Renewable Energy: technologies and government policies

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Renewable Energy Association
Overview of talk

- About the REA
- European and UK targets for Renewable Energy
  - 2001 Renewable Electricity Directive
  - 2009 Renewable Energy Directive
  - Post 2020 targets?
- Support mechanisms (for electricity)
  - NFFO
  - Renewables Obligation
  - Electricity Market Reform
- Current contributions to power generation
- The state of play with renewables technologies (with marine renewables in detail)
About the Rea

- Pan-technology trade association
- Heat, power generation and transport
- 950 corporate members
- Established 2001
- Magazine and flyer on the registration desk
RES Directive (the first one)

- RES = (Electricity from) Renewable Energy Sources
- An EU White paper (of 1997) set a target of 12% of gross inland energy consumption from renewables for the EU-15 by 2010, of which electricity would represent 22.1%
- The 2001 Directive put this into effect (for EU 15) and later with enlargement target reduced to 21%
- UK’s share was 10% renewable electricity by 2010
- Repealed by 2009 Renewable Energy Directive (the “RED”)
# RES Directive 2001

<table>
<thead>
<tr>
<th>Country</th>
<th>% in 1997</th>
<th>target (%) in 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>1,1</td>
<td>6</td>
</tr>
<tr>
<td>Denmark</td>
<td>8,7</td>
<td>29</td>
</tr>
<tr>
<td>Germany</td>
<td>4,5</td>
<td>12,5</td>
</tr>
<tr>
<td>Greece</td>
<td>8,6</td>
<td>20,1</td>
</tr>
<tr>
<td>Spain</td>
<td>19,9</td>
<td>29,4</td>
</tr>
<tr>
<td>France</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Ireland</td>
<td>3,6</td>
<td>13,2</td>
</tr>
<tr>
<td>Italy</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>2,1</td>
<td>5,7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3,5</td>
<td>9</td>
</tr>
<tr>
<td>Austria</td>
<td>70</td>
<td>78,1</td>
</tr>
<tr>
<td>Portugal</td>
<td>38,5</td>
<td>39</td>
</tr>
<tr>
<td>Finland</td>
<td>24,7</td>
<td>31,5</td>
</tr>
<tr>
<td>Sweden</td>
<td>49,1</td>
<td>60</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1,7</td>
<td>10,0</td>
</tr>
<tr>
<td><strong>EU Community overall</strong></td>
<td>13,9</td>
<td>22</td>
</tr>
</tbody>
</table>
The RED
(Renewable Energy Directive)

• Agreed in 2009, replaced the RES Directive
• EU(27) overall target 20% of gross inland energy consumption
• Of which transport comprises 10%
• Was part of the “20-20-20” package
  – A 20% reduction in GHG from 1990 levels
  – 20% EU energy consumption from renewables
  – A 20% improvement in the EU's energy efficiency
• UK target 15%
DECC’s expectations for achieving the 15% EU target

• Renewable heat: 12%
• Renewable transport fuels: 10%
• To make up the shortfall:

30% from renewable electricity!
A 2030 target?

- The EC is developing a 2030 framework climate change and energy policies.
- A Green Paper of March 2013 launched a public consultation on what the 2030 framework should contain
  - Continue as before (RE, EE and GHGs) or have a carbon only target?
  - What type, nature and level of climate and energy targets should be set for 2030?
  - How can coherence between different policy instruments be attained?
  - How can the energy system best contribute to EU competitiveness?
  - How can Member States' different capacities to act be taken into account?

- EC will conclude on this at end of 2013
- Discussion in spring summit in March 2014.
REA’s views

• Renewables are about more than carbon
• The previous package got it right
• Continue with separate renewable energy target for 2030, set at EU level but made up of mandatory national targets for all Member States
• Stick with a separate transport target
• REA did not suggest a target for 2030, although EREC called for 45%
Overview of support since 1990
1) Non Fossil Fuel Obligation

• Started in 1990, not influenced by Europe but by the need to assist with the privatisation of the Electricity Supply Industry. Nuclear was proving a hard sell ..... 
• shares many characteristics with the new arrangements which will be introduced following Electricity Market Reform
• Companies bid in their projects, giving the technology, the size (capacity) and the generation cost
• Winning projects would get a contract for 15 years – like EMR!
• Five rounds in total, last of which in 1998.
• Criticised for “picking winners”, but the policy initiated renewable energy industry and had much to commend it
Overview of support since 1990

2) The Renewables Obligation (RO)

