2. Renewable Energy Sources

The major sources of this section are:

2010 Renewable Energy Data Book, U. S. Department of Energy, September 2011.

Renewable Energy Projects Handbook, World Energy Council, 2004

Renewable Energy Sources and Characteristics

- Our focus
  - Wind Power
  - Solar Power
- Applications
  - Home and cottage
  - Mobile, RV and Marine
  - Commercial Industrial
- Major Resources
  - SWERA (Solar and Wind Energy Resources Assessment)
  - http://maps.nrel.gov/SWERA
  - http://en.openei.org/apps/SWERA/
  - National Renewable Energy Laboratory (NREL): http://www.nrel.gov/
  - Windfinder: www.windfinder.com

Brief on Electricity

Transporting Electricity

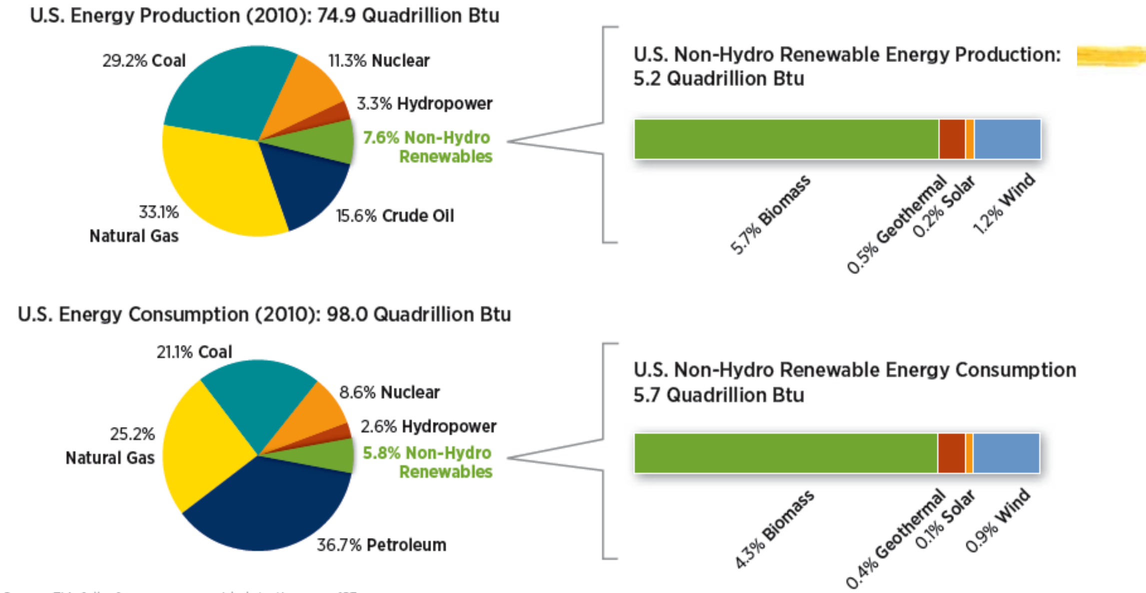
Explain what each of the components numbered below does to get electricity from the generator to the consumer.

- 1. Power Plant 2. Transformer (Step-up)
  3. Transmission Line 4. Power Tower
  5. Transformer (Step-down) 6. Distribution Line
  7. Transformer (neighborhood)

Renewable Energy Sources in US - Summary

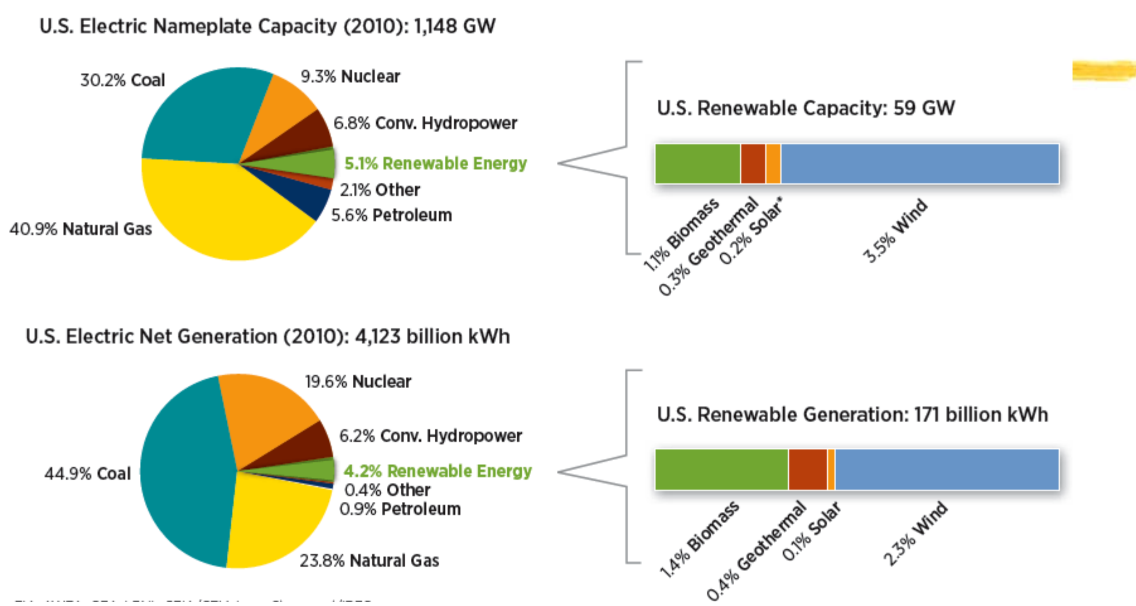
- In the United States, the installed global renewable energy capacity has more than quadrupled between 2000 and 2010.
- Including hydropower, renewable energy represents nearly 12% of total installed capacity and more than 10% of total generation in the United States in 2010.
- Installed renewable energy capacity (including hydropower) is more than 137 gigawatts (GW).
- Not including hydropower, 2010 renewable electricity installed capacity has reached about 59 GW in the United States.
- In 2010 in the United States, wind and solar photovoltaics (PV) were two of the fastest growing generation technologies.
- In 2010, cumulative wind capacity increased by 15% and cumulative solar PV capacity grew 71% from the previous year.
- Worldwide, wind energy is one of the fastest growing renewable energy technologies—between 2000 and 2010, wind energy generation worldwide increased by a factor of 11. The United States experienced even more dramatic growth, as installed wind energy capacity increased by a factor of nearly 16 between 2000 and 2010.
- In the United States, in 2010, renewable energy accounted for more than 25% of all new electrical capacity installations in the United States—a large change from 2004 when all renewable energy captured only 2% of new capacity additions

U. S. Energy Production and Consumption

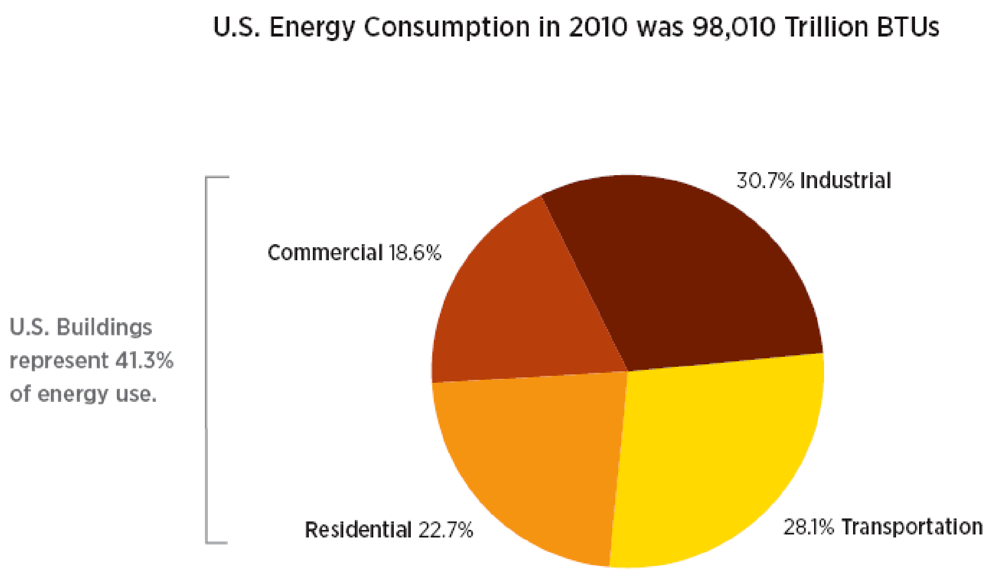


Source: EIA; full references are provided starting on p. 123.

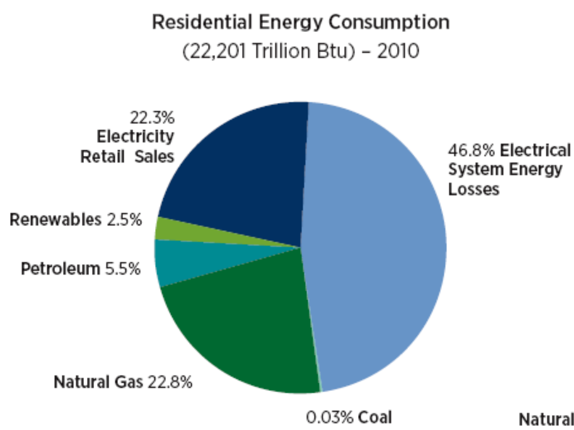
U. S. Electric Generation

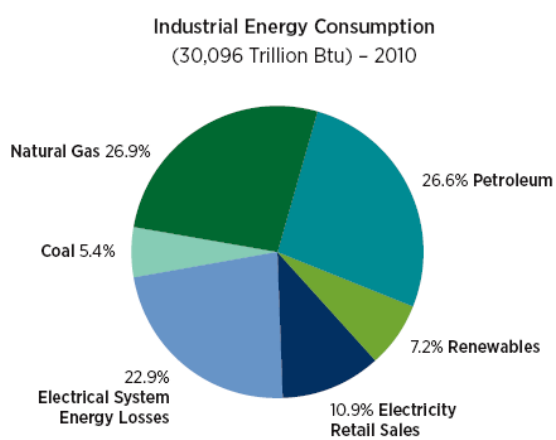


U. S. Energy Consumption by Sector



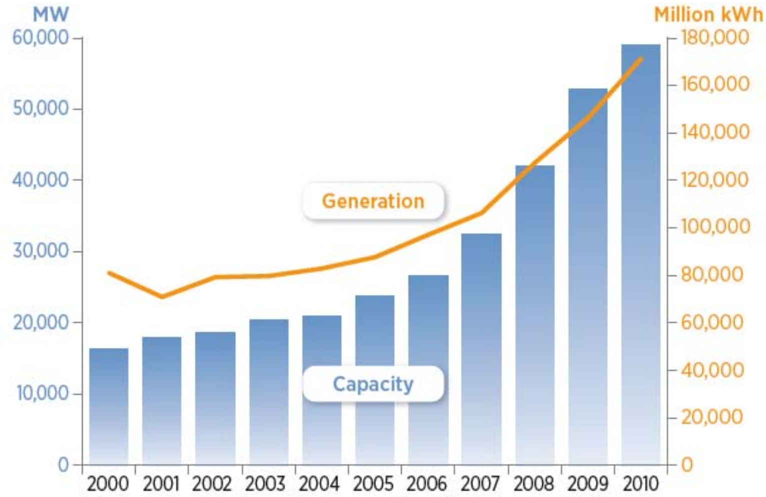
U. S. Energy Consumption - Details





Capacity and Generation --- All Renewables

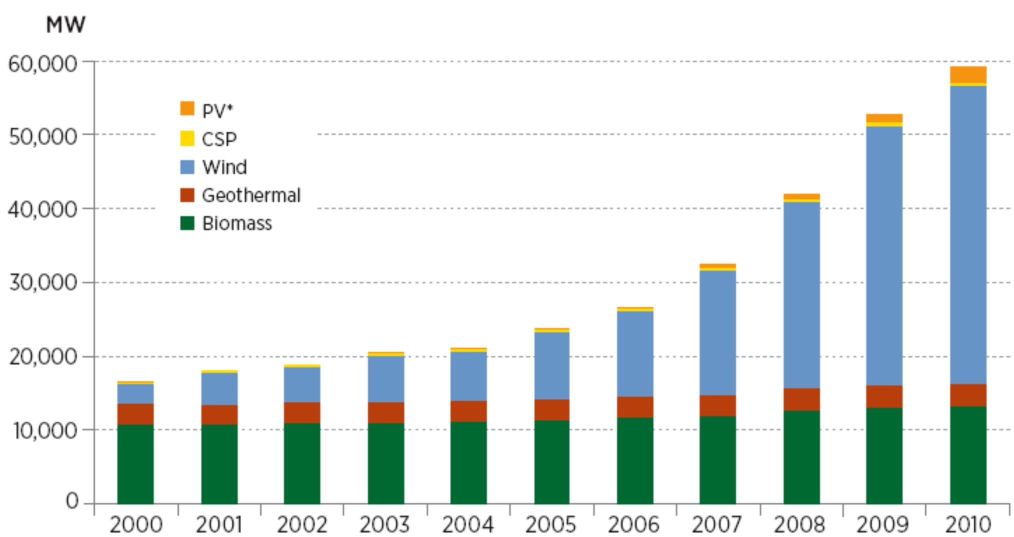
⌘Excluding Hydropower



	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	16,424	81,216
2001	18,032	71,048
2002	18,757	79,411
2003	20,458	79,880
2004	21,065	83,048
2005	23,759	87,808
2006	26,653	97,228
2007	32,413	106,344
2008	42,000	127,445
2009	52,768	146,310
2010	59,082	171,350

Generating Capacity by Source

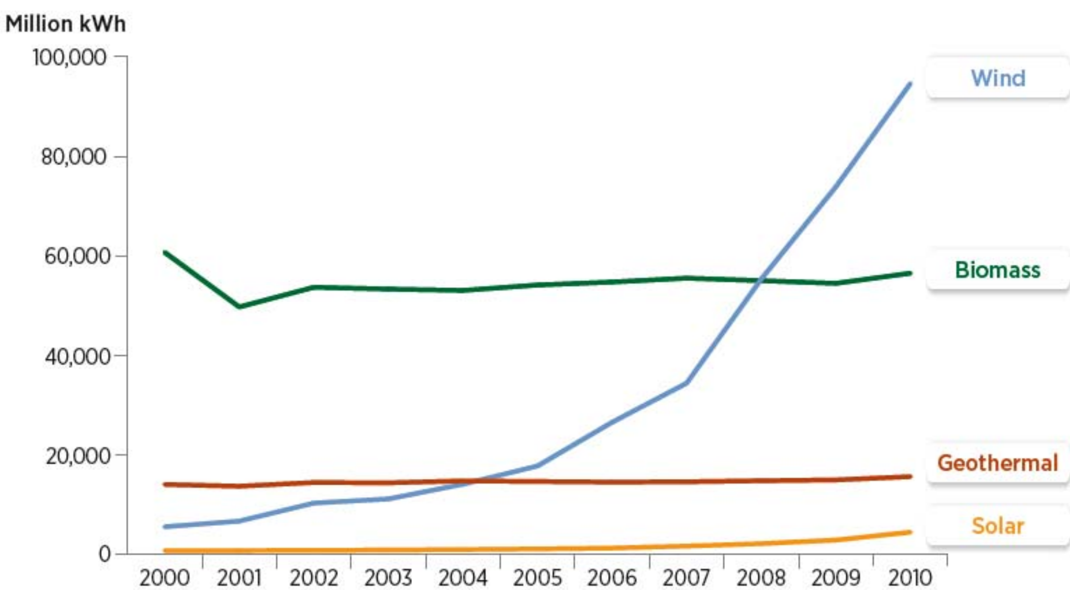
⌘Excluding Hydropower



CSP ?

