

Renewable Energy: Global Status and Impact, NGOs as Market Facilitators, and Municipal Policies

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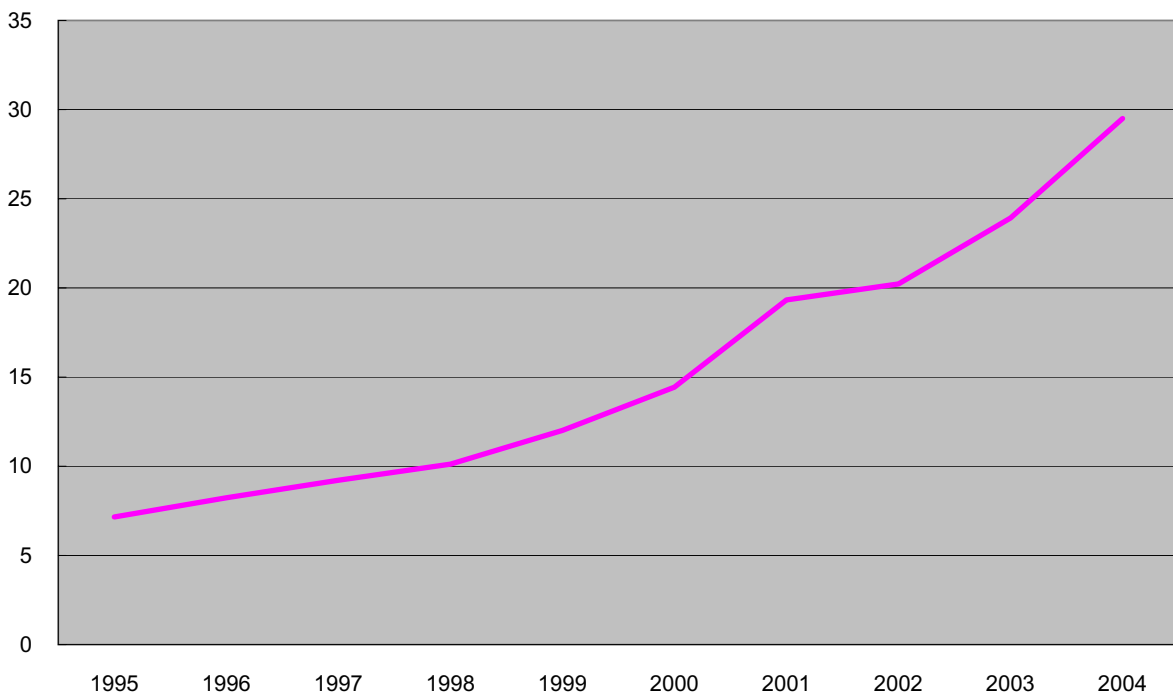
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图10: 1995-2004年可再生能源年投资量 (10亿美元)

Figure 10: Annual Investment in Renewable Energy, 1995-2004 (billion dollars)



Displacement of Conventional Energy by Renewables

- Renewable energy supplies 17 percent of the world's primary energy, including 9% traditional biomass, 6% large hydropower, and 2% new renewables.
- Renewable power capacity totals 160 GW worldwide (excluding large hydropower). This is 4% of total global power capacity (3,800 GW).
- Developing countries account for 44% of power capacity, with 70 GW.
- There are more than 4.5 million green power consumers in Europe, US, Canada, Australia, and Japan
- Renewable energy generates as much power annually as one-fifth of the world's nuclear power plants.
- There are 40 million households worldwide using solar hot water, and even more heating supply comes from biomass fuels and geothermal.

Displacement of Conventional Energy by Renewables

- Renewable energy provides electric power, heat, motive power, and water pumping for tens of millions of people in rural areas of developing countries.
- 16 million rural households cook and light their homes with biogas, and 2 million households use solar lighting systems.
- CO₂ reduction from renewable energy is estimated at over 0.9 billion tons CO₂ per year (plus 3.7 billion tons CO₂/year from large hydropower).
- If the "Bonn Action Programme" adopted last year at the Renewables 2004 conference is fully implemented, it will displace another 1.2 billion tons CO₂/year by 2015.
- There are over 1.7 million jobs in the renewable energy industry worldwide.

