International Energy Agency

Energy Technology Perspectives 2010

Madrid, 20 September 2010

The context

■ **Need a global energy technology revolution to meet climate change and energy security challenges.**

■ **Some early signs of progress, but much more needs to be done.**

> ➢ **Which technologies can play a role?**

> ➢ **What are the costs and benefits?**

> ➢ **What policies are needed?**
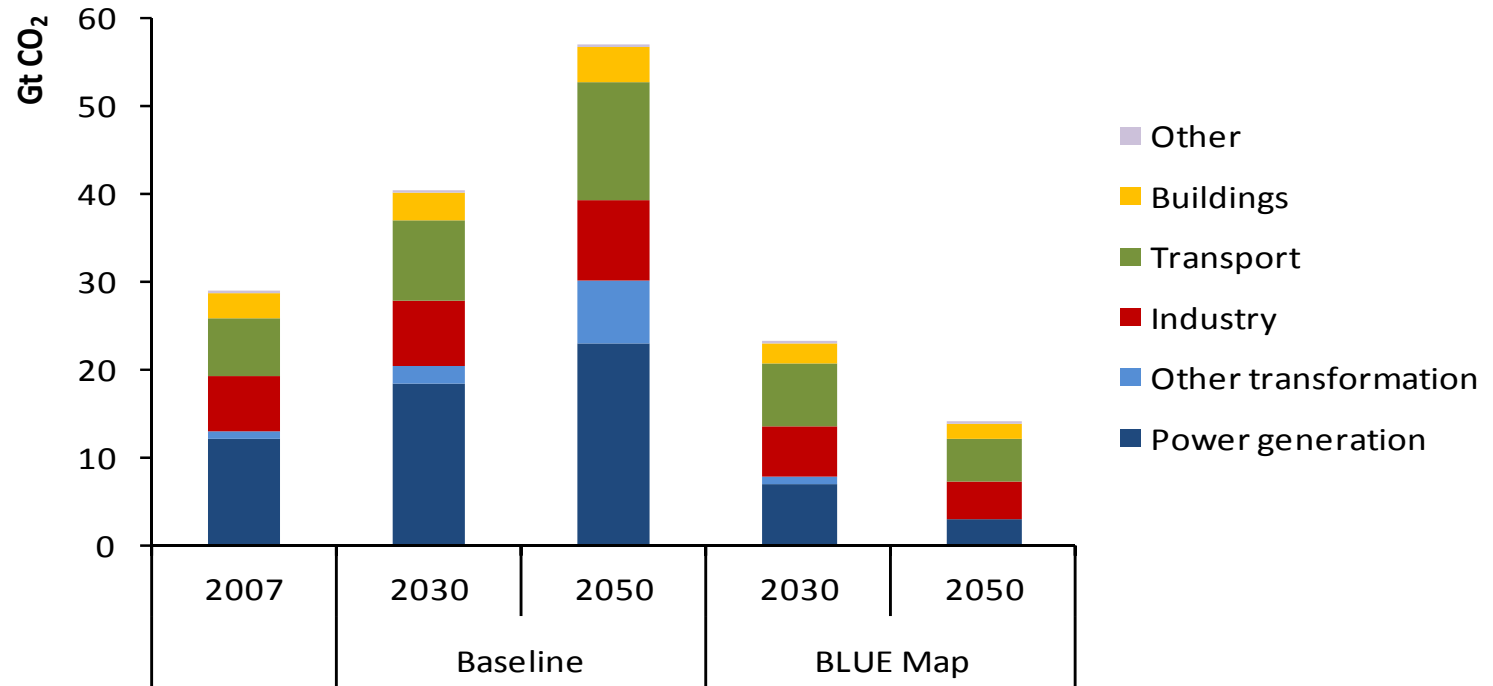
OECD and non-OECD primary energy demand
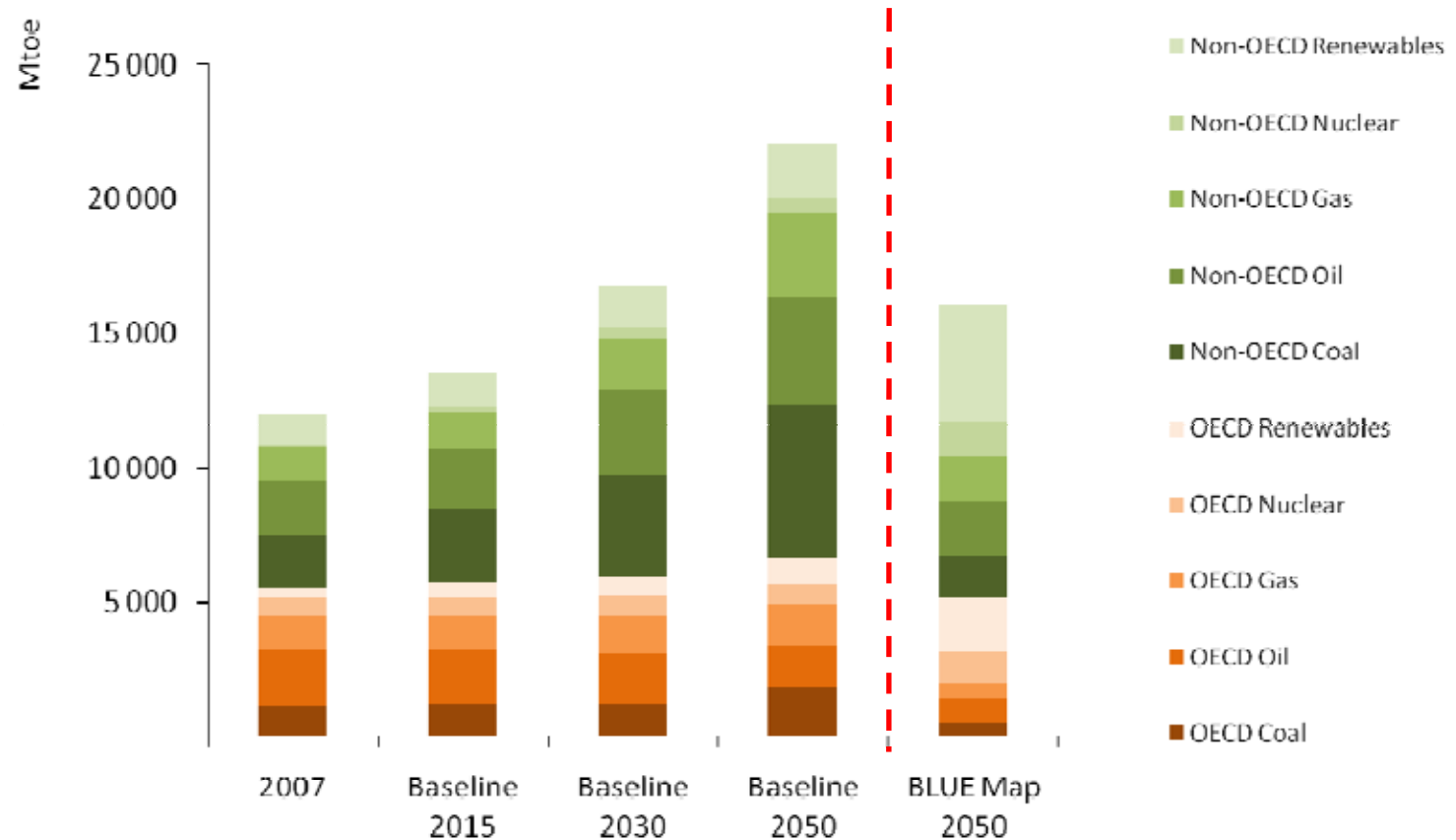
Primary energy demand in non-OECD countries is projected to increase much faster than in OECD countries.
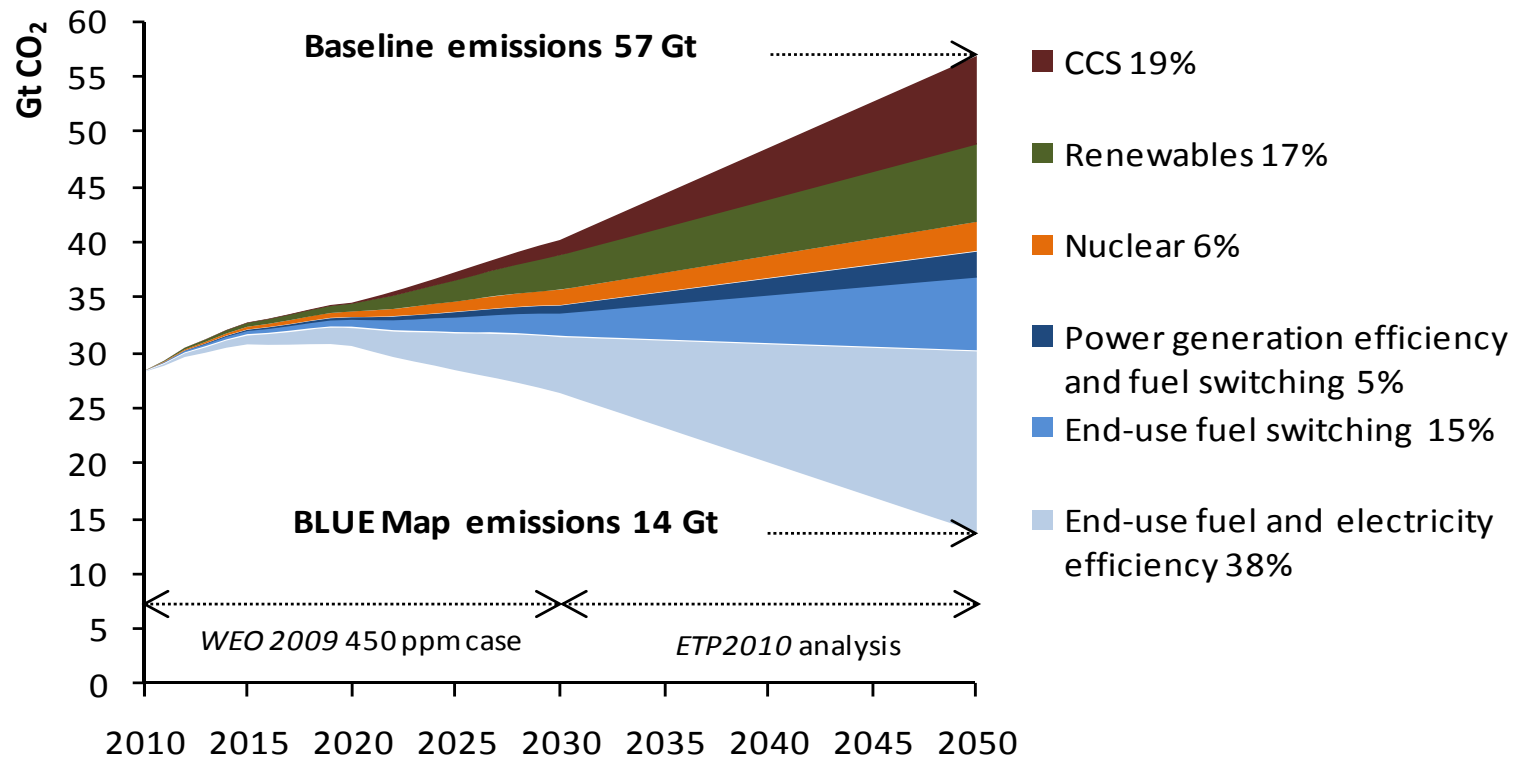
Global energy-related CO$_2$ emissions in the Baseline and BLUE Map scenarios

Gt CO$_2$

60
50
40
30
20
10
0

Other
Buildings
Transport
Industry
Other transformation
Power generation

| 2007	2030	2050	2030	2050
	Baseline		BLUE Map	

Global CO$_2$ emissions double in the Baseline, but in the BLUE Map scenario abatement across all sectors reduces emissions to half 2005 levels by 2050.