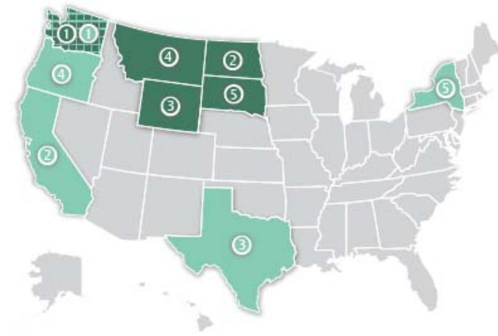
- CSP (Concentrated Solar Power): PV with mirrors and lenses to concentrate a large area of sunlight on to a small area.
- Heliostat

Renewable Generation Capacity by Technology



Top States for Renewable Electricity Installed Capacity

- w/o Hydro — w/ Hydro



Total Renewables (excluding hydropower)
1 Texas
2 California
3 Iowa
4 Minnesota
5 Oregon

Per Capita Renewables (excluding hydropower)
1 Wyoming
2 North Dakota
3 Iowa
4 South Dakota
5 Maine

Total Renewables (including hydropower)
1 Washington
2 California
3 Texas
4 Oregon
5 New York

Per Capita Renewables (including hydropower)
1 Washington
2 North Dakota
3 Wyoming
4 Montana
5 South Dakota

Top States for Renewable Electricity Capacity

Solar PV
1 California
2 New Jersey
3 Colorado
4 Arizona
5 Nevada

CSP
1 California
2 Florida
3 Nevada
4 Arizona
5 Colorado

Biomass
1 California
2 Florida
3 Maine
4 Virginia
5 Georgia

Wind
1 Texas
2 Iowa
3 California
4 Minnesota
5 Oregon/ Washington

Geothermal
1 California
2 Nevada
3 Utah
4 Hawaii
5 Idaho

Hydropower
1 Washington
2 California
3 Oregon
4 New York
5 Alabama

Financial Incentives by State for Promotion

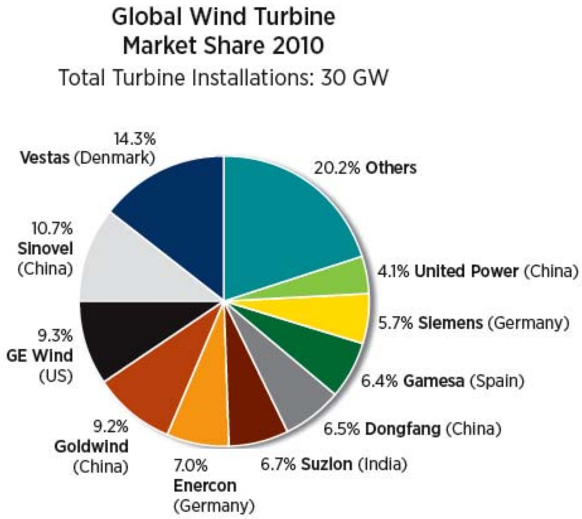
State/Territory	Personal Tax	Corporate Tax	Sales Tax	Property Tax	Rebates	Grants	Loans	Industry Recruit.	Leasing/ Sales	Production Incentive
Alabama	1-S					1-S				1-U, 1-P
Alaska			1-S				1-S			1-P
Arizona	2-S		1-S		3-U					1-P
Arkansas								1-S		1-P
California	2-S	2-S		1-S	2-S, 6-U		1-S, 2-U		2-U	
Colorado	1-S	1-S			1-S, 1-L		1-U, 1-L			2-L, 1-P
Connecticut				1-S	1-P		1-S			
Delaware					1-S					1-P
Florida			1-S		2-U					1-P
Georgia	1-S	1-S								1-U, 1-P
Hawaii	1-S	2-S	2-S		3-U		2-L, 1-U	1-S		1-P
Idaho	1-S	1-S				1-P	1-S			1-P
Illinois			1-S	1-S	4-S, 1-U	2-S, 1-P				1-P
Indiana		1-S		1-S		5-S				1-P
Iowa		1-S	2-S	3-S		1-S	3-S			1-P
Kansas	1-S	1-S		1-S		1-S				1-S, 1-P
Kentucky										1-U, 1-P
Louisiana	1-S	1-S		1-S						1-P
Maine					1-P	1-S				
Maryland	2-S	2-S	2-S	2-S			2-S			1-P
Massachusetts	2-S	3-S	1-S	1-S	2-S, 1-P	2-S				1-P
Michigan						4-S		3-S		1-P
Minnesota			2-S	1-S	1-S		2-S			2-S, 1-P
Mississippi							1-S			1-U, 1-P
Missouri		1-S					1-S			1-S, 1-P
Montana	3-S	5-S		2-S	4-S	1-P, 1-S	1-S			1-S, 1-P
Nebraska		1-S					1-S			1-P
Nevada			1-S	2-S	2-U	1-S				1-S, 1-P
New Hampshire				1-S	1-P					
New Jersey			1-S		1-S	1-S				1-P
New Mexico		1-S								1-P
New York	1-S	1-S		1-S	4-S, 1-U	2-S	1-S			1-P
North Carolina	1-S	1-S		1-S			1-S	1-S		1-U, 1-P
North Dakota	1-S	1-S	1-S	2-S						1-S, 1-P
Ohio	1-S	2-S	1-S	1-S			1-S	2-S		1-P
Oklahoma	1-S	3-S					2-S	1-S		1-P
Oregon	1-S	1-S		1-S	6-U, 2-S	1-P, 1-S	1-S, 4-U			2-P
Pennsylvania					1-L	2-S, 4-L	4-L			1-U, 1-P
Rhode Island	1-S		1-S	1-S	2-S, 1-P	1-S				1-S, 1-P
South Carolina										1-P
South Dakota		2-S		2-S						1-S, 1-P
Tennessee				1-S			1-S			1-U, 1-P

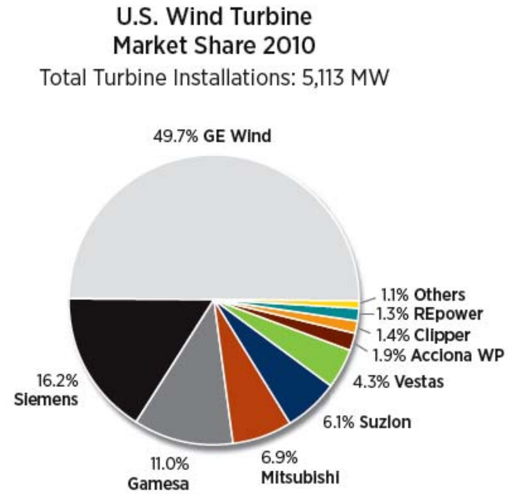
Financial Incentives by State

State/Territory	Personal Tax	Corporate Tax	Sales Tax	Property Tax	Rebates	Grants	Loans	Industry Recruit.	Leasing/ Sales	Production Incentive
Texas		1-S		1-S	1-U		1-U	1-S, 1-L	1-U	1-P
Utah	2-S	2-S	1-S			1-S	1-S			1-P
Vermont			1-S	1-S	1-S, 1-P					
Virginia		1-S		1-S				2-S		1-U, 1-P
Washington			1-S		1-S, 5-U	1-P	2-U	1-S		2-U, 2-P
West Virginia	1-S	1-S		1-S						1-P
Wisconsin				1-S	1-S, 1-U	2-S	1-S			1-S, 1-P
Wyoming		1-S	1-S			1-S			1-U	1-P
District of Columbia										1-P
Palau										
Guam										
Puerto Rico	1-S		2-S							
Virgin Islands										
N. Mariana Islands										
American Samoa										
Totals	29	41	24	33	66	39	42	14	4	70

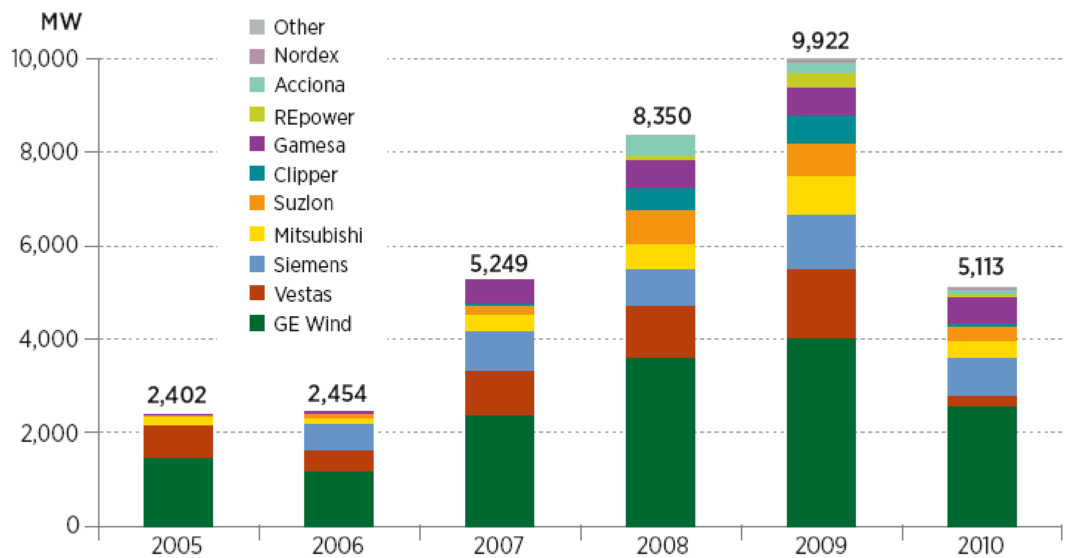
S = State/Territory, L = Local, U = Utility/Energy Service Co., P = Private

Turbine Manufacturing

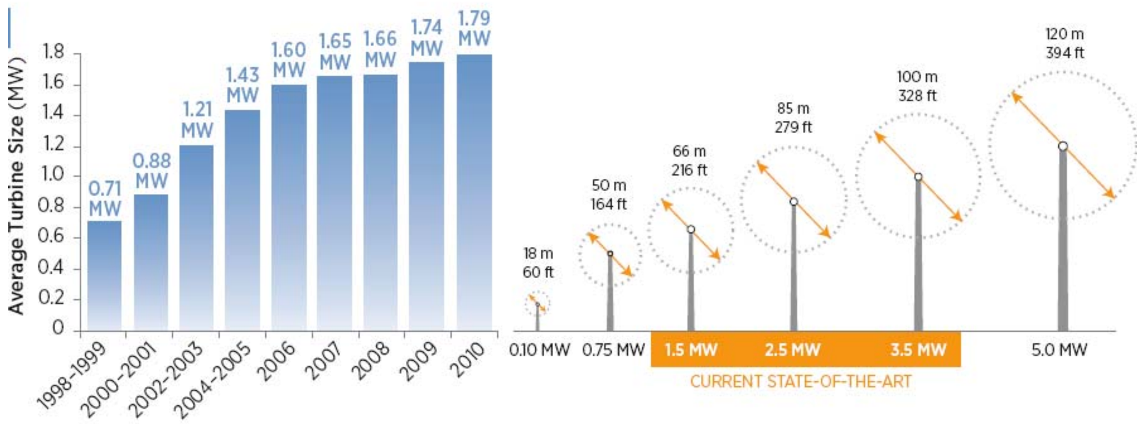




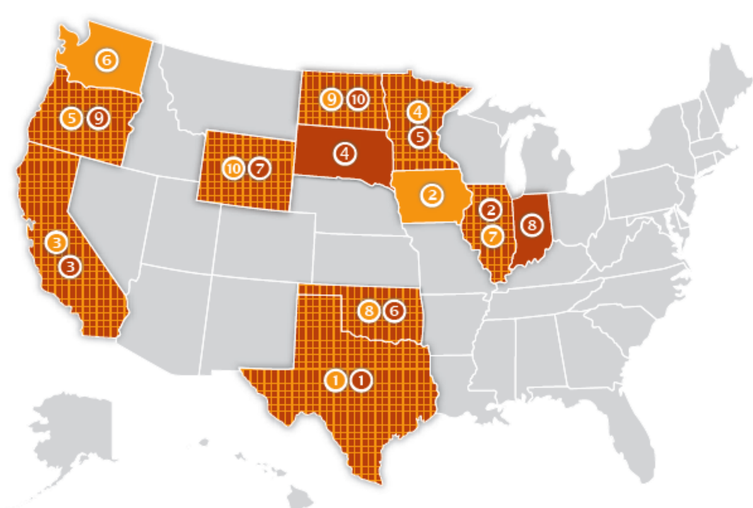
Wind Turbine Installations (US) by Manufacturer



