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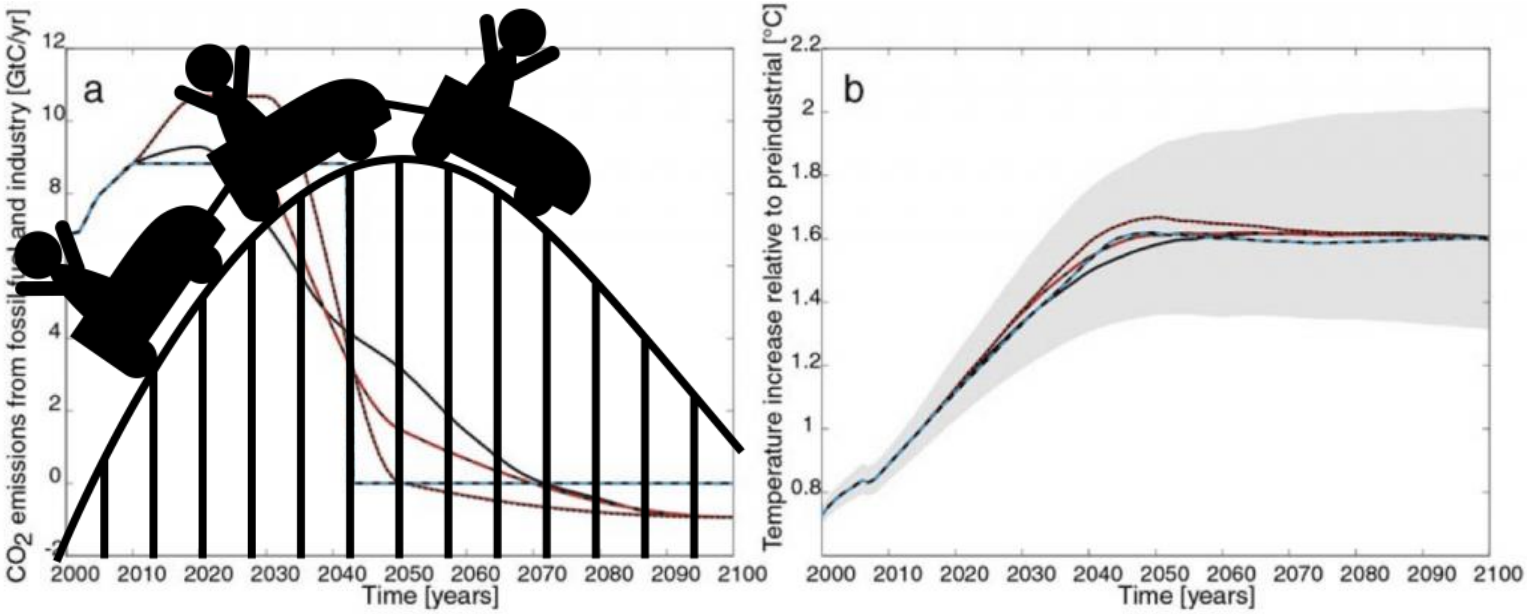
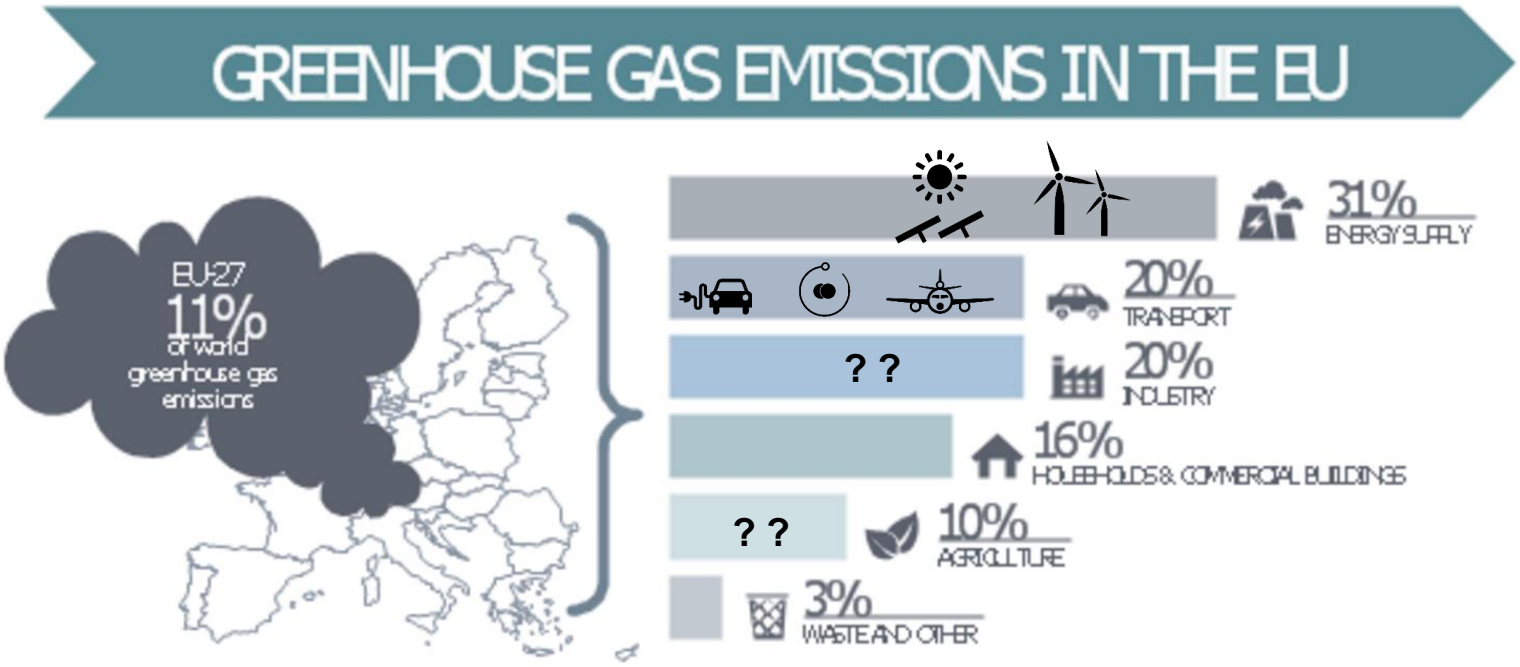
MANUFACTURING OUR FUTURE: INDUSTRIES, EUROPEAN REGIONS AND CLIMATE ACTION

