CLEAN clinKER by calcium looping for low-CO_2 cement

CLEANKER

8 February 2023 – Roma
CLEANKER H2020 Project

CO_2 industrial emissions: strategies for Capture, Utilization and Storage

Stefano Consonni
Politecnico di Milano – President of LEAP

The
energy situation

Co-funded by the Horizon 2020
Framework Programme of the European Union

In the media

1 minute read · January 26, 2023 10:35 AM GMT+1 · Last Updated 12 days ago

Italy plans to extend relief measures to soften energy prices

REUTERS®

Reuters

3 minute read · January 26, 2023 8:04 AM GMT+1 · Last Updated 12 days ago

South Korea to double energy vouchers amid soaring bills, cold wave

By Hyonhee Shin and Hanna Song

Gas, i prezzi scendono ma la crisi energetica non è finita: cosa succederà in Italia e in Ue?

Money.it

Stefano Rizzuti 13 Gennaio 2023 - 16:39

Scenari

24+

Sudafrica ostaggio della crisi energetica, verso i 100 giorni consecutivi di blackout

Il colosso locale Eskom impone tutti i giorni blackout fino a 12 ore al giorno per salvare il sistema dal collasso. Una carenza energetica che rischia di affondare l'economia più industrializzata del Continente

Germany's Energy Crisis Sends It Tumbling Down Investment Rankings

OILPRICE.com The No. 1 Source for Oil & Energy News

By Irina Slav - Jan 16, 2023, 2:48 AM CST

ANSA.it › Ambiente&Energia › Energia › Per zero emissioni servono cattura carbonio, idrogeno,biogas

Per zero emissioni servono cattura carbonio, idrogeno,biogas

A&E › Energia

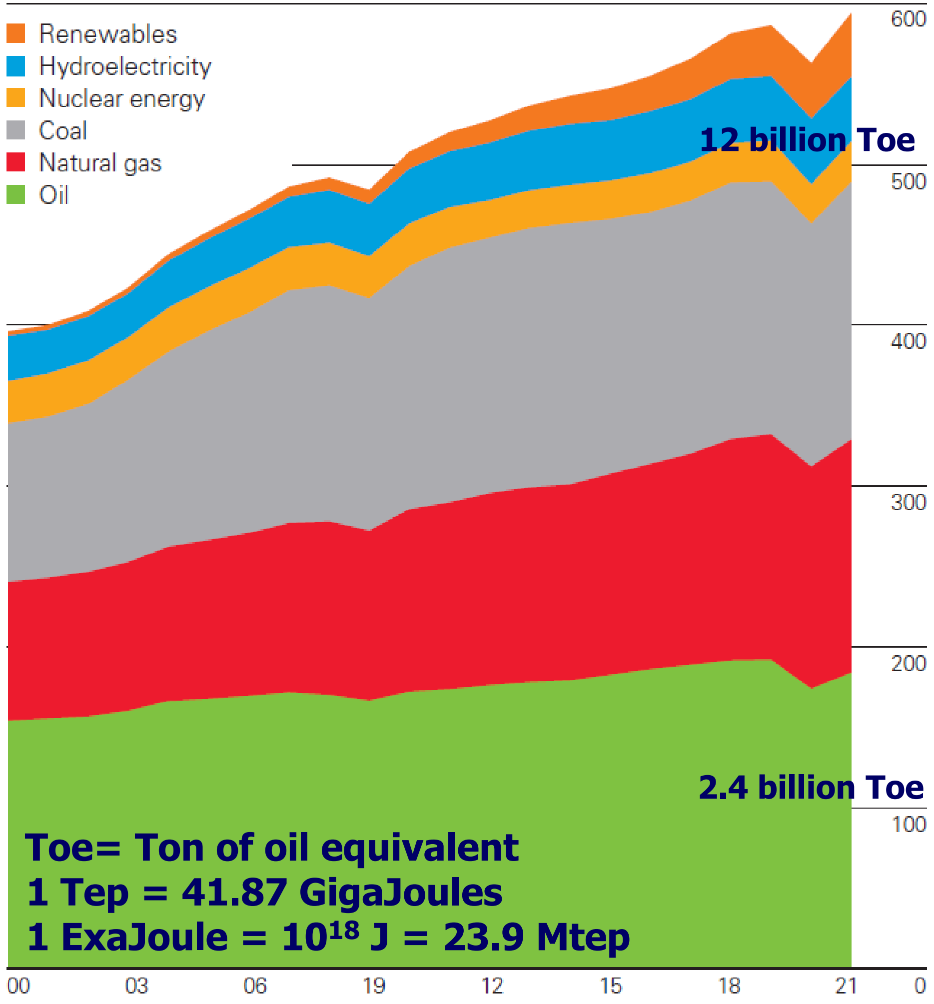
Ricerca Ambrosetti-Eni, vale principio di neutralità tecnologica

Redazione ANSA ROMA 07 febbraio 2023 16:03 Scrivi alla redazione Stampa

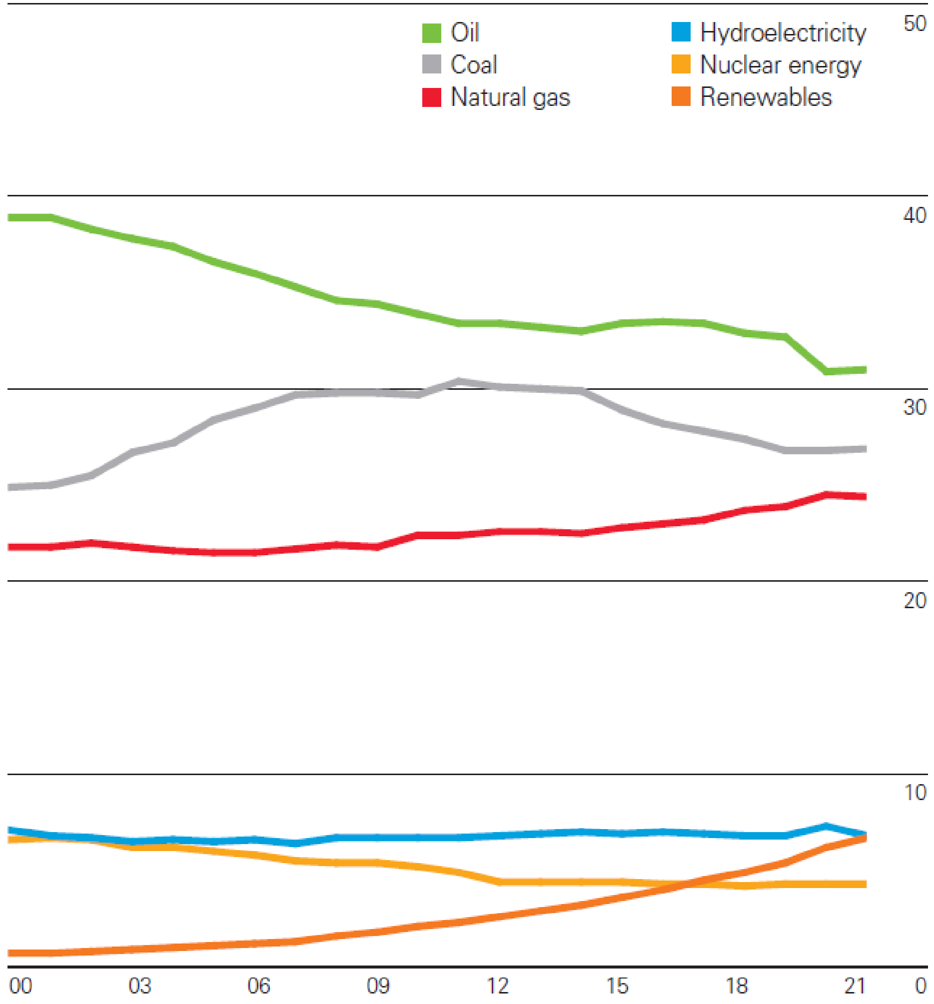
Co-funded by the Horizon 2020 Framework Programme of the European Union

Current energy scenario

World consumption
Exajoules



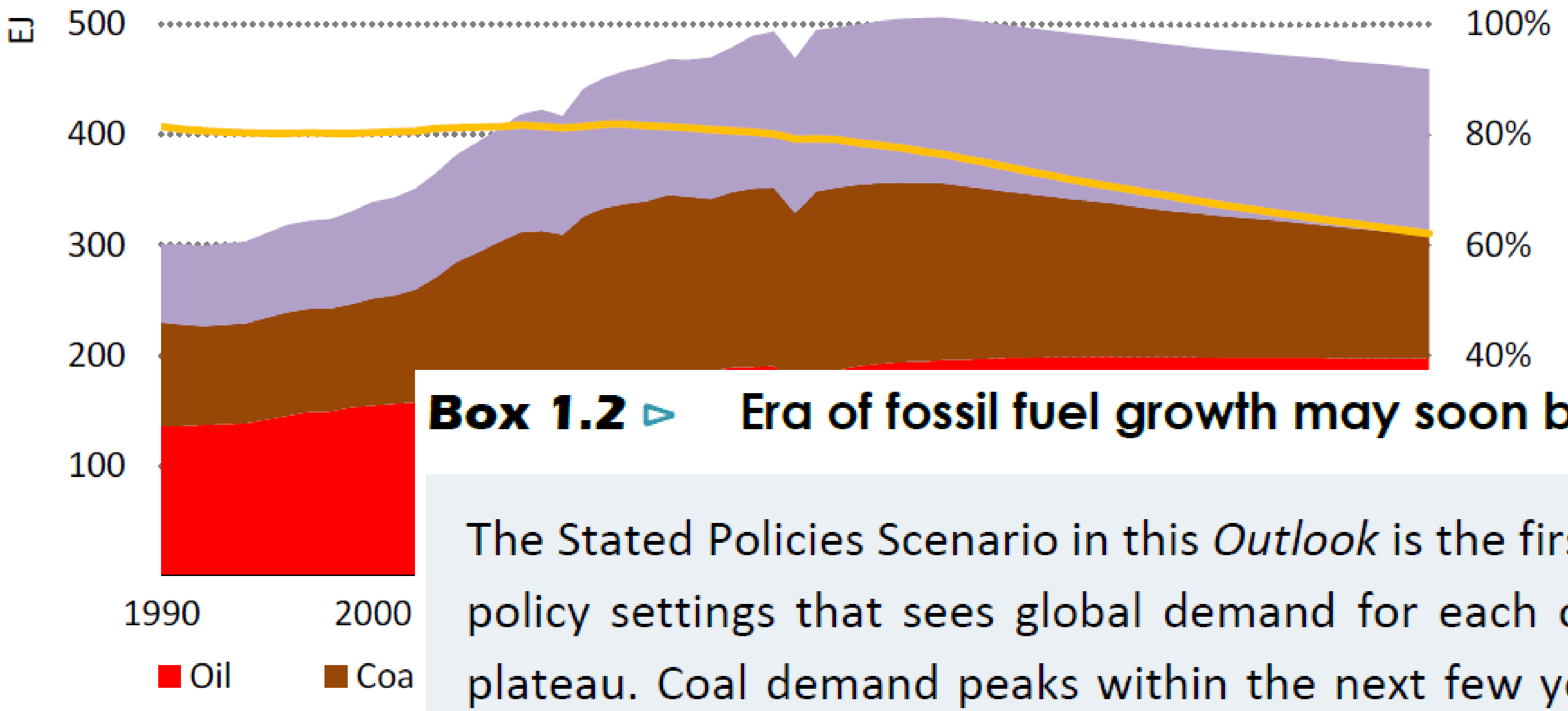
Shares of global primary energy
Percentage



