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Feed-in Tariffs: Accelerating the Deployment of Renewable Energy

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Presentation to the Sustainable Electricity Association of New Zealand (SEANZ)

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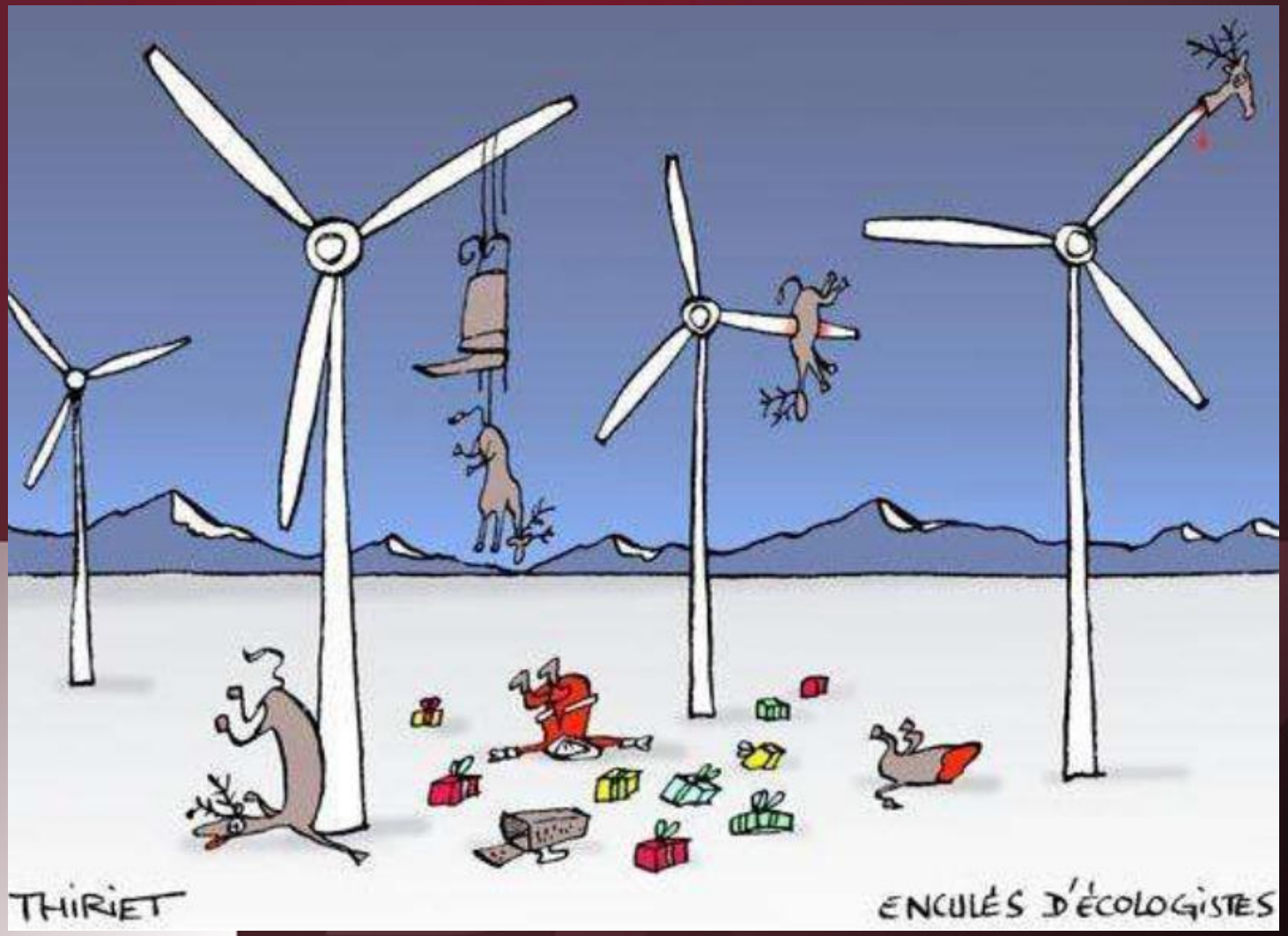
Preview of presentation

- A brief overview of Feed-in Tariffs (FITs)
- Exploring the impact of FITs in Germany, Spain, and Canada
- Assessing the "cost effectiveness" of FITs
- Possible Benefits to New Zealand
- The components of a well designed FIT
- The importance of comprehensive government policy

But first, three caveats



- **What is a “renewable” electricity generator?**

Brief overview of FITs

FITs = guaranteed, fixed price for renewable energy, often for 20 or 30 years, with any increased costs spread across all consumers as a whole; justification premised on five arguments:

1: Subsidies – fossil fuels and nuclear tend to dominate international government subsidies
2: Market failures – a host of market failures and barriers impede renewable electricity
3: Climate change – renewable power technologies have immense environmental benefits
4: Flexibility – FITs are less onerous than command-and-control regulatory approaches
5: Cost – FITs cost governments virtually nothing

Why should New Zealand adopt one?

Consider Germany

- If you want to:
- Create jobs (250,000 jobs)
- Reduce emissions (115m tonnes CO2 saved p.a.)
- Save energy imports (€4.3bn)
- Build an industry (€25 bn turnover in plant construction and operation)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Final energy consumption (FEC)	[%]									
Electricity generation (in relation to total gross electricity consumption)	4.8	5.5	6.3	6.7	7.8	8.1	9.5	10.4	11.7	14.2
Heat supply (in relation to total heat supply) [1]	3.5	3.5	3.9	3.8	3.9	4.6	4.9	5.4	5.8	6.6
Fuel consumption [2] (in relation to total fuel consumption)	0.2	0.2	0.4	0.6	0.9	1.4	1.8	3.8	6.3	7.6
Renewables as a share of total FEC	**3.1**	**3.3**	**3.8**	**3.8**	**4.3**	**4.9**	**5.5**	**6.6**	**7.5**	**8.6**

Source: Miguel Mendonca, World Future Council

Brief overview of FITs

FITs can differ greatly:

1, differentiate by technology
2, differentiate by size or application
3, differentiate by resource or site
4, differ by length of payments
5, provide for periodic review
6, provide for balancing accounts to spread program cost
7, differ by target size or quota
8, differ by level of degression

Brief overview of FITs

- Differentiation by application

German Solar Tariffs, 2007		
Solar Photovoltaic	**Years**	**/kWh**
Freestanding	20	0.380
<30 kW rooftop	20	0.492
<100 kW rooftop	20	0.468
>100 kW rooftop	20	0.463
Facade cladding <30 kW	20	0.535
Facade cladding <100 kW	20	0.511
Facade cladding >100 kW	20	0.506

Brief overview of FITs

- Differentiation by size

German Biogas Tariffs, 2007		
Biogas	**Years**	**/kWh**
<150 kW	20	0.110
<500 kW	20	0.095
<5 MW	20	0.085
<20 MW	20	0.080

Brief overview of FITs

- Differentiation by location

Greek Solar Thermal Tariffs, 2007		
Solar Thermal	**Years**	**/kWh**
<5 MW Mainland	20	0.25
<5 MW Islands	20	0.27
>5 MW Mainland	20	0.23
>5 MW Islands	20	0.25

Brief overview of FITs

- Differentiation by target or quota

Latvijas Republikas
Ekonomikas ministrija
Ministry of Economics
Republic of Latvia

- **Hydro**: 5 MW on small rivers
- **Wind**: 135 MW (currently installed 27 MW)
- **Biomass for electricity**: 72 MW biomass & biogas CHP

Brief overview of FITs

- Differentiation by resource:

French Wind Energy Tariffs, 2007				
		Full Load	Capacity	Tariff
	Years	Hours	Factor	/kWh
Wind Energy				
Offshore	1-10			0.082
Small-scale	11-15	2,400	0.27	0.082
		2,500	0.29	0.079
		2,600	0.30	0.075
		2,700	0.31	0.072
Medium	11-15	2,800	0.32	0.068
		2,900	0.33	0.063
		3,000	0.34	0.058
		3,100	0.35	0.053
		3,200	0.37	0.048
		3,300	0.38	0.043
		3,400	0.39	0.038
		3,500	0.40	0.033
High	11-15	3,600	0.41	0.028

Brief overview of FITs

- Differentiation by degression (Germany, again):

Technology	Level of degression	
Hydroelectric power	---	1 %*
Wind energy	1.5 %	2 %
Photovoltaics	5 %	5 %
Geothermal power	---	1 %
Landfill/sewage plant/mine gases	---	1.5 %
Biomass	1 %	1.5 %

Exploring the impacts of FITs in Germany

Renewable energy proportion of total electricity consumption	
1990:	3.4%
2000:	6.3%
2004:	9.3%
2006:	12.0%

Source: AGEE-Stat/BMU

Composition of renewable electricity production for 2006	
Wind power:	41.3%
Hydroelectric power:	29.3%
Biomass:	19.2%
Photovoltaics:	2.7%
Landfill gas, sewage plant gas, biogenic waste:	7.5%

Primary energy consumption in Germany (share of renewable energies)	
2000:	14.401 PJ
(renewable energy 2.6%)	
2005:	14.286 PJ
(renewable energy 4.7%)	
2006:	14.465 PJ
(renewable energy 5.8%)	
2010: (estimate)	13.492 PJ
(renewable energy 8.4%)	