Just and achievable industrial decarbonisation


a
b
Time [years]
Time [years]
Temperature increase relative to preindustrial [°C]
2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
0.8 1 1.2 1.4 1.6 1.8 2 2.2



Long-term goal
By 2050, the EU aims to cut its emissions substantially – by 80-95% compared to 1990 levels as part of the efforts required by developed countries as a group

GHG ~ 4,550 Million tonnes
– lets cut that by 90% by 2050
GHG ~ 455 Million tonnes


EMB


STOPPT CHINA
DUMPING
STOPPT CHINA
DUMPING


Decarbonising industry in Sweden
an assessment of possibilities and policy needs
Max Åhman*
Alexandra Nikolaris
Lars J Nilsson
RICARDO-AEA
sation of heat in industry
search evidence
INTERGOVERNMENTAL PANEL ON Climate change
IPCC
CLIMATE CHANGE 2014
Mitigation of Climate Change
Summary for Policymakers
and Technical Summary
WGIII
WORKING GROUP III CONTRIBUTION TO THE
FIFTH ASSESSMENT REPORT OF THE
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WHO
UNEP
/21
2050
A STEEL ROADMAP FOR A
LOW CARBON EUROPE 2050
This report has been prepared for the
Department of Energy and Climate Change and
the Department for Business, Innovation and Skills
Industrial Decarbonisation &
Energy Efficiency Roadmaps
to 2050
Iron and Steel
MARCH 2015
Energy Technology
Perspectives 2015
Mobilising Innovation to Accelerate Climate Action
WSP
PARSONS BRINCKERHOFF
DNV·GL
pathways to
deep decarbonization
2014 report
A Systematic Re
Cost for Industrial
ELECTRICITY
INDUSTRY
TRANSPORT
LOWEST COST DECARBONISATION FOR TH
THE CRITICAL
Report to the Secretary of State f
Industrial Strategy from the

How is CCS development going in Europe?

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Two CO_2 storage projects – one dating form 1996 and both oil and gas related

No commercial scale transport of CO_2

No CO_2 capture at industrial facilities

What are Europe's goals for industrial development and policy tools for decarbonisation ?

