COP 15

Copenhagen/Denmark

15th December 2009

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[r]evolution

A SUSTAINABLE GLOBAL ENERGY OUTLOOK

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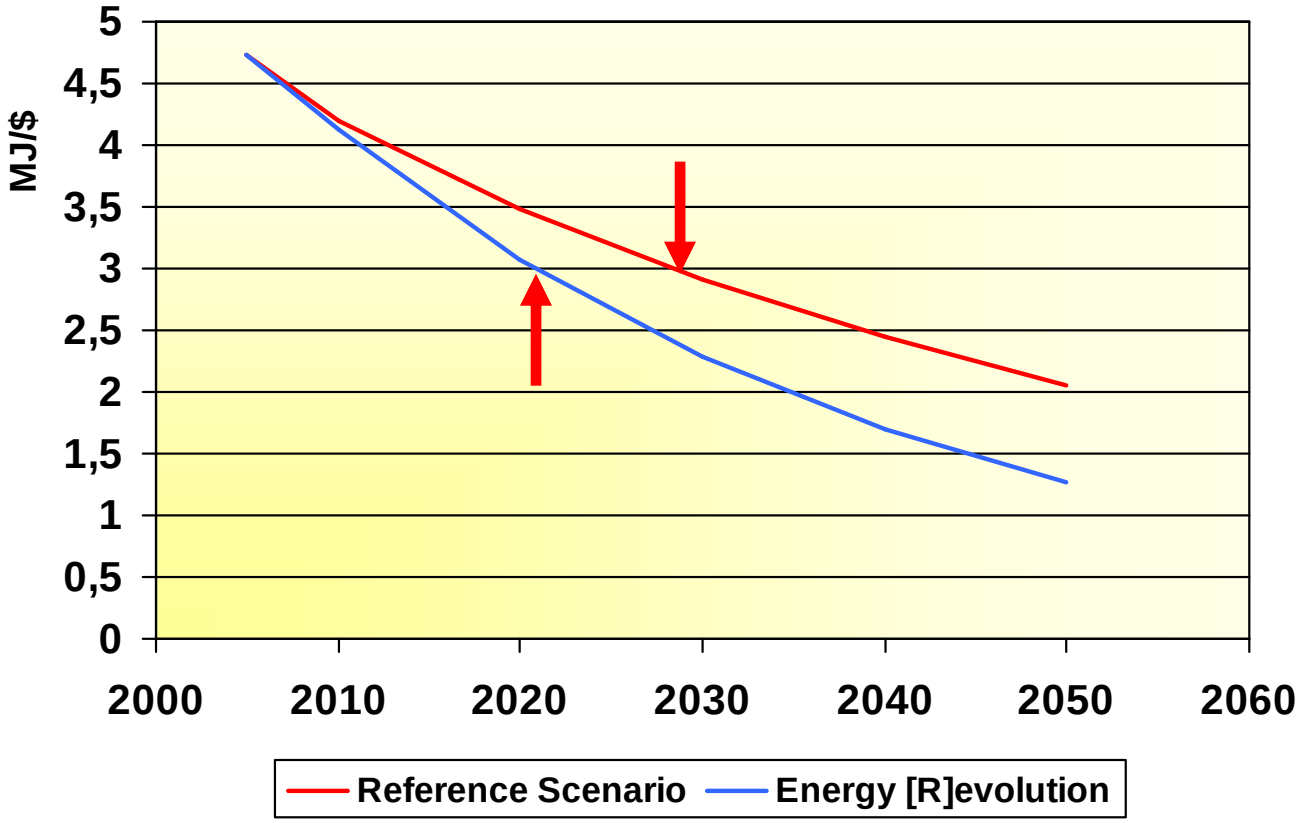
Key driver for growing energy demand

C) Global Energy intensity: technical potential for energy efficiency largely exploited



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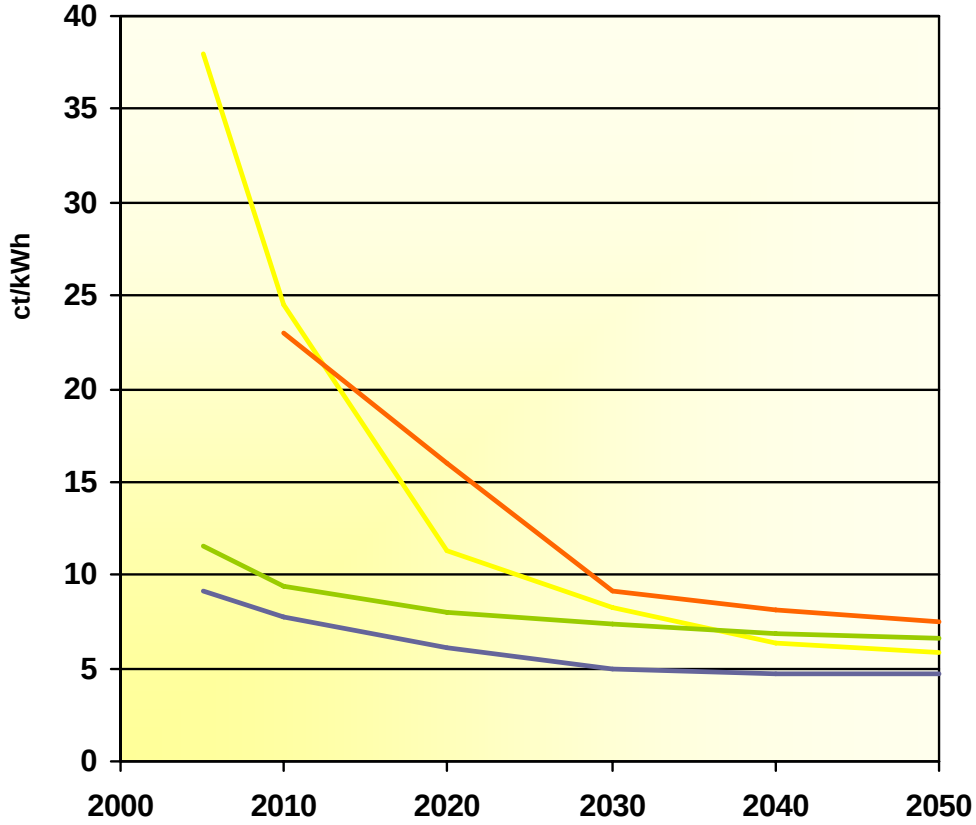
Cost development of renewable electricity generation



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Fossil Fuels costs (Imports)

	2005	2010	2020	2030	2040	2050
Oil ($$_{2005}$$/barrel)	52,5	100	110	120	130	140
Natural Gas ($$_{2005}$$/GJ)	5,8	10	13,3	17,2	20,6	23
Coal ($$_{2005}$$/t)	76,8	143	194	251	311	359

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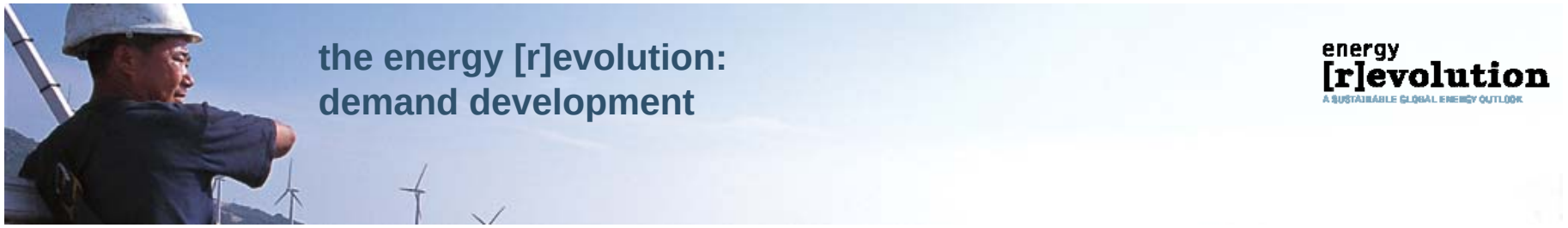

the energy [r]evolution: demand development

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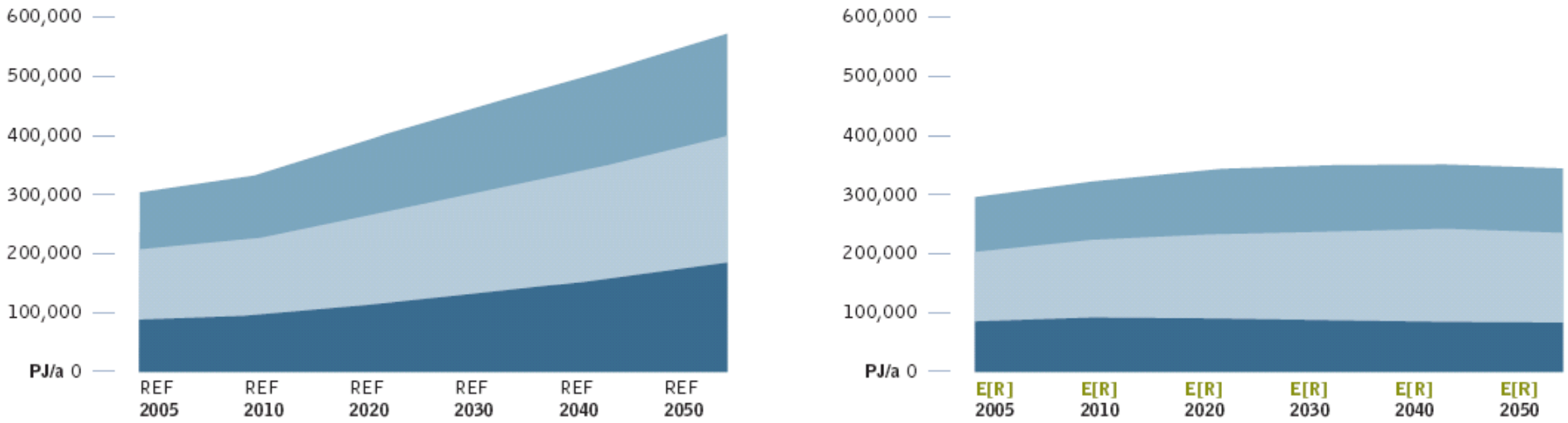
The Energy [R]evolution scenario saves 91 Exa-Joule by 2020 – compared to the Reference Scenario – this is equal to Europe's current total energy demand.

Most important mesasures:

- Building insulation
- Strict efficiency standards for all electrical applications
- Strict efficiency standards for all vehicles,

figure 6.4: global: projection of final energy demand by sector for the two scenarios



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the energy [r]evolution: shift towards renewables

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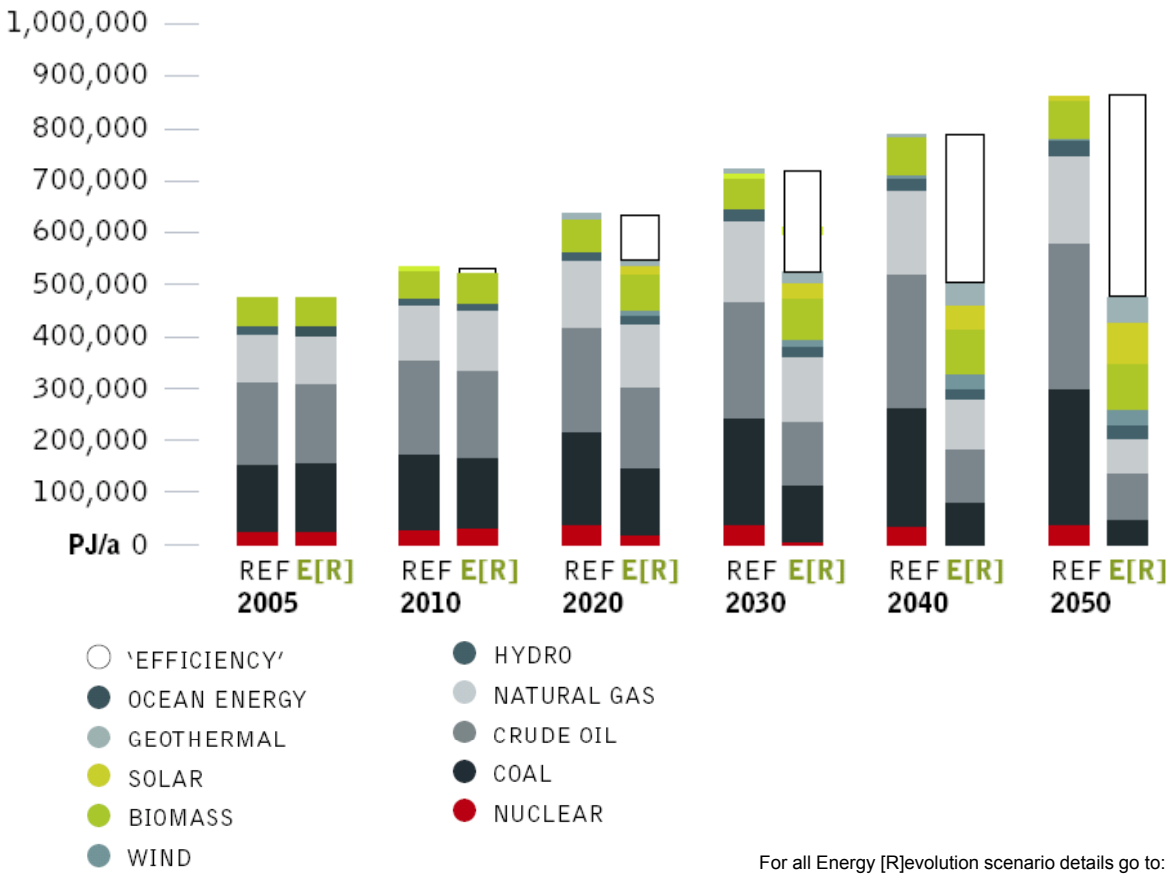
Renewable energy shares:

	Primary energy	Final energy
today:	12.9 %	16.4%
2020:	21.0 %	24.4%
2030:	30.9%	33.8%
2050:	56.1%	56.8%

figure 6.13: global: development of primary energy consumption under the two scenarios

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)



