Low-carbon energy intensive industries

Options, challenges & policy framework

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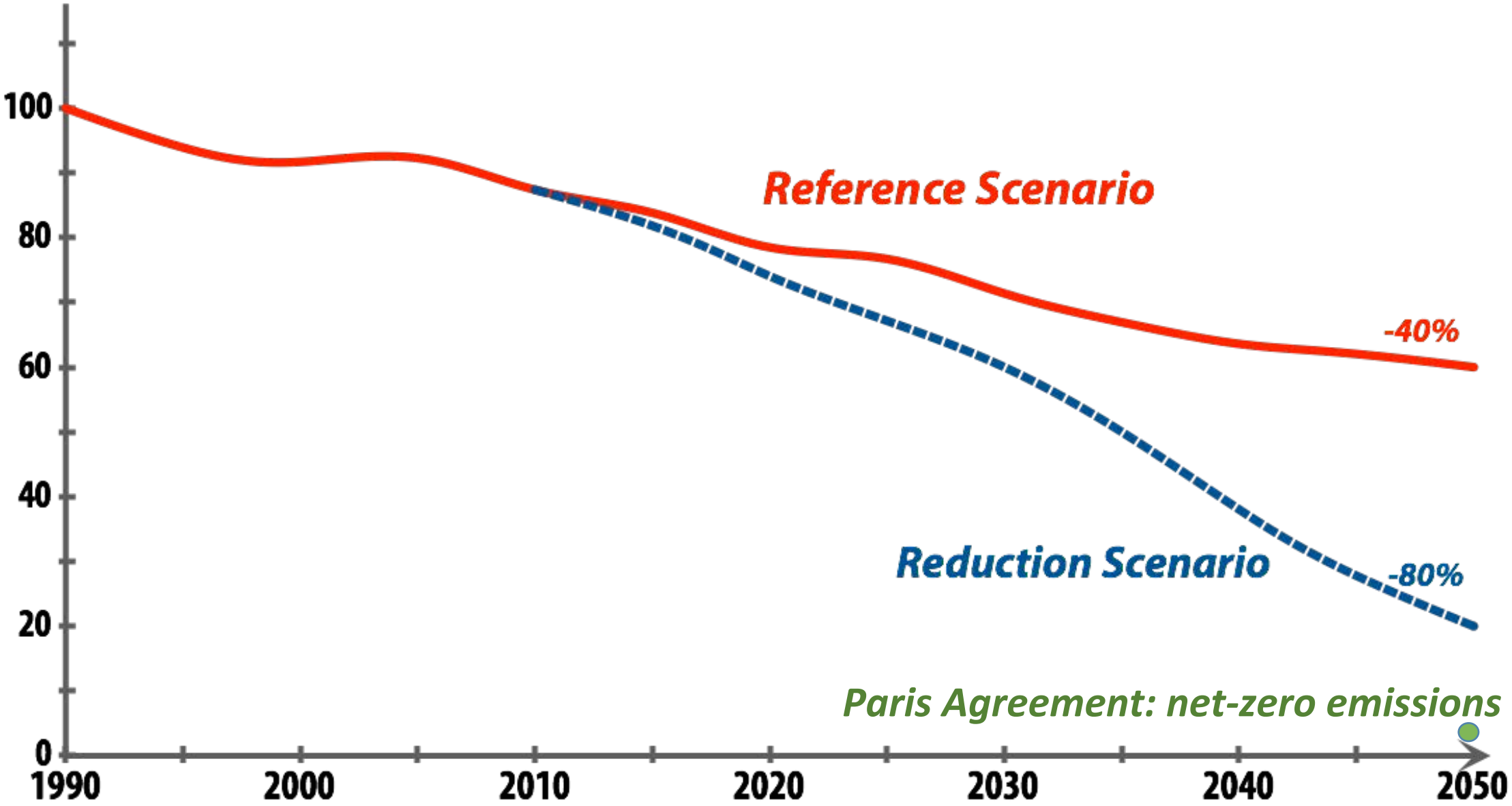
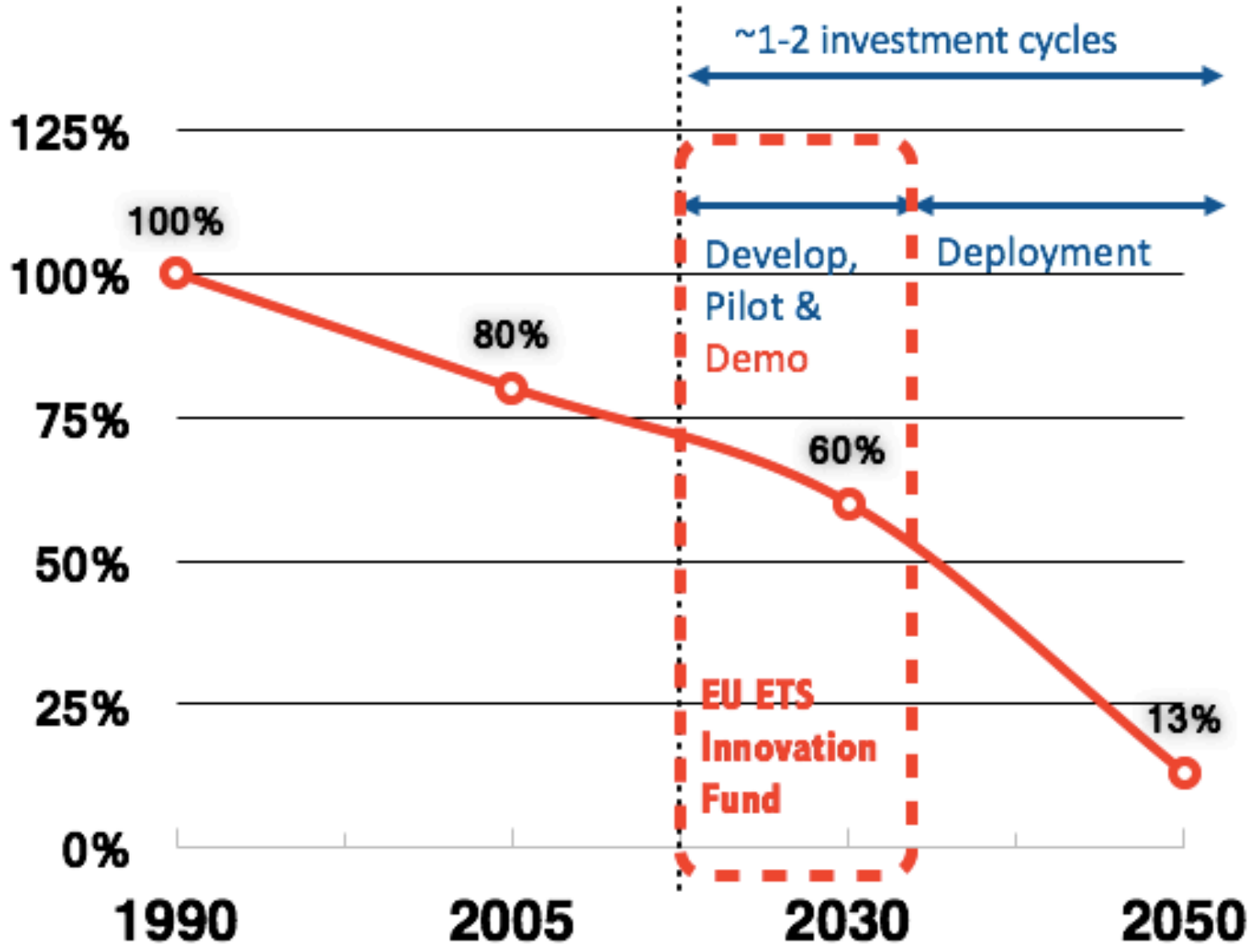
1. *EU Industrial Decarbonisation challenge*
2. *Examples of possible breakthrough technologies in energy intensive industries*
3. *Challenges and need for broader framework*
4. *Possible Policy responses*