Turbine Size (US)



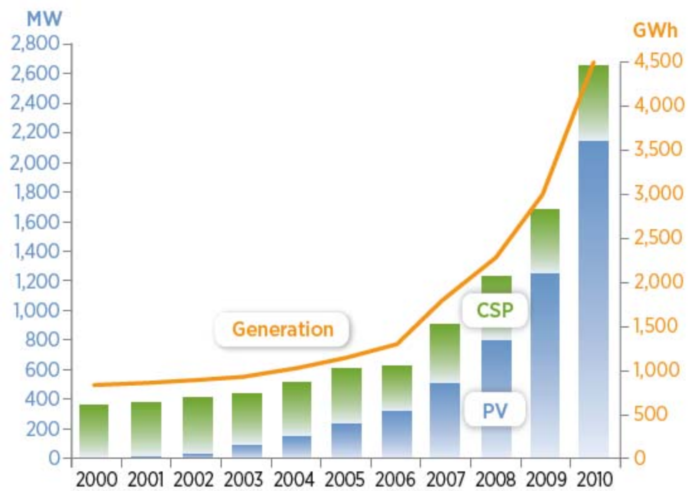
Wind Power by State



Cumulative Capacity (2010, MW)	
1 Texas	10,089
2 Iowa	3,675
3 California	3,253
4 Minnesota	2,205
5 Oregon	2,104
6 Washington	2,104
7 Illinois	2,045
8 Oklahoma	1,482
9 North Dakota	1,424
10 Wyoming	1,412

Annual Capacity (2010, MW)	
1 Texas	680
2 Illinois	498
3 California	455
4 South Dakota	396
5 Minnesota	396
6 Oklahoma	352
7 Wyoming	311
8 Indiana	303
9 Oregon	283
10 North Dakota	221

U.S. Solar Capacity



	U.S. Solar Energy Generation (Million kWh)	U.S. Solar Energy Capacity (MW) and % Increase from Previous Year			
		PV*	CSP	Total	Increase
2000	804	18	354	372	4.3%
2001	822	29	354	383	3.0%
2002	857	52	354	406	5.9%
2003	929	97	354	451	11.2%
2004	1,020	155	354	509	12.8%
2005	1,145	234	354	588	15.5%
2006	1,312	339	355	694	18.0%
2007	1,718	508	419	927	33.5%
2008	2,208	819	419	1,237	33.5%
2009	2,922	1,257	430	1,686	36.3%
2010	4,505	2,153	507	2,660	57.7%

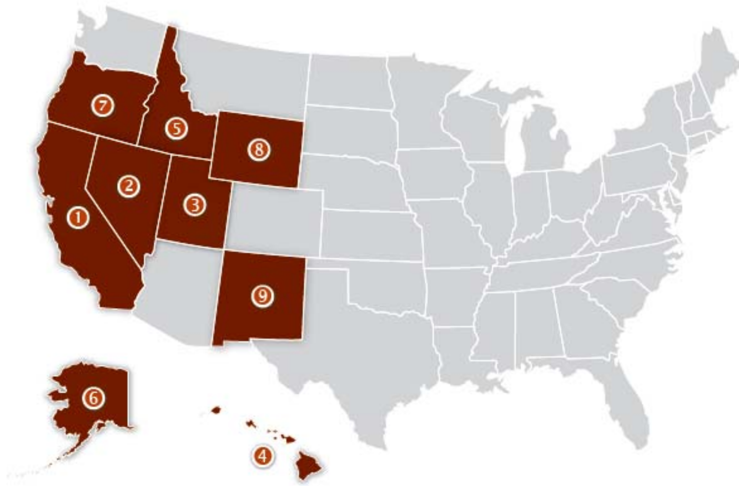
Solar Energy by State

PV Cumulative Capacity (2010, MW)	
1 California	1,021.7
2 New Jersey	259.9
3 Colorado	121.1
4 Arizona	109.8
5 Nevada	104.7
6 Florida	73.5
7 New York	55.5
8 Pennsylvania	54.8
9 Hawaii	44.7
10 New Mexico	43.3

PV Annual Capacity Additions (2010, MW)	
1 California	252.0
2 New Jersey	132.4
3 Nevada	68.3
4 Arizona	63.6
5 Colorado	62.0
6 Pennsylvania	46.5
7 New Mexico	40.9
8 Florida	34.8
9 North Carolina	28.7
10 Texas	25.9

CSP Cumulative Capacity (2010, MW)	
1 California	364
2 Florida	75
3 Nevada	64
4 Arizona	2
5 Hawaii	1
6 Colorado	1

Geothermal by State

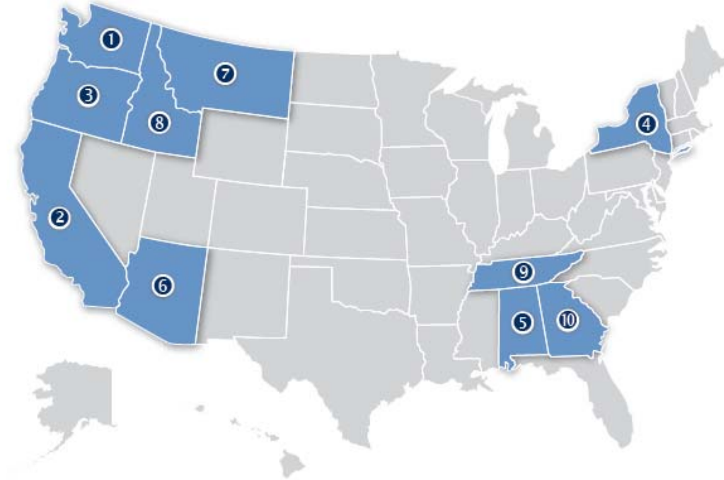


Total Installed Capacity (2010, MW)	
1 California	2,565.5
2 Nevada	441.8
3 Utah	42.0
4 Hawaii	35.0
5 Idaho	15.8
6 Alaska	0.7
7 Oregon	0.3
8 Wyoming	0.3
9 New Mexico	0.2

Biopower by State

Total Installed Capacity (2010, MW)	
1 California	1,258
2 Florida	1,197
3 Maine	771
4 Virginia	770
5 Georgia	684
6 Alabama	627
7 Pennsylvania	597
8 New York	510
9 Minnesota	478
10 Washington	437

Hydropower by State

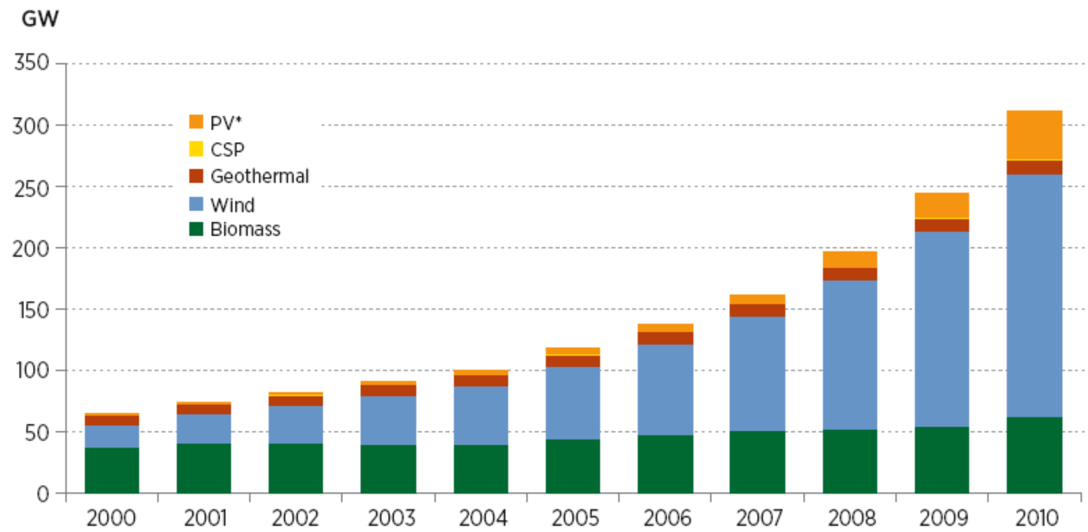


Capacity (2010, MW)	
1 Washington	20,815
2 California	10,049
3 Oregon	8,240
4 New York	4,657
5 Alabama	3,280
6 Arizona	2,718
7 Montana	2,570
8 Idaho	2,531
9 Tennessee	2,479
10 Georgia	1,932

Global Renewable Energy Development - Summary

- Global renewable electricity installations (excluding hydropower) have more than quadrupled from 2000–2010.
- Including hydropower, renewable energy accounts for 21% of all global electricity generation; without hydropower, renewable energy accounts for 3.8% of global generation.
- Wind and solar energy are the fastest growing renewable energy technologies worldwide. Wind grew by a factor of 11 and solar PV generation grew by a factor of more than 28 between 2000 and 2010.
- In 2010, Germany led the world in cumulative solar PV installed capacity. The United States leads the world in geothermal and biomass installed capacity. China leads in wind, and Spain leads in CSP.

Renewable Energy Capacity (w/o hydro)

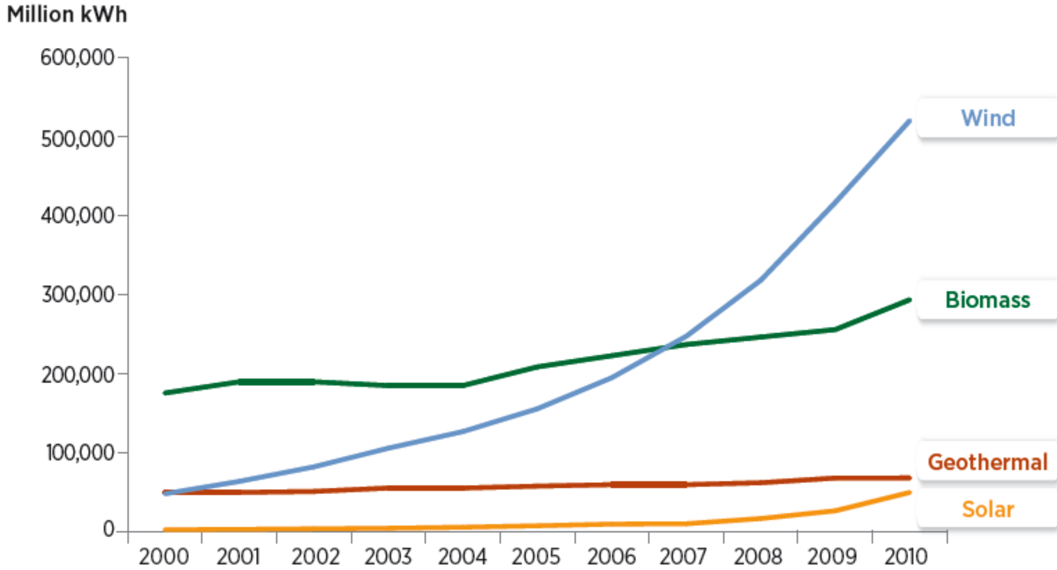


Main Characteristics

Category	Conversion System	Scale Range, MW_e	Efficiency, %	Availability
Biomass	Combustion/stand alone	20.0 – 100.0	20–40 (elect.)	Seasonal, climate dependent
	Combustion/CHP	0.1 – 1.0	60–90 (H+P)	
	Combustion/CHP	1.1 – 10.0	80–100 (H+P)	
	Co-Combustion	5.0 – 20.0	30–40 (elect.)	
	Gasification/Diesel Turbine	0.1 – 1.0	15–25 (elect.)	
	Gasification/Gas Turbine	1.0 – 10.0	25–30 (elect.)	
	Gasification/BIG/CC	30.0 – 100.0	40–55 (elect.)	
	Digestion/Wet Biomass	Up to several MW_e	10–15 (elect.)	
Wind	Modern wind turbines	~ 5.0		Highly variable, weather dependent (load factor 23%)
Geothermal	Dry Steam Plants	35.00 – 120.0	10–25 (elect.)	Constant (capacity factor over 90%)
	Flashed Steam Plants	10.00 -- 55.0		
	Binary Cycle Plants	0.25 – 130.0		
	Combined Cycle Plants	10.00 – 130.0		
IHRP	ORC	0.25 -- 20.0	10–20 (elect.)	Constant, depends on industrial process (load factor over 90%)
Hydro	Run-of-River	0.1 - 14,000.0	80-93 (elect)	Hydrology dependent (capacity factor 40-90%)
Hydro	Reservoir storage	1.0 - 18,000.0	80-93 (elect)	20-90% utilisation factor (peaking and/or baseload)
Solar	Photovoltaic (PV)	0.05 – 1.00 kW_p (stand alone)	10–15 (elect.)	Daily, seasonal, weather dependent
		0.50 – 5.00 kW_p (roof top grid connected)		
		10 kW_p–several MW_p (ground based, grid connected)		
	Thermal SPPP	< 5.0	10 (elect.)	
	Thermal Parabolic trough	~ 100.0	14 (elect.)	
	Thermal Dish - Stirling	5.0	24 (elect.)	