图5: 2004年可再生能源容量 (GW) , 发展中国家, 欧盟和前5名国家 (不含大水电)

Figure 5: Renewable Power Capacities in 2004 (GW) for Developing Countries, EU, and Top Five Individual Countries (excluding large hydropower)

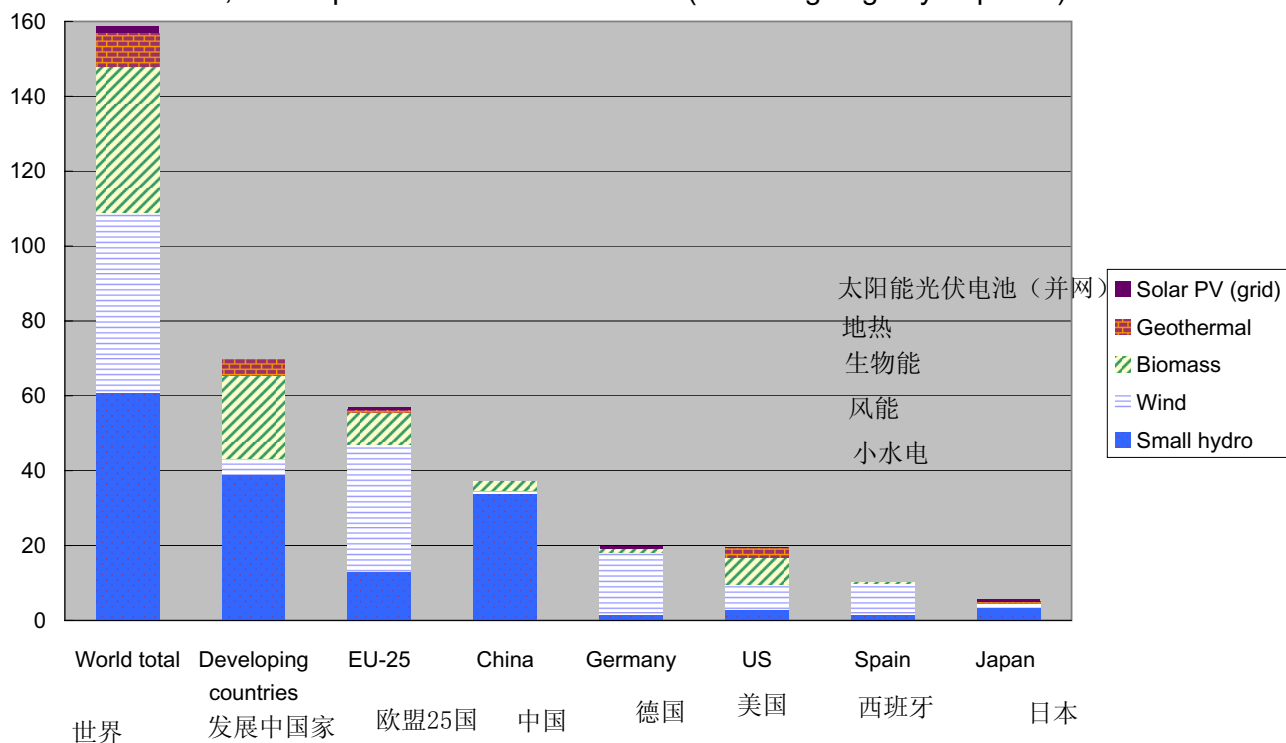


图3 : 世界太阳能光伏电池容量 , 1990-2004 (MW)

Figure 3: Solar PV, Existing World Capacity, 1990-2004 (MW)

