Decarbonisation & industrial dynamics of energy intensive sectors

Effective innovation support under the forthcoming **EU ETS "Innovation Fund" and examples of breakthrough technologies**

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15 March 2016, Brussels

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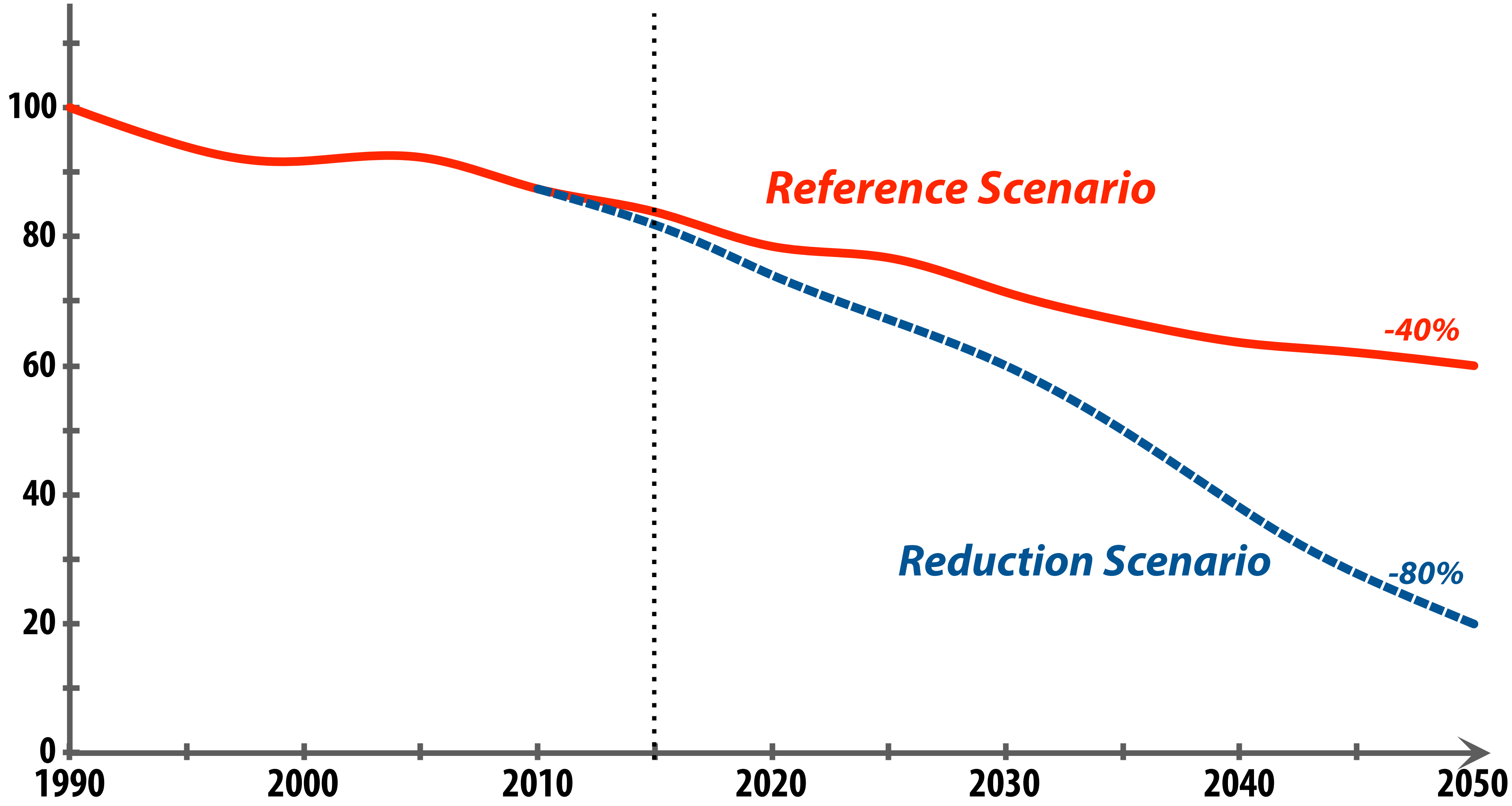
Outline

