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A Critical Assessment of the Electricity Market Design Reform in relation to EU Industrial Competitiveness

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This thesis is dedicated to my late uncle Leen, aunt Sylvia, and grandfather Ed. I carry their memory with me wherever I go, and their personal qualities are an inspiring example to emulate during the rest of my life.

Abstract

This project concerns the proposed EU's electricity market design reform and its potential impact on the industrial competitiveness of European member states. The reform aims to (1) boost renewable energy investments, (2) better protect and empower EU consumers, and (3) enhance the competitiveness of European industry. This thesis examines to what extent the proposed reform can significantly contribute to achieving policy objective three. It does so by assessing the expected impact on the European aluminium industry. This requires a detailed investigation of the EU manufacturing sector, its electricity market design, and the energy crisis. Theoretical frameworks, secondary data, and primary data merge those issues into an analysis of the electricity market reform. The paper concludes that the reform is unlikely to significantly decrease energy prices as these are caused by a stressed gas market. The reform does not tackle this issue and is therefore unlikely to contribute to EU industrial competitiveness in the short to mid term. Two-way Contracts for Differences are assessed to be capable of creating an effective subsidy scheme for industrial consumers and accelerate the deployment of renewable energy resources, thereby potentially resolving the supply issues causing high energy prices in the long term.

Keywords: European Union, Industrial Competitiveness, Electricity Market Design, Aluminium Industry, Energy Prices

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List of Abbreviations & Acronyms

ACER	Agency for the Cooperation of Energy Regulators
EC	European Commission
EII	Energy intensive industries
EIB	European Investment Bank
EMD	Electricity Market Design
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
MENA	Middle-East and North-Africa
RES	Renewable Energy Sources
SME	Small and Medium Enterprises
TSO	Transmission System Operator

1. Introduction

Surviving and adapting to the challenges and transformations of the 21st-century has become a core goal of the European Union (EU) (CEPS, 2020). The seed of economic cooperation between six European countries, planted in 1952 with the creation of the European Coal and Steel Community, has blossomed into a political union of 27 sovereign states. Although the EU remains a political institution focused on the co-existence, cooperation, and coordination between its member states, it has been forced to enhance its external vision, posture, and related policies in its modus operandi. That dynamic was underlined by Commissioner President Ursula von der Leyen, who stated her ambition to lead a 'geopolitical Commission' in her inauguration speech (European Commission, 2019c). The main priorities: (1) The Green Deal, (2) the digital transition, (3) an inclusive European economy, (4) strengthening Europe's global position, (5) promoting European values, and (6) revitalising European democracy (European Parliament, 2019). The simultaneous and effective pursuit of those six priorities is, however, only feasible in theory. Practice shows that anticipating and responding to events in the world forces political trade-offs. For example, the French president Emmanuel Macron has called for a 'pause' in the roll-out of EU environmental regulations amidst the efforts of member states to protect their national industries and job markets (Le Monde, 2023).

This is indicative of the challenges, caused by COVID-19 and the energy crisis, that European economies are faced with. Although the immediate threat of COVID-19 to the public health has been mitigated, it is clear that the pandemic has created a new paradigm regarding international trade (Noerr, 2022) Amidst recurring national lockdowns from 2019 till 2022, Europe's supply chains were painfully exposed to their dependency on the supply of rare-earth minerals, raw materials and processing capacities of other countries, particularly China (Wozniak & Axioglou, 2022; European Commission, 2023g). This has led to a push for a new strategy on the EU's supply chains, entailing increased domestic sourcing and diversified supply chains with like-minded partners. Recurring terms, such as re-shoring, friend-shoring, and reindustrialisation in recent speeches of Ursula von der Leyen, Thierry Breton, and Emmanuel Macron underline this new paradigm (European Commission, 2022c). Its necessity springs from the indispensable role of secure supply chains in the EC's core priorities, such as the Green Deal, Digital Transition, and the EU's global position. Consequently, several policy-initiatives have been launched, including the Critical Raw Materials Act, European Chips Act and the European Supply Chain Directive (Niclas et al., 2022).[1]

[1] The focus of these differing legislative packages is to strengthen the EU's geopolitical position by incentivising production of strategic materials in Europe, including microchips and critical materials, and diversifying supply chains to reduce strategic dependencies.

In light of these ambitions, the Russian invasion of Ukraine in February 2022 should be seen as more than a direct challenge to the European security architecture, the rules-based international order, and morally unacceptable. The deteriorated relations between the European states and Russia triggered an unprecedented global energy crisis, skyrocketing electricity prices, and severe implications for the EU's strategic objectives. Whereas COVID-19 fostered the political will to re-shore industries and strengthen local supply chains, the 2022 crisis eradicated a critical component within the EU's capacity to do so: the price of energy (ERT, 2022). This constitutes a crucial indicator for the competitiveness of firms within several sectors, like energy-intensive industries (EII) and increasingly digitalised sectors (CEPS, 2019). Their exposure to competition with companies across the globe makes a persisting high energy price an existential threat for their survival on European soil. Consequently, the opposite of what the EU aspires might occur: deindustrialization (Politico, 2023).

In response, Ursula von der Leyen announced in her state of the Union Speech in September 2022 the need for a 'deep and comprehensive reform' of the European Electricity Markets as 'it is no longer fit for purpose' (Szoke, 2022). The need for reform was encouraged by member states in the European Council in October and December 2022 (European Council, 2022b; European Council, 2022c). Subsequent communication from the European Commission (EC) has stressed that the proposal for Electricity Market Design (EMD) reform focuses on three objectives: (1) Boosting renewable energy investments, (2) better protect and empower EU consumers, and (3) enhancing the competitiveness of EU industry (European Commission, 2023h). This paper assesses the potential capacity of the initial proposal of the EC to achieve objective three. Can the EU protect its industrial competitiveness through a reform of the EMD? Or is this ambition really just a paper tiger? What does it entail for the industrial ambitions of the EU?

The aforementioned context and related challenges are particularly relevant for the EU's aluminium industry (Manthey, 2022). Aluminium is recyclable, lightweight, and capable of conducing heat and electricity. More specifically, aluminium is a key component in the production of solar PV systems, wind turbines, grid technologies, and batteries (Hodgson & Vass, 2022). Substituting steel with aluminium in cars, trains, and aircrafts significantly decreases their weight and thus CO2 footprint (European Aluminium, 2023b). Consequently, global aluminium demand is expected to increase by 30% in 2030 (Amanor-Wilks, 2022). However, since the outbreak of the energy crisis in 2022, European aluminium production output has decreased by 50% due to high electricity prices (European Aluminium, 2023c). Two primary aluminium smelters have been closed in Europe, and experts warn that this trend will continue in 2024 if no solutions to ongoing problems are created (Rani, 2023; Majumder, 2023; Home, 2023). Such a developments are illustrative for the fears of European deindustrialization. Moreover, the aluminium industry in Europe is among the most sustainable in the business and scores high in energy efficiency (International Aluminium Institute, 2023). The aluminium industry currently accounts for 3% of worldwide industrial C02 emissions, meaning that a decreasing market share of Europe will most likely translate in increased emissions on a global scale (IEA, 2023a). Taken together, Europe's aluminium industry constitutes a fitting case to study whether the reform of the European electricity market design can address concerns regarding industrial competitiveness and electricity prices.

2. Research Design & Methodology

The previously sketched context and dilemmas will be investigated through a more narrowly defined research question, namely: To what extent can the Commission's proposed reform of the EU Electricity Market Design significantly contribute to the competitiveness of EU energy-intensive industries in the short to mid term? This paper tests the hypothesis, based on the communication of the European Commission (EC), that the EMD reform can significantly contribute to the competitiveness of the EU energy-intensive industry (EII) in the short-to midterm. The criterium for determining a significant contribution of the EMD to industrial competitiveness is its assessed capacity to decrease energy costs for EII operating in the EU on the short to mid term. This criterium is evaluated on a scale, enabling the research to assess to what extent the reform impacts energy prices. The research would ideally formulate a binary answer, but that is hard given the complex technical issues, policy realities, and unforeseen future developments underpinning the project.

It shall be noted that this paper investigates a hypothetical causal relationship. It examines the potential impact of an independent variable, the impact of the EMD reform in its current shape, on a dependent variable, the industrial competitiveness of EII in the EU in the mid to short term. Such a hypothetical question cannot be answered by solely gathering data and literature on events in the past. The research therefore concerns a combination of desk research and interviews with experts and relevant actors, which enables an analysis of foreseeable consequences. The gathered data consists of primary sources in the form of interviews and legislative proposals, and secondary sources in the form of established academic literature, research reports and relevant data.

