The European House Ambrosetti

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Proposal for a Zero Carbon Technology Roadmap

The alternative decarbonisation for Europe

Presentation of the Strategic Study
Valerio De Molli – Managing Partner & CEO, The European House - Ambrosetti
Markus Kerber - Chief Strategist, CDU; Scientific Advisor of the Strategic Study

November 10th, 2022

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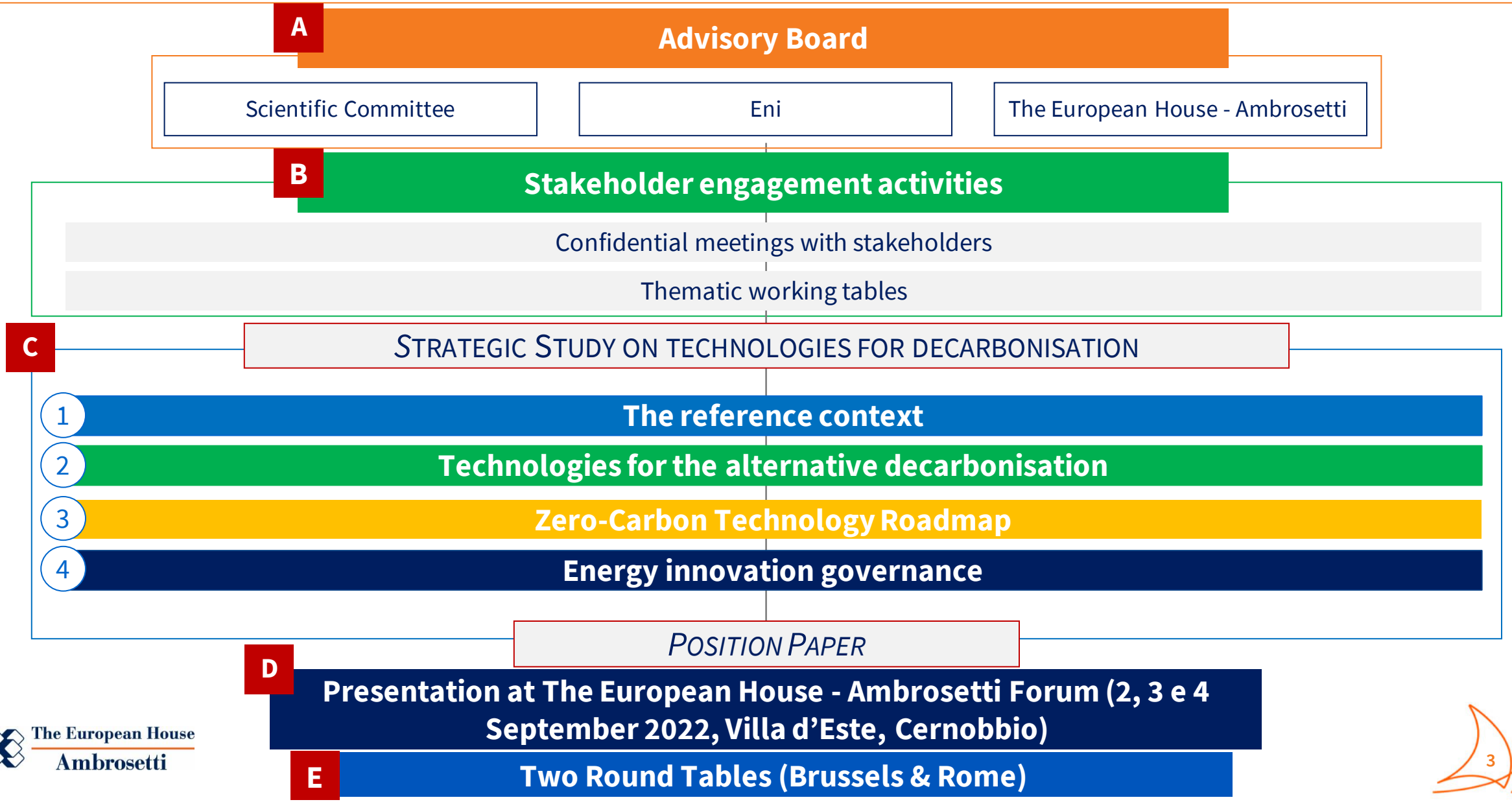
If a man does not know to which port he is steering, no wind is favorable

The mission of the Strategic Study

Promote a principle of **technological neutrality** in Europe in the field of decarbonisation, in which the synergic and complementary **contribution of all available technologies** needs to be exploited in order to reach the zero-carbon target.

Present with the utmost authority and according to super-partes criteria, a **reference framework to manage decarbonisation** in Hard to Abate sectors providing a first in kind **technology-roadmap**.

The framework of the Strategic Study



The guiding questions of the Strategic Study

The reference context

1. *How are **emissions distributed among different sectors** (e.g.: manufacturing, transport, etc.)?*
2. *What are the **scenarios for reducing emissions** and absorbing CO_2?*

Technologies for the alternative decarbonisation

3. *What are the **available technologies and technological developments** with the greatest impact on decarbonisation targets?*
4. *What **criticalities** in the current system do they help to solve? What is the **impact** on the ability to meet climate targets?*
5. *What are the **potential breakthrough technologies** that will be available in the future?*

Zero Carbon Technology Roadmap

6. *What are the criteria for **technological neutrality**?*
7. *What are the **impacts of the technologies on different sectors**?*
8. *What are the **recommendations for a Zero-Carbon Technology Roadmap for Europe**?*

Zero Carbon innovation governance

9. *What are the possible **policies for the governance of energy innovation**?*
10. *What are the consequent **economic** and **social impacts** for European value chains?*

The European House Ambrosetti

Source: The European House - Ambrosetti, 2022

The Members of the Advisory Board of the Strategic Study



JOAQUÍN ALMUNIA
Professor, Paris School of International Affairs-Sciences Po; Former European Commissioner for Competition [2010 - 2014]; Former European Commissioner for Economic and Monetary Affairs [2004 - 2010]



VALERIO DE MOLLI
Managing Partner and CEO, The European House - Ambrosetti



CLAUDIO DESCALZI
CEO, ENI



FABIOLA GIANOTTI
General Director, CERN; member of several international committees (Scientific Council of the CNRS, Physics Advisory Committee of the Fermilab Laboratory)



MARKUS KERBER
Chief Strategist, CDU; Former State Secretary, Ministry of the Interior - Government of the Federal Republic of Germany; former CEO & Director General, BDI

The stakeholder engagement activity and the scientific studies to support evidences



13 key-experts
have been engaged in one-to-one interview



41 stakeholders
from leading European industries in 3 working tables (Hard to Abate industries, transport, nuclear fusion)



185 academic papers
analysed to support evidences

To address the analysis and gather strategic insights, 13 key-experts have been engaged in one-to-one interview

- **Robert C. Armstrong** (Professor of Chemical Engineering, MIT; Director, MIT Energy Initiative)
- **Alessandra Beretta** (Professor of Chemical Engineering, Politecnico di Milano)
- **Klaus-Dieter Borchardt** (Senior Energy Advisor, European & Competition Law Practice, Baker McKenzie, Brussels)
- **Maria Chiara Carrozza** (President, National Research Council; Full Professor of Industrial Bioengineering, Scuola Superiore Sant'Anna)
- **Valerio Cozzani** (Full Professor Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna; industrial plant safety expert)
- **Giulia Galli** (Professor of electronic structure and simulations, The University of Chicago)
- **Mark Alan Hughes** (Founding Faculty Director, Kleinman Center for Energy Policy)
- **Christopher Jay Faranetta** (CEO and Co-Founder, Nearstart)
- **Zoe Knight** (Managing Director and Group Head of the HSBC Centre of Sustainable Finance, HSBC)
- **Jan Laubjerg** (Global Sector Head for Natural Resources, HSBC)
- **Giacomo Luciani** (Scientific Advisor, Master in International Energy, Paris School of International Affairs - Sciences Po)
- **Ennio Macchi** (Professor Emeritus in Energy and Environmental Systems, Politecnico di Milano)
- **Thomas Pellerin-Carlin** (Director, Jacques Delors Energy Centre)

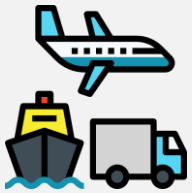
A bottom-up assessment has been carried out involving 41 stakeholders from leading European industries in 3 thematic working tables