Source: BP Statistical Review of World Energy 2022

Co-funded by the Horizon 2020 Framework Programme of the European Union

Predictions



Source: World Energy Outloo

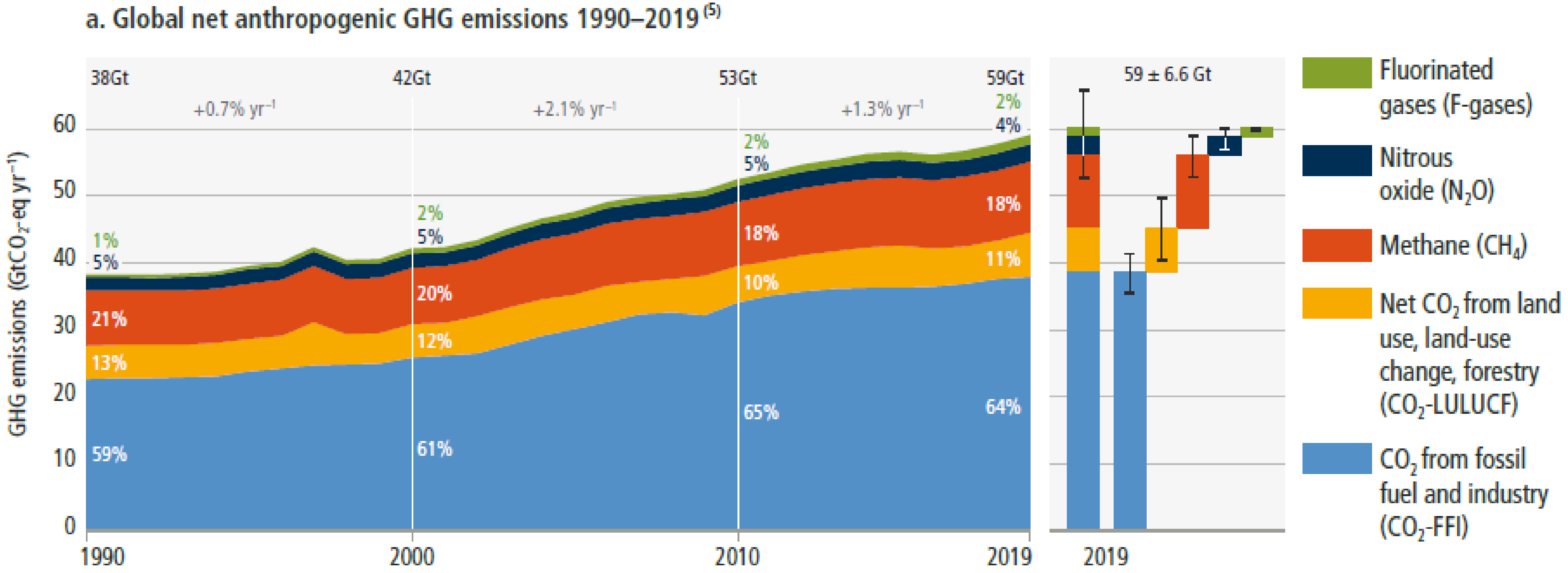
Box 1.2 ▷ Era of fossil fuel growth may soon be over

The Stated Policies Scenario in this *Outlook* is the first *WEO* scenario based on prevailing policy settings that sees global demand for each of the fossil fuels exhibit a peak or plateau. Coal demand peaks within the next few years, natural gas demand reaches a plateau by the end of the decade, and oil demand reaches a high point in the mid-2030s before falling. The result is that total demand for fossil fuels declines steadily from the mid-2020s by around 2 exajoules (EJ) (equivalent to 1 million barrels of oil equivalent per day [mboe/d]) every year on average to 2050 (Figure 1.9).

CO_2 emissions

Co-funded by the Horizon 2020
Framework Programme of the European Union

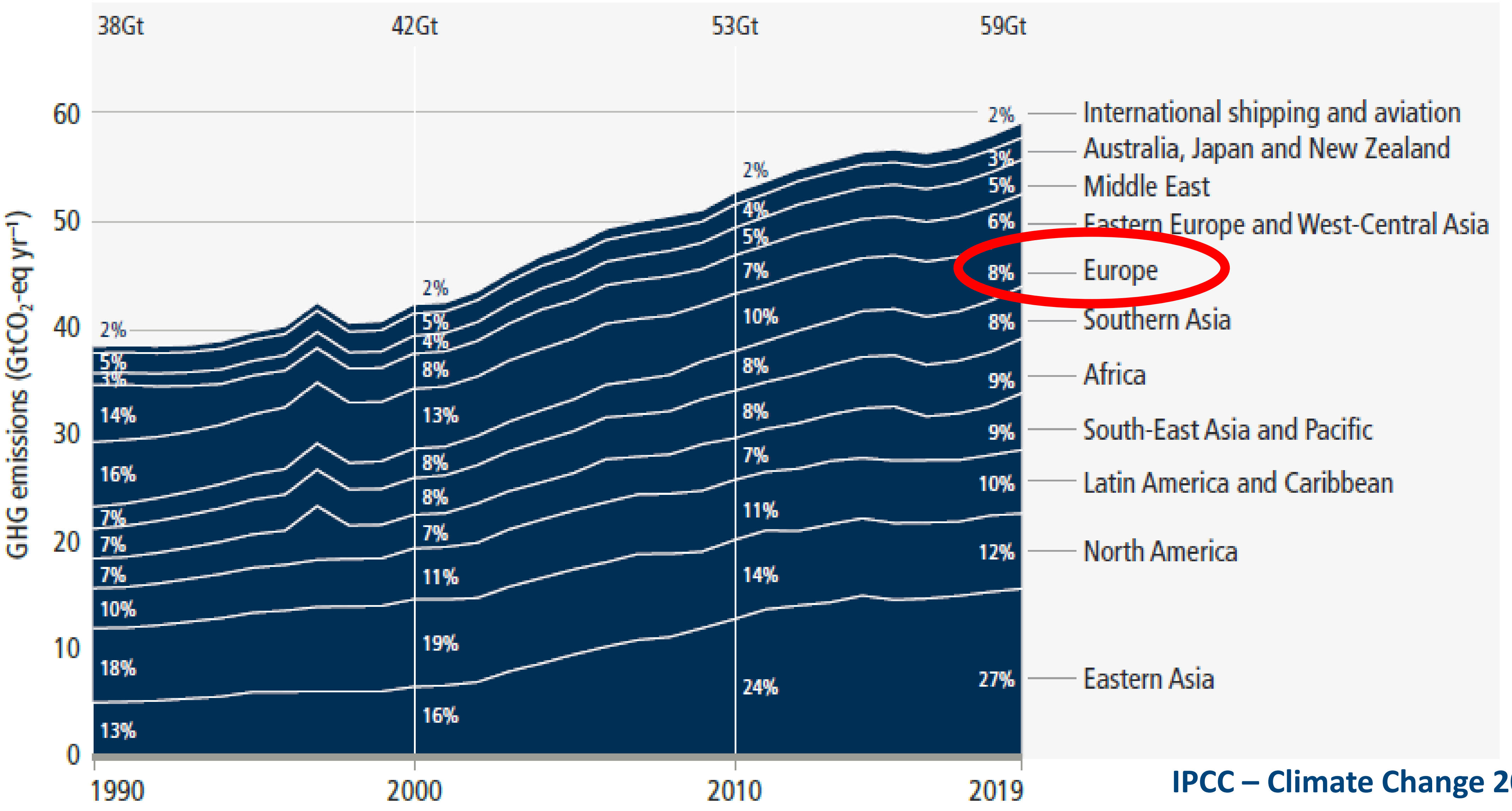
Global anthropogenic emissions CONTINUE TO RISE



