EXPERIENCES WITH RENEWABLE ENERGY:
A FEW CONSIDERATIONS FOR REGULATORS

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The INOGATE Programme
OUTLINE OF PRESENTATION

• RES support: rationales and counter arguments

• RES technology development and penetration

• Alternative RES support schemes

• Non-cost related barriers to RES penetration
  ▶ Grid access and grid integration
  ▶ Regulatory barriers

• Regulatory lessons
RATIONALS TO PROMOTE RES

- Reduce local and global pollution
  ‣ First best solution: pollution taxation/pricing, including CO2 pricing
- Increase supply security
  ‣ Gas import dependence
  ‣ Fuel mix diversity
- Industrial development
  ‣ Developing local industry and employment
    • Germany, Spain, Denmark
  ‣ Importing the positive externalities of technological innovation or developing a local champion – choice of support system
  ‣ Developing an exporting EU industry
    • Given that world trends are for RES…China, India?
  ‣ Importance of understanding local comparative advantages

COST EFFICIENCY, GRADUALITY
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RES PENETRATION IN EUROPE – 1

Total installed capacity, GW

- Other RES
- PV+Solar
- Wood
- Wind
- Hydro
- Non RES
RES PENETRATION IN EUROPE – 2
GLOBAL WIND PENETRATION – 1

Global annual installed capacity 1996-2008

Source: GWEC
Global cumulative installed capacity 1996-2008

Source: GWEC
GLOBAL WIND PENETRATION – 3

Annual installed capacity by region 2003-2008

Source: GWEC
EUROPEAN WIND PENETRATION – 1

Annual wind energy installations MW

Source: EWEA
EUROPEAN WIND PENETRATION – 2

Cumulative wind energy installations

Source: EWEA
PROBLEMS WITH RES

• The application of RES is costly…
  › …but non-RES has been developed by massive subsidies for centuries
  › …fossil fuel price trend is increasing (?)

• RES is not available everywhere…
  › …but the goal is not to fully replace conventional

• RES is often weather dependent…
  › …but balancing markets can successfully integrate forecastable
  › …the development of storage might help
  › …also some demand is non-continuous, e.g. heating

• RES is indeed producing pollution…
  › …but this is relative to an alternative state of the world without RES
FUEL CHOICE FOR NEW GENERATION EUROPE, 2008

Total: 19,651 MW

Wind: 8,484 MW
Gas: 6,932 MW
Fuel Oil: 2,495 MW
Coal: 762 MW
Hydro: 473 MW
Biomass: 296 MW
Other*: 149 MW
Nuclear: 60 MW

*Geothermal, peat and waste

Source: EWEA and Platts Power Vision
FUEL CHOICE FOR NEW GENERATION EUROPE, 2000 – 2008

New electricity generating capacity EU 2000-2008

Total: 177,920 MW

- Gas: 54%
- Wind: 31%
- Biomass: 4%
- Coal: 6%
- Nuclear: 1%
- Hydro: 2%
- Fuel Oil: 1%
- Other*: 1%

*Geothermal, peat and waste

Source: EWEA and Platts Power Vision
TARGETS VS FACTS, RES ELECTRICITY

2004: 14.5%, 2006: 15.7%  2010 target: 21%

Rest of old: hydro

Rest of new: wind

Source: based on normalised Eurostat 2006 data and 2010 targets
RES ELECTRICITY GROWTH BY TECHNOLOGY

Also only a few countries…

Source: "Promotion and growth of renewable energy sources and systems" Final Report, Ecofys et al. (hydropower excluded)
BREAKDOWN OF TOTEL RES-E CAPACITY BY ENERGY SOURCES, EU-15 VS EU-10

Source: Eurostat
BREAKDOWN OF TOTEL RES-E CAPACITY WITHOUT HYDRO, EU-15 VS EU-10

Source: Eurostat
State renewable portfolio standard

Arizona (AZ): 15% by 2025

California (CA): 20% by 2010

Colorado (CO): 20% by 2020 (IOUs)
10% by 2020 (co-ops & large munis)*

Connecticut (CT): 23% by 2020

District of Columbia (DC): 20% by 2020

Delaware (DE): 20% by 2019*

Florida (FL): 15% by 2025

Georgia (GA): 15% by 2025

Idaho (ID): 10% by 2015 (Xcel: 30% by 2020)

