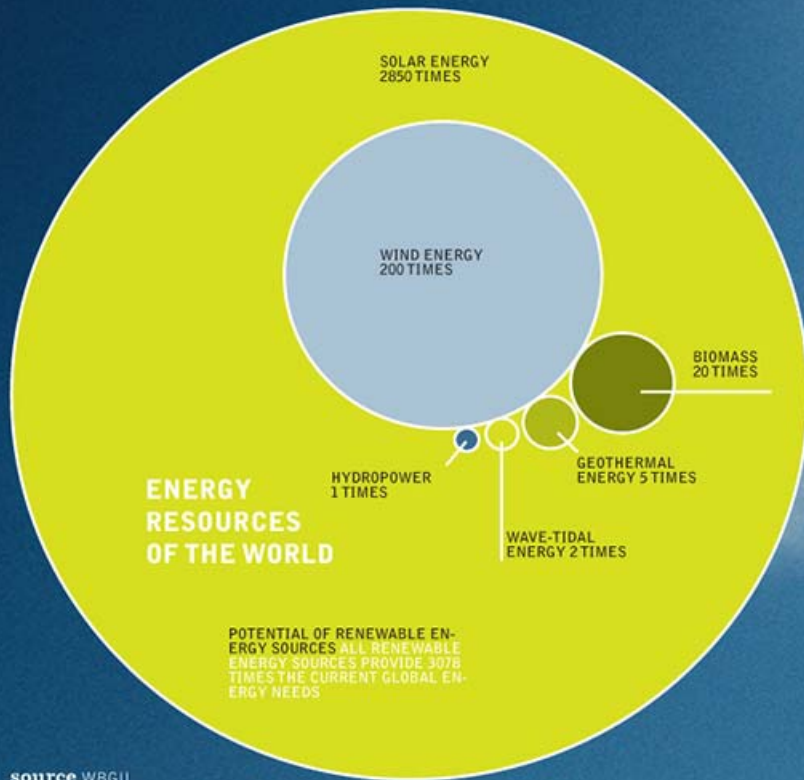


figure 10: energy resources of the world

Energy [R]evolution for India

Delhi
5th December 2008



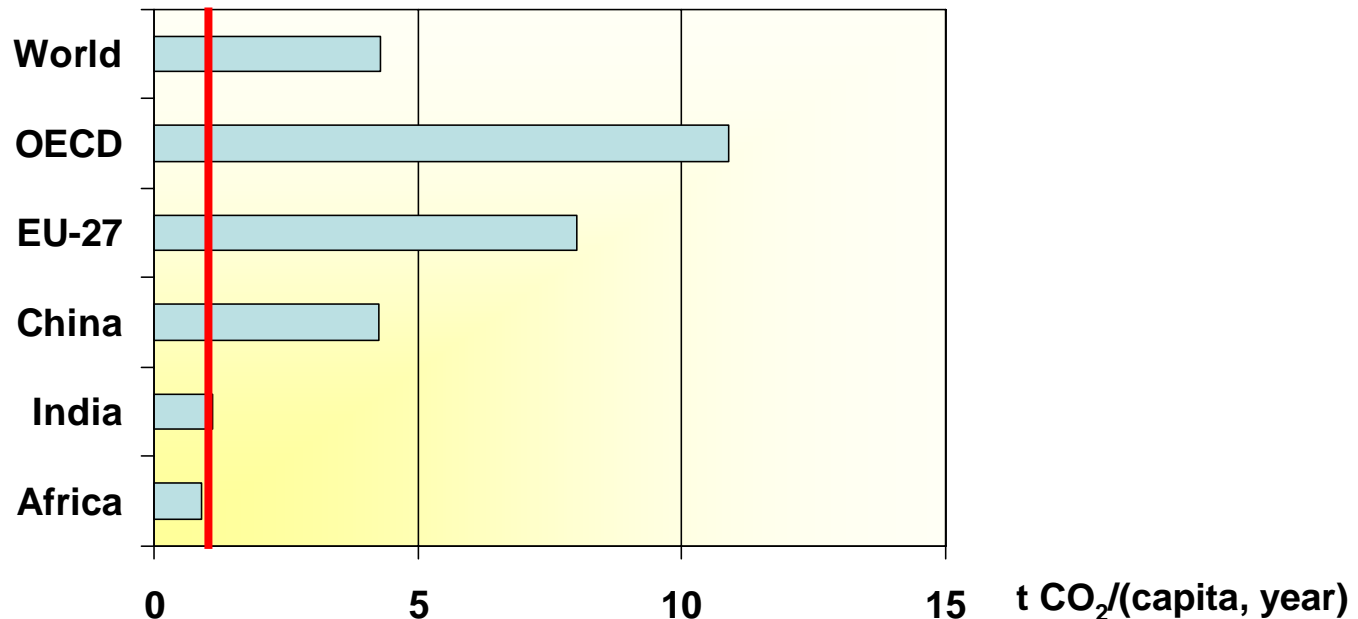
source WBGU

THE ENERGY [R]EVOLUTION SCENARIO USES ONLY 1.3% OF THE KNOWN AVAILABLE RENEWABLE ENERGY RESOURCES OF DEVELOPED ECONOMIES BY 2020 - THIS ALONE WILL PROVIDE 21% OF GLOBAL ENERGY NEEDS (BY 2020).



Climate policy targets

- Stabilize global CO₂-concentration under 400 ppm
- Global CO₂ emission peak by 2015
- Reduction of global energy related CO₂-emissions from today's 29 Gt/a to approx. 10 G t/a in 2050



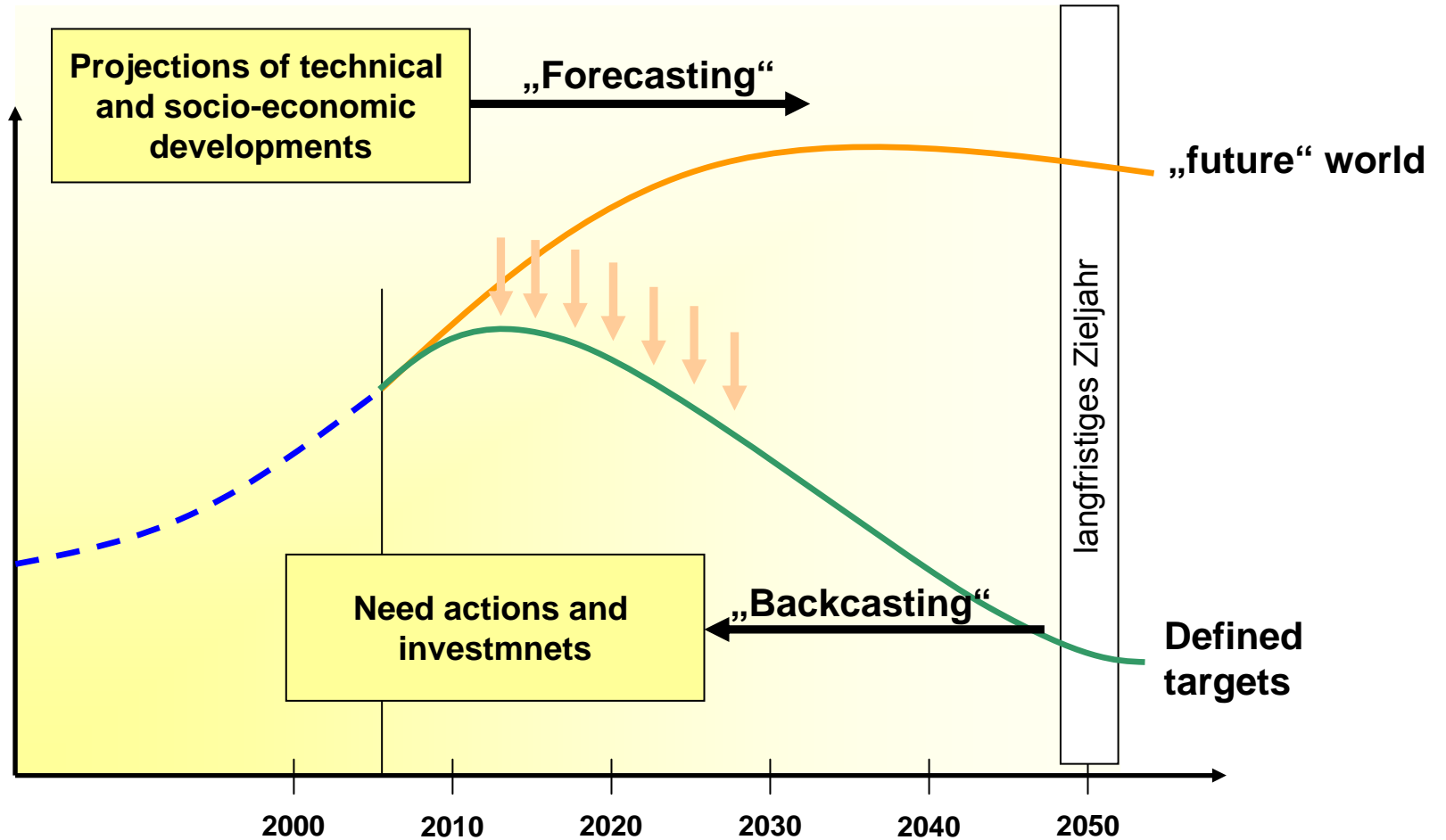


Energy Policy targets:

