# Policy Options for Renewable Energy Incentives: the View from Europe

or

What's with Feed-in Tariffs?

Massachusetts Wind Working Group

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# Overview

- Renewable energy in Europe today
- Historical wind energy growth
- Need for incentives
- Renewable energy policy incentives in US
- The situation in Europe
- Implications for Massachusetts?

# Context for European Interest in Renewable Energy

- Meltdown at Chernobyl nuclear plant, 1986
- Awareness of “social costs” of energy production
  - Olav Hohmeyer (Germany, 1990’s) initiated the discussion
- Climate change/ attempt to meet Kyoto protocol requirements
- Relatively limited conventional fuels in Europe
- Renewable energy products/economic growth

# Renewable Energy Vision in Europe

- A very high rate of deployment of renewable energy projects is needed
- Some form of financial support is required
  - Cannot rely on market alone
- Regulatory encouragement

  e.g. building codes
- Support of research and development

  Comprehensive approach
- Support for education at all levels

  e.g. European Masters in Renewable Energy

# A Significant Role for Renewable Energy is Envisioned

- Possible transformation of world's energy supply:

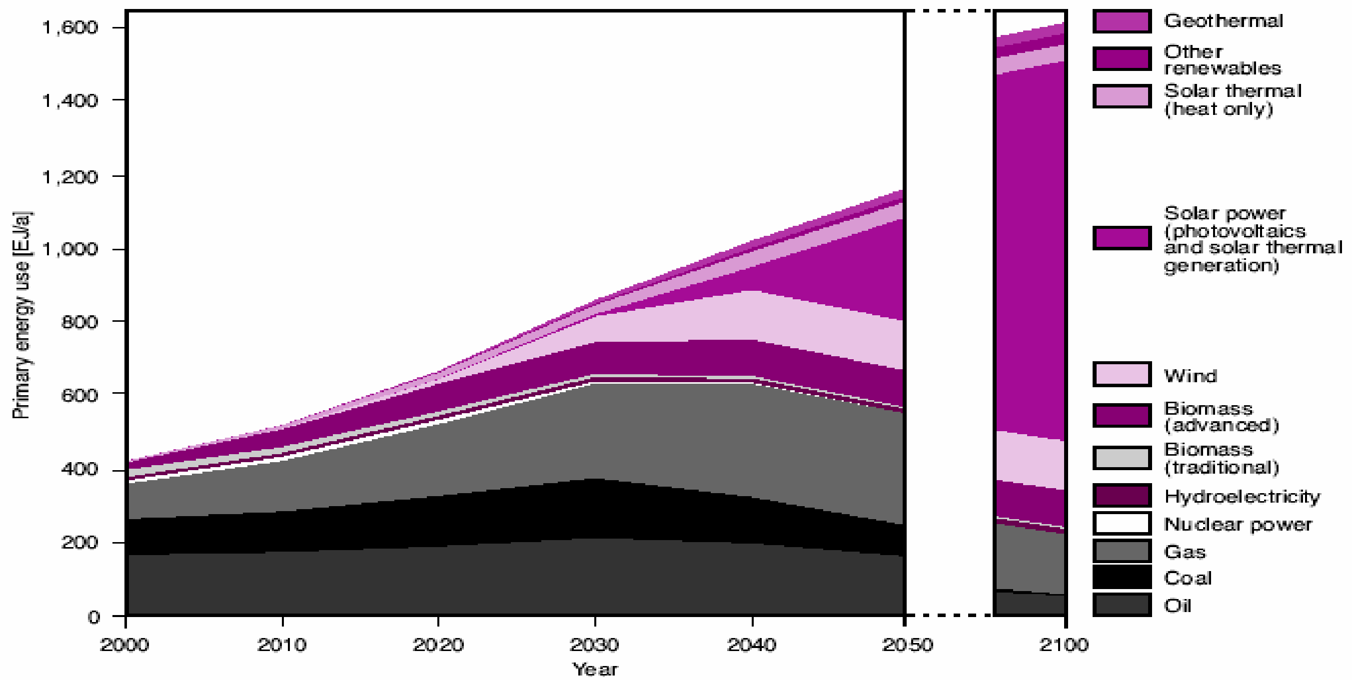



**Figure 1**
Transforming the global energy mix: The exemplary path until 2050/2100.
Source: WBGU

*Source: German Advisory Council on Global Change, 2003*

# The Debate in Europe

- There is a general consensus that incentives are needed for renewable energy systems
- There has been considerable debate over which incentive should be used: RPS vs. Feed-in Tariffs
- Arguments particularly between Germany and the UK
- Have resulted in rifts within the European renewable energy community
  - World Wind Energy Assoc. (“German”)
  - Global Wind Energy Council (“UK”)
- Consensus in favor of feed-in may be emerging