IPCC – Climate Change 2022: Mitigation

Co-funded by the Horizon 2020 Framework Programme of the European Union

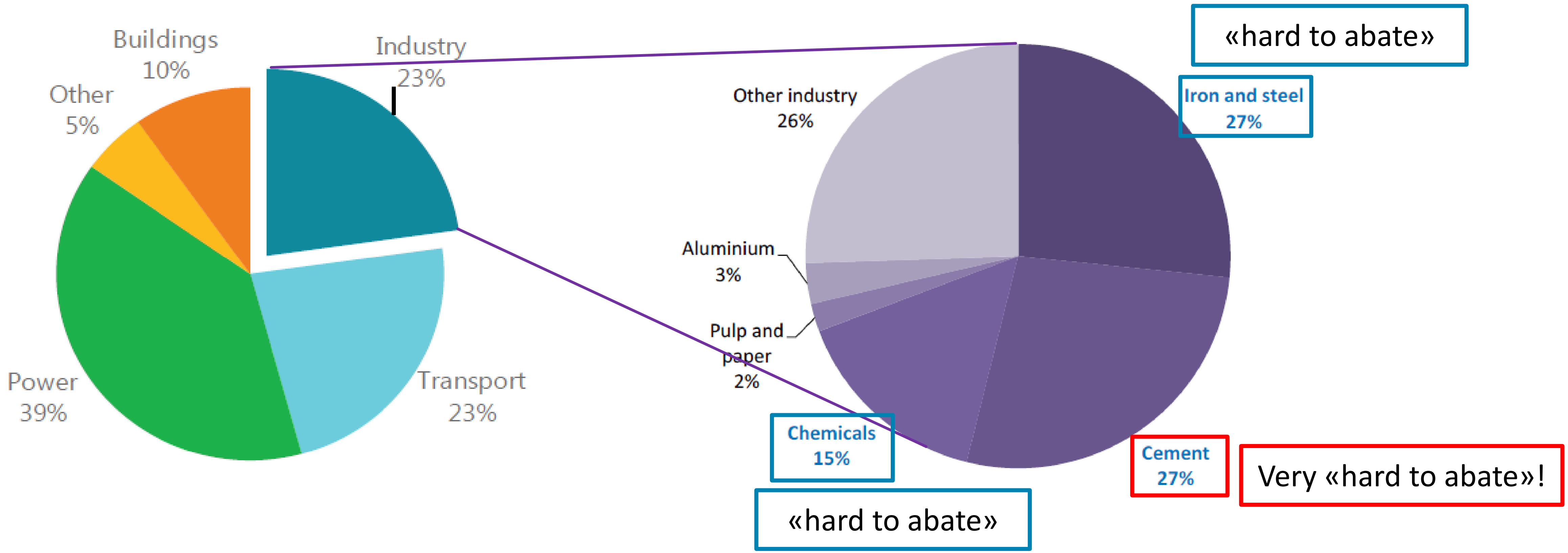
Global net anthropogenic GHG emissions by region



IPCC – Climate Change 2022: Mitigation

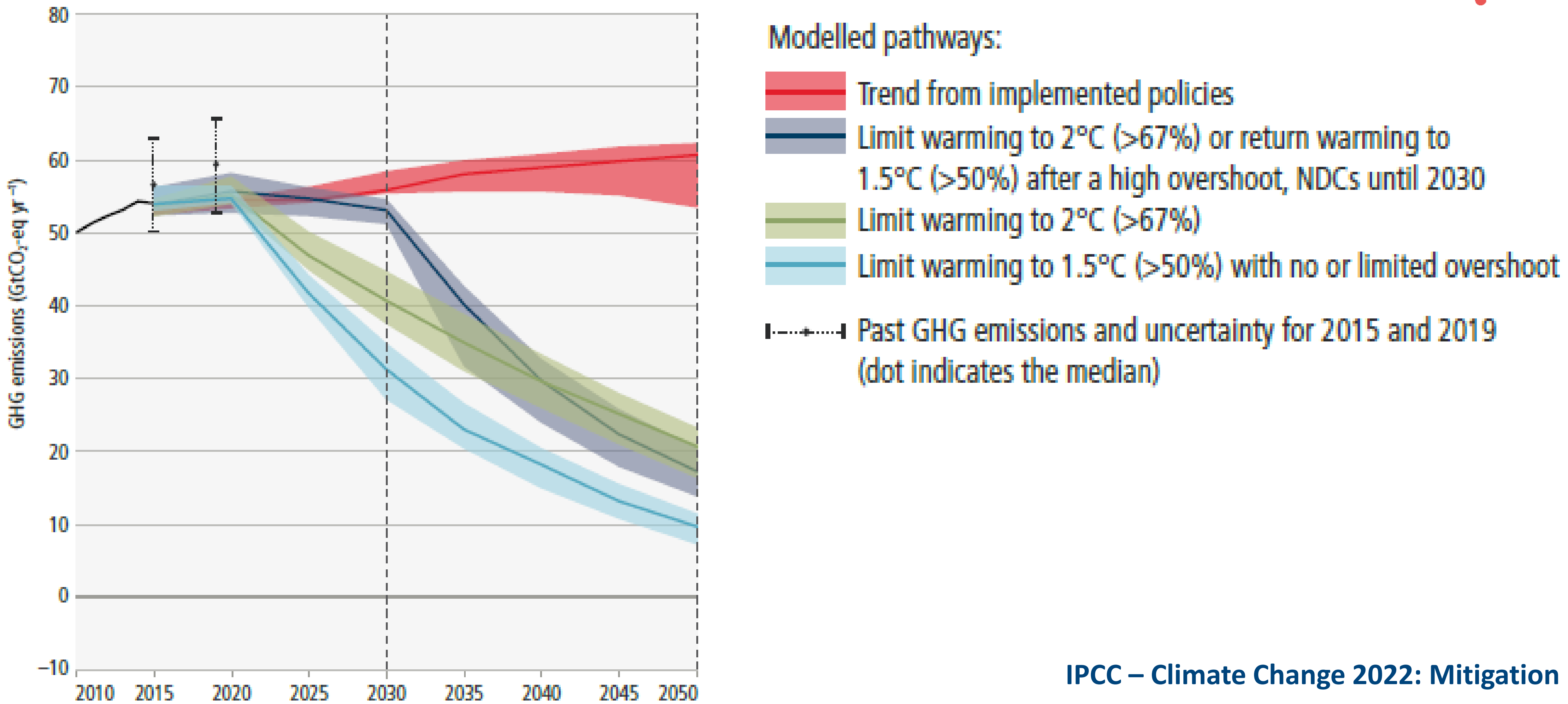
Co-funded by the Horizon 2020 Framework Programme of the European Union

Breakdown by sector (2017)