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Key technologies for reducing global CO_2 emissions

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Gt CO_2

Baseline emissions 57 Gt

BLUE Map emissions 14 Gt

WEO 2009 450 ppm case   ETP 2010 analysis

2010 2015 2020 2025 2030 2035 2040 2045 2050

- CCS 19%
- Renewables 17%
- Nuclear 6%
- Power generation efficiency and fuel switching 5%
- End-use fuel switching 15%
- End-use fuel and electricity efficiency 38%

A wide range of technologies will be necessary to reduce energy-related CO_2 emissions substantially.
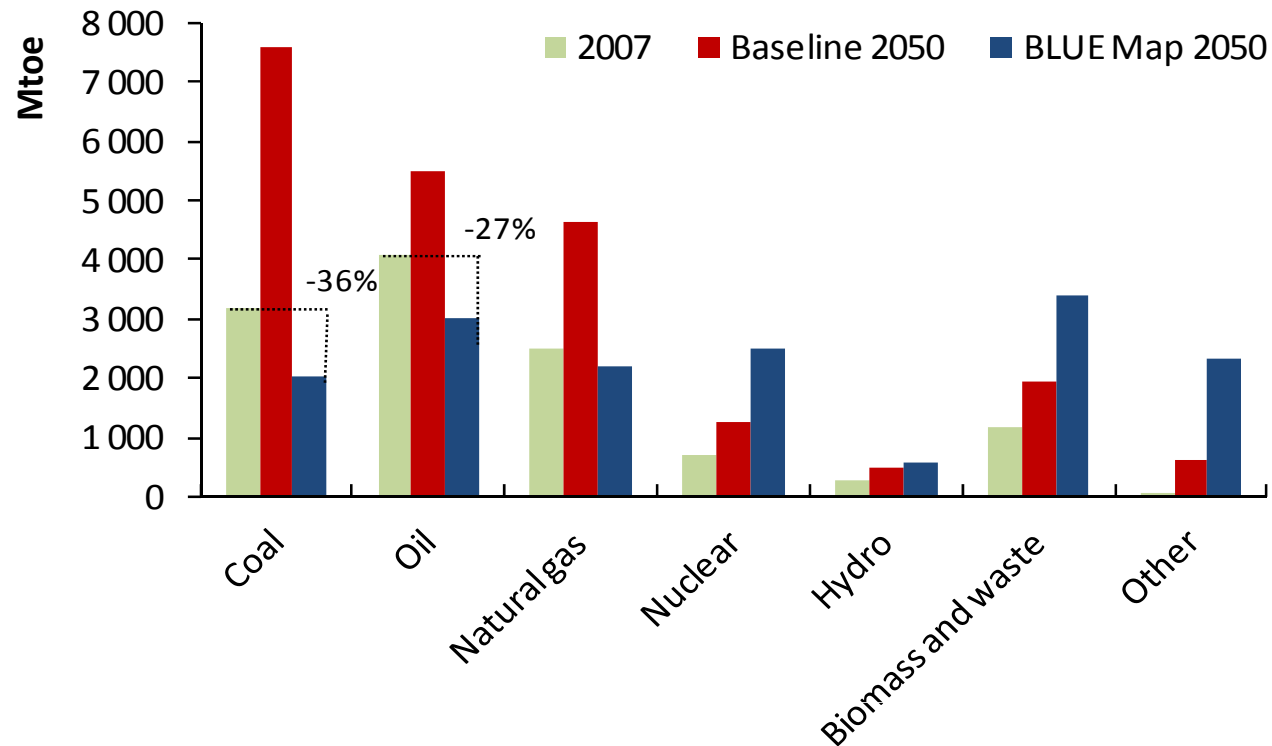
World energy-related CO_2 emissions abatement by region
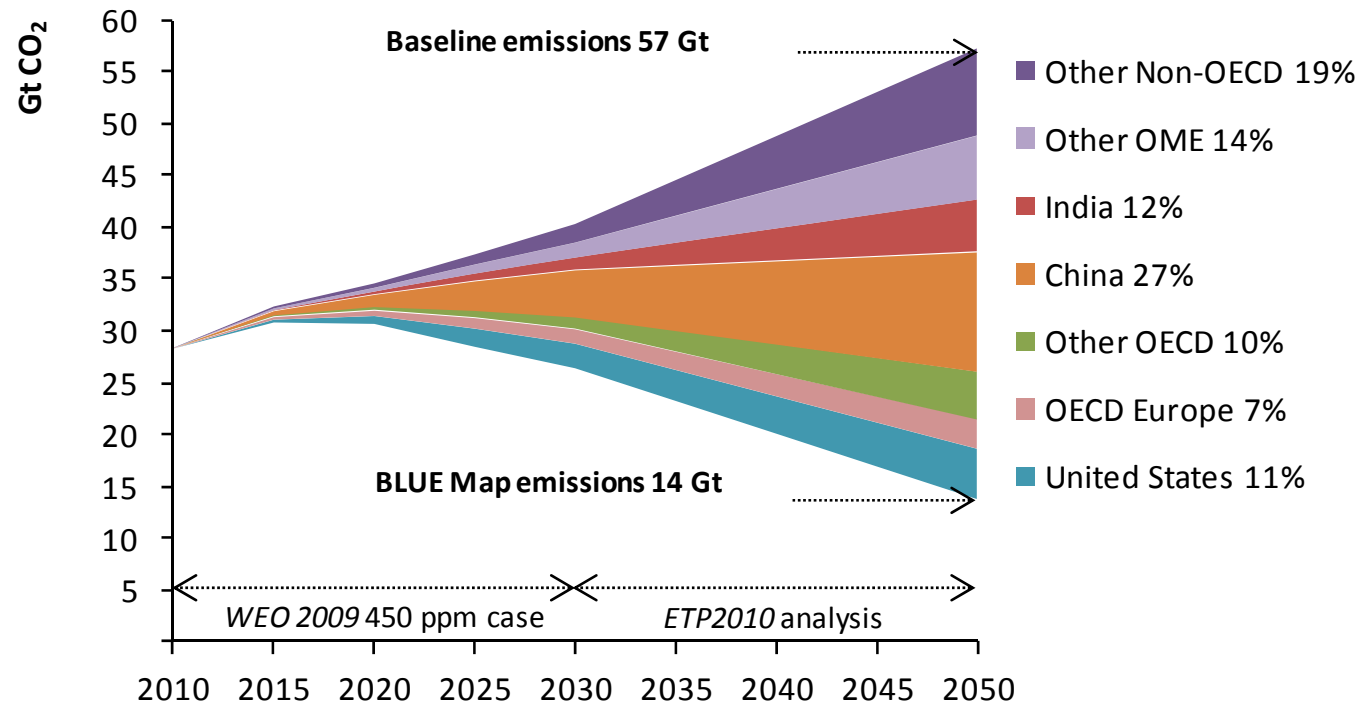
In the BLUE Map scenario, most of the reductions in energy-related CO_2 emissions are in non-OECD countries.
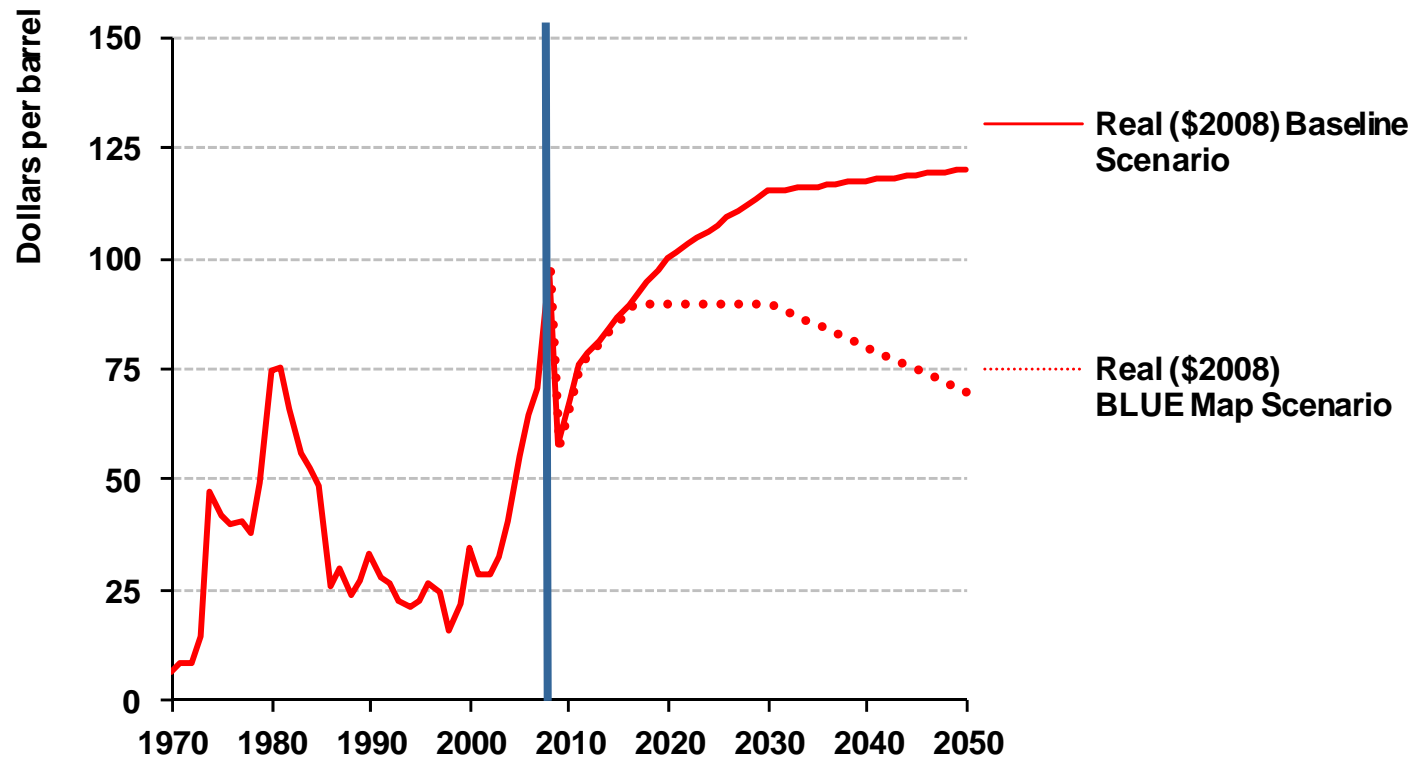
Primary energy demand by fuel and by scenario

By 2050, coal, oil and gas demand are all lower than today under the BLUE Map scenario.
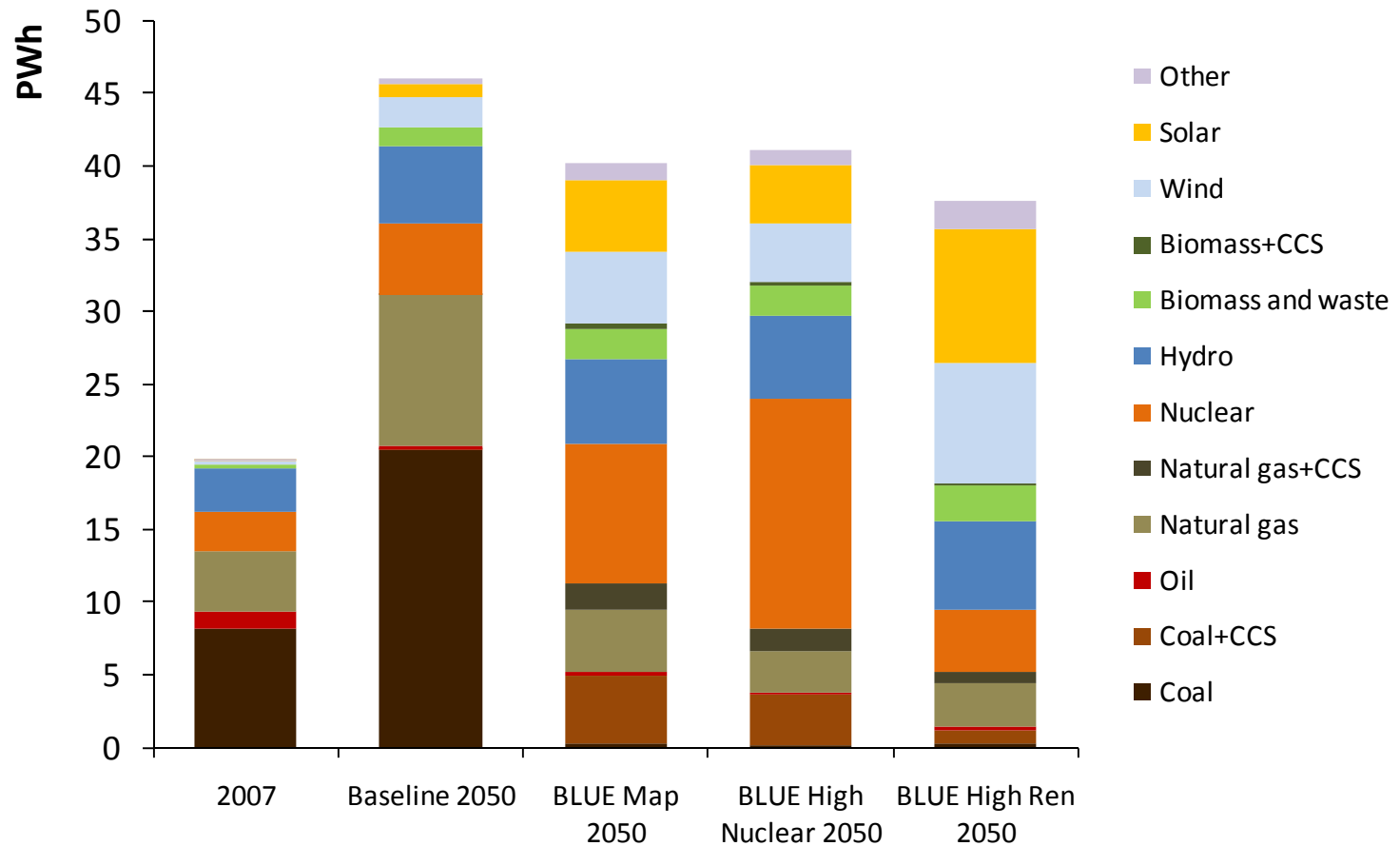
Crude oil price

Real ($2008) Baseline Scenario

Real ($2008) BLUE Map Scenario

Impact of CO_2 price on costs for crude oil:
2020   50 USD/t CO_2= 21 USD/bbl: 90+21 =111 USD/bbl
2030 110 USD/t CO_2= 43 USD/bbl: 90+43 =133 USD/bbl
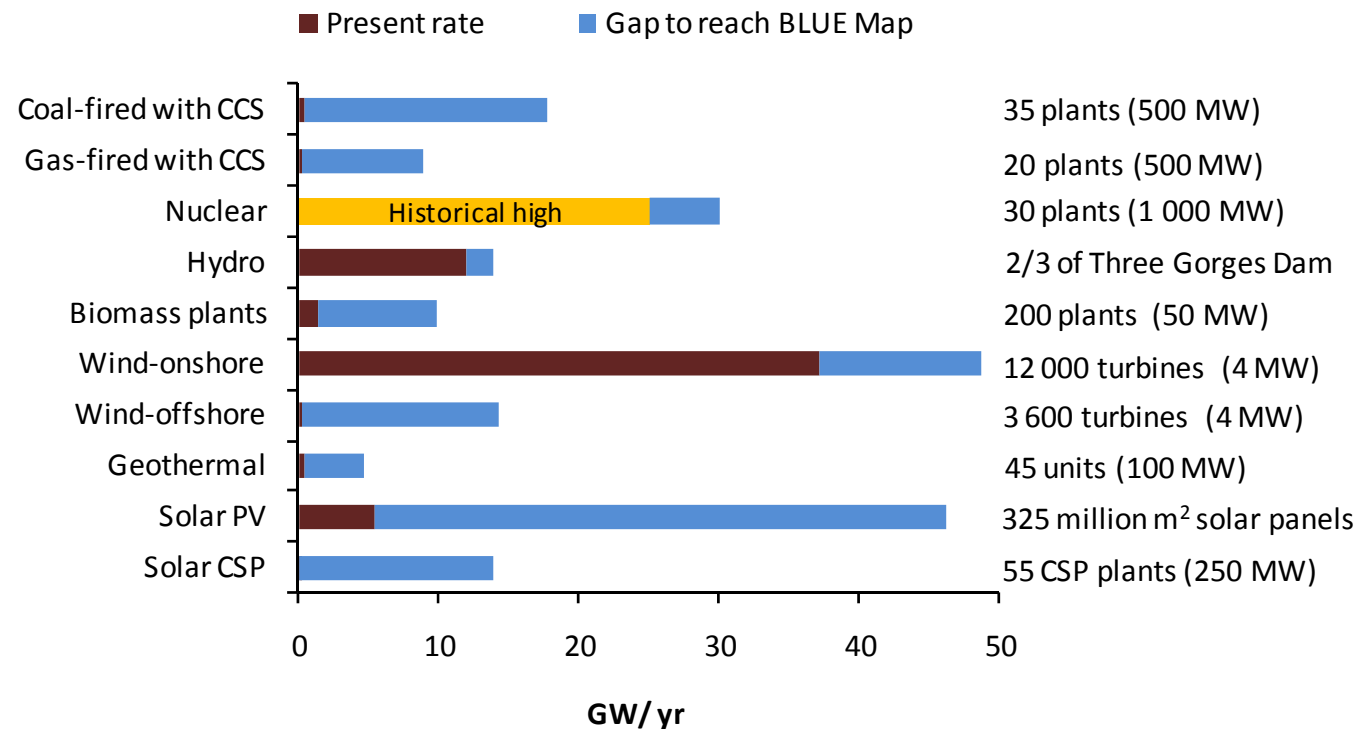2050 175 USD/t CO_2= 73 USD/bbl: 70+73 =143 USD/bbl

Decarbonising the power sector – a new age of electrification?

A mix of renewables, nuclear and fossil-fuels with CCS will be needed to decarbonise the electricity sector.

Average annual electricity capacity additions to 2050, BLUE Map scenario

■ Present rate   ■ Gap to reach BLUE Map

Technology		Annotation
Coal-fired with CCS		35 plants (500 MW)
Gas-fired with CCS		20 plants (500 MW)
Nuclear	Historical high	30 plants (1 000 MW)
Hydro		2/3 of Three Gorges Dam
Biomass plants		200 plants (50 MW)
Wind-onshore		12 000 turbines (4 MW)
Wind-offshore		3 600 turbines (4 MW)
Geothermal		45 units (100 MW)
Solar PV		325 million m^2 solar panels
Solar CSP		55 CSP plants (250 MW)

GW/ yr

Annual rates of investment in many low-carbon technologies must be massively increased from today's levels.

Wind Roadmap
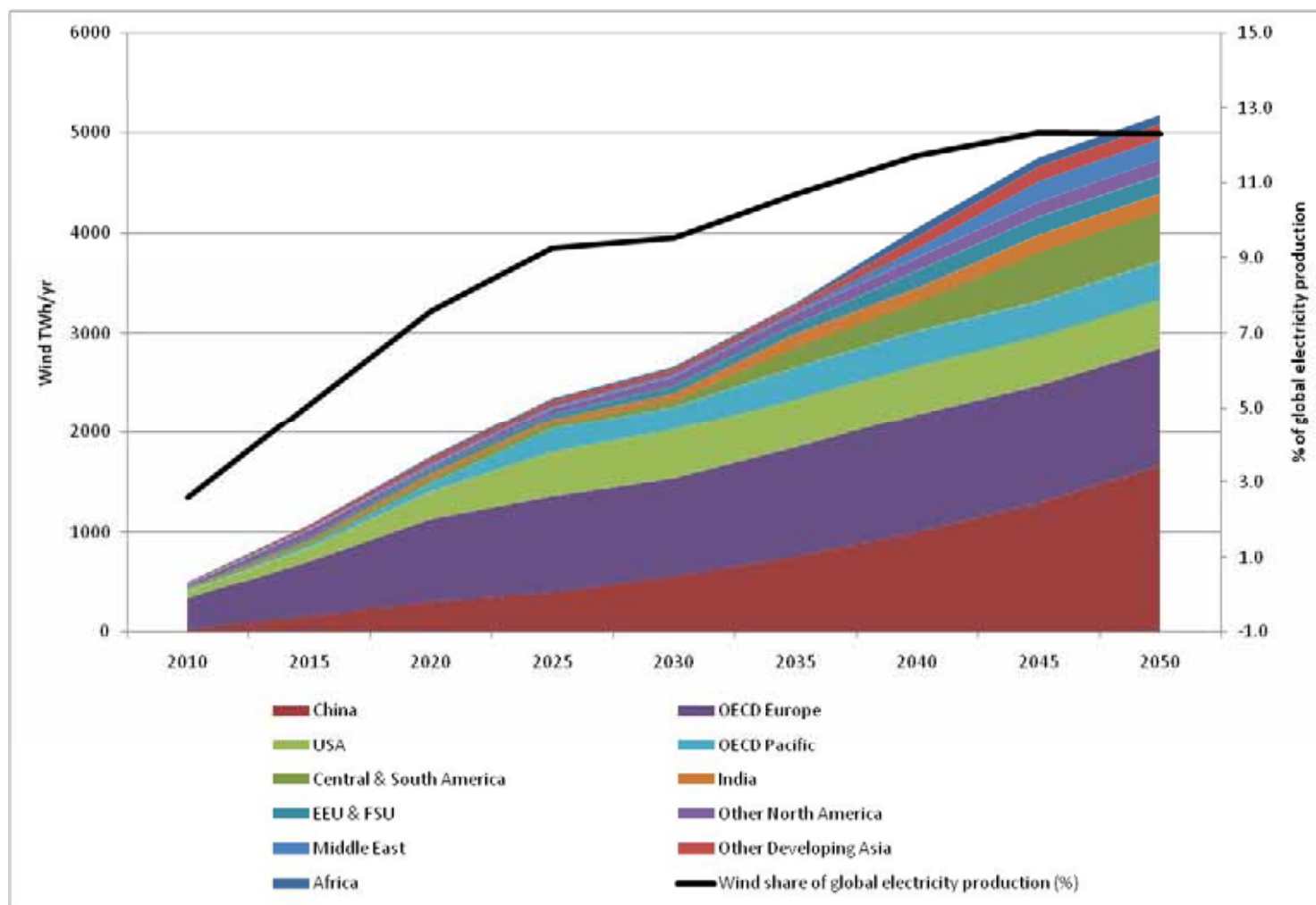
Wind has the potential to provide 12% of global electricity production in 2050
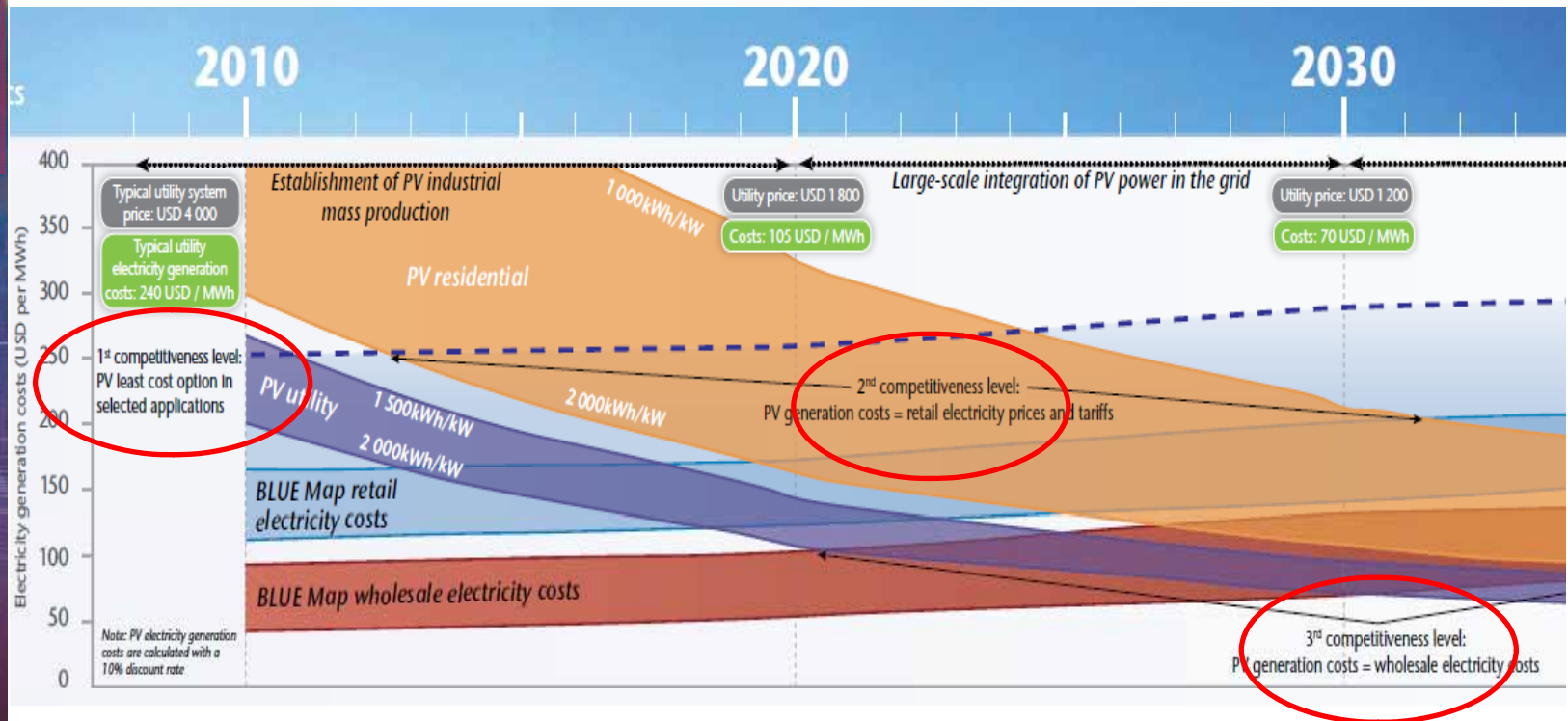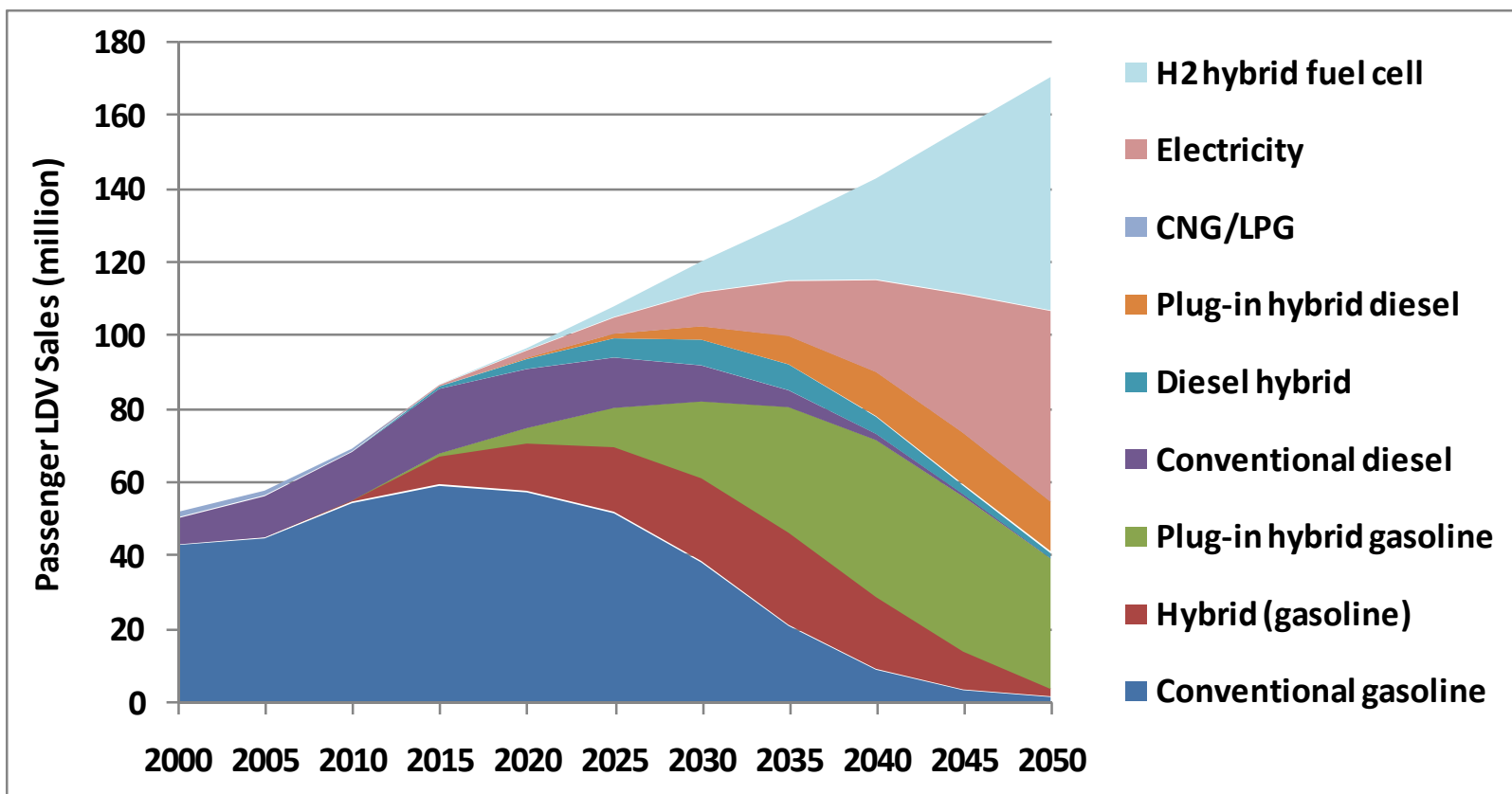
PV Roadmap

PV can provide 5% of global electricity generation in 2030, 11% in 2050

Electric Vehicle Roadmap

Light-duty vehicle sales by technology type to 2050

Unprecedented rates of change in market penetration of advanced technologies

Smart grid CO$_2$ reductions in 2050
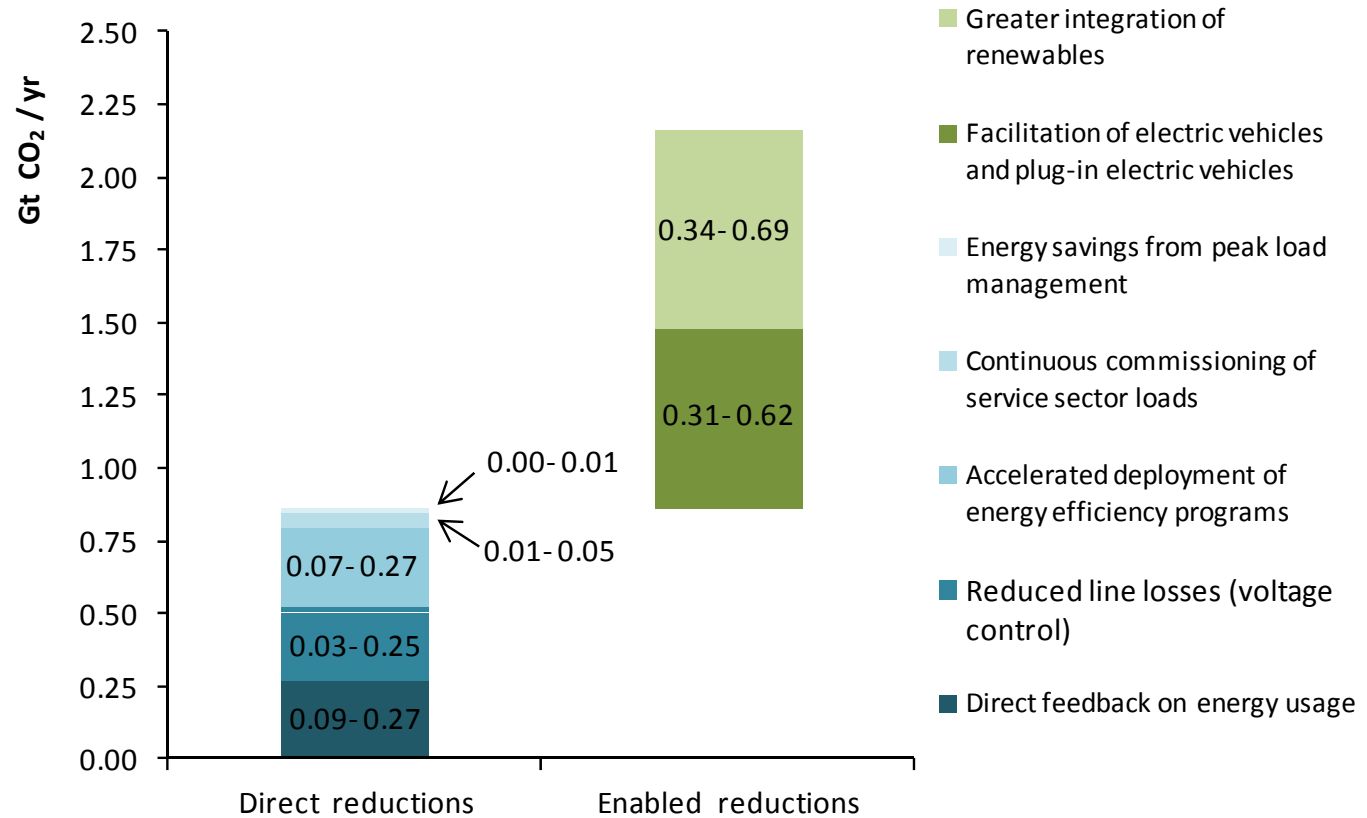
Gt CO$_2$ / yr

Direct reductions:
- 0.00- 0.01
- 0.01- 0.05
- 0.07- 0.27
- 0.03- 0.25
- 0.09- 0.27

Enabled reductions:
- 0.34- 0.69
- 0.31- 0.62

Legend:
- Greater integration of renewables
- Facilitation of electric vehicles and plug-in electric vehicles
- Energy savings from peak load management
- Continuous commissioning of service sector loads
- Accelerated deployment of energy efficiency programs
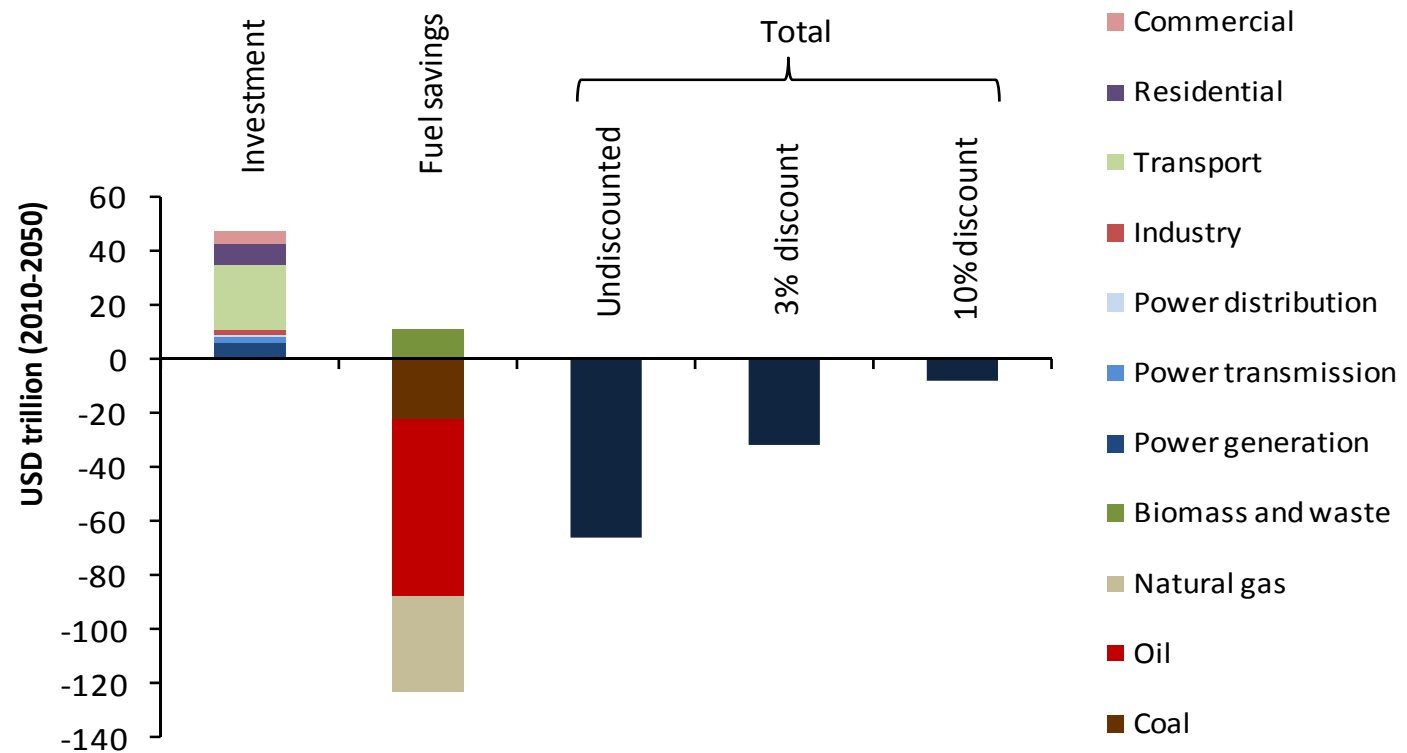- Reduced line losses (voltage control)
- Direct feedback on energy usage

Smart grids allow better management of the grid and can facilitate the deployment of low-carbon technologies, such as renewables and electric vehicles.

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Additional investment and fuel savings, 2010-2050

Even using a 10% discount rate, fuel savings in the BLUE Map scenario more than offset the additional investment required.

Environmental co-impacts of electricity generation technologies

Energy Technologies	Life Cycle Impacts (Pre- and Post-Generation)			Power Generation Impacts			CO_2 Emissions t/MWh
	Air	Water	Land	Air	Water	Land	
Coal - USC	Baseline Technology for Relative Assessments Below						0.777
Coal - Biomass	Positive	Positive	Variable / Uncertain	Variable / Uncertain	Minimal	Minimal	0.622
Coal - CCS	Negative	Negative	Negative	Variable / Uncertain	Negative	Minimal	0.142
Coal - IGCC	Minimal	Variable / Uncertain	Minimal	Positive	Positive	Minimal	0.708
NGCC	Positive	Positive	Positive	Positive	Positive	Positive	0.403
Nuclear	Positive	Variable / Uncertain	Variable / Uncertain	Positive	Negative	Positive	0.005
Solar - CSP	Positive	Positive	Positive	Positive	Negative	Minimal	0.017
Solar - PV	Positive	Positive	Positive	Positive	Positive	Minimal	0.009
Wind	Positive	Positive	Positive	Positive	Positive	Variable / Uncertain	0.002

Most renewable technologies have positive environmental co-impacts.

OECD EUROPE

Contributions to emissions reductions in OECD Europe

Legend:
- CCS 24%
- Renewables 21%
- Nuclear 7%
- Power generation efficiency and fuel switching 3%
- End-use fuel switching 12%
- End-use fuel and electricity efficiency 33%

Baseline emissions 4.0 Gt

BLUE Map emissions 1.1 Gt

WEO 2009 450 ppm case   ETP2010 analysis
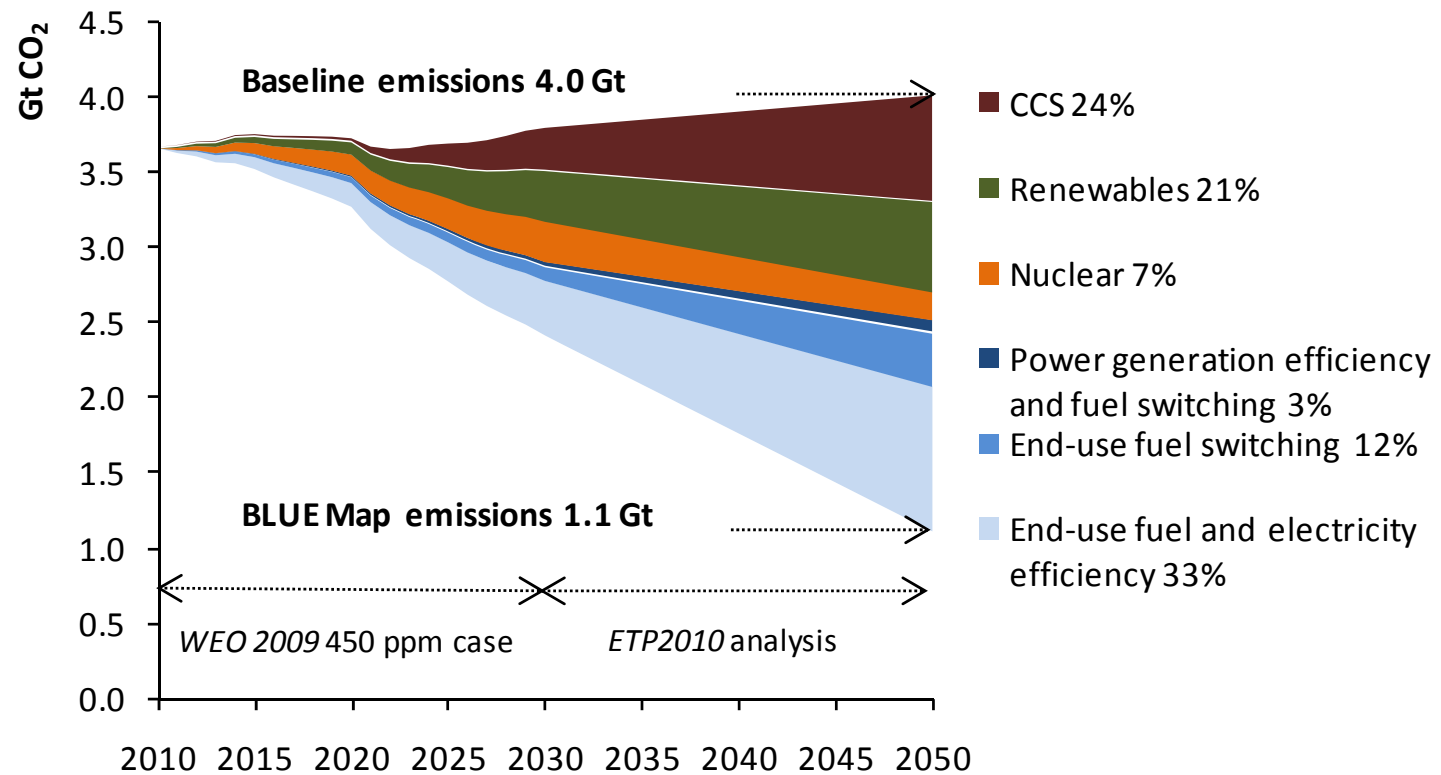
End-use sector measures contribute nearly two-thirds of the emissions reductions between the Baseline and BLUE scenarios in 2050.
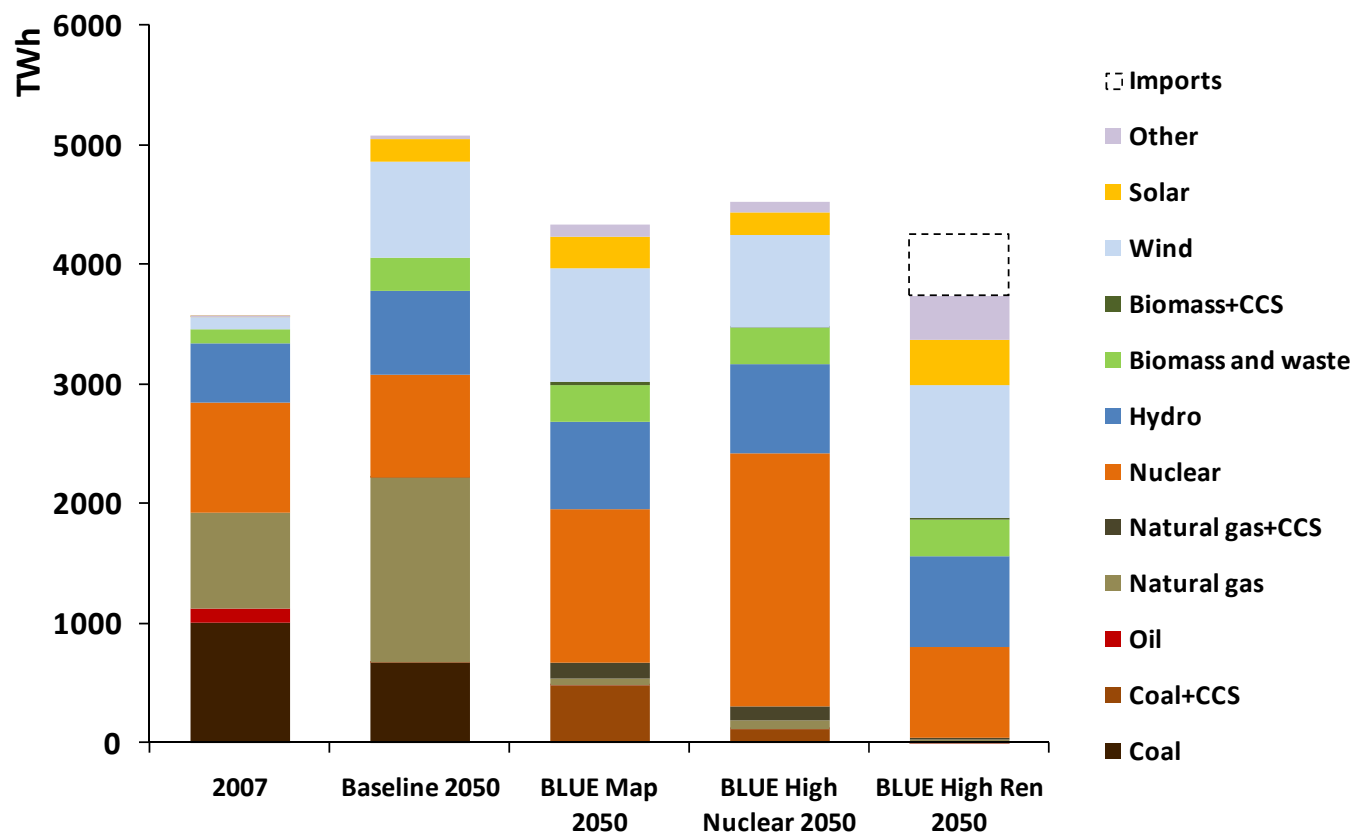
Primary energy demand by fuel and by scenario in OECD Europe
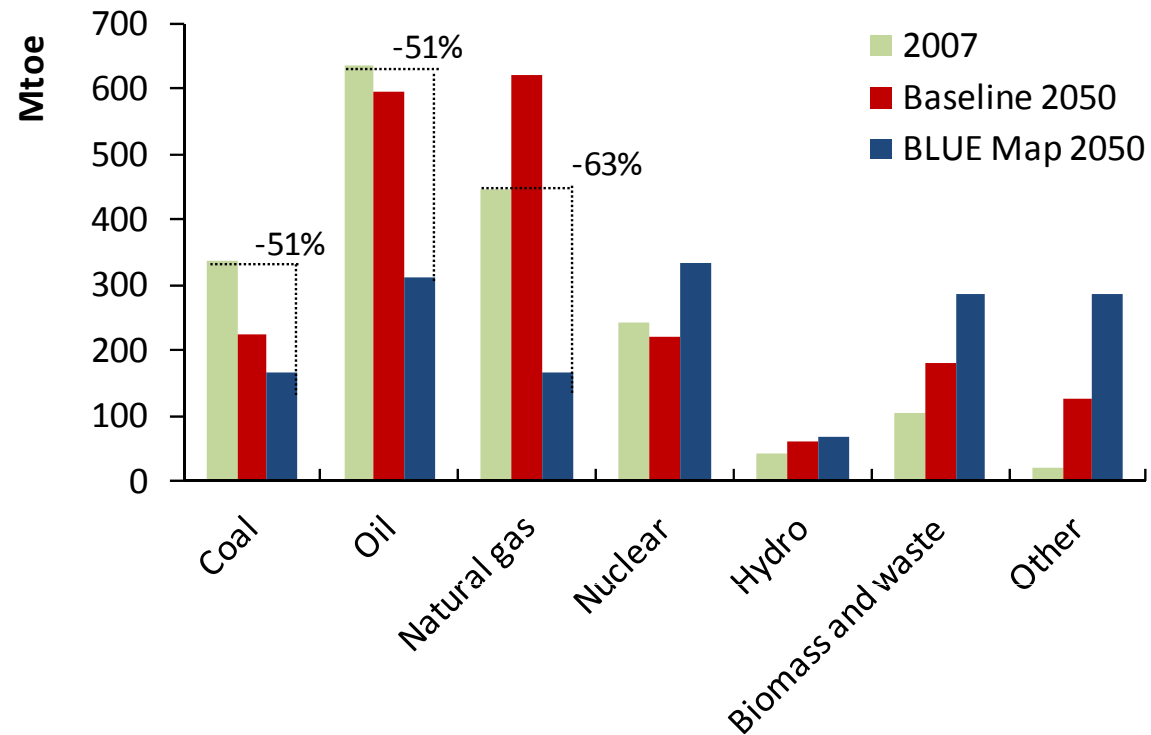
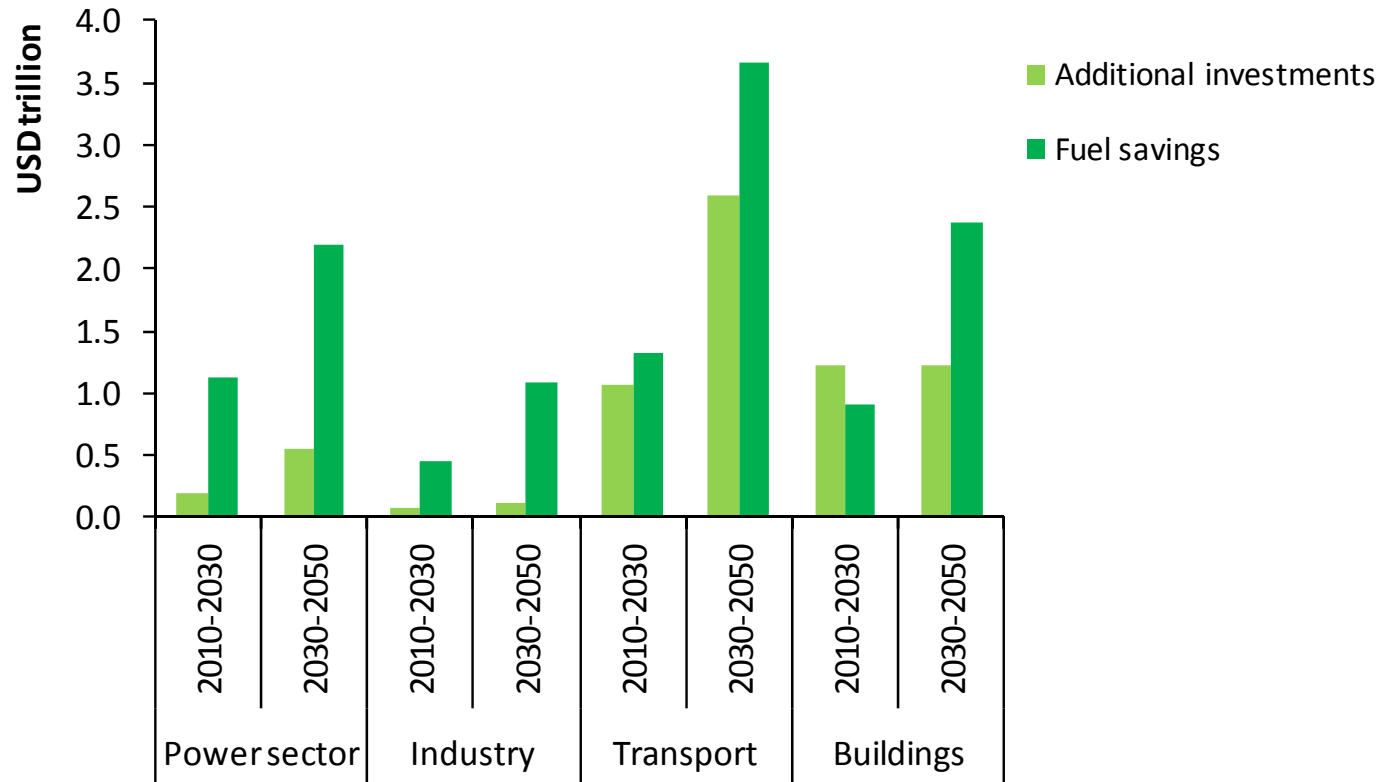Fossil fuel demand is reduced to one half under the BLUE Map scenario.

Decarbonisation of power generation in OECD Europe

A mix of nuclear, renewables and fossil-fuels with CCS will be needed to decarbonise the electricity sector.

Additional investment needs and fuel cost savings for OECD Europe

Large investment needs in transport and the building sectors may be compensated by fuel savings.

Projected electric and plug-in hybrid vehicle sales through 2020, based on national targets
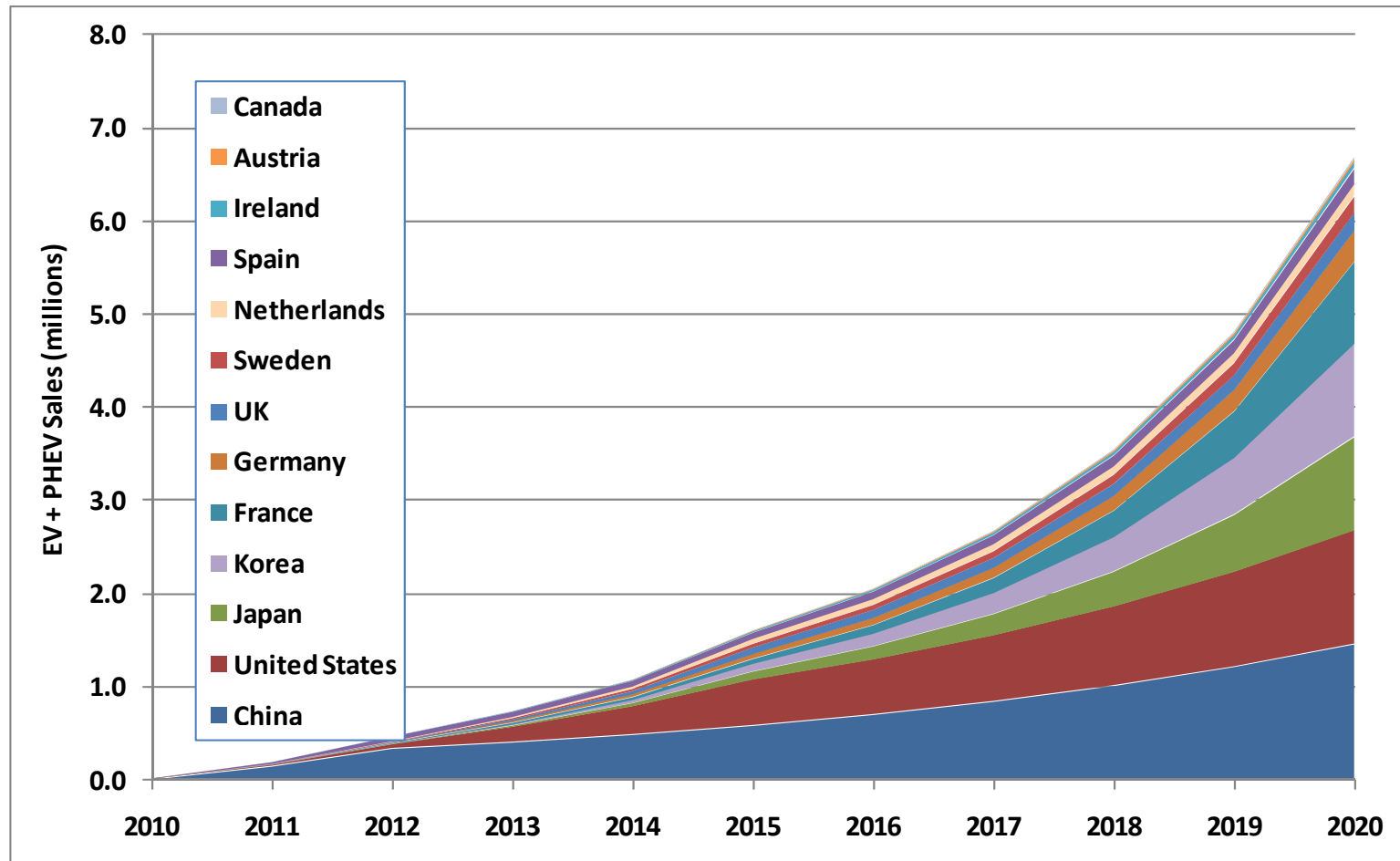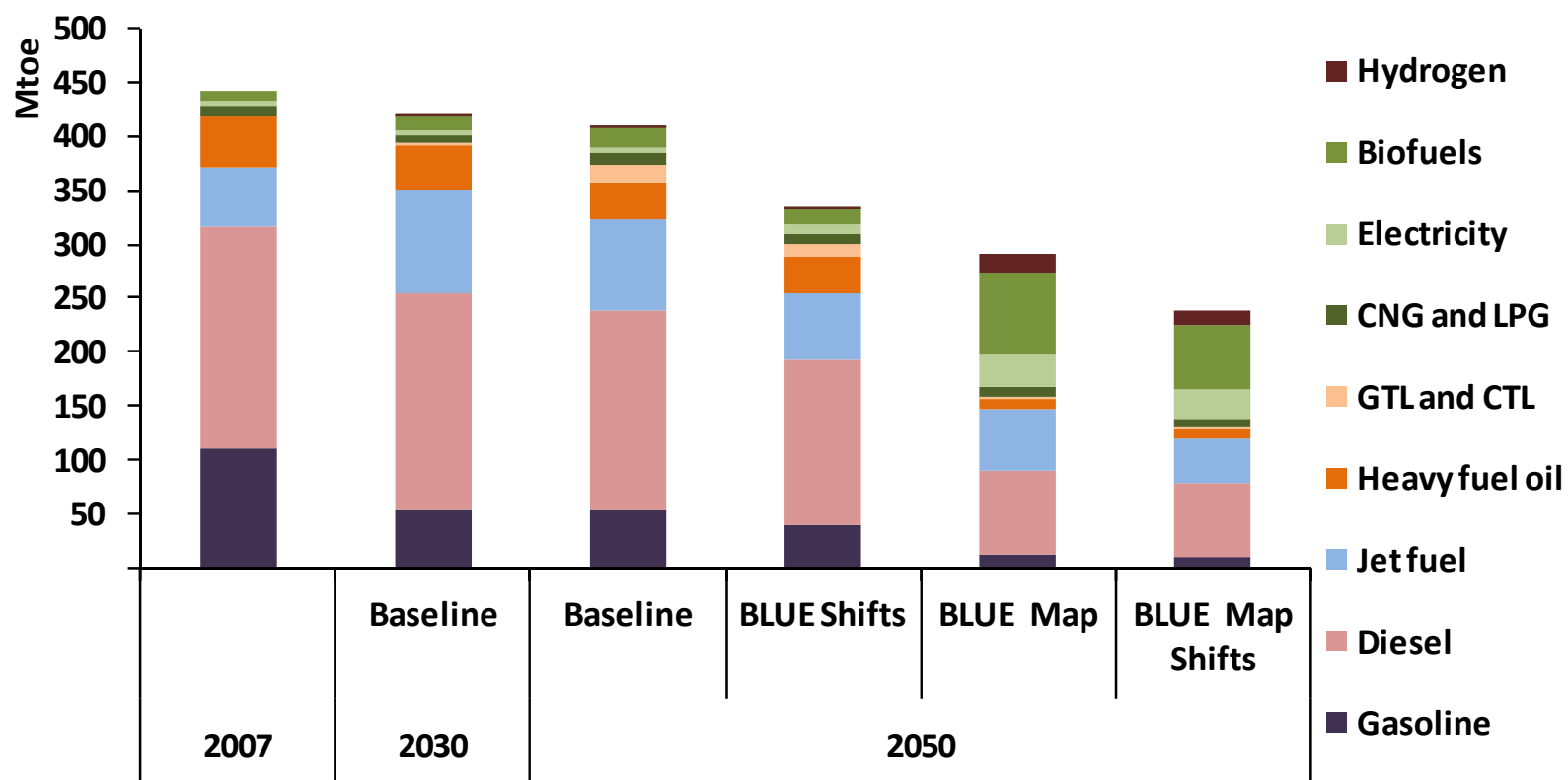
Figure based on announced national sales and stock targets, with assumed 20% annual sales growth after target is met, if target is before 2020 (e.g. China's target is for end of 2011).

EV / PHEV sales could reach nearly seven million by 2020

Fuel use in transport in OECD Europe

The use of fossil fuels in the transport sector falls by over 60% in the BLUE Map scenario

Passenger light-duty vehicles sales by technology in OECD Europe in the Baseline and BLUE Map scenarios

Baseline scenario

BLUE Map scenario

Legend:
- Hydrogen fuel cell
- Hydrogen hybrid
- Electricity
- CNG and LPG
- Plug-in hybrid diesel
- Plug-in hybrid gasoline
- Hybrid diesel
- Hybrid gasoline
- Diesel
- Gasoline
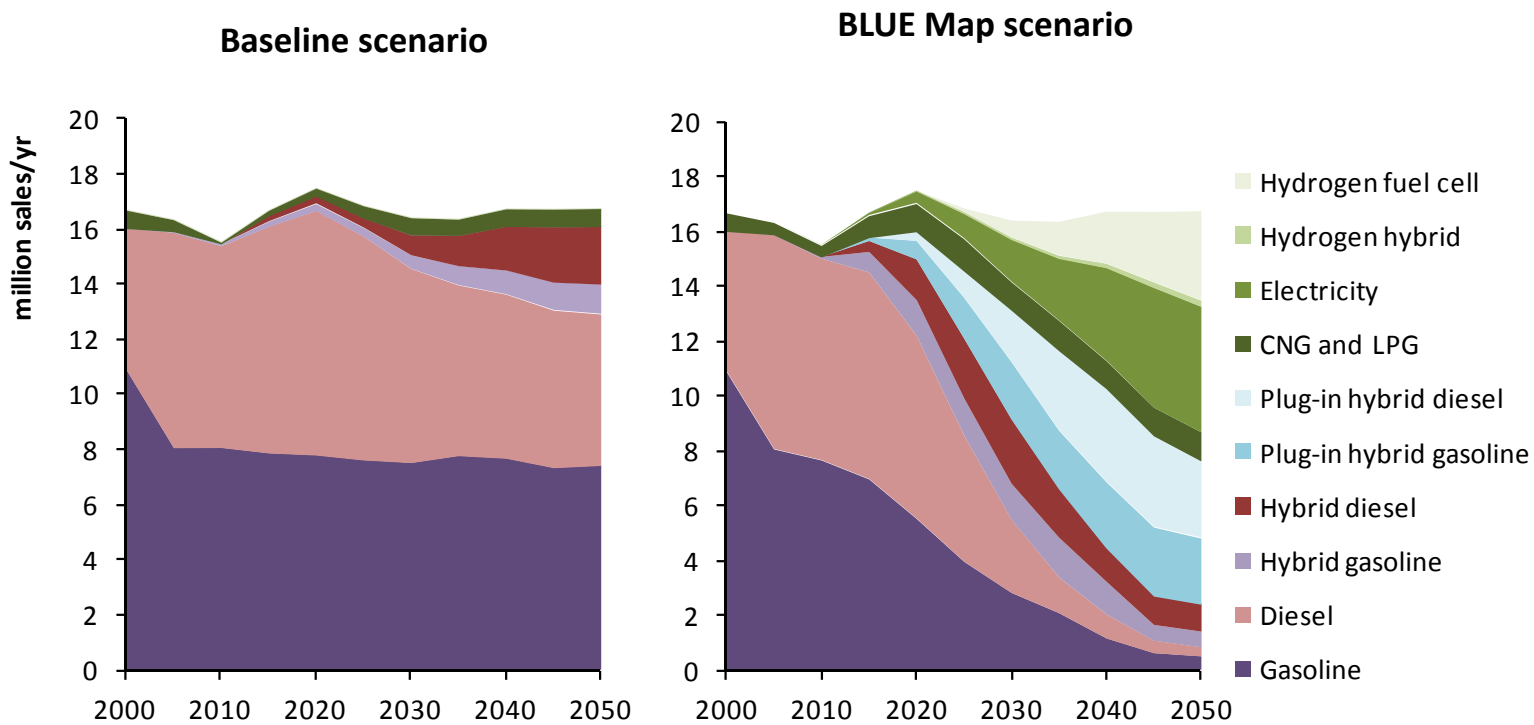
A wide range of new LDV technologies contribute to emissions reductions under the BLUE scenario.

CO$_2$ emissions in the buildings sector in OECD Europe

Space and water heating and cooling 21%

Building shell 15%

Cooking, lighting and appliances 9%

Electricity decarbonisation 55%
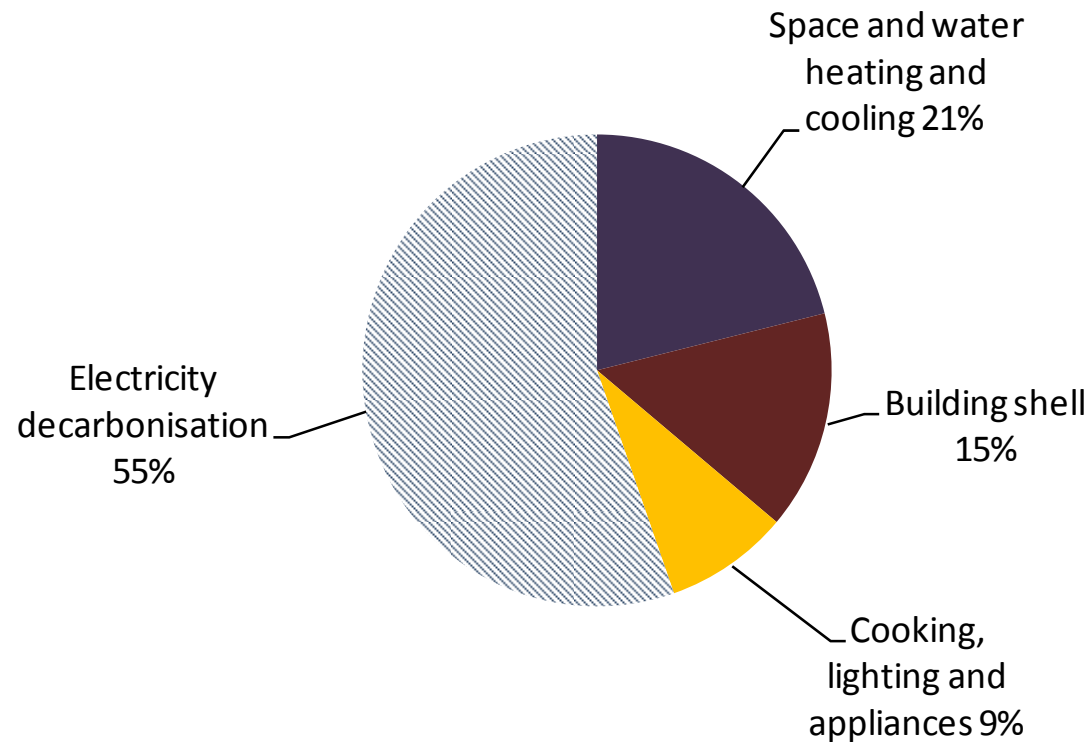
Decarbonisation of the electricity sector contributes over half of emissions reduction in the buildings sector.

