Integration New and Renewable Energy into the grid

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St. Regis Hotel, Bangkok, Thailand
1. Thailand’s Energy Situation and Energy policy

2. Alternative Energy Development Plan (AEDP) and Supporting Measures


4. Testbed of “DC-PV Micro-grid”

5. Key Take-aways
1. Thailand’s Energy Situation and Energy policy
Total Energy Consumption in 2012 = 73,316 ktoe

Final energy consumption by economic sector

- Industry: 36.70%
- Transportation: 35.78%
- Residential: 15.12%
- Commercial: 7.23%
- Agriculture: 5.17%

Total Energy Use 2.0 million barrels (oil equivalent) per day = 1.9 trillion baht

Energy import value in 2012 = 1.125 trillion baht (Sharing 18% of GDP)
=> 77% of import value = Crude Oil
Thailand’s Energy Situation in 2012

Proportion of Import and Domestic Production

- **Crude oil**
  - Domestic production: 15
  - Import: 85
  - Import Value: 927

- **Petroleum Products**
  - Domestic production: 99
  - Import: 1
  - Import Value: 10

- **Natural Gas**
  - Domestic production: 74
  - Import: 26
  - Import Value: 136

- **Coal**
  - Domestic production: 49
  - Import: 51
  - Import Value: 40

- **Electricity**
  - Domestic production: 96
  - Import: 4
  - Import Value: 12

**Total Import Value** 1,125

- Import 81% of oil consumption
- Import 56% of overall energy demand
Thailand’s Electricity Situation in 2012

**Thai Electricity Challenges**

- Increased and fluctuated **world oil/gas price**
- Limited **petroleum reserved**
  - needs to import 85% of supply
- 70% of electricity supply depends on **Natural Gas**
- Lacking of **public acceptance** on Energy projects
  - affects long term energy security

**Fuel Consumption for Electricity Generation**

- Natural Gas: 63.80%
- Coal/Lignite: 27.70%
- RE & Others: 6.90%
- Fuel oil & Diesel: 1.60%
Renewable energy Plan & Policy

11th National Economic and Social Development Plan

Balance of Food and Energy Security

- Develop Natural Resource to Strengthen Agricultural Base
- Enhance Agricultural Productivity & Value creation
- Enhance Food & Bio-energy security & Biomass -- at Household & community Level
- Develop Bio-Energy Security
- Improve Agricultural Management to Food & Energy Balance

Sustainable Management of Natural Resources & Environment

- Shifting Development paradigm towards Low-Carbon Society
Renewable energy Plan & Policy

Thailand’s Energy Policies

- Develop Infrastructure to be “Regional Energy Center”
  - Land Bridge
  - Smart Grid
  - Gas Pipeline
  - Power Grid

- Secure Thailand Energy supply
  - Power Plant / Oil Storage
  - International Cooperation
  - Participation

- Fair Energy Pricing
  - Energy Price Restructure

- Up-scaling RE mix to 25% in 10 years
  - CBG
  - Feed in Tariff
  - Distributed Green Generation
  - Research & Development

- Target Energy Intensity reduction by 25% within 20 years (based on 2010 level)
  - Energy Conservation Law & Regulation
  - CDM
2. Alternative Energy Development Plan (AEDP) and Supporting Measures
Renewable Energy Policies

• Critical Factors of Renewable Energy Dissemination:

1. Government policies on “Target & Incentives”

2. How much the existing “National Grid” can take up RE-power

3. “Grid Parity” : RE Cost vs. Electricity Tariff
How we count RE....

Final Energy Consumption

- Fossil fuels: 77.40%
- Renewable Energy & Traditional Biomass: 20.40%
- Imported Hydro power: 1.20%
- Large Hydro power: 1.00%
- Traditional RE: 10.5%
- Biofuels: 1.6%
- Heat: 6.9%
- Power Generation: 1.3%
- Small Hydro Power: 0.1%
- Renewable Energy (under AEDP): 9.9%
**Alternative Energy Development Plan (AEDP)**

