International Energy Agency

Secure • Sustainable • Together

IEA Energy Technology Perspectives: Scenarios for Industry Decarbonisation

EPRI and IEA Workshop Renewables and Clean Energy for Industries

29 November 2016, Washington, DC

Eric Masanet, PhD

Energy Technology Policy Division

International Energy Agency

www.iea.org

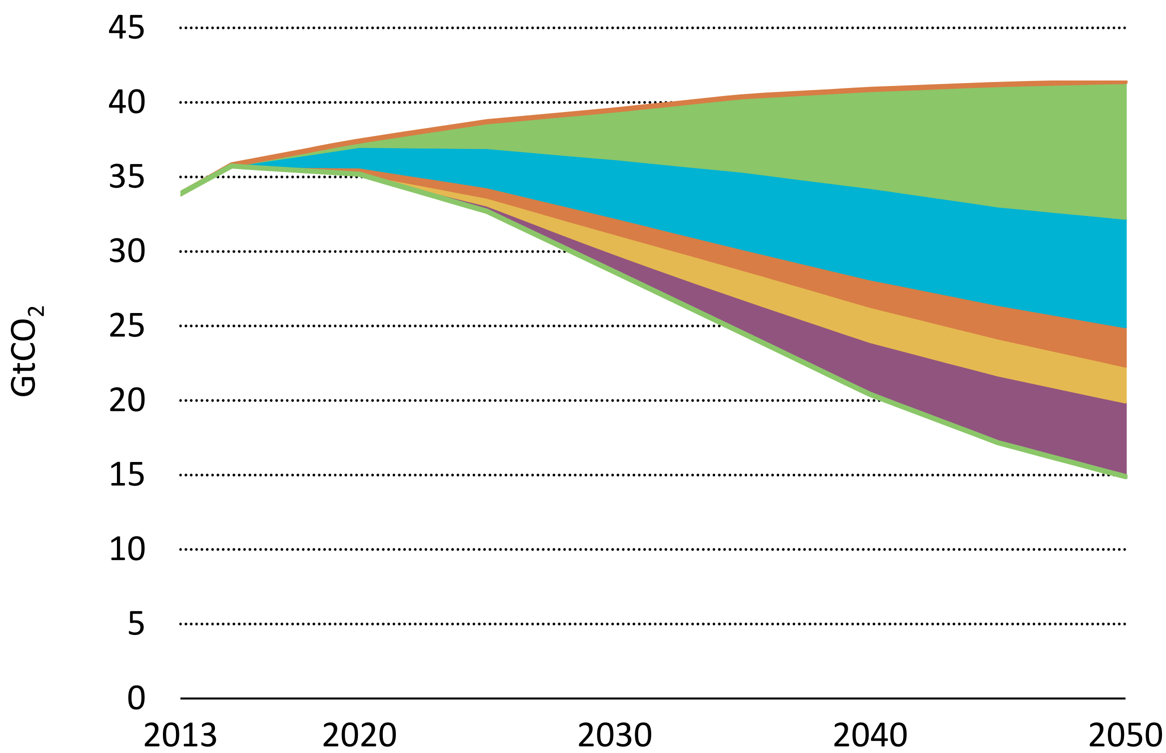
IEA Energy Technology Activities

- **Where do we need to go?**
- **Where are we today?**
- **How do we get there?**

Sizing the scale of the challenge…
… and its solutions

ETP 2016

Contribution of technology area to global cumulative CO_2 reductions



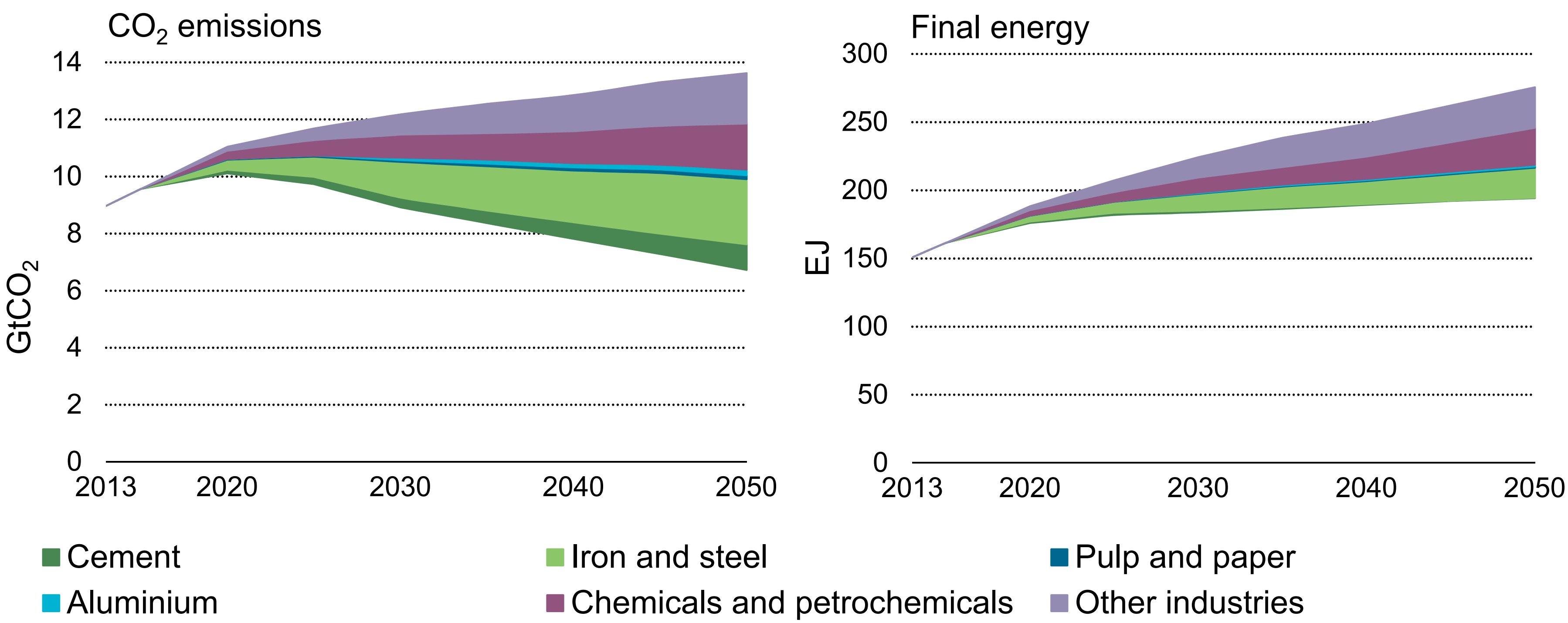
The industrial sector accounts for 23% of cumulative CO_2 reductions in the 2DS

The carbon intensity of the global economy can be cut by two-thirds through a diversified energy technology mix

The path forward for industry?

ETP 2016

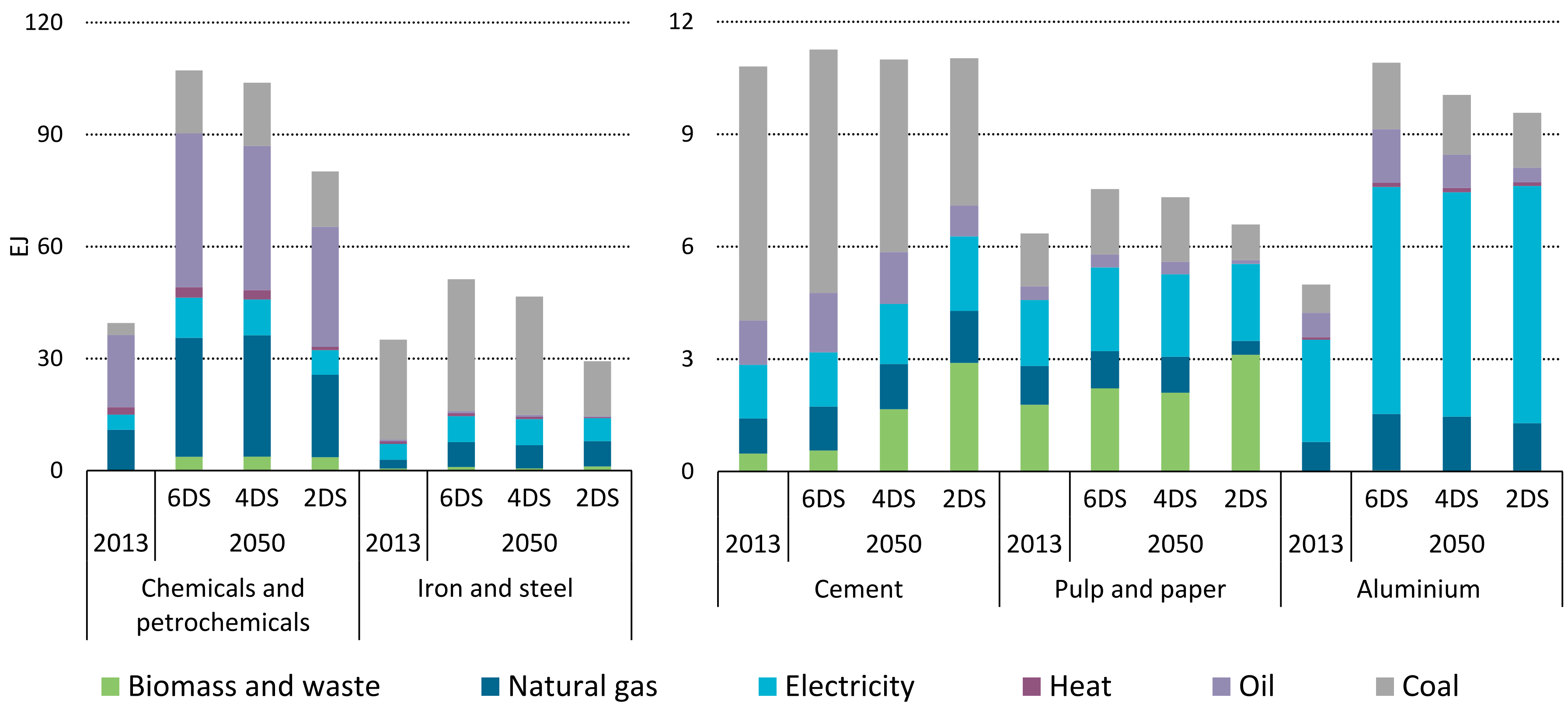
Direct industrial CO2 emissions and final energy reductions in the 2DS compared with the 6DS



Large reductions in direct CO_2 emissions are possible, but energy use and emissions must be decoupled

