTHA</td>
<td>Initiates, develops &amp; implements energy policy and programmes</td>
</tr>
<tr>
<td>UKAS (Public Private Partnership Unit)</td>
<td>Private Finance Initiatives in major project</td>
</tr>
<tr>
<td>Energy Commission</td>
<td>Electricity and piped gas industry regulation</td>
</tr>
<tr>
<td>National Green Technology Centre</td>
<td>Formulating green technology development plan. This centre function as the focal point to set standards and promote green technology</td>
</tr>
<tr>
<td>Petronas</td>
<td>Oil and Gas exploration, production, processing, manufacturing and marketing</td>
</tr>
<tr>
<td>Petronas Gas</td>
<td>Processing and transmission of natural gas</td>
</tr>
<tr>
<td>TNB, SESB, SESCO</td>
<td>Electricity generation, transmission, distribution and supply</td>
</tr>
<tr>
<td>Gas Malaysia, Sabah Energy Corp, Sarawak Gas</td>
<td>Distribution and reticulation of gas</td>
</tr>
<tr>
<td>Sustainable Development Authority</td>
<td>Development of RE/ EE Initiatives and Implementation of FIT</td>
</tr>
<tr>
<td>MyPOWER Corp</td>
<td>MESI Reform Initiatives</td>
</tr>
</tbody>
</table>
## Key Energy Policies

<table>
<thead>
<tr>
<th>Policy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum Development Act 1974</td>
<td>Vested on PETRONAS: the exclusive rights to explore, develop and produce petroleum resources of Malaysia.</td>
</tr>
<tr>
<td>National Energy Policy 1979</td>
<td>To ensure adequacy, security and cost-effectiveness of energy supply.</td>
</tr>
<tr>
<td>National Depletion Policy 1980</td>
<td>To promote efficient utilization of energy.</td>
</tr>
<tr>
<td>Four-Fuel Diversification Strategy 1981</td>
<td>To minimize negative environmental impacts in the energy supply chain.</td>
</tr>
<tr>
<td>Five-Fuel Diversification Strategy 2001</td>
<td>Renewable Energy/EE included as the “fifth fuel” in energy supply mix.</td>
</tr>
</tbody>
</table>

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“What software would you recommend to give my presentation so much flash and sizzle that nobody notices that I have nothing to say?”
The Energy Commission: Regulatory Process

- Minister sets major policies
- Members of EC set & review policies & standards
- EC undertakes consultative process/creates awareness with stakeholders
- EC issues licences, certificates & approvals
- EC promotes, monitors, investigates & enforces compliance
- EC advises / proposes to policy makers
- EC seeks solutions to industry issues
Historical Development of MESI Structure

Early 1990’s - Fully Regulated
- Generation
- Transmission
- Distribution
  - “Vertically Integrated”
  - Dominated by National Utility-TNB

Mid 1990’s - Multiple Generation Players
- TNBG & TNBH
- IPPs
- Transmission and Distribution by TNB
- Privately-owned IPPs allowed to participate in the generation sector

Present
- Transmisson
- Distribution
- Franchised Retailers
- TNB Distribution Retail
- Transmission and Distribution by TNB
- Privately-owned IPPs allowed in generation and franchised retailers in limited areas for distribution
- Energy Commission
Disruptive Forces

- Decarbonization & Climate Change
- Smart Grid
- Need for Greater Energy Efficiency
- Distributed Generation & Storage
Intelligent Grid

What is a Smarter Grid?
A smarter grid uses digital technologies to improve the reliability, security, and efficiency of the electric system.
What is Smart Grid

- "Smart Grid" is today used as a marketing term, rather than a technical definition. For this reason there is no well defined and commonly accepted scope of what "smart" is and what it is not.