# The Debate Has Sometimes Been Difficult!


*Source: Rickerson and Zytaruk, AWEA, 2006*

# The Central Difference

- RPS (Renewable Portfolio Standard)
  - Fixed quota for RE projects/unspecified price for electricity sold (set by bidding)
- Feed-in Tariffs
  - Fixed price for electricity sold/unspecified quantity of RE capacity (deployment rate is function of price)

# Wind Energy Historical Background (1)

- Widely used throughout world (for mechanical power) until industrial revolution; decline through 19th century
- Little development anywhere in last 200 yrs until approx. 1975
  - Except wind water pumpers in U.S. west in 1800's and small wind electric systems in U.S. in 1930's
  - Some R&D projects and proposals

# Wind Energy Historical Background (2)

- Occasional efforts to revive wind energy (for electricity) throughout 20th century
- Oil crises of 1970's lead to federal R&D and policy changes in US, especially due to Pres. Carter and Gov. Brown (California)
- US was early leader in 1970's (95% of wind energy capacity before 1980)
  - Beginning of the "wind farm" era
- World leaders are now Germany and Spain

# Some pre-Wind Farm Era Wind Turbines

*Smith-Putnam, VT, 1930's-40's*

*Gedser, Denmark, 1950's*

*Hütter, Germany, 1950'-60's*

*WF-1, UMass, 1970's*

# 1970’s Policy Incentives in US

- Investment tax credits in US and California
  - Tax incentives based on cost of wind turbines
- Pubic Utility Regulatory Policy Act of 1978 (PURPA)
  - Guaranteed access to grid
  - Required utilities to buy electricity at “avoided cost”
  - Utilities offered attractive “standard offers” for sales in California
- These lead to the growth of California wind farms (among other projects)

# Wind Farm Era Turbines

## 1970's-80's

*Enertech (from VT), in California*

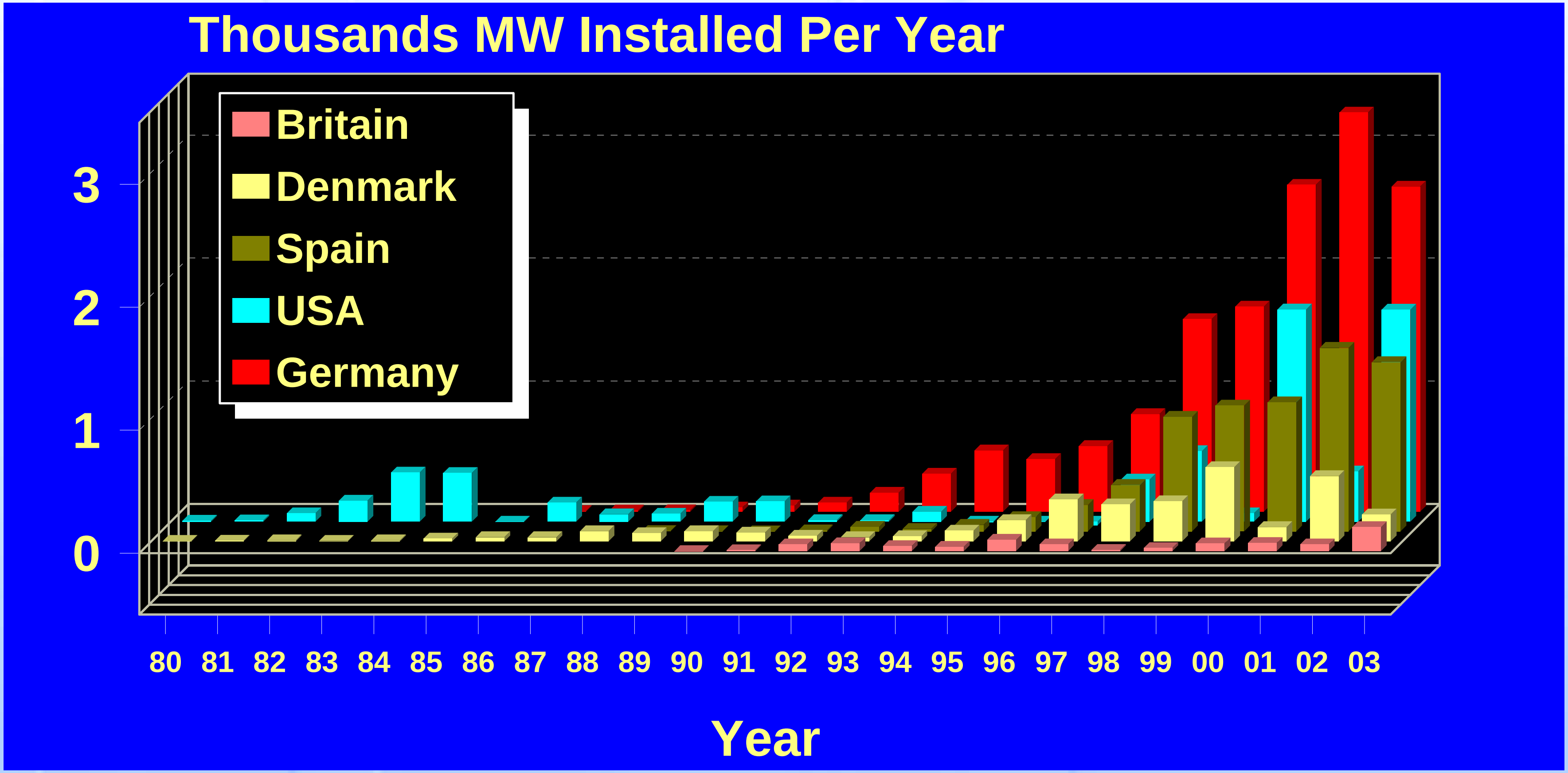
*US Windpower (from Massachusetts), in California*