EU Industrial Decarbonisation challenge

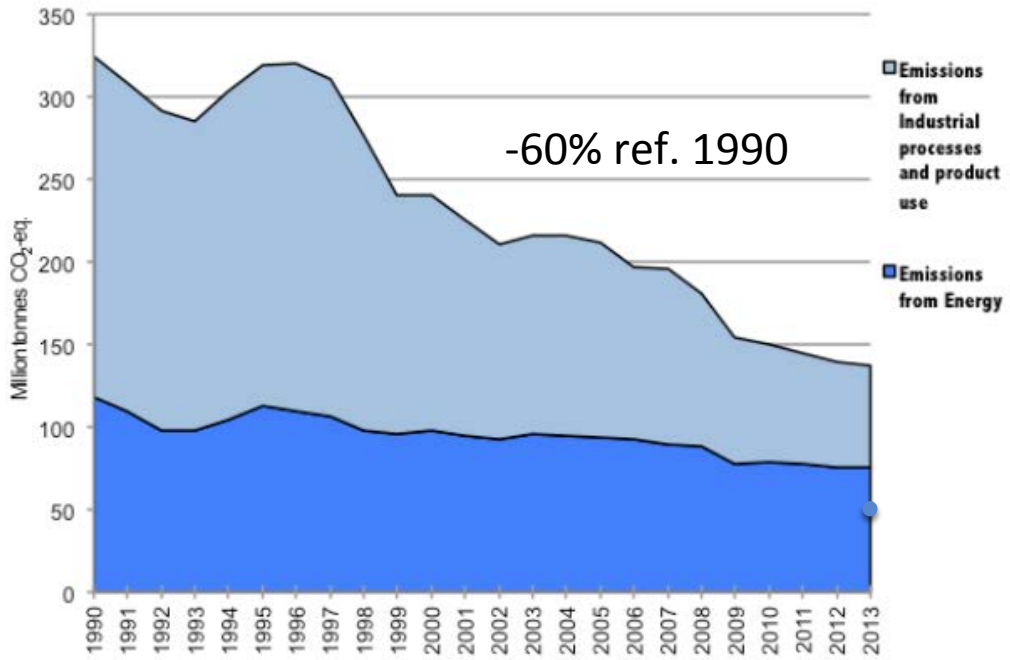


Ref. European Commission low-carbon roadmap (2010)

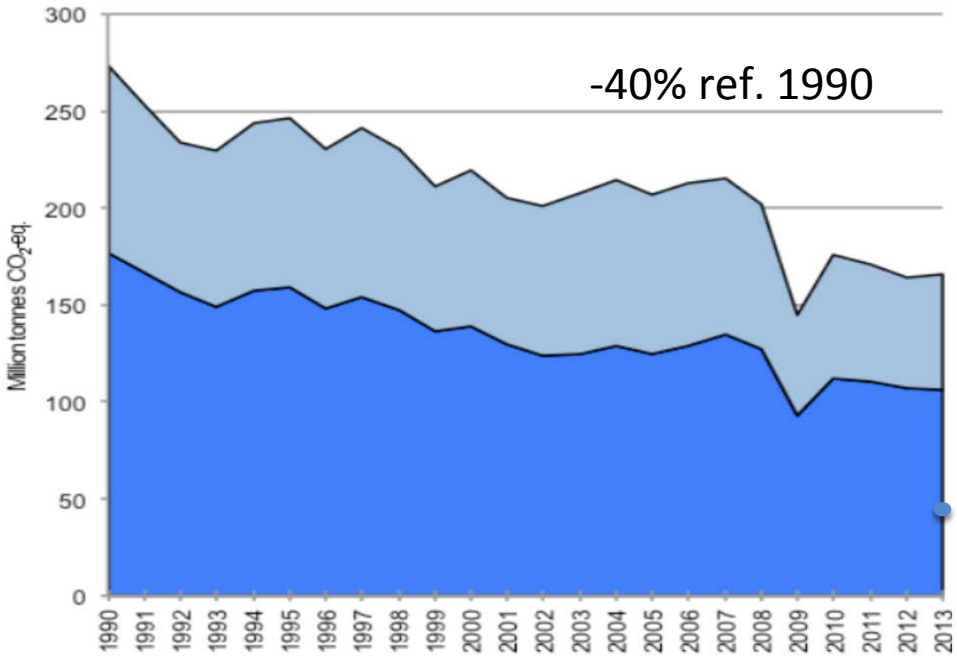

~1-2 investment cycles
125%
100%
75%
50%
25%
0%
100%
80%
60%
13%
Develop, Pilot & Demo
Deployment
EU ETS Innovation Fund
1990
2005
2030
2050

- Significant reductions in steel, cement and chemicals production since 1990
- Related to reduced production capacitv (steel, cement)
- Major non-CO2 mitigation in chemicals + efficiency improvements

