Renewable Energy: Overview of Global Markets and Policies and Prospects for Japan

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Note: Figures for 2009 are preliminary and subject to revision. Figures are based on the REN21 Renewables 2010 Global Status Report, Review Draft (April 26, 2010)

Fourth Annual
"Renewables Global Status Report"
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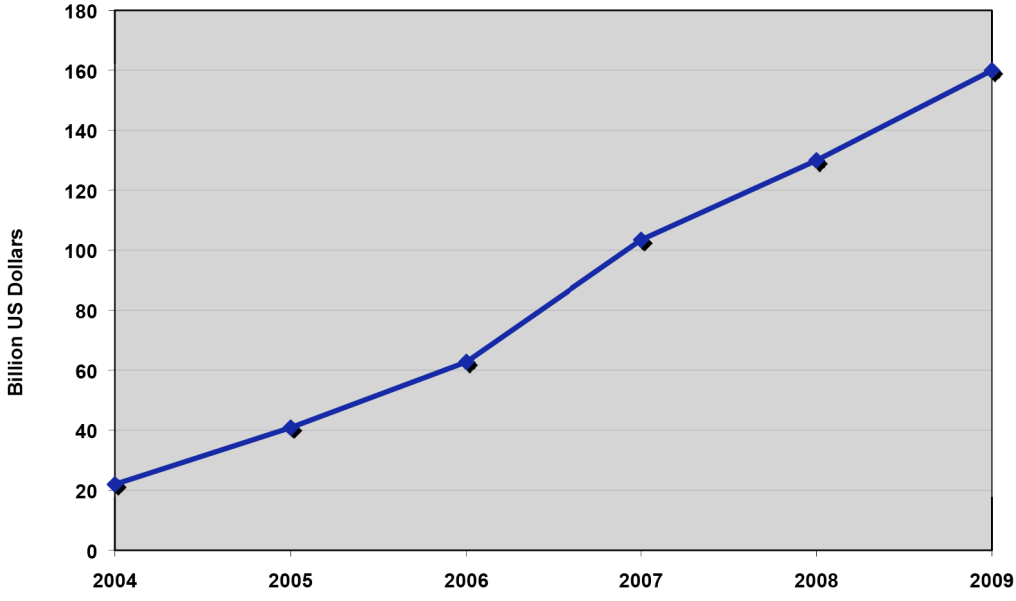
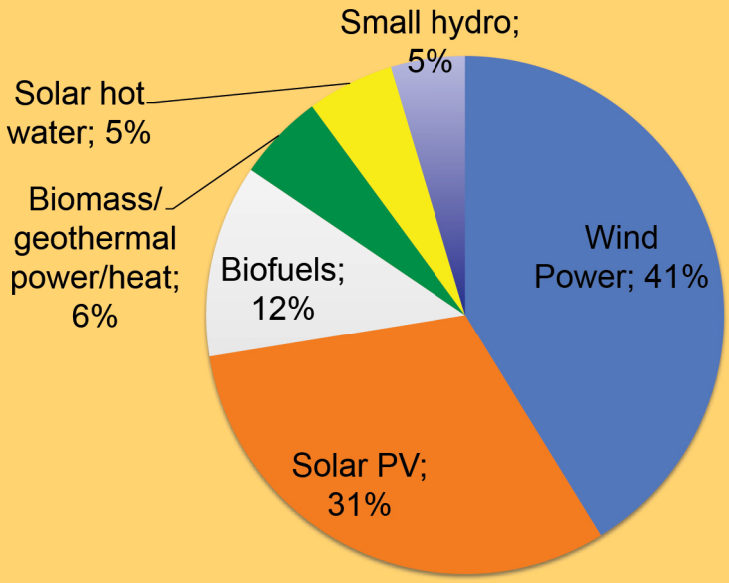
SELECTED INDICATORS	2007 →	2008 →	2009
Investment in new renewable capacity (annual)	104 →	130 →	160 billion USD
Renewables power capacity (existing, non-hydro)	135 →	195 →	245 GW
Renewables power capacity (existing, including hydro)	1,070 →	1,140 →	1230 GW
Wind power capacity (existing)	94 →	121 →	159 GW
Solar PV capacity, grid-connected (existing)	7.5 →	13 →	20 GW
Solar PV production (annual)	3.7 →	6.9 →	7.5 GW
Solar hot water capacity (existing)	126 →	144 →	180 GWth
Ethanol production (annual)	50 →	67 →	74 billion liters
Biodiesel production (annual)	9 →	12 →	15 billion liters
Countries with policy targets	66 →	73 →	80
States/provinces/countries with feed-in policies[1]	49 →	63 →	73
States/provinces/countries with RPS policies	44 →	50 →	52
States/provinces/countries with biofuels mandates	53 →	55 →	64

Figure 12. Annual Investment in New Renewable Energy Capacity, 2004–2009



Annual Investment – Technology Shares (2008)

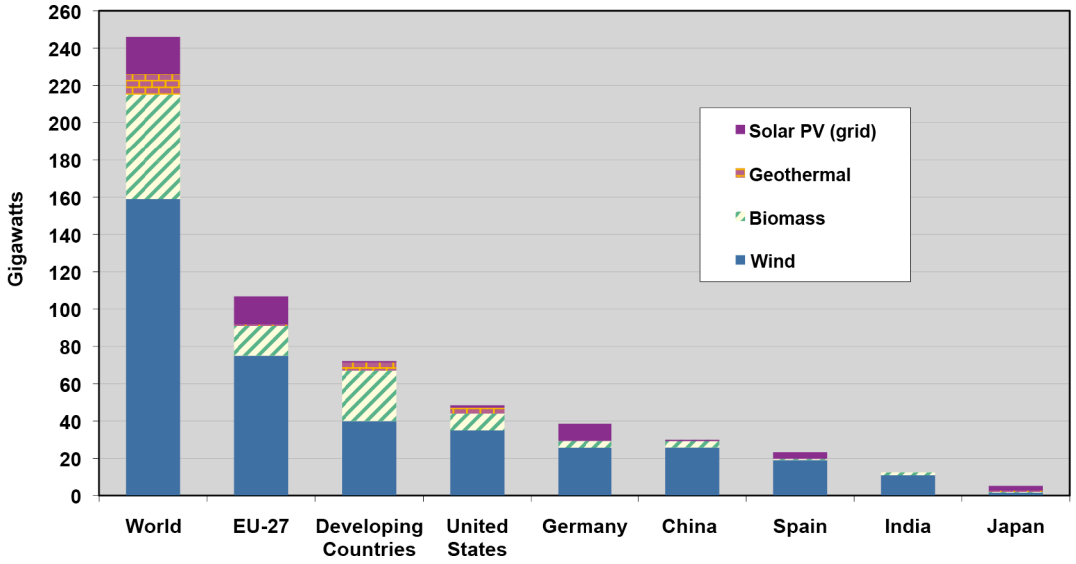


Power capacity milestone in 2008

For the first time,
both the United States and the European Union
added more power capacity from renewables
than from conventional sources
(gas, coal, oil and nuclear)

(Note, however, that annual power generation from a unit of renewable capacity is typically less than from conventional capacity)

Figure 4. Renewable Power Capacities: EU, Developing Countries, and Top Six Countries, 2009