Decoupling energy use and CO_2 requires a mix of technologies …

ETP 2016

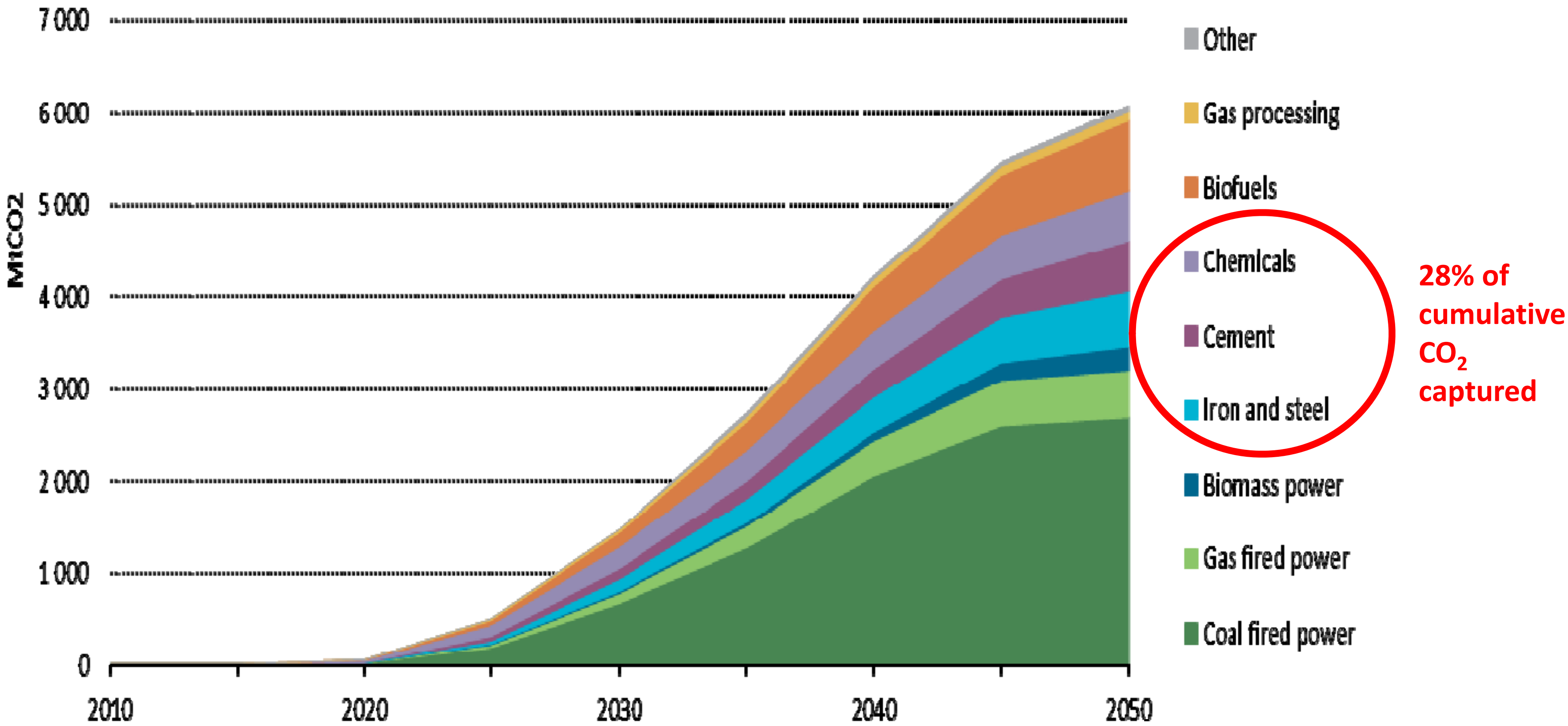


By 2050, biomass, waste, and electricity grow to 25% of final energy demand, while overall energy use decreases by 24%

… including a pivotal role for industrial carbon capture

ETP 2016

Sources of CO_2 emissions captured in the 2DS

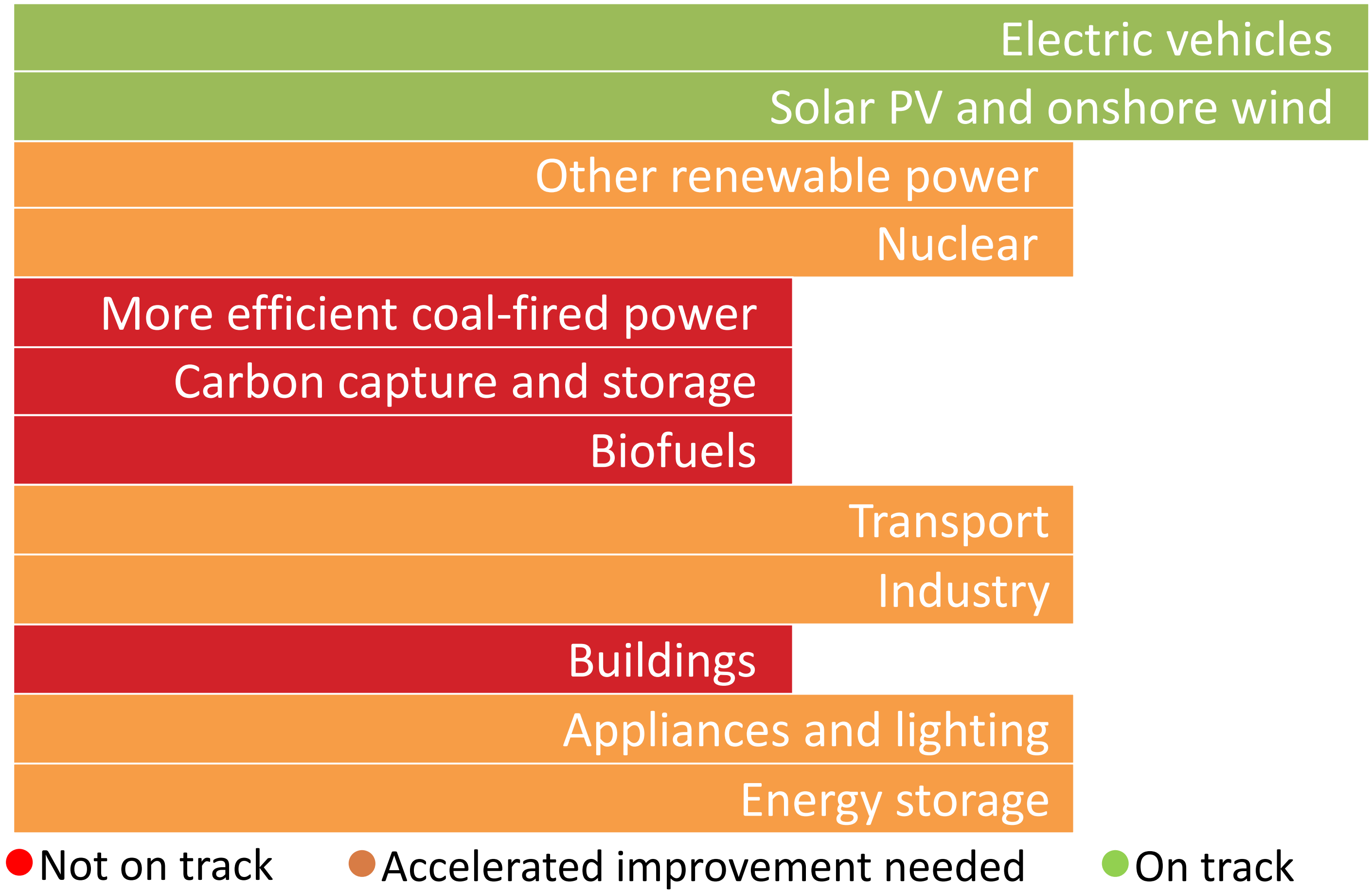


The deployment of CCS from all sources must be accelerated to stay on track for the 2DS

Progress in clean energy needs to accelerate

ETP 2016

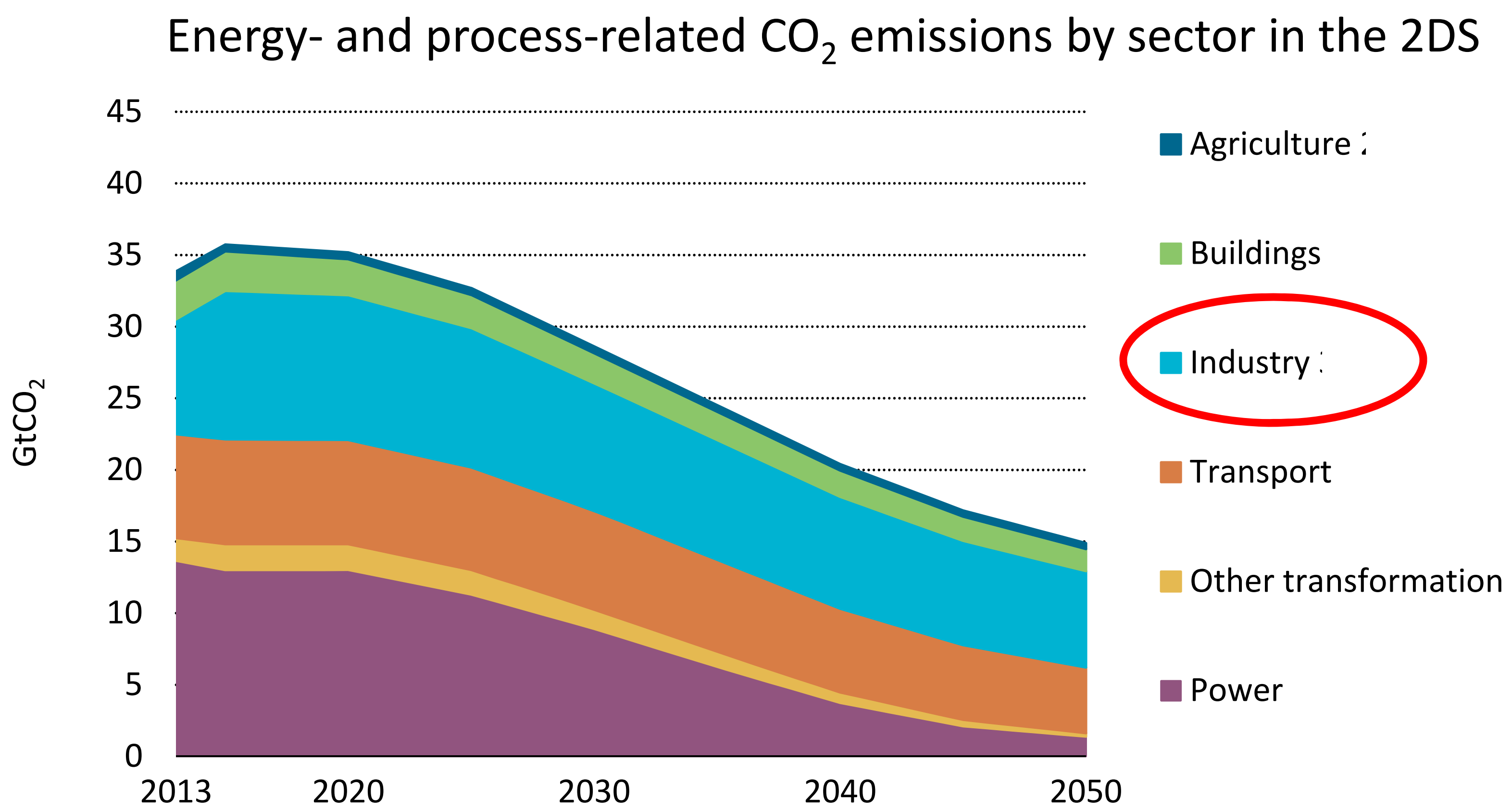
Technology Status today against 2DS targets by 2025