Contributions to emissions reductions in OECD Europe

Pie chart: Contributions to emissions reductions in OECD Europe

- Nuclear 7%
- Wind 3%
- Solar 1%
- Other power generation 11%
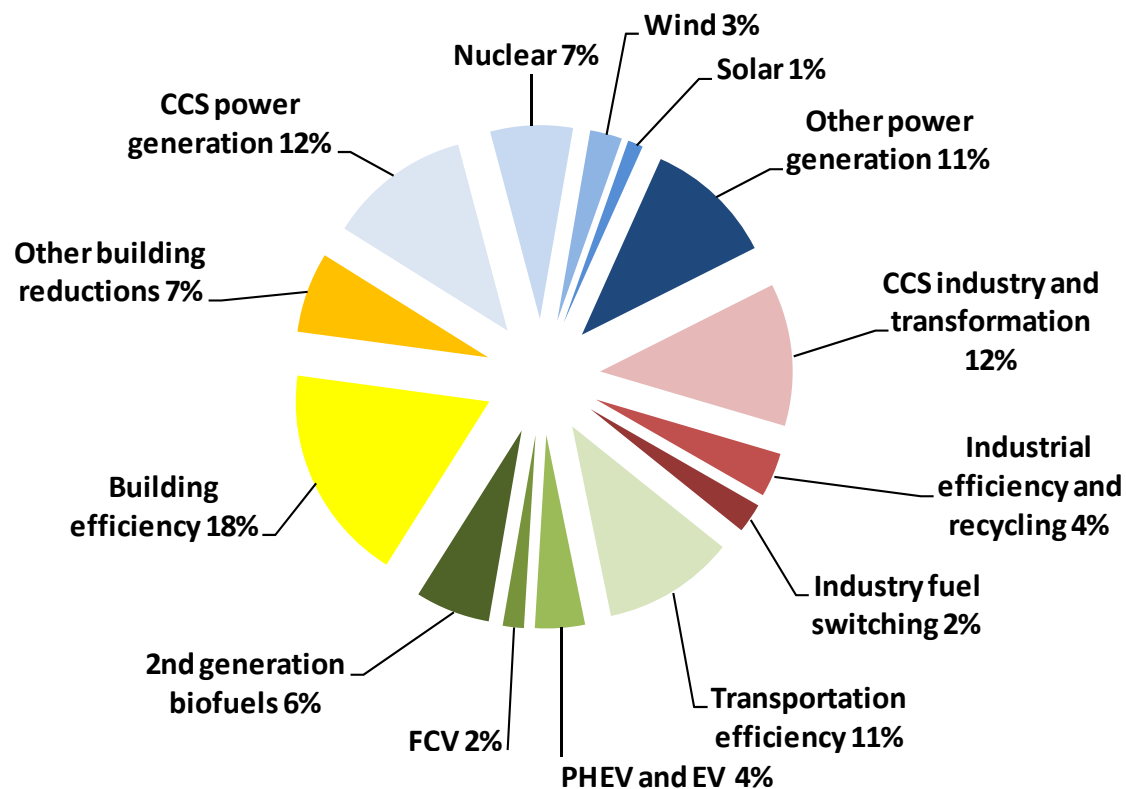- CCS industry and transformation 12%
- Industrial efficiency and recycling 4%
- Industry fuel switching 2%
- Transportation efficiency 11%
- PHEV and EV 4%
- FCV 2%
- 2nd generation biofuels 6%
- Building efficiency 18%
- Other building reductions 7%
- CCS power generation 12%

Reductions in the buildings and power sector represent the largest savings
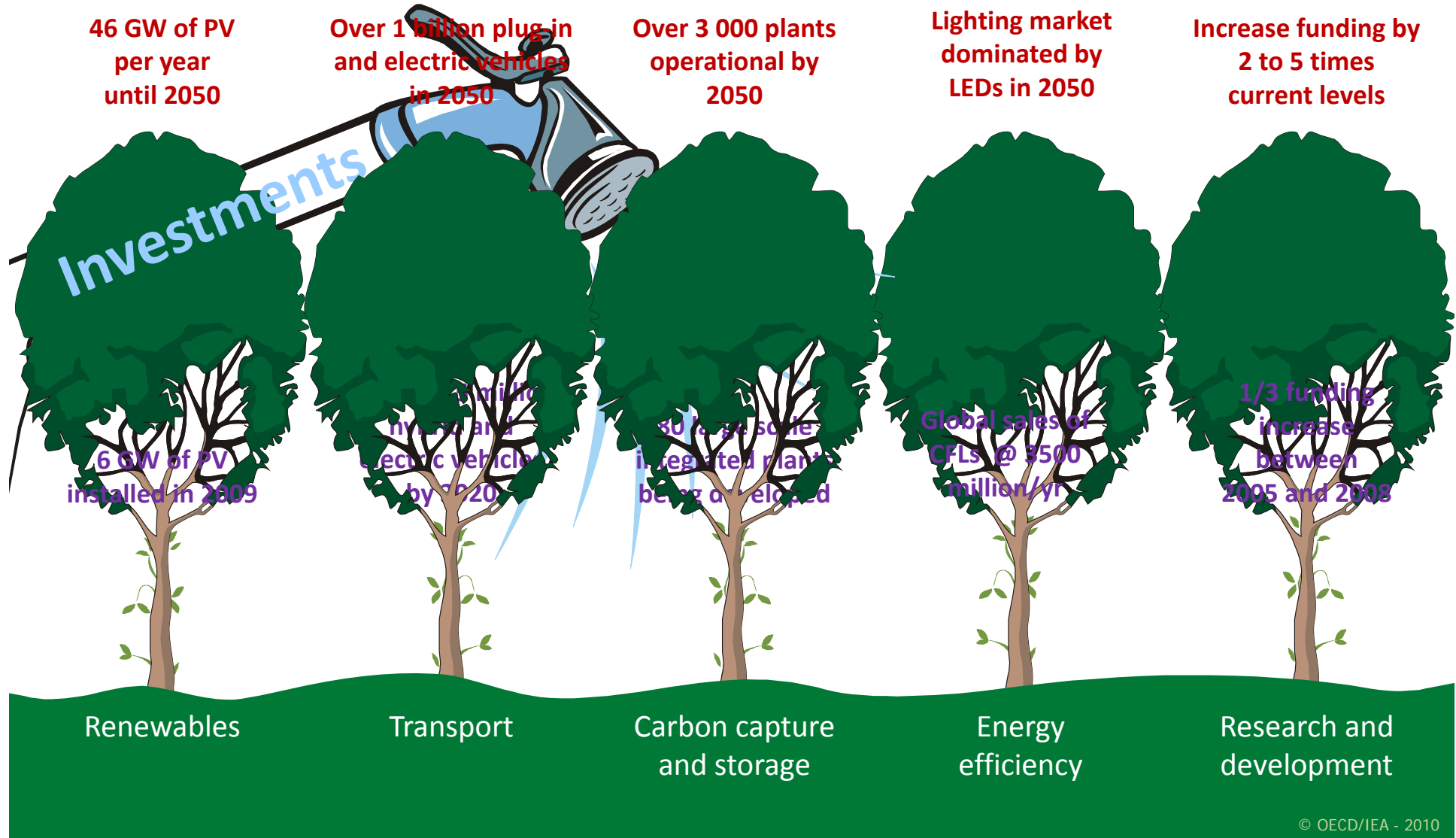
Policies for supporting low-carbon technologies
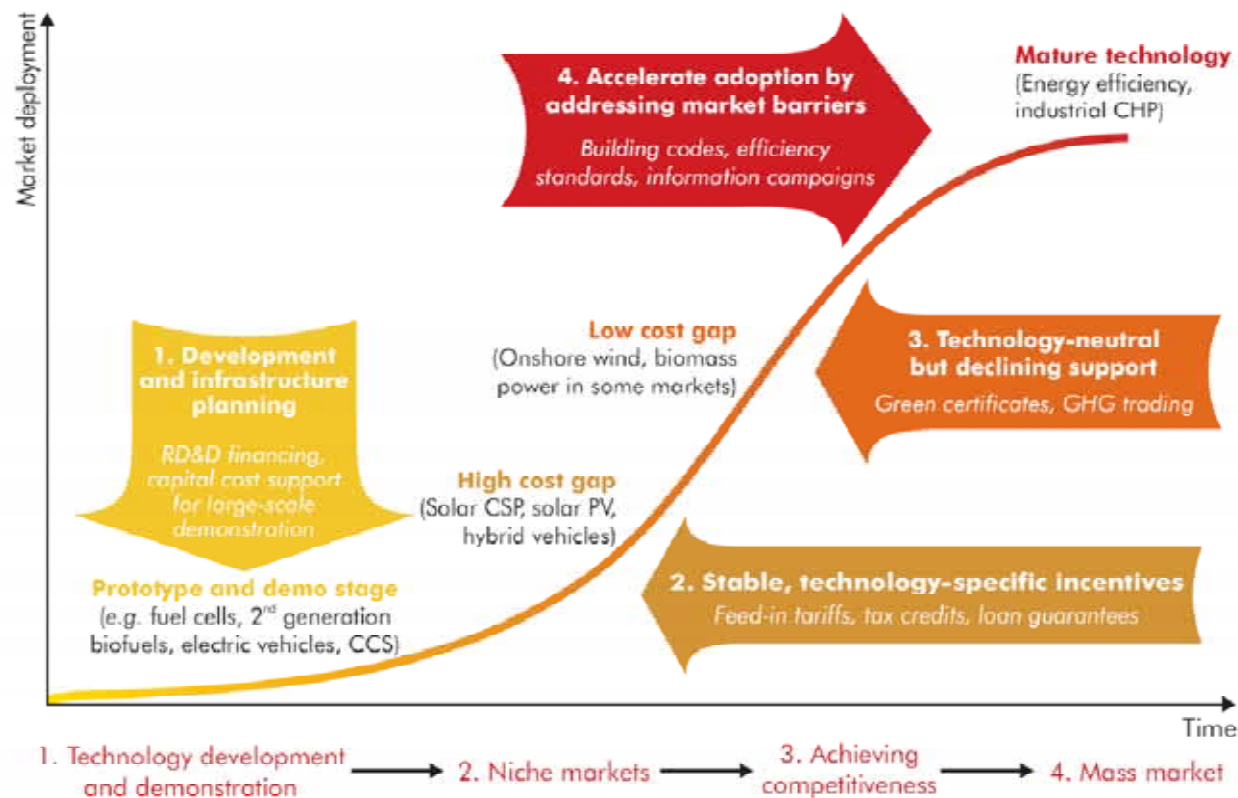
Government support policies need to be appropriately tailored to the stage(s) of technological development.

The first green shoots...

...much more needs to be done

of an energy technology revolution...

Investments

| 46 GW of PV per year until 2050 | Over 1 billion plug-in and electric vehicles in 2050 | Over 3 000 plants operational by 2050 | Lighting market dominated by LEDs in 2050 | Increase funding by 2 to 5 times current levels |

6 GW of PV installed in 2009

million hybrid and electric vehicles by 2020

small scale integrated plants being developed

Global sales of CFLs @ 3500 million/yr

1/3 funding increase between 2005 and 2008

Renewables | Transport | Carbon capture and storage | Energy efficiency | Research and development

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ANNEX

GDP projects

	2007-2015	2015-2030	2030-2050
OECD	**1.4**	**1.9**	**1.2**
OECD North America	1.8	2.3	1.4
United States	1.8	2.2	1.3
OECD Europe	1.0	1.8	0.7
OECD Pacific	1.3	1.3	1.7
Non-OECD	**5.7**	**4.1**	**3.4**
Economies in transition and non-OECD Europe	3.3	3.3	3.5
Middle East	4.5	4.0	2.5
Africa	4.7	3.1	3.1
Latin America	3.1	2.5	2.5
China	8.8	4.4	3.8
India	7.0	5.9	3.3
Other developing Asia	3.2	3.5	2.6
World	**3.3**	**3.0**	**2.6**

(% per year based on purchasing power parity)

Oil, gas and coal price assumptions

	Unit	2008	2030	2050
IEA crude oil imports	Barrel	97	115	120
Natural gas				
United States imports	MBtu	8.3	11.4	11.9
European imports	MBtu	10.3	14.0	14.7
Japanese imports	MBtu	12.6	15.9	16.7
OECD steam coal imports	Tonne	121	109	115

For the Baseline Scenario (in USD per unit)

	Unit	2008	2030	2050
IEA crude oil imports	Barrel	97	90	70
Natural gas				
United States imports	MBtu	8.3	10.2	7.9
European imports	MBtu	10.3	11.0	8.6
Japanese imports	MBtu	12.6	12.5	9.7
OECD steam coal imports	Tonne	121	65	58

For the BLUE Scenario (in USD per unit)

Carbon Price in the BLUE Map scenario

USD / t CO_2	2020	2030	2050
OECD	50	110	175
Non-OECD	0	65	175