# More Recent Wind Turbines

*Vestas (from Denmark), in Hull, MA, 2001*

*REpower (Germany) 2006*

# Sample Wind Energy Installation Rates




*Source: Gipe, OSEA*

# Current Incentives in the US

- Tax credits
- RPS (in some states)
- Systems benefit charges (SBC)
  - Such as Renewable Energy Trust Fund
- Net metering
- Green power

*See www.dsireusa.org for information by state*

# Tax Credits

- Investment tax credits
  - No guarantee that generator actually works
  - No longer commonly used for wind energy
- Production tax credits (PTC)
  - Often required to make projects economic
  - Boom/bust cycles
  - Need tax liability
  - Not applicable to public entities
- Renewable Energy Production Incentive (REPI)
  - Somewhat analogous to PTC, but for public entities
  - Appropriation of funds needed annually

# Renewable Portfolio Standards (RPS)

- RPS in place in some US states (e.g. Texas, Mass.) and some European countries (e.g. UK)
- Based on **quota**
- Retail suppliers required to supply certain fraction of electricity from renewable sources
- Requirement translates to a value for each kWh
  - – Upper limit set by penalty for non-compliance

# RPS (2)

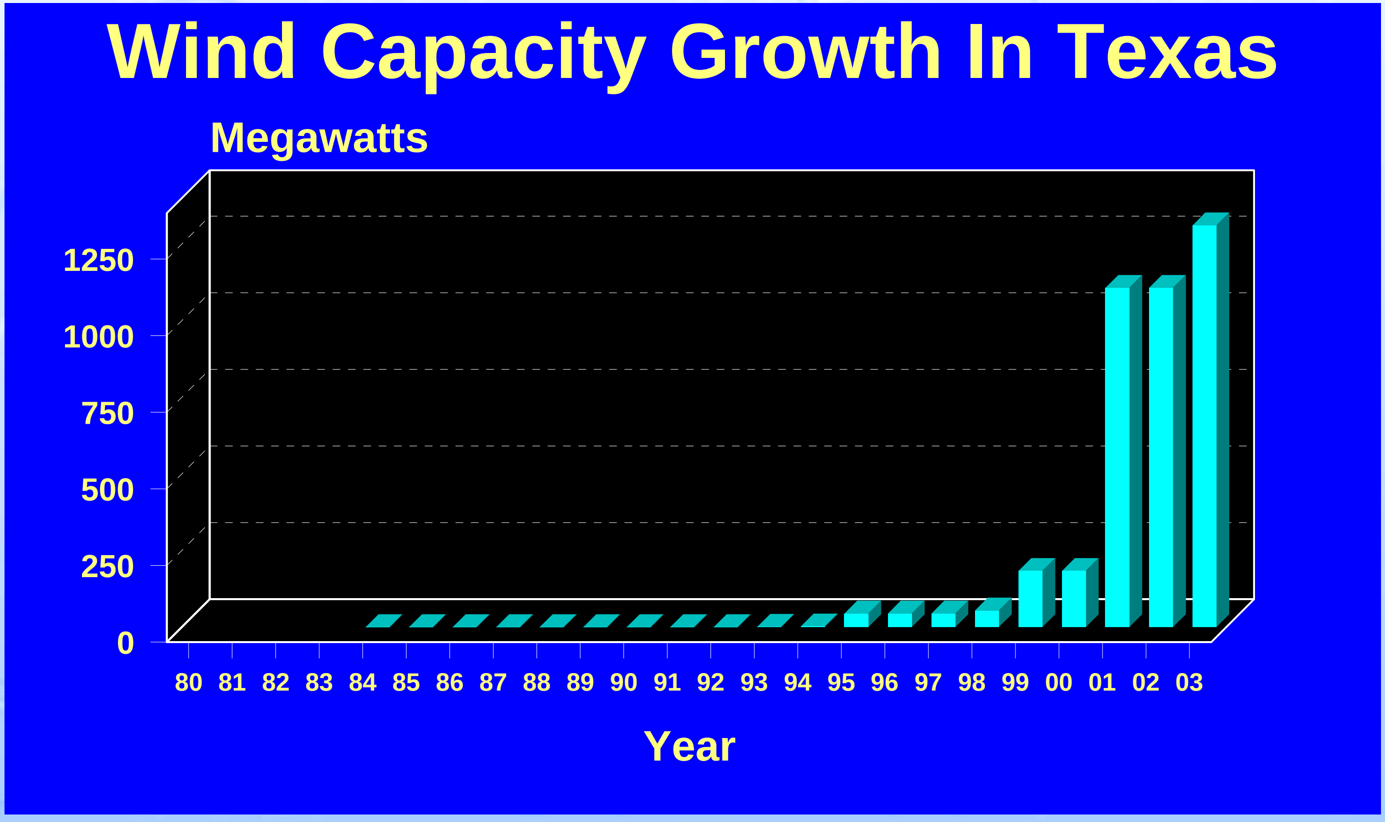
- Typically, renewable aspect of electricity is “unbundled” from the electrons
- Renewable aspect is represented by renewable energy credits (REC’s)
- REC’s can be bought and sold
- Obligation is met by acquiring sufficient REC’s
- Price set by bidding; supply and demand

# RPS (3)

- Value of REC's difficult to quantify *a priori*
- Power purchase agreement (PPA) for REC's needed for project financing
  - PPA for energy sale needed as well
- Value of REC's could change with time, making a PPA difficult to obtain
- Supply/demand effect on REC's value creates difficulties when changing eligibility
  - E.g. hydro or biomass in Mass.