Note: Excludes hydropower

Figure 3. Average Annual Growth Rates of Renewable Energy Capacity, 2005-2009

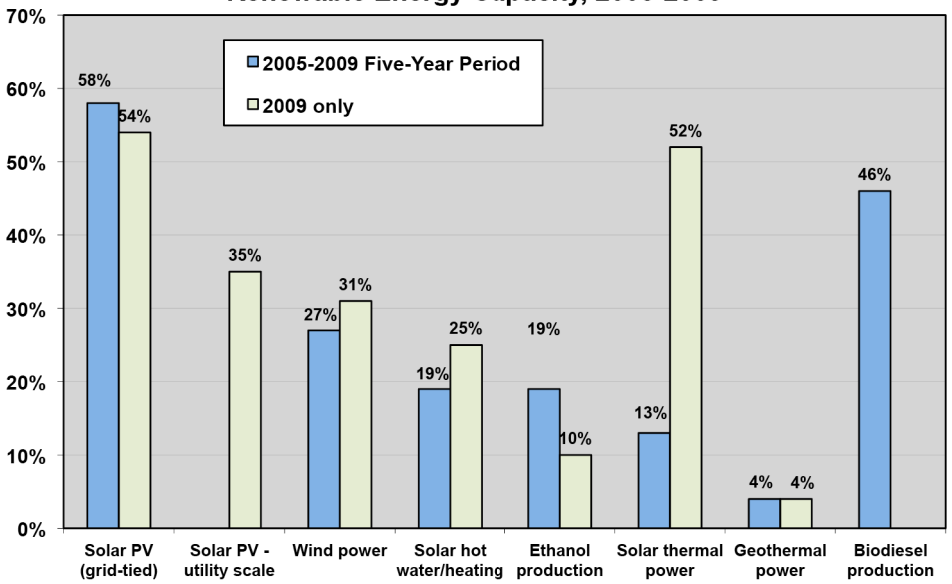


Table 1. Status of Renewables Technologies—Characteristics and Cost

Technology	Typical Characteristics	Typical Energy Costs (U.S. cents/kilowatt-hour)
Power Generation		
Large hydro	*Plant size:* 10 megawatts (MW)–18,000 MW	3–4
Small hydro	*Plant size:* 1–10 MW	4–7
On-shore wind	*Turbine size:* 1–3 MW *Blade diameter:* 60–100 meters	5–8
Off-shore wind	*Turbine size:* 1.5–5 MW *Blade diameter:* 70–125 meters	8–12
Biomass power	*Plant size:* 1–20 MW	5–12
Geothermal power	*Plant size:* 1–100 MW *Type:* binary, single- and double-flash, natural steam	4–7
Solar PV (module)	*Cell type and efficiency:* single-crystal 17%; polycrystalline 15%; amorphous silicon 10%; thin film 9-12%	—
Rooftop solar PV	*Peak capacity:* 2–5 kilowatts-peak	20–80*
Concentrating solar thermal power (CSP)	*Plant size:* 50–500 MW (trough), 10-20 MW (tower); *Types:* trough, tower, dish	12–18†

Renewable Energy Applications by Sector

	Buildings (and DG)	Bulk power generation	Industry	Transport
Hydro	• micro-hydro plant (DG)	• large-scale hydro plant • small-scale hydro plant		• electric cars powered from renewable electricity
Geothermal	• ground-source geothermal heat pump	• geothermal power plant		
Wind	• household-scale wind turbine (DG)	• wind farm		
Solar	• solar PV panels (DG) • solar hot water panels • solar heating panels • passive solar architecture	• large-scale solar PV power plant • solar thermal power plant (CSP)	• solar hot water for process heating	
Biomass	• on-site small-scale biomass CHP plant (DG) • small-scale biogas engine	• biomass power plants (and CHP plants) • biogas or biomass gasification with gas turbine	• on-site small-scale biomass CHP plant	• ethanol fuel • biodiesel fuel

CHP = combined heat and power
DG = distributed generation
CSP = concentrating solar (thermal) power