Clean energy deployment is still overall behind what is required to meet the 2°C goal, but recent progress on electric vehicles, solar PV and wind is promising

The challenge increases to get from 2 degrees to "well below" 2 degrees …

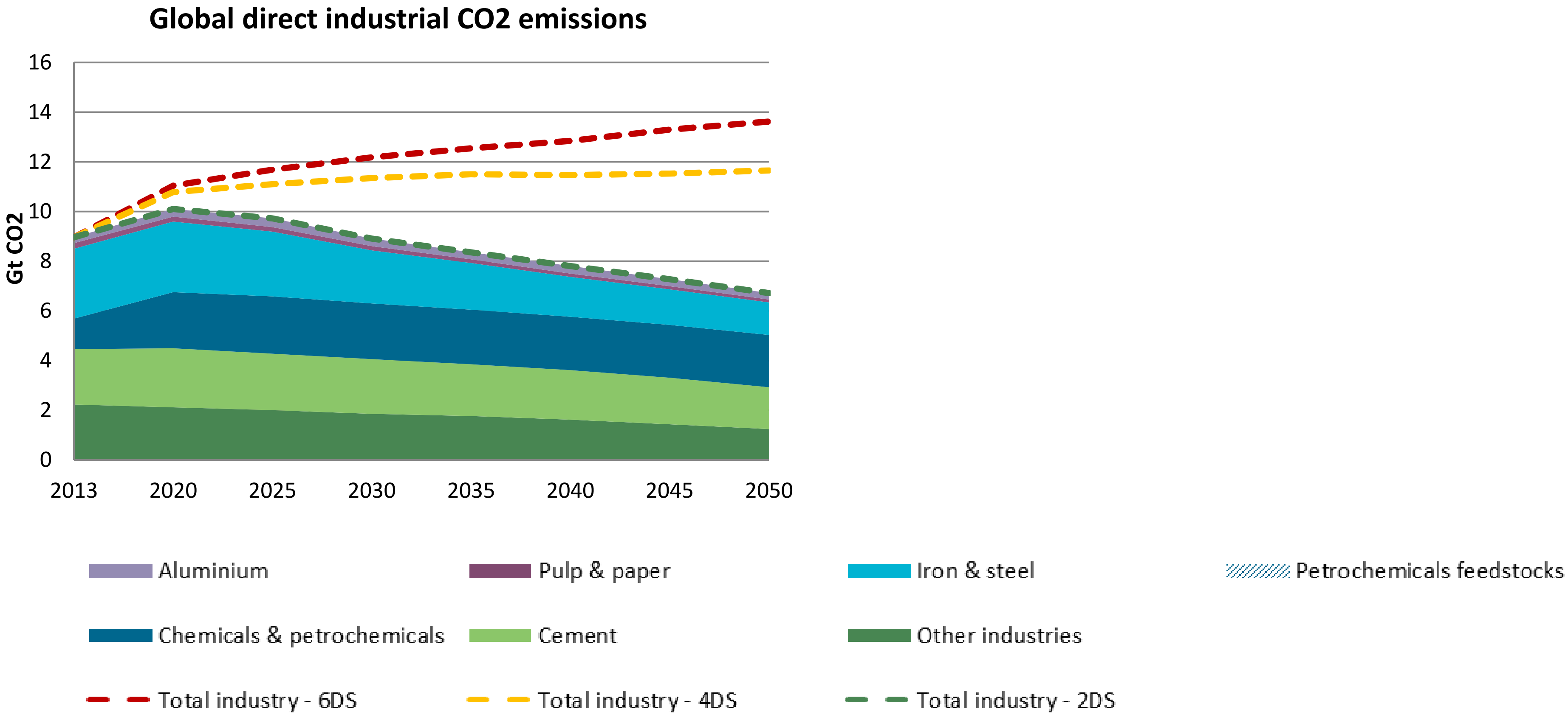
ETP 2016



Industry and transport account for the majority of remaining direct emissions in the 2DS in 2050.

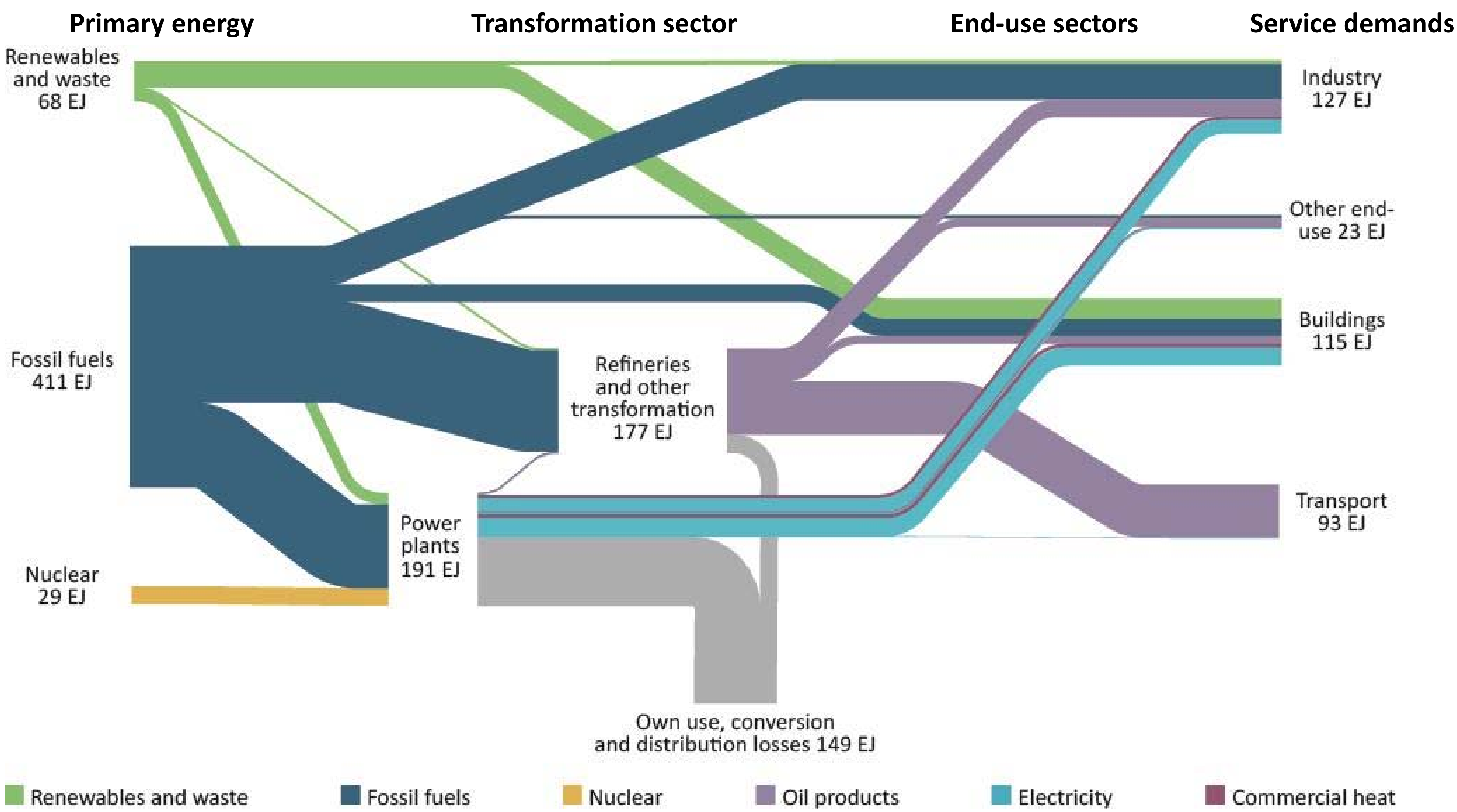
… and energy-intensive industries must lead the way

ETP 2016



Decarbonizing energy-intensive industries requires accelerated technology and policy innovation