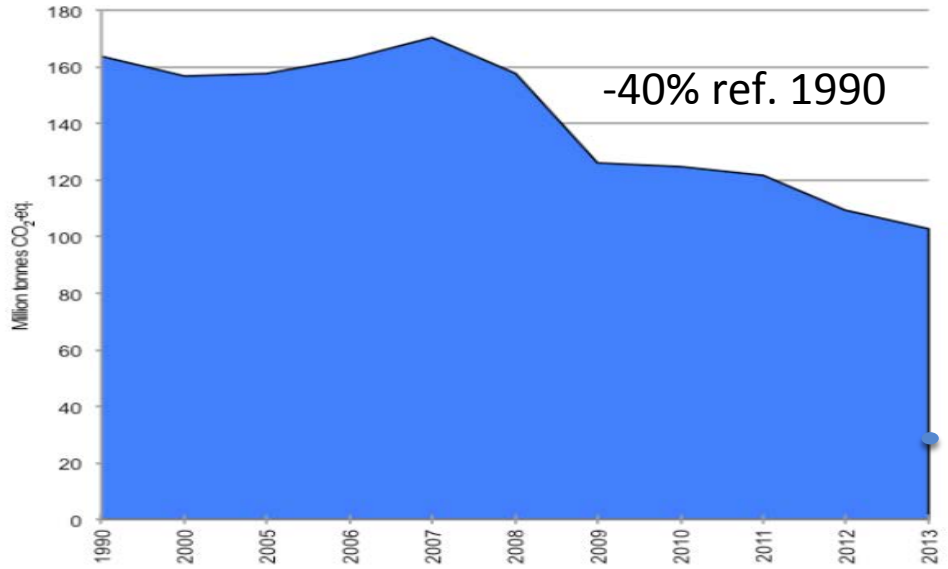
Emissions from EU Chemical industry



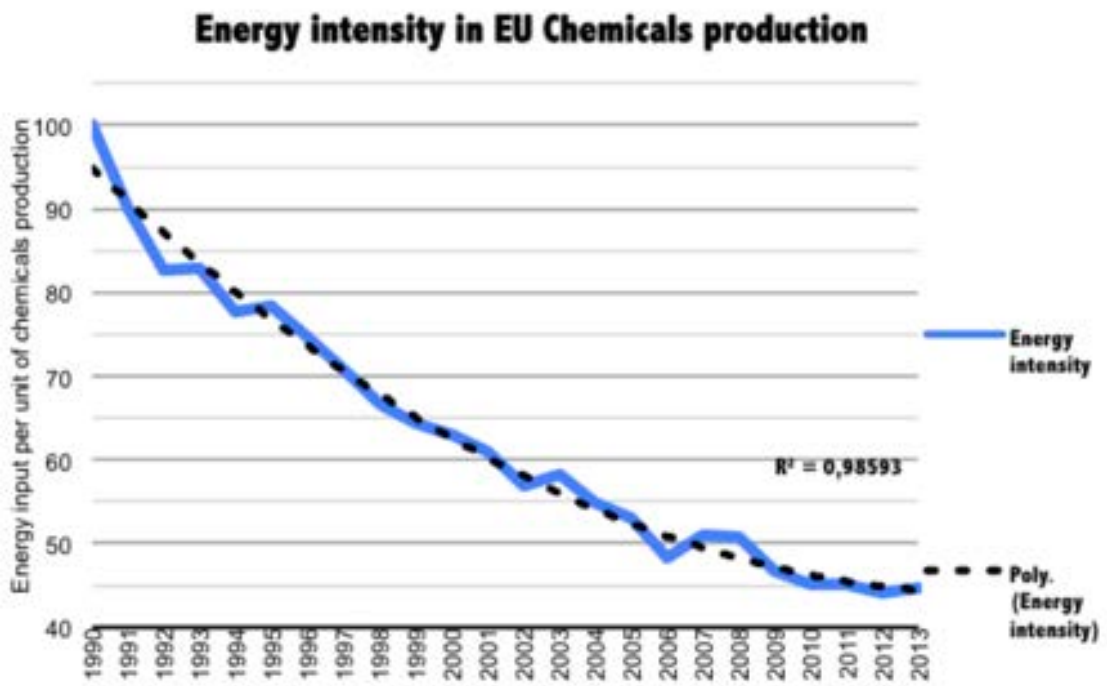
Emissions from EU Steel industry

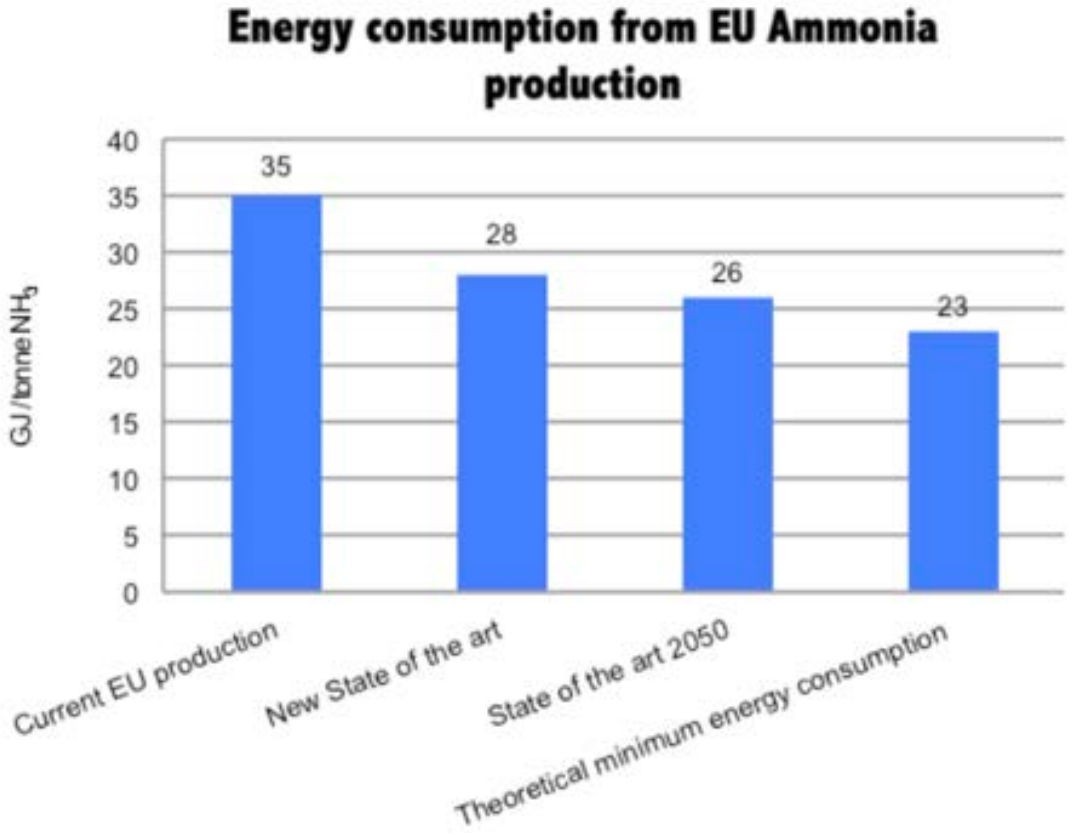


Emissions from EU Cement industry



Technical reduction potential using ‘existing’ processes comes closer





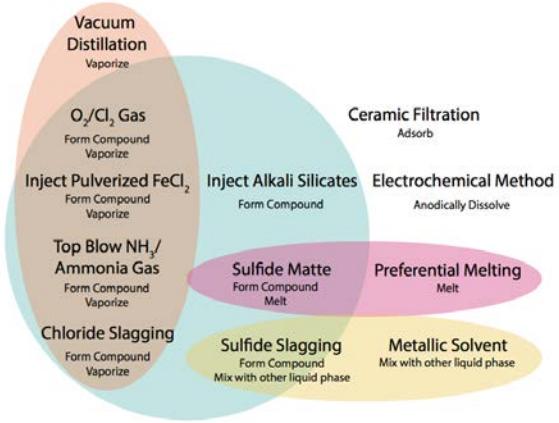
Examples of possible breakthrough technologies in energy intensive industries