IEA, 2019. *Transforming Industry through CCUS.*

Projected global CO2 emissions

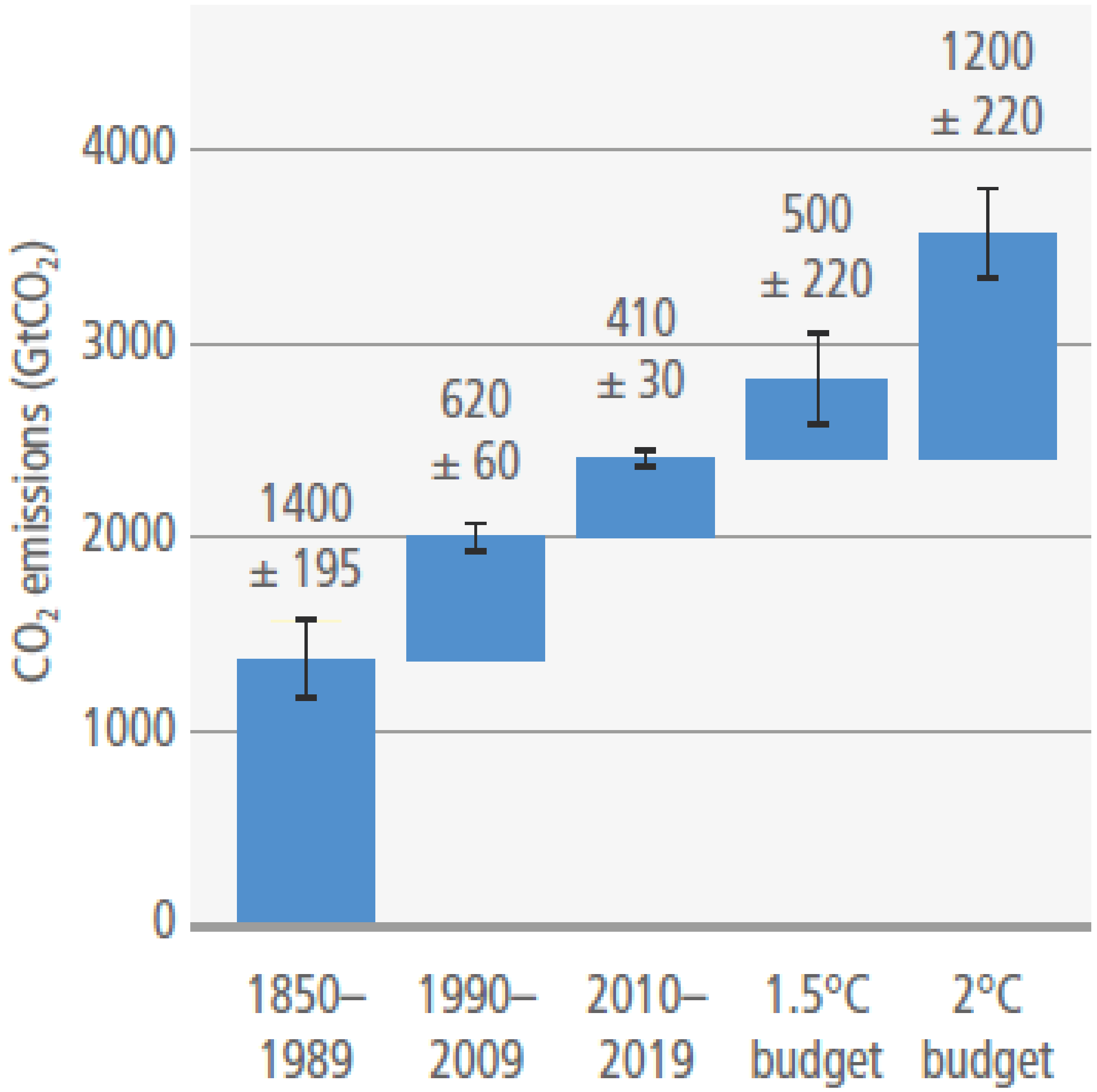


IPCC – Climate Change 2022: Mitigation

Envisioning a Wonderful World

Co-funded by the Horizon 2020
Framework Programme of the European Union

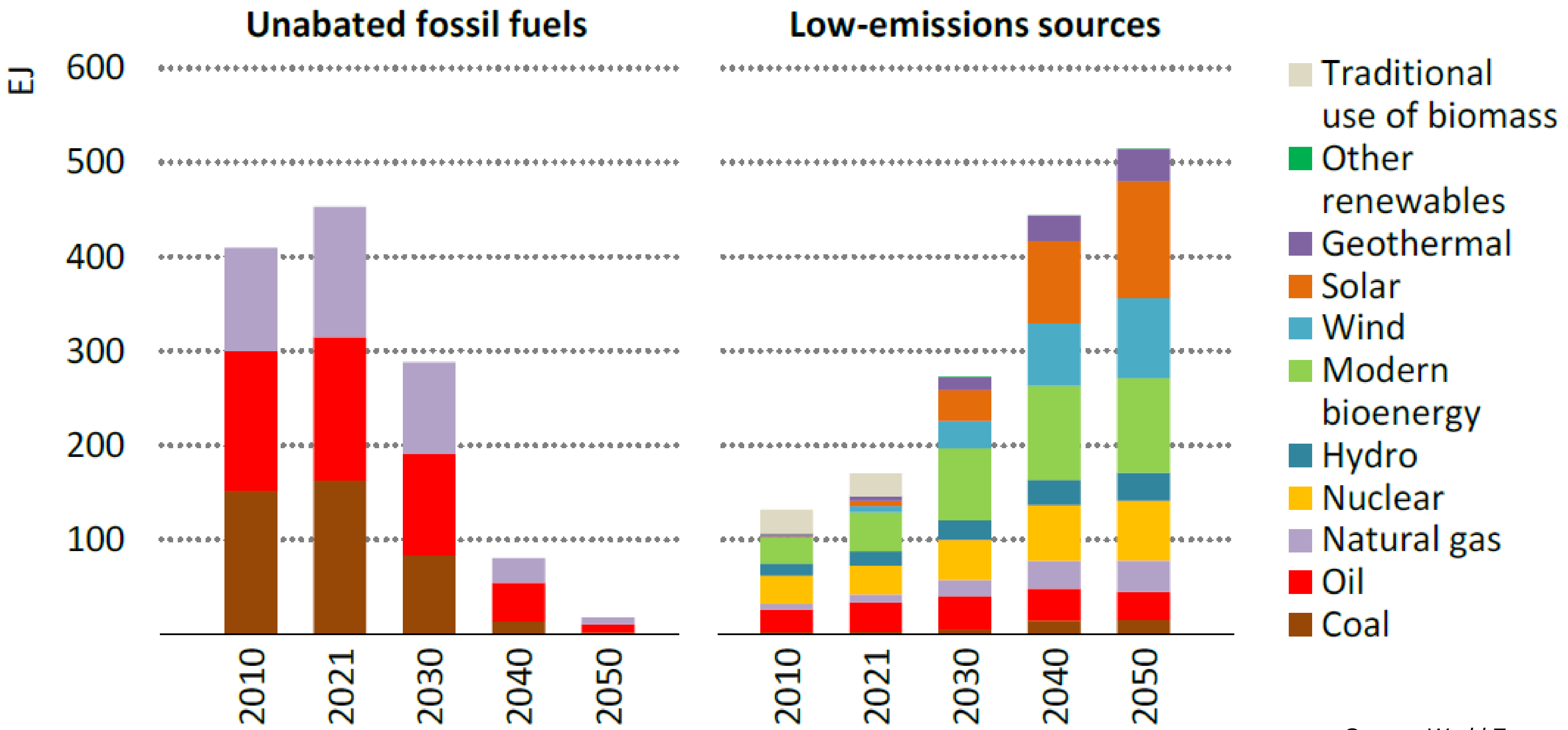
Historical cumulative CO_2 emissions vs budgets for limiting temperature increase



IPCC – Climate Change 2022: Mitigation

Co-funded by the Horizon 2020 Framework Programme of the European Union

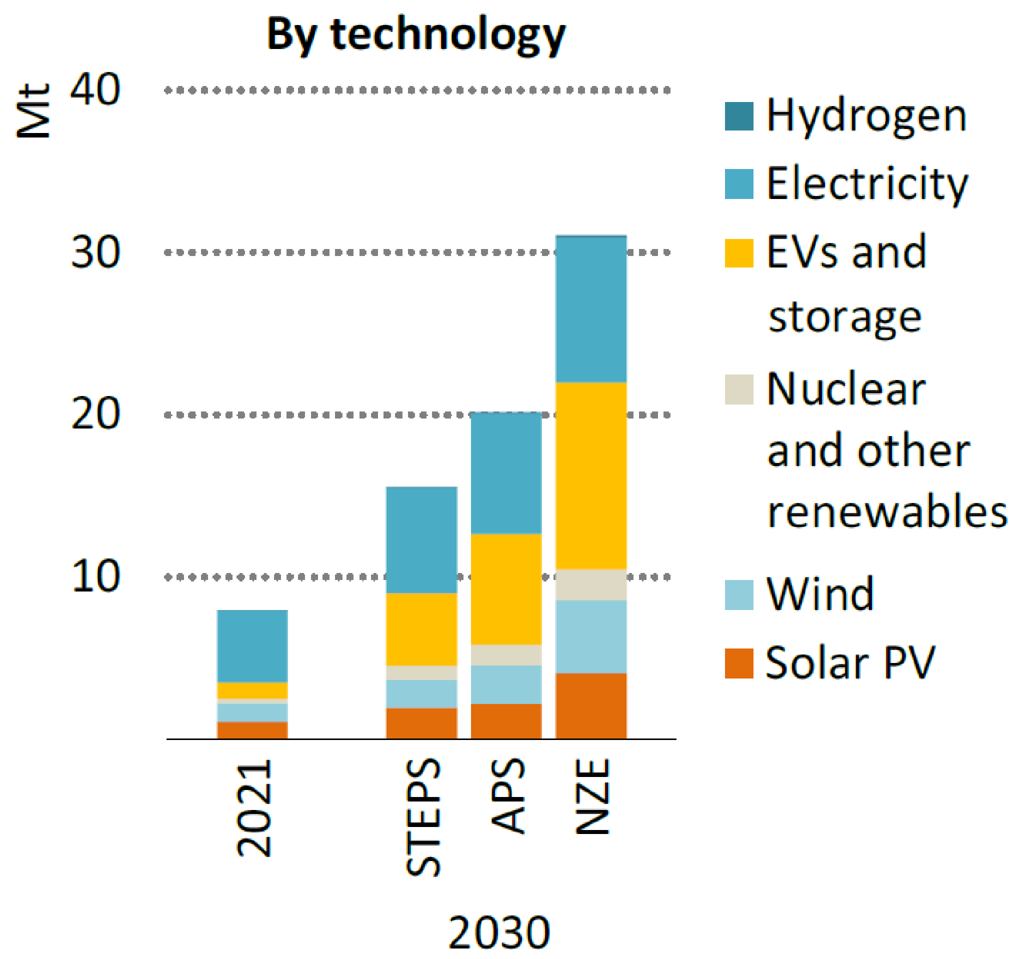
Net Zero Emission (NZE) scenario (i.e. what is needed to limit warming to 1.5°C)