Detailed picture of today's energy system

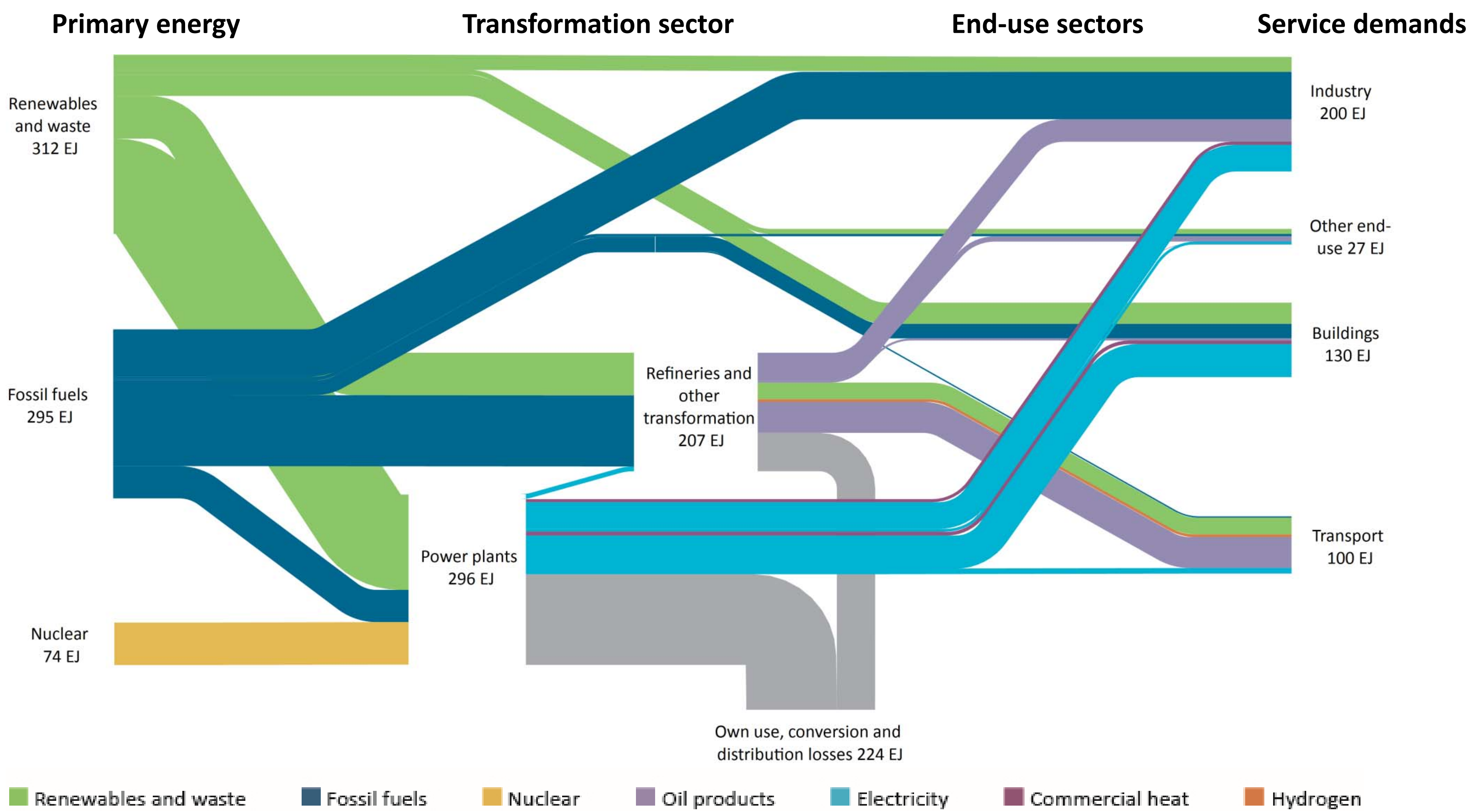


Global energy system today

International Energy Agency
Secure • Sustainable • Together

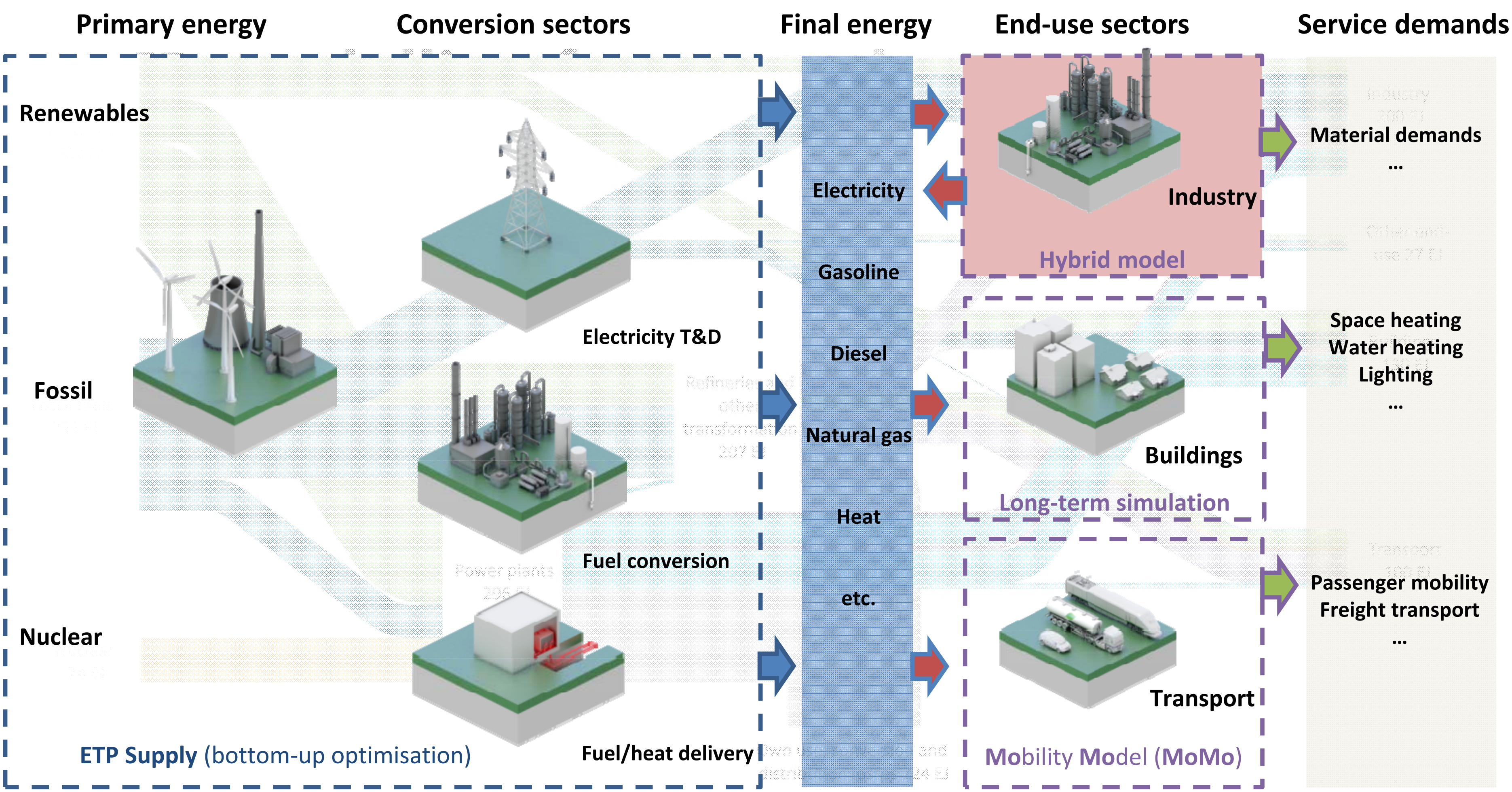
What would a 2DS world look like?

www.iea.org



Global energy system in the 2DS 2050

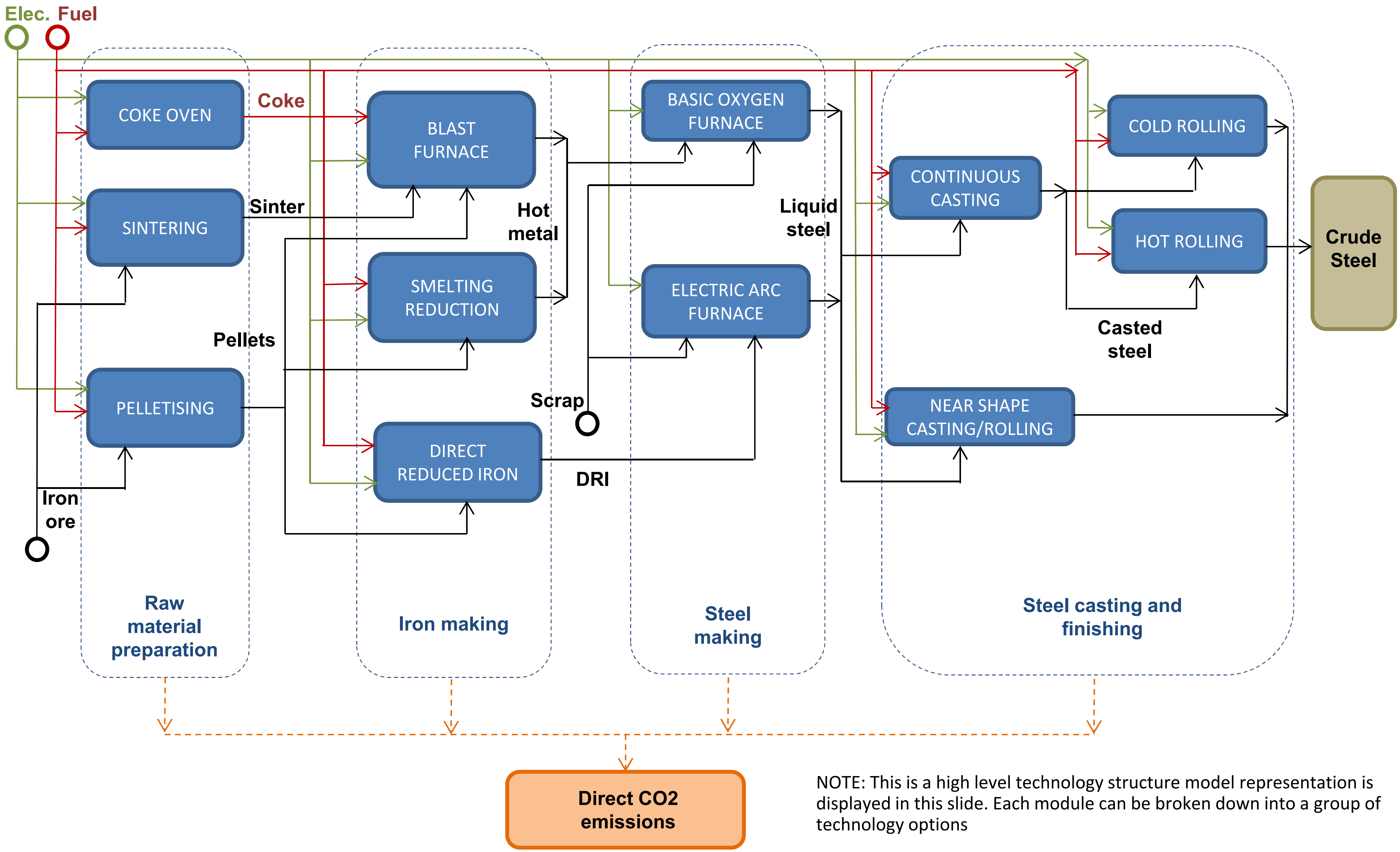
ETP modelling framework



International Energy Agency
Secure • Sustainable • Together

ETP Times Iron & Steel model scope

www.iea.org

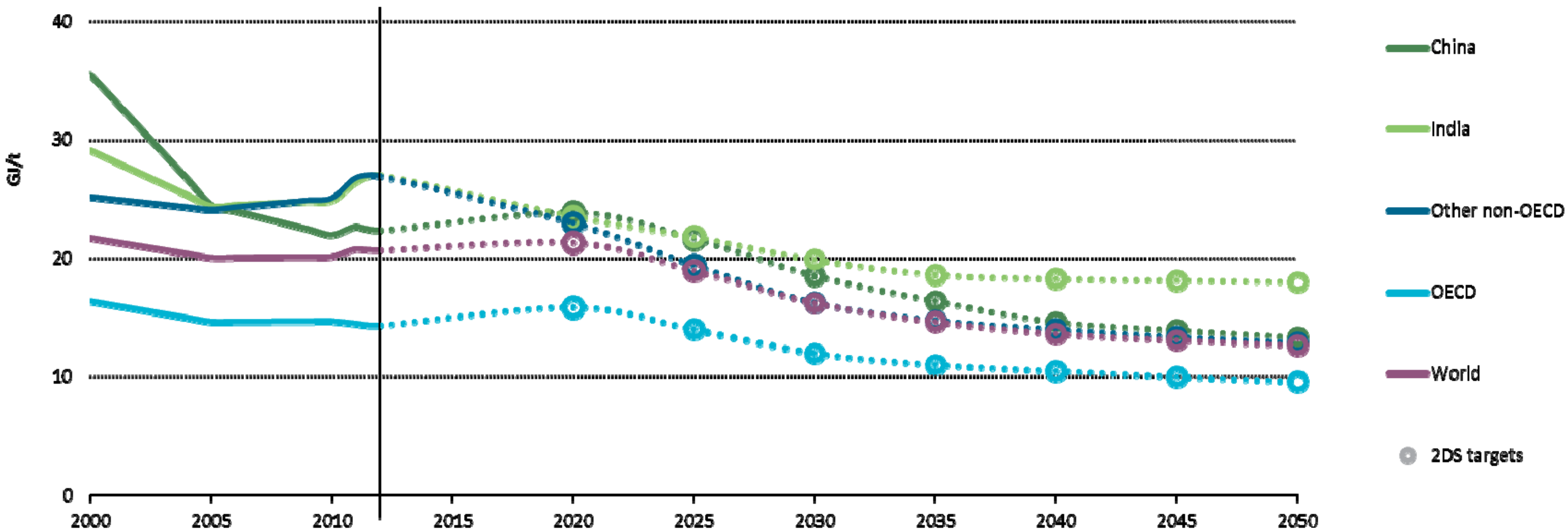


NOTE: This is a high level technology structure model representation is displayed in this slide. Each module can be broken down into a group of technology options