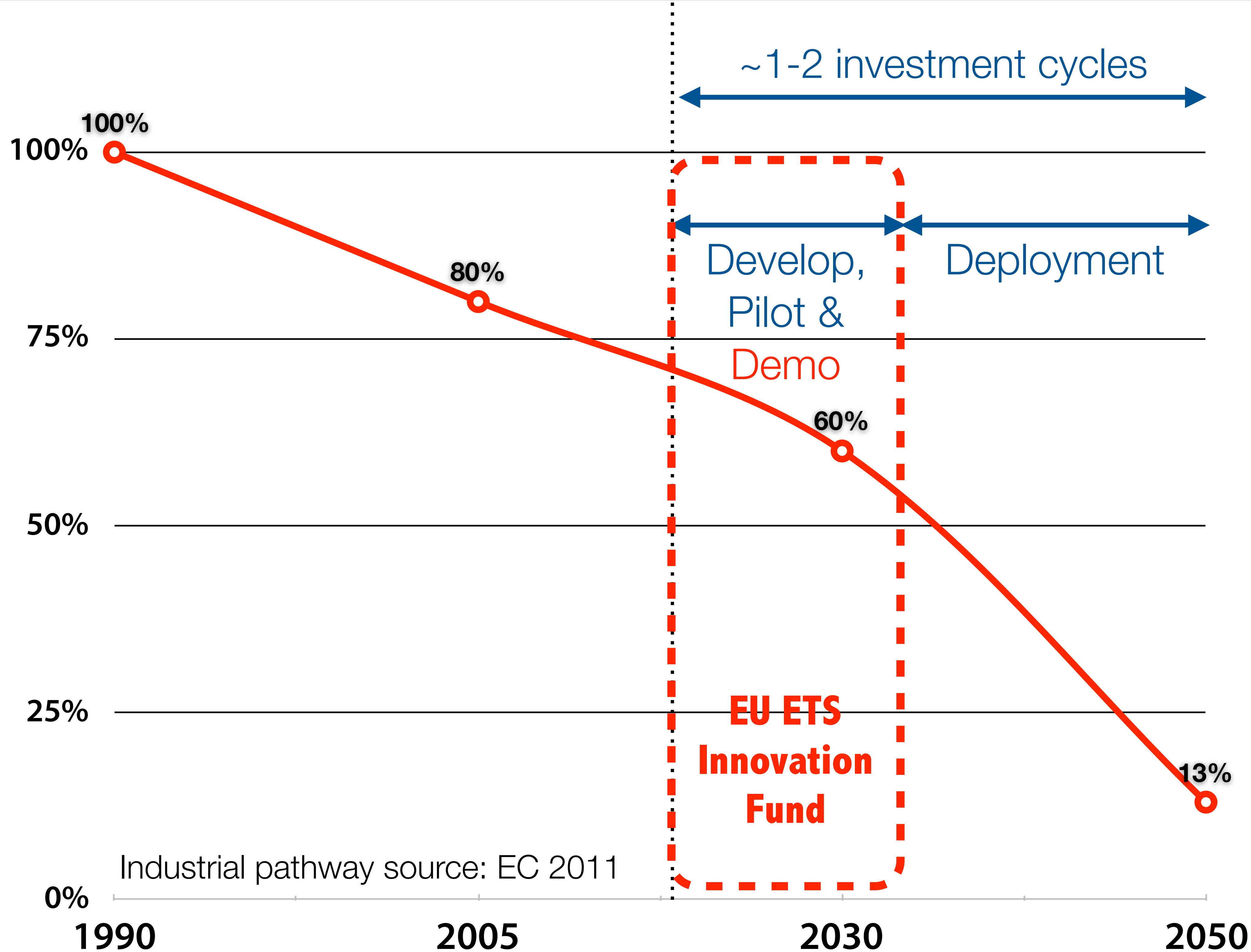
- Decarbonising the European economy (context)
- Industrial decarbonisation & challenges
- Parameters influencing radical process innovation
- Barriers for radical low-carbon process innovation
- Policy options to enhance process innovation
- Examples of industrial breakthrough technologies (steel, aluminium, chemicals, cement)
- Conclusions

