



Renewable Energy Research Laboratory

Policy Options for Renewable Energy Incentives: The European Experience

From Local to Global: The Rhode Island Model For Harnessing Wind Energy Worldwide

Roger Williams University

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J. F. Manwell

Professor and Director

Renewable Energy Research Laboratory

Department of Mechanical and Industrial Engineering

University of Massachusetts 



Wind Energy US Background

- Occasional efforts to revive wind energy throughout early to mid 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 leader in 1970's (95% of wind energy capacity before 1980)
 - Beginning of the “wind farm” era
- World leaders are now Germany and Spain

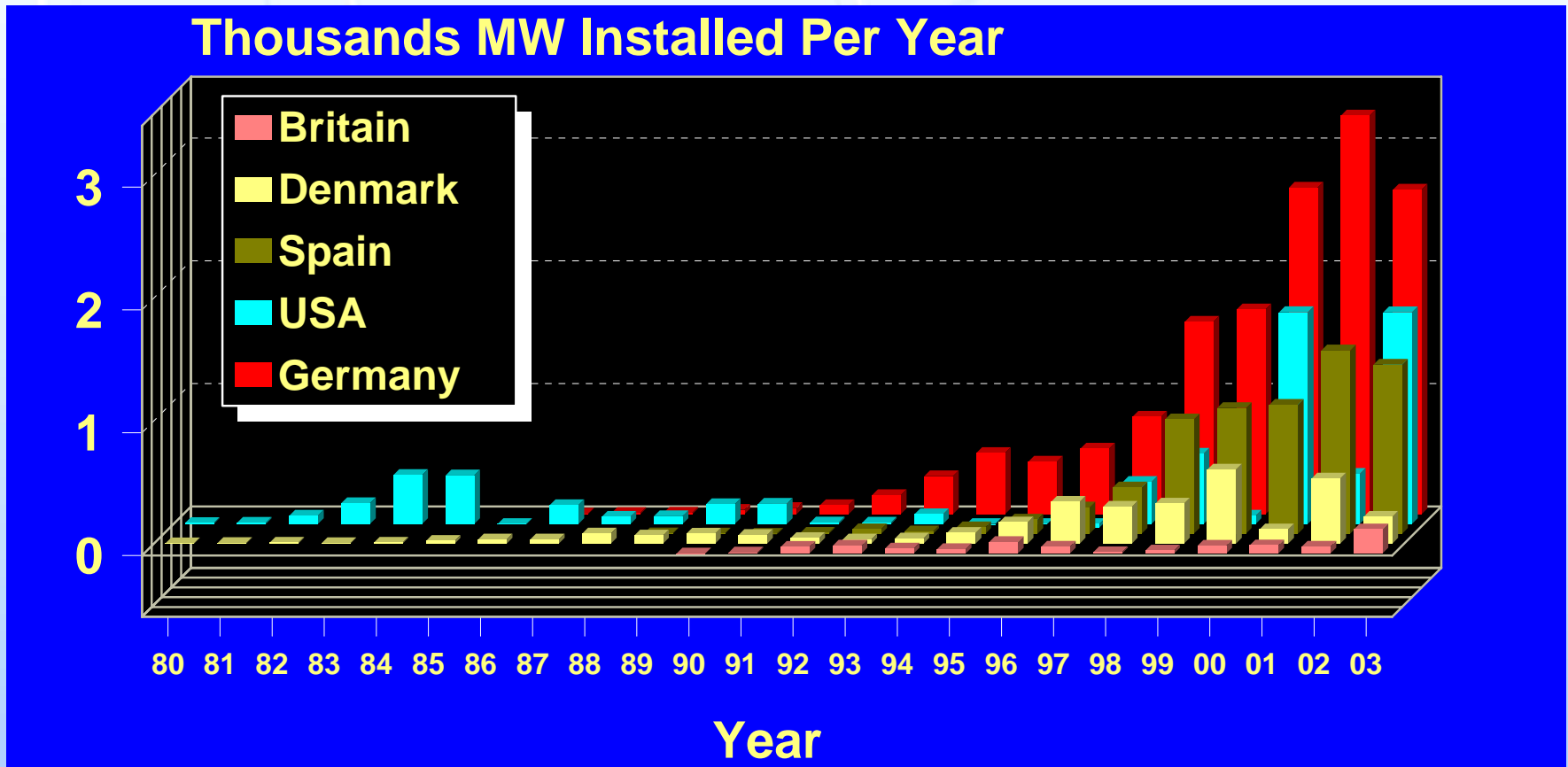


Incentive Options in the US

- Investment tax credits
- Public Utility Regulatory Policy Act of 1978 (PURPA)
- Production tax credits (PTC)
 - REPI for public entities
- Renewable Portfolio Standard (RPS)
- Systems benefit charges (SBC)
 - Such as Massachusetts' Renewable Energy Trust Fund
- Net metering
- Green power