EU industrial policies and targets (20 % increase in industrial output by 2020)

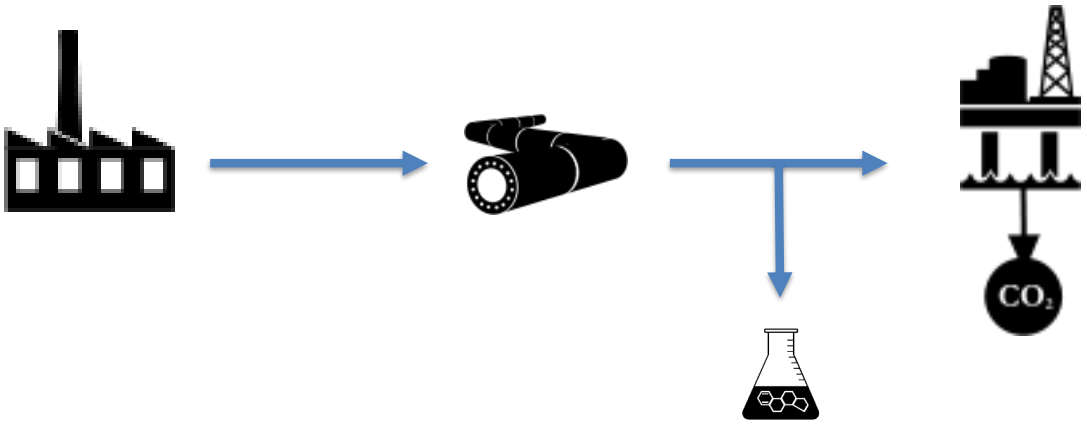
EU goals: reduction CO_2
40% - 2030, **80-95% - 2050**

There is tension between these two goals

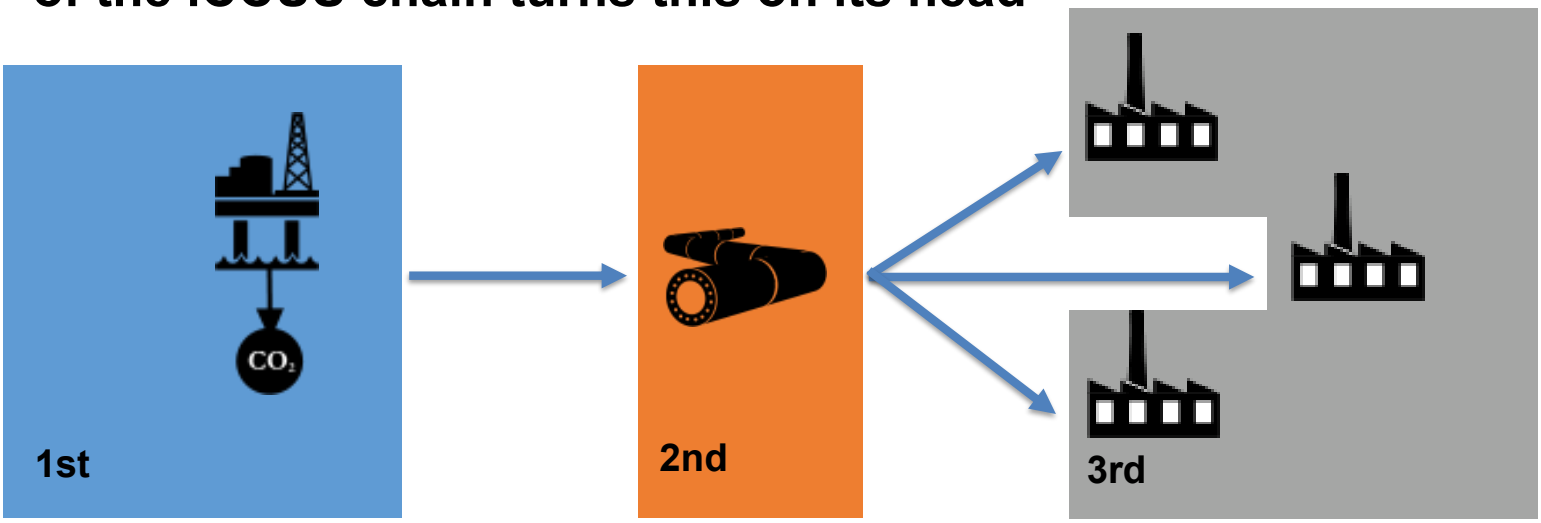
Global competitiveness & Employment

The core reason for the tension is there is currently no accessible cost effective pathway for most CO_2 intensive industries to deeply decarbonise

What is Industrial Carbon Capture Use and Storage?

