

Energy Technology Perspectives 2012

Pathways to a Clean Energy System

Berne, Switzerland, 24 September 2012

Bo Diczfalusy, Director, Directorate of Sustainable Energy Policy and Technology

Markus Wråke, ETP Project Leader, Head of Energy Supply Technology Unit

ETP 2012 – Choice of 3 Futures

ETP
2012

2DS

a vision of a **sustainable** energy system of reduced Greenhouse Gas (GHG) and CO₂ emissions

The 2°C Scenario

4DS

reflecting pledges by countries to cut emissions and boost energy efficiency

The 4°C Scenario

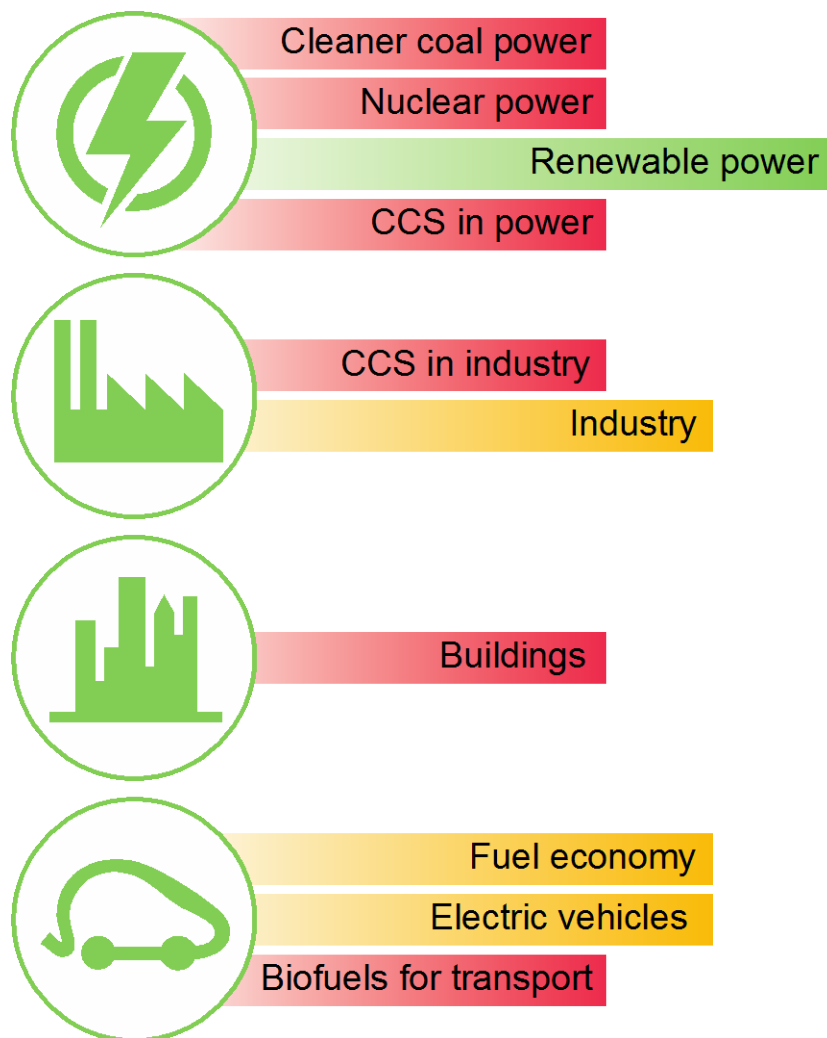
6DS

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

The 6°C Scenario

Clean energy: slow lane to fast track

ETP
2012



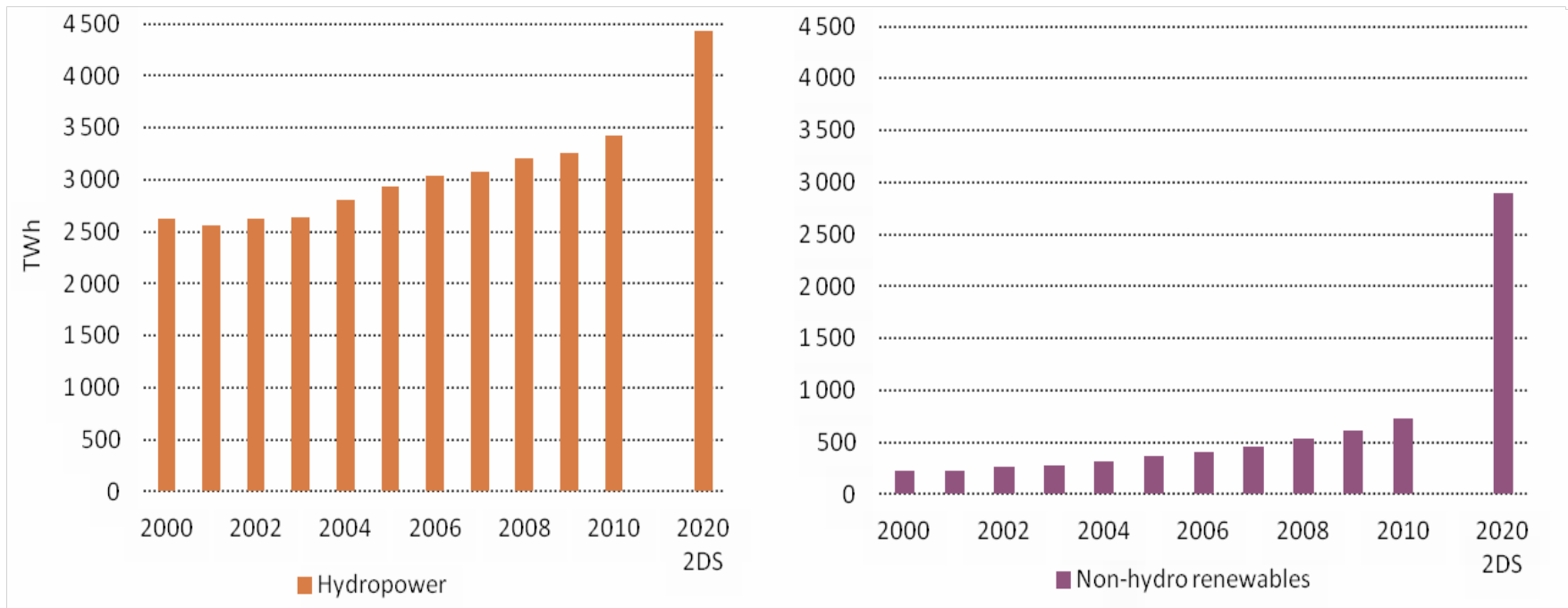
Progress is too slow in almost all technology areas

Significant action is required to get back on track

Renewables provide good news

ETP
2012

Renewable power generation



42%

Average annual
growth in Solar PV

75%

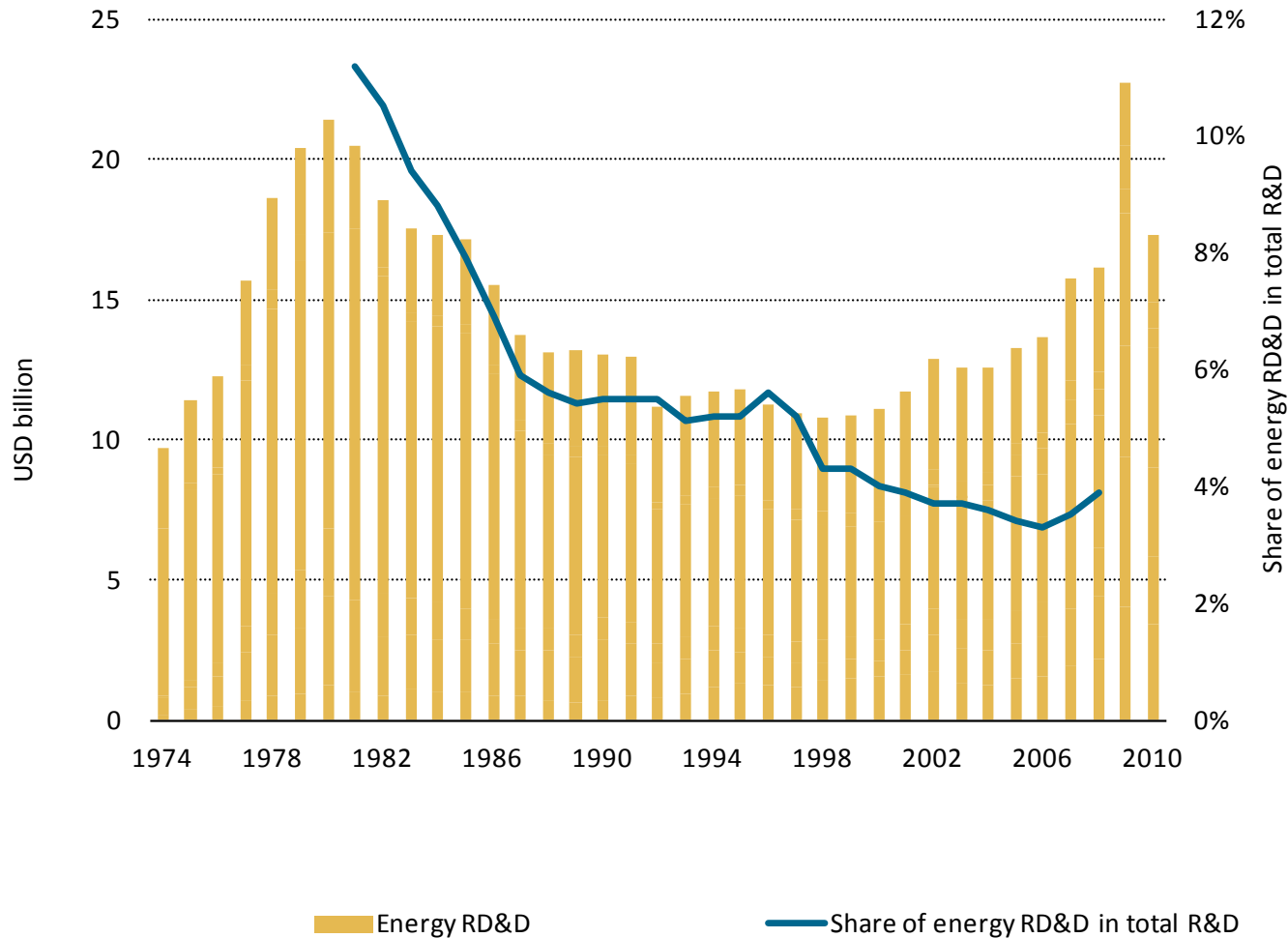
Cost reductions in
Solar PV in just
three years in
some countries