Given that the scope of this research is limited, the choice was made to conduct a single-case study focussing on the aluminium industry in Europe. The characteristics of this sector made for a fitting case to study in terms of competitiveness in relation to the EMD reform. The aluminium sector is exposed to intense global competition, is of growing strategic relevance for the EU climate agenda, and severely impacted in its competitiveness due to the European energy crisis.[2] Additionally, this sector is electro-intensive, meaning that the correlation between the competitiveness of the European sector and the EMD reform is stronger than other EII like steel, cement, chemicals and paper. The impact of other initiatives and proposals like the EU's Net-Zero Industry Act, fall outside of the scope of this research.[3] Other determinants of competitiveness which are more firm-specific rather than sector-specific, such as vertically integrated firms, demand-dynamics and commercial strategies, are also not taken into account for this reason. Taken together, these limitations provide a literature gap for future studies to address.

The relevance of the stated hypothesis needs to be assessed before studying the topic. Collier (2011) explains that single-case studies can judge the relevance of a stated hypothesis through its justified confirmation or denial whilst providing additional context, explanation, and recommendations. The mere confirmation of the relevance does not provide sufficient evidence to categorically deny or confirm its universal generalisability. The wider aim of the project is thus to explore the relevance of the posed hypothesis within a growing body of literature and research on the topic which can serve as an indicator and guide for future studies. The conclusion of the research should be read with the previously mentioned limitations in mind and not be applied to other cases without taking their specific characteristics into account.

Lastly, it shall be noted that this thesis does not touch upon the growing discussion within the EU concerning the carbon-intensity and polluting impact of energy-intensive industries such as steel and aluminium. Although such considerations are important to take on board in a normative investigation on whether the EU should re-shore industries, this research is concerned with the capacity of the EU to do so.

3. Roadmap

First, this thesis provides a brief introduction into the concept of competitiveness. The model used by the European Investment Bank (EIB) in a research report on European competitiveness will be the focal point of this section. Secondly, the overall state of the EU manufacturing industry and the the aluminium sector specifically will be described in chapter one. This includes an assessment of fragmented global supply chains to explain the increasing geopolitical pressure on the EU to manufacture strategic goods in Europe - or potentially face severe consequences. Chapter two explores the history, legislation and structure of the European electricity market at the hand of the

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[2] See section 'aluminium industry' (Chapter 1, section III)

[3] The EU Net-Zero Act (2023) is an EU initiative aimed at stimulating the decarbonisation of the EU's industry whilst preserving its competitiveness in a global playing field.

merit order model. Subsequently, chapter three investigates the most important components within the Commission's proposal on EMD reform. This chapter also includes an examination into the causes, effects and implications of the European energy crisis, and the political process leading to the eventual publication of the proposed EMD reform. The findings, arguments, and data displayed in the first three chapters will be combined into an analysis and argument related to the central research question in chapter four. The paper will be concluded with a concise conclusion including recommendations for policymakers and future studies concerning the wider topic.

4. Theoretical Framework: Competitiveness

Competitiveness is a term which refers to the capacity of firms to mobilise and efficiently allocate resources with the goal of maximising their business potential, thus revenue and profits, vis-a-vis competitors (EIB, 2016). Competitive companies and industries attract investments, drive technological innovation, and create job opportunities, thereby contributing to the overall creation of wealth within an economy. This dynamic is underlined by the Ricardian theory of comparative advantage, a dominant strand of thinking within international trade and economics. The central hypothesis states that nation gain trade advantages if they produce the lowest opportunity cost in comparison to other competitors, thereby attracting trade and business (Saylor Academy, 2019). Improving competitiveness is, within this school of thought, then defined as the process of lowering opportunity costs and thereby improving international trade advantages. The EIB has formulated a theoretical model which grasps the aforementioned dynamics in a single framework

Figure 1: Conceptualising competitiveness (EIB, 2016)

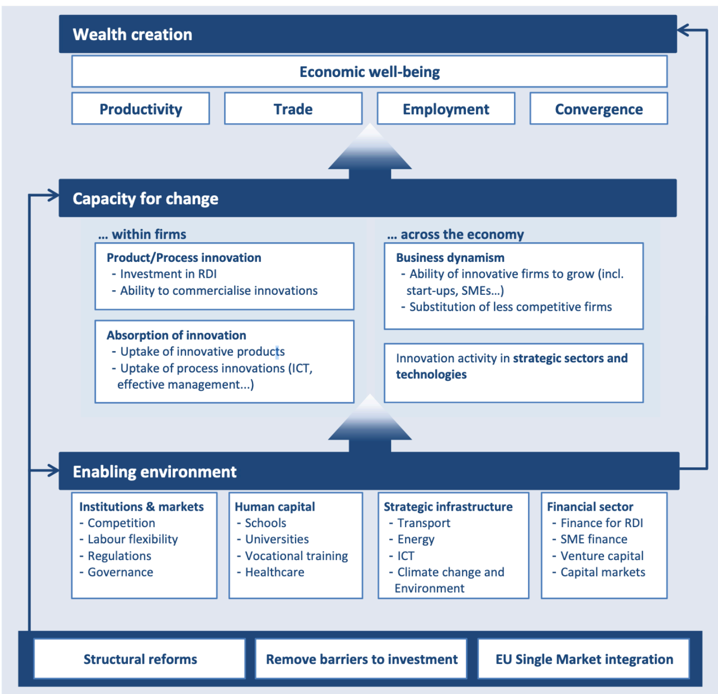


Figure 1 demonstrates that the competitiveness of a single firm is dependent on its own capacities, dynamics within a specific sector, the economy as a whole, and the rules and legislations that regulate society and the state. The EIB identifies the three levels underpinning the competitiveness of the EU as (1) structural reforms, (2) enabling environment, and (3) capacity for change. This research is concerned with a component of the enabling environment in the EU market, the strategic energy infrastructure and its effect on industrial competitiveness.

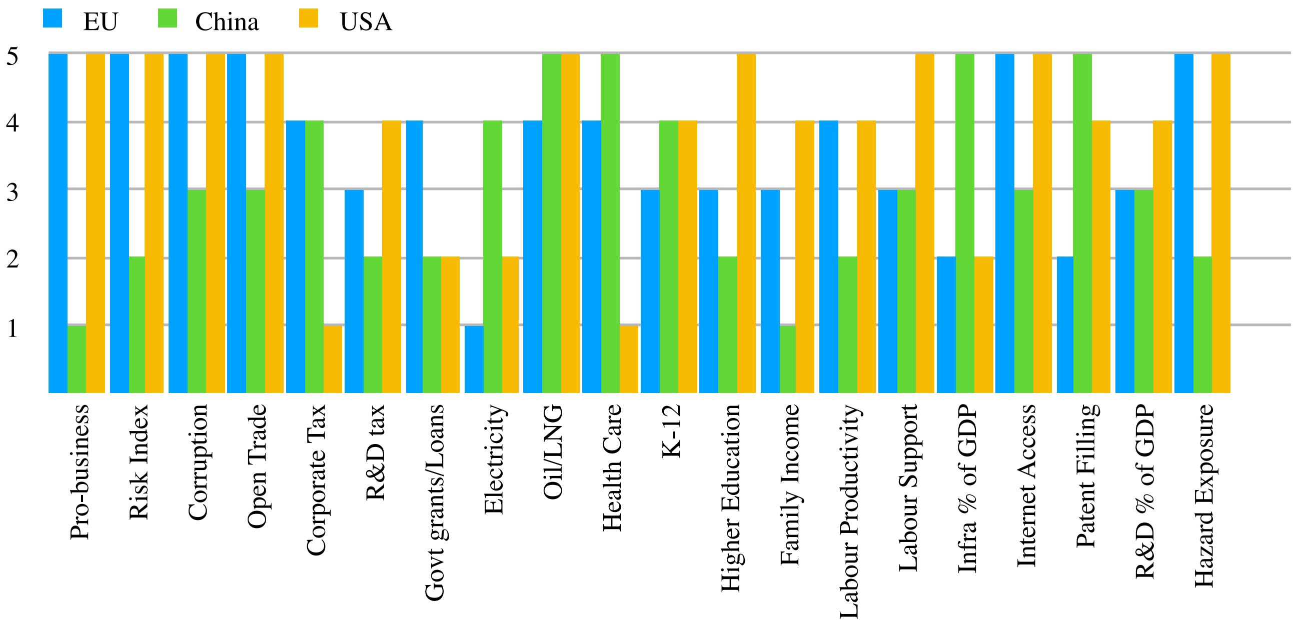
The importance of strategic infrastructure within the energy sector on the competitiveness of economies is increasing due to a variety of factors, most primarily by the so called 'Twin Transition' (Joint Research Center, 2022). This term relates to simultaneous digitalisation of economies and societies, which will significantly increase demand for energy, and the transition to a green economy which is powered by sustainable and clean energy. Additionally, climate and environmental change poses a threat to current strategic infrastructure within the energy sector (IEA, 2022a). Droughts and water shortages are expected to occur more frequently, posing a risk to the efficiency and capacity of hydro-electric power plants. This concern is also shared by operators running nuclear power plants, which rely on a steady supply of water to cool reactors. Moreover, the destabilisation of the international geopolitical system has put the domestic availability of strategic energy infrastructure and possible dependencies on external actors for energy supplies in the spotlight (Kardaś, 2023). Taken together, these factors are simultaneously driving (1) increased demand for energy within states, (2) a transformation of the current and developing energy system, and (3) threats to the efficiency and functioning of existing key energy infrastructure. Navigating these challenges will thus be key in creating or sustaining an enabling environment for competitiveness within economies.