- 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



Development of different scenarios





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

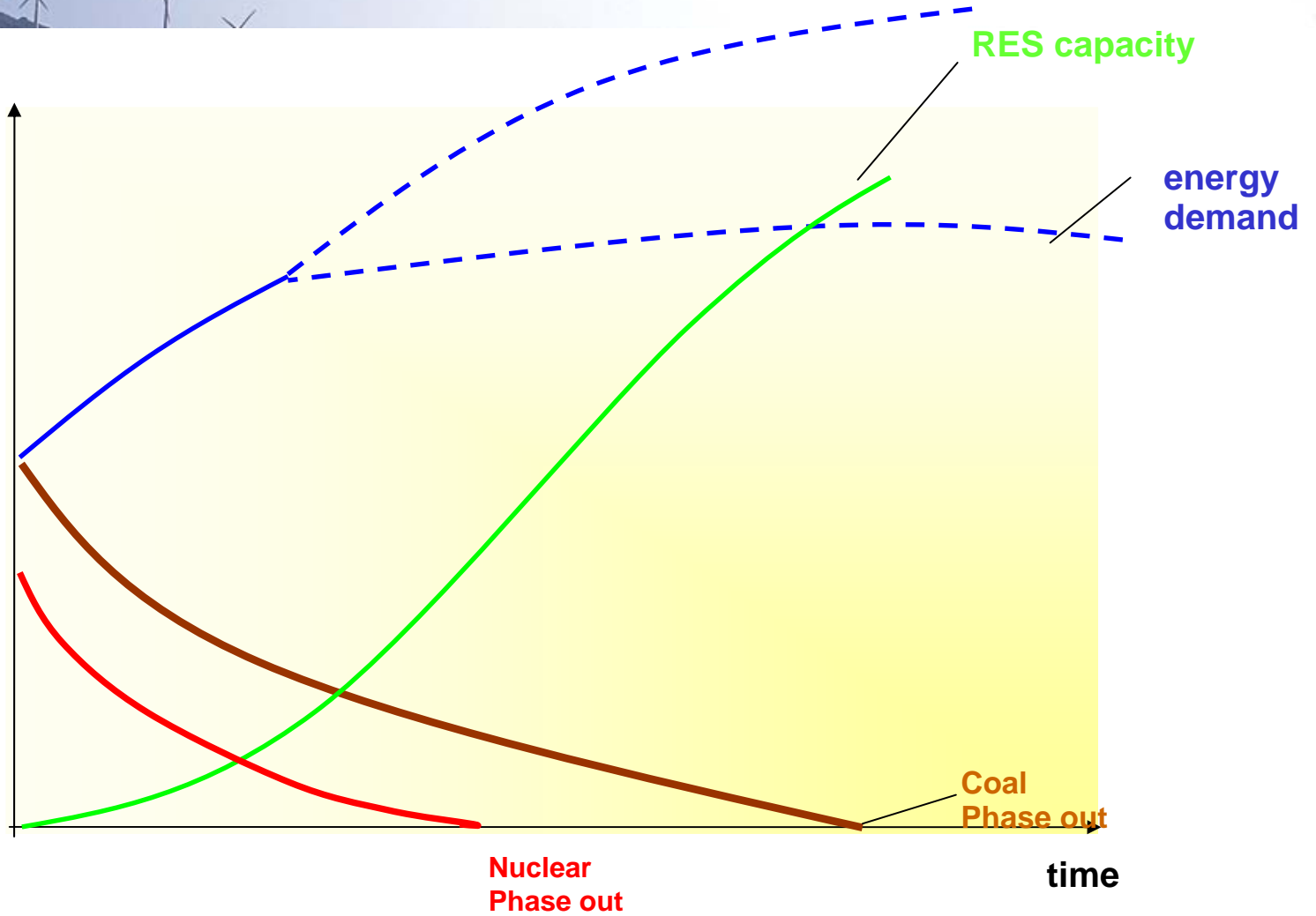
- . Decentralised energy and large scale renewables
- . Cogeneration

Step 3: Energy Efficient Transport

- . Efficient Public Transport Systems
- . Efficient Cars, Trucks etc.
- . Sustainable biofuels

Scenario principles in a nutshell

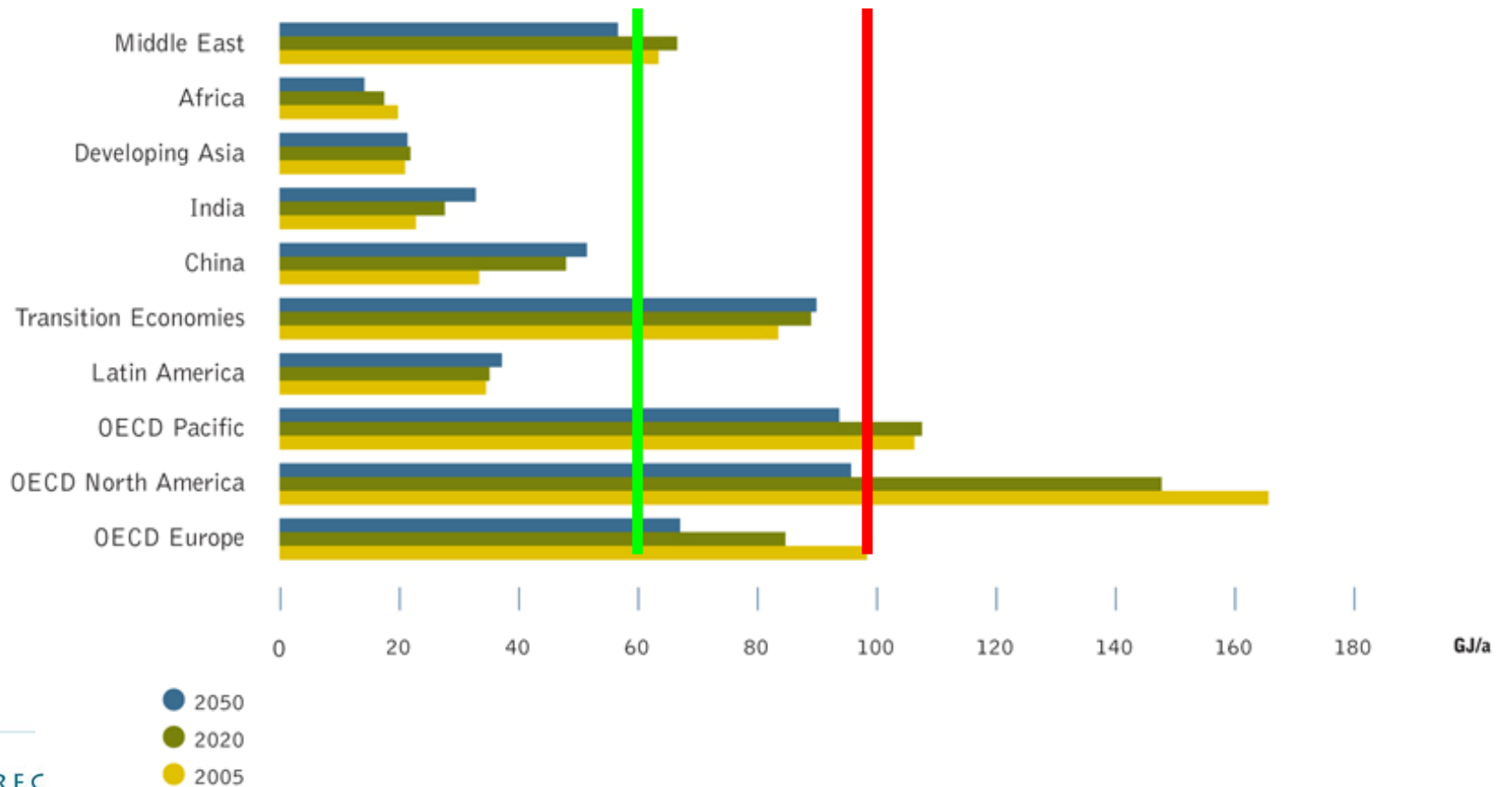
- . Smart consumption, generation and distribution
- . Energy production moves closer to the consumer
- . Maximum use of locally available, environmentally friendly fuels



