Power 101

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Undersecretary

E-Power Mo Energy 101 for Media
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Grand Xing Imperial Hotel, Iloilo City
Philippine Power System
 Philippine Power System

- Luzon, Visayas and Mindanao grids
- Connected to main transmission backbone

Interconnection Line Capacity
- Leyte-Luzon (440 MW)
- Leyte-Cebu (400 MW)
- Cebu-Negros (200 MW)
- Negros – Panay (200 MW)
- Leyte-Bohol (100 MW)
Grid Power System

Load

2017 Electricity Sales

- Residential: 34%
- Commercial: 33%
- Industrial: 29%
- Others: 4%

77,793 GWh

Distribution

- PIOUs: 23
- ECs: 100
- LGUOUs: 2

Peak Demand: 13.789 GW

Transmission

- 31,501 MVA
- 20,053 ckt-km

Generation

- GenCos: 219 GW
- Installed Capacity: 22.26 GW
- Gross Generation: 94,370 GWh

Sources of Data: DOE; NGCP

- DU data as of December 2017
- Based on 2014-2015 TDP
- Gross Generation data as of December 2017

PIOUs - Private-Investor Owned Utilities
ECs - Electric Cooperatives
LGUOUs - LGU-Owned Utilities
Philippine Power System

Power System

Off-Grid

- Missionary areas
- Also known as Small Islands and Isolated Grid (SIIG)
- Power supplied by NPC SPUG and Private Sector (New Private Provider and Qualified Third Party)
Off-Grid (SPUG) Power System

Load

- Residential: 12%
- Commercial: 7%
- Industrial: 24%
- Others: 57%

2016 Electricity Sales

- 996 GWh

Distribution

- 21 ECs
- 1 MPCs
- 3 LGUOUs
- 2 QTP

Generation

- 277 NPC
- 38 Non-NPC

Total Installed Capacity

- 465 MW

Transmission

- 185 MVA
- 776 ckt.-km

Gross Generation

- 1,315 GWh

Source of Data: DOE; NPC; NEA

*As of January 2018; excluding ARMM ECs
**Gross Generation data as of December 2017
***Transmission data as of April 2018

ECs - Electric Cooperatives
MPCs - Multi-Purpose Cooperatives
LGUOUs - LGU-Owned Utilities
QTP - Qualified Third Parties

76.6%* Energized
Philippine Power System

Grid
- Luzon, Visayas, and Mindanao grids
- Connected to main transmission backbone

Off-Grid
- Missionary areas
- Also known as Small Islands and Isolated Grid (SIIG)
- Power supplied by NPC SPUG and Private Sector (New Private Provider and Qualified Third Party)
How the Power System Works

- Need for continuous and near instantaneous balancing of generation and load
Load Sector

Load is a power required of or consumed by a circuit.

Customer Types of Load:
- Residential
- Commercial
- Industrial
- Others

2017 Percent Electricity Consumption*, (%)

<table>
<thead>
<tr>
<th>CUSTOMERS</th>
<th>LUZON</th>
<th>VISAYAS</th>
<th>MINDANAO</th>
<th>PHILIPPINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>34</td>
<td>36</td>
<td>37</td>
<td>34</td>
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<tr>
<td>Commercial</td>
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<td>16</td>
<td>16</td>
<td>29</td>
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<tr>
<td>Industrial</td>
<td>31</td>
<td>36</td>
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<td>Others*</td>
<td>2</td>
<td>12</td>
<td>5</td>
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</table>

* Excluding Own-Use and Systems Loss
** Others includes public buildings, street lights, irrigation, energy recovered and others not elsewhere classified.

Source: DOE Power Statistics 2017
Typical 24-hour Load Profile

24 – HOUR LOAD PROFILE, a load profile is a graph of the variation in the electrical load versus time. A load profile will vary according to customer type (typical examples include residential, commercial and industrial), temperature and holiday seasons.