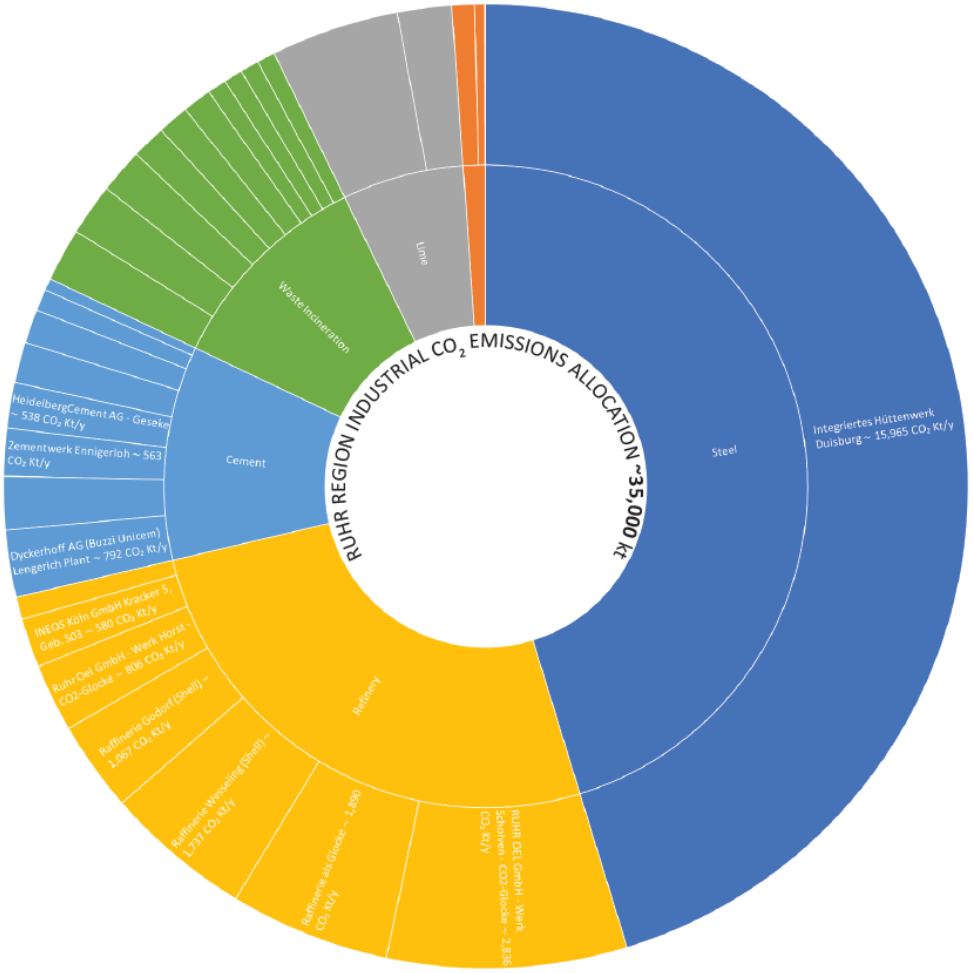


Reviewing the investment and delivery profile of each part of the iCCUS chain turns this on its head