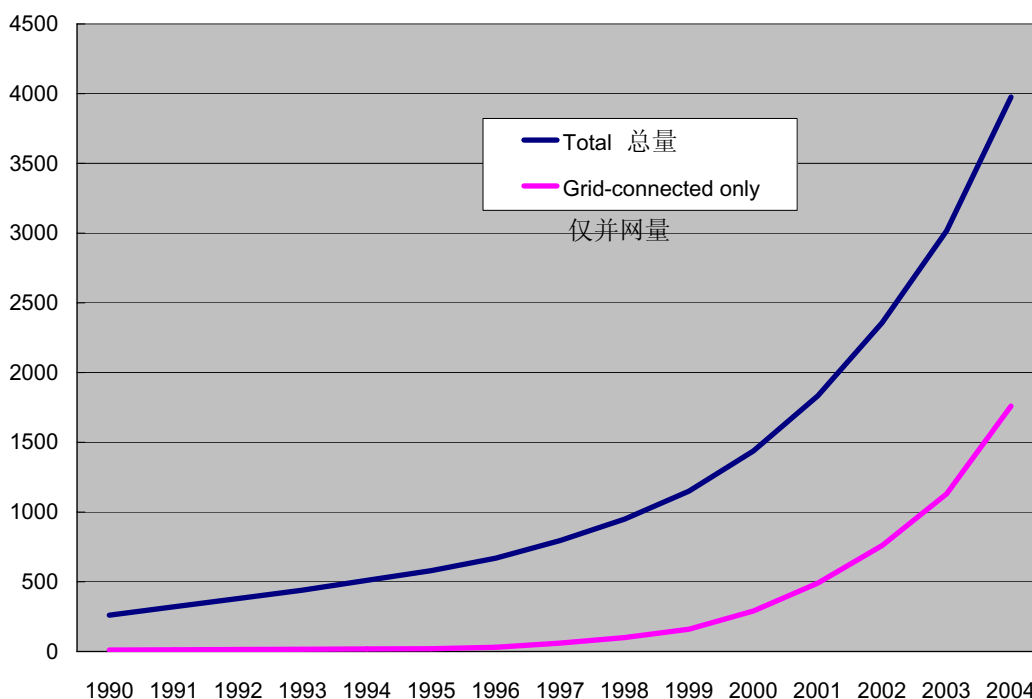


图2：可再生能源总量平均年增长率，2000-2004

Figure 2: Average Annual Growth Rates of Renewable Energy Capacity, 2000-2004

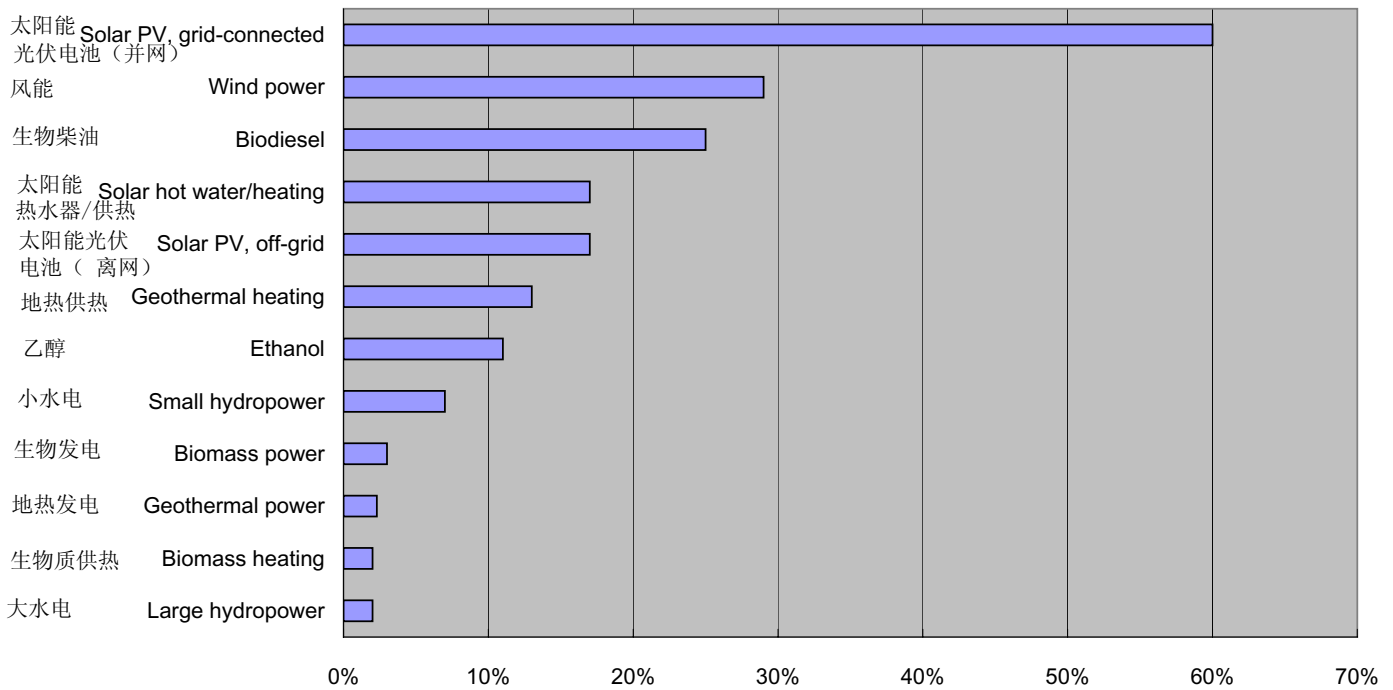


图7：2004年太阳能热水器/供热容量（总容量=77GWth）