Illinois (IL): 25% by 2025

Indiana (IN): 10% by 2015 (IOUs)
10% by 2020 (co-ops & large munis)*

Iowa (IA): 105 MW

Kansas (KS): 20% by 2020

Kentucky (KY): 10% by 2015

Louisiana (LA): 20% by 2025

Maine (ME): 30% by 2000
New RE: 10% by 2017

Maryland (MD): 20% by 2022

Massachusetts (MA): 15% by 2020
+ 1% annual increase (Class I Renewables)

Michigan (MI): 10% + 1,100 MW by 2015*

Minnesota (MN): 25% by 2025
(Xcel: 30% by 2020)

Missouri (MO): 15% by 2021

Montana (MT): 15% by 2015

Nebraska (NE): 10% by 2015

Nevada (NV): 25% by 2025*

New Mexico (NM): 20% by 2020 (IOUs)
10% by 2020 (co-ops)

New York (NY): 24% by 2013

North Carolina (NC): 12.5% by 2021 (IOUs)
10% by 2018 (co-ops & munis)

North Dakota (ND): 10% by 2015

Ohio (OH): 25% by 2025

Ohio (OH): 25% by 2025†

Oklahoma (OK): 15% by 2021

Oregon (OR): 25% by 2025 (large utilities)*
5% - 10% by 2025 (smaller utilities)

Pennsylvania (PA): 18% by 2020†

Rhode Island (RI): 16% by 2020

South Carolina (SC): 15% by 2021

South Dakota (SD): 10% by 2015

Tennessee (TN): 15% by 2025

Texas (TX): 5,880 MW by 2015

Utah (UT): 20% by 2025†

Vermont (VT): (1) RE meets any increase in retail sales by 2012;
(2) 20% RE & CHP by 2017

Virginia (VA): 15% by 2025*

Washington (WA): 15% by 2020*

West Virginia (WV): Varies by utility;
10% by 2015 goal

Wisconsin (WI): Varies by utility;
10% by 2015 goal

Wyoming (WY): 15% by 2021

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
TARGETS VS FACTS, BIOFUEL

2005: 1%, 2007: 2,6%, 2010 target: 5,75 (expected 5%)

Source: Member States 2006 and 2007 reports, and EurObserver Biofuels Barometer
Heating is responsible for 50% of our final energy consumption

Source: Eurostat
COST DEVELOPMENT IN RES TECHNOLOGIES: SCALE AND LEARNING

Source: IEA
RES COST TRENDS


These graphs are reflections of historical cost trends NOT precise annual historical data.
Updated: October 2002
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THE WIDER REGULATORY ENVIRONMENT

• Impact of related policies
  ‣ Price subsidies on RES ‘competitors’ (gas, coal, district heating, end customer prices)
  ‣ Environmental taxation
    • Effluent charges, energy tax
  ‣ CO₂ policy
  ‣ Agricultural policy /subsidies

• Sector regulation
  ‣ RE incentives (feed-in, investment subsidies, tax credits)
  ‣ Heating: missing incentives
  ‣ Licensing
  ‣ Grid connection
  ‣ Quota limits (e.g. wind in Hungary)
# TYPOLOGY OF RES SUPPORT SCHEMES

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

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>General purchase obligation at regulated prices („feed-in obligation”)</td>
<td>- Inefficient; little incentive for cost reduction; no 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>- 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>- 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>- 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)
FEED-IN TARIFF

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

• Arguments for differentiation?

• Regulated price vs. premium
FEED-IN TARIFF: STRONG INCENTIVE..

Increase in RES-E production, HU

Increase in CHP production, HU
... OR EVEN TOO STRONG??