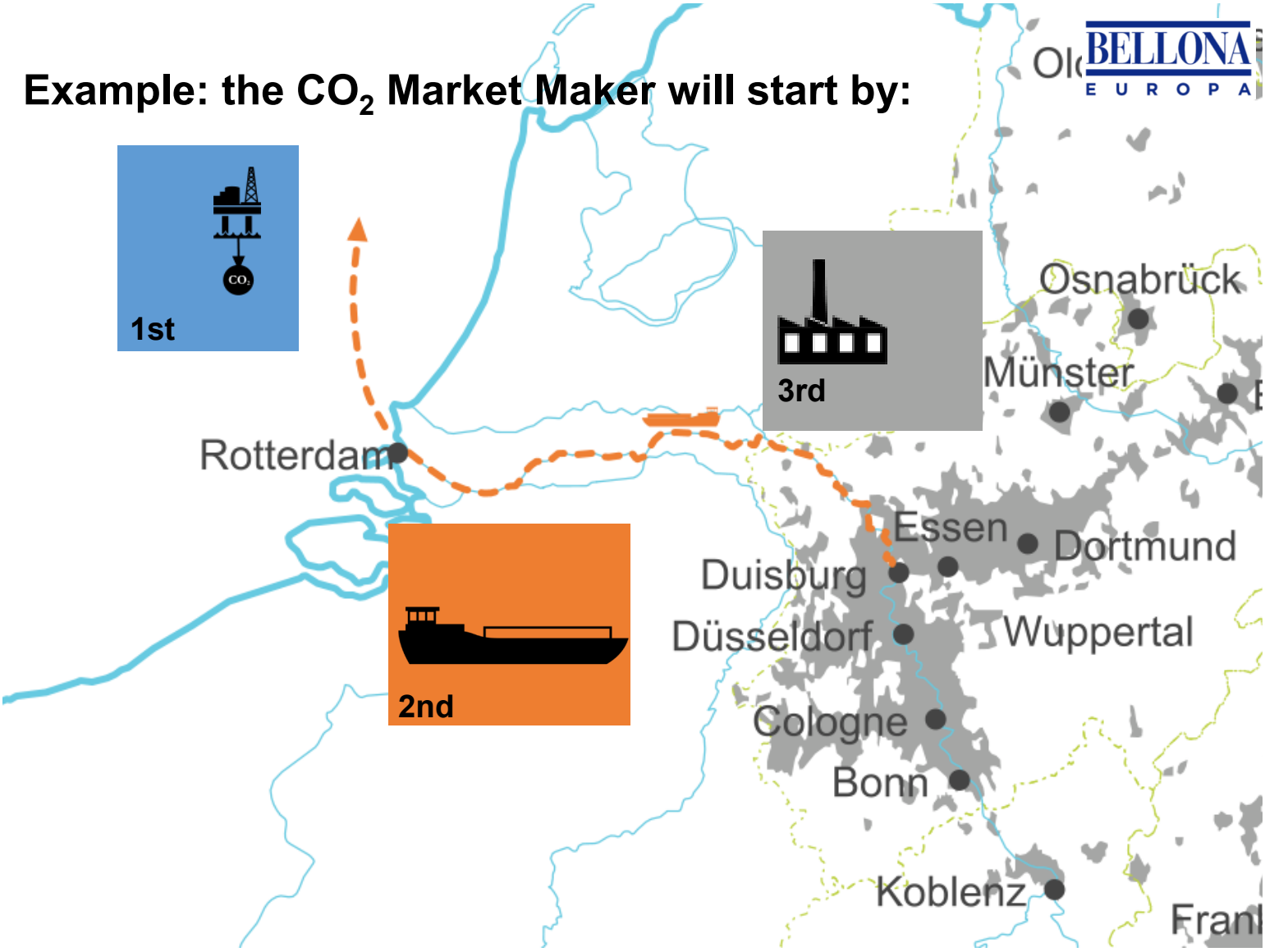


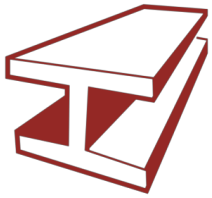
The case of the Ruhr Germany

a) Very large industrial CO_2 cluster, including Europe's largest steel complex.
b) Inland shipping already extensive for industrial products, inland shipping of CO_2 on barges is a scalable and affordable connection to CO_2 storage in North Sea through Rotterdam.
c) **CO_2 storage onshore in Germany currently not permitted!**



Example: the CO_2 Market Maker will start by:





Steel Production

Steel will be used in the fabrication of wind turbines, mass transit systems, electric vehicles, ships and energy efficient housing and cities. At present the EU hosts 500 production sites, split between 23 EU countries and provides ***328 000 direct jobs***

Current steel production is CO_2 intensive. Iron ore, a mixture of iron and oxygen must be separated to produce steel. Coking coal is added and reacts with the oxygen to produce CO_2, leaving raw iron behind. In Europe one tonne steel produced emits ~ 1.3 tonnes of CO_2.

Decarbonising Steel

CO_2 capture has the potential to deeply decarbonise steel production. The largest single point source is the blast furnace, where 32% of the emissions can be captured from. The other large sources are the coke plant and the sinter plant, which each account for 27% of the overall emissions. UK Department of Energy and Climate Change estimates that in the absence of CCS, only emission reductions of 41% can be achieved, as opposed to 60% or more with CCS.


A typical wind turbine is 89% steel
The high renewable scenario of the EU energy 2050 roadmap anticipates 1,000 GW of wind power to be installed. This will require 100 million tonnes of steel
Deeply decarbonising steel requires CO_2 transport and storage infrastructure
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Credit: thinkstock, moodboard