Source: WEC Committee on Renewables

Renewable Energy Generation by Technology



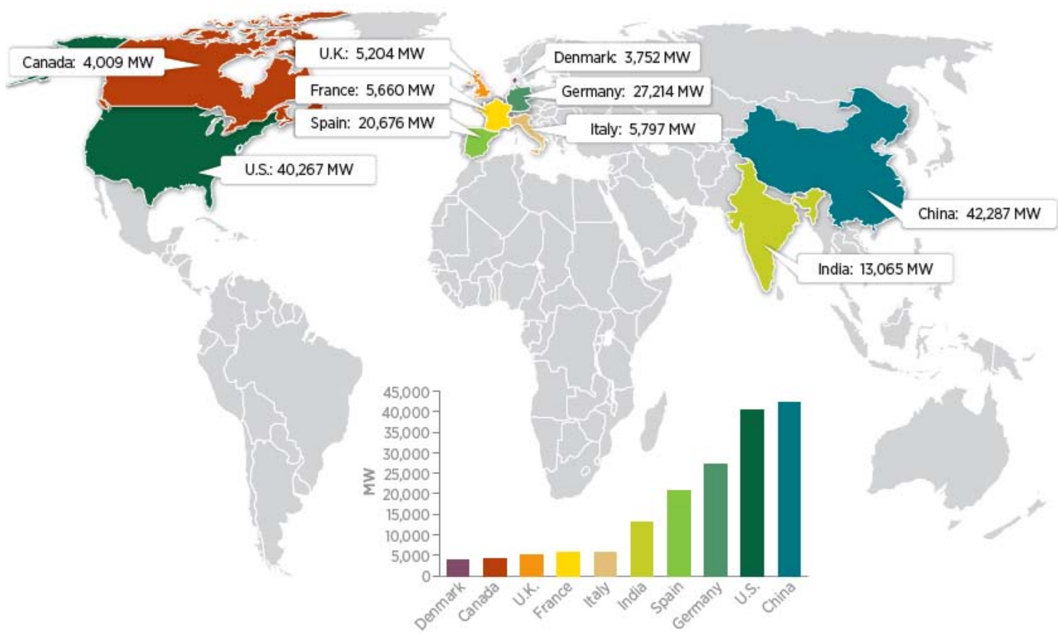
Top Countries with Renewable Electricity

* Majority of China's renewable energy is from small hydropower.

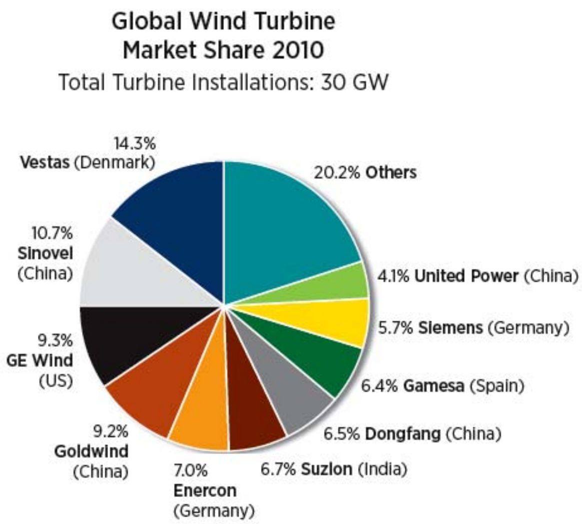
Top Countries

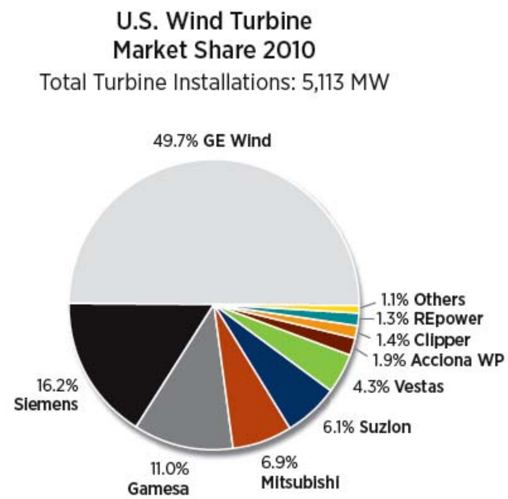
Geothermal	Wind	Solar PV	CSP	Biomass
1 U.S.	1 China	1 Germany	1 Spain	1 U.S.
2 Philippines	2 U.S.	2 Spain	2 U.S.	2 Brazil
3 Indonesia	3 Germany	3 Japan		3 Germany
4 Mexico	4 Spain	4 Italy		4 Spain
5 Italy	5 India	5 U.S.		5 India

