The Electric Power System

- Thailand -
Basic facts

- Area: 513,000 km² (198,000 sq mi),
- Number of electricity consumers (2014):
  - 20.6 million households
- Number of TSOs: 1
- Number of DSOs: 2
- Peak load (June 2015): 27.3 GW
- Average interruption of electricity (2014):
  - 188.38 minutes / delivery points / year

sources: Thailand National Statistical Office,
Electricity Generating Authority of Thailand (EGAT),
Metropolitan Electricity Authority (MEA),
Provincial Electricity Authority (PEA),
Energy Policy & Planning Office (EPPO)
Global map of the grid and of its interconnections

- Interconnectors with:
  - Cambodia
  - Lao PDR
  - Malaysia
  - Myanmar (future)
Grid facts and characteristics

The electricity grid in Thailand is sub-divided into transmission grids (maximum voltage) and distribution grids (high, medium and low voltage).

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Total length (Circuit-km)</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 kV</td>
<td>4,746.488</td>
<td>TSO</td>
</tr>
<tr>
<td>230 kV</td>
<td>14,651.372</td>
<td>TSO</td>
</tr>
<tr>
<td>115 kV</td>
<td>13,828.898</td>
<td>TSO</td>
</tr>
<tr>
<td>115-69 kV</td>
<td>241,803.13</td>
<td>DSO</td>
</tr>
<tr>
<td>22-33 kV</td>
<td>490,950.50</td>
<td>DSO</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>765,980.388</strong></td>
<td></td>
</tr>
</tbody>
</table>

Sources: EGAT, MEA, PEA
Structure of electrical power system

TSO-Grid

500 kV

230 kV

115 kV

115 kV

DSO-Grid

69/22 kV

380 V

Utilities

Dispersed Generation

Households

DSO

Conventional Generation

Industry

TSO

Utilities

380 V

Source: EGAT

Thailand Power System
Map of the high voltage grid

Thailand Power System
Information on TSO(s)

EGAT

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Network length [km] (500 kV)</td>
<td>4,746.488</td>
</tr>
<tr>
<td>Network length [km] (230 kV)</td>
<td>14,651.372</td>
</tr>
<tr>
<td>Served area [km²]</td>
<td>513,115</td>
</tr>
<tr>
<td>Annual transmission [TWh]</td>
<td>177</td>
</tr>
<tr>
<td>Share load [%]</td>
<td>100</td>
</tr>
</tbody>
</table>

website: http://www.egat.co.th
Cooperation of TSO and DSO

Transmission grid:

NCC
- MACC
- CAC
- NEC
- SAC
- NAC

Distribution grid:

MEA
- PEA 1
- PEA 2
- PEA 3
- PEA 4
- PEA 5
- PEA 6
- PEA 7
- PEA 8
- PEA 9
- PEA 10
- PEA 11
- PEA 12
- PEA 13

Thailand Power System
Responsibilities within the cascade

- Maintain Grid reliability and quality of the System according to Thailand power system standard
- Control frequency, voltage and power flow of high voltage transmission system
- Co-ordinate with IPPs, SPPs and Fuel Suppliers
- Supervise the switching operation and be responsible for power system restoration in case of black and brown out.

- Monitoring own system
- Operative contact to generators on DSO-Level
- Support of TSO to operate the cascade

*SoS = Security of Supply

- Support of industrial customers to SoS through demand response scheme
- Support of TSO / DSO to SoS through decreasing / increasing the power of generation units
Power structure of the country

- EGAT: Electricity Generating Authority of Thailand
- IPP: Independent Power Producer
- SPP: Small Power Producer

**Total Installed Capacity**

36,171.03* MW

Remarks: * AS of June 2015
Installed capacity with reference to primary resources

- Installed capacities (36,171.03 MW), June 2015
  - Coal: 2,376.0 MW
  - Gas: 24,601.2 MW
  - Hydro power: 5,511.0 MW
  - Lignite: 2,671.0 MW
  - Oil: 323.9 MW
  - Renewable: 387.9 MW (connected to EGAT)
  - EGAT-TNB: 300.0 MW

Source: Power System Control and Operation Division /EGAT
Energy production with reference to primary resources