Exploring the impacts of FITs in Germany

Development of the German PV market

Market data grid-connected systems 2007

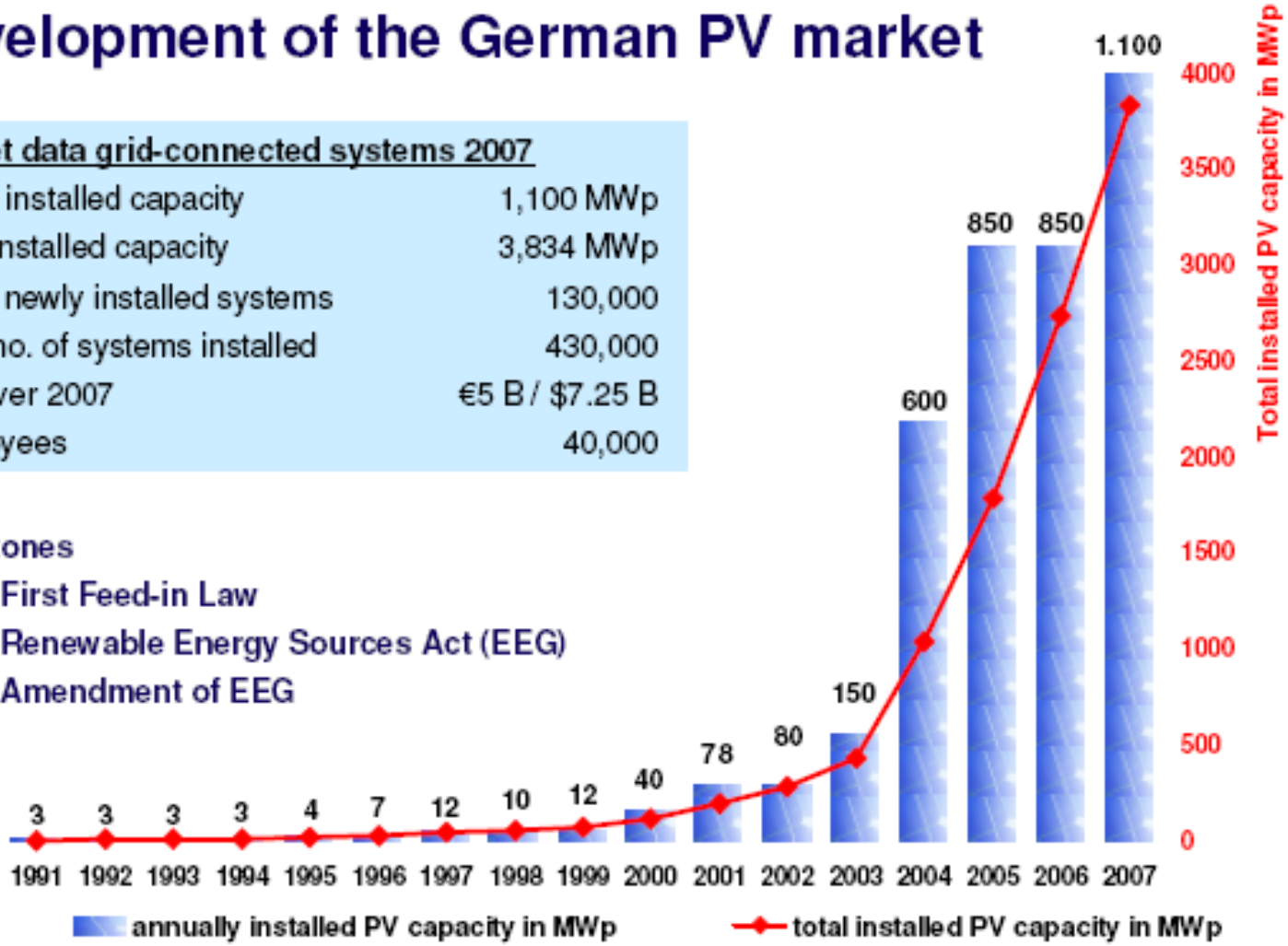
Newly installed capacity	1,100 MWp
Total installed capacity	3,834 MWp
No. of newly installed systems	130,000
Total no. of systems installed	430,000
Turnover 2007	€5 B / $7.25 B
Employees	40,000

Milestones

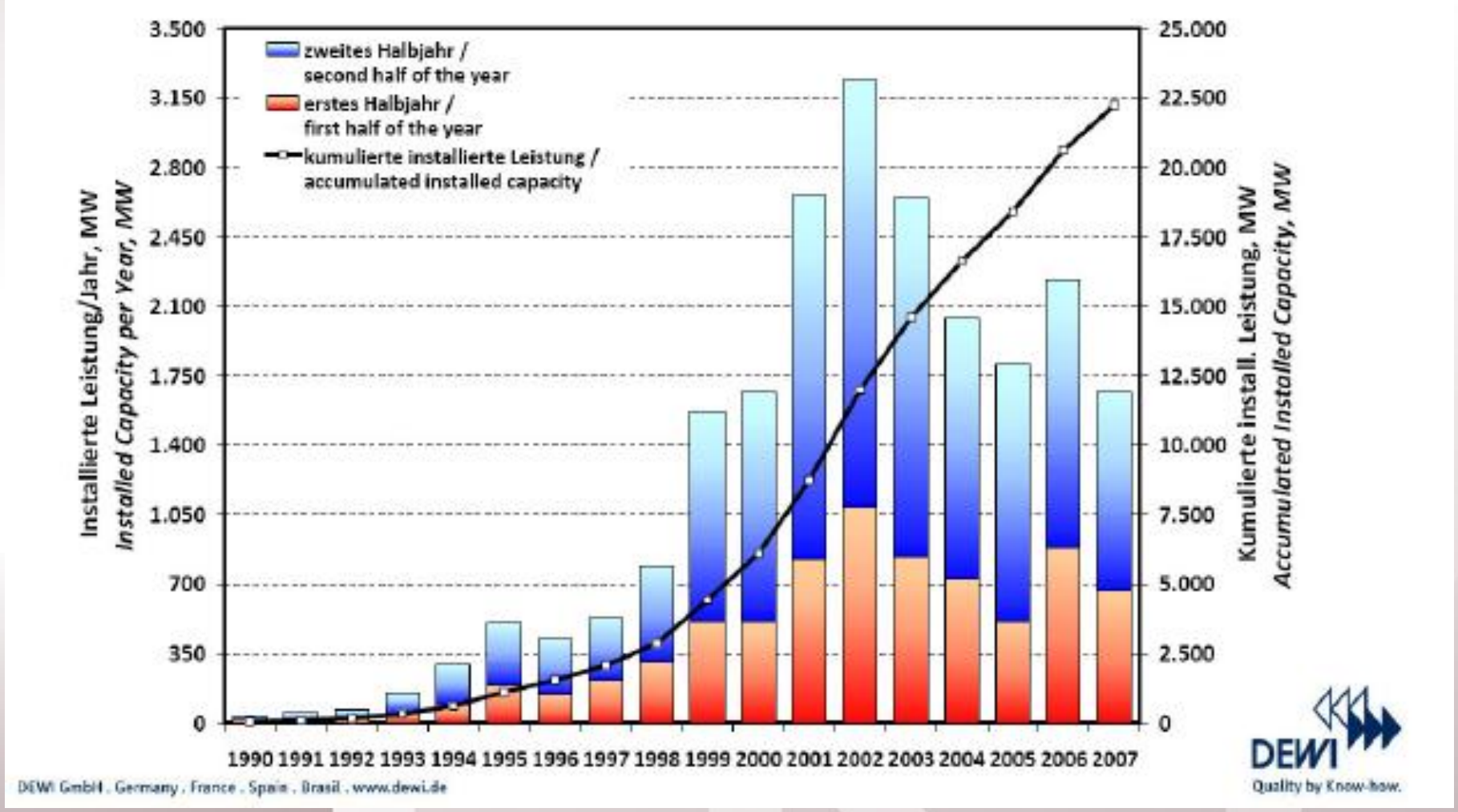
1991: First Feed-in Law

2000: Renewable Energy Sources Act (EEG)

