Integration of renewables supply and demand; social acceptance of crucial smart grid elements.

Scale Conflicts about Distributed Generation

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Renewable Energy:

“Distributed generation”

- Micro/decentralized generation:
  * PV (PhotoVoltaics)
  * micro CHP (biofuels, preferably bio-waste),
  * onshore wind
  * geothermal (prudential) hydro (tidal etc)
- Small scale, spatially dispersed
- Spatial claims renewables: "huge" 
  * MacKay DJC 2008
- Variable sources
- Power grid applied as 'storage' capacity
  * Charles D 2009 Science 324: 172-175 "Renewables test IQ of the grid"
## Distributed Generation

Ackermann, Andersson, Söder 2004

<table>
<thead>
<tr>
<th>Technology</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined cycle gas T.</td>
<td>35–400 MW</td>
</tr>
<tr>
<td>Internal combustion engines</td>
<td>5 kW–10 MW</td>
</tr>
<tr>
<td>Combustion turbine</td>
<td>1–250 MW</td>
</tr>
<tr>
<td>Micro-Turbines</td>
<td>35 kW–1 MW</td>
</tr>
<tr>
<td><strong>Renewable</strong></td>
<td></td>
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<tr>
<td>Small hydro</td>
<td>1–100 MW</td>
</tr>
<tr>
<td>Micro hydro</td>
<td>25 kW–1 MW</td>
</tr>
<tr>
<td>Wind turbine</td>
<td>200 Watt–3 MW</td>
</tr>
<tr>
<td>Photovoltaic arrays</td>
<td>20 Watt–100 kW</td>
</tr>
<tr>
<td>Solar thermal, central receiver</td>
<td>1–10 MW</td>
</tr>
<tr>
<td>Solar thermal, Lutz system</td>
<td>10–80 MW</td>
</tr>
<tr>
<td>Biomass, e.g. gasification</td>
<td>100 kW–20 MW</td>
</tr>
<tr>
<td>Fuel cells, phosacid</td>
<td>200 kW–2 MW</td>
</tr>
<tr>
<td>Fuel cells, molten carbonate</td>
<td>250 kW–2 MW</td>
</tr>
<tr>
<td>Fuel cells, proton exchange</td>
<td>1 kW–250 kW</td>
</tr>
<tr>
<td>Fuel cells, solid oxide</td>
<td>250 kW–5 MW</td>
</tr>
<tr>
<td>Geothermal</td>
<td>5–100 MW</td>
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<tr>
<td>Ocean energy</td>
<td>100 kW–1 MW</td>
</tr>
<tr>
<td>Stirling engine</td>
<td>2–10 kW</td>
</tr>
<tr>
<td>Battery storage</td>
<td>500 kW–5 MW</td>
</tr>
<tr>
<td>V2G (electr vehicle batteries)</td>
<td>10-100 kW</td>
</tr>
</tbody>
</table>
Definition

- **Distributed Generation**

  *is an electric power source*

  - connected directly to the distribution network

  - or on the customer site of the meter.

  Ackermann et al 2004
Feasibility RES requires integration of:
- different supply patterns
- and (adapted) demand patterns

- Different patterns of variable supply
- Optimization supply and demand: needs (micro-)optimization

- Development of (local) micro-grids,
  - several ‘prosumers’ in a 'community'
  - load-control *(supporting DG, not central)*
  - including local storage (e.g. electr. vehicles)
- Smart meters, including smart regulation *(supporting ‘prosumers’ and ‘micro-grid’)*
Strong pressure on the power grid: towards a "Smart Grid"

- Fundamental question: *Which institutional changes needed to establish smart micro-grids with renewable DG generation as much as possible?*
- Who will invest? Who has control about what? Does micro-generation get priority over large-scale unsustainable generating capacity?
Social acceptance in innovation primarily issue with an institutional character

**Community Acceptance**
end users, local authorities, residents → project decision making on infrastructure, investments and adapted consumption; based on trust, distributional justice and fairness of process

**Market Acceptance**
producers, distributors, consumers, intra-firm, financial actors → investing in RES-E and DG infrastructure, using RES generated power

**Socio-Political Acceptance**
regulators, policy actors, key stakeholders, public
→ craft institutional changes & effective policies fostering market & community acceptance
Acceptance of what?
- key issue: *institutional scale conflict*
- socio-political and market acceptance of control of increasingly active consumers (‘prosumers’)

Peacock, Owens. Energy Efficiency 2014
Institutional lock-in: existing patterns of thinking and behaviour

“Alternatives representing radical technological change have to come from outside organisations representing the existing technologies, whereas the existing incumbents even make efforts to eliminate alternatives from decision-making processes.”


Comparison of 12 decision-making processes in RES projects in 1st country successful in RES implementation
Example V2G integration

- controlled Electric Vehicles charging reduce required transmission capacity
- reduce electricity dispatch costs,
- curtailment of variability renewable energy sources (RES)
- curtailment storing energy by utilizing pumped hydro
- absorbs unserved load.

Verzijlbergh et al, 2014
Grid Regulation with an EV
Centralized vision
V2G Centralized vision
V2G: *Prosumer vision*: storage V2G helps RE integration in microgrid; enhancing acceptance and limiting transmission
EU ‘vision’ on the ‘smart’ grid
‘Smart grid’: “...rescaling and distributed generation” ... “integrated micro-grids that can monitor and heal itself”  
Example: DG units with LowVoltage DC network  [Justo et al. 2013, 390]
Institutional conflict: taxation

- Integrated production/demand
- Co-operating ‘prosumers’ (wind, solar, geothermal, storage etc.)
- Smart meters supporting co-operation and integration → no energy company control
- Where are the energy-flows taxed?
- Interest of the state (incumbent/vested interest) in current power supply system
DG with local storage in smart grid

- When the aim is to maximize IS [information system]-enhanced ESS [electricity storage system] ... most promising to give private households absolute control rights over theses systems ... to maximize personal security of supply”

“... policy-makers could impose laws that give distribution system operators control rights over IS-enhanced ESS in private houses....”

- Römer et al, Electr Markets in press 2014, p.11
Thank you

References


Verzijlbergh R et al. (2014) Does controlled electric vehicle charging substitute cross-border transmission capacity? Applied Energy 120, 169-180