Decarbonising the European economy



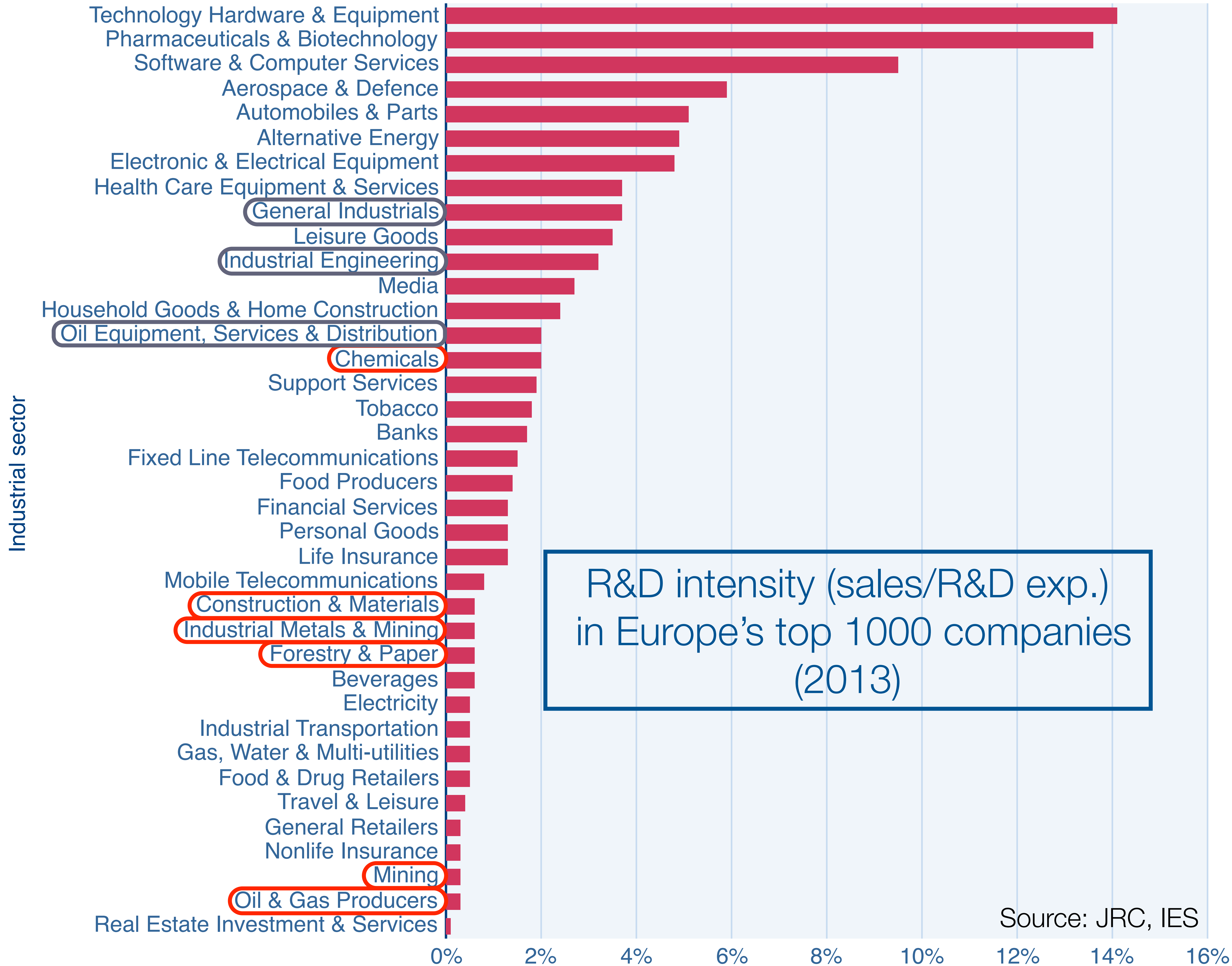
- European Commission low-carbon roadmap (2010)
- Followed by transport and energy roadmaps
- No EU industrial decarbonisation roadmap (or vision)
- Most (energy intensive) industrial sectors developed sectoral roadmaps

Industrial decarbonisation



Specific challenges for energy intensive sectors in the EU

- Still **recovering from crisis** (weak balance sheets, low credit ratings, possible consolidation, …)
- **Higher energy costs** compared to e.g. US and Middle East
- **Growth in EU remains low c**ompared to e.g. emerging markets
- and therefore **investments in new large process plants in EU have been low** for at least a decade (mature economy)
- **Long investment cycles <—> predictability of policies and costs**
- **Low R&D intensity in most energy intensive sectors**, restricted ability of companies to make needed investments in R&D