2004: Amendment of EEG

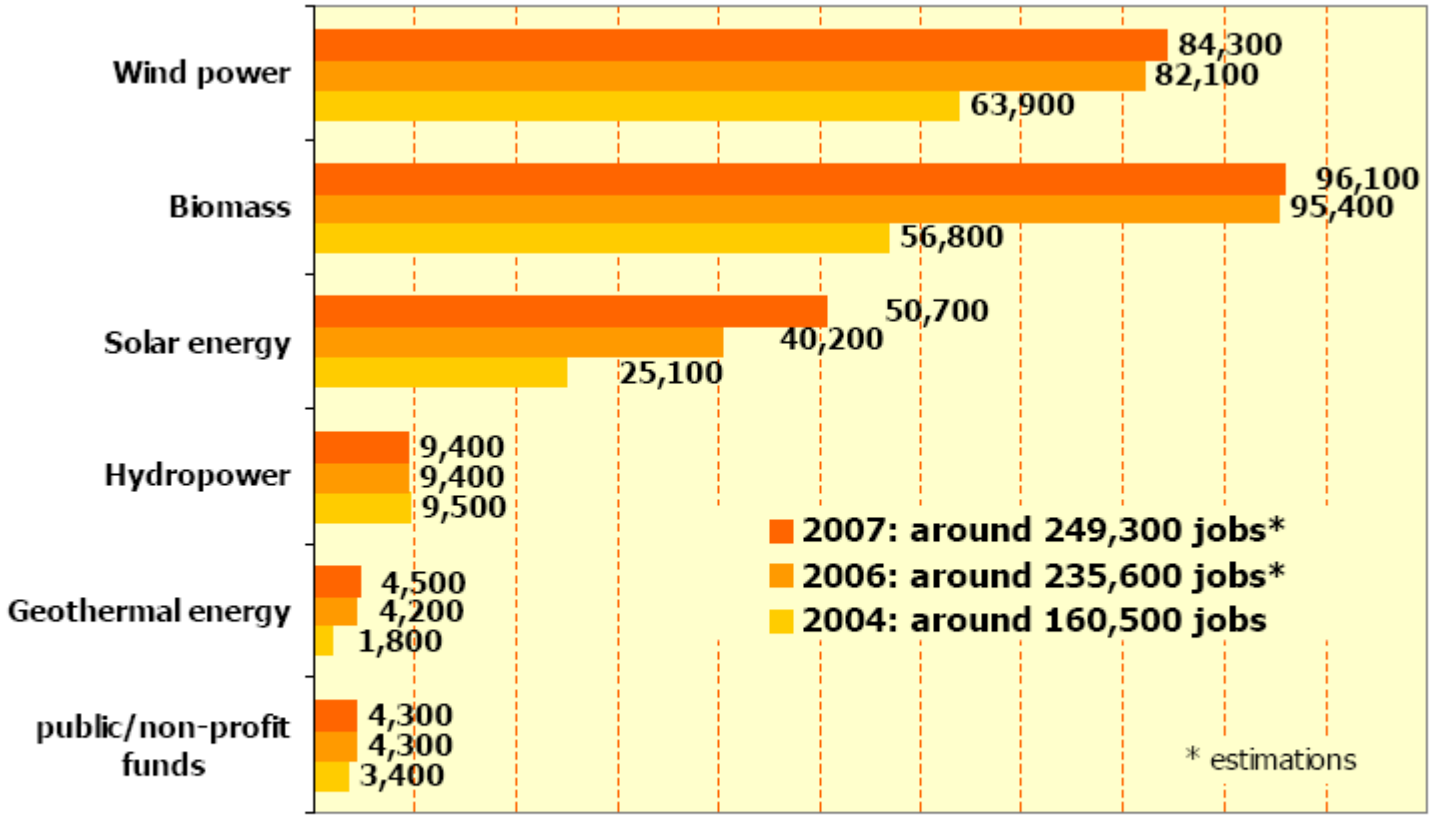


Wind energy in Germany: Installed capacity



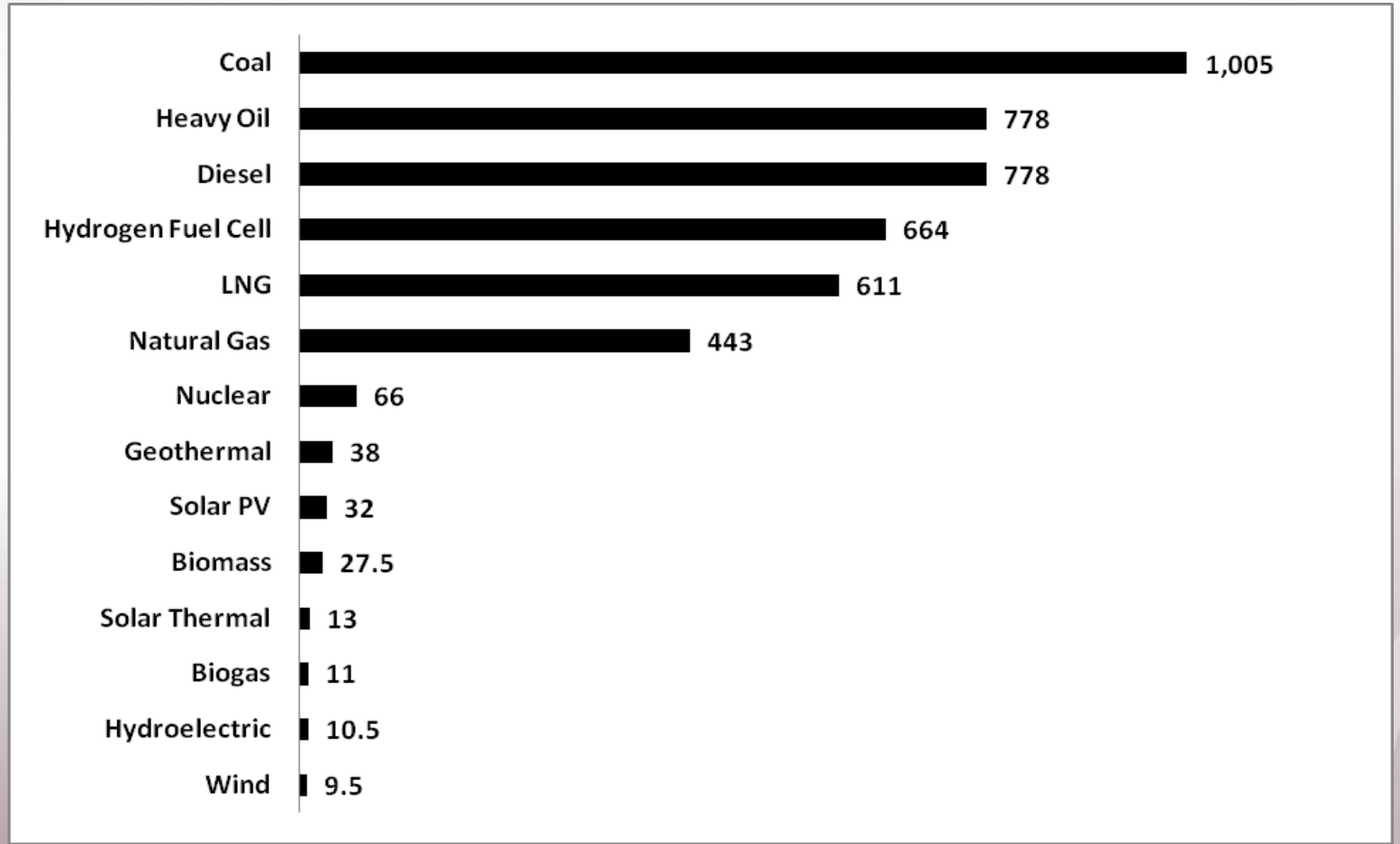
Source: Rainer Hinrichs—Rahlwes/German Renewable Energy Federation

Exploring the impacts of FITs in Germany

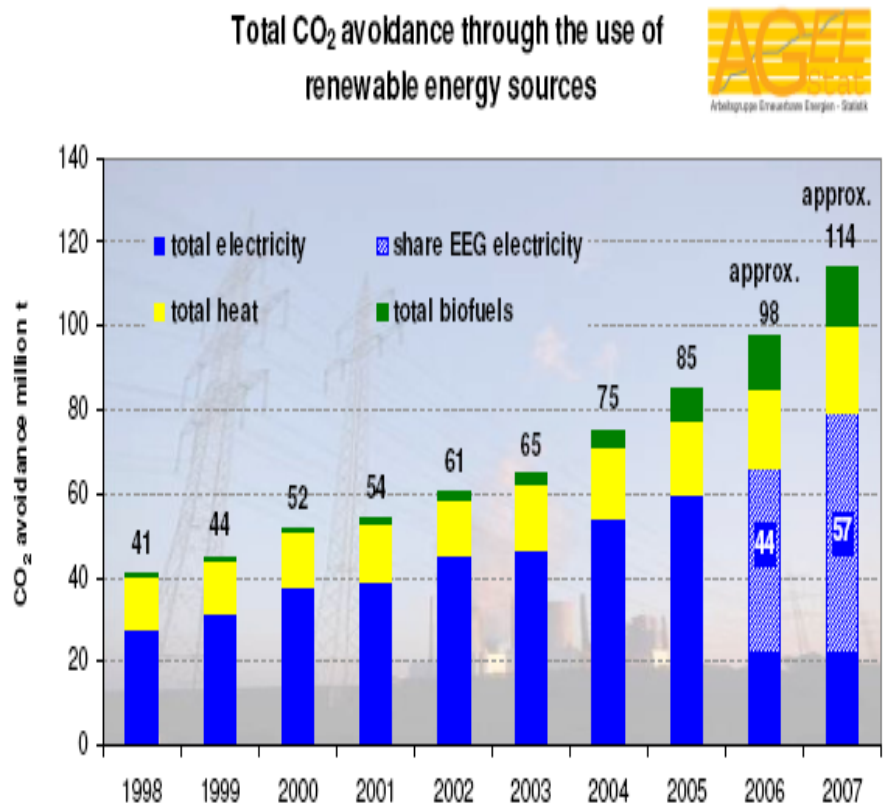


Exploring the impacts of FITs in Germany

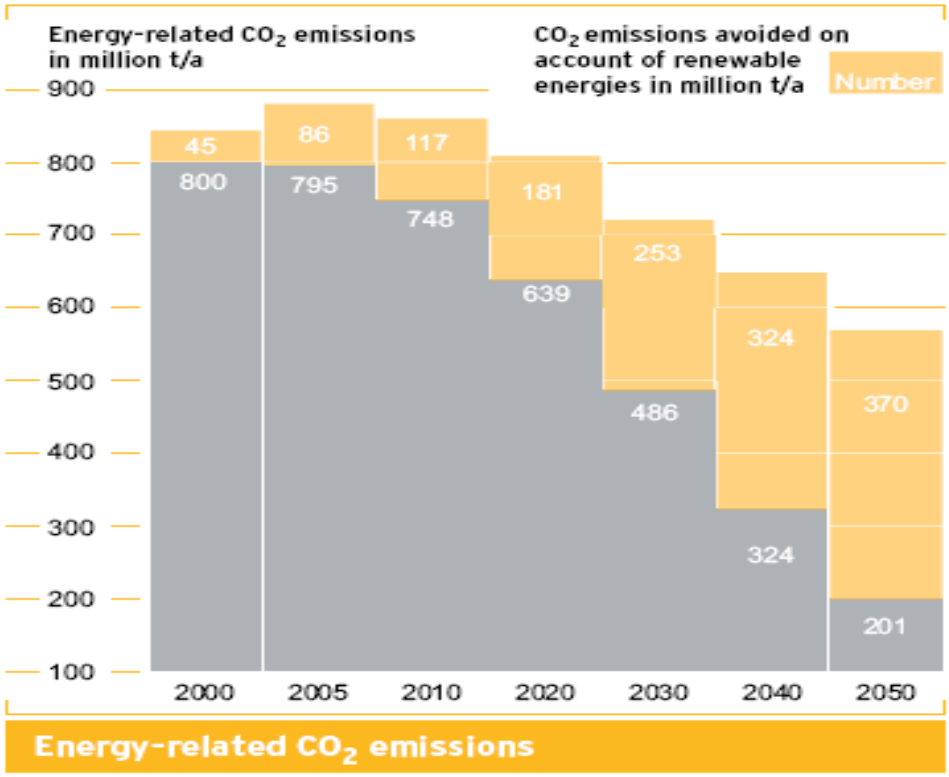
Lifecycle Greenhouse Gas Emissions for Conventional and Renewable Power Plants (equivalent grams of CO_2/kWh)