- Started in 2002
- “Lean and mean as well as clean and green”....
- Aiming to avoid criticism of "picking winners"
- Certificate based system, with 1 RO Certificate per 1MWh
- Suppliers required to source increasing percentage of their power from renewables, leaving technology choice to market
- Frequent revisions, with banding introduced in 2009
- In effect it works like a “premium feed in tariff” with generators earning money for ROCs as well as for the power ..... 
- … power prices increasing… leading to criticism of not being good value for money
- In process of being phased out.... to be replaced by EMR
- However, it worked!
Overview of support since 1990

3) EMR and Contracts for Difference

• Horrendously complex!
• Degree of intervention never seen before….
• Its heart may be in the right place….
• Could have been achieved by a large NFFO
# High level summary

<table>
<thead>
<tr>
<th>Non Fossil Fuel Ob. (NFFO)</th>
<th>Renewables Ob. (RO)</th>
<th>Contracts for Diff. (CfDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 MW capacity</td>
<td>5% by 2003</td>
<td>Decarbonisation and remaining push to meet RED</td>
</tr>
<tr>
<td></td>
<td>10% by 2010 (later extended)</td>
<td></td>
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<tr>
<td>Not Europe-driven</td>
<td>Europe-driven</td>
<td>Carbon-driven</td>
</tr>
<tr>
<td>Assistance to nuclear</td>
<td>Meeting RES and RED</td>
<td>Assistance to nuclear?</td>
</tr>
<tr>
<td>Competitive bidding</td>
<td>Administered prices</td>
<td>Administered prices, then competition</td>
</tr>
<tr>
<td>15 year contracts</td>
<td>20 year entitlement to certificates</td>
<td>15 year contracts</td>
</tr>
</tbody>
</table>

Assistance to nuclear?
Government strategy

- Renewable Energy Strategy 2009
- 2011 Renewable energy roadmap, July 2011
- December 2012 update
- Reported on actions in the 2011 document … “72 of the 110 actions set out there are now complete and we have made good progress on the remaining 38”
- Solar PV is now identified as a key technology
- Key priorities will be to introduce the domestic RHI, implement the RO banding review, legislate for EMR and set strike prices for the new CfDs.
### Anticipated contributions

**the Government view**

**Renewable Energy Roadmap 2011**

<table>
<thead>
<tr>
<th>Technology breakdown (TWh) for central view of deployment in 2020</th>
<th>TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore wind</td>
<td>24-32 TWh</td>
</tr>
<tr>
<td>Offshore wind</td>
<td>33-58 TWh</td>
</tr>
<tr>
<td>Biomass electricity</td>
<td>32-50 TWh</td>
</tr>
<tr>
<td>Marine</td>
<td>1 TWh</td>
</tr>
<tr>
<td>Biomass heat (non-domestic)</td>
<td>36-50 TWh</td>
</tr>
<tr>
<td>Air-source and Ground-source heat pumps (non-domestic)</td>
<td>16-22 TWh</td>
</tr>
<tr>
<td>Renewable transport</td>
<td>Up to 48TWh</td>
</tr>
<tr>
<td>Others (including hydro, geothermal, solar and domestic heat)</td>
<td>14 TWh</td>
</tr>
<tr>
<td>Estimated 15% target</td>
<td>234 TWh</td>
</tr>
</tbody>
</table>
Current Generation

Data from 08:50 on 2 October 2013 (5 min. averages).

- Combined Cycle Gas Turbine: 27.1% (10,510 MW)
- Nuclear: 19.3% (7,472 MW)
- Other: 0.1% (43 MW)

- Open Cycle Gas Turbine: 0.0% (0 MW)
- Wind: 9.7% (3,755 MW)
- French Interconnector: 2.2% (841 MW)

- Oil: 0.0% (0 MW)
- Pumped Storage Hydro: 1.0% (386 MW)
- Irish Interconnector: 0.0% (0 MW)

- Coal: 38.0% (14,747 MW)
- Non-Pumped Storage Hydro: 0.9% (351 MW)
- Dutch Interconnector: 1.7% (667 MW)

Total Generation: 38,772 MW
Onshore wind

- 4026 turbines, 6565MW capacity operational
- 655 turbines, 1572 MW capacity under construction, weighted average turbine size 2.4MW
- 1988 turbines, 4830 MW consented
- Only technology with community benefit protocol, £5k/MW/year
Offshore wind

- 1075 turbines (largest 6MW) 3653 MW operational, weighted average size 3.6MW
- 4 projects currently under construction (incl 1 x7MW test turbine) 1.GW capacity, 3GW consented
- Generation cost challenge “Based on the evidence gathered and assuming our recommendations are followed, the CRTF concludes offshore wind can reach £100/MWh by 2020.”
Biomass

