REGULATORY TOOLS TO SUPPORT RENEWABLE ENERGY

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RES PENETRATION IN EUROPE – 2
EUROPEAN WIND PENETRATION – 2

Cumulative wind energy installations

Source: EWEA
FUEL CHOICE FOR NEW GENERATION EUROPE, 2008

Total: 19,651 MW

*Geothermal, peat and waste

Source: EWEA and Platts Power Vision
Installed Capacity in Renewable Energy in 2008 in ERRA Countries without large hydro
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Coal</th>
<th>Coal CCS retrofit</th>
<th>Gas CCS</th>
<th>Gas CCS retrofit</th>
<th>Nuclear</th>
<th>Wind Onshore</th>
<th>Wind Offshore</th>
<th>Solar PV</th>
<th>Solar CSP</th>
<th>Solar Biomass</th>
<th>Solar Geothermal</th>
<th>Solar Large Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline 34% RES 49% coal/gas 17% nuclear</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>80% RES 10% CCS 10% nuclear</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>19</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>60% RES 20% CCS 20% nuclear</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>20</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>40% RES 30% CCS 30% nuclear</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>30</td>
<td>9</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

1 Only on “CCS ready” plants
OUTLINE OF PRESENTATION

• RES policy components

• Market share mandates and scheme typology

• Feed in tariffs

• Quota obligation schemes

• Other support mechanisms (investment subsidy, tax credit)
First best policy – internalization of external costs

- **Supply of non-renewables**
- **Supply of renewables**
- **Demand**
- **Supply**

Internalization of environmental costs

- **P2**
- **P1**

Graph showing the interaction between supply and demand for electricity.
Second best policy – subsidy for renewables

[Diagram showing supply of non-renewables and supply of renewables with support points indicated]
MAJOR RES POLICY COMPONENTS

• General energy strategy – sets framework for RES
  › Assessment of RES potential
  › National targets on RES?
  › Climate, supply security, industrial development

• Primary legislation
  › Part of Energy Act, Electricity Act… or separate RES Act
  › Pros and cons?

• Secondary legislation
• Duties and tax policy
• Choice of support mechanism – see later
## ASSESSMENT OF RES POTENTIAL

### Renewable resource potential and utilization in Hungary, PJ

<table>
<thead>
<tr>
<th>Renewable energy Source</th>
<th>Academy of Sciences, theoretical potential</th>
<th>2006 level of utilisation</th>
<th>Renewable Energy Strategy, 2020 level of utilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>1838</td>
<td>0.1</td>
<td>2</td>
</tr>
<tr>
<td>Hydro</td>
<td>14.4</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>Geothermal</td>
<td>63.5</td>
<td>3.6</td>
<td>11</td>
</tr>
<tr>
<td>Biomass/Fuel wood</td>
<td>203-328</td>
<td>49.2</td>
<td>131</td>
</tr>
<tr>
<td>Organic waste</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Biogas + bio-methane</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Bio-fuel</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Wind</td>
<td>532.8</td>
<td>0.16</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>2600-2700</td>
<td>53.8</td>
<td>186</td>
</tr>
</tbody>
</table>

- Accomplishment of wind and geothermal maps, registry of wells, biogas sources, etc.
- Information should be publicly available
MAJOR REGULATORY COMPONENTS

- Licensing
  - Should be simple
-Tariffs
  - In case of obligatory feed-in
-Green certification
  - Accounting, disclosure, tradability
-Grid access and grid integration
  - Forecasting, load following, balancing, grid access, grid reinforcement and related tariffs, metering…
-Identifying and combating non-cost barriers to RES penetration
OUTLINE OF PRESENTATION