Chapter 1. EU manufacturing & Europe's aluminium industry

I. Manufacturing in the EU

This section will zoom in on the EU manufacturing industry and its aluminium industry in specific. Europe's manufacturing industry contributed around 15% to EU GDP in 2020, in comparison to the 17% contribution to global GDP (Eurostat, 2021b; Worldbank, 2021; Macrotrends, 2023). France, Italy and Germany ranked among the top 10 manufacturing countries in 2021 (Shiphub, 2023). An assessment of the competitive score of the EU's main manufacturing economies is provided in figure 5, based on 20 indicators in comparison to China and the USA. It is visible that concerns mentioned by the EIB (2016) in regards to European competitiveness are reflected in this assessment of the manufacturing environment within economies. The weighted average of the main European manufacturing countries scores high on risk indexes, corruption, open trade, and internet access. However, spending on infrastructure, R&D and electricity are an obvious competitive disadvantage for the European manufacturing environment (Eurofound, 2019).

Figure 2: Comparing global manufacturing environments (West & Lansang, 2018)



The economic significance of this sector is underlined by the main export items of the EU in 2021, which include industrial equipment (12.19%), motor vehicles (10.3%), chemical products (9.1%), and computer and electronic equipment (7.9%) (Kompass International, 2022). Main importing countries were the USA (18%), UK (13%) and China (10%) (Eurostat, 2022).

In 2020, over 29 million people were employed in in the EU's manufacturing industry (Eurostat, 2021a). The employment rate of the sector in Poland, (20%), Germany (19%), Italy (19%), France (12%), Spain (12%), and Netherlands (10%) underscores its economic and political importance (West & Lansang, 2018). To put those numbers in contrast, the average percentage of manufacturing employment in the Western world has declined from 27% in 1970 to 13% in 2011. East Asian (China and South Korea) employment grew from 14% to 22% in 2011 within that same time period (Ibid).

The manufacturing industry comprises firms which transform raw materials and components into finished goods for sale, and are often divided into metallic and non-metallic minerals industries (European Commission, 2023e). It is important to distinguish between various sector within the value chain of a manufacturing industry. These are concerned with mining, the production of raw materials, and the use of raw materials for the production of goods and products. Mining and production of raw materials are often referred to as 'upstream' sectors and manufacturing goods like cars, airports, and electronic equipment by using semi-fabricated products and raw materials as 'downstream sectors' (Freeman & Baldwin, 2020). Another distinction within the manufacturing can be made in regards to process or discrete manufacturing. The former refers to a business model which produces materials in bulk that are indistinguishable from each other, the latter to distinct objects. The functioning of 'downstream' discrete European manufacturers, those that produce Europe's tops export products, is dependent on the supply of raw and processed materials manufactured 'upstream'. The COVID-19 pandemic demonstrated this link painfully: As lockdowns restricted Chinese exports, manufacturers across the world experienced shortage of supplies - or significantly increased prices - which hindered their own production capacities (Bruegel, 2023e). Figure 3 underscores the overall large exposure of China's manufacturing sector world wide. China's shut-down causes problems for Europe's economy directly through disrupted trade flows between both actors, but the indirect consequences reach even further. The manufacturing sectors in the USA, South-Korea, and Taiwan feature a large exposure to China's economy, causing problems for European supply chains located in these countries . These countries boast a significant share in the value chain of electronic equipment and computers. Europe was thus left with a supply shortage of both raw materials created upstream but also of high-end products created in other high-developed economies. In turn, a disruption in upstream supply of materials to downstream producers in Europe's largest manufacturing economies leads to a shortage of finished products. The economic ties thus cut across regions, sectors, and economies alike (Freeman & Baldwin, 2020; Ortega, 2021).

Consequently, the European Union has awoken to the threat of global and partial concentrated supply chains for its economic security. The Commission launched an investigation into Europe's strategic dependencies and capacities in its Updated Industrial Strategy of 2020

Figure 3: Exposure of row nations to column nations manufacturing sectors (Freeman & Baldwin, 2020)

		Factory North America			Factory Europe							Factory Asia									
		usa	can	mex	deu	gbr	fra	ita	esp	tur	nld	che	chn	jpn	kor	ind	twn	aus	idn	bra	rus	sau
Factory North America	usa		1.6	1.6	1.0								6.5	1.2	1.0							
	can	14.1		1.4	1.2	0.5							7.2	1.2	1.1		0.5					
	mex	15.5	1.0		1.7			0.6	0.6				14.3	2.3	2.6	0.7	1.1			0.6		
Factory Europe	deu	1.6				1.0	2.0	1.9	1.1	0.6	1.3	1.0	4.6	0.9	0.6						0.8	
	gbr	2.6	0.5		3.9		1.6	1.2	1.0	0.6	1.0		4.8	0.6	0.6	0.6						
	fra	2.4			5.7	1.2		2.3	1.9		0.8	0.6	4.1	0.6							0.5	
	ita	1.1			4.9	0.8	2.3		1.6	0.8	0.8	0.6	4.6		0.7	0.6					1.2	
	esp	1.2			4.5	1.2	3.3	2.3		0.6	0.8		4.6	0.6	0.6	0.6						
	tur	1.1			2.1	0.6	0.8	1.2	0.8				5.0		1.3	1.0					2.0	
	nld	1.8			5.0	1.2	1.2	0.9	0.7				3.7	0.7							0.9	
	che	2.4			8.2	1.6	1.9	3.1	1.1	0.6	0.7		5.2	0.9		0.5						
Factory Asia	chn	1.5			0.9									1.9	3.0		1.9					
	jpn	1.4			0.7								6.3		1.2		0.6					
	kor	2.9			1.8			0.5					16.4	4.4		0.6	1.8				0.6	
	ind	2.1			0.9	0.5							7.2	0.9	1.5		0.5				0.7	0.5
	twn	2.7			1.3								13.8	6.4	3.4	0.6			0.8		0.6	
	aus	1.8			1.0								7.1	2.2	1.5		0.5					
	idn	0.9			0.5								7.4	2.1	1.9	0.6	0.7					
	bra	2.2			1.0								4.6	0.5	0.6	0.6						
	rus	1.0			1.9		0.6	0.8					5.7	0.8	0.8							
	sau	1.3			1.8	0.9	0.5						3.8	0.6	1.0	1.0						

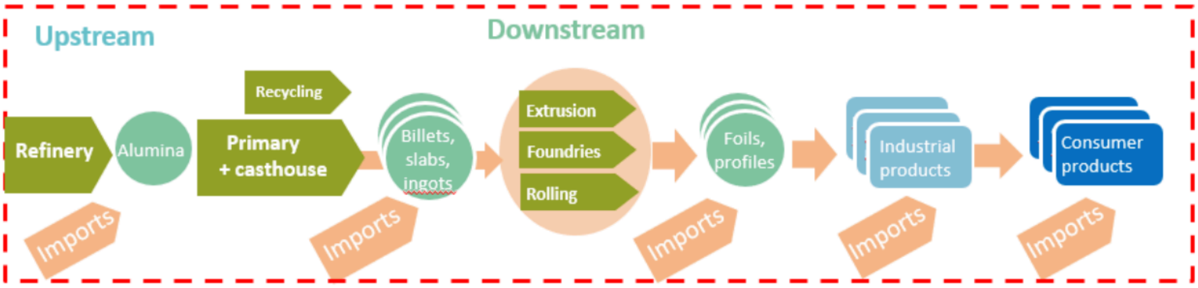
(European Commission, 2021). This report identified the supply of 137 goods in the EU's most sensitive ecosystems as overdependent on external suppliers, particularly China, Vietnam, and Brazil. 99 of these dependent products are situated in energy intensive industries. Subsequently, the Commission has taken the initiative to secure its supply chains by stimulating re-shoring to Europe and diversifying supply chains globally (Interreg Europe, 2023). This strategic paradigm is underscored by the launch of the the Critical Raw Materials Act, the Chips Act, Net-Zero Industry Act, and most recently the Economic Security Strategy.

II: Europe's Aluminium Industry

Having provided an overview of the manufacturing sector within the EU, this section zooms in on the state of play within the EU aluminium industry. This specific industry features an electro-intensive manufacturing process, thereby relating to the matter of strategic dependencies laid out by the European Commission and the question of competitiveness in light of high energy prices. The aluminium industry is becoming increasingly important to modern economies as aluminium is required for the production of goods for the twin transition, the decarbonisation of the transport sector, and given its suitability for recycling (Hydro, 2021; Hodgson & Vass, 2022).

