Renewable Energy: Policy options & integration issues

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BPPT, Jakarta, 28/11/06

Outline

- Sustainability context
- Renewable energy technologies & characteristics
- Key issues with high levels of renewable energy penetration
Sustainability context for the electricity industry (IPCC COP7)

Must also achieve resource adequacy: Short & long-term system security (availability & quality of supply)

Climate change emissions (Tonnes C per capita, Grubb 2006)

per-capita emissions vs population, 2000
Renewable energy barriers, challenges & opportunities, IEA, 2006

IPE Brent Crude Oil Closing Price (begin July 1988)

Figure 3. Development in oil prices since 1988 (www.oilenergy.com, 2006-02-13)

Renewable energy & coal comparison (IEA, 2006)
Aust. non-hydro RE market shares (%)

Coal-fired power station approx 35€/MWh

Costs of electricity (LRMC - Payback time: 15 years) [€/MWh]
Status of RE technologies: hardware perspective (IEA, 2006)

Low-emission generation cost trends (MMA, 2006)
The most effective policy options depend on the context (Grubb, 2006)

<table>
<thead>
<tr>
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<th>Voluntary, regulatory and systemic instruments</th>
<th>Economic instruments</th>
<th>Innovation instruments</th>
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<tbody>
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<td>Behaviour</td>
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<td>Substitution</td>
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<td>Technical innovation</td>
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Successful innovation requires both technology push & market pull (Grubb, 2006)
Renewable energy support policy taxonomy

(Rivier, 2006; Enzesberger et al, 2002)

### Policy instruments

- **Legislative measures**
  - Direct control
  - Supply push
  - Construction incentives
- **Non-legislative measures**
  - Economic based
  - Demand-pull
  - Production incentives

#### Legislative measures
- **Direct control**
  - Economic based
  - Supply push
  - Construction incentives

#### Economic based
- **Nondirect control**
  - Player-initiated (voluntary)
  - Information

#### Player-initiated (voluntary)
- **Information**
  - Feed-in tariffs (Germany)
  - Tradable certificates (Australia, UK)
  - Green pricing (many countries)

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### Renewable Energy: Policy Options & Integration Issues

- Transmission network
- Distribution network
- Wholesale market regions

**Primary energy markets**

- Interchange to other wholesale market regions
- Large generators

**Wholesale market regions**

- Primary energy markets
- Transmission network

**Retail market regions**

- Retail Market 1
- Distribution network
- Most end-users
- Embedded generators

- Retail Market 2
- Distribution network
- Retail Market 3
- Distribution network
- Large end-users

**A restructured electricity industry must understand & efficiently manage, by centralised & decentralised decision-making, the location-dependent risks to the flow of end-use energy services**

**Climate change impacts**

- Small end-user, embedded generators & storage should be supported by energy service advisers
- Wholesale & retail designs should be compatible, with spot & derivative markets that model flow constraints
**Contributors to unavailability of electricity supply for small end-users** (USA data, AEMC, 2006)

<table>
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<tr>
<th>Contributor</th>
<th>Average unavailability per customer year</th>
<th>(%)</th>
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<tr>
<td></td>
<td>(minutes)</td>
<td></td>
</tr>
<tr>
<td>Generation/transmission</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>132 kV</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>66kV and 33kV</td>
<td>8.0</td>
<td>8.3</td>
</tr>
<tr>
<td>11kV and 6.6kV</td>
<td>58.8</td>
<td>60.7</td>
</tr>
<tr>
<td>Low voltage</td>
<td>11.5</td>
<td>11.9</td>
</tr>
<tr>
<td>Arranged shutdowns</td>
<td>15.7</td>
<td>16.2</td>
</tr>
<tr>
<td>Total</td>
<td>96.8 minutes</td>
<td>100.0</td>
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**Security & commercial regimes** (global & local)

- **Unreachable or unacceptable futures**
- **Emergency control**
- **Secure operating limits** (probabilistic)
- **Growing uncertainty**
- **Present state**

- **Commercial regime** Possible futures managed by decentralised decisions
- **Security regime** Possible futures managed by centralised decisions

*Renewable energy increases future uncertainty but forecasts can help*
Wind farm response to varying wind conditions

S1: Infra-red satellite map (BoM Aust.1125 UTC 24/4/05)
Low-pressure cell over southern Australia

(BoM, 2006)
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Key technical issues for high-penetration renewable energy

- Design & demonstration of distributed resource systems (generation, storage, end-use response)
- Advanced metering, communication & control for distributed resources
- Improved power electronic devices
- Compact, high-capacity & cost-effective reversible energy storage
- Mathematic modelling & forecasting for renewable energy generation & distributed resources

Key regulatory & policy issues for high-penetration renewable energy

- Institutional issues:
  - Robust security regime with security-constrained dispatch
  - Efficient commercial regime (operation & investment)
  - Effective regulatory framework (network services)
  - Compatible arrangements for gas industry

- Policy issues:
  - Appropriate innovation in renewable energy technologies
  - Correct location & timing for investment in renewables
  - Forecasting for security & commercial regimes
  - Active end-user participation (value, timing, efficiency)
  - Skill development in all relevant areas

Key commercial issues for high RE

- Advanced auction-style electricity markets:
  - Spot & derivative energy; ancillary services
    - Within continually updated security constraints
    - With active end-users supported by ESCOs
    - With attention to equity issues

- Efficient network access regimes:
  - Availability & quality; active end-user participation

- Renewable energy forecasting tools for:
  - Renewable energy generators
  - Other generators and end-users
  - System operators & policy-makers

- Efficient financial mechanisms to counter un-costed fossil fuel externalities
Many of our publications are available at:
www.ceem.unsw.edu.au