Wind Energy Capacity

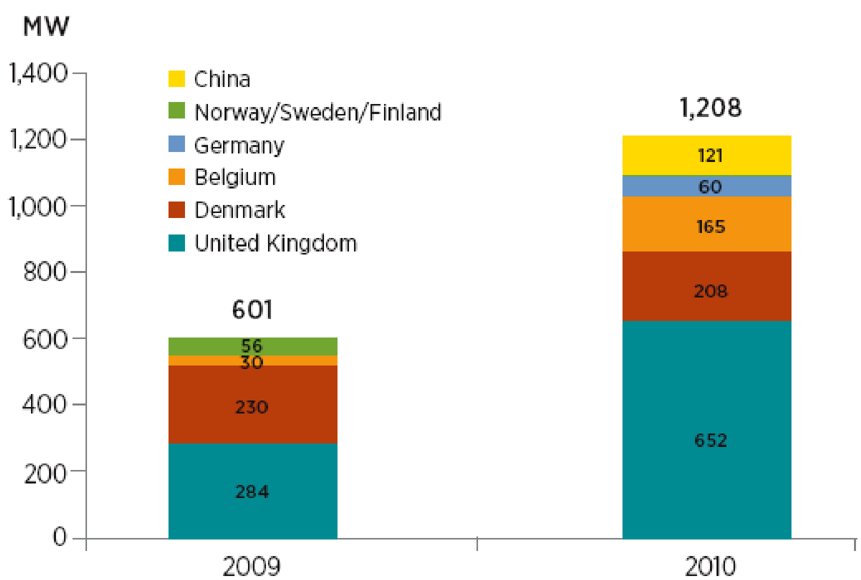


Turbine Manufacturing

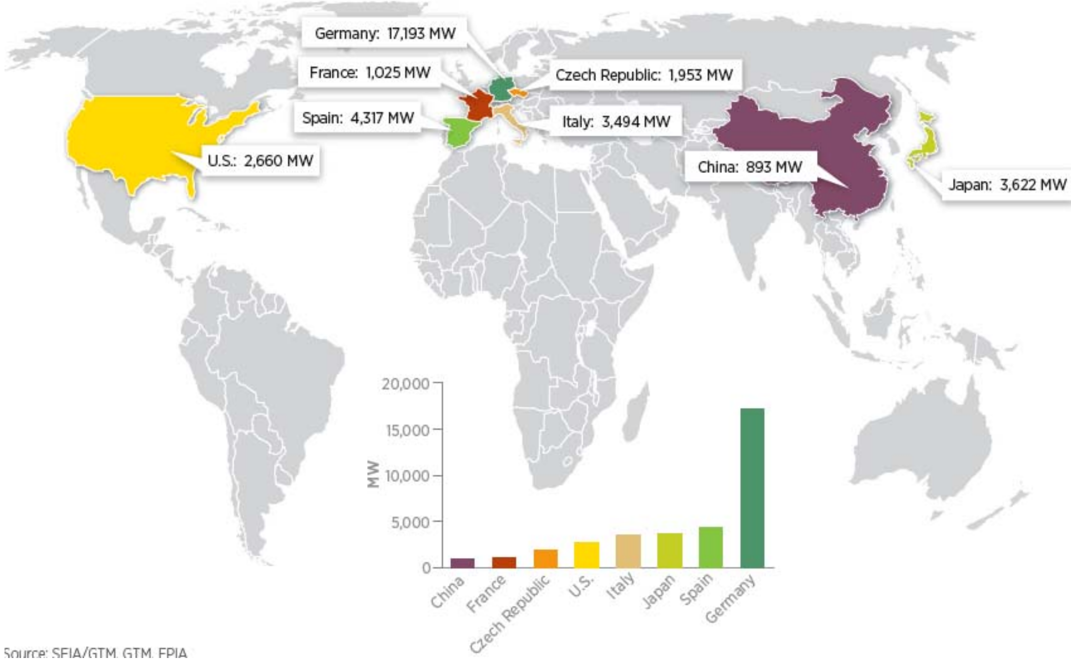




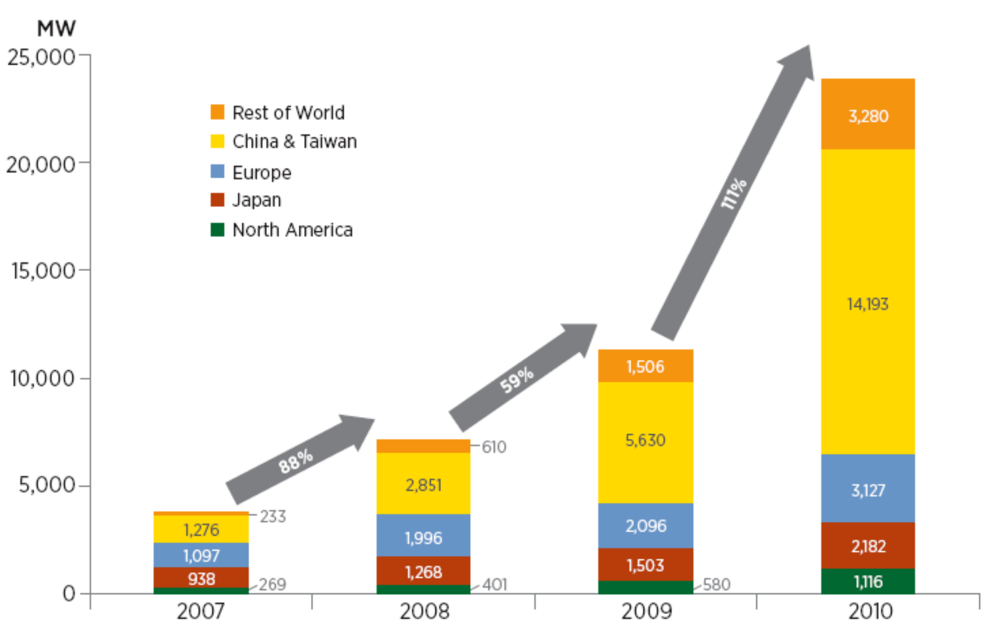
Annual Installed Offshore Wind Capacity



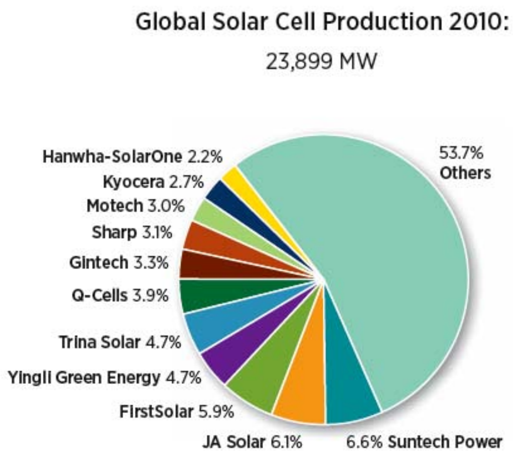
Solar Installed Capacity by Country

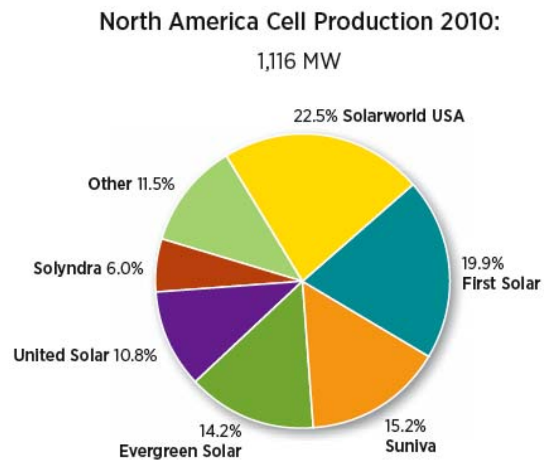


Solar Manufacturing by Country

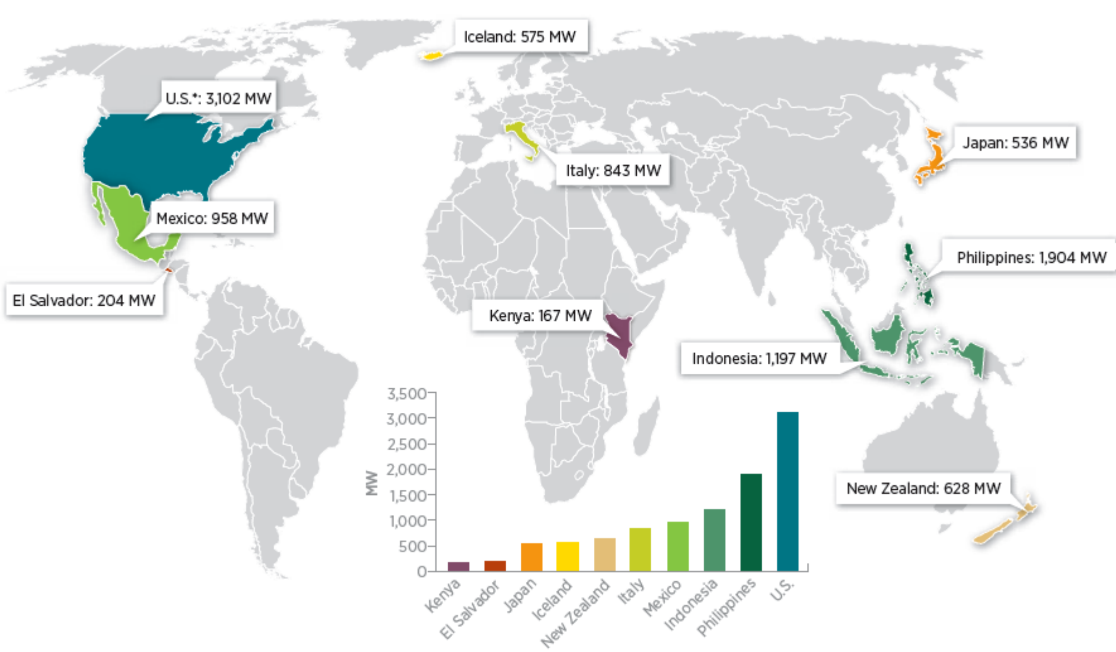


PV Manufacturing

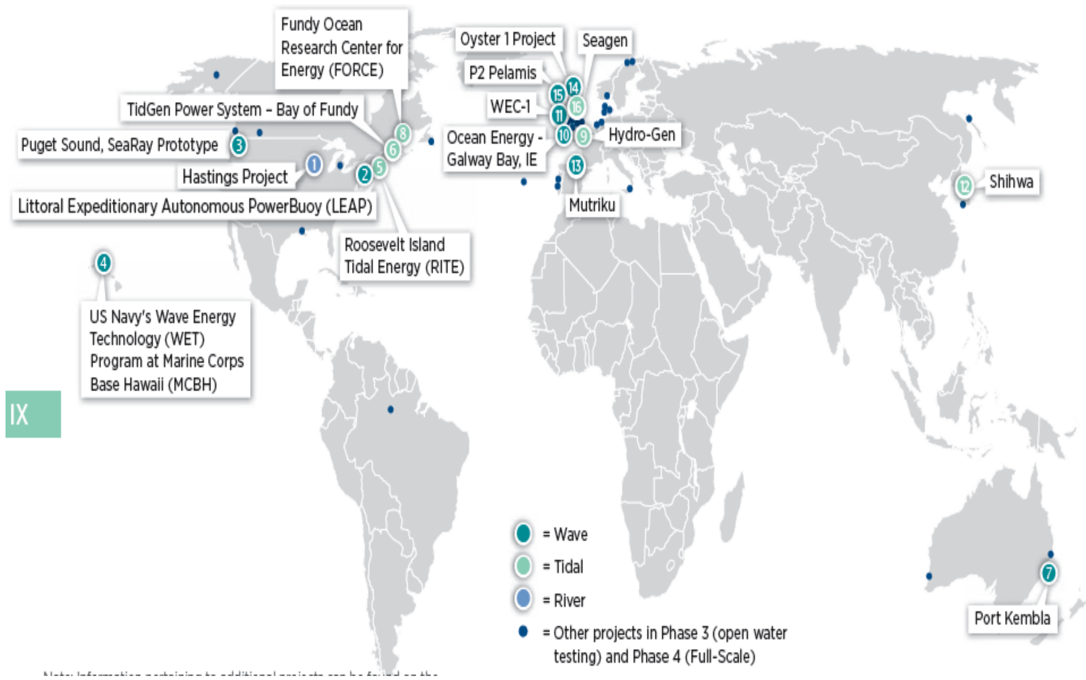




Geothermal by Country



Global Advanced Power (tidal, river, ocean current)



Sample of Commercial and Pilot Plants

PROJECT NAME	Type	Country	Location	Size (MW)	Installed
1 Hastings Project	River	United States	Mississippi River, Hastings, MN	0.07	2009
2 Littoral Expeditionary Autonomous PowerBuoy (LEAP)	Wave	United States	New Jersey	0.04	2011
3 Puget Sound, SeaRay Prototype	Wave	United States	Puget Sound, WA	0.08	2011
4 US Navy's Wave Energy Technology (WET) Program at Marine Corps Base Hawaii (MCBH)	Wave	United States	1 mile off Kaneohe Bay, Oahu, HI	0.1	2004
5 Roosevelt Island Tidal Energy (RITE)	Tidal	United States	New York City, NY	0.175	2002
6 TidGen Power System - Bay of Fundy	Tidal	United States	Maine (Bay of Fundy)	0.01	2010
7 Port Kembla	Wave	Australia	New South Wales, Port Kembla	0.45	2005
8 Fundy Ocean Research Center for Energy (FORCE)	Tidal	Canada	Bay of Fundy, Nova Scotia	1	2009
9 Hydro-Gen	Tidal	France	Brouennou	1	2011
10 Ocean Energy - Galway Bay, IE	Wave	Ireland	Galway Bay	0.015	2006
11 WEC-1	Wave	Ireland	Galway Bay (near Belmullet)	0.25	2006
12 Shihwa	Tidal	South Korea	40km south-west of Seoul	254	2011
13 Mutriku	Wave	Spain	Near Bilbao	0.3	2011
14 Oyster 1 Project	Wave	United Kingdom	Scotland Stromness, Orkney	0.315	2008
15 P2 Pelamis	Wave	United Kingdom	Scotland Stromness, Orkney	0.75	2011
16 Seagen Strangford	Tidal	United Kingdom	Northern Ireland Strangford Narrows	1.2	2003

U. S. Hydrogen Stations

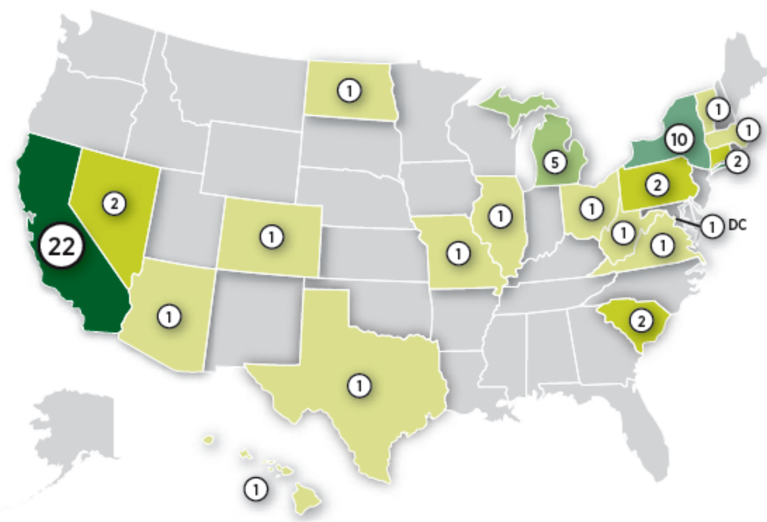
Hydrogen Production

50 million tons of hydrogen are produced each year worldwide; **9 million** tons are consumed in the United States.

Approximately **60%** is used for making ammonia for fertilizer; **23%** is used to make gasoline cleaner by removing sulfur; **9%** is used to make methanol; and the remainder is for chemical processing, metal production, electronics, and for space exploration.

Number of Operational U.S. Hydrogen Fueling Stations

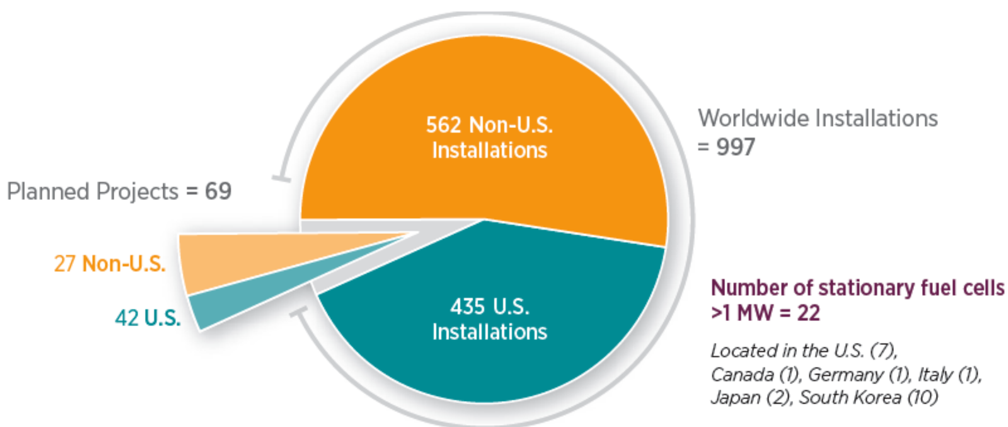
(December 2010 – **Total of 58**)



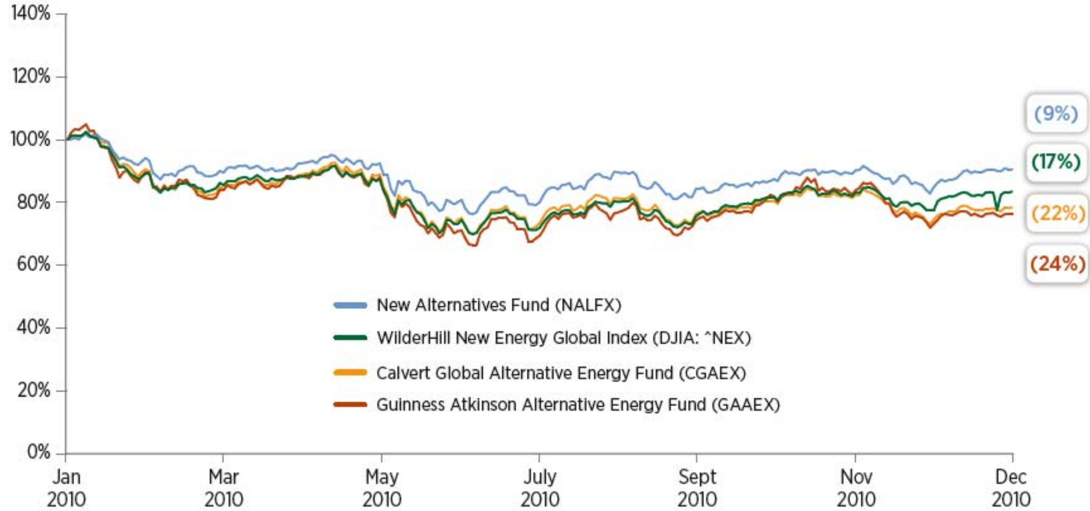
Number of recorded fuel cell vehicles in the United States = 156

Hydrogen - Electricity

Stationary Fuel Cell Installations (2010)



Public Renewable Energy Index



Barriers and Success Factors

Barriers		Success Factors	
1. Perceptions			
Complementary energy, still in phase of "learning curves" Poor public awareness Energy for the "rich": - Small, dispersed, abundant resources - Resource uncertainty, no sustainability - Technology under constant R&D, few field prove technologies - Expensive purchase, installation and maintenance - High impediments to capital mobilisation		Need for energy, strategic need for diversification of energy mix Importance in use of existing indigenous resources Need to lessen dependence on fossil fuel imports (geopolitical and economic impacts) Awareness of importance of clean, environmentally friendly energy ("Green is beautiful") Reduction of energy security risk	
Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
"Niche" technologies, introduced only due to mounting environmental reasons	Technologies that poor nations cannot afford: Sophisticated, difficult to maintain, not solving the "big" electrification problem abundant resources, non visible in the centre	Growing political pressures to diversify energy resources and to promote renewables	Use of indigenous resources Opening of possibilities to attract foreign capital
2. Policies			
Subsidies and other benefits for traditional, fossil energy Inconsistent policies towards renewables The socio-environmental costs ("externalities") are not taken into account		Climate change and other environmental policies (taxation, incentives, green certificates, etc.) Planning and implementation of renewable energy policy ("set asides", RPS, re-regulation)	
Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
De-regulation, causing policy of "laissez-faire" Promotion of merchant power plants Lack of institutional infrastructure	Quest to address problems quickly (installation of diesel generators) Political barriers (instability, lack of transparency, lack of regulatory frameworks to support private ownership	Distributed power policy	Rural electrification Programmes based on indigenous resources Off-grid electrification Incentives to developing countries including GHG accountability (CDM, JI, emissions trading) Technology and skill transfer policy from developed countries

Barriers and Success Factors

Barriers		Success Factors	
3. Legislation			
Lack of basic laws and regulations to support renewables Lack of legal transparency in energy Incompetent environmental legislation		New regulations promoted by international financing institutions (IFI), export credit agencies (ECAs) and multilateral assistance agencies for agreed project environmental guidelines Regulations and laws to promote renewables (RPS, renewable obligations, renewable energy laws, etc.) Basic laws and regulations to accommodate private investment	
Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
Lack of consistency in energy jurisdiction	Lack of transparent laws (project structure, private-public relationship, currency convertibility and transferability, international arbitration) Lack of environmental legislation	Jurisdiction to promote renewables (laws, regulations) Jurisdiction to promote climate change mitigation targets	Rural energy promotion regulations Governmental guarantees securing private sector investments Regulations ensuring access to international renewables financing
4. Renewables Project Finance			
Traditional project finance designed for large projects Lack of financing structures for small projects Complicated review, environmental and closing standards, tailored to large infrastructure projects Uneven competition with conventional energy projects High up-front capital requirements Socio-environmental externalities are not included		"Bundling" of small projects into aggregated renewable project for financing reasons Developing of micro financing tools Financing from private sector stimulated with multilateral assistance and investments (World Bank Group, Global Environment Facility, Regional Development Banks) and export credit agencies (ECAs) Government guarantees Multilateral insurance policy addressing relevant risks Flexibility in financing schemes (fast-track/one-stop financing, standardised procedures, standard purchase and project agreements, short review period and project closing schedule)	

Technology Specific Barriers and Success Factors

BIOMASS			
Barriers		**Success Factors**	
Dispersed form of energy, variety of technological solutions Competition from higher value applications Biomass technologies perceived as not sufficiently mature: risk to private investors Difficulties due to collection and transportation Deforestation Bioenergy is very land-intensive Low load factors increase energy system costs		Reducing fossil fuel imports (indigenous energy resource) and their associated foreign exchange costs No expensive storage devices Private sector involvement in deploying bioenergy CO_2 emissions neutral resource Distributed energy production	
Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
Perceived depletion of natural resources (wood) Small-scale resources, difficulty in creating economies of scale Not considered "emission-free".	Minor influence on nation's energy supply Not "modern enough"	Distributed energy resource Utilisation of indigenous energy resources Diversification of energy mix	Increased production capacity in income generating activities, reduction of poverty Brings jobs, capital and sources of revenue to rural areas Service to rural households