Figure 5. Wind Power, Existing World Capacity, 1996–2009

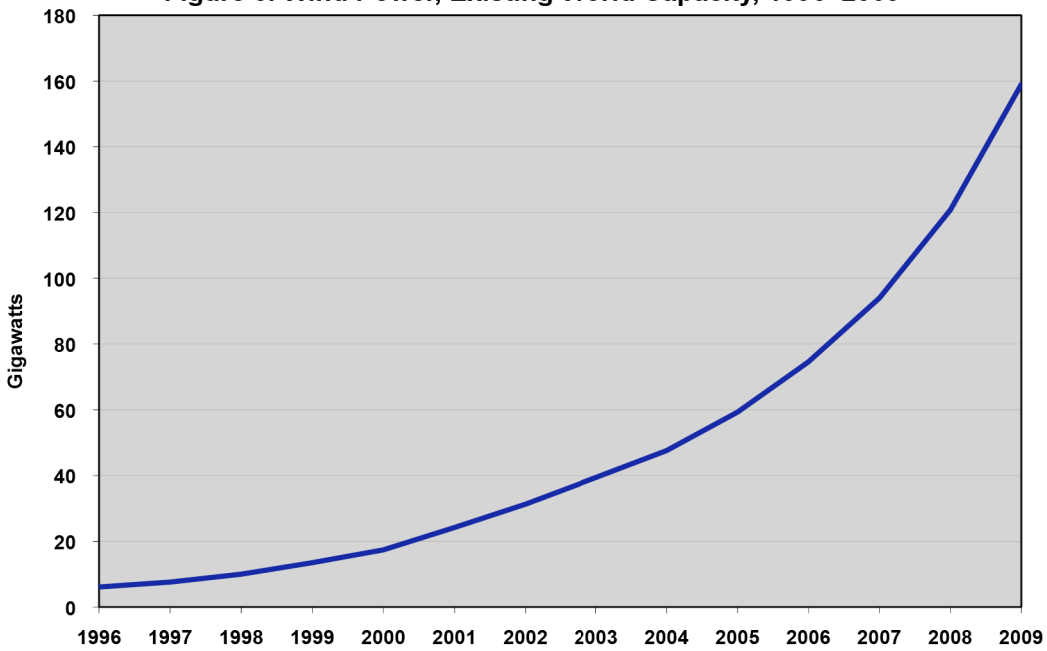


Figure 6. Wind Power Capacity, Top 10 Countries, 2009

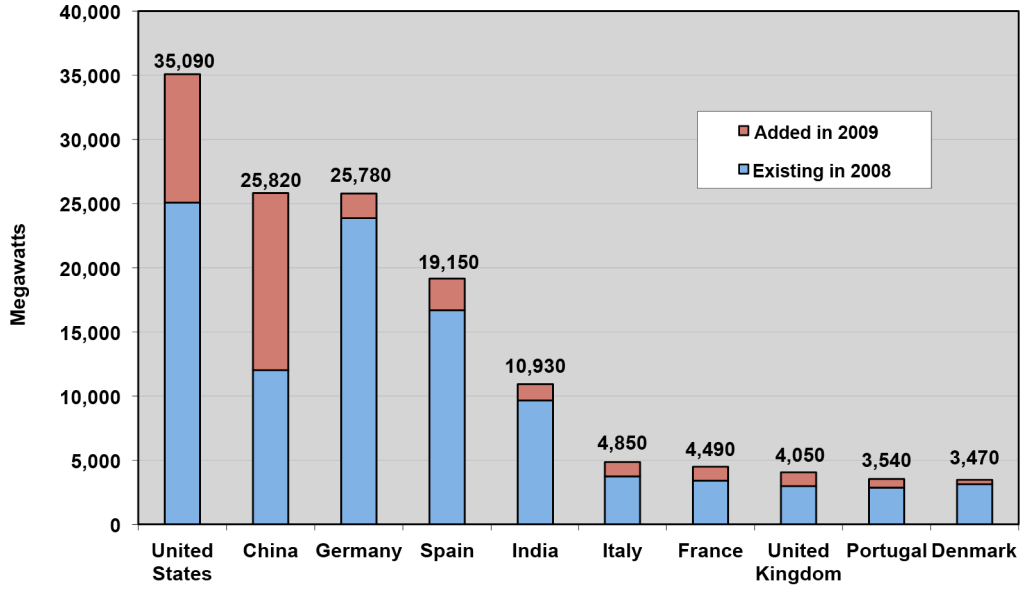


Figure 13. Market Shares of Top-Ten Wind Manufacturers, 2009

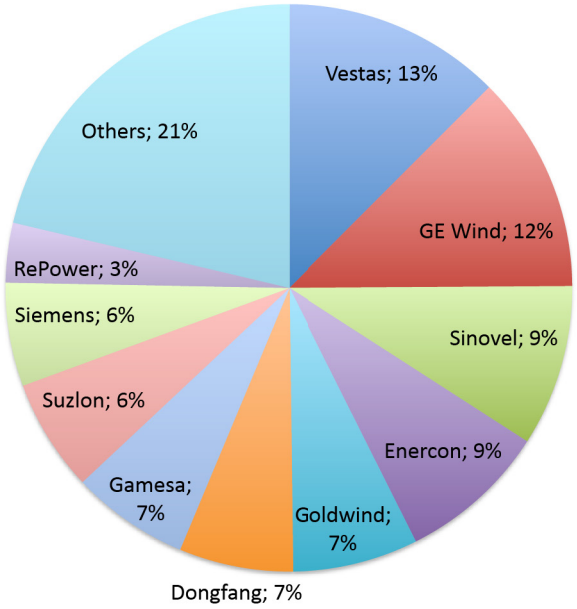


Figure 7. Solar PV, Existing World Capacity, 1995–2009

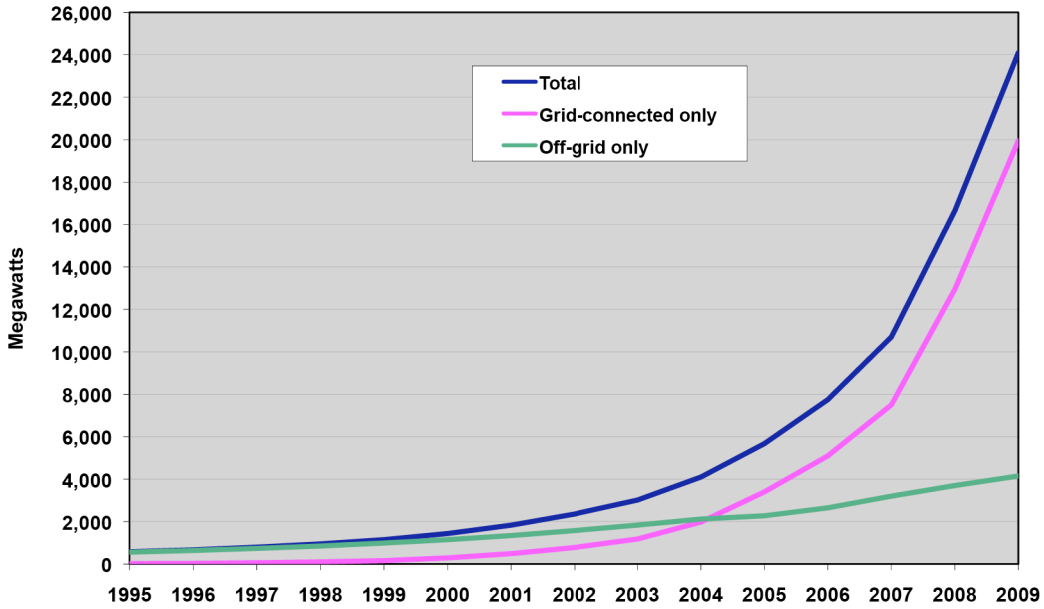
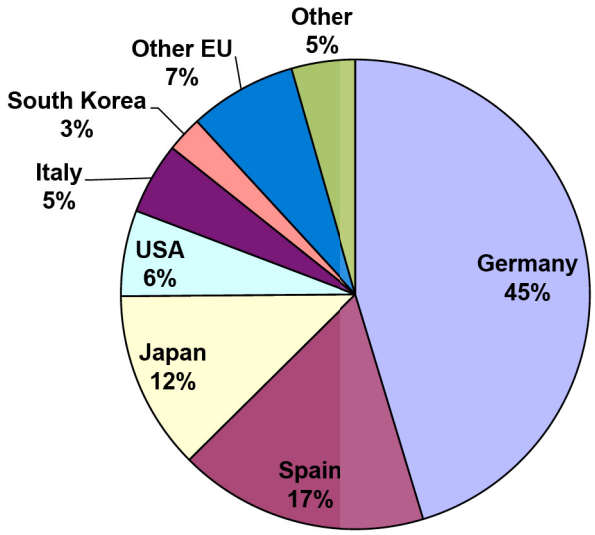


Figure 8. Solar PV, Existing Capacity -- Top Six Countries, 2009



Global Total = 20 GW

Figure 14. Market Shares of Top-Ten Solar PV Manufacturers, 2009

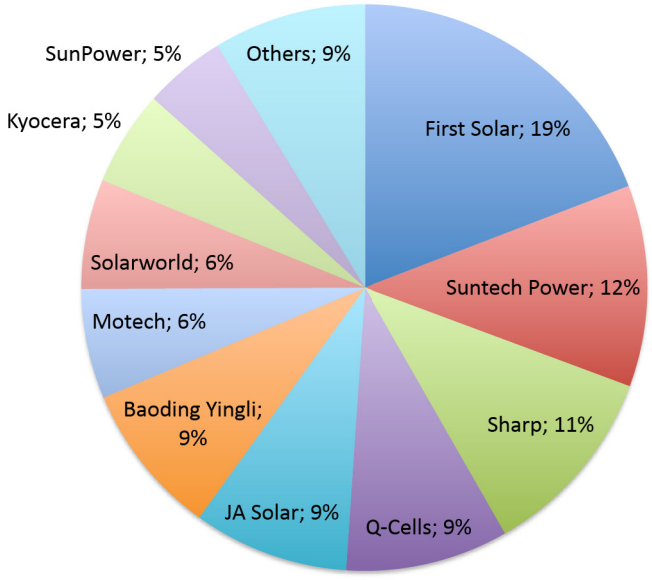
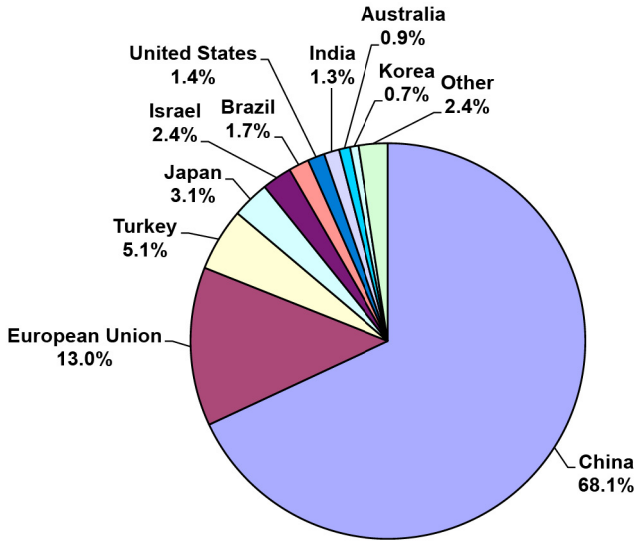
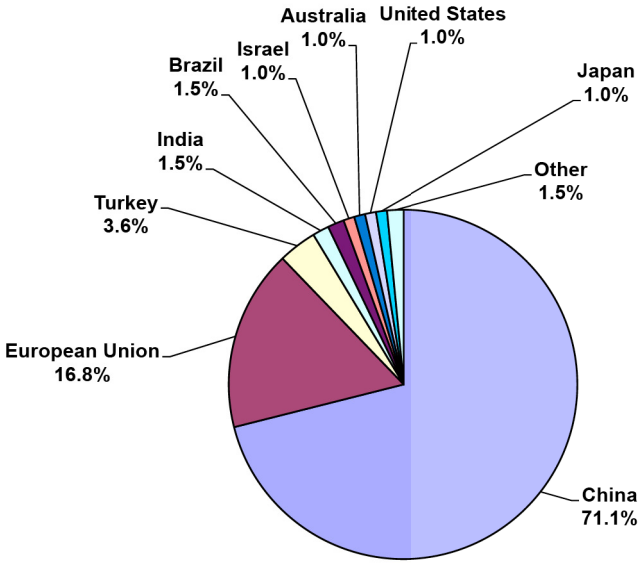


Figure 9. Solar Hot Water/Heating Capacity Existing, Top 10 Countries/Regions, 2008