HARD TO ABATE INDUSTRIES

15 stakeholders involved

BURGO
CEMBUREAU The European Cement Association
FERALPI GROUP
DANIELI
Tenaris
Cerame-Unie The European Ceramic Industry Association
cersanit
cefic
BASF We create chemistry
Linde
sasol
Valagro
NSG GROUP
Cepi
rethink. storaenso



HARD TO ABATE TRANSPORTS

15 stakeholders involved

IVECO
VOLVO
SOLARIS
era european regions airline association
LEONARDO
BOEING
Avio Aero A GE Aviation Business
ZEROAVIA
BRITISH AIRWAYS
NAPOLI SALERNO AIRPORTS GESAC
IATA
SEA MilanAirports
WÄRTSILÄ
HYUNDAI HEAVY INDUSTRIES
MAN
MAN Energy Solutions
GRIMALDI GROUP



NUCLEAR FUSION TECHNOLOGY

11 stakeholders involved

tokamak energy a faster way to fusion
ANSALDO ENERGIA
RENAISSANCE FUSION
BUTTING
Studsvik
OXFORD SIGMA
Commonwealth Fusion Systems
FUSION INDUSTRY ASSOCIATION
ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile
IAEA
POLITECNICO MILANO 1863

Working table 1: Hard to Abate industries

- **Koen Coppenholle** (CEO, Cembureau - European Cement Association)
- **Maurizio Fusato** (Head of Ecological and Energy Transition, Feralpi Group)
- **Rolando Paolone** (CTO, Danieli)
- **Marco Geneletti** (Energy Senior Director, Tenaris)
- **Renaud Batier** (Director General, Cerame-Unie)
- **Łukasz Gajkowski** (Chief Strategy Officer, Cersanit)
- **Florie Gonsolin** (Director for Climate Change Transformation, European Chemical Industry Council - CEFIC)
- **Astrid Palmieri** (Senior Sustainability Community Manager for EMEA, BASF)
- **Tim Heisterkamp** (Head of Technology & Environmental Policy, Linde)
- **Silvio Di Cesare** (Head of Value Chain and Sustainability Strategy, Sasol)
- **Marco Rosso** (Global Corporate Affairs Director, Valagro)
- **David Cast** (Climate Change Director, NSG Group)
- **Luca Sassoli** (Amministratore Delegato, Burgo Energia; Climate Change and Energy Committee Chairman, Confederation of European Paper Industries – CEPI)
- **Heinz Felder** (SVP Group Technology & Investments, Stora Enso)

Working table 2: Heavy Transports

- **Michele Ziosi** (Senior Vice President Institutional Relations & Sustainability, IVECO Group)
- **Lars Mårtensson** (Environment and Innovation Director, Volvo Trucks)
- **Riccardo Cornetto** (After Sales Director, Solaris Italia)
- **Martina Di Palma** (Sustainability Manager, European Region Airlines Associations - ERA)
- **Roberto Garavaglia** (Senior Vice President Strategy & Innovation, Leonardo)
- **Martin Gorricho** (Regional Lead-EU Sustainability Policy and Partnership, Boeing)
- **Sandro De Poli** (President, AvioAereo)
- **Val Miftakov** (Founder and CEO, ZeroAvia)
- **Andy Kershaw** (Environment Manager, British Airways)
- **Hemant Mistry** (Director Energy Transition, International Air Transport Association)
- **Davide Canuti** (Head of Environmental Assessment and Certifications, SEA Milan Airports)
- **Roberto Barbieri** (CEO, GESAC)
- **Michele Miedico** (Head of Salerno Project, Planning & Environnment, GESAC)
- **Giulio Tirelli** (Director Business Development Marine Power, Project Services, Wärtsilä)
- **Hyun-ho Lee** (Vice President and Managing Director of Maritime Research Institute, Hyundai Heavy Industries)
- **Pierpaolo Da Fieno** (Managing Director, MAN Energy Solutions)
- **Dario Bocchetti** (Head of Energy Saving, R&D and Ship Design, Grimaldi Group)

Working table 3: Nuclear Fusion

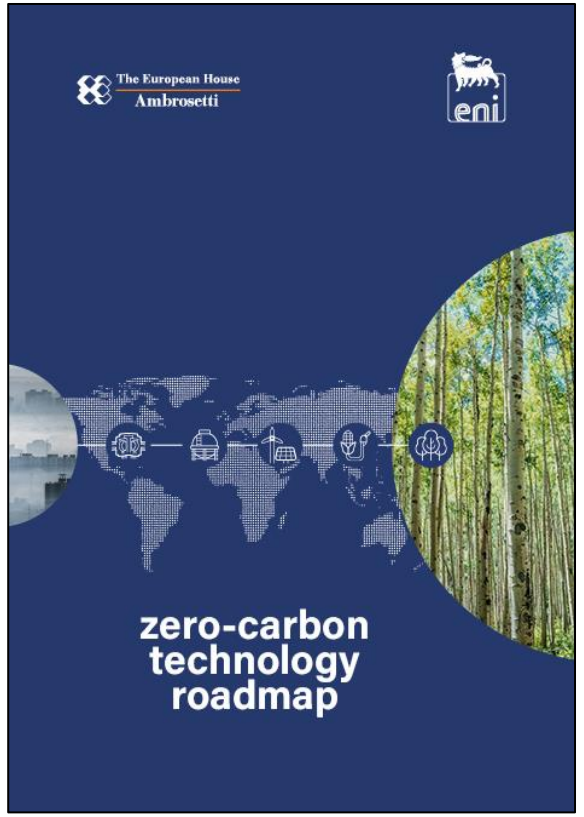
- **Roberto Adinolfi** (President, Ansaldo Nucleare)
- **Paola Batistoni** (Head of Fusion Development, ENEA)
- **Chris Martin** (Chairman, Tokamak Energy)
- **Mark Anderton** (Project Development Engineer, Oxford Sigma)
- **Johan Öijerholm** (Project Manager - Nuclear Materials and Water Chemistry, Studsvik)
- **Elisabetta Bragagni** Capaccini (Group CEO, Tratos Cavi)
- **Norbert Heinzle** (COO, Butting Group)
- **Francesco Volpe** (Founder, CEO & CTO, Renaissance Fusion)
- **Melanie Windridge** (Founder, Fusion Energy Insights)
- **Marco Ricotti** (Chairman of Technical Working Group on Small Modular Reactors, IAEA; Full professor in Nuclear Engineering, Politecnico di Milano)
- **Alessandro Maffini** (Assistant Professor & Researcher Project ENSURE, Politecnico di Milano)
- **Dan Brunner** (CTO, Commonwealth Fusion Systems)
- **Christopher Jay Faranetta** (Vice President & Co-Founder, NearStar Fusion Inc.)

Results of the analyses have been summed up into a Strategic Report…

The results of the Strategic Study analyses will be included in a Final Report

Objectives:

- Identify the building blocks of the technological reference scenario as enablers of the decarbonisation process in Europe
- Build and make available an innovative, distinctive and super partes "knowledge base" that is recognised as a "point of accumulation" of knowledge
- Draw attention to the priorities and proposals for optimising the pathway to a net-zero society
- Be a document for communication



…that has been presented at the 48th edition of The European House - Ambrosetti Forum held at Villa d'Este in Cernobbio

- **Objectives**: give a preview to the business community, present the main results of the initiative and position the theses of the Strategic Study
- **Date**: Friday 2nd September 2022
- **Session participants**:



Fabiola Gianotti (General Director, CERN) - Moderator



Robert Playter (CEO, Boston Dynamics)



Markus Kerber (Chief Strategist and Political Coordinator to the German Leader of the CDU)



Gill Pratt (CEO, Toyota Research Institute)





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The principle of technological neutrality has been embraced by the Italian Prime Minister Giorgia Meloni during her first speech to the Italian Parliament

«Combining environmental, economic and social sustainability. Accompanying businesses and citizens towards the green transition without handing ourselves over to new strategic dependencies and respecting the ***principle of technological neutrality****. This will be our approach»*