Figure 7: Solar Hot Water/Heating Capacity Existing in 2004

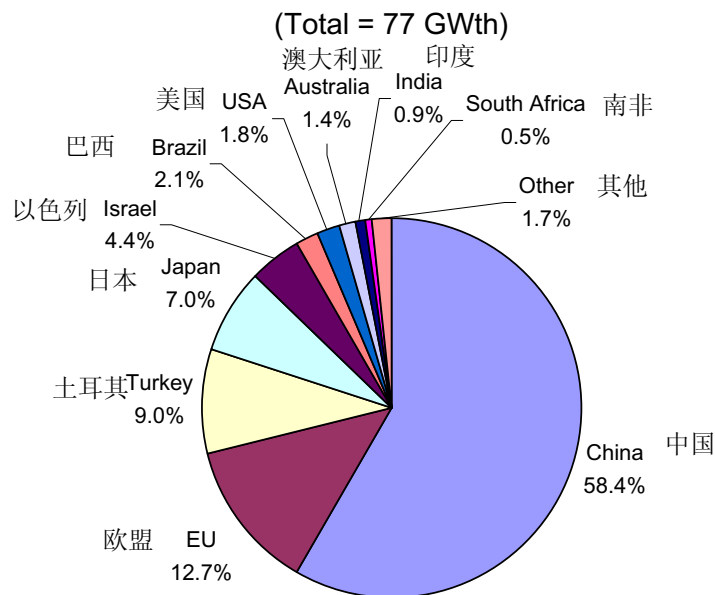


图9：2000年和2004年燃料乙醇生产量（10亿升/年）

Figure 9: Fuel Ethanol Production, 2000 and 2004 (billion liters/year)