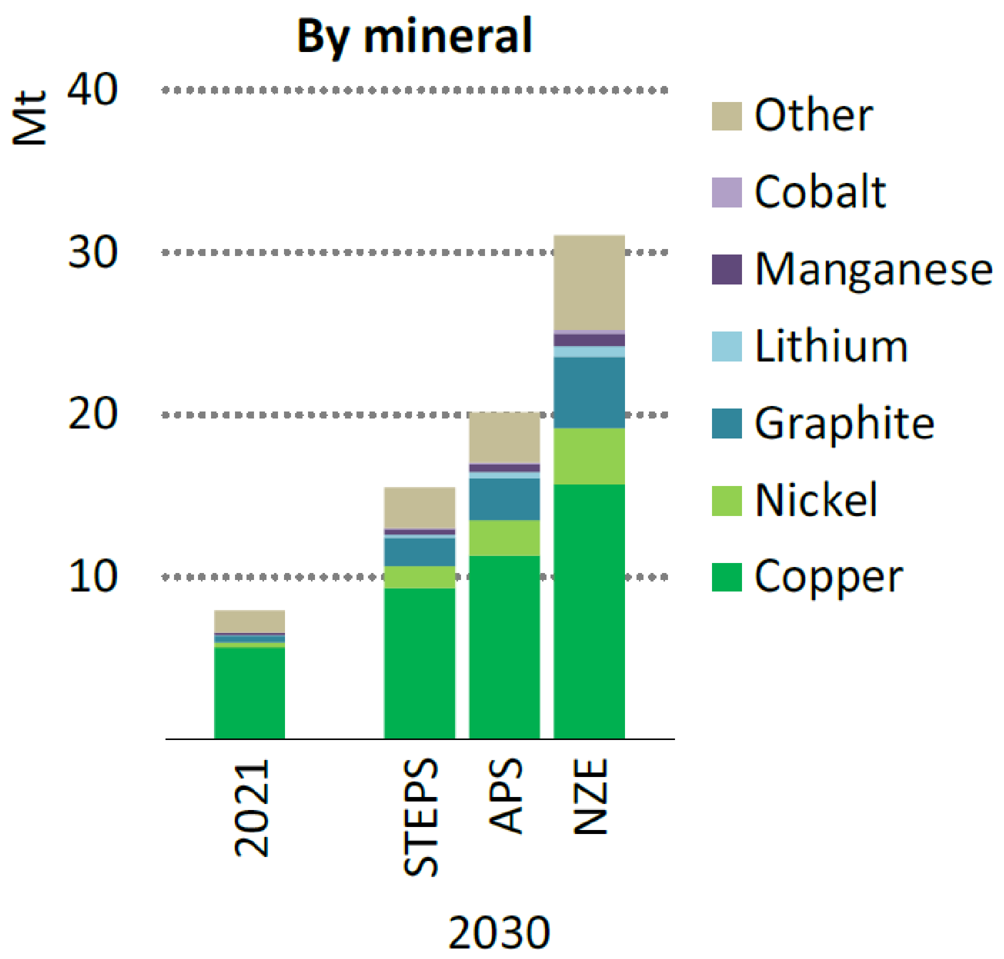


Source: World Energy Outlook 2022

Co-funded by the Horizon 2020 Framework Programme of the European Union

Mineral requirements



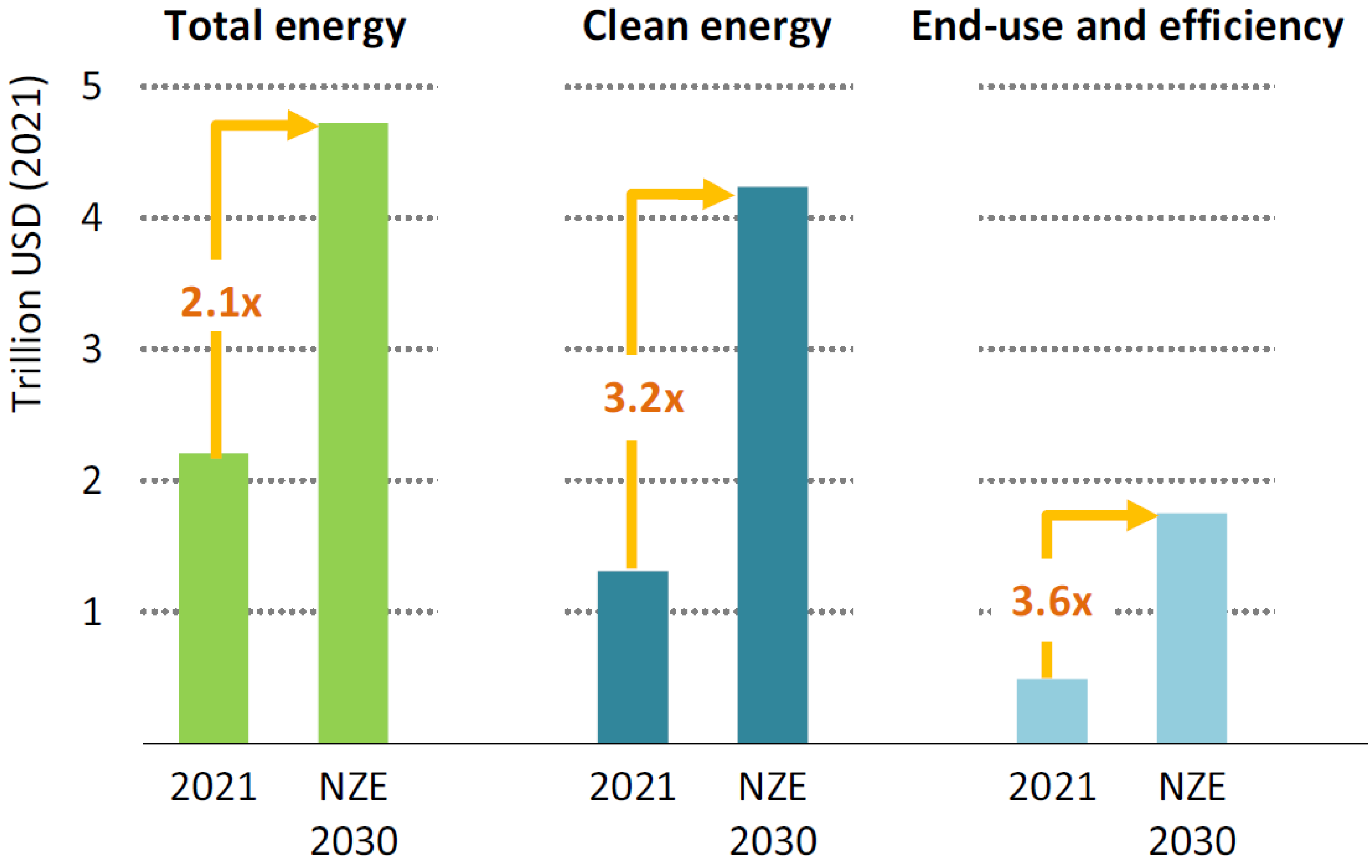


STEPS = Stated Policies scenario
APS = Announced Pledeges scenario
NZE = Net Zero Emission scenario