While continued efficiency improvements are critical …

ETP 2015

Iron and steel aggregated energy intensity



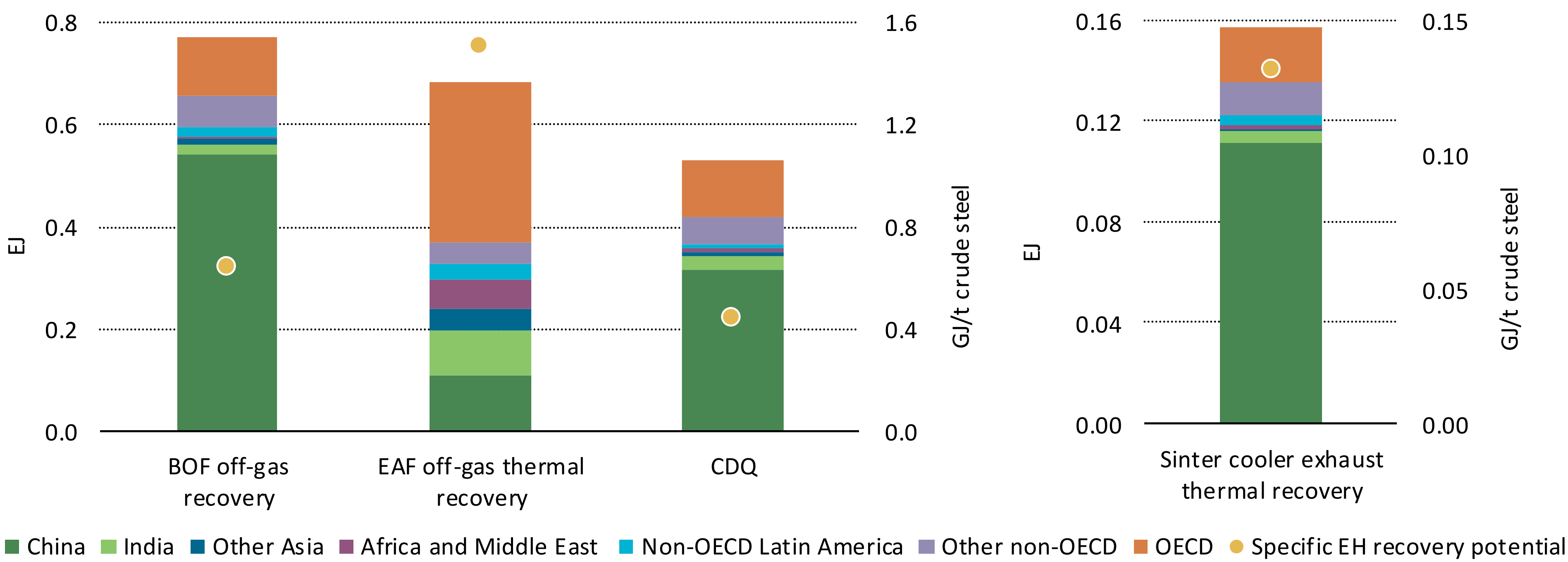
Note: Aggregate energy intensity includes final energy consumption in blast furnaces and coke ovens, as well as the portion of fuel consumption related to thermal energy generation of captive utilities for internal use.
Source: Derived from IEA Energy Balances.

Energy efficiency continues to deliver, but is limited by current technology and scrap availability

… expanding spatial boundaries may achieve greater energy savings …

ETP 2016

Global excess heat recovery technical potential – Iron and steel

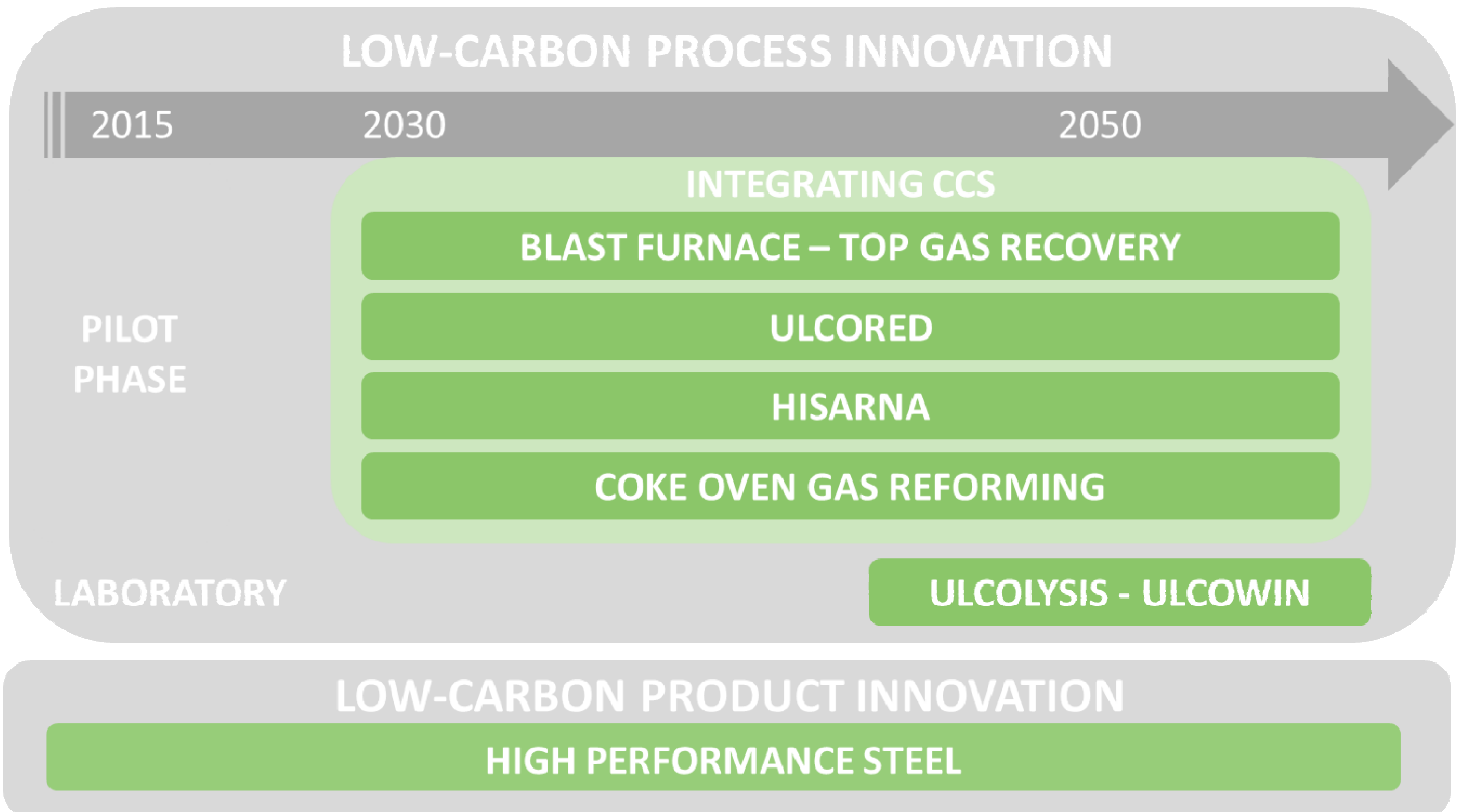


NOTE: Only medium and high temperature IEH sources (>100 degC) and commercial recovery technologies included.
SOURCE: Energy Technology Perspectives 2016

Globally, 6% of the final energy use in iron and steel making could be technically recovered

… and more innovative low-carbon technology options are needed

ETP 2015



Note: This slide is not intended to provide an exhaustive list. Sketch is not at scale and time milestones are just illustrative.

