report The Energy [R]evolution for the EU 2o

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The Energy [R]evolution

for EU28

The Roadmap towards Independent Energy Supply

DLR /

Greenpeace International

Dipl.Ing. Sven Teske,

March 2015

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The “Transition Logic” of the

Greenpeace Energy [R]evolution

The 7 Steps of the Energy [R]evolution "Transition Logic" :

1. Define Natural Limits:

    1. CO_2 - Emissions > towards zero
    2. Fossil Fuels – Resource Assessment

2. Define Renewable Energy Resource Limits:

    1. Solar, Wind, Geothermal, Hydro, Ocean Energy
    2. Sustainable Bio Energy

3. Identify Driver for Demand :

    1. Population
    2. Economic Development

4. Define Efficiency Potentials by Sector:

    1. Power
    2. Heating / Cooling
    3. Transport

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The Energy [R]evolution "Transition Logic":

5. Establish time lines for implementation :

1. Power Plant Market Development
2. Future Market projection

6. Identify Required Infrastructure :

1. Power – and Gas grids
2. Storage, e-Transport and "Smart-Grids"

7. Identify Required Policy :

1. Climate target (< 2° C)
2. RE Target (towards 100%)
   - FiT or comparable reliable RE policies
   - Mandatory Grid Connection
   - Priority Dispatch

(8). Just DO IT!

1. Natural Limits:

a. CO_2 - Emissions > towards zero
b. Fossil Fuels – Resource Assessment
   - Oil
   - Gas
   - Coal

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figure 4.4: global oil production 1950 to 2011 and projection till 2050

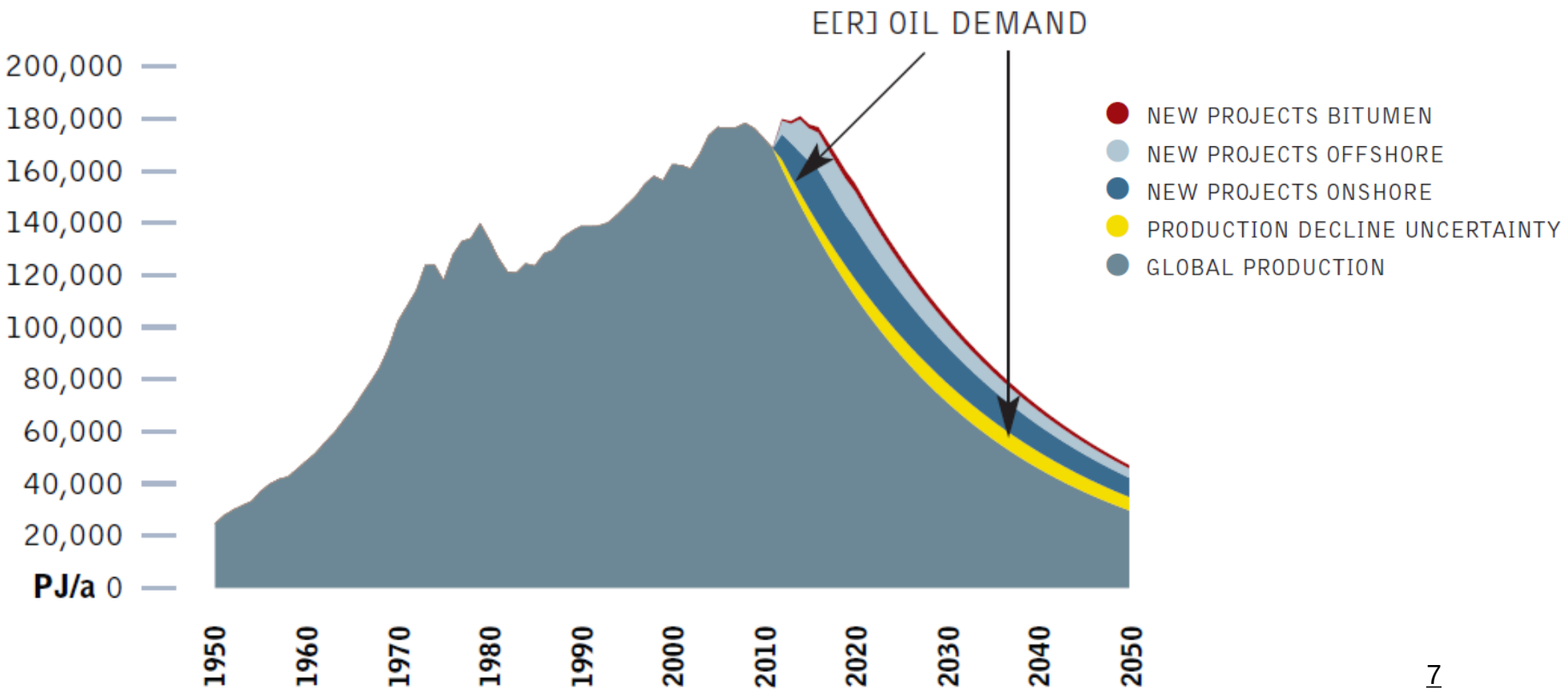
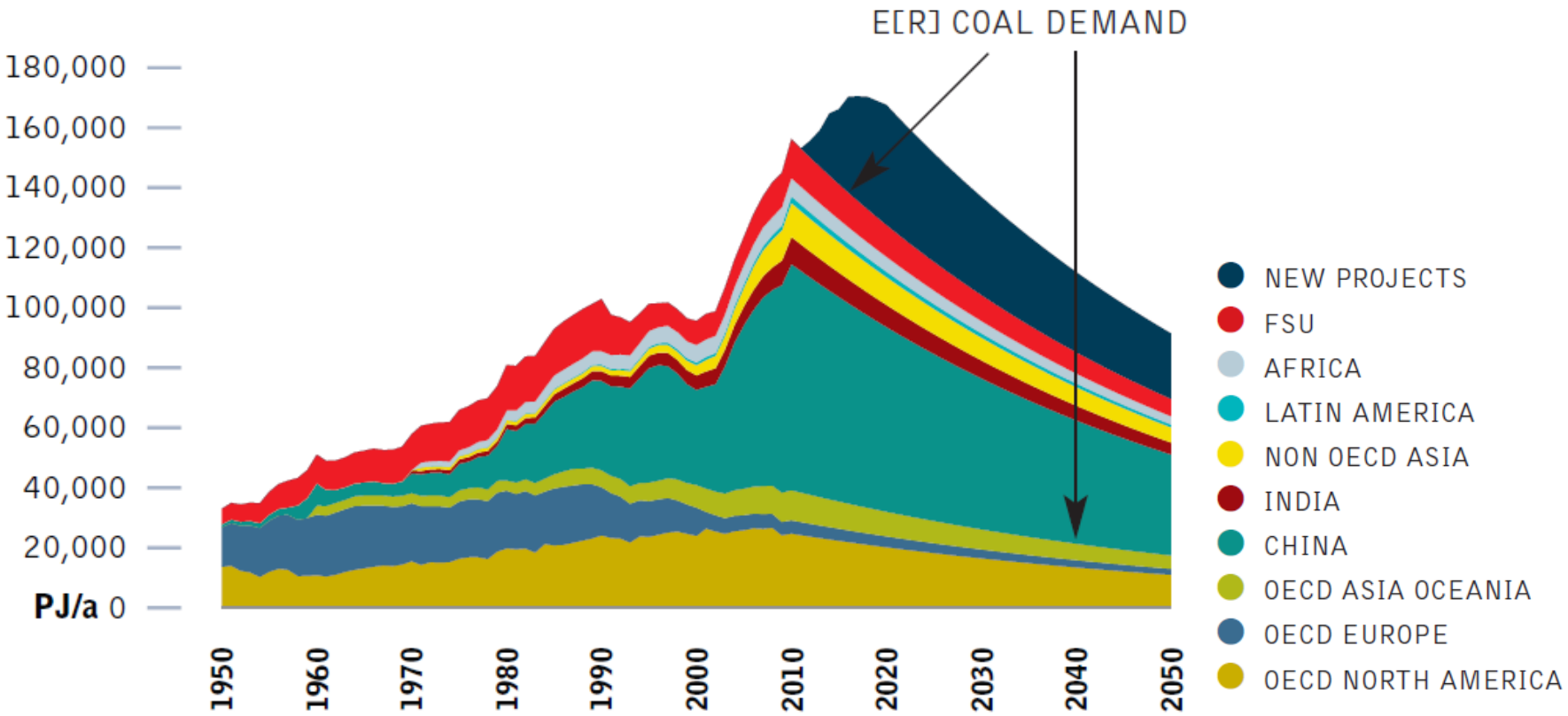


figure 4.5: coal scenario: base decline of 2% per year and new projects



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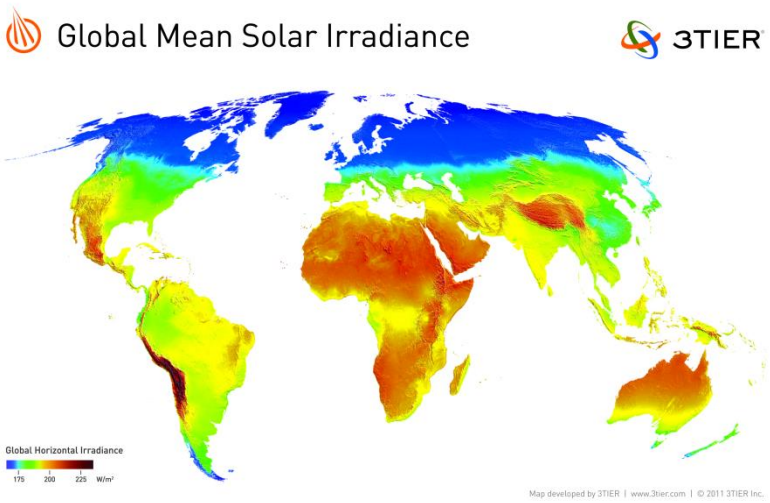
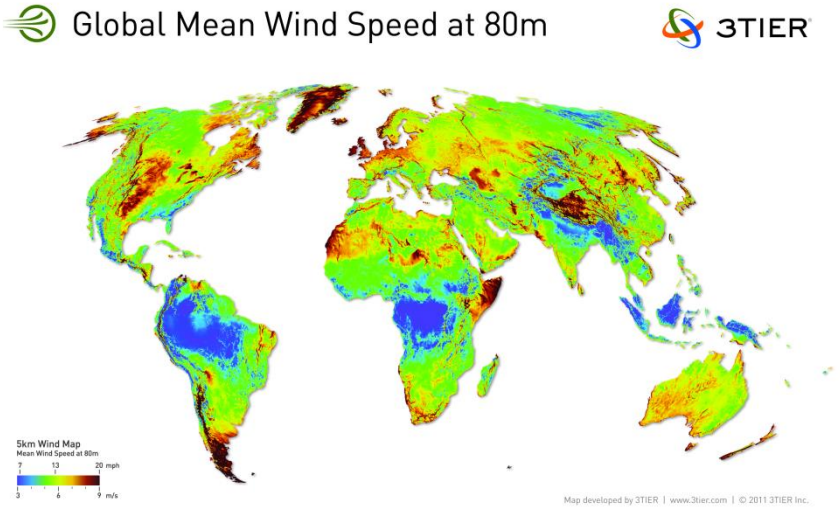
2. Sustainable Natural Resource Limits:

a. Solar
b. Wind
c. Hydro
d. Bio Energy
e. Geothermal
f. Ocean Energy

> Define optimal local mix





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3. Identify Driver for Demand :

a. Population

REGION	2009	2015	2020	2025	2030	2040	2050
World	6,818	7,284	7,668	8,036	8,372	8,978	**9,469**
OECD Europe	555	570	579	587	593	599	**600**
OECD North America	458	484	504	524	541	571	**595**
OECD Asia Oceania	201	204	205	205	204	199	**193**
Eastern Europe/ Eurasia	339	340	341	340	337	331	**324**
India	1,208	1,308	1,387	1,459	1,523	1,627	**1,692**
China	1,342	1,377	1,407	1,436	1,452	1,474	**1,468**
Non OECD Asia	1,046	1,128	1,194	1,254	1,307	1,392	**1,445**
Latin America	468	499	522	544	562	589	**603**
Africa	999	1.045	1,278	1,417	1,562	1,870	**2,192**
Middle East	203	229	250	270	289	326	**358**

source UN WORLD POPULATION PROSPECTS - 2010 REVISION, MEDIUM VARIANT, AND NATIONAL POPULATION SCENARIO FOR CHINA.