Sample Wind Energy Installation Rates





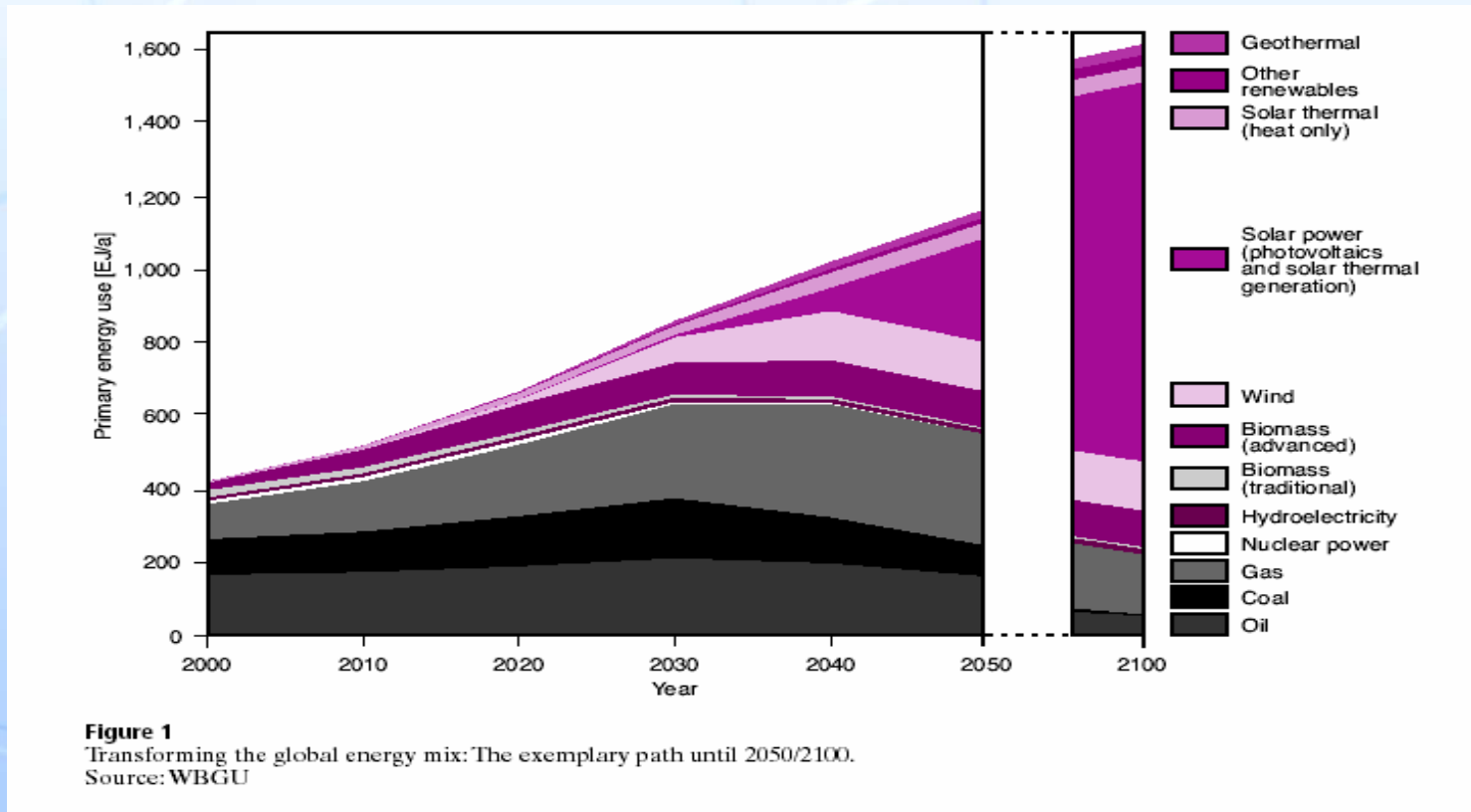
Context for European Interest in Renewable Energy

- 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



A Significant Role for Renewable Energy is Envisioned

- Possible transformation of world's energy supply:





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



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
- Has 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



RPS vs. Feed-In: 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)



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	



Feed-in Tariff

- Also known as “EEG tariff” or “Advanced Renewable Energy Tariff” (ART)
- 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 **obligated to connect** RE power plants 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 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 New England are better than 60% of reference

**Assumes Rayleigh distribution, 97% availability*

Also see <http://www.wind-fgw.de/>



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.



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



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
- Contract needed for RPS REC's as well as kWh
- Most action is in towns with municipal utilities



Lessons from Europe for New England?

- Massachusetts has RPS that is still relatively young
 - Results not in
 - Should be closely watched
- Incentives similar to Germany's should be considered
 - Hybrid system with quotas for various sectors (e.g. wind, PV, biomass, hydro) with minimum prices could be option
- State wide wind zoning law (analogous to Germany's)
 - Reduce impact of NIMBY
- Municipal utilities have some intrinsic advantages
 - More encouragement needed?