Source: World Energy Outlook 2022

Co-funded by the Horizon 2020 Framework Programme of the European Union

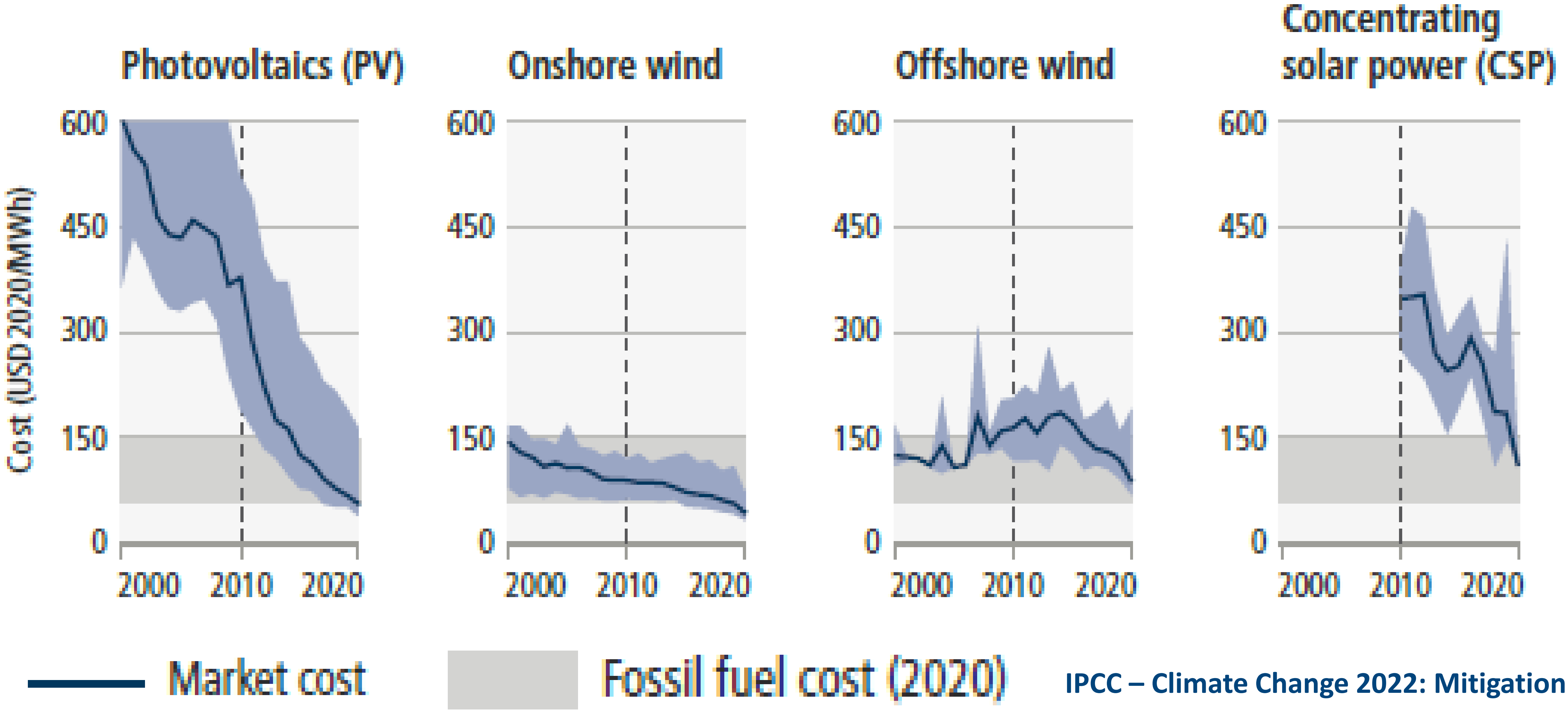
Energy investments



Source: World Energy Outlook 2022

Co-funded by the Horizon 2020 Framework Programme of the European Union

Good news: unit cost of renewable energy continues to decrease



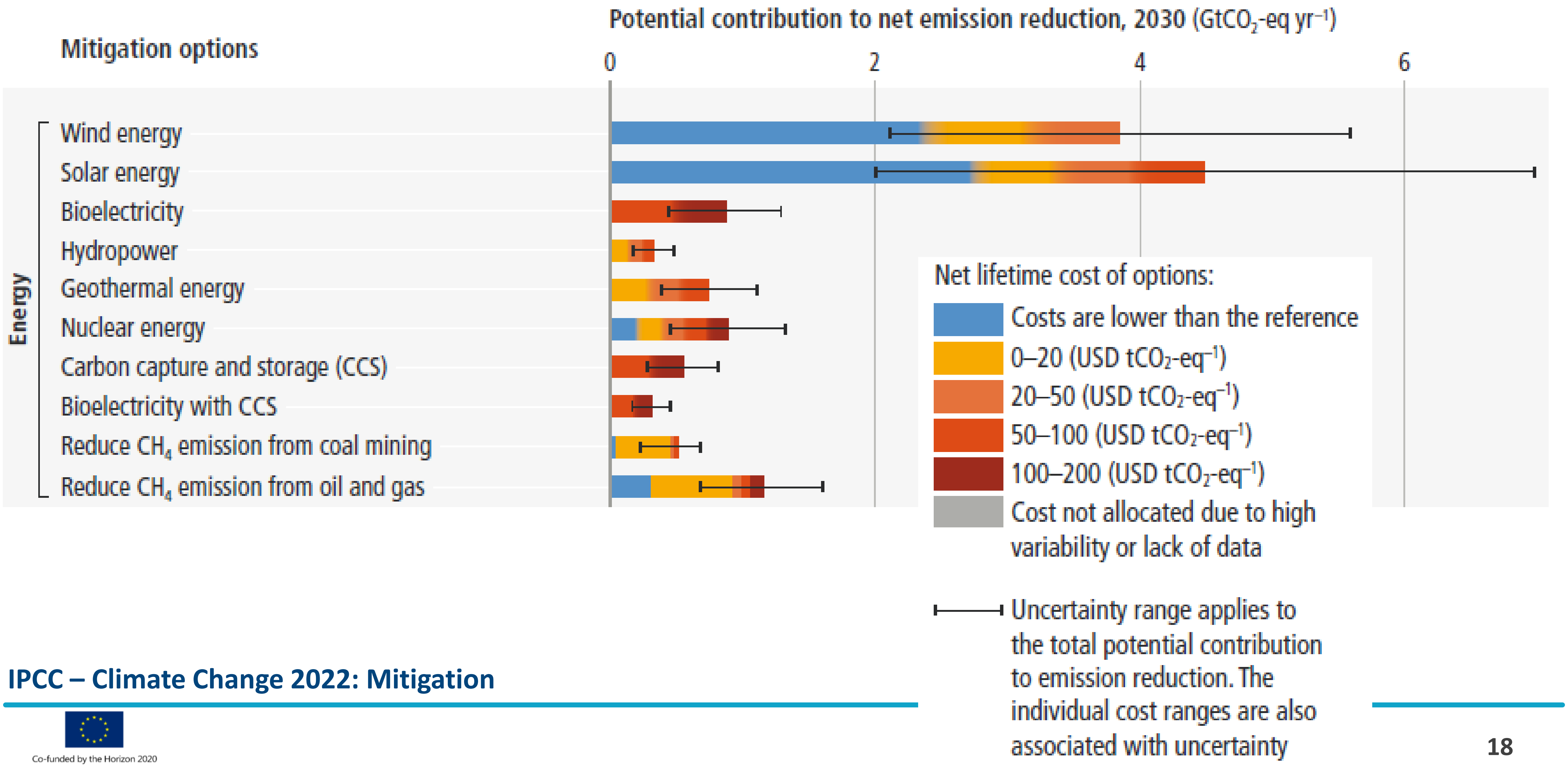
IPCC – Climate Change 2022: Mitigation

Co-funded by the Horizon 2020 Framework Programme of the European Union

Mitigation strategies

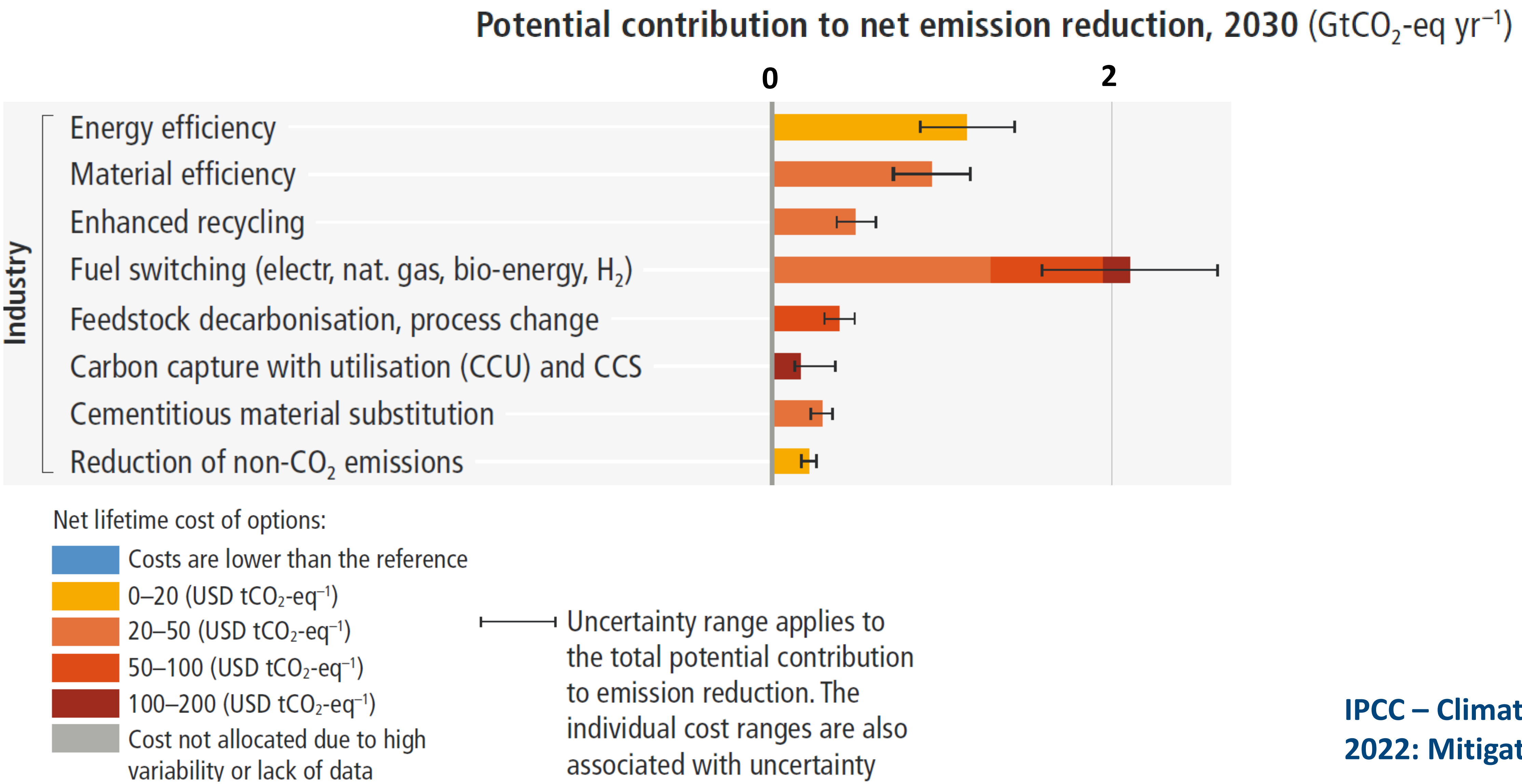
Co-funded by the Horizon 2020
Framework Programme of the European Union

Potential contribution to reduction of CO2 emissions by 2030: Energy



IPCC – Climate Change 2022: Mitigation

Potential contribution to reduction of CO2 emissions by 2030: Industry



IPCC – Climate Change 2022: Mitigation

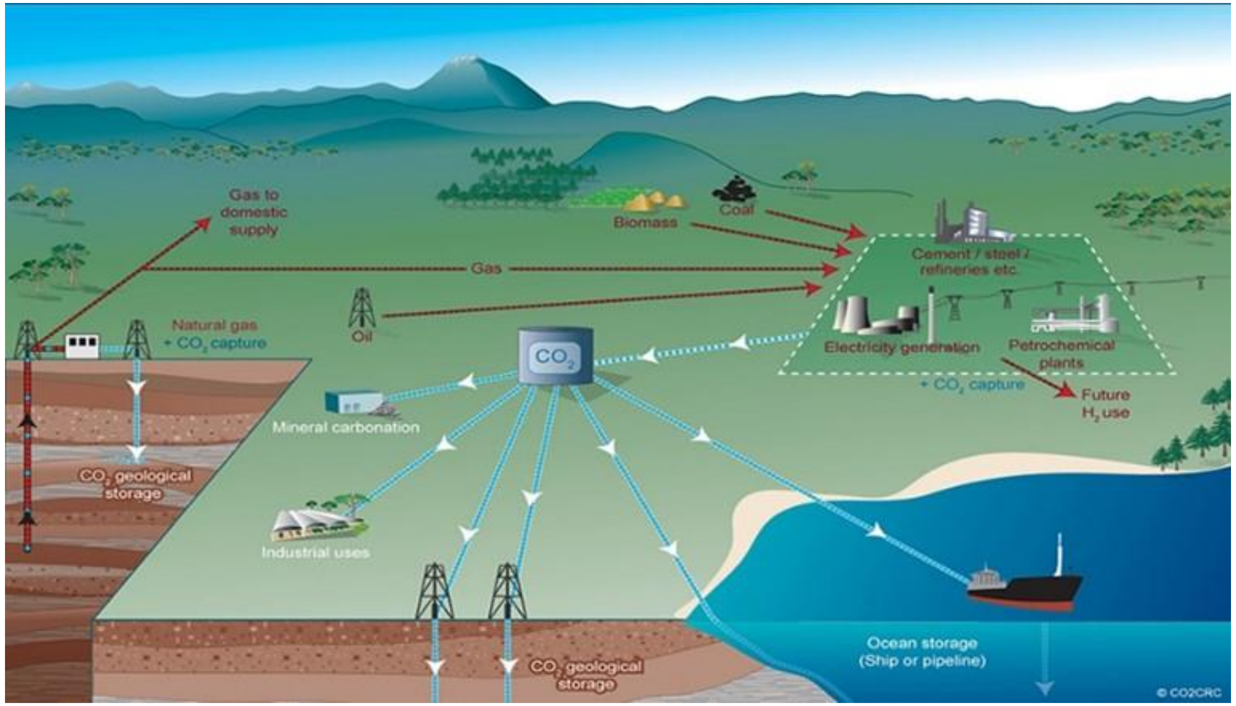
Co-funded by the Horizon 2020 Framework Programme of the European Union

What is CC(U)S ?

