IEA Energy Technology Activities

- Where do we need to go?
- Where are we today?
- How do we get there?
The carbon intensity of the global economy can be cut by two-thirds through a diversified energy technology mix.

The industrial sector accounts for 23% of cumulative CO₂ reductions in the 2DS.
The path forward for industry?

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

Large reductions in direct CO₂ emissions are possible, but energy use and emissions must be decoupled.
Decoupling energy use and CO₂ requires a mix of technologies ...

By 2050, biomass, waste, and electricity grow to 25% of final energy demand, while overall energy use decreases by 24%
The deployment of CCS from all sources must be accelerated to stay on track for the 2DS.
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 ...

Energy- and process-related CO₂ emissions by sector in the 2DS

Industry and transport account for the majority of remaining direct emissions in the 2DS in 2050.
Decarbonizing energy-intensive industries requires accelerated technology and policy innovation... and energy-intensive industries must lead the way
Detailed picture of today’s energy system

Global energy system today

- **Primary energy**
  - Renewables and waste: 68 EJ
  - Fossil fuels: 411 EJ
  - Nuclear: 29 EJ

- **Transformation sector**
  - Power plants: 191 EJ
  - Refineries and other transformation: 177 EJ
  - Own use, conversion and distribution losses: 149 EJ

- **End-use sectors**
  - Industry: 127 EJ
  - Buildings: 115 EJ
  - Transport: 93 EJ
  - Other end-use: 23 EJ

- **Service demands**

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What would a 2DS world look like?

Global energy system in the 2DS 2050
ETP modelling framework

Primary energy
- Renewables
  - Electricity T&D
- Fossil
  - Fuel conversion
- Nuclear
  - ETP Supply (bottom-up optimisation)

Conversion sectors
- Electricity T&D
- Fuel conversion
- Fuel/heat delivery

Final energy
- Electricity
- Gasoline
- Diesel
- Natural gas
- Heat
- etc.

End-use sectors
- Industry
- Buildings
- Transport
  - Passenger mobility
  - Freight transport

Service demands
- Material demands
  - etc.
- Space heating
- Water heating
- Lighting
  - etc.

Mobility Model (MoMo)
Long-term simulation

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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 gains are needed...

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
Globally, 6% of the final energy use in iron and steel making could be technically recovered.
Low-carbon process technology RD&D is promising, but progress must be accelerated
Technology Roadmapping: Bringing stakeholders together

- 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

#### Final industrial energy use, 2014 (154 EJ)

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**Tentative:**
- Global Cement Update
- Iron and steel

**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

**Incremental improvement**: relatively small and anticipated technological advances in the “normal course of business”
GHG emissions avoidance potential in chemical industry

**Best practice technology (BPT):** widespread deployment of best practice/established technologies in existing plants or new facilities.
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.
Hydrogen from water cleavage for ammonia and methanol production

Diagram:
- **Coal** → Partial oxidation → CO₂ → Reverse water-gas shift → H₂ → MeOH synthesis → MeOH
- **Water** → Electr. water cleavage → H₂ compression → H₂ → NH₃ synthesis → NH₃
- **Air** → Air separation unit → N₂

**Chemical Reactions:**
1. Partial oxidation: CO₂ + H₂O → CO + H₂
2. Reverse water-gas shift: CO + H₂O → CO₂ + H₂
3. MeOH synthesis: CO + 2H₂ → CH₃OH
4. NH₃ synthesis: N₂ + 3H₂ → 2NH₃
GHG emissions avoidance potential in chemical industry
Additional energy and fossil energy savings for ammonia and methanol via hydrogen

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