**Committed to the development of low-carbon society**

**Government Funding**
- On R & D & D Activities

**Private-Led Investment**

**10 years Alternative Energy-Development Plan (AEDP-Master Plan 2012-2021)**

**Target 25 % of RE (excl. Large Dams, Imported Hydro & Traditional Biomass) in Total Energy Consumption By 2021**

### New energy
- Ocean & Tidal: 2 MW
- Geothermal: 1 MW
- 3 MW

### Solar
- 2,000 MW
- 1,200 MW
- 3,200 MW

### Wind
- Small: 324 MW
- Micro: 1,284 MW
- 1,608 MW

### Hydro power plant
- Pumped-Storage: 1,608 MW
- 4,390 MW

### Bio-energy
- Biomass: 3,630 MW
- Bio-gas: 600 MW
- MSW: 160 MW

### Biofuels
- Ethanol: 9 ML/day
- Biodiesel: 5.97 ML/day
- 2nd - Gen. Biofuels: 25 ML/day

**Excl. Large Dams & Imported Hydro**

**Excl. Traditional Biomass**

**Renewable fuel 44%**
Renewable Energy Policy

Measure for RE Promotion

- **BOI-Investment Incentives**
  - Renewable energy maps
  - Data from demonstration site
  - Renewable energy potential info

- **Investment Grant**
  1. Biogas
  2. Solar hot water
  3. MSW

- **“Energy Soft Loan”**
  - Revolving funds for Renewable energy and energy conservation

- **ESCO Venture Capital Fund**

- **Future change of “Adder” to Feed-in Tariff (FIT) Policy**

Offices giving licenses

- ONEP
- ERC-DIW
- Local Admin

Technical support

Subsidy request

Private Investor

Banks loan

Carbon credit sale

CDM

- Firm
- Non Firm

Electricity authorities

Adder/ FIT (pending)

Consumers
## AEDP targets and Current Situations

<table>
<thead>
<tr>
<th>Types</th>
<th>Units</th>
<th>Goal 2021</th>
<th>Current Capacity Feb 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td>MW</td>
<td>9,201</td>
<td><strong>2,786 MW</strong></td>
</tr>
<tr>
<td>Solar</td>
<td>MW</td>
<td>2,000</td>
<td>376.72</td>
</tr>
<tr>
<td>Wind</td>
<td>MW</td>
<td>1,200</td>
<td>111.73</td>
</tr>
<tr>
<td>Small Hydro</td>
<td>MW</td>
<td>1,608</td>
<td>101.75</td>
</tr>
<tr>
<td>Biomass</td>
<td>MW</td>
<td>3,630</td>
<td>1,959.95</td>
</tr>
<tr>
<td>Biogas</td>
<td>MW</td>
<td>600</td>
<td>193.40</td>
</tr>
<tr>
<td>MSW</td>
<td>MW</td>
<td>160</td>
<td>42.72</td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td>Ktoe</td>
<td>9,335</td>
<td><strong>4,882 Ktoe</strong></td>
</tr>
<tr>
<td>Solar</td>
<td>Ktoe</td>
<td>100</td>
<td>4.0</td>
</tr>
<tr>
<td>Biomass</td>
<td>Ktoe</td>
<td>8,200</td>
<td>4,342</td>
</tr>
<tr>
<td>Biogas</td>
<td>Ktoe</td>
<td>1,000</td>
<td>458</td>
</tr>
<tr>
<td>MSW</td>
<td>Ktoe</td>
<td>35</td>
<td>78</td>
</tr>
<tr>
<td><strong>Biofuel</strong></td>
<td>ML/day</td>
<td>39.97</td>
<td><strong>4.3 ML/day</strong></td>
</tr>
<tr>
<td>Ethanol</td>
<td>ML/day</td>
<td>9</td>
<td>1.6</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>ML/day</td>
<td>5.97</td>
<td>2.7</td>
</tr>
<tr>
<td>Total RE (ktoe)</td>
<td></td>
<td></td>
<td>7,290.1</td>
</tr>
</tbody>
</table>

Now 9.9% of RE in Total Energy Consumption
Renewable energy potential

**RE Potential**

### Natural
- Solar
- Hydro
- Wind

### Crop
- Sugar cane (Molasses)
- Cassava
- Palm

### Waste
- Agricultural
- Industrial
- Municipal solid waste (MSW)

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*Total realizable potentials for RE in ASEAN-6 countries, by technology to 2030; IEA 2010*
Thailand’s Energy situation in 2012

Installed Capacity of RE power generation

- Fossil Fuel: 28,140 MW
- Imported Hydro: 2,185 MW
- Large Hydro Power: 3,406 MW
- Renewable Energy: 2,786 MW