Giorgia ***Meloni****,*

Italian Prime Minister



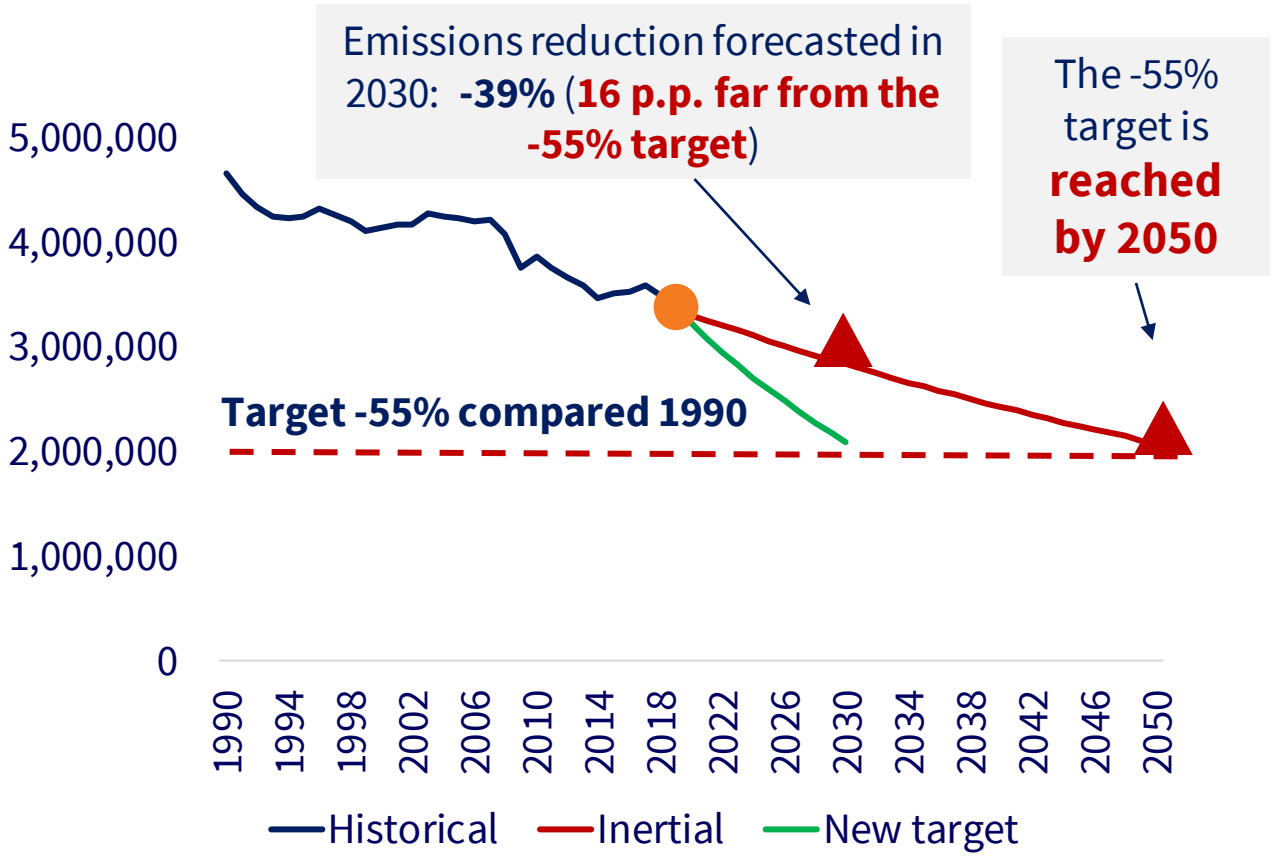


The Outset

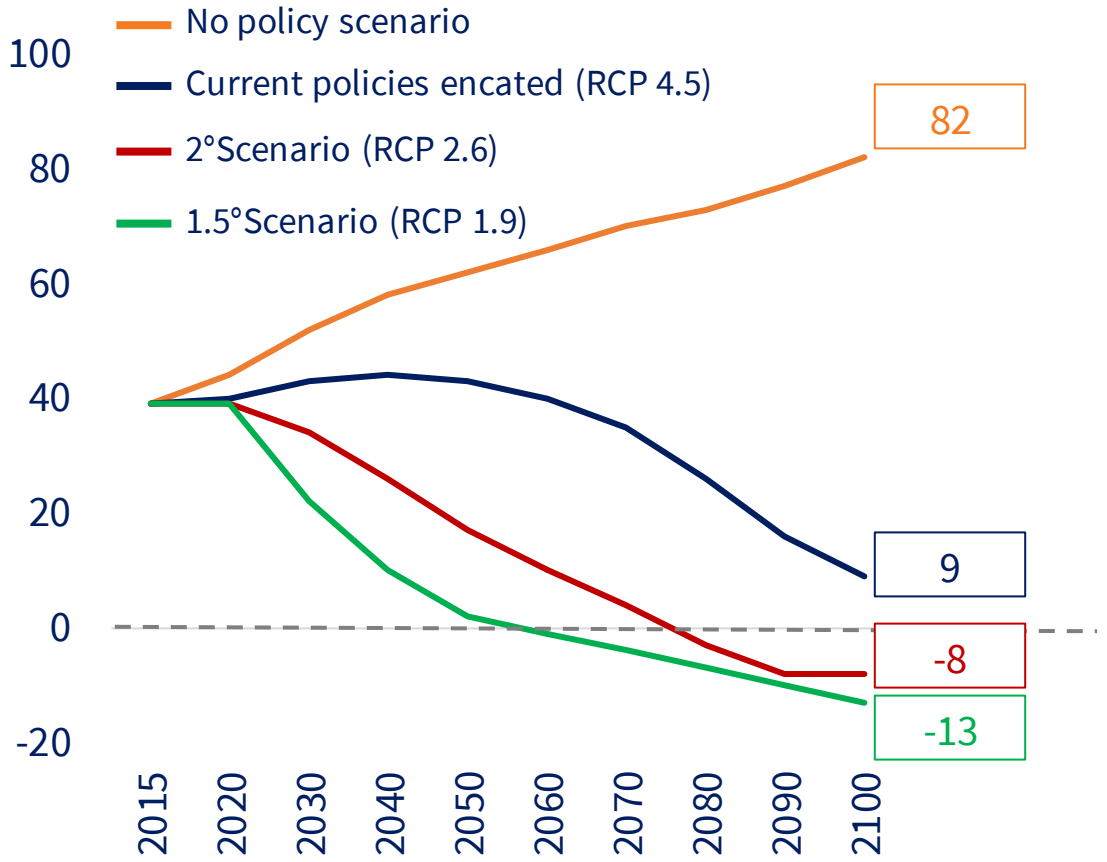
The Paris agreement was signed in 2015 to limit temperature rise well below 2°C, but step change is required to meet EU decarbonisation goals

Climate-changing gas emissions in Europe

($MtonCO_2e$), 1990 - 2019 and policy scenarios



CO_2 emission trends in the main scenarios considered by the IPCC ($Gton\ of\ CO_2$), 2015-2100