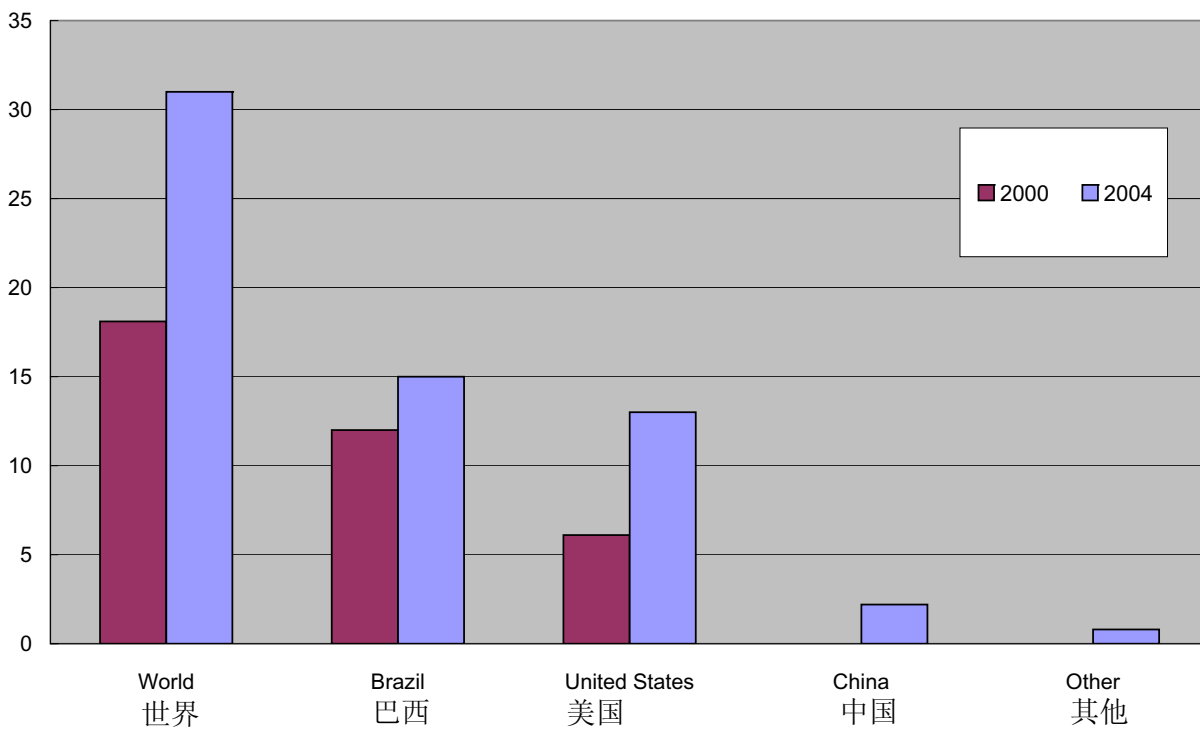


Table 8: Common Existing Applications of Renewable Energy in Rural (Off-Grid) Areas

Energy services	Renewable energy applications	Conventional alternatives
Cooking (homes, commercial stoves and ovens)	<ul style="list-style-type: none"> • biomass direct combustion (fuel wood, crop wastes, forest wastes, dung, charcoal, and other forms) • biogas from household-scale digester • solar cookers 	LPG, kerosene
Lighting and other small electric needs (homes, schools, street lighting, telecomm, hand tools, vaccine storage)	<ul style="list-style-type: none"> • hydropower (pico-scale, micro-scale, small-scale) • biogas from household-scale digester • small-scale biomass gasifier with gas engine • village-scale mini-grids and solar/wind hybrid systems • solar home systems 	Candles, kerosene, batteries, central battery recharging, diesel generators
Process motive power (small industry)	<ul style="list-style-type: none"> • small hydro with electric motor • biomass power generation and electric motor • biomass gasification with gas engine 	Diesel generators
Water pumping (agriculture & drinking)	<ul style="list-style-type: none"> • mechanical wind pumps • solar PV pumps 	Diesel pumps
Heating and cooling (crop drying and other agricultural processing, hot water)	<ul style="list-style-type: none"> • biomass direct combustion • biogas from small- and medium-scale digesters • solar crop dryers • solar water heaters • ice making for food preservation 	LPG, kerosene, diesel generators

Impacts of Fossil Fuels on Global Environment

Insult	Flow from all human activity (tons/year)	Share of flow from fossil fuels
Oil added to oceans	2,000,000	44%
Lead emissions to atmosphere	200,000	41%
Cadmium emissions to atmosphere	8,000	13%
Mercury emissions to atmosphere	3,500	20%
Sulfur emissions to atmosphere	84,000,000	85%
Nitrous Oxide emissions to atmosphere	16,000,000	12%
Carbon dioxide flows to atmosphere	28,000,000,000	75%

Source: *World Energy Assessment*, UNDP/UNDESA/WEC, 2004

Environmental Impacts of Energy

	Air pollution	Climate change	Land use	Water impact	Radiation
Coal	Very high	Very high	High	Low to high	Low
Oil	High	High	Moderate	Moderate	None
Natural gas	Moderate	Moderate	Low	Low	None
Nuclear	None	Very low	Very low	High	Potentially very high
Hydroelectric	None	Low	High	High	None
Biomass	Low to high	Low to high	Low to high	High	None
Wind	None	Low	High	None	None
Photovoltaic	None	Low	Very high	None	None
Geothermal	None	Low	Low	None	None

