



International  
Energy Agency

Secure • Sustainable • Together

# Energy and Climate: From Paris to Marrakesh and Beyond

*Marrakesh September 8, 2016*

*Philippe Benoit  
Head, Energy Environment Division  
International Energy Agency*

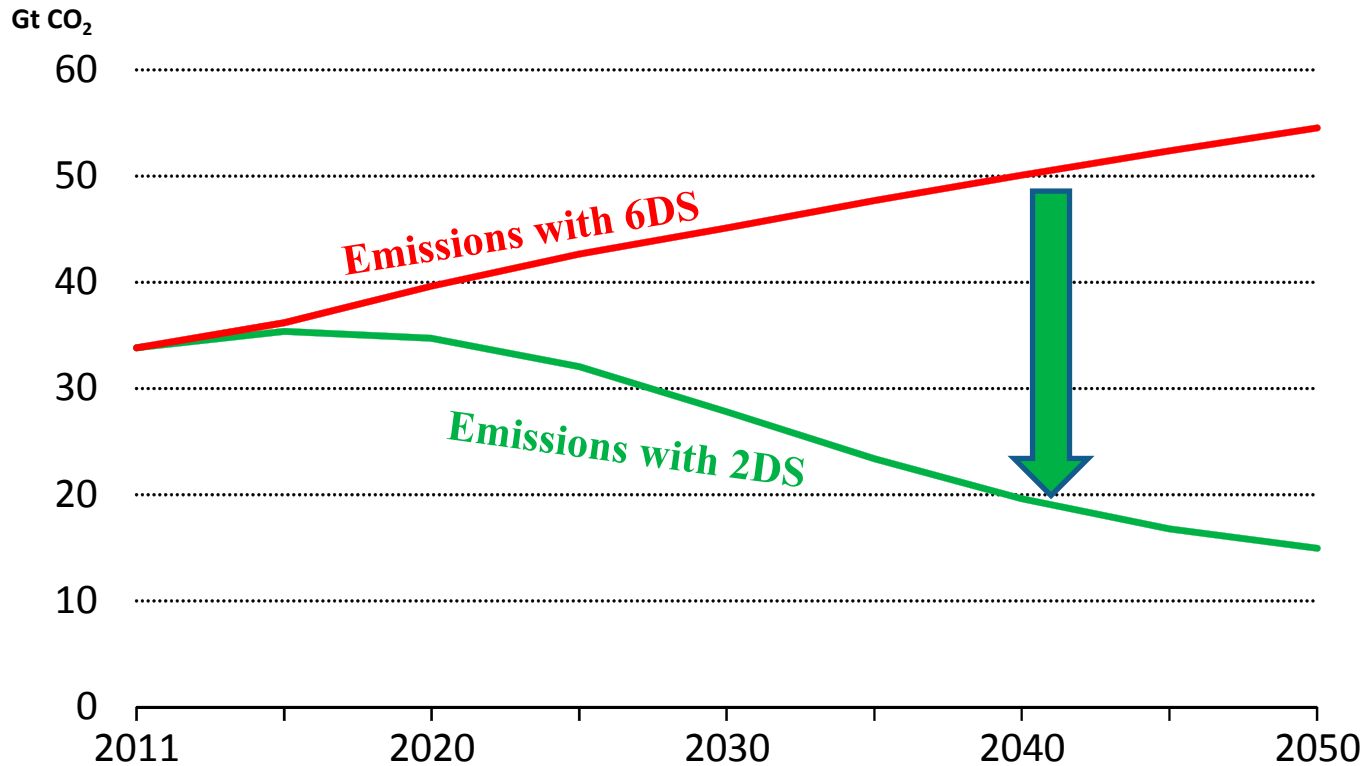
[www.iea.org](http://www.iea.org)

# Today's storyboard

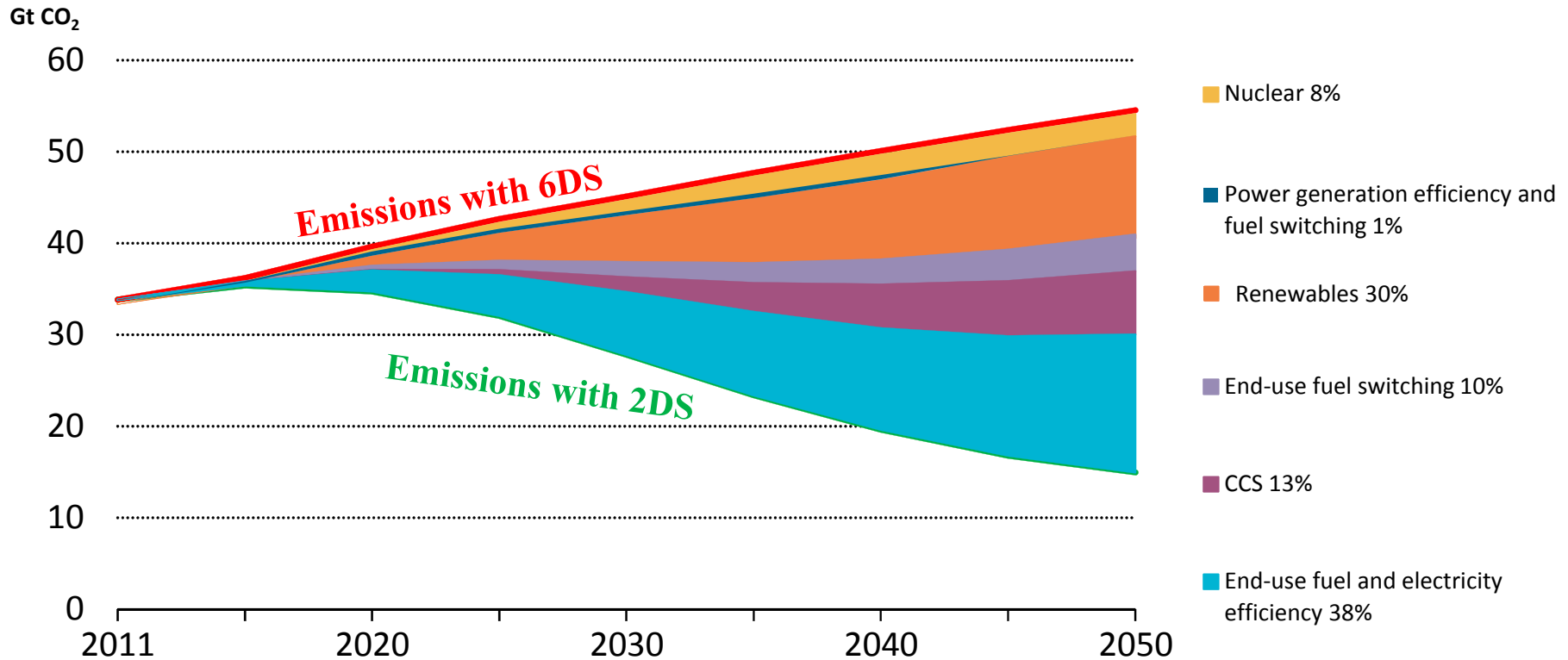
- *Act 1: A portfolio of action for the low-carbon energy transition*
- *Act 2: INDCs and the Paris Agreement*
- *Act 3: From 2°C to 'well below' 2°C*
- *Act 4: The decarbonization challenge in the power sector*
- *Act 5: Renewables and Energy Efficiency are two keys*
- *Act 6: Carbon Pricing in IEA models*
- *Act 7: Reversing the 'lock-in' of emissions: facing up to the challenge of existing fossil fuel facilities*
- *Act 8: The world keeps changing ...*
- *Act 9: State-owned enterprises – important and special*

***Act 1:  
A portfolio of actions  
for the low-carbon  
energy transition***

# Changing our portfolio of energy technologies to respond to the climate change challenge

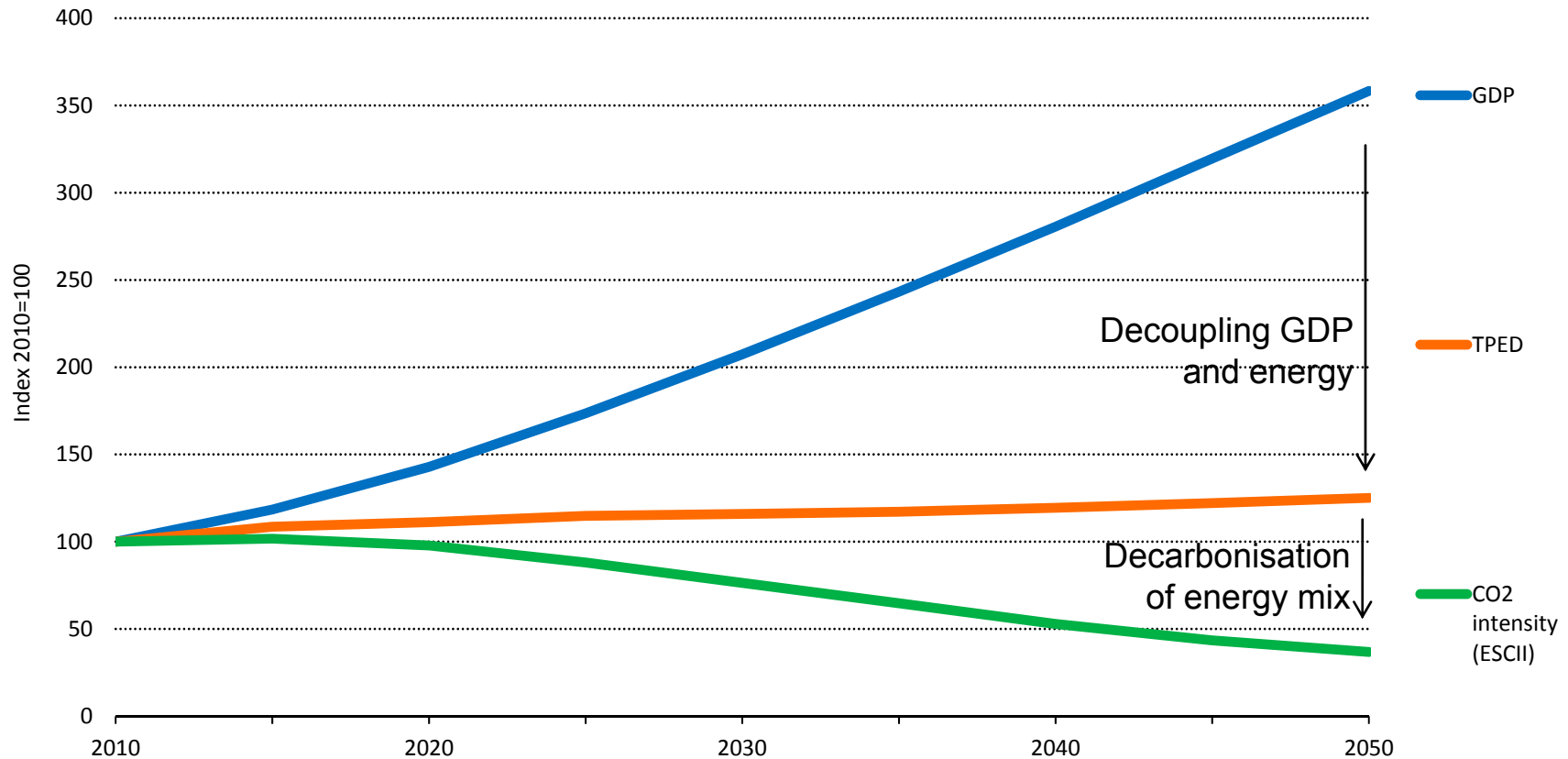


# Changing our portfolio of energy technologies to respond to the climate change challenge



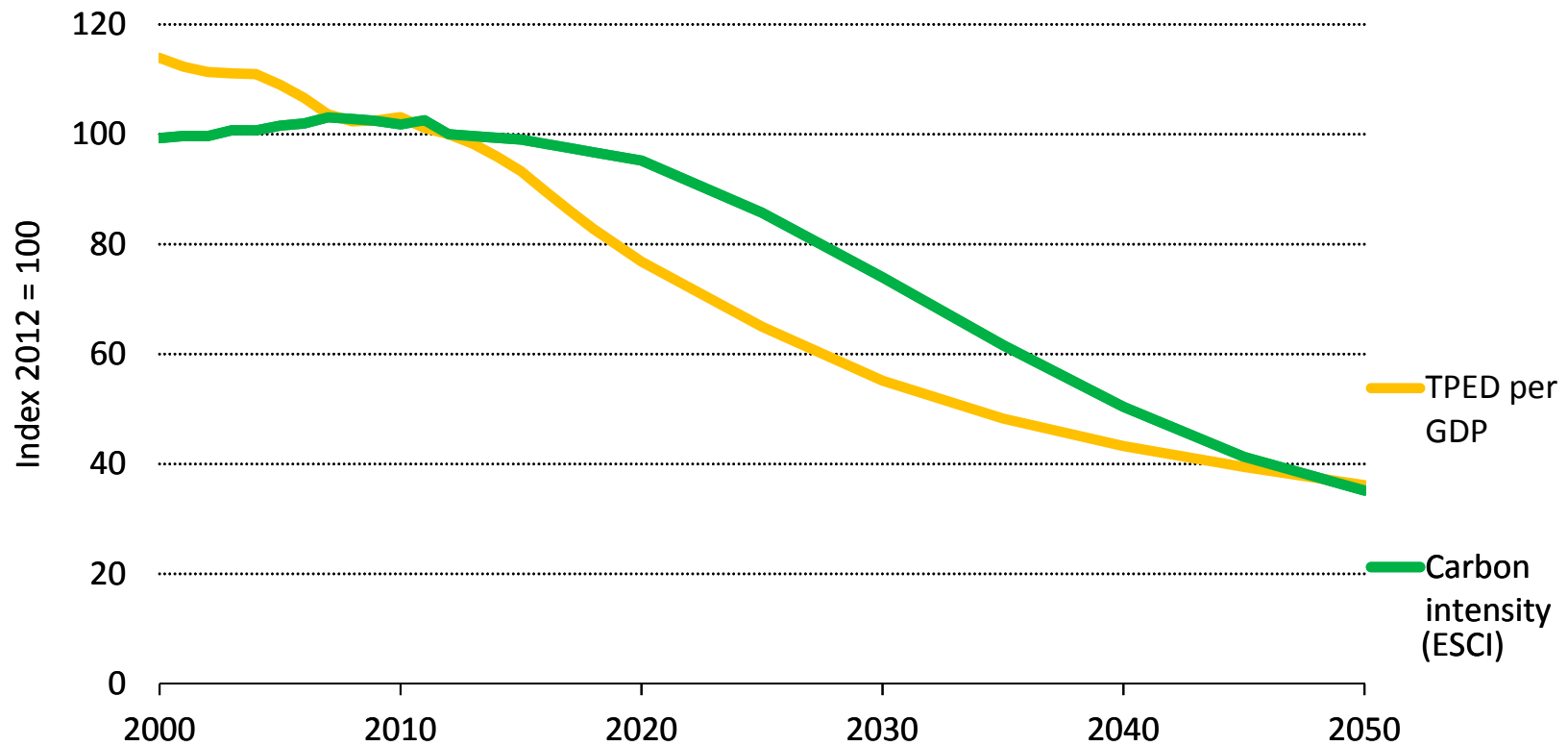
# To 2 Degrees: More growth, more efficiency, more low carbon

GDP, Primary Energy and CO<sub>2</sub> pathways in the 2DS



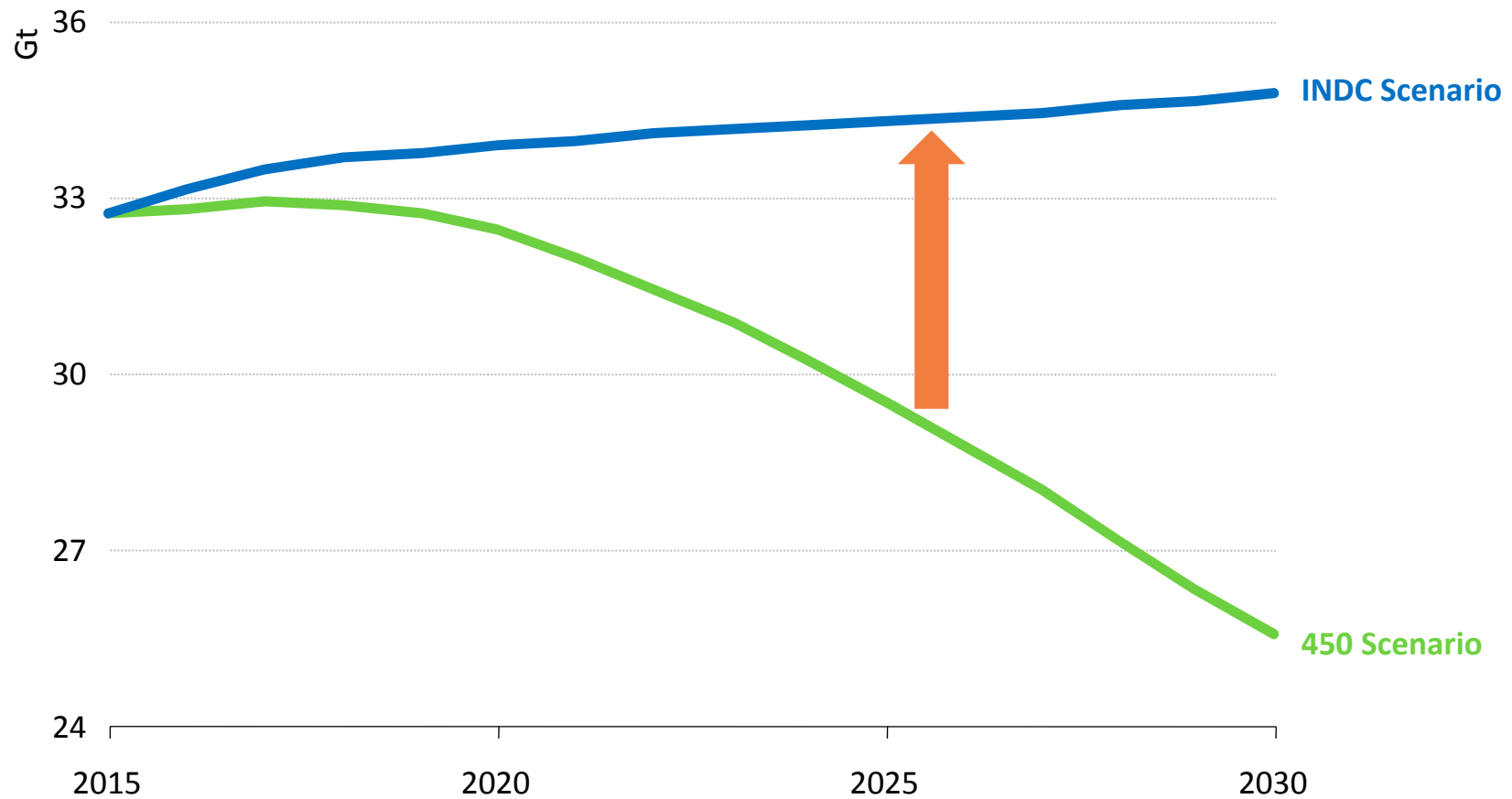
**IEA scenarios predicated on continued robust global growth**

# Energy intensity of GDP and CO<sub>2</sub> intensity of primary energy in 2DS



# *Act 2: INDCs and the Paris Agreement*





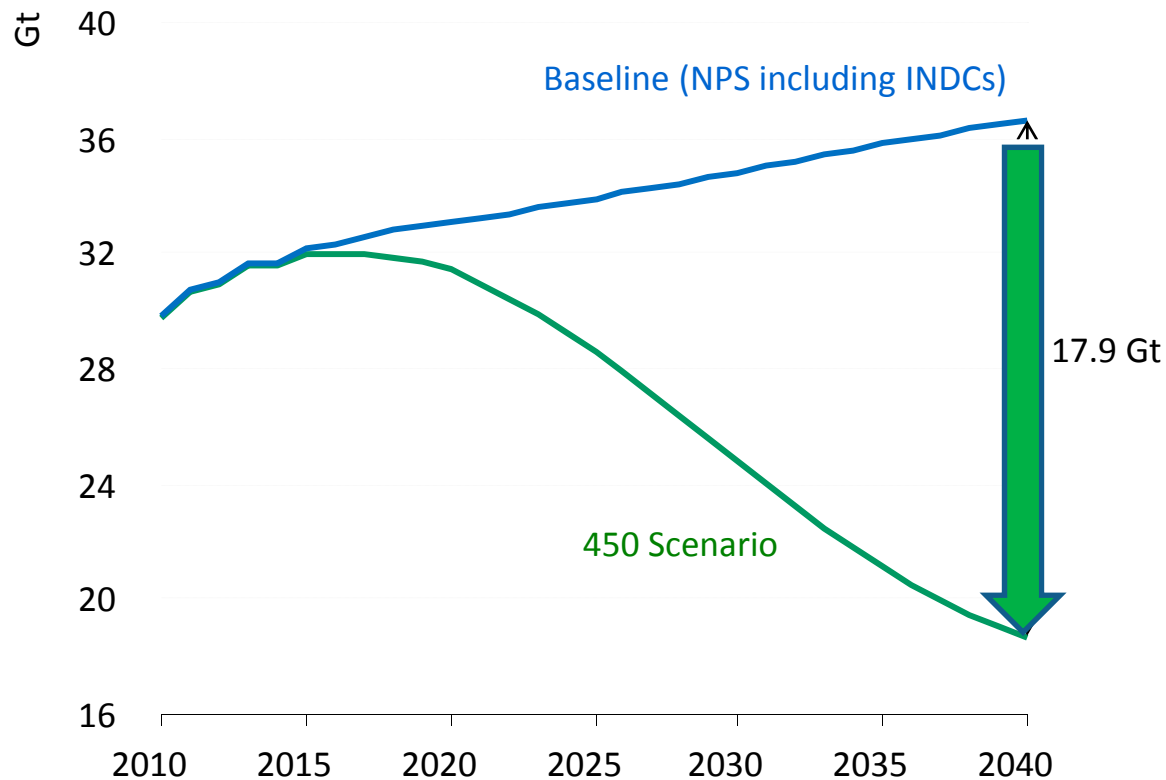
- **INDC Scenario above 2DS**
- **INDCs will set the new 'reference case' (NPS)**

# INDC Climate pledges shift the energy sector

---

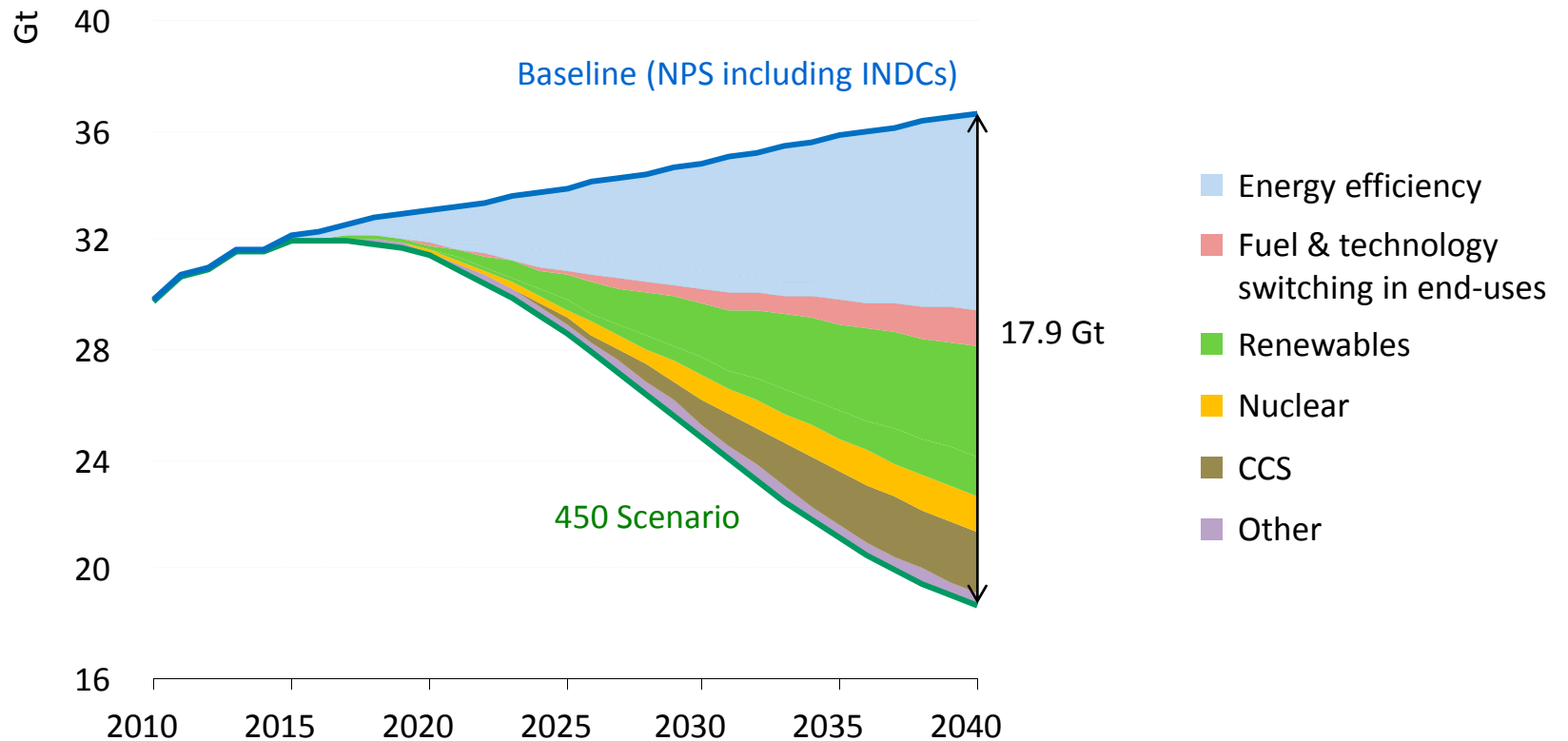
- **One-quarter** of the world's energy supply is **low carbon in 2030**; **energy intensity improves** three-times faster than the last decade
- **Renewables** reach nearly **60% of new capacity** additions in the power sector; two-thirds of additions are in China, EU, US & India
- **Natural gas** is the only fossil-fuel that **increases its share** of the global energy mix
- Total **coal demand** in the US, Europe & Japan **contracts by 45%**, while the growth in India's coal use slows by one-quarter
- **Inefficient coal plants** installed in **2030** are only **marginally lower than today**

# A 2 °C pathway requires efforts well beyond INDCs and 2030



# A 2 °C pathway requires efforts well beyond INDCs and 2030

[www.iea.org](http://www.iea.org)



# Paris Agreement and the energy sector www.iea.org

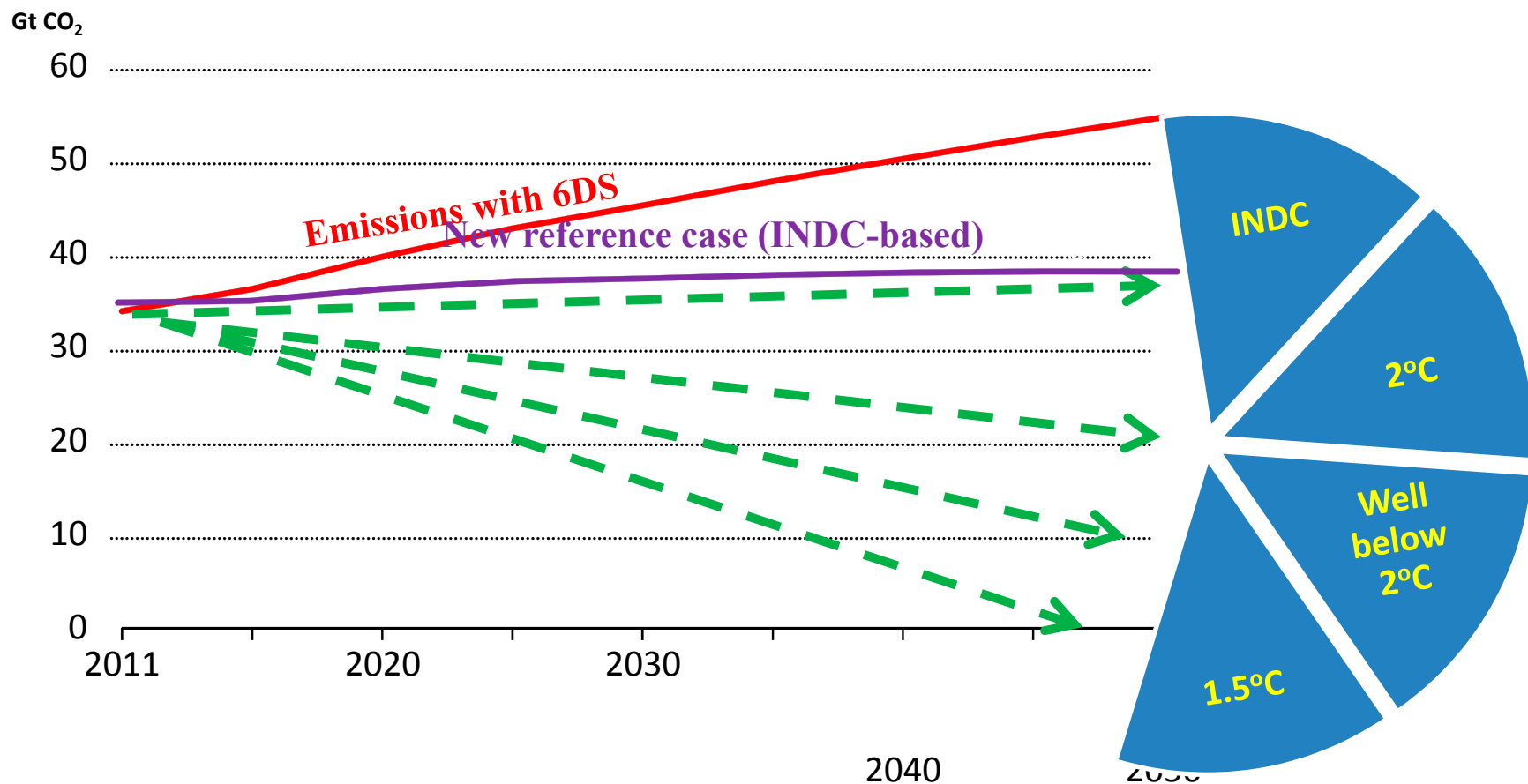
- **“Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;”**
- **“... Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions ... so as to achieve a balance between anthropogenic emissions by sources and removals by sinks ... in the second half of this century ...”**

# Paris Agreement and the energy sector

- “Holding the increase in the global average temperature to **well below 2°C** above pre-industrial levels and to pursue efforts to limit the temperature increase **to 1.5°C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;”
- “... Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions ... so as to achieve **a balance between anthropogenic emissions by sources and removals by sinks ... in the second half of this century ...**”

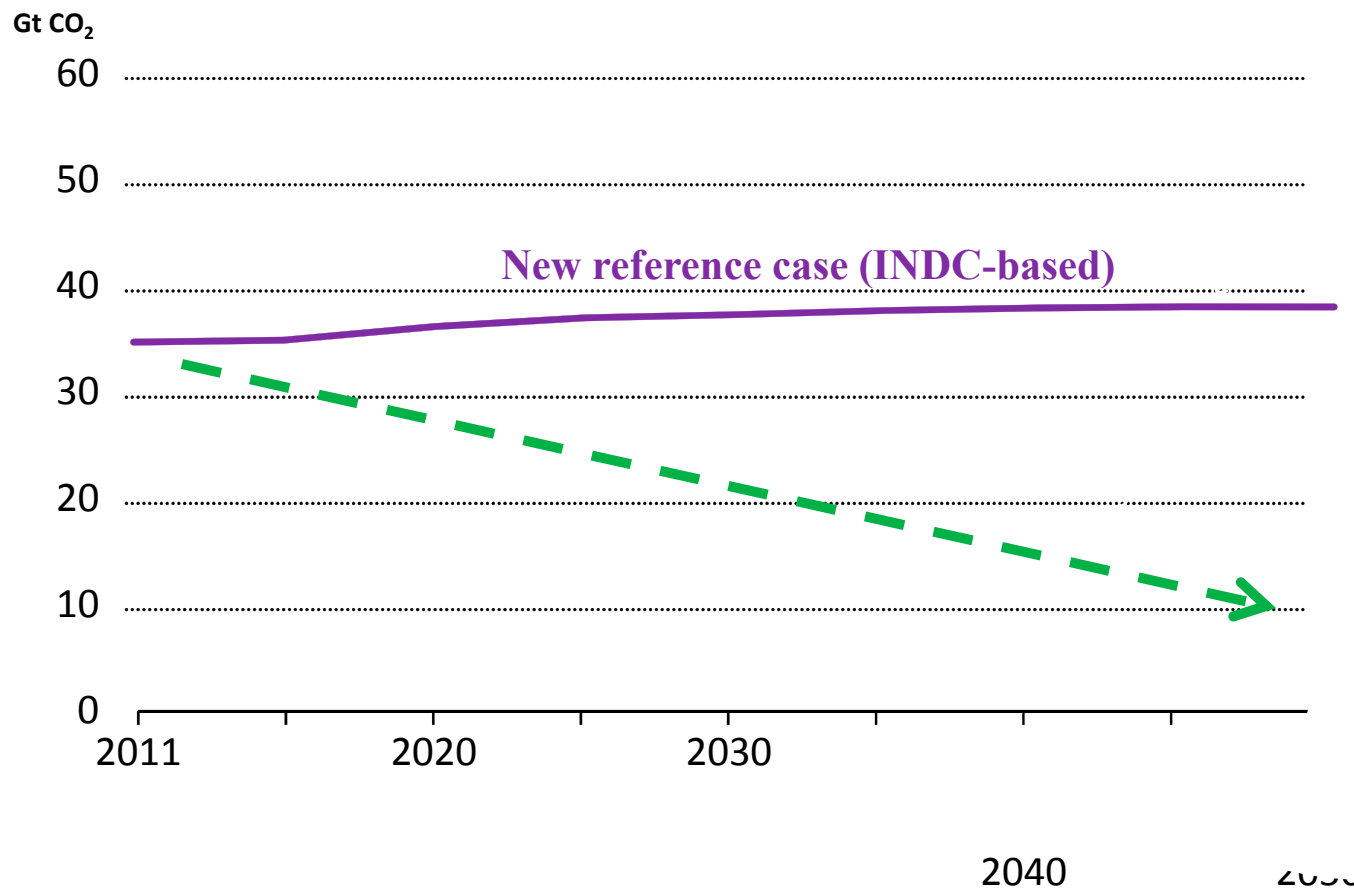
# Climate target: Where do we want to go?

*Different targets: (i) INDCs, (ii) 2°C, (iii) well below 2°C, and (iv) 1.5°C*



# Climate target: Where do we want to go?

*targets  
well below 2°C*

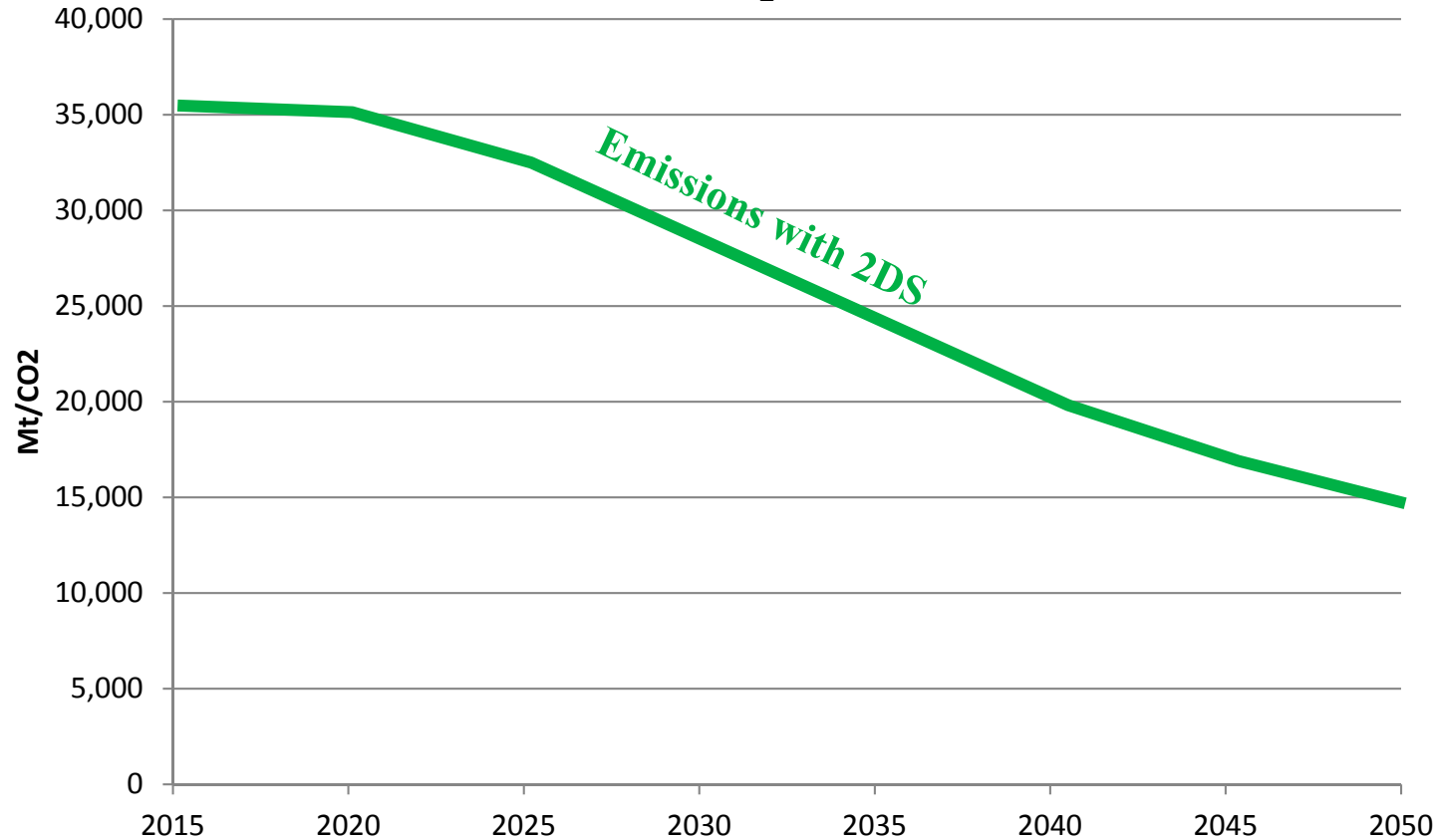




***Act 3:***  
**From 2°C to**  
**‘well below’ 2°C**

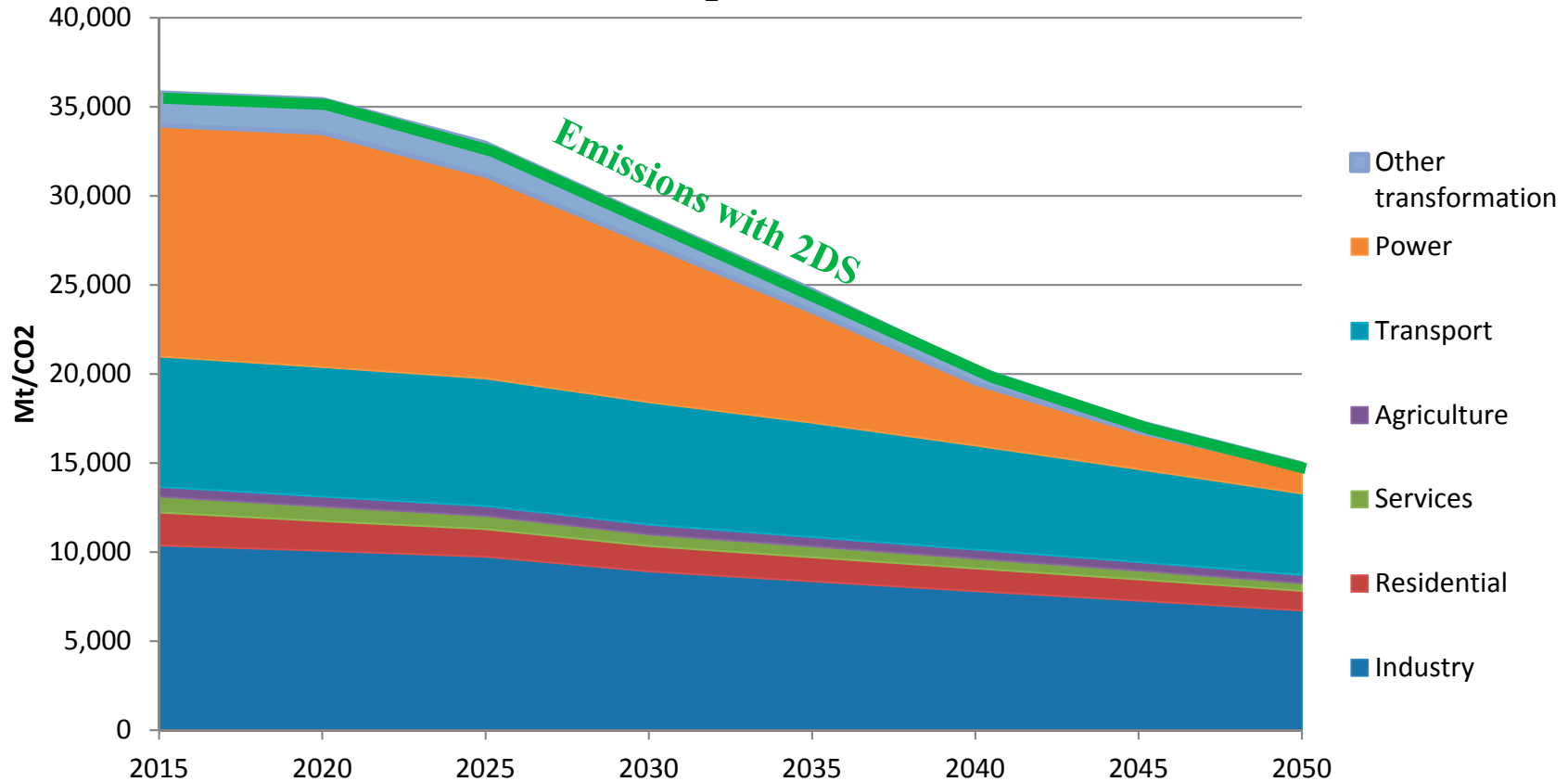
# From 2°C ... to 'well below 2°C'

Remaining CO<sub>2</sub> emissions under 2DS



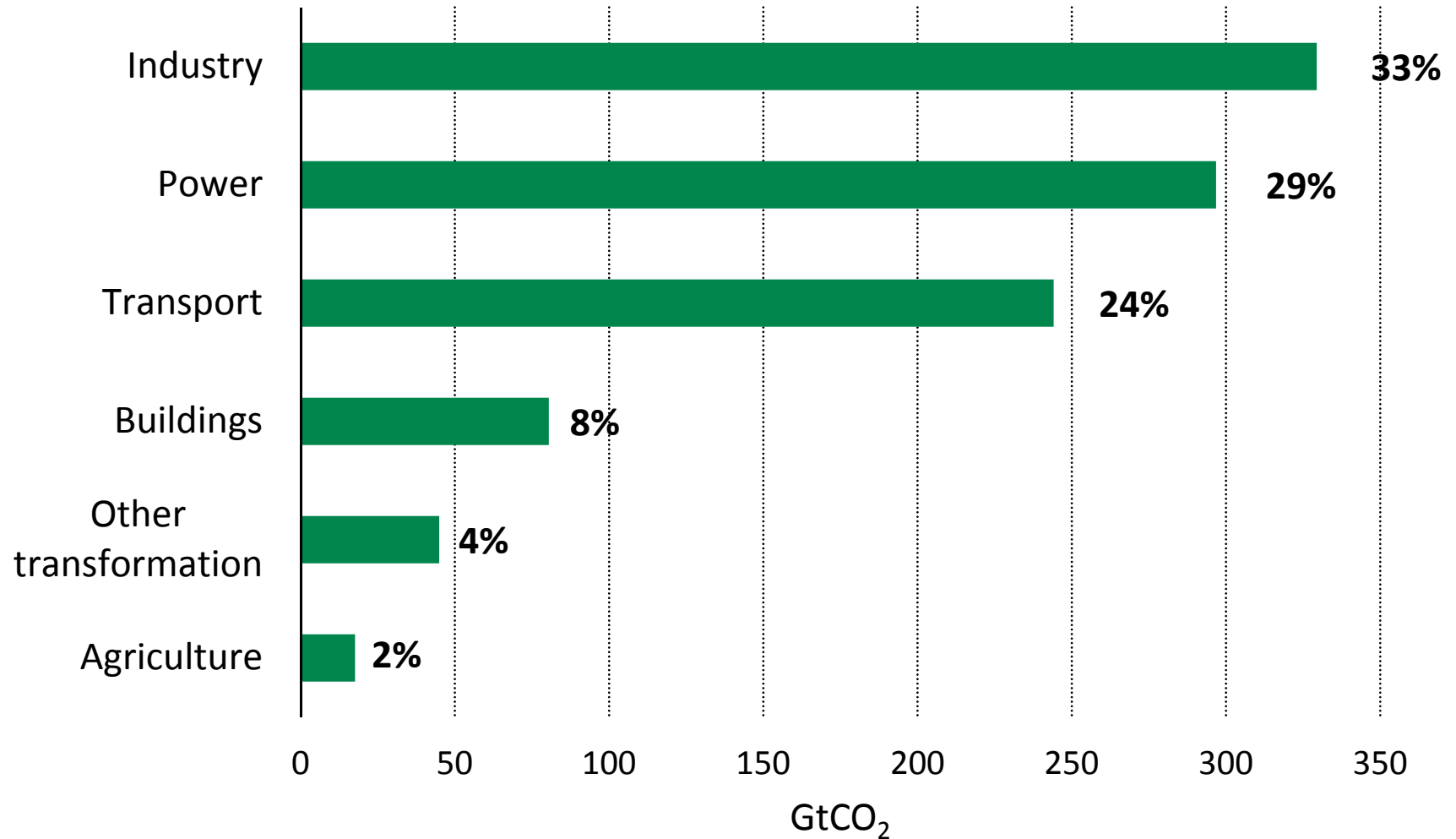
# From 2°C ... to 'well below 2°C'

## Remaining CO<sub>2</sub> emissions under 2DS



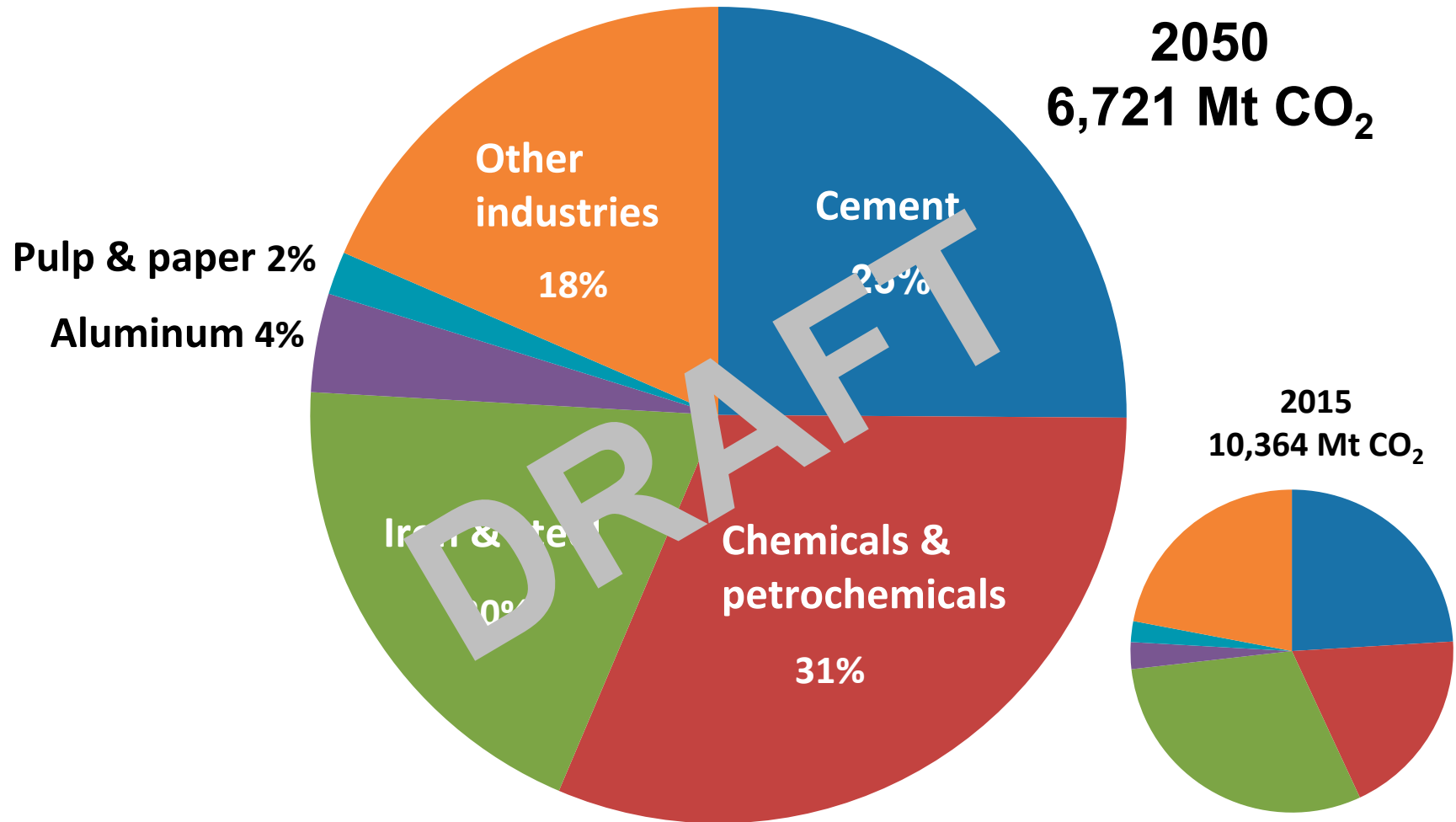
# Sectoral shares of cumulative 2DS emissions - 2015-2050

[www.iea.org](http://www.iea.org)

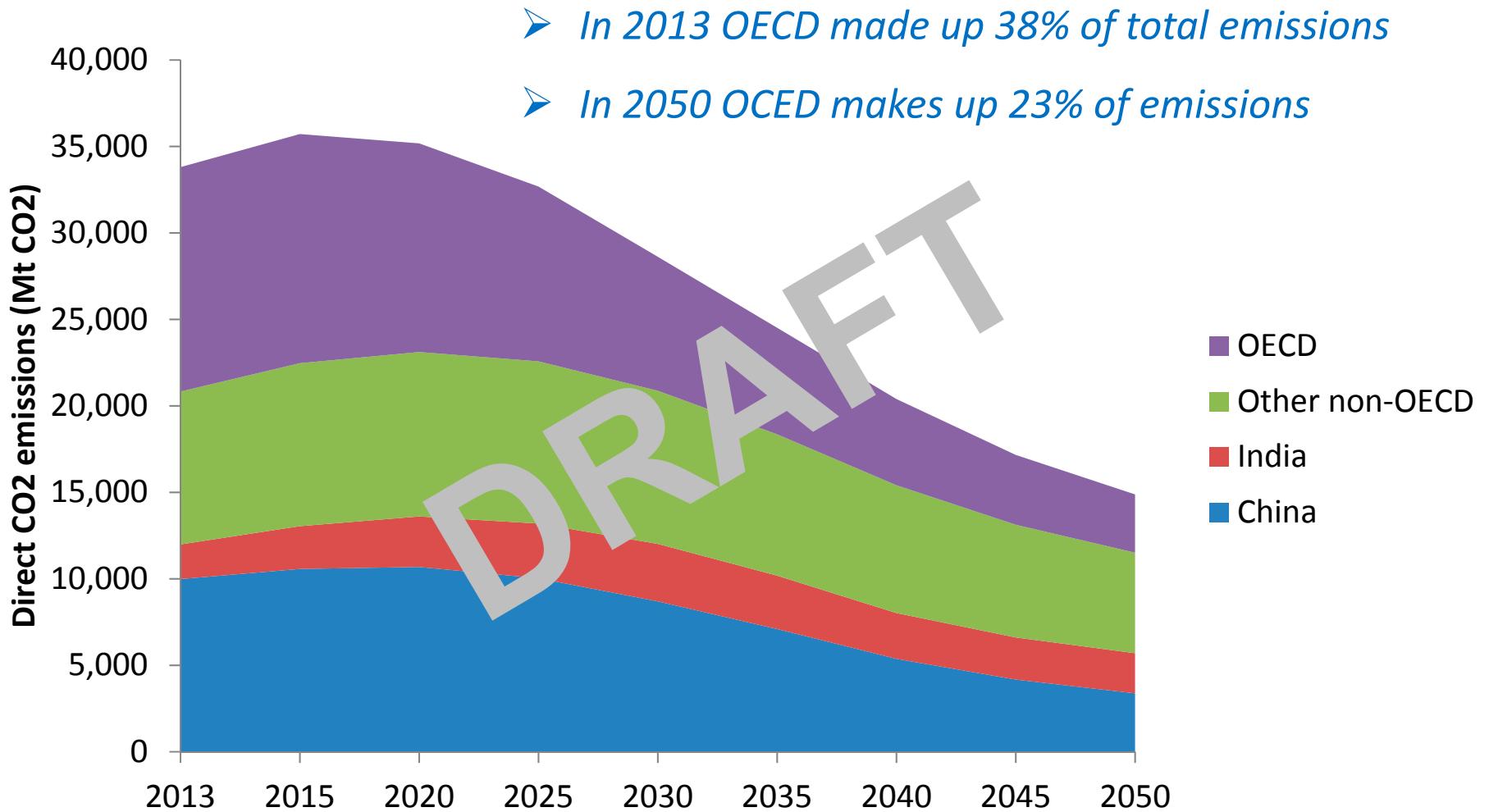


# Residual industry emissions shares under 2DS in 2050

www.iea.org

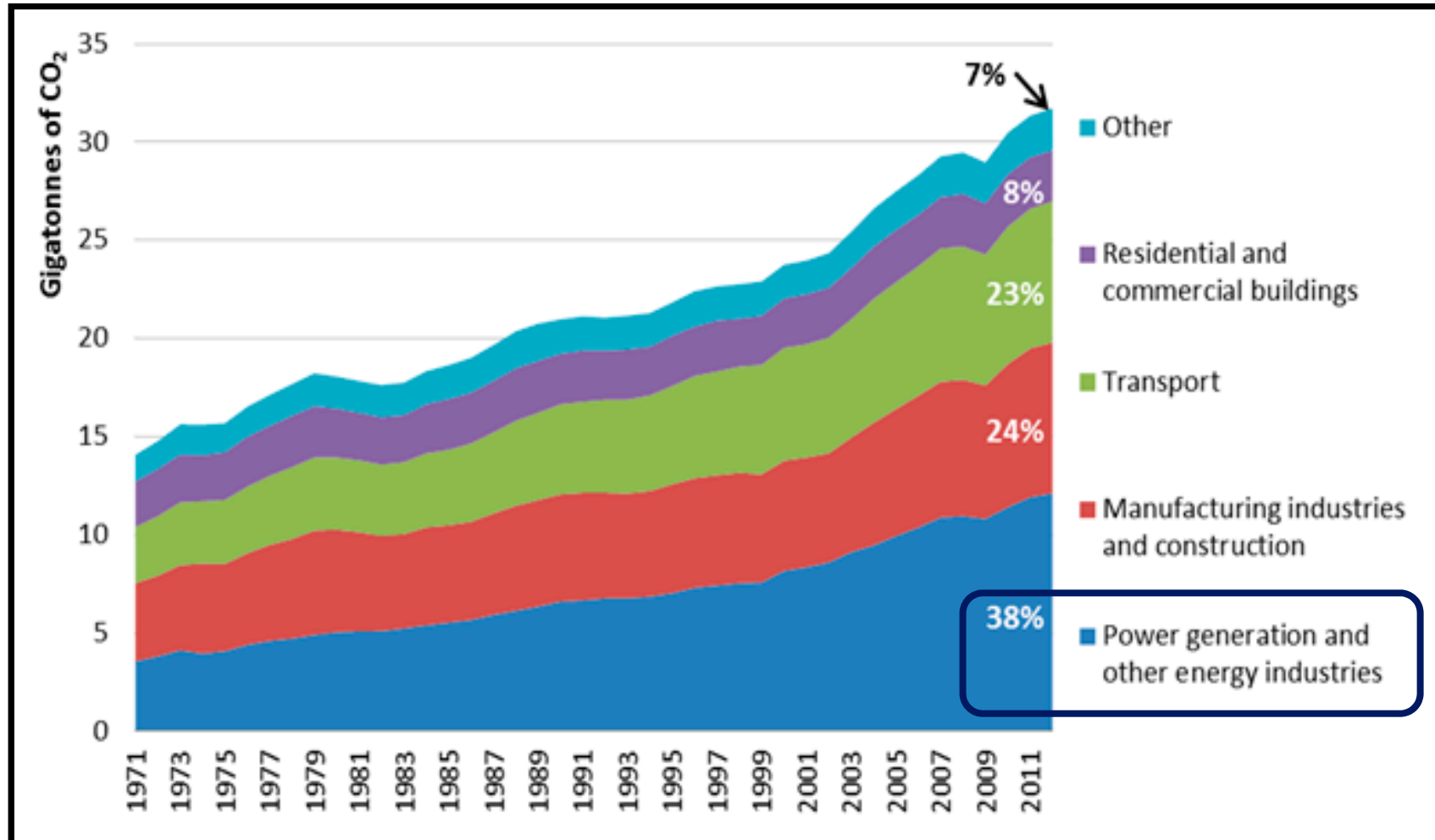


# Direct CO<sub>2</sub> emissions by region in 2DS



# ***Act 4: The decarbonization challenge in the power sector***

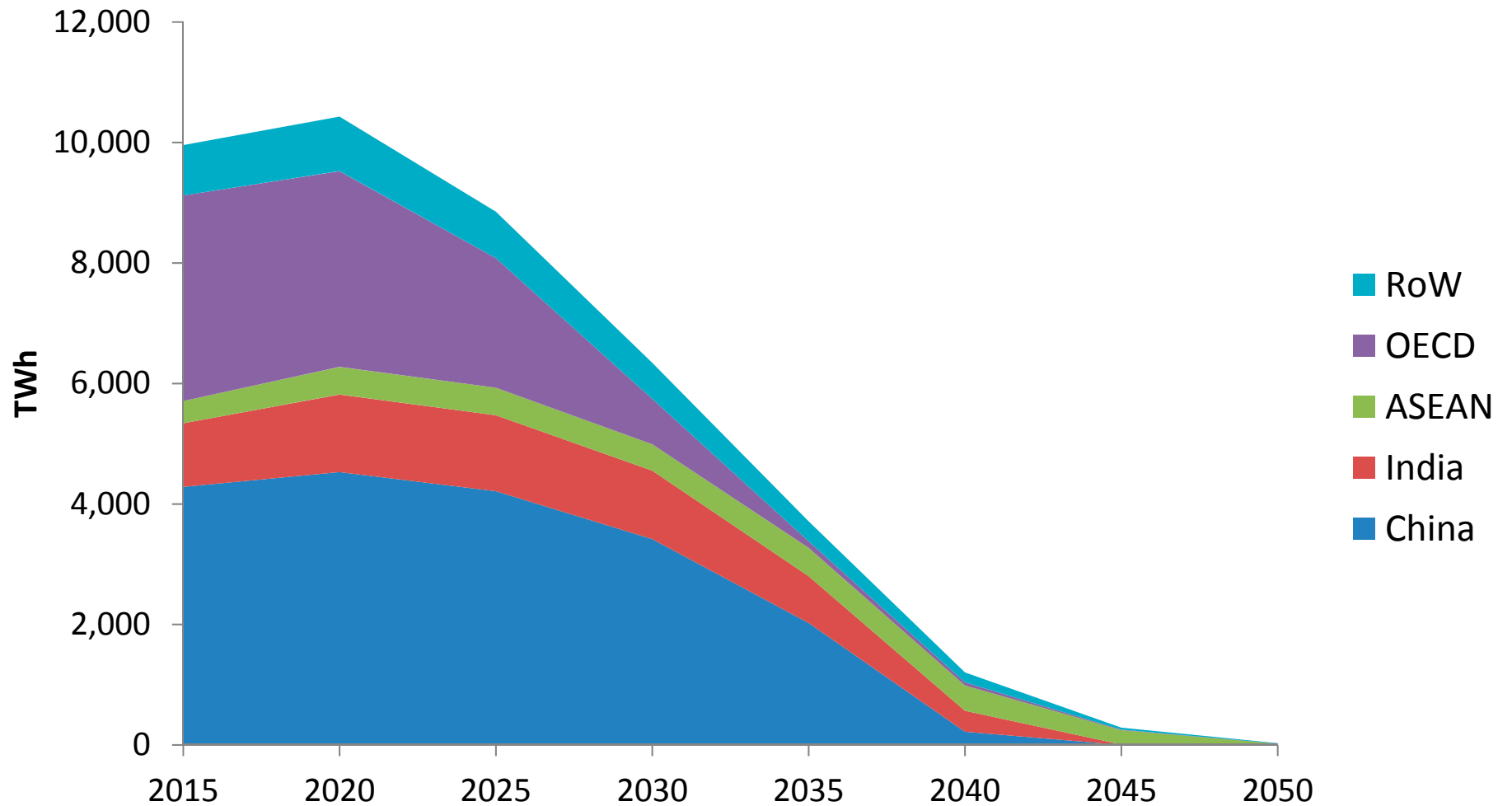
# CO<sub>2</sub> energy emissions: power dominates sectoral shares





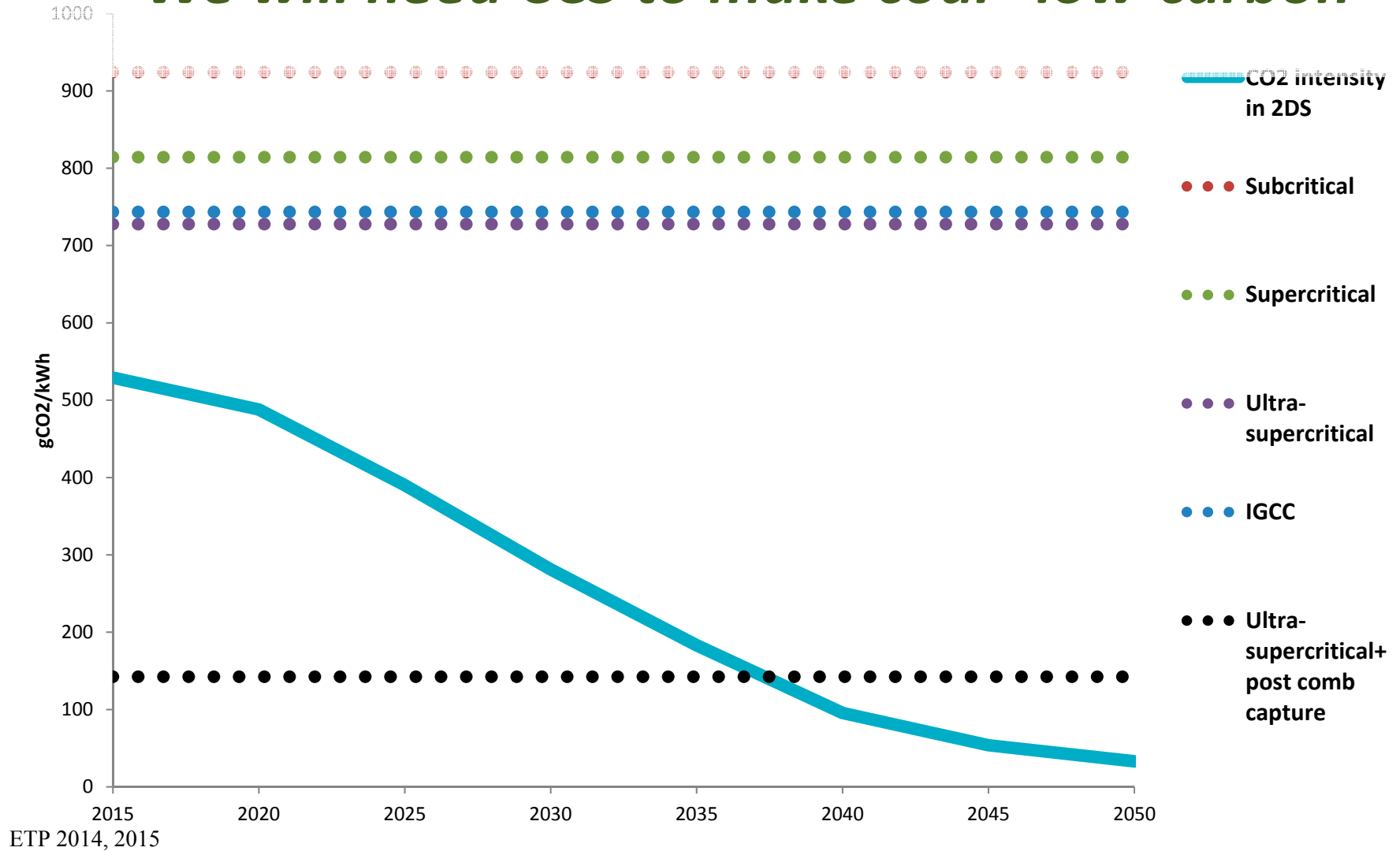
# Coal

Global Coal Power Generation (without CCS) – 2DS



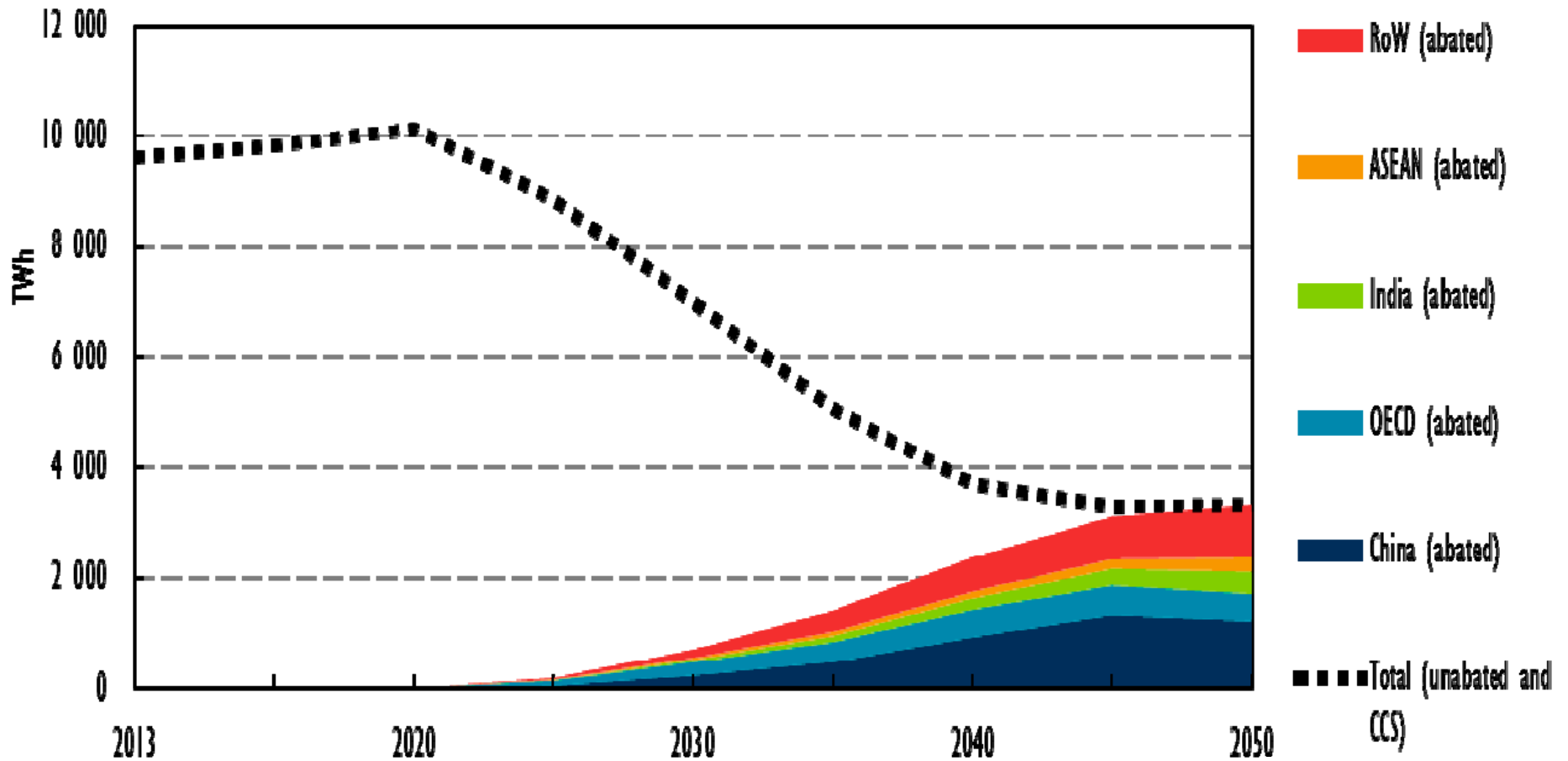
# Coal: 'High efficient-low emissions'?

*We will need CCS to make coal "low-carbon"*



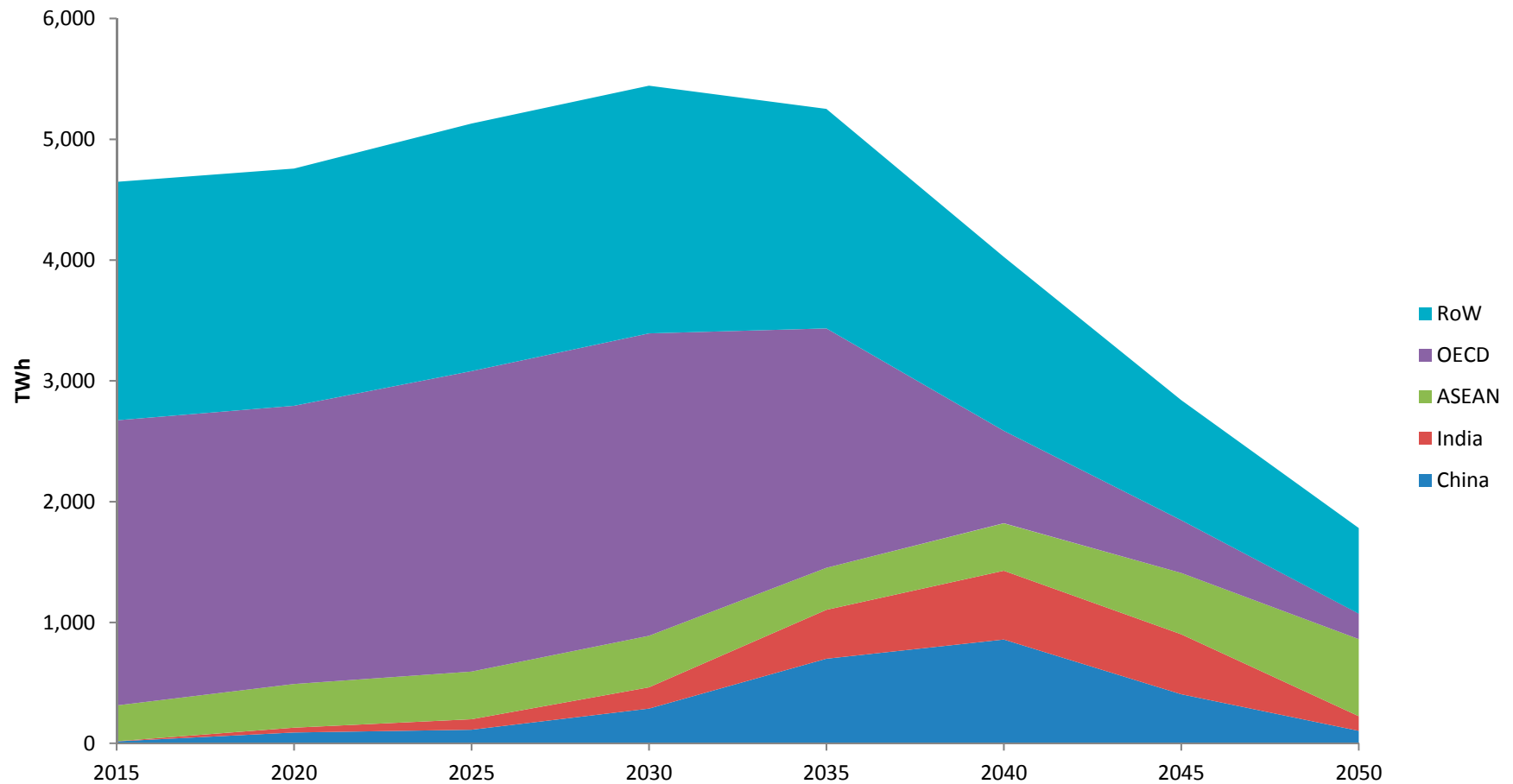
ETP 2014, 2015

# Coal: total generation (unabated and abated – with CCS) in the 2DS

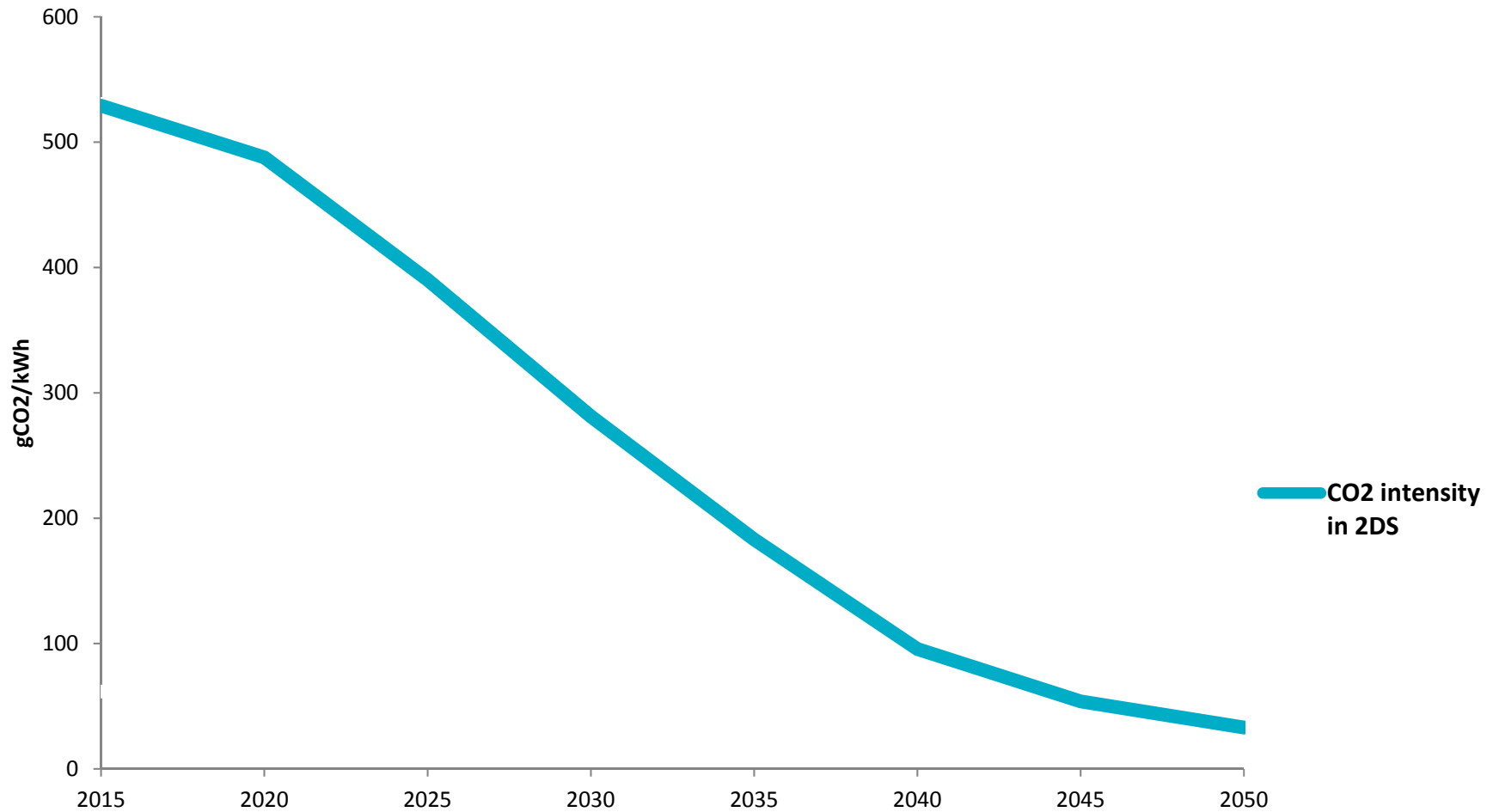


# Gas:

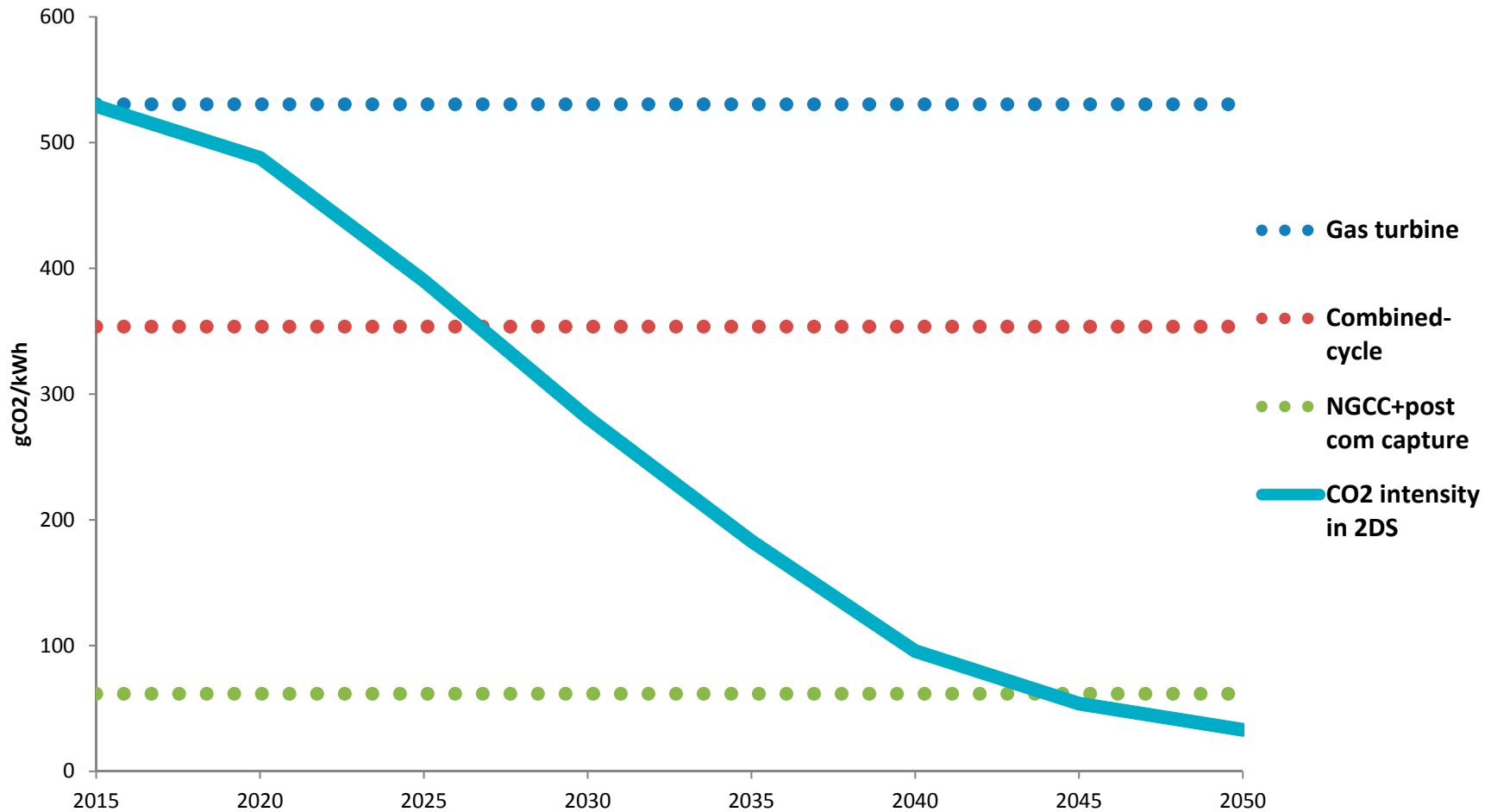
## Unabated Global Gas Power Generation – 2DS



# Gas: a transition or a destination?

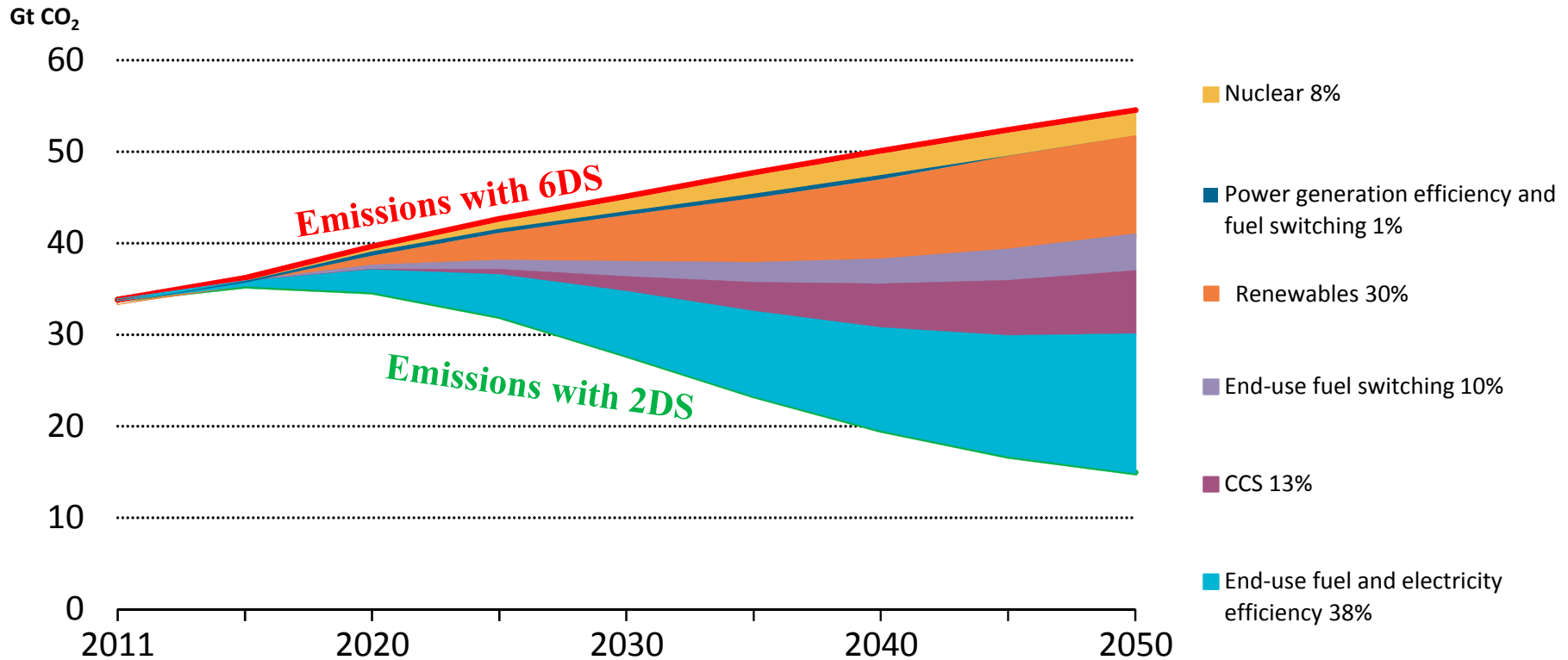


# Gas: a transition or a destination?



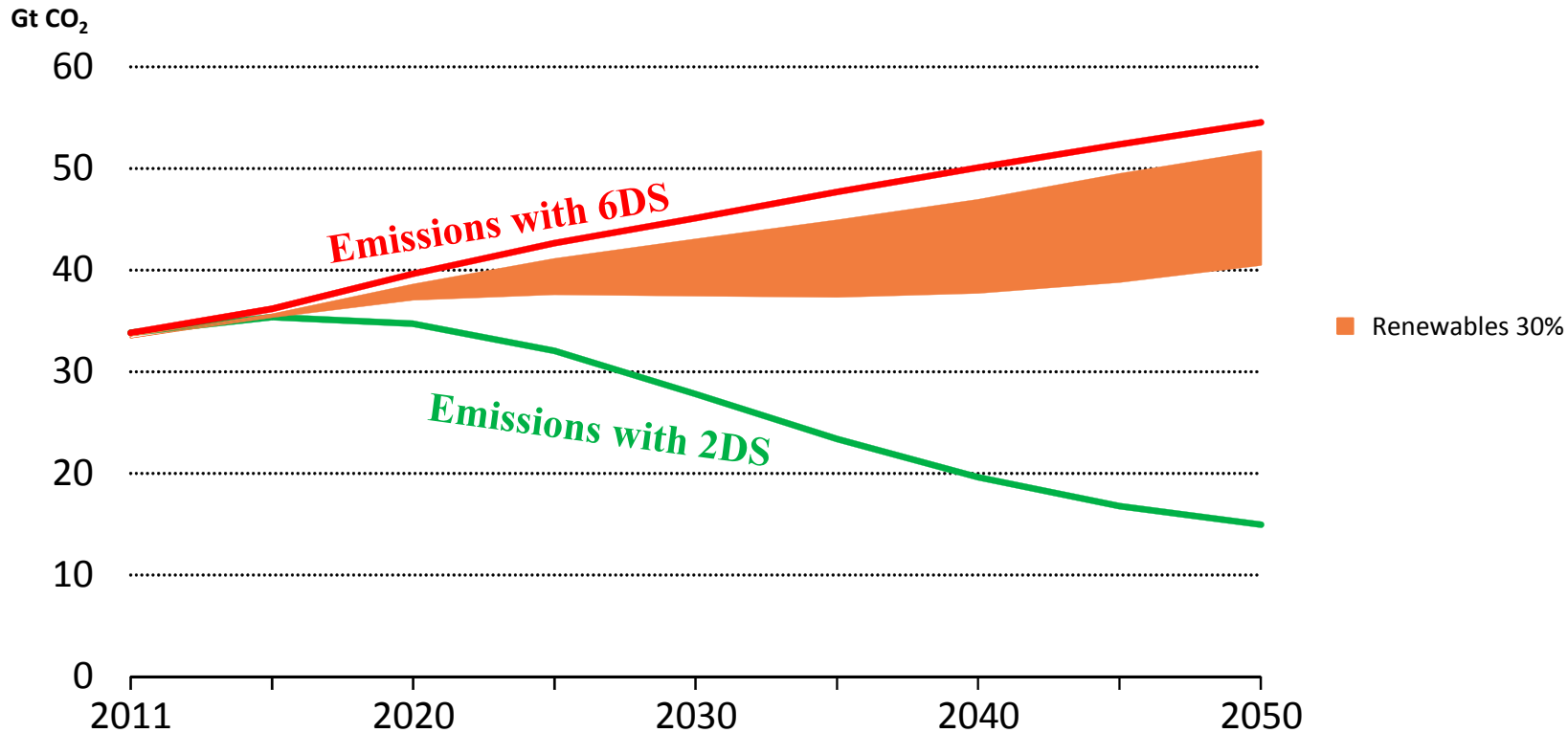
# *Act 5: RE and EE – two key solutions*

# Changing our portfolio of energy technologies to respond to the climate change challenge





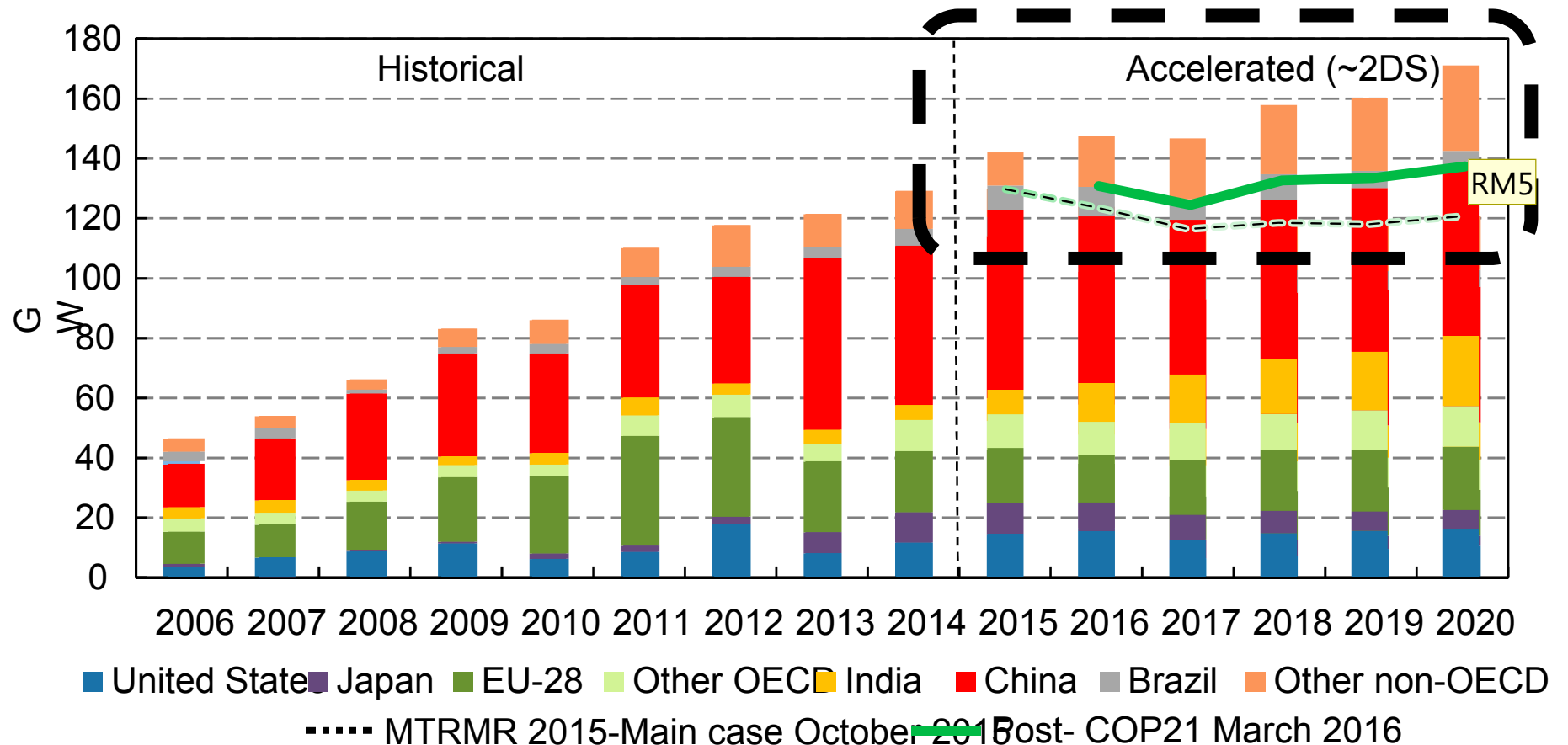
# Changing our portfolio of energy technologies to respond to the climate change challenge



**Renewables are key**

# Renewable Energy deployment prospects

## World renewable power annual capacity additions, *main vs. accelerated case*



***With recent policy changes, 35% of gap between main and accelerated case is bridged***

## Slide 34

---

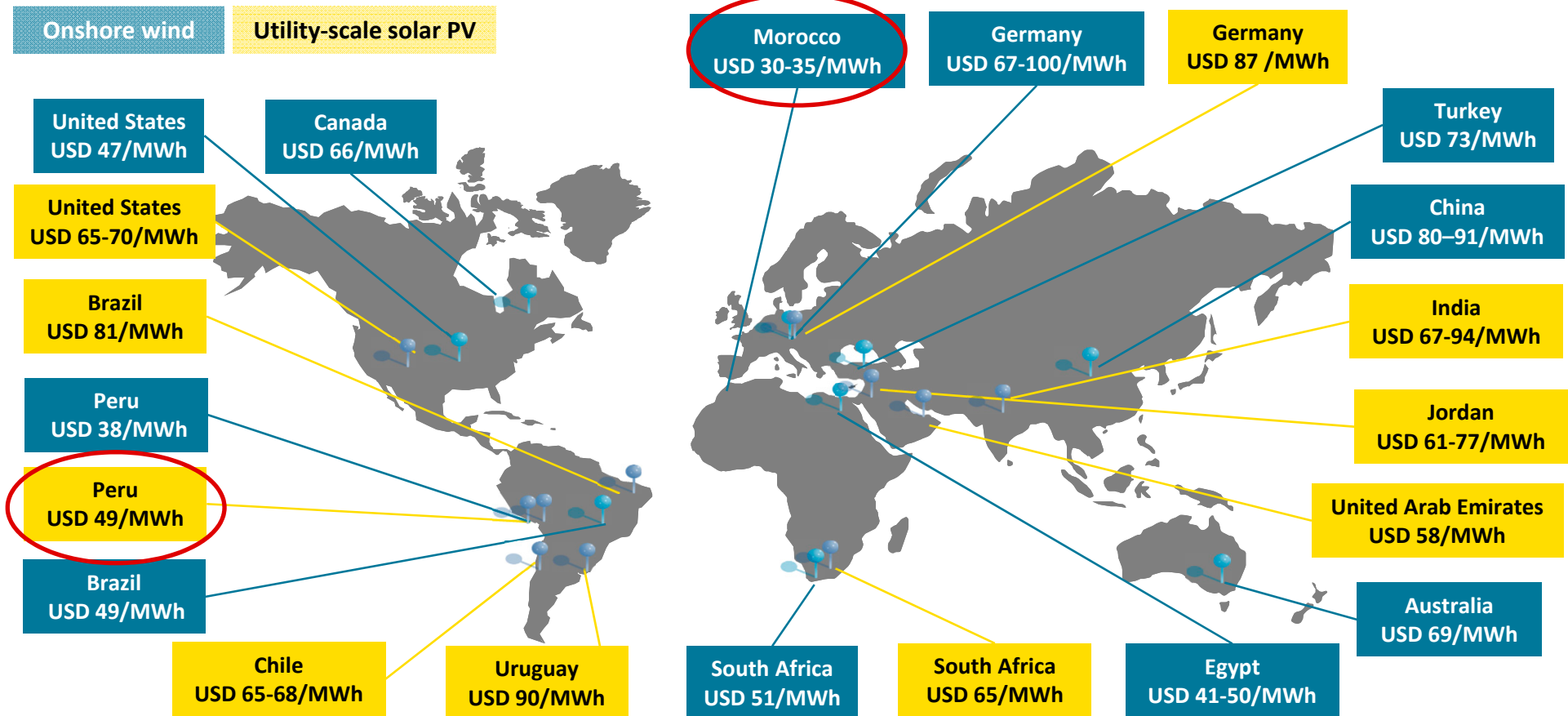
**RM5**

The animation and color coding of the figure doesnt work right now properly! Unfortunately I dont quite see how the right version looks like.

MALISCHEK Raimund, IEA/STO/ETP/EST, 9/1/2016

# Wind and Solar PV prices declining

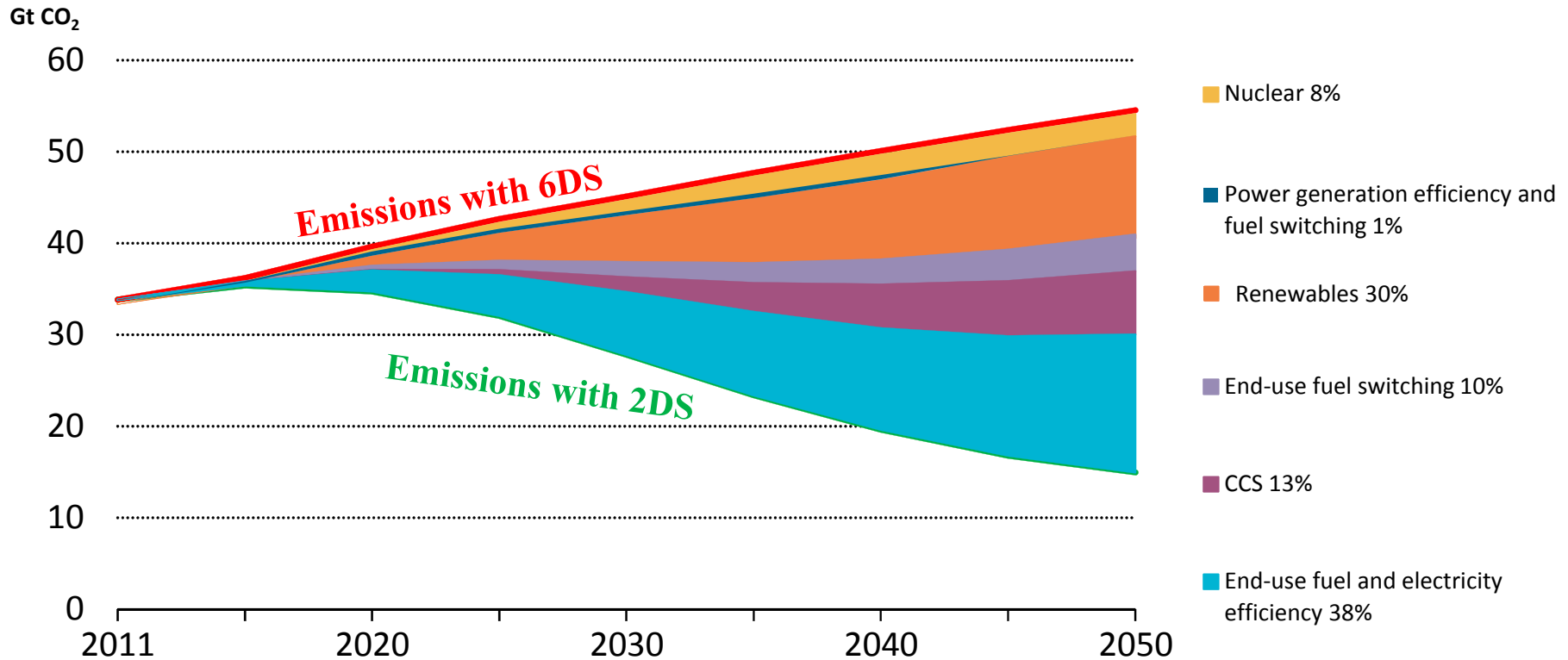
Recent announced long-term contract prices for new renewable power to be commissioned over 2016-2019



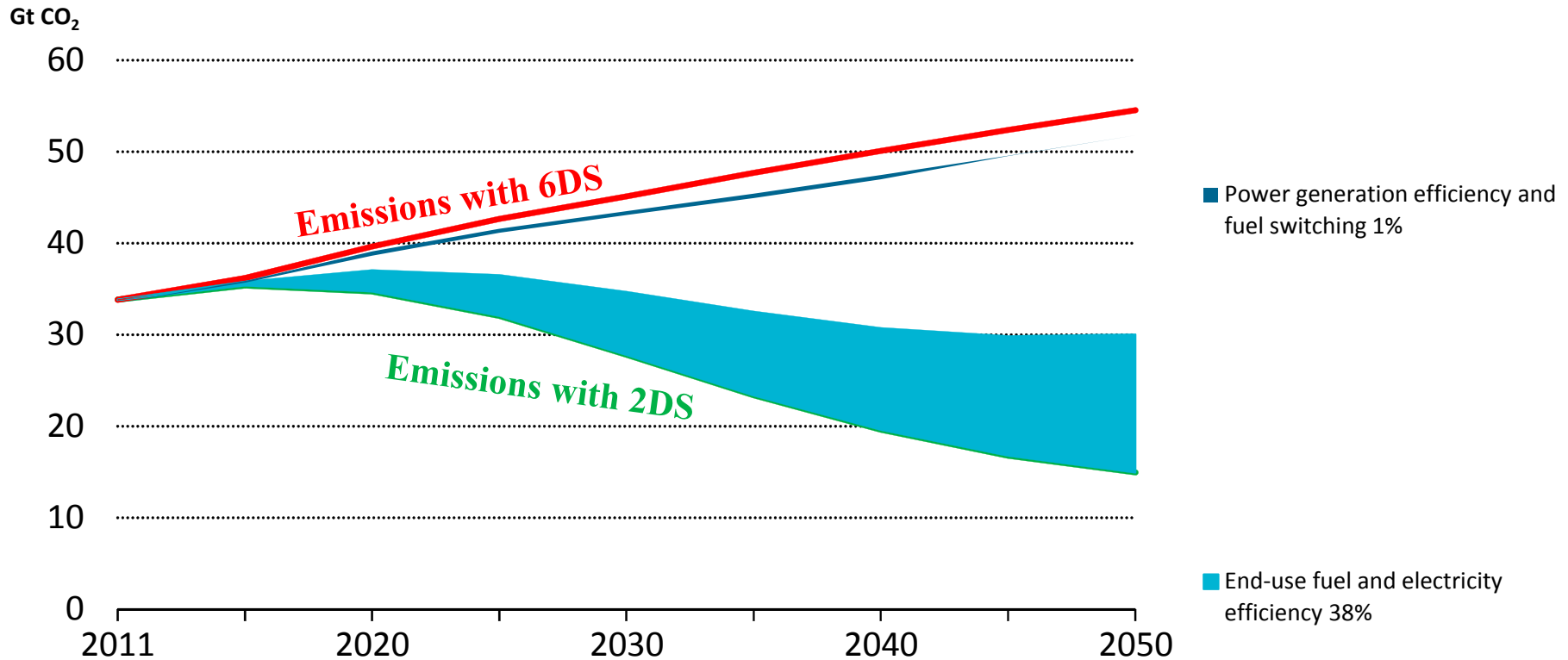
This map is without prejudice to the status or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area  
 Note: Values reported in nominal USD includes preferred bidders, PPAs or FITs. US values are calculated excluding tax credits. Delivery date and costs may be different than those reported at the time of the auction.

**Best results occur where price competition, long-term contracts and good resource availability are combined**

# Changing our portfolio of energy technologies to respond to the climate change challenge



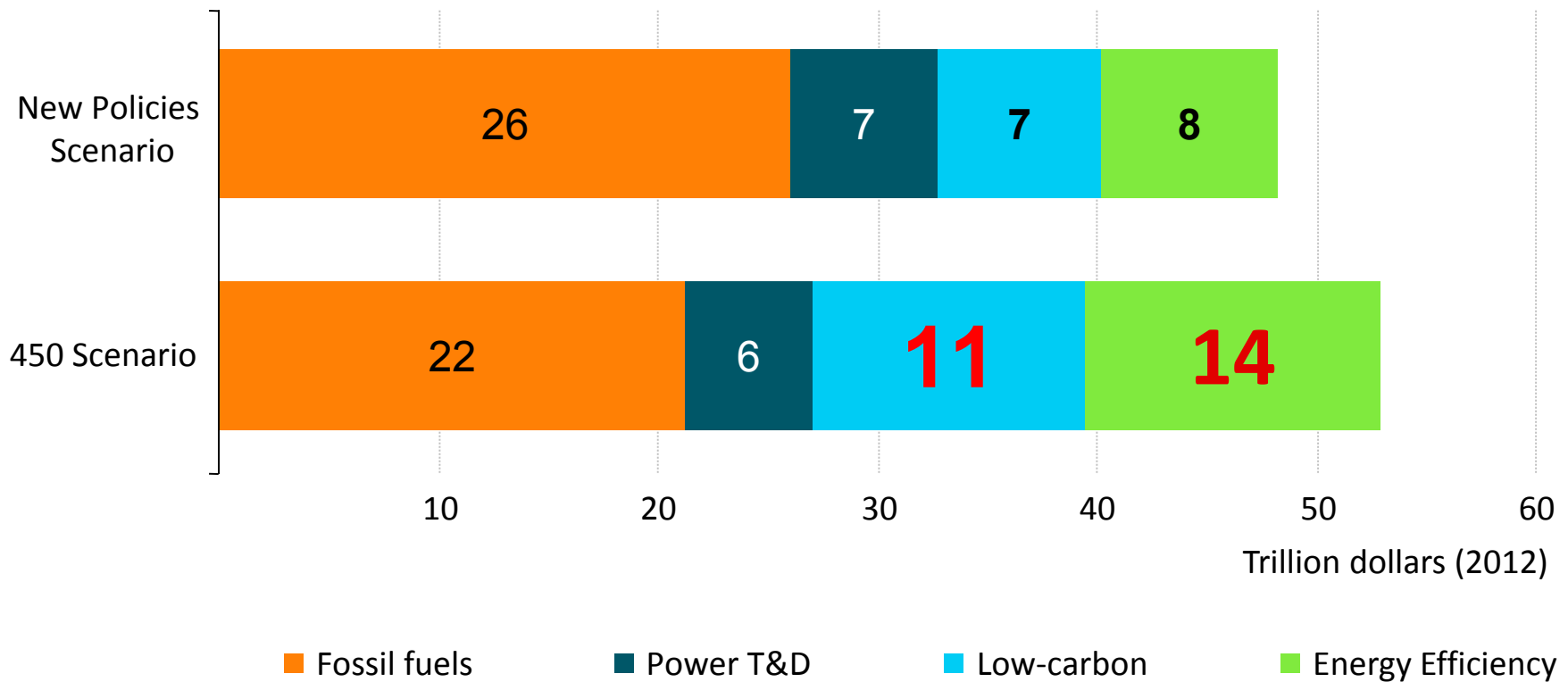
# Changing our portfolio of energy technologies to respond to the climate change challenge



**Energy efficiency is the most important driver to decarbonize**

# More investment in energy efficiency

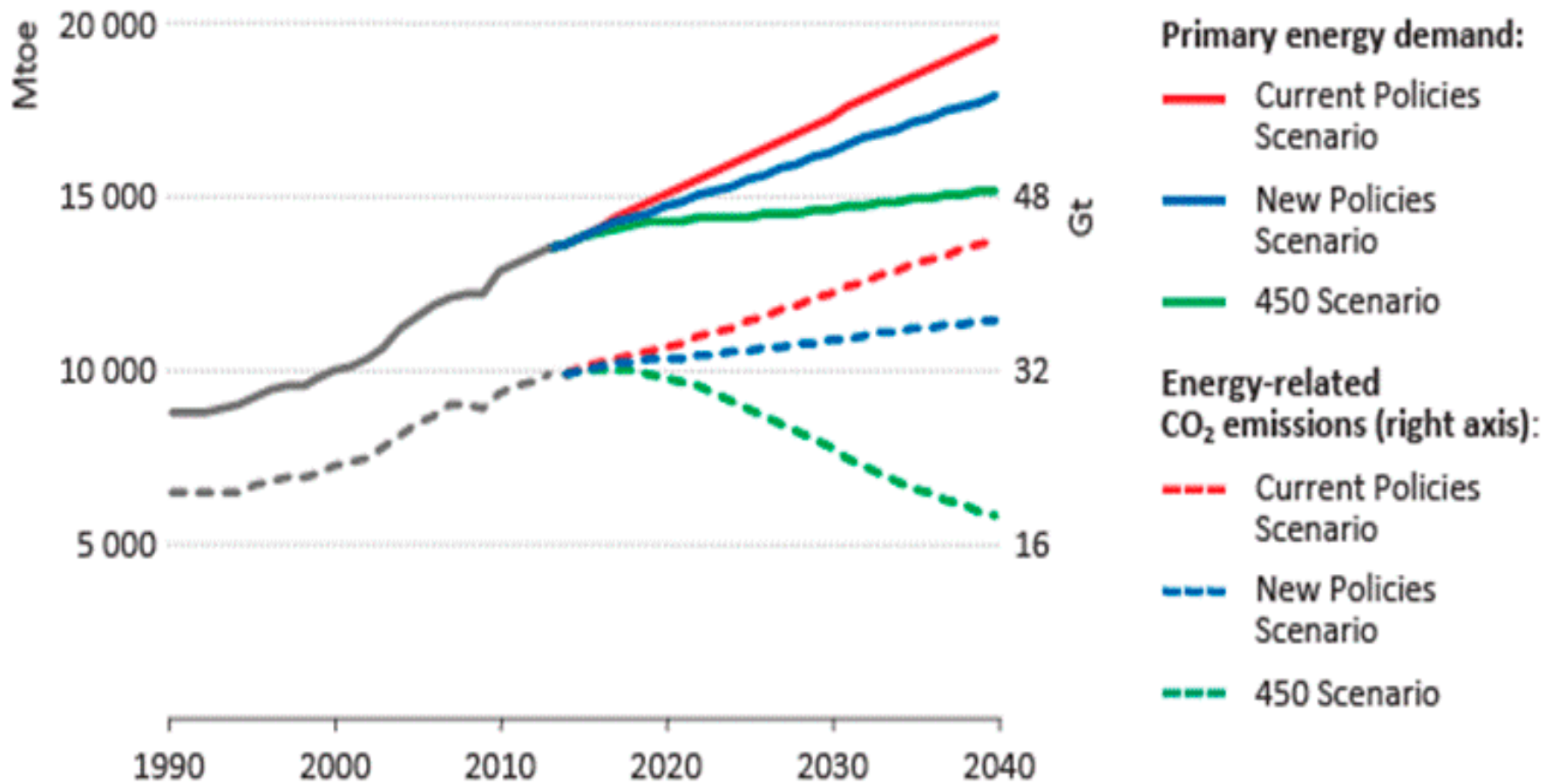
## Global Cumulative Investment in the New Policies and 450 Scenarios, 2014-2035



**Spending on RE is \$4 trillion and on EE is \$6 trillion higher in the 450 (2DS) scenario**

# Demand and emissions are linked

## World primary energy demand and CO<sub>2</sub> emissions by scenario





# Demand-side drivers: EE and structural change

---

DRAFT

**Analysis in upcoming publication: Energy, Climate  
Change and Environment: 2016 Insights**



International  
Energy Agency

Secure • Sustainable • Together



[www.iea.org](http://www.iea.org)

# *Act 6: Carbon pricing in IEA Scenarios*

# ETP CO<sub>2</sub> price assumptions

(USD/tCO <sub>2</sub> )	2020	2030	2040	2050
2DS	30-50	80-100	120-140	140-170
4DS	10-30	20-40	30-50	40-60
6DS	20	30	40	50

Note: 6DS only assumes carbon pricing in the European Union for the sectors currently included in the ETS (electricity generation, industry and aviation), as well as in Korea for the power and industry sectors.

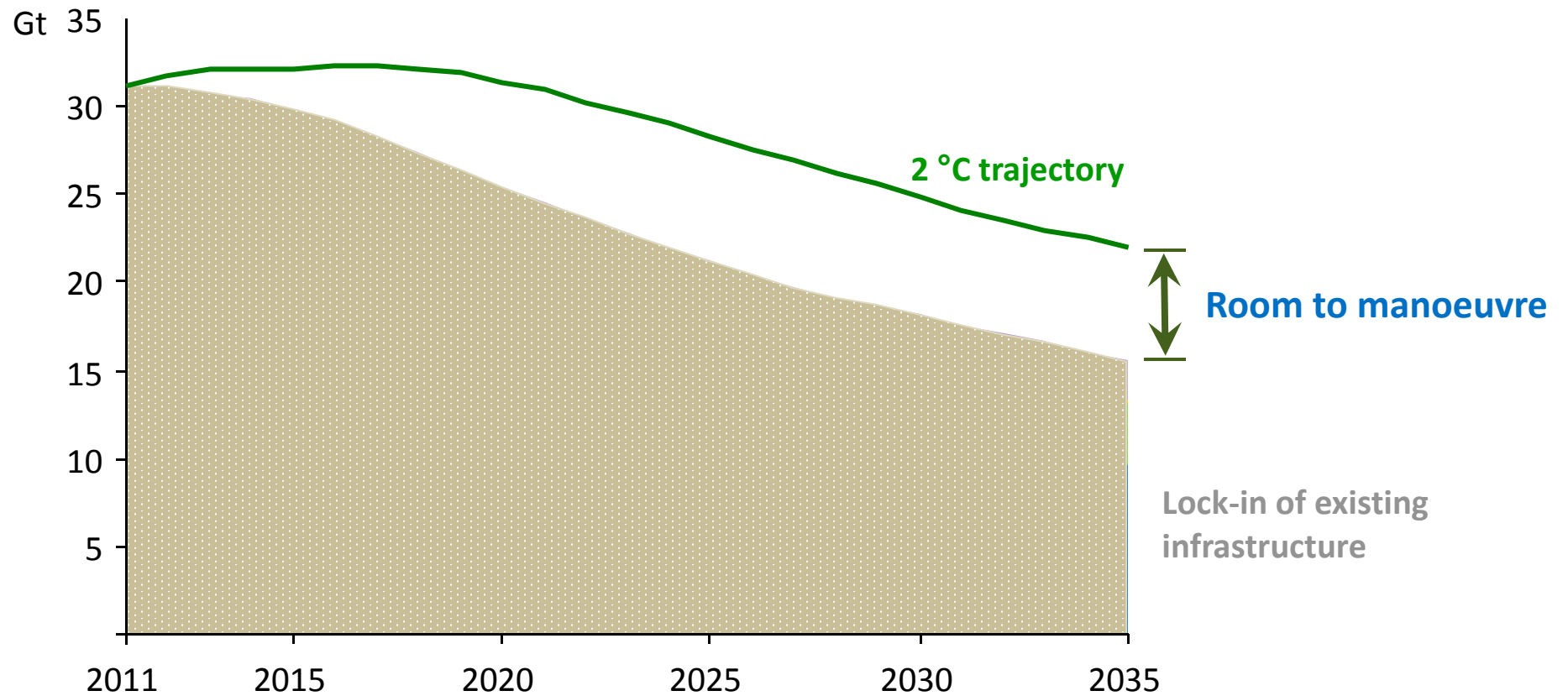
Source: *Energy Technology Perspectives, 2015*

# WEO CO<sub>2</sub> price assumptions (\$2014 per tonne)

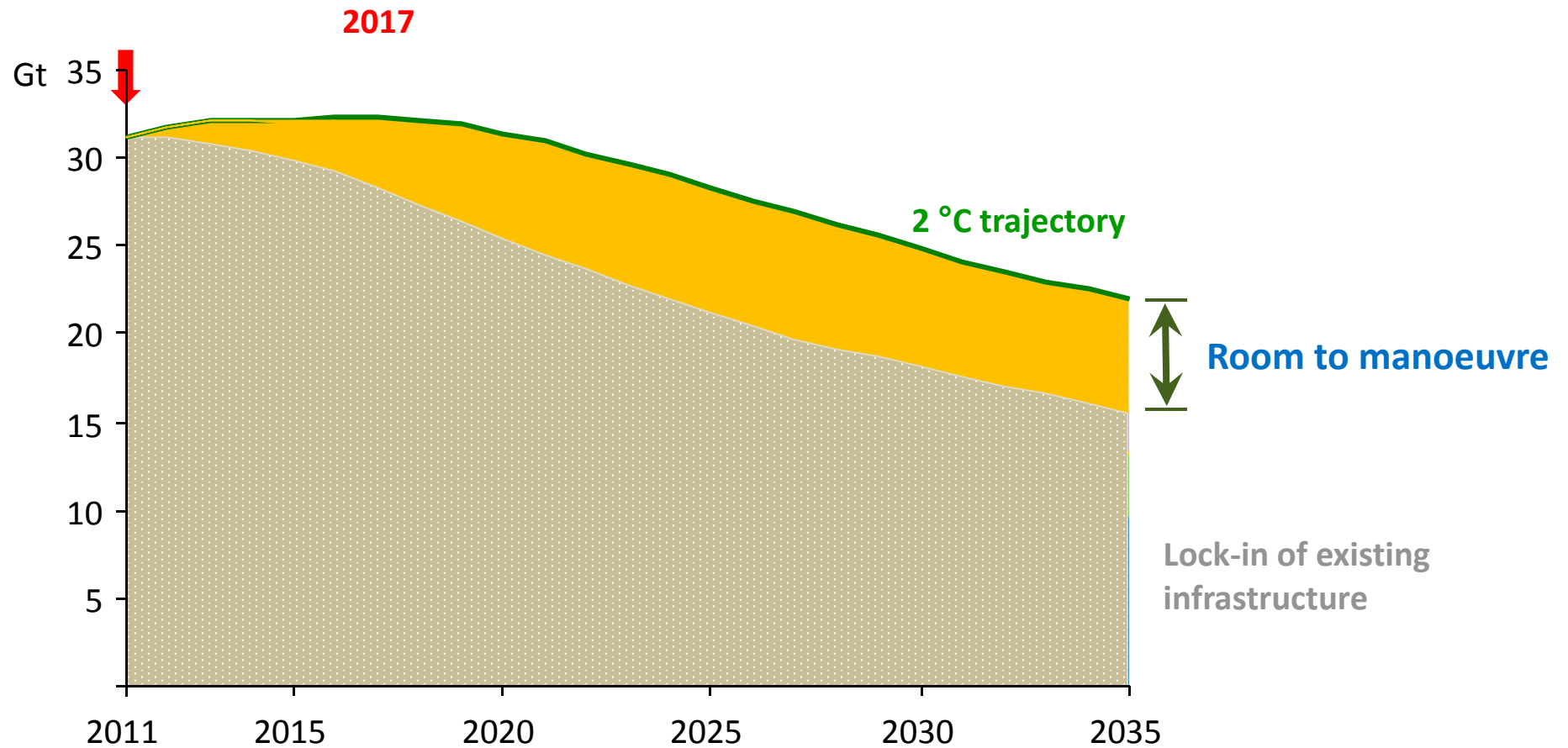
	Region	Sectors	2020	2030	2040
<b>Current Policies Scenario</b>	European Union	Power, industry, and aviation	20	30	40
	Korea	Power and industry	20	30	40
<b>New Policies Scenario</b>	European Union	Power, industry, and aviation	22	37	50
	Chile	Power	6	12	20
	Korea	Power and industry	22	37	50
	China	Power and industry	10	23	35
	South Africa	Power and industry	7	15	24
<b>450 Scenario</b>	United States and Canada	Power and industry	20	100	140
	European Union	Power, industry, and aviation	22	100	140
	Japan	Power and industry	20	100	140
	Korea	Power and industry	22	100	140
	Australia and New Zealand	Power and industry	20	100	140
	China, Russia, Brazil, and South Africa	Power and industry	10	75	125

***Act 7:  
Reversing emissions  
'Lock-in' :  
facing up to the challenge  
of fossil fuel facilities***

# 'Lock-In' of 2°C Emissions



# 'Lock-In' of 2°C Emissions



***Planned fossil fuel infrastructure through 2017 will generate all energy emissions under 2DS through 2035***

# New clean energy vs. fossil fuels

- *Looking simply at clean energy side of the equation is inadequate given 'lock-in'*
- *Need to address 'incumbent' (existing and imminent) fossil fuel facilities – reversing 'lock-in'*



# 'Un-locking' while meeting current/future energy demand

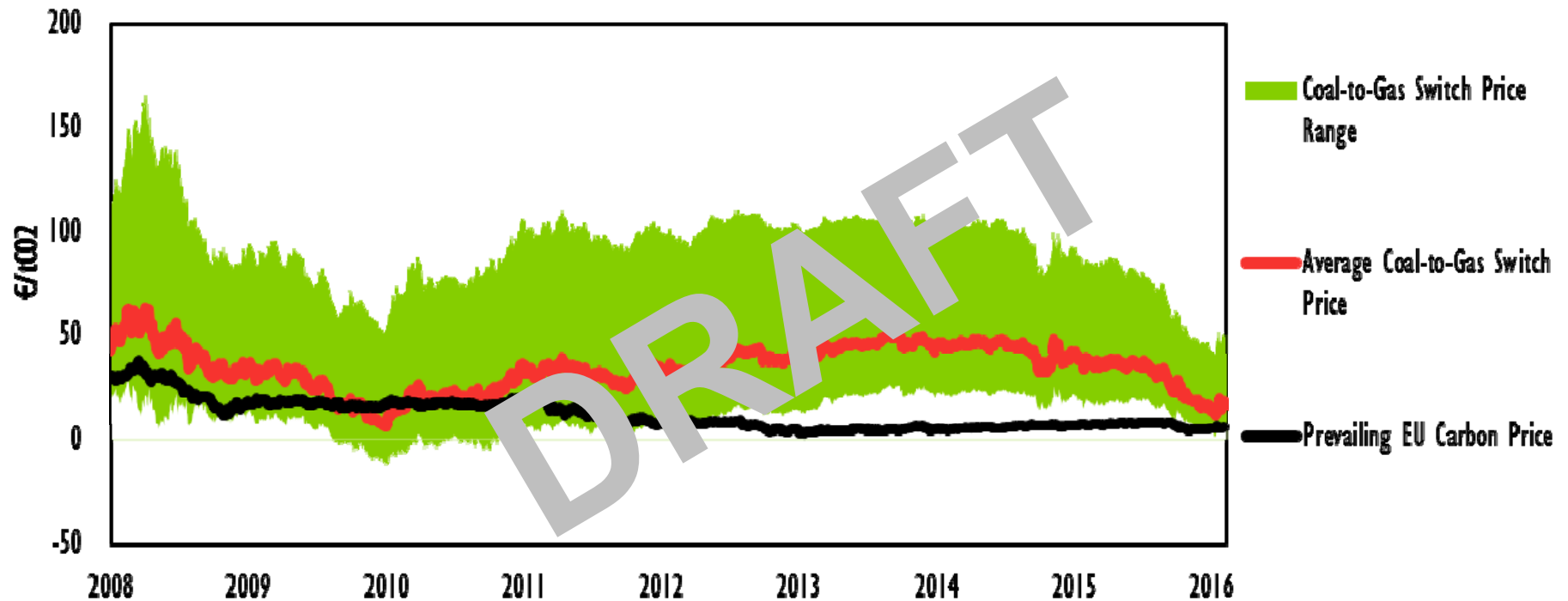
---

## Three basic types of context:

- Existing coal for existing cleaner (e.g., OECD)
- Existing coal replaced by new cleaner (e.g., China)
- New fossil in favor of new low carbon (e.g. Indonesia)

# Unlocking emissions from existing coal plants through fuel switching

*Marginal cost economics of coal to gas switching compared with the prevailing EU carbon price*



Source: Bloomberg LP data (2016), IEA analysis (2016)

Notes: Hard coal and gas plant efficiency of 32% and 60%, respectively, for low range. Hard coal and gas plant efficiency of 44% and 32%, respectively, for high range.

# Unlocking emissions from existing coal plants through new build

*CO2 prices needed to make a new gas, solar PV and onshore wind plant competitive with an existing unabated coal plant in 2020 (7% discount rate)*

**DRAFT**

	CO2 price required to make a new gas plant compete with an existing unabated coal plant (USD/tCO2)	CO2 price required to make a new solar PV plant compete with an existing unabated coal plant (USD/tCO2)	CO2 price required to make a new onshore wind plant compete with an existing unabated coal plant (USD/tCO2)
United States	\$40	\$50	\$10
Germany	\$150	\$130	\$80
China	\$80	\$40	\$30
Japan	\$160	\$230	\$160

Source: IEA (2015), *Project Costs of Generating Electricity: 2015 Edition*, OECD/IEA, Paris.

# Locking-out emissions from new coal plants through new build

www.iea.org

*CO<sub>2</sub> prices needed to a new make gas, solar PV and onshore wind plant competitive with a new unabated coal plant in 2020 (7% discount rate)*

**DRAFT**

	CO2 price required to make a new gas plant compete with a new coal plant (USD/tCO2)	CO2 price required to make a new solar PV plant compete with a new coal plant (USD/tCO2)	CO2 price required to make a new onshore wind plant compete with a new coal plant (USD/tCO2)
United States	0	10	0
Germany	100	80	50
China	60	30	30
Japan	100	180	110

Source: IEA (2015), *Project Costs of Generating Electricity: 2015 Edition*, OECD/IEA, Paris.

# Policies to reverse 'lock-in'

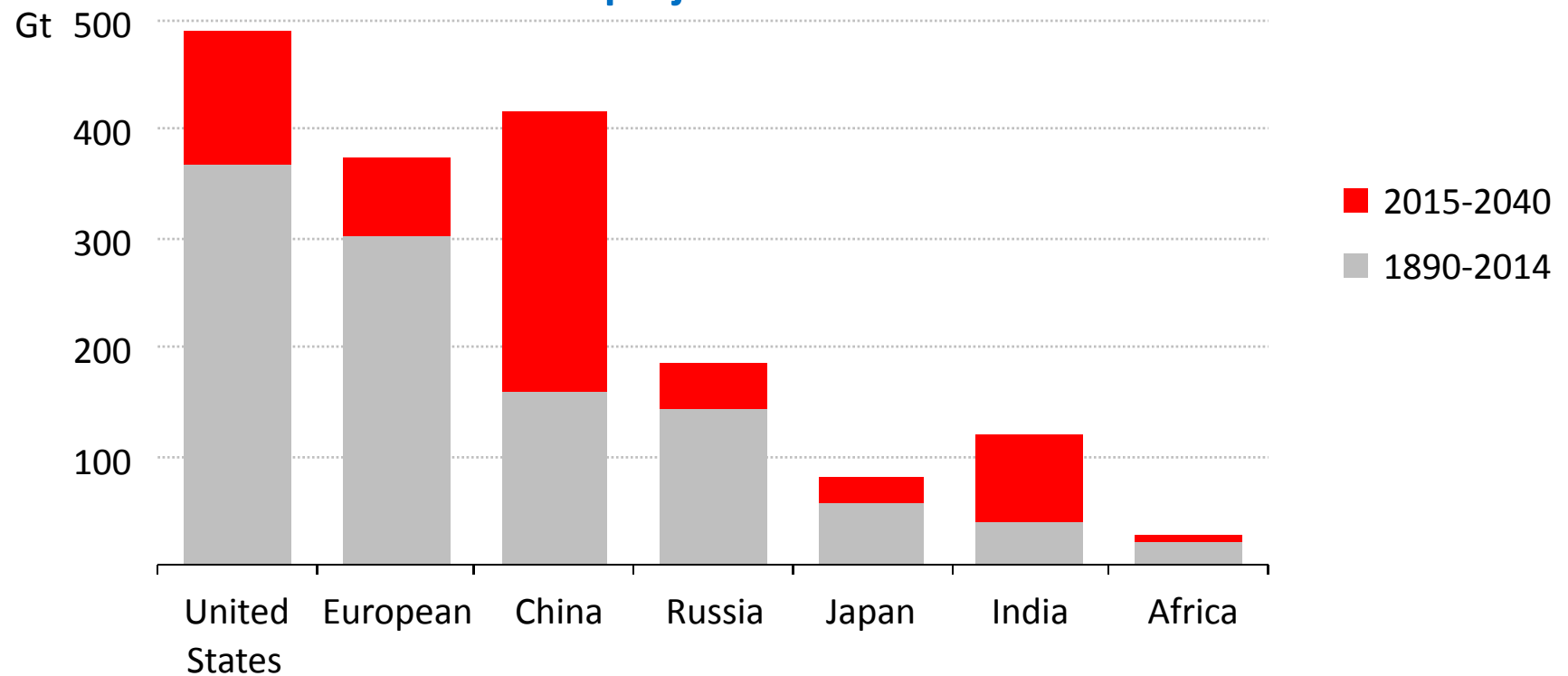
## Possible Policy tools to unlock:

- **Market mechanisms**
  - ETS
  - Carbon taxing
  
- **Mandates – portfolio prescriptions /restrictions**
  
- **Policy directives (e.g. to state-owned enterprises)**
  
- **Influencing relative pricing**

***Act 8:  
The World  
keeps on changing . . .***

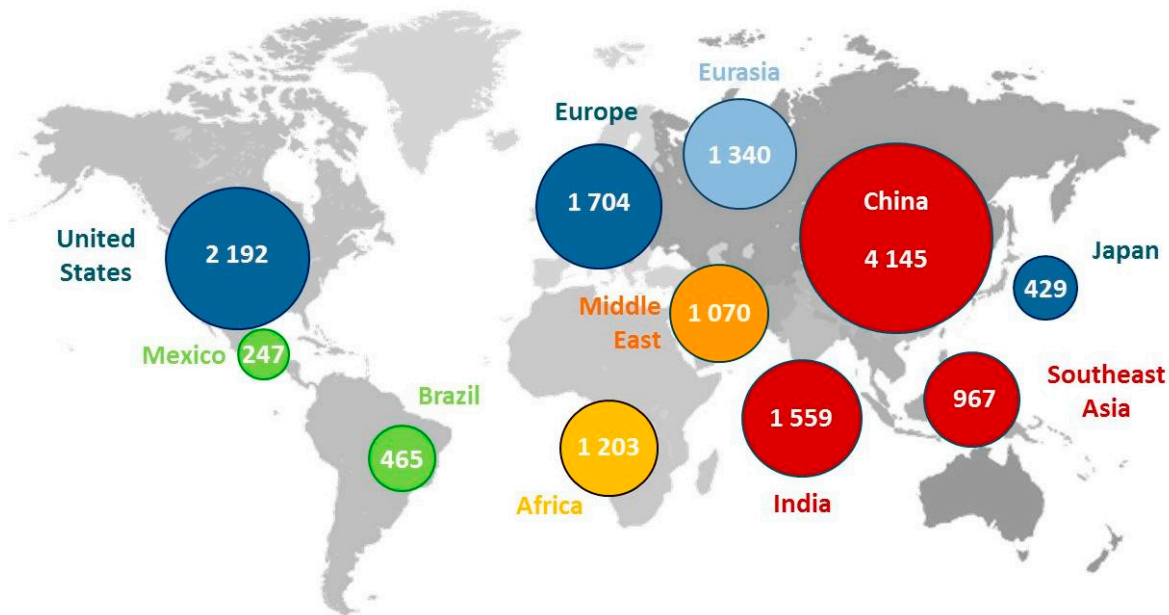
# Shifting emissions patterns ...

Cumulative energy-related CO<sub>2</sub> emissions by region – projection in 'BAU'



# Growing weight of developing countries in global energy demand

Primary Energy Demand, 2035 (Mtoe)

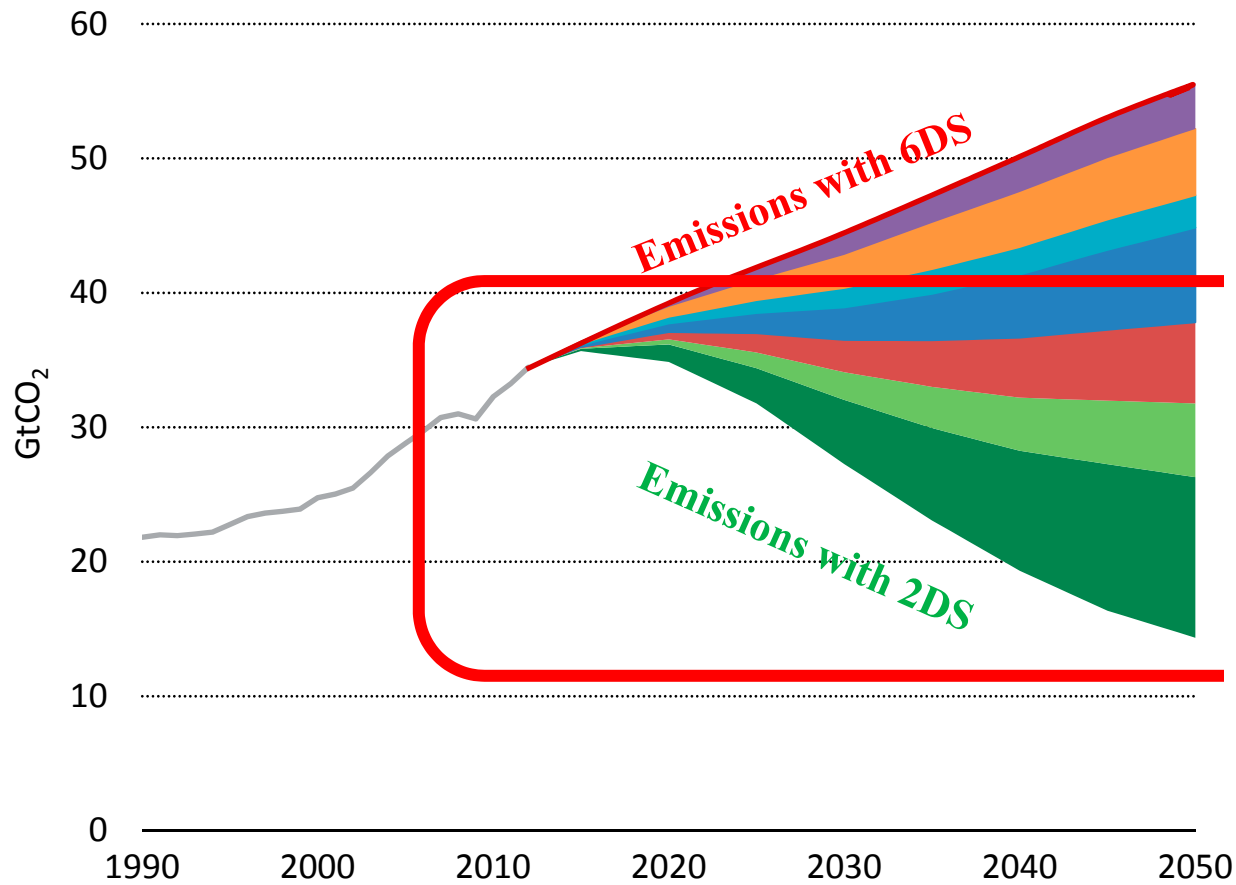


**Over 95% of the projected growth in energy demand between now and 2035 happens outside the OECD (NPS)**



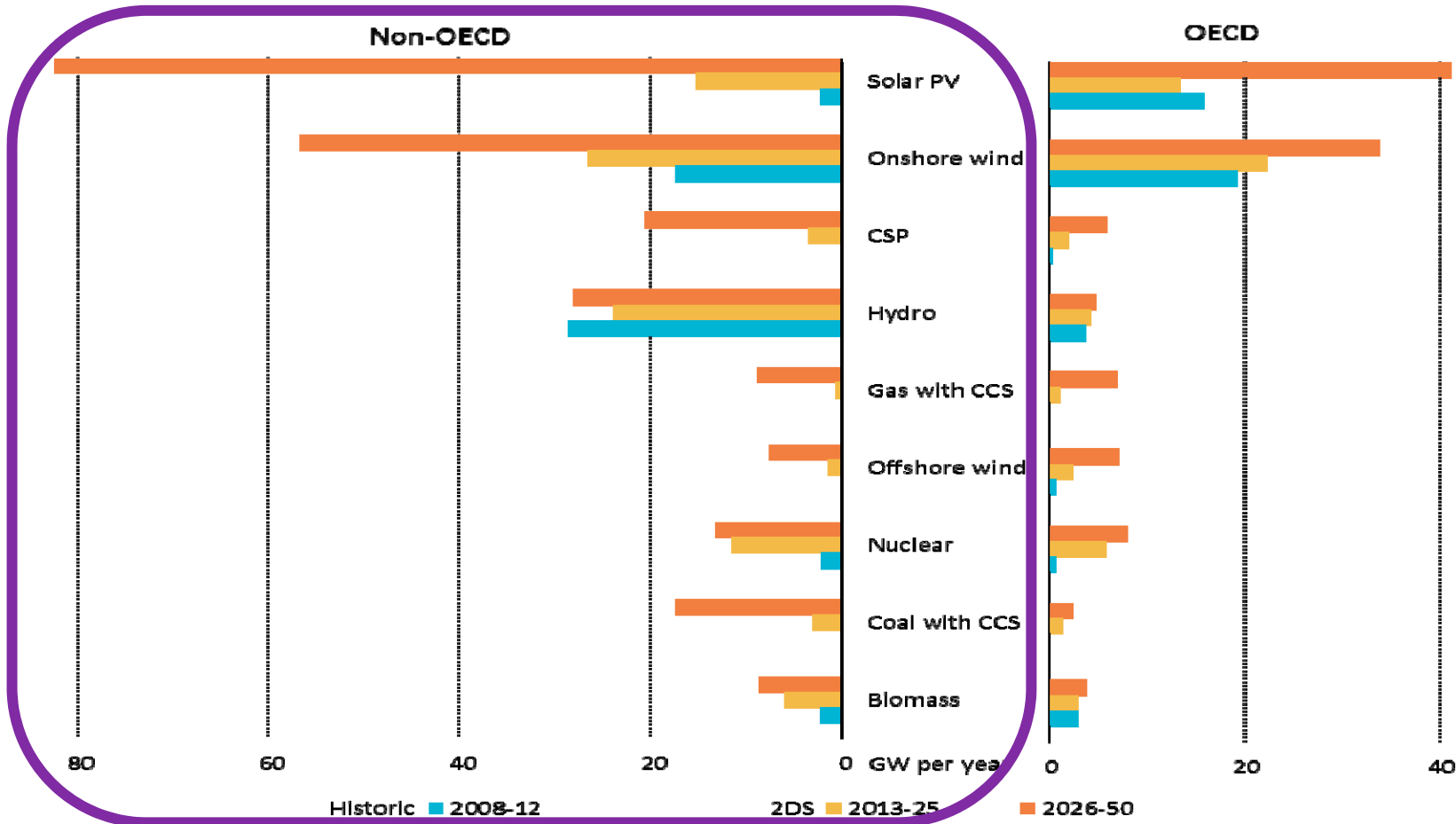
# OECD and non-OECD action for a low-emissions future in 2DS

[www.iea.org](http://www.iea.org)



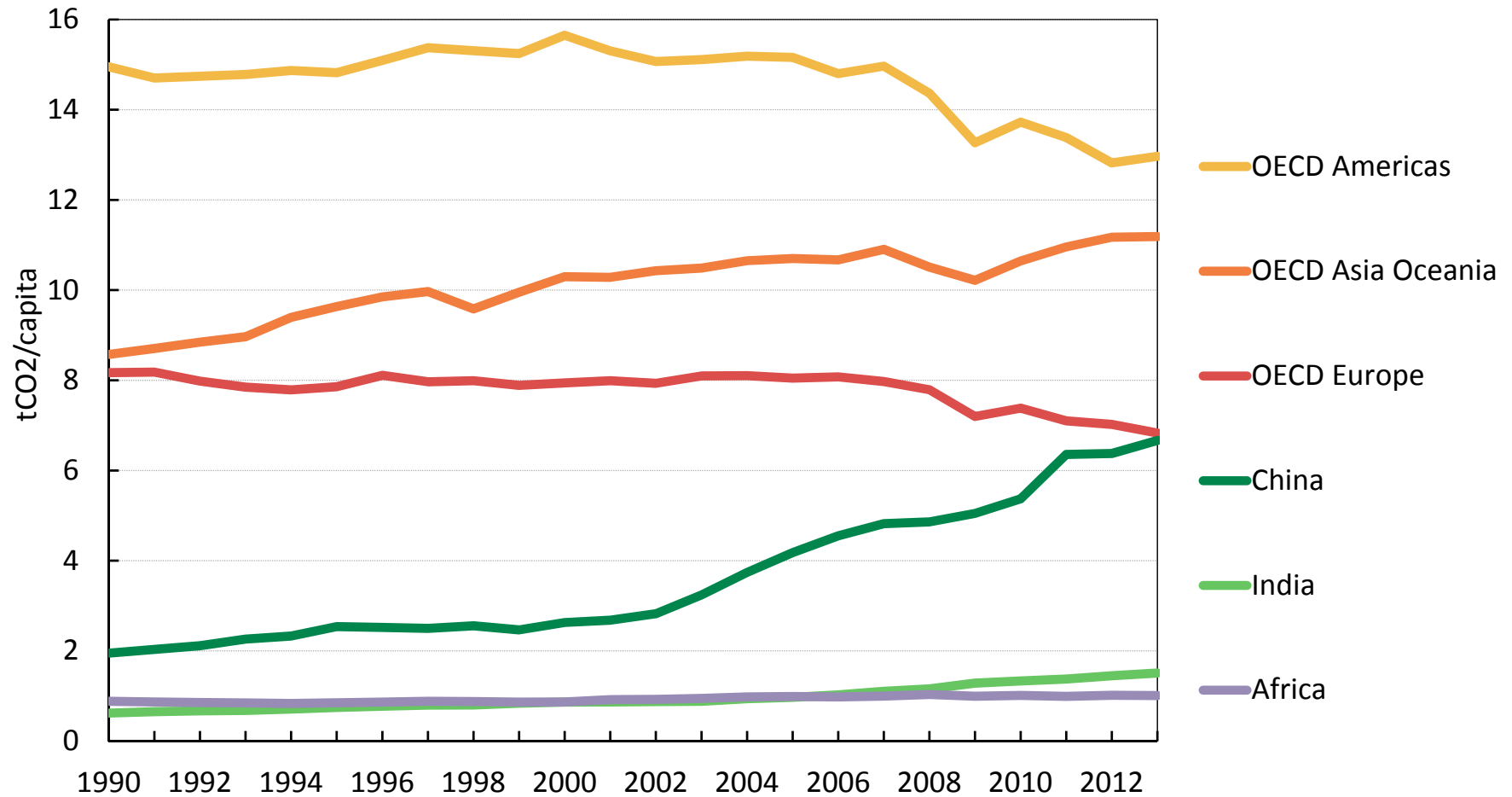
# Non-OECD key to deployment of clean energy technologies in the 2DS

Power sector technology deployment rates in the 2DS



*High deployment of low-carbon technologies in emerging economies needed to keep pace with projected near-term energy demand growth.*

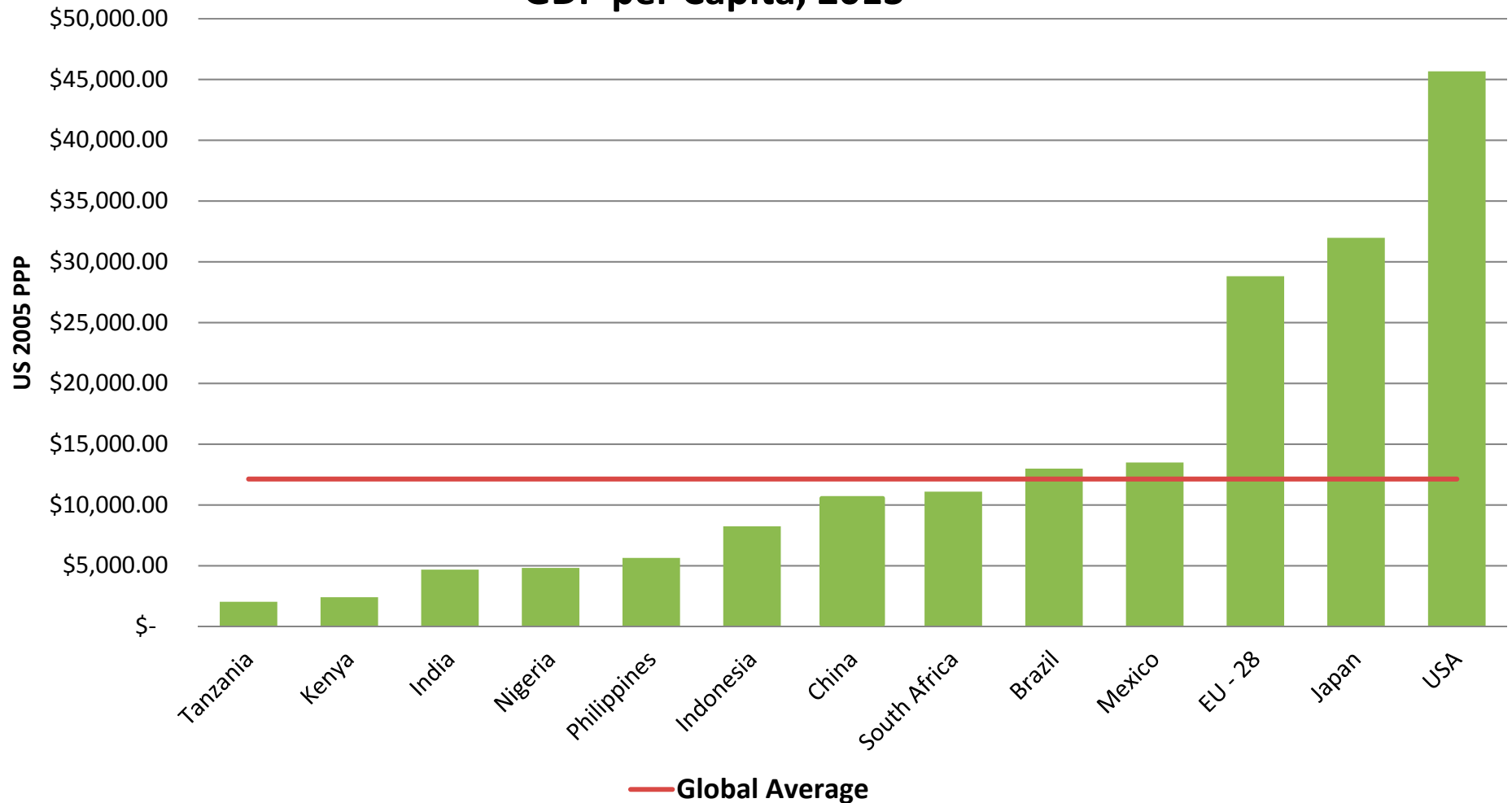
# CO<sub>2</sub> emissions per capita



Source: Track the energy transition (2015)

# GDP/capita in Non-OECD: starting low with lots of room to grow

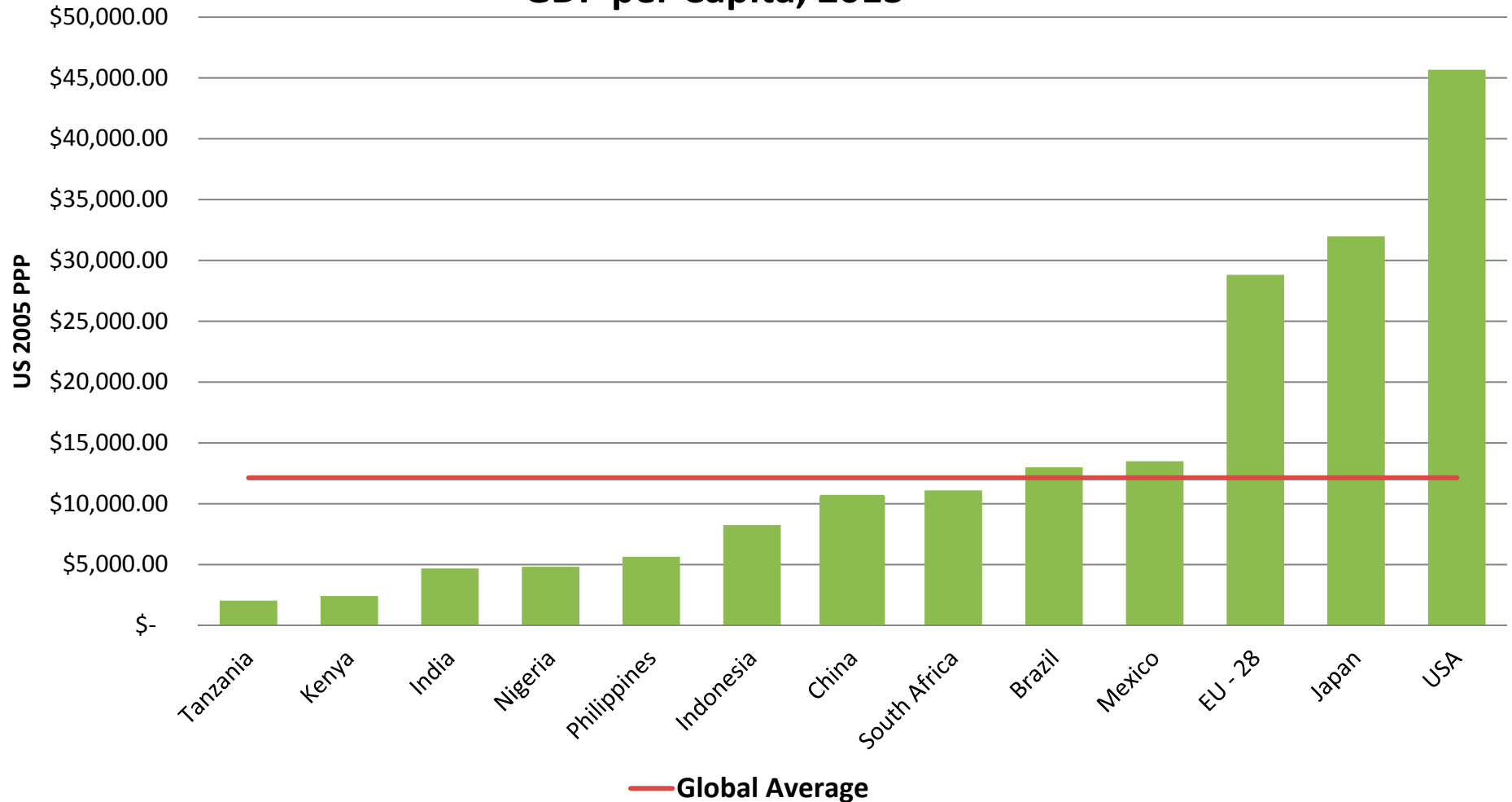
GDP per Capita, 2013



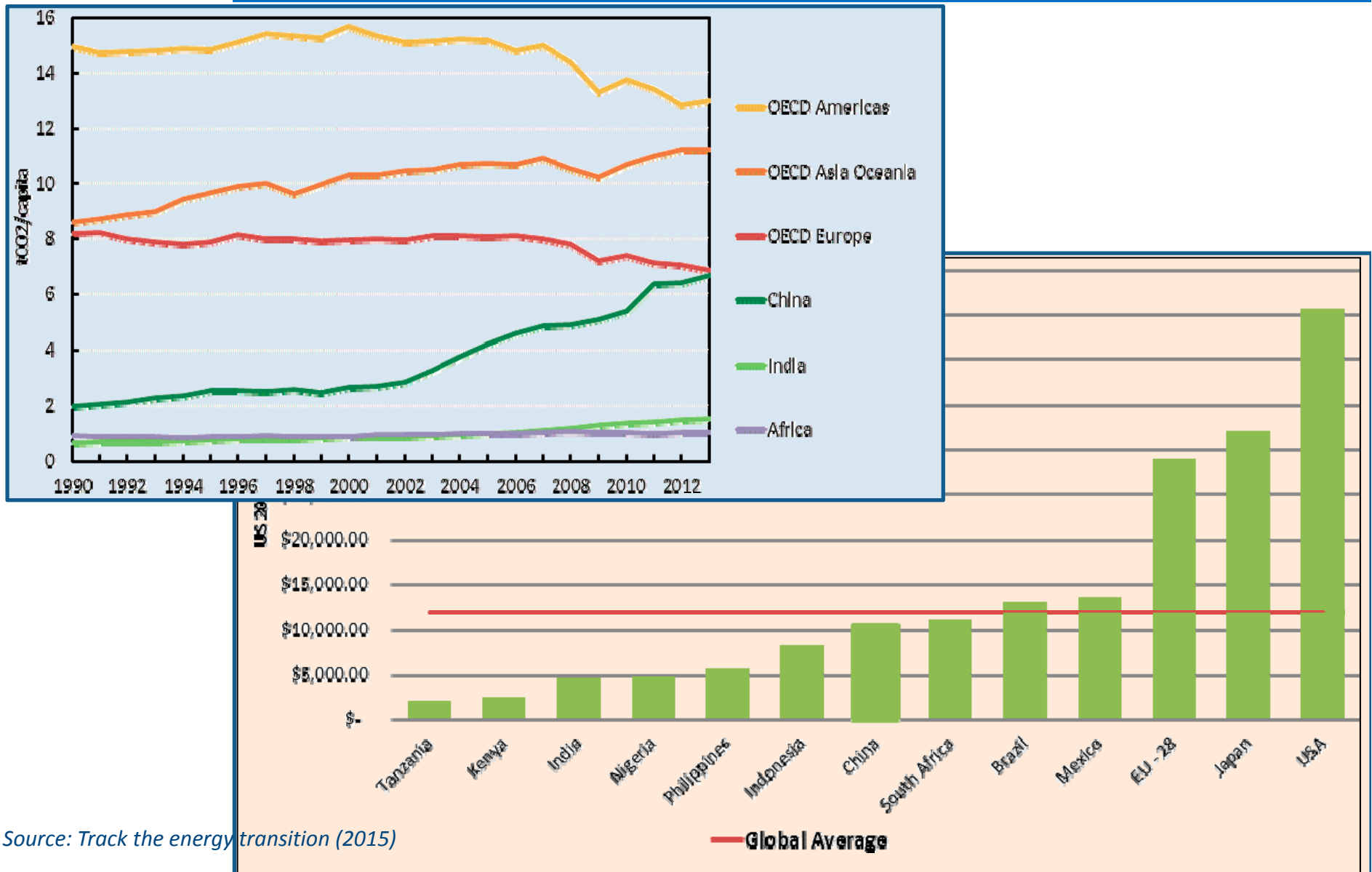
# GDP/capita in Non-OECD: starting low with lots of room to grow

[www.iea.org](http://www.iea.org)

## GDP per Capita, 2013



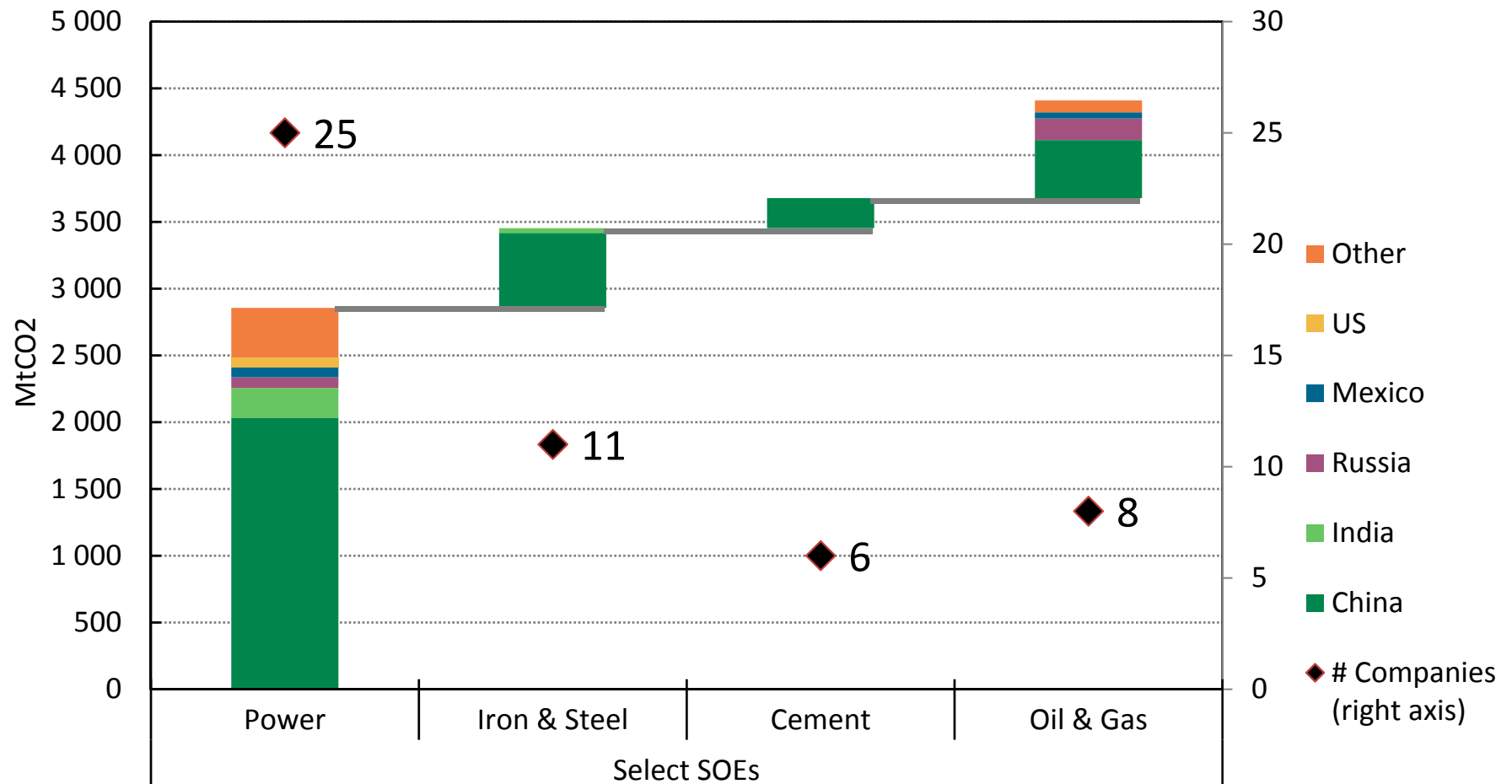
# Per capita: emissions and GDP



Source: Track the energy transition (2015)

***Act 9:  
State-Owned Enterprises:  
a special class of actors  
that are  
a big part of the story***

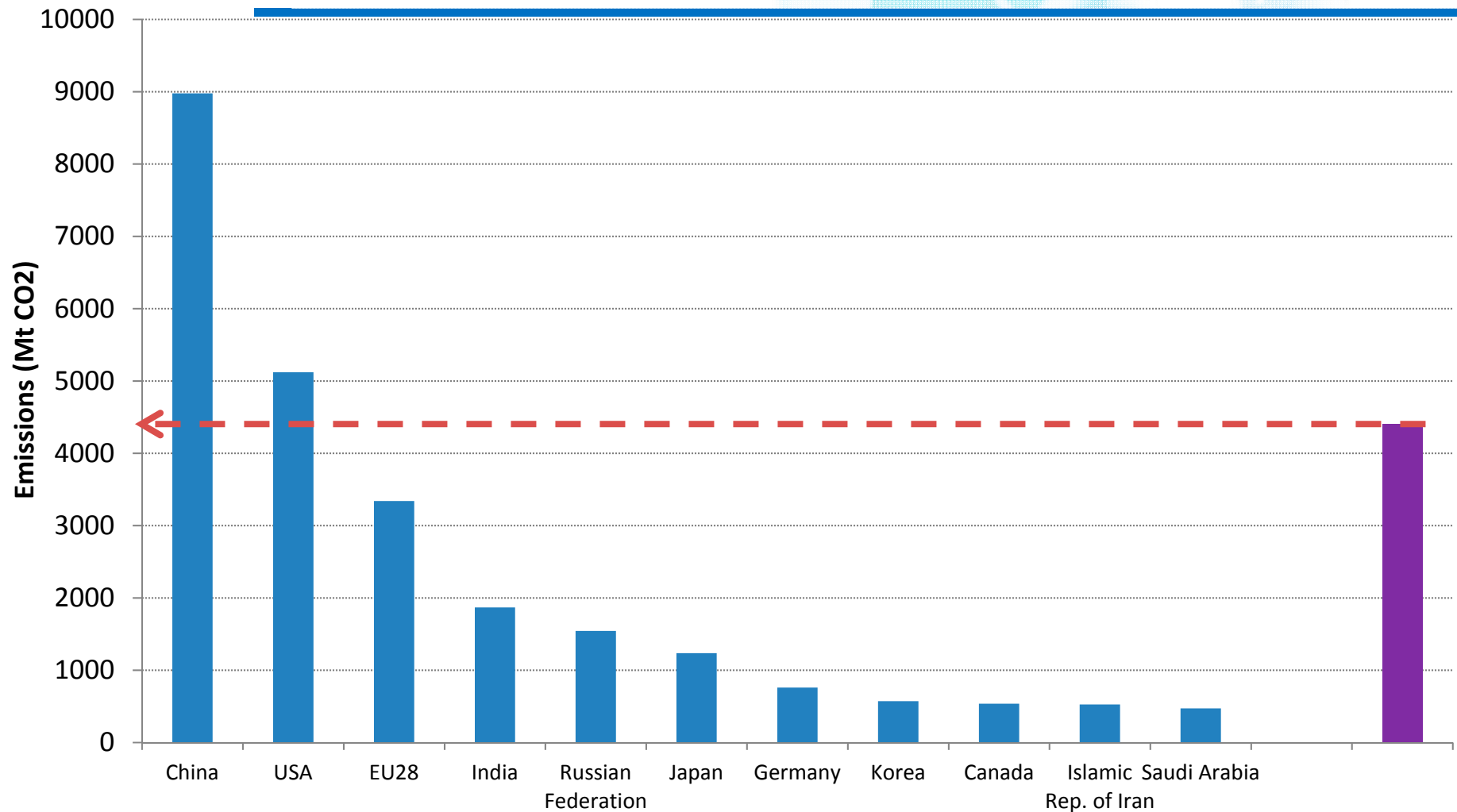
# State-owned enterprises: not just the what and how, but the who



**Selected 50 SOEs emit about 4.4GT CO<sub>2</sub>-e**



# 'Top 10' energy GHG emitting 'countries'

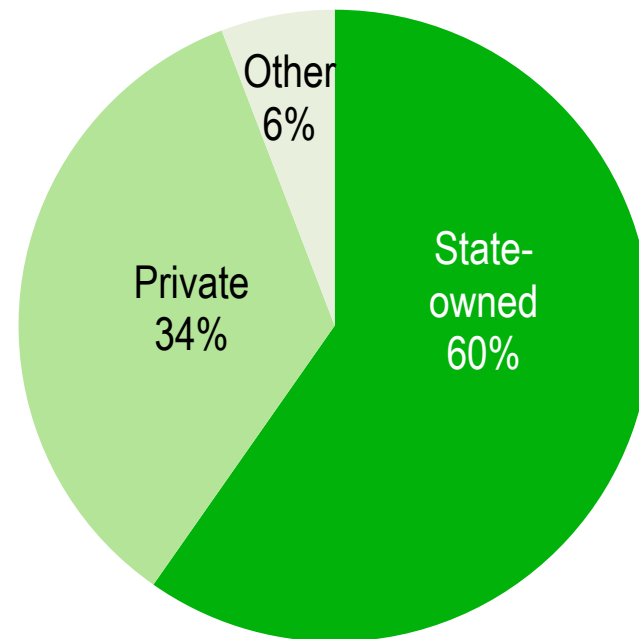
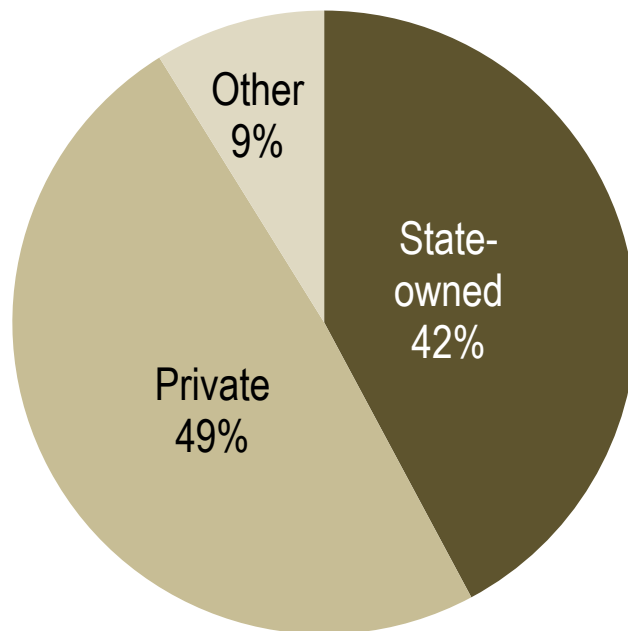


***Selected 50 SOEs would, by themselves, constitute the third largest emitting country***

# SOEs own a large share of

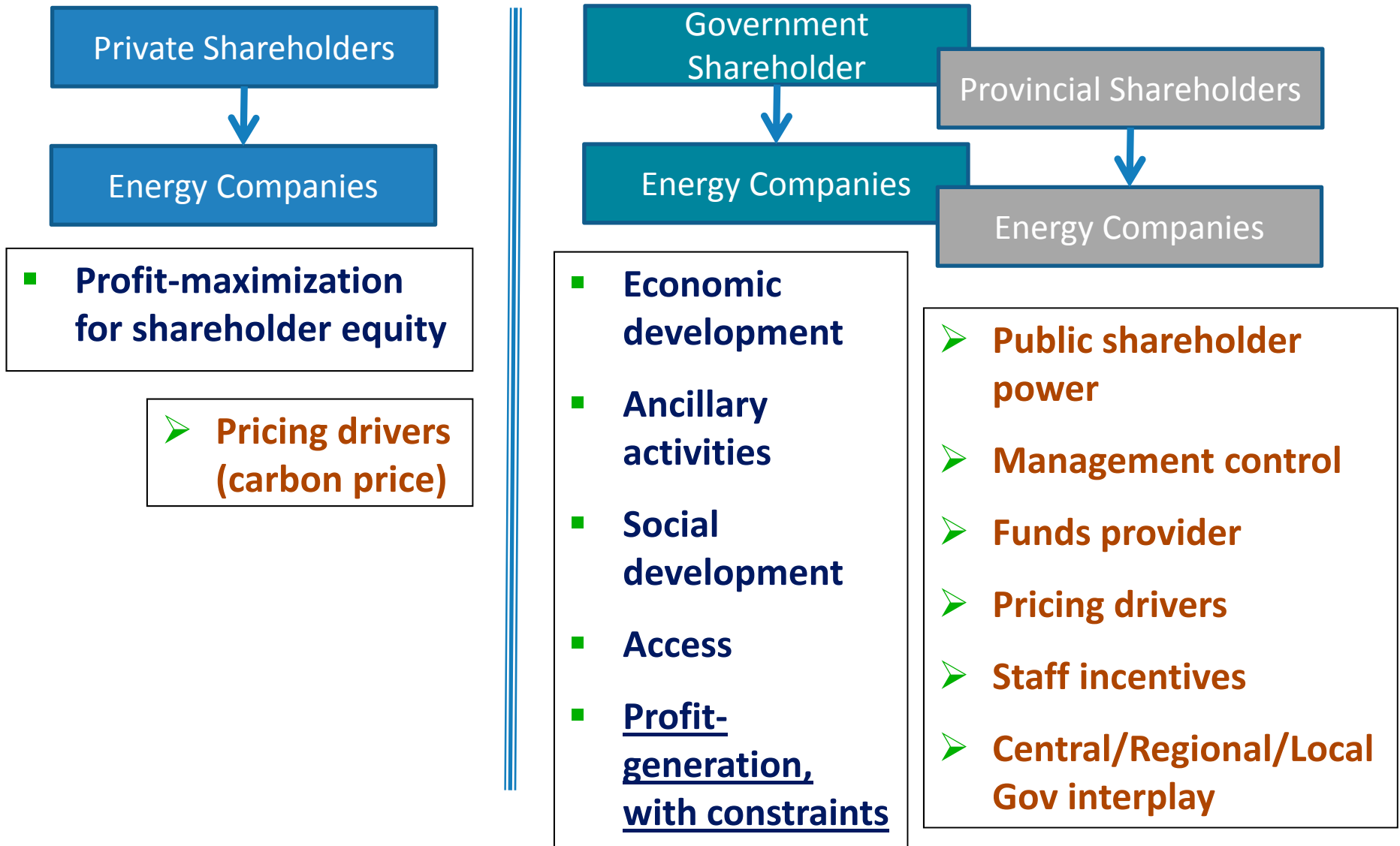
## Ownership of fossil fuel generation capacity

3 702 GW



# SOEs are different from 'traditional' private sector companies

www.iea.org





International  
Energy Agency

Secure • Sustainable • Together



[www.iea.org](http://www.iea.org)


# *Epilogue*

# Conclusions

- **Paris Agreement sets strong platform for action, but with increased ambitions**
- **IEA adjusting modeling to match new climate goals**
- **Need to expand efforts – not only on clean, but also on incumbent high-carbon**
- **Need to expand approaches: SOEs require adapted tools; not just about the what and the how, but also the who**
- **Continued ability of energy to support economic and social development is key**

# Thank you

**THE WAY FORWARD**  
FIVE KEY ACTIONS TO ACHIEVE A LOW-CARBON ENERGY SECTOR



01 Seize the benefits of immediate action to bend the global emissions curve. To 2020, bridging 80% of the gap to an optimal 2°C path with no extra GDP cost.

02 Accelerate investment in clean energy. Multilateral collaboration, development and tailored appropriate technology.

03 Reshape investment innovation now in low-carbon energy. Multilateral collaboration, development and tailored appropriate technology.

04 Mobilise investment to promote decarbonisation. Energy security also drive energy security.

## ENERGY EFFICIENCY Market Report 2015



International Energy Agency  
Secure • Sustainable • Together

## Energy and Climate Change

World Energy Outlook Special Report

International Energy Agency

## The Power of Transformation

Wind, Sun and the Economics of Flexible Power Systems



Explore the data behind ETP