Process innovation in Steel industry

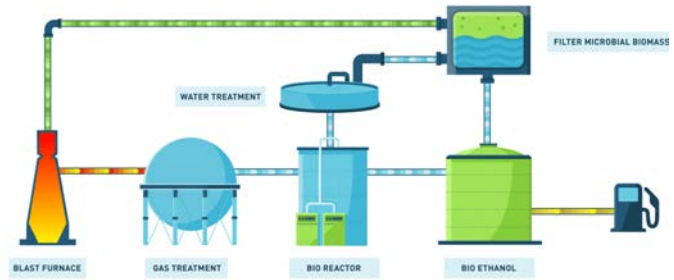
- Multi-purpose integrated steel plant: producing steel, cement, concrete aggregates (CCUS), high value chemicals (CCU) and/or electricity
- Higher levels of Re- and up-cycling steel through electric arc furnaces
- CCS with other operational co-benefits
- (renewable) Hydrogen steelmakingProduct and business model changes: specialisation, product-service hybrid, leasing, …

HIsarna (ULCOS/Tata)

steel slag + CO2 —> concrete (CCUS Blue planet/Carbicrete)



Re/upcycling steel technologies (source Allwood 2016)



Steelanol (CCU)(ArcelorMittal)

Hydrogen based steel production (SSAB, Voestalpine, Thyssen-Krupp)

Process innovation in Chemical industry

- Bio-based chemistry (intra-EU supply chain) gradually replacing petrochemicals (processes and products)
- Higher level of re/up-cycling (plastics)
- Further (renewables based) electrification of processes (e.g. H2, NH3)
- Product and business model changes (e.g. chemical services, leasing of chemicals)

BIO-BASED INDUSTRIES
Public-Private Partnership

- €3.7 billion investments in bio-based innovation from 2014-2020
- Deliver bio-based products that are comparable and/or superior to fossil-based products in terms of price, performance, availability and environmental benefits.
- on average reduce CO2 emissions by at least 50% compared to their fossil alternatives.

from: Horizon 2020, NER300

Solid State Ammonium Synthesis

Utilisation of CO(2) from other industries e.g. steel industry

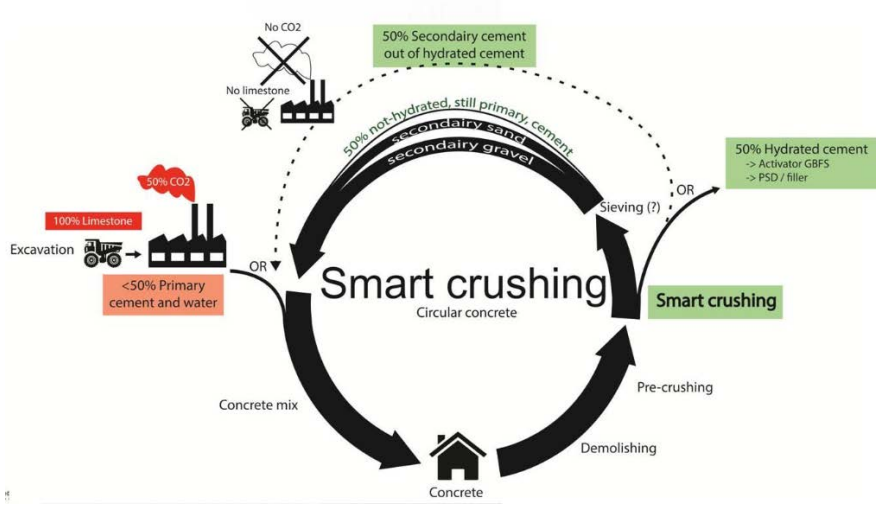
Process innovation in Cement industry

- Modernisation and efficiency gains (site + sector level)
- More clinker substitution (alternatives beyond BF slag and fly ash)
- CCS, but with co-benefits to clinker production process
- Alternative concrete formulas (physical/chemical)
- Concrete and cement re/up-cycling

Aether© cement (partial clinker replacement)

Calcium looping CCS

Landfill-mining; plasmarok



re/up-cycle concrete to cement

Process innovation Non-ferrous metals

- Inert anodes (primary aluminium production)/moltent metal batteries
- Industrial demand response
- Advanced/automated scrap sorting technologies

Advanced Green Aluminium Anode (AGRAL: H2020)

Industrial demand response (Trimet)

X-ray spectroscopy (Alcoa, ARPA-e)

Challenges and need for broader framework

Issues and challenges

- **Full electrification of industry** will require massive amounts of additional electricity (capacity): e.g. for chemicals electrification alone up to 4900 TWh by 2050 (more than current EU power production).