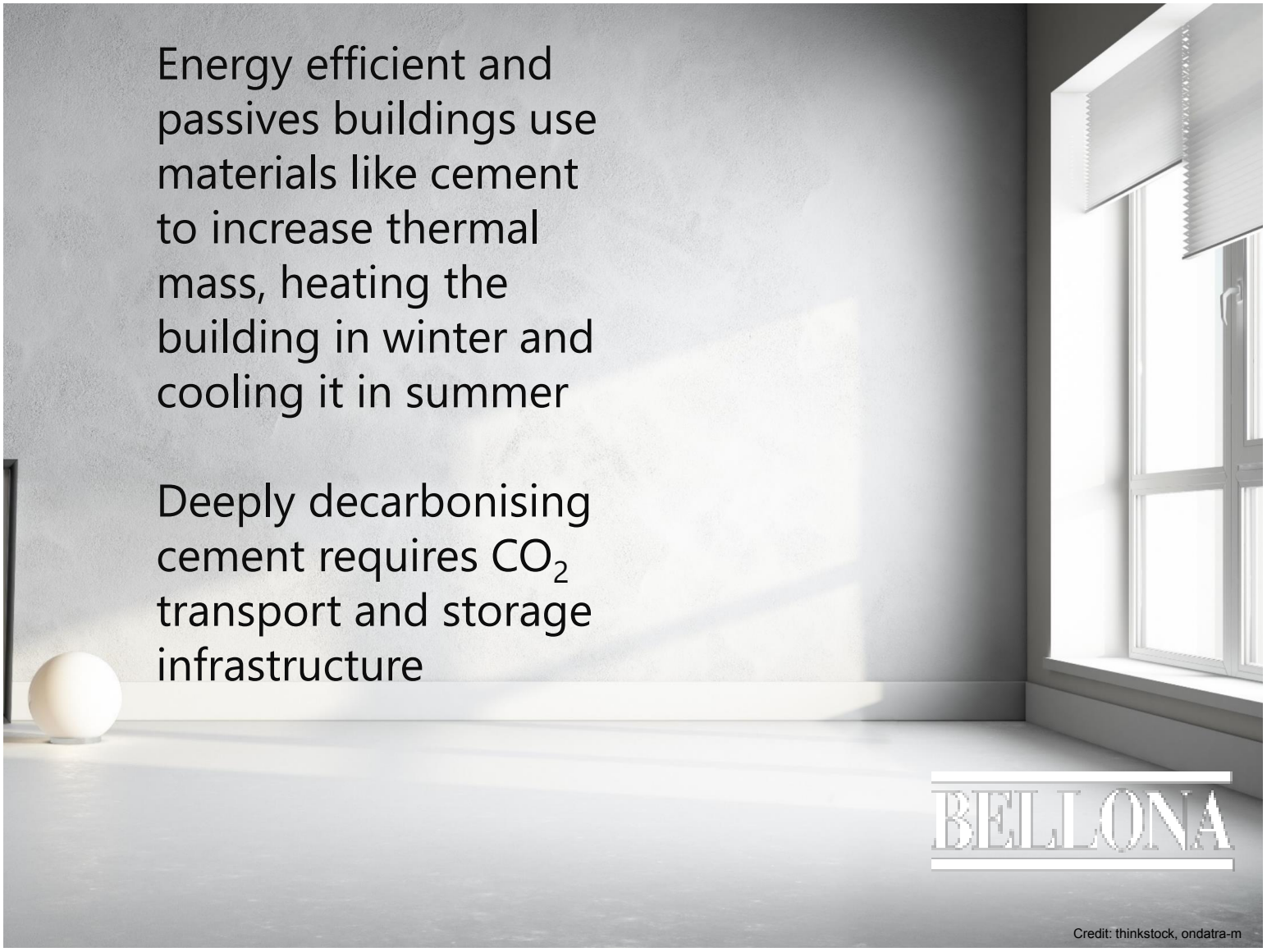
Cement Production

Cement and concrete are the most common construction materials today. Cement is a core input in construction and ***renovation of residential, businesses, civil engineering and transport infrastructure.*** Between 0.8 and 0.9 tonnes of CO_2 is released into the atmosphere for every tonne of cement that is produced. ~ 60% of the industry's CO_2 emissions do not originate from energy use but from the very manufacture of cement from limestone. ***Requires CO_2 Capture, transport and storage***

Substitution

Substitution of limestone clinker with other material can help reduce the CO_2 intensity of cement. Additives such as fly ash, volcanic ash and slag from steel making are already widely used.

It is unlikely that there will be one single substitute for cement. Substitutes will depend on the specific functions that need to be provided. One such substitute could be geopolymers, with 80% lower CO_2 emissions than traditional cement. However due to high alkalinity, little water can be added, resulting in thick mixture making it much less workable.