- Biomass: 70.4%
- Solar: 13.5%
- MSW: 4%
- Wind: 3.7%
- Biogas: 6.9%

- MSW: 42 MW
- Small Hydro Power: 102 MW
- Wind: 112 MW
- Biogas: 193 MW
- Solar: 377 MW
- Biomass: 1,960 MW
North
Total 1,458 MW
- Large Hydro = 1,279 MW
- Biomass = 110 MW
- Mini hydro = 40 MW
- Solar = 24 MW
- Geothermal = 0.3 MW
- Biogas = 5 MW

Northeast
Total 1,377 MW
- Large Hydro = 737 MW
- Biomass = 352 MW
- Mini hydro = 24 MW
- Solar = 120 MW
- Biogas = 51 MW
- Wind = 180 MW

South
Total 430 MW
- Large Hydro = 312 MW
- Biomass = 48 MW
- Mini hydro = 4 MW
- Solar = 0.1 MW
- Biogas = 47 MW
- Wind = 2 MW
- MSW = 17 MW

Central
Total 1,606 MW
- Large Hydro = 1,078 MW
- Biomass = 241 MW
- Mini hydro = 13 MW
- Solar = 230 MW
- Biogas = 43 MW
- Wind = 0.1 MW
- MSW = 1 MW
Solar-Farm Power Plants

- Promotion of Solar PV Rooftop
- Feed-in Tariff system (FIT)
- On the drawing board but Not yet approved
Trend & Opportunities

- Promoting community collaboration
- Focus areas = Korat, Petchaboon, Chaiyaphum & Southern Thailand
- Next wave = Small-scale Wind Turbines
Small & Mini-Hydro Power Plants Map

Potential Area

Generate hydro power at Village level

Very small power plant 48 projects
1,807 KW
Non-electrified household (Off-Grid)

DEDE & EGAT develop small hydro power system of downstream irrigation dam
Biomass Power Plants Map

Potential Areas

- Promote “Distributed Green Generation”
- Promote Fast Growing Trees
- Extending transmission & distribution lines
- Promote biogas production in household level
- Promote “CBG” Compress Bio-Methane Gas
- Biogas Safety Campaign

New Initiatives:
- Promote “Distributed Green Generation”
- Promote Fast Growing Trees
  - Encourage farmers to grow energy plant
  - Co-investing in biogas power plant
  - Produce - electricity
    - CBG
    - use for LPG Substitution
• Promote MSW in medium/small size Local Admin Organization
• Promote “RDF” Refuse-Derived Fuel

Bangkok & Vicinities & Other Big Cities
Geo-Thermal Power Plant Map

- The only existing plant

- Geo-thermal in Northern part of Thailand (Chiang Mai)
3. Case Study of “I-sarn” (Northeast Thailand)
Power Plants in I-sarn

Contract Capacity of Thailand’s Northeastern System (by power plant type) in 2012

<table>
<thead>
<tr>
<th>Power Plant Type</th>
<th>Capacity (MW)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Cycle</td>
<td>650</td>
<td>16%</td>
</tr>
<tr>
<td>Hydro (Laos)</td>
<td>2,104.6</td>
<td>51%</td>
</tr>
<tr>
<td>Hydro (Domestic)</td>
<td>744.3</td>
<td>18%</td>
</tr>
<tr>
<td>Solar</td>
<td>113.3</td>
<td>3%</td>
</tr>
<tr>
<td>Wind</td>
<td>180</td>
<td>4%</td>
</tr>
<tr>
<td>Biomass/Biogas</td>
<td>420.6</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,125</strong></td>
<td></td>
</tr>
</tbody>
</table>

Renewable Energy 3,475 MW (84%)
**Myanmar**

MOU 4th July 1997: 1,500 MW
Potential: 40,000+ MW

- High of potential areas => North & Northeast
- Available to Imported electricity from neighboring countries

**Laos**

MOU 22nd Dec 2007: 7,000 MW
Signed PPA: 2,913 MW
COD: 1,891 MW
Potential: 26,000 MW

**Cambodia**

Potential: 10,000 MW

*ข้อมูล ณ วันที่ 31 มกราคม 2555*
Integrating New & Renewable Energy into the grid

The service area of PEA Area3 (North East) is approx. 51,720 km², accounting for 10.079% of the country.

- 4 Provinces
- 72 amphurs
- 760 districts
- 9359 villages
- 6,645,088 populations
- 1,687,620 customers
Thailand Generation Transmission and Distribution Power System

- **Generation** 13.8 kV
- **Transmission Line** 115 kV, 230 kV, 500 kV
- **Substation**
  - Transmission Line 69 kV, 115 kV
  - MV Distribution Line 22 kV, 33 kV
  - LT Distribution Line 400/230 V
- **Switchyard**
- **Power Plant**
- **Large Industrial**
- **Industrial**
- **Distribution Transformer**
- **Household**
The service area of PEA Area 3 (North East) is approx. 51,720 km², accounting for 10.079% of the country.