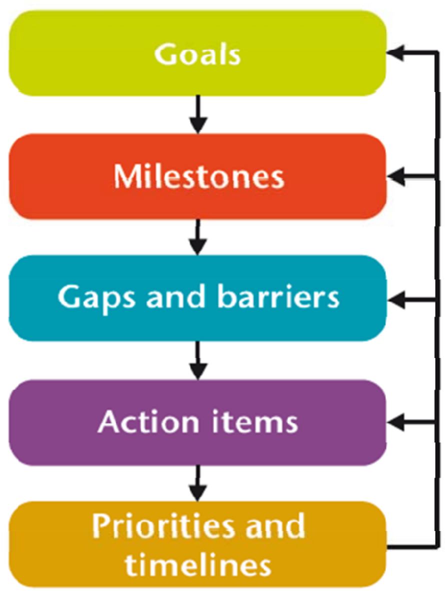
Low-carbon process technology RD&D is promising, but progress must be accelerated

International Energy Agency
Secure • Sustainable • Together

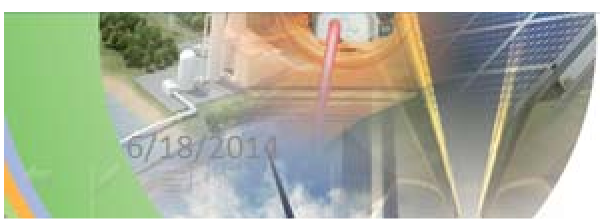
Technology Roadmapping:
Bringing stakeholders together

2009 2010 2011 2012 2013 2014 2015

- Goal to achieve
- Milestones to be met
- Gaps to be filled
- Actions to overcome gaps and barriers
- What and when things need to be achieved



- **32 global publications, 21 different technology areas**
- **Re-endorsed at G7 Energy Ministerial Meeting in May 2016 (Kitakyushu)**
- **New Cycle for Implementation:**
  - Near-term actions
  - Regional Relevance
  - Key partnerships (e.g. Finance)
  - Metrics and Tracking



Low-Carbon Technology Roadmaps

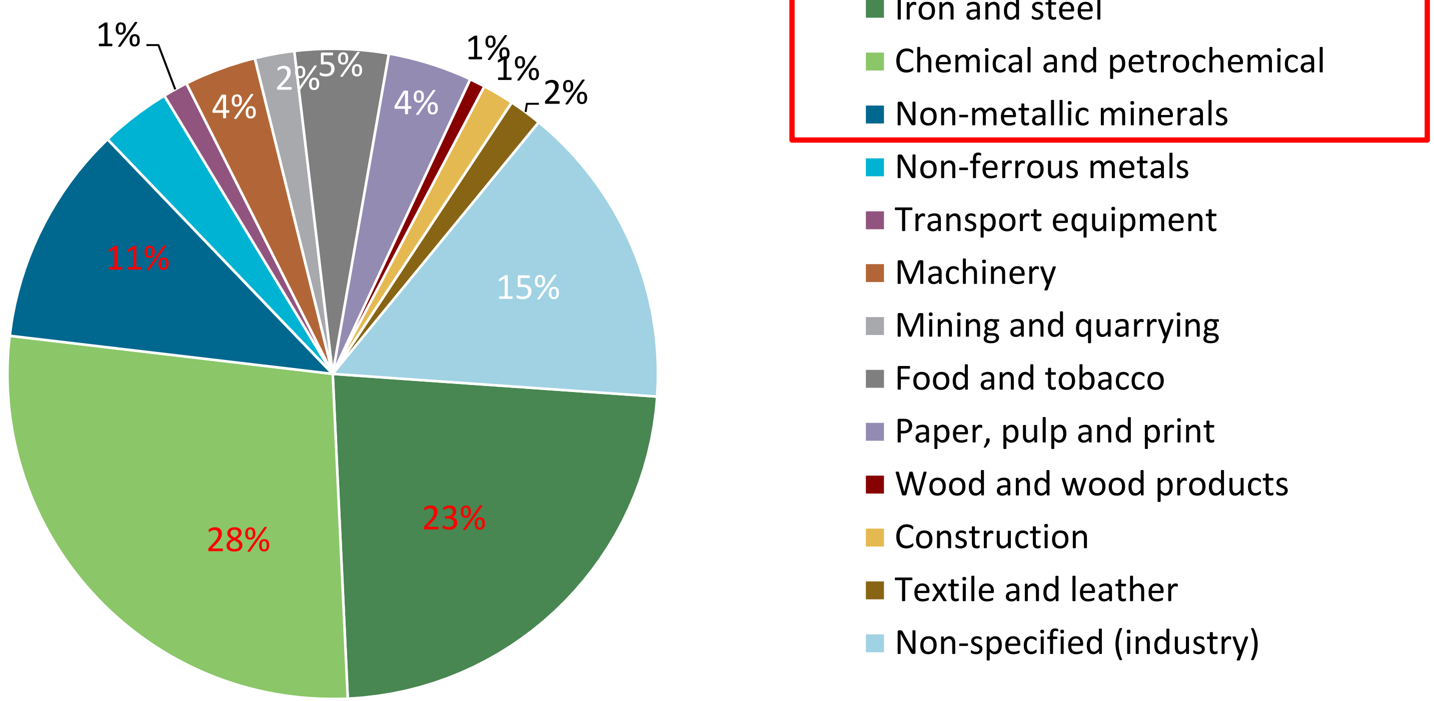
IEA Roadmaps: action plans to accelerate industrial energy transitions

International Energy Agency
Secure • Sustainable • Together

www.iea.org

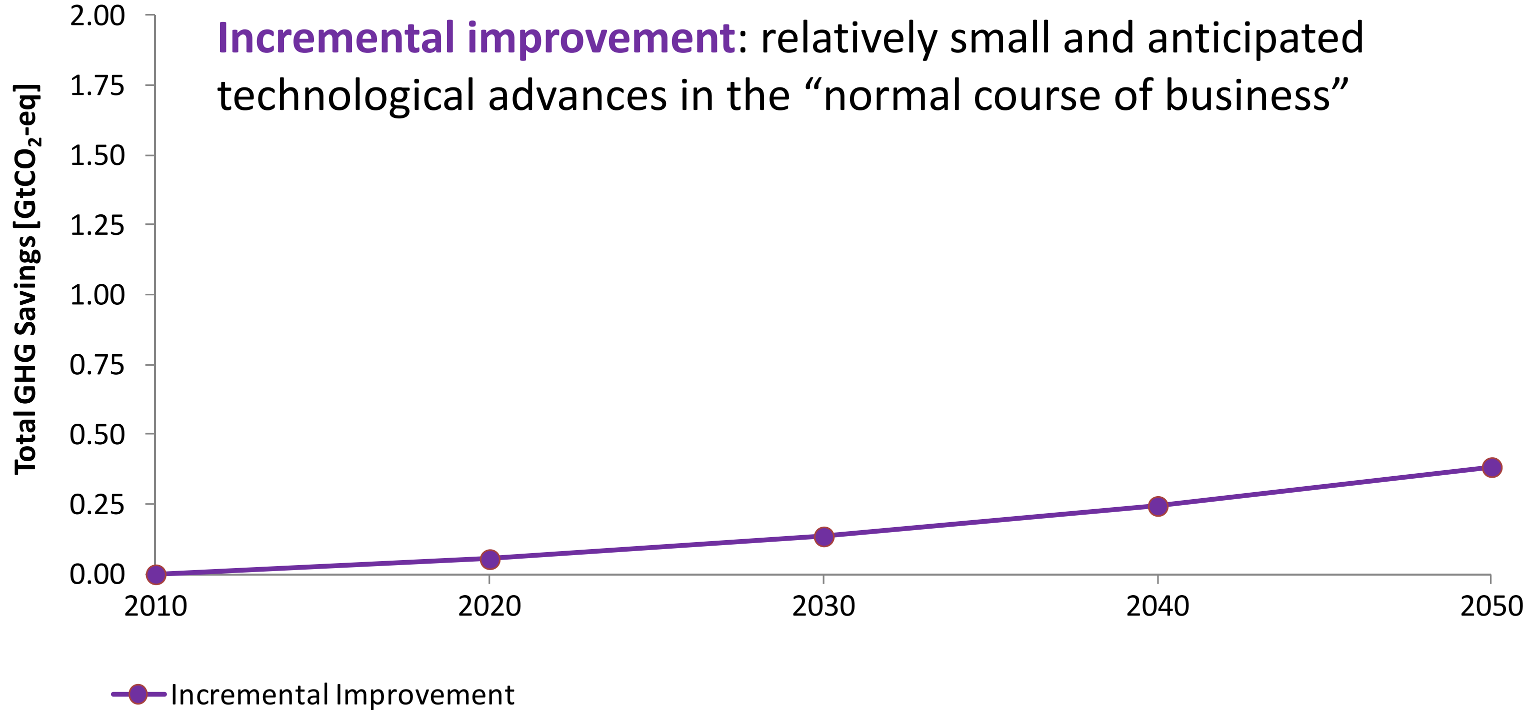
2009	2013	2015	2017
✓ Global Cement	✓ India Cement ✓ Chemical catalysis ✓ CCS	✓ Hydrogen	✓ Brazil Cement ✓ India Cement Update Tentative: • Global Cement Update • Iron and steel

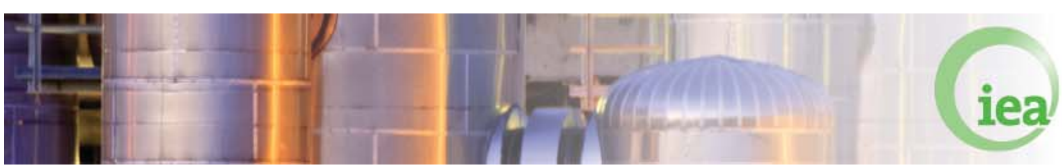
Final industrial energy use , 2014 (154 EJ)



SOURCE: IEA Energy Balance.
Note: Iron & Steel includes blast furnaces and coke ovens. Chemicals & Petrochemicals includes petrochemicals feedstocks.

