Financing hydropower and geothermal

Cédric PHILIBERT
Renewable Energy Division
International Energy Agency

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Hydropower drivers

➢ Affordable energy, security of supply
  ▪ Proven, reliable, safe
  ▪ Competitive
  ▪ Fostering social and economic development
  ▪ Improving access to modern energy and alleviating poverty

➢ Energy services
  ▪ Reserves, voltage and frequency support, black-start, etc.

➢ Multipurpose water resource management
  ▪ Irrigation
  ▪ Freshwater supply
  ▪ Flood control
  ▪ Navigation
  ▪ Recreation

➢ Support to deploying PV and wind power
  ▪ Flexibility from:
    ▪ Reservoir hydropower
    ▪ Pumped-hydro power
Hydropower generation will double by 2050 and reach 2,000 GW and 7,000 TWh, mostly from large plants in emerging/developing economies.
## Vision for PSP deployment by 2050

<table>
<thead>
<tr>
<th>Low</th>
<th>vRE/total energy</th>
<th>Hydro/total energy</th>
<th>PSP/total capacity</th>
<th>Total GW</th>
<th>Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>China</strong></td>
<td>21%</td>
<td>14%</td>
<td>4%</td>
<td>119</td>
<td>109</td>
<td>412</td>
</tr>
<tr>
<td><strong>USA</strong></td>
<td>24%</td>
<td>6%</td>
<td>4%</td>
<td>58</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>43%</td>
<td>13%</td>
<td>6%</td>
<td>91</td>
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<td></td>
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<tr>
<td><strong>Japan</strong></td>
<td>18%</td>
<td>12%</td>
<td>11%</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RoW</strong></td>
<td></td>
<td></td>
<td>2%</td>
<td>109</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>412</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>vRE/total energy</td>
<td>Hydro/total energy</td>
<td>PSP/total capacity</td>
<td>Total GW</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>34%</td>
<td>15%</td>
<td>5%</td>
<td>179</td>
<td>164</td>
<td>700</td>
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<tr>
<td><strong>USA</strong></td>
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<td>6%</td>
<td>8%</td>
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<tr>
<td><strong>Europe</strong></td>
<td>48%</td>
<td>11%</td>
<td>10%</td>
<td>188</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>33%</td>
<td>13%</td>
<td>12%</td>
<td>39</td>
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<tr>
<td><strong>RoW</strong></td>
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<td></td>
<td>3%</td>
<td>164</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>700</td>
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</tbody>
</table>
Financing challenges

- Although cost-effective, hydropower faces financial challenges
  - Large projects, capital intensive, long building times
  - Returns on investment vary from year to year
  - Long tenures from commercial banks difficult to get
  - Flexibility under-valued on most markets
  - Market design based on marginal running costs may not deliver the right incentives
Financing: the need for innovation

The Nam Theun 2 case: utilising World Bank’s partial risk guarantees to mobilise private debt financing

- Addressing all risks requires complex financing structures associating private and public tools

*Nam Theun Power Company (Special Purpose Vehicle)*
vRE and the value of storage

Past

Future

Today-Medium term

- Medium-term: PV reduces value of flexible resources

<table>
<thead>
<tr>
<th>€/MWh</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tbody>
<tr>
<td>Phelix Base</td>
<td>37.99</td>
<td>66.76</td>
<td>38.85</td>
<td>44.49</td>
<td>51.12</td>
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<tr>
<td>Phelix Peak</td>
<td>56.16</td>
<td>88.07</td>
<td>51.15</td>
<td>55.02</td>
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<tr>
<td>Spread [%]</td>
<td>149</td>
<td>134</td>
<td>132</td>
<td>124</td>
<td>115</td>
</tr>
</tbody>
</table>

- Long-term: Mutual increase of market value
Roadmap vision of geothermal power production by region (TWh/y)

Geothermal electricity capacity could reach 200 gigawatts by 2050, providing 1400 TWh per year (3.5% of electricity production)
Enhanced Geothermal Systems (EGS) plays an important role in the roadmap vision for geothermal energy
Roadmap vision of direct use of geothermal heat by region (EJ/y)

Geothermal heat could contribute to 5.8 EJ per year by 2050, (3.9% of final energy for heat), excluding ground source heat pumps
Risks compared

- **Hydropower**
  - Acceptance risk
  - Construction risks
  - Hydrologic risk
  - Off-taker risk
  - Regulatory risk

- **Geothermal**
  - Drilling risks