the energy [r]evolution: the global context

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

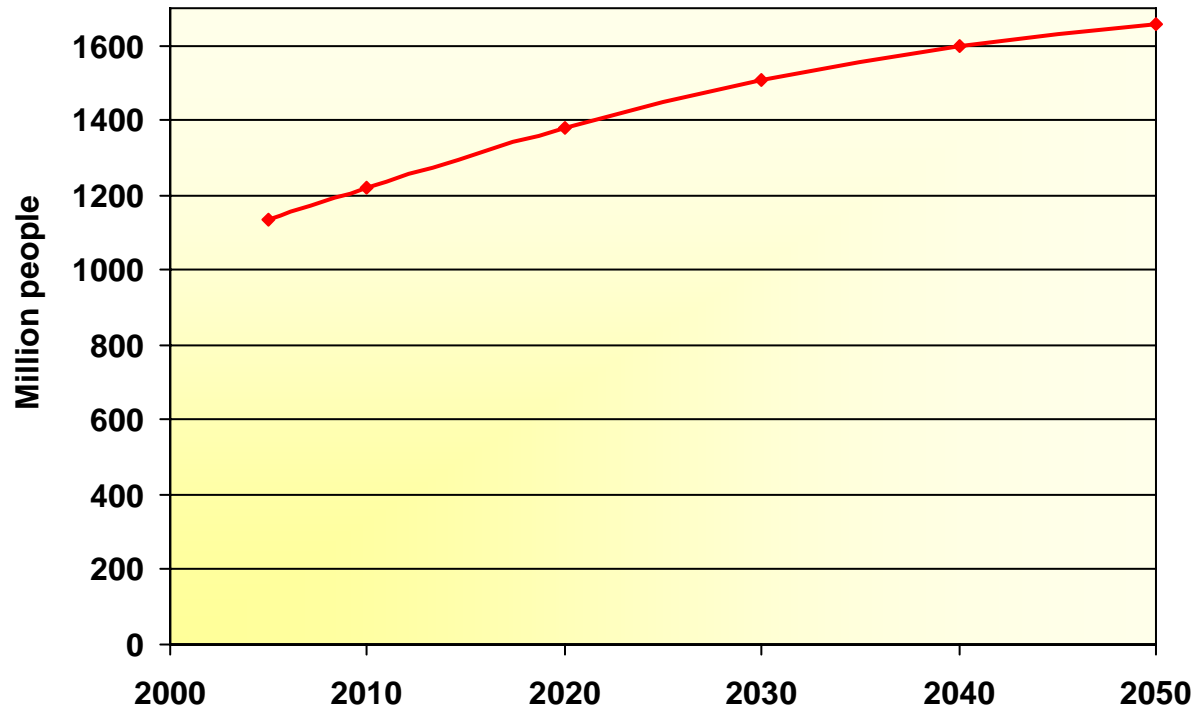
figure 1: energy use per capita





Key driver for growing energy demand

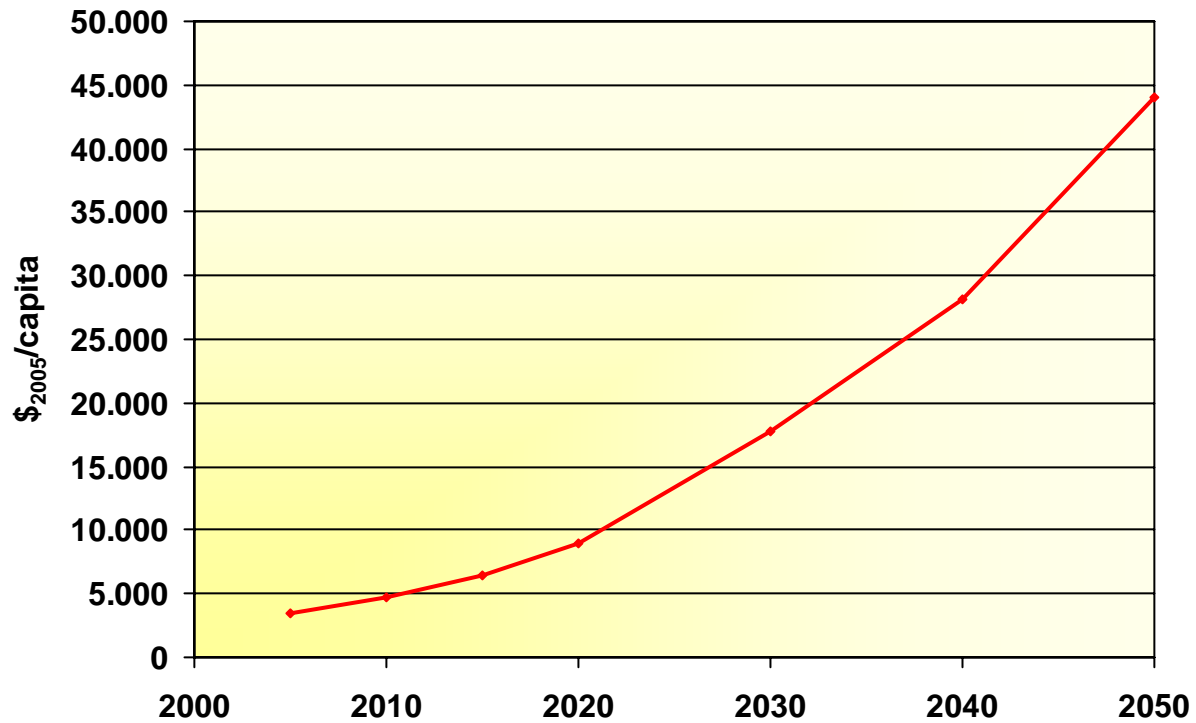
A) India's population steady growth until 2050





Key driver for growing energy demand

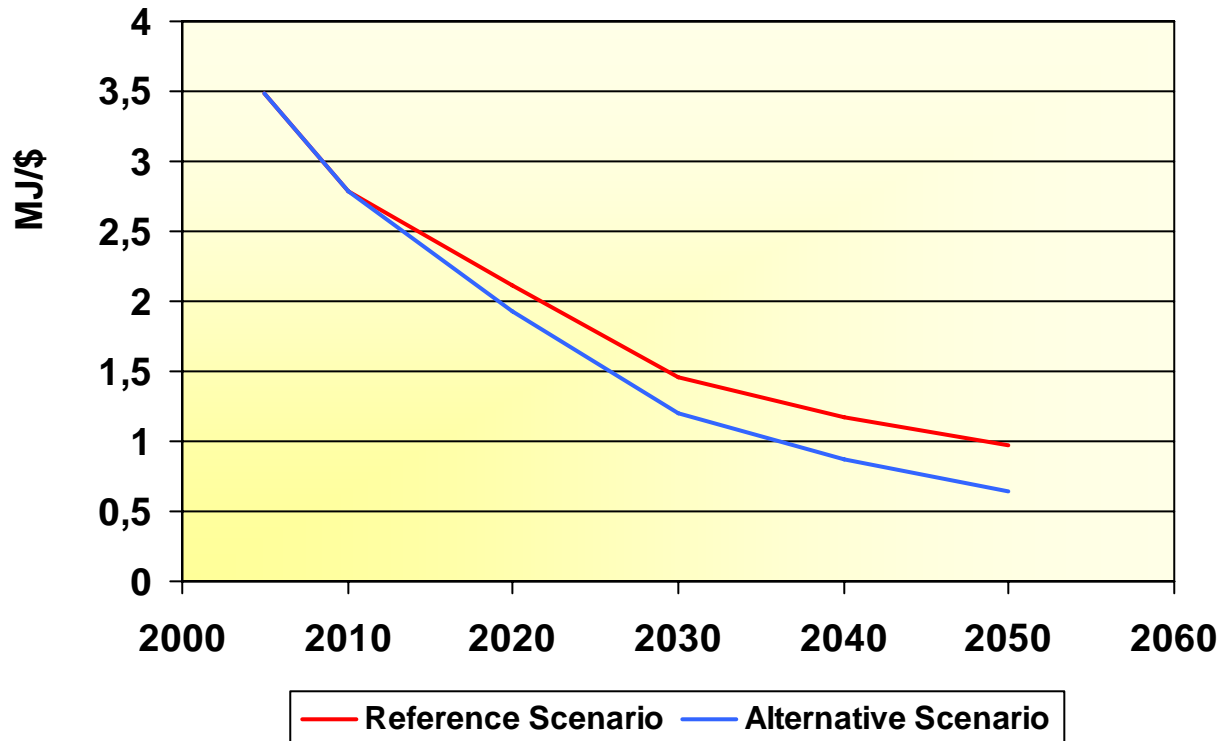
B) India GDP growth between 2005 and 2030: + 10 % average





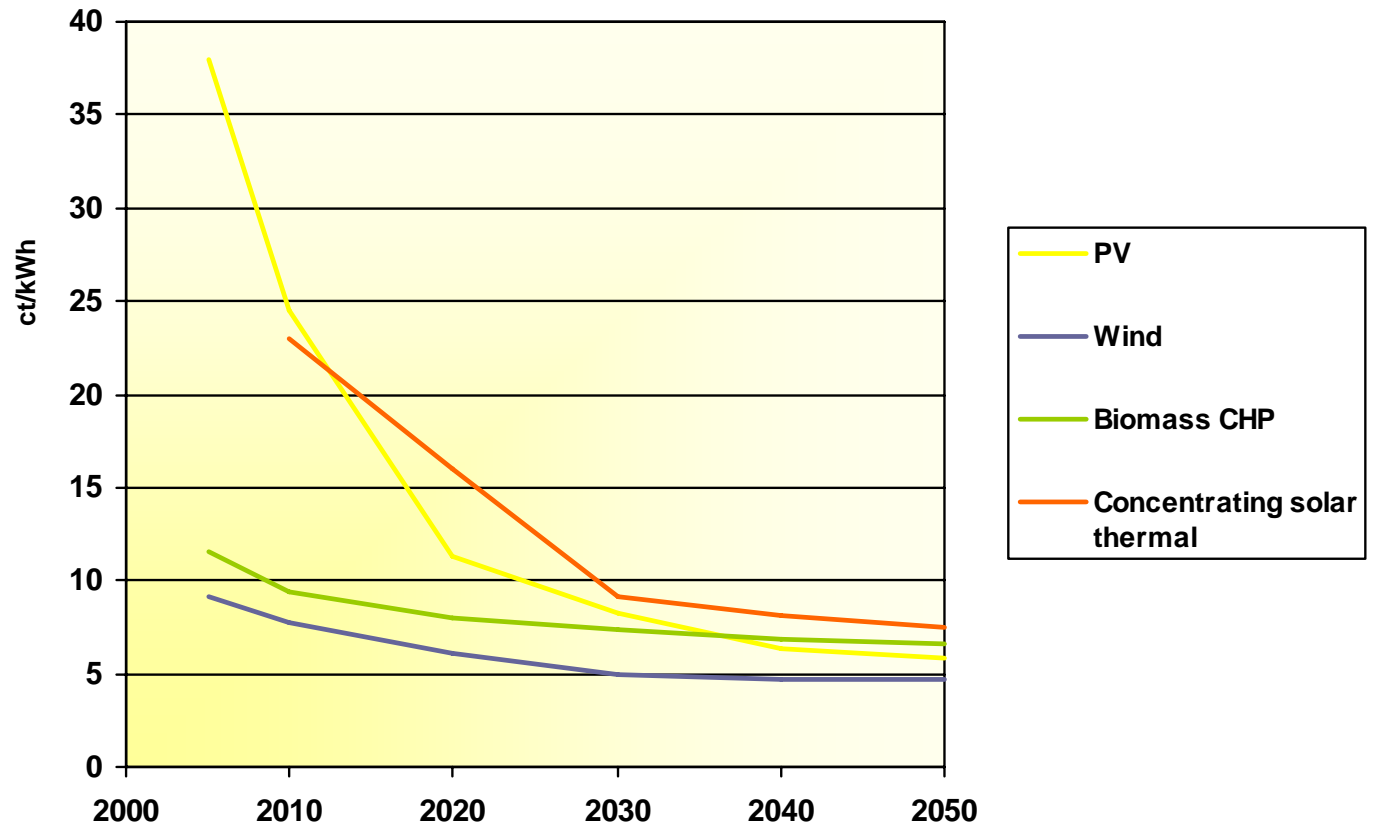
Key driver for growing energy demand

C) India's Energy intensity: technical potential for energy efficiency largely exploited