Source: adapted from Adam Serchuk, "The Environmental Imperative for Renewable Energy", Renewable Energy Policy Project, 2000

External Costs

Research results on socio-environmental damages due to electricity and transport



STUDY

EUR 20198

EXTERNAL COSTS OF ENERGY AND TRANSPORT:
IMPACT PATHWAYS OF HEALTH AND ENVIRONMENTAL EFFECTS INCLUDED IN THE ANALYSIS

Impact Category	Pollutant / Burden	Effects
Human Health – mortality	PM ₁₀ ^a , SO ₂	Reduction in life expectancy
	NOx, O ₃	
	Benzene, Benzo-[a]-pyrene, 1,3-butadiene, Diesel particles	Cancers
	Noise	Loss of amenity, impact on health
	Accident risk	Fatality risk from traffic and workplace accidents
Human Health – morbidity	PM ₁₀ ^a , O ₃ , SO ₂	Respiratory hospital admissions
	PM ₁₀ ^a , O ₃	Restricted activity days
	PM ₁₀ ^a , CO	Congestive heart failure
	Benzene, Benzo-[a]-pyrene, 1,3-butadiene, Diesel particles	Cancer risk (non-fatal)
	PM ₁₀	Cerebro-vascular hospital admissions
		Cases of chronic bronchitis
		Cases of chronic cough in children
		Cough in asthmatics
		Lower respiratory symptoms
	O ₃	Asthma attacks
	Symptom days	
Noise		Myocardial infarction
		Angina pectoris
		Hypertension
		Sleep disturbance
	Accident risk	Risk of injuries from traffic and workplace accidents
Building Material	SO ₂	Ageing of galvanised steel, limestone, mortar, sand-stone, paint, rendering, and zinc for utilitarian buildings
	Acid deposition, Combustion particles	Soiling of buildings
Crops	NO _x , SO ₂	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O ₃ , Acid deposition	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed Increased need for liming
Global Warming	CO ₂ , CH ₄ , N ₂ O, N, S	World-wide effects on mortality, morbidity, coastal impacts, agriculture, energy demand, and economic impacts due to temperature change and sea level rise
Amenity losses	Noise	Amenity losses due to noise exposure
Ecosystems	Acid deposition, nitrogen deposition	Acidity and eutrophication (avoidance costs for reducing areas where critical loads are exceeded)

^a particles with an aerodynamic diameter < 10 µm, including secondary particles (sulphate and nitrate aerosols)

D

EXTERNAL COST FIGURES FOR ELECTRICITY PRODUCTION IN THE EU FOR EXISTING TECHNOLOGIES¹
(IN € CENT PER KWH*)

Country	Coal & lignite	Peat	Oil	Gas	Nuclear	Biomass	Hydro	PV	Wind
AT				1-3		2-3	0.1		
BE	4-15			1-2	0.5				
DE	3-6		5-8	1-2	0.2	3		0.6	0.05
DK	4-7			2-3		1			0.1
ES	5-8			1-2		3-5**			0.2
FI	2-4	2-5				1			
FR	7-10		8-11	2-4	0.3	1	1		
GR	5-8		3-5	1		0-0.8	1		0.25
IE	6-8	3-4							
IT			3-6	2-3			0.3		
NL	3-4			1-2	0.7	0.5			
NO				1-2		0.2	0.2		0-0.25
PT	4-7			1-2		1-2	0.03		
SE	2-4					0.3	0-0.7		
UK	4-7		3-5	1-2	0.25	1			0.15

* sub-total of quantifiable externalities (such as global warming, public health, occupational health, material damage)

** biomass co-fired with lignites

QUANTIFIED MARGINAL EXTERNAL COSTS OF ELECTRICITY PRODUCTION IN GERMANY²
(IN € CENT PER KWH)

	Coal	Lignite	Gas	Nuclear	PV	Wind	Hydro
Damage costs							
Noise	0	0	0	0	0	0.005	0
Health	0.73	0.99	0.34	0.17	0.45	0.072	0.051
Material	0.015	0.020	0.007	0.002	0.012	0.002	0.001
Crops	0	0	0	0.0008	0	0.0007	0.0002
Total	0.75	1.01	0.35	0.17	0.46	0.08	0.05
Avoidance costs							
Ecosystems	0.20	0.78	0.04	0.05	0.04	0.04	0.03
Global Warming	1.60	2.00	0.73	0.03	0.33	0.04	0.03