Exploring the impacts of FITs in Germany



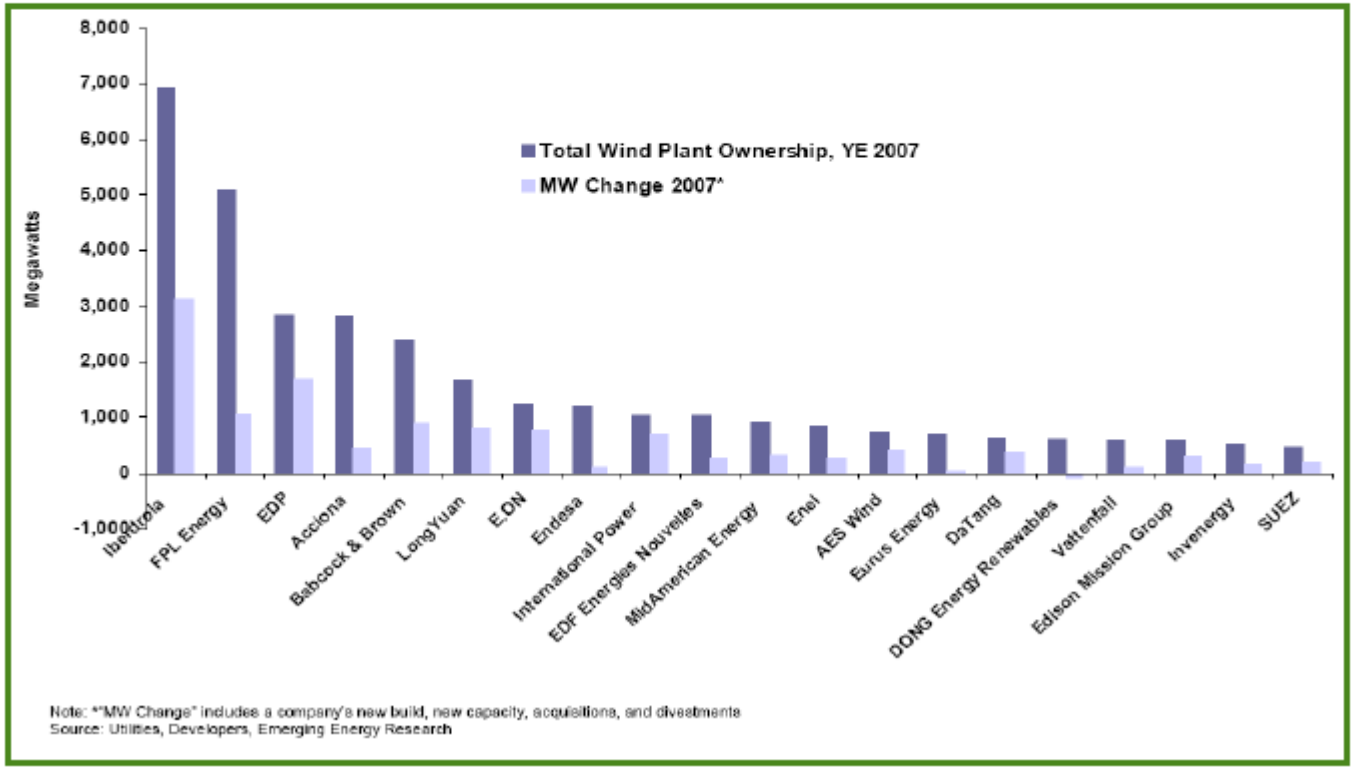
Version: March 2008; all figures provisional
Source: BMU according to Working Group on Renewable Energies / Statistics (AGEE-Stat)



Exploring the impacts of FITs in Spain

Three spanish companies in the top 10

Iberdrola is the 1st company worldwide in wind capacity



Source for all slides from Iberdola: Carlos Gasco

Employment Creation in the Renewable Energy Sector

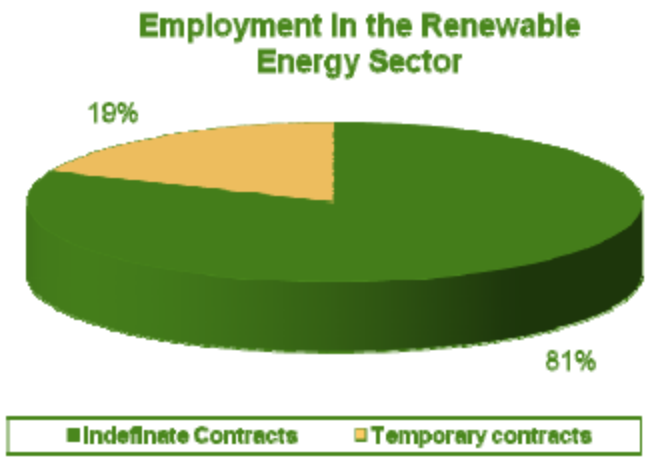
IBERDROLA RENEWABLES

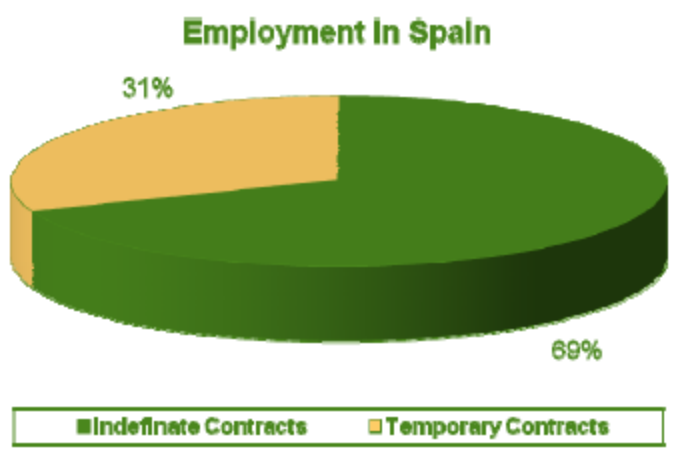
1,027 companies working in the renewable energy sector suppose an important employment growth driver

Renewable energy's contribution to employment in Spain:

Direct employment: **89,001** jobs + Indirect Employment: **99,681** jobs = **Total Employment: 188,682 jobs**

The employment quality in the renewable energy sector is significantly better than in Spain as a whole



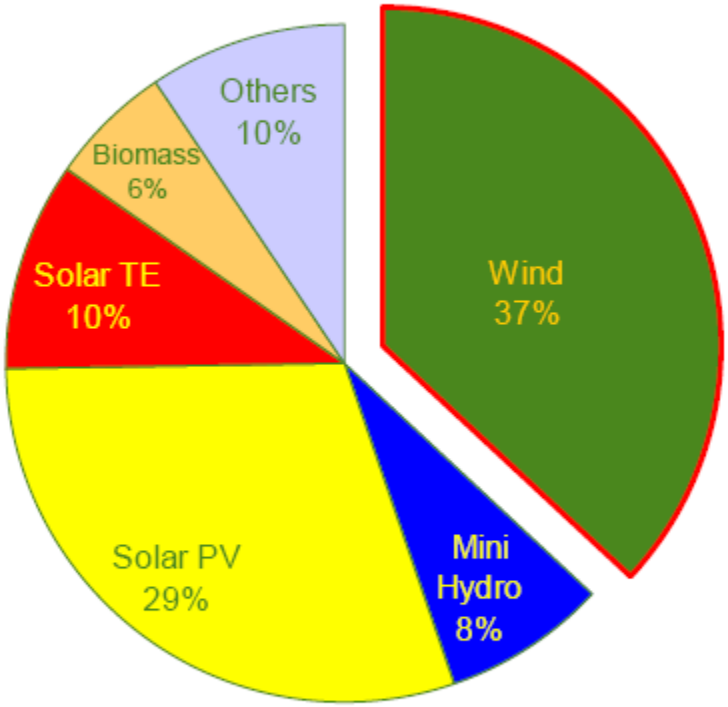


Employment Creation in the Renewable Energy Sector

IBERDROLA RENEWABLES

Concerning renewables, wind energy creates 37% of the jobs

Renewable Technology	Number of workers
Wind	32,906
Mini Hydro	6,661
Thermal Solar	8,174
Solar Thermoelectric	968
Solar Photovoltaic	26,449
Biomass	4,948
Others	8,895
Total	89,001



Source: CCOO review on renewable energy

50% of the workers in the renewable energy sector have university degrees

Iberdrola Renewable

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Worldwide leader in wind energy …