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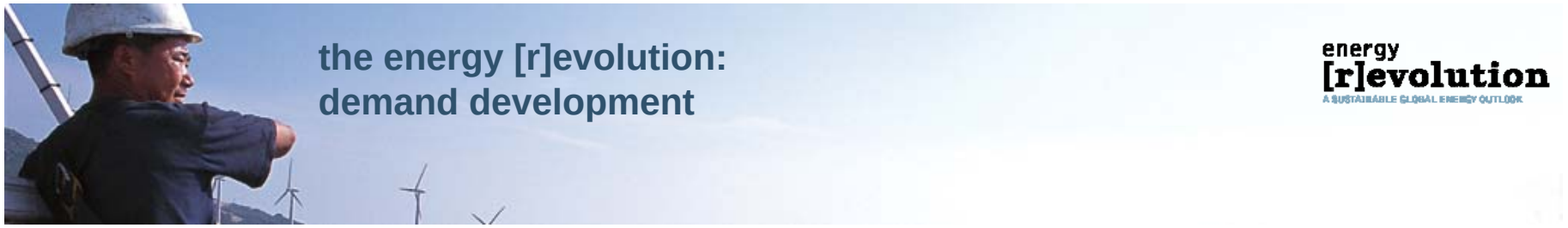

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The heating sector:

- Heating/Cooling Demand: -8500 PJ/a by 2020 -46,000 PJ/a by 2050
- Production: 2005: 24% RE, 2020: 34% RE 2050: 71% RE

figure 6.6: global: development of heat demand by sector

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)

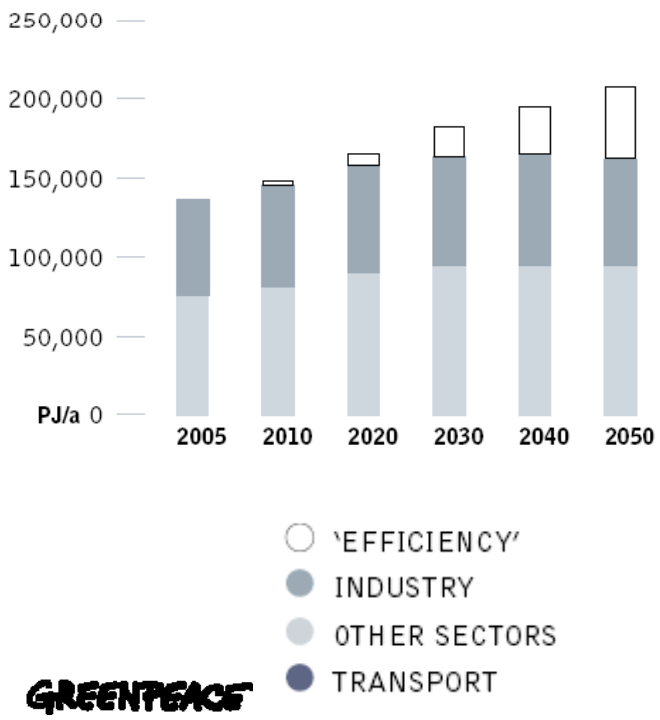
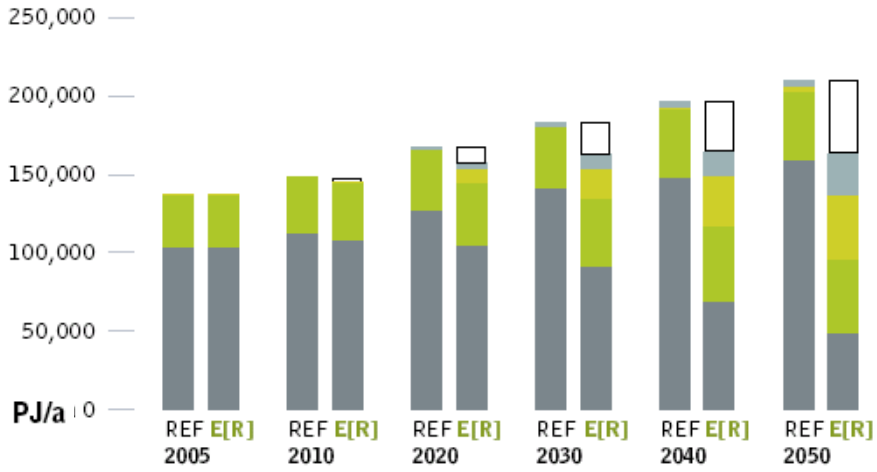


figure 6.11: global: development of heat supply structure under the two scenarios

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)



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the energy [r]evolution: Power Sector

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Power Sector

- Demand: - 2,580 TWh by 2020 and – 12,145 TWh by 2050
- Generation: 2005: 18% RE 2020: 33% RE 2050: 77% RE

figure 6.5: global: development of electricity demand by sector

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO; OTHER SECTORS = SERVICES, HOUSEHOLDS)

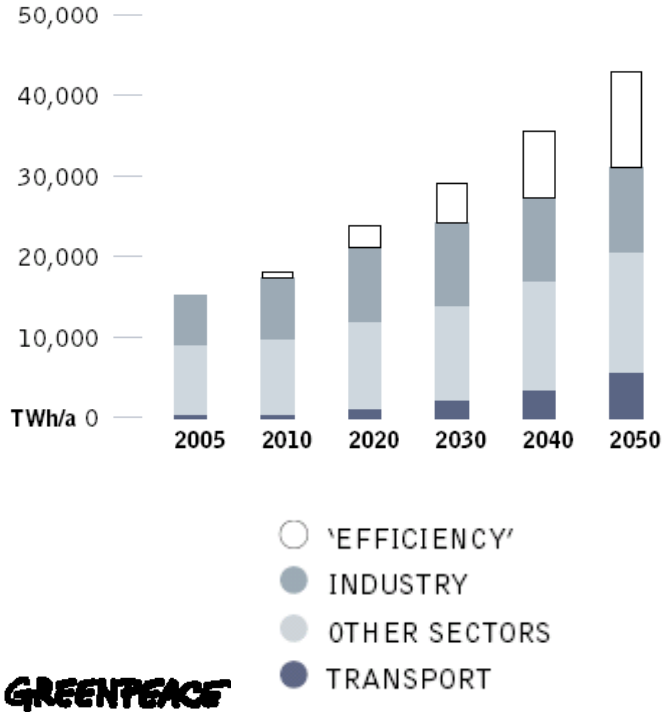

figure 6.7: global: development of electricity supply structure under the two scenarios

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)

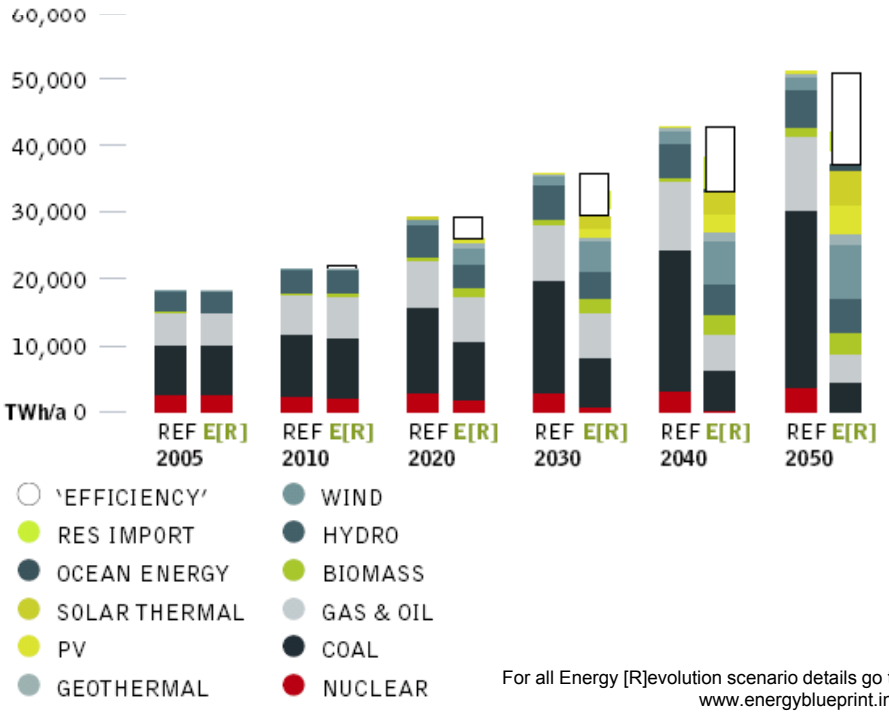

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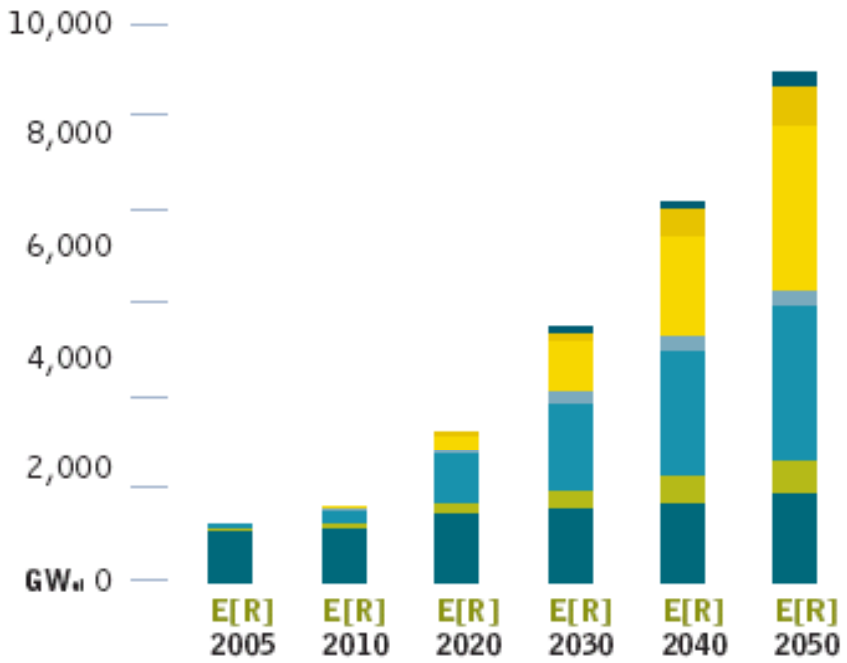
figure 6.8: global: growth of renewable electricity generation under the energy [r]evolution scenario

BY INDIVIDUAL SOURCE



Global RE capacities quadruples by 2050

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figure 33: wind speed in the north sea during august 2003 (extreme summer event).

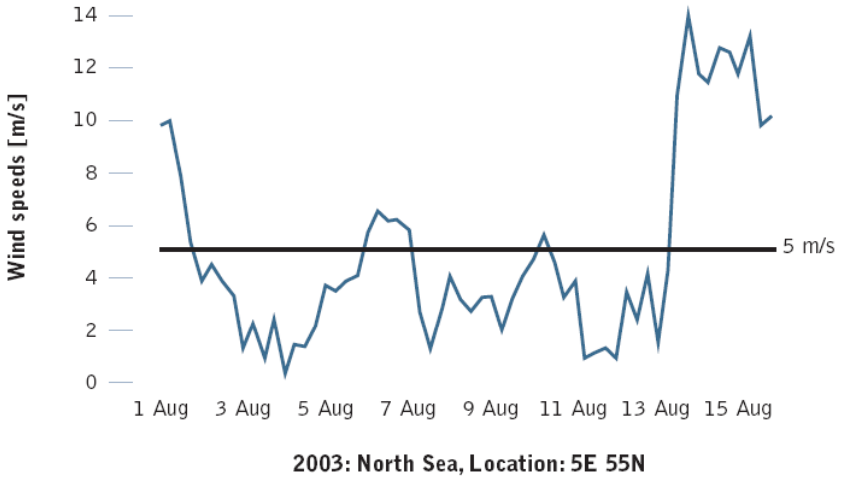
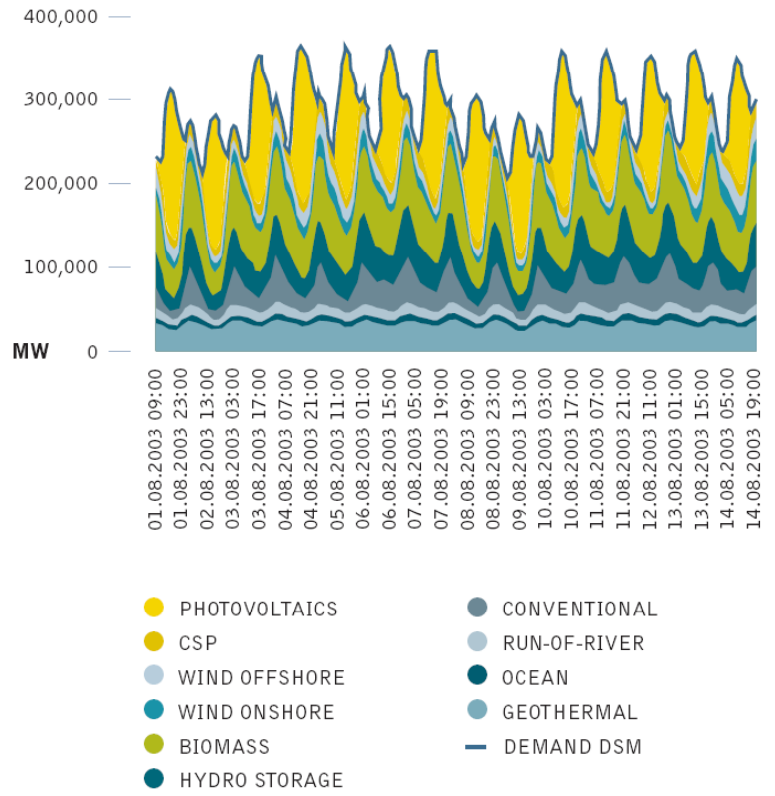


figure 36a: power production (in MW) from different sources and overall demand in europe during extreme august event.