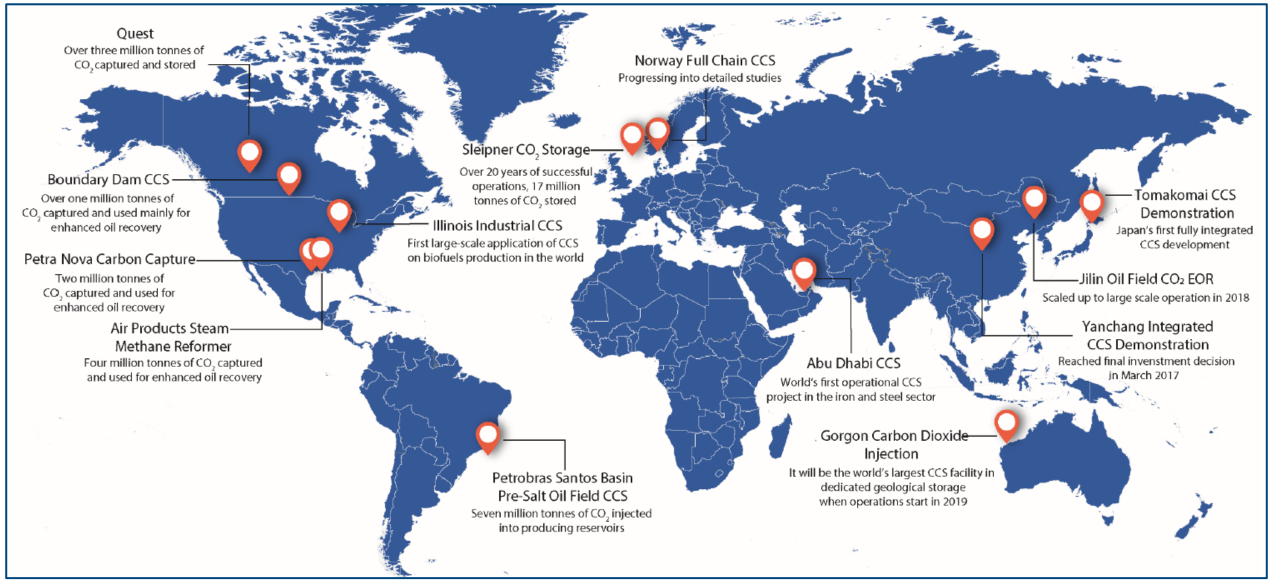
CLEANKER

CCS refers to a set of CO2 capture, transport and storage technologies that are put together to abate emissions from various stationary CO2 sources

1. **Capture a reach-CO2 gas from industrial plant(s);**
2. **Transport (pipeline or shipping);**
3. **Injection (or utilization)**



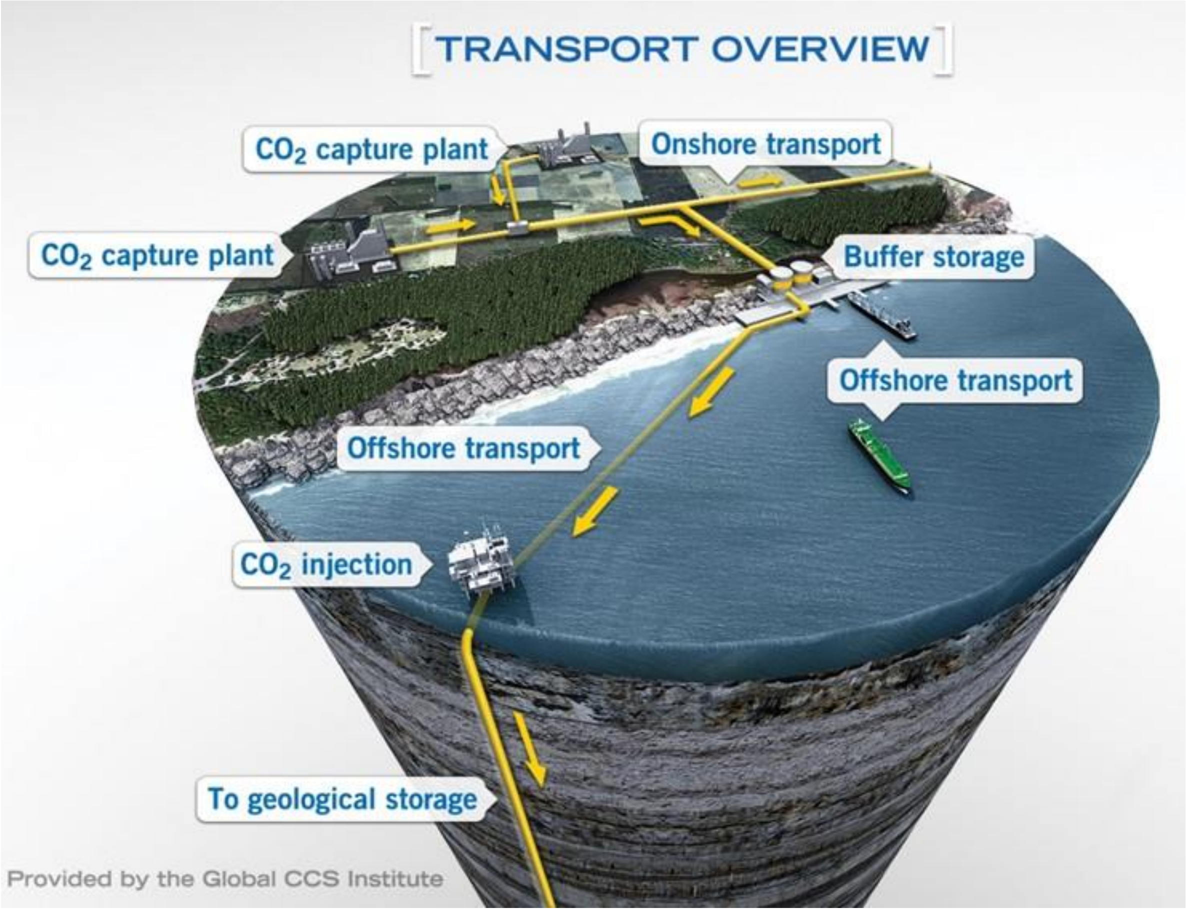
CCS PROJECTS

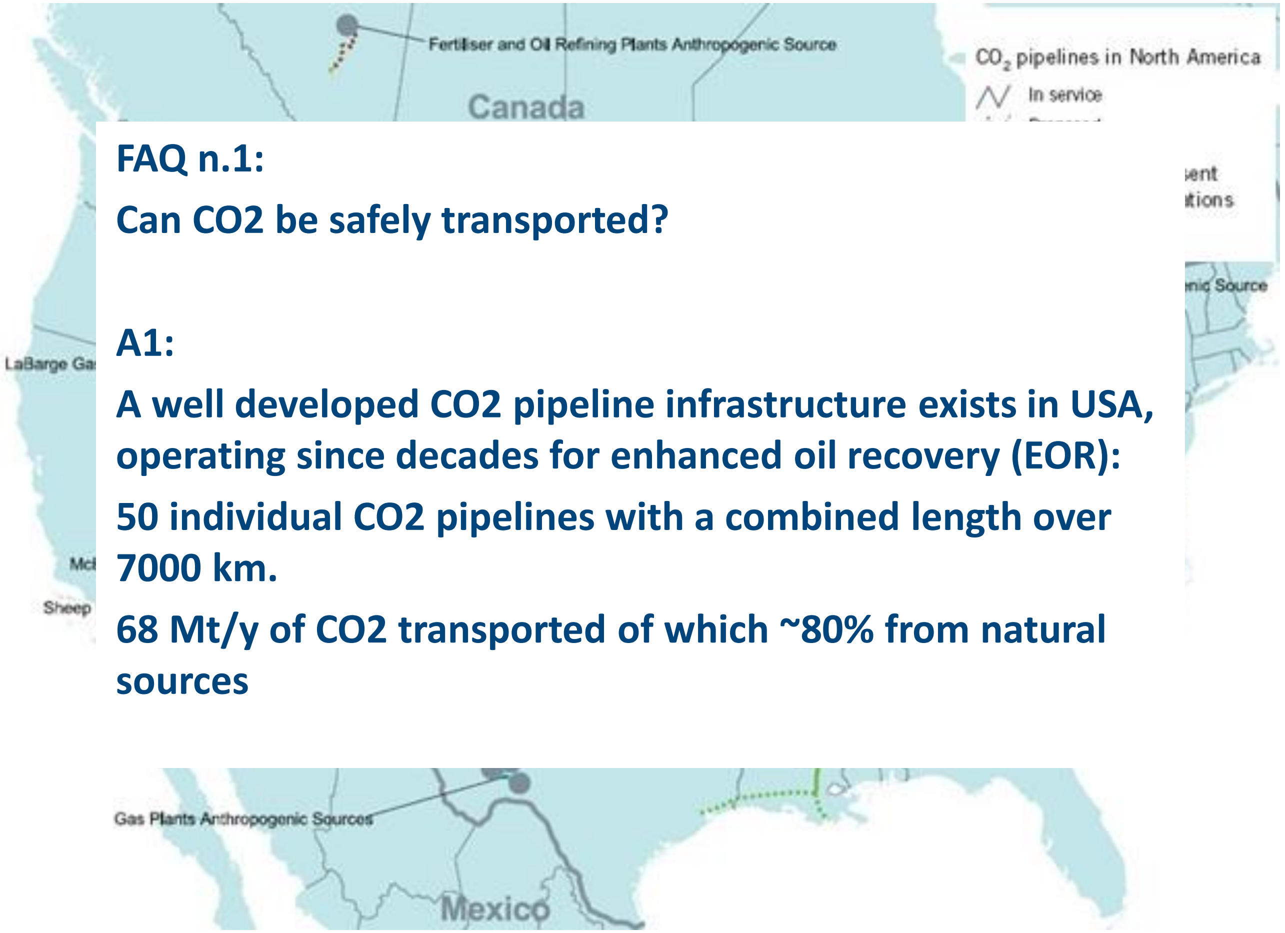


Global CCS Institute, The global status of CCS, 2018.

20

CO_2 Transport





FAQ n.1:

Can CO2 be safely transported?