7,704 MW of installed capacity

+

42,053 MW of pipeline*

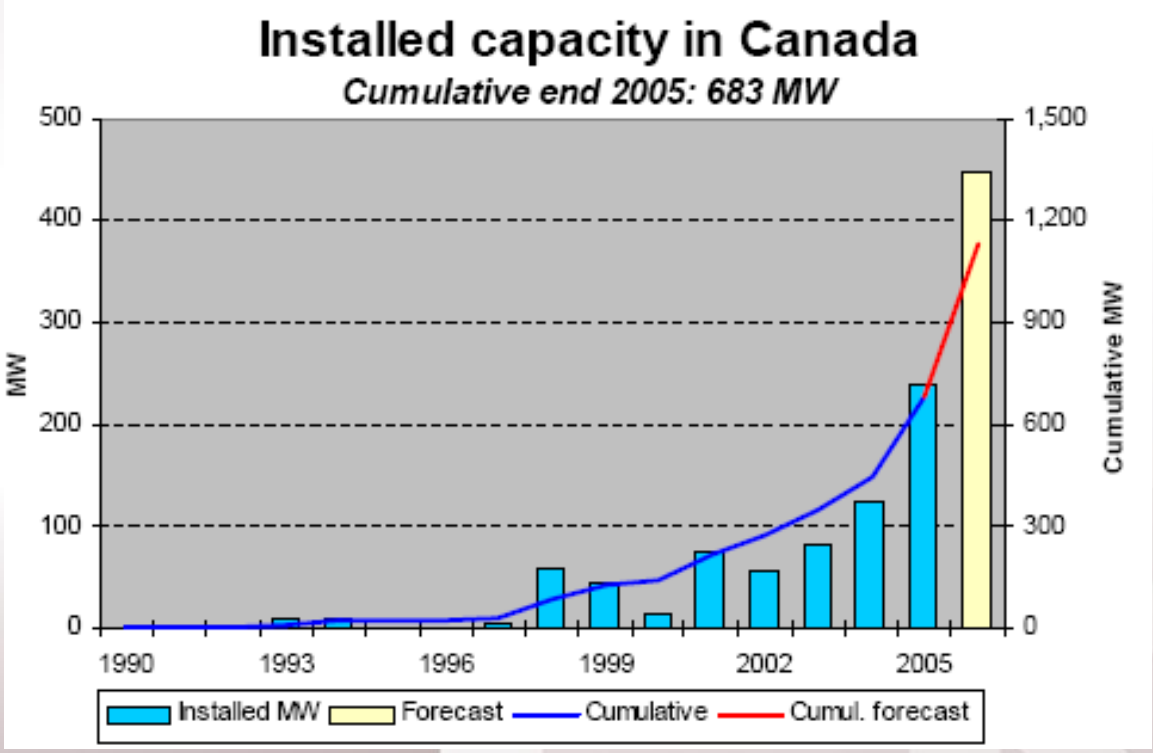
	Pipeline
Spain	17%
U.K.	13%
USA	52%
Rest of world	18%

… with a huge pipeline that provides for future growth

* Includes mini-hydro & other renewable energy technologies

Exploring the impacts of FITs in Canada

FIT provides 11 cents per kWh for mini-hyro, biomass, and wind; 42 cents per kWh for solar, all 20-year contracts (had ~17 MW of solar in 2005)



- Wind = ~655 MW
- PV = ~316 MW
- Hydro = ~66 MW
- Bio-energy = ~67 MW

(as of February 2008)

Source for all slides from York/David Suzuki: Jose Etcheverry

Assessing the cost-effectiveness of FITs

- A note on electricity prices: they are incredibly skewed in favor of conventional sources, excluding subsidies

	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Biomass
Min	0.06	0.03	0.003	0.0003	0.02	0	0	0
Max	72.42	39.93	13.22	64.45	26.26	0.80	1.69	22.09
Mean	**14.87**	**13.57**	**5.02**	**8.63**	**3.84**	**0.29**	**0.69**	**5.20**
SD	16.89	12.51	4.73	18.62	8.40	0.20	0.57	6.11
N	29	15	24	16	11	14	7	16

True $ of Power (Marginal LCOE + Social Cost)

Energy Efficiency and DSM	2.5 U.S. ¢/kWh
Offshore Wind	3.0 U.S. ¢/kWh
Onshore Wind	6.0 U.S. ¢/kWh
Geothermal	7.1 U.S. ¢/kWh
Hydroelectric	7.8 U.S. ¢/kWh
Biomass (Landfill Gas)	10.8 U.S. ¢/kWh
Parabolic Troughs (Solar Thermal)	11.4 U.S. ¢/kWh
Biomass (Combustion)	13.6 U.S. ¢/kWh
Advanced Nuclear	16.0 U.S. ¢/kWh
Solar Ponds (Solar Thermal)	19.7 U.S. ¢/kWh
Advanced Gas and Oil Combined Cycle	20.2 U.S. ¢/kWh
Gas Oil Combined Cycle	20.5 U.S. ¢/kWh
Advanced Gas and Oil CC w/ CCS	24.8 U.S. ¢/kWh
Integrated Gasification Combined Cycle	25.9 U.S. ¢/kWh
Scrubbed Coal	26.3 U.S. ¢/kWh
IGCC with Carbon Capture	27.9 U.S. ¢/kWh
Advanced Combustion Turbine	39.0 U.S. ¢/kWh
Solar Photovoltaic (panel)	39.9 U.S. ¢/kWh
Combustion Turbine	42.1 U.S. ¢/kWh

Costs in Germany:

Cost effects of EEG-promoted electricity generation (estimated / 2006)		Benefit effects of EEG-promoted electricity generation (estimated / 2006)	
EEG differential costs Additional costs as compared with conventional electricity generation in accordance with Section 15 of the EEG.	3.2 billion euros	5.0 billion euros	Reduction in the wholesale price Price reduction through merit-order effect, i.e. EEG electricity crowding out electricity produced from fossil fuels
Additional costs, regulation energy Estimate of the upper limit, as no coherent information is available from the transmission system operators.	0.1 billion euros	3.4 billion euros	Avoided external costs for electricity generation External costs from climate change and air pollutants
Transaction costs Estimate of personnel costs, as no information is available from the grid operators.	0.002 billion euros	1,0 billion euros	Avoided energy imports Savings in hard coal and gas imports for electricity generation, including large-scale hydroelectric power plants.
= 3.3 billion euros		= 9.4 billion euros	

Cost and benefit effects of the EEG

Costs in Spain:

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Wind energy costs

- 1MWh of wind costs = premium + incentive = 38 €/MWh
- Wind production in 2007 = 26.7 TWh
- Total cost of wind energy to the system = 26.7 TWh x 38 € MWh = 1,014 M€

Avoided costs provided by wind energy in the market option

- Without wind, market price would have increased an average of 6 €/MWh
- Costs avoided by wind energy = total demand x 6€/MWh = 276 TWh x 6 €/MWh = 1,656 M€

Wind costs → 1,014M€

Avoided costs → 1,656 M€

SAVINGS 641 M€

Wind production's impact on the pool's price

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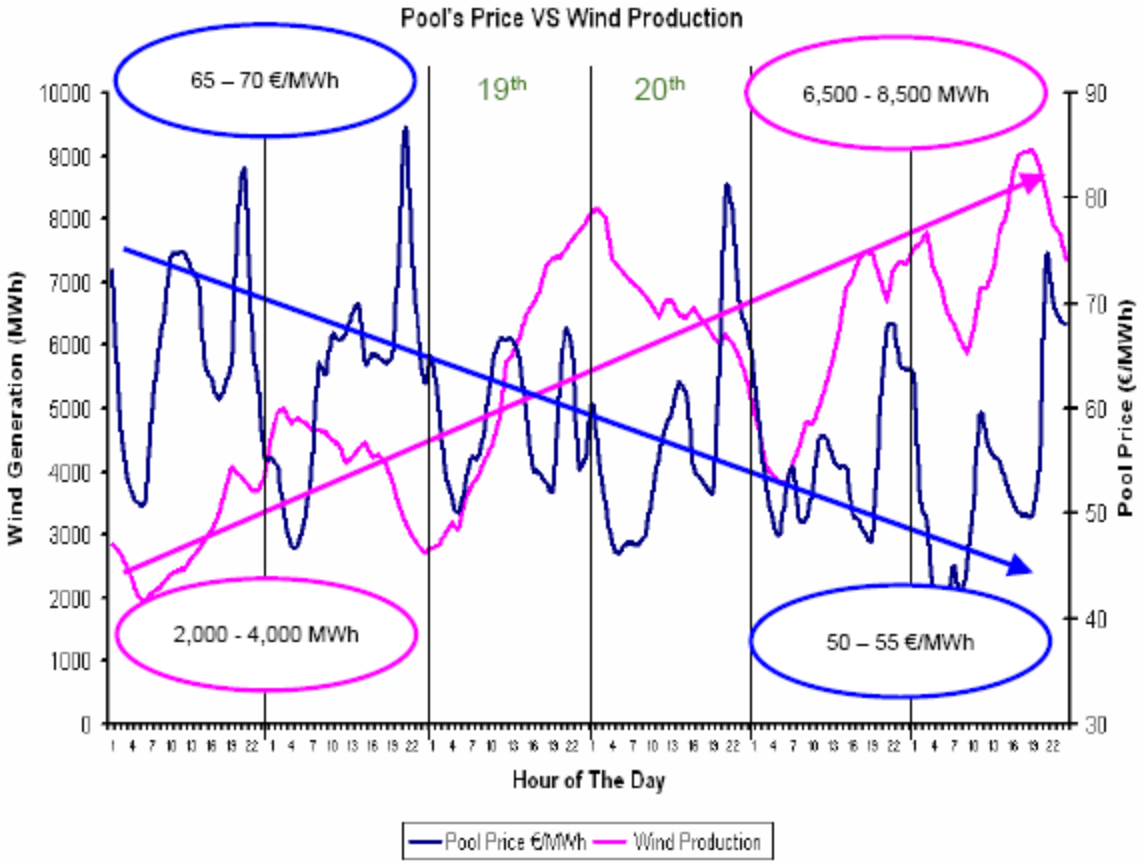
Example March 17th-22nd 2008: A wind generation increase, causes a reduction of the pool's price of some 15€/MWh.