# RPS in Texas

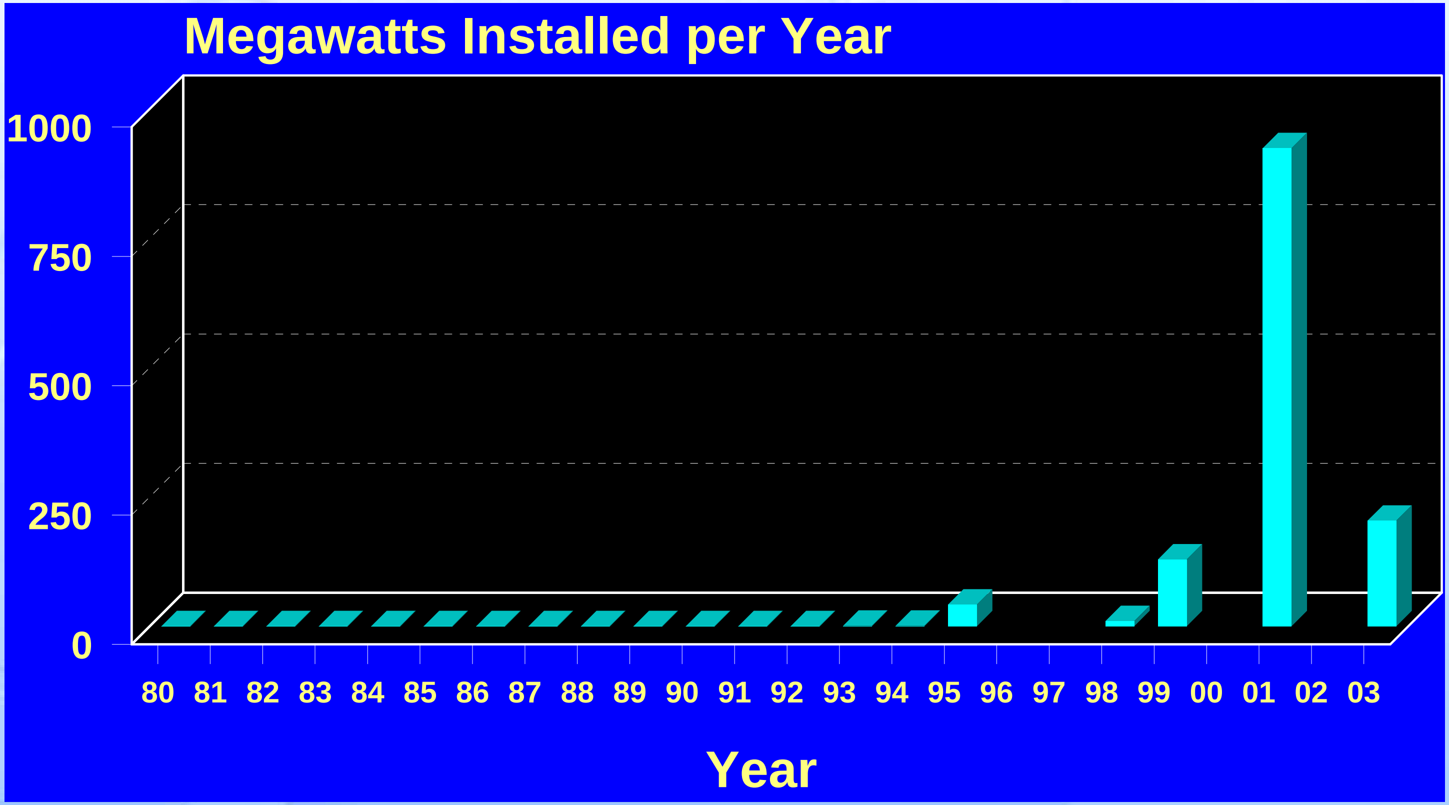
- RPS has had some success in Texas:




*Source: Gipe, OSEA*

# RPS in Texas (2)

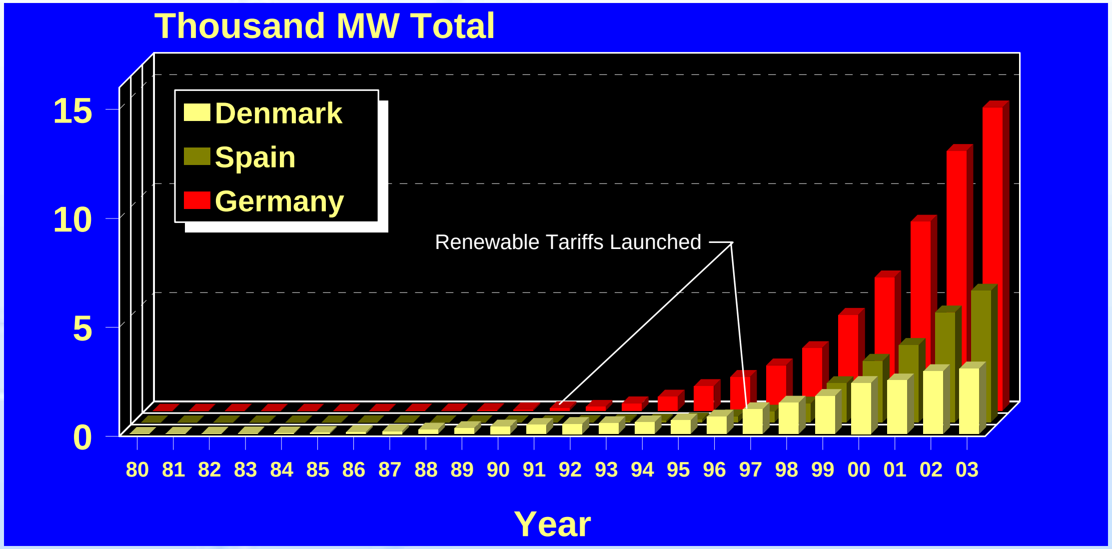
- PTC has been needed as well:




*Source: Gipe, OSEA*

# Wind Energy Growth in Europe

- Growth in Germany, Spain started when renewable tariffs implemented
- Growth in Denmark declined when renewable tariffs stopped




*Source: Gipe, OSEA*

# The European Feed-in/RPS Breakdown

- Note: Denmark switched from feed-in after change of government
- Conservatives in UK are now recommending feed-in tariffs

| Feed-in | RPS |
|---|---|
| Austria | Belgium |
| Denmark | Italy |
| France | Sweden |
| Germany | UK |
| Greece | Poland |
| Ireland | |
| Luxembourg | |
| Netherlands | |
| Portugal | |
| Spain | |
| Czech Republic | |
| Estonia | |
| Hungary | |
| Latvia | |
| Lithuania | |
| Slovak Republic | |
| Slovenia | |

*Source: Rickerson and Zytaruk, AWEA, 2006*

# Feed-in Tariff

- Also known as “EEG tariff” or “Advanced Renewable Energy Tariff”
- Used in most European countries (e.g. Germany, Spain)
- Based on mandated **price** of electricity sold into the electric grid from RE source
- Different prices for different **sources**
- Different prices for different **wind regimes**

# Origin of Feed-in Tariffs

- Denmark had something like the feed-in tariff for wind in the 1980's
- Germany introduced method in 1991
  - *Stromeinspeisungsgesetz für Erneuerbare Energien* (Act on **Feeding in** to the Grid Electricity Generated from Renewable Energy Sources)
- Has been updated (2000)
  - *Erneuerbare Energie Gesetz* (**EEG**, Renewable Energy Sources Act)

# EEG: Obligation to Purchase Renewable Energy and Pay for it

- Utility is obliged to connect RE power plants o to their grid at connection point that is technically and economically suitable
- Suitability includes reasonable upgrade if required
- Utility must purchase electricity at fixed rates of EEG

# EEG: Grid Connection Costs

- Costs to connect to the grid must be paid by project operator
- Costs to upgrade grid paid for by grid operator

# EEG: Payment

- Local utility pays project operator for electricity at required rates
- Excess costs are distributed throughout German electricity networks

# Overview of German EEG Tariffs

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| Solar power | 48,1 | 45,7 | 43,4 | 41,2 | 39,1 | 37,1 | 35,2 | 33,4 | 31,7 |
| Wind power initial tariffs/ prolongation* | 9 | 8,9 | 8,8 | 8,7 | 8,6 | 8,5 | 8,4 | 8,3 | 8,2 |
| Wind power final tariffs | 6,1 | 6 | 5,9 | 5,8 | 5,7 | 5,6 | 5,5 | 5,4 | 5,3 |
| Biomass < 500 kW | 10,1 | 10 | 9,9 | 9,8 | 9,7 | 9,6 | 9,5 | 9,4 | 9,3 |
| Biomass 500 kW - 5 MW | 9,1 | 9 | 8,9 | 8,8 | 8,7 | 8,6 | 8,5 | 8,4 | 8,3 |
| Biomass 5 MW - 20 MW | 8,6 | 8,5 | 8,4 | 8,3 | 8,2 | 8,1 | 8 | 7,9 | 7,8 |
| Hydropower and Gas (from landfills, mines, sewage plants) < 500 kW | 7,65 | 7,65 | 7,65 | 7,65 | 7,65 | 7,65 | 7,65 | 7,65 | 7,65 |
| Hydropower and Gas < 5 MW | 6,63 | 6,63 | 6,63 | 6,63 | 6,63 | 6,63 | 6,63 | 6,63 | 6,63 |
| Geothermal power < 20 MW | 8,93 | 8,93 | 8,93 | 8,93 | 8,93 | 8,93 | 8,93 | 8,93 | 8,93 |
| Geothermal power more than 20 MW | 7,14 | 7,14 | 7,14 | 7,14 | 7,14 | 7,14 | 7,14 | 7,14 | 7,14 |

*windpower: initial tariffs: first 5 years (onshore), first 9 years (offshore, if installed till 2006), Prolongation 0-15 years depending on site quality, Feed-In tariff duration 20 years