Technology Hardware & Equipment
Pharmaceuticals & Biotechnology
Software & Computer Services
Aerospace & Defence
Automobiles & Parts
Alternative Energy
Electronic & Electrical Equipment
Health Care Equipment & Services
General Industrials
Leisure Goods
Industrial Engineering
Media
Household Goods & Home Construction
Oil Equipment, Services & Distribution
Chemicals
Support Services
Tobacco
Banks
Fixed Line Telecommunications
Food Producers
Financial Services
Personal Goods
Life Insurance
Mobile Telecommunications
Construction & Materials
Industrial Metals & Mining
Forestry & Paper
Beverages
Electricity
Industrial Transportation
Gas, Water & Multi-utilities
Food & Drug Retailers
Travel & Leisure
General Retailers
Nonlife Insurance
Mining
Oil & Gas Producers
Real Estate Investment & Services
Industrial sector
0%
2%
4%
6%
8%
10%
12%
14%
16%
R&D intensity (sales/R&D exp.)
in Europe's top 1000 companies
(2013)
Source: JRC, IES

Parameters influencing radical process innovation in industrial sectors - literature

- **Product innovation**: innovative products drive process innovation (Reichstein, Salter 2006)
- **Cost savings factor**: cost reduction is factor in driving process innovation (Reichstein, Salter 2006) but comes over time with lower marginal returns
- **Productivity increase** key enabler & driver of important recent industrial process innovations at firm (CEO & board) level (Luiten, Blok 2001)
- **Cross company/sectoral collaboration/network** (e.g. open innovation) shows important correlation with (radical) process innovation (Reichstein, Salter 2006) (Luiten, Blok 2001) (CEPI 2-team project, 2012)
- **Stricter legislation/targets** or expectation thereof drive process innovation (e.g. ULCOS)

Barriers for (radical) process innovation in industrial sectors

- **High Capital risk** and problems with balance sheet financing in some companies
- **General (negative) investment climate** in Europe (e.g. mature market (low growth), international consolidation, costs in EU, policy risk, …)
- **Low room and acceptance of failure** at company and policy level
- **Low R&D intensity** of energy intensive companies
- Transparency and governance related to **EU state aid rules** (NER 300)
- **Incumbents** **(Schumpeter Mark II)** **dominate** policy/stakeholder debate

Policy options to enhance process innovation (i)

- **Link low-carbon demonstration support with increase in productivity** in the process design (if and where possible) and project selection criteria (e.g. post 2020 NER 300). Within the firm, the higher management should be made aware of possible productivity improvements in these new processes (where possible). —> **Enhances competitiveness**

- Enable the **linkages between process and product (& business model) innovation** at the design stage and in the project selection criteria (e.g. post 2020 NER 300). —> **Low-carbon transformation across value chain**

- **Encourage cross company and cross sectoral collaboration** in the R&D phase of process innovation and at the demonstration phase (e.g. to lower investment risk). —> **Can accelerate innovation**

- Identify and mitigate economic and legal barriers with regard to intellectual property rights and competition (e.g. related to cross company collaboration).

Policy options to enhance process innovation (ii)

- Have **upfront clarity** on what type or extent of national (additional) support would constitute unacceptable State Aid. —> **Reduces financial/regulatory risk**
- Developing a **practical guide** for companies' project developers and governments, using the experiences (and examples) from the two NER 300 calls could facilitate the process for post 2020 (co-)financing of industrial low-carbon demonstration plants. —> **Accelerates learning curve**
- **Improved project risk sharing:** Link the financial reward ETS innovation fund not only with successful *final* project implementation but also with key *intermediate* (engineering) **milestones**.
- **Develop a financing toolbox** (e.g. EIB's risk sharing facility, equity participation, EIF, …) that facilitates de-risking/financing of projects. —> **Leveraging factor**
- **Tolerate failure** (mitigate through early warning system) and implement lessons learned from failure

Steel sector "low carbon steel for mature economy"

*Successful testing of **HIsarna** (ULCOS) pilot blast furnace in Ijmuiden (Netherlands).*

- *20% less CO2 ref. current best practice*
- *up to -80% possible if linked to CCS*
- *Increased productivity*
- *Smaller design —> modularity, can deal better with cyclicality of steel economics*
- *Endurance test this summer, followed by start of Demonstration size design (NER 400, …)*

important for EU to pioneer + keep these new technologies

Aluminium: Game changing breakthrough(s)

Argonne NATIONAL LABORATORY

arpa·e CHANGING WHAT'S POSSIBLE

INFINIUM

JOINT RESEARCH CENTRE The European Commission's in-house science service

"New inert anode process can virtually eliminate direct CO2 emissions and reduce energy consumption/ costs by 50%"