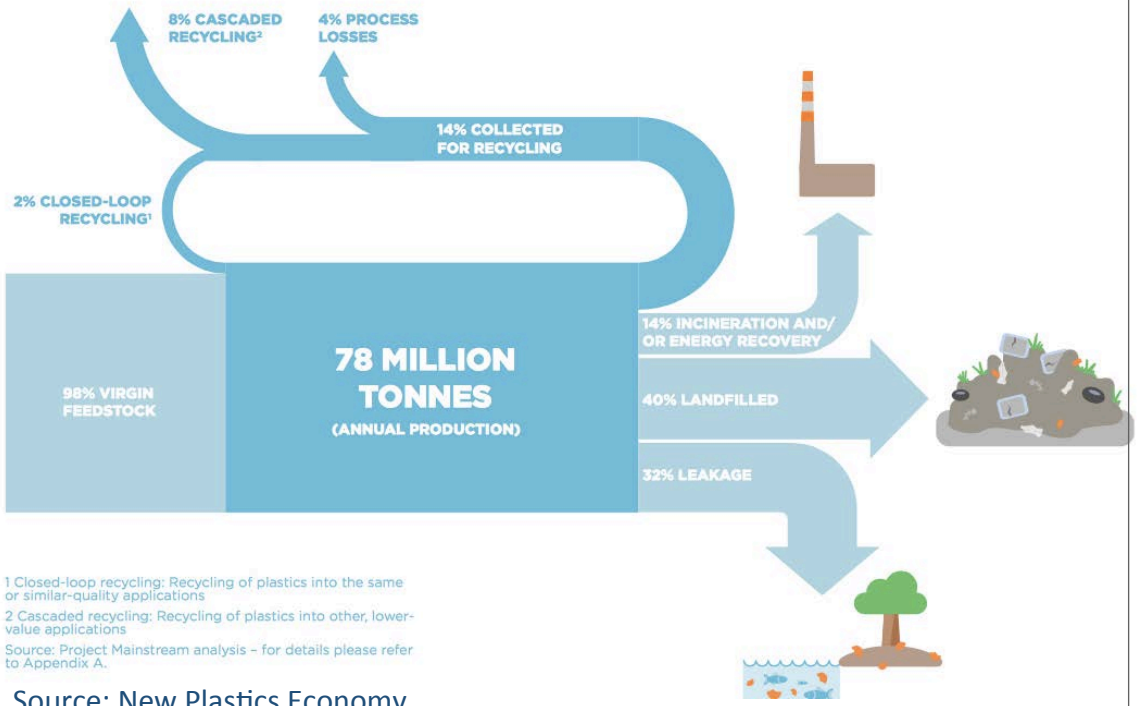
- **Biomass supply** (in EU): limited and competition between power generation, biofuels and chemical feedstock…

- **CCS:** will be difficult to get bankable projects (on medium term; high CO2 price required)

- **CCU:** accounting framework needed (e.g. avoid shifting emissions between sectors)