August 2003:
2 weeks no wind within the North Sea area

No problem as solar photovoltaic
could have supplied the needed power

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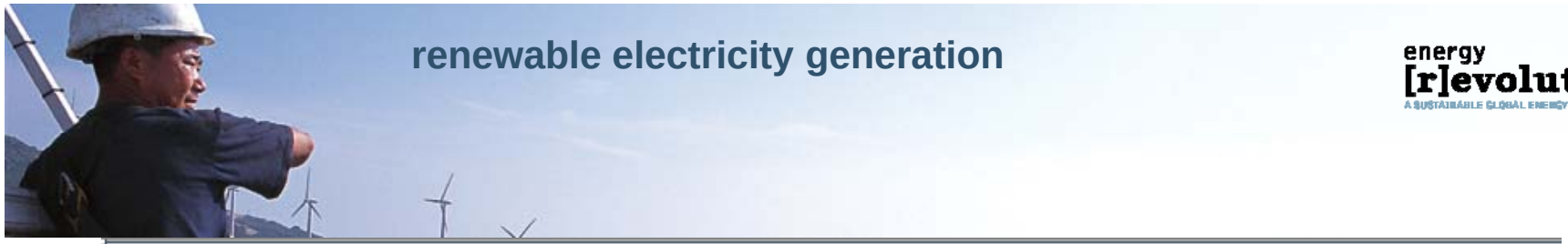

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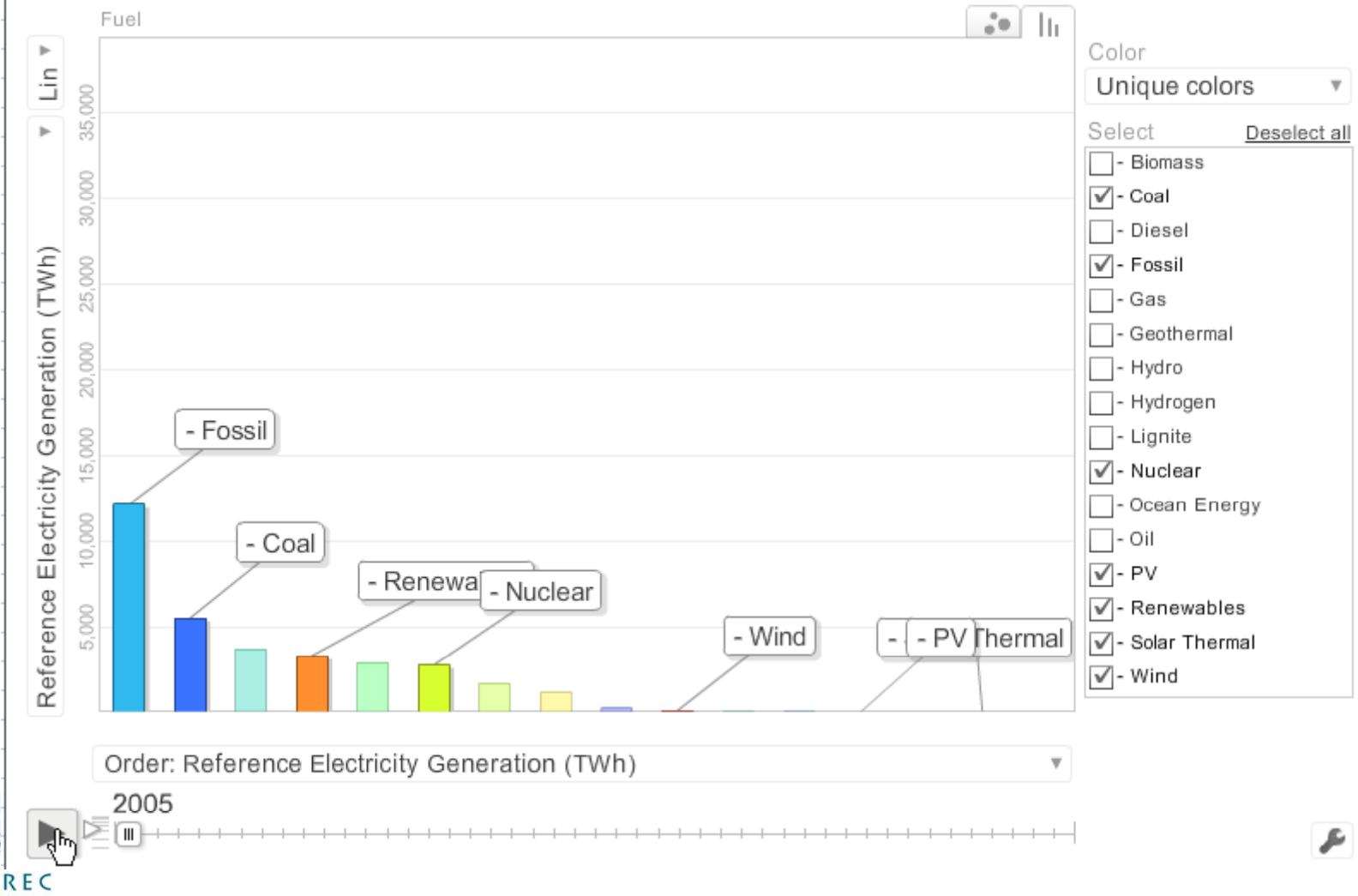

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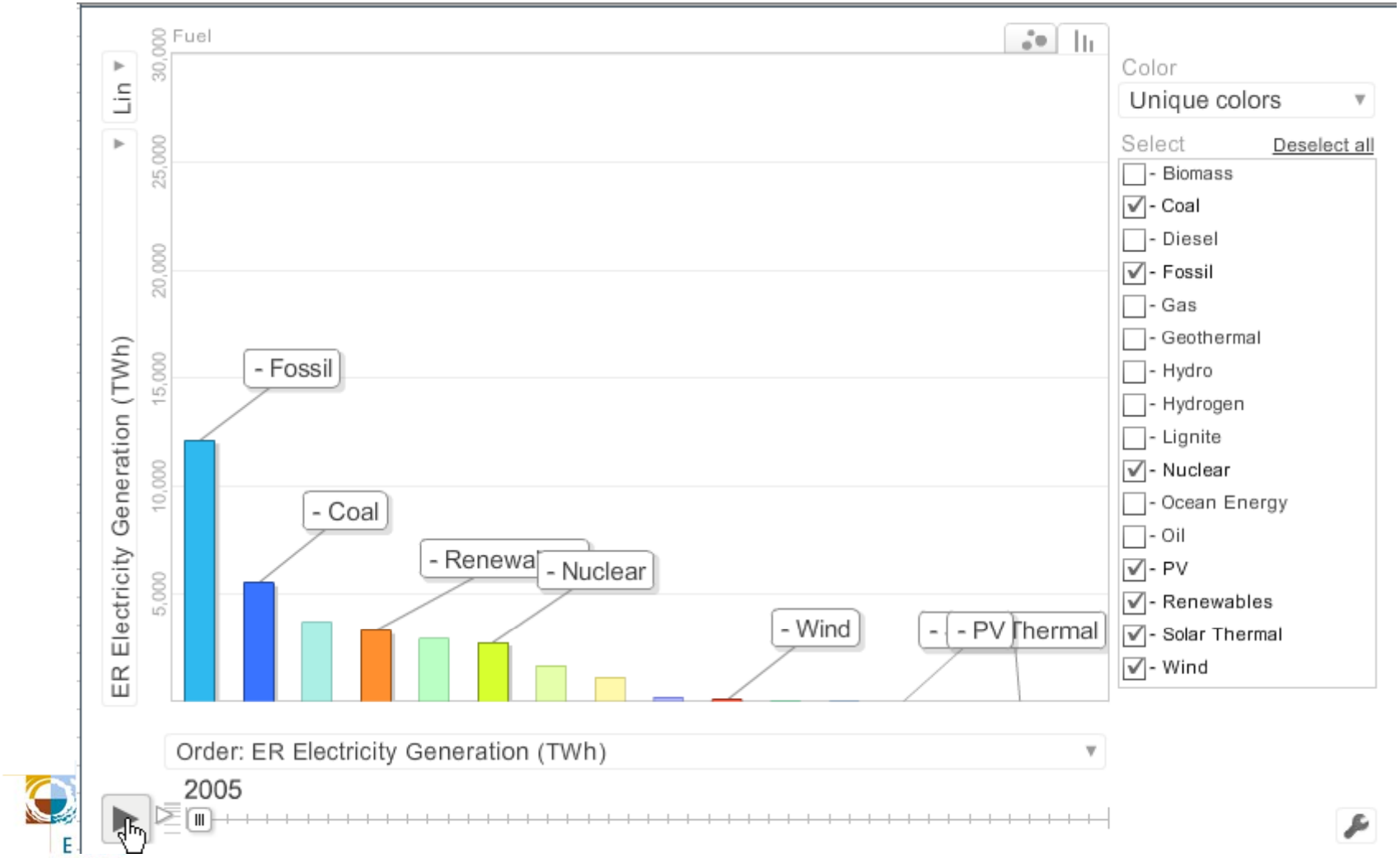

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keeping energy affordable

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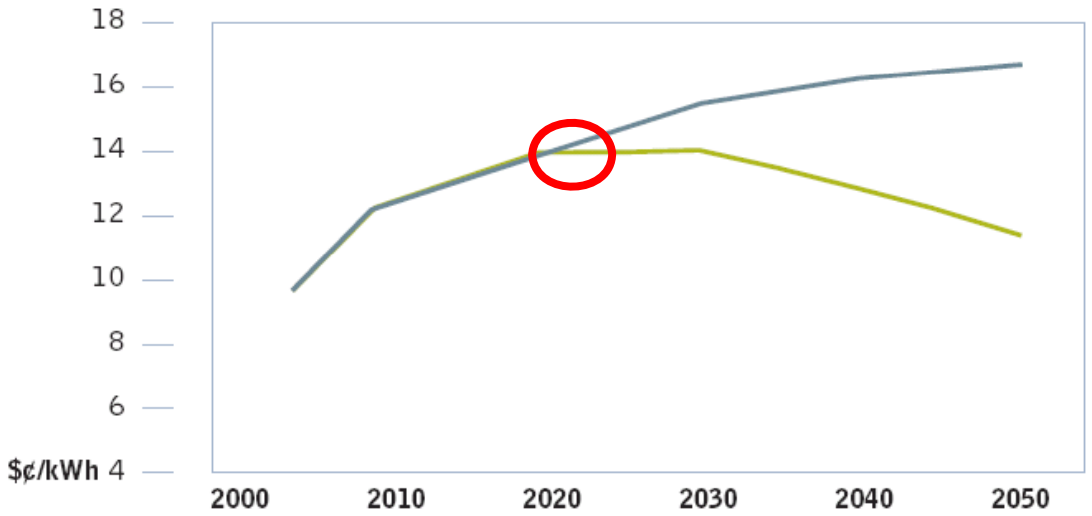
Power generation costs:

- Reference in 2050: US$ 7,3 Billion
- Energy [R]evolution in 2050: US$ 4 Billion
- Break even: around 2015 - 2020

figure 6.9: global: development of specific electricity generation costs under the two scenarios

(CO_2 EMISSION COSTS IMPOSED FROM 2010,
WITH AN INCREASE FROM 15 $/$T_{CO_2}$ IN 2010 TO 50 $/$T_{CO_2}$ IN 2050)



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Global CO_2-Reduction - Basis:

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Global CO_2-Reduction - Basis:

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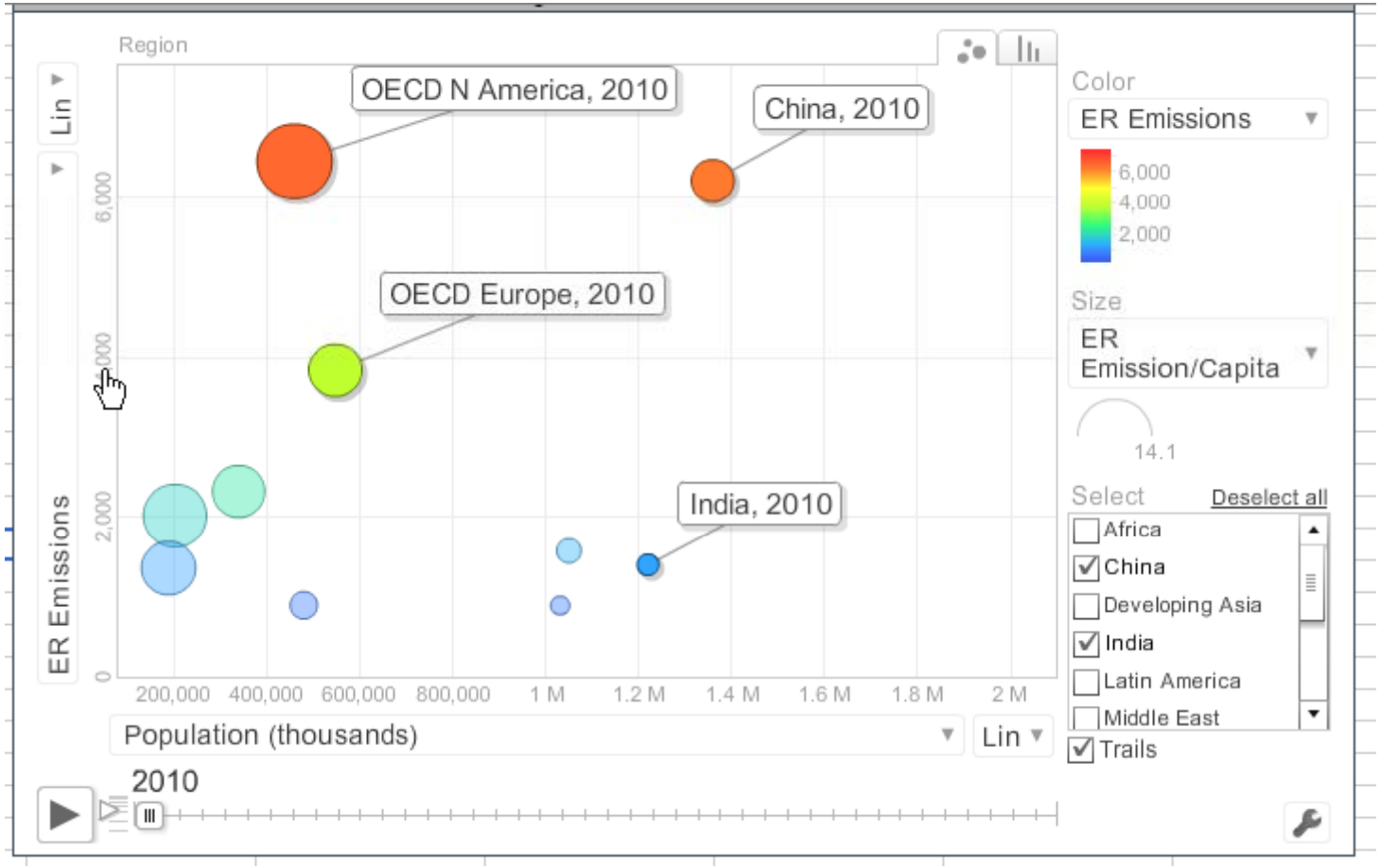