Technology Specific Barriers and Success Factors

WIND			
Barriers		Success Factors	
Lack of good wind conditions Uncompetitive technology in the short and medium run		Sites with sufficient wind-potential Political will to introduce subsidies The Kyoto protocol continued decreasing kWh costs from wind	
Developed Countries	Developing Countries	Developed Countries	Developing Countries
NIMBY (not in my back yard) effects Limited sites onshore Excess generating capacity in electricity sector Unstable production of power	Lack of financial resources to subsidise wind turbines	Heavy dependence on imported energy resources Available offshore sites	High energy demand growth rates in combination with shortages of capacity Hybrid solutions suitable for rural electrification

HYDRO		
Barriers		Success Factors
High upfront investment		Renewable energy source No GHG emissions during operation Widely distributed around the world
Developed Countries	Developing Countries	
Best sites have already been developed	Inadequacy of water resources and supply Competition for water from other economic sectors (agriculture)	

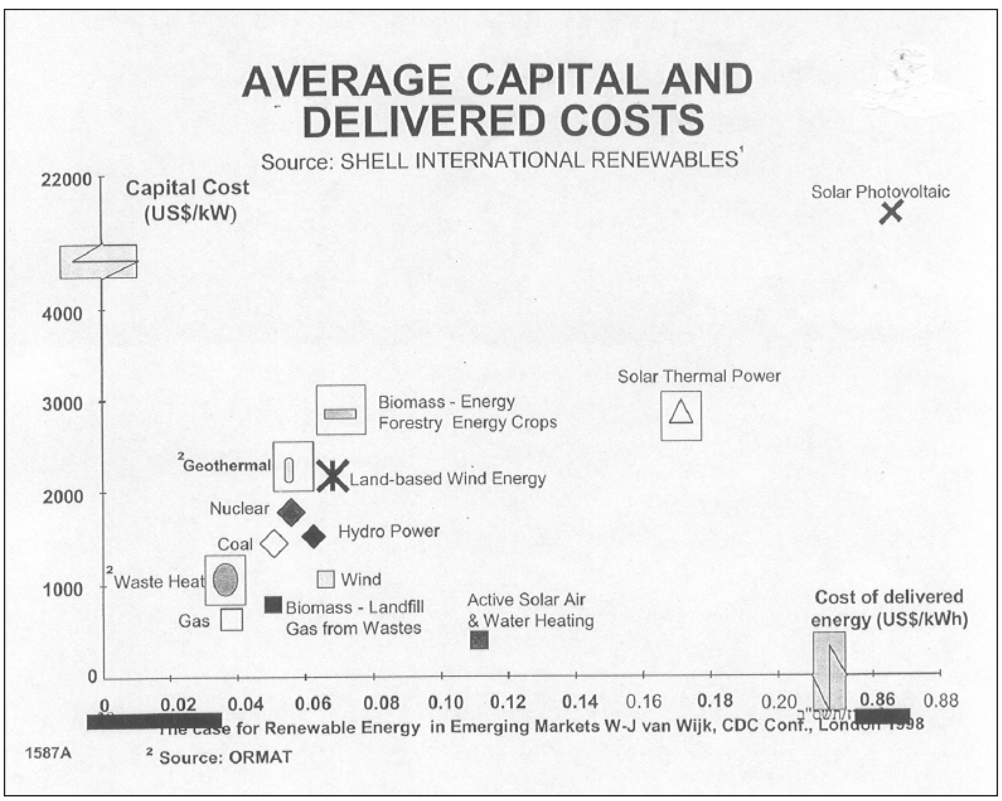
Technology Specific Barriers and Success Factors

GEOTHERMAL			
Barriers		Success Factors	
Perception of high-risk energy resource due to past experience: Early development and production difficulties Early mismanagement of resource by overproduction limited the life of the resource (not sustainable) Drilling technology difficulties (high-temperature environments) High costs of geothermal assessment (including exploratory drilling) High up-front investment In the past "old" traditional technologies causing certain environmental problems by direct release of geothermal steam into the atmosphere or hot water into rivers (no reinjection) and difficulties to use water dominated resources Resource handling problems, e.g. corrosion, scaling, resource depletion		Economically viable energy resource; can compete with small thermal or internal combustion power plants Modularity of big part of geothermal power plants reduces downtime for maintenance Superior environmental characteristics (almost zero pollution – a recognised and acceptable emissions mitigation activity, minimal land requirement, low profile Quantities of potential geothermal resource Some 40 million tones of CO_2 emissions can be saved by doubling geothermal power capacity (of over 8000 MW)	
Developed Countries	Developing Countries	Developed Countries	Developing Countries
Small resources with minor influence on nation's energy supply (complementary resource) No accountability for GHG emission reductions Not considered "renewable"	Financing constraints due to high up-front costs Competition from fossil fuel power plants	Reliable, field proven, zero pollution energy resource Significant base-load resource in sites with indigenous geothermal resources	• Over 620 million people in 39 developing countries could be 100% supplied by geothermal power

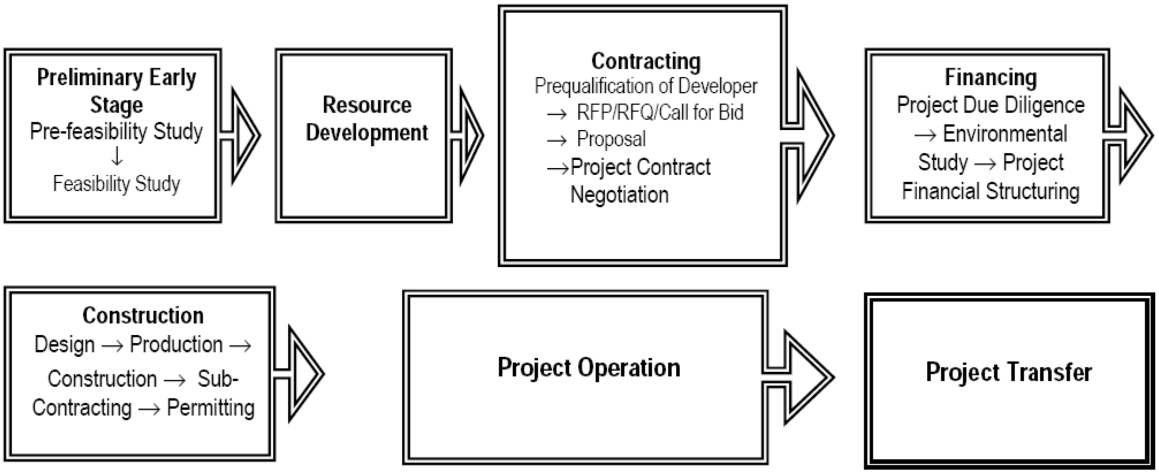
Technology Specific Barriers and Success Factors

SOLAR			
Barriers		**Success factors**	
Low energy density Resource available only during daytime, sensible to atmospheric and weather fluctuations (influence on low solar plant factor) Costs of solar PV electricity considerably higher than other renewable sources, high capital costs, long payback periods Grid connection issues, intermittency, storage issues High cost of storage solutions, material limitations Hazardous materials in PV systems		Clean, distributed power solutions Substantial drop in PV installation and generation costs Integrated types of PV Thermal electric technologies success for larger solar stations Grants and subsidies for solar energy	
Solar Heating Solar installations are additional to basic components in heating systems Few large industrial suppliers Lack of competent installation capacity		Solar Heating Vast roof- and façade area available Energy security Kyoto protocol, way of "green" profiling of buildings, businesses Relatively low kWh costs compared to other renewables	
Developed Countries	**Developing Countries**	**Developed Countries**	**Developing Countries**
Not cost effective for grid electrical power and even in the peaking power markets Need for "net metering"	High costs, low availability of PV electricity	Low maintenance requirements High reliability systems "Solar architecture" solutions Distributed energy resource	Off grid applications in remote rural areas where small amounts of energy are required
Solar Heating Volatile production Necessary integration in buildings	Solar Heating Lack of financial capability to subsidise renewable energy projects	Solar Heating Heavy dependence on non-indigenous energy sources	Solar Heating High growth rates in combination with shortage capacity Reduced need for import, solar cooling potential

Average Capital and energy cost by technology

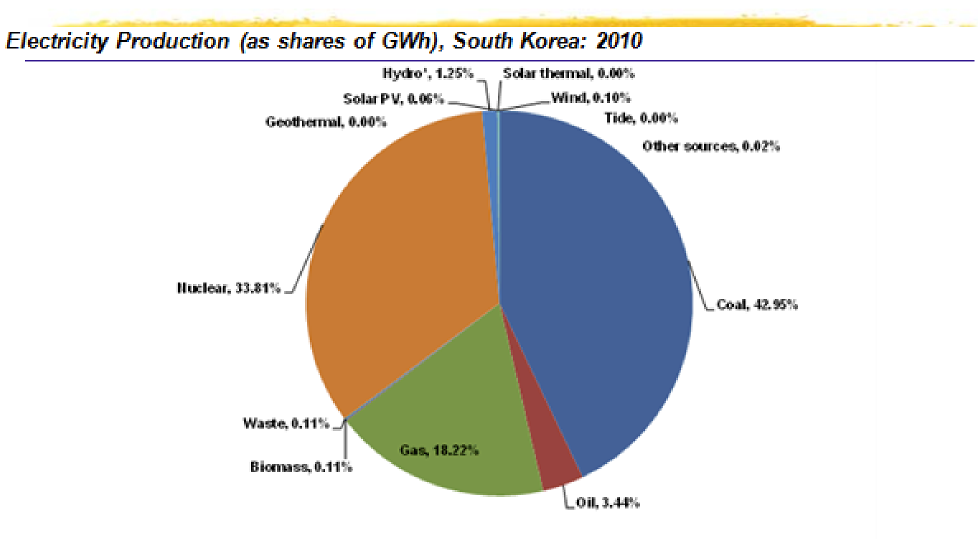


Project Stages



Source: WEC Committee on Renewables

Electricity Generation in Korea



(Source: International Energy Agency)

**Includes production from pumped storage plants.*

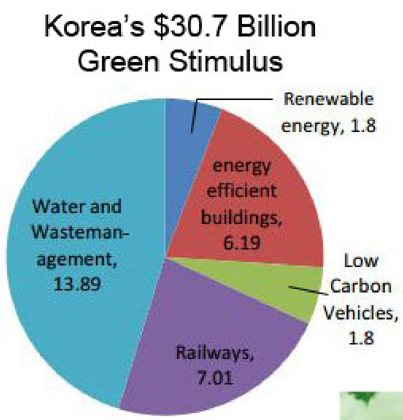
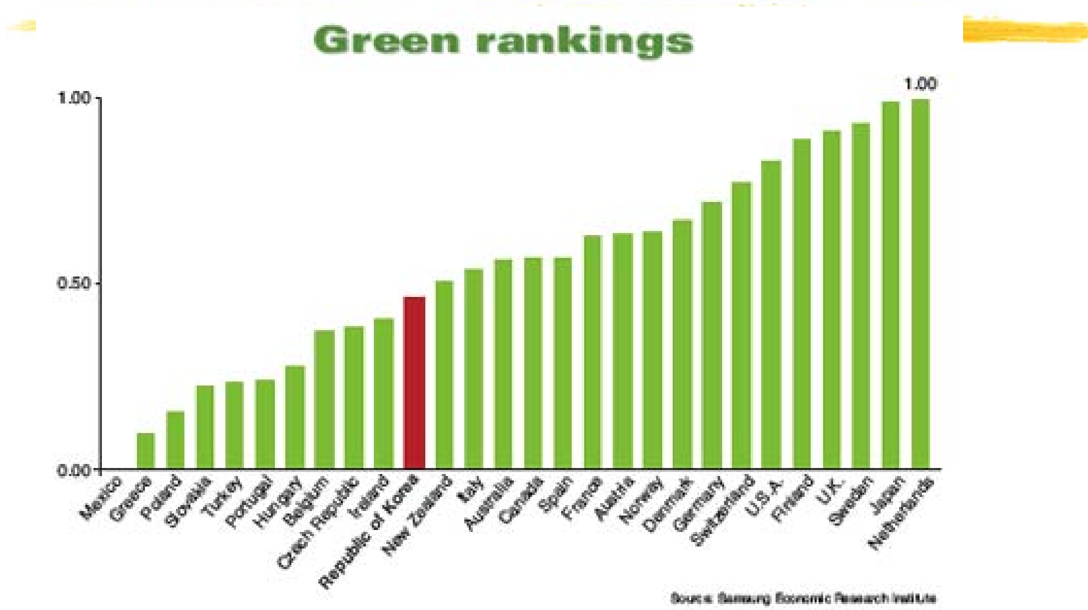


Table 2: Estimated economic effects of Korea's Five-Year Plan for Green Growth

Indicator/period	Economic gains: Production inducement (US$ Billion)		Economic gains: Value-Added inducement (US$ Billion)		Economic gains: Job creation (thousand people)	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
2009-2013	141.1	160.4	58.4	73.9	1,561	1,805
Yearly average	28.3	32.1	11.7	14.8	312	362
Ratio of Yearly Average to GDP (%) **	3.5*	4.0*	1.5*	1.8*	34.4**	39.8**