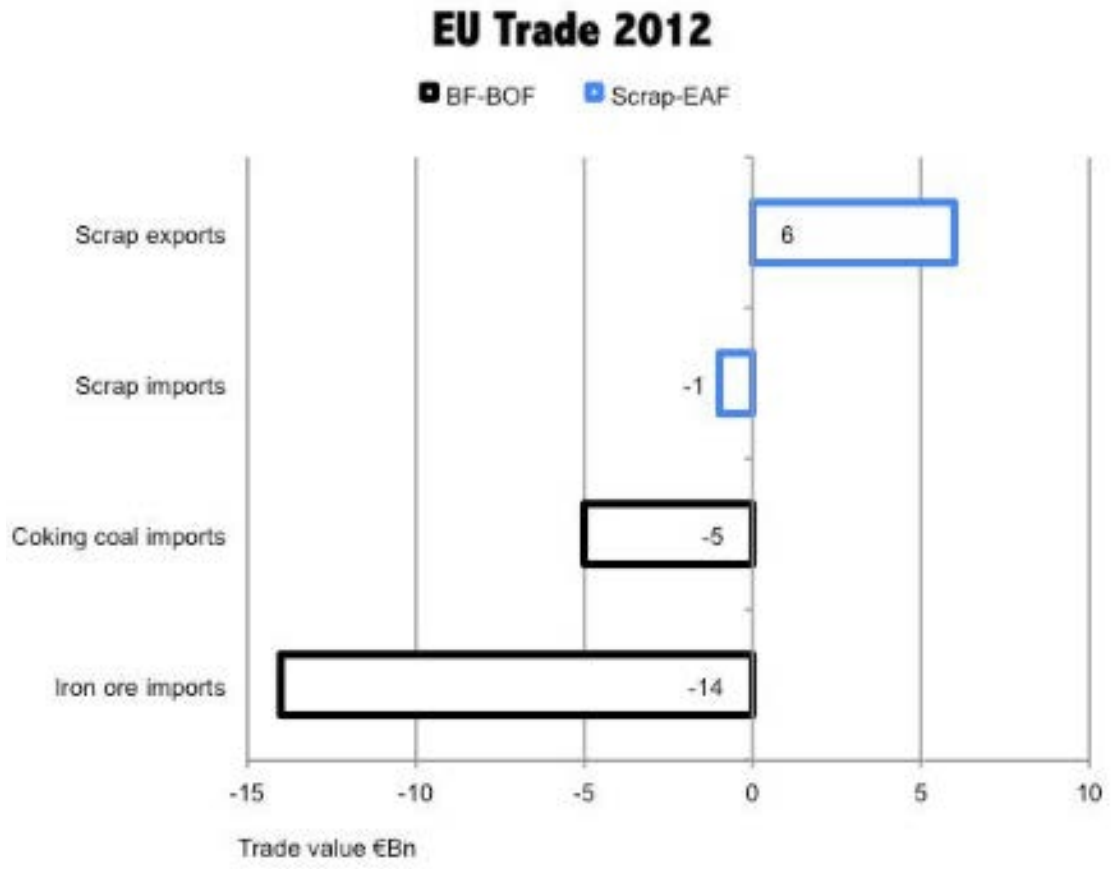
→

- *Process innovations alone are not silver bullet*
- *Holistic approach needed with focus on demand reduction*
- *Consider evolution in other sectors (e.g. power sector → renewable e. & EV)*



Source: New Plastics Economy

Plastics: 2% closed loop recycling



Process breakthrough technologies alone will not suffice for cost-effective industrial decarbonisation

- **Product innovation**: high value added & lower carbon footprint products (assisting decarbonisation in other sectors e.g. buildings, automotive, …)
- **Optimalise industrial symbiosis and industrial clustering:** e.g. waste to feedstock processes
- **Synchronise industrial processes with (future) high levels of renewable energy**: demand response (valley filling & peak shaving), storage, industrial RE PPA's, …
- **Advance Business Model/value proposition innovation**: from 'volume' to 'value' (e.g. rent iso sell)
- **Circularity approach to products and processes** (full recovery/reuse of plastics, metals, …)
- **Shorten value and supply chains through industrial digitisation**

Possible Policy Responses

- **Circular economy** and resource efficiency: *Create ambitious regulatory framework for full circularity main materials at highest use level*

- **Proactive use of low-carbon (EU) Standards:** *establish market for low-carbon products (LC cement, steel, EVs …) produced in EU*

- **Public Procurement for low-carbon market formation:** (*compulsory) low-carbon PP at national and EU level (MFF/Funds))*

- **Promote industrial clustering and industrial symbiosis**: *e.g. through EU funds & projects of common EU interest*

- **Use national promotional banks and EU investment funds** *to build key enabling infrastructure (and process-plants) for low-carbon economy.*

- **Establish mission oriented (low-carbon) R&I programmes/moonshots** (FP9/H2030): *across all TRLs (basic R&I to commercialisation)*

- **Trade defense measures:** *for climate free-riding countries* ***if appropriate/proportionate*** *(WTO compliant)*

- **Use solid EU Carbon price** to raise revenues *to finance/ accelerate industrial transformation along value chain & economic transition (education, skills, employment, …)*

- **Smart Fiscal realignment:** *link harmonised EU VAT with pollution, reduction of corporate taxes for first movers/risk takers*

- **Flexibility in EU budget rules** *for low-carbon investments/ R&I by EU Member States*