- **Average feed-in tariff**
- **Estimated wholesale price**
- **Unit price subsidy**
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 TWO-PRODUCT MODEL

buyer A  buyer B

electricity  "renewable" attributes

renewable energy producer

€  €
Both cost and price of renewable energy are high
Voluntary willingness to pay for renewable energy is low
Thus a quota obligation scheme must be enforceable and regulate for cases of non-compliance (not buying enough renewable energy)
Non-compliance is to be sanctioned by payment of a fee for each unit of renewable energy not purchased: buy-out price or exit fee
The buy-out price will be a price cap for tradable renewable energy certificates
Setting the buy-out price serves not only to penalize non-compliance but also to provide cost safety for consumers of renewable energy
THE POLISH GREEN CERTIFICATE MARKET, 2006-2008

Source: POLPX
THE RATIO OF THE AMOUNT OF PRODUCED GREEN CERTIFICATES (GWh) AND THE TARGET, GB AND IT (%)
ADDITIONAL SUPPORT MECHANISMS: THE EXAMPLE OF HUNGARY

![Diagram showing support scheme with tax exemption, investment subsidy, and production support. KIOP (2004-2006) and KEOP (2007-2013) are highlighted with renewable energy sources such as biofuels, heat generation, and RES-E generation.]
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NON-COST BARRIERS

- Licensing procedures for investment: length, inconvenience and uncertainty
- Lack of access to technology
  - Supply shortage (e.g. wind farm equipment)
  - Barriers to importing technology (e.g. domestic approval procedures)
- Difficulties with network access
  - Difficulties in establishing connection to the distribution grid (lack of motivation on the DSO’s part)
  - Measurement problems (impossibility to feed in excess energy from small scale generation)
- System balancing problems caused by integrating weather-dependent generation
- Explicit investment quotas
- Uncertainty in regulation
  - Length of assured mandatory feed-in period (and prices)
  - Frequency and unpredictability of changes in rules and investment support schemes
- Lack of internationally accepted guarantee of origin schemes for renewable energy (constrains demand)
- Informational barriers
  - Lack of public information on technology choices and support schemes
- Local opposition to renewable investment
  - Opportunities for stalling development by local communities
  - Materialized opposition to certain forms of renewable energy
- Support schemes for using traditional energy sources (as a disincentive to consider renewables)
- Households’ captivity in existing heating systems (e.g. district heating)
## NON-COST BARRIERS: THE EXAMPLE OF THE UK

<table>
<thead>
<tr>
<th>Potential Issue</th>
<th>Causes</th>
<th>Scale of problem/ is it a barrier?</th>
<th>Recent / ongoing development?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; licensing Regime</td>
<td>Decisions are taken by 3 bodies (Scottish Government, Welsh Assembly Government and Department for Energy and Climate Change) and can take up to 2 years. Permissions also required at a local level which can be time consuming and subject to vested interests.</td>
<td>7,600MW of onshore renewable energy and 1400MW of offshore wind is in the planning system, of which over half is in Scotland.</td>
<td>The Planning Act created an Infrastructure Planning Commission in England which will approve projects over 50MW (but circa 3,500MW below 50MW)</td>
</tr>
<tr>
<td>Delays in the planning system (for plant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delays in the planning system (for associated infrastructure)</td>
<td>Local objections to large infrastructure, length of lines creates a need to engage with multiple authorities.</td>
<td>Significant. The last transmission line in E&amp;W took 10 years to build. There were over 10,000 objections to the most pressing line in Scotland. That project has had a planning enquiry ongoing for 3 years. Large numbers of lines are required to realise GB’s renewable energy potential.</td>
<td>Creation of infrastructure planning commission in England.</td>
</tr>
<tr>
<td>Radar operator objections to wind development</td>
<td>Wind farms can cause “clutter” on civil aviation or military radar. As such the Ministry of Defence or Air Traffic Authorities routinely object to planning requests.</td>
<td>In excess of 4500MW of wind energy projects in the planning system are subject to objections because of radar. A further 3400MW offshore may also face objections.</td>
<td>Memorandum of understanding between industry and government signed in 2008 - commitment to progress.</td>
</tr>
<tr>
<td>Well understood marine policy framework</td>
<td>The new nature of offshore wind, wave and tidal development creates policy challenges.</td>
<td>Possibly. A framework for offshore wind has been created but greater clarity required.</td>
<td>Marine and Coastal Access Bill planned</td>
</tr>
<tr>
<td>Clear, transparent system of environmental impact assessment etc</td>
<td>Obligations need to be well understood by developers and timescales need to be predictable.</td>
<td>Unlikely at present. Time consuming but not excessively onerous.</td>
<td>-</td>
</tr>
</tbody>
</table>
## Sourcing and installing

