Decarbonizing Industrial Sources of CO_2

INTERNATIONAL CCS KNOWLEDGE CENTRE

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Developing a National CCS Program in Trinidad and Tobago

International Knowledge-Sharing Symposium

ccsknowledge.com

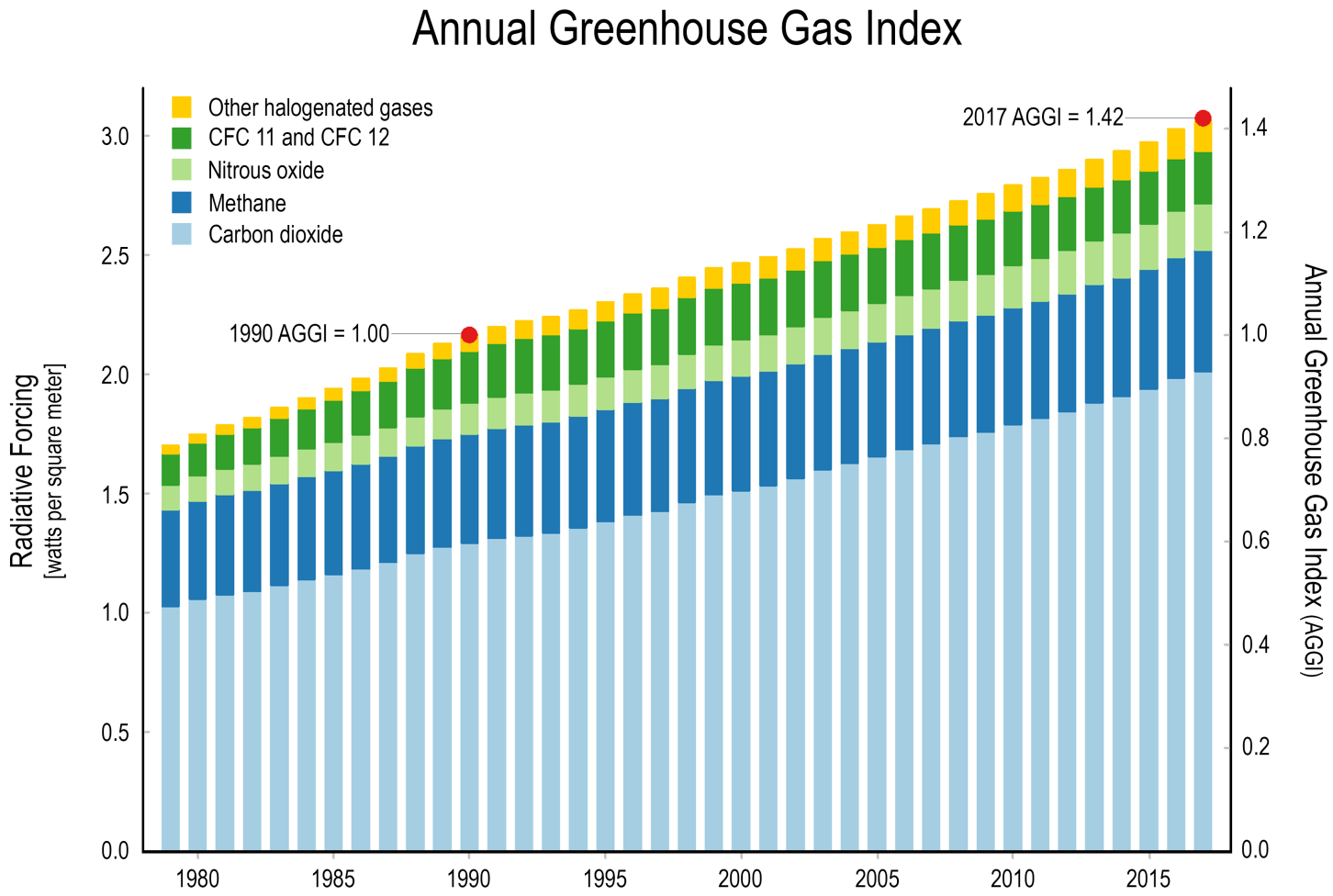
Did You Know....

The technology behind CCS on power plants can also be applied to post combustion capture on industrial processes like cement, iron and steel.

SHAND CCS FEASIBILITY STUDY

CCS - Designed for the World

The greenhouse effect

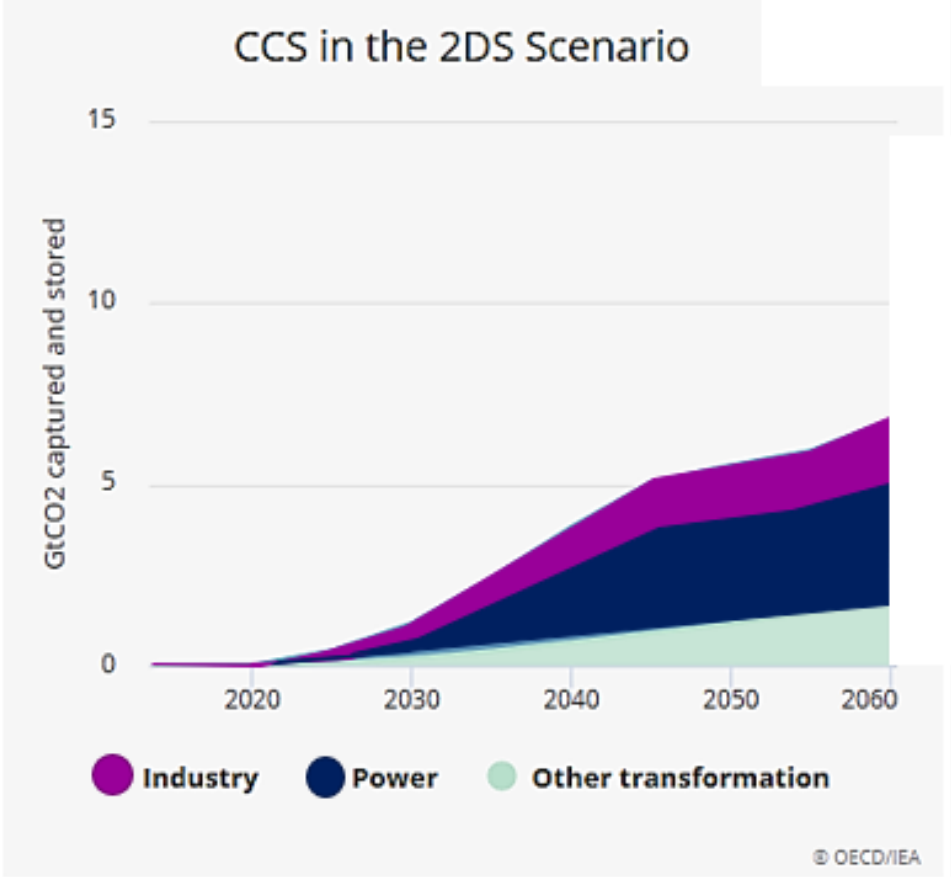


https://www.globalchange.gov/browse/indicators/indicator-annual-greenhouse-gas-index

Increased levels of CO_2 is causing the earth's temperature to rise, which is being attributed to an increased level of anthropogenic or man-made greenhouse gas emissions. GHGs are generated by a variety of industrial processes and applications. Systems that include the burning of fossil fuels in power plants to make electricity, **and industrial processes such as refining oil or producing iron, steel, cement and ammonia** all emit large amounts of CO_2.

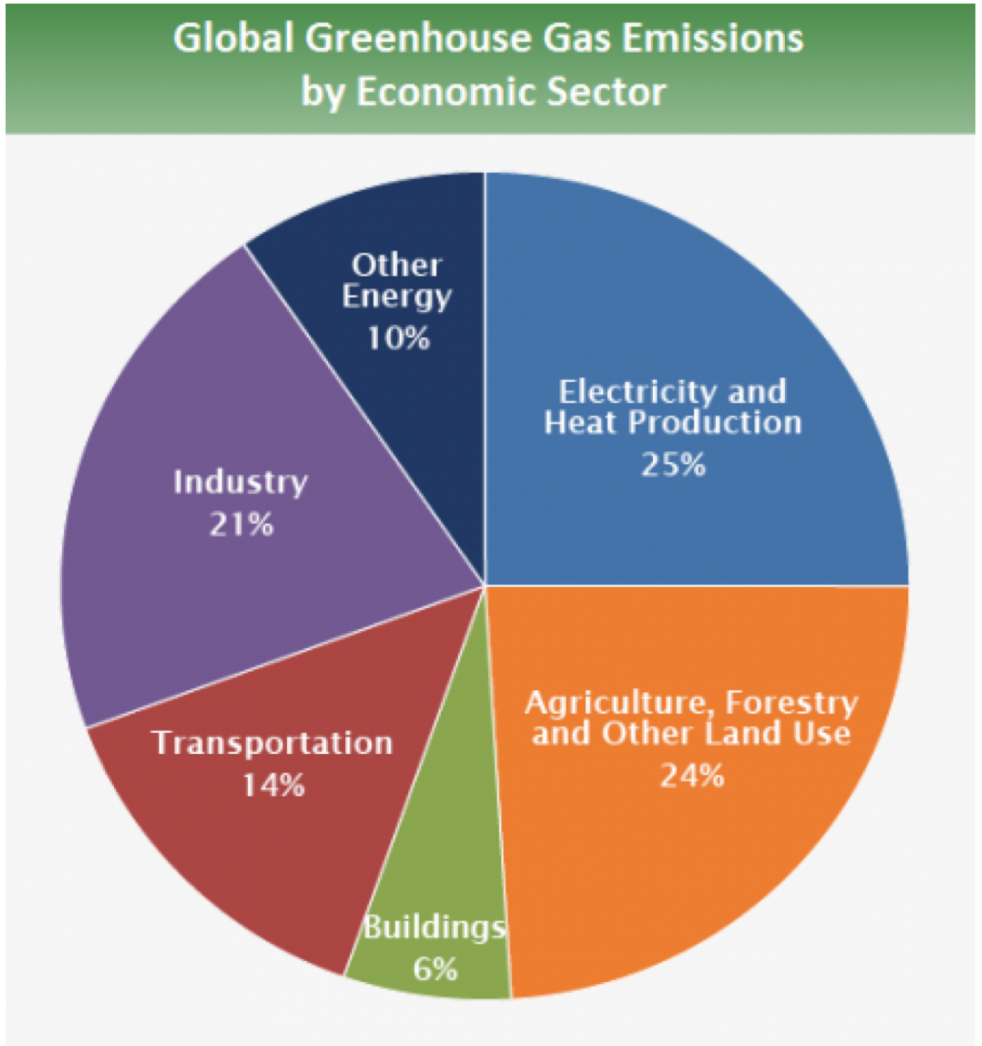
CCS and Paris Commitments

- CCS is the only technology able to significantly reduce emissions from coal- and gas-fired power plants. (IEA)
- CCS can address emissions from industrial processes, including the production of steel, cement, and chemicals.
- CCS technology has been proven and understood, so de-risked deployment can now occur.



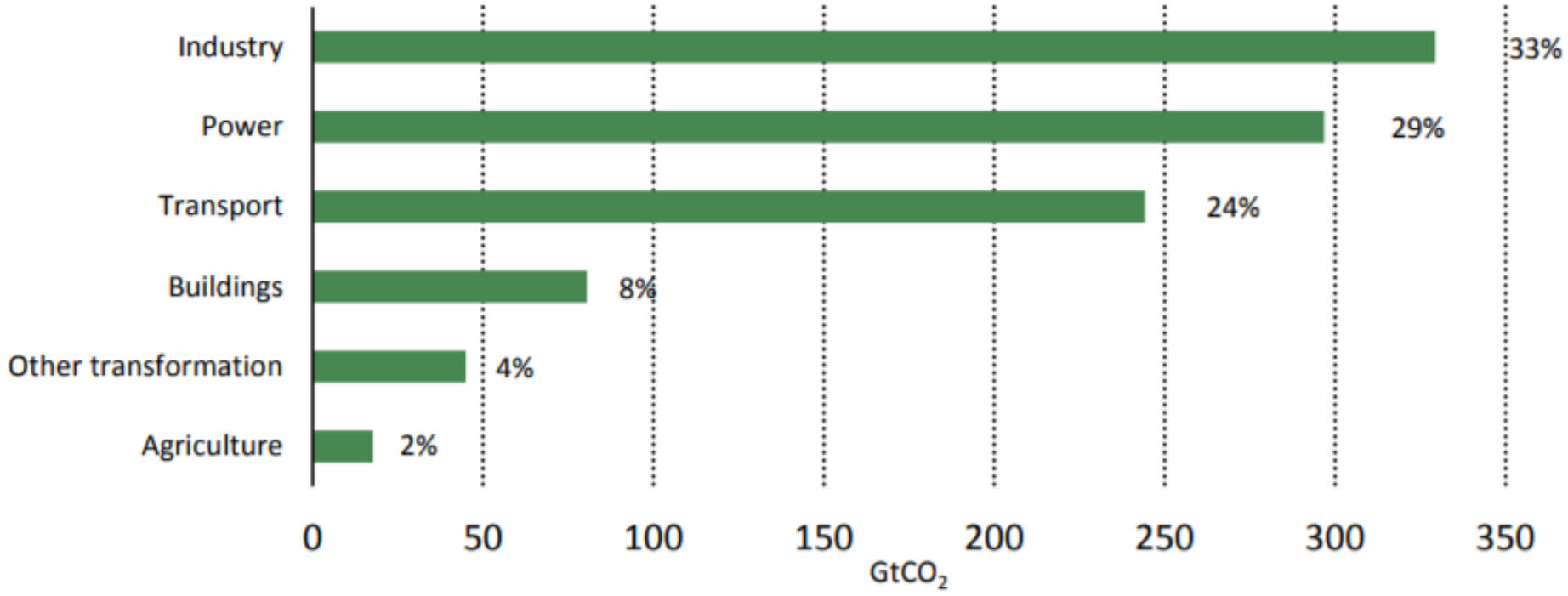
The sources of our problem

At a combined emissions level of more than 7 gigatonnes of CO_2 ($GtCO_2$) in 2011, seven large industrial sectors that include cement, iron and steel, chemicals and refining are responsible for one-fifth of the total of 31 $GtCO_2$ emitted globally. Emissions from each of these sectors are expected to grow by around 35% up to 2050, which can be attributed to the increasing demand for consumer products and infrastructure



Source: IPCC (2014) based on global emissions from 2010. Details about the sources included in these estimates can be found in IPCC's Contribution of Working Group III to the Fifth Assessment Report.

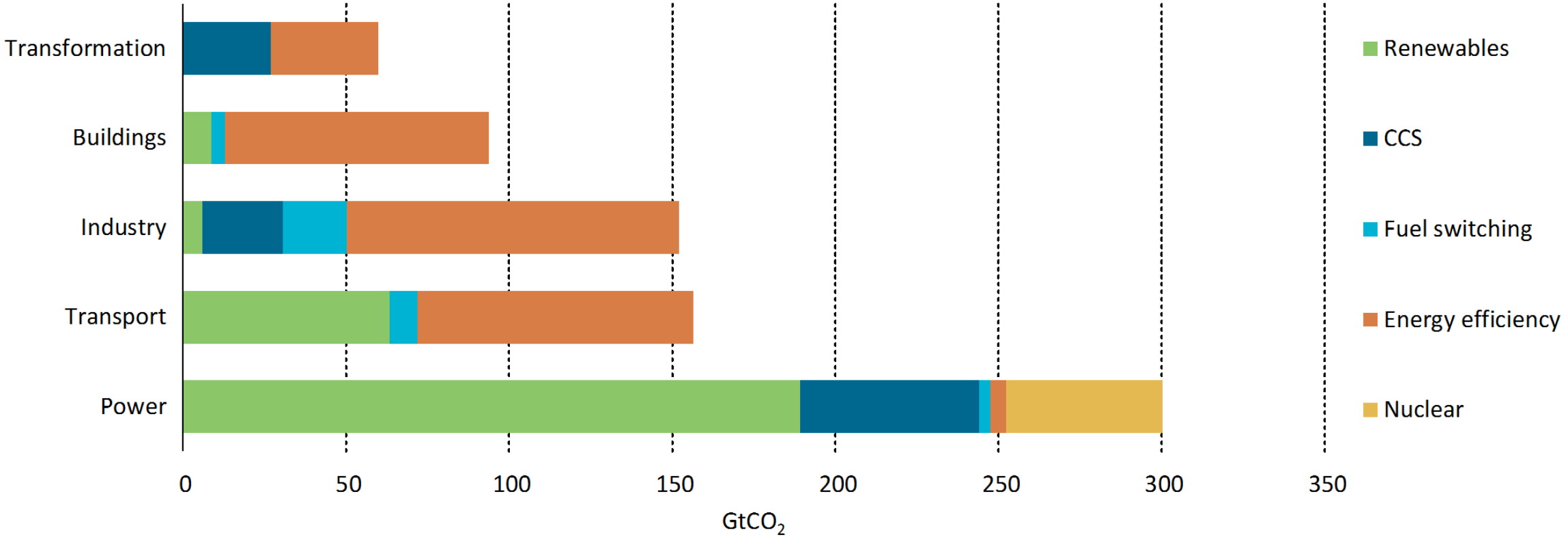
Cumulative CO_2 emissions through 2050 (2DS)



Source: Derived from IEA (2016b), *Energy Technology Perspectives 2016.*

CO_2 emissions reductions by sector and technology

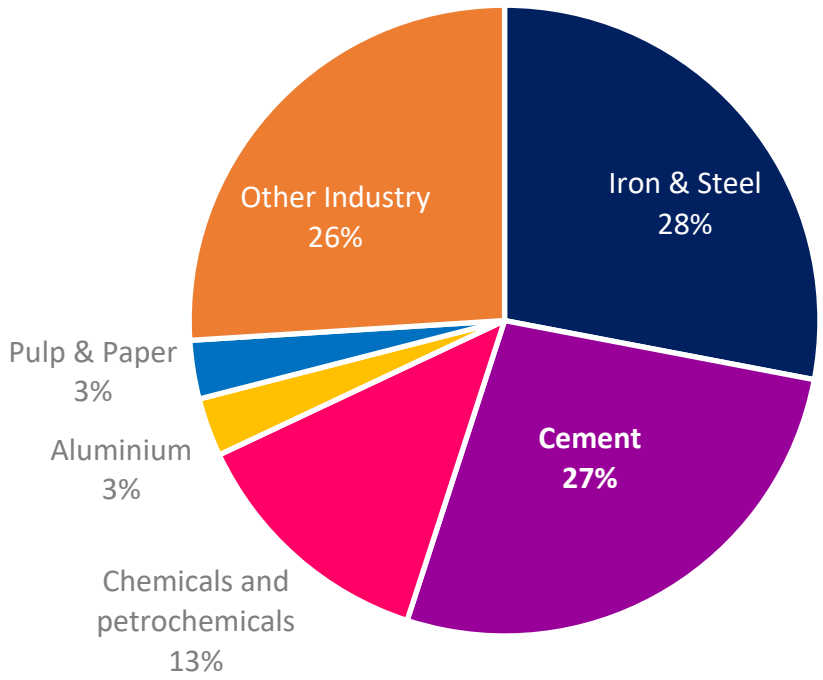
Approximately 50% of CCS expected to be from Industry in 2DS scenario



Source: IPCC (2014) based on global emissions from 2010. Details about the sources included in these estimates can be found in IPCC's Contribution of Working Group III to the Fifth Assessment Report.

Direct Industrial CO_2 emissions

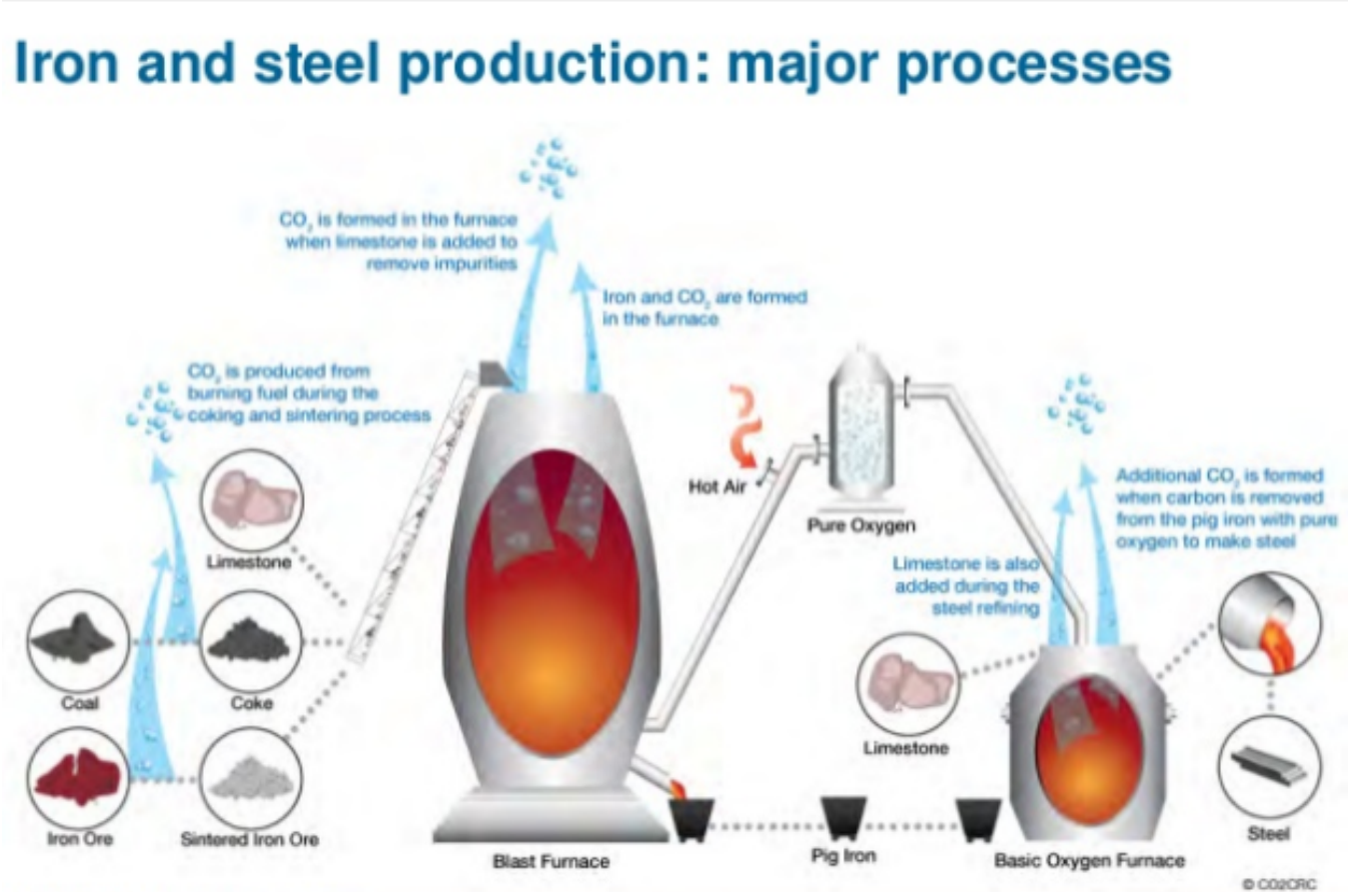
Direct industrial CO2 emissions (2014)



Source: International Energy Agency, Energy Technology Perspectives 2017

- Industrial CO_2 emissions represent 24% of global CO_2 emissions at 8.3 Gt CO_2 (2014).
- Large process-related emissions make the cement sector the 2nd highest CO_2 emitter in industry with 2,230 Mt CO2/year
- To reach a 2°C target by 2060 the cement industry must reduce emissions by 485 Mt.
- But, to reach a 1.75°C target in the same time period, as much as 80% of global cement emissions would need to be captured.

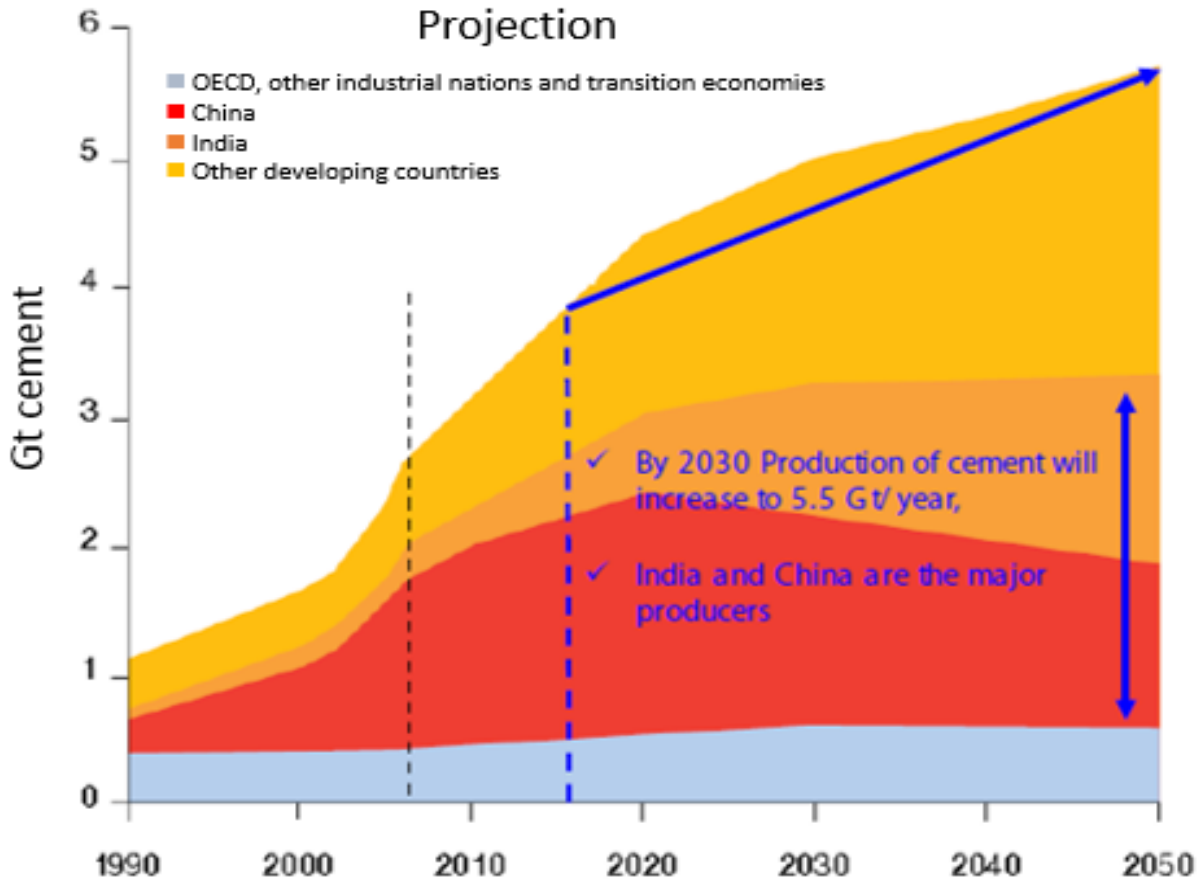
Direct Industrial CO_2 emissions



Source: UK Carbon Capture and Storage Research Centre

- Regular steel plants produce 1.8 ton CO_2/ ton crude steel
- Estimates of cumulative steel production by 2030 amount to 30.5 Gt
- total CO_2 emissions estimated at near 3 Gt - 35% of CO_2 industrial sources = 9 % of global energy-related CO_2 emissions.
- Applying CCS to 15% of the steel industry would capture 8.3 Gt of CO_2

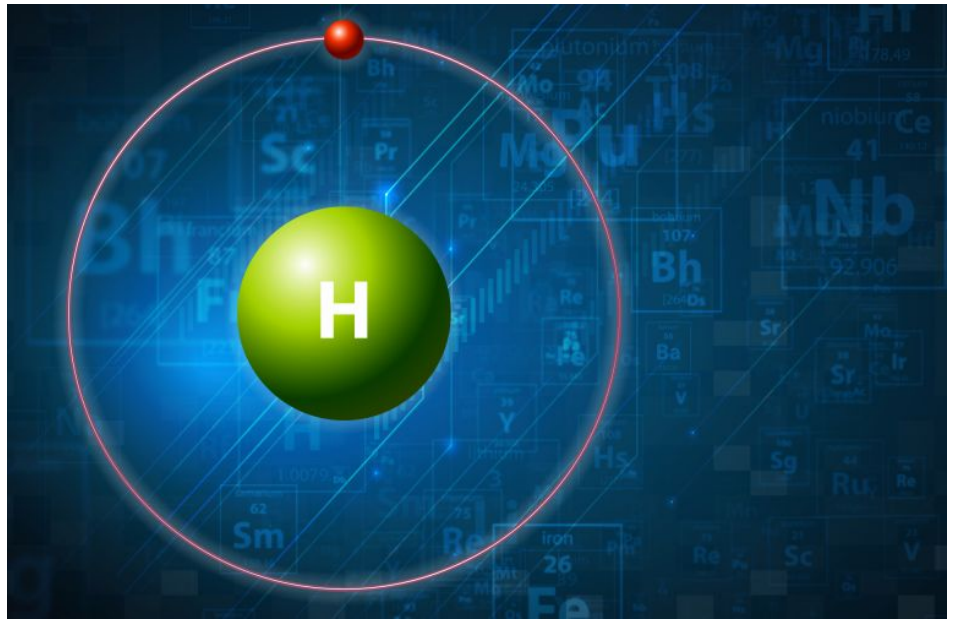
Cement manufacturing



Source: Nicholas Muller & Jochen Harnisch, A blueprint for a climate friendly cement industry

- Cement production is growing by 2.5% annually
- Increasing demand for cement, is driven partially by population growth and urbanization.
- Process CO_2 emissions from the calcination of limestone remain an important challenge for the cement sector
- CCS plays a critical role for reducing emissions since there are no fuel switching alternatives.