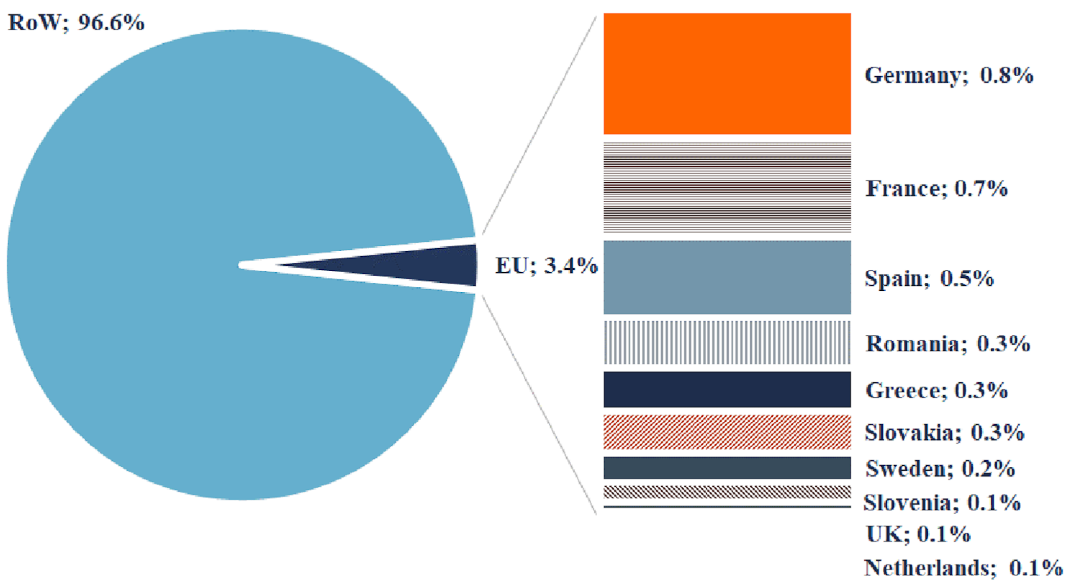
The aluminium sector is divided into various components, including (1) the upstream production of raw materials, (2) primary aluminium smelters, (3) secondary smelter i.e, aluminium recycling and remelting, and (4) downstream manufacturers which produce a variety of products through rolling, extruding, casting, and drawing unwrought aluminium (basystems, 2017; Luiss Guido Carli University, 2019). Access to alumina, made from mined bauxite, is necessary in the upstream part of the value chain. Temperatures of up to 960 degrees are required in the 'Bayer process' for transforming bauxite minerals into alumina. Subsequently, the alumina is melted into aluminium via the Hall-Héroult process (ibid). The primary production of aluminium is the most energy-intensive process within the value chain, and specifically electro-intensive as the aluminium industry uses electricity for its most energy intensive production processes (Holman, 2022). Recycling aluminium requires about 5% of the energy needed to produce aluminium, whilst the material retains its original qualities (Aluminium France, 2022). Energy is also needed for downstream manufacturers to cast the aluminium into semi-fabricated products. These are subsequently transformed by specialised producers into specific consumer products or used in the transport sector, car industry, high-tech products, and as building material (Maratou & Marcu, 2021). See figure 4 for an overview of the aluminium value chain.

Figure 4: The aluminium value chain (Maratou & Marcu, 2021)



China, Russia and India dominate the global market for primary aluminium production, which has gradually resulted in a significantly declined market share of European based producers (Luiss Guido Carli University, 2019). The top 3 producers in Europe are Russia, Norway and Iceland (Statista, 2023). Their market share is significantly higher than the EU top producers, which include Germany, France, Romania, Spain and Greece (ibid). This difference can be attributed to access to cheap energy and electricity in Russia, Norway and Iceland in the form of gas, hydro-electricity and geo-thermal power (International Aluminium, 2022).

Figure 5: Production capacity of raw aluminium (Luiss Guido Carli University, 2019)



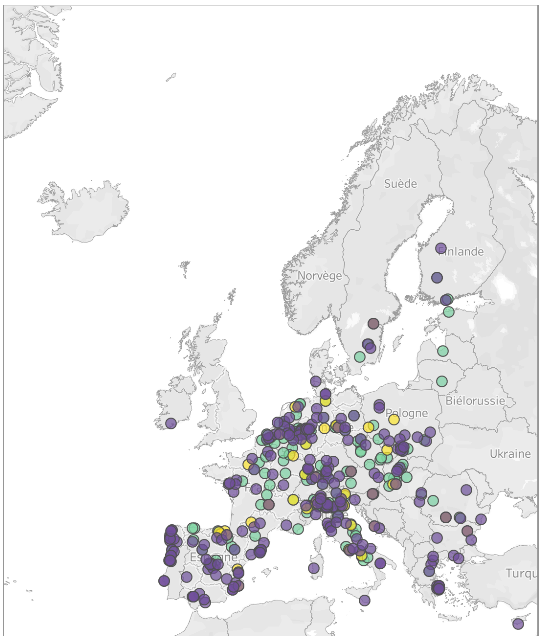
Source: Authors on CRU Group and World Aluminium

Europe's aluminium industry is significant in terms of absolute size but also economic importance. The industry has more than 300 industrial plants located across 30 European countries. Around 230.000 people are directly employed in the sector, and around 1 million indirect jobs are facilitated through its activities in Europe (European Aluminium, 2023a). It shall be noted that these figures include the EU, EFTA, United Kingdom and Turkey.

Although Europe's demand for aluminium has steadily increased in the last decades, the production capacity on the continent has experienced a decline. Whereas Europe produced 40% of its aluminium supply domestically in 1990, it produced about 14% of its supply domestically in 2021 (Ibid). A reversed trend is observable in the level of imports, which stood about 28% in 1990 and increased to 47% in 2021. In 2019, 13 plants were active in France, Germany, Greece, the Netherlands, Spain, Romania, Slovakia, Slovenia, and Sweden in comparison to 26 facilities in 2002 (Ibid). Together they represent about 3.5% of global aluminium production. Remaining supplies originate from Europe's recycling plants, which are known to be among the most competitive in the global industry due to high levels of innovation (Aluminium France, 2022).

Figure 5: Primary aluminium smelters in Europe (Luiss Guido Carli University, 2019)

Figure 6: Downstream aluminium plants in Europe (Luiss Guido Carli University, 2019)



The market for primary aluminium production within the EU is highly-concentrated as six companies constitute more than 76% of the EU's production capacity. These companies are Trimet Aluminium SE; Alcoa Corporation; Rio Tinto; ALRO S.A.; Aluminium de Greece and Norsk Hydro (CEPS, 2019). The EU market for downstream manufacturing of aluminium is more diversified, featuring a larger amount of SME and specialised firms. Most firms involved in upstream aluminium production are large, multinational corporation with facilities all over the world (Ibid). Consequently, large corporations can decide to re-shore their facilities to other locations if this provides them with a competitive advantage on the global aluminium market.

The decision of a firm to produce in Europe or abroad has a significant impact on the climate emissions of a company. Globally, the aluminium industry contributes about 3% to direct industrial CO2 emissions (Hodgson & Vass, 2022). The total number increases to about 1.1 billion tons of CO2 emissions when considering indirect emissions, which constitutes about 4% of anthropocene greenhouse gas emissions (de Berker, 2023). The average C02 per kg aluminium produced are 16.1 across the global aluminium industry. European producers significantly outperform their global competitors with an average of 6.8 kg of C02 emissions, especially considering the Chinese average of 20kg C02 per kg produced (European Aluminium, 2023b). This difference can be attributed to the Chinese reliance on coal generators for the power provision to aluminium plants (International Aluminium, 2022).

Having established that the decision of a firm to produce in Europe or abroad matters from a strategic, economic, and environmental perspective, it is important to understand the motivation that drive such choices. This requires an examination into the production costs of aluminium producers. These are outlined in table 1. A standard aluminium smelting facility requires a lot of power, as the Hall-Héroult process is an extremely electro-intensive process required to produce aluminium. Additionally, access to alumina and carbon anodes are required as input for the production process, which are both traded on global markets. Moreover, corporations make labour costs for the payment of employees and machinery in the facility. Lastly, there are other costs related to business operations and regulations.