20,000 MW of wind by 2010 will avoid the deterioration of some 2.300 MM € per year of the spanish Current Account Balance

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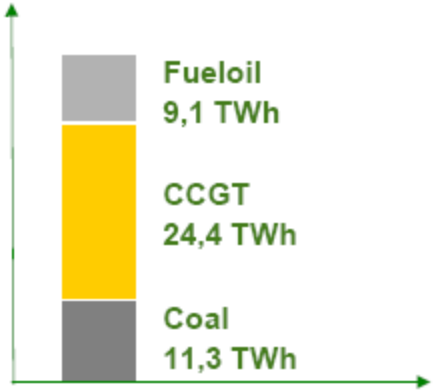
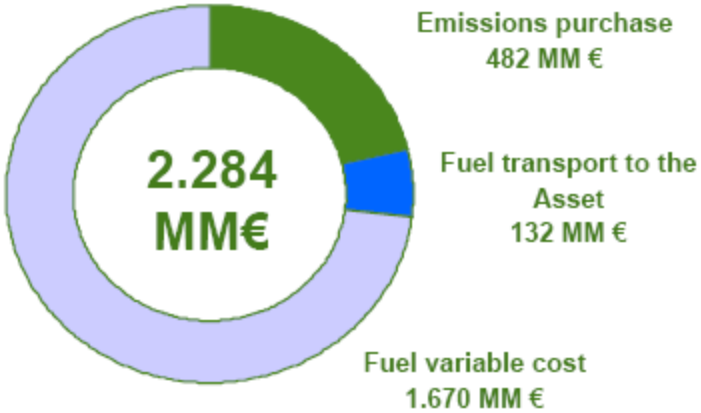
Substitution of 45 TWh installed of wind energy



Associated Variable Costs

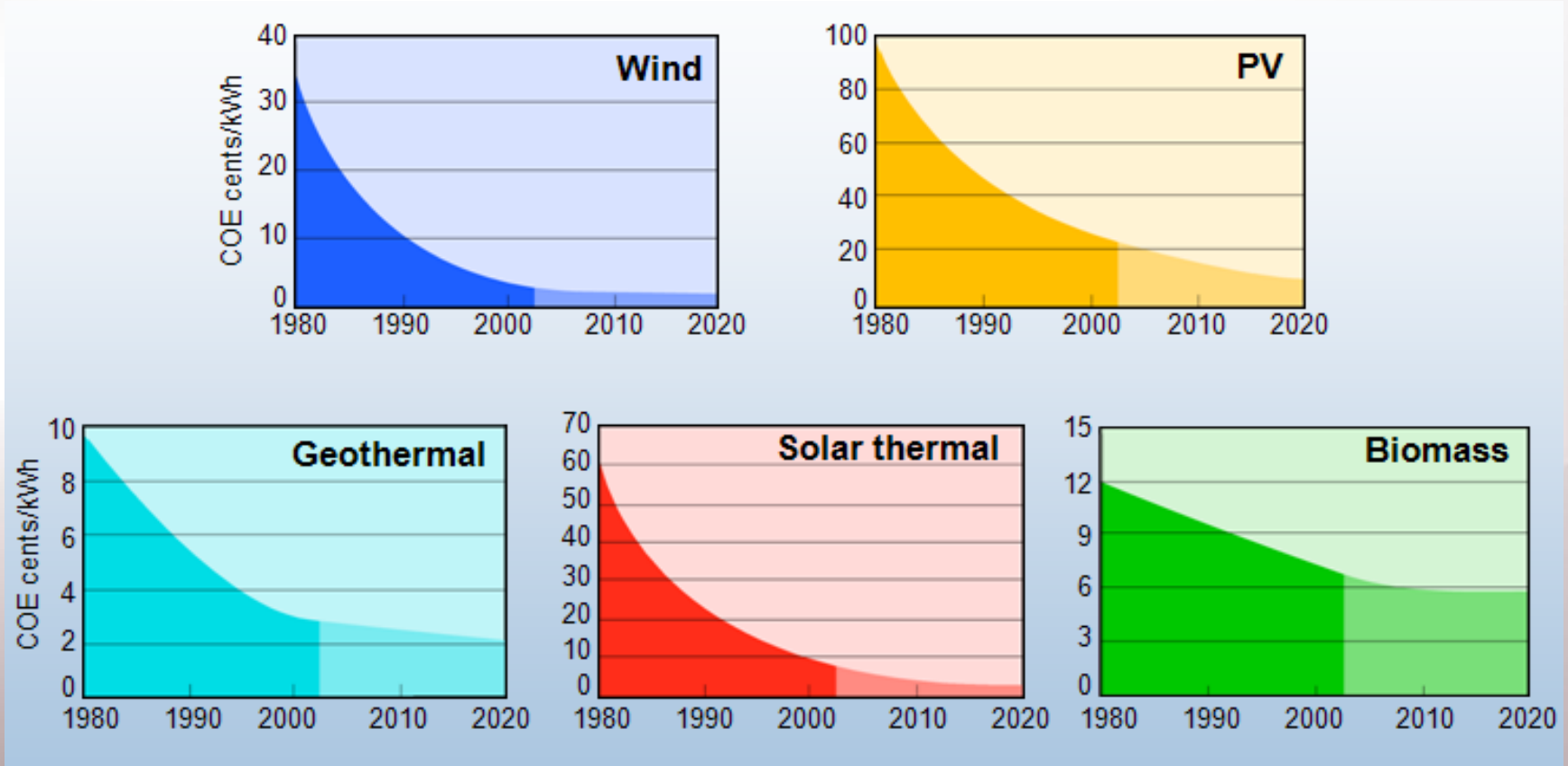


…replacing the wind production with the imported fossil fuels…

Assessing the cost-effectiveness of FITs

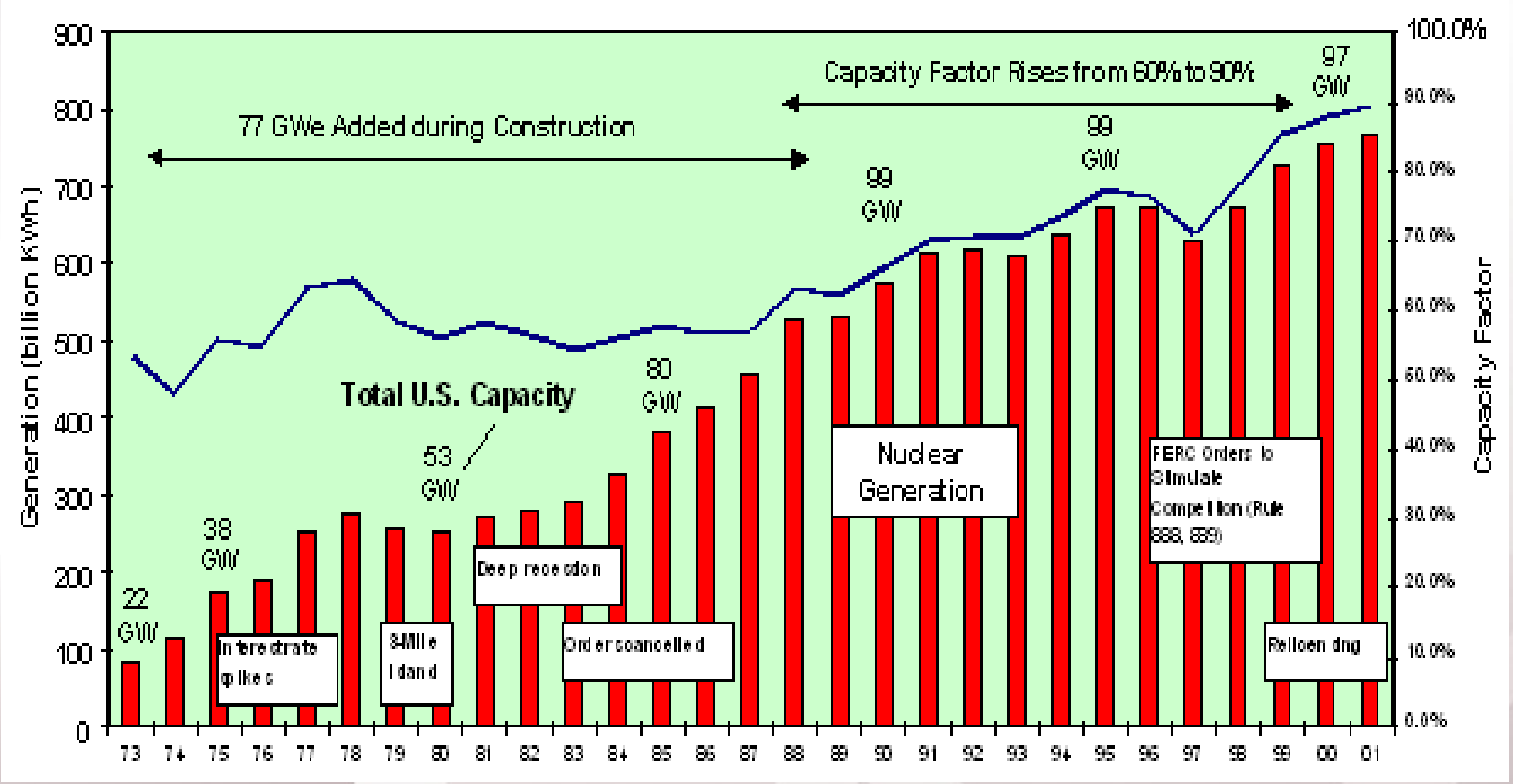
- Technological learning

Reduction in Cost of Renewable Energy Technologies (Levelized cents/kWh at $2000)