• RES policy components

• Market share mandates and scheme typology

• Feed in tariffs

• Quota obligation schemes

• Other support mechanisms (investment subsidy, tax credit)
<table>
<thead>
<tr>
<th>Country</th>
<th>Share of energy from renewable sources in gross final consumption of energy, 2005</th>
<th>Target for share of energy from renewable sources in gross final consumption of energy, 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>2.2 %</td>
<td>13 %</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>9.4 %</td>
<td>16 %</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>6.1 %</td>
<td>13 %</td>
</tr>
<tr>
<td>Denmark</td>
<td>17.0 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Germany</td>
<td>5.8 %</td>
<td>18 %</td>
</tr>
<tr>
<td>Estonia</td>
<td>18.0 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.1 %</td>
<td>16 %</td>
</tr>
<tr>
<td>Greece</td>
<td>6.9 %</td>
<td>18 %</td>
</tr>
<tr>
<td>Spain</td>
<td>8.7 %</td>
<td>20 %</td>
</tr>
<tr>
<td>France</td>
<td>10.3 %</td>
<td>23 %</td>
</tr>
<tr>
<td>Italy</td>
<td>5.2 %</td>
<td>17 %</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2.9 %</td>
<td>13 %</td>
</tr>
<tr>
<td>Latvia</td>
<td>32.6 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Lithuania</td>
<td>15.0 %</td>
<td>23 %</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.9 %</td>
<td>11 %</td>
</tr>
<tr>
<td>Hungary</td>
<td>4.3 %</td>
<td>13 %</td>
</tr>
<tr>
<td>Malta</td>
<td>0.0 %</td>
<td>10 %</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>2.4 %</td>
<td>14 %</td>
</tr>
<tr>
<td>Austria</td>
<td>23.3 %</td>
<td>34 %</td>
</tr>
<tr>
<td>Poland</td>
<td>7.2 %</td>
<td>15 %</td>
</tr>
<tr>
<td>Portugal</td>
<td>20.5 %</td>
<td>31 %</td>
</tr>
<tr>
<td>Romania</td>
<td>17.8 %</td>
<td>24 %</td>
</tr>
<tr>
<td>Slovenia</td>
<td>16.0 %</td>
<td>25 %</td>
</tr>
<tr>
<td>The Slovak Republic</td>
<td>6.7 %</td>
<td>14 %</td>
</tr>
<tr>
<td>Finland</td>
<td>28.5 %</td>
<td>38 %</td>
</tr>
<tr>
<td>Sweden</td>
<td>39.8 %</td>
<td>49 %</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.3 %</td>
<td>15 %</td>
</tr>
</tbody>
</table>
RENEWABLE PORTFOLIO STANDARDS IN THE US

www.dsireusa.org / August 2009

WA: 15% by 2020*
MT: 15% by 2015
MN: 25% by 2025 (Xcel: 30% by 2020)
MI: 10% + 1,100 MW by 2015*
VT: (1) RE meets any increase in retail sales by 2012; (2) 20% RE & CHP by 2017
ME: 30% by 2000
New RE: 10% by 2017
MA: 15% by 2020
+ 1% annual increase (Class I Renewables)
NH: 23.8% by 2025
RI: 16% by 2020
CT: 23% by 2020
CA: 20% by 2010
OR: 25% by 2025 (large utilities)*
5% - 10% by 2025 (smaller utilities)
NY: 24% by 2013
PA: 18% by 2020†
NJ: 22.5% by 2021
MD: 20% by 2022
DC: 20% by 2020
AZ: 15% by 2025
CO: 20% by 2020 (IOUs)
10% by 2020 (co-ops & munis)*
IL: 25% by 2025
KS: 20% by 2020
OH: 25% by 2025†
NC: 12.5% by 2021 (IOUs)
10% by 2018 (co-ops & munis)
MO: 15% by 2021
VT: (1) RE meets any increase in retail sales by 2012; (2) 20% RE & CHP by 2017
VA: 15% by 2025†
UN: 18% by 2020†
TX: 5,880 MW by 2015
HI: 40% by 2030

State renewable portfolio standard
State renewable portfolio goal
Solar water heating eligible

Minimum solar or customer-sited requirement
Extra credit for solar or customer-sited renewables
† Includes separate tier of non-renewable alternative resources

29 states & DC have an RPS
5 states have goals
COST DEVELOPMENT IN RES TECHNOLOGIES: SCALE AND LEARNING