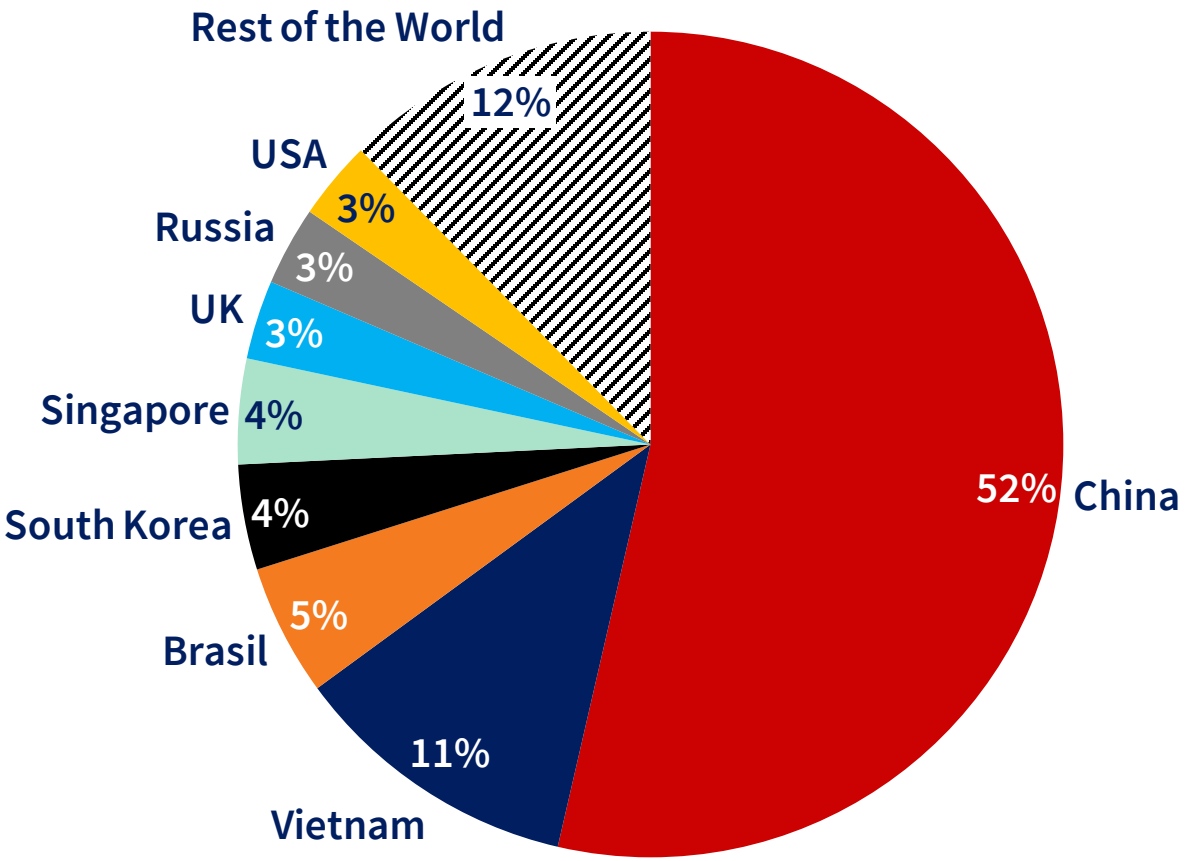


Note: RCP stands for Representative Concentration Pathways, i.e. the greenhouse gas concentration trajectories on which the IPCC builds its climate change models, based on possible future GHG emission levels

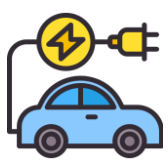
Source: The European House - Ambrosetti on IPCC data, 2022

Technological dependence must be considered on a par with energy dependence: 137 product categories in which the EU is dependent with impact on energy

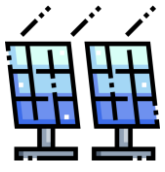
Country of origin of dependency (percentage of total), 2019



Four technologies are **dependent on high risk/risk supply chain materials**, and their import **demand is expected to increase** by 2030 – European Commission









Batteries	Wind power	Solar Photovoltaic	Electric vehicles fuel cells
Import demand increase by 2030			
x49	x44	x7	N.A.

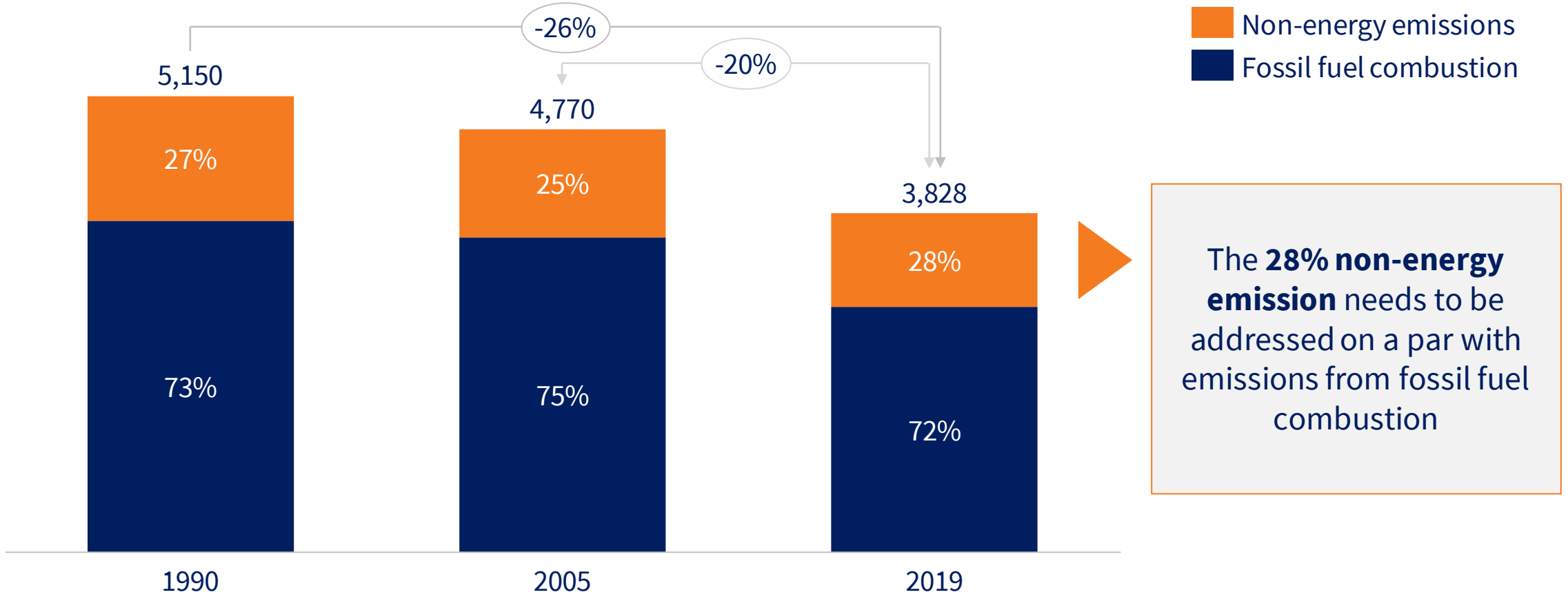
*Only electric vehicles batteries are considered

Source: elaboration by The European House - Ambrosetti on European Commission data, 2022

The most strategic and effective way to address decarbonisation is by working on both energy (72% of total emissions) and non-energy emissions (28%)

CO_2e emissions by fossil fuel combustion and other emitting processes in the European Union 27

(% and Mton CO_2e), 1990, 2005 and 2019



The **28% non-energy emission** needs to be addressed on a par with emissions from fossil fuel combustion

Note: the component 'CO_2 emissions from non-energy processes' includes industrial processes, chemical reactions, agriculture, livestock farming and waste management

Source: The European House - Ambrosetti on Eurostat data, 2022

The Outset

Hard to Abate industries, heavy transports and power generation are the hardest sectors to decarbonise, posing a technological development challenge for Europe

Sectors most difficult to decarbonise

Hard to Abate industries



Cement



Iron and Steel



Chemical

- Hard to Abate industries rely on fossil energies for **81%**
- **51%** of emissions generated from **industrial processes**

Heavy transports



Heavy Duty vehicles



Marine



Aviation

- **+90%** of transports modes relies on fossil fuels
- Electrification is a **long term** challenge in heavy duty
- Electrification is **not an option for aviation**