- The general understanding is that the Smart Grid is the concept of modernizing the electric grid. The Smart Grid comprises everything related to the electric system in between any point of generation and any point of consumption. Through the addition of Smart Grid technologies the grid becomes more flexible, interactive and is able to provide real time feedback.

http://www.iec.ch/smartgrid/
## Smart Grid Drivers & Technology Options

<table>
<thead>
<tr>
<th></th>
<th>AMI</th>
<th>Distribution automation</th>
<th>HEMS/ BEMS</th>
<th>Energy storage</th>
<th>Demand response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing renewable generation</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Improved grid reliability</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Reduce non technical losses</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EV integration</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Rising peak demand</td>
<td>√</td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Ageing infrastructure</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
**Smart Grid Drivers & Technology Options**

- Advanced metering infrastructure
- Variable renewable energy integration
- Demand response
- Wind
- Distributed energy resources
- Renewable energy standards or targets
- System efficiency improvements
- Reliability improvements
- Enabling customer choice and participation
- Enabling new products, services, markets
- Energy efficiency improvements

**Survey responses**
Issues & Challenges – Customer Acceptance

2009: Cyber-Security

2011–2012: Cyber-Security, Privacy

Opt-Out

2010 – 2011: Health (RF Concerns)

2009–2010: Meter Quality (Accuracy, High Bills)

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Pilot Smart Meter Deployment in Melaka - Customer Experience

- Continuous customer engagement
- Improved efficiency and availability.
- Customer benefits
- TNB SmartLiving enabled programs
- Localised events
  - Community engagements
- Voluntary participation
- Pre Installation Letter
  - Bill Inserts
  - Video/Advert
  - Door Hanger
  - Social Media Engagement
- Online YouTube community engagement
- Personalized engagement
- Post-installation survey
- Community Briefings & Engagement
  - Pre Installation
    - Phone & Installation
      - Post Survey
    - Survey
      - Bill Inserts
    - Web & Advert
      - Mobile Tools
      - Smart Meter Web Portal
      - Smart Meter Help Desk
      - Installation Survey
- Incentive Campaign

Better. Brighter.
Challenges & Critical Enabler - Interoperability

- As information technology (IT) and operations technology (OT) converge in the smarter grid of the future, network interoperability will be the starting point and precondition for all.

- Interoperability in multiple network technology must support end-to-end data quality and security, network system performance and application service provisioning and management.
Current IEC TC57 Reference Architecture – Scope and Layers

*Notes: 1) Solid colors correlate different parts of protocols within the architecture.
2) Non-solid patterns represent areas that are future work, or work in progress, or related work provided by another IEC TC.
Challenges & Enabler – Infrastructure Development

- Shared vision for the smart electricity among stakeholders
- Widespread deployment of Intelligent Electronic Devices (IED)
  - Retrofitting of existing components are required to make them “ smarter” as well as keeping the cost lower
- Infrastructure for integrated communications need to be fully developed

South Korea Smart Grid Test-bed with budget allocation of $200 million has been made ($68 mil public funds, $170 mil private investment)
Host of New Technologies

SMART GRID
A vision for the future—a network of interconnected microgrids that can monitor and heal itself

- **Smart appliances**
  - Can shut off in response to frequency fluctuations

- **Demand management**
  - Use can be shifted to off-peak times to save money

- **Storage**
  - Energy generated at off-peak times could be stored in batteries for later use

- **Wind farm**

- **Offices**

- **Houses**

- **Disturbance in the grid**

- **Processors**
  - Execute special protection schemes in microseconds

- **Generators**
  - Energy from small generators and solar panels can reduce overall demands on the grid

- **Central power plant**

- **Isolated microgrid**

A typical vision of a smart grid includes networks of micro-grids that can detect problems and disconnect themselves temporarily. Demand-response equipment that shuts off nonessential appliances and other power drains if necessary, and sources of distributed power that can take some of the load off central power plants.
Part 5: IPPs and PPAs
Beginning 1993, IPP license was awarded to a total of 15 IPPs to build and operate generating plants in Peninsular Malaysia.