- Lots of different fuels and types
- Large contribution anticipated, but mostly co-firing or conversion, and regarded as temporary
- Controversial
- 400MW cap on new dedicated plant recently introduced
Sources of Marine Energy

• Tidal Power
• Wave Power
• Ocean Thermal Energy Conversion (OTEC)
• Salinity Gradients
Tidal Energy

• The “pull” of the moon (and sun) on oceanic waters causes:
  – Tidal height changes
  – Tidal flows of water
Tidal Barrage: La Rance

- 24 turbines
- Total generation 240 MW
- Operates on ebb and flood
- Has operated successfully for 40 years
Hafren Power
Proposed Severn Barrage

- Lavernock Point to Brean (18 km)
- Generates on ebb and flood
- Annual output: ~ 16.5 TWh or 5% of UK consumption
- Cost undisclosed but > £26 billion
UK Tidal Stream Resource

- 50% of Europe’s resource
- 10-15% of global resource
- 12 TWh / year exploitable now
- In long term, 3-5% of current UK energy demand
UK: acknowledged global leader in marine renewable energy

- Test facilities
  - EMEC
  - Wavehub
  - NaREC
- Supportive government policies
- Creative engineers
- Transferable skills from offshore O&G
- Pentland Firth and Orkney Waters leasing round
Tidal energy devices, clockwise from top right: Alstom, Andriz Hydro Hammerfest, Atlantis, Seagen
Seagen: a UK world first!

- 1.2 MW twin turbines
- Power first delivered to the grid in July 2008
- Has now exceeded 8 GWh generation
- Accredited as a UK generating station by Ofgem and is eligible for ROCs
Scotrenewables Tidal Turbine

- Installed at EMEC, March 2011
- Floating cylindrical tube with 2 horizontal axis rotors – 250 kW
- Two configurations:
  - operational with the rotors down
  - survivability mode with rotors retracted
Open Hydro Tidal Turbine

- Installed at the European Marine Energy Centre, Jan 2007
- 250 kW, open-centre turbine with permanent magnet generator in rim
The next stage - arrays of tidal devices

- To identify:
  - Interactions between devices / electricity export
  - Cumulative environmental impacts

- Projects:
  - Scottish Power Renewables, Islay: 4 Andriz Hydro Hammerfest and 4 Alstom devices (10MW)
  - Seagen Kyle Rhea: 8MW
  - Seagen Anglesey: 10MW
Wave Power

- Concentrated form of solar energy
- Solar power 100 W per square metre
- Wave power 70 kW per metre of crest length
UK Wave Energy Resource

- 35% of Europe’s resource
- Less location-dependent than tidal resource
- In long term, 10-15% of current UK energy demand
Wave energy devices, clockwise from top left:
Oyster, Pelamis, PB150, Limpet
Oyster – hinged flap device

- Flap drives pistons that push high-pressure water ashore to drive turbines
- Oyster 315 kW installed at EMEC in 2009
- Oyster 800 deployed at EMEC 2011
Pelamis Development

- 750 kW machine tested at EMEC in 2004
- 2.25 MW wave farm installed off the coast of Portugal in 2008
- Testing two P2 machines at EMEC
Limpet – first grid-connected wave generator

- Shore-based generator, installed on the coast of Islay in 2000
- Oscillating water column drives air through contra-rotating twin turbines
- 0.5MW of power for local communities
The next stage - arrays of wave devices

- Projects:
  - Aegir, Shetlands: 10MW, up to 14 Pelamis devices
  - West coast of Lewis: 10MW and 30MW, up to 40 Oyster devices
- As Stage 1 of Pentland and Orkney Waters leasing round:
  - Four Point (Pelamis) : 7.5 MW
  - Brough Head (Oyster): eventually 200MW
Wave and Tidal Energy versus Wind

Advantages:

- Higher energy density: water is 830 times denser than air
- More predictable energy resource and capture
- Tidal has a totally predictable energy schedule
- Low visual impact
Conclusions

• Forgive the focus on power generation!
• Some renewables starting to achieve grid parity in some places, and this trend will continue
• UK does not provide good case study for RE support
• EMR will mean renewables, nuclear and CCS competing as low carbon options
• Renewables should fare well, but timing is not helpful for marine renewables
• Overall outlook extremely encouraging
Thank you for listening

Renewable Energy Association
www.r-e-a.net