Potential for CCS in the Iron and Steel Sector

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Seminar on Reducing the Footprint of the Iron and Steel Sector,

Zaandam – Petten, NL ,

19-20th April 2017

WMO Current Climate Status Report March 2017

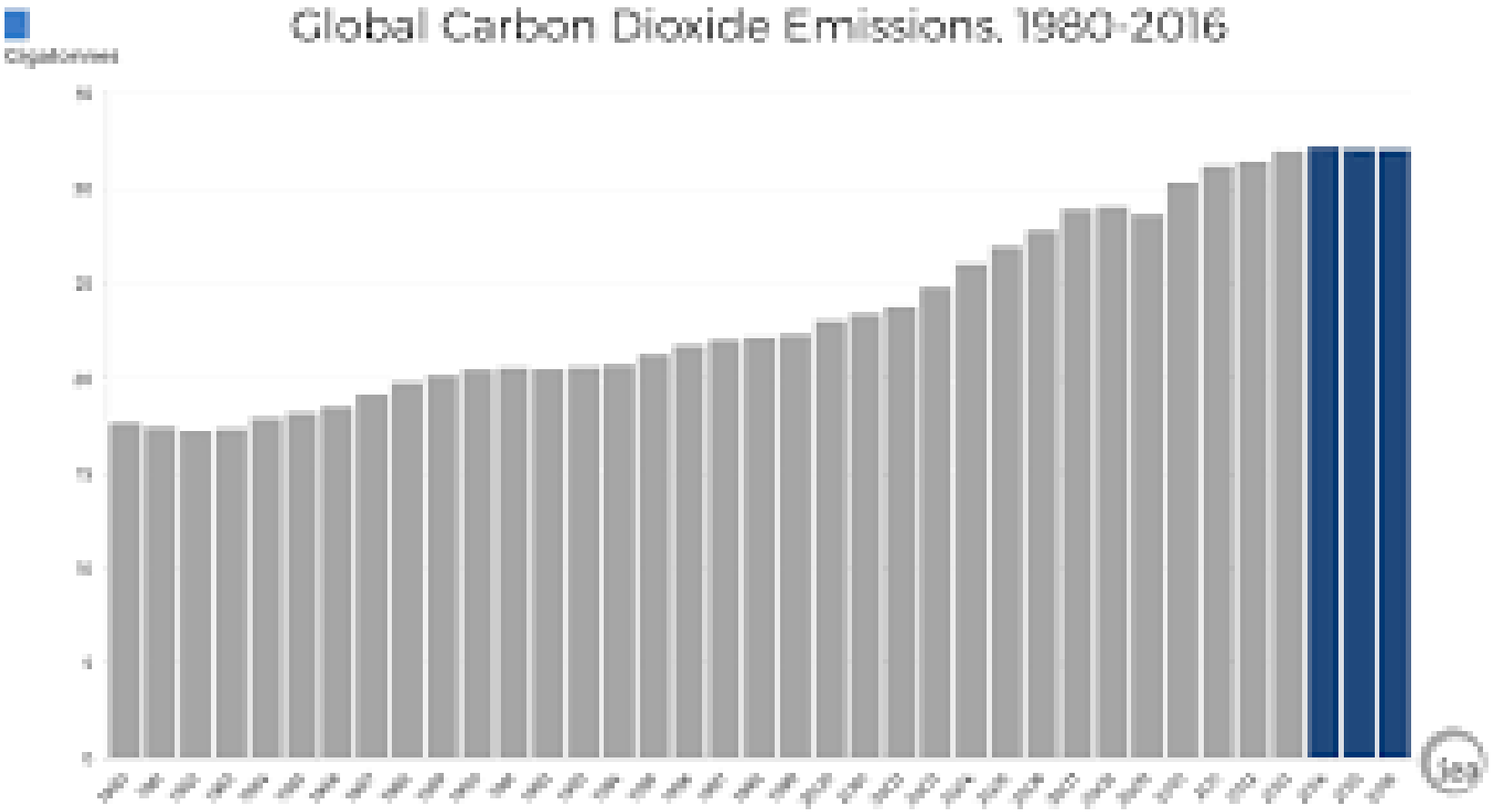
- Levels of CO_2 in the atmosphere reached a new high (>400ppm)
- 2016 was the warmest year on record
  - 1.1°C above the pre-industrial period, which is 0.06 °C above the previous record set in 2015.

- Globally averaged sea surface temperatures were also the warmest on record,
  - global sea levels continued to rise,
  - and Arctic sea-ice extent was well below average for most of the year.

- Conclusion: "the influence of human activities on the climate system has become more and more evident"

https://public.wmo.int/en/media/press-release/climate-breaks-multiple-records-2016-global-impacts

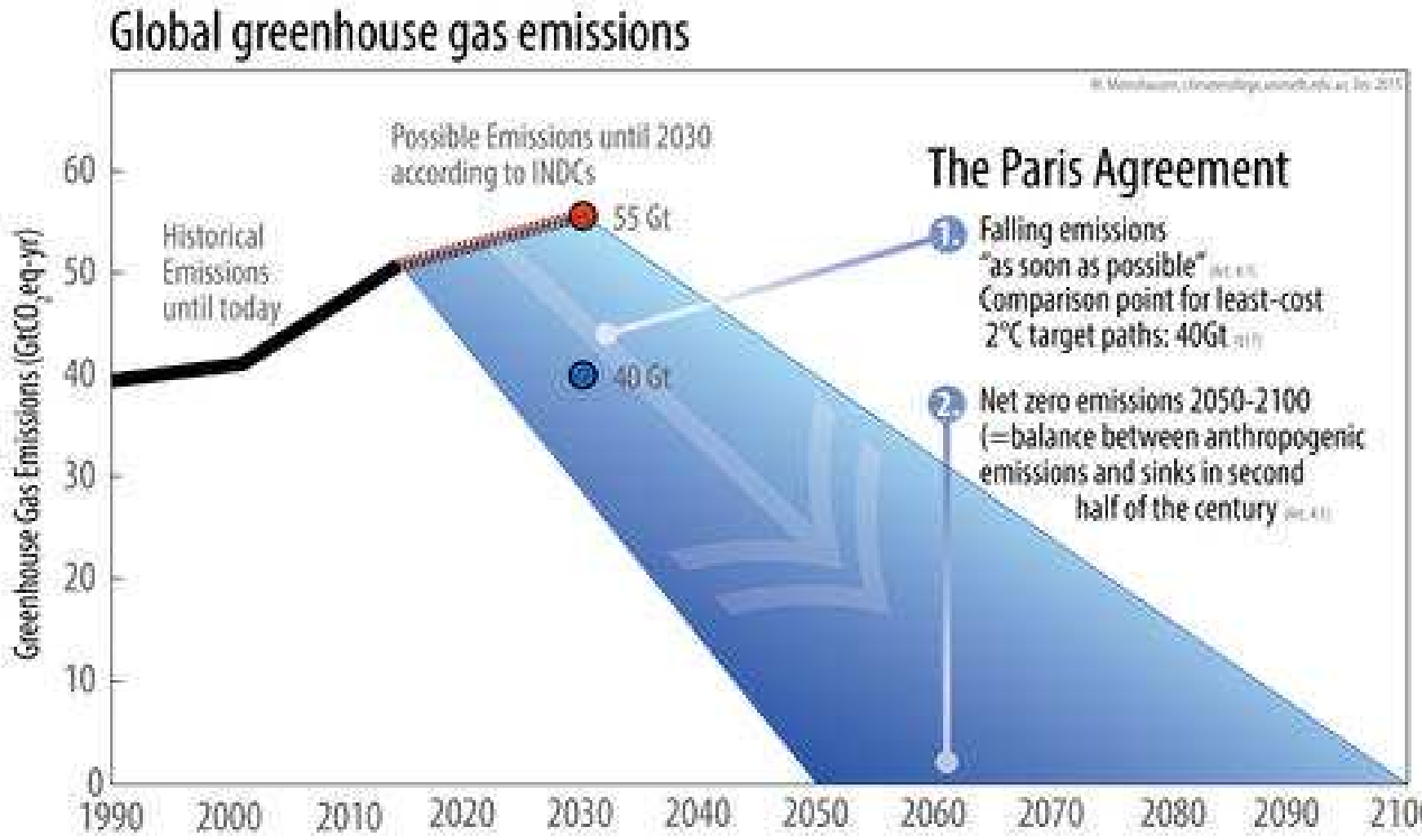
IEA Global Emissions Peaked



CCUS – a key climate policy option

- The IPCC AR5 indicated - CCS is a crucial technology to meet the 2^0C target
  - *Climate scenarios could not meet 2^0C without CCS*
  - *The costs of meeting the 2^0C will be 138% higher if CCS is not included as a mitigation option*
- Post Paris CCS "lowered" the target to limit temperature rise to below 2^0C target.
- CCS is expected to be an even more crucial technology if we are to achieve below 2^0C target.
- To meet the below 2^0C target significant reductions in greenhouse gases will be required in all sectors not just the power sector.
- CCS is a key technology, probably the only one, that can achieve deep emissions cuts in the industry sector.
- If significant early emission reductions are not achieved, then "negative emission" technologies like BioCCS will need to be deployed from 2030 onwards.

The Paris Agreement

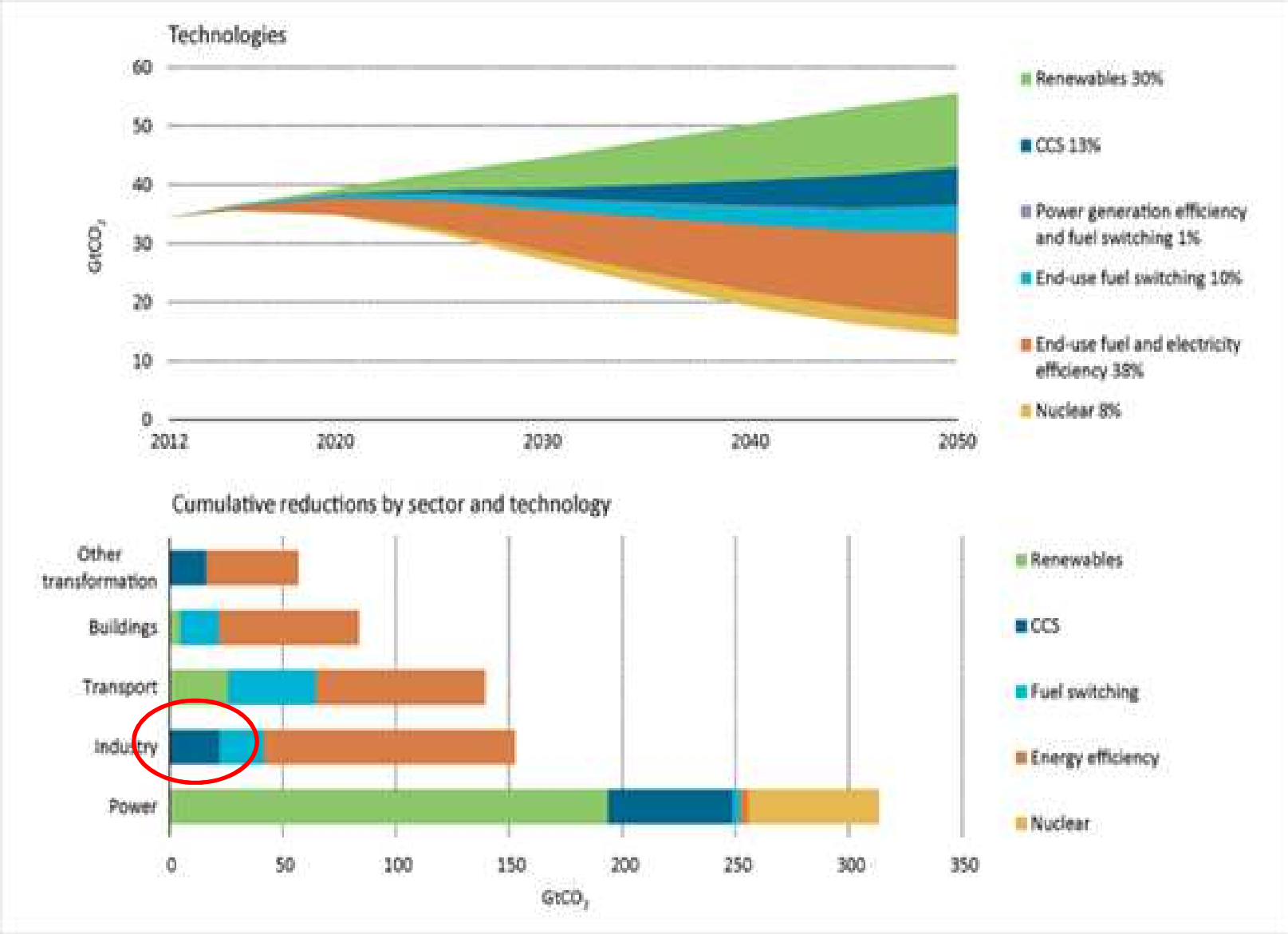


CCS – a key climate policy option (2)

- To go below 2^0C significant reductions in greenhouse gas emissions will be required in all sectors not just the power sector.

- CCS is a key technology to achieve deep emissions cuts in the industry sector.

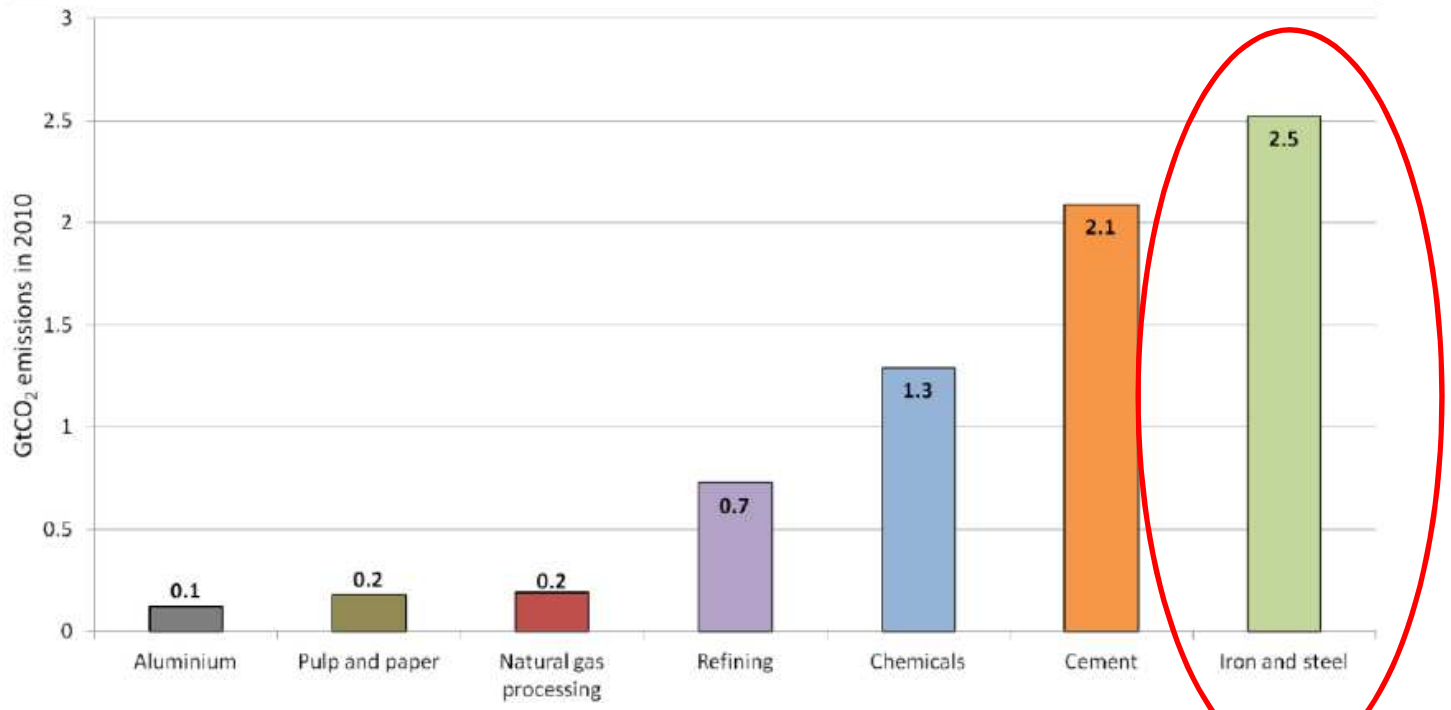
- “Negative emission” technologies like BioCCS will likely need to be deployed from 2030 onwards.



The technologies and sectors making the largest contributions to shifting the world from a 6C to a 2C path between now and 2050. Source: [IEA Energy Technology Perspectives 2015](#).

Rationale for CCS: Only large-scale option for many industries

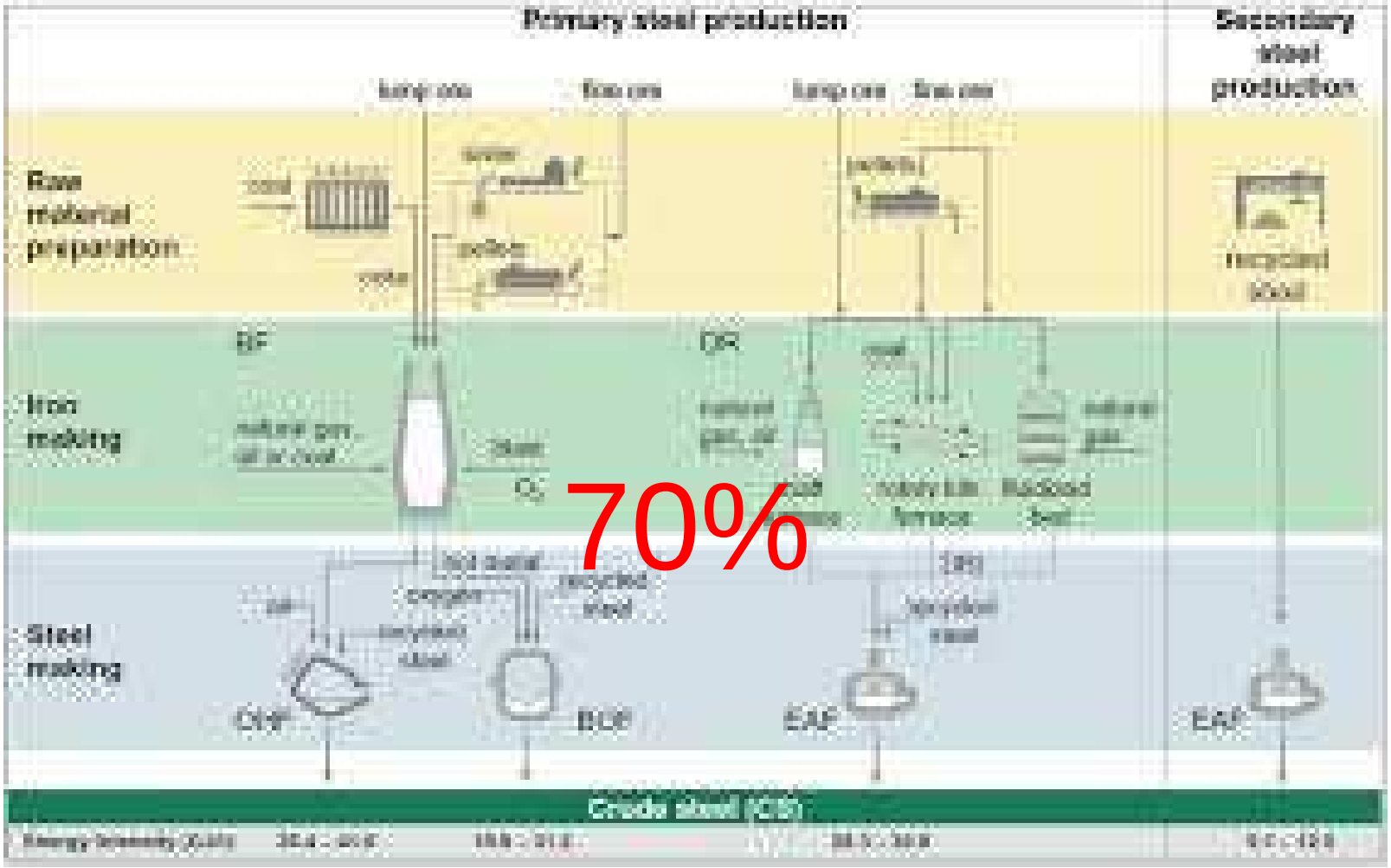
Figure 1. Global emissions from the seven most CO_2-intense industrial sectors in the IEA *Energy Technology Perspectives* analysis



Tracking Clean energy Progress report 2013, industry-CCS annex

CCS is the only large-scale mitigation option for many industrial sectors.

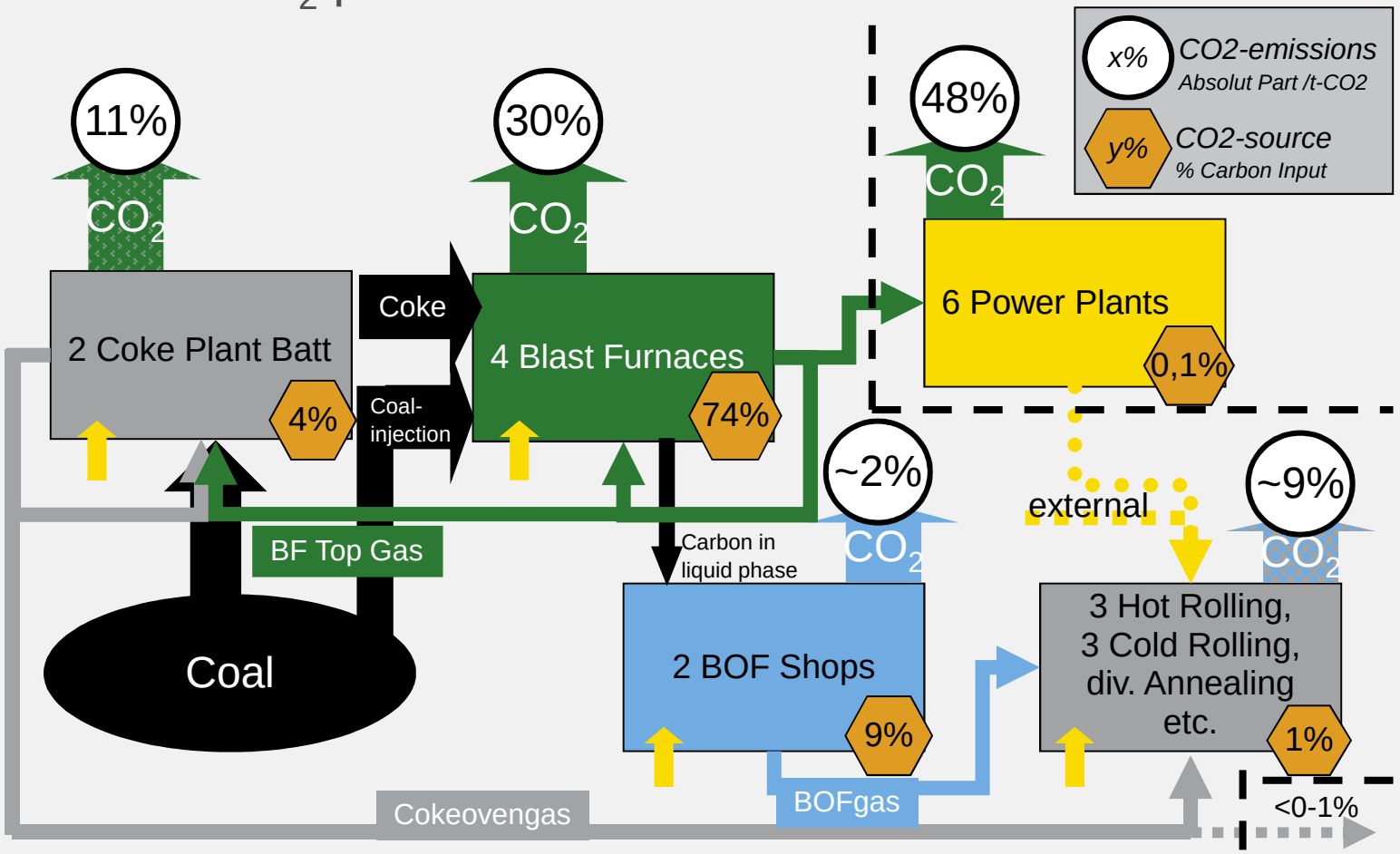
Iron and Steel Production Routes



Source: World Steel Association

ThyssenKrupp Steel Europe – Main CO_2-Emitters (schematically)

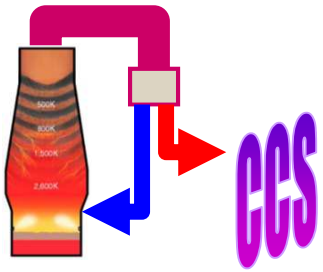
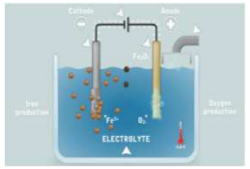
up to 20 mio t CO_2 p.a.



IEAGHG Iron and Steel Sector CCS activities

- 1st Steel industry CCS workshop with VDEH in Germany in November 2011
  - http://www.ieaghg.org/docs/General_Docs/Reports/2011-17.pdf
- Techno- economic assessment of CCS in steel sector 2013
  - Included a case evaluating Oxy-Blast Furnace with TGR & MDEA CO2 Capture
  - http://www.ieaghg.org/docs/General_Docs/Reports/2013-04.pdf
- Overview of the current state and future development of CO2 capture technologies in the Iron Making Process, TR3, April 2013
  - http://www.ieaghg.org/docs/General_Docs/Reports/2013-TR3.pdf
- 2nd Steel industry CCS workshop in Japan November 2013 – collaboration with WSA and IETS
  - http://www.ieaghg.org/docs/General_Docs/Reports/2014-07.pdf

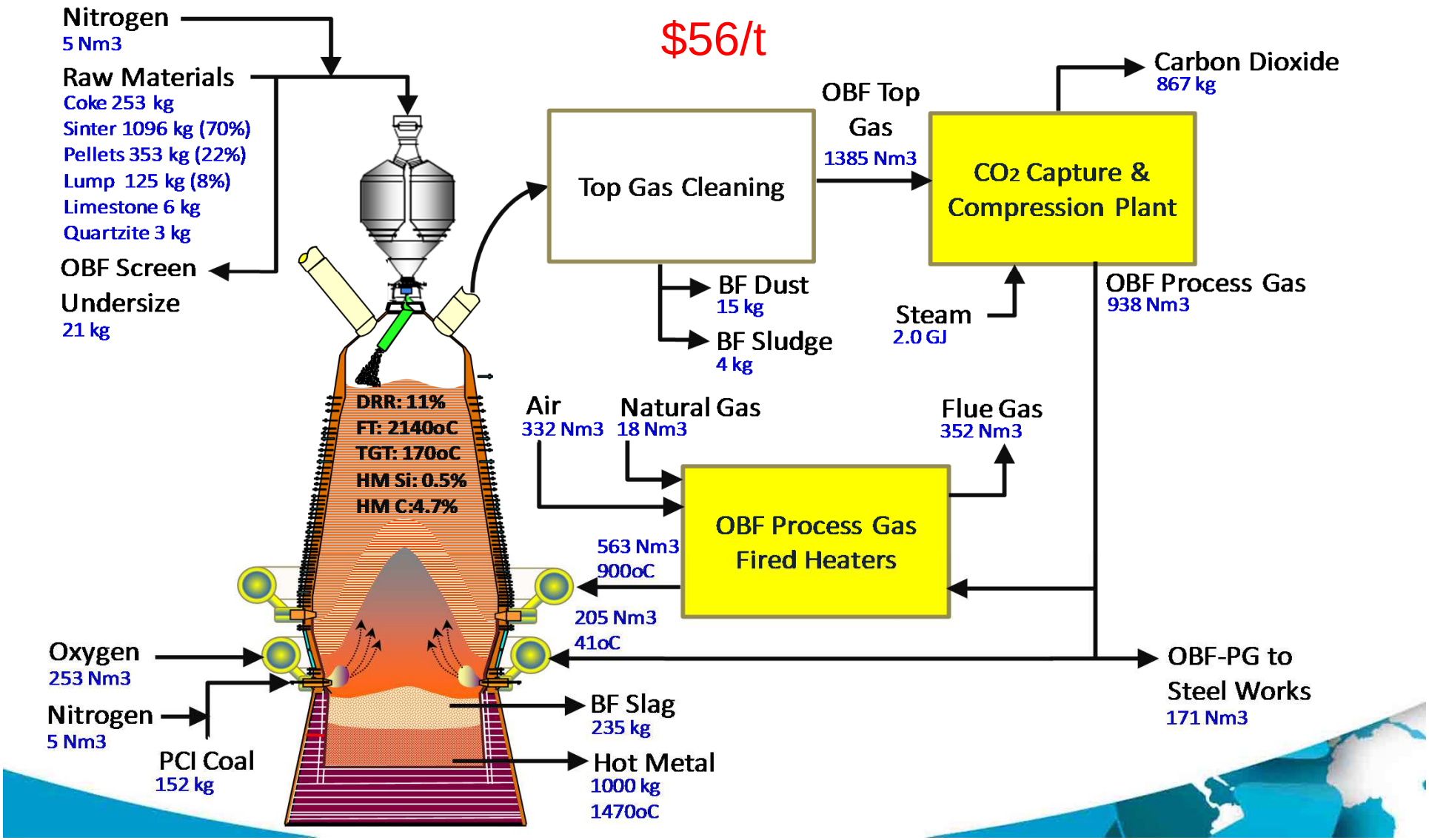
The 4 ULCOS process routes

Coal & sustainable biomass		Natural gas	Electricity
Revamped BF	Greenfield	Revamped DR	Greenfield
ULCOS-BF 	HIsarna 	ULCORED 	ULCOWIN ULCOLYSIS 
Pilot tests (1.5 t/h) Demonstration 2007-2010	Pilot plant (8 t/h) start-up 2010	Pilot plant (1 t/h) to be erected in 2013?	Laboratory

Note report on ULCOS TGRBF work can be found at: file://fscluster2/data/IEAGHG/Homes/John.Gale/Documents/KINA26414ENN_002.pdf

Oxy-Blast Furnace Operation

(Picture of OBF courtesy of Tata Steel)



Summary

- CCS can play a significant role in reducing industry CO_2 emissions
- The blast furnace route offers the biggest potential for iron and steel sector emissions reduction
- IEAGHG studies have shown that OxyBF with TGR and CO2 capture can offer a cost effective way of reducing CO2 emissions
  - Proof of concept of this options has been demonstrated at pilot scale
  - The planned large scale tests at Florange in France were cancelled
  - Future???

Issues to Consider

- If industry pursues the deployment of CCU we need to understand
  - the global implications wrt to CO2 mitigation
  - and our ability to meet the Paris goals

- CCS deployment in industry will require the development of a CO2 transport infrastructure
  - It is proposed to de-link capture and the transport and storage component to reduce the cost burden on projects
  - Who will finance the infrastructure?
  - EU – will this be the European Commission?
  - In USA, CO2-EOR has helped finance the pipeline network.

Thank you, any Questions?

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