Table 1: Breakdown of production costs of primary aluminium smelter (Ecofys et al., 2015)

Type of production costs	% of production cost	Type of factor	Volatile
Power	32,5	Competitive factor with large impact on costs	Yes
Carbon	13	No competitive factor with small impact on costs	Yes
Alumina	34,8	No competitive factor with large impact on costs	Yes
Labour	6,8	Competitive factor with small impact on costs	No
Other costs	12,9	Competitive factor with small impact on costs	No

Aluminium producers are business actors, driven by the search of profit. Their capacity to do so in enhanced when maximising their competitiveness, especially in a market which is exposed to global competition. A competitive advantage within the production process of an aluminium smelter can be created be lowering production costs which are not similarly distributed to global producers. Although small margins exists, it is hard for aluminium producers to gain access to cheaper bauxite and carbon anodes since these are traded on global market (Ecofys et al., 2015). Even if they were to gain access to these products at a slightly cheaper price, it would not make them significantly more competitive as the % of money spent on purchasing these materials is rather low (CEPS & Economisti Associati, 2013). It is more important for the survival of a firm to beat the competition in a production cost which constitutes a high share of the overall costs. This rules out a focus on labour and other business costs as well, which increase or decrease competitiveness as they differ across regions and countries, but do not constitute a major breakthrough in the overall business case due to the relative small share in the production costs of aluminium smelters. Observing table 1, it becomes clear that the power costs for an aluminium smelter are the most decisive competitive factor within the production costs of a facility. They represent about 33% of the production costs, differ widely per country, region, and continent, and are subjected to volatility (Ibid). Combined, power costs constitute the largest production cost which can impact producers asymmetrically. This is underscored by academic literature and a wide range of research report, as well as respondents in interviews.

Having covered the average production costs of primary aluminium producers, a theoretical framework is formulated which models the aforementioned information and consideration in figure 7. This framework solely accounts for cost factors and does not consider demand and commercial related factors, activities and capacities. It does therefore not represent a perfect overview of the competitiveness of a firm or sector, but does enable a structured assessment on the significance of increasing or decreasing specific production costs in relation to the overall competitiveness of a firm within a sector. The Y-axis indicates whether a cost factor in the production process affects competing firms in a similar manner or not. The X-axis indicates whether a cost factor represents a small or large share of the production costs within a facility.

Figure 7: Assessing competitive production costs

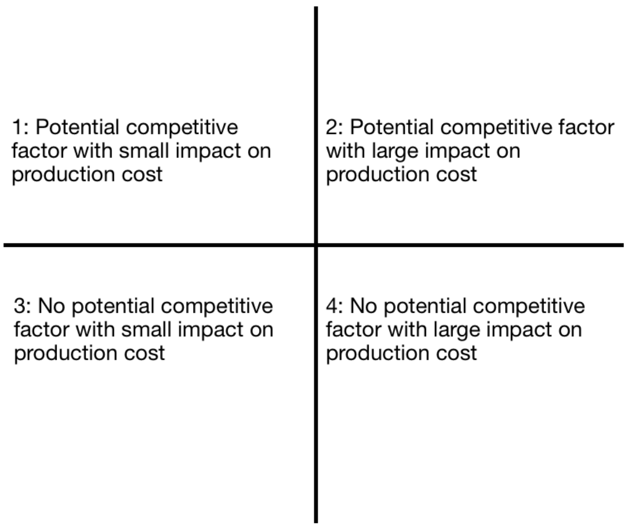
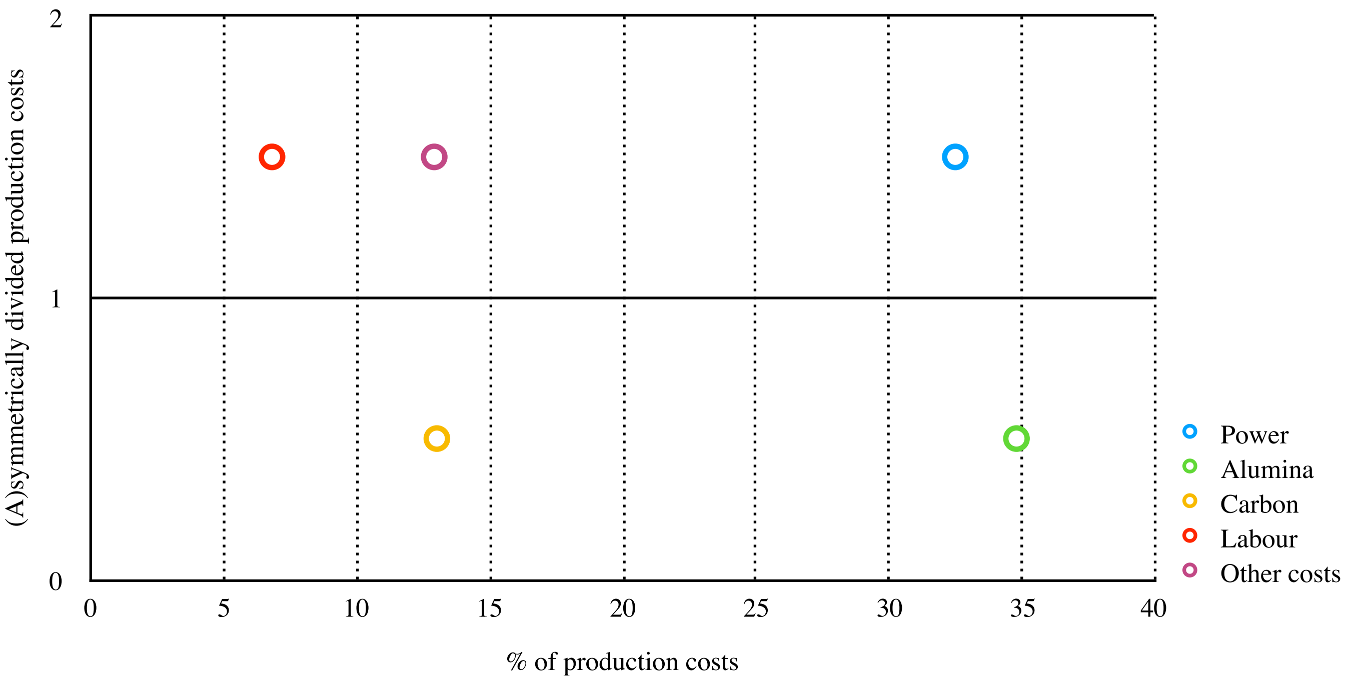


Figure 8: Competitive production costs (CEPS & Economisti Associati, 2013)



Consequently, four distinct types of cost factors are created within the production processes of a firm in the context of competition with other firms: (1) A cost factor which is asymmetrically distributed across firms, thereby giving advantage to firms with a favourable distribution but representing a small margin of the costs of a company. The potential gains in this area are profitable but not relatively significant in size and impact; (2) A cost factor which is asymmetrically divided across firms, allowing for a potential advantage vis-a-vis competitors whilst representing a large share of the production costs of a company. Potential gains in this area can be decisive for the survival of a company subjected to intense competition; (3) A cost factor which is symmetrically divided across firms, therefore not enabling firms with any advantage vis-a-vis each other whilst representing a small portion of the production costs; (4) A cost factor which is symmetrically divided across firms, therefore not enabling firms with any advantage vis-a-vis each other whilst representing a large portion of the costs of a company. Figure 8 models the facts displayed in table 31in similar manner to the theoretical framework displayed in figure 7. This visibly demonstrates that power costs are the focal point of competition between firms in the global aluminium industry.

Having established that power costs are the main competitive factor in the production process of primary aluminium smelters, a break down of the various components within those power costs are necessary. These consist of (1) taxes and levies, (2) energy procurement on the wholesale market, and (3) network costs (Ecofys et al., 2015). On average, European aluminium firms spend about 82% of their power cost on energy procurement on the market (Ibid). It has been noted by researchers, analysts, and industry representatives that these costs are higher in Europe than other parts of the world (CEPS & Economisti Associati, 2013; eia, 2016; Sultan, 2018; (Luiss

Guido Carli University, 2019; Home, 2023). Consequently, European based firms experience a competitive disadvantage which states try to remediate by alleviating pressure for industrial consumers by cutting their taxes and levies. Table 2 demonstrates that the largest share of the power costs, identified as the decisive competitive factor in the production costs of primary aluminium plants, consists of energy procurement. Understanding the price dynamics of energy procurement in Europe requires an examination of the European electricity system, specifically its market design.

Table 2: Break-down of price components within power costs (Ecofys et al., 2015)

Build-up energy costs	% of power costs
Taxes & levies	6
Energy procurement	82
Network costs	12

Chapter 2. European Electricity Markets

I. History & Legislative Framework

Europe's electricity market evolved drastically over the last decades, from nationally orientated and monopolistic markets into a continental and liberalised European market. This evolution started in 1986 with the adoption of the Single European Act (Eurelectric, 2023b). The European Communities, currently the European Union, sought to integrate their markets more closely in response to sluggish economic performance in the 1970's and 1980's. This strategic course also meant an overhaul of the national electricity and gas markets, as these systems provide the allocation of critical resources for the functioning of an economy. This was implemented about a decade later and gradually rather than abruptly as demonstrated by the large amount of legislative packages which include regulations, targets and directives (European Commission, 2023a).