Electricity generated 177.58 TWh, Year 2014

- Coal 16.33 TWh
- Gas 98.41 TWh
- Hydro power 16.83 TWh
- Lignite 17.35 TWh
- Nuclear -
- Oil 1.87 TWh
- SPP+Others 26.77 TWh

Source: Power System Control and Operation Division /EGAT
Development of generation capacity since 2015 (share of primary energy)
Consumption per customer groups

Source: Energy Policy & Planning Office (EPPO)
Location of renewable energy sources

Installed Wind turbines

Installed PV panels
Development of wind power

Thailand Power System
## Development of Photovoltaic Power

### Development of Capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.54</td>
</tr>
<tr>
<td>2005</td>
<td>0.54</td>
</tr>
<tr>
<td>2006</td>
<td>0.60</td>
</tr>
<tr>
<td>2007</td>
<td>2.00</td>
</tr>
<tr>
<td>2008</td>
<td>2.34</td>
</tr>
<tr>
<td>2009</td>
<td>6.78</td>
</tr>
<tr>
<td>2010</td>
<td>15.11</td>
</tr>
<tr>
<td>2011</td>
<td>21.89</td>
</tr>
<tr>
<td>2012</td>
<td>160.87</td>
</tr>
<tr>
<td>2013</td>
<td>395.62</td>
</tr>
<tr>
<td>2014</td>
<td>887.85</td>
</tr>
<tr>
<td>2015</td>
<td>492.24</td>
</tr>
<tr>
<td>2016</td>
<td>1,211.29</td>
</tr>
</tbody>
</table>

### Accumulated Capacity (End of Year)

<table>
<thead>
<tr>
<th>Year</th>
<th>MW</th>
</tr>
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<tbody>
<tr>
<td>2004</td>
<td>0.54</td>
</tr>
<tr>
<td>2005</td>
<td>1.08</td>
</tr>
<tr>
<td>2006</td>
<td>1.68</td>
</tr>
<tr>
<td>2007</td>
<td>3.98</td>
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<tr>
<td>2008</td>
<td>6.32</td>
</tr>
<tr>
<td>2009</td>
<td>13.10</td>
</tr>
<tr>
<td>2010</td>
<td>25.21</td>
</tr>
<tr>
<td>2011</td>
<td>47.09</td>
</tr>
<tr>
<td>2012</td>
<td>76.95</td>
</tr>
<tr>
<td>2013</td>
<td>366.27</td>
</tr>
<tr>
<td>2014</td>
<td>884.12</td>
</tr>
<tr>
<td>2015</td>
<td>1,376.36</td>
</tr>
<tr>
<td>2016</td>
<td>2,168.55</td>
</tr>
</tbody>
</table>

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*Thailand Power System*
RES installed capacity since 1990

MW

Thailand Power System
Price development for industry consumers

Average price of electricity for industry consumers [THB/kWh], exclusive of VAT

<table>
<thead>
<tr>
<th>Year</th>
<th>Tariff Adjust</th>
<th>Base tariff</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>0.1950</td>
<td>2.9409</td>
<td>3.1359</td>
</tr>
<tr>
<td>2013</td>
<td>0.5099</td>
<td>2.9409</td>
<td>3.4508</td>
</tr>
<tr>
<td>2014</td>
<td>0.6567</td>
<td>2.9409</td>
<td>3.5976</td>
</tr>
<tr>
<td>2015</td>
<td>0.5165</td>
<td>2.9409</td>
<td>3.4574</td>
</tr>
</tbody>
</table>

Sources: EGAT, EPPO
Price development for households
Average price of electricity for households [THB/kWh], exclusive of VAT

Sources: EGAT, EPPO
Electricity market organisation

- Thailand Electricity Market is enhanced single-buyer
- EGAT takes the role of single-buyer and oversee main transmission system including major part of generation

- EGAT : Electricity Generating Authority of Thailand
- MEA : Metropolitan Electricity Authority
- PEA : Provincial Electricity Authority
- IPP : Independent Power Producer
- SPP : Small Power Producer
- VSPP : Very Small Power Producer

Thailand Power System
Power balance in 2014

- Generation 177.58 TWh
- Consumption 173.60 TWh
- Difference ~4 TWh
Approximate Energy Exchanges

Values in GWh, Jan 2014 – Dec 2014

*HONG-SA Lignite, June 2015 – Sep 2015

Source: Power System Control and Operation Division/EGAT

Thailand Power System