27%

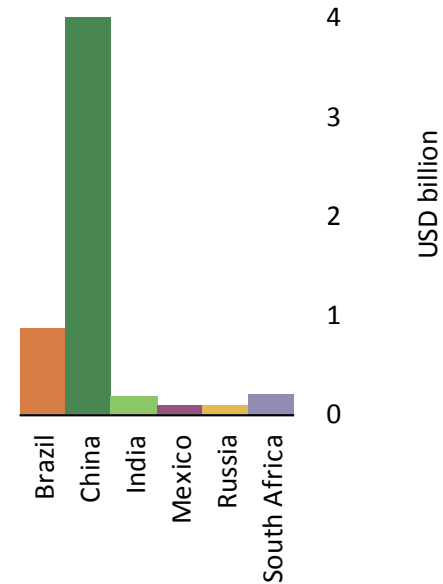
Average annual
growth in wind

Energy RD&D has slipped in priority

ETP
2012

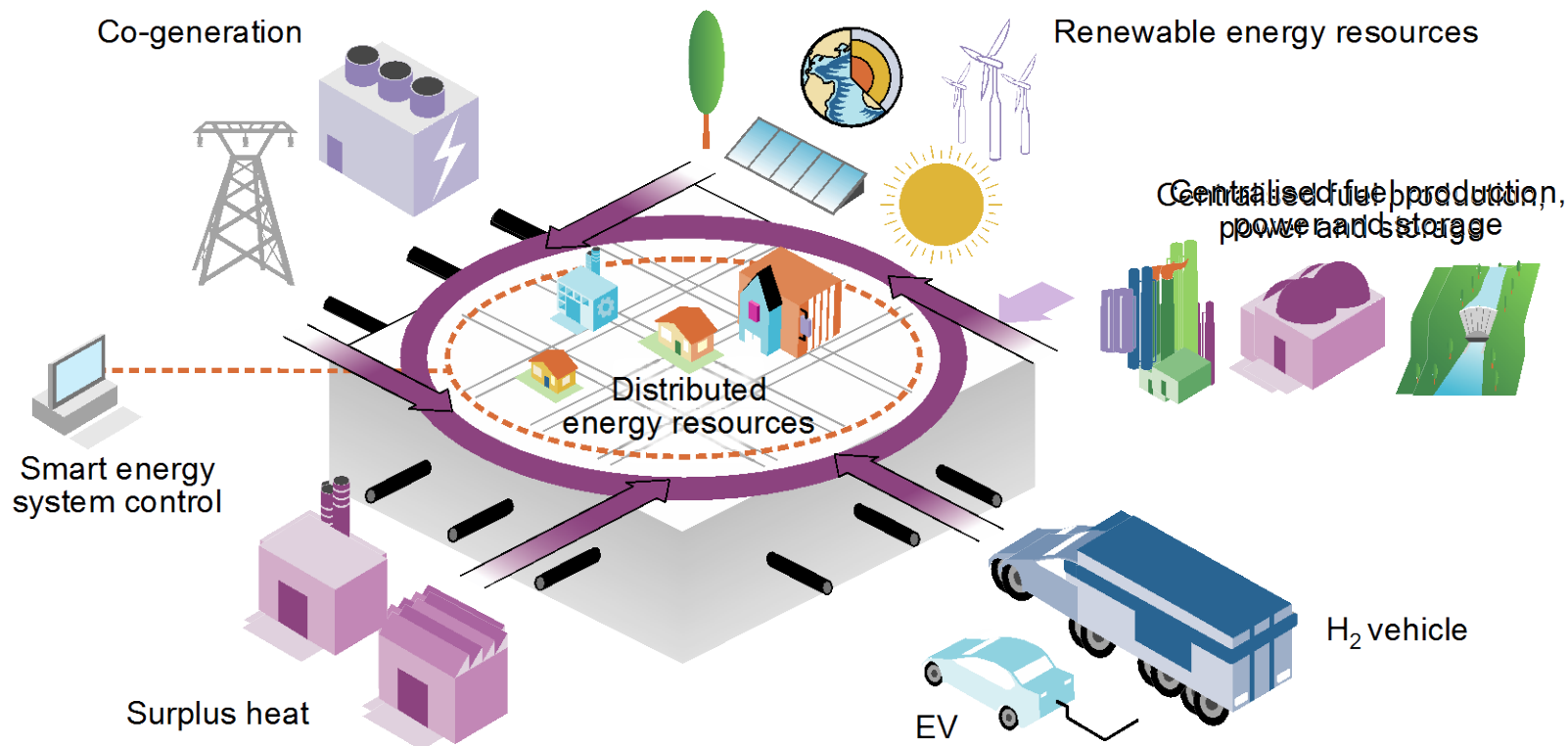


2008 non-IEA country spending



A smart, sustainable energy system

ETP
2012



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

Recommendations to Governments

ETP
2012

1. Create an investment climate of confidence in clean energy

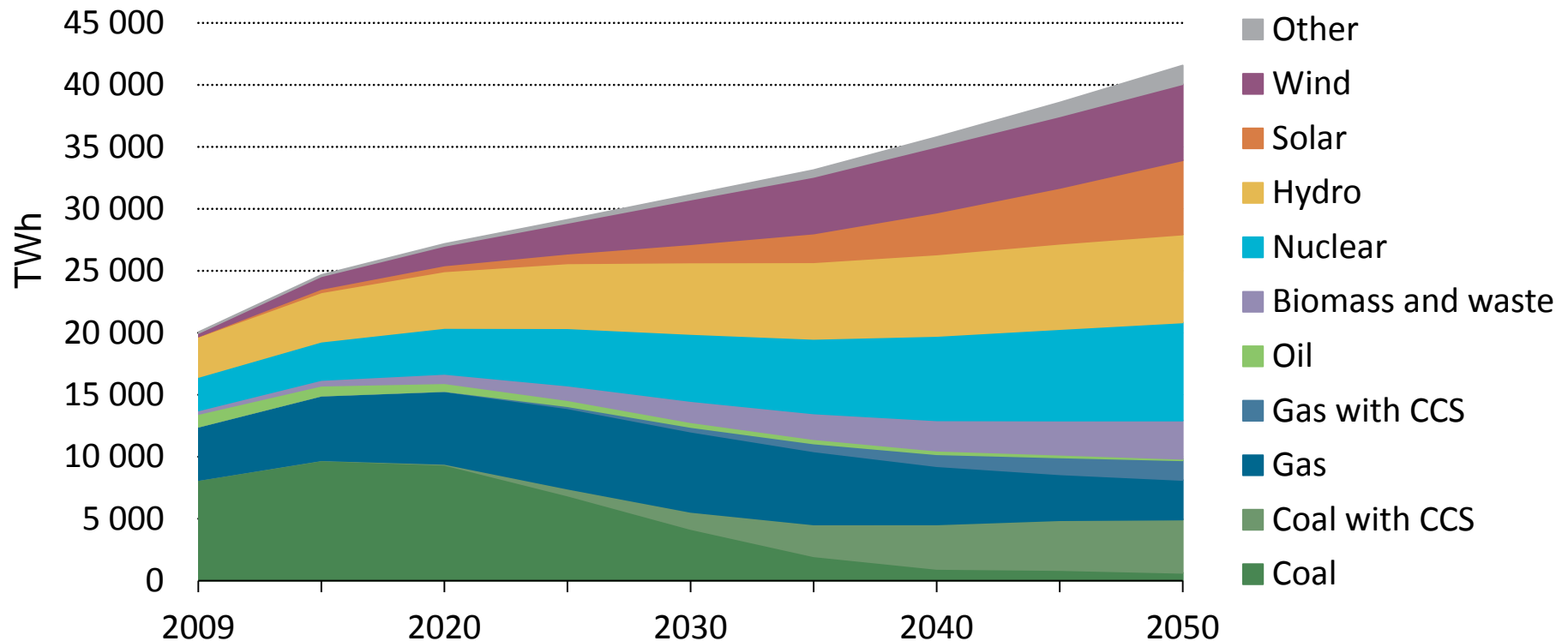
2. Unlock the incredible potential of energy efficiency – “the hidden” fuel of the future