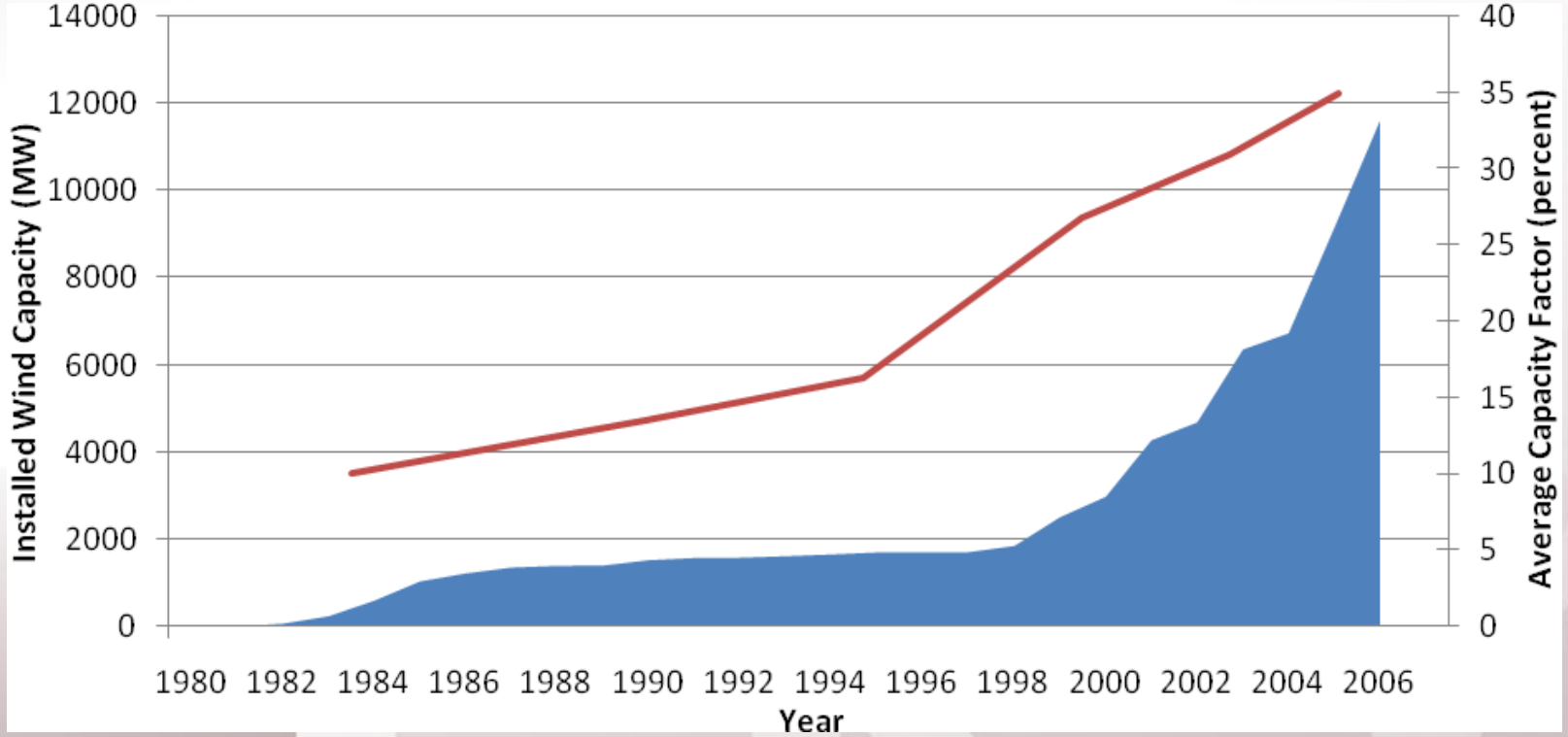
Assessing the cost-effectiveness of FITs

Capacity Factor and Nuclear Generation, 1973 to 2001



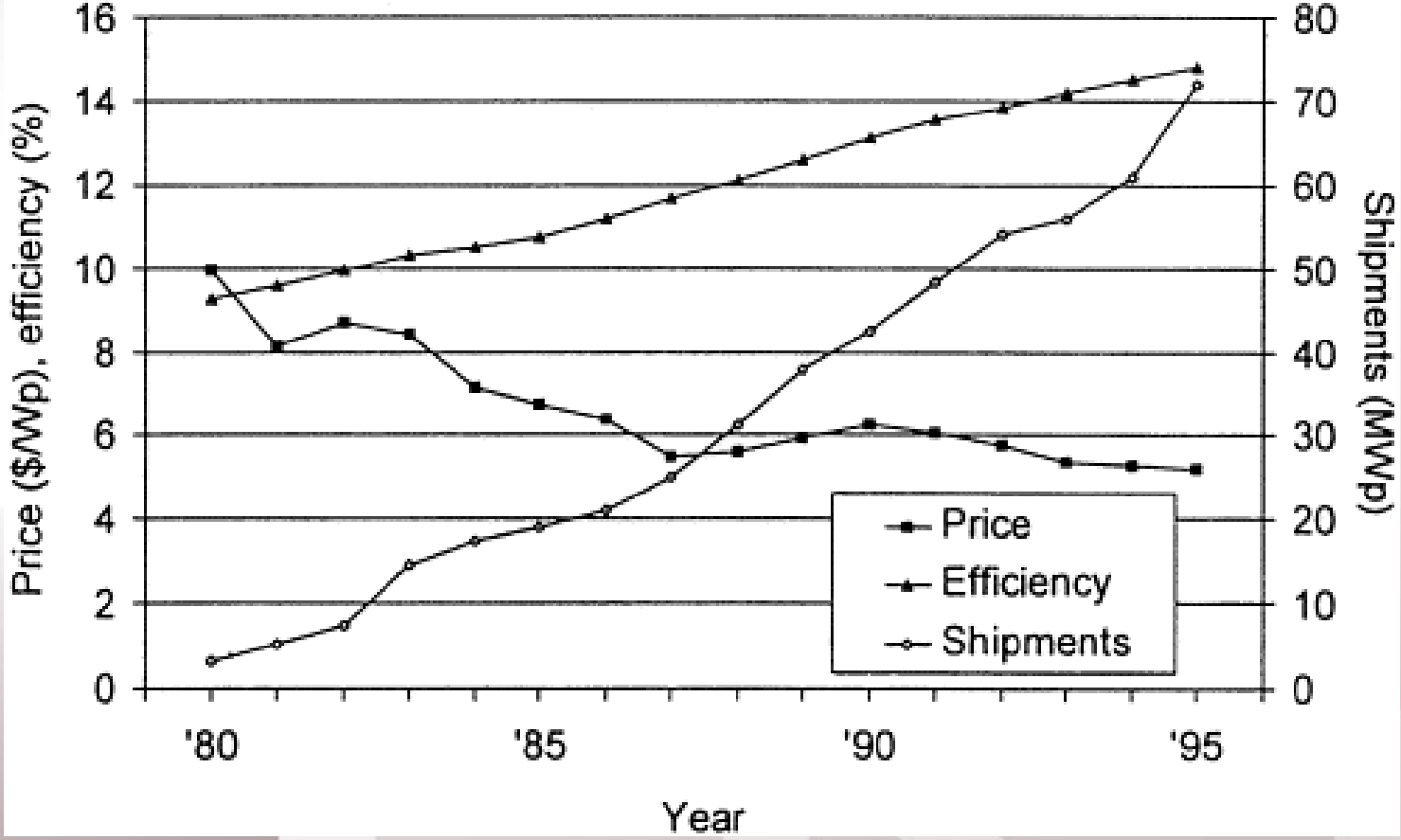
Assessing the cost-effectiveness of FITs

Capacity Factors and Installed Capacity for Wind Generators in the United States



Assessing the cost-effectiveness of FITs

Capacity Factors and Installed Capacity for Solar Generators in the United States



Components of a well-designed FIT

Support mechanisms must be:

1. predictable and consistent
    1. provide certainty in the market
    2. draw investors
    3. provide lead-time to prepare for change
2. appropriate
    1. policies must match objectives
    2. should not be too high or too low
3. flexible
    1. small adjustments can be made on a regular, predetermined time schedule
    2. Built in flexibility towards meeting mandates
4. Credible/enforceable
5. Clear, simple, and transparent

Source: Janet Sawin, "National Policy Instruments: Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World," In D. Abmann, U. Laumanns, and D. Uh (Eds.) *Renewable Energy: A Global Review of Technologies, Policies, and Markets* (London: Earthscan, 2006).

Components of a well-designed FIT

All effective FITs must have 2 components:

- Access to the grid and interconnection;
- Price for electricity must contribute to profitability or prospect of profitability

Prerequisites for RE policy must include

- Political desire and commitment
- Willingness to pay for renewable energy
- Stable public policy to guarantee returns on investment

Source: Paul Gipe, *Renewable Energy Policy Mechanisms* (Tehachapi, CA: Wind Works Organization, 2006).