b. Economic Development

REGION	2009-2020	2020-2035	2035-2050	2009-2050
World	4.2%	3.2%	2.2%	3.1%
OECD Americas	2.7%	2.3%	1.2%	2.0%
OECD Asia Oceania	2.4%	1.4%	0.5%	1.3%
OECD Europe	2.1%	1.8%	1.0%	1.6%
Eastern Europe/ Eurasia	4.2%	3.2%	1.9%	3.0%
India	7.6%	5.8%	3.1%	5.3%
China	8.2%	4.2%	2.7%	4.7%
Non OECD Asia	5.2%	3.2%	2.6%	3.5%
Latin America	4.0%	2.8%	2.2%	2.9%
Middle East	4.3%	3.7%	2.8%	3.5%
Africa	4.5%	4.4%	4.2%	4.4%

source 2009-2035: IEA WEO 2011 AND 2035-2050: DLR, PERSONAL COMMUNICATION (2012)

4. Define Efficiency Potentials by Sector:

a. Power

b. Heating / Cooling

c. Transport

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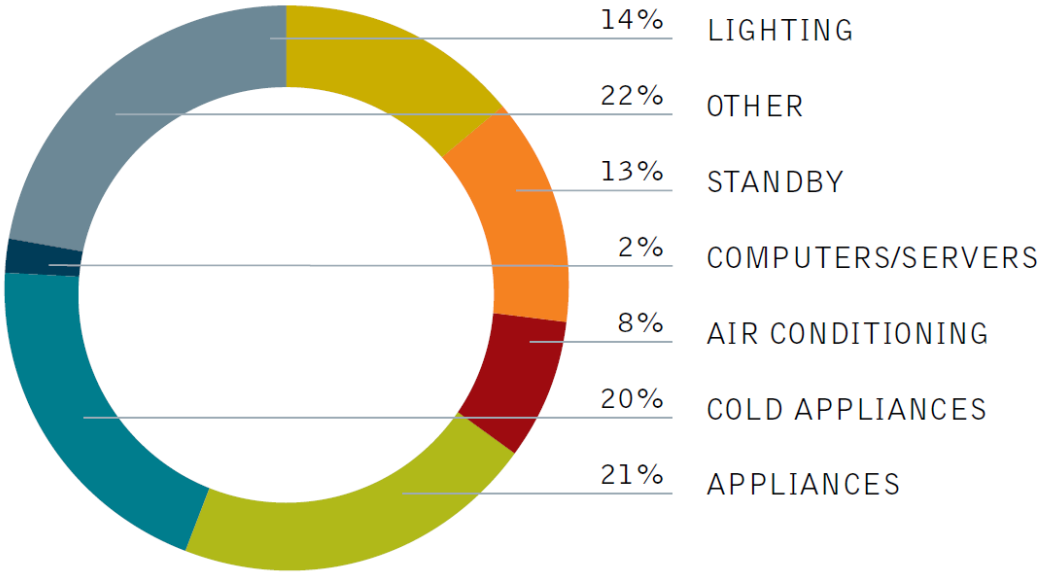
4. Define Efficiency Potentials by Sector:

a. Power Demand: Example: Development of a “Global Standard Household”

figure 10.20: electricity savings in households (energy [r]evolution versus reference) in 2050



note

BY 2050, STRICT ENERGY EFFICIENCY STANDARDS, WOULD MEAN ALL GLOBAL HOUSEHOLDS COULD SAVE OVER 4,000 TWH COMPARED TO THE REFERENCE SCENARIO. THIS WOULD TAKE OVER 570 COAL POWER PLANTS OFF THE GRID.

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Global Effect of introducing strict energy efficiency standards based on currently available technology in "saved power plants blocks" (= 750 MW)

	ELECTRICITY LIGHTING	ELECTRICITY STANDBY	ELECTRICITY AIR CONDITIONING	ELECTRICITY SET TOP BOXES	ELECTRICITY OTHER APPLIANCES	ELECTRICITY COLD APPLIANCES	ELECTRICITY COMPUTERS/ SERVERS	ELECTRICITY OTHER
OECD Europe	16	11	11	2	27	15	2	23
OECD Americas	32	19	19	3	47	26	4	42
OECD Asia Oceania	5	5	5	1	13	7	1	11
China	3	3	3	1	7	4	1	6
Latin America	5	2	3	0	6	3	1	6
Africa	3	2	2	0	4	2	0	4
Middle East	5	2	3	0	6	3	1	6
Eastern Europe/Eurasia	6	3	3	1	7	4	1	7
India	2	1	1	0	3	2	0	3
Other Non-OECD Asia	4	2	2	0	6	3	1	5
World	**80**	**50**	**52**	**9**	**126**	**69**	**11**	**113**

	ELECTRICITY SERVICES - COMPUTERS	ELECTRICITY SERVICES - LIGHTING	ELECTRICITY SERVICES - AIR CONDITIONING	ELECTRICITY SERVICES - COLD APPLIANCES	ELECTRICITY SERVICES - OTHER APPLIANCES	ELECTRICITY - AGRICULTURE	NUMBER OF COAL POWER PLANTS PHASED OUT	INDUSTRY	**TOTAL** INCLUDING INDUSTRY
OECD Europe	8	30	18	6	33	7	209	106	315
OECD Americas	15	62	34	11	60	21	397	107	503
OECD Asia Oceania	5	11	10	3	18	1	96	52	148
China	1	3	3	1	5	21	61	144	205
Latin America	2	8	4	1	7	3	52	39	90
Africa	1	3	1	0	2	6	30	23	53
Middle East	1	6	3	1	5	10	51	8	59
Eastern Europe/Eurasia	2	9	4	1	7	8	62	63	125
India	0	2	1	0	1	14	31	23	54
Other Non-OECD Asia	2	7	3	1	6	6	50	33	85
World	**37**	**140**	**81**	**27**	**144**	**98**	**1,038**	**613**	**1,651**

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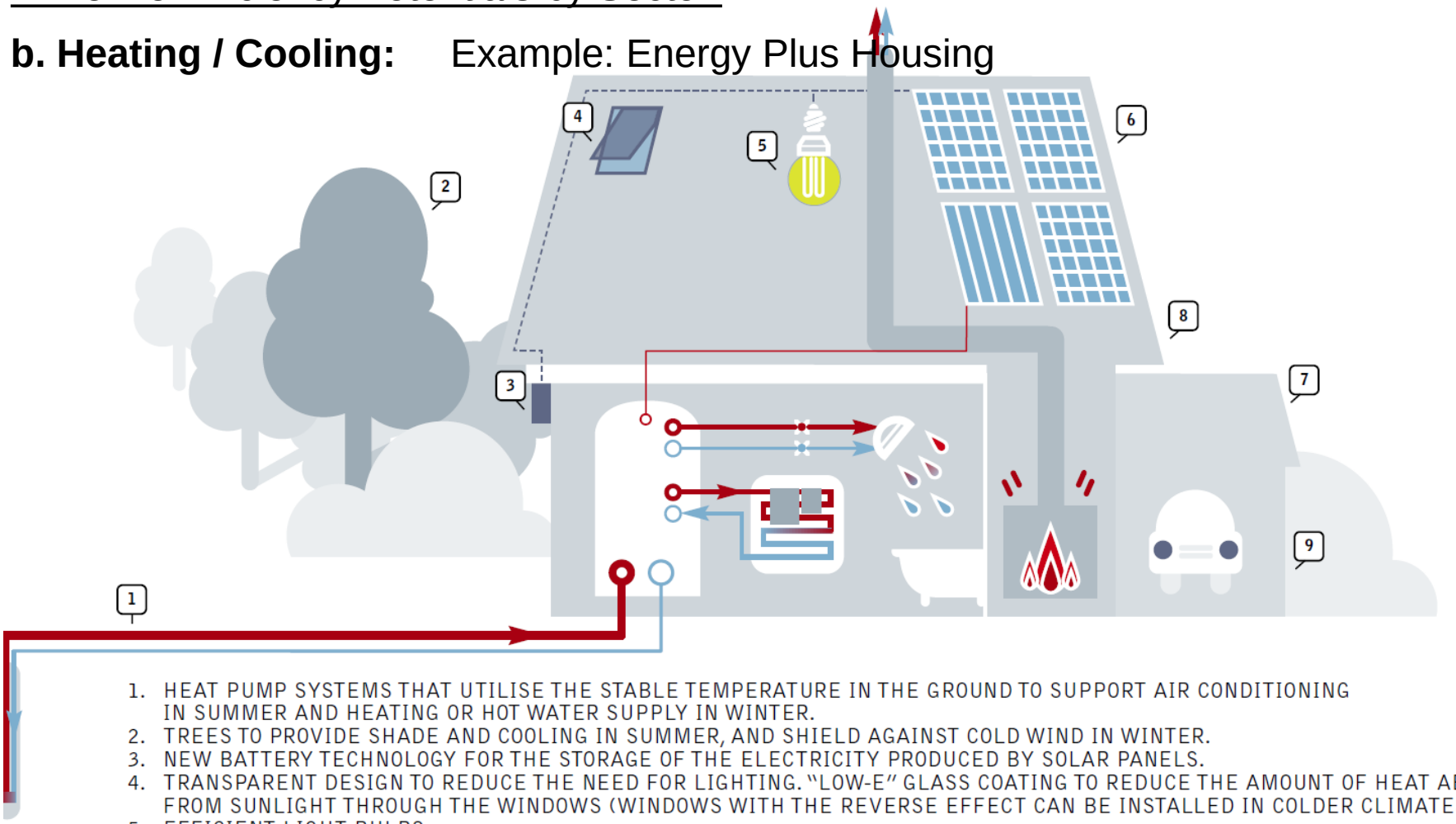
4. Define Efficiency Potentials by Sector:

b. Heating / Cooling: Example: Energy Plus Housing



1. HEAT PUMP SYSTEMS THAT UTILISE THE STABLE TEMPERATURE IN THE GROUND TO SUPPORT AIR CONDITIONING IN SUMMER AND HEATING OR HOT WATER SUPPLY IN WINTER.
2. TREES TO PROVIDE SHADE AND COOLING IN SUMMER, AND SHIELD AGAINST COLD WIND IN WINTER.
3. NEW BATTERY TECHNOLOGY FOR THE STORAGE OF THE ELECTRICITY PRODUCED BY SOLAR PANELS.
4. TRANSPARENT DESIGN TO REDUCE THE NEED FOR LIGHTING. "LOW-E" GLASS COATING TO REDUCE THE AMOUNT OF HEAT ABSORBED FROM SUNLIGHT THROUGH THE WINDOWS (WINDOWS WITH THE REVERSE EFFECT CAN BE INSTALLED IN COLDER CLIMATES).
5. EFFICIENT LIGHT BULBS.
6. SOLAR PHOTOVOLTAIC PANELS FOR ELECTRICITY PRODUCTION AND SOLAR THERMAL PANELS FOR WATER HEATING.
7. ROOMS THAT ARE NOT NORMALLY HEATED (E.G. A GARAGE) SERVING AS ADDITIONAL INSULATION.
8. VENTILATED DOUBLE SKIN FAÇADES TO REDUCE HEATING AND COOLING REQUIREMENTS.
9. WOOD AS A BUILDING MATERIAL WITH ADVANTAGEOUS INSULATION PROPERTIES, WHICH ALSO STORES CARBON AND IS OFTEN PRODUCED WITH BIOMASS ENERGY.

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4. Define Efficiency Potentials by Sector

c. Transport

figure 11.3: world average (stock-weighted) passenger transport energy intensity for 2009 and 2050

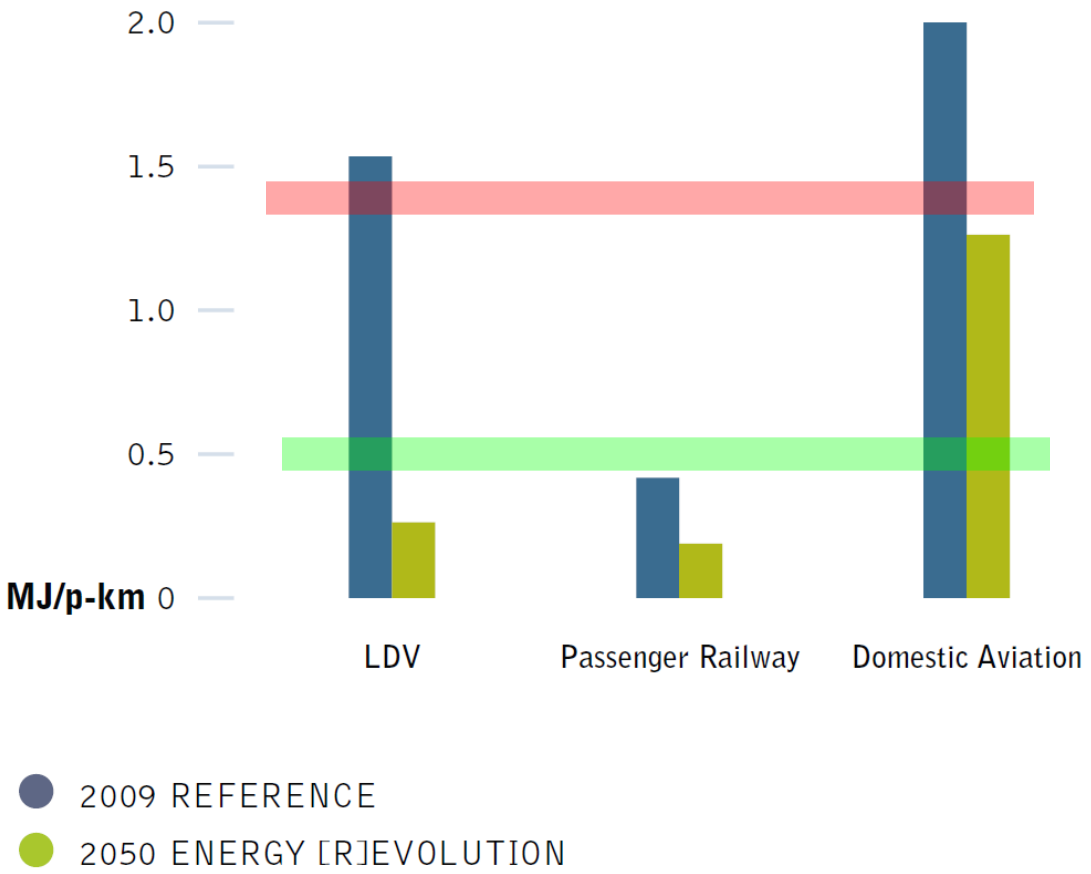

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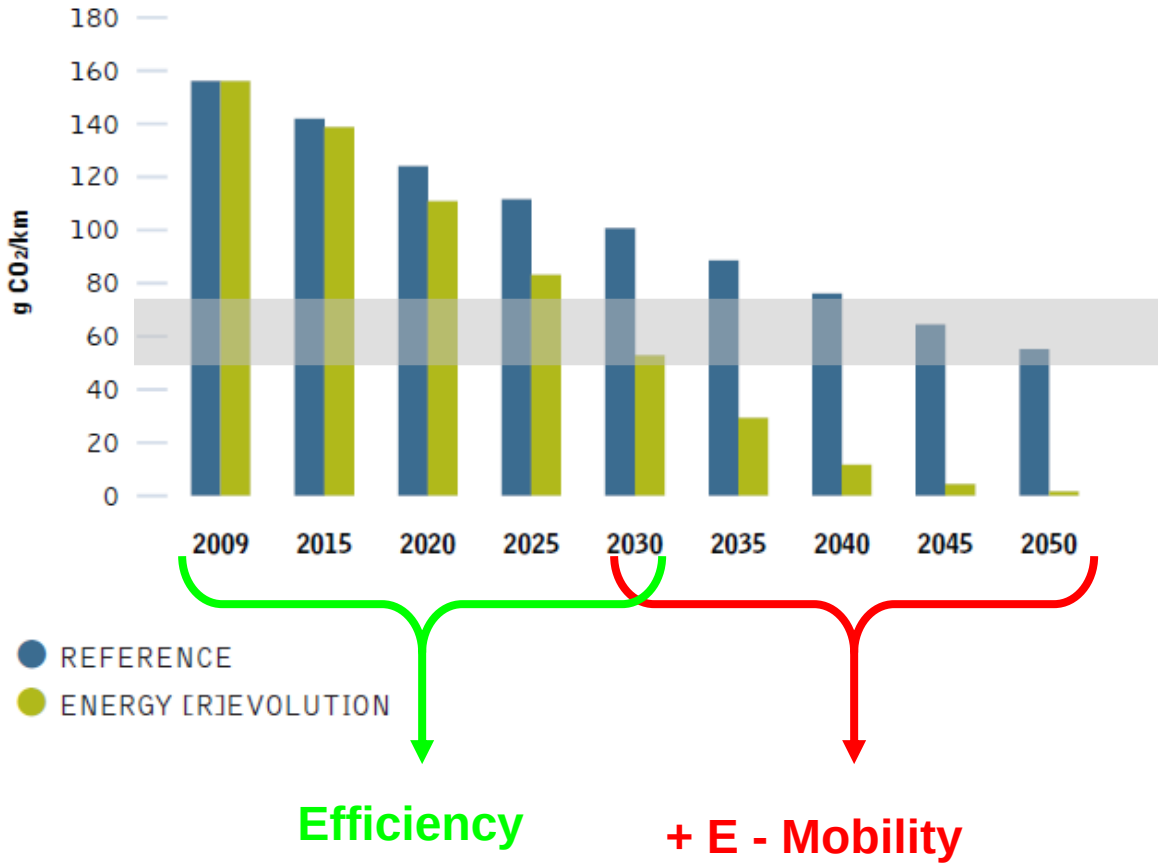
figure 9.19: tailpipe CO_2 emissions for light-duty vehicles (stock weighted fleet average) in the reference and energy [r]evolution scenario



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Energy Intensity

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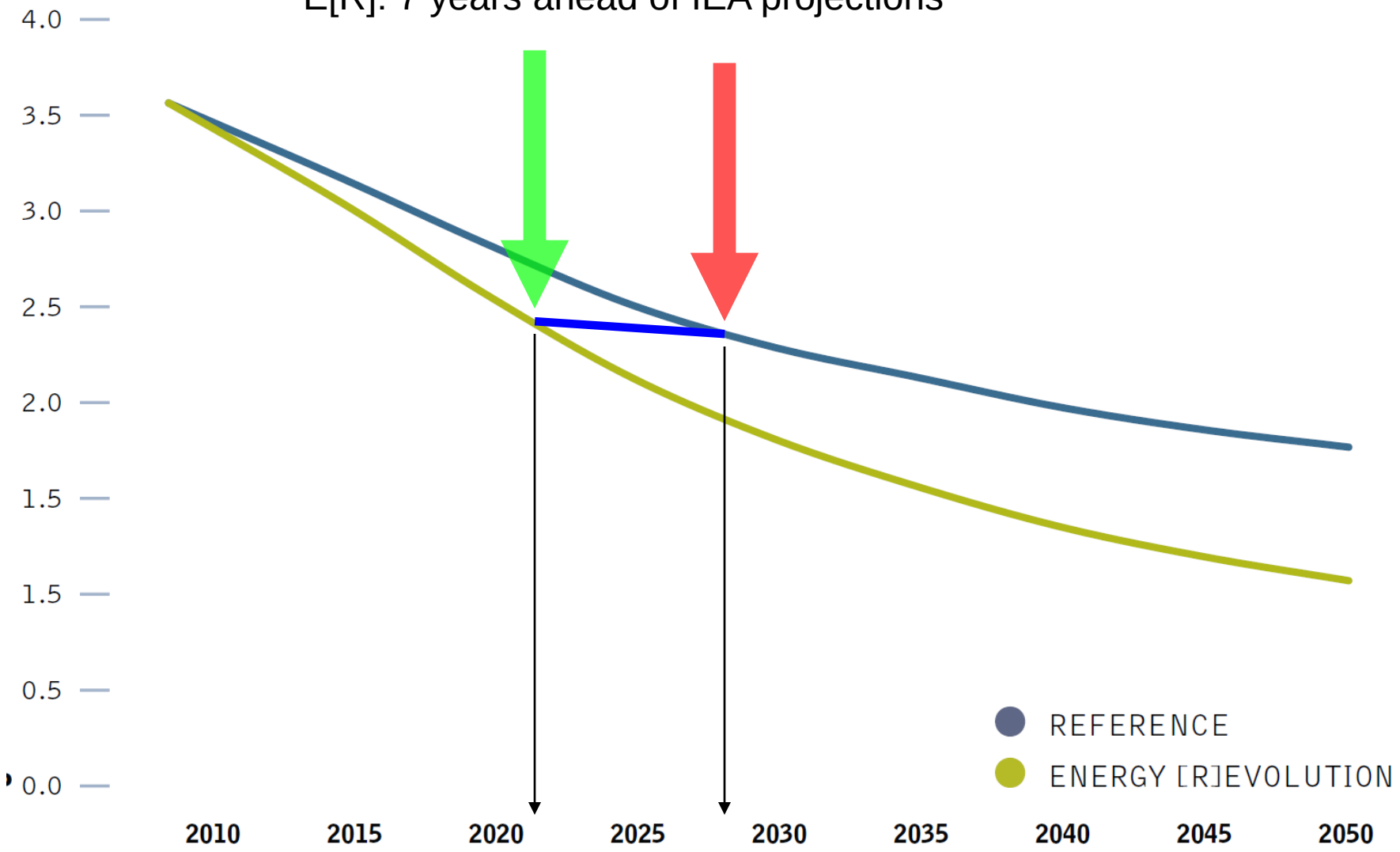
Conclusion – Efficiency indicator „Energy Intensity“

E[R]: 7 years ahead of IEA projections



The Energy [R]evolution "Transition Logic":