Source: IEA
## TYPOLOGY OF RES SUPPORT SCHEMES

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>determined by market</td>
<td>fixed by regulator</td>
</tr>
<tr>
<td>fixed by regulator</td>
<td>general purchase obligation at regulated prices</td>
</tr>
<tr>
<td>indirect incentives for renewable energy purchase</td>
<td>limited purchase obligation for regulated quantity at regulated prices</td>
</tr>
<tr>
<td>renewable energy quota obligation - tradable or non-tradable (i.e. non-tradable purchase rate requirements or tradable renewable energy certificates)</td>
<td></td>
</tr>
</tbody>
</table>
### PROS AND CONS OF RES SUPPORT SCHEMES

<table>
<thead>
<tr>
<th></th>
<th>merit</th>
<th>drawback</th>
</tr>
</thead>
<tbody>
<tr>
<td>general purchase obligation at regulated prices („feed-in obligation“)</td>
<td>very effective; simple; low bureaucratic load; Security of sales for producers, low risk of return on investments, low capital costs, much investment, good for infant industry</td>
<td>incompatible with competition; quantity might overshoot; funds needed for price support might run dry; prices regulated, regulatory trap, dependent constituency, can create stranded cost</td>
</tr>
<tr>
<td>limited purchase obligation for regulated quantity at regulated prices</td>
<td>relatively low risk for incumbent producers, who might compete for support, opportunity for more cost-efficiency; proves non-sustainability of feed-in schemes</td>
<td>non-transparent distribution of incumbent status means loss of efficiency, rent-seeking, rent siphoning</td>
</tr>
<tr>
<td>indirect incentives for renewable energy purchase</td>
<td>support scheme remains flexible, able to increase efficiency and welfare when R&amp;D is fast, both quantity and price is determined by market (i.e. bidding schemes like NFFO)</td>
<td>Low level of security for producers, high risk return on investments, few investment, some technologies</td>
</tr>
<tr>
<td>renewable energy quota obligation - tradable or non-tradable (i.e. non-tradable purchase rate requirements or tradable renewable energy certificates)</td>
<td>the most cost-efficient of support instruments: the most renewable energy at the lowest cost; non-distorted prices; stable price signals for investors, the specified amount of renewable energy is ensured, low administrative cost</td>
<td>not necessarily efficient if not tradable; price might overshoot; safety valve needed on cost exit fee acts as regulated prices; too low exit fee sets too low quantity; stable certificate market needs many producers, liquidity, high cost technologies would not get to the market, not simple if tradable</td>
</tr>
</tbody>
</table>
RES SUPPORT SCHEMES IN THE EU

Source: Rickerson et al. (2007)
OUTLINE OF PRESENTATION

• Market share mandates

• Feed in tariffs

• Quota obligation schemes

• Other support mechanisms (investment subsidy, tax credit)
Model of the renewable electric energy feed-in tariff scheme
Efficiency stimulating effect of feed-in schemes

- MC₁ marginal cost of renewable electricity before technological development
- MC₂ marginal cost of renewable electricity after technological development
- Feed-in tariff for renewable
- Effect of technical development
- Costs, prices
- Gains of technical development remain at the
- Generated electricity before the technical development
- Increase of generated electricity due to technical development
- All profit increase

\[ P_h \]

\[ Q_1 \]

\[ Q_2 \]

\[ kWh \text{ renewable} \]
FEED-IN TARIFF

• Uniform vs Differentiated by
  ▶ technology
  ▶ time (peak, off-peak)
  ▶ size
  ▶ new-existing
  ▶ etc.

• Arguments for differentiation?

• Basis for the feed-in tariff?