Cost development of renewable electricity generation





Fossil Fuels costs (Imports)

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

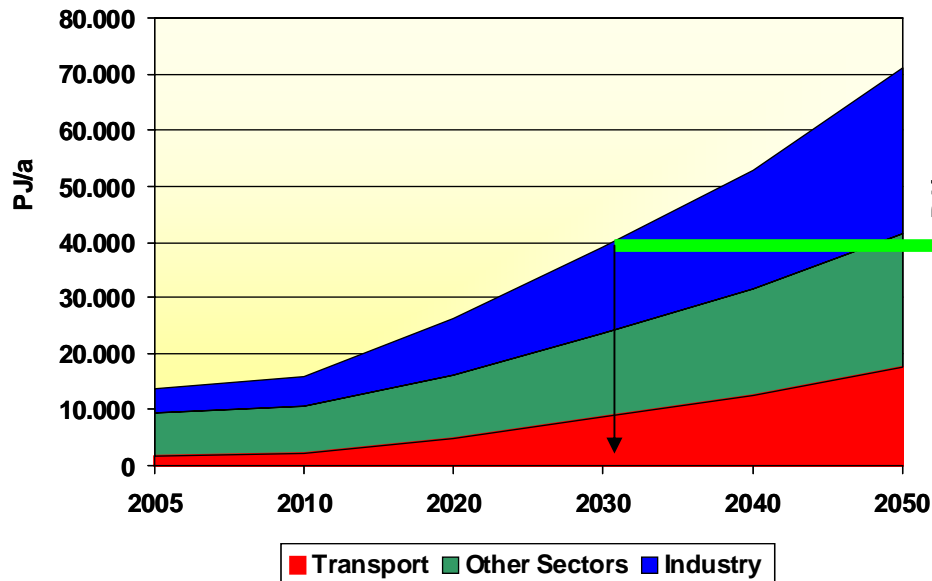
the energy [r]evolution: demand development

The Energy [R]evolution scenario saves over 20 Exa-Joule by 2050

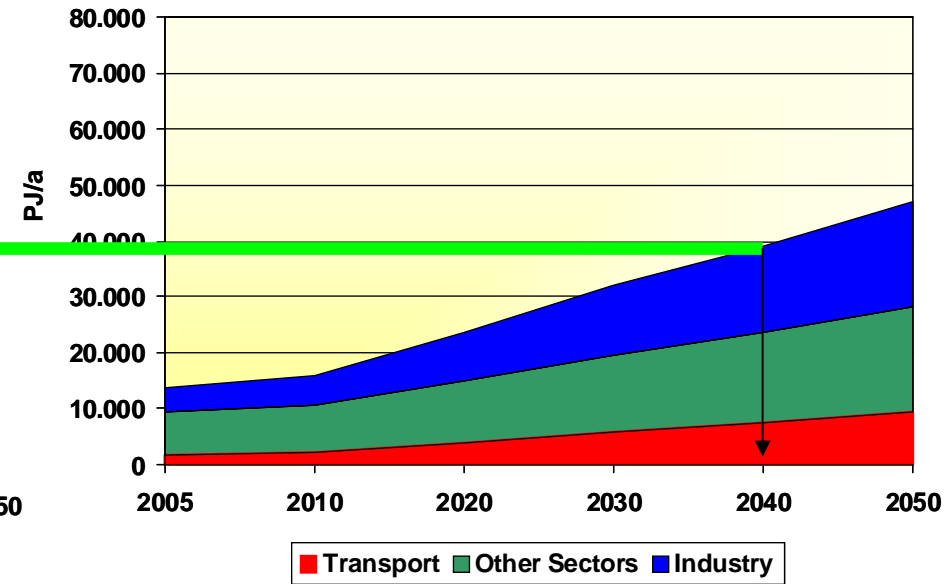
Most important mesasures:

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

Reference Scenario



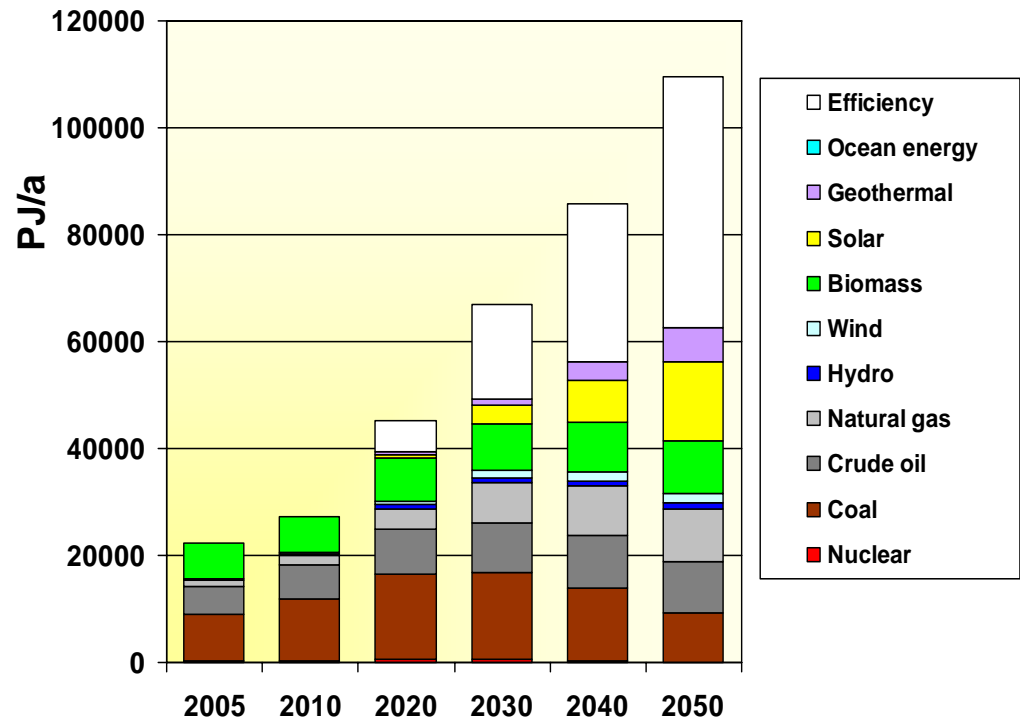
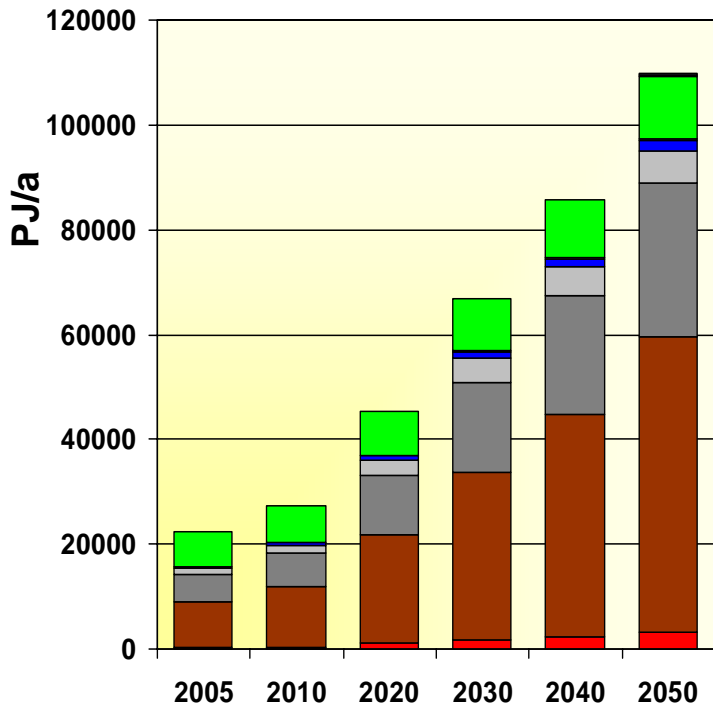
Energy Revolution Scenario