Power generation



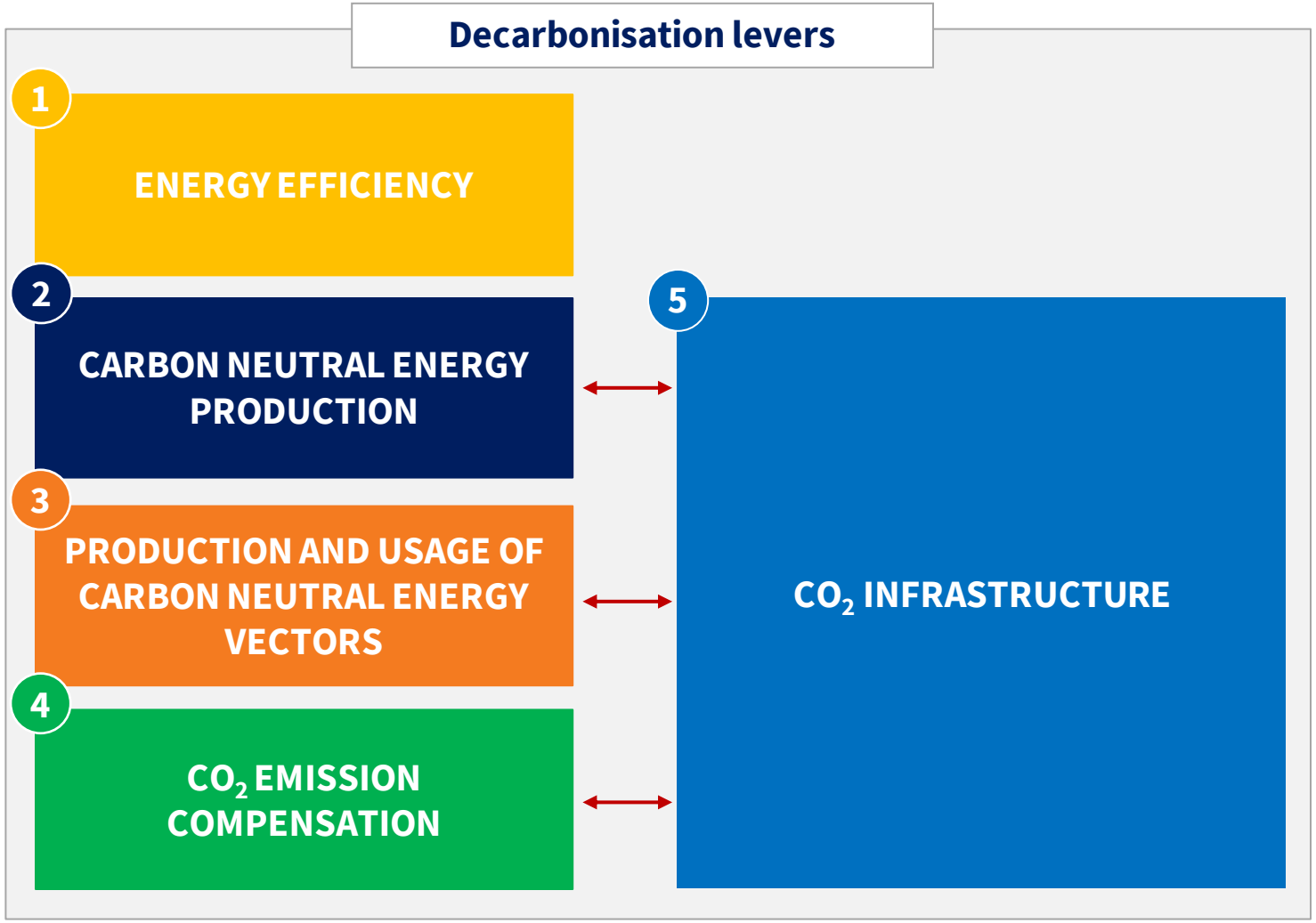
Fossil fuel power generation

- A minimum share of fossil fuels (**3.4%** in EU in 2050) will be required to ensure energy system **adequacy** and **flexibility**

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Source: The European House - Ambrosetti on Eurostat data, 2022

Findings We have identified 5 decarbonisation levers based on 100 technologies, the combination of which enables the carbon neutrality of each economic activity



The synergic combination of the five technology levers could enable the carbon neutrality of each emitting activity

The application of this principle to whole value chains allows to achieve full decarbonisation under a Life Cycle Assessment perspective

We have mapped a set of

100

technologies *that need to be considered to achieve climate goals*

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Source: The European House - Ambrosetti, 2022

Findings CCUS & CDR, H_2 and biofuels are key technological clusters to achieve full decarbonisation: this is reflected in IEA, IPCC scenarios and EU States strategies

KEY TECHNOLOGIES CONSIDERED IN THE STRATEGIC STUDY



CCUS & CDR

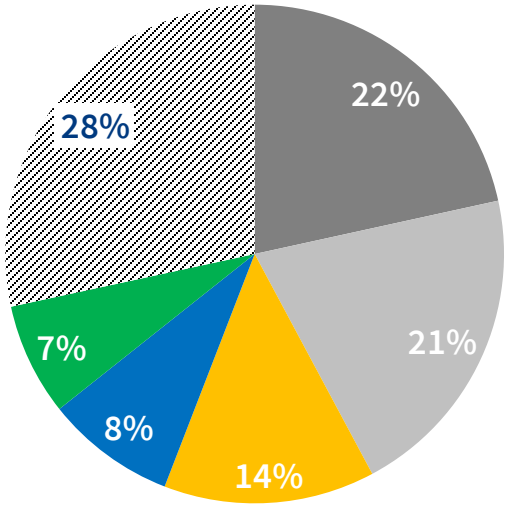


Hydrogen



Biofuels & Synthetic fuels

Share of contribution of each mitigation measure in the NZE** 2050 scenario (% of total emission reduction), 2020-2050



- Electrification
- Wind and solar

43%

- CCUS & CDR
- Hydrogen
- Bioenergy

29%

- Energy efficiency & behavioral change

- With respects to the **IPCC** comparable scenarios, IEA tends to attribute a smaller share to bioenergies, CCUS and CDR
- **Long Term Strategies of major European Member States** foresee a considerable role of CCUS, CDR and bionergies to achieve decarbonisation target in 2050

*CCUS: Carbon Capture Utilization and Storage for CO_2 emitted from industrial processes; CDR: Carbon Dioxide Removal of CO_2 captured from the atmosphere

** The Net Zero Emissions by 2050 Scenario (NZE) is an IEA scenario that shows a narrow but achievable pathway to achieve net zero CO2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others

Source: The European House - Ambrosetti on IEA data, 2022

CCUS & CDR

CCUS and CDR are available, scalable, competitive and safe technologies to accelerate the decarbonisation path, with 38 currently existing European projects

- There are currently **135 CCUS projects** worldwide, **38 are located in Europe** (28% of total): **43%** of global projects are in an **advanced development** phase, while only **20%** are **operational**
- **11 European National Energy and Climate Plans** contain explicit mention of CCUS as a measure to achieve the net zero emissions objectives, especially for the decarbonisation of **Hard to Abate sectors**, and dedicate parts of their National Resilience and Recovery Plans to develop national CCUS infrastructures

€1.85 bn to capture **0.4 Mtons CO_2/yr** from a cement factory in Norway. Development of a CO_2 transport and storage solution with a final **capacity of 5 Mtons/yr**

€27mln to support the development and demonstration of **CO_2 storage** sites in depleted oil and gas fields in the Danish North Sea

2 CCUS projects to decarbonize the East Coast **industrial clusters** of Teesside and Humberside and the Liverpool Bay industrial cluster (**10Mtpa** by 2030). **Drax** is investing over **£2bn** in two **BECCS** units at its Power Station to remove **8 MtonCO_2/yr**

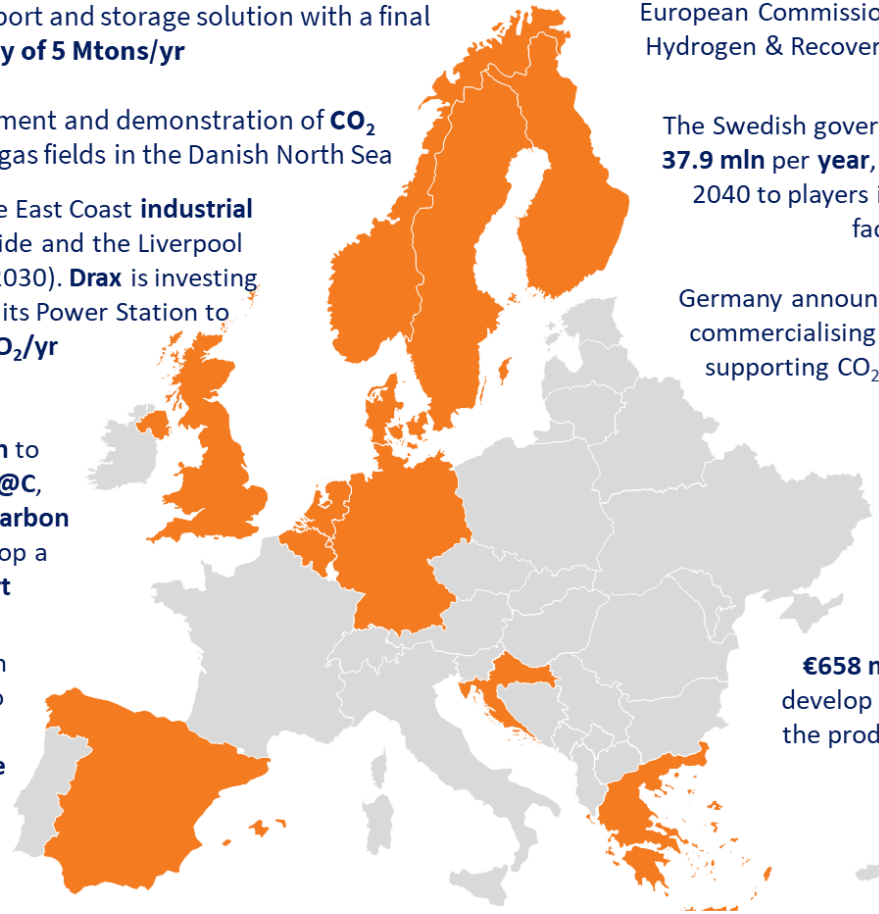
The Belgian NRRP allocated **€10mln** to support the CCUS project **Antwerp@C**, **€50mln** for the development of **low-carbon emission industry**, **€95mln** to develop a network for **H_2** and **CO_2 transport**