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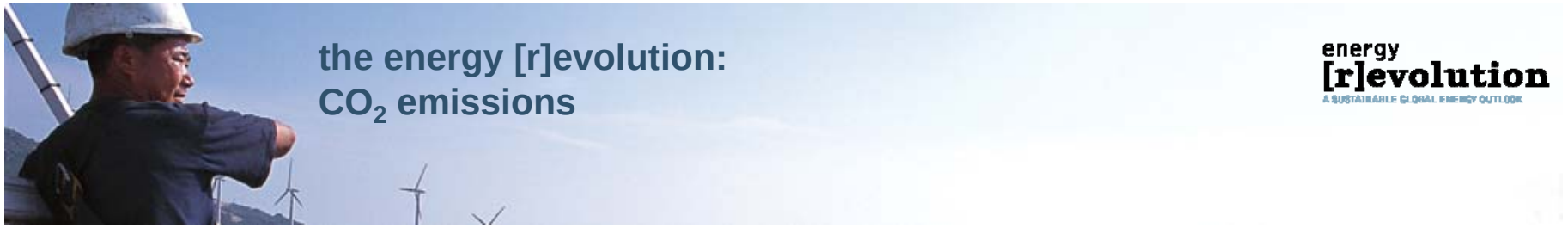


Energy related CO2 emissions – reductions based on 1990 levels:

2005: +14% 2010: +26% 2020: +19% 2030: -2% 2040: -27% 2050: -51%

figure 6.14: global: development of CO_2 emissions by sector under the energy [r]evolution scenario

('EFFICIENCY' = REDUCTION COMPARED TO THE REFERENCE SCENARIO)

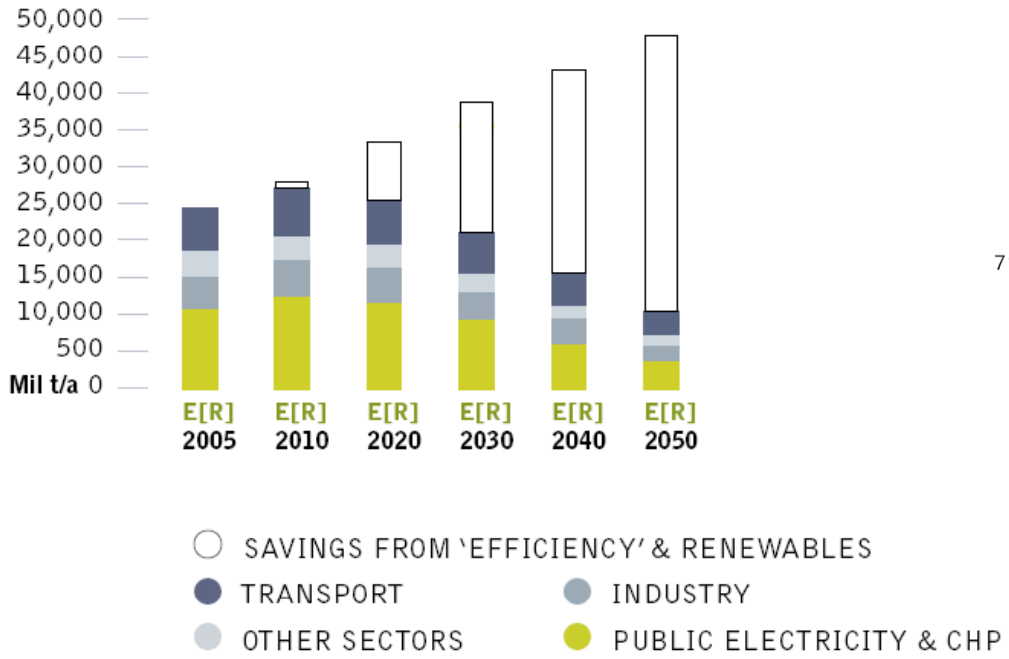
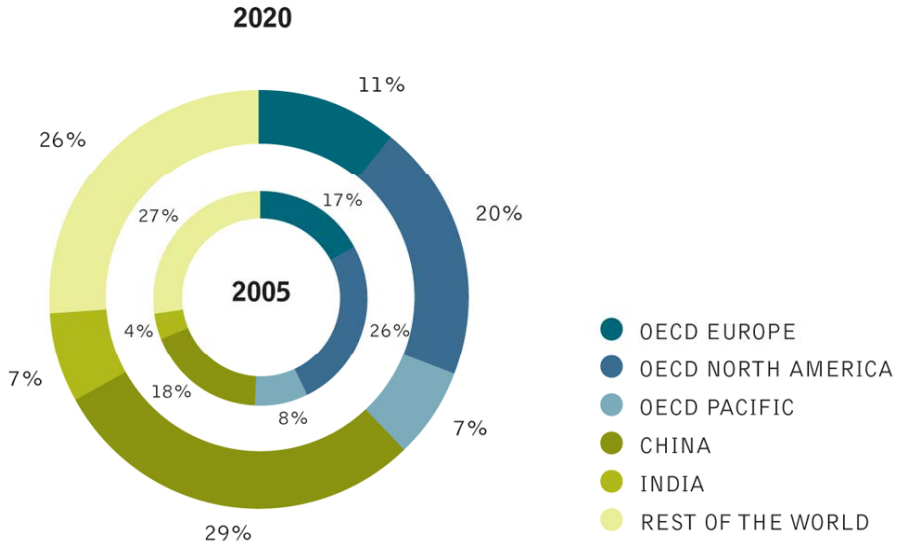


figure 2: CO_2 emssions by region in 2005 and 2020



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Financing the energy [r]evolution in developing countries

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figure 2.1: **ftsm scheme**

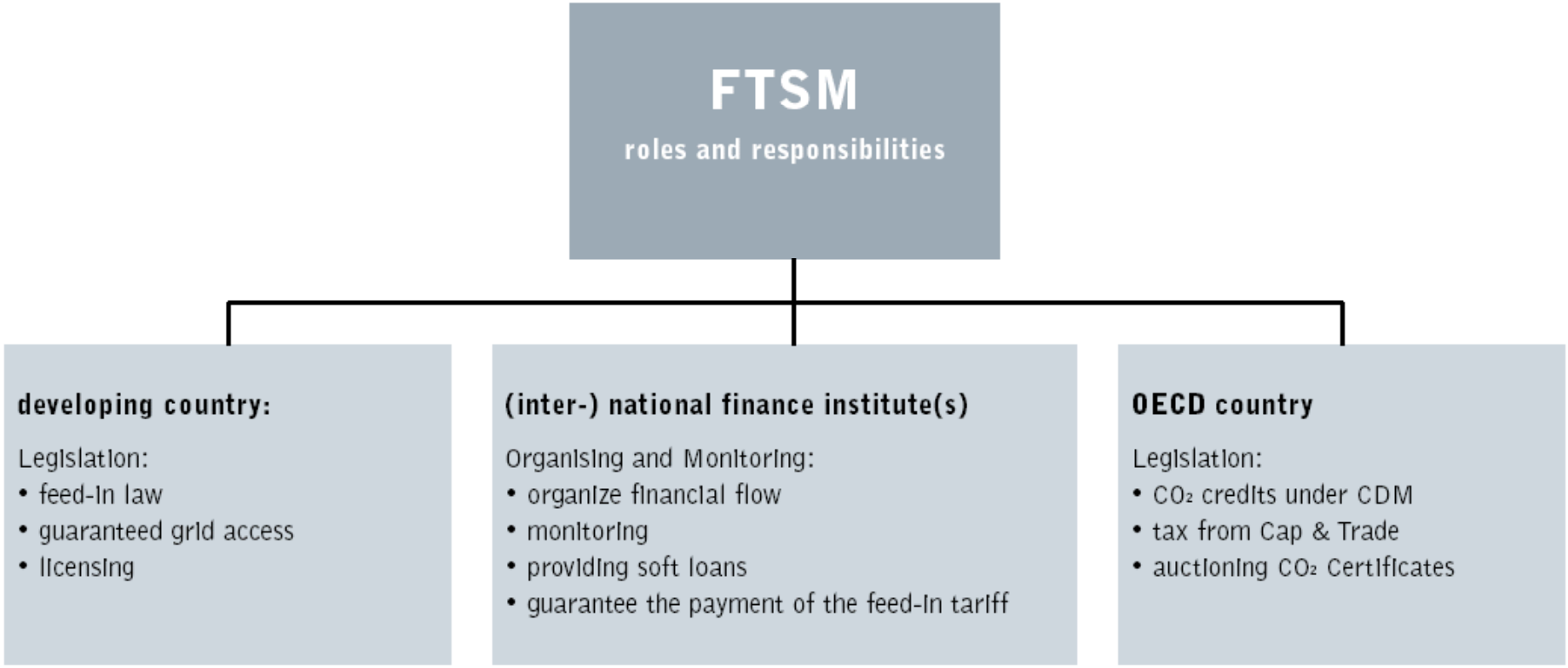

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table 5.1: assumptions for the calculation for a ftsm for non-oecd countries

Key parameter	CONVENTIONAL POWER GENERATION COSTS [CT/KWH]	AVERAGE FEED-IN TARIFF EXCL. SOLAR PV [CT/KWH]	AVERAGE FEED-IN TARIFF FOR SOLAR PV [CT/KWH]	SPECIFIC CO_2 REDUCTION PER KWH [GCO_2/KWH]
2010	5	12	20	0.871
2020	10	11	15	0.864
2030	10	10	10	0.857

figure 5.2: feed in tariffs with conventional power generation

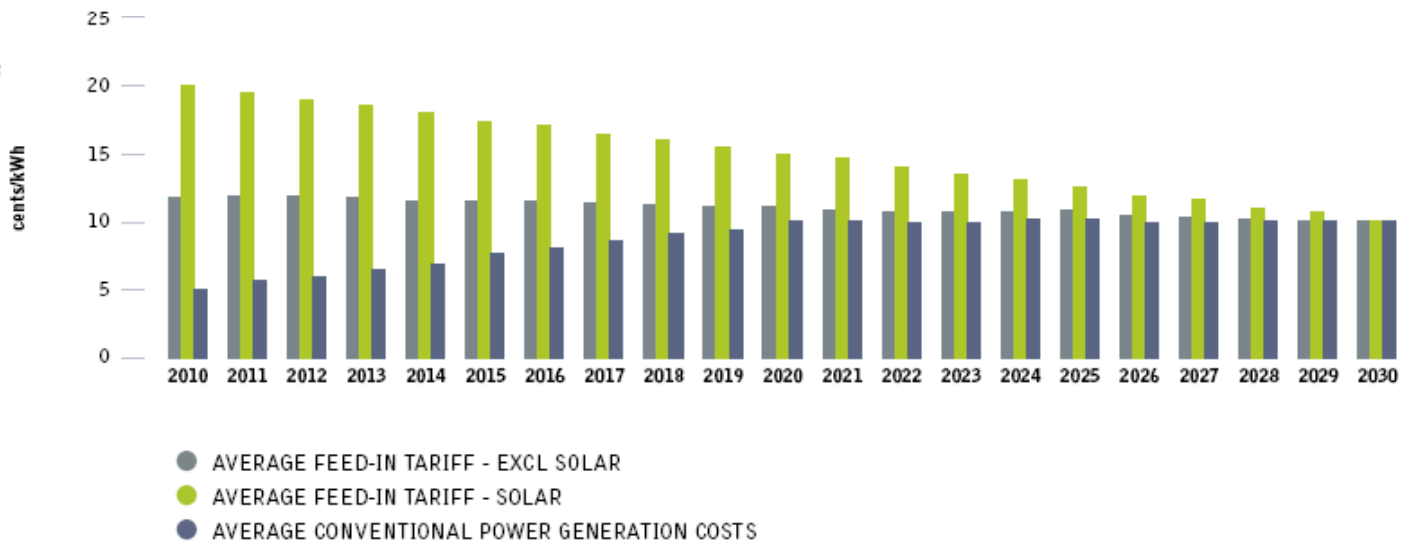

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table 5.2: results of study of costs of proposed Feed-In Tariff Support Mechanism

KEY RESULTS TOTAL NON-OECD	YEAR	TOTAL RENEWABLE ELECTRICITY GENERATION UNDER FTSM PROGRAM [TWH]	AVERAGE ANNUAL CO_2 EMISSION CREDITS [MILLION T CO_2]	TOTAL CO_2 CERTIFICATES PER PERIOD [MILLION T CO_2]	AVERAGE CO_2 COST PER TON [$/T$CO_2$]	TOTAL ANNUAL COSTS [BILLION $]	TOTAL COSTS PER PERIOD [BILLION $]
Period 1	2010-2019	36,326	3,217	32,169	26	72	717
Period 2	2020-2030	93,511	7,330	80,633	13	77	847
Period 1+2	2010-2030	129,837	5,273.6	112,802	19.8	74.4	1,564

table 5.3: renewable power for non-oecd countries under ftsm program

ELECTRICITY GENERATION [TWH/A]	2005	2010	2015	2030	2030	INSTALLED CAPACITY [GW]	2005	2010	2015	2030	2030
Wind	10	80	310	956	2,296	Wind	5.65	36.46	135.45	353.12	891.07
PV	0	4	18	139	1,080	PV	0.08	2.64	12.51	60.77	506.23
Biomass	41	124	296	529	950	Biomass	10.03	27.90	65.30	111.00	168.74
Geothermal	20	31	54	123	288	Geothermal	3.57	4.96	8.66	17.95	42.17
Solar Thermal	1	4	26	388	1,708	Solar Thermal	0.24	1.71	10.28	38.10	130.35
Ocean Energy	0	0	9	33	77	Ocean Energy	0.00	0.00	2.51	9.20	21.00
Total-new RE	**71**	**243**	**713**	**2,167**	**6,398**	**Total-new RE**	**19.57**	**73.67**	**234.71**	**590.13**	**1,759.56**

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+ approx. 25 National E[R] scenarios