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

Low-carbon electricity: a clean core

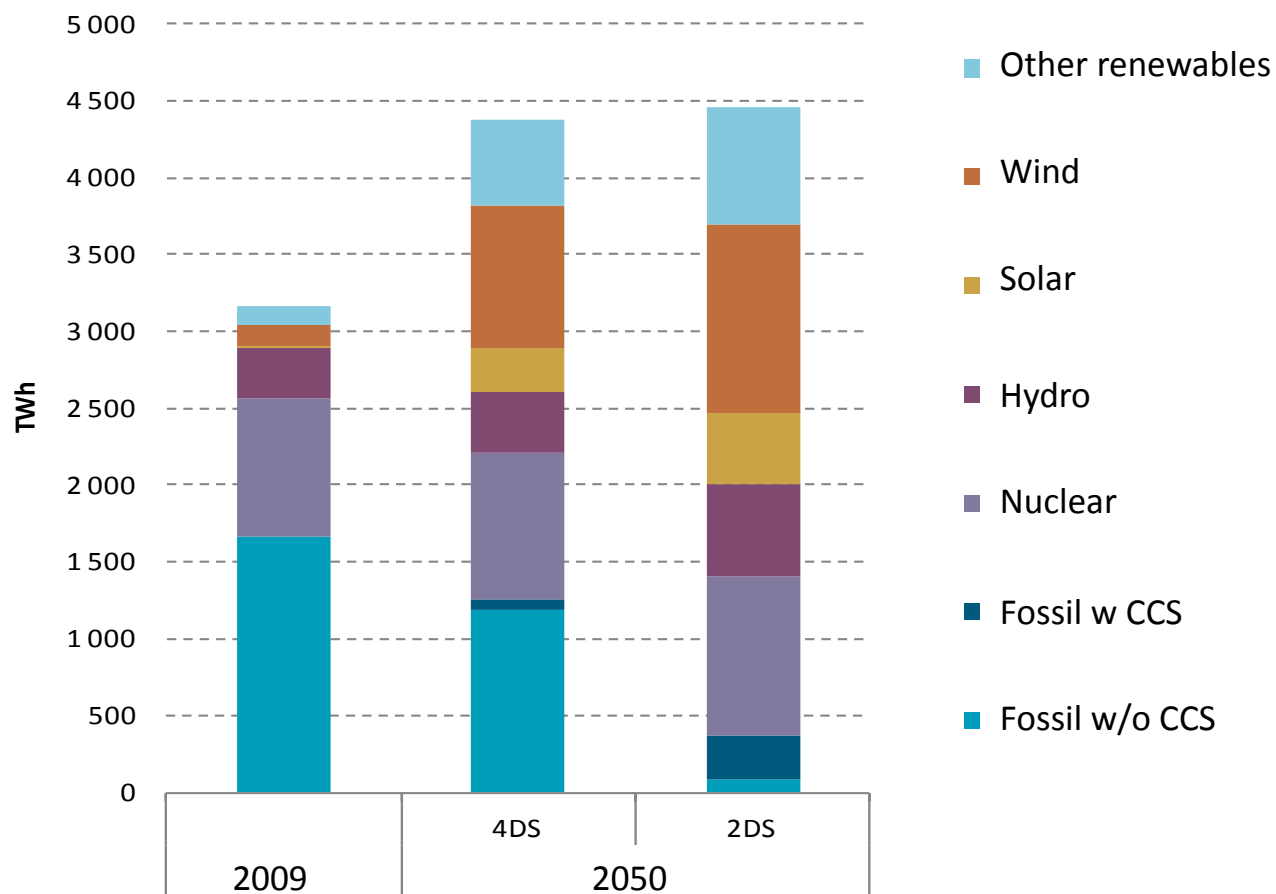
ETP
2012

Global electricity generation in the 2DS



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

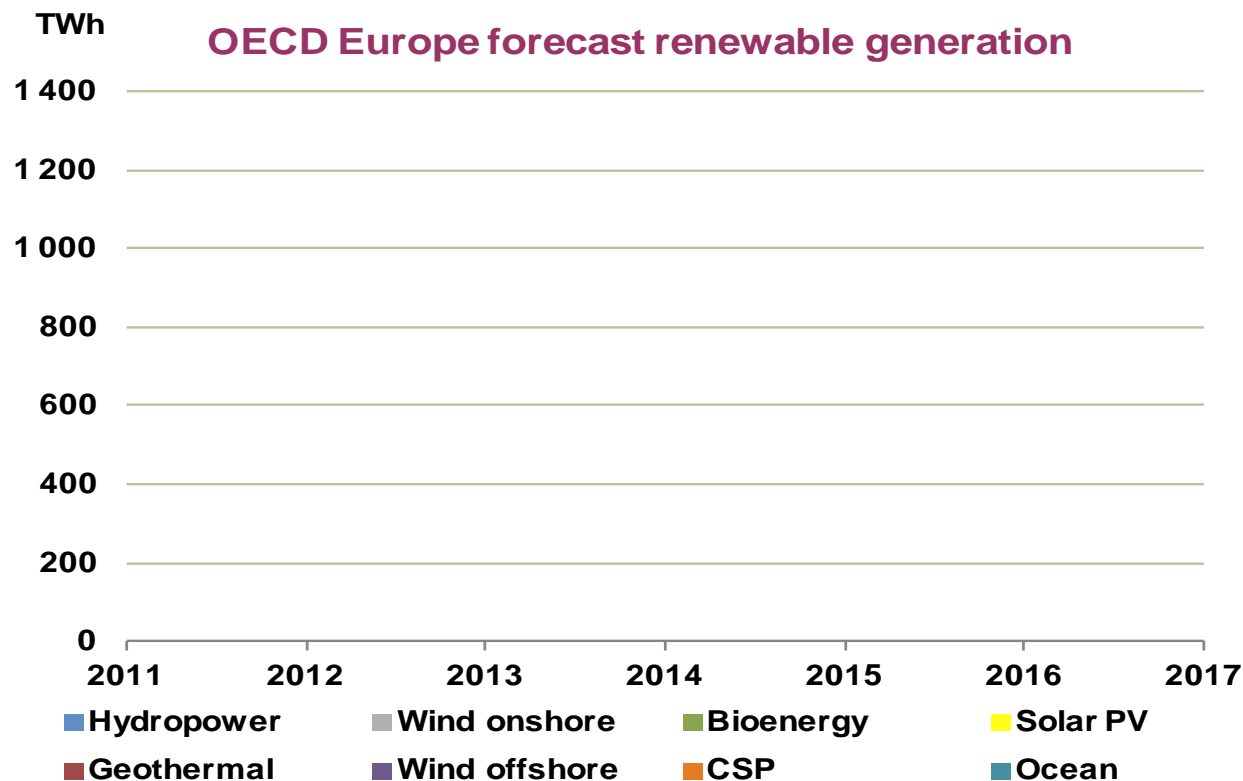
Renewables need to dominate EU electricity



Renewables cover two-thirds of the electricity mix in 2050 in the 2DS, with wind power alone reaching a share of 30% in the mix.

Renewables growth in Europe continues but slows

ETP
2012

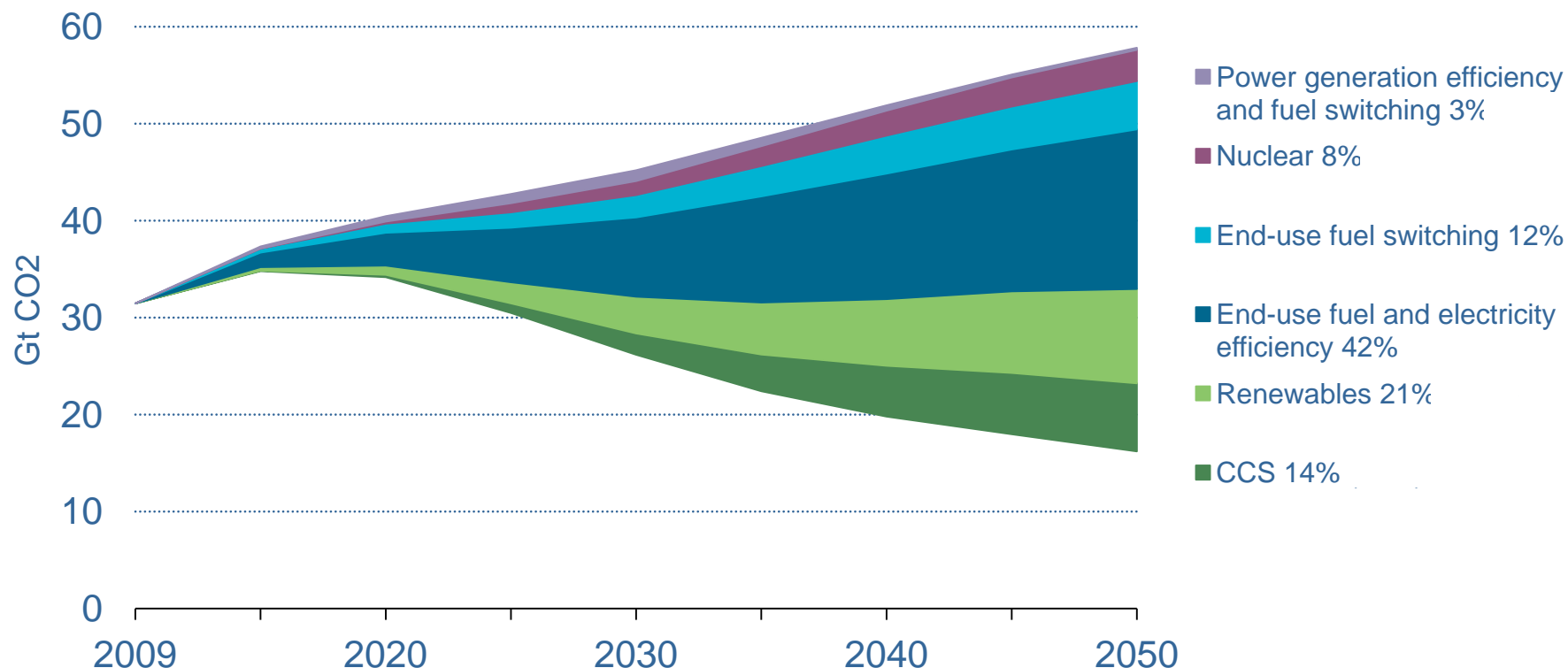


Despite policy adjustments and macroeconomic situation, growth continues

All technologies have roles to play

ETP
2012

Technology contributions to reaching the 2DS

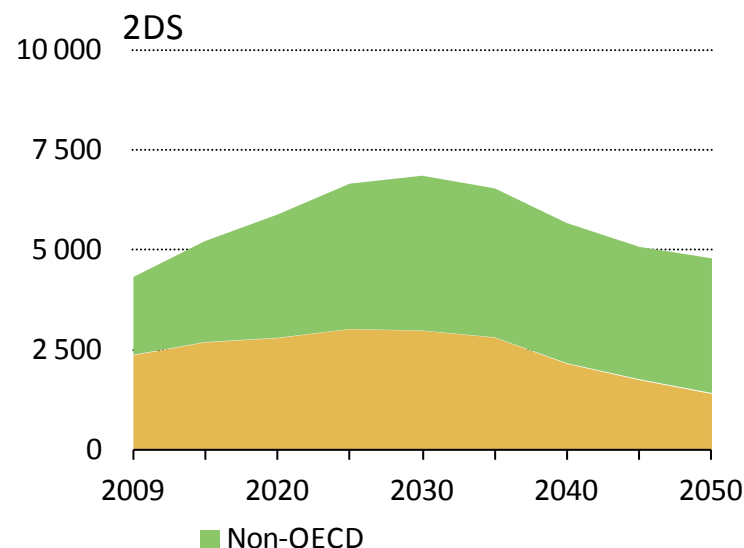
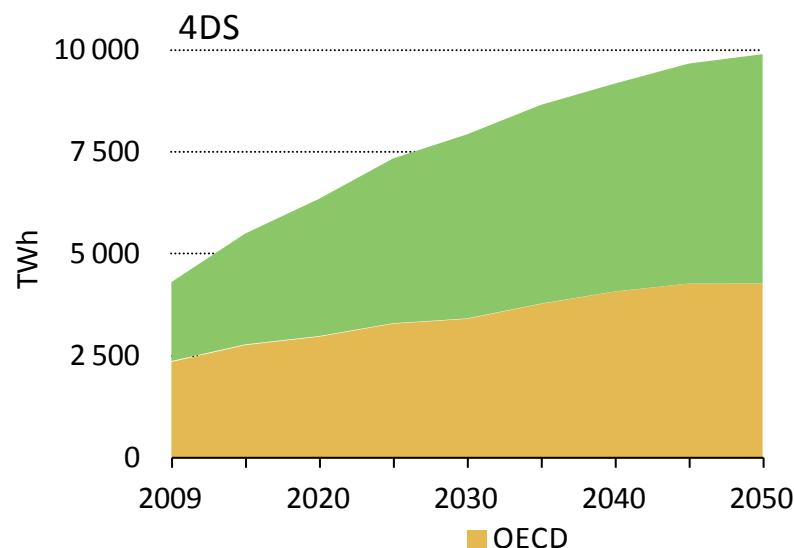