The Dutch NECP regards CCUS as an **inevitable transition technology** to reduce CO_2 emissions in sectors where **no cost-effective alternative is available** in the short term

A Finnish oil refinery was granted **€88 mln** by the European Commission for its Sustainable Hydrogen & Recovery of Carbon project

The Swedish government will subsidize **€ 37.9 mln** per **year**, over the period 2026-2040 to players investing in **bio-CCS** facilities

Germany announced a **funding directive** for commercialising capture technologies and supporting CO_2 transport infrastructure options



€658 million of the Croatian PNRR to develop innovative CCS projects, support the production of advanced biofuels and renewable hydrogen

The Spanish NECP proposes the integration of **CCUS technologies to reduce emissions**

The Greek NRRP destinates **€300mln** to develop the **Prinos CCS project**, with CO_2 stored in the depleted offshore fields

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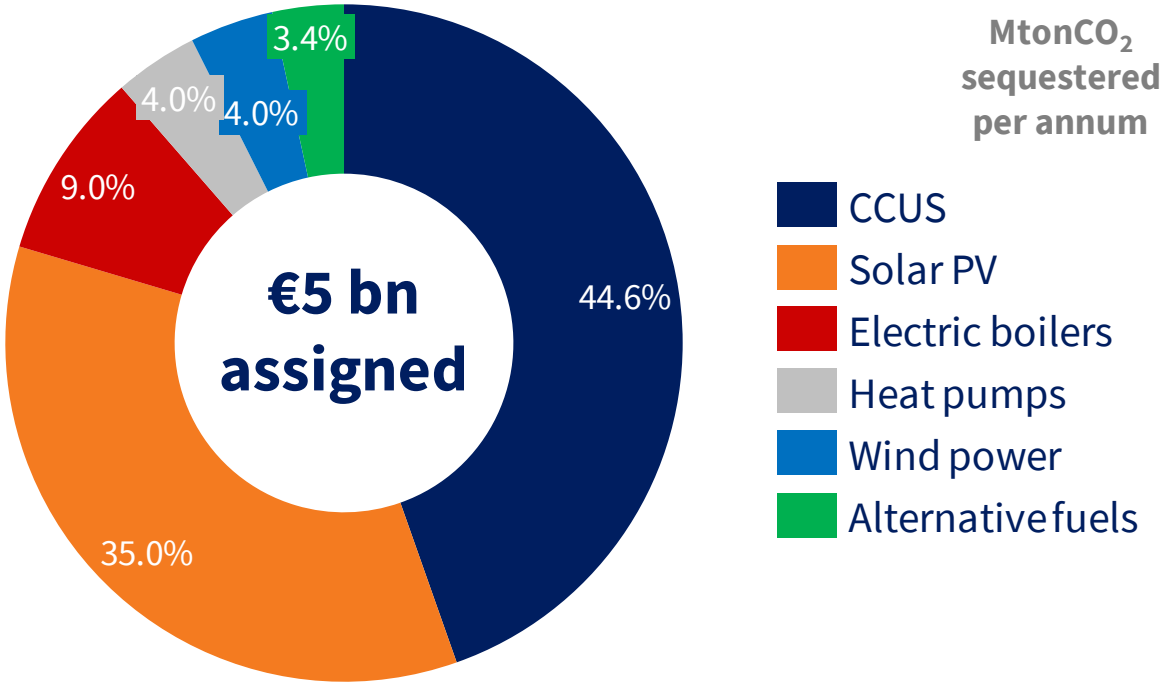
Source: The European House - Ambrosetti on NECP and PNRR data, 2022

CCUS & CDR

The Dutch government has recently awarded CCUS as the most cost-effective technology, granting to its development the largest amount of financial support

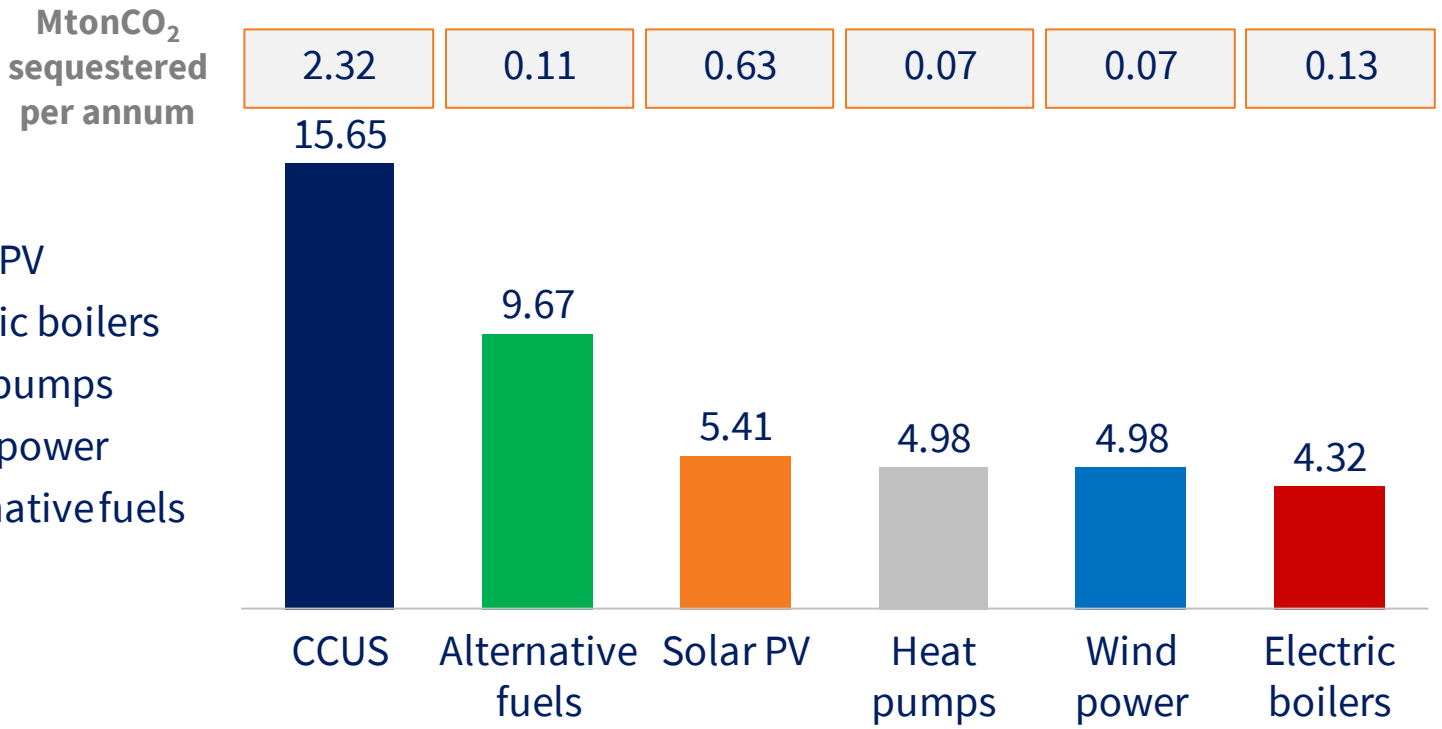
SDE++ 2020 budget allocation

(% and billion of Euro)



Technology efficiency: amount of CO_2 sequestered in 15 years per bn of investment

($MtonCO_2$ absorbed in 15 years/bn Euro)



Note: technology efficiency is calculated considering the amount of CO_2 captured in **15 years**, the timespan of the allocated funds

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Source: The European House - Ambrosetti on SDE++ Data, 2022

CCUS & CDR

The diffusion of CCUS and CDR technologies needs to be supported with adequate policies across Europe