Energy efficient and passives buildings use materials like cement to increase thermal mass, heating the building in winter and cooling it in summer
Deeply decarbonising cement requires CO_2 transport and storage infrastructure
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Credit: thinkstock, ondatra-m

Chemicals Production

The European chemicals manufacturing base is hugely varied, supplying hundreds of products manufactured by diverse processes, with diverse climate and environmental impacts. The EU is second in chemical production, with German is third in chemicals sales at €147 billion. Almost 2/3 of the chemicals produced are used in European industry.

Deep decarbonisation of the chemicals industry will rely on a mix of increasing efficiency, potential biomass use, use of hydrogen, both from electrolysis and decarbonisation of natural gas, decarbonisation of electricity supply and the carbon capture at both process and combustion emissions points. The UK department of energy and climate change estimates that CO_2 capture would be responsible for more than half of the CO_2 reductions in a deeply decarbonised chemical industry.

Chemelot in the Nehterlands alone emits ~8 million tonnes of CO_2 a year, the equivalent of a large coal power plant.

Requires CO_2 Capture, transport and storage

And / or

Requires abundant low carbon hydrogen

Hydrogen Production

Hydrogen has endlessly diverse low carbon applications from residential and industrial ***heating, water heating, industrial processes, cooking, road transport, shipping, aviation, electricity generation and energy storage***. Hydrogen will be ***especially important in the decarbonisation of industry***. H_2 will be required to replace fossil fuels used in process heating, boilers and stem generation throughout varied industrial processes.

Production

Natural gas (methane) reforming is currently the most widely used process for production of hydrogen. Low carbon hydrogen can be produced with the addition of CO_2 capture. ***Requires CO_2 transport and storage***

Hydrogen can be production through the electrolysis of water with renewable electricity. ***Requires large amounts of low carbon electricity***

Scale

The JRC estimates that in 2050, 1,000 petajoules of hydrogen will be needed to decarbonise parts of European industrial production. ***This is equivalent to 10 times the energy produced by all German solar today.***

Low carbon hydrogen is already produced thanks to CO_2 capture. Hydrogen is produced at the Valero Port Arthur Refinery, Texas, USA. 1,000,000 tonnes of CO_2 is captured and prevented from entering the atmosphere every year.

Air Products and Chemicals, Inc. - Port Arthur 2

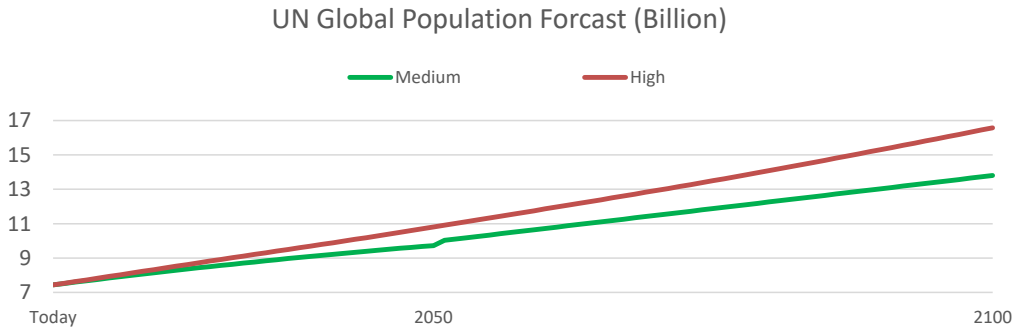
U.S. DEPARTMENT OF ENERGY | Fossil Energy

Fertiliser Production

It is estimated that almost ***half the world's population would not be alive today if it were not for the synthetic fertiliser ammonia***. World population has grown 4 fold from 1.7 billion people to 7.1 billion people today.

Production

The Haber-Bosch Process combines nitrogen from the air with hydrogen derived mainly from natural gas (methane) into ammonia. The production of ***one tonne of ammonia results in almost one tonne of high purity CO_2***. In Western Europe ~8 million tonnes of high-concentration CO_2 vented to the atmosphere and some used. ***Requires CO_2 transport and storage***

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Nitrogen fertilisers are responsible for 1% of global CO_2 emissions
Using less will improve the climate and the environment
To deeply decarbonise what remains requires CO_2 transport and storage infrastructure
Credit: thinkstock, David De Lossy