the energy [r]evolution: shift towards renewables



Renewable Primary energy shares: 2005: 31 %, 2020: 27 %, 2030: 32%, 2050: 54%

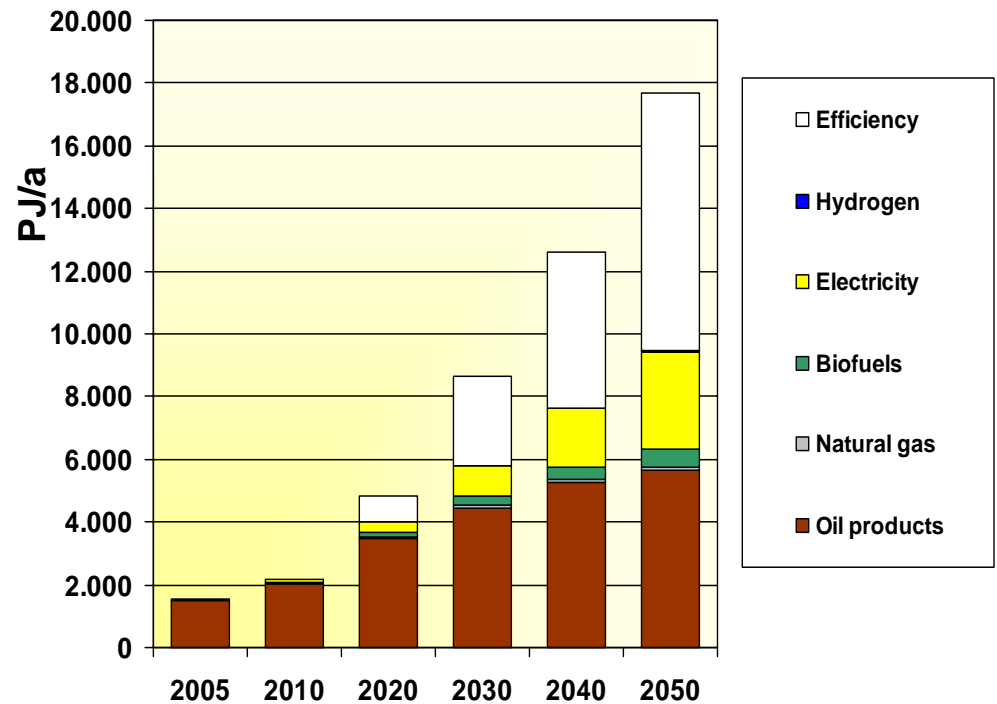
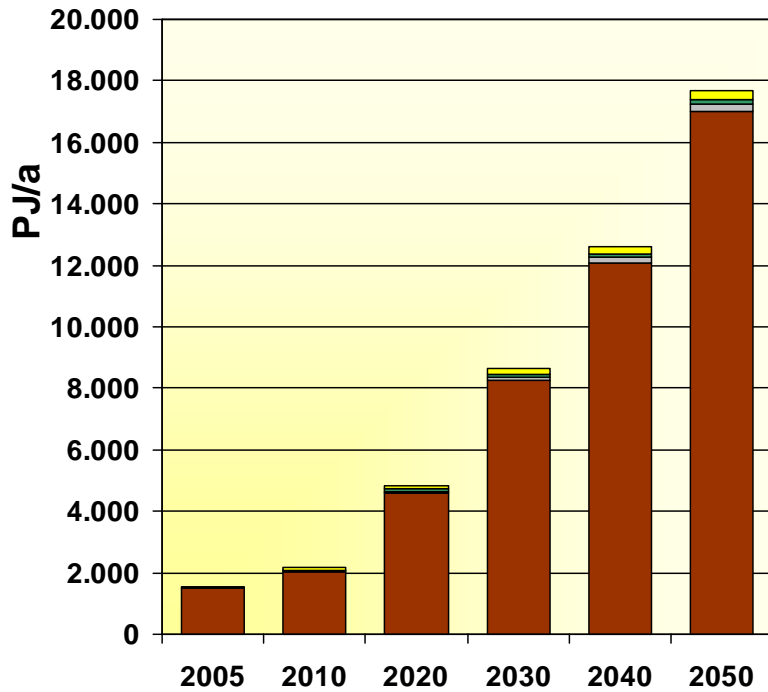


the energy [r]evolution: a transport [r]evolution



Needed changes in the transport sector: Renewable Share in 2020: 5 % 2050: 28.8%

- More efficiency in ALL technologies within the transport sector
- Shift from road to rail and from aviation to ships
- Strict efficiency standards for cars
- Phase-in of electrical drives

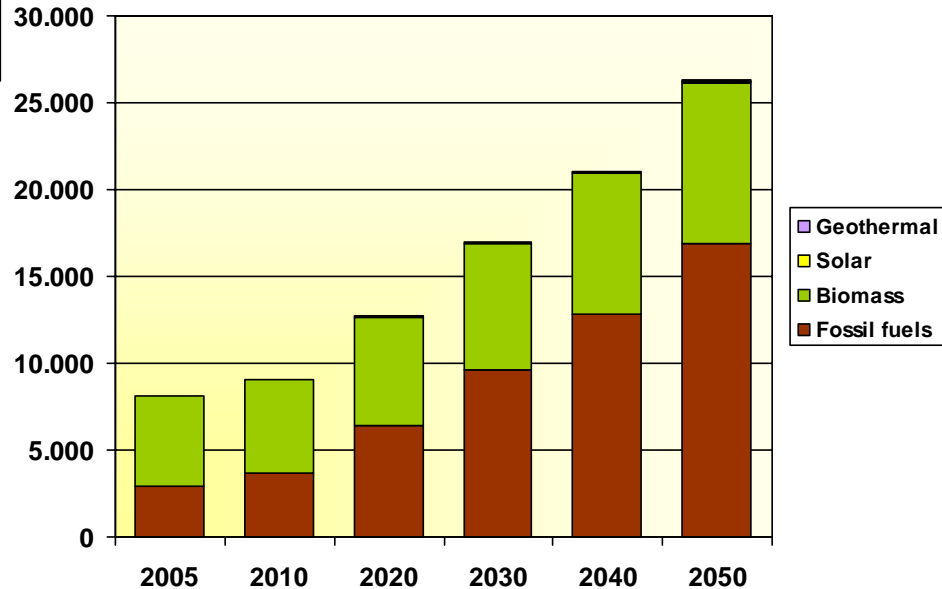
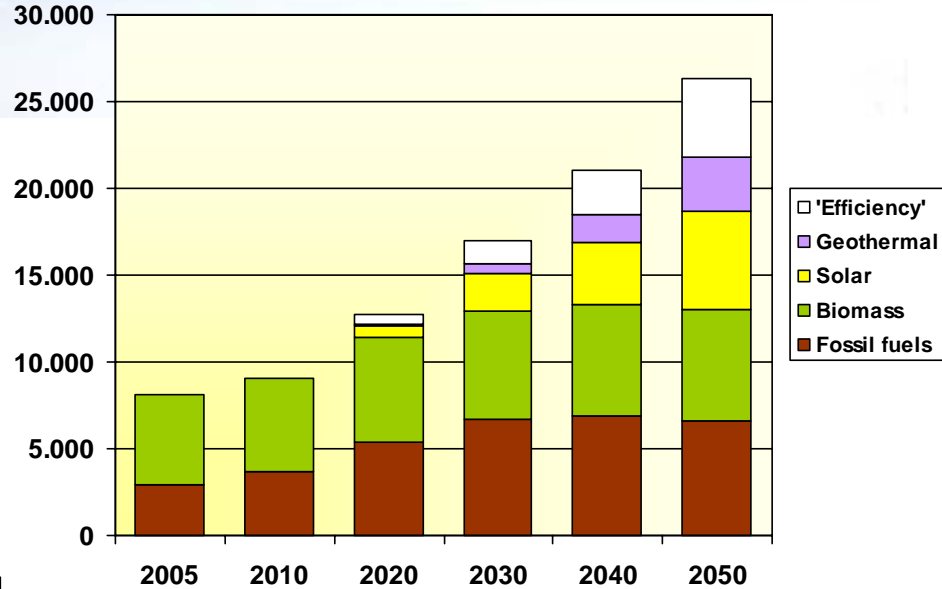
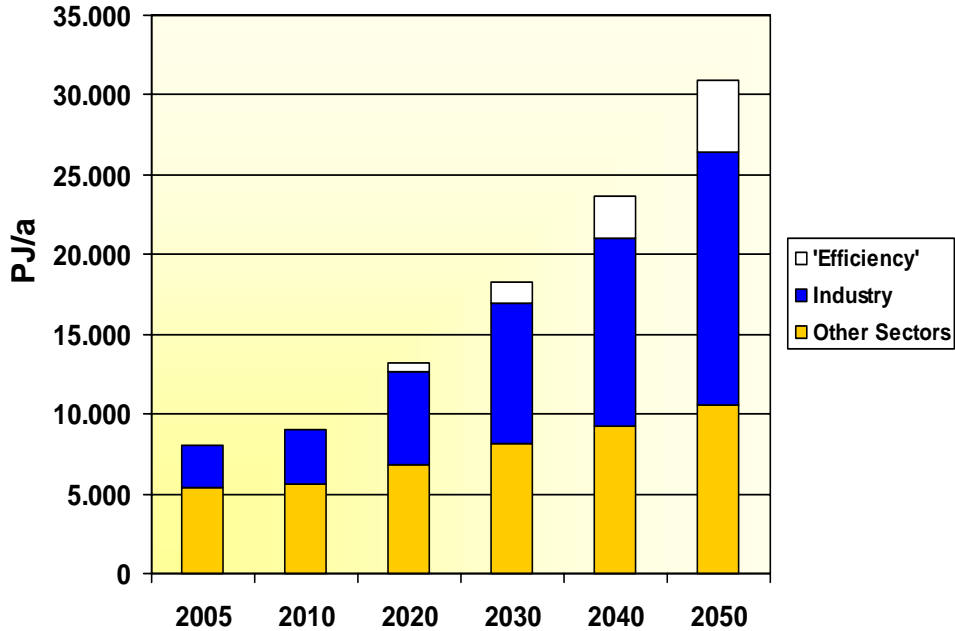


the energy [r]evolution: demand development



The heating sector:

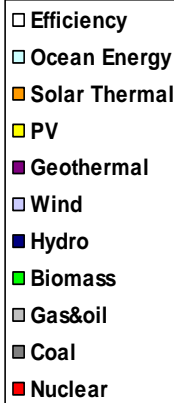
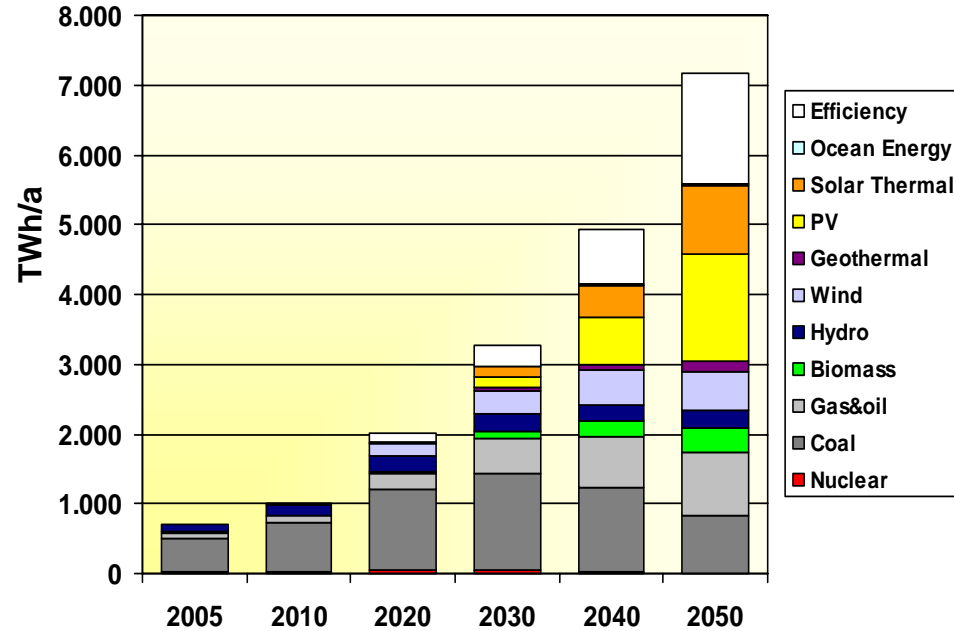
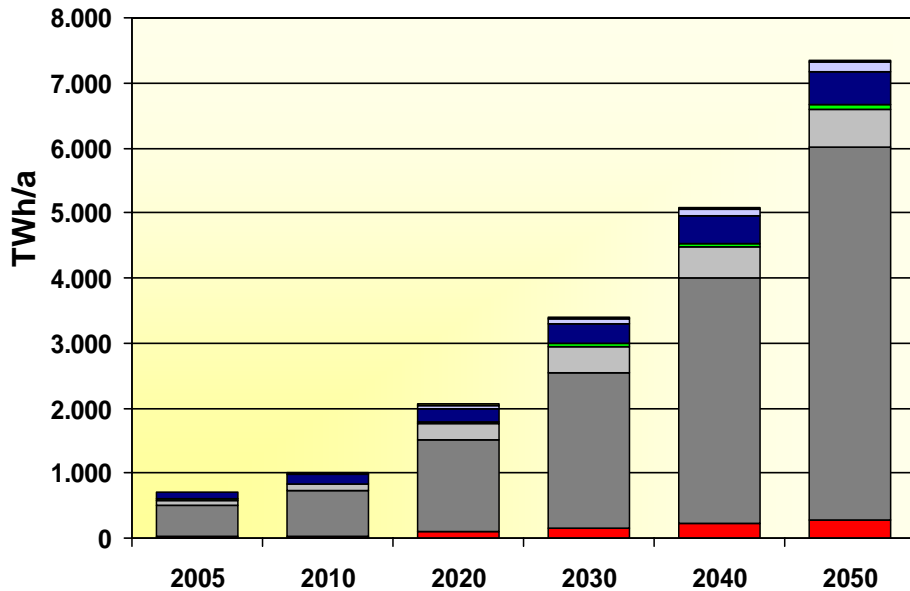
- Heating/Cooling Demand: - 4500 PJ/a by 2050 (2005: 8082 PJ/a)
- Production: 56% RE by 2020 and 70% by 2050 (2005: 63.4%)



the energy [r]evolution: Power Sector

Power Sector

- Demand: - 108 TWh by 2020; - 305 TWh by 2030; - 4669 TWh by 2050
- Generation: 24.6 % RE by 2020, 34.6% by 2030 and 69 % RE by 2050



the energy [r]evolution: Power Sector - Renewables

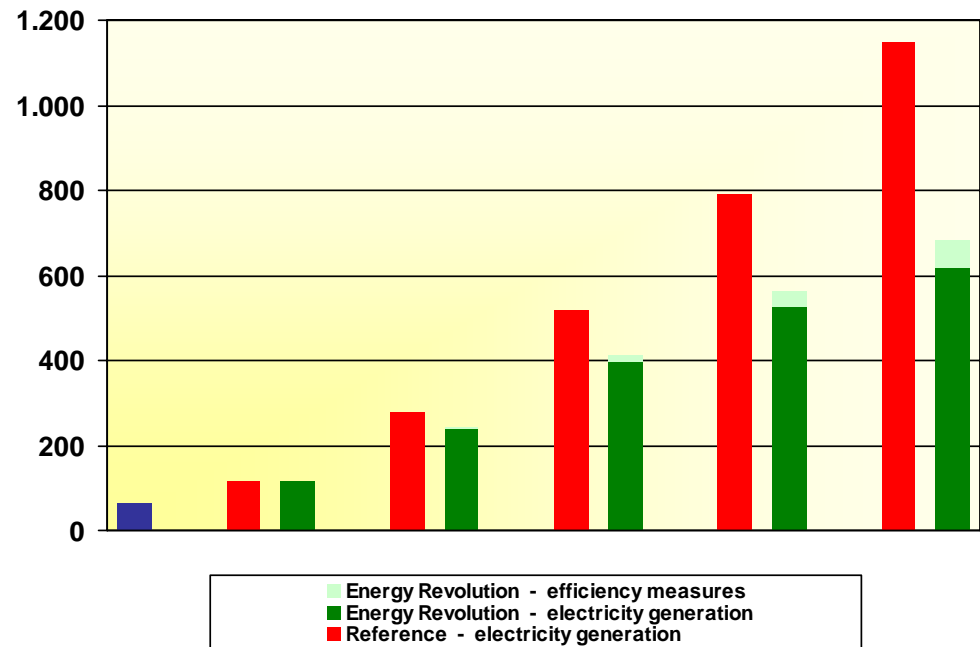
	2005	2010	2015	2020	2030	2040	2050
Total generation	147	208	273	406	763	1313	2050
- Fossil	105	147	177	234	367	410	391
- Coal	77	112	135	180	228	213	157
- Lignite	2	3	2	2	1	1	0
- Gas	16	21	31	48	137	197	234
- Oil	10	11	9	4	1	0	0
- Diesel	0	0	0	0	0	0	0
- Nuclear	3	4	7	7	6	3	0
- Hydrogen	0	0	0	0	0	0	0
- Renewables	38	56	88	165	390	899	1659
- Hydro	34	44	53	73	80	80	80
- Wind	4	12	29	69	143	200	224
- PV	0	0	2	10	118	486	1093
- Biomass	0	1	4	8	19	41	70
- Geothermal	0	0	0	2	6	18	30
- Solar Thermal	0	0	0,5	3	23	70	151
- Ocean Energy	0	0	0	1	3	5	11



keeping energy affordable

Electricity supply costs

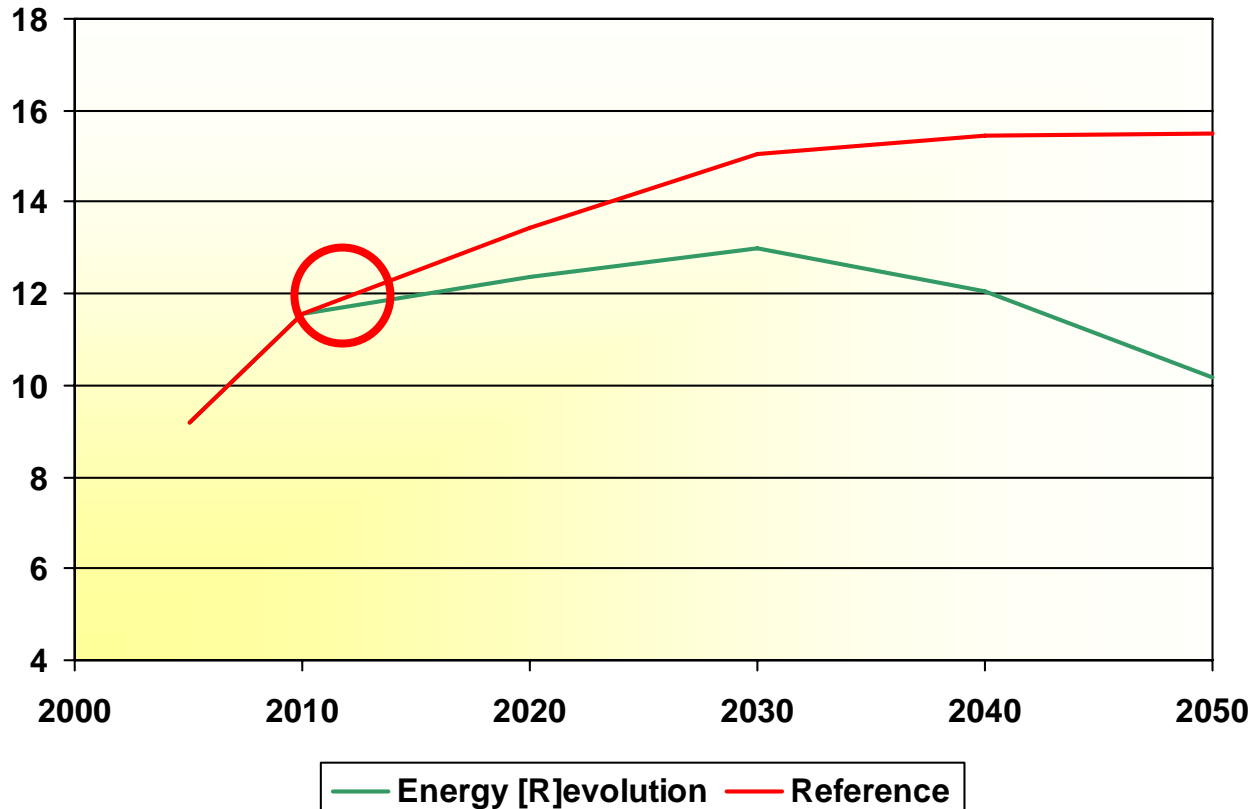
- Today: \$ 65 billion
- Reference
 - 2020: \$279 billion
 - 2030: \$ 516 billion
- Energy [R]evolution
 - 2020: \$ 238 billion
\$ 6 billion (efficiency)
 - 2030: € 395 billion
€ 16 billion (efficiency)



keeping energy affordable

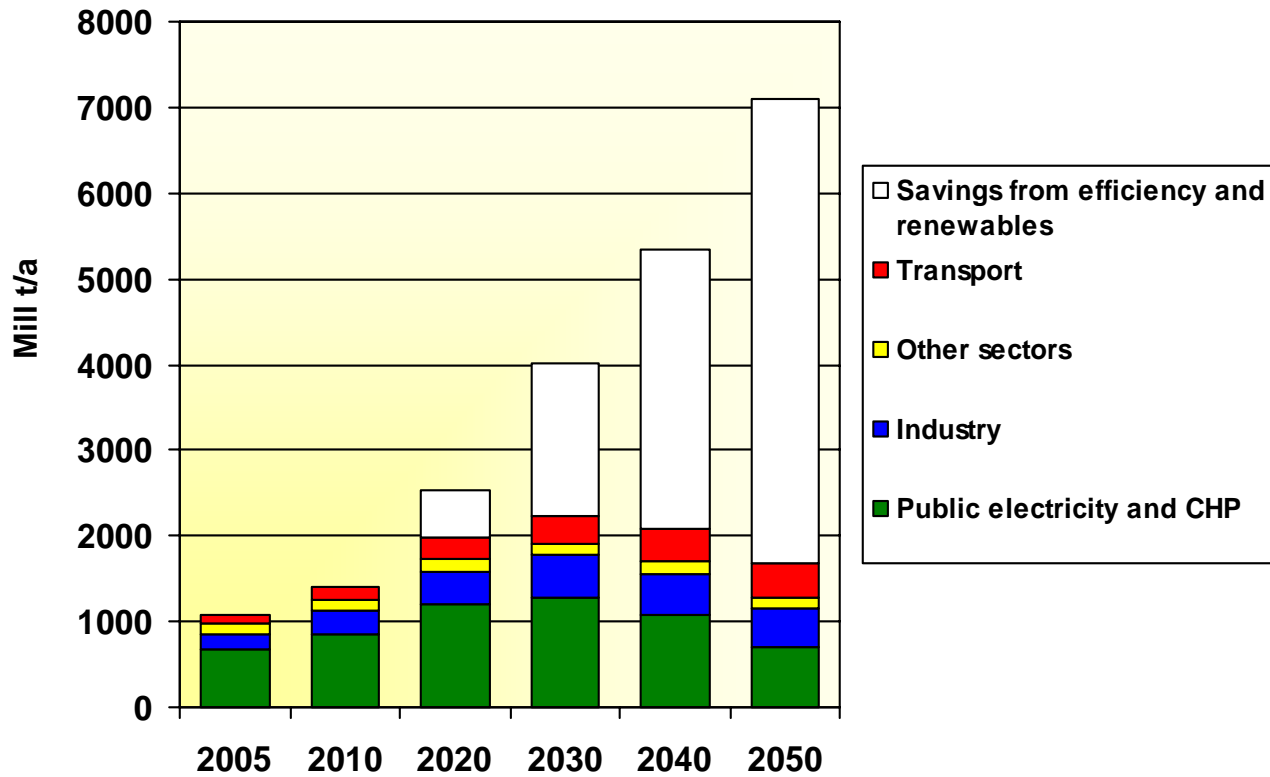
Specific Electricity supply costs

- Break even: 2010



the energy [r]evolution: CO₂ emissions

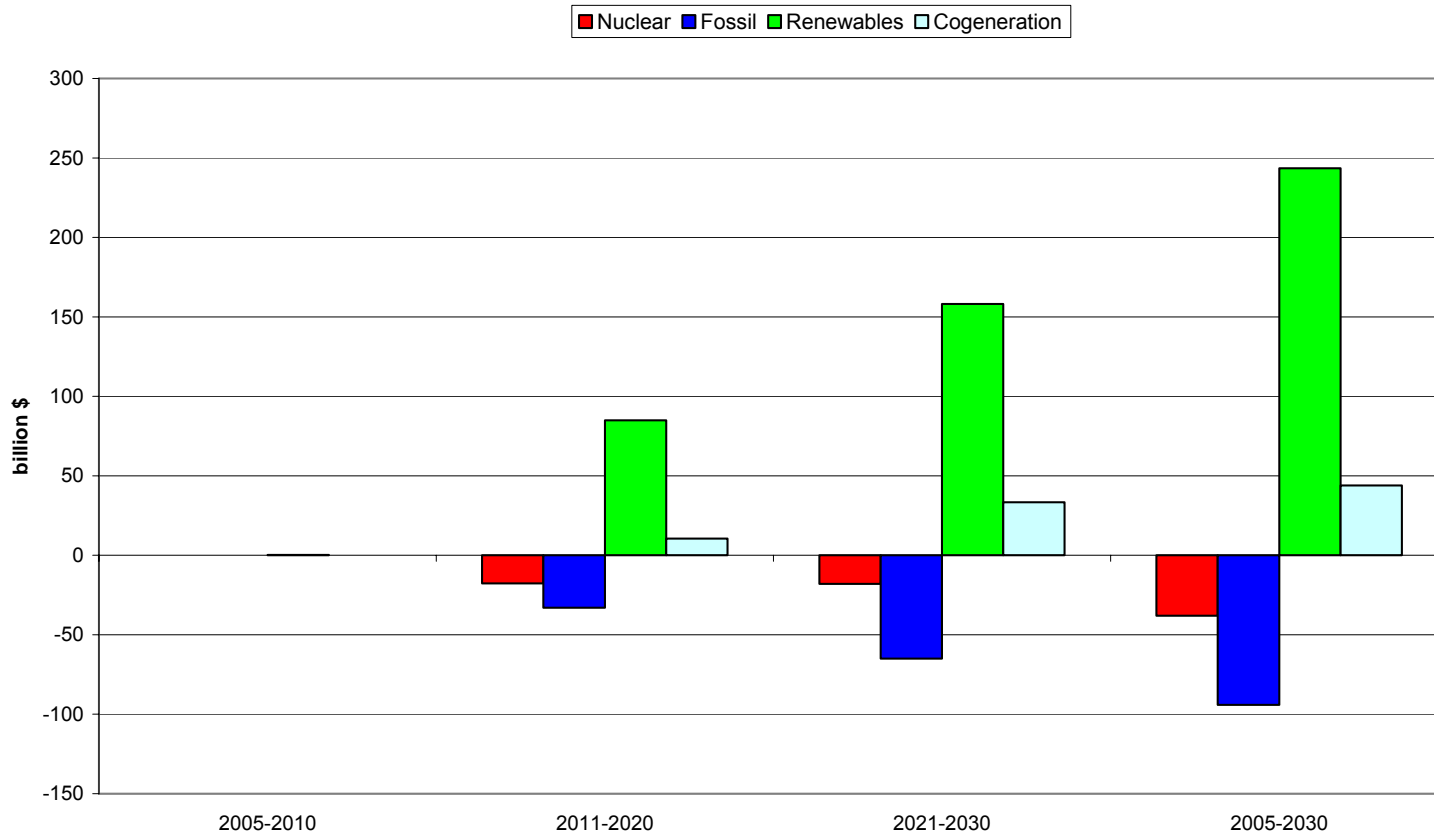
Energy related CO₂ emissions – reductions based on 1990 levels: Emission peak in 2030





Investments in Renewable Energy until 2020: \$ 238 billion

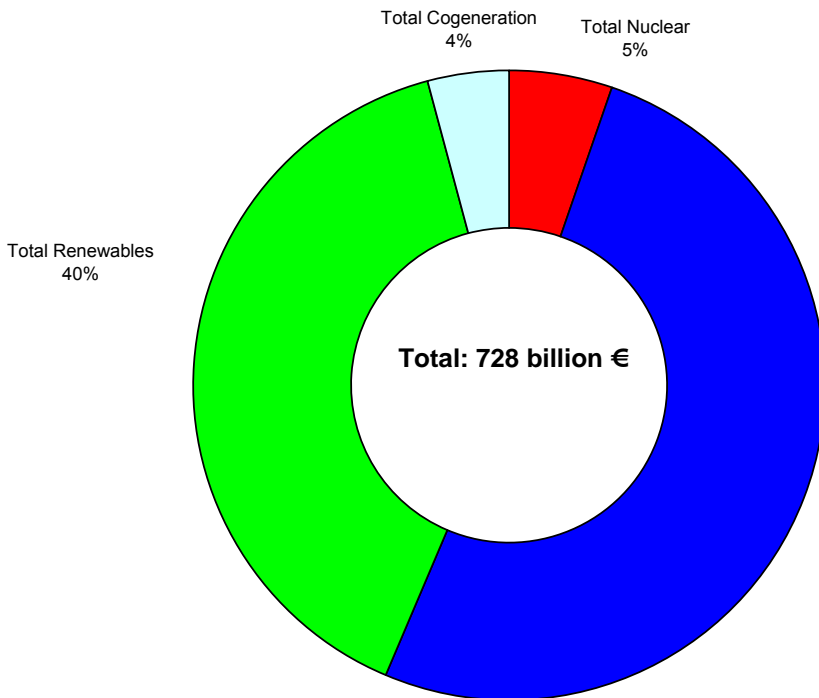
Change in cumulative power plant investments in India - energy [r]evolution scenario