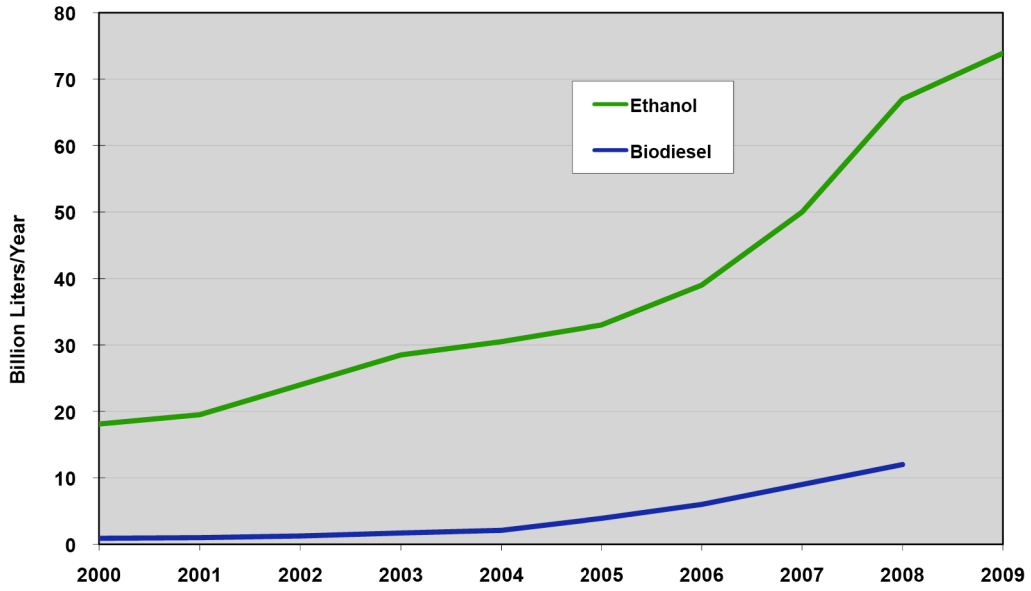
Total = 144 gigawatts-thermal

Figure 10. Solar Hot Water/Heating Capacity Added, Top 10 Countries/Regions, 2008



Total added = 19.7 gigawatts-thermal

Figure 11. Ethanol and Biodiesel Production, 2000–2009



Industry	Estimated jobs worldwide	Selected national estimates
Biofuels	> 1,500,000	
Wind power	400,000	Germany 87,000; United States 85,000; Spain 33,000, Denmark 22,000, India 10,000
Solar hot water	300,000	China 250,000
Solar PV	170,000	Germany 80,000, Spain 26,000, United States 7,000
Biomass power	---	Germany 110,000, United States 66,000, Spain 5,000
Hydropower	---	Europe 20,000, United States 8,000, Spain 7,000
Geothermal	---	Germany 9,000, United States 9,000
Solar thermal power	2,000	Spain 1,000, United States 1,000
Total	> 3,000,000	

Policy Landscape

- 73 countries now have policy targets
- 63 countries with policies to promote renewable power generation
- 45 countries and 18 states/provinces/territories with feed-in tariffs
- 49 countries, states, and provinces with renewable portfolio standards
- 55 countries, states, and provinces with biofuels blending mandates
- 5 million households and businesses worldwide voluntarily purchase green power.

Table 2. Renewable Energy Promotion Policies

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			✓		✓	✓				
France	✓		✓	✓	✓		✓		✓	✓
Germany	✓		✓	✓	✓				✓	
Greece	✓		✓	✓					✓	
Hungary	✓		✓		✓					
Ireland	✓		✓	✓		✓	✓			✓
Italy	✓		✓	✓		✓	✓	✓		
Israel	✓									
Japan	(*)	✓	✓		✓				✓	
Korea	✓		✓							
Latvia	✓		✓	✓					✓	✓
Lithuania	✓		✓	✓						✓
Luxembourg	✓		✓	✓	✓					
Malta	✓		✓	✓						
Netherlands	✓		✓	✓		✓				
New Zealand			✓	✓		✓			✓	
Norway			✓	✓	✓					✓
Poland		✓	✓	✓	✓					✓
Portugal	✓		✓	✓	✓					
Romania			✓		✓					
Russia			✓			✓				
Slovak Republic	✓		✓	✓					✓	
Slovenia	✓		✓	✓					✓	
Spain	✓		✓	✓					✓	
Sweden	✓	✓	✓	✓	✓	✓		✓		
Switzerland	✓	✓	✓		✓					
United Kingdom	✓	✓	✓		✓	✓				
United States	(*)	(*)	✓	✓	✓	✓		(*)	✓	(*)

Table R10. Cumulative Number of Countries/States/Provinces Enacting Feed-in Policies

Year	Cumulative Number	Countries/States/Provinces Added That Year
1978	1	United States
1990	2	Germany
1991	3	Switzerland
1992	4	Italy
1993	6	Denmark, India
1994	8	Spain, Greece
1997	9	Sri Lanka
1998	10	Sweden
1999	13	Portugal, Norway, Slovenia
2000	13	—
2001	15	France, Latvia
2002	21	Algeria, Austria, Brazil, Czech Republic, Indonesia, Lithuania
2003	28	Cyprus, Estonia, Hungary, South Korea, Slovak Republic, Maharashtra (India)
2004	33	Israel, Nicaragua, Prince Edward Island (Canada), Andhra Pradesh and Madhya Pradesh (India)
2005	40	Karnataka, Uttaranchal, and Uttar Pradesh (India); China, Turkey, Ecuador, Ireland
2006	43	Ontario (Canada), Argentina, Thailand
2007	49	South Australia (Australia), Albania, Bulgaria, Croatia, Macedonia, Uganda
2008	61	Queensland (Australia); California (USA); Gujarat, Haryana, Punjab, Rajasthan, Tamil Nadu, and West Bengal (India); Kenya, the Philippines, Poland, Ukraine
2009 (early)	63	Australian Capital Territory (Australia); South Africa

Table R11. Cumulative Number of Countries/States/Provinces Enacting RPS Policies

Year	Cumulative Number	Countries/States/Provinces Added That Year
1983	1	Iowa (USA)
1994	2	Minnesota (USA)
1996	3	Arizona (USA)
1997	6	Maine, Massachusetts, Nevada (USA)
1998	9	Connecticut, Pennsylvania, Wisconsin (USA)
1999	12	New Jersey, Texas (USA); Italy
2000	13	New Mexico (USA)
2001	15	Flanders (Belgium); Australia
2002	18	California (USA); Wallonia (Belgium); United Kingdom
2003	19	Japan; Sweden; Maharashtra (India)
2004	34	Colorado, Hawaii, Maryland, New York, Rhode Island (USA); Nova Scotia, Ontario, Prince Edward Island (Canada); Andhra Pradesh, Karnataka, Madhya Pradesh, Orissa (India); Poland
2005	38	District of Columbia, Delaware, Montana (USA); Gujarat (India)
2006	39	Washington State (USA)
2007	44	Illinois, New Hampshire, North Carolina, Oregon (USA); China
2008	49	Michigan, Missouri, Ohio (USA); Chile; India