Source: NGCP
How the Power System Works

- Need for continuous and near instantaneous balancing of generation and load

1. Household / Residential Sector
2. Commercial Sector
Generation Sector

Fossil-based Power Plants
- Coal
- Natural Gas
- Oil-based
- Liquefied Natural Gas (LNG)
- Nuclear

Renewable Energy Power Plants
- Biomass
- Geothermal
- Solar
- Hydro
- Ocean / Tidal
- Wind
Generation Sector

Fossil-based Power Plants

- Coal
- Natural Gas
- Oil-based
- Liquefied Natural Gas (LNG)
- Nuclear

No existing facilities yet within the Philippines

Photo credits:
PEDC Coal-fired Power Plant
Ilijan Combined-Cycle Power Plant
Therma Marine Inc. – Nasipit Oil-fired Power Barge
Generation Sector

Renewable Energy Power Plants

- Biomass
- Geothermal
- Solar
- Hydro
- Ocean / Tidal
- Wind

No existing facilities yet within the Philippines

Photo credits:
VMC Bagasse-fired Cogeneration Plant
Leyte Geothermal Production Field
Burgos Wind – EDC
Burgos Solar – EDC
Angat Hydroelectric Power Plant
Plant Operations

Hours

BASELOAD
INTERMEDIATE
PEAKING
Plant Operations

Baseload Power Plants

- Plants which can generate **consistent power** to meet daily demand
- Produce **continuous, reliable and efficient power at low cost**
- **Run at all times** through the year except in the case of repairs or scheduled maintenance
- Capacity Factor at 67% and above
- Typically Coal, Biomass, and Geothermal Power Plants

- 2 x 315 MW AES Masinloc Coal-Fired Power Plant (Zambales)
- 20 MW Maibarara Geothermal Power Plant (Batangas)
- 2 x 647 MW TeaM Energy Sual Coal-Fired Power Plant (Pangasinan)
Intermediate / Mid-merit load Power Plants

- Fill the gap between base load and peaking plants
- Compared to peaking plants, Intermediate/Mid-merit plants are larger so the construction costs are higher but their operational costs are cheaper.
- Also they run more efficiently
- Capacity Factor between 23% to 67%

Natural Gas Power Plants

2 x 600 MW KEILCO Ilijan Natural Gas-fired Power Plant (Batangas)

First Gas Power Corp. 2 x 250 MW San Lorenzo and 4 x 250 MW Sta. Rita Natural Gas-fired Power Plant (Batangas)
Plant Operations

Peaking Power Plants

- Provide power **during peak system demand** periods
- **More responsive to changes** in electrical demand and can be **started up relatively quicker**
- **Expensive to operate** (for oil-based power plants due to usage of diesel/bunker oil as fuel)
- Capacity Factor below 23%
- Dam-type Hydro and Oil-Based Power Plants

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242 MW TMI Therma Mobile Power Barges (Navotas)

235 MW 1590ec Bauang Diesel Power Plant (La Union)

4 x 90 MW SNAP Magat Hydroelectric Power Plant (Isabela)
Capacity Terms

**Installed Capacity**
- Maximum amount of electricity that the power plant can produce
- The total manufacturer-rated capacity of equipment (as indicated in the nameplate)

**Dependable Capacity**
- The load carrying ability of an electric power plant or a generating unit
- The capacity that can be relied upon (monthly or annually)
- For Medium Term (MT) and Long Term (LT) Planning

**Available Capacity**
- The current available capacity of an electric power plant
- The ability of a power plant or a generating unit to produce electricity in a certain time period (hourly or daily)
- For Short Term (ST) planning

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<th>MW</th>
<th>Time</th>
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<tr>
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<tr>
<td>20</td>
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</table>

- **Installed Capacity**: 100 MW
- **Dependable Capacity**: 70 MW
- **Available Capacity**: 50 MW
- **Outage (Forced/Planned/Unplanned)**: 20 MW
How the Power System Works

Need for continuous and near instantaneous balancing of generation and load

1. **GENERATION**
   - Household / Residential Sector
   - Industrial Sector

2. **TRANSMISSION**
   - Natural Gas Plant
   - Coal Plant
   - Embedded Generator

3. **TRANSMISSION**
   - Substation
   - Transformer
   - Distribution line
   - Single-phase Transformer
   - SF₆ Load Break Switch

Transmission Sector

Thick wires on tall towers carry high-voltage electricity from power plants to local communities and connect one region to another.