Possible benefits of a FIT for New Zealand electricity consumers

- Lower capital cost as economies of scale and learning is established
- Additional revenue from investments and becoming a quasi-utility
  - Normal 7% return on investment at average rates
  - Clearing prices determined every half hour at each NZ T&D node (remember the prison!)
  - Possible export of unbundled renewable energy credits
- Improved energy security and efficiency
- More stable electricity rates and cheaper rates when grid parity is reached (electricity rates have increased 70% from 1990 to 2002)
- Cleaner air, climate, and water

Possible benefits of a FIT for New Zealand electric utilities (in addition to lower capital costs, more stable rates, and happier customers)

- Direct revenue stream (geothermal, hydroelectric upgrades and small-scale hydro, large-scale wind and solar, distributed solar PV)
- Indirect revenue stream from renewable energy credits
- Displaced fuel costs
  - More than one-third of New Zealand electricity in 2008 came from natural gas (26%), coal (7%) and diesel (2%)
  - Decreased global volatility
  - Decreased import dependence (diesel/oil)
- T&D displacement / less grid congestion
  - Electricity demand increased 2.4% annually from 1974 to 2007, imbalance between North Island and South Island
  - Ancillary services from distributed solar PV
  - Better lead times / debt to equity ratios
- Insulation from possible carbon tax / post-Kyoto agreement

Possible benefits of a FIT for New Zealand regulators (in addition to happier customers and cleaner utilities)

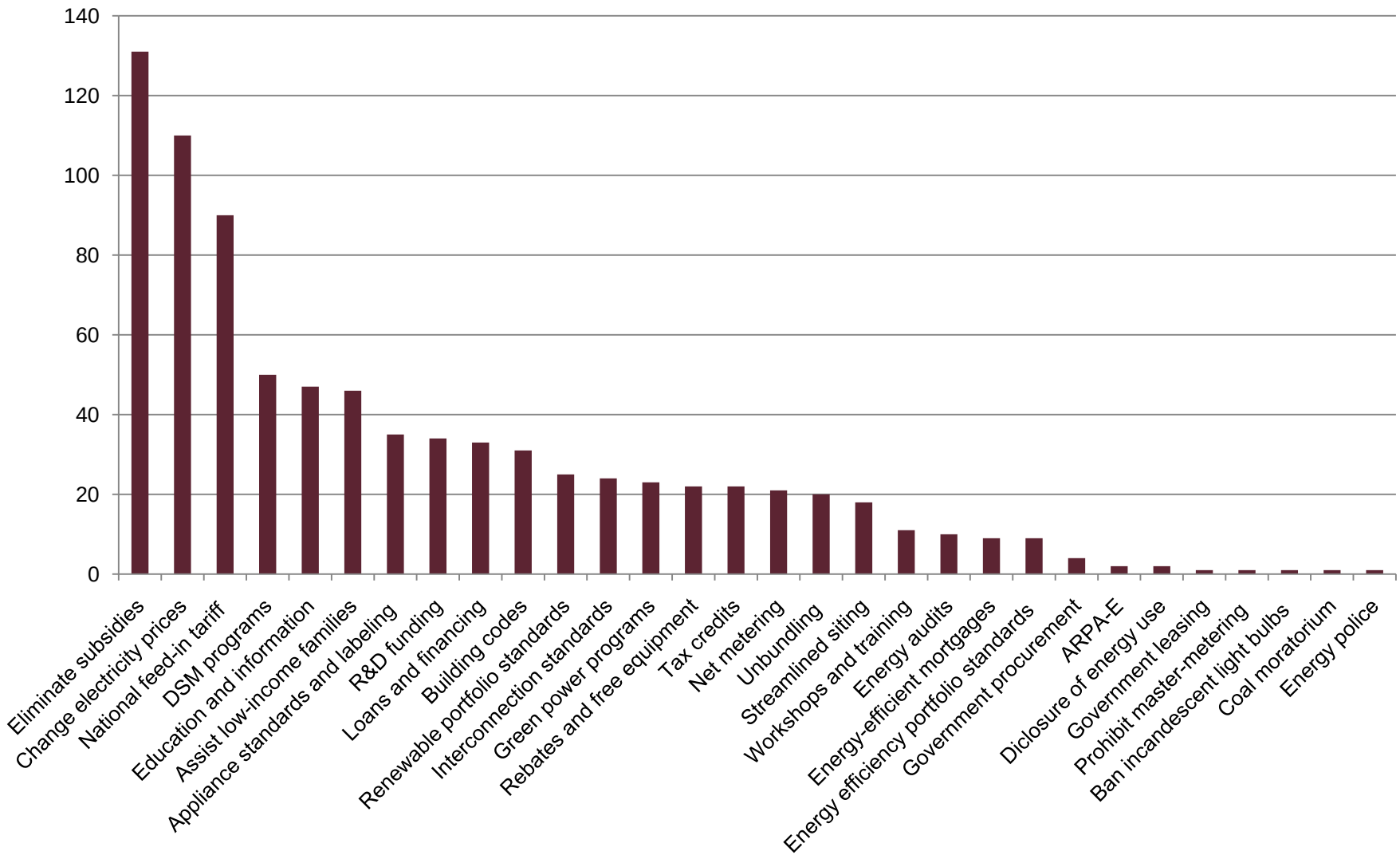
- Jobs, infrastructure investments, and economies of scale (all major FIT countries now export renewable technologies)
- Less greenhouse gas emissions
- Improved energy security and diversification
  - By fuel type (hydroelectric!)
  - By location (spatial distribution and intermittency)
  - Terrorism and accidents
- Enhanced competitiveness / improved trade balance
- Improved visibility and leadership (meet and surpass the 90% by 2025 target)

The importance of comprehensive policy

- Rigorous government policy is needed to overcome the market barriers to renewable power technologies

Country	Feed-in tariff	Renewable portfolio standard	Capital subsidies, grants, or rebates	Investment or other tax credits	Sales tax, energy tax, excise tax, or VAT reduction	Tradable renewable energy certificates	Energy production payments or tax credits	Net metering	Public investment, loans, or financing	Public competitive bidding
Developed and transition countries										
Australia		✓	✓			✓			✓	
Austria	✓		✓	✓		✓			✓	
Belgium		✓	✓		✓	✓		✓		
Canada	(*)	(*)	✓	✓	✓			(*)	✓	(*)
Croatia	✓			✓					✓	
Cyprus	✓		✓							
Czech Republic	✓		✓	✓	✓	✓		✓		
Denmark	✓				✓	✓		✓	✓	✓
Estonia	✓				✓					
Finland			✓		✓	✓	✓			

Public policy mechanisms

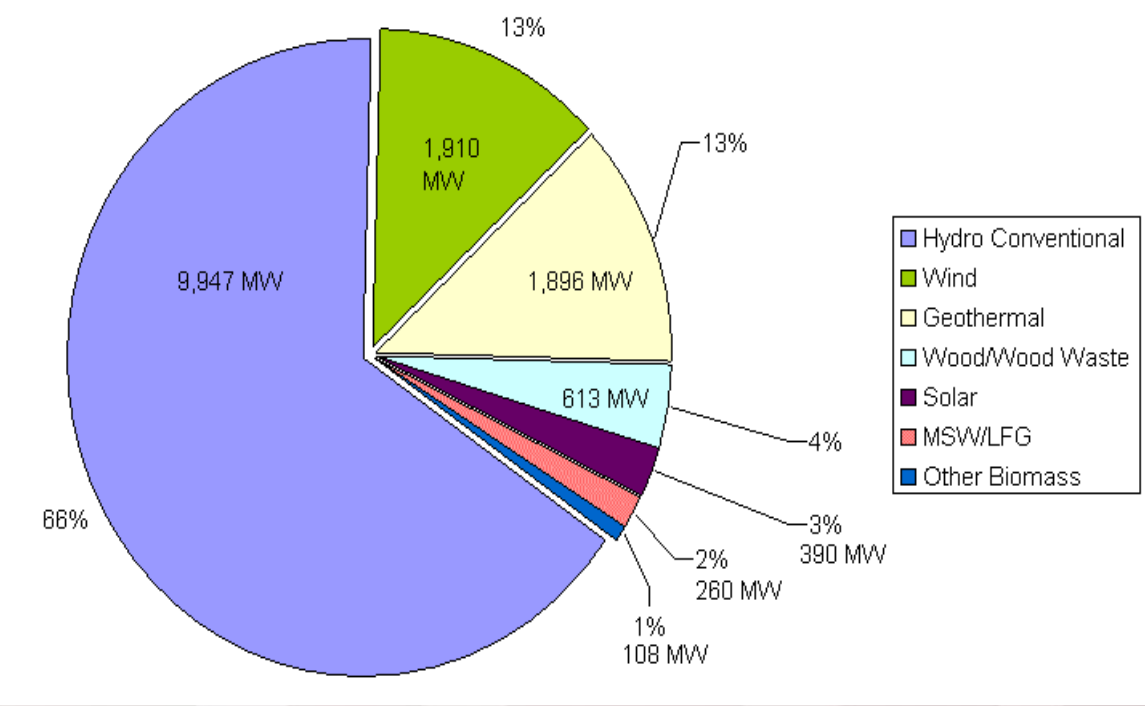


- Policy architecture must respond to impediments as a whole

Impediment	Policy	Details
Utilities and businesses will not invest in clean power	Make clean power mandatory	Create a national feed-in tariff (FIT) and guarantee clean power access to the grid
Political support for clean power has been inconsistent and unfair	Eliminate subsidies	Immediately repeal federal government subsidies for nuclear and fossil fuel technologies
Consumers do not receive accurate price signals for electricity	Get the price right	Abolish electricity rate caps, eliminate declining block rate pricing, reflect time of use in electricity rates, and internalize external costs
Property owners and environmentalists are uninformed about clean power technologies	Inform the public and protect the poor	Establish a national systems benefit charge (SBC) to generate revenue to distribute information and educate the public, provide low-income assistance and weatherization, and promote energy efficiency and DSM programs

Consider California:

- Accurate price signals
  - Time of use rates
  - Unbundled electricity bills
  - Transparency
- Uniform rules
- Stable and committed government support
- Consistent definitions of eligible resources
- Tax credits
- Renewable Portfolio Standard
- Considering FIT



California Renewable Energy Capacity by Source, 2003

Thank you!

For great holiday gifts: