Energy Technology Perspectives 2012

Pathways to a Clean Energy System

A clean energy future, is it still possible?

Washington DC, July 2012

Richard H. Jones, Deputy Executive Director

Dr. Markus Wråke, ETP Project Leader,

International Energy Agency

ETP 2012 – Choice of 3 Futures

ETP 2012

2DS

a vision of a **sustainable** energy system of reduced Greenhouse Gas (GHG) and CO_2 emissions

The 2°C Scenario

4DS

reflecting pledges by countries to cut emissions and boost energy efficiency

The 4°C Scenario

6DS

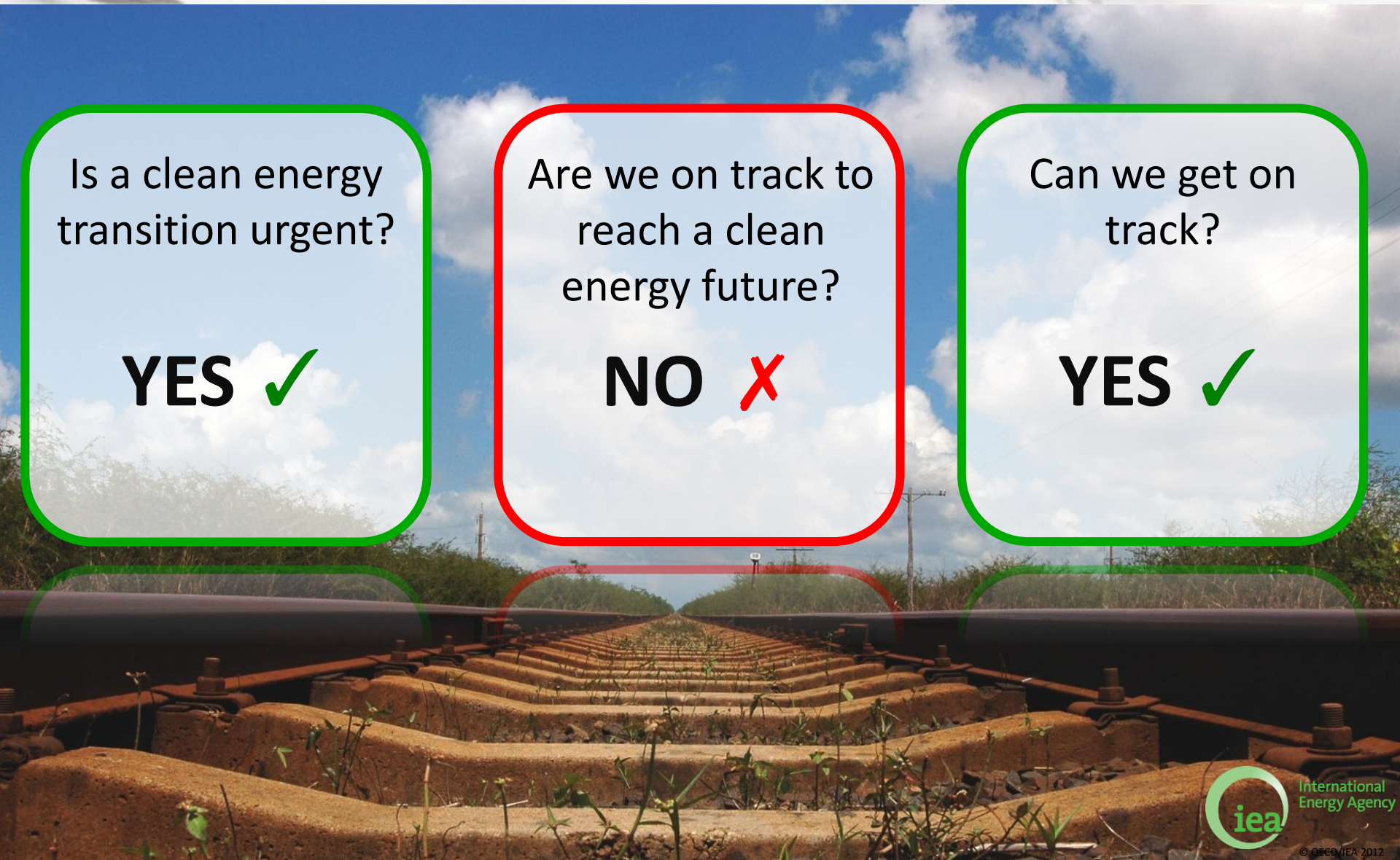
where the world is now heading with potentially **devastating** results

The 6°C Scenario

International Energy Agency

Sustainable future still in reach

ETP 2012



Is a clean energy transition urgent?

YES ✓

Are we on track to reach a clean energy future?

NO ✗

Can we get on track?

YES ✓

International Energy Agency

Clean energy: slow lane to fast track

ETP 2012

Cleaner coal power

Nuclear power

Renewable power

CCS in power

CCS in industry

Industry

Buildings

Fuel economy

Electric vehicles

Biofuels for transport

Progress is too slow in almost all technology areas

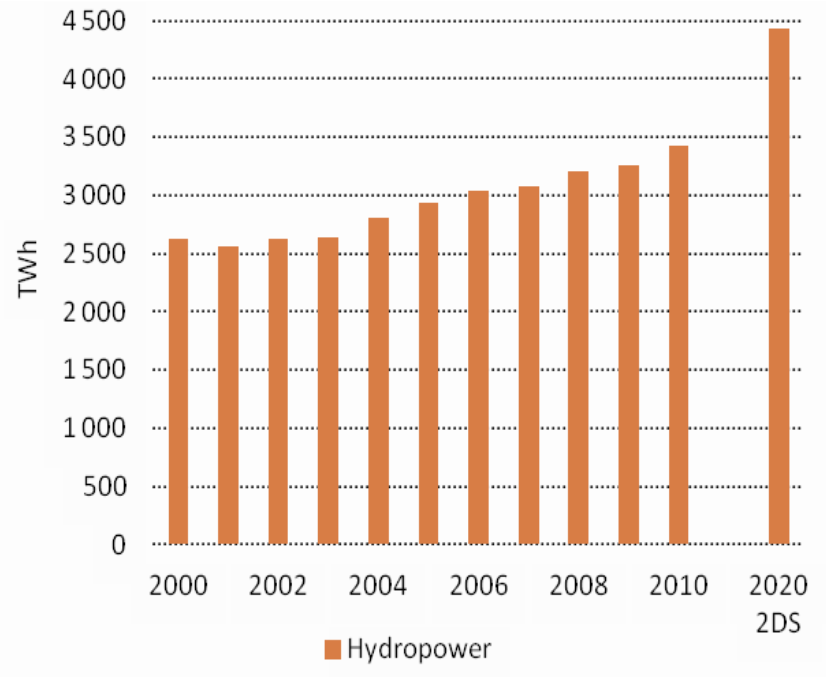
Significant action is required to get back on track

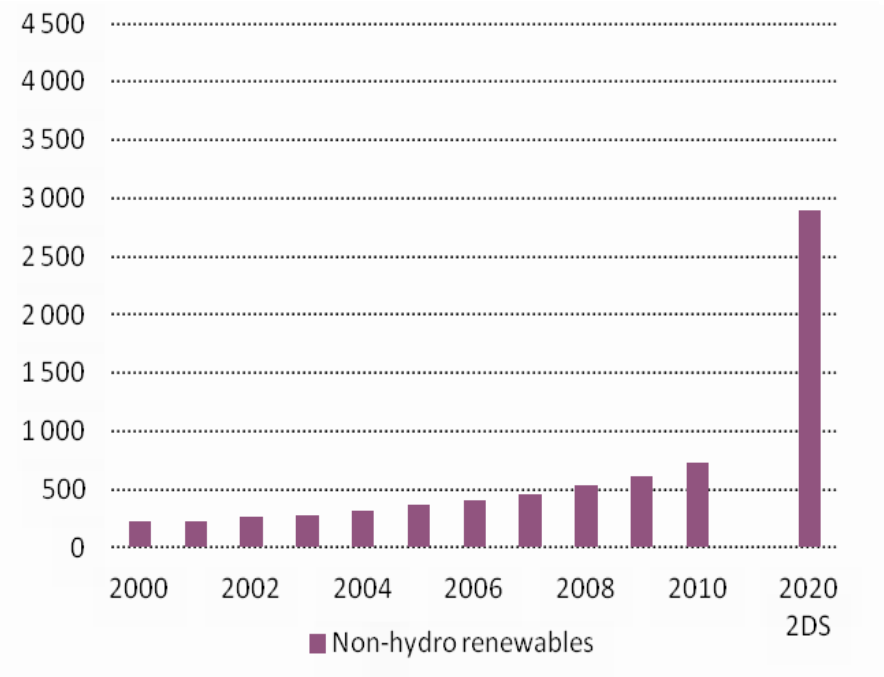
International Energy Agency

Renewables provide good news

ETP 2012

Renewable power generation





42%

Average annual growth in Solar PV

75%

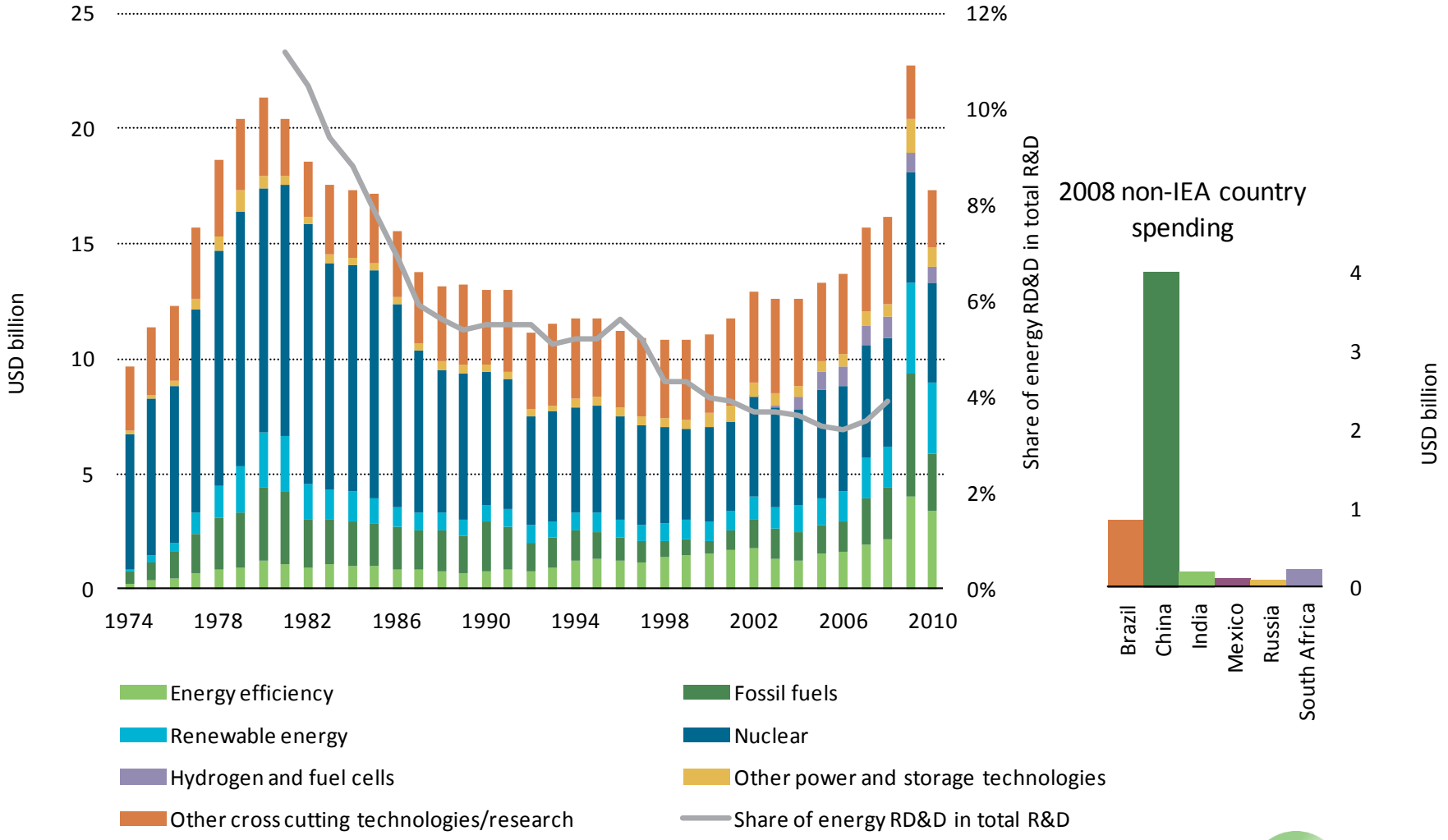
Cost reductions in Solar PV in just three years in some countries

27%

Average annual growth in wind

Energy RD&D has slipped in priority

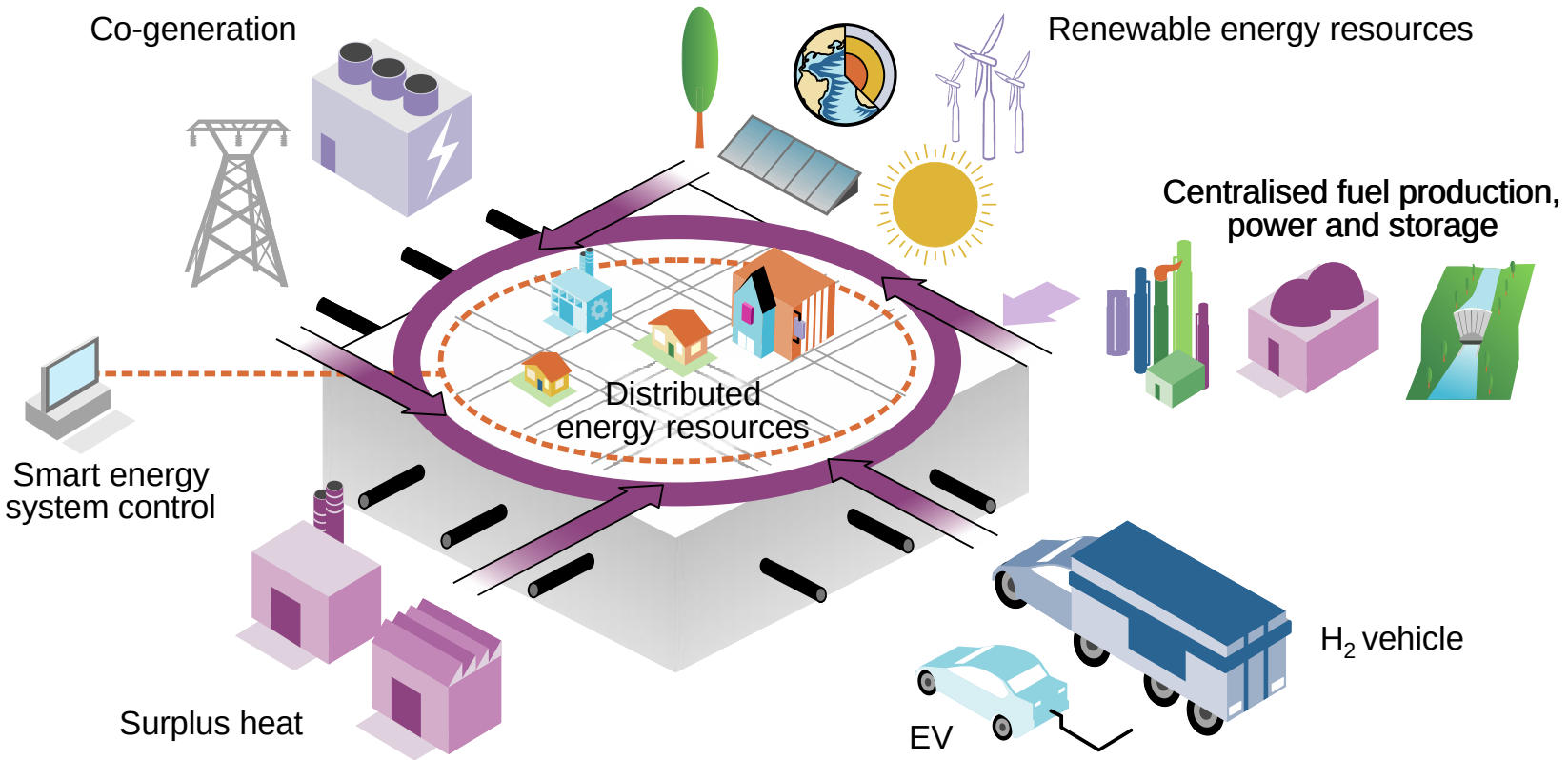
ETP 2012



International Energy Agency

A smart, sustainable energy system

ETP 2012



A sustainable energy system is a smarter, more unified and integrated energy system

International Energy Agency

Recommendations to Governments

ETP 2012

1. Create an investment climate of confidence in clean energy

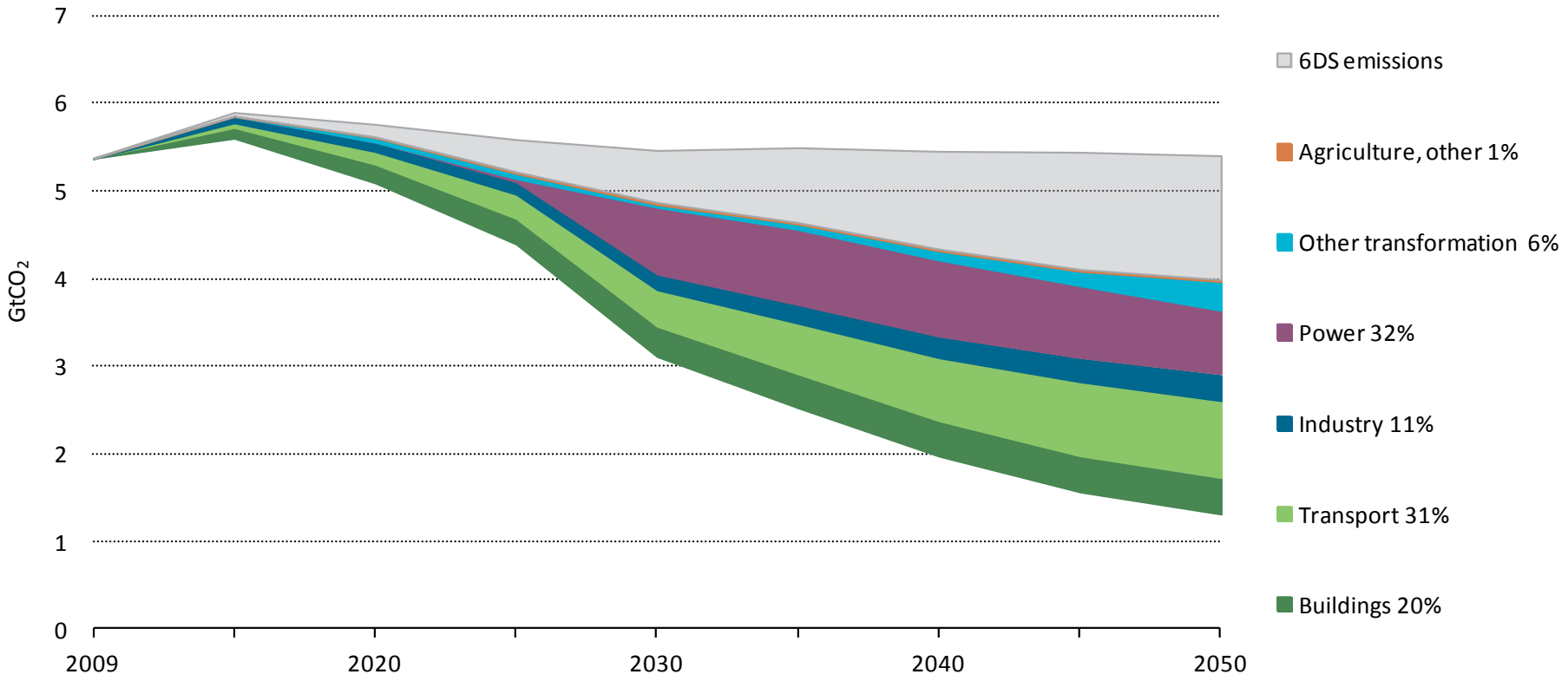
2. Unlock the incredible potential of energy efficiency – “the hidden” fuel of the future

3. Accelerate innovation and public research, development and demonstration (RD&D)

International Energy Agency

CO_2 reductions in the US

ETP 2012

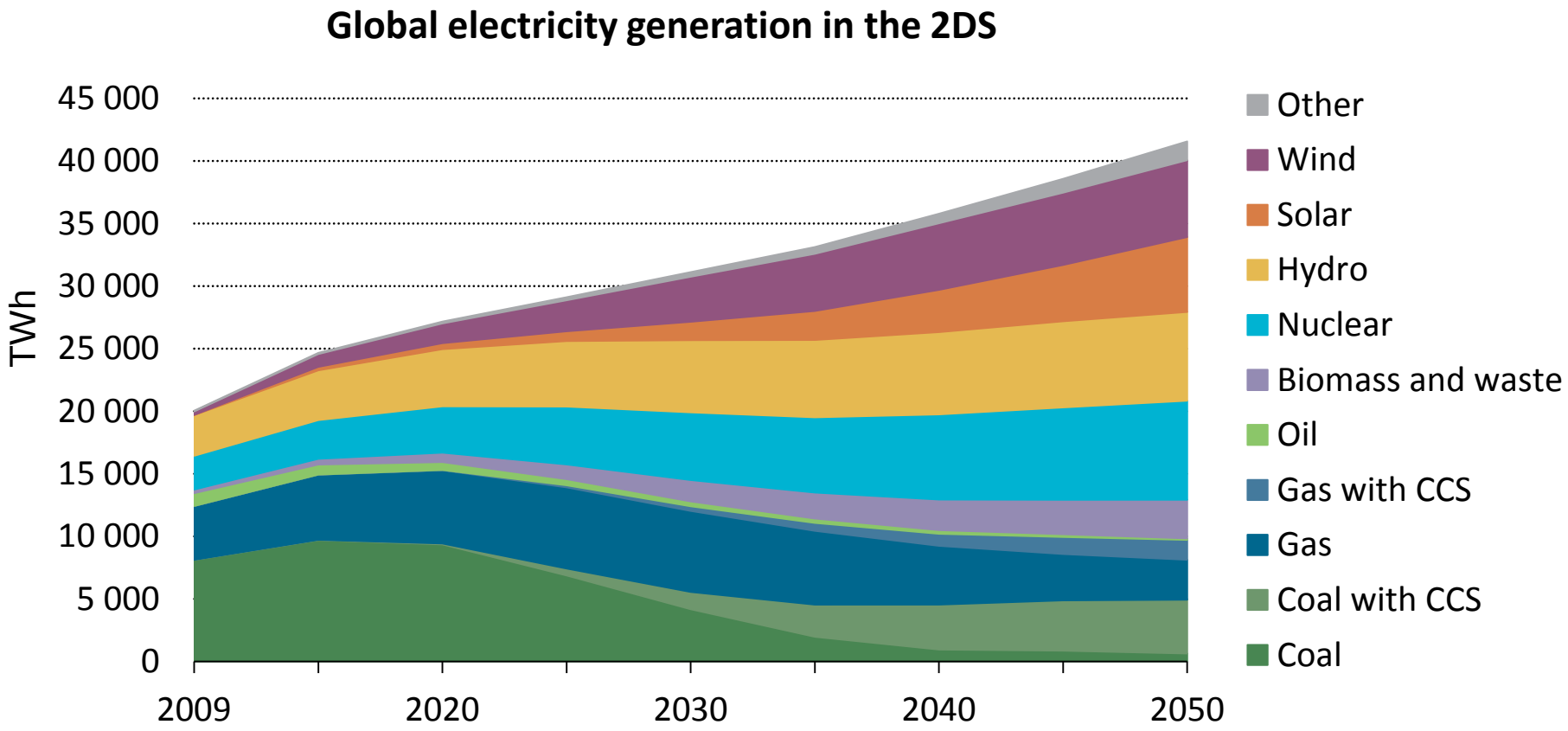


The power and transport sectors are key to achieving the 2DS.

International Energy Agency

Low-carbon electricity: a clean core

ETP 2012

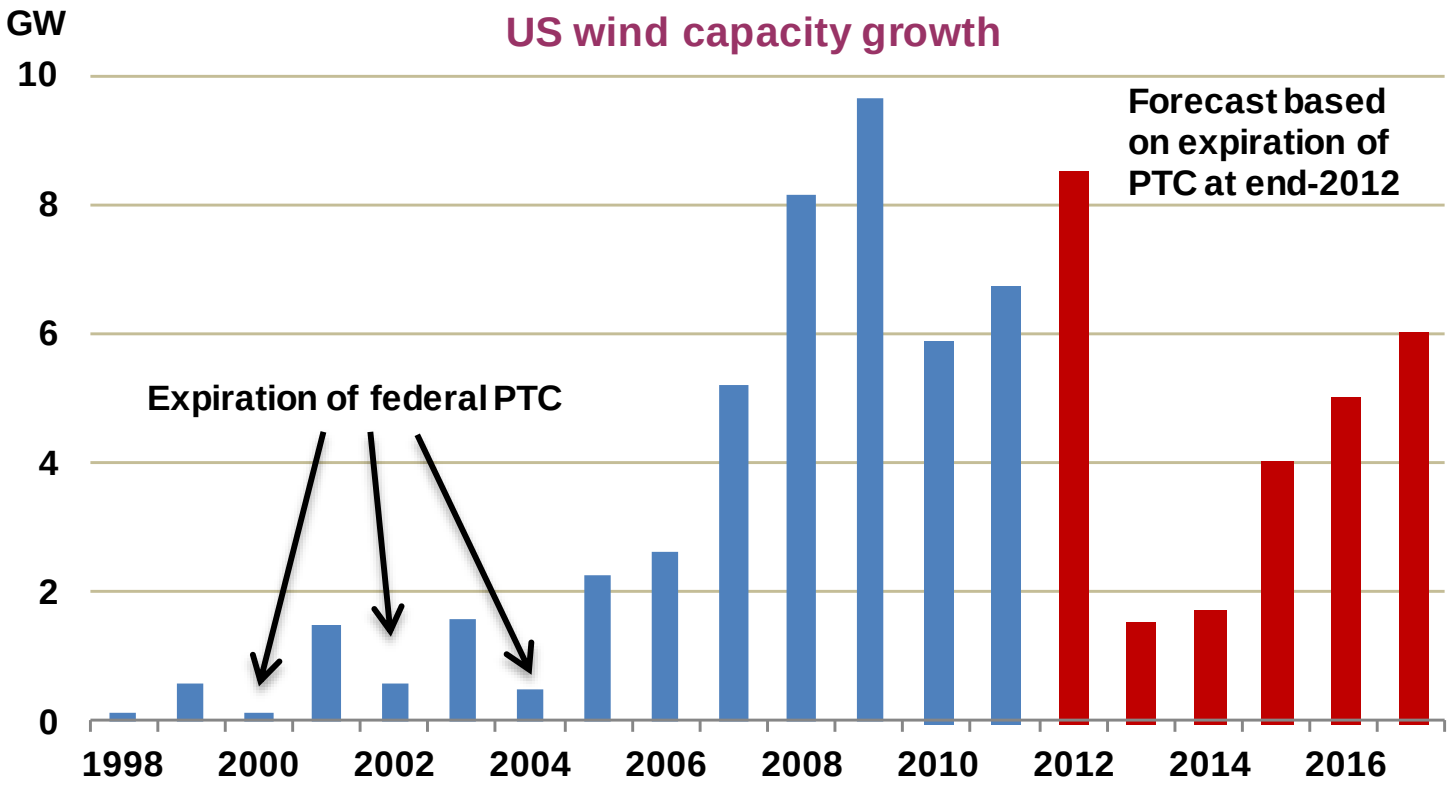


Renewables will generate more than half the world's electricity in 2050 in the 2DS

International Energy Agency

Rocky road ahead for US renewables

ETP 2012



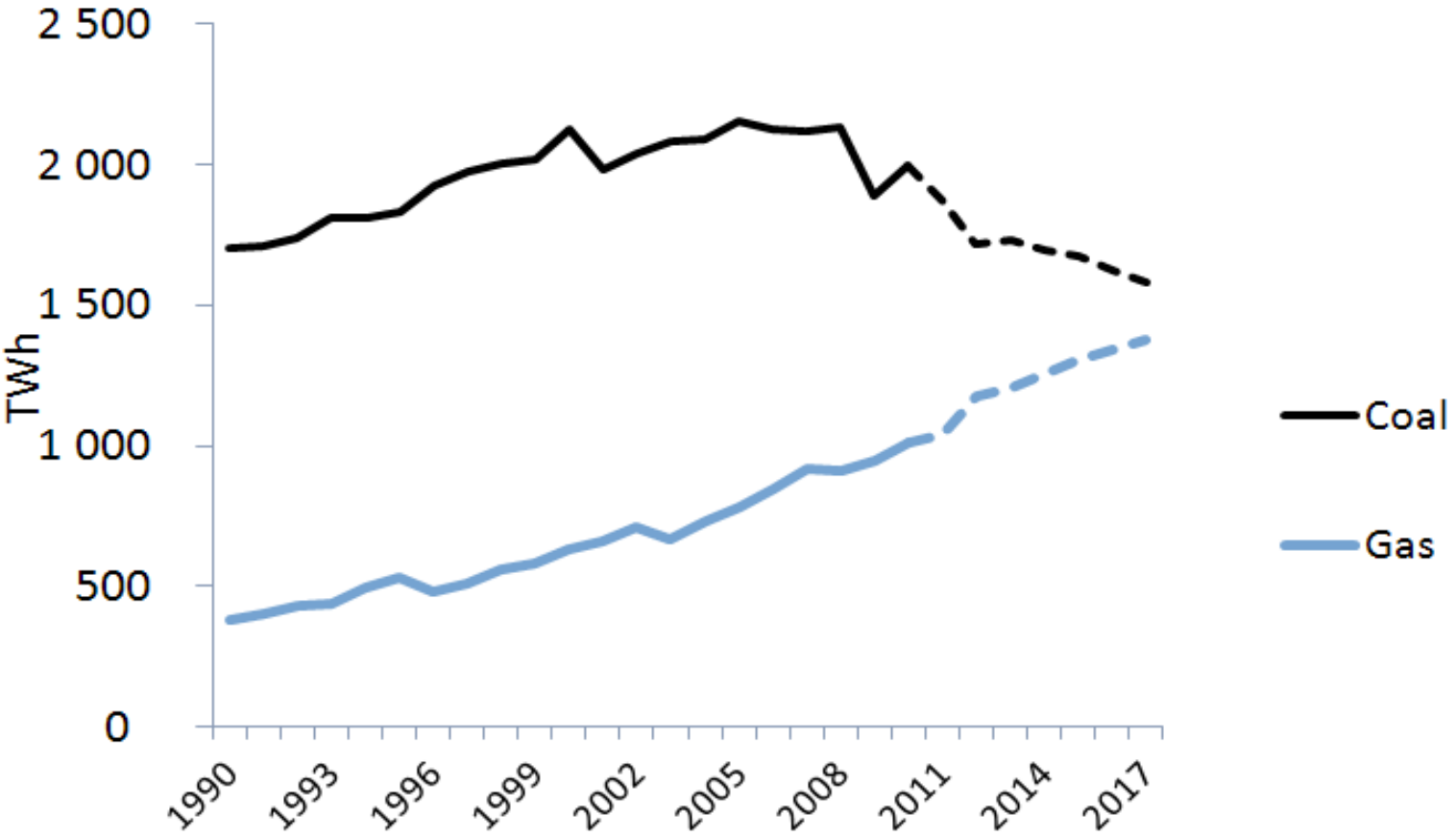
Policy uncertainty, competition from natural gas and cost of capital slow renewables growth

International Energy Agency

Natural gas is lowering emissions…

ETP 2012

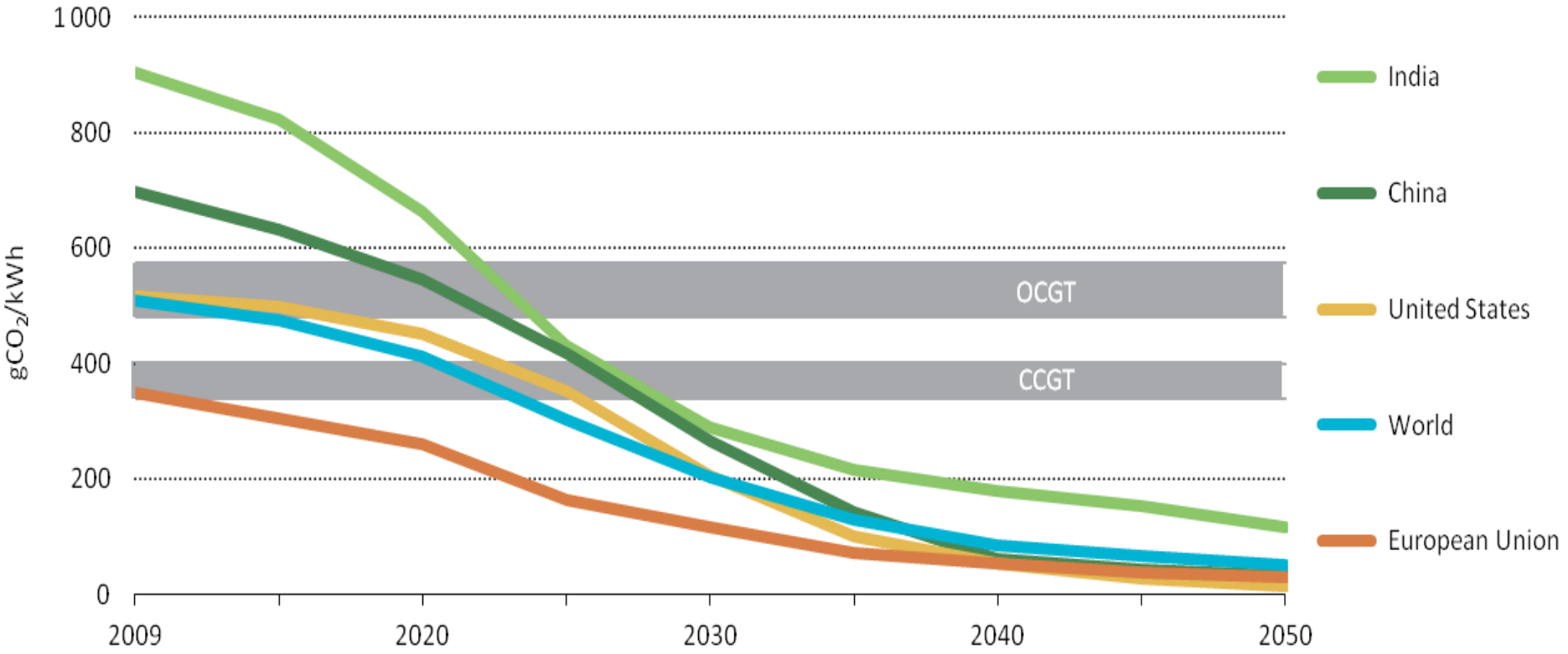
Gas and coal fired power generation in the US, actual and IEA Medium Term Outlook



International Energy Agency

…but is not a panacea

ETP 2012

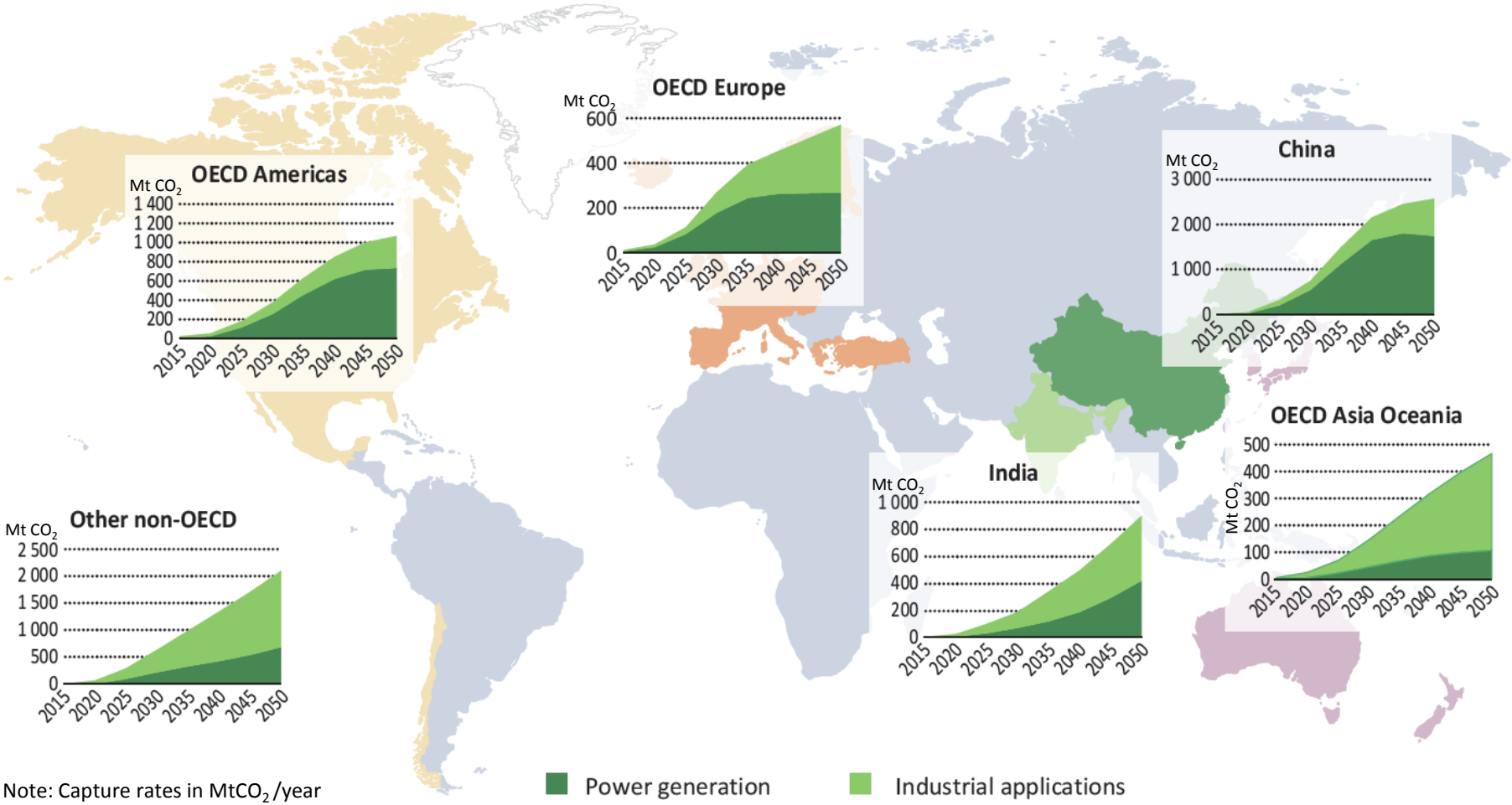


Around 2030, natural gas becomes 'high carbon'. CCS must play a role if gas use should continue to grow.

International Energy Agency

The CCS infant must grow quickly

ETP 2012

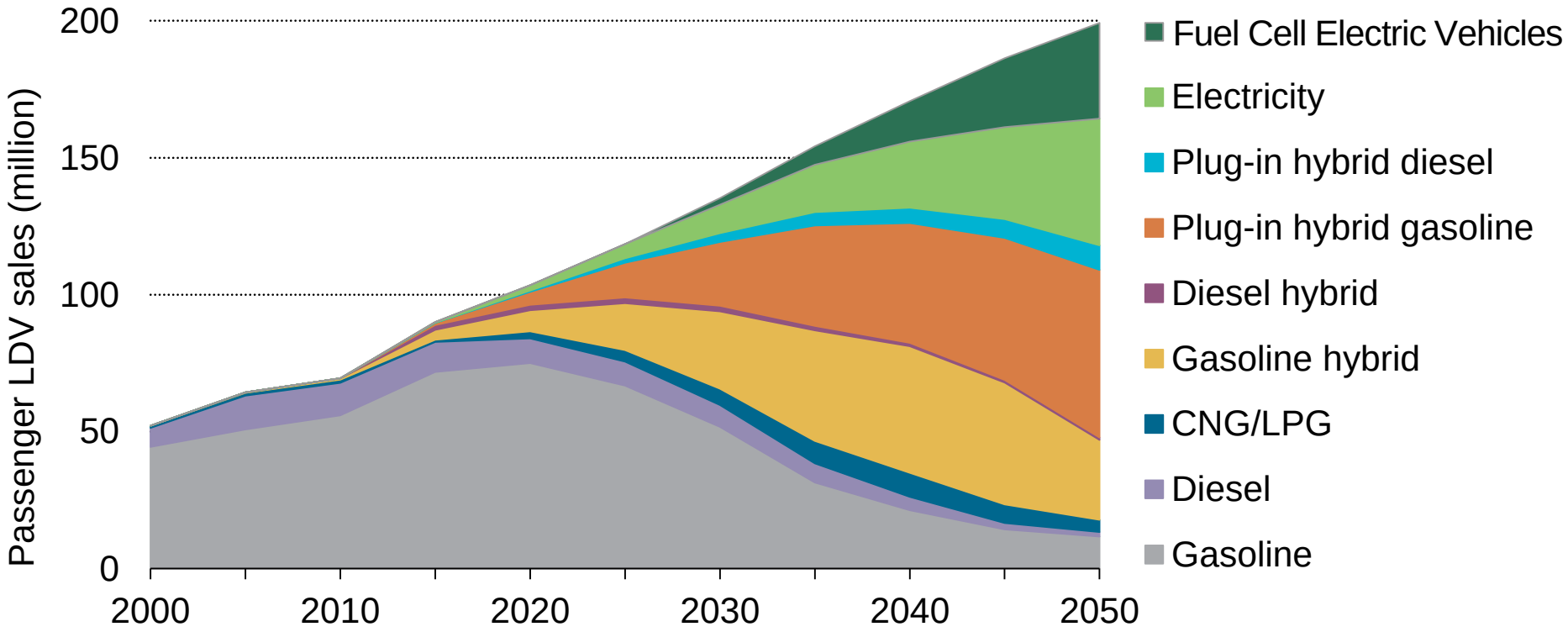


Note: Capture rates in $MtCO_2$/year

International Energy Agency

Electric vehicles need to come of age

ETP 2012

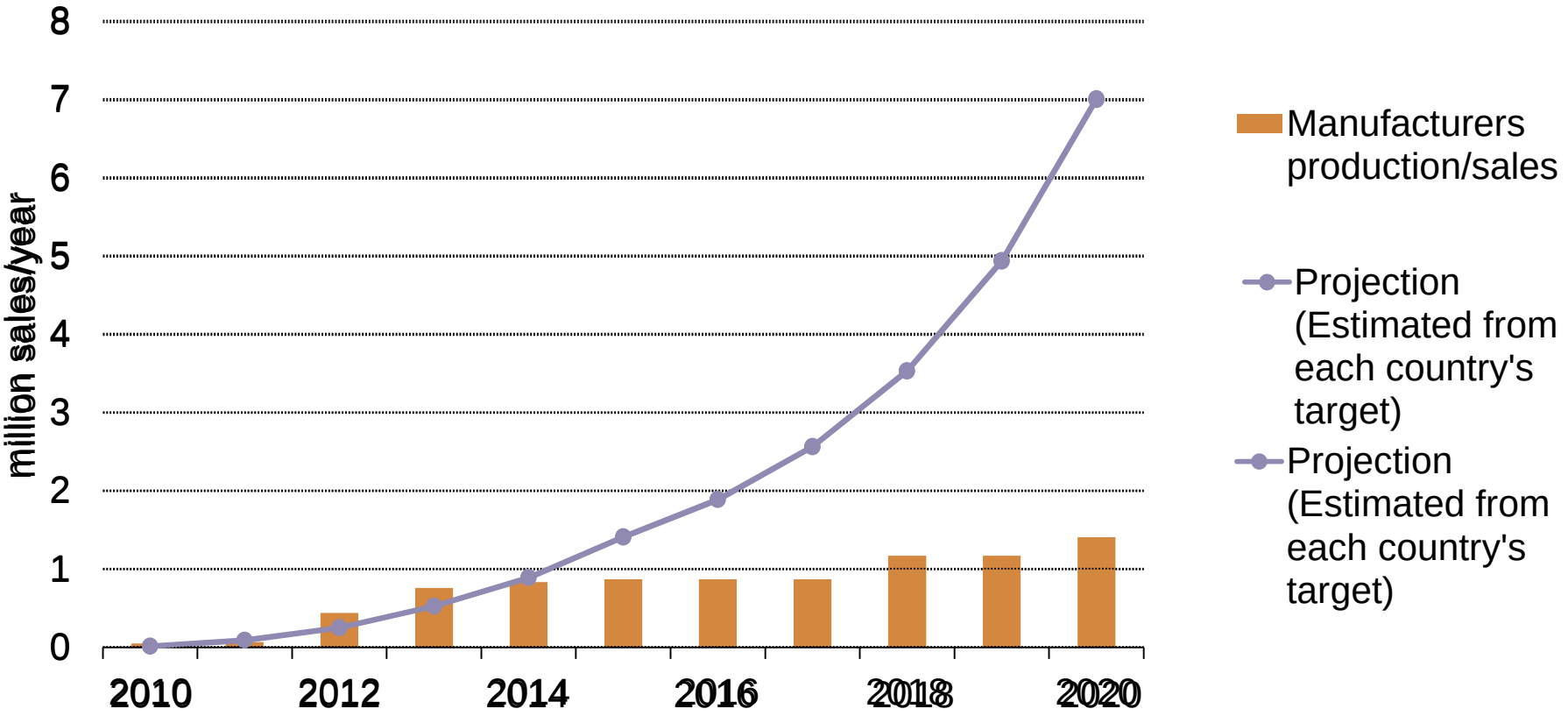


More than 90% of new light duty vehicles need to be propelled by an electric motor in 2050

International Energy Agency

Translating targets into action

ETP 2012

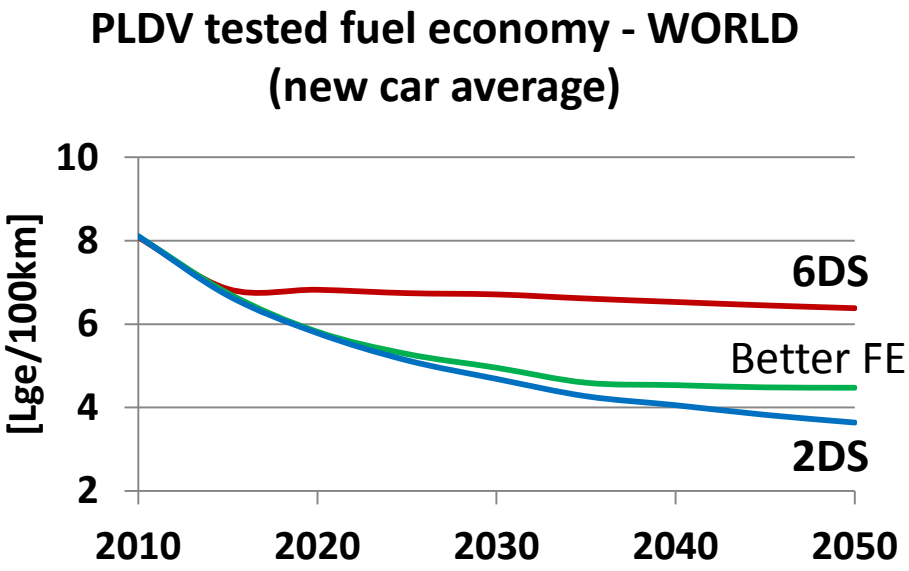


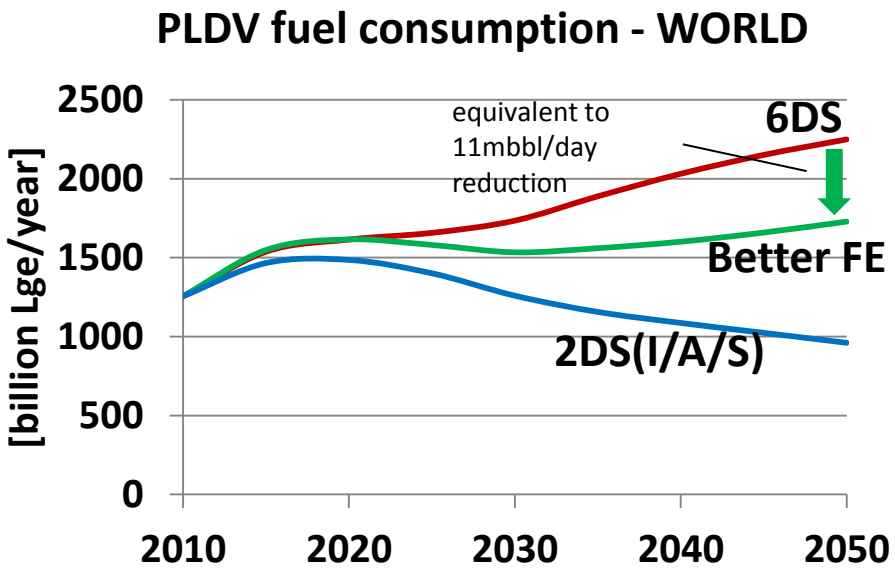
Government targets need to be backed by policy action

International Energy Agency

Fuel economy makes a difference

ETP 2012





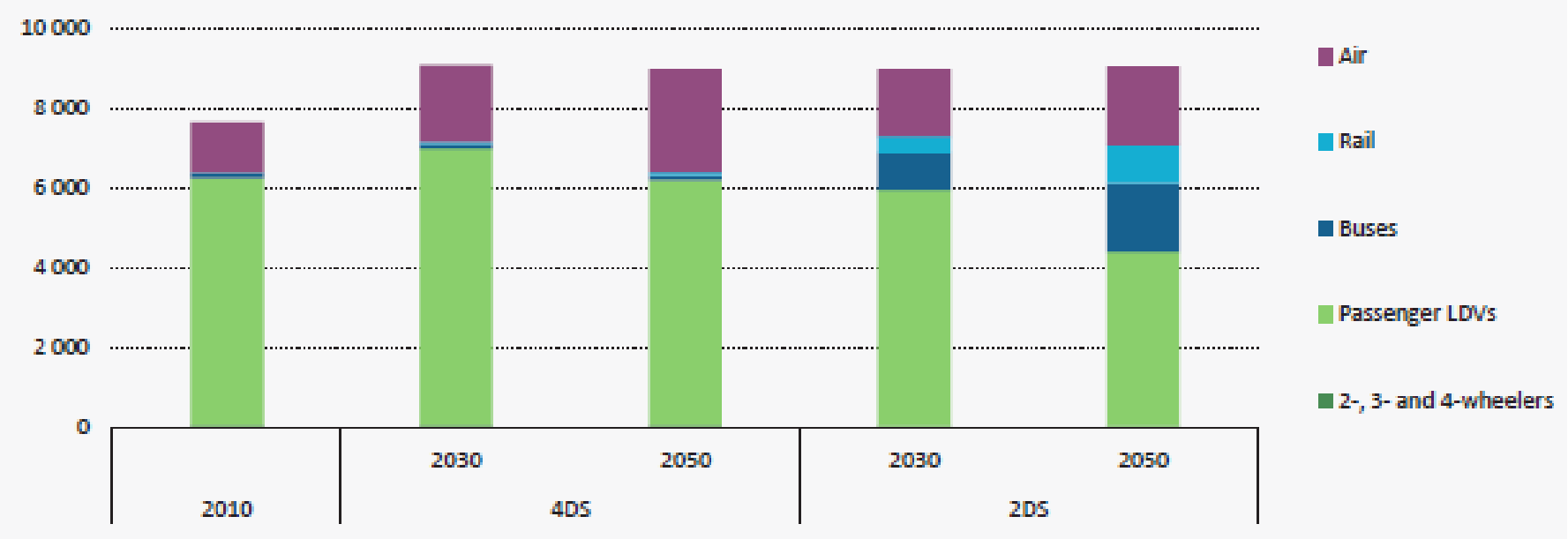
Fuel economy improvements in conventional and hybrid vehicles alone can save 11 mbbl/day.

International Energy Agency

…but modal shift is also needed

ETP 2012

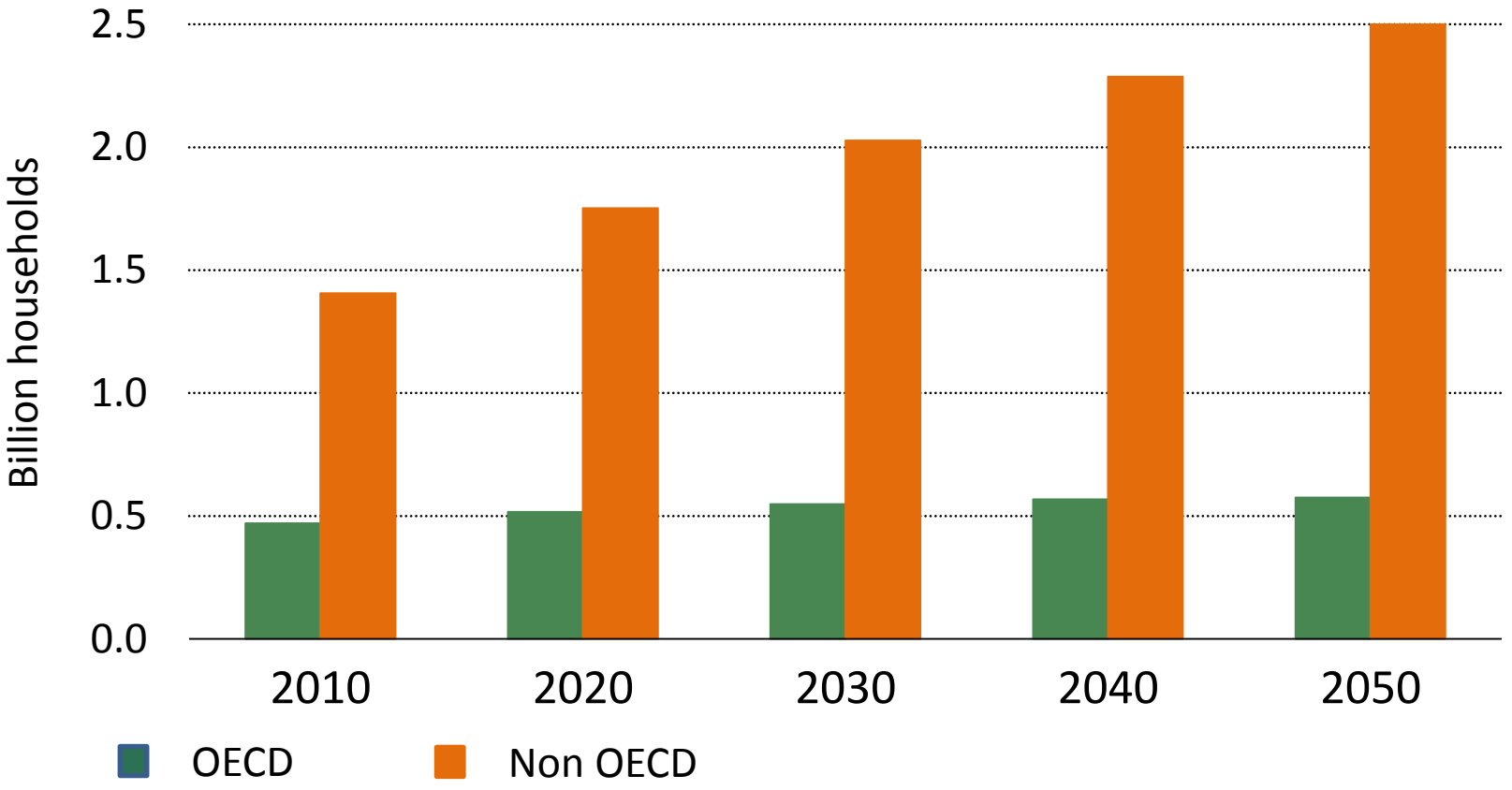
Passenger mode share in the US



Fuel economy alone is not enough to meet 2DS targets

Building sector challenges differ

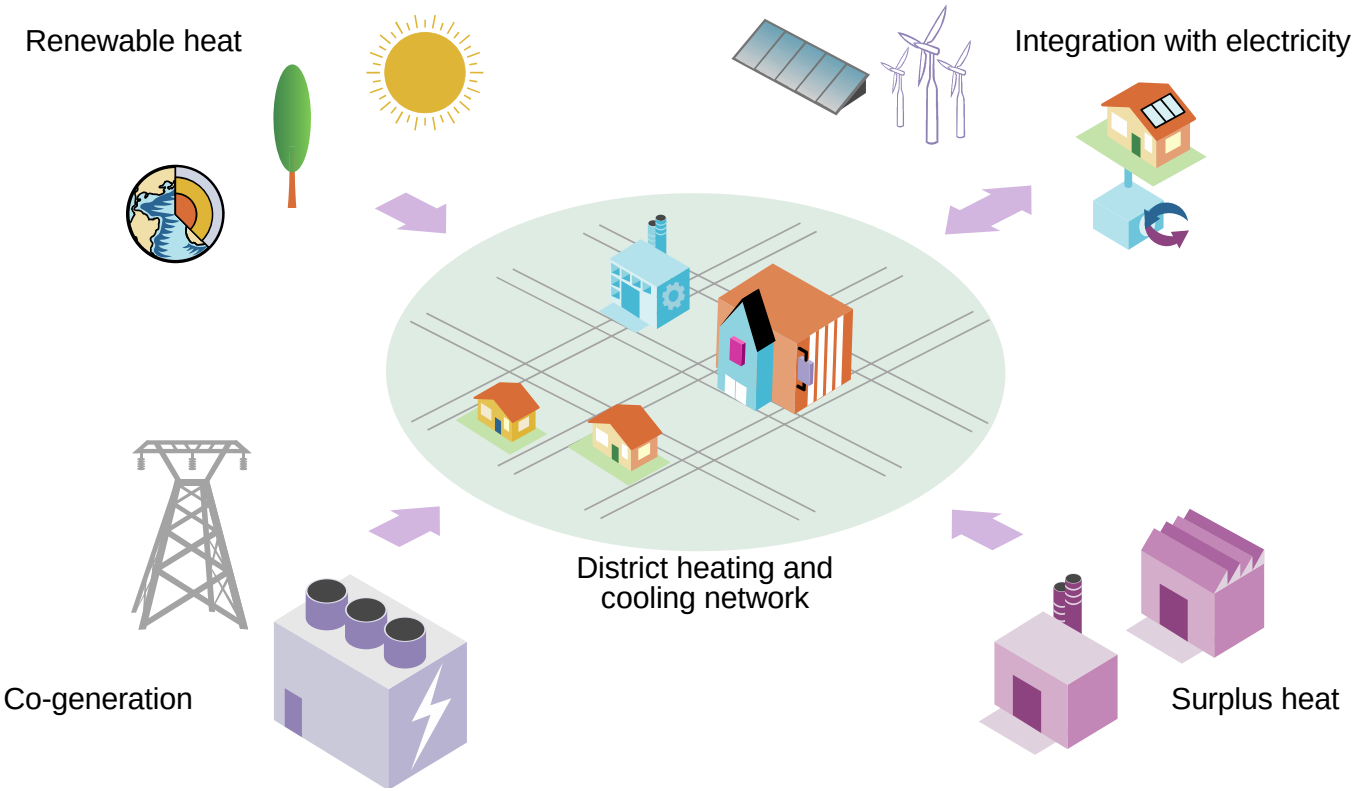
ETP 2012



75% of current buildings in OECD will still be standing in 2050

Heating & Cooling: the forgotten giant

ETP 2012

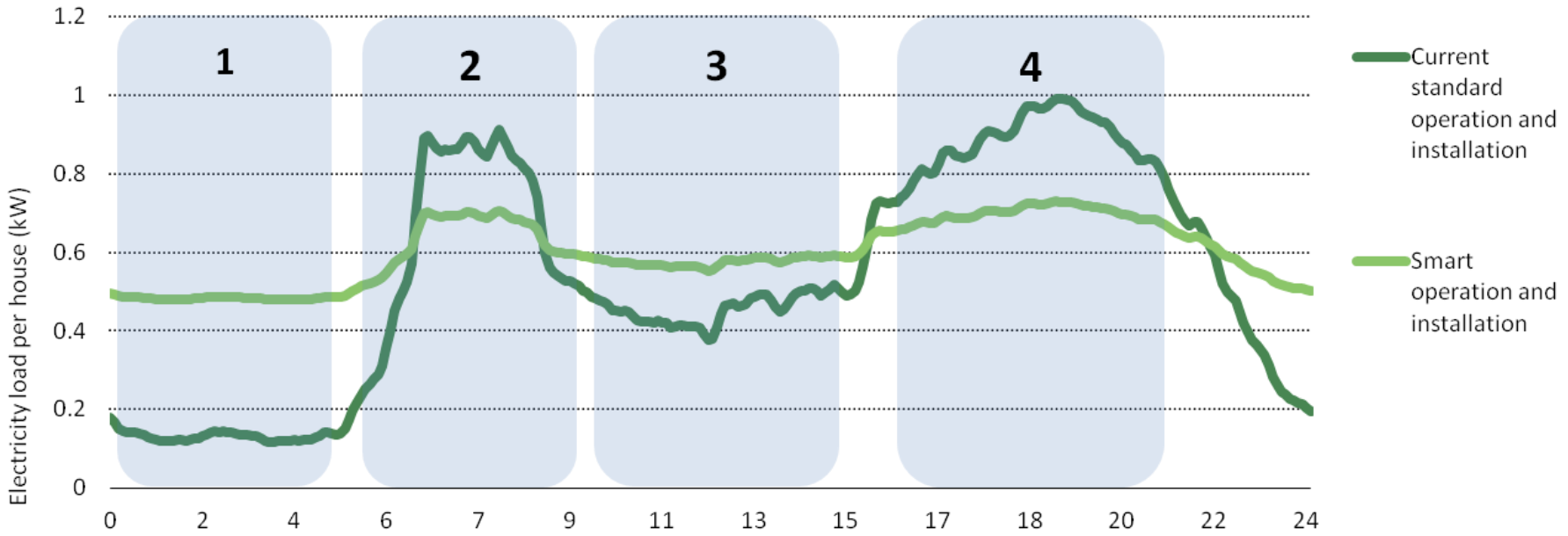


Heating and cooling account for 46% of global energy use.
Their huge potential for cutting CO_2 emissions is often neglected.

International Energy Agency

Electrification is a double-edged sword

ETP 2012

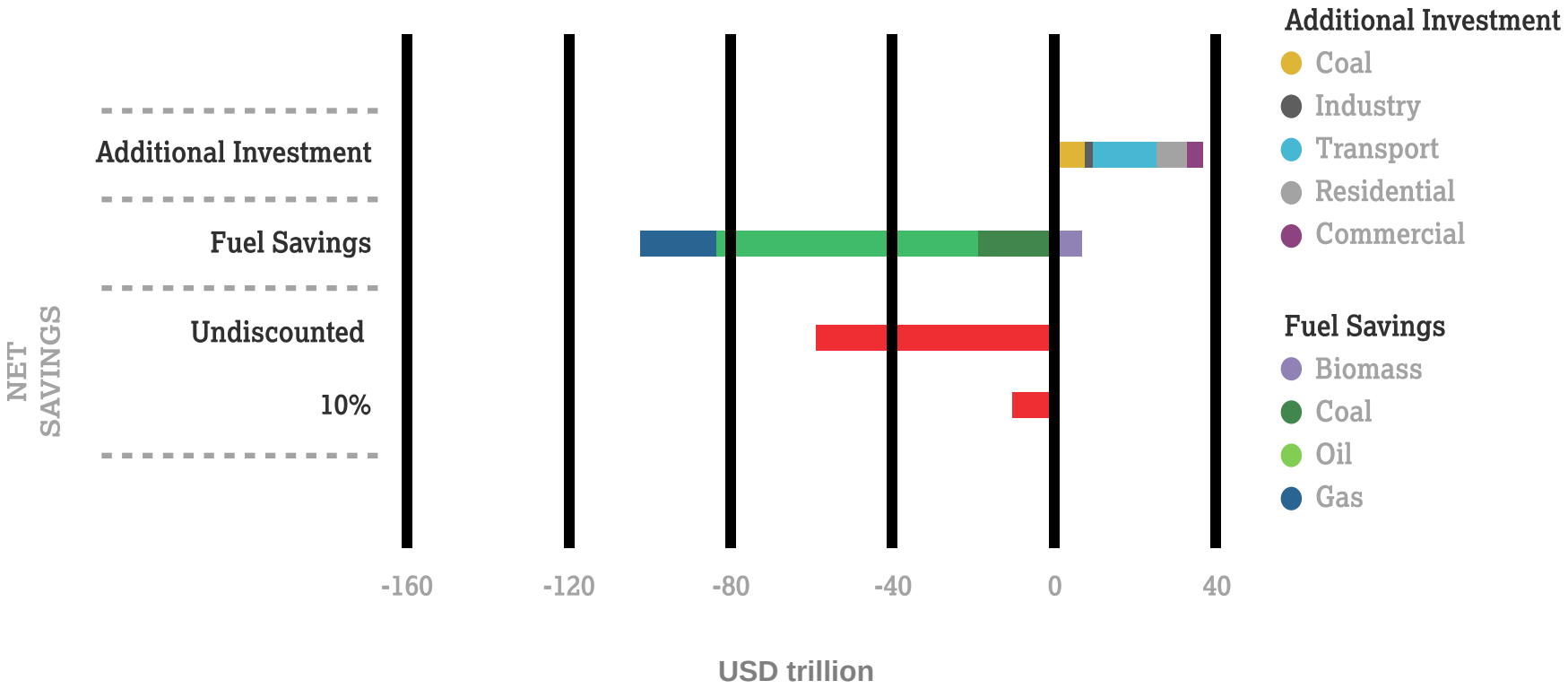


Heat pumps can deliver great savings - under the right conditions and with correct operation.

International Energy Agency

Clean energy investment pays off

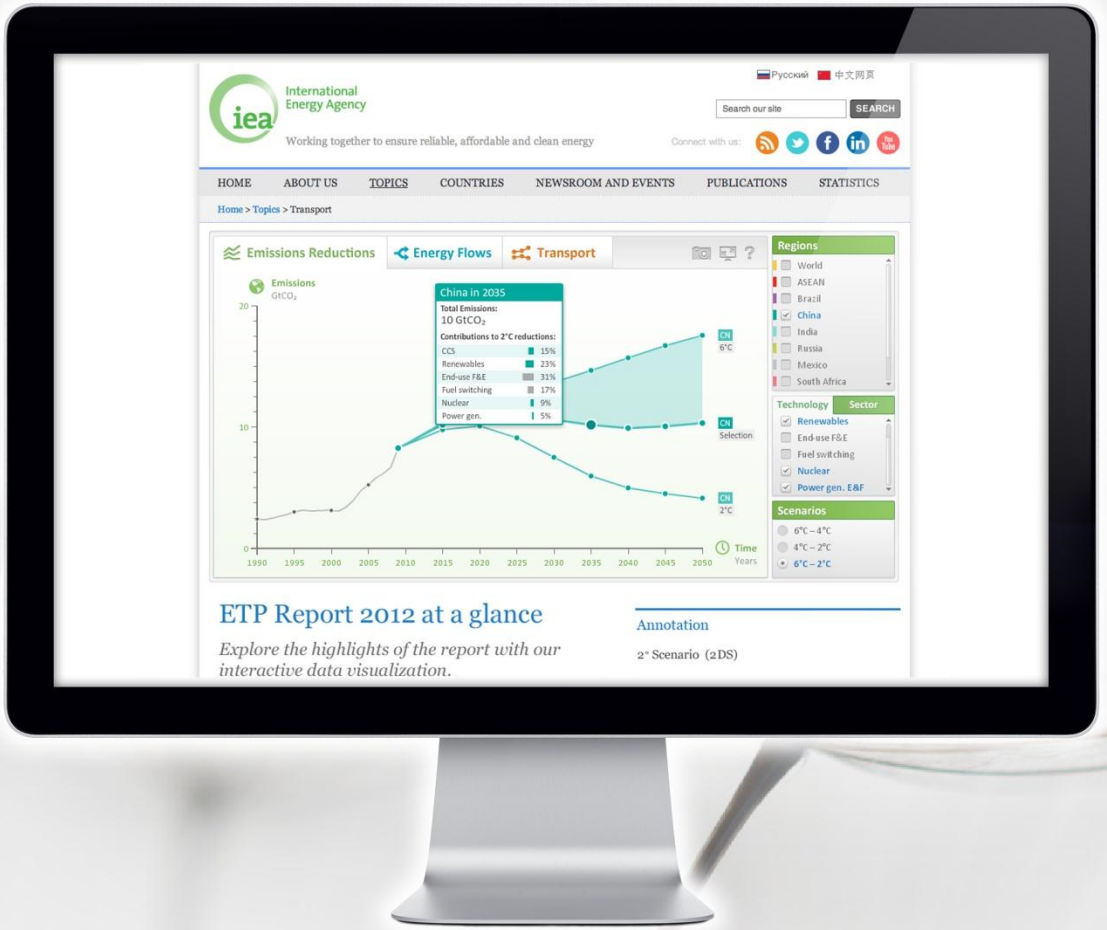
ETP 2012



Every additional dollar invested in clean energy can generate 3 dollars in return.

International Energy Agency

Explore the data behind *ETP*



www.iea.org/etp

Assumptions- GDP and population

ETP 2012

Table A.1 GDP projections in *ETP 2012* (assumed identical across scenarios)

CAAGR (%)	2009-20	2020-30	2030-50	2009-50	2050-75
World	4.2	3.1	2.9	3.3	2.7
OECD	2.4	2.0	1.8	2.0	1.8
Non-OECD	6.1	4.1	3.5	4.3	3.1
ASEAN	5.3	3.5	3.8	4.1	3.9
Brazil	4.3	3.3	3.0	3.4	2.8
China	8.1	4.4	3.2	4.8	2.4
European Union	2.0	1.8	1.7	1.8	1.6
India	7.7	5.9	4.8	5.8	3.9
Mexico	3.7	3.1	2.8	3.1	2.4
Russia	4.1	3.3	2.4	3.1	1.8
South Africa	3.6	2.6	2.9	3.0	3.1
United States	2.6	2.2	2.1	2.3	2.1

Notes: CAAGR = compounded average annual growth rate; ASEAN = Association of Southeast Asian Nations.
Sources: IMF, 2011 and 2011-16; IEA analysis.

Table A.2 Population projections used in *ETP 2012*

Country	2010	2020	2030	2040	2050	2060	2070	2075
World	6 896	7 657	8 321	8 874	9 306	9 615	9 827	9 905
OECD	1 234	1 302	1 353	1 385	1 403	1 408	1 409	1 410
Non-OECD	5 662	6 354	6 969	7 489	7 904	8 207	8 418	8 495
ASEAN	592	654	704	738	756	759	750	743
Brazil	195	210	220	224	223	217	208	203
China	1 341	1 388	1 393	1 361	1 296	1 212	1 126	1 086
European Union	500	511	516	515	512	504	496	494
India	1 225	1 387	1 523	1 627	1 692	1 718	1 708	1 692
Mexico	113	126	135	142	144	143	140	138
Russia	143	141	136	131	126	121	116	115
South Africa	50	53	55	56	57	57	57	57
United States	310	337	362	383	403	421	438	446

Note: Mumbers in millions
Source: UN, 2011

Assumptions- fossil fuel prices

ETP 2012

Table A.3 Fossil fuel prices by scenario

Oil	Scenario	2010	2020	2025	2030	2035	2040	2045	2050
IEA crude oil import price	2DS	78	97	97	97	97	92	89	87
2010 USD/bbl	4DS	78	109	114	117	120	119	119	118
	6DS	78	118	127	134	140	143	146	149
Coal	**Scenario**	**2010**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
OECD steam coal import price	2DS	99	93	83	74	68	64	62	60
2010 USD/tonne	4DS	99	106	108	109	110	109	109	109
	6DS	99	109	113	116	118	121	123	126
Gas	**Scenario**	**2010**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
United States import price	2DS	4	7	8	8	8	7	7	7
2010 USD/Mbtu	4DS	4	7	7	8	9	8	8	8
	6DS	4	7	8	8	9	9	9	10
Europe import price	2DS	7	10	10	10	9	9	9	8
2010 USD/Mbtu	4DS	7	10	11	12	12	12	12	12
	6DS	7	11	12	13	13	13	14	14
Japan import price	2DS	11	12	12	12	12	12	11	11
2010 USD/Mbtu	4DS	11	13	13	14	14	14	14	14
	6DS	11	14	14	15	15	15	16	16

Note: bbl = barrel, Mbtu = million British thermal units

International Energy Agency

Carbon prices (model result)

ETP 2012

Table 1.1 Global marginal abatement costs and example marginal abatement options in the 2DS

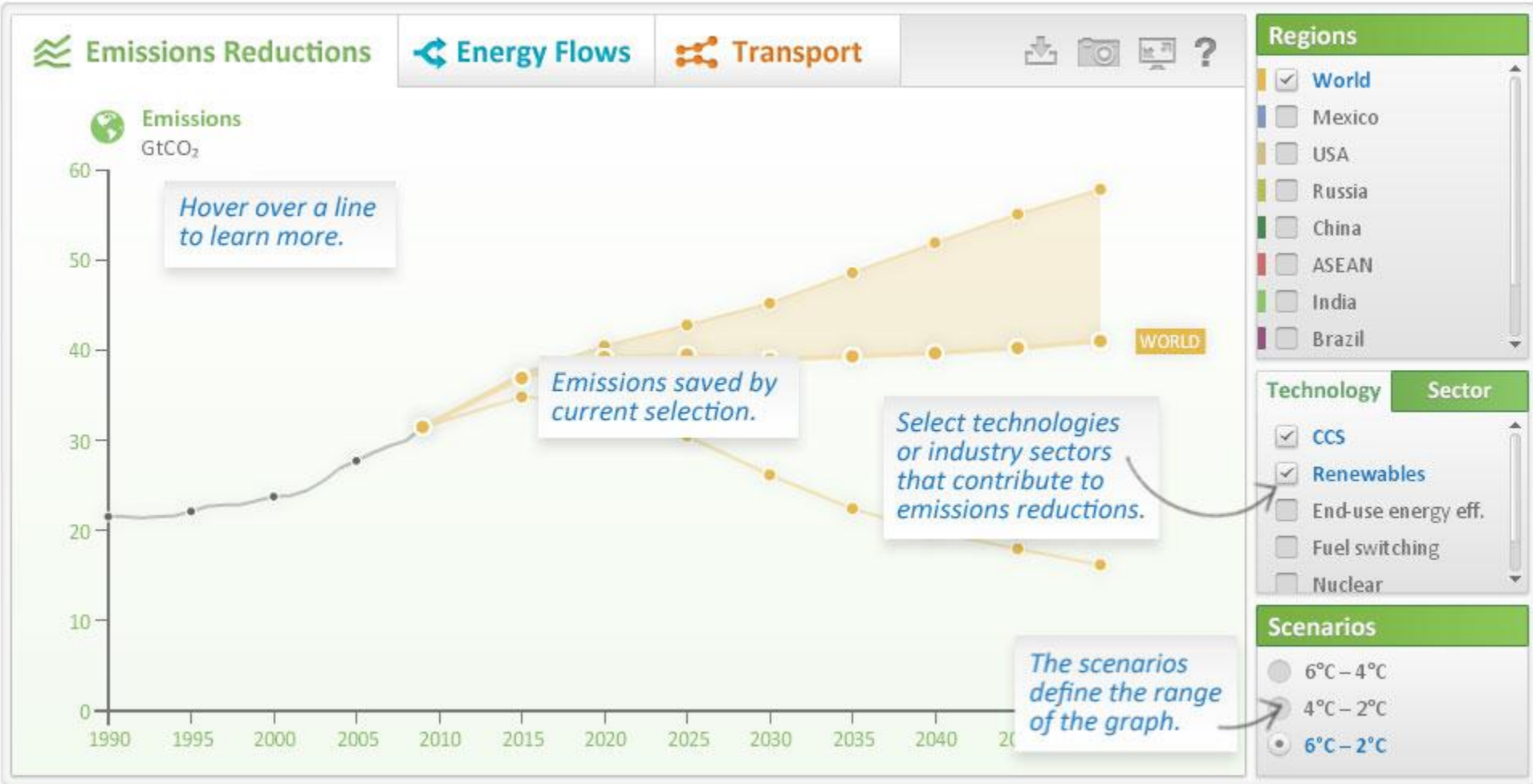
	2020	2030	2040	2050
Marginal cost (USD/tCO_2)	30-50	80-100	110-130	130-160
Energy conversion	Onshore wind Rooftop PV Coal w CCS	Utility scale PV Offshore wind Solar CSP Natural gas w CCS Enhanced geothermal systems	Same as for 2030, but scaled up deployment in broader markets	Biomass with CCS Ocean energy
Industry	Application of BAT in all sectors Top-gas recycling blast furnace Improve catalytic process performance CCS in ammonia and HVC	Bio-based chemicals and plastics Black liquor gasification	Novel membrane separation technologies Inert anodes and carbothermic reduction CCS in cement	Hydrogen smelting and molten oxide electrolysis in iron and steel New cement types CCS in aluminium
Transport	Diesel ICE HEV PHEV	HEV PHEV BEV Advanced biofuels	Same as for 2030, but wider deployment and to all modes	FCEV New aircraft concepts
Buildings	Solar thermal space and water heating Improved building shells	Stability of organic LED System integration and optimisation with geothermal heat-pumps	Solar thermal space cooling	Novel buildings materials; development of "smart buildings" Fuel cells co-generation

Notes: HVC = high-value chemicals, FCEV = fuel-cell electric vehicle, LED = light emitting diode.

International Energy Agency

Visualising ETP Data – reductions

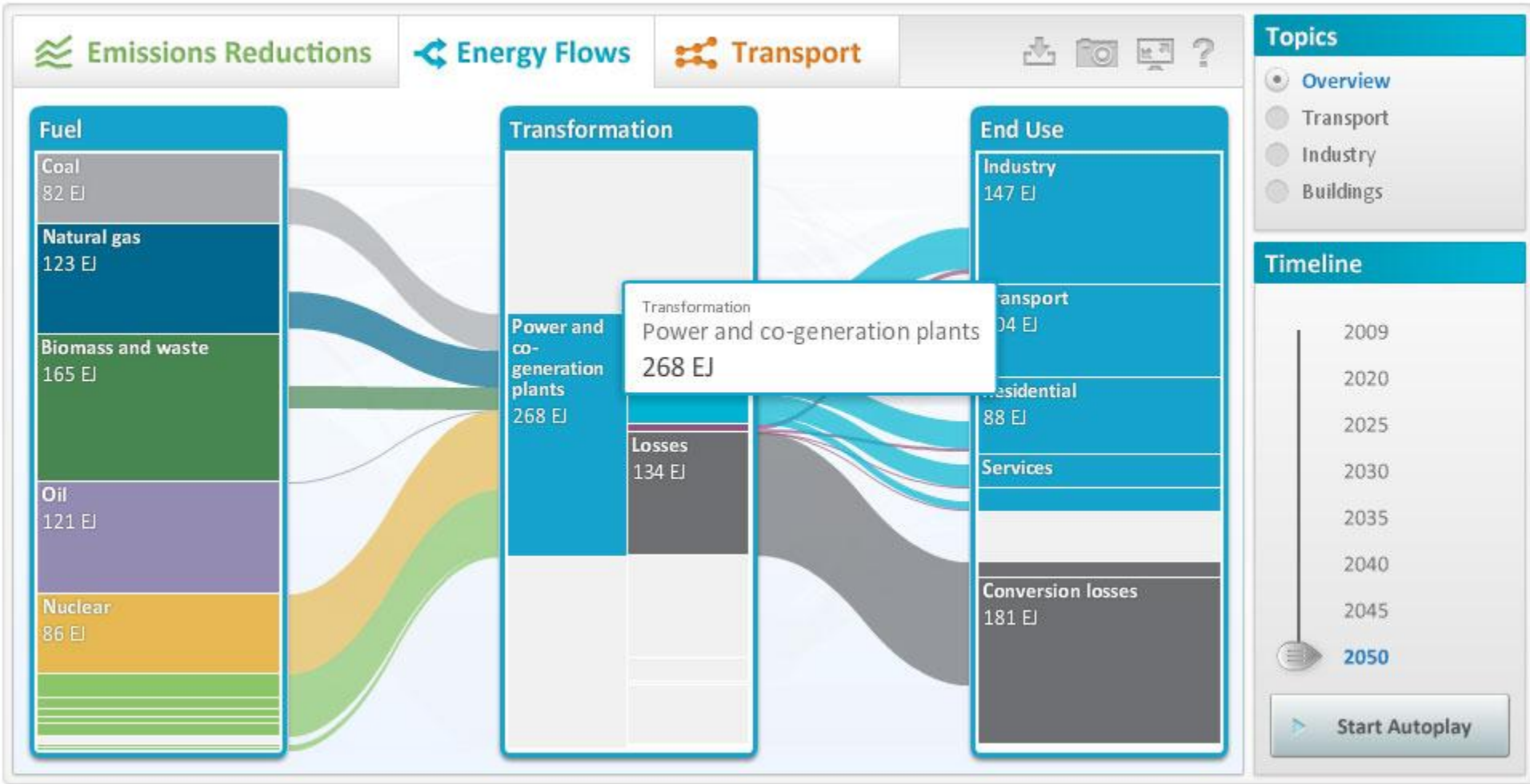
ETP 2012



International Energy Agency

Visualising ETP Data – energy flows

ETP 2012



International Energy Agency

Visualising ETP Data – fuel flows

ETP 2012