Nuclear is one piece of the puzzle

Natural gas as a transitional fuel

ETP
2012

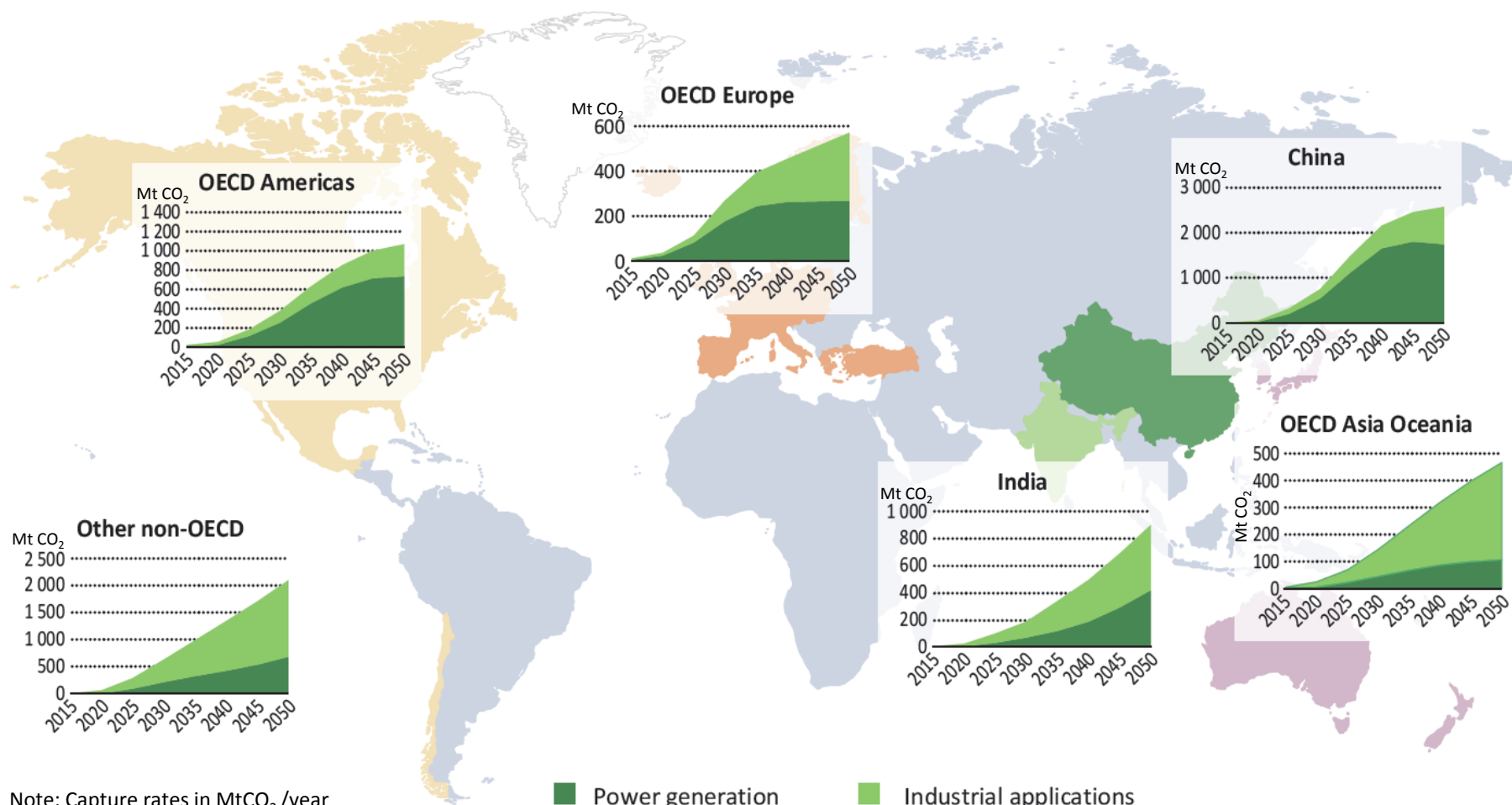
- Power generation from natural gas increases to 2030 in the 2DS and the 4DS.
- From 2030 to 2050, generation differs markedly.



Natural gas-fired power generation must decrease after 2030 to meet the CO₂ emissions projected in the 2DS scenario.

The CCS infant must grow quickly

ETP
2012

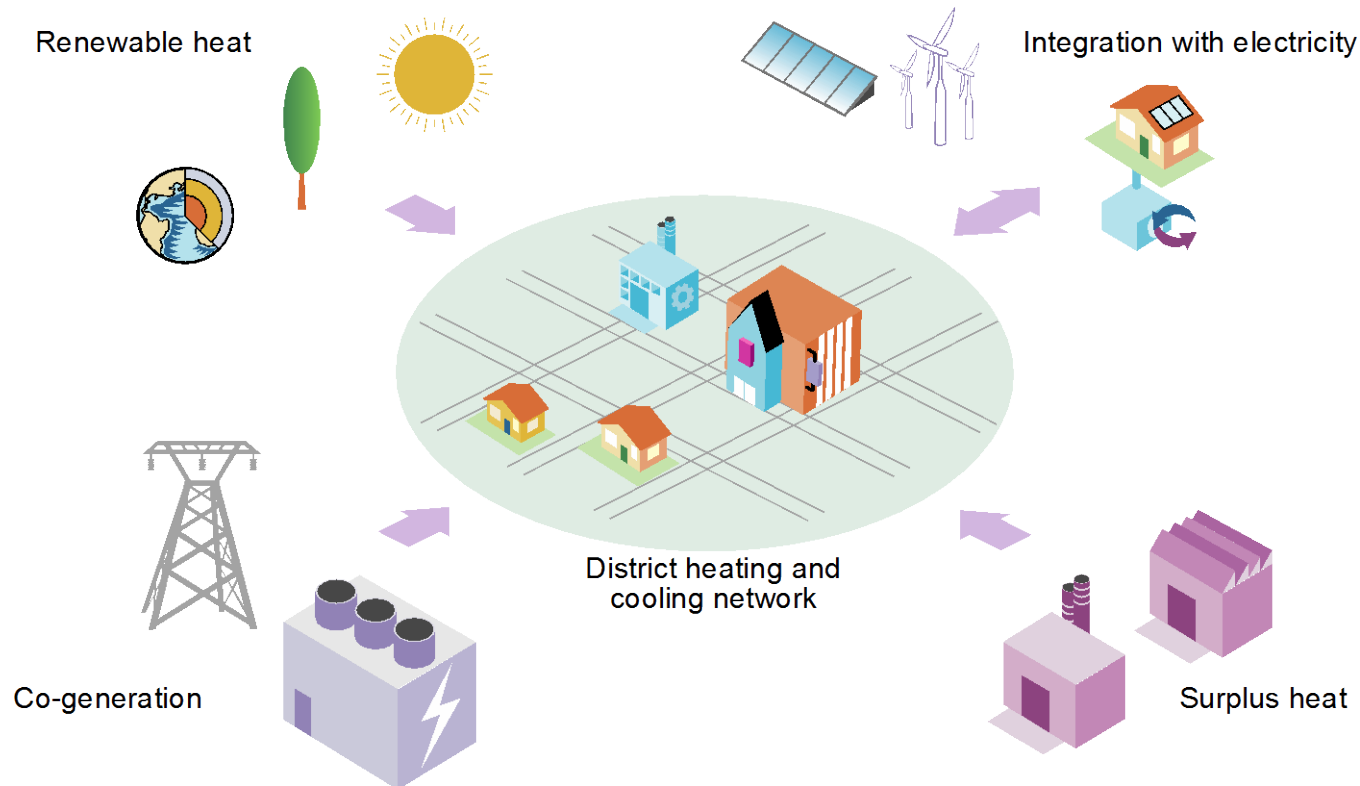


Note: Capture rates in MtCO₂/year

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Heating & Cooling: the forgotten giant

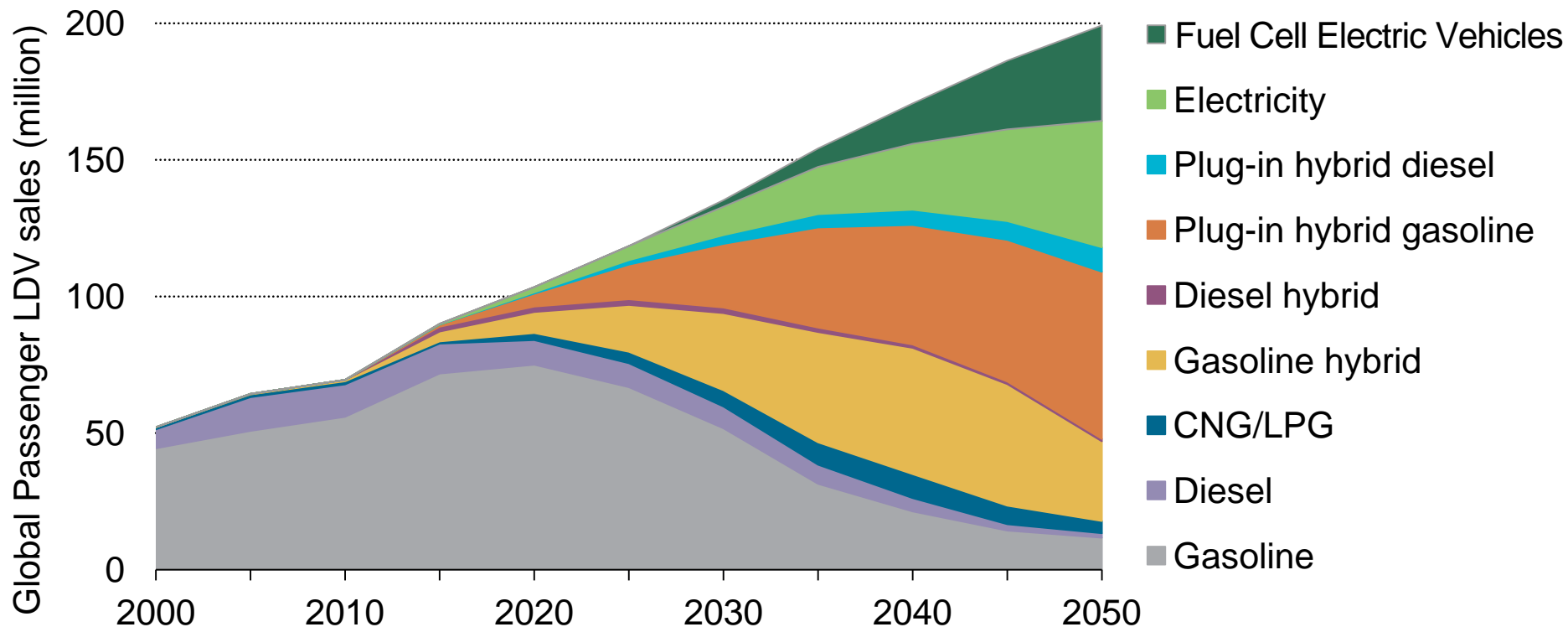
ETP
2012



*Heating and cooling account for 46% of global energy use.
Their huge potential for cutting CO₂ emissions is often neglected.*