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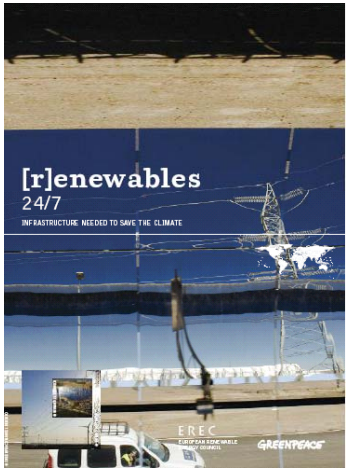
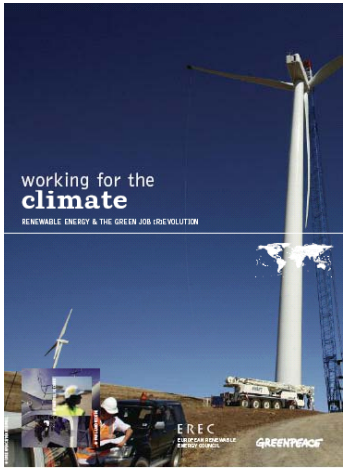
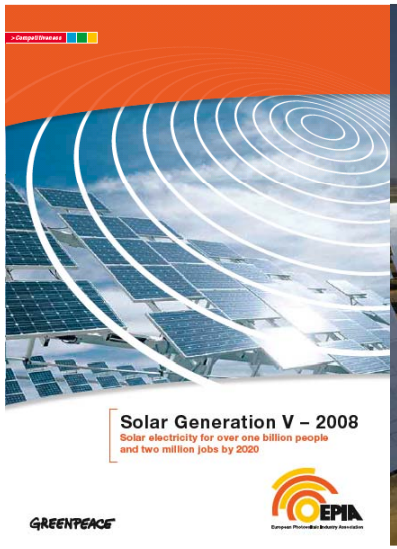
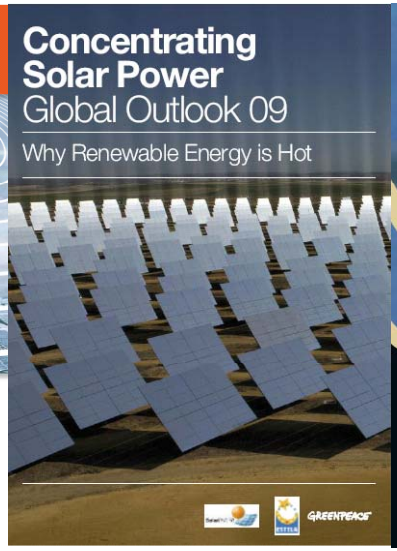
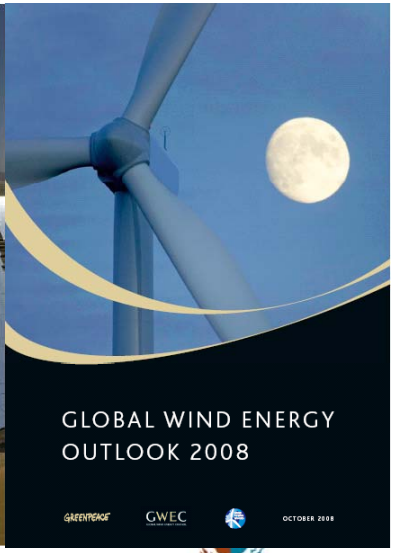
"THE RESERVES OF RENEWABLE ENERGY THAT ARE TECHNICALLY ACCESSIBLE GLOBALLY ARE LARGE ENOUGH TO PROVIDE ABOUT SIX TIMES MORE ENERGY THAN THE WORLD CURRENTLY CONSUMES - FOREVER."











Thank you!

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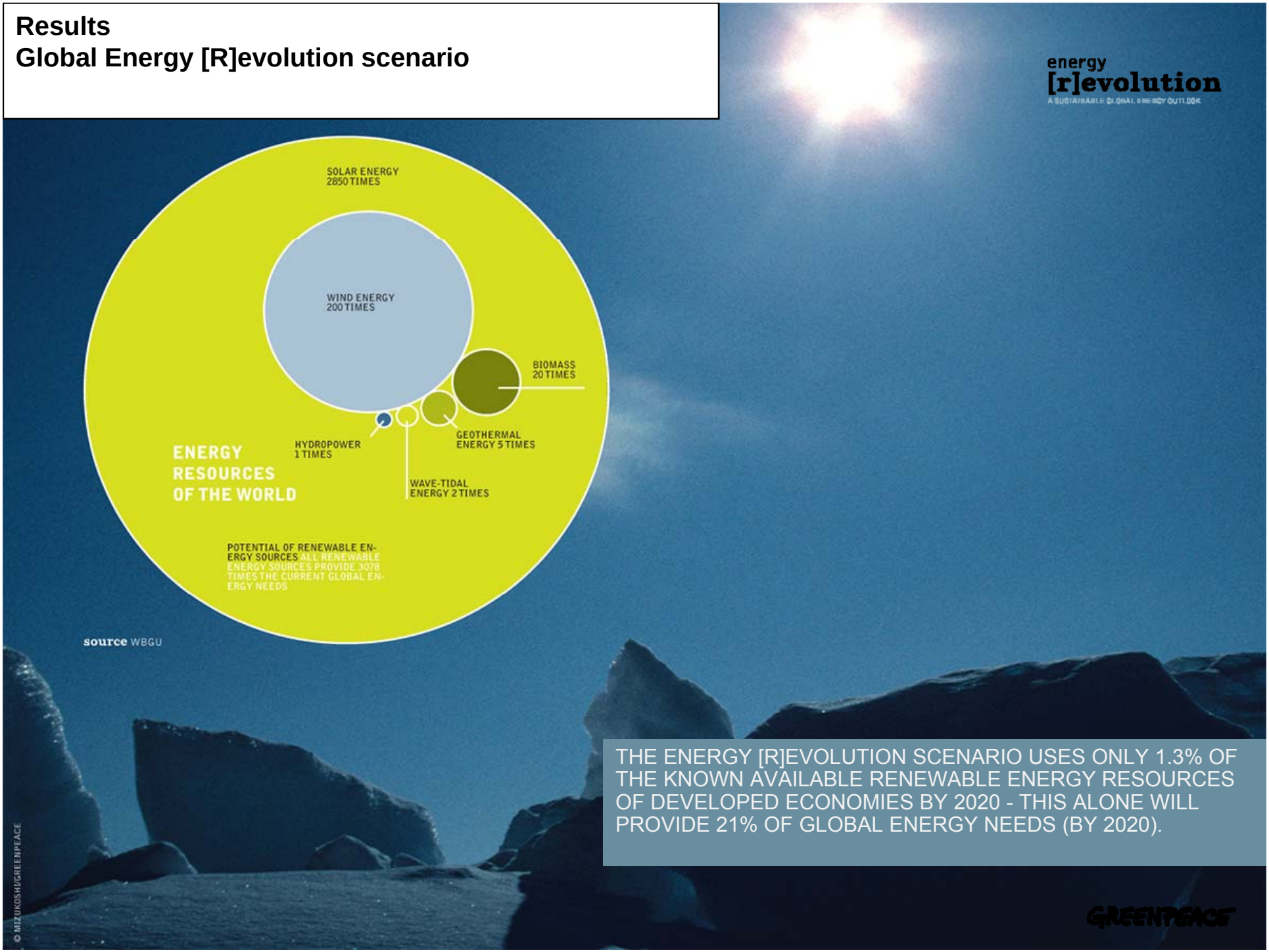
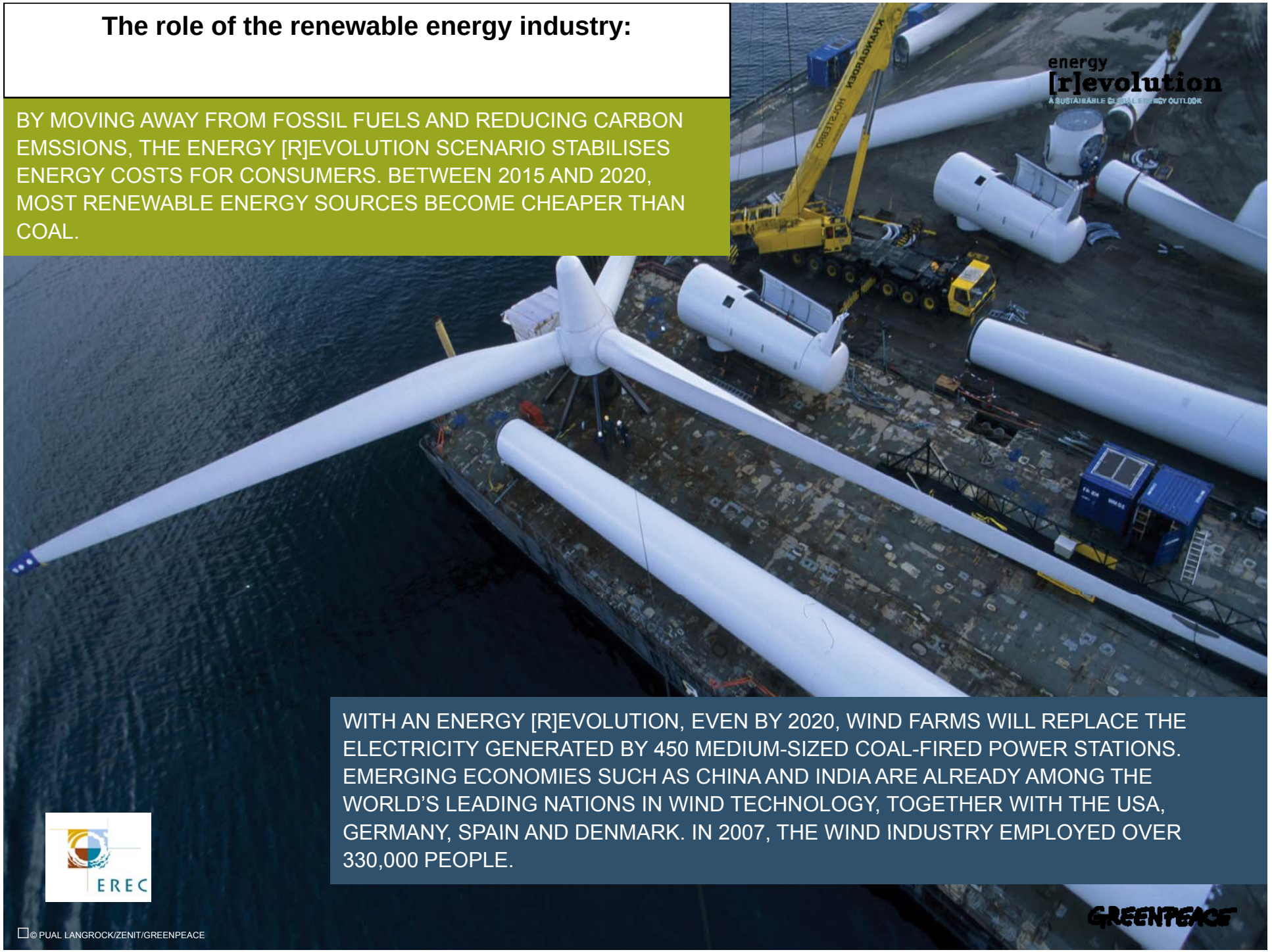
Results
Global Energy [R]evolution scenario



The role of the renewable energy industry:

BY MOVING AWAY FROM FOSSIL FUELS AND REDUCING CARBON EMSSIONS, THE ENERGY [R]EVOLUTION SCENARIO STABILISES ENERGY COSTS FOR CONSUMERS. BETWEEN 2015 AND 2020, MOST RENEWABLE ENERGY SOURCES BECOME CHEAPER THAN COAL.



WITH AN ENERGY [R]EVOLUTION, EVEN BY 2020, WIND FARMS WILL REPLACE THE ELECTRICITY GENERATED BY 450 MEDIUM-SIZED COAL-FIRED POWER STATIONS. EMERGING ECONOMIES SUCH AS CHINA AND INDIA ARE ALREADY AMONG THE WORLD'S LEADING NATIONS IN WIND TECHNOLOGY, TOGETHER WITH THE USA, GERMANY, SPAIN AND DENMARK. IN 2007, THE WIND INDUSTRY EMPLOYED OVER 330,000 PEOPLE.

August 1997: Wenig Wind und PV in Europa Lösung: Netzausbau um CSP in Afrika und Wasserkraft in Skandinavian und Europa zu nutzen

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figure 32: available wind power (in GW) according to energy [r]evolution scenario in january 1997 compared to 30 years average. (6 hour values)

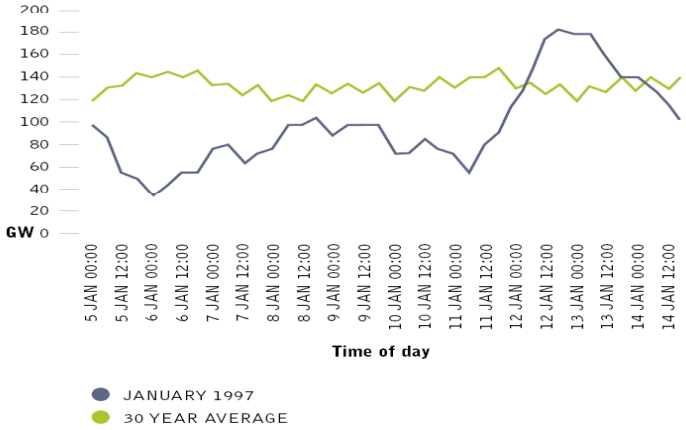


figure 30: available solar PV power (in GW) according to Energy [R]evolution scenario in january 1997 compared to 5 years average. (1 hour values)