Policy Proposal #1

- Envisage the **development of a regulatory framework for CCUS** according to a single European market logic, providing the creation of infrastructures with access for all Member States
- Foster the **inclusion of CCUS in the energy and climate planning** of all EU Member States

Policy Proposal #2

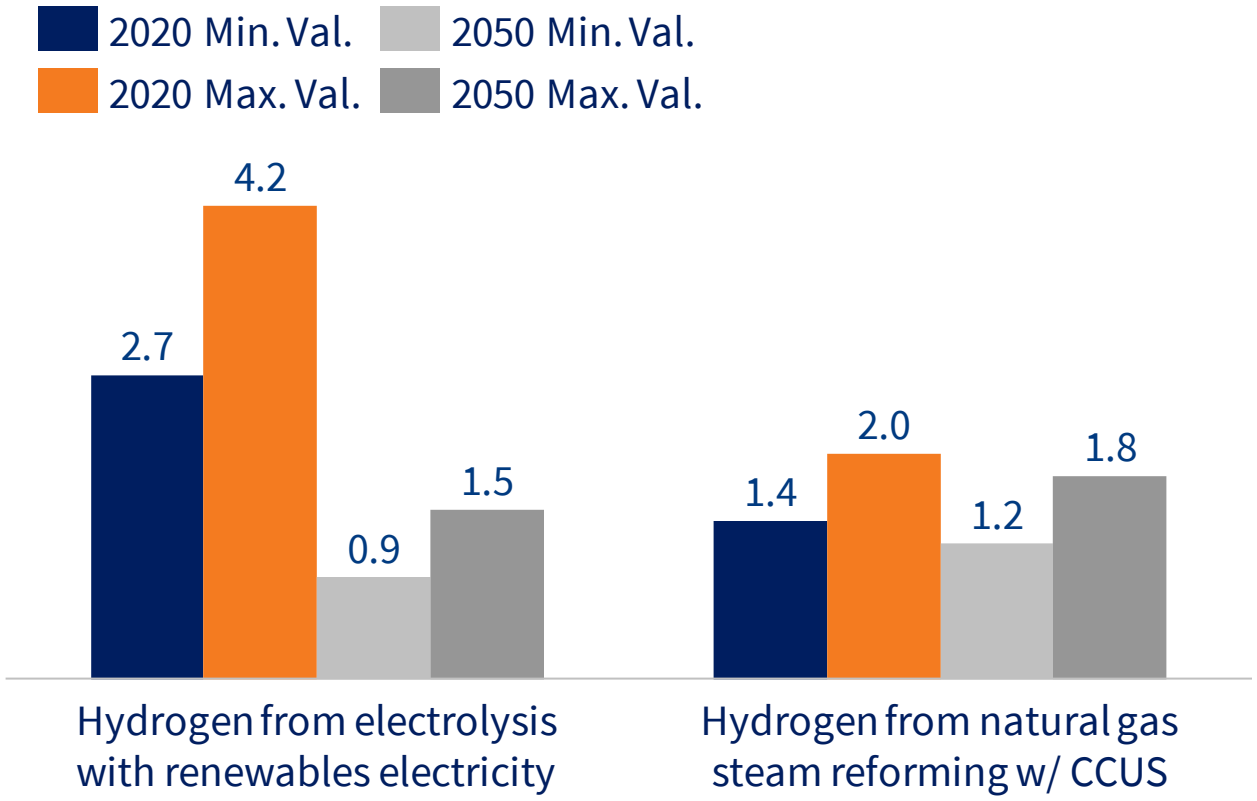
- Put in place a **policy mechanism that allows to account for negative emissions**, currently not possible under the EU Emissions Trading System (ETS)
- Introduce a **financing mechanism to de-risk industrial investments** in large-scale **CDR** demonstration facilities

Source: The European House - Ambrosetti, 2022

H_2 Production of carbon neutral hydrogen from fossil fuel is required to enable fast and competitive market growth without increasing competition with renewables

Higher market uptake price

Hydrogen's costs according to different technologies
(€/KgH_2), based on 2020 prices



Scarsity due to competition for electric renewable

Share of the capacity of renewable electricity required to produce from electrolysis all the **hydrogen demanded in the EU**

In 2030:
+34%

In the medium term, **the production of hydrogen with electrolysis reduces by about 3 times the decarbonisation potential of electric RES**

1 kWh of electricity from RES

- **Substitute fossil sources** in electricity generation: **350-700 g CO_2 saved**
- **Replace hydrogen produced from fossil sources: 94 g CO_2 saved**

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Source: The European House - Ambrosetti on Paper «Cost-effective Decarbonisation Study», European University Institute and Florence School of Regulation (2020) and other sources, 2022

H_2 To accelerate hydrogen market diffusion, it is important to have a strong support from policy makers

Policy Proposal #3

- **Recognize as sustainable the hydrogen generated from fossil fuel with CCUS when demonstrated that there are no unabated or uncompensated emissions under a Life Cycle Assessment.** This will make it possible to sustain the conversion of current gray hydrogen plants and support the diffusion of hydrogen fuelled technologies in the short-term, facilitating the future uptake of hydrogen from electrolysis
- Promote the diffusion of a **European policy reference standard** to be applied in all Member States to provide **technical** and **regulatory** clarity for companies involved in hydrogen valleys and other implementation projects

Source: The European House - Ambrosetti, 2022

Bio-fuels

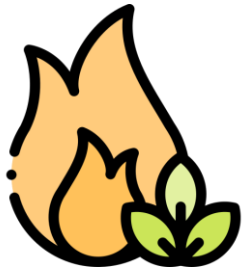
Biofuels, produced not in competition with food, can be a carbon neutral solution to replace traditional fuels, minimizing changes in consumption systems

SOURCES FOR BIOENERGIES GENERATION NOT IN COMPETITION WITH FOOD



Residues and wastes

34.9 million tons of waste per year available in EU for biofuels production



Agriculture crops not in competition with food

60 million hectares of Marginal Lands in EU can be exploited for bioenergy production

Biofuels can be used right away in existing systems, accelerating the decarbonisation process

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Source: The European House - Ambrosetti, 2022

Bio-fuels

Africa is the world's first area for marginal lands that can be developed for "energy crops", bringing important socio-economic benefits to local African communities

In Africa, there are **784 million hectars** of land that can be exploited to cultivate energy crops, fostering **economic and social development**

Moreover, oilseed crops can also be used to **bring back some marginal land after some years to be useful for food crops**

Main socio-economic benefits for local African communities involved in the cultivation of energy crops in marginal lands

Up to **171%**

differences in income perceived between workers in energy crops plantation and "normal" worker

Up to **181%**

differences in expenditure capacity between workers in energy crops plantation and "normal" worker

Up to **30 p.p.**

earned in the comparison of multidimensional poverty* between workers in energy crops plantation and "normal" worker

(*) The global Multidimensional Poverty Index (global MPI) is a poverty measure that reflects the multiple deprivations that poor people face in the areas of education, health, and living standards. Definition Oxford University

Source: The European House - Ambrosetti on report "Fuelling rural development? The impact of biofuel feedstock production in Southern Africa on household income and expenditures", South Africa University, University of Oxford and Stockholm Environment Institu te, 2022

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Bio-fuels

Policy proposal to fully exploit bioenergies potential

Policy Proposal #4

Ensure that all the feedstocks' sources from **wastes, residues and crops, not in competition with food and feed chains, are considered sustainable** to produce carbon neutral bioenergies when demonstrated that there are no emissions other than biogenics ones

Source: The European House - Ambrosetti, 2022

Policy proposals to accompany a more effective deployment of technologies within different areas of use

Policy Proposal #5

- To incentivize investments in decarbonisation infrastructures and technologies, resources should be allocated according to the **economic efficiency to abate CO_2**, evaluating the potential in comparison with other alternative technologies and according to a **Technology Neutrality principle**

Policy Proposal #6

- Introduce a **Carbon Contracts for Difference** model that encourage the investments in Zero Carbon technologies by reducing the risks in the investment phase, in a similar way as done to incentivise the diffusion of electric renewable energies

Policy Proposal #7

- **Moving beyond the "tank-to-well" emissions calculation** approach and promoting a "**well-to-wheel**" Life Cycle Assessment (LCA) approach in assessing overall fuel emissions
- Recognize, in the European taxonomy, the status of "carbon neutral fuels" to **biofuels** and **hydrogen** produced from fossil sources in **combination with CO_2 Capture technologies**
- Foster the **creation of infrastructure**, such as refilling stations, required for a massive deployment of alternative fuels on roads, ports and airports and introduce **fiscal policies to reduce the price gap with traditional fuels**