Figure 1. Renewable Energy Share of Global Final Energy Consumption, 2008

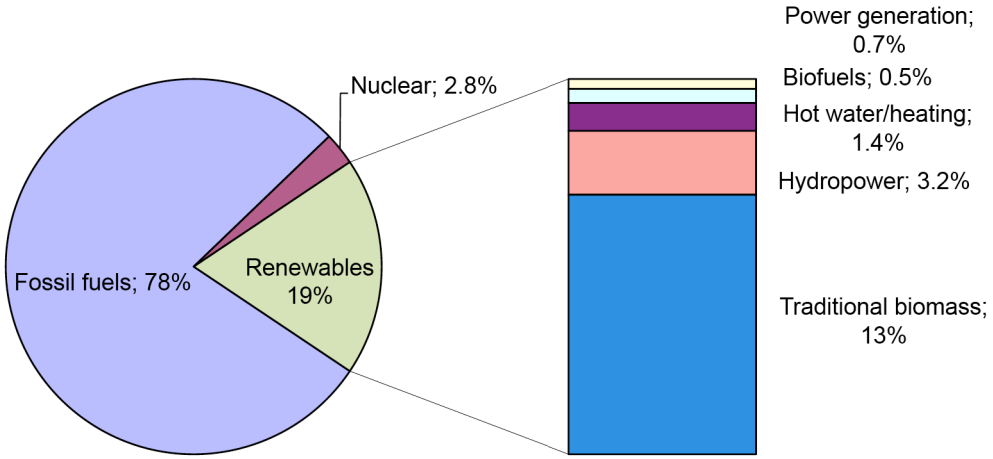


Figure 15. EU Renewable Energy Targets—Share of Final Energy by 2020

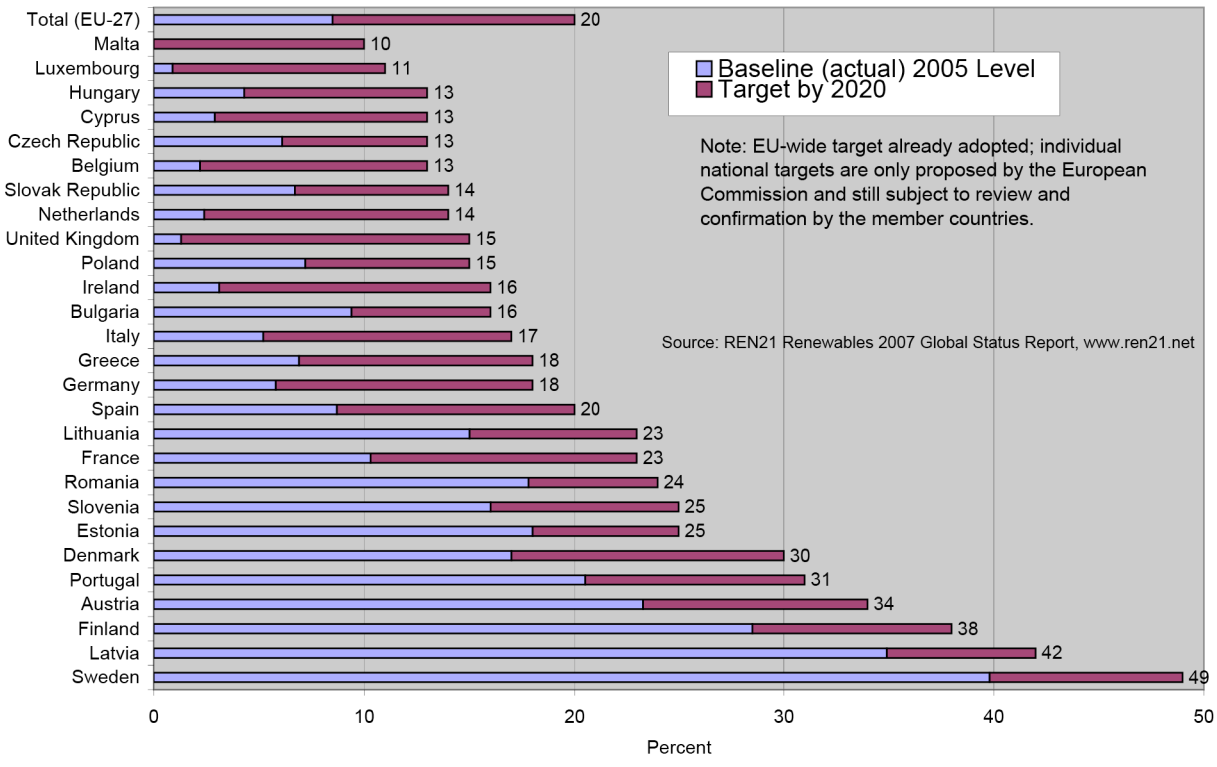


Figure 2. Share of Global Electricity from Renewable Energy, 2008

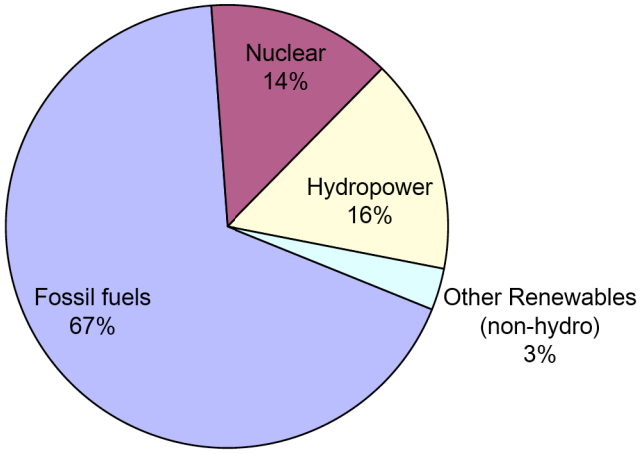


Table R8. Share of Electricity from Renewables, Existing in 2006 and Targets

Country/region	Existing share (2006)	Future target
World	18%	—
EU-25	14%	21% by 2010
Selected EU Countries		
Austria	62%	78% by 2010
Belgium	2.8%	6.0% by 2010
Czech Republic	4.2%	8.0% by 2010
Denmark	26%	29% by 2010
Finland	29%	31.5% by 2010
France	10.9%	21% by 2010
Germany	11.5%	12.5% by 2010
Greece	13%	20.1% by 2010
Hungary	4.4%	3.6% by 2010
Ireland	10%	13.2% by 2010
Italy	16%	25% by 2010
Luxembourg	6.9%	5.7% by 2010
Netherlands	8.2%	9.0% by 2010
Poland	2.6%	7.5% by 2010
Portugal	32%	45% by 2010
Slovak Republic	14%	31% by 2010
Spain	19%	29.4% by 2010
Sweden	49%	60% by 2010
United Kingdom	4.1%	10% by 2010
Other Developed/OECD Countries		
Australia	7.9%	—
Canada	59%	—
Israel	—	5% by 2016
Japan*	0.4%	1.63% by 2014
Korea	1.0%	7% by 2010
Mexico	16%	—
New Zealand	65%	90% by 2025
Switzerland	52%	—
United States	9.2%	—
Developing Countries		
Argentina*	1.3%	8% by 2016
Brazil*	5%	—
China	17%	—
Egypt	15%	20% by 2020
India	4%	—
Malaysia	—	5% by 2005
Morocco	10%	20% by 2012
Nigeria	—	7% by 2025
Pakistan	—	10% by 2015
Thailand	7%	—

The Promise of Local Action for Renewable Energy

City and local governments can play a key role in encouraging renewable energy at the local level as:

- Decision-makers (legislative and taxing authority)
- Planning authorities
- Managers of municipal infrastructure (purchasing power)
- Role models for citizens and businesses
- Facilitators for private activity

The "energy systems of tomorrow" could enable moving towards 100% renewable energy – and many are now calling for this – with distributed generation, demand-side measures, embedded energy storage, smart grids, and electric vehicles. Local governments can be leaders in shepherding and managing these transitions.

Global Status Report on Local Renewable Energy Policies

(Working Draft: September 2009)

Lead Author: Eric Martinot

A Collaborative Report by REN21, ISEP and ICLEI

Table 2: Europe – Selected Local Renewable Energy Policies

	Target setting	Regulation based on legal responsibility and jurisdiction				Operation of muni infrastructure			Voluntary actions and government as role model				Info/ promo
		Urban	Building	Taxes	Other	Purch	Invest	Utility	Demo	Grants	Land	Other	
Barcelona	X	X	X				X					X	X
Berlin	X	X								X	X		X
Bologna	X	X	X										
Bristol	X	X			X	X			X				X
Copenhagen	X												
Cremona							X			X			
Edinburgh	X	X							X				
Frederikshavn	X	X		X								X	X
Freiburg	X					X			X		X		X
Gelsenkirchen		X							X			X	X
Göteborg	X	X							X				
Grenoble	X			X						X			
Hamburg	X	X					X		X			X	X
Languedoc reg		X								X		X	
Lausanne		X					X			X			
Leister	X												
Linz							X					X	
London	X	X	X			X						X	
Madrid	X	X			X	X							X
Malmö	X	X					X						
Milagro												X	
Münster	X				X								
Oslo	X	X					X			X		X	
Oxford	X	X								X			X
Paris	X	X											
Ponferrada			X			X				X			
Rhône-Alpes r.	X											X	
Rome	X						X			X			
Rovigo prov.	X	X					X			X			X
Samsø	X						X					X	
Seville	X												X
Stockholm	X	X				X	X					X	X
The Hague	X	X							X				
Växjö	X	X											X
Walloon region	X						X					X	X
Woking Boro.	X	X	X		X	X			X			X	X
Zaragoza	X	X	X									X	X

Table 5: Japan – Selected Local Renewable Energy Policies

	Target setting	Regulation based on legal responsibility and jurisdiction				Operation of muni infrastructure			Voluntary actions and government as role model				Info/ promo
		Urban	Building	Taxes	Other	Purch	Invest	Utility	Demo	Grants	Land	Other	
Chiba	X									X			
Fukuoka	X												
Hamamatsu	X									X			
Hiroshima	X									X			
Hokuto		X					X			X			X
Iida	X	X				X				X	X	X	X
Kanagawa pr	X	X				X	X			X		X	X
Kawasaki	X	X				X	X			X			X
Kitakyushu	X	X								X			X
Kobe	X	X								X			
Kyotango		X								X			
Kyoto	X	X							X	X		X	X
Matsuyama							X			X			
Nagoya	X	X											
Niigata	X	X											
Osaka	X												
Saitama	X	X											
Sakai	X	X								X			
Sapporo	X	X				X			X	X			X
Sendai	X												
Shizuoka	X												
Tokyo	X	X	X	X	X				X	X	X	X	X
Tsuru		X				X				X		X	
Yokohama	X	X			X		X			X	X	X	X

(Slide 1 of 5) Framework for Local Renewable Energy Policies/Activities

Policy/Activity Category	Descriptions of Policies/Activities by Sub-Category
1. Target setting	(a) CO2 reduction targets
	(b) Future shares/amounts of renewable electricity or energy for all consumers in city
	(c) Future shares/amounts of renewable electricity or energy for government operations and/or buildings
	(d) Future shares or absolute numbers of buildings or homes with renewable energy installations
	(e) Future shares/amounts of biofuels for the government vehicle fleet and/or for public transport
	(f) Other types of targets, for example to become fossil-fuel free or "carbon neutral"

Of the 180 cities and local governments in the report, at least 140 have some type of future target for renewable energy and/or CO2.