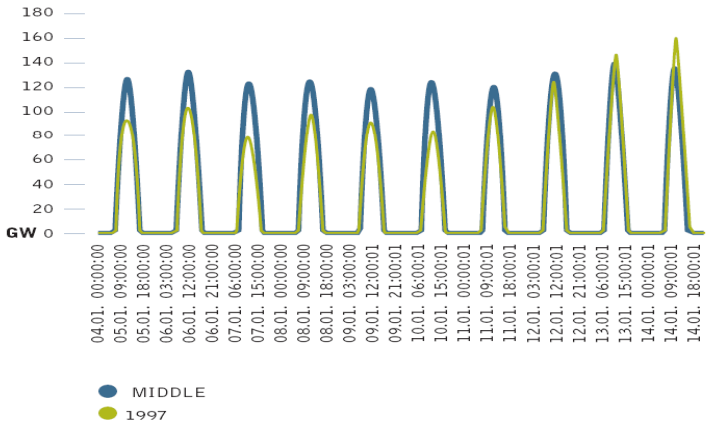
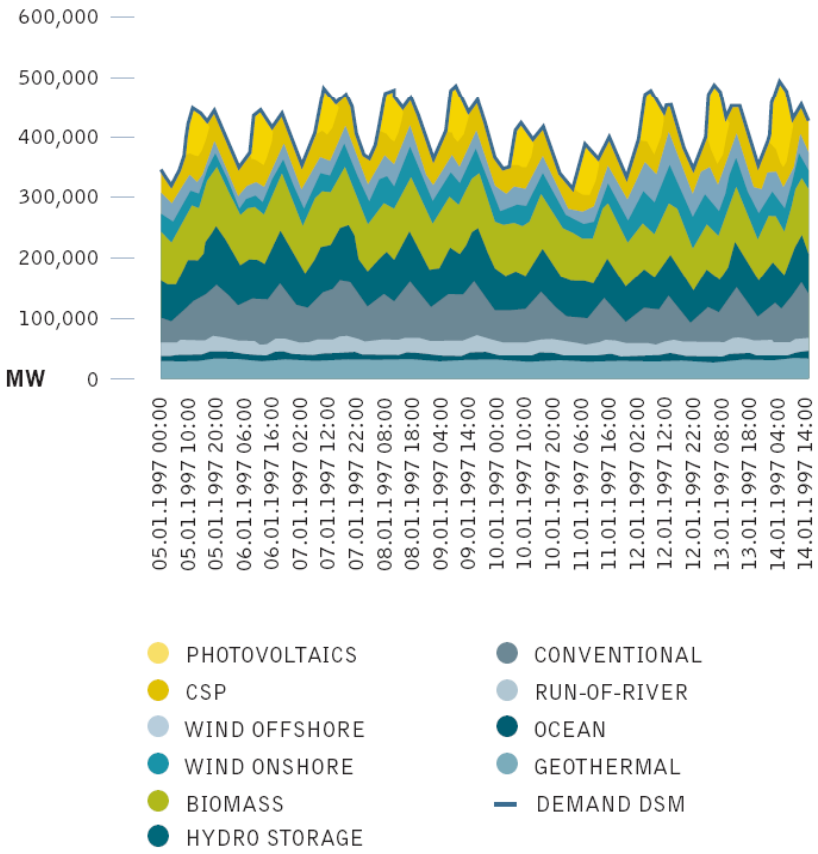


figure 35: power production (in MW) from different sources and overall demand in Europe during extreme January event.



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The renewable energy industry – Status Quo

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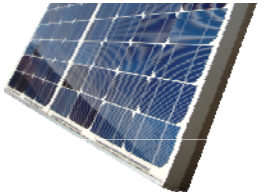
SELECTED INDICATORS AND TOP FIVE COUNTRIES

SELECTED INDICATORS	2006	2007	2008
Investment in new renewable capacity (annual)[1]	63	104	120 billion USD
Renewables power capacity (existing, excl. large hydro)	207	240	280 GW
Renewables power capacity (existing, incl. large hydro)	1,020	1,070	1,140 GW
Wind power capacity (existing)	74	94	121 GW
Grid-connected solar PV capacity (existing)	5.1	7.5	13 GW
Solar PV production (annual)	2.5	3.7	6.9 GW
Solar hot water capacity (existing)	105	126	145 GWth
Ethanol production (annual)	39	50	67 billion liters
Biodiesel production (annual)	6	9	12 billion liters
Countries with policy targets		66	73
States/provinces/countries with feed-in policies[2]		49	63
States/provinces/countries with RPS policies		44	49
States/provinces/countries with biofuels mandates		53	55



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Global renewable energy market situation by the end of 2008

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figure 1.1: new renewable energy installed worldwide, 2008, after REN 21 Renewable Energy Outlook 2008

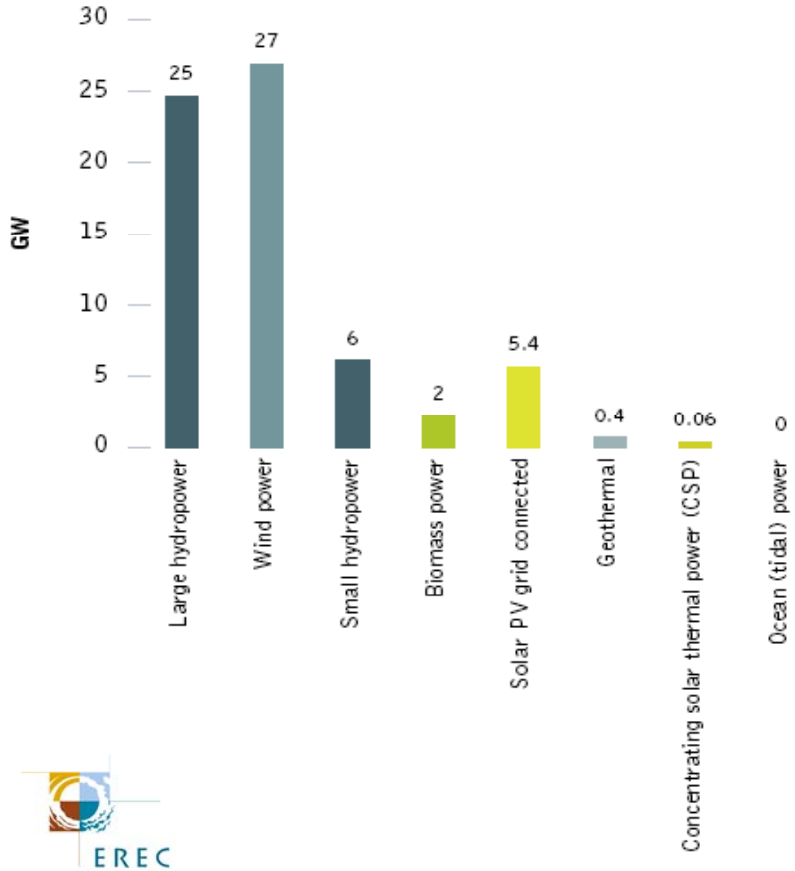
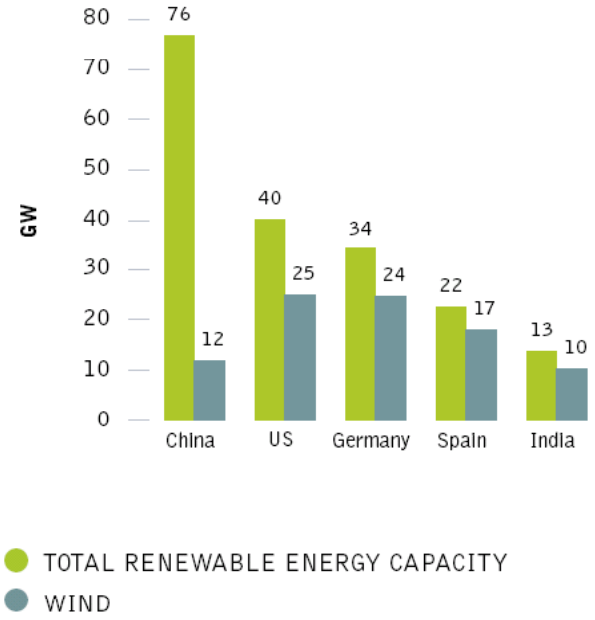


figure 1.2: top five countries for renewable energy installation in 2008, after Ren21 (2008)



Wind	⬆29% in 2008	⬆600% since 2004
Solar photovoltaic (PV)	⬆70% in 2008	⬆250% since 2004
Small hydro power	⬆8% in 2008	⬆75% since 2004

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a blueprint for a Europe´s renewable energy future

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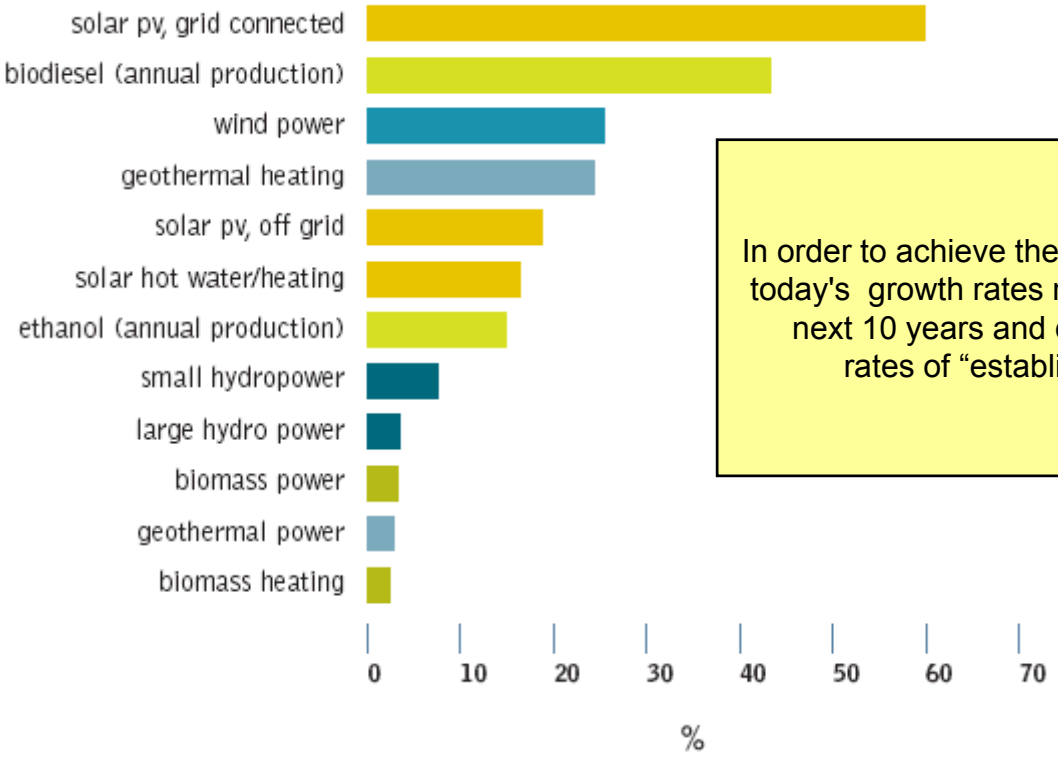
figure 7.2: average annual growth rates of renewable energy capacity, 2002-2006



In order to achieve the Energy [R]evolution scenario today's growth rates need to be maintained for the next 10 years and drop afterwards to growth rates of “established” industry sectors

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source REN21

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The renewable energy industry – Status Quo -> Future

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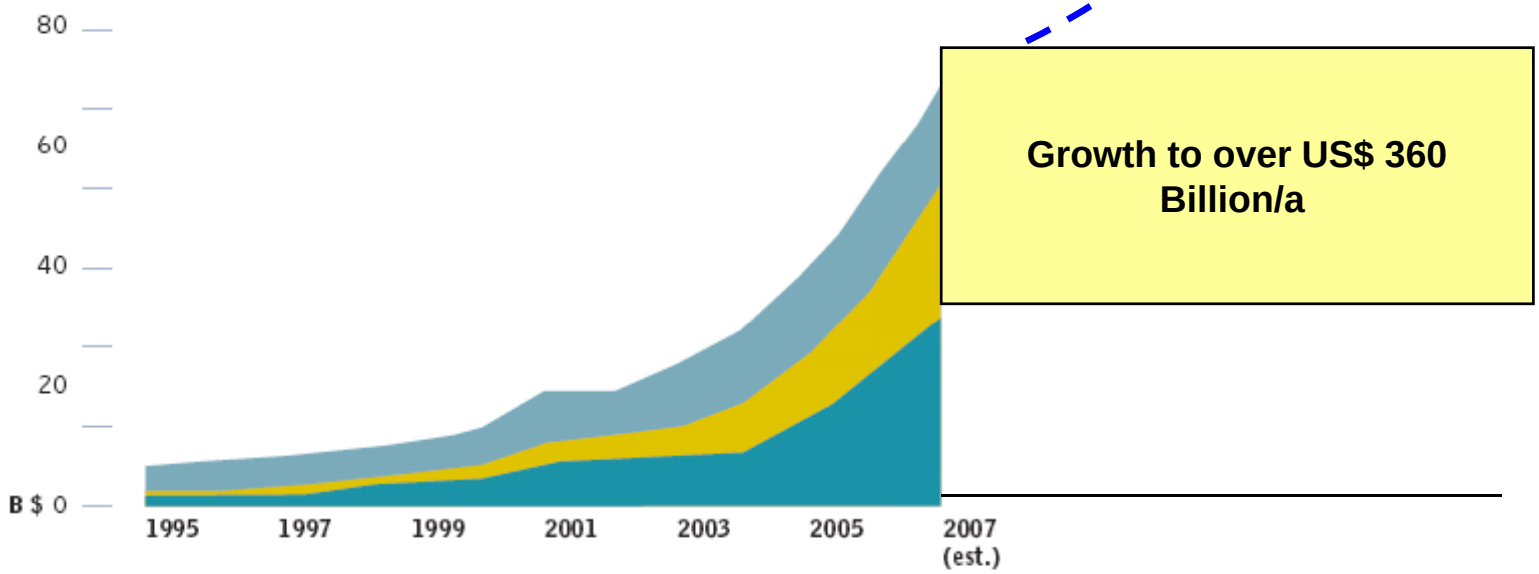
figure 7.1: annual investment in renewable energy capacity, 1995-2007 EXCLUDES LARGE HYDROPOWER



Growth to over US$ 360 Billion/a

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source REN21

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table 7.2: **required production capacities for renewable energy technologies in different scenarios**

NEW RENEWABLE ELECTRICITY GENERATION TECHNOLOGIES	2010	2020	2030	2040	2050	TOTAL INSTALLED CAPACITY IN 2050	ELECTRICITY SHARE UNDER E[R] DEMAND PROJECTION IN 2050
			INCLUDES PRODUCTION CAPACITY FOR REPOWERING				
	GW/a	GW/a	GW/a	GW/a	GW/a	GW	%
Solar Photovoltaics PRODUCTION CAPACITY IN 2007 (APPROX. 5-7 GW)							
Reference	2	5	5	5	5	153	0
Energy [R]evolution	4	40	65	100	125	2,911	10
Advanced	4	45	165	165	165	3,835	13
Concentrated Solar Power PRODUCTION CAPACITY IN 2007 (APPROX. 2-3 GW)							
Reference	0.5	0.5	0.5	0.5	0.5	17	0
Energy [R]evolution	1	12	17	27	33	801	12
Advanced	1	15	32	65	105	2,100	32
Wind PRODUCTION CAPACITY IN 2007 (APPROX. 25 GW)							
Reference	25	25	25	25	25	593	4
Energy [R]evolution	30	82	85	100	100	2,733	18
Advanced	36	142	165	165	165	3,500	23
Geothermal PRODUCTION CAPACITY IN 2007 (APPROX. 1-2 GW)							
Reference	1	1	1	1	1	36	1
Energy [R]evolution	1	5	6	10	10	276	4
Advanced - not available							
Ocean PRODUCTION CAPACITY IN 2007 (APPROX. >1 GW)							
Reference	0.2	0.2	0.2	0.3	0.3	9	0
Energy [R]evolution	0	2	3	5	10	194	2
Advanced - not available							
Total PRODUCTION CAPACITIES PRODUCTION CAPACITY IN 2007 (APPROX.)							
Reference	28	32	31	31	31	808	5
Energy [R]evolution	36	141	176	242	278	6,916	46
Advanced	41	202	362	395	435	9,435	68

