



Decarbonization of energy

As part of the “Green Activists for Climate Friendliness” Erasmus+ project, participants worked in international teams to develop practical solutions for decarbonising the energy sector.

Their proposals focused on renewable energy, energy efficiency, and climate-friendly policies, encouraging youth action for a sustainable future.

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1. INTRODUCTION

KEY FINDINGS

The Fit for 55 package foresees a significant speeding up of European decarbonisation. This requires many new and upgraded policy frameworks. The European Commission has already proposed extensive reforms to the EU's energy and climate policy framework, and more are forthcoming before the end of 2021.

The purpose of this report is to provide insight into the rationale behind these revisions. Specifically, this is done by informing policymakers about the implications of different fuel mixes in a decarbonised EU in 2050. We explore three scenarios with differing demand assumptions for electricity, hydrogen and alternative green gases.

1.1. Objective, scope, and targeted output of the Study

This study provides science-based recommendations for adapting the European regulatory framework for the gas, coal and hydrogen sectors to increased decarbonisation² ambition. Based on transparent assumptions, we develop three scenarios of the contribution of hydrogen, natural gas and electricity to final European Union (EU) energy use. For each scenario, we describe the demand for each fuel by sector, the implied necessary upstream investments (e.g., electrolyzers for hydrogen production), the implied investment needed for infrastructure (e.g., hydrogen pipelines) and the required annual payments for imports where appropriate.

By comparing scenarios, we outline trade-offs in terms of speed of decarbonisation, security of supply (import shares), volume and timing of investment needs, corresponding investment gaps and total cost (chapter 6). For each of the fuels (hydrogen, natural gas and coal) a separate chapter describes in a detailed and illustrative way the impact of the individual scenarios. Thereby, crucial elements of the current regulatory framework, as well as current Commission proposals, are discussed with respect to their adequacy and consistency with the outlined scenarios. This allows us to identify policy gaps.

Based on the above, we make clear recommendations on how to ensure that European policy enables the most effective and efficient transformation of the coal, natural gas and hydrogen sectors.

1.2. Background

With the European Green Deal (EGD), the EU aims to become the first climate neutral continent by 2050. This vision, also fostered by the European Parliament's climate emergency declaration of November 2019, was enshrined into legislation with the European Climate Law³. This transformed the EU's climate-neutrality pledge into a binding obligation, and increased the EU's 2030 emissions reductions target from 40% to at least 55% compared to 1990 levels.

To deliver on its climate obligations, the EU must pursue one main goal: make its energy sector climate neutral. The production and use of energy across economic sectors accounts for more than 75% of the EU's greenhouse gas (GHG) emissions⁴.

² Throughout the paper, we use the term decarbonisation referring to a move toward climate neutrality. That is, by using decarbonisation we do not intend bias against synthetic hydrocarbon molecules in the cases that they have a net-zero carbon emissions effect.

³ See https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en for a description of the EU's Climate Law.

⁴ See <https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer> for an overview of the EU's greenhouse gas emissions as reported to the UNFCCC.

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1.3. Recent and upcoming developments

The use of coal in Europe's energy sector has substantially decreased in the last decades, for economic reasons, because of emissions regulation and following national phase-out policies. The share of coal (lignite and hard coal) in electricity generation in the EU has been reduced significantly in the past two decades, from 31% in 2000 to 19% in 2018 and 14% in 2019. Recently, the EU ETS reform further deteriorated the economics of coal.

Importantly, national, coal-sector-specific policies now lead to the definite phase-out of coal in many EU Member States. Often, national policies take the form of mandated phase-out schedules with planned closures of coal power plants and mining sites. Only rarely are alternative policies, such as emission performance standards, chosen as a phase-out policy. Table 1-1 reports on the progress of the coal phase-out in EU Member States. Nine of the 27 Member States are already coal-free and eleven more will have shut down all their coal-fired power plants by 2030. Germany, Romania, Poland and the Czech Republic currently plan for a phase-out later than 2030. Bulgaria, Croatia and Slovenia have not yet decided on the timing of their coal phase-out.

Table 1-1: Coal phase-outs in EU countries

Coal free	Coal phase-out achieved	Coal phase-out by 2025	Coal phase-out by 2030	Coal phase-out by 2040	Coal phase-out later than 2040	Coal phase-out under consideration	No coal phase-out planned
Cyprus	Austria	France	Denmark	Czech Republic	Poland	Bulgaria	
Estonia	Belgium	Hungary	Finland	Germany		Croatia	
Latvia	Sweden	Ireland	Greece	Romania		Slovenia	
Lithuania		Italy	Netherlands				
Luxembourg		Portugal	Spain				
Malta		Slovakia					

Source: Updated from https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/coal-regions-transition_en, <https://beyond-coal.eu/wp-content/uploads/2021/03/Overview-of-national-coal-phase-out-announcements-Europe-Beyond-Coal-22-March-2021.pdf>.

For natural gas and hydrogen, in contrast, the relevant policy developments take place at the EU level. The EC has already started the process of reviewing and revising the Gas Directive 2009/73/EC⁶ and the Gas Regulation (EC) No 715/2009⁷, generally referred to as the hydrogen and decarbonised gas market package. The Commission has already presented a hydrogen strategy⁸ and an energy-system integration strategy⁹, which will serve as building blocks for the forthcoming package.

⁶ Available here: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0073>.

⁷ Available here: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009R0715>.

⁸ Available here https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf.

⁹ Available here: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0299&from=EN>.

EU Energy Transition: Key Changes

Currently, 75% of the EU's energy comes from fossil fuels, with oil (35%), natural gas (24%), and coal (14%) dominating the mix. Renewables and nuclear each contribute 14% and 13% respectively. The European Green Deal (EGD) aims to achieve carbon neutrality by 2050.

By 2030, fossil fuels will still make up 50% of the energy mix, but coal must be drastically reduced. Between 2030 and 2050, oil will be nearly phased out, and natural gas will drop to 10%.

To drive this shift, the Fit for 55 package strengthens emissions rules, expands carbon trading, and tightens vehicle CO₂ standards. The Hydrogen Strategy prioritizes renewable hydrogen, with low-carbon hydrogen as a temporary solution.

Infrastructure changes under the TEN-E Regulation Revision end support for natural gas and fund hydrogen transport and storage. The Energy-System Integration Strategy promotes efficiency, electrification, and low-carbon fuels.

With these measures, the EU is set to transform its energy system, reducing fossil fuel dependence and boosting renewables.

Red positive:

Direct electrification of transport and heating is the most efficient solution.

- Massive build-up of renewable electricity generation is essential.
- Investments in fossil fuel infrastructure should be avoided.
- Clear energy policy signals are needed from 2021–2030.
- Coal phase-out is underway in 20+ EU countries; others need support.
- Hydrogen will be key in hard-to-decarbonise sectors like aviation and heavy industry.
- Natural gas will be replaced by biomethane, hydrogen, or electricity.
- Energy transition helps coal regions with EU Just Transition Mechanism.
- NECPs and EU targets must align for an effective transition.
- Scenario modeling supports three paths: all-electric, hydrogen-import, and

green gases.