EC JRC (2015): multiple options such as inert anodes, dynamic AC induced magnetic fields, CCS. FP7, Horizon 2020, NER 400 crucial to bring these to the market

Petrochemicals —> Bio-based chemicals

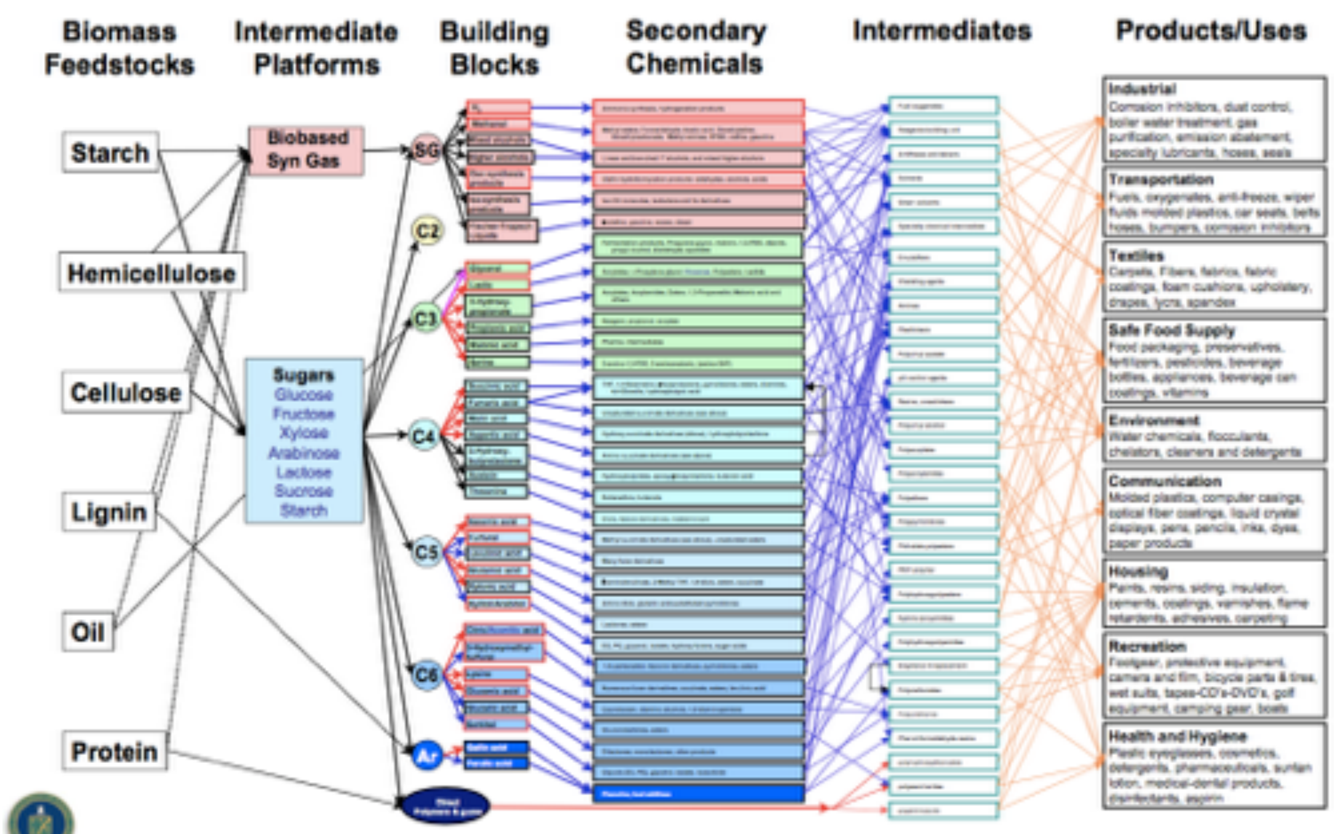


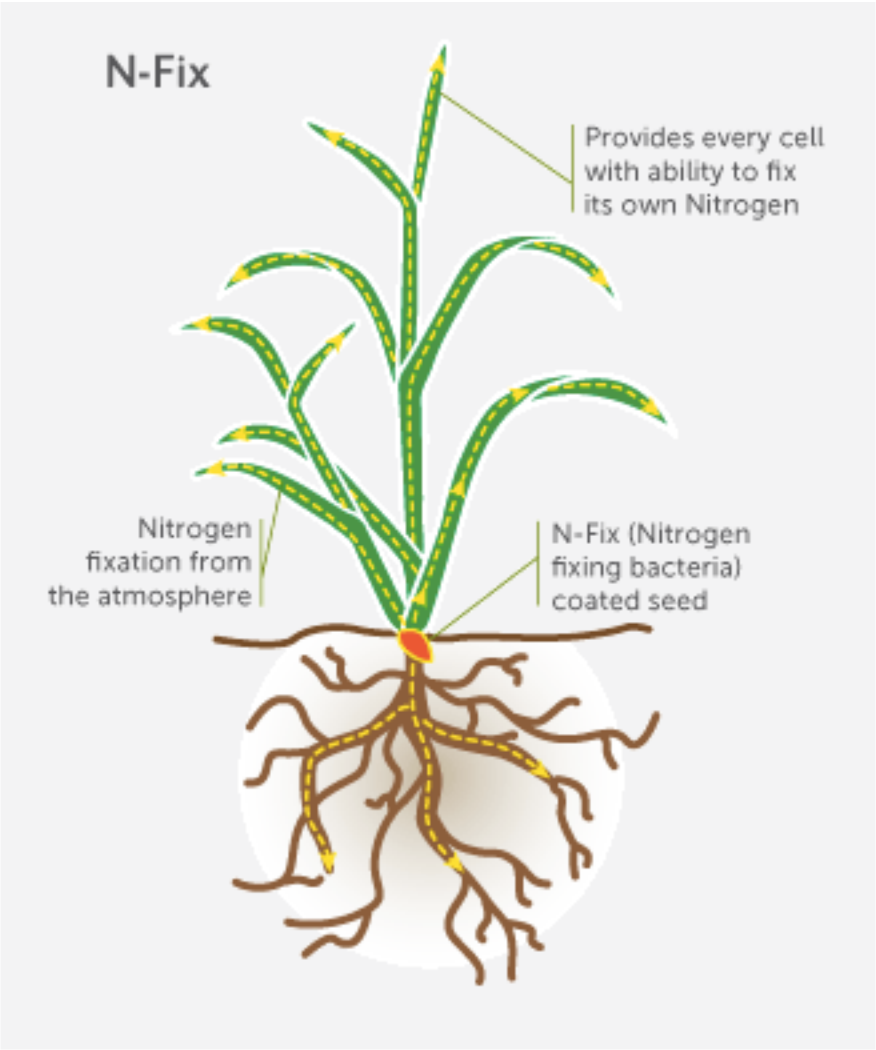
Figure 3 – Analogous Model of a Biobased Product Flow-chart for Biomass Feedstocks

US DOE: focus on creating top (12) value added chemicals from biomass. Very hot research/commercial field

- €3.7 billion investments in bio-based innovation from 2014-2020; €975 million of EU funds (Horizon 2020) and €2.7 billion of private investments
- Replace at least 30% of oil-based chemicals and materials with bio-based and biodegradable ones by 2030.
- 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 CO_2 emissions by at least 50% compared to their fossil alternatives.

Ammonium production emission reductions: "out of the box thinking" Direct "Nitrogen" fixation