Targets for Share of Renewable Energy -- Examples

- Ballarat, Australia: 10% of total energy by 2016
- Beijing, China: 4% of electric power capacity by 2010 and 6% of heating
- Calgary AB, Canada: 30% of total energy by 2036
- Cape Town, South Africa: 10% of total energy by 2020
- Grenoble, France: 21% of total energy (currently 8%)
- Lüchow-Dannenberg district, Germany: 100% of total energy by 2010-2015
- Madrid, Spain: 20% reduction in fossil-fuel use by 2020
- Münster, Germany: 20% of total energy by 2020
- Rajkot, India: 10% reduction in conventional energy by 2013
- Samsø, Denmark: 100% of total energy
- Shanghai, China: 5% of energy (capacity) by 2010
- Stockholm, Sweden: 80% of district heating from renewable sources
- Tokyo, Japan: 20% of total energy by 2020
- Växjö, Sweden: 100% of total energy (fossil-fuel free)

Targets for Installed Capacity of Renewable Energy -- Examples

- Adelaide, Australia: 2 MW of solar PV on residential and commercial buildings
- Barcelona, Spain: 100,000 m2 of solar hot water by 2010
- Kunming, China: 6 million m2 surface area covered by of solar PV and solar hot water, with at least 100 MW solar PV
- Leister, UK: 1000 buildings with solar hot water by 2010
- Los Angeles: 1.3 GW of solar PV by 2020, though a combination of residential and commercial programs and city-owned facilities
- San Francisco: 50 MW of renewables by 2012, including 31 MW of solar PV
- Shanghai: 200-300 MW of wind and 10 MW of solar PV by 2010
- Tokyo: 1 GW of added solar PV by 2010

Targets for Share of Buildings with Renewable Energy -- Examples

- Cape Town, South Africa: 10% of homes with solar hot water by 2010
- Dezhou, China: 50% of buildings with solar hot water by 2010
- Iida City, Japan: 30% of homes with solar PV by 2010
- Kunming, China: 50% of buildings with solar hot water and/or solar PV by 2010; 90% of new construction
- Oxford, UK: 10% of homes with solar hot water and/or solar PV by 2010

(Slide 2 of 5) Framework for Local Renewable Energy Policies/Activities

Policy/Activity Category	Descriptions of Policies/Activities by Sub-Category
2. Regulation based on legal responsibilities and jurisdiction	(a) Urban planning and zoning that encourages and integrates the local generation, distribution and use of renewable sources of power in the local jurisdiction--including planning and zoning for public transportation and electric vehicle infrastructure.
	(b) Building codes and/or permitting that applies to, or incorporates renewable energy in some manner. Examples: mandates for solar hot water and solar PV installations, zero-net-energy homes, shading legislation, and mandated design review/scoping of opportunities and potentials for renewable energy.
	(c) Tax credits and exemptions within tax systems: for example, sales, property and fuel taxes, permitting fees, and carbon taxes.
	(d) Other regulation, including municipal departments mandated to promote or plan for renewable energy, mandates for biofuels use in vehicles or biofuels blending, and mandatory carbon cap-and-trade.

Of the 180 cities and local governments in the report, at least half have some type of urban planning that incorporates renewable energy, and at least 35 have some type of building code or permitting policy

Urban Planning -- Examples

- Adelaide, Australia "Adelaide City Development Plan" calls for green buildings and renewable energy technologies
- Berlin, Germany: "Berlin Energy Action Plan"
- Göteborg, Sweden: "Göteborg 2050" envisions being fossil-fuel-free
- Hamburg, Germany: Wilhelmsburg model urban district w/renewables
- Melbourne, Australia: "Zero Net Emissions by 2020"
- Porto Alegre, Brazil: "Program for Solar Energy in Buildings"
- Shanghai: "Regulations of Renewable Energy Development in Shanghai"
- Tokyo: "Tokyo Renewable Energy Strategy" (2006); "Tokyo Climate Change Action Plan" (2007)
- Toronto ON, Canada: "Sustainable Energy Action Plan"
- Växjö, Sweden: "Fossil Fuel Free Växjö" targets per-capita CO2
- Yokohama, Japan: "Yokohama Energy Vision" targets commercial and public buildings, electric vehicles, solar PV, green power, solar hot water

Building Codes and Permitting -- Examples

- Barcelona, Spain: Mandates 60% of hot water heating energy from solar in all new buildings and major renovations; was subsequently copied by 70 other municipalities throughout Spain
- Lianyangang, China: Requires solar hot water in all new residential buildings up to 12 stories, and in new construction and renovation of hotels and commercial buildings
- Rajkot, India: Requires new residential buildings larger than 150 m2 and hospitals and other public buildings to install solar hot water
- Rio de Janeiro: Requires all public buildings to use solar hot water for 40% of heating energy
- San Francisco: Requires all new buildings over 100,000 ft2 to supply 5% of building energy use from on-site solar
- Tokyo: Requires property developers to assess and consider possibilities for solar hot water and other renewables and report assessments to owners

(Slide 3 of 5) Framework for Local Renewable Energy Policies/Activities

Policy/Activity Category	Descriptions of Policies/Activities by Sub-Category
3. Operation of municipal infrastructure	(a) Local government purchasing (and joint-purchasing with other municipalities or with private sector) to integrate renewable energy into government operations. Includes renewable electricity, biofuels, and bulk purchasing for market transformation programs.
	(b) Local government investment in renewable energy for government buildings, schools, vehicle fleets, and public transport.
	(c) Public utility regulation, including tariff regulation, renewable energy targets, feed-in tariffs, interconnection standards, net metering, and portfolio standards; also designates private utility policies of these types.

Of the 180 cities and local governments in the report, at least half have some type of policy related to municipal infrastructure and operations

Transport Infrastructure and Fuels Mandates, Operation, Investment, and Subsidies -- Examples

- Adelaide, Australia: Operate solar-electric public buses and charge using 100% solar electricity
- Ann Arbor MI, USA: Subsidies for public-access biofuels stations
- Betim, Brazil: Mandates for biofuels in public transport and taxis (plan through 2017); also preference to flex-fuel vehicles for municipal vehicle fleet purchases.
- Calgary AB, Canada: B5 and B20 used in municipal fleet vehicles
- New Castle, Australia: B20 used in public vehicles
- Portland OR, USA: Mandate for biofuels blending B5 and E10 for all diesel and gasoline sold within city limits; biofuels investment fund to enhance production, storage, distribution; biofuels infrastructure grants for conversion of fueling stations; use of biofuels in municipal fleet
- Stockholm, Sweden: Plan to have 50% of all public transit buses run on biogas or ethanol by 2011, and 100% of buses by 2025. Metro and commuter trains run on green electricity. Additional biofuels stations.

Electric Utility Policies -- Examples

- Austin TX, USA: Renewable portfolio standard 30% by 2020
- Boulder CO, USA: Carbon tax on fossil-fuel electricity purchases
- Gainesville FL, USA: Feed-in tariff for solar PV (32 cents/kWh for 20 years)
- Mexico City: Net metering for solar PV
- Minneapolis MN, USA: Renewable portfolio standard 30% by 2020 (for Xcel Energy)
- New York City: Net metering up to 2 MW capacity
- Oakville ON, Canada: Local utility voluntary green power sales
- Sacramento CA, USA: Feed-in tariff for eligible generation starting January 2010 (by SMUD)

(Slide 4 of 5) Framework for Local Renewable Energy Policies/Activities

Policy/Activity Category	Descriptions of Policies/Activities by Sub-Category
4. Voluntary actions and government serving as a role model	(a) Demonstration projects, including participation in national pilot and demonstration projects. Often done with private sector.
	(b) Grants, subsidies, and loans for investments in renewable energy by homeowners or businesses
	(c) Using local government land/property for renewable energy installations (leasing/selling/permitting). Can also include deals that require developer promises for renewables and efficiency.