<table>
<thead>
<tr>
<th></th>
<th>Significant demand for components and limited manufacturing capability.</th>
<th>Delays in planning, grid tend to be greater than component delays. Hence largely manageable.</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delays in sourcing components</strong></td>
<td>Access to ports, access to project locations, availability of installation equipment etc.</td>
<td>Some shortages in offshore installation but can be managed due to other delays.</td>
<td>-</td>
</tr>
<tr>
<td><strong>Transport constraints (physical)</strong></td>
<td>Import quotes, permitting licensing rules etc.</td>
<td>Not thought to be significant.</td>
<td>-</td>
</tr>
</tbody>
</table>
## Regulatory Framework

<table>
<thead>
<tr>
<th>Non-Cost Barriers: The Example of the UK - cont</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grid access Issues</strong> (Transmission Voltage)</td>
</tr>
<tr>
<td>The rules mean developers must wait until wires are constructed, discriminate in favour of incumbents and do not provide products to match renewable generators needs.</td>
</tr>
<tr>
<td><strong>Grid access issues</strong> (Distribution voltages)</td>
</tr>
<tr>
<td>Similar issues to transmission compounded by absence of actively managed distribution networks.</td>
</tr>
<tr>
<td><strong>Approach to network pricing</strong></td>
</tr>
<tr>
<td>GB’s network prices vary by location and are highest in windy locations. Costs of system balancing are targeted to parties that cause them.</td>
</tr>
<tr>
<td><strong>Proportionality of market rules</strong></td>
</tr>
<tr>
<td>Market rules largely designed for large-scale, centralised plant. Not clear that they are proportionate or fit-for-purpose for micro-generation of distributed generation.</td>
</tr>
<tr>
<td><strong>Presence of export tariffs etc</strong></td>
</tr>
<tr>
<td>Arrangements for exporting energy at certain times of the day not fully established.</td>
</tr>
<tr>
<td><strong>Regulatory Uncertainty</strong></td>
</tr>
<tr>
<td>The prospect of further market rule changes creates significant uncertainty for prospective investors.</td>
</tr>
</tbody>
</table>
GRID INTEGRATION

• Integration of massive wind generation in Europe became a Union-wide TSO / regulatory issue
  ‣ Complaints about loop-flows
  ‣ Polish plan to limit NTC

• ERGEG / ACER pilot study for the future ENTSO Grid Code and also part of 2009 Work Plan:

<table>
<thead>
<tr>
<th>EWG Deliverable</th>
<th>Wind generation &amp; Green Package Issues:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- CEER Status Review of Wind Generation and the Implications of the Green Package</td>
</tr>
</tbody>
</table>

- Public consultations: -  
- Public hearings, workshops: -  
- Finalisation: Q4 2009

The objective is to highlight the unique characteristics and key issues facing wind generation and to assess the regulatory impacts of certain aspects of the renewables directive (e.g. intermittency).
GRID INTEGRATION COSTS

- Regulation cost
- Load following cost
- Unit commitment cost
- Transmission upgrade
- Who should pay?

- Challenges: forecasting
GRID INTEGRATION SOLUTIONS

- Build transmission
- Planning – regional integration (ENTSO-E)
- Improve forecasting
- Consolidate balancing areas
- Increase new resources (gas, pump-storage)
- Very short balancing markets
- Tariff solutions, e.g. imbalance charges
- Storage
- Demand response
THE LICENSING TROUBLE

Average number of authorities involved in the building permission procedure
Source: "Promotion and growth of renewable energy sources and systems" Final Report, Ecofys et al. p67
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LESSONS, TASKS, QUESTIONS

- Careful choice of RES target
- Careful choice of RES support scheme
- Certification, tradability
- Tariff setting
- Regulations related to grid integration
- Market monitoring
- Heating?
- Future technologies? (solar from Sahara, etc…)