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figure 7.4: change in cumulative power plant investment in the energy [r]evolution scenario

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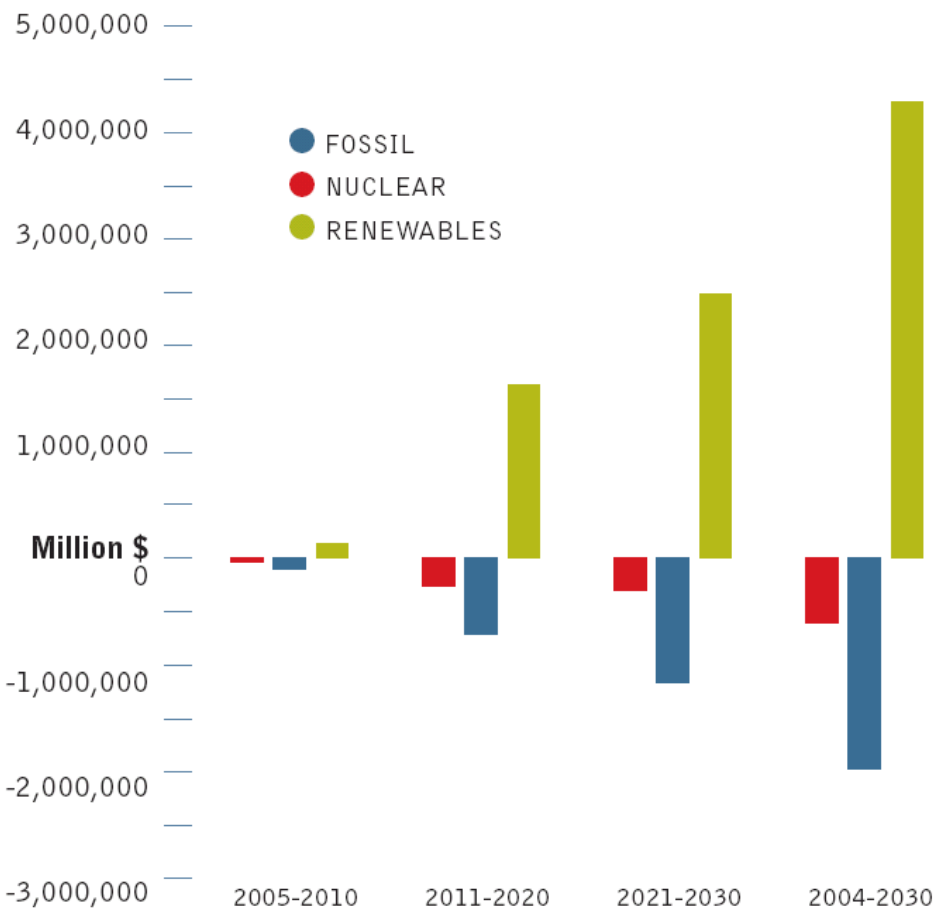

Investitionen in Erneuerbare Energien bis 2030: 9 Billionen Dollar

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Future Investment

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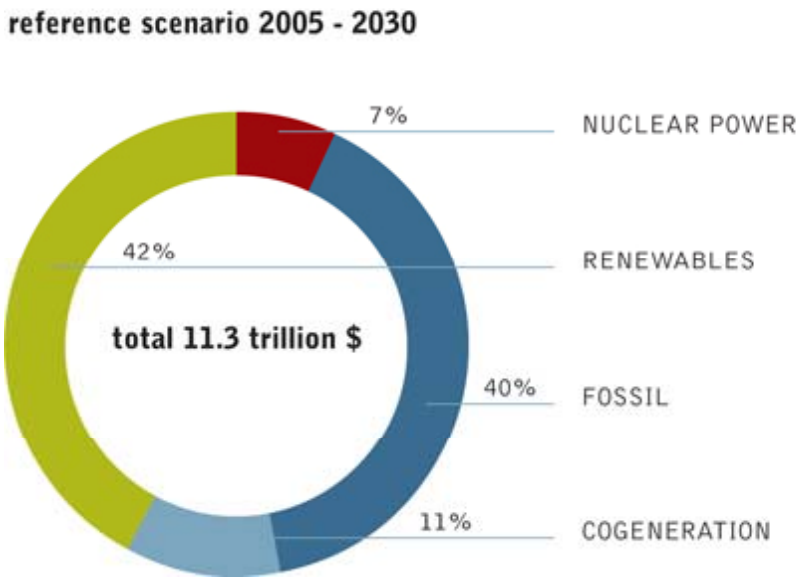
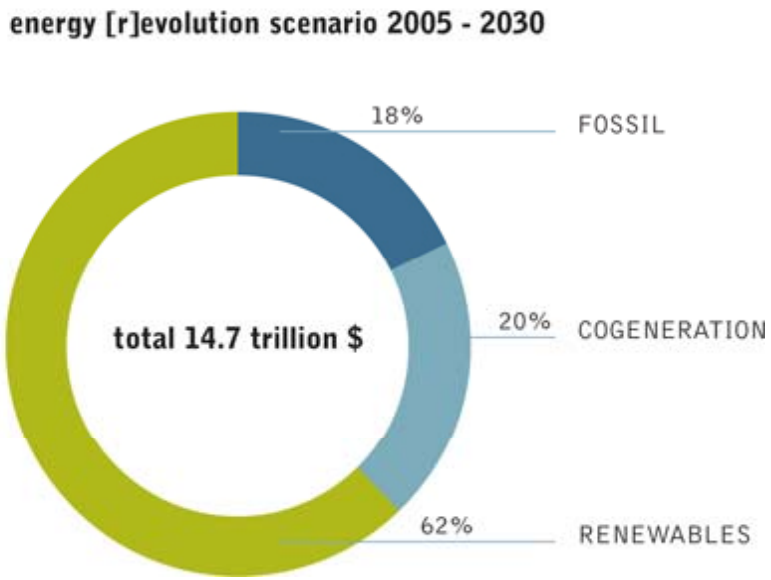
figure 11: investment shares - reference versus energy [r]evolution





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Global renewable energy market situation by the end of 2008

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table 1.0: renewable electricity employment – selected countries and world

ENERGY SOURCE	SELECTED COUNTRIES	
Wind	Germany	84,300[g]
	United States	16,000[a]
	Spain	32,906[b]
	Denmark	21,612[c]
	India	10,000[d]
	World estimate	**300,000[f]**
Solar PV	Germany	50,700[g]
	United States	6,800[a]
	Spain	26,449[b]
	World estimate	**170,000[f]**
Solar Thermal electricity	United States	800[a]
	Spain	968[b]
Biomass power	United States	66,000[a]
	Spain	4,948[b]
Hydropower	Europe	20,000
	United States	8,000[a]
	Spain (small hydro)	6,661[b]
Geothermal	Germany	4,500[g]
	United States	9,000[a]
All sectors	**World estimate**	**1.3[e] - 1.7[f] million**

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Global renewable energy market: Case Study: Germany

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figure 1.4: jobs in the renewable sector in germany

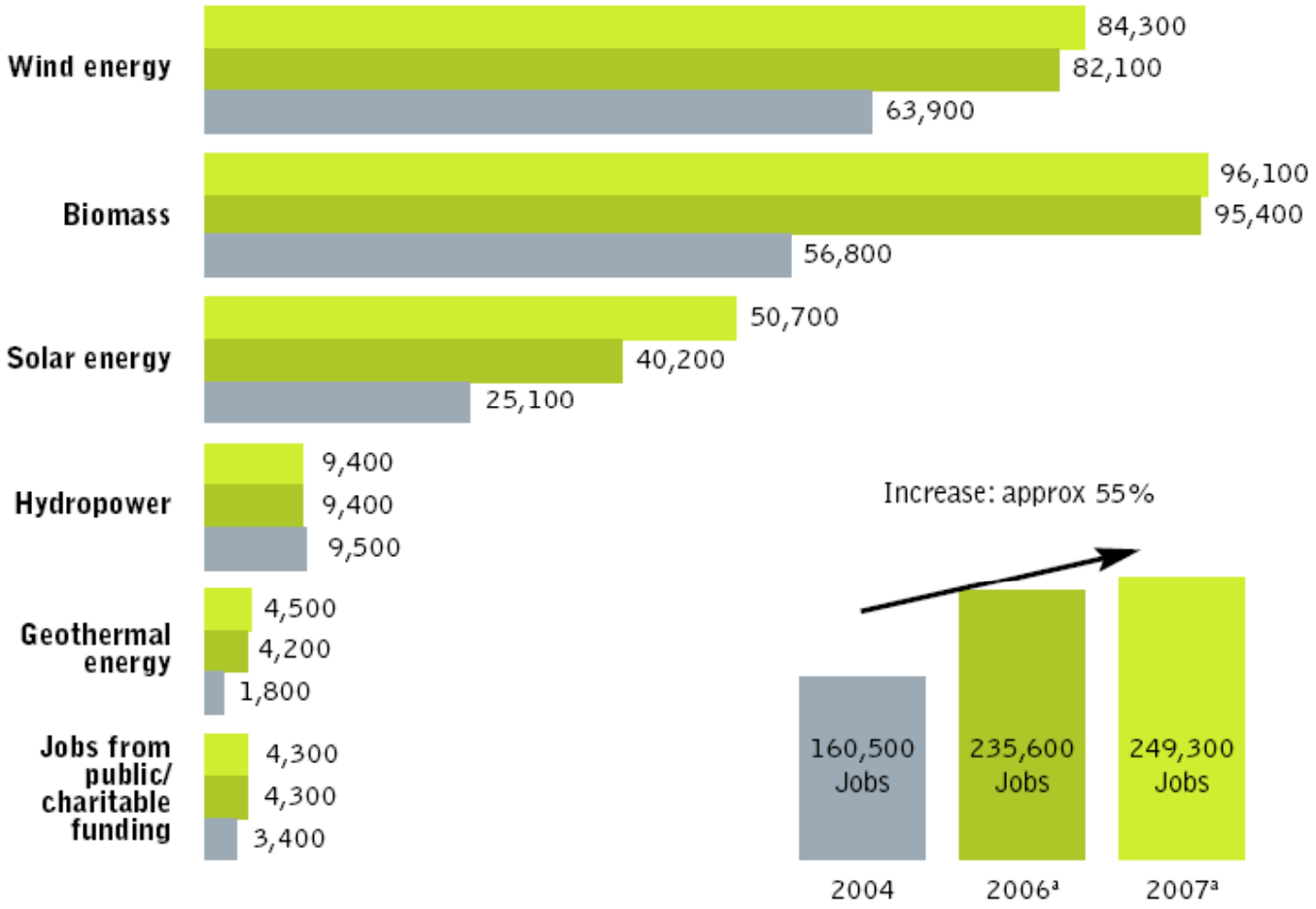

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table 0.1: global: total power sector jobs

BUSINESS AS USUAL a largely coal dependent economy		ENERGY [R]EVOLUTION huge renewable & energy efficiency deployment	
2010	9.1 million	2010	9.3 million
2020	8.5 million	2020	10.5 million
2030	8.6 million	2030	11.3 million
Total loss in energy sector over period	**500,000**	**Total gain** in energy sector over period	**2 million**
JOBS IN RENEWABLES DO NOT BALANCE OUT LOSSES IN COAL SECTOR BY 2030		2.7 MILLION MORE JOBS IN 2030 THAN WITH 'BUSINESS AS USUAL'	

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by 2030:

- Under the Energy [R]evolution, the whole power sector would be employing about 2 million more than now (2.7 million more people than the 'business as usual' scenario). Without the Energy [R]evolution, the coal sector would be providing most of the power, but not as much employment.
- Under business as usual, there will be about 500,000 jobs lost in the power sector, because the 2 million reduction in coal power jobs is not compensated for by the rise in renewable and efficiency jobs.
- Coal, gas, oil and diesel sectors would provide around 2.5 million fewer jobs under an Energy [R]evolution scenario.
- The renewable sector would support 6.9 million jobs — about 5.3 million jobs more — under the Energy [R]evolution scenario.