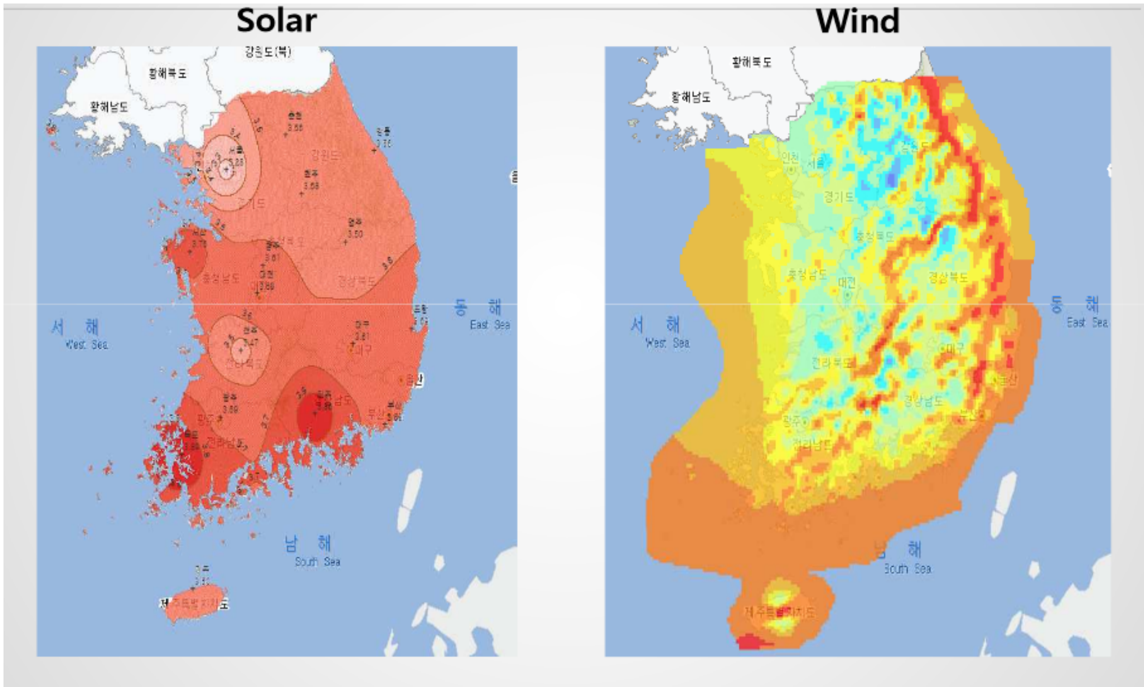
* Estimated 2009 GDP = 1,029.5 trillion won (= US$801.0 Billion)
** Number of unemployed in 1st quarter 2009 (908,000)

(from the UNEP's 2010 assessment of South Korea's green growth plan)

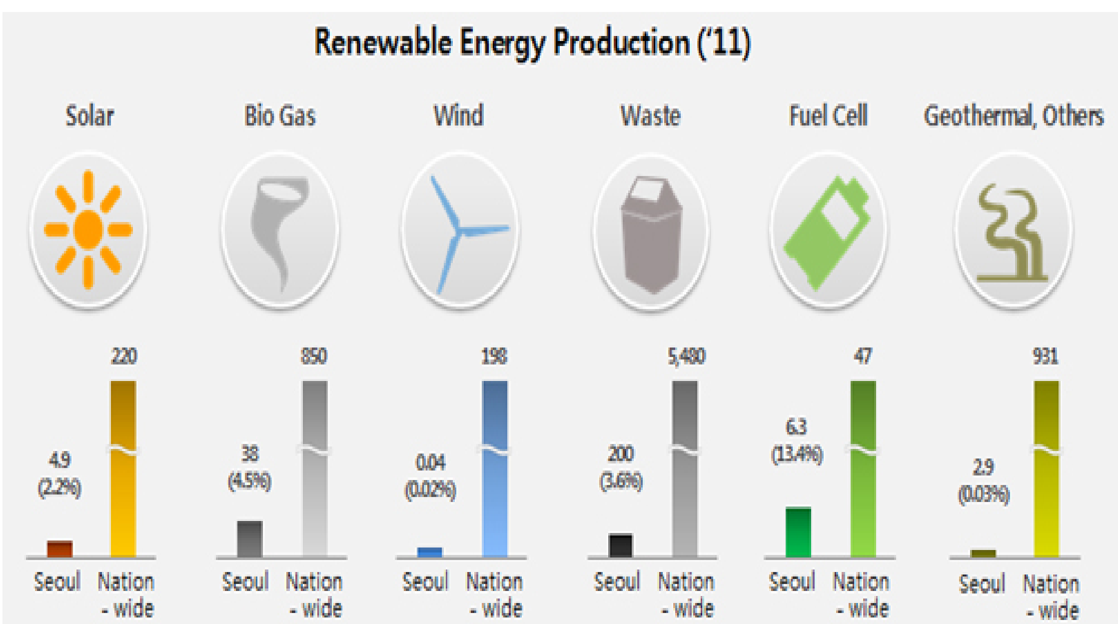

Green rankings
1.00
0.50
0.00
1.00
Mexico
Greece
Poland
Slovakia
Turkey
Portugal
Hungary
Belgium
Czech Republic
Ireland
Republic of Korea
New Zealand
Italy
Australia
Canada
Spain
France
Austria
Norway
Denmark
Germany
Switzerland
U.S.A.
Finland
U.K.
Sweden
Japan
Netherlands
Source: Samsung Economic Research Institute

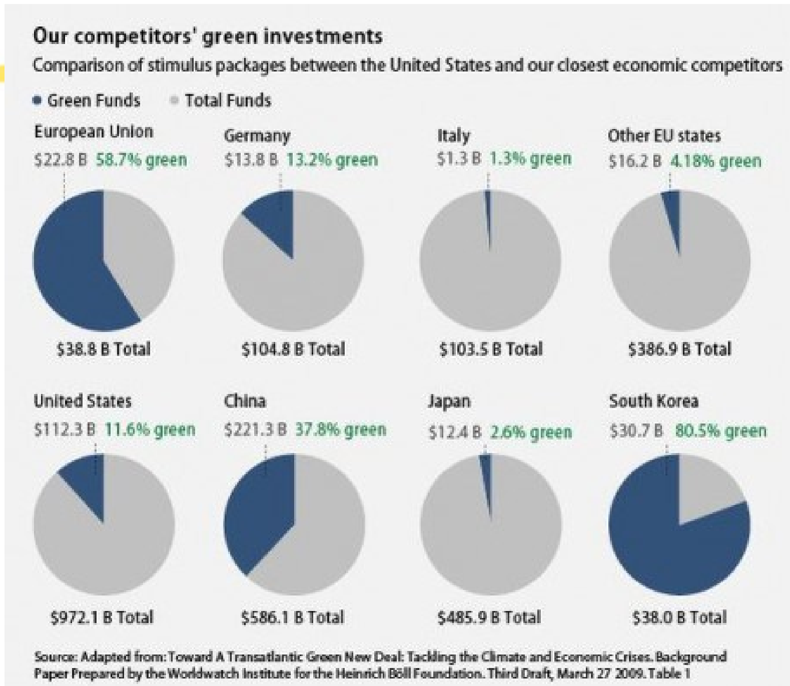

Republic of Korea
Self-sufficiency
18%
Power generation
497 TWh
thereof nuclear
30%
Per capita consumption
9,186 kWh
per capita
CO₂ emissions per capita
5.7 t
Population
49.4 million
CO₂ emissions of power sector
279 Mt
CO₂ intensity of power sector
620 g
per kWh
Calculations for 2010
Source: IEA – WEO 2012; IEA – Energy Balances 2012; The World Bank – World Data Bank; Siemens calculations

Renewable Energy Source Potential



Renewable Energy Production (2011)





Renewable Energy Development in Korea (2010)

⌘Policy

- Aims to generate 5% of energy from renewables by 2011, increasing to 11% by 2030. This is compared with a current figure of 2.4%, therefore achievement of these targets would more than double energy from renewables by the end of next year.
- South Korea already has Financial Incentives in place for wind and solar power; however, from 2012 these will be replaced by a Renewable Portfolio Standard (RPS), approved by the South Korean Assembly in March 2010. This RPS will require 14 state-run and private power utilities with capacity in excess of 500MW to generate 4% of energy from renewable sources by 2015, increasing to 10% by 2022. This program, which will become effective in 2012, will mandate 350MW/year of additional RE to 2016, and 700MW/year to 2022.
- South Korea's Government has announced that a total KRW40t (€25.8b, US $34.2b) will be invested in RE by 2015. This includes KRW22.4t (€14.4b, US $19b) to be invested by the nation's 30 largest industrial groups by 2013. The Government will contribute approximately KRW7t (€4.5b, US $5.96b) and the remaining KRW10.6t (€6.8b, US $9b) coming from other areas of the private sector. South Korea has already seen substantial financial investment in RE in recent years, including KRW2t (€1.3b, US $1.7b) from Government in the last two years.
- Further, all RE technologies receive a 5% tax credit, and in 2009, import duties were halved on all components/equipment used in RE power plants. The Government also provides subsidies to local governments of up to 60% for the installation of renewable facilities, as well as offering low interest loans (5.5%-7.5%) to RE projects, including a 5-year grace period followed by a 10-year repayment period.

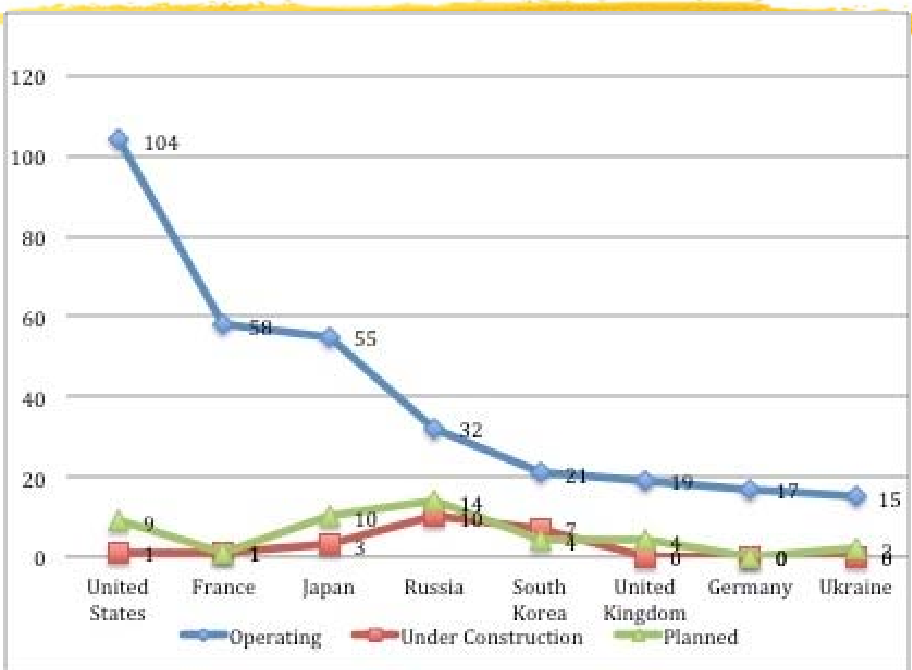
Renewable Energy Development in Korea (2010)

- Wind
  - Wind power is currently supported through a FIT of KRW107.29 (€0.07, US $0.09)/kWh, decreasing annually by 2% from October 2009. However, this FIT will be replaced by the RPS from 2012 onwards. It is estimated that South Korea has potential reserves of 186.5TWh per annum. The current installed capacity is around 348MW and there is a substantial project pipeline including Hyundai Heavy Industries' 200MW wind farm due to be operational by 2012 and costing KRW500b (€322m, US $426m).
  - The country has also seen investment by turbine manufacturers in a bid to develop a strong domestic supply chain. Samsung has already started operations, with scope to produce turbines with 500MW per year in generation capacity.
- Offshore wind
  - South Korea aims to be the world's third largest offshore wind power generator. At the end of Q3, it was announced that the country will launch a KRW9.2t (€5.9b, US $7.8b) offshore wind farm project in the Yellow Sea. An initial testing phase will install 20 5MW turbines by 2013, but the site will have an estimated generating capacity of 2.5GW by 2019 and it is reported that domestic companies will build the 500 turbines required.

Renewable Energy Development in Korea (2010)

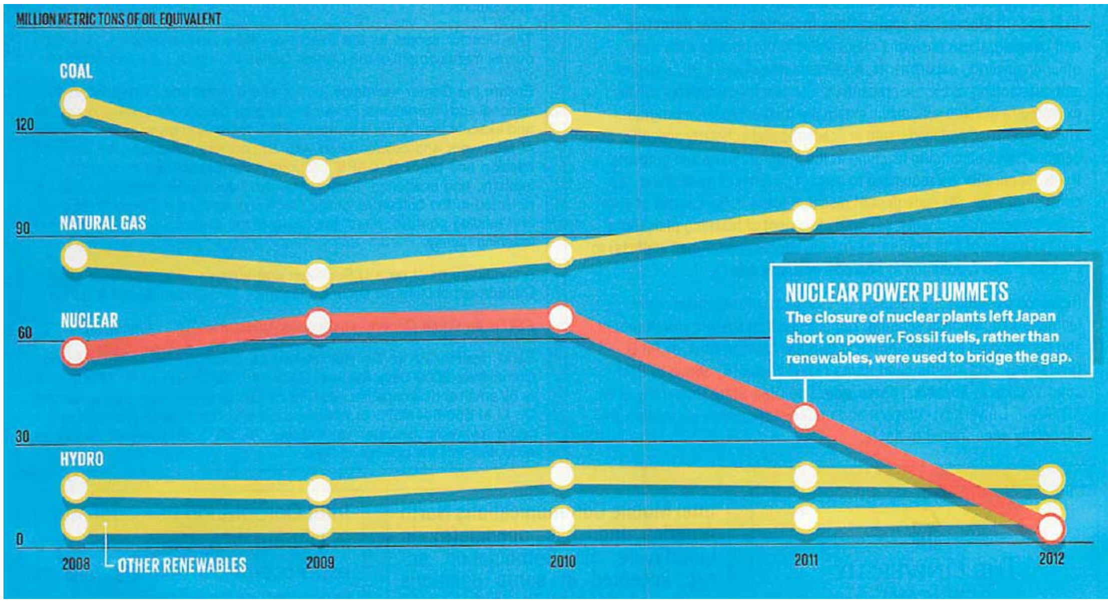
- Solar
  - Solar FITs were first adopted in 2006 and were considered to be quite generous. A decision was made in 2008, however, to reduce the rate by up to 30% as a way of encouraging local production. Rates now range from KRW572 (€0.37, US $0.48)/kWh for systems smaller than 30kW to KRW509 (€0.33, US $0.43)/kWh for those larger than 1MW capacity.
  - As with wind, the solar FIT scheme will be replaced in 2012. In addition to the RPS enforcement, utility companies will be given a separate solar energy production quota of 120MW in the first year, gradually increasing to 200MW in 10 years, after the rules are enacted.
  - Grid-connected solar PV totalled 430MW at the end of 2009, including Samsung's 18.4MW plant and Conergy's 19.6MW plant (reported to be Asia's largest in 2008). The European PhotoVoltaic Industry Association (EPIA) has estimated the country's solar PV market could grow to 1.3GW by 2013, and the current pipeline includes SunEdison's 400MW of solar plants to be built across the country,
- Hydro
  - It has been estimated that South Korea has a small-scale hydro potential of up to 1.5GW, and that 198MW could be generated by 2012. Installed capacity represents less than 5% of the domestic potential, indicating significant untapped resources. The project pipeline includes five small hydro plants as part of the Four Rivers Project.