**First Generation IPPs**
- YTL
- GSP
- SEV
- PDP
- PTEK

**1998 - 1999**
- TNB Janamanjung
- TTPC
- NUR
- Pahlawan

**2001 - 2003**
- Prai Power
- GB3 Sdn Bhd
- Panglima
- Kapar Energy

**2003 – 2005**
- Tanjung Bin
- TNB Janamanjung
- Jimah Energy

**Second Generation IPPs**
- Strictly Private & Confidential
## Independent Power Producers

<table>
<thead>
<tr>
<th>IPP</th>
<th>Capacity (MW)</th>
<th>Type of Plant</th>
<th>Fuel</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Generation IPPs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YTL Power Sdn Bhd</td>
<td>1,170</td>
<td>CCGT</td>
<td>Gas</td>
<td>YTL</td>
</tr>
<tr>
<td>SEV Energy Ventures Sdn Bhd</td>
<td>1,303</td>
<td>CCGT</td>
<td>Gas</td>
<td>Malakoff</td>
</tr>
<tr>
<td>Genting Sanyen Power Sdn Bhd</td>
<td>762</td>
<td>CCGT</td>
<td>Gas</td>
<td>Genting Group</td>
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<tr>
<td>Powertek Bhd</td>
<td>434</td>
<td>OCGT</td>
<td>Gas</td>
<td>Tanjong</td>
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<tr>
<td>PD Power Sdn Bhd</td>
<td>436.4</td>
<td>OCGT</td>
<td>Gas</td>
<td>Sime Darby</td>
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<tr>
<td><strong>Second Generation IPPs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pahlawan Power Sdn Bhd</td>
<td>322</td>
<td>CCGT</td>
<td>Gas</td>
<td>Tanjong</td>
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<tr>
<td>Kapar Energy Ventures Sdn Bhd</td>
<td>2,420</td>
<td>CSP, OCGT</td>
<td>Coal, MFO, Gas</td>
<td>60% TNB/40% Malakoff</td>
</tr>
<tr>
<td>Panglima Power Sdn Bhd</td>
<td>720</td>
<td>CCGT</td>
<td>Gas</td>
<td>Tanjong</td>
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<tr>
<td>GB3 Sdn Bhd</td>
<td>640</td>
<td>CCGT</td>
<td>Gas</td>
<td>Malakoff</td>
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<tr>
<td>Prai Power Sdn Bhd</td>
<td>350</td>
<td>CCGT</td>
<td>Gas</td>
<td>Malakoff</td>
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<tr>
<td>Teknologi Tenaga Perlis Consortium Sdn Bhd (TTPC)</td>
<td>650</td>
<td>CCGT</td>
<td>Gas</td>
<td>Jati Cakerawala</td>
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<tr>
<td><strong>Third Generation IPPs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>TNB Janamanjung Sdn Bhd</td>
<td>2,070</td>
<td>CSP</td>
<td>Coal</td>
<td>TNB</td>
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<tr>
<td>Tanjung Bin Power Sdn Bhd</td>
<td>2,100</td>
<td>CSP</td>
<td>Coal</td>
<td>Malakoff</td>
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<tr>
<td>Jimah Energy Ventures Sdn Bhd</td>
<td>1,400</td>
<td>CSP</td>
<td>Coal</td>
<td>Jimah Teknik</td>
</tr>
</tbody>
</table>

Note: CCGT (Combined-Cycle Gas Turbine), OCGT (Open Cycle Gas Turbine), CSP (Conventional Steam Plant)
PPA: Product & Payment

1st Generation
- Minimum Take or Pay (Energy) (YTL only)
- Capacity & Energy

2nd Generation
- Product
- Capacity & Energy
- Payment
- Capacity & Energy Payment

3rd Generation
- Product
- Capacity & Energy
- Payment
- Capacity, Utilisation & Energy Payment

Year:
- 1998: PPA Signed
- 2002: PPA Signed
PPA: Product and Payment (2)

- Capacity Payment
  - for availability & performance of the plant
  - Payment is based on availability regardless of whether the plant is despatched or not.

- Daily Utilisation Payment (for Jimah & Tanjung Bin only)
  - introduced to encourage IPP to share demand risks and to reduce fixed capacity payment when plant is not utilised.

- Energy payment
  - Payment for energy despatched from the plant
  - covers fuel & variable operating costs
ANY QUESTIONS?