*J. Lackman, Bundesverband Erneuerbare Energie e.V., 2002*

# Close-Up of Some German EEG Rates

- Rates for **wind** depend on onshore or offshore
  - Early years have higher rates
  - Length of time depends on percentage of reference yield
- Rates for PV depend on size and type of application

| | Years | Rate (USD) * |
|---|---|---|
| **On Land Wind** | | |
| 60% Reference Yield | 11.5 | 0.109 |
| 100% Reference Yield | 9.2 | 0.109 |
| 150% Reference Yield | 5 | 0.109 |
| All | To year 20 | 0.069 |
| **Offshore** | | |
| 60% Reference Yield | | 0.114 |
| 100% Reference Yield | | 0.114 |
| 150% Reference Yield | | 0.114 |
| All | To year 20 | 0.069 |
| **Solar PV** | | |
| < 100 kW rooftop | 20 | 0.681 |
| > 100 kW rooftop | 20 | 0.674 |
| Freestanding | 20 | 0.570 |

**converted from Euros*

# Wind Turbine Energy Yields

- Consider reference yield, 60% and 150% of reference
- Example: Vestas V47 on 50 m tower (“Hull I”)*

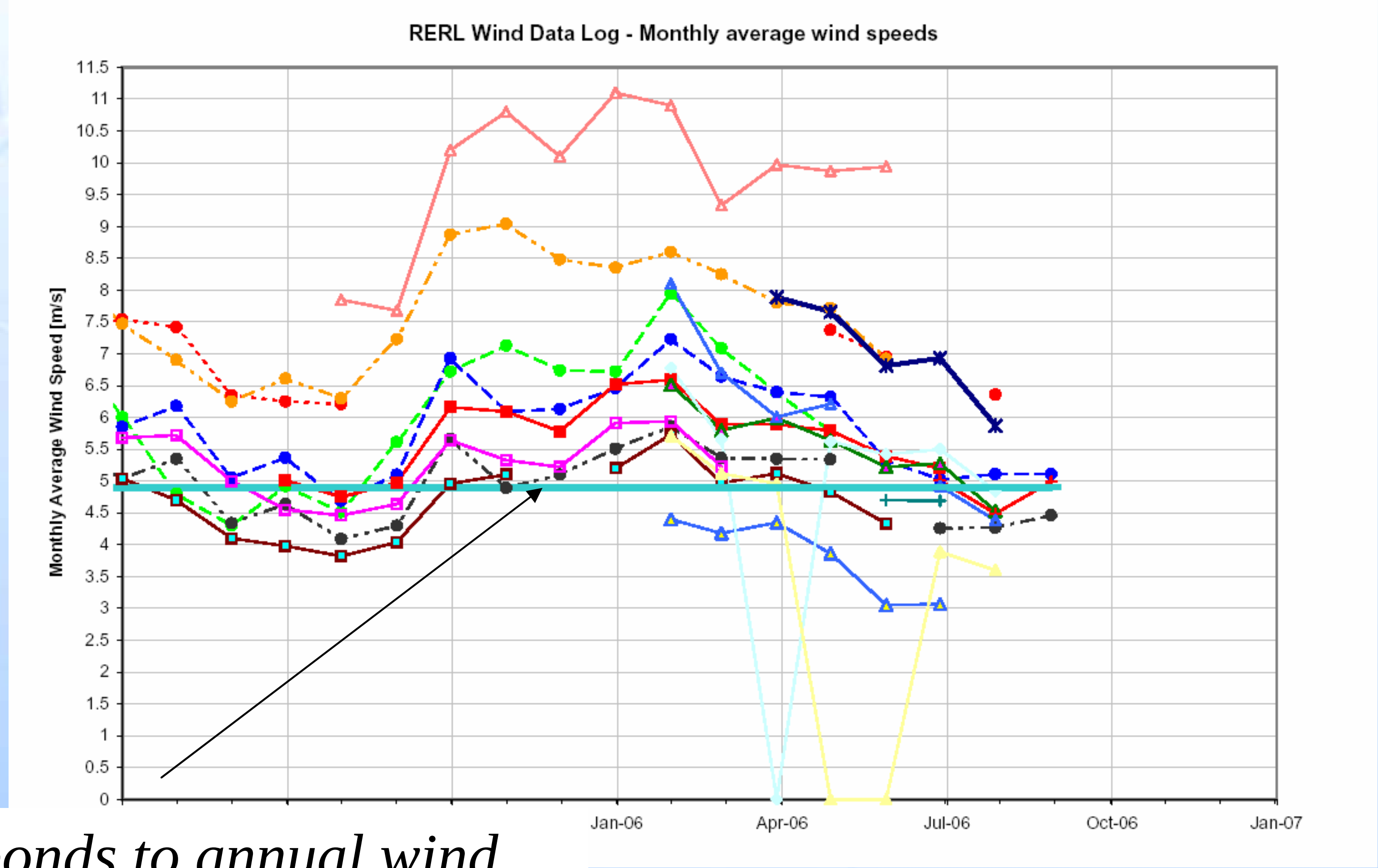
| Reference Yield | kWh/yr | Mean Wind, m/s | Capacity Factor |
|---|---|---|---|
| 100% | 1,331,800 | 6.0 | 0.230 |
| 60% | 799,080 | 4.9 | 0.138 |
| 150% | 1,997,700 | 7.4 | 0.346 |