Power Generation Costs (US cents/kWh)

Renewables still more expensive but wind becoming competitive

	Low range	High range
Coal	2-4	---
Gas turbine	3-4	---
Nuclear	5-7	7-12
Small hydro	2-3	9-15
Solar PV	18-20	25-80
Concentrating solar thermal	10-15	20-25
Biomass	2-3	10-15
Geothermal	2-5	6-12
Wind	3-5	10-12

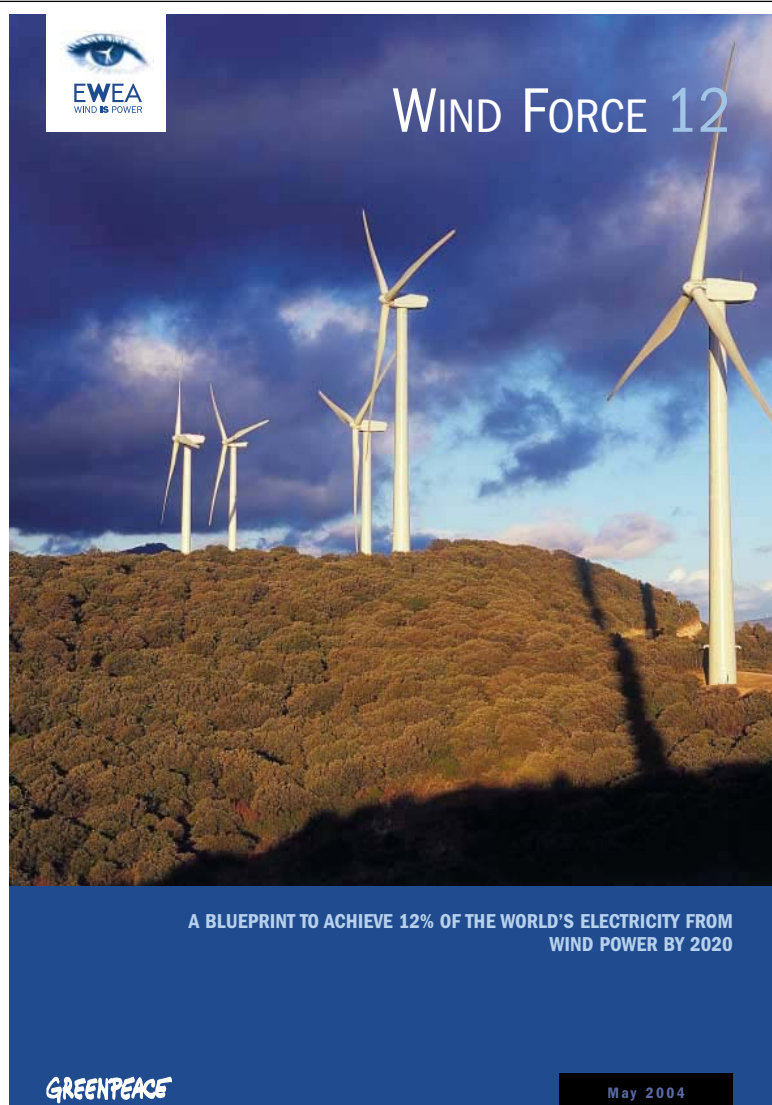
Sources: International Energy Agency, *Renewables for Power Generation*, 2003; ICCEPT 2002

Traditional Cost Comparisons Are Not Fair

Renewables more competitive considering external costs and subsidies

- External costs can include damages to human health, agriculture, fisheries, ecosystems, and infrastructure. Costs of climate change are potentially infinite.
- EU estimates external cost of coal and oil power generation at 3-11 cents/kWh
- Energy subsidies to fossil fuels worldwide are \$150 billion per year
- Energy subsidies to nuclear power in OECD countries are \$16 billion per year

B



Primary Energy Consumption: "Factor 4"- compared to WEC-Scenarios