Of the 180 cities and local governments in the report, at least 50 have subsidies, grants, or loans for end-users to install renewable energy

Subsidies, Grants, and Loans -- Examples

- Adelaide, Australia: Subsidy for solar PV, A$1000/watt for > 1kW
- Alice Springs, Australia Subsidies for solar hot water (35%)
- Aspen CO, USA: Subsidies for solar PV ($1500 for > 2kW)
- Berkeley CA, USA: Loans to households for solar PV, repaid through property tax bills (up to $37,500 per installation)
- Berlin, Germany: Subsidies for solar PV (40%) and solar hot water (30%) on apartment buildings
- Boulder CO, USA: Small loan program ($3000-5000 loans)
- Christchurch, New Zealand: Lower permit costs for solar hot water
- Kawasaki, Japan: Subsidies for solar PV for households (JPY 70,000/kW up to 3.5 kW)
- Porto Alegre, Brazil: Grants for solar hot water in buildings
- Rome, Italy: Subsidies for solar hot water (to 30%), solar PV (to 60%)
- Toronto ON, Canada: Sustainable energy fund low interest loans

Support for Private and Community Initiative -- Examples

- Christchurch, New Zealand: Working with private solar hot water companies to reduce purchase costs
- Moreland, Australia: Established Moreland Energy Foundation to support private and community initiative; also Solar Bulk-Buying Forum
- Milagro, Spain: Citizen-owned 10-MW solar PV power plant, contributing 60% of Navarra's electricity supply (750 citizen-owners)
- Iida City, Japan: Community-directed investment fund for solar PV of $2 million equivalent
- Samsø, Denmark: Citizen-owned wind turbines that provide 100% of community's power needs
- Tokyo, Japan: Facilitates "Green Energy Purchasing Forum" for trading of green electricity and green-heat certificates

(Slide 5 of 5) Framework for Local Renewable Energy Policies/Activities

Policy/Activity Category	Descriptions of Policies/Activities by Sub-Category
5.Information promotion, and raising awareness	Includes public media campaigns and programs; recognition activities and awards; organization of stakeholders; forums and working groups; training programs; enabling access to finance by local stakeholders; enabling stakeholder-owned projects; removing barriers to community participation; energy audits and GIS databases; analysis of renewable energy potentials; information centers; and initiation and support for demonstration projects.

Virtually all cities have some type of activity in this category

Global Scenarios for Renewable Energy

- International Energy Agency “Blue Map” scenario (2008) shows 50% of electricity from renewables by 2050.
- Greenpeace advanced “revolution” scenario (2008): renewables 77% of electricity by 2050.
- Global Wind Energy Council (GWEC) advanced scenario: wind power provides 20-25% of global electricity by 2030, using growth rates much less than current growth.
- Distributed generation (DG), including solar PV, biomass and biogas power, small wind: most scenarios do not envision a large role, but one group of European experts estimated 30% of total electricity in the EU from DG by 2020.
- Distributed solar PV provides 30% of global electricity beyond 2040? Some analysts have constructed scenarios based on radical cost reduction in solar PV technology.

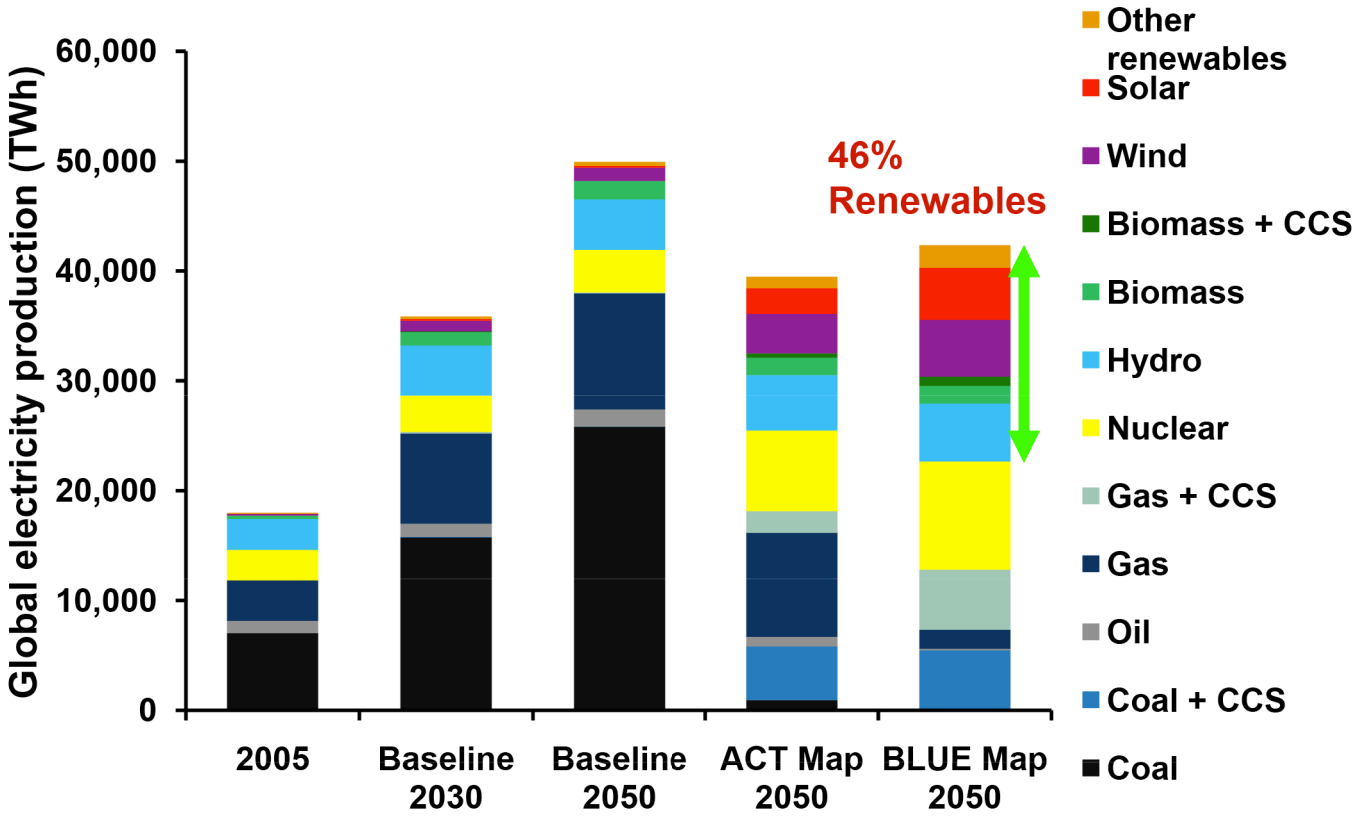
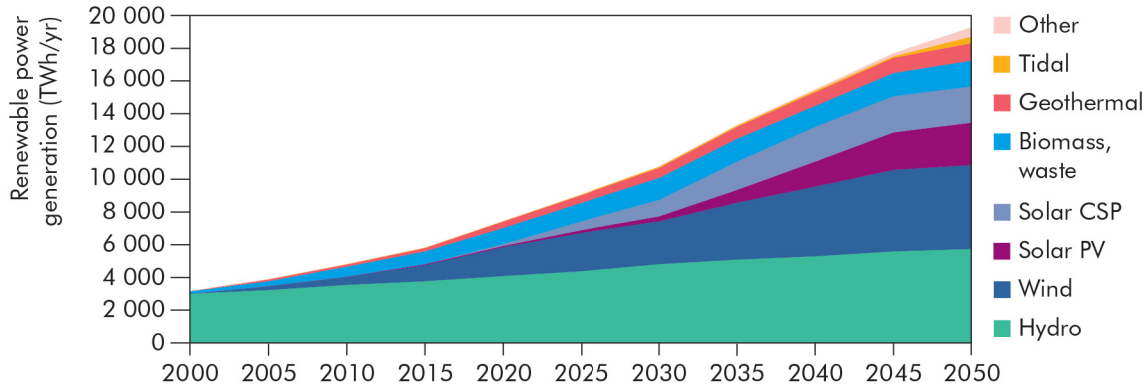


Figure 2.18 ▶ Growth of renewable power generation in the BLUE Map scenario, 2000-2050



Key point

There is a very strong growth of different renewables options in BLUE Map.