Nuclear Power



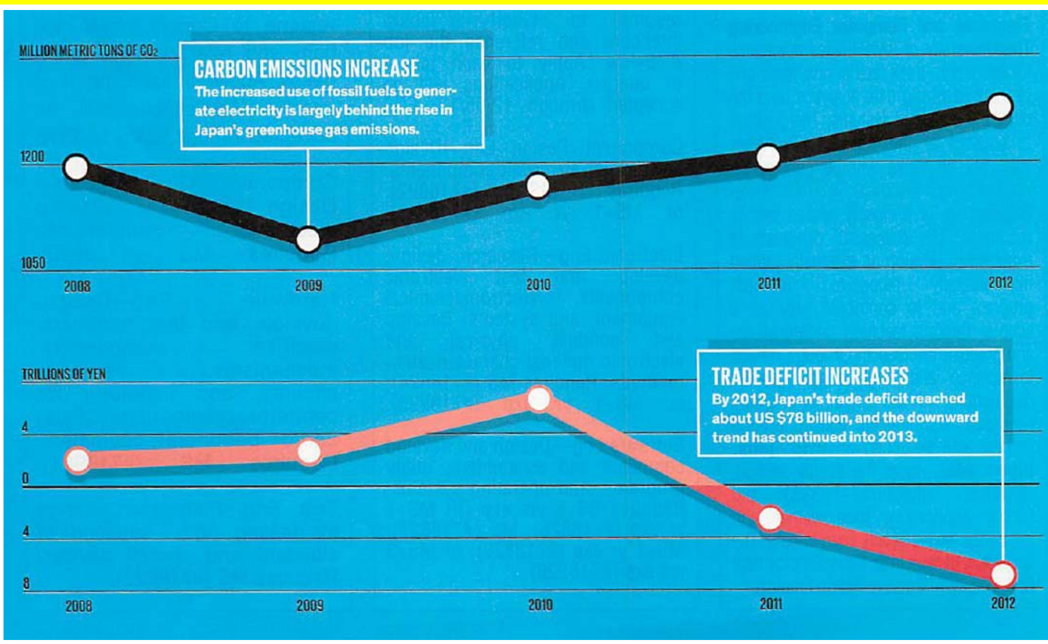
Campaign for "Less Nuclear Power"

Other Fallouts from Fukushima



- IEEE Spectrum Nov 2013: Nuclear Power Plummets

Other Fallouts from Fukushima – Carbon Emission Increase



- IEEE Spectrum Nov 2013: The closure of nuclear power plants left Japan short on power. Fossil fuels, rather than renewables, were used to bridge the gap. The increased use of fossil fuels to generate electricity is largely behind the rise in Japan's green house gas emission.

What Kyoto?

Newsbytes: Japan Kills Climate Agenda – What Kyoto?

Posted on April 26, 2013 by Anthony Watts

Turns Back To Coal, Abandons Emissions Targets

From Dr. Benny Peiser at The GWPF

The Japanese government is moving to speed up the environmental assessment process for new coal-fired power plants. According to Japanese media reports, the government intends to make 12 months the maximum period for assessing and approving new coal-fired power plants as its utilities seek to develop more power stations to stem surging energy supply bills. With the government considering the closure of much of the installed nuclear capacity over the medium term, the spotlight is back on coal as the cheapest energy source, notwithstanding plans to cut carbon emissions. A commitment to slice 2020 carbon emissions by 25 per cent from their 1990 level will be revised by October, according to Japanese newspaper reports. –Brian Robins, The Sydney Morning Herald, 26 April 2013

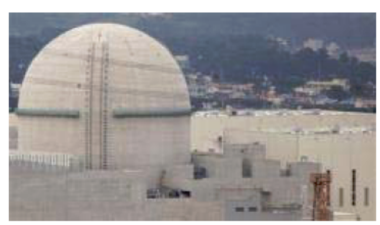
Japan is likely to abandon an ambitious pledge to slash greenhouse gas emissions by a quarter, the top government spokesman said on Thursday. Asked to confirm if the new administration would review Tokyo's 2009 pledge, Chief Cabinet Secretary Yoshihide Suga said the government was "moving in that direction in principle". "I have been saying for some time that it is a tremendous target and would be impossible to achieve," he told a regular news conference. Prime Minister Shinzo Abe's business-friendly Liberal Democratic Party ousted the Democratic Party in December elections after pledging to review the emissions cut target in light of the post-Fukushima switch to fossil fuels. –AFP, 24 January 2013

Less Nuclear and More LNG

Stung by scandal, South Korea weighs up cost of curbing nuclear power

4:59am EDT

By Meeyoung Cho



SEOUL (Reuters) - It started with a few bogus safety certificates for cables shutting a handful of South Korean nuclear reactors. Now, the scandal has snowballed, with 100 people indicted and Seoul under pressure to rethink its reliance on nuclear power.

A shift away from nuclear, which generates a third of South Korea's electricity, could cost tens of billions of dollars a year by boosting imports of liquefied natural gas, oil or coal.

Although helping calm safety concerns, it would also push the government into a politically sensitive debate over whether state utilities could pass on sharply higher power bills to households and companies.

Gas, which makes up half of South Korea's energy bill while accounting for only a fifth of its power, would likely be the main substitute for nuclear, as it is considered cleaner than coal and plants can be built more easily near cities.

"If the proportion of nuclear power is cut, other fuel-based power generation has to be raised. If we use LNG, the cost will definitely go up," said Hwang Woo-hyun, vice president of state-run utility Korea Electric Power Corp (KEPCO).

KEPCO owns Korea Hydro and Nuclear Power Co Ltd (KHNP), which operates the county's nuclear reactors, and also has a quarter stake in Korea Gas Corp (KOGAS), the world's largest corporate buyer of LNG.

The extra cost to Asia's fourth-largest economy of importing

more LNG to replace nuclear could be approaching $20 billion per year by 2035, according to Reuters calculations based on government projections for power capacity growth and South Korea's average LNG prices for last year.

South Korea could need as much as 25 million extra tons by 2035 if a proposal to reduce nuclear's share of its energy mix is drafted into power policy.

The cost projection could be conservative if rising demand from South Korea fuels further price rises in LNG. Top LNG importer Japan is also buying more gas than ever as it compensates for its own nuclear shutdown in the wake of the Fukushima disaster.

Are Utilities Dying Dinosaurs?

Feature Article

Citibank: Utilities are dinosaurs waiting to die

Oct 9, 2013 Talk Back Free Alerts More On This Topic SHARE

1

Quick Take: *A new report authored by prominent Citibank analysts claims the global energy mix is shifting more rapidly than realized. If true – and these are some smart, smart people – it has major implications for generators, consumers, and most of all utilities. In fact, the study says utilities are most at risk because their business model is likely to change.*

I've been arguing for years that utilities should either evolve to become "wires only" companies. Or else get busy offering additional services, such as rooftop solar and microgrids. For instance, in my "Electronomics" series, I explained ***why utilities MUST change their business model (and one way to get started)****.*

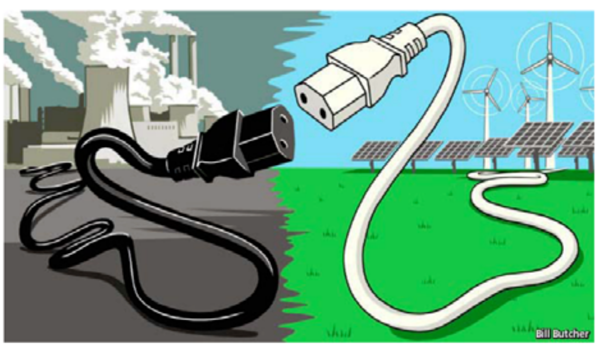
Threat to the Existing System

European utilities

How to lose half a trillion euros

Europe's electricity providers face an existential threat

Oct 12th 2013 | From the print edition Like 5.7k Tweet 551



ON JUNE 16th something very peculiar happened in Germany's electricity market. The wholesale price of electricity fell to minus €100 per megawatt hour (MWh). That is, generating companies were having to pay the managers of the grid to take their electricity. It was a bright, breezy Sunday. Demand was low. Between 2pm and 3pm, solar and wind generators produced 28.9 gigawatts (GW) of power, more than half the total. The grid at that time could not cope with more than 45GW without becoming unstable. At the peak, total generation was over 51GW; so prices went negative to encourage cutbacks and protect the grid from overloading.

The trouble is that power plants using nuclear fuel or brown coal are designed to run full blast and cannot easily reduce production, whereas the extra energy from solar and wind power is free. So the burden of adjustment fell on gas-fired and hard-coal power plants, whose output plummeted to only about 10% of capacity.

Slow death of EU utilities?

Smart Grid Markets

Respected journal documents the slow death of European utilities

Oct 16, 2013 Talk Back Free Alerts More On This Topic SHARE

Germany's recent "renewables oversupply" issues are a microcosm of the changes affecting the rest of Europe as renewable energy becomes plentiful. In June, the wholesale price of electricity fell to -100 euros per MWh. That's right, generating companies had to pay grid managers to take their energy. Total generation was 6 GW more than the grid could handle, so prices went negative to encourage cutbacks.

Environmentalists are thrilled with the changes because renewables account for an ever-higher percentage of the total. But for established utilities, says the Economist, "this is a disaster."

"Their gas plants are being shouldered aside by renewable-energy sources. They are losing money on electricity generation. They worry that the growth of solar and wind power is destabilizing the grid, and may lead to blackouts or brownouts. And they point out that you cannot run a normal business, in which customers pay for services according to how much they consume, if prices go negative. In short, they argue, the growth of renewable energy is undermining established utilities and replacing them with something less reliable and much more expensive."

German Situation

SPIEGEL ONLINE
09/04/2013 07:15 PM

Germany's Energy Poverty

How Electricity Became a Luxury Good

By SPIEGEL Staff

Germany's agressive and reckless expansion of wind and solar power has come with a hefty pricetag for consumers, and the costs often fall disproportionately on the poor. Government advisors are calling for a completely new start.

If you want to do something big, you have to start small. That's something German Environment Minister Peter Altmaier knows all too well. The politician, a member of the center-right Christian Democratic Union (CDU), has put together a manual of practical tips on how everyone can make small, everyday contributions to the shift away from nuclear power and toward green energy. The so-called Energiewende, or energy revolution, is Chancellor Angela Merkel's project of the century.

"Join in and start today," Altmaier writes in the introduction. He then turns to such everyday activities as baking and cooking. "Avoid preheating and utilize residual heat," Altmaier advises. TV viewers can also save a lot of electricity, albeit at the expense of picture quality. "For instance, you can reduce brightness and contrast," his booklet suggests.

Altmaier and others are on a mission to help people save money on their electricity bills, because they're about to receive some bad news. The government predicts that the renewable energy surcharge added to every consumer's electricity bill will increase from 5.3 cents today to between 6.2 and 6.5 cents per kilowatt hour -- a 20-percent price hike.

German consumers already pay the highest electricity prices in Europe. But because the government is failing to get the costs of its new energy policy under control, rising prices are already on the horizon. Electricity is becoming a luxury good in Germany, and one of the country's most important future-oriented projects is acutely at risk.

Existential Threat to EU Utilities?

Huge success or massive failure? German renewables debate rages on

Oct 18, 2013 Talk Back Free Alerts More On This Topic SHARE

Quick Take: *As one of the countries that has made the most progress in renewable energy, Germany is an important touchstone for the rest of the world. By watching what works and what doesn't, we can emulate the successful strategies and avoid the mistakes.*

And yet, as we've documented in Smart Grid News, some **Germans are beginning to revolt at the exceptionally high power prices caused by the country's high-priced renewables subsidies**. What's more, **a German ministry wants to delay or do away with plans to install smart meters**.

Then there's Canadian Davis Swan, an oil & gas executive who has been an energy policy advisor in the Alberta Legislature. He believes **"the backlash against renewable subsidies that is beginning to become evident throughout Europe will turn into a contagion**."

Meanwhile, the highly respected Economist is just out with a story documenting the **"existential threat" to Europe's electric power utilities** "existential threat" to Europe's electric power utilities and warning about "Germany in particular."

And Higher Cost of Electricity

Higher Electricity Costs Raise Alarm Across Europe

By Bill Sweet
Posted 18 Oct 2013 | 4:33 GMT

Share | Email | Print

- " …. British government predictions of sharply increased electricity prices in the next decades are getting renewed attention these days, …"