Source: The European House - Ambrosetti, 2022

Scenario implications

Decarbonisation levers have been applied to two different scenarios in order to assess their impact on CO_2 abatement

The decarbonisation impact of these three technologies…

- **CCUS & CDR**
- **Hydrogen**
- **Biofuels & Synthetic fuels**

…has been evaluated on the Hard to Abate sectors…



Cement



Iron and Steel



Chemical



Heavy Duty vehicles



Marine



Aviation



Fossil fuel power generation

…considering two different penetration scenarios

Zero Carbon Technology Scenario considers the **full application of Policy Proposals**

Inertial Scenario is developed **without the application of proposed policies**

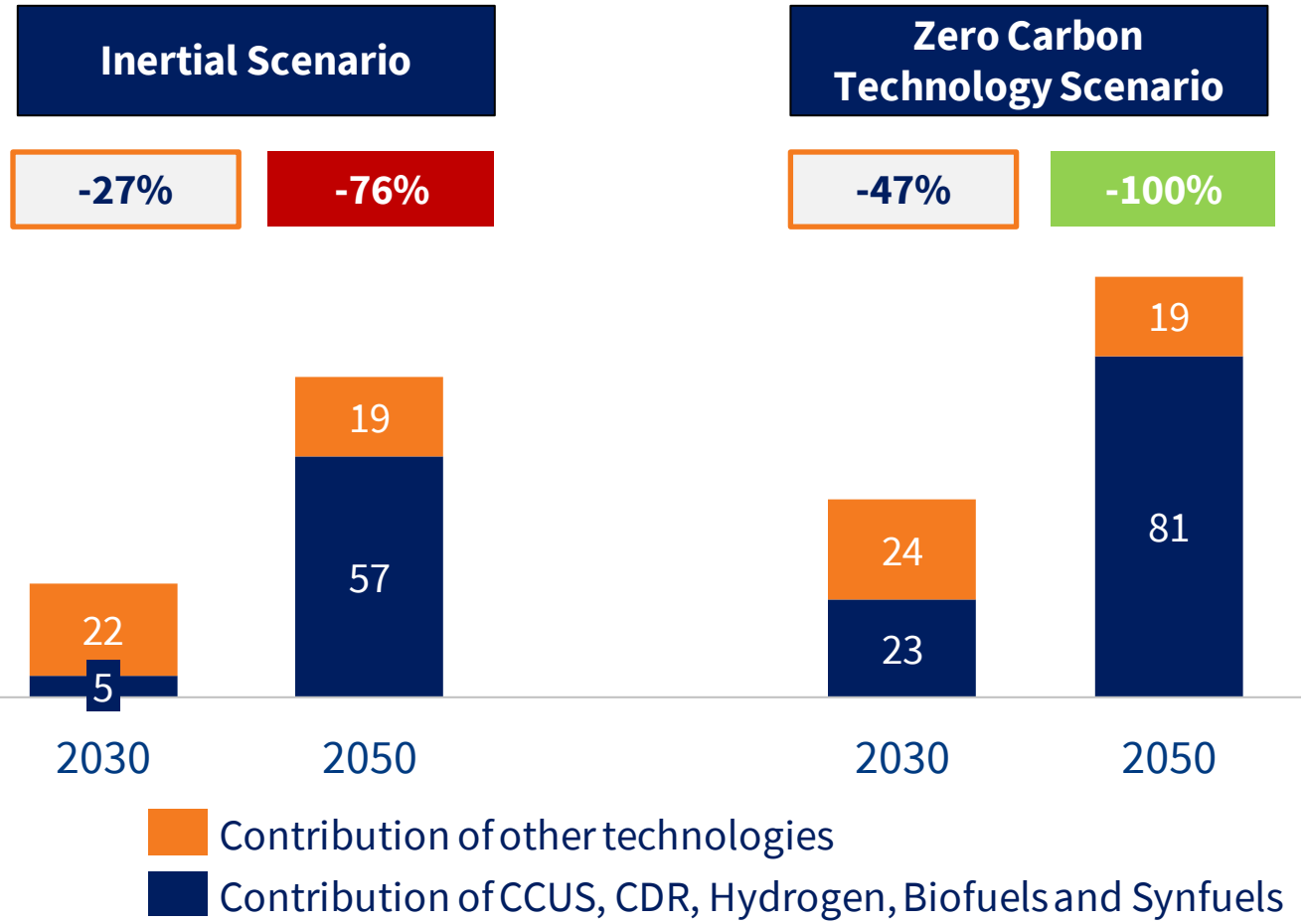
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Source: The European House - Ambrosetti, 2022

Scenario implications

Only under the Zero Carbon Technology Scenario assumptions it is possible to achieve full decarbonisation by 2050

CO_2 emissions reduction, Inertial scenario and Zero Carbon Technology Scenario, in EU27 (%), 2030 and 2050



From 2023 to 2050

+31%

of CO_2 cumulated emissions reduction in the Zero Carbon Technology Scenario vs. Inertial Scenario

corresponding to

6 years

of **total emissions** of the considered sectors

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Source: The European House - Ambrosetti on data from proprietary models, 2022

The rewards

In EU, the impact on value chains will be significant, generating € 2,700 bn of cumulative added value from 2023 to 2050 and 1.7 mln employees in 2050

MAIN RESULTS OF THE ECONOMETRIC MODEL

€ 181 billion
total Added Value in 2050

€ 2,700 billion
cumulative Added Value from 2023 to 2050

1.7 million
employees generated in 2050

With reference only to CCUS, CDR, hydrogen, biofuels and synfuels in the Cement, Iron & Steel, Chemistry, Heavy Transport and Power Generation sectors

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Source: The European House - Ambrosetti on data from proprietary models, 2022

Discontinuity in the decarbonisation process will be generated by some breakthrough technologies: it is crucial for EU to develop an industrial advantage

Nuclear fusion technology highlights:

- offers virtually **limitless, clean power**; it could complement renewables by providing electricity during peaks and throughs, it could provide **clean industrial heat**, and it can **generate hydrogen** to replace natural gas
- produces **no harmful emissions or radioactive waste**, and the elements required are easily attainable and readily available
- has recently achieved important milestones:
  - In February 2022, the JET project experiments produced **59 megajoules of energy in 5 seconds** (11 megawatts of power)
  - In the UK, Tokamak Energy achieved important milestones in early 2022: reached a plasma **temperature of 100 million degrees Celsius**, the threshold required for nuclear fusion
  - In September 2021, the MIT CFS generated a **magnetic field of 20 Tesla**, demonstrating that the new technology based on high-temperature superconducting magnets is suitable for the nuclear fusion process and enables small-scale power plants

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Initiatives around the world claim that nuclear fusion will be commercially available in the 2030s

Source: The European House - Ambrosetti on Fusion Industry Association data, 2022

The horizons

It is necessary for EU to adopt a strategy that also looks at long-term in order to gain a solid industrial advantage

MAGNETIC CONFINEMENT FUSION

Working Table with **11 stakeholders**

tokamak energy – a faster way to fusion; ANSALDO ENERGIA; RENAISSANCE FUSION; BUTTING; Studsvik; OXFORD SIGMA; Commonwealth Fusion Systems; FUSION INDUSTRY ASSOCIATION; ENEA – Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile; IAEA; POLITECNICO MILANO 1863; The European House Ambrosetti

Policy Proposal #8

- Foster the **leadership in research and development of frontier technologies** that will potentially be disruptive in decarbonisation processes, such as nuclear fusion
- Ensure **policy support** (regulatory framework, incentives, etc.) **to promote the creation of public-private partnerships** between academia, research centres, industries and public authority to accelerate the developments of such technologies

Policy Proposal #9

- Provide **clarity on the overall regulatory regime** for fusion energy facilities, considering all the differences with respect to nuclear fission technology
- Ensure regulators have the **technical capability** to regulate fusion energy facilities effectively
- **Maximise public confidence** in the regulatory framework for fusion, envisioning occasions for public debate and discussion
- Create a **platform mechanism through which innovation projects and financial investors** can be brought together

Source: The European House - Ambrosetti, 2022

Thank you for the attention!