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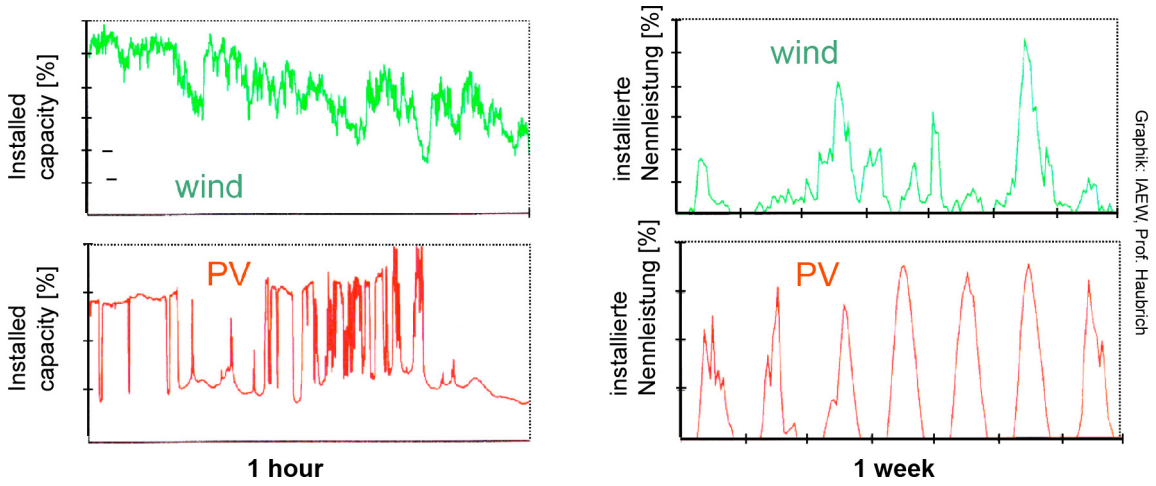
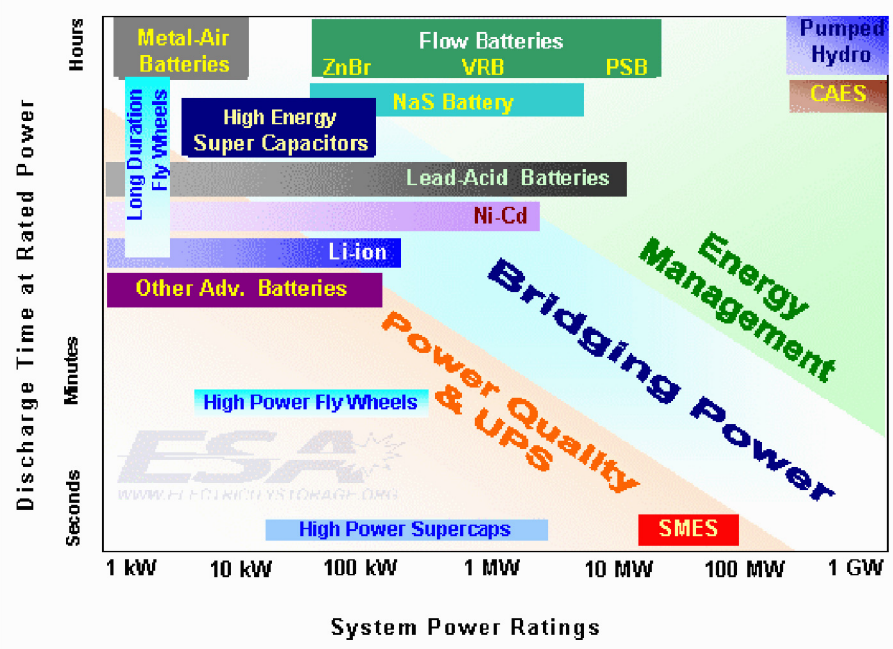
Fluctuating power generation from solar and wind



Technology Capacity Ratings



» These ESA charts are being updated …

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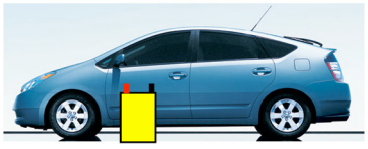
Electrification concepts for passenger cars



Hybrid electric vehicle (HEV)
Storage capacity approx. 1 kWh, charging only during driving, fuel reduction max. 20%

Plug-in Hybrid electric vehicle (PHEV)
Storage capacity 5 – 10 kWh, charging from the grid, 30 to 70 km electrical driving range, full driving range with conventional engine or fuel cell, driving with empty battery possible

Electric vehicle (EV)
Storage capacity 15 – 40 kWh, charging from the grid, 100 to 300 km electrical driving range

Low-Carbon Transport: Electric Vehicles, Energy Storage, "Smart Grids"

A New Paradigm: ***Integration of smart power grid technologies with energy storage technologies and electric vehicles will make renewable energy cheaper and viable at large scales, due to five key trends:***

(1) Emergence of energy storage technologies – still costly, but prices expected to decline with economies of scale and technology improvement. Options include:

- Grid-smoothing stationary storage such as vanadium redox flow batteries, high-temperature sodium batteries, compressed air storage, supercapacitors, flywheels.
- Mobile storage in electric vehicles, primarily lithium batteries now under development but possibly including compressed air or hydrogen/fuel cells.
- Thermal heat storage, for building space heating and hot water and industrial process heat. This includes seasonal storage to store heat during summer for use in winter.
- Renewable-embedded storage -- molten salt reservoirs or compressed air -- allow solar thermal power plants to operate as base load with higher economic value.

(2) The evolution of power systems, from centralized to distributed and from dumb to smart

- "Smart grids" allow electricity customers to be micro-generators and/or provide system balancing and stability. Two-way communication and real-time demand and pricing signals take place between interconnected elements of the power system.
- Electric vehicles supply peak power and soak up ("follow") variable renewable power.

Low-Carbon Transport: Electric Vehicles, Energy Storage, "Smart Grids"

(3) The paradigm-changing concept that "load follows supply" on a power grid (i.e., the loads know about the supply situation and adjust themselves as supply changes).

- Electric vehicles can represent a variable-demand component of the power system that can adjust itself, automatically within pre-established parameters, according to prevailing supply conditions, from variable renewable power. With enough vehicles connected, total demand can shift significantly in response to variable output from even large installations of variable renewables.

(4) The institutional and technical interconnection of the electric power and transport systems, really for the first time in history.

- Never before have the transport and electric power industries had any significant common ground or reason to interact, commercially and institutionally speaking. In the future, there need to be new forms of interaction and new management structures.

(5) Changing institutional and managerial role of (local) power distribution companies.

- Historical role to ensure that customers are served with adequate capacity.
- May become "power managers" who balance distributed generation and variable loads and sources, as well as foster end-use energy efficiency.
- New regulation and business models needed to ensure all this happens efficiently.

Renewable Energy for Japan – Development and Research Priorities

1. Cities and buildings (issues: local planning, building standards, industry development, training/certification, distributed generation)
   - Rooftop solar hot water and heating
   - Rooftop solar power
   - Passive solar architecture (combined with energy efficient buildings)
   - Geothermal heat pumps
   - Small-scale biomass combined-heat-and-power
2. Bulk power generation (issues: grid stability, transmission access, geographic balance and resource variability)
   - Large-scale wind farms
   - Grid-based battery storage (i.e., Vanadium redox flow batteries)
   - Pumped hydropower storage
3. Transportation (issues: integration of electric power and transportation infrastructure, integrated planning)
   - Electric vehicles charged with renewable energy through “smart grids” and vehicle-to-grid (V2G) technologies

Motivations for Renewables

- Energy security / energy autonomy
- Local economic development
- Industrial competitiveness
- Climate change
- Other environmental impacts (i.e., urban air pollution, acid rain, oil spills, habitat destruction from oil and gas drilling, land degradation from coal mining, waterway thermal pollution)