It shall be noted that energy as a policy area falls under the pillar of shared competences within the EU's legislative framework, established in article 194 of TFEU (European Parliament, 2023b). This entails a consensus on the need to move towards a harmonisation of national policies in this area, whilst member states reserve the right to determine the conditions of that process. They remain in charge of decisions on the exploitation of different energy resources and the overall structure of their energy supply (TFEU 194(2)) (European Parliament, 2023b). The situation is further complicated as the energy systems of the European member states require a radical transformation to facilitate the EU green agenda. Additionally, it can be argued that developments in energy markets touch upon the functioning of the EU internal market, which would legally allow a stronger role of the European Commission.

The overarching goal of the EU was to enhance competition in the electricity markets, facilitate cross-border trade, and ensure security of supply (Meeus, 2020). Four major legislative packages were adopted in 1996, 2003, 2009, and most recently 2019 (Nguyen, 2022). With each package, state-owned monopolies were increasingly broken up into smaller actors with individual responsibility for generation, transmission, and distribution of energy (Eurelectric, 2023b). Various entities came into existence, such as independent national regulating authorities (NRA's), transmissions system operators (TSO's), and distribution system operators (DSO's). These entities would cooperate in dedicated fora, i.e. the new political-legal institutions such as the ENTSO-E and ACER (EU4Energy, 2020; Meeus, 2020).[4] ACER estimated that enhanced cross-border trade, achieved through the aforementioned legislations, has delivered 34 billion euros in benefits in 2021 alone (ACER, 2022).

The EU Energy Union Strategy (2015) provides a framework which enables a clear view on what the various European political actors hope to achieve in the future. The five pillars of the strategy are (1) ensuring energy security and solidarity between member states, (2) fully integrating the internal energy market, (3) improving energy efficiency, (4) facilitating the decarbonisation of the EU economy to retain climate leadership, and (5) supporting research and development in low-carbon technologies (European Commission, 2023b). On paper, the EU energy union thus aspires to pursue competitive and integrated markets alongside decreasing carbon emissions whilst enhancing security of supply. In reality, these are priorities that are valued differently by various actors. Every European member state views EU energy regulations from a unique point of view due to the specifics of its national energy structure, which have evolved for more than a century. Additionally, such discussions are influenced by the political orientation of governments, the policy ambitions of the European Commission and European Parliament, and external shocks and developments.

Despite the different political standpoints, a variety of concerns emerged prior to the outbreak of the energy crisis in regards to the evolution of Europe's electricity network and market design ((Böckers et al., 2013; (Conejo & Sioshansi, 2018; Florence School of Regulation, 2020). This relates to the increasing presence of renewable energy sources (RES) in Europe's electricity mix (Hirth, 2023b). The enhanced share of RES constitutes a decreasing pressure on the price of electricity, causing the risk for operators to cannibalise on their own profits. This applies to fossil fuel generators, who risk seeing their generating capacity being pushed out of the merit order model as more cheap renewables enter the market (Ibid). It also concerns renewable energy producers, as a higher share of RES means a decreasing electricity price and a smaller capture of profits in the market (Hirth, 2023c). Consequently, this price dynamic can function as a brake on the willingness of companies to commit capital to the large-scale roll-out if their returns are not guaranteed (Jones & Rothenberg, 2019). This risk might seem far removed from current policy concerns given the profits being made by energy producers as a consequence of the high gas prices, but experts have repeatedly expressed their concerns on this issue prior to 2021. Additionally, concerns exists on the availability of necessary supplies for the roll-out of the required building material to facilitate renewable energy (International Energy Agency, 2021). This matter feeds into the previously sketched context on the EU's dependence on external partners for the supply of minerals and materials that are necessary for building low-carbon technologies. Examples include cobalt, copper, and aluminium, for which the EU is dependent on geopolitically unstable partners such as China and the Democratic Republic of Congo (European Commission, 2021; European Commission, 2022b; European Commission, 2023g). It should however be noted that concerns regarding dependencies on the supply of fossil fuels like gas and oil, originating from countries like Russia and countries in the MENA region, also pose a risk for the stability and functioning of the electricity market. This is caused by the high share of gas in Europe's electricity mix and the capacity of gas fired generators to function as dispatch power. This will be further investigated in section II and chapter 3. Moreover, a substantial expansion of the EU's electricity grid is required to facilitate the increased demand for electricity from household consumers, industries, and other sectors such as transport. Doing so is a capital-intensive process, which simultaneously requires tight coordination with fellow member states to enhance the integration of the internal energy market (European Investment Bank, 2023).

Taken together, the diverging political standpoints of political actors, the varying energy structures of member states, the need to balance various strategic priorities, and the necessity to address the aforementioned technical challenges have created created a complicated policy puzzle. A deeper investigation into the technicalities of the electricity market is needed before zooming out and connecting to the energy crisis, the competitiveness of the EU's aluminium industry and the proposed EU electricity market reform.

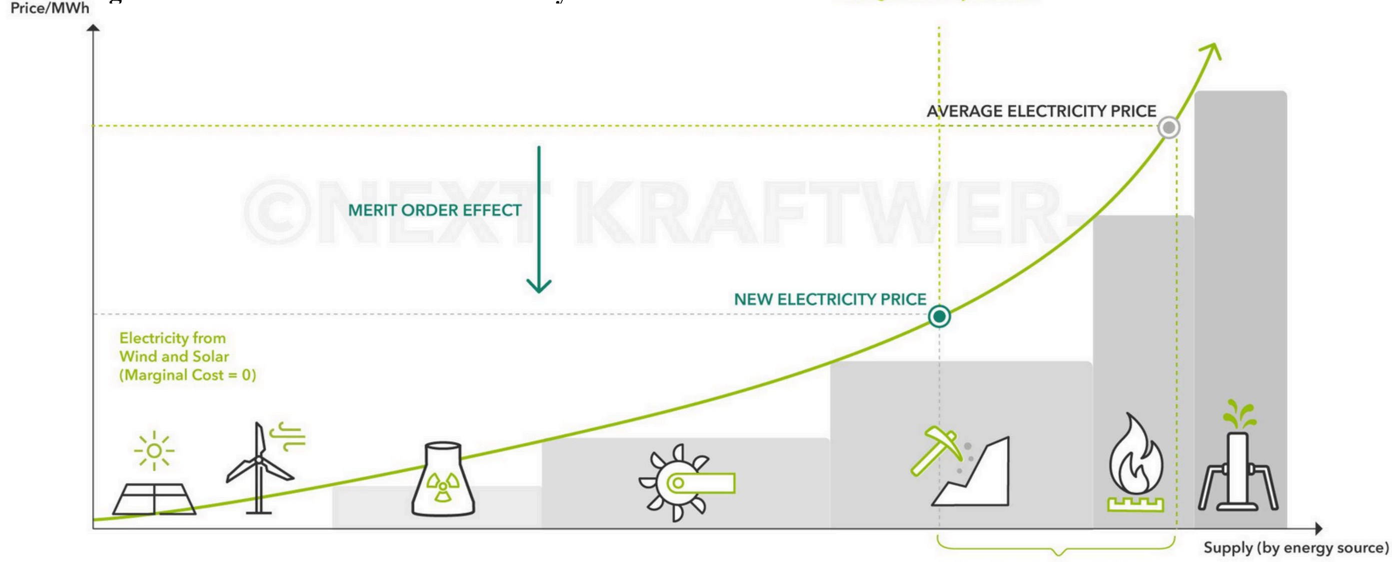
II. Electricity Market Design

Having covered the abstract evolution and challenges of the European electricity market system, this section zooms into the current electricity market design (EMD). This involves the merit order model, the difference between wholesale markets and retail markets, and the variety of time-frames in which trades occur on the European electricity market. An outline of the specific features of electricity as a tradable and usable good is necessary to understand the technical challenges which face the electricity market.

Electricity possesses specific features which need to be taken into account when considering the market design that regulates its trade as a commodity. (1) There is an inelastic demand for electricity, given that it is essential for the functioning of modern societies. (2) A significant constraint in this trading process is that electricity as a good is not storable in large quantities. Progress is being made in this field due to the development of large-scale batteries, but is not yet in capable of playing a significant role on a wider scale in the trade of electricity. (3) Additionally, the supply and demand of electricity are highly variable due to technological constraints and peak-hours of electricity consumption. (4) Moreover, electricity can be generated through multiple technologies, and (5) electricity demand must always be equal to supply in every node of the network in order to avoid blackouts (Conejo & Sioshansi, 2018; Florence School of Regulation, 2020; Hirth, 2022).