• Regulated price vs. premium/bonus?
### THE HUNGARIAN FEED-IN TARIFFS IN FORCE FROM JANUARY 2009, (HUF (¢€))

<table>
<thead>
<tr>
<th>FEED-IN TARIFF</th>
<th>From 1st January 2009 HUF (¢€)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak</td>
</tr>
<tr>
<td>Based on resolution of Hungarian Energy Office (HEO) if it was adopted or the application was received before 01. 01. 2008. [except hydro power station units (PSU) &gt;5 MW]</td>
<td></td>
</tr>
<tr>
<td>(10.1)</td>
<td>(10.1)</td>
</tr>
<tr>
<td>Other than Solar and Wind</td>
<td>31.42</td>
</tr>
<tr>
<td>(11.2)</td>
<td>(10.1)</td>
</tr>
<tr>
<td>Produced from renewable energy sources</td>
<td></td>
</tr>
<tr>
<td>Based on resolution of HEO adopted after 01. 01. 2008. (except hydro PSU &gt;5 MW, other PSU &gt; 50 MW)</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>27.86</td>
</tr>
<tr>
<td>(10.0)</td>
<td>(10.0)</td>
</tr>
<tr>
<td>Produced by PSU of 20 MW or less (except Solar)</td>
<td>31.13</td>
</tr>
<tr>
<td>(11.1)</td>
<td>(10.0)</td>
</tr>
<tr>
<td>Produced by PSU of &gt;20 MW - max. 50 MW (except Wind from 30th Nov. 2008, Solar)</td>
<td>24.90</td>
</tr>
<tr>
<td>(8.9)</td>
<td>(8.0)</td>
</tr>
<tr>
<td>Produced by Wind PSU of &gt;20 MW - max. 50 MW from 30th Nov. 2008</td>
<td>31.13</td>
</tr>
<tr>
<td>(11.1)</td>
<td>(10.1)</td>
</tr>
<tr>
<td>Produced by PSU comprising used equipment</td>
<td>19.36</td>
</tr>
<tr>
<td>(6.9)</td>
<td>(4.4)</td>
</tr>
<tr>
<td>Produced by hydro PSU &gt; 5 MW, other PSU &gt;50 MW</td>
<td>19.36</td>
</tr>
<tr>
<td>(6.9)</td>
<td>(4.4)</td>
</tr>
</tbody>
</table>
Average RES Electricity Prices in ERRA Countries in 2008 by Technology

- Average
- Solar
- Wind
- Hydropower <10MW
- Hydropower <1MW
- Hydropower >10MW
- Biomass
- Biogas
- Other

Countries: Georgia, Croatia, Romania, Bulgaria, Macedonia, UNMIK, Average, Albania, Jordan, Turkey, B-H, Hungary, Poland, Estonia, Latvia.
FEED-IN TARIFF: STRONG INCENTIVE.

Increase in RES-E production, HU

Increase in CHP production, HU

I. Electricity Act (1994)
II. Electricity Act (2001)
III. Electricity Act (2007)
OUTLINE OF PRESENTATION

• Market share mandates

• Feed in tariffs

• Quota obligation schemes

• Other support mechanisms (investment subsidy, tax credit)
QUOTA OBLIGATION SCHEMES

- Renewable quota obligation or purchase rate obligation
- Customers (suppliers) must purchase the regulated amount from producers of their choice
- Compliance is verified by purchased renewable energy certificates
- Renewable energy certificates are tradable
- Compliance can be met without the physical purchase of renewable energy
- Physical and commercial flows are independent
- Renewable energy producers sell their products to the main (non-renewable) energy markets
- Examples: tradable green electricity certificate schemes, bio-fuel blend-in schemes
The model of green certificate trading

Demand: all obligatory renewable electricity purchase

Market price of renewable electric power

MC

Q_p

Q_h

market price of 1 kWh of tradable green certificate

market price of electricity

kWh renewable electric power

renewable energy viable even without green certificates

renewable energy production prompted by green certificates

Demand: all obligatory renewable electricity purchase

MC_A

MC_B

P_p

P_pm

costs, prices

market price of renewable energy
THE TWO-PRODUCT MODEL

buyer A

electricity

buyer B

"renewable" attributes

renewable energy producer

€

€
ADDITIONAL SUPPORT MECHANISMS: THE EXAMPLE OF HUNGARY