5. Establish time lines for implementation :

a. Power Plant Market Development
b. Future Market projection

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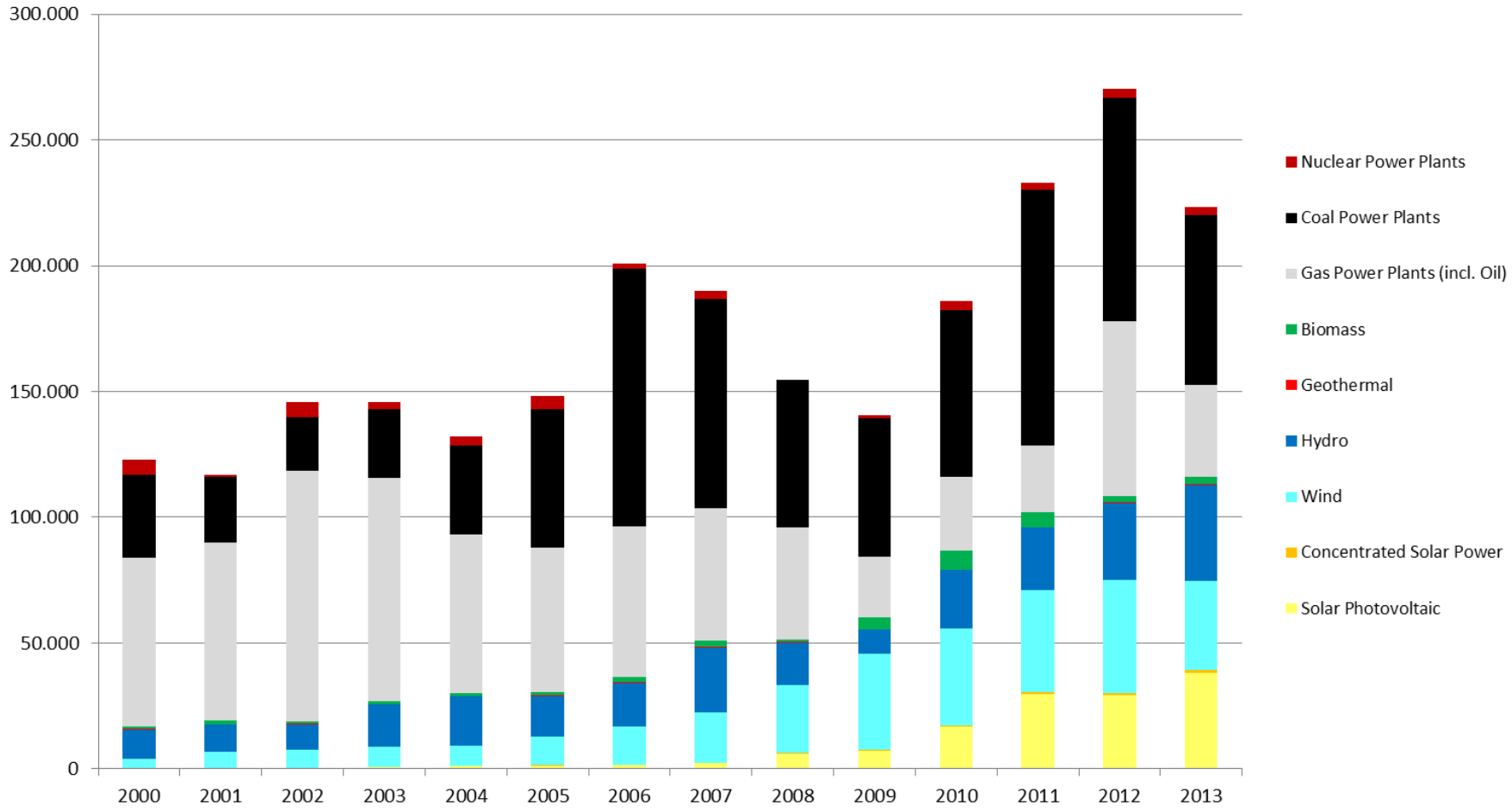
Global Power Plants - Annual Market 2000 - 2013

Sources: Platts, REN21, EWEA, GWEC, EPIA, National Statistics, IEA, Breyer - **Data Compilation:** Sven Teske/Greenpeace



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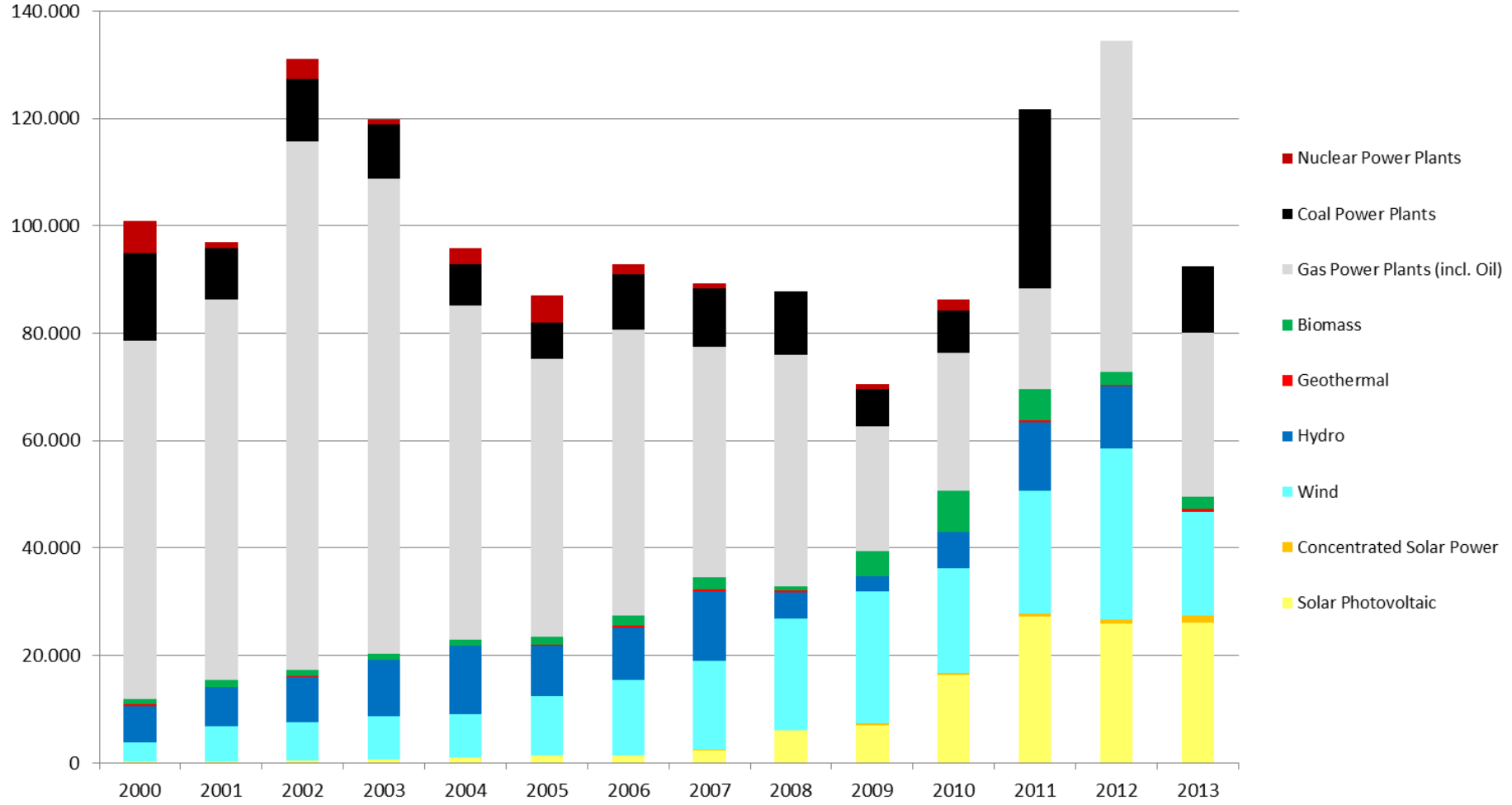
Global Power Plants - excluding China

Annual Market 2000 - 2013

[MW/a] **Sources:** Platts, REN21, EWEA, GWEC, EPIA, National Statistics, IEA, Breyer - **Data Compilation:** Sven Teske / Greenpeace



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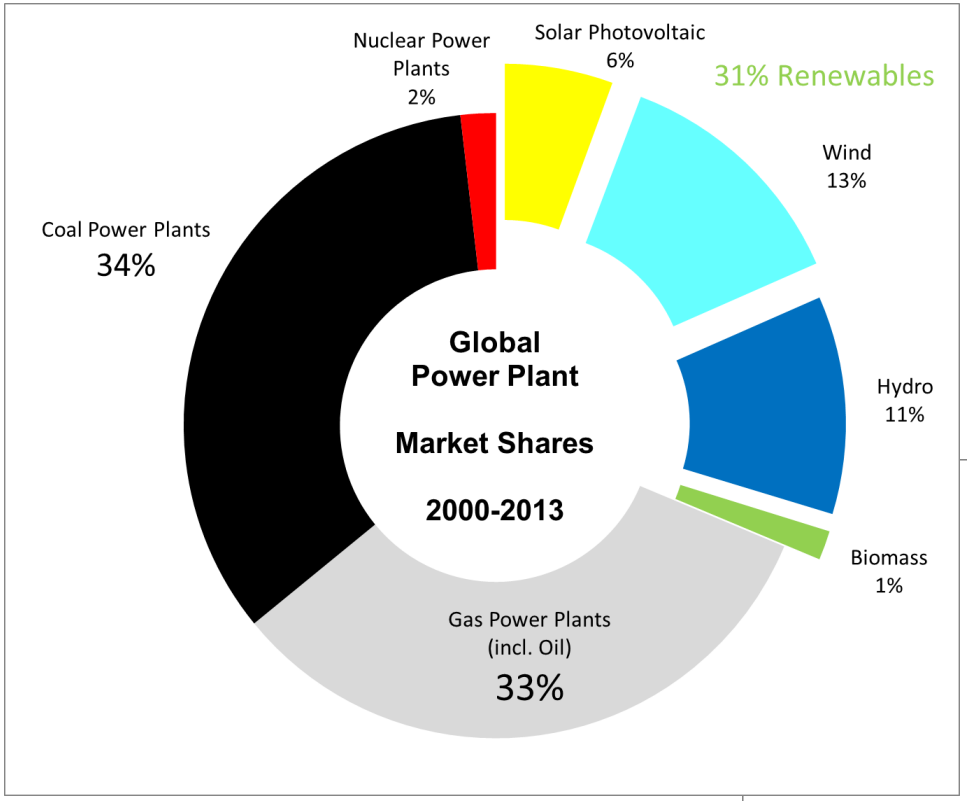

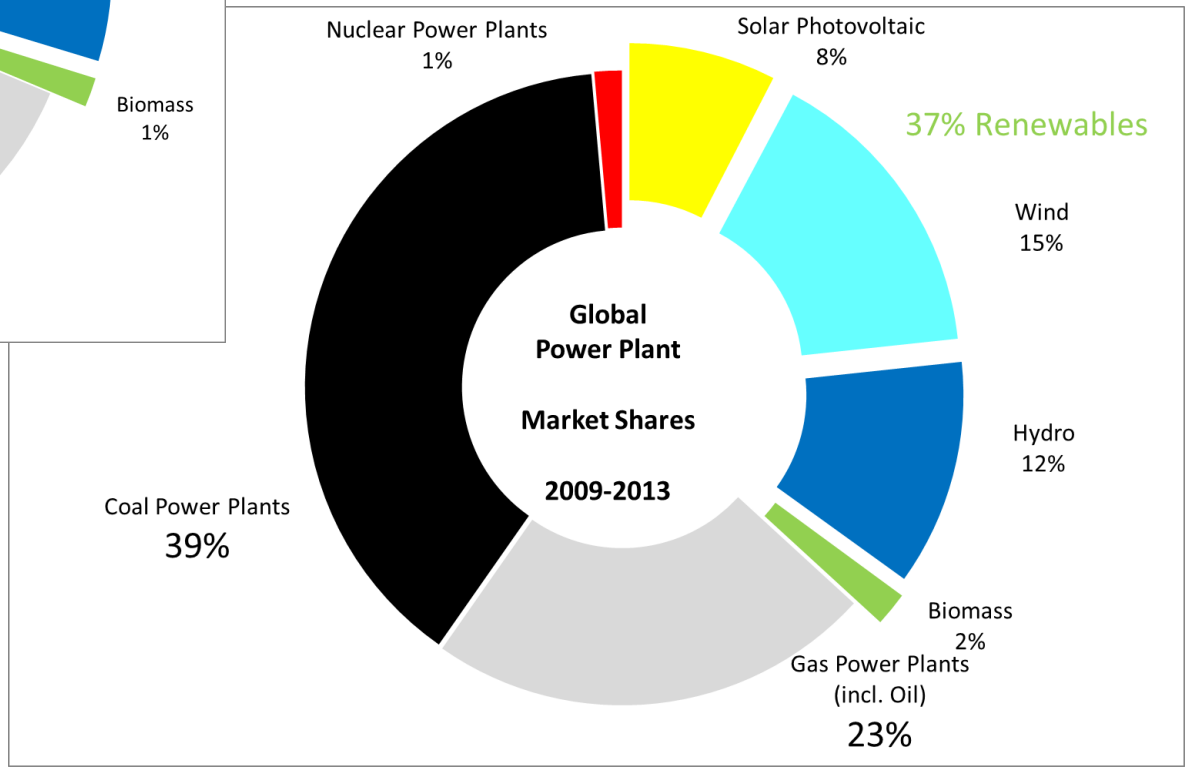

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poweE[R] 2030:

A European Grid for ¾ Renewable Electricity by 2030

Energynautics /

Greenpeace International

published in May 2014

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The Roadmap towards Independent Energy Supply

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DLR /

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figure 2.1: development of total final energy demand by sector in the energy [r]evolution scenario (high efficiency)

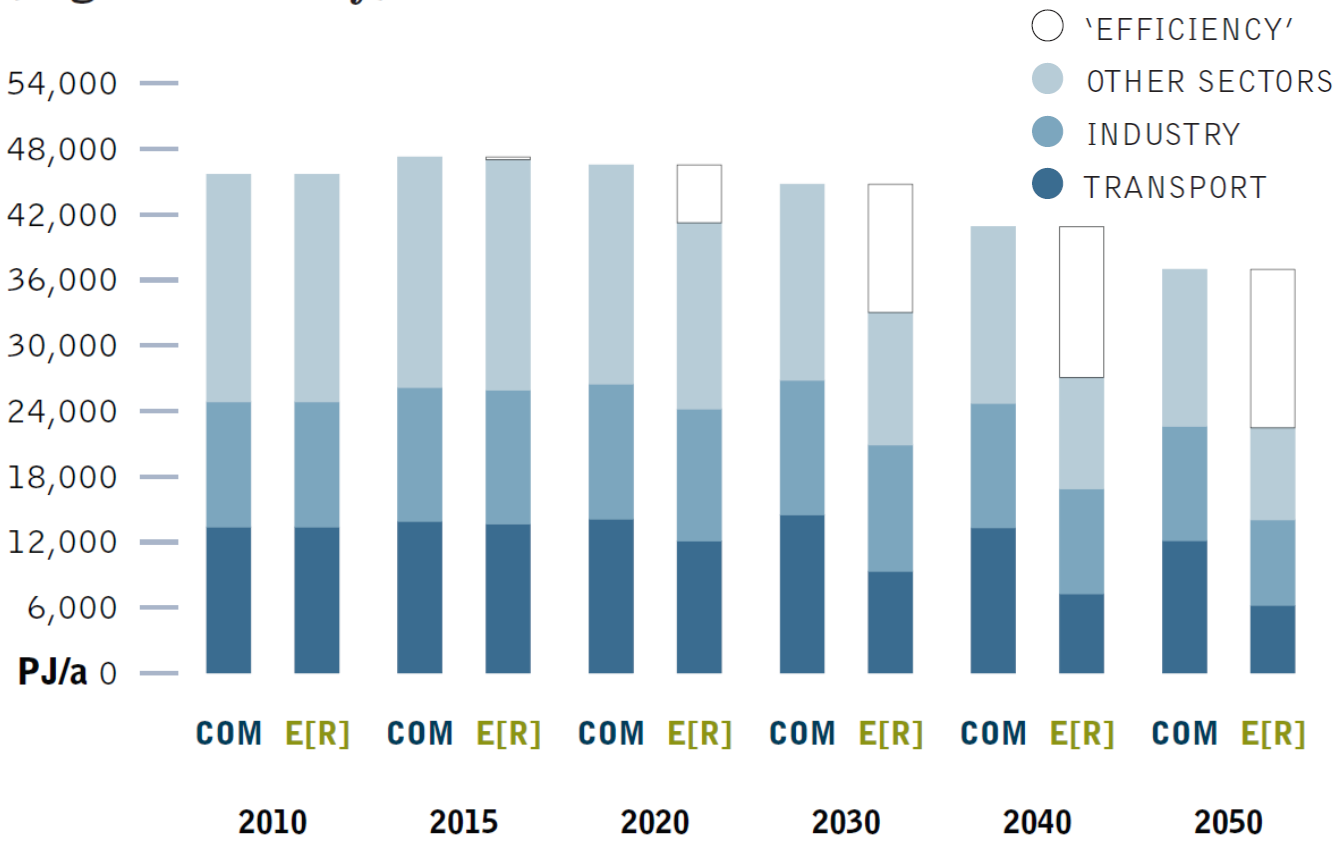

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figure 2.2: development of electricity demand by sector in the energy [r]evolution scenario (high efficiency)

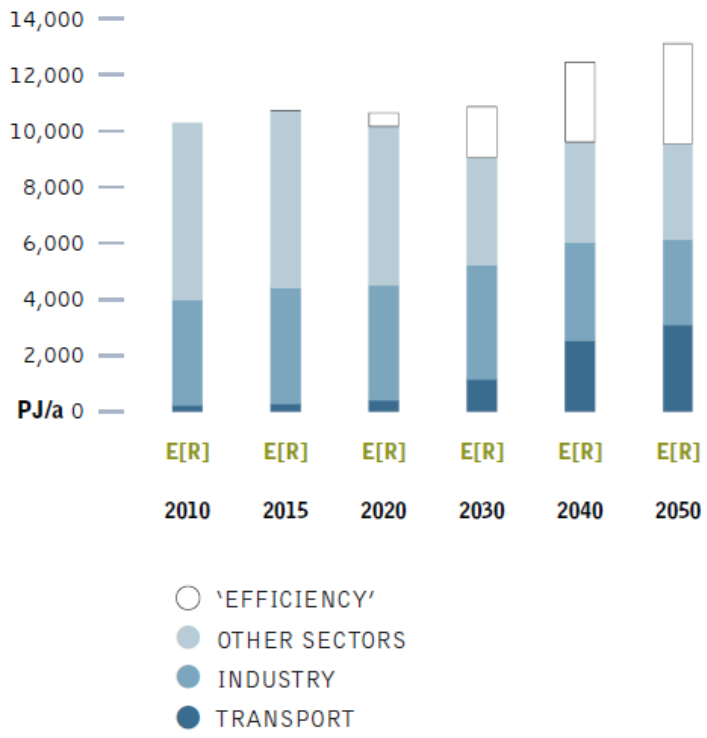

figure 2.3: development of heat demand by sector in the energy [r]evolution scenario (high efficiency)

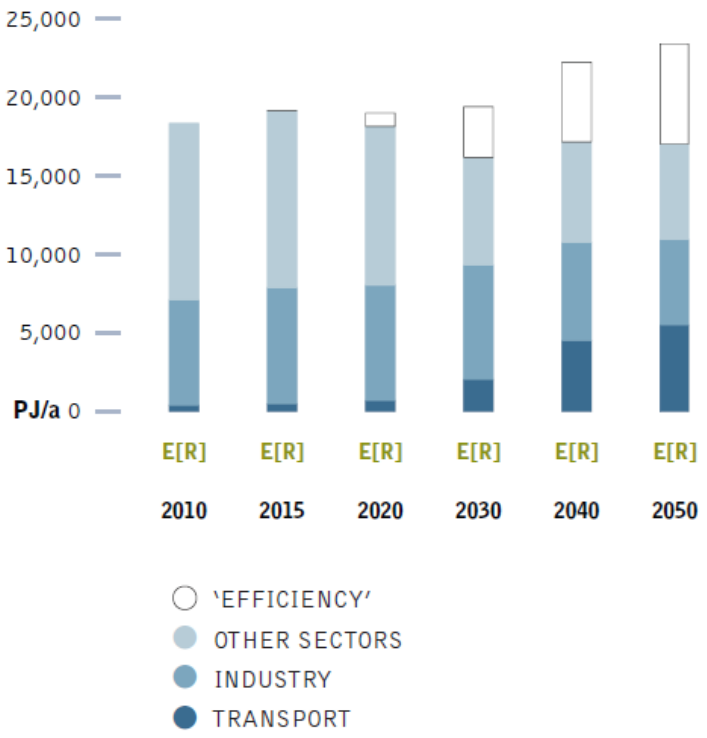

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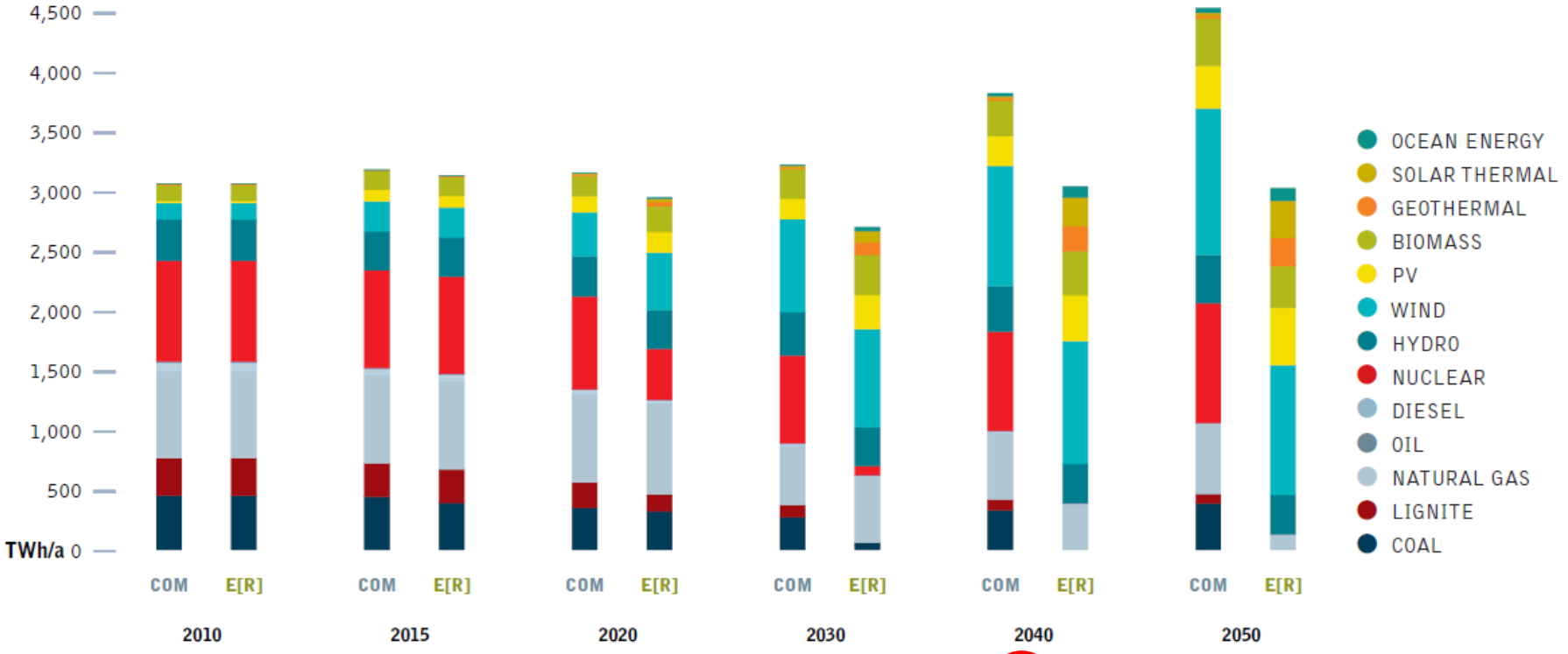
figure 2.4: electricity generation structure under the COM and the energy [r]evolution scenario (high efficiency)

(INCLUDING ELECTRICITY FOR ELECTROMOBILITY, HEAT PUMPS AND HYDROGEN GENERATION)



TWh/a	2010	2015	2020	2030	2040	2050
Power plants	**2,644**	**2,716**	**2,443**	**2,137**	**2,526**	**2,628**
Fluctuating RES (PV, Wind, Ocean)	173	381	720	1,240	1,634	1,812
Share of fluctuating RES	5.2%	11.2%	22.5%	42.3%	49.4%	54.7%
RES share (domestic generation)	**20.9%**	**26.9%**	**42.9%**	**74.1%**	**87.0%**	**95.0%**
'Efficiency' savings (compared to Com.)	**0**	**0**	**152**	**597**	**855**	**1,059**

table 2.4: renewable electricity generation capacity under the COM scenario and the energy [r]evolution scenario (high efficiency) IN GW