Electric vehicles need to come of age

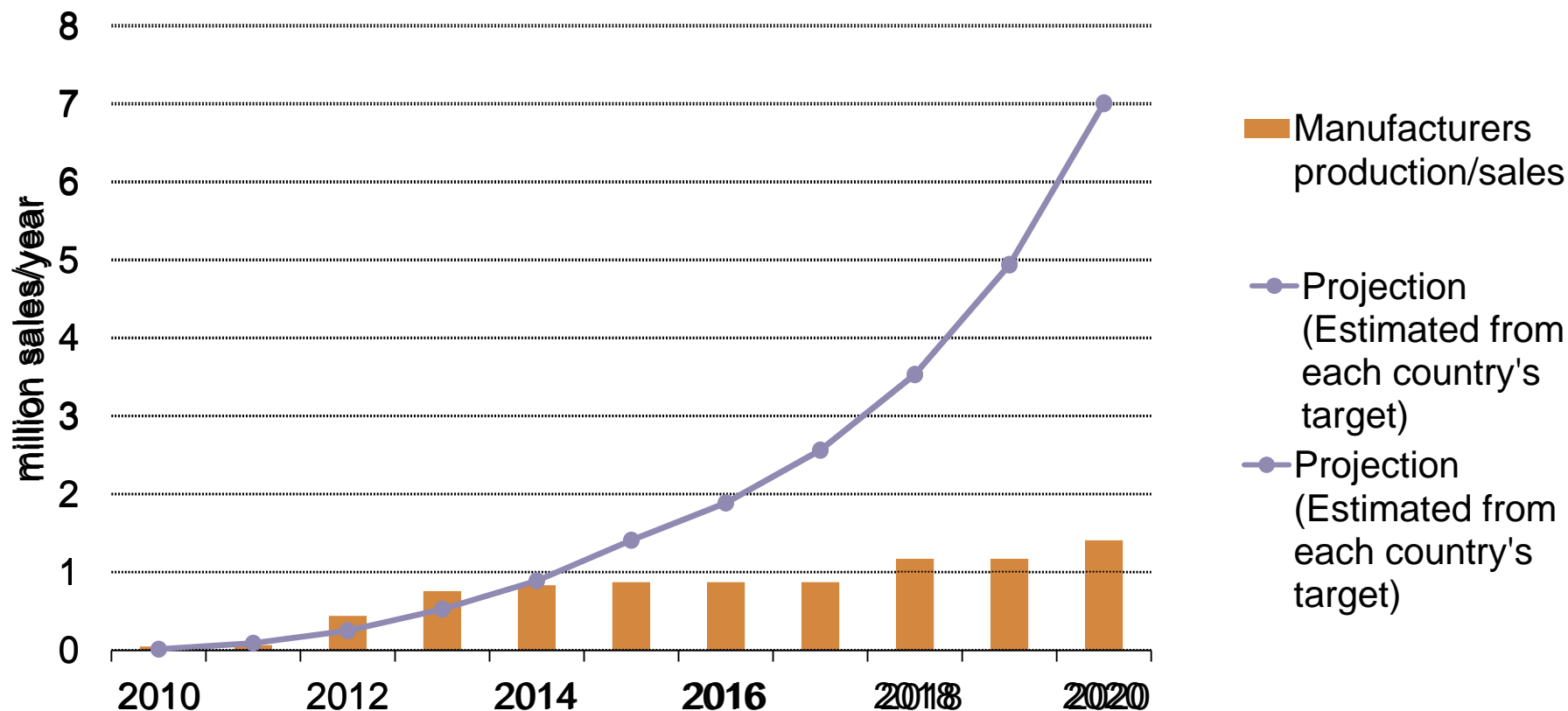
ETP
2012



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

Translating targets into action

ETP
2012

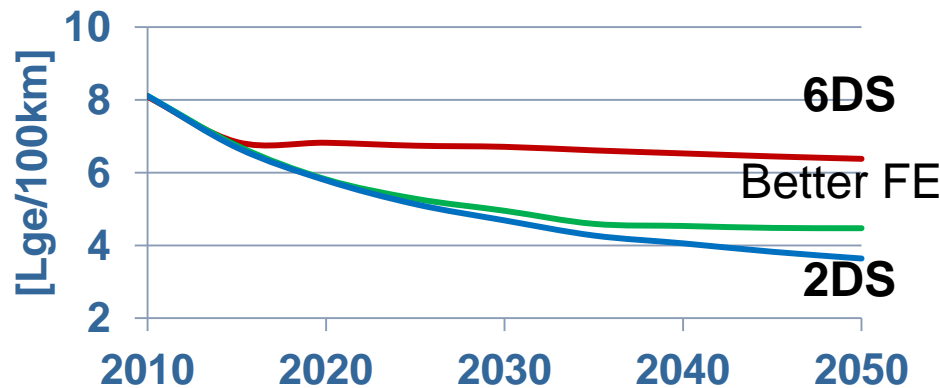


Government targets need to be backed by policy action

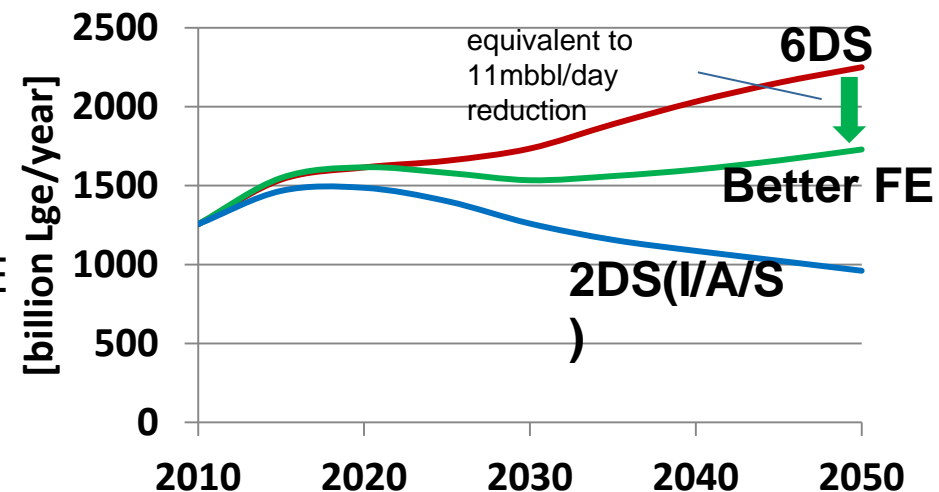
Fuel economy makes a difference

ETP
2012

PLDV tested fuel economy -
WORLD
(new car average)



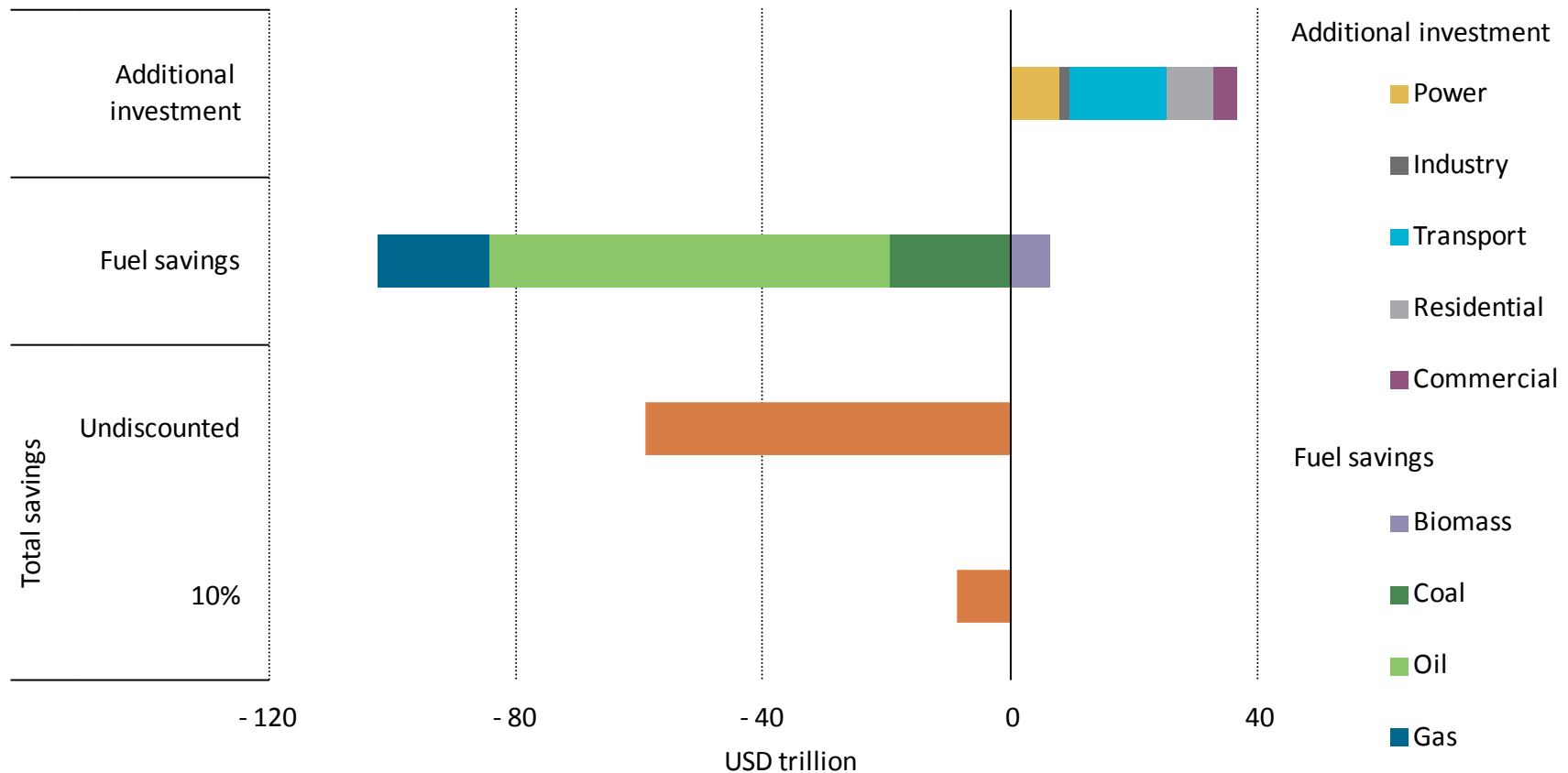
PLDV fuel consumption - WORLD



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

Clean energy investment pays off

ETP
2012



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

Sustainable future still in reach

ETP
2012

Is a clean energy transition urgent?