The merit order is the basic framework which enables an abstract understanding of European electricity market design prior to zooming into future, day-ahead, and intraday markets. In its essence, the merit order model explains how the price of electricity comes into existence through matching demand with the available supply of power generators which feature diverging operational costs (Hirth, 2022). When few people require electricity, demand is low and can be matched with generators that run low operational costs such as RES. This results in a low electricity price (ACER, 2022). When demand is high, supply can only be guaranteed by providing power through activating more expensive (and polluting) power generators based on coal, gas, and oil (Erbach, 2016). The availability of generators for this specific functioning as 'dispatch power' can be limited by technological constraints, as certain generators (gas) are easier to turn on than others (nuclear) (Next Kraftwerke, 2019; Hirth, 2022).

Figure 9: The merit order in the electricity market



Source: German Renewable Energies Agency (02/2011)

Prior the start of the European energy crisis in late 2021, Europe's electricity generation capacity consisted of contributions from various energy resources: oil (4%) bioenergy (6%) solar (6%), hydro (13%), wind (13%), coal (14%), gas (19%), and nuclear (25%) (Eurostat, 2023b; Ritchie & Roser, 2022). Note that these numbers reflect the EU's average, and that the electricity mix of member states varies significantly. For example, Hungary and Spain produced more than 10% of their annual power in 2021 from solar alone (Dunne, 2023). France on the other hand produces about 75% of its electricity via nuclear resources, whereas most countries in Eastern-Europe are heavily dependent on gas-powered generators (Moore, 2022). Additionally, not all member states are capable of satisfying their electricity demand through domestic consumption and rely most notably on exports from France, Germany and Italy in the EU electricity market (Ibid).

The electricity mix changes per season and according to weather related factors. For instance, potential water shortages in the summer can undermine the power generating capacity of hydro-facilities but enhance the capacity of solar assets due to increased sun power and exposure. Electricity prices experience significant volatility throughout the day due to collective behaviour which causes demand to increase or decrease drastically (Petcu, 2022). The hours between 17:00 and 20:00 are considered 'peak hours', as a large share of the European population consumes more electricity for household activities (Hirth, 2022). Prices peak during this timeframe due to the necessity to meet demand through bringing expensive power generators 'online'. On the other hand, a base load of electricity is needed throughout the day in order to maintain balance in the electricity system, also during low consumption hours, and provide electricity to base load consumers. The difference between two is managed by dispatch power (Hirth, 2023c).

A consequence of the merit order model is that the price of electricity is determined by the last, i.e. with the higher marginal price, available generator within the generating capacity. This is referred to as marginal pricing, which causes several price-dynamics that have become the focus of policymakers due to undesired external effects (Hirth, 2022). First, an increase in the operational costs of generators within the category of 'dispatch power' causes an overall increase in the price of electricity in the wholesale market. Concretely, this means that an increase in the price of coal, gas and oil triggers an electricity price hike, although that price signal is not shared by other generators running on RES, nuclear, or hydro-power. Although it is theoretically possible that coal and oil trigger such a price hike, in reality the gas generators are the cause behind price hikes in peak hours (Ibid). Second is the price cannibalisation effect for companies and firms owning RES-generators. As the share of RES increases in the energy production of the member states, the electricity price decreases due to their low operational cost. Currently, the increasing price pressure of the last available generator pushes the price up during peak hours in Europe. But this situation can also be reserved: the Netherlands witnesses an increasing amount of hours with negative electricity prices. During such periods of time, usually during low consumption hours in the summer when the electricity mix is dominated by solar and wind power, consumers receive money for the electricity the consume. The Netherlands witnessed 83 hours of negative electricity prices in 2022 and this year 101 hours so far(NL Times, 2023). The large scale roll-out of RES in the country are the result of efficient subsidy schemes, which also feature in the discussion on the EMD reform.

Having sketched the functioning of the market model, an overview of the various markets that exist within the overarching European electricity market design will be provided. It is important to note the difference between the wholesale electricity market and the retail electricity market (Constellation, 2023). The wholesale electricity market matches the production by generators, for direct selling to industrial plants or retailers. The retail energy market consists of energy retailers offering their electricity to end consumers, often households and SME's, through a variety of contracts that are executed by utility companies (Ccomptes, 2022). As both are linked, a price increase in the wholesale market eventually leads to price hike in the retail energy market and changes of contracts and included arrangements. Second, there are a variety of markets within the EU EMD based on the time-frames which the contracts cover (Pototschnig, 2022; Eurelectric, 2023a; Eurelectric, 2023b). These are illustrated in figure 10.

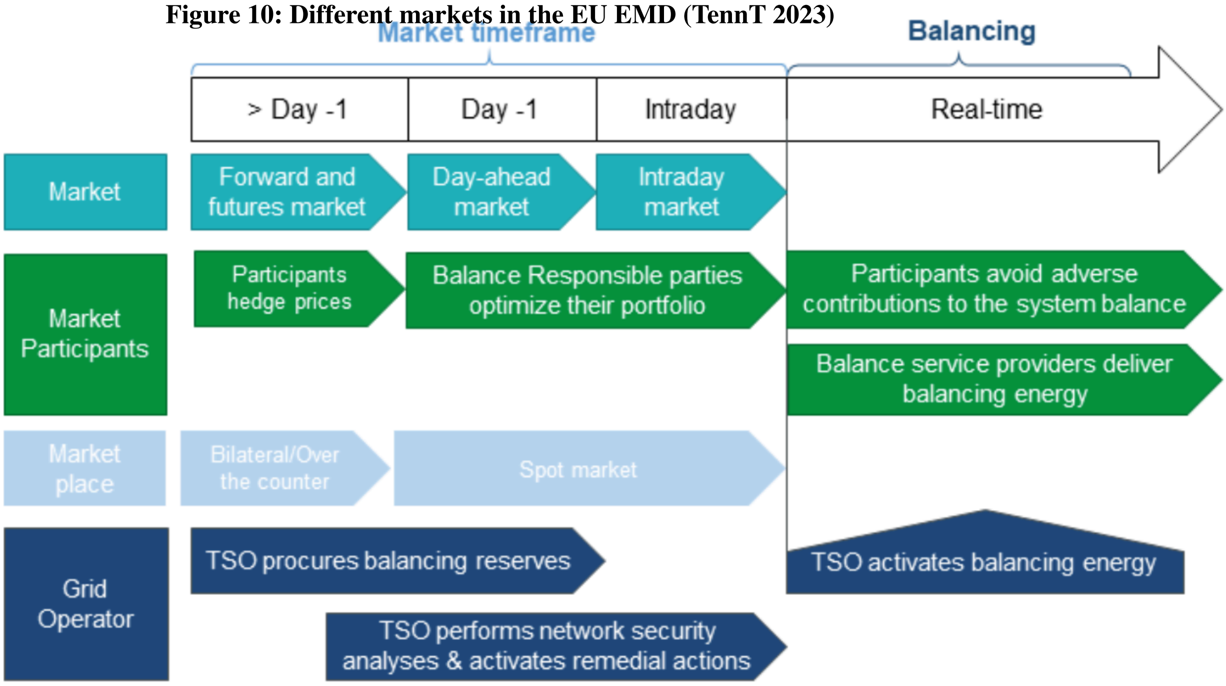
First, there are the futures or forward markets which cover trades in electricity in the long-term, defined between 4 year and 1 month prior to delivery (Commission Deregulation de l'energie, 2021). This enables large producers, consumers, suppliers, traders, and entities responsible for balancing the market to hedge their prices. Financial security is enhanced for actors operating on the future markets. The relative low liquidity of long-term contracts in the European electricity markets has been a concern for companies and policy-makers alike through the European energy crisis. Low liquidity in this market segment indicates that parties are dependent on short-term markets, which are more sensitive to price volatility, for their access to electricity (Hirth, 2023a; TenneT, 2023).

Second are the day-ahead markets, where parties can buy or sell electricity 24 hours before delivery on auctions throughout Europe. The price in the day-ahead market is determined per hour, which allows parties to assess their supply capacities and demand needs more accurately. Note that this price diverges per bidding zone, which is defined as the geographical area that is covered by the contracts decided at a specific 'auction' (Hirth, 2023c; TenneT, 2023).

Third is the intraday market, which allows market suppliers and consumer to balance their previously indicated capacity and demand according to weather forecasts, unexpected changes in consumption patterns, or other unaccounted events. In this specific market, deals can be settled 5 minutes prior to delivery. Providing actors with a chance to realign their supply and demand with new information is crucial to preserve a balanced electricity network and thereby prevent power outages. Taken together, the day-ahead and intraday markets are referred to as the 'spot market' (Hirth, 2023c; TenneT, 2023).

Fourth is the balancing markets, where the TSO operates to preserve balance in the electricity system by consistently matching supply and demand. Suppliers and generators are also active on this market as they provide the service to increase or decrease output or consumption if instructed by the TSO. As market operators have already bought the electricity at a certain price, they need to be compensated for their balancing action services. This is done by the TSO through the balancing market (Commission Deregulation de l'energie, 2021; TenneT, 2023; SEMO, 2023).