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table 3.1: **global: summary of results**

	REFERENCE SCENARIO			[R]EVOLUTION SCENARIO		
Jobs (millions)	2010	2020	2030	2010	2020	2030
Coal	4.65 m	3.16 m	2.86 m	4.26 m	2.28 m	1.39 m
Gas	1.95 m	2.36 m	2.55 m	2.08 m	2.12 m	1.80 m
Nuclear, oil and diesel	0.61 m	0.58 m	0.50 m	0.56 m	0.31 m	0.13 m
Renewable	1.88 m	2.41 m	2.71 m	2.38 m	5.03 m	6.90 m
Energy supply jobs	**9.1**	**8.5**	**8.6**	**9.3**	**9.7**	**10.2**
Energy efficiency jobs	-	-	-	0.06	0.72	1.13
Total Jobs	**9.1**	**8.5**	**8.6**	**9.3**	**10.5**	**11.3**
Electricity generation (TWh)						
Coal	9,283	12,546	16,030	8,751	8,953	7,784
Gas	4,447	6,256	7,974	4,704	6,126	6,335
Nuclear, oil & diesel	4,004	4,133	4,079	3,814	2,309	1,003
Renewable	4,047	5,871	7,286	4,254	8,355	14,002
TOTAL electricity generation (TWh)	**21,780**	**28,807**	**35,369**	**21,523**	**25,743**	**29,124**

Note: *This underestimates energy efficiency jobs because it only includes jobs additional to the Reference scenario.*

table 4.5: **capacity, investment, and direct jobs – wind**

		REFERENCE SCENARIO			[R]EVOLUTION SCENARIO		
Energy parameters	UNIT	2010	2020	2030	2010	2020	2030
Installed capacity	GW	114	293	295	154	802	1,405
Generated electricity	TWh	274	887	1,260	362	2,255	4,298
Share of total supply	%	1%	3%	4%	2%	9%	15%
Direct jobs							
Construction and manufacturing	Jobs	0.29 m	0.36 m	0.41 m	0.43 m	1.26 m	1.38 m
Operations and maintenance	Jobs	0.07 m	0.15 m	0.18 m	0.09 m	0.43 m	0.65 m
Total jobs		**0.36 m**	**0.51 m**	**0.59 m**	**0.52 m**	**1.68 m**	**2.03 m**

„For each job lost in the coal industry, 3 jobs will be created in the renewable industry.“

Renewables are more labour intensive, but they don´t need fuel!

table 4.9: **capacity, investment, and direct jobs – coal**

		REFERENCE SCENARIO			[R]EVOLUTION SCENARIO		
Energy parameters	UNIT	2010	2020	2030	2010	2020	2030
Installed capacity	GW	1,477	2,054	2,665	1,400	1,460	1,263
Generated electricity	TWh	8,575	11,771	15,217	8,110	8,313	7,067
Share of total supply	%	40%	46%	52%	38%	32%	24%
Direct jobs		2.01 m	1.11 m	0.94 m	1.76 m	0.50 m	0.05 m
Construction and manufacturing	Jobs	0.26 m	0.27 m	0.29 m	0.25 m	0.20 m	0.14 m
Operations and maintenance	Jobs	1.93 m	1.49 m	1.38 m	1.90 m	1.25 m	0.88 m
Total jobs		**4.20 m**	**2.87 m**	**2.60 m**	**3.91 m**	**1.94 m**	**1.07 m**

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Saved Fuel Costs

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table 7.3: **fuel and investment costs in the reference and the energy [r]evolution scenario**

INVESTMENT COST	DOLLAR	2005-2010	2011-2020	2021-2030	2005-2030	2005-2030 AVERAGE PER YEAR
DIFFERENCE E[R] VERSUS REF						
Total Fossil & Nuclear	billion $ 2005	-101	-967	-1,443	-2,511	-100
Total Cogeneration	billion $ 2005	89	678	902	1,669	67
Total Renewables	billion $ 2005	136	1,637	2,514	4,287	171
Total	billion $ 2005	124	1,348	1,973	3,445	138
SAVINGS REF VERSUS E[R]						
Fuel Oil	billion $/a	27	438	949	1,415	57
Gas	billion $/a	-59	-147	1,291	1,085	43
Coal	billion $/a	185	3,476	12,241	15,901	636
Lignite	billion $/a	7	100	236	343	14
Total Fossil Fuel Savings	billion $/a	161	3,866	14,716	18,744	750

Factor 5

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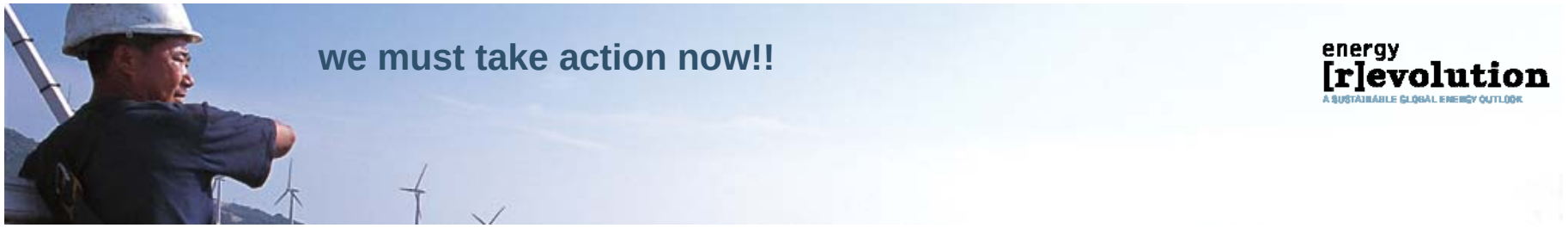

we must take action now!!

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Governments around the world must show that they are serious about climate change by acting now to bring about an Energy [R]evolution.

☐Standby power is wasted power. Globally, we have 50 dirty power plants running just for our wasted standby power.

We need our global leaders to:

1. Phase out all subsidies for fossil fuels and nuclear energy
2. Internalise the external (social and environmental) costs of energy production through “cap and trade” emissions trading
3. Mandate strict efficiency standards for all energy-consuming appliances, buildings and vehicles
4. Establish legally binding targets for renewable energy and combined heat and power generation
5. Reform the electricity markets by guaranteeing priority access to the grid for renewable power generators
6. Provide defined and stable returns for investors, for example by feed-in tariff programmes
7. Increase research and development budgets for renewable energy and energy efficiency.

☐For a full copy of the report and to join the Energy [R]evolution, go to: http://www.greenpeace.org/energyrevolution

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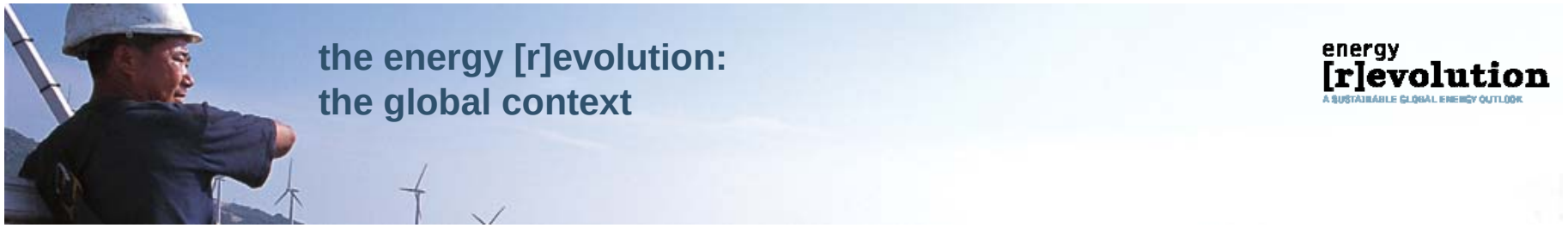
Futu[R]e Investments + Policy Recommendations

SCENARIO PRINCIPLES IN A NUTSHELL:

- SMART CONSUMPTION, GENERATION, DISTRIBUTION
- ENERGY PRODUCTION MOVES CLOSER TO THE CONSUMER
- MAXIMUM USE OF LOCALLY AVAILABLE, ENVIRONMENTALLY FRIENDLY FUELS



the energy [r]evolution: the global context

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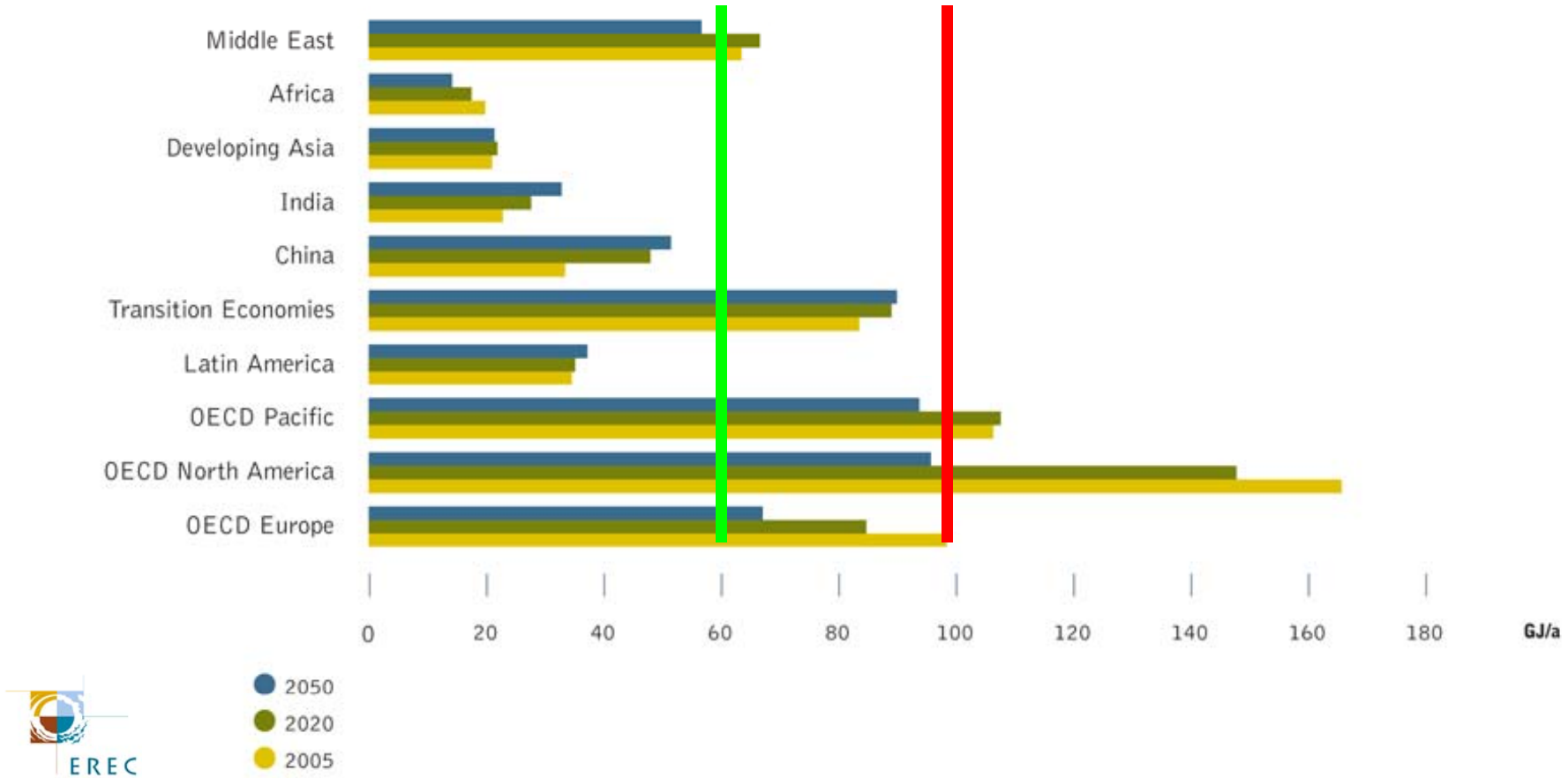
The Energy [R]evolution: More energy equity for developing countries

figure 1: energy use per capita



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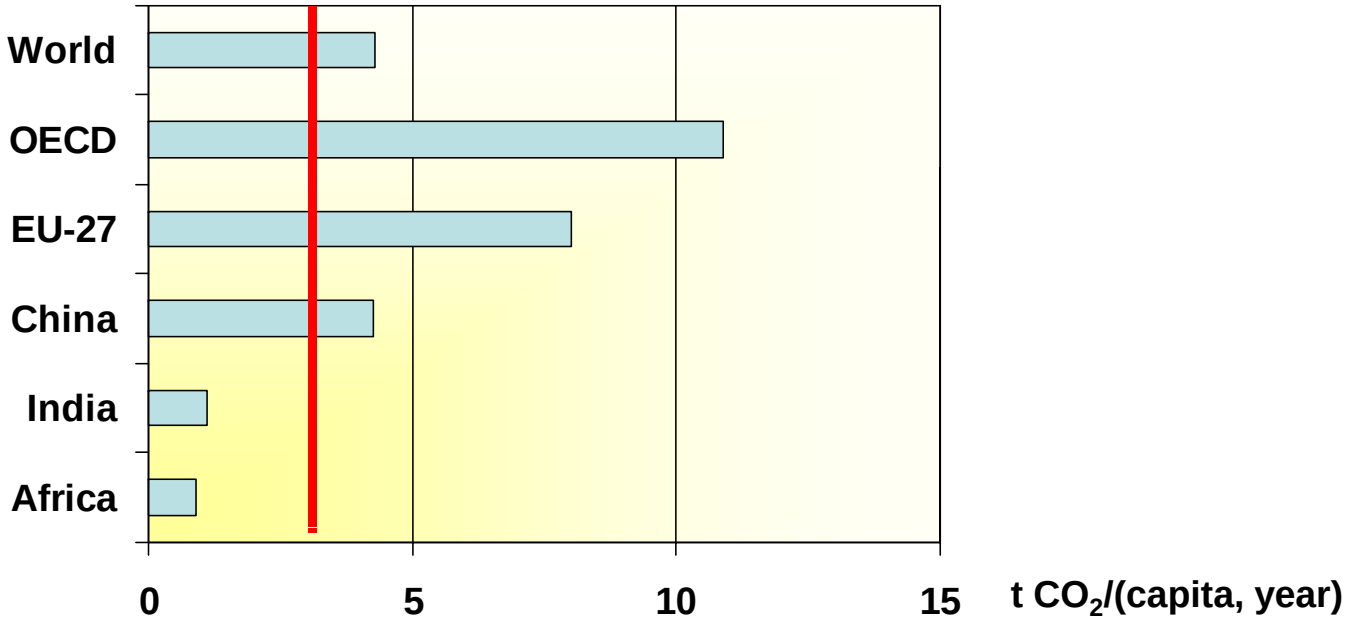
Climate policy targets

- Stabilize global CO_2-concentration under 400 ppm
- Global CO2 emission peak by 2015
- Reduction of Global energy related CO_2-emissions from today's 29 Gt/a to approx. 10 Gt/a in 2050
- Per capita emissions by 2050: ~ 1 tCO2/a



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Energy Policy targets:

- Rapid fossil fuel phase-out
- Only proven technology will be used
- Achieve global climate target with a parallel nuclear phase-out
- Equity and fairness, sustainable economic growth

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The logic of the “energy [r]evolution scenario”

From principles to practice - Use the current “time window” for

Step 1: Energy Efficiency

Step 2: Structural Changes
- Decentralised energy and large scale renewables
- Cogeneration

Step 3: Energy Efficient Transport
- Efficient Public Transport Systems
- Efficient Cars, Trucks etc.
- Sustainable biofuels

Scenario principles in a nutshell
- Smart consumption, generation and distribution
- Energy production moves closer to the consumer
- Maximum use of locally available, environmentally friendly fuels

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RES capacity

energy demand

Coal Phase out

Nuclear Phase out

time