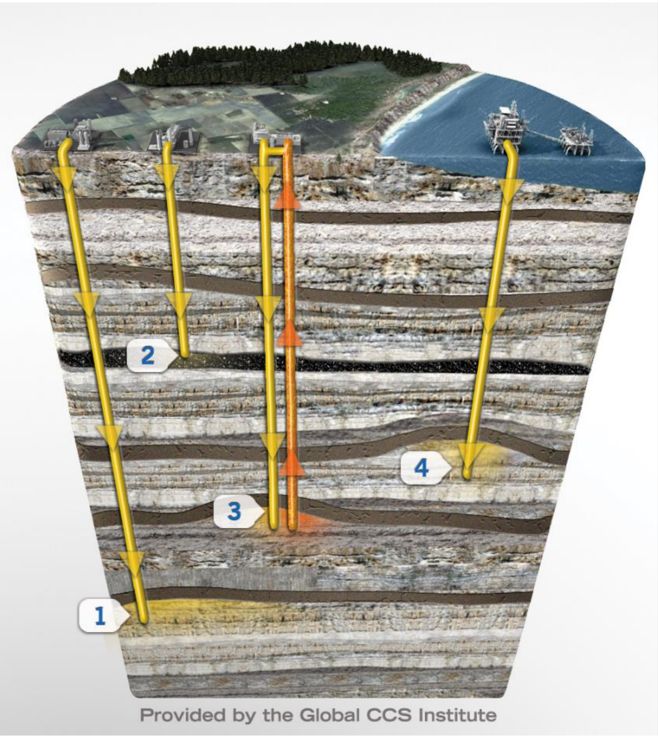
A1:

A well developed CO2 pipeline infrastructure exists in USA, operating since decades for enhanced oil recovery (EOR):

50 individual CO2 pipelines with a combined length over 7000 km.

68 Mt/y of CO2 transported of which ~80% from natural sources

CO_2 Storage (or utilization)



1 – Saline formation
2 – Deep unmineable coal seams
3 - EOR
4 – Depleted oil and gas reservoirs

FAQ n.2:

Will CO_2 remain stored for sufficiently long (i.e. several thousand years)?

Won't CO_2 escape back to the atmosphere?

A1:

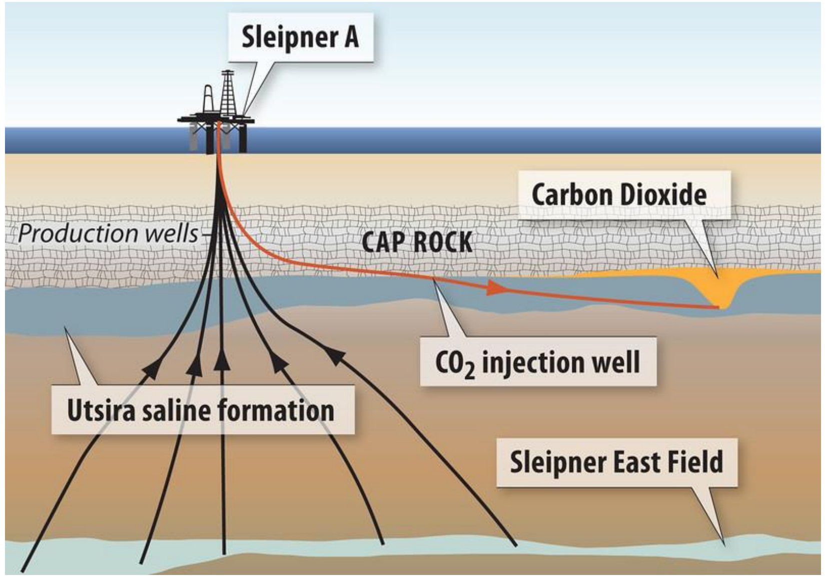
There is a huge number of natural CO_2 fields naturally storing CO_2 and other gases on geologic time scales

FAQ n.3:

Is there enough CO2 storage capacity in the world?

A2:

Yes: 100-200 GtCO2 should be stored in the next 50 years and the worldwide geologic storage capacity is much larger than this.



Sleipner plant:
0.85 Mt/year of CO2 (1996).

The strategic role of CC(U)S

CC(U)S is strategic for two reasons:

1) **give us the time we need** to convert the activities which can be decarbonized to "low-carbon" or even "zero carbon" operation, e.g. production of electricity
2) **reduce** to very low levels the **CO2 emissions from activities which are hard (or impossible) to decarbonize**, e.g. cement and steel production

The rationale of 1) is that the dependence of our economy from fossil fuels is so massive and pervasive that the time needed for its conversion to a "low-carbon mode" cannot match the urgency of Climate Change mitigation

The extent to which 2) is needed will depend on how much and how fast shall we achieve decarbonization where decarbonization is physically / technologically possible.

No matter how much and when we'll succeed in decarbonizing, **the sooner the better**

Co-funded by the Horizon 2020 Framework Programme of the European Union

The *hard-to-abate* industry

Co-funded by the Horizon 2020
Framework Programme of the European Union

Distinctive features of the *hard-to-abate* industry

1) Cement, steel and petrochemical industry are the largest industrial contributors to CO_2 emissions:
2) A significant fraction of these CO_2 emissions are intrinsically associated to the industrial process, rather than to the generation of energy
3) Unlike power production, where fossil fuels and thus CO_2 emissions can be reduced / eliminated by substitution with renewable sources, the emission of CO_2 from process has no alternative (unless the production process is changed)
4) High CO_2 concentration in flue gases
5) The variety of sources and processes tends to require a CO_2 capture process and plant configuration tailored to the specific application
6) The usual classification in post-combustion / pre-combustion / oxy-fuel technology may not apply

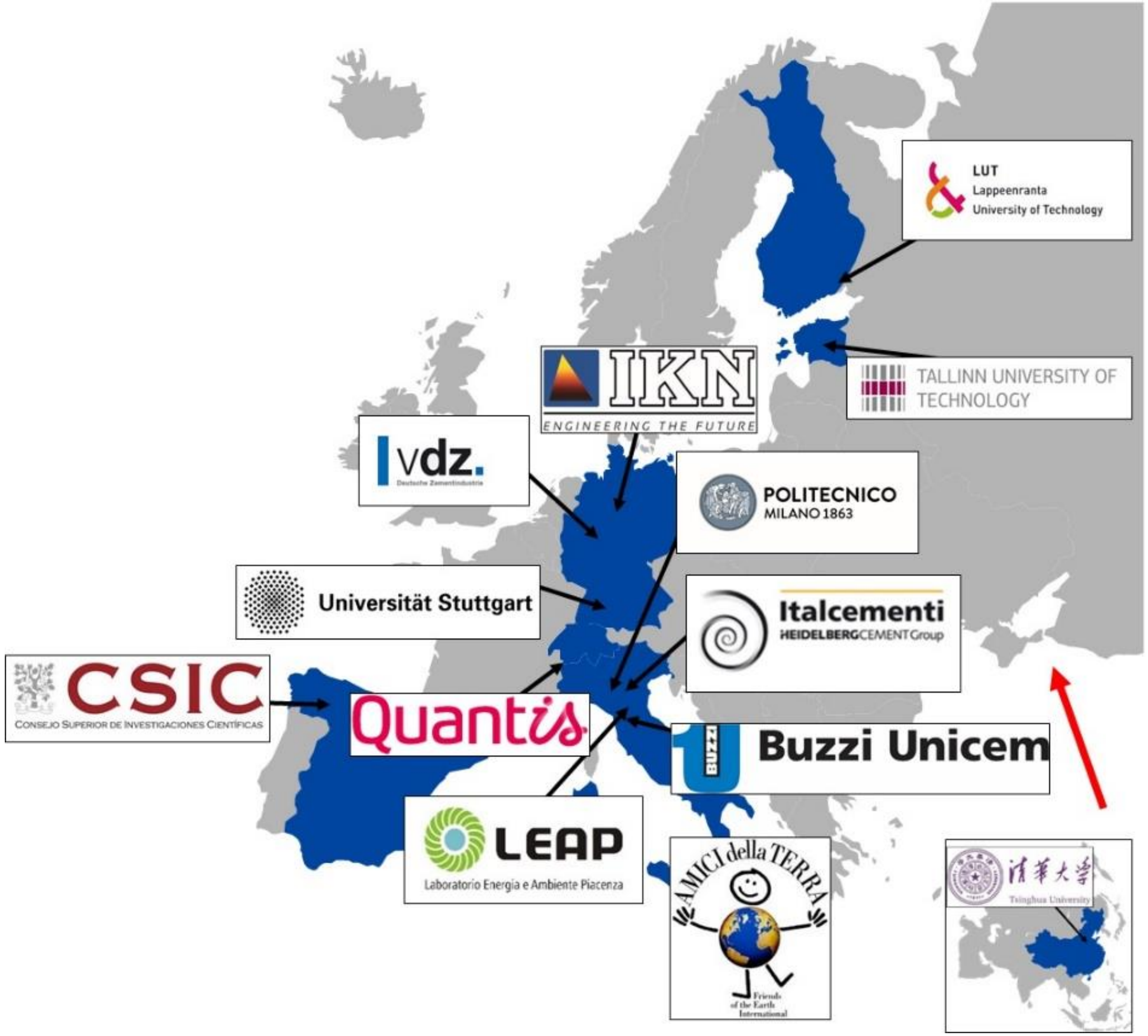
Although more "difficult", CO_2 capture in these sectors is more compelling → the *hard-to-abate* industry is a very good candidate for the initial penetration of CC(U)S

Co-funded by the Horizon 2020 Framework Programme of the European Union

Non-Power: Cement - CLEANKER project

The ultimate objective of CLEANKER is <u>advancing the integrated Calcium-looping process for CO_2 capture in cement plants</u>.

Kick-off meeting - Piacenza, 18-19 October 2017



Co-funded by the Horizon 2020
Framework Programme of the European Union

The CLEANKER project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement n. 764816

This work is supported by the China Government (National Natural Science Foundation of China) under contract No.91434124 and No.51376105

www.cleanker.eu

Twitter: @CLEANKER_H2020

LinkedIn: www.linkedin.com/company/14834346