YES ✓

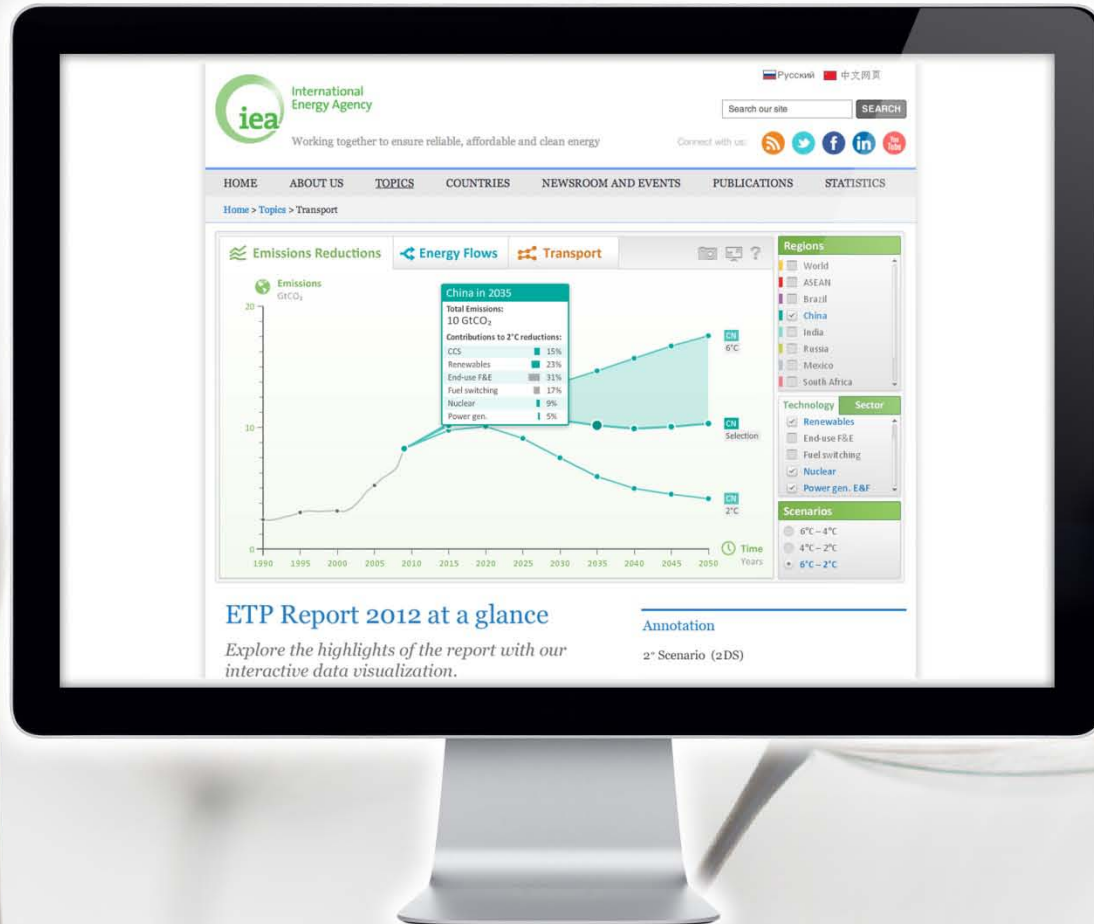
Are we on track to reach a clean energy future?

NO ✗

Can we get on track?

YES ✓

Explore the data behind *ETP*



www.iea.org/etp

Additional slides

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: Numbers 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 2010 USD/bbl	2DS	78	97	97	97	97	92	89	87
	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 2010 USD/tonne	2DS	99	93	83	74	68	64	62	60
	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 2010 USD/Mbtu	2DS	4	7	8	8	8	7	7	7
	4DS	4	7	7	8	9	8	8	8
	6DS	4	7	8	8	9	9	9	10
Europe import price 2010 USD/Mbtu	2DS	7	10	10	10	9	9	9	8
	4DS	7	10	11	12	12	12	12	12
	6DS	7	11	12	13	13	13	14	14
Japan import price 2010 USD/Mbtu	2DS	11	12	12	12	12	12	11	11
	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

Carbon prices (model result)

ETP
2012

Table 1.1

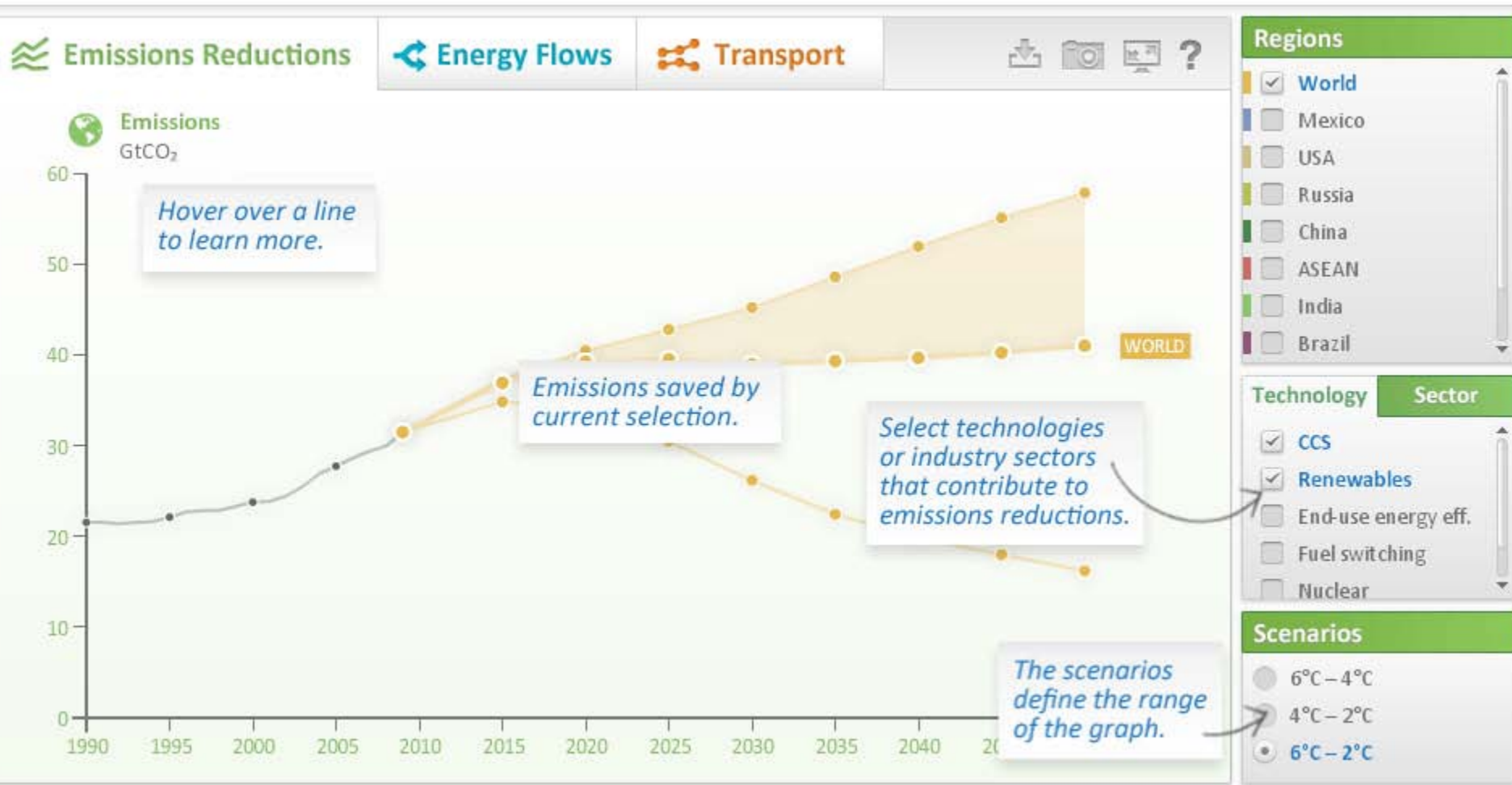
Global marginal abatement costs and example marginal abatement options in the 2DS

	2020	2030	2040	2050
Marginal cost (USD/tCO₂)	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.