azotic TECHNOLOGIES

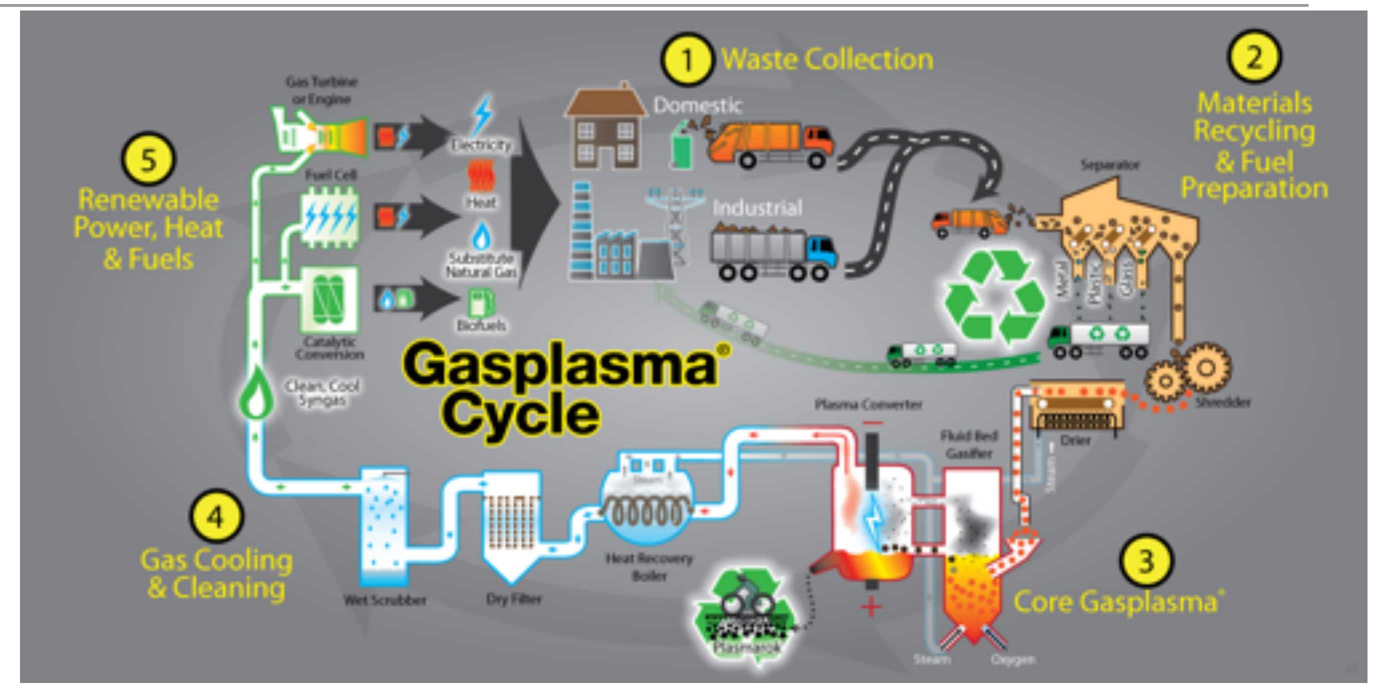


N-Fix by Azotic technologies (UK)

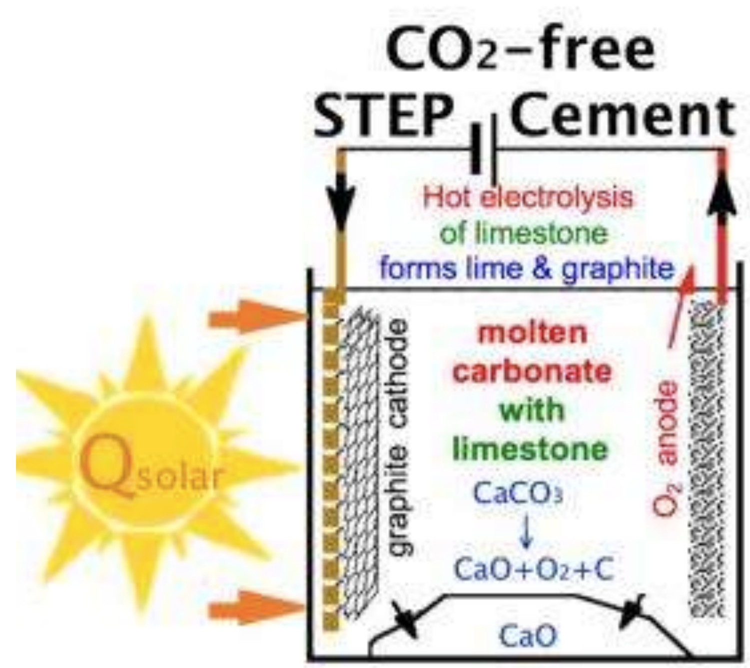
- Direct fixation of Nitrogen (using bacteria)
- Reduce use of ammonium based fertiliser by 50%
- Same crop yield
- Major environmental co-benefits
- Tested now

Cement: multiple options for deep emission reductions

Biomason: Using bacteria to grow concrete bricks from basic raw materials virtually no CO2 emissions



Geo-polymer cement: Plasmarok using urban mining for raw materials



Solar Thermal electrochemical production of cement

Conclusions

- Additional industrial decarbonisation vision, policy and financing framework needed

- 10-15 years left to develop and commercialise key low-carbon breakthroughs

- There are important barriers and triggers towards radical process innovation

- We can develop the policy and financing tools to address these

- If radical process innovations happen first “outside” EU, structural competitive loss of Europe is certain.

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