Figure 10: Different markets in the EU EMD (TennT 2023)



Chapter 3. The Energy Crisis & Electricity Market Design Reform

I. The European Energy Crisis

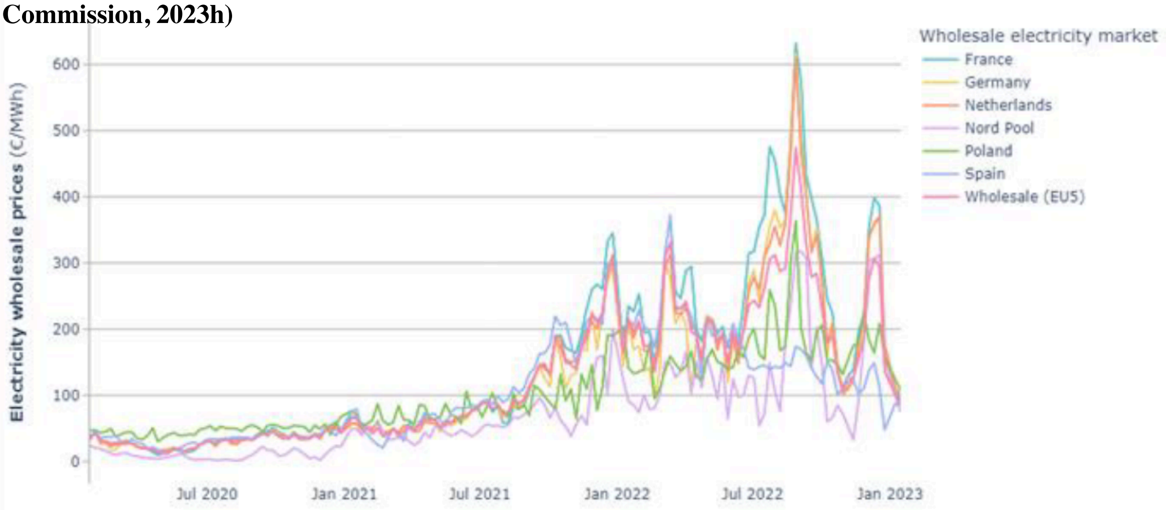
Having sketched the state of the EU manufacturing sector with a focus on the aluminium industry as a representative of energy-intensive industries, combined with an exploration of the evolution and design of the EU electricity market, this section will connect the previous chapters and relate them to the outbreak of the European energy crisis. First, the underlying factors contributing to increased electricity and gas prices will be examined. Second, the EU response and solutions to the multi-faceted challenge will be outlined. The impact of the situation will be related to the state of the EU aluminium industry.

The European energy crisis reached mainstream political discourse in the wake of the Russian invasion of Ukraine on the 24th of February 2022. Research indicates however that the energy prices already increased throughout the last months of 2021 due to rising tensions between the USA, EU, Ukraine, and Russia. Experts thus attribute the start of the European energy crisis prior to the outbreak of the war, which underscores how domestic economic factors are impacted by geopolitical tensions even before open conflicts (European Commission, 2023h). This is explained by Europe's heavy dependence on Russia for the supply of gas to satisfy domestic consumption.

The EU imported around 45% of its gas demand from Russia in 2021, totalling 155 billion cubic metres (bcm) whereas its overall demand is around 400 bcm (Kardaś, 2023). Around 26% of gas is used for power generation, 23% for direct industrial consumption, and the remaining supplies are used in households and heating of buildings (European Commission, 2022a). In 2022, these trade flows decreased by almost 70 bcm which constitutes around 40% of total EU-Russia gas trade (McWilliams & Zachmann, 2023). The disruption of gas supplies from Russia to Europe coincided with the start of the 'filling season' of gas storages across Europe. Member states use these storages to satisfy domestic demand in the winter when consumption of gas is high, and as a strategic reserve to deal with emergencies (McWilliams et al., 2022). Gas fired generators play an important role in base load and dispatch power across Europe. Additionally, natural gas has a pivotal role in the EU 's climate ambitions, as policymakers aim to phase out polluting coal assets by replacing them with gas generators. The IEA predicted that the share of gas in the electricity mix of Eastern-European states was set to increase due to these policy ambitions (IEA, 2019).

The EU thus had to find alternative sources of supply to replace the share of Russian gas in its energy mix to satisfy domestic demand and prepare for a possible cold winter. This combination fed into insecurity in the energy market, which contributed to unprecedented increases in gas and electricity prices across the EU in 2022 (Zettelmeyer et al., 2022). Figure 11 illustrates the development in the wholesale electricity price in several European countries. Although the disruption in the gas supplies from Russia are considered to be the main contributing factor to the observed energy price spikes in 2022, other contributing factors also need to be taken into account. Europe was faced with unprecedented heat temperatures in the summer of 2022, which caused a variety of problems for the functioning of critical infrastructure (Horowitz, 2022). For example, French nuclear reactors ran on low capacity throughout the summer due to the scarcity of cooling water. This decreased the base load generating capacity in France, which is usually an exporter of electricity in the EU market. Apart from the decreased availability of cooling water, France's electricity generating capacity was already severely decreased due to unfortunately scheduled maintenance of nuclear reactors (Wheeldon, 2023). Germany also proceeded with its scheduled closing of various nuclear facilities and Dutch gas supplies from the Groningen gas field could not be ramped up due to internal political reasons. Moreover, the generating capacity of hydro-electric power dams was decreased throughout Europe due to increased water scarcity. The disrupted gas supplies and extreme weather conditions thus constitute the two external factors that created supply problems and power capacity decreasing dynamics in 2022 (Cam & Alvarez, 2023).

Figure 11: Evolution of wholesale electricity market price in the European energy crisis (European Commission, 2023h)



Source: S&P Global Platts.
Note: Wholesale (EU5) stands for the weighted average of prices of main EU electricity markets (DE, ES, FR, NL) and Nordpool market (NO, DK, FI, SE, EE, LT, LV).

The EU and member states formulated a variety of responses to the arisen emergency in the form of (1) reducing gas consumption, (2) purchasing alternative gas supplies in the form of liquid-natural gas (LNG), and (3) ramping up gas trade between the EU and established trade partners such as the USA, Norway, Algeria, and Azerbaijan (Hernandez, 2022; Bruegel, 2023c; Cam & Alvarez, 2023; McWilliams et al., 2022; Zettelmeyer et al., 2022; Zeniewski et al., 2023; European Commission, 2023h). The Commission launched the RePowerEU Plan, which compromises measures, regulations, and targets to rapidly boost the deployment of RES across Europe to decrease the dependence on Russian fossil fuels (IEA, 2022c). The explosion of Nord Stream I and II in October of 2022 brutally underlined this new geopolitical reality, as the required infrastructure for natural gas trade with Russia was destroyed. Additionally, subsidy schemes and price-caps were adopted to mitigate or redistribute the internal economic impact of the energy crisis within member states (Sgaravatti et al., 2022). These regulations were specifically concerned with the political salience of energy poverty, the windfall profits of (renewable) energy producers, and ensuring the survival of systematically relevant companies and industries. The Commission suspended the state aid regime and allowed for emergency interventions to enable member states with the means and legal space to execute the aforementioned plans (European Commission, 2023). It shall be noted that the first of this range of measures, the energy price toolbox, was launched by the European Commission in October 2021. This underscores the fact that political concerns regarding the price of energy and electricity existed prior to the outbreak of the war in 2022, which subsequently accelerated those pre-existing dynamics.

The decision of the EU to attract large quantities of liquified natural gas as an alternative for Russian natural gas transformed the European energy crisis into a global energy crisis (IEA, 2022b; Bruegel, 2023d). Gas flows between the EU and close situated trade partners such as Russia, Norway and Algeria are facilitated through pipelines. Concretely, this means that both the supplier and consumer in this arrangement are not subjected to fierce levels of competition, as the trade can only be conducted if the necessary infrastructure is in place. This is different in the LNG market, as LNG entails gas which is transformed into a liquid substance during an energy-intensive process, transported onto a cargo ships, and hence capable of being delivered globally (Yergin, 2021). Admittedly, a buyer of LNG needs the required infrastructure to bring the liquified gas on land and transform it back into its original form. This infrastructure is referred to as an LNG terminals. The global orientation of the LNG market creates different dynamics between suppliers and consumers than natural gas trade based on pipelines. Major suppliers are Qatar, the USA, and Australia. Largest consumers include China, Japan, South-Korea, and India (Ibid). The EU's turn to the LNG market thus implied entering into competition with the aforementioned countries for this type of gas. This level of competition drastically increases the price of gas for all buyers on the market, thereby contributing to higher global energy prices in 2022 (IEA, 2022b). States which used to rely on a steady supply of LNG for local consumption found themselves short on supplies and thus turned to other and often more polluting energy resources such as coal and oil.

Taken together, the EU measures helped to prevent physical shortages of energy and