1,217 MW Peak-Demand

- 4 Provinces
- 72 amphurs
- 760 districts
- 9359 villages
- 6,645,088 populations
- 1,687,620 customers
### Numbers of SPP/VSPP in “PEA Area3”

<table>
<thead>
<tr>
<th>REType</th>
<th>SPP</th>
<th>VSPP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nb of Project</td>
<td>Capacity (MW)</td>
<td>Nb of Project</td>
</tr>
<tr>
<td>Biomass</td>
<td>6</td>
<td>90</td>
<td>14</td>
</tr>
<tr>
<td>Biogas</td>
<td>-</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>Solar</td>
<td>-</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Wind</td>
<td>1</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>20</strong></td>
<td><strong>47</strong></td>
</tr>
</tbody>
</table>

**RE proportion in the grid in “PEA Area3” = 40%**
Needs of the SCADA System

Area of High Penetration of RE needs proper Data management

- GSM Modem (Telephone Simcard)
- Switched Capacitor Bank I/f
- Line Regulator Recloser I/f
- Fiber Optic / Leased Line
- UHF 450 MHz MARS
- Remote Controlled Switch I/F
Show case “PEA Area3” Electrical Power System

<table>
<thead>
<tr>
<th>Substation</th>
<th>Transformer (MVA)</th>
<th>Feeder</th>
<th>Peak Load(MW) Year 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 of 115 kV-substations (include 1 switching substation)</td>
<td>1,050</td>
<td>93</td>
<td>766.2</td>
</tr>
<tr>
<td>11 of 22 kV -substations</td>
<td>1,125</td>
<td>143</td>
<td>450.8</td>
</tr>
<tr>
<td>Total 35 Substations</td>
<td>2,175</td>
<td>236</td>
<td>1,217</td>
</tr>
</tbody>
</table>

- Transmission System: 115 kV 815.39 cct-km
- Distribution System: 22 kV 27,928.50 cct-km
- L.V. Distribution Lines: 40,215.25 cct-km
- 1,217 MW of peak load
- **Distribution Generators:** 8 SPP and 47 VSPP
SPP/VSPP connect with the electric power system of PEA(Area3)

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSPP 40</td>
<td></td>
<td>(365.933 MW)</td>
</tr>
<tr>
<td>SPP 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>19</td>
<td>(184.60 MW)</td>
</tr>
<tr>
<td>Biogas</td>
<td>13</td>
<td>(30.133 MW)</td>
</tr>
<tr>
<td>Solar</td>
<td>14</td>
<td>(86 MW)</td>
</tr>
<tr>
<td>Wind</td>
<td>2</td>
<td>(180 MW)</td>
</tr>
</tbody>
</table>
Lesson Learned from I-Sarn

Problems & Barriers

1. Multiple Sources of Electricity
   - Swing voltage
   - High cost of investment
   - Power Quality

2. SCADA/Data Collection
   - RE-facilities = lots of data
   - need more system / servers
   - need to develop real-time system

3. Readiness indicator prior to any future upgrade to “Smart system”
   - Smart Grid
   - Energy Storage
4. Testbed of “DC-PV Micro-grid ”
Hybrid DC Microgrid Pilot Project

- Community DC power grid system with low voltage from PV-Biodiesel

25.5 kW PV
Load:
1 office, 1 minimart, 1 restaurant, 1 coffee shop, 1 farm, 6 houses
Location:
Smart Community
Chiang Mai World Green City
Chiang Mai Rajabhat University, Chiang Mai Thailand
Data management at the community level
5. Key Take-Aways
Key Take-Aways

1. Thailand has L/T goal as well as supporting policies for RE-investment.

2. Thailand national power-grids (T&D) have some capability to take up more RE-power. However, upgrading T&D is another key area to boost RE-investment in Thailand.

3. One region of Thailand, I-Sarn, has already 84% of RE-power.

4. **Proper investment in the SCADA** system is the critical step before going into “SMART Grid. Thailand’s PEA has actively invested in the SCDADA system.

5. “**PV-DC Micro-grid**” may be the solution for community-based RE-facility, especially in the case of island or mountaintop villages.
Thank you for Your attention

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