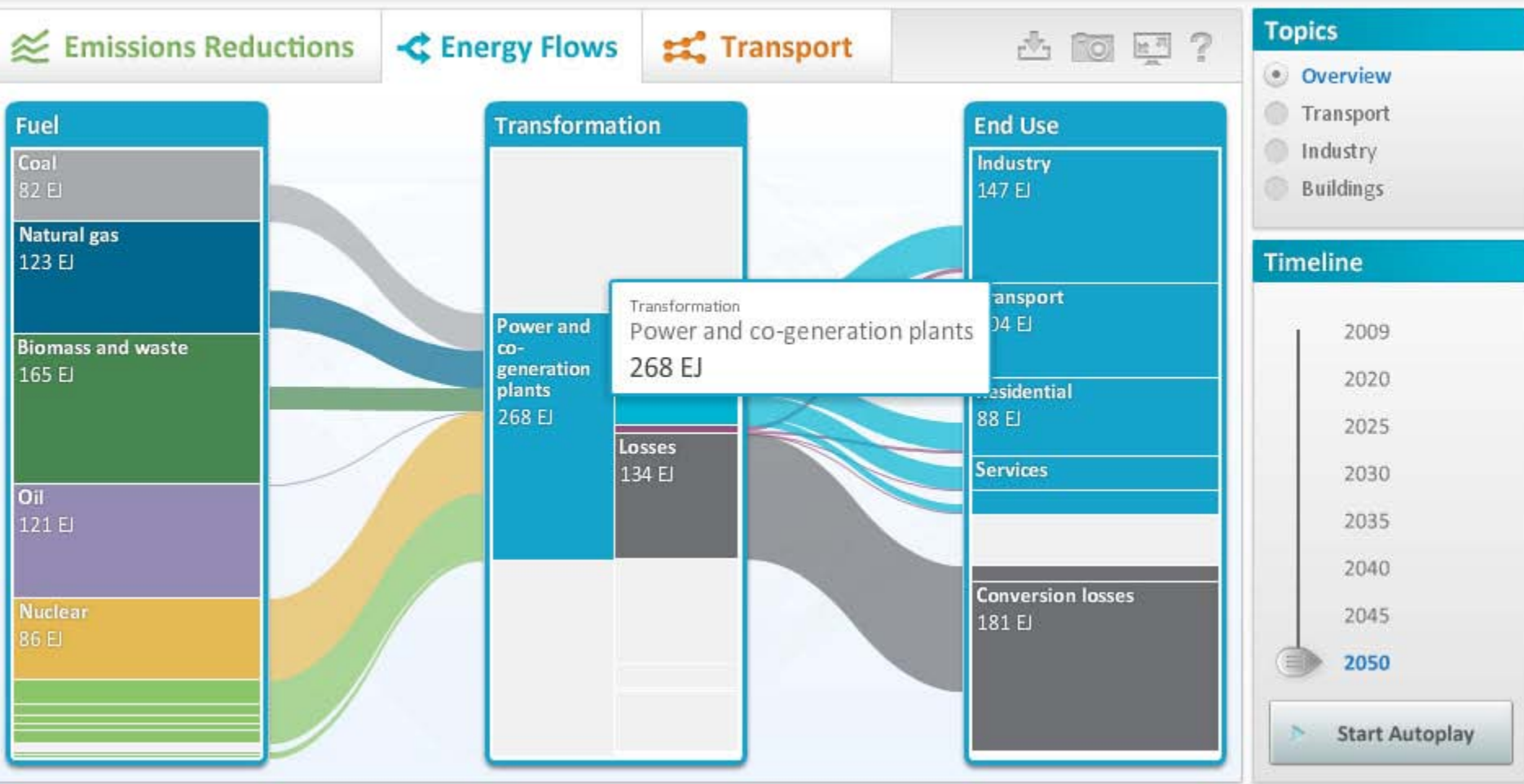
Visualising ETP Data – reductions

ETP
2012



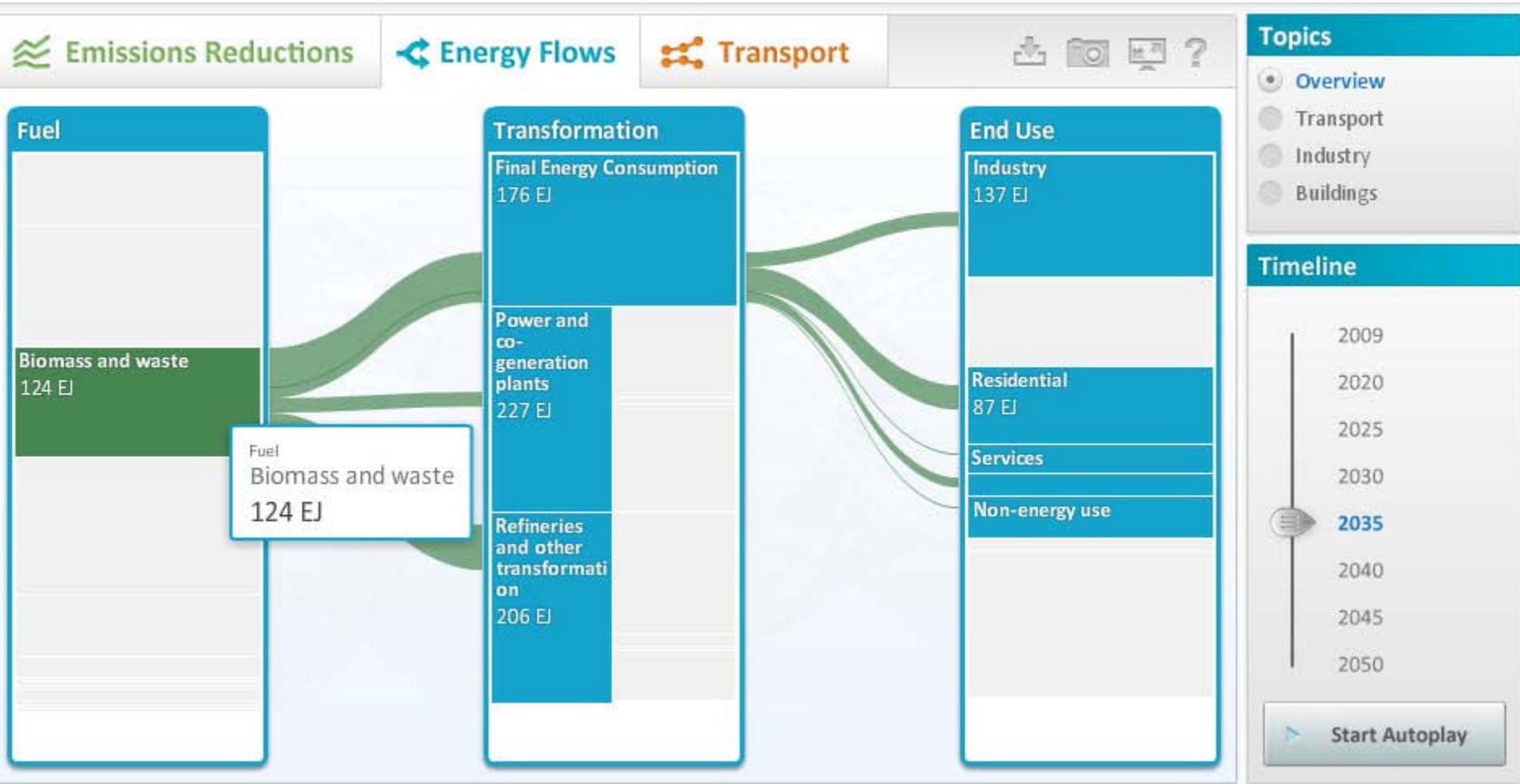
Visualising ETP Data – energy flows

ETP
2012



Visualising ETP Data – fuel flows

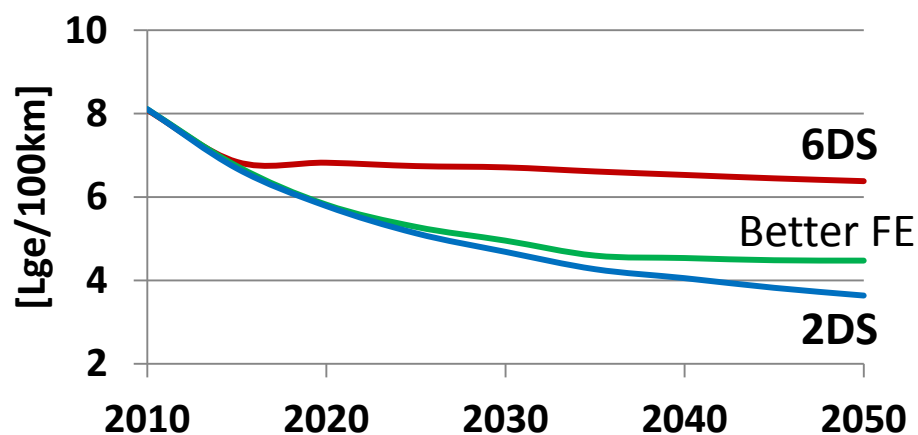
ETP
2012



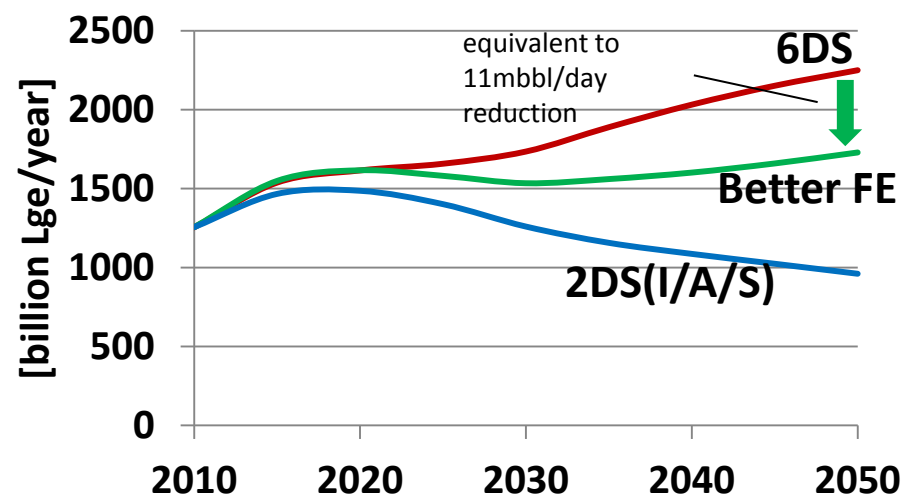
Fuel economy makes a difference

ETP
2012

PLDV tested fuel economy - WORLD
(new car average)