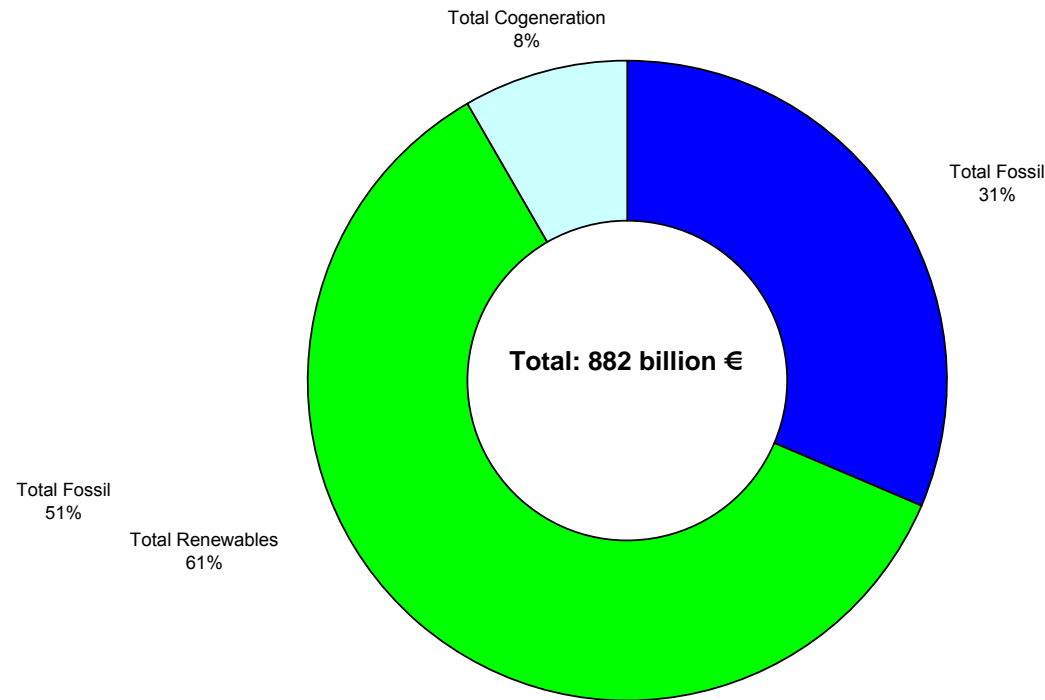


Change in cumulative power plant investment under the Energy [R]evolution scenario - Share of investments

reference - investment in power sector India - 2005-2030



Energy [R]evolution scenario - investment in India's power sector - 2005-2030



Saved Fuel Costs versus additional Investments



Reference Scenario			2005-2010	2011-2020	2021-2030	2005-2030	2005-2030 average per year
Investment cost	Euro						
Total Nuclear	billion \$	REF	3	18	18	39	2
Total Fossil	billion \$	REF	55	140	176	371	15
Total Renewables	billion \$	REF	45	107	136	288	12
Total Cogeneration	billion \$	REF	3	12	15	30	1
Total	billion \$	REF	107	276	345	728	29

Alternative Scenario			2005-2010	2011-2020	2021-2030	2005-2030	2005-2030 average per year
Investment cost	Euro						
Total Fossil	billion \$	E[R]	58	107	111	276	11
Total Renewables	billion \$	E[R]	46	192	294	531	21
Total Cogeneration	billion \$	REF	3	23	49	74	3
Total	billion \$	E[R]	107	321	454	882	35

Chapter 8, Table 2 Difference E(R) VERSUS REF			2005-2010	2011-2020	2021-2030	2005-2030	annual average 2005 - 2030
Investment cost	Euro	DIF					
Total Fossil & Nuclear	billion \$	DIF	0	-50	-83	-133	-5
Total Renewables	billion \$	DIF	0	85	158	243	10
Total Cogeneration	billion \$	DIF	0	11	33	44	2
Total	billion \$	DIF	0	45	109	154	6

Saved Fuel Costs versus additional Investments



Fuel Costs REF in billion \$	billion \$/a	2005-2010	2011-2020	2021-2030	2005 - 2030	Average annual 2005-2030
Total Fuel Oil	billion \$/a	26	62	65	153	6
Total Gas	billion \$/a	33	164	383	580	23
Total Coal	billion \$/a	699	2.463	4.697	7.859	314
Total Lignite	billion \$/a	2	6	10	18	1
Total Fossil Fuels	billion \$/a	761	2.695	5.154	8.610	344

Fossil Fuel Costs E[R] in billion \$	billion \$/a	2005-2010	2011-2020	2021-2030	2005 - 2030	Average annual 2005-2030
Total Fuel Oil	billion \$/a	26	40	12	79	3
Total Gas	billion \$/a	33	156	485	675	27
Total Coal	billion \$/a	700	2.181	2.800	5.680	227
Total Lignite	billion \$/a	2	3	2	7	0
Total Fossil Fuels	billion \$/a	761	2.380	3.299	6.440	258

Savings Fuel Costs REF VERSUS E[R] in billion \$	billion \$/a	2005-2010	2011-2020	2021-2030	2005 - 2030	Average annual 2005-2030
fuel oil	billion \$/a	0	22	52	74	3
gas	billion \$/a	0	8	-102	-94	-4
hard coal	billion \$/a	0	282	1.897	2.179	87
lignite	billion \$/a	0	3	8	11	0
Total Fossil Fuel Savings	billion \$/a	0	315	1.855	2.170	87

Saved Fuel Costs versus additional Investments



Difference E(R) VERSUS REF			2005-2010	2011-2020	2005-2020	annual average 2005 - 2020
Investment cost	Euro	DIF				
Total Fossil & Nuclear	billion \$	DIF	0	-50	-50	-3
Total Renewables	billion \$	DIF	0	85	85	6
Total Cogeneration	billion \$	DIF	0	11	11	1
Total	billion \$	DIF	0	45	45	3

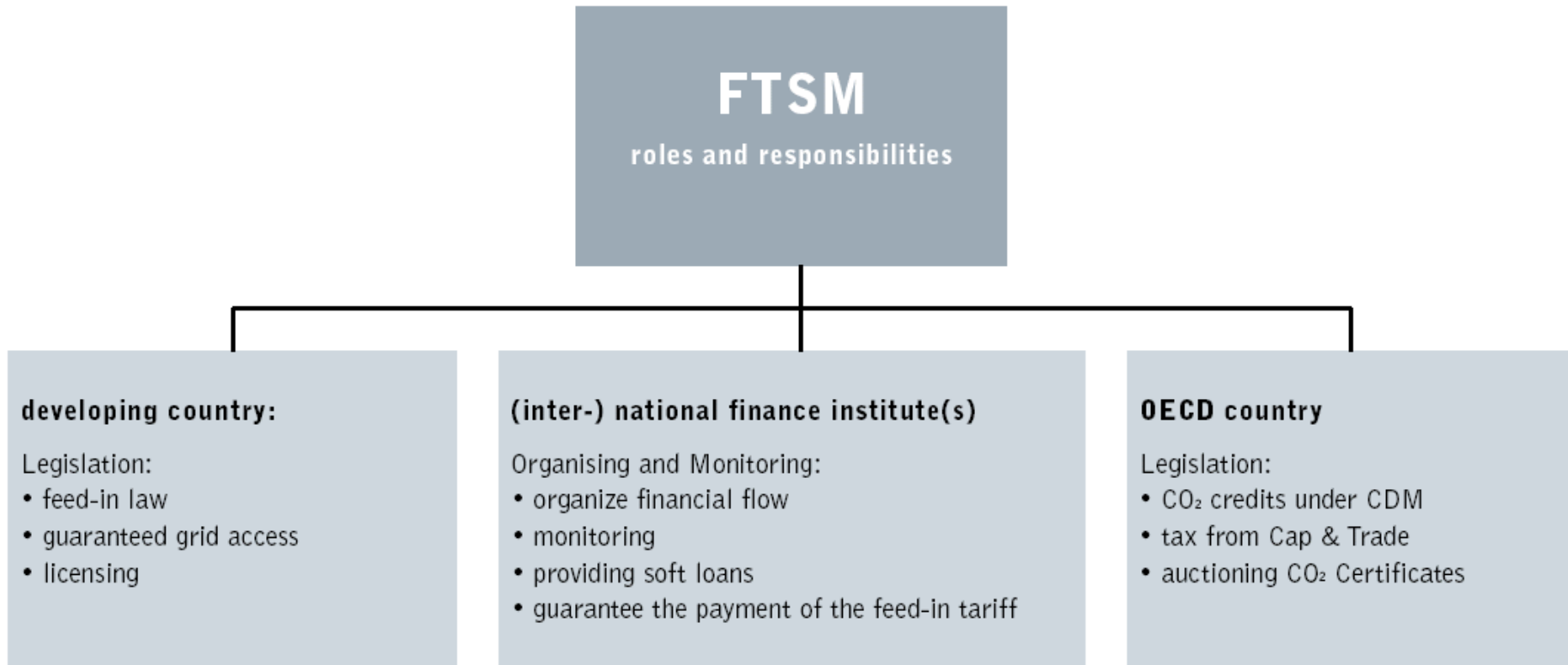
Savings Fuel Costs REF VER: billion \$/a			2005-2010	2011-2020	2005 - 2020	Average annual 2005-2020
fuel oil	billion \$/a		0	22	22	1,5
gas	billion \$/a		0	8	8	0,5
hard coal	billion \$/a		0	282	282	18,8
lignite	billion \$/a		0	3	3	0,2
Total Fossil Fuel Savings	billion \$/a		0	315	315	21

2005 – 2020: Saved fuel costs are 7 x higher than additional investments costs

Factor 7



figure 2.1: ftsm scheme



Energy [R]evolution for the EU-27

Brussels
2 December 2008

energy
[r]evolution

A SUSTAINABLE GLOBAL ENERGY OUTLOOK