Transmission Voltages

- **Luzon**: 500, 230, 138, 115, & 69 kV
- **Visayas**: 230, 138, & 69 kV
- **Mindanao**: 138 & 69 kV

*Note: 1 kiloVolt = 1,000 Volts*
TOTAL REQUIREMENT (DEMAND + RESERVE)

**Dispatchable Reserve**
- Generating capacity that is readily available for dispatch in order to replenish the Contingency Reserve Service whenever a generating unit trips or a loss of a single transmission interconnection occurs. (replaces Contingency Reserve)
- Equivalent to the sum of the load of the second largest generating unit connected to the Grid
- Luzon = 647 MW, Visayas = 150 MW, Mindanao = 150 MW

**Contingency Reserve**
- Synchronized generation capacity from Qualified Generating Units and Qualified Interruptible Loads allocated to cover the loss or failure of a synchronized generating unit or a transmission line or the power import from a single circuit interconnection, whichever is larger. (addresses forced outage)
- Equivalent to the sum of the load of the largest generating unit connected to the Grid
- Luzon = 647 MW, Visayas = 135 MW, Mindanao = 150 MW

**Regulating Reserve**
- Generating capacity that is allocated exclusively to cover inter- and intra-hour variations in demand (load behaviors), variations from generation schedules and hourly forecasts (regulation of frequency and voltage)
- Equivalent to the 4% of System Demand

**Demand**
- Total Demand of the System
- Includes Residential, Commercial, Industrial and Others (Street lights and public offices)
- Also includes non-utility customers (directly connected customers)

Source: Ancillary Service Procurement Plan (ASPP)
www.erc.gov.ph/Files/Render/media/1%20ASPP_%20Nov2011.pdf
Grid Alert Levels / Notices

TOTAL REQUIREMENT (DEMAND + RESERVE)

- Demand
- Regulating Reserve
- Contingency Reserve
- Dispatchable Reserve

TOTAL AVAILABLE CAPACITY

- NORMAL STATE
- YELLOW ALERT STATE
- RED ALERT STATE

- Working within normal operating limits of System Frequency, Voltage and all transmission line and equipment loading
- Operating Margin is SUFFICIENT
- Grid Configuration allows for interruption and isolation of any fault current
- Contingency Reserve is LESS THAN the capacity of the Largest Synchronized Generating Unit of the grid
- Contingency Reserve is ZERO
- Generation deficiency exists
- There is Critical loading
- Imminent Overloading of transmission lines or equipment
- May lead to Manual Load Dropping / Rotating brownouts

Blue Alert
A notice issued by the System Operator when a tropical disturbance is expected to make a landfall within 24 hours

Source: Philippine Grid Code (PGC)
How the Power System Works

- Need for continuous and near instantaneous balancing of generation and load

1. **GENERATION**
   - Household / Residential Sector
   - Industrial Sector
   - Commercial Sector

2. **DISTRIBUTION**
   - Embedded Generator

3. **TRANSMISSION**
   - Transforming power from generation to distribution
   - SUBSTATION

Distribution Sector

Thinner wires on smaller towers or electric poles; carry much lower voltage power to homes, businesses and other load centers.

Distribution Voltages

- Primary: 4.16 kV, 13.8 kV, 34.5 kV, 69 kV
- Secondary: 110/115 or 220/230 V

Note: 1 kiloVolt = 1,000 Volts
Terminologies

Brownout: Reduced voltage in certain areas which may result in flickering of lights and/or damage to equipment/appliances.

Power interruption: Loss of electric power in a specific area. May be scheduled for service improvements, or unscheduled due to emergencies.

Blackout: Total or partial system collapse in the power grid.
Thank You!

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