Hydrogen production



- Hydrogen is significant for many different processes like petroleum refining, ammonia and fertilizer production, general chemical production and food processing.
- Over 50 million tonnes of hydrogen is manufactured every year globally
- One tonne of hydrogen is a source of 9 to 12 tonnes of CO2.
- Approximately 60% of the total CO_2 created in a steam reforming hydrogen plant is produced by the gas shift reaction.
- The other 40% is the product of the combustion of the additional fuel gas needed by the steam reformer.

Petroleum refining

WHAT ARE THE SOURCES OF CO2 IN TYPICAL COMPLEX REFINERY?

CO_2 emitter	Description	% of total refinery emissions
Furnaces and boilers	Producing heat and steam	30–60%
Utilities	Electricity and steam	20–50%
Fluid catalytic cracker	CO_2 as by-product	20–35%
Hydrogen manufacturing	CO_2 as by-product	5–20%

Source: Staerlen et. al. CO2 capture for refineries, a practical approach International Journal of Green House Gas control, 2010, 4 (2), 316-320

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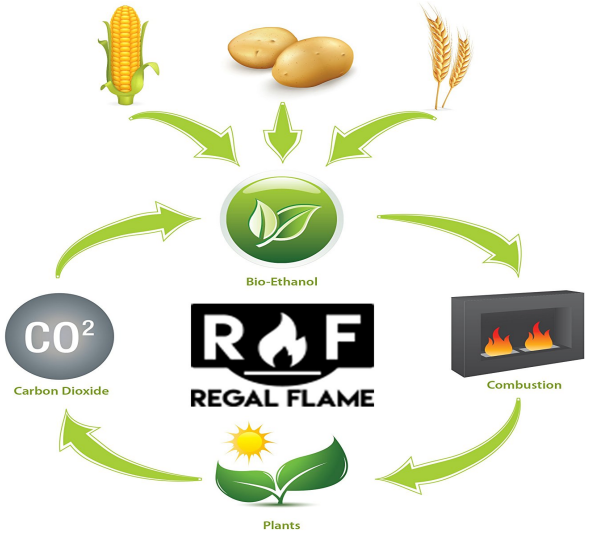
- Petroleum refining equal to 10% of total CO_2 emissions produced by industrial sector.
- The main CO_2 emissions coming from Furnances and boilers producing heat and steam (30-60% of total refinery emissions), utilities producing electricity and steam (20-50% of total emissions), fluid catalytic cracker (20-35 % of total emissions and hydrogen manufacturing (5-20%)

Other sources of CO_2 emissions in industrial sector

Gas Processing: natural gas

3%

Bio-ethanol manufacturing



3%

Pulp & Paper

3%

CCS in industrial processes separation: The Norwegian Cement Industry

- Norway is leading the integration of CCS technology into the cement industry.
- Brevik and Kjøpsvi, two prominent cement kilns in Norway, produce capacity of 1,415,000 tonnes per annum (tpa) of clinker used.
- The Norwegian government is a great proponent of CCS development within its country.

Abu Dhabi CCS Project

- The project is owned by two companies: Abu Dhabi National Oil Company (ADNOC) and Masdar - Abu Dhabi Future Energy Company.
- The facility is the first CCUS project in the region.
- Amine solvents are used in a DRI process to capture the CO_2.
- The DRI process applied at Emirates Steel fabricates a pure (98%) stream of carbon dioxide which is sent to the atmosphere.
- The facility went online in November 2016 with a capture capacity of 0.8 Mtpa.

Illinois Industrial Carbon Capture and Storage

- Capture technology is Industrial separation/ Fermentation.
- CO_2 captured capacity is 1 million tpa
- Geological storage of CO_2 s is at an onshore deep saline formation in Mount Simon Sandstone.
- Operation started in April 2017.
- The facility is scheduled to operate for 5 years with a storage potential of around 5 million tonnes of CO_2.

QUEST Project in Alberta

- The CO_2 is captured from the three stream methane reformer facilities that produce hydrogen for the bitumen.
- designed to capture and store over 1 Mt CO_2/year
- The facility begun capturing in November 2015.
- The main storage is located in onshore deep saline formations at Basal Cambrian Sands at a depth of around 2 km.
- The method of capture is designed by Shell and consists of absorption chemical solvent-based process using amine but also Industrial separation

Conclusions

- **CCS is a proven technology around the world, ideally suited for high emitting industrial sectors.**
- **There are currently 15 industrial separation CCS projects globally**
- **Post-Combustion Capture can be applied to Industrial Sources.**
- **This large-scale CCS is the only technology that can achieve megatonne reductions in emissions.**

Source: http://climateactiontracker.org

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Thank You

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