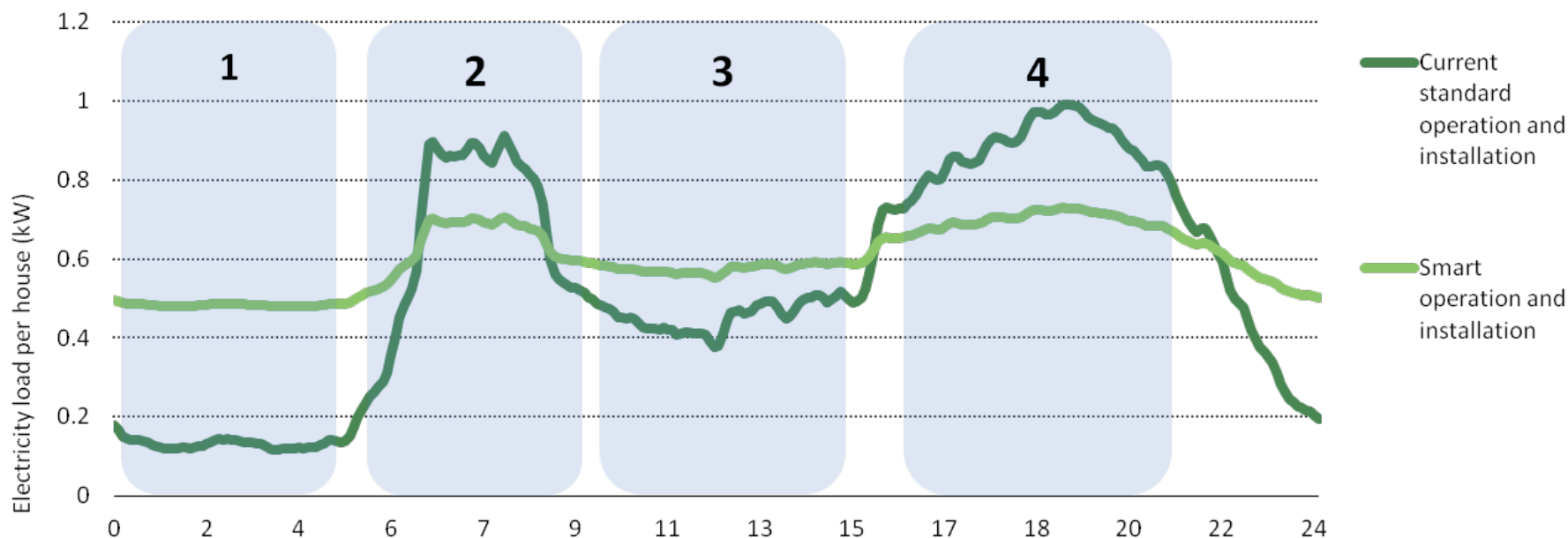
PLDV fuel consumption - WORLD



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

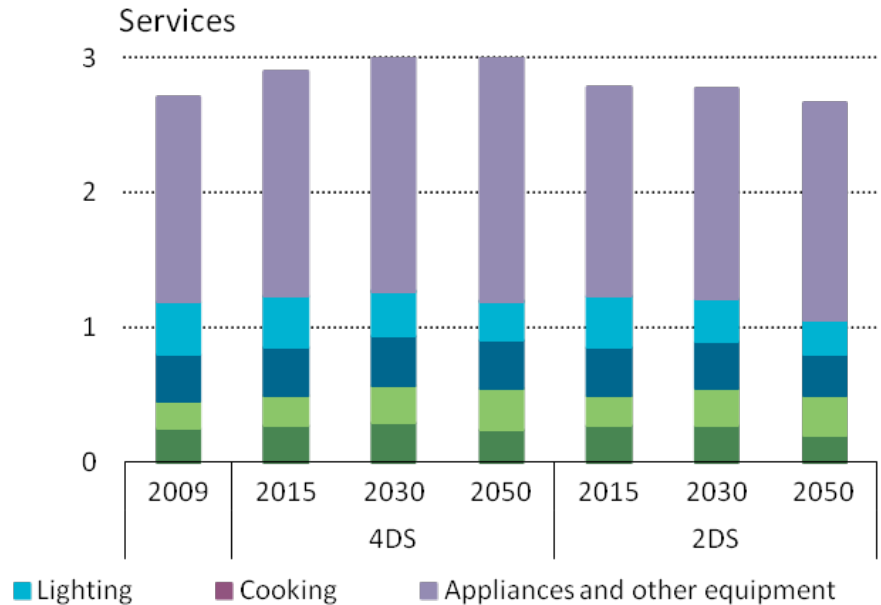
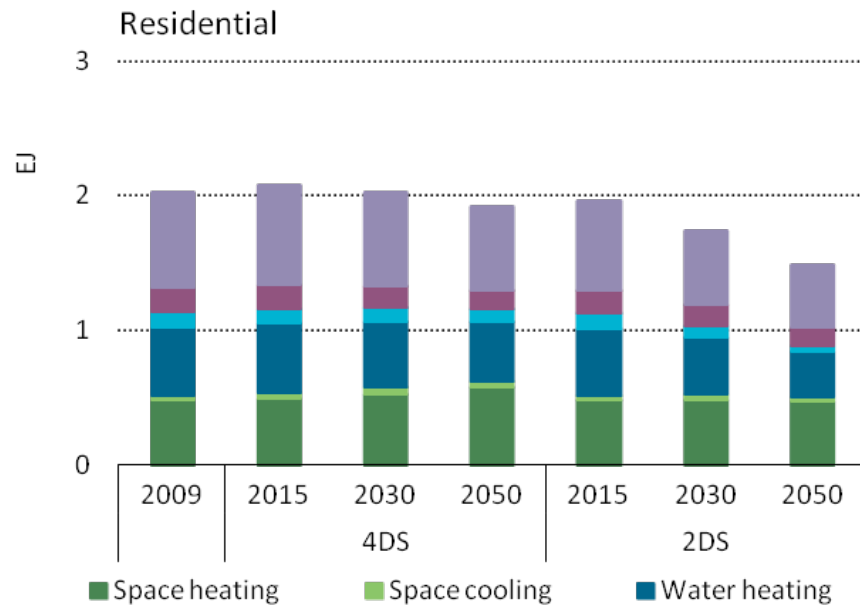
Electrification is a double-edged sword

ETP
2012



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

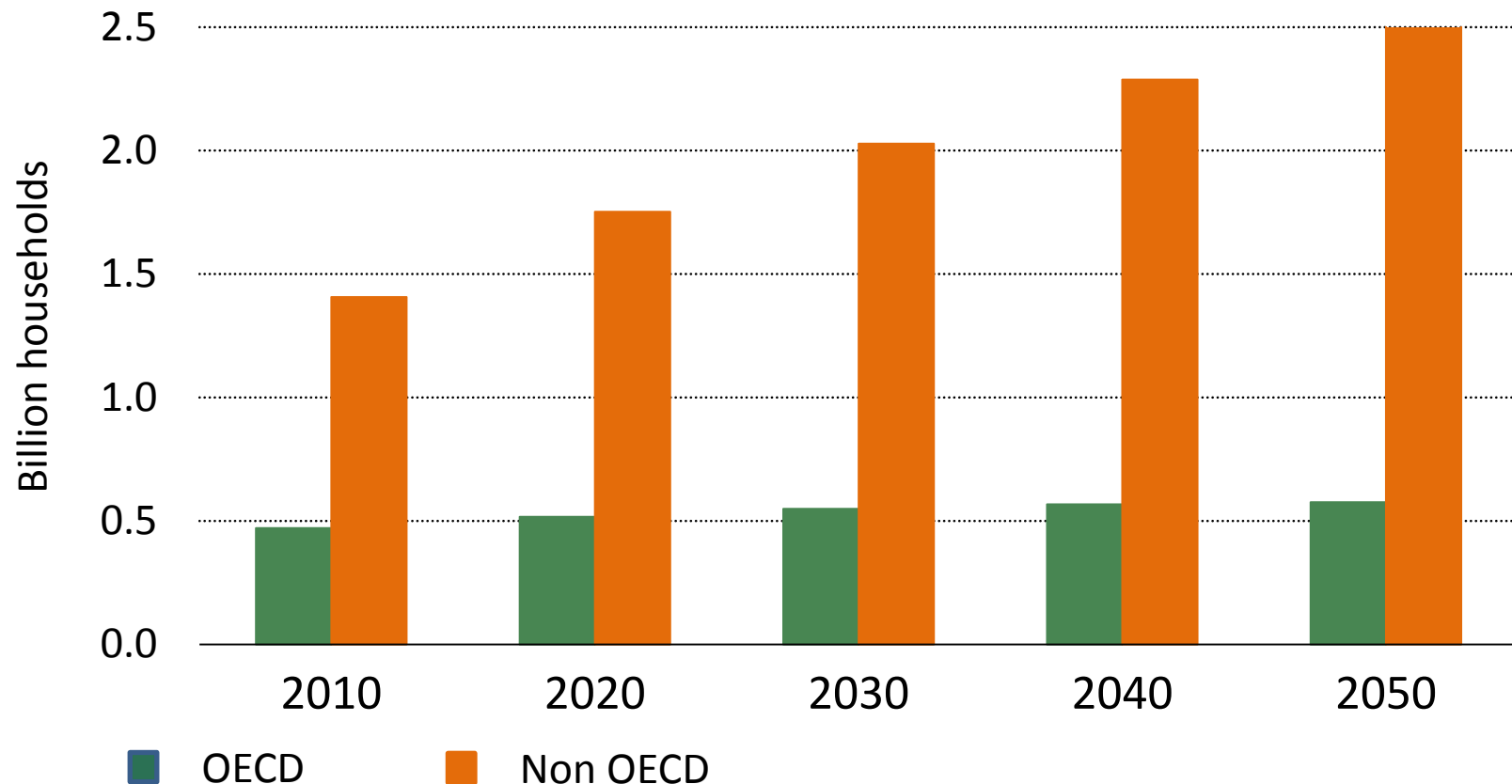
Energy consumption in Japanese buildings sector



Buildings' energy consumption decline in the 2DS because of energy efficiency improvement and population decrease

Building sector challenges differ

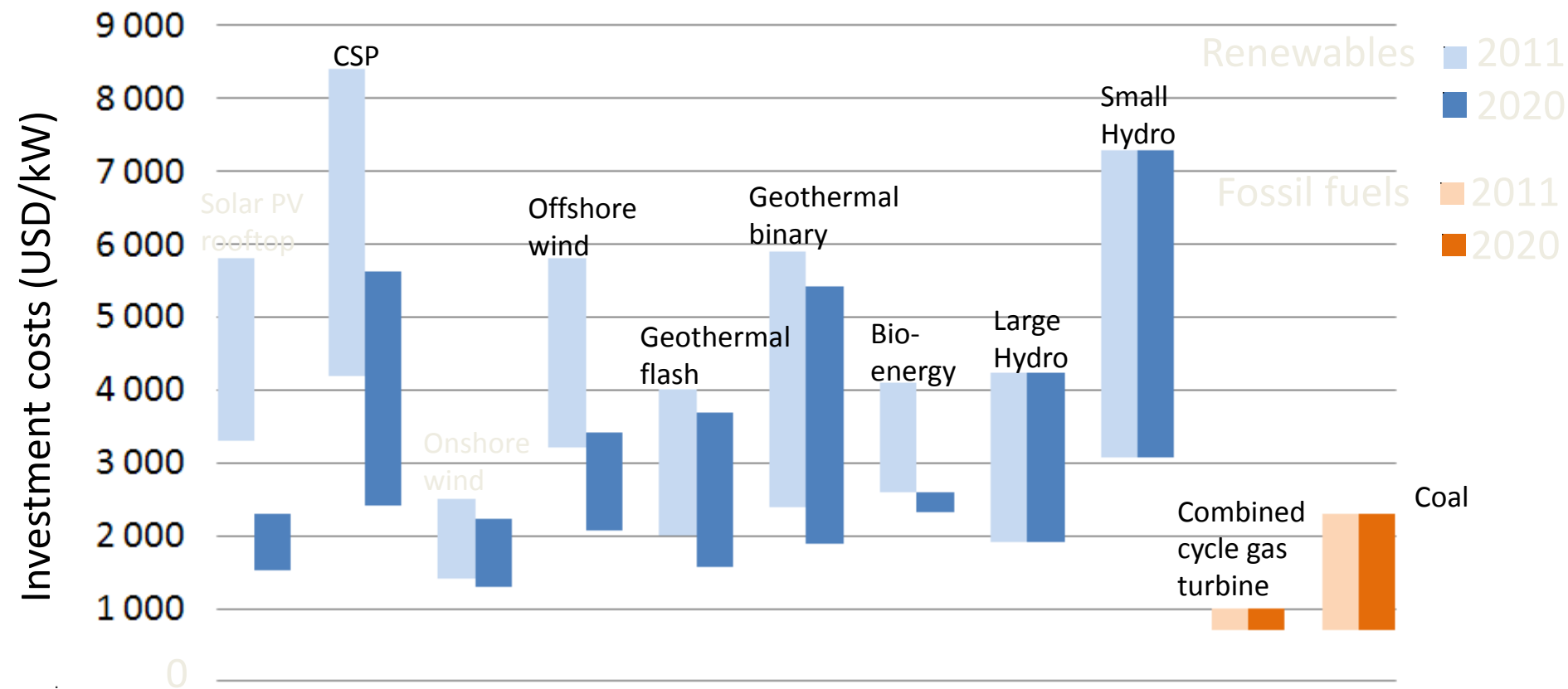
ETP
2012



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

Power generation; Renewables

ETP
2012



Most renewables are broadly on track to achieve the 2DS objectives by 2020. Some renewable technologies still need policy support to drive down costs (e.g. CSP and offshore wind).