- Implication: Hull I site is better than reference (CF = approx. 0.28)
- Many sites in Massachusetts are better than 60% of reference (see next slide)

**Assumes Rayleigh distribution, 97% availability*

*Also see http://www.wind-fgw.de/*

# Measured Wind Data in Massachusetts




*Line corresponds to annual wind speed for EEG 60% reference yield*

# Example: Dortmund

- Inland Germany
- Unremarkable wind: 5.1 m/s
- Municipal electric company
- Enercon 500 kW turbine
- Capacity factor: 0.17
- Cost: Eur 511k (~$639k)
- Financed with bonds



*http://www.energie-cites.org/db/dortmund_139_en.pdf*

# More on the Debate

# Feed-in EEG

- Advantages claimed
  - High efficiency
  - Allows price differentiation and reduces costs
  - Planning certainty
  - Low administration expense
  - No effect on government budgets
- Disadvantages noted
  - Lack of a acceptance by some sectors

# Arguments for Feed-in

- Rapid deployment of resources
- Rapid development of local manufacturing
- Increases in local acceptance and participation
- Encourages geographic distribution
- Transparent and lower administrative cost
- More jobs, more investment, more competition in manufacturing, equipment suppliers
- Projected costs minimal

*Source: Rickerson and Zytaruk, AWEA, 2006*

# Arguments for RPS

- Predictable market growth
- Minimizes costs to taxpayers and/or rate payers through increased competition among developers
- No picking technological winners
- Market based system of tradable credits
- Projected costs minimal

*Source: Rickerson and Zytaruk, AWEA, 2006*

# Issues with RPS

- Focus on lower price
  - Geographic concentration
  - NIMBY and best sites first
  - High contract failure rates
- Targets near market technologies and leaves technology market to foreign manufactures
- Deployment rates relatively slow
- Single price means “windfall” for best sites
- Favors large developers
- Less portfolio diversity
- Administratively cumbersome and costly

*Adapted from: Rickerson and Zytaruk, AWEA, 2006*

# German Building Code

- For building in rural areas, “Paragraph 35”
- Wind turbines in designated regions are permitted **by right**
- **Evidence** now has to be given as to **why** turbines should **not** be permitted
  - Rather than the other way around.
  - Streamlined the planning and approval process
- Cities and communities are obliged to **identify local** wind resource areas.

# Feed-in Tariff in North America?

- Already implemented in Canada (Ontario and Prince Edward Island)
- In place to some degree in US in Washington state, Minnesota, Wisconsin (PV and biogas), New Mexico (PV only) and California (PV only)

# Recent Experience in Massachusetts

- Wind studies reveal that resource is often as good as much of Germany
  - In spite of that, resource often thought of as too low for development
- Deployment is still slow
- NIMBY is a problem
- Most of the action is in towns with municipal utilities

# Lessons from Europe for Massachusetts?

- Massachusetts RPS still relatively young
  - Results not in
  - Should be closely watched
- Could system be developed that includes some of the advantages of RPS and feed-in?
  - Hybrid system with quotas for various sectors (e.g. wind, PV, biomass, hydro); set minimum prices?
- State wide wind zoning law
  - Reduce impact of NIMBY
- Municipal utilities have some intrinsic advantages
  - More encouragement needed?

# References

- Much information is available on the Internet
- Links to many documents of relevance:
*http://www.wind-works.org/*