GHG emissions avoidance potential in chemical industry



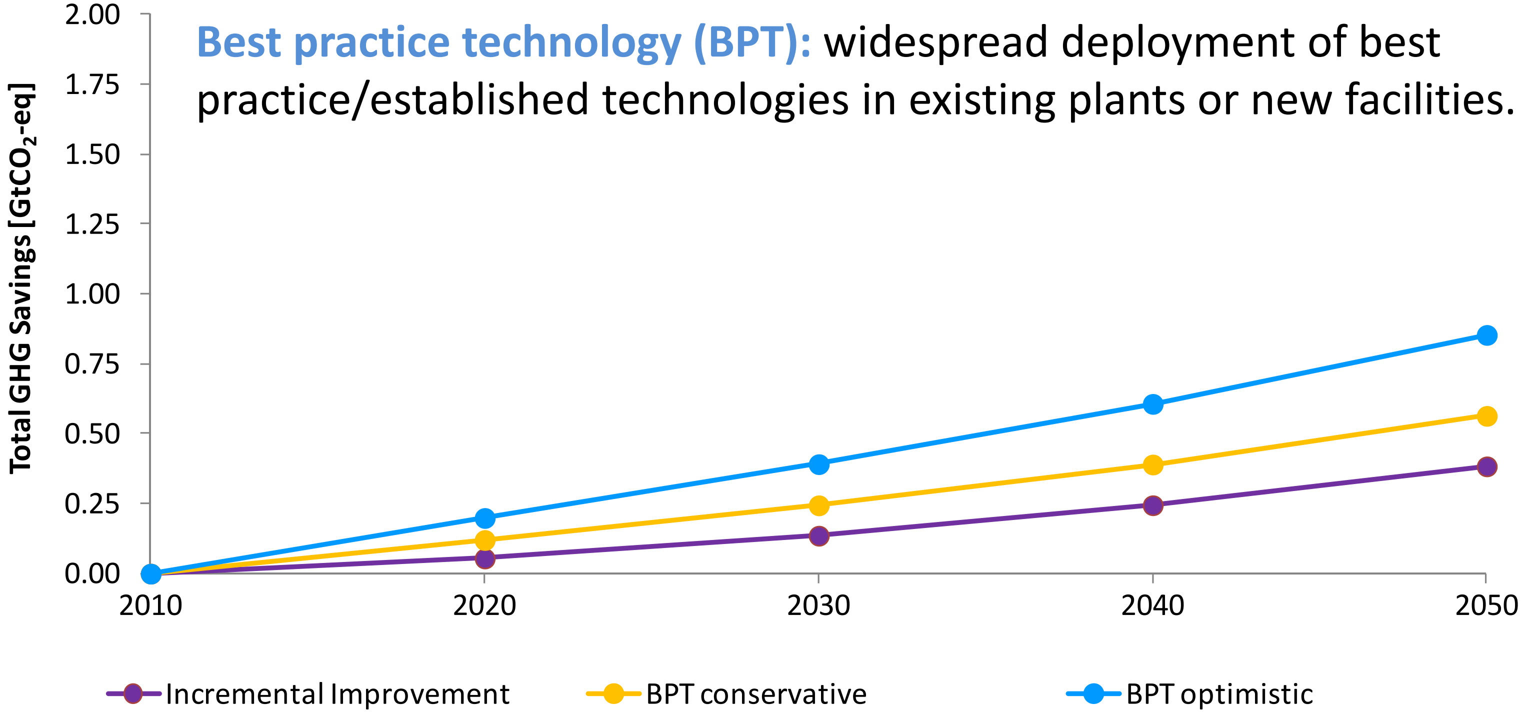


International Energy Agency

ICCA INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS

DECHEMA

GHG emissions avoidance potential in chemical industry



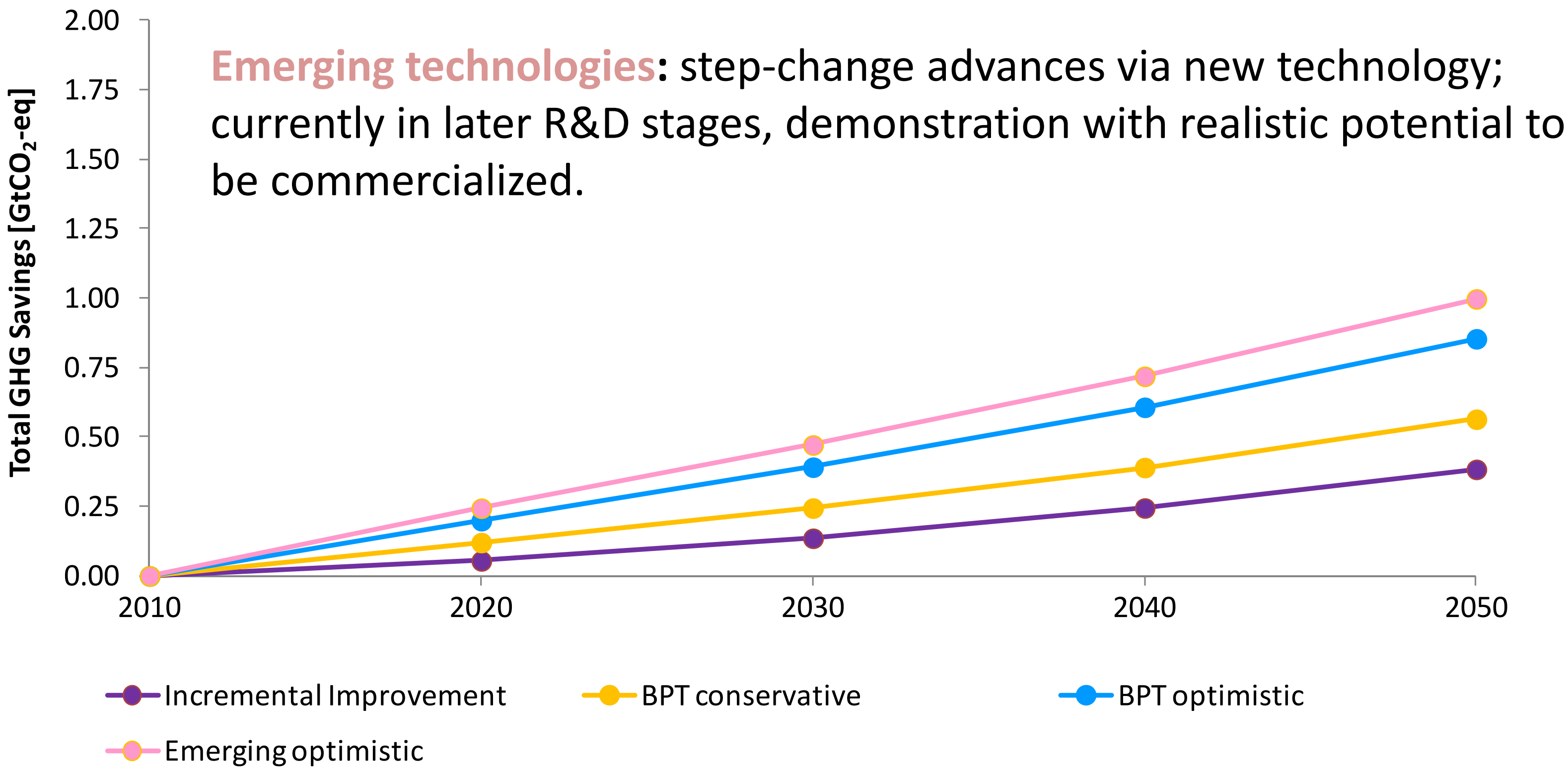
International Energy Agency

INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS

DECHEMA

GHG emissions avoidance potential in chemical industry

Emerging technologies: step-change advances via new technology; currently in later R&D stages, demonstration with realistic potential to be commercialized.

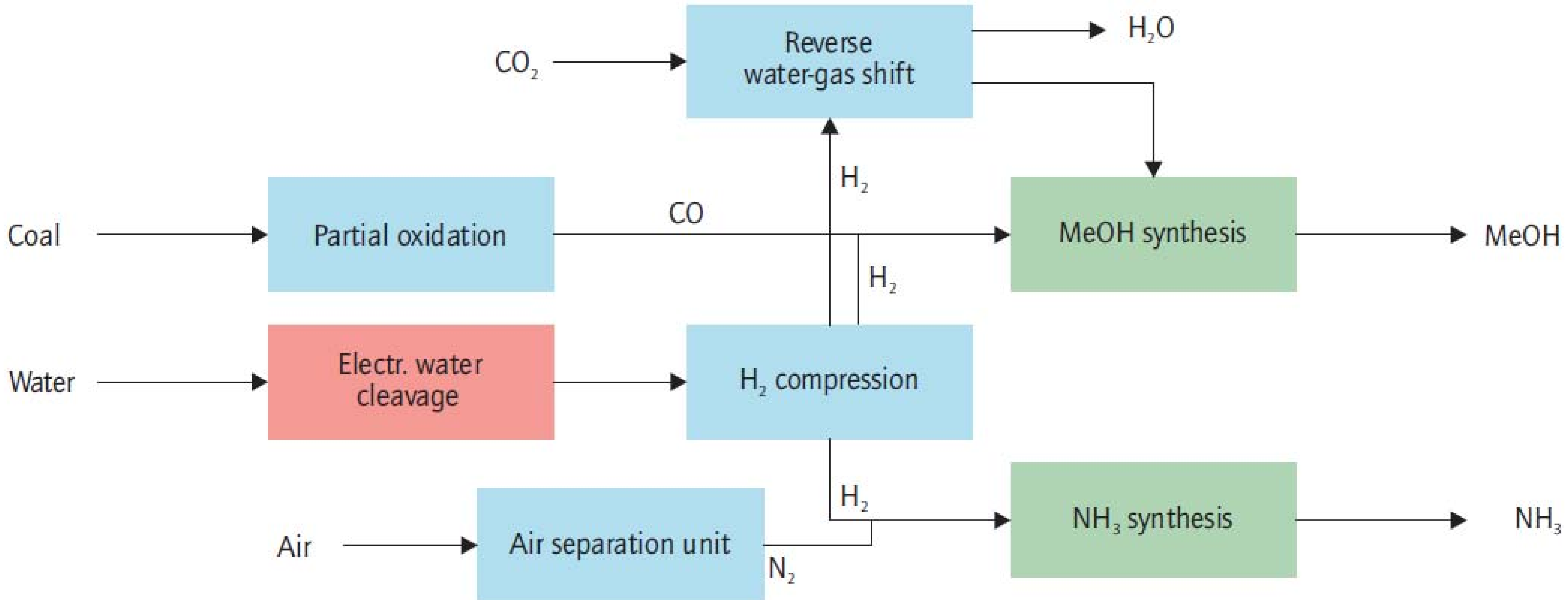


International Energy Agency

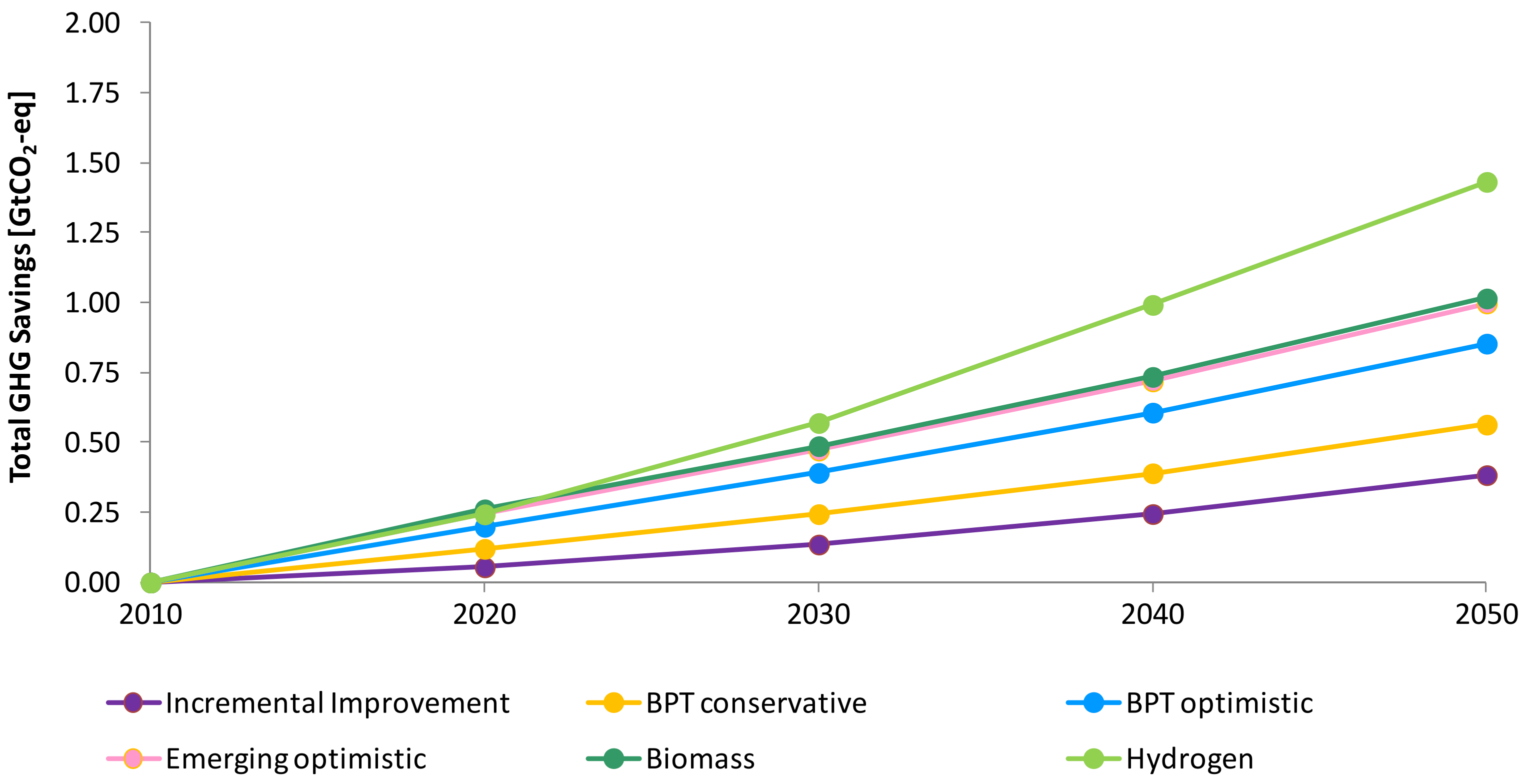
INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS

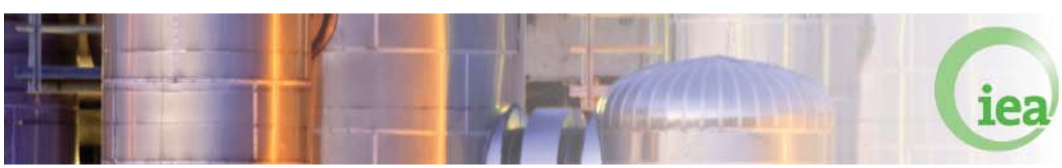
DECHEMA

Hydrogen from water cleavage for ammonia and methanol production

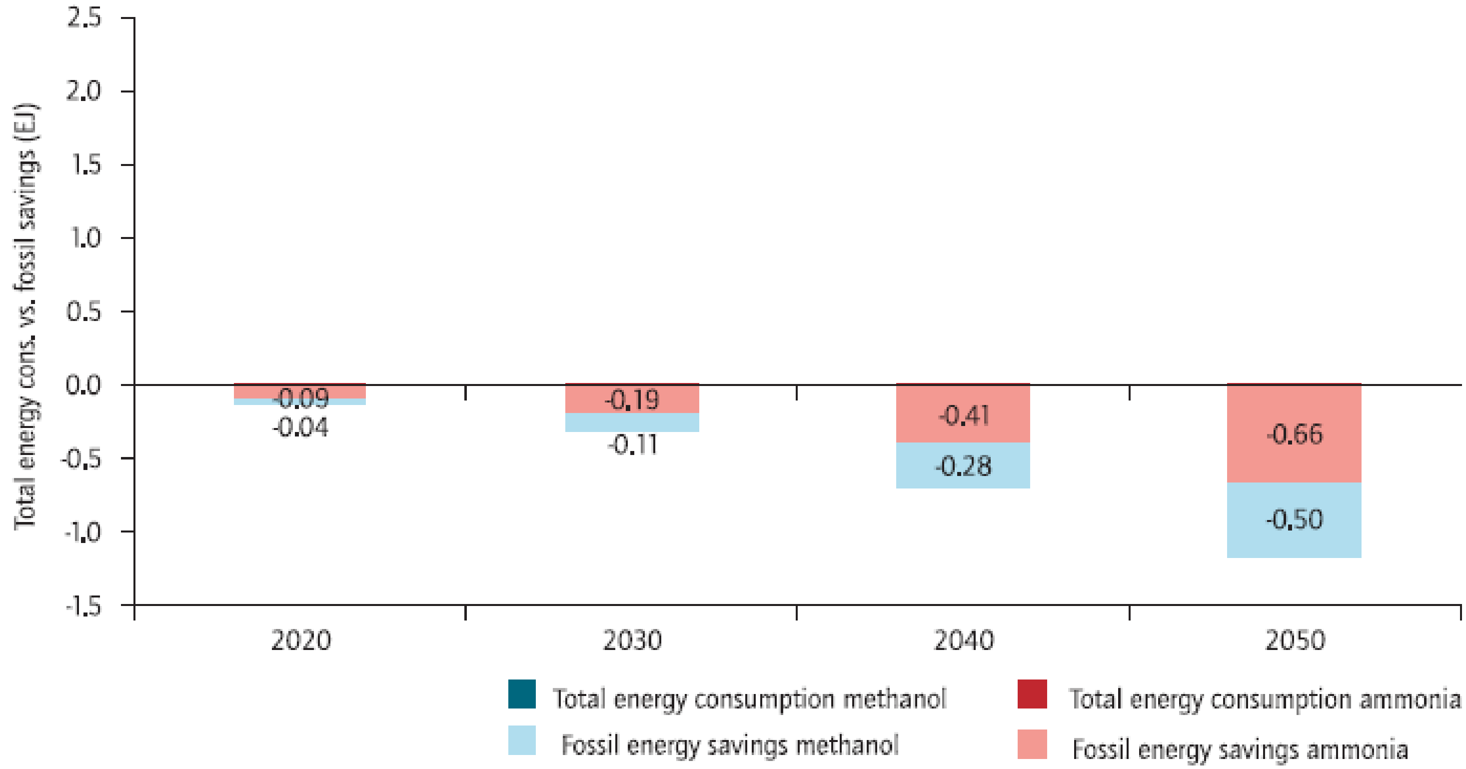


GHG emissions avoidance potential in chemical industry





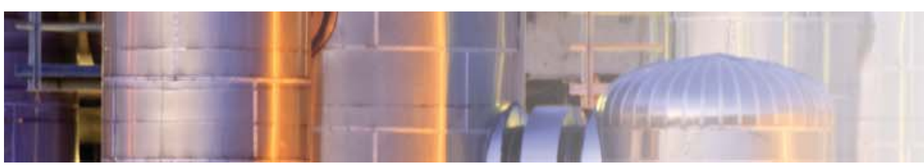
Additional energy and fossil energy savings for ammonia and methanol via hydrogen



Note: % = implementation rate of hydrogen route.

Source: DECHEMA.

Production of H2 results in significant additional energy use, but also significant GHG savings



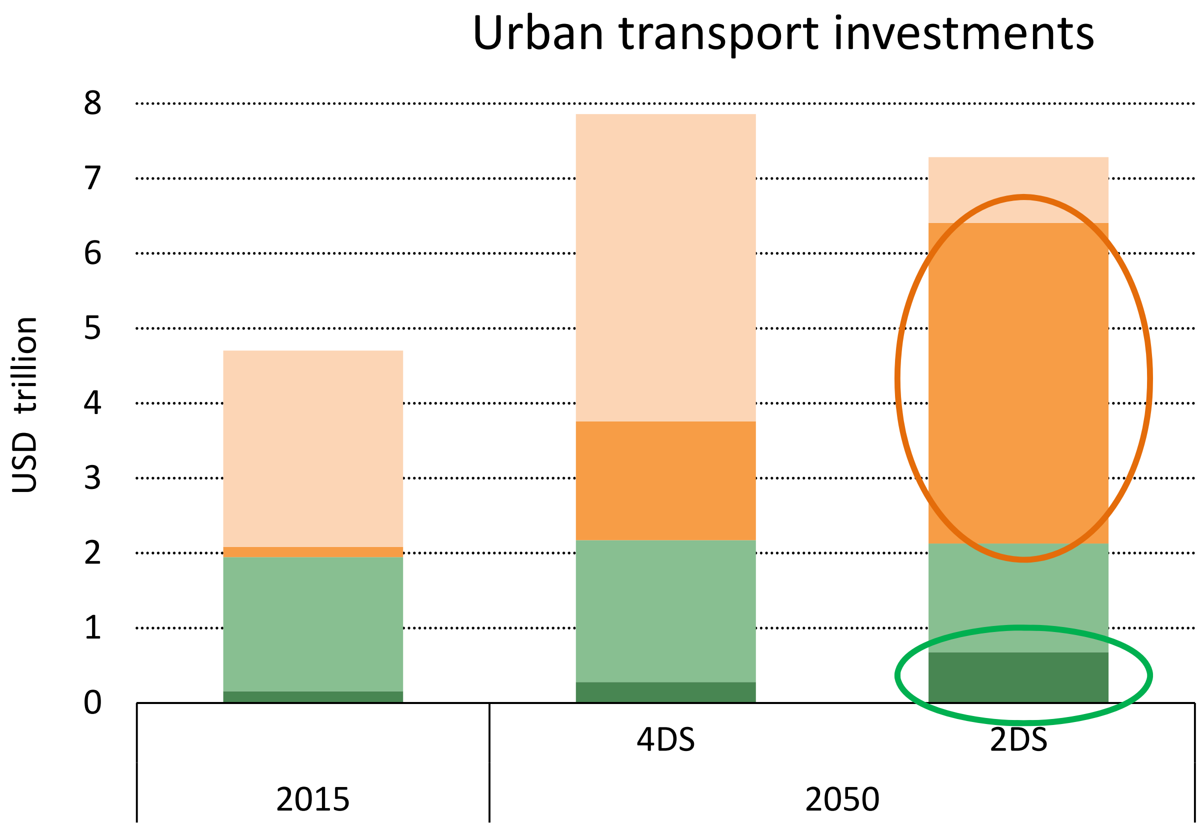
International Energy Agency

INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS

DECHEMA

Rethinking materials cycles

ETP
2016



In the 2DS, by 2050 one billion cars are electric vehicles while public transport travel activity more than doubles

Priorities for decarbonizing industry

- **Achieving BAT performance is critical, while accelerating low-carbon innovations is essential**
  - BAT includes energy and resource efficiency (e.g., yield improvements)
  - The pace of CCS deployment must increase
  - Low-carbon process innovations require accelerated RD&D, investments
- **Low-carbon fuel switching plays a key role**
  - Biomass for renewable fuels and feedstocks, but supplies may be uncertain
  - Low-carbon electrification scale depends on innovation
- **Expanding boundaries of influence can create new opportunities**
  - Waste heat recovery for local plants/buildings
  - Materials efficiency in end use product applications
- **Multiple aspects of strong policy support are needed:**
  - Long-term energy and climate policy signals
  - Increased support for technology RD&D
  - Low-carbon and energy efficiency labels and standards