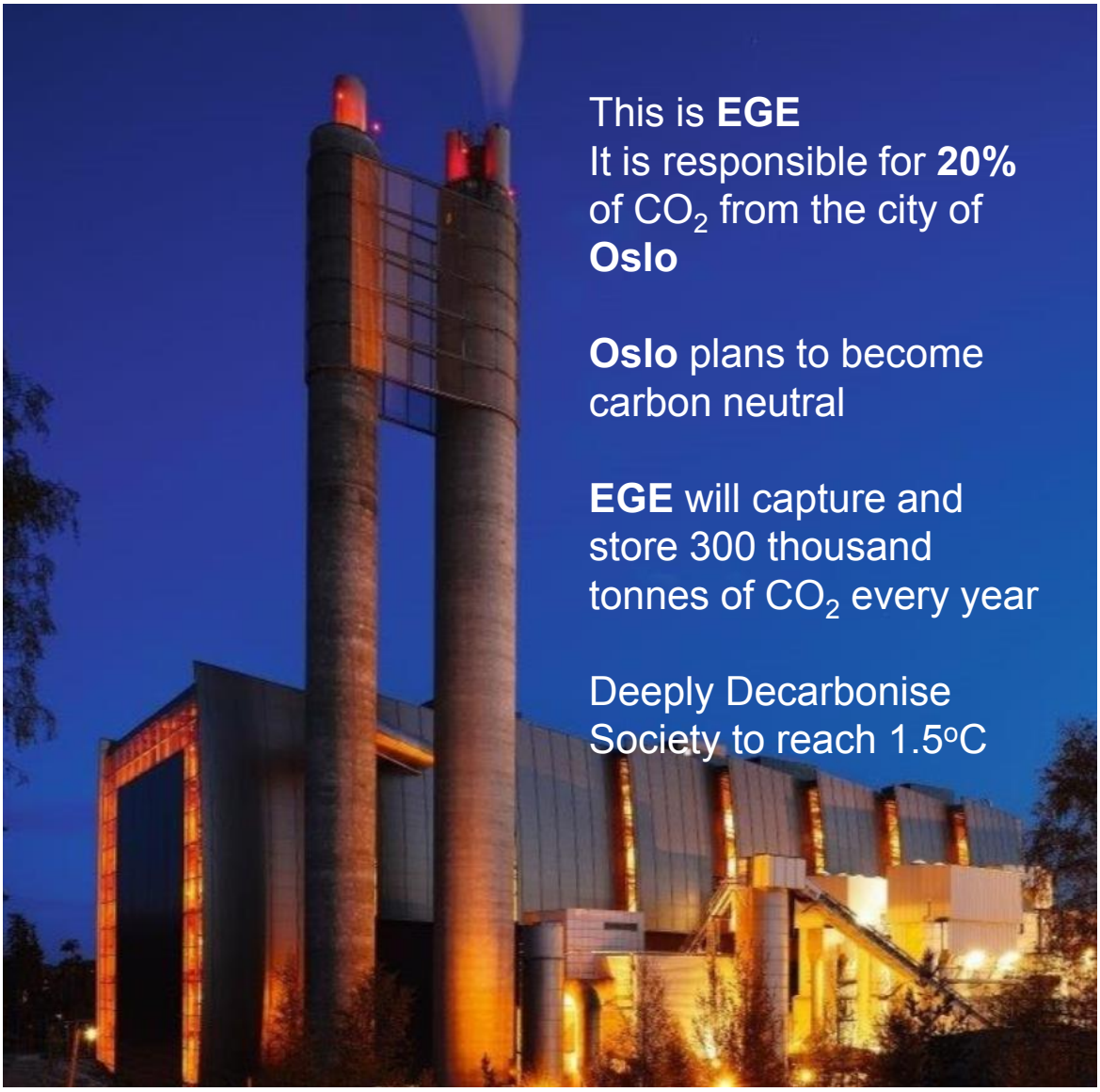
Waste to Energy

Waste incineration and waste to energy has become a significant source of CO_2 emissions in Europe. EU-15 emissions from waste incineration is has grown to ~9 million tonnes CO_2 per year. Offsetting through afforestation would require and area equivalent to Belgium.

Solution

Reducing the amount of waste produced is the primary method to reduce CO_2 emissions from this sector. The EU Circular Economy Strategy sets a common EU target for recycling 65% of municipal waste by 2030.

When waste cannot be prevented or recycled, waste to energy will remain the preferable option. This will have the effect of decarbonising district heating and energy generated by waste to energy plants. ***Requires CO_2 Capture, transport and storage***


This is **EGE**
It is responsible for **20%** of CO_2 from the city of **Oslo**
Oslo plans to become carbon neutral
EGE will capture and store 300 thousand tonnes of CO_2 every year
Deeply Decarbonise Society to reach 1.5°C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