		2010	2020	2030	2040	2050
Hydro	COM	147	156	170	178	186
	E[R]	147	152	152	153	154
Biomass	COM	23	29	41	49	63
	E[R]	23	36	56	61	59
Wind	COM	83	188	383	454	519
	E[R]	83	270	477	546	569
Geothermal	COM	1	2	2	3	4
	E[R]	1	6	19	38	42
PV	COM	23	130	171	216	303
	E[R]	23	170	277	336	406
CSP	COM	0	2	4	5	6
	E[R]	0	7	22	54	68
Ocean energy	COM	0	0	2	7	12
	E[R]	0	3	10	28	32
Total	**COM**	**277**	**507**	**772**	**912**	**1,093**
	E[R]	**277**	**607**	**907**	**1,103**	**1,211**

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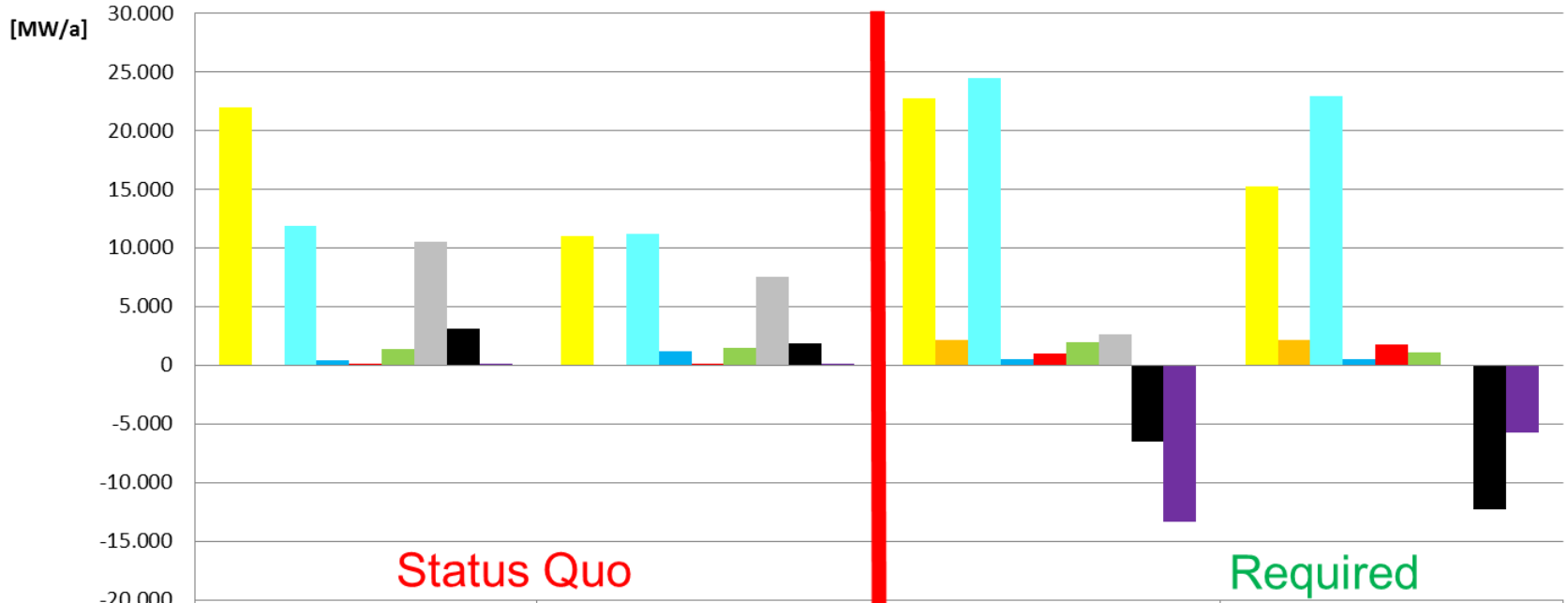
EU 28 - Annual Power Plant Market

Status 2012 + 2013 versus required under Energy [R]evolution for 2020 + 2025



	2012	2013	2020	2025
Solar Photovoltaic	22.000	10.975	22.714	15.219
Concentrated Solar Power	0	0	2.129	2.126
Wind	11.895	11.159	24.504	22.925
Hydro	424	1.216	510	526
Geothermal	5	10	976	1.709
Biomass	1.388	1.455	1.936	1.121
Gas Power Plants (incl. Oil)	10.534	7.491	2.580	-58
Coal Power Plants	3.065	1.900	-6.479	-12.278
Nuclear Power Plants	22	120	-13.312	-5.708

figure 2.5: development of total electricity supply costs & of specific electricity generation costs

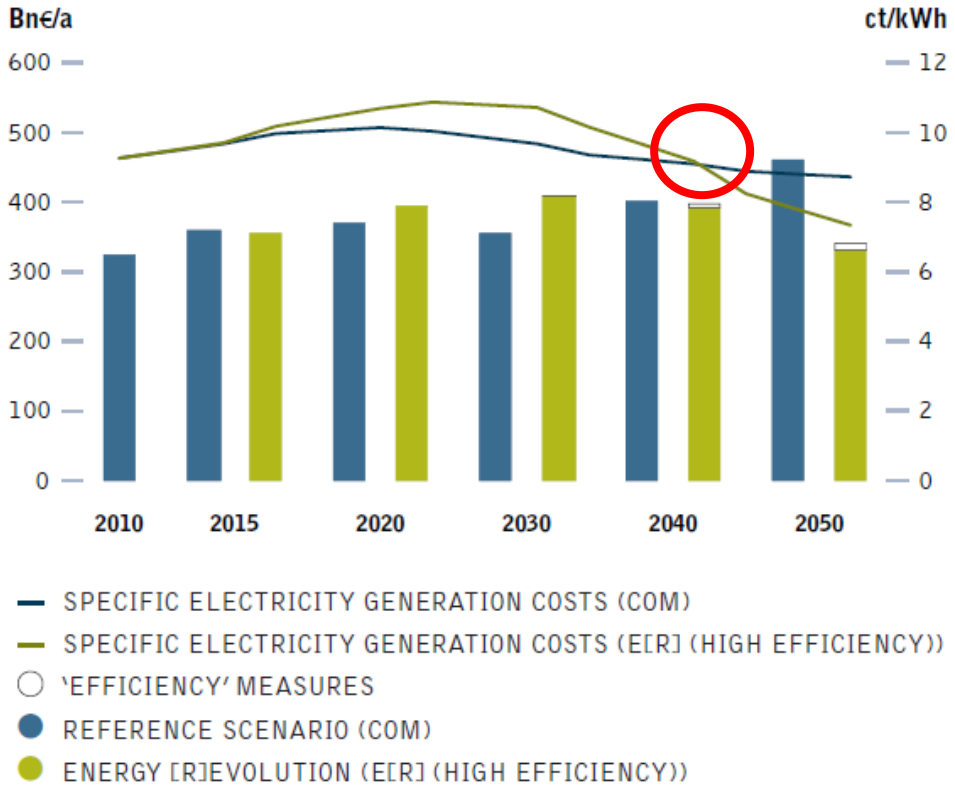


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figure 2.7: development of total transport energy demand by fuel under the COM and the energy [r]evolution scenario (high efficiency)

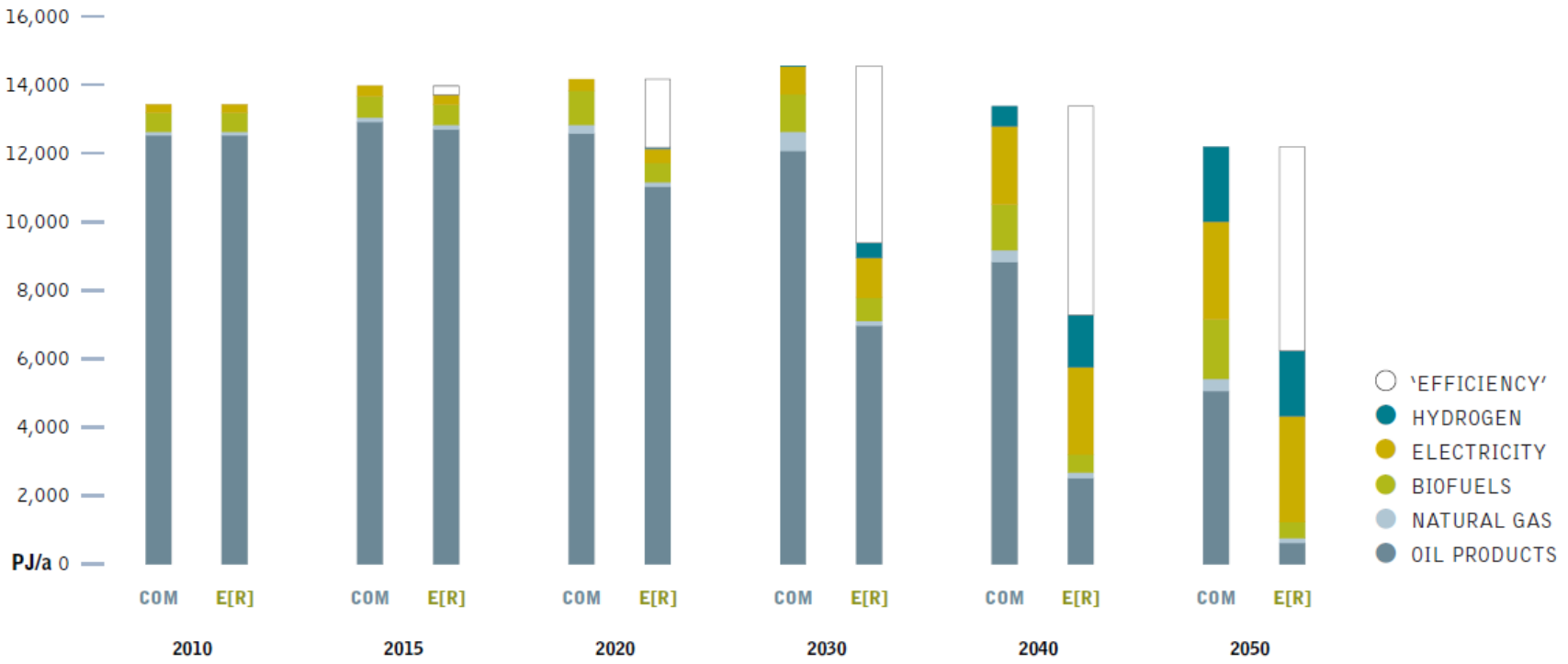

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figure 1.1: **gas-production 1990-2010 and projection until 2050 for europe**

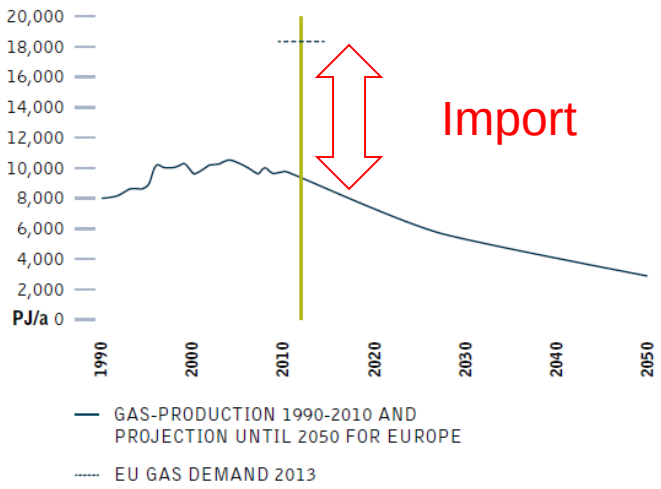
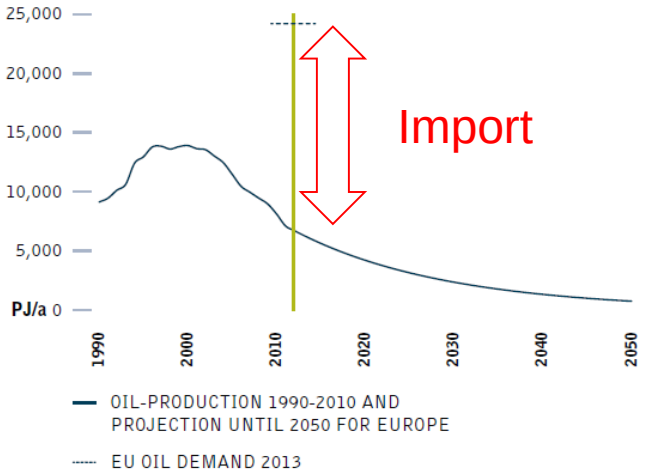


figure 1.2: **oil-production 1990-2010 and projection until 2050 for europe**



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Policy Demands:

<u>Setting mandatory and binding targets for 2030:</u>
45% RE
40 % EE (basis 2005)
-55% CO2 (basis 1990)

<u>Measures</u>

1. Strictly implement & strengthen existing EU energy efficiency legislation
2. Set-up an EU Energy Security Fund for buildings renovation
3. Eliminate subsidies for fossil and nuclear energy technologies
4. Improve electricity grid connections between EU countries
5. Plan infrastructure projects using the rights assumptions

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Thank you for listening!

More information:

www.energyblueprint.info
www.greenpeace.org

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Annex:

Energy Publications from Greenpeace

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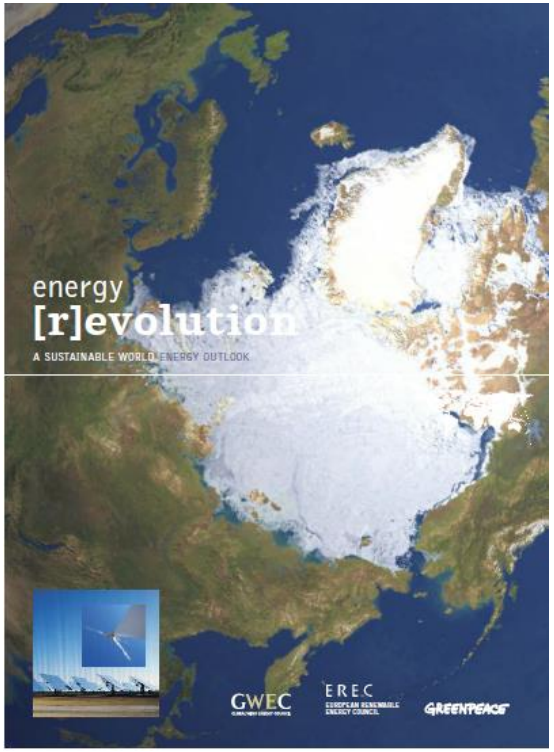
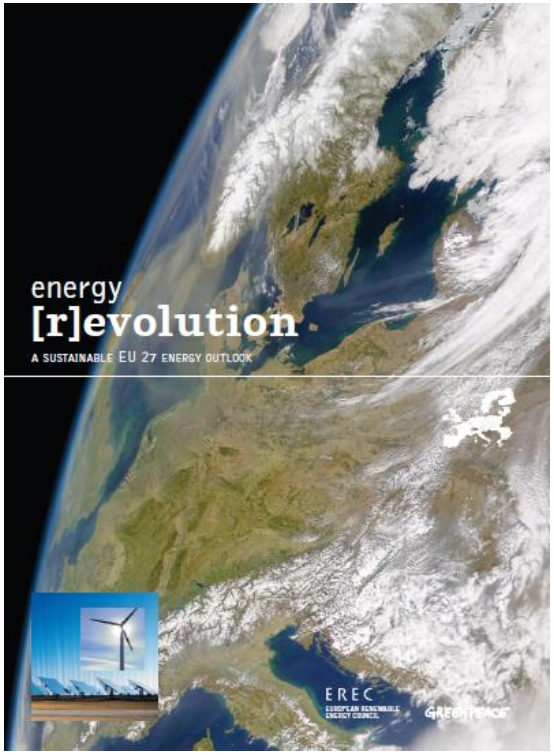
Scientifical Publications:

Energy Scenarios





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2. E[R] South Korea (04/2012)
3. E[R] Global (06/2012)
4. E[R] Czech Rep. (06/2012)
5. E[R EU 27 (10/2012)
6. E[R] India (11/2012)
7. E[R] Finland (11/2012)
8. E[R] Romania (11/2012)

- Global Wind Energy Outlook (11/2012)

9. E[R] Mexico (01/2013)
10. E[R] France (01/2013
11. E[R] New Zealand (02/2013)
12. E[R] Israel (04/2013)
13. E[R] Brazil (08/2013)
14. E[R] ASEAN (09/2013)
15. E[R] Poland (10/2013)
16. E[R] Switzerland (10/2013
17. E[R] Italy (11/2013)
18. E[R] USA (05/2014)
19. E[R] Turkey (11/2014)

- Global Wind Energy Outlook (11/2014)

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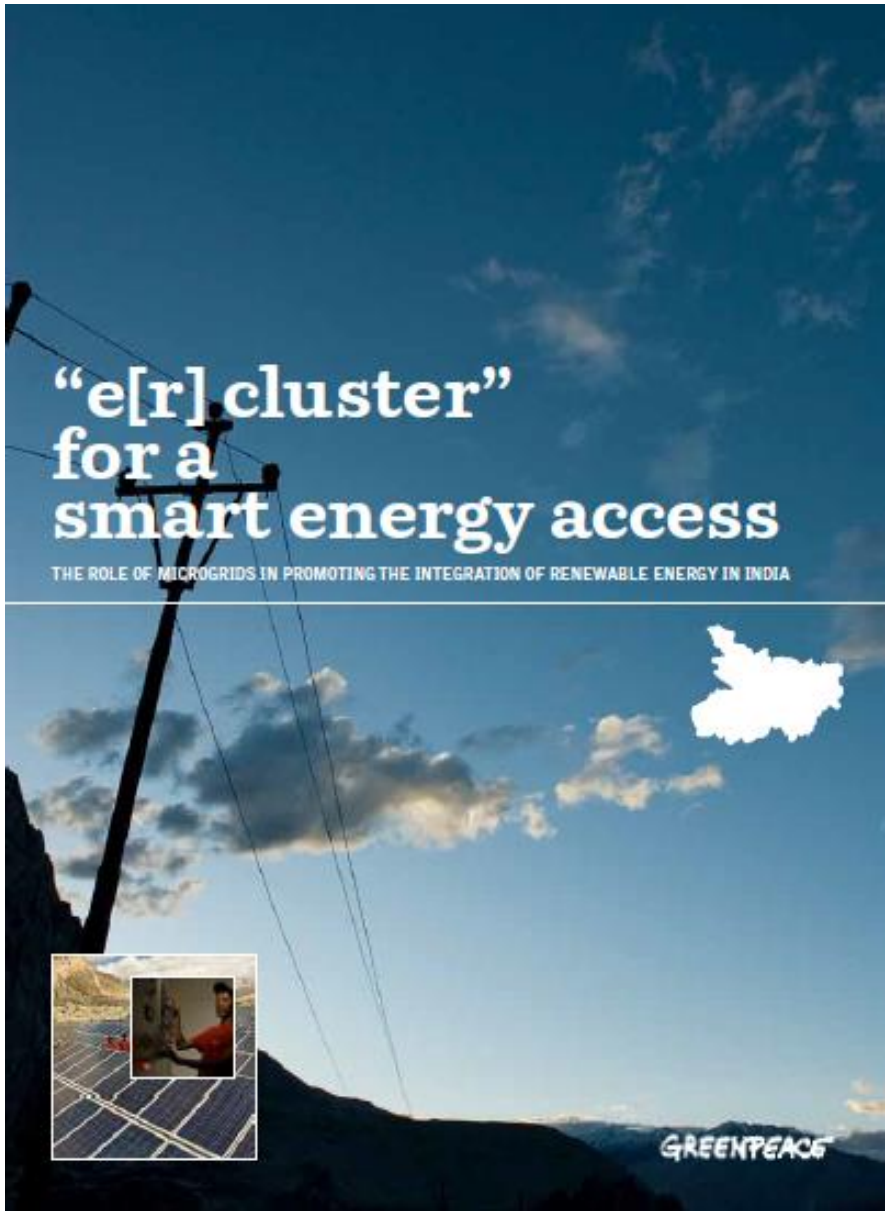

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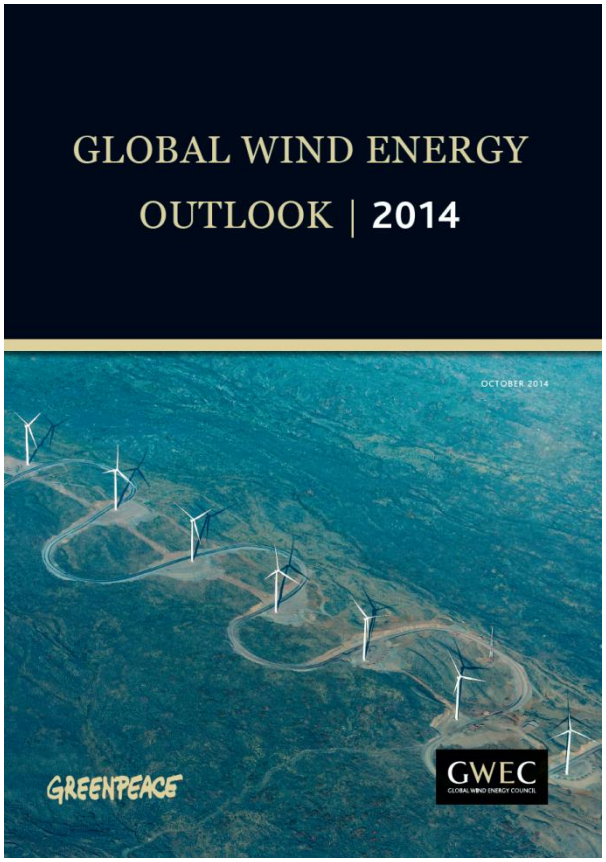

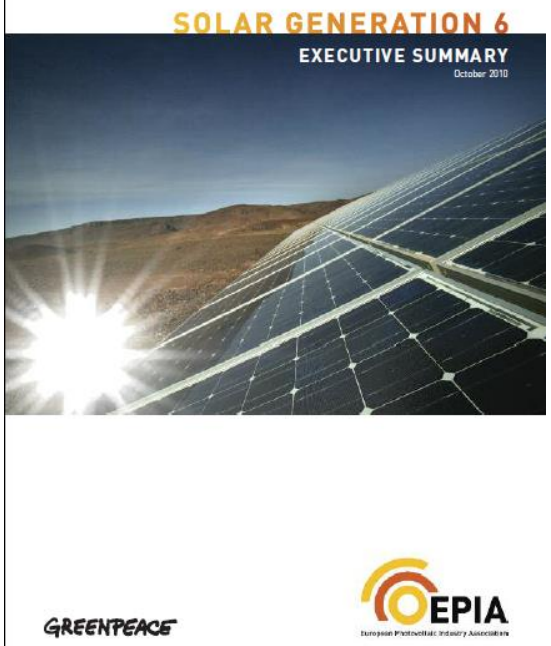

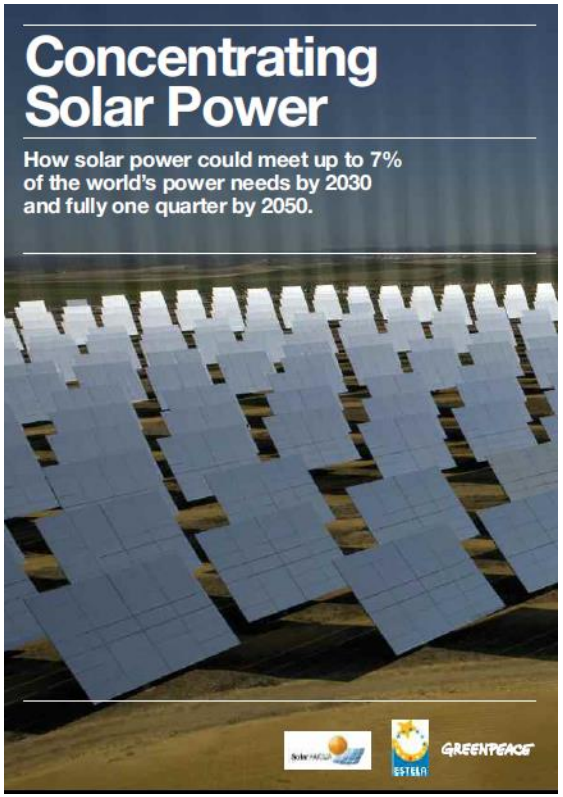

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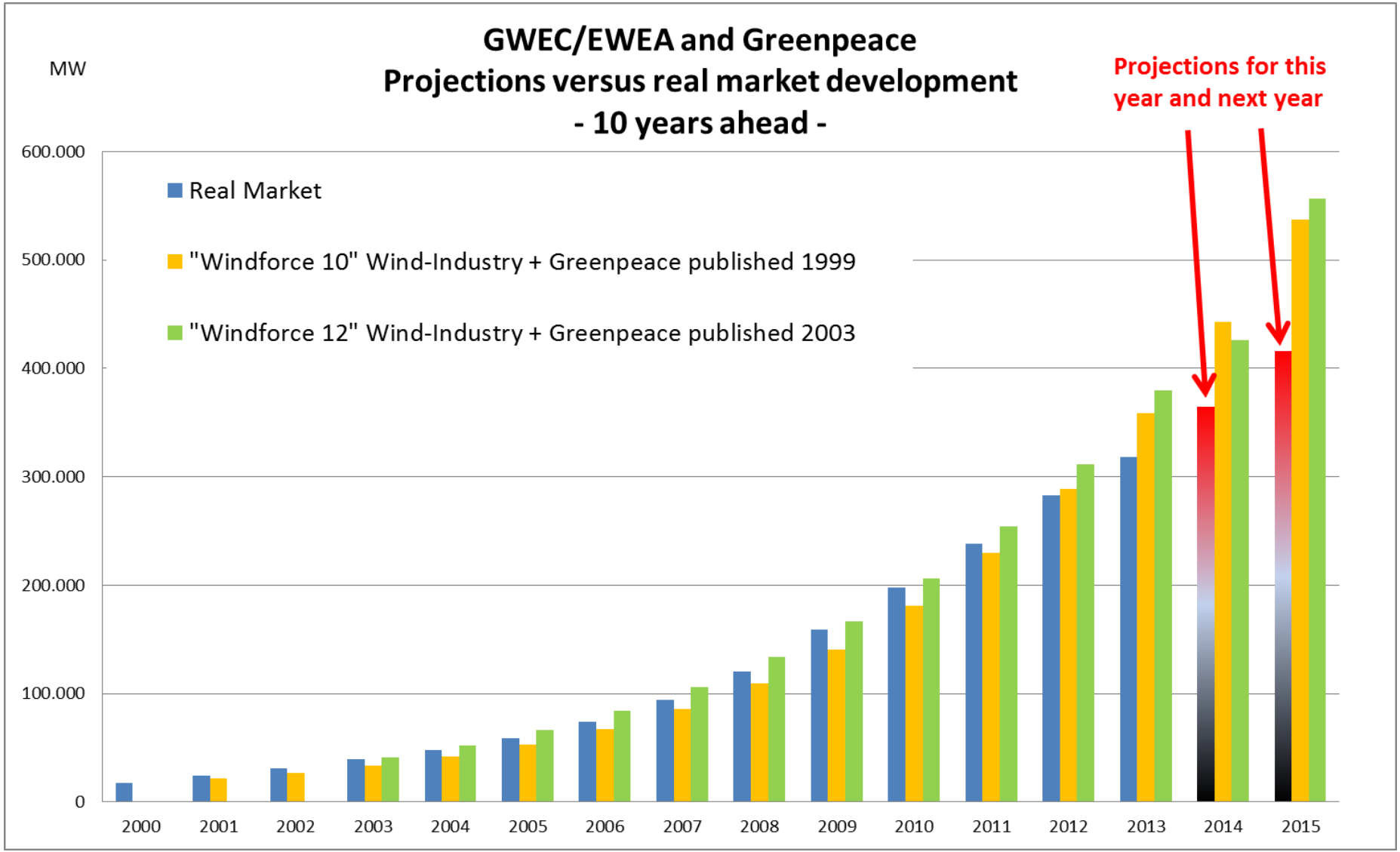
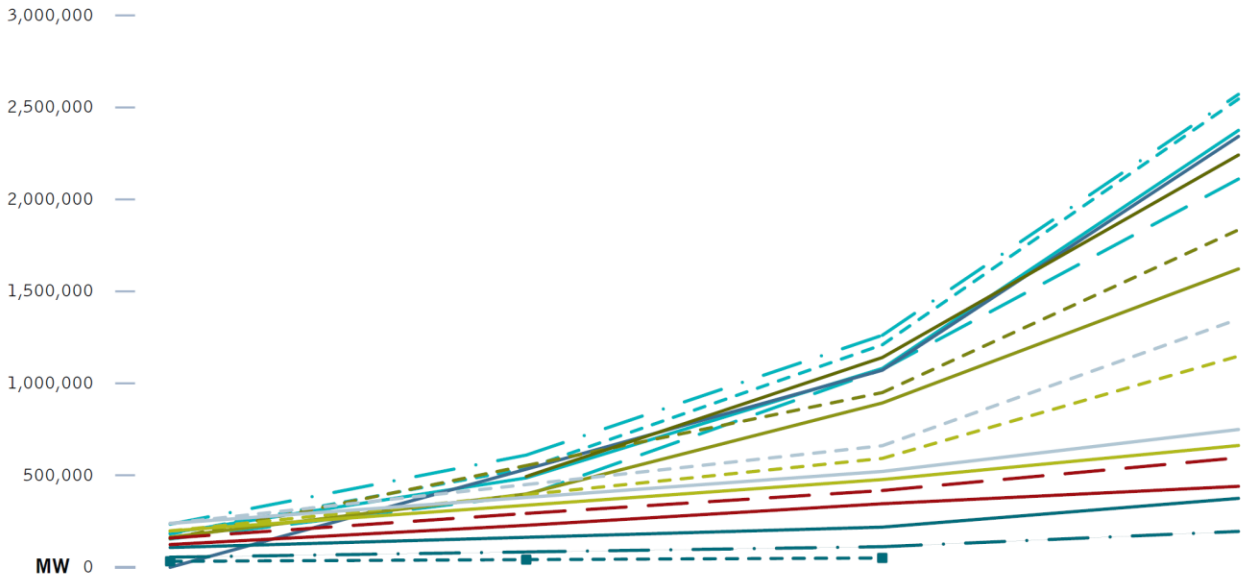
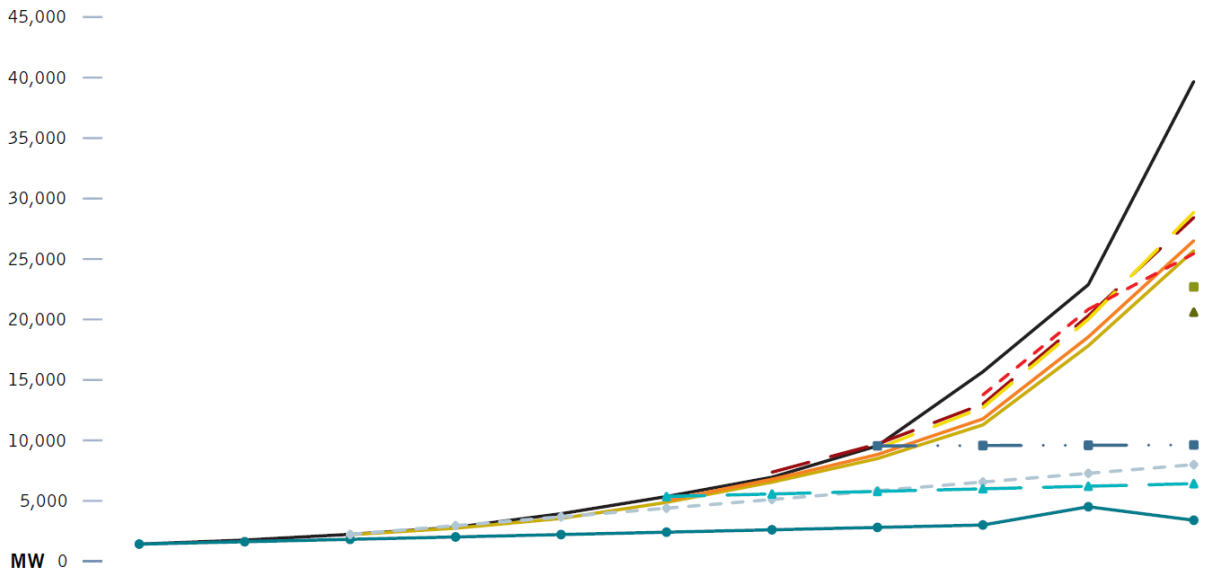


figure 4.7: **wind power: long term market projects until 2030**



	2010	2015	2020	2030
WF 10 (1999)	181,252	537,059	1,209,466	2,545,232
WF 12 (2002)	233,905	610,000	1,261,157	2,571,000
GWEO 2006 (Advanced)	153,759	391,077	1,074,835	2,110,401
GWEO 2008 (Advanced)	186,309	485,834	1,080,886	2,375,000
GWEO 2008 (Advanced)	0	533,233	1,071,415	2,341,984
E[R] 2007	156,149	552,973	949,796	1,834,286
E[R] 2008	163,855	398,716	893,317	1,621,704
ADVANCED E[R] 2010		493,542	1,140,492	2,241,080
IEA WEO 2000 (REF)	32,500	41,550	50,600	
IEA WEO 2002 (REF)	55,000	83,500	112,000	195,000
IEA WEO 2005 (REF)	107,541	162,954	218,367	374,694
IEA WEO 2007 (REF)	123,660	228,205	345,521	440,117
IEA WEO 2009 (REF)	158,864	292,754	417,198	595,365
IEA WEO 2010 (REF)	197,637	337,319	477,000	662,000
IEA WEO 2010 (450ppm)	197,637	394,819	592,000	1,148,000
IEA WEO 2011 (REF)	238,351	379,676	521,000	749,000
IEA WEO 2011 (450ppm)	238,351	449,676	661,000	1,349,000

figure 4.8: **photovoltaics: short term prognosis vs real market development - global cummulative capacity**



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
REAL	1,428	1,762	2,236	2,818	3,939	5,361	6,956	9,550	15,675	22,878	39,678
SG I 2001			2,205	2,742	3,546	4,879	6,549	8,498	11,285	17,825	25,688
SG II 2004						5,026	6,772	8,833	11,775	18,552	26,512
SG III 2006							7,372	9,698	13,005	20,305	28,428
SG IV 2007 (Advanced)								9,337	12,714	20,014	28,862
SG V 2008 (Advanced)									13,760	20,835	25,447
SG VI 2010 (Advanced)											36,629
ER 2007											22,694
ER 2008											20,606
ADVANCED ER 2010											
IEA WEO 2000 (REF)	1,428	1,625	1,822	2,020	2,217	2,414	2,611	2,808	3,006	4,516	3,400
IEA WEO 2002 (REF)			2,236	2,957	3,677	4,398	5,118	5,839	6,559	7,280	8,000
IEA WEO 2005 (REF)						5,361	5,574	5,787	6,000	6,213	6,425
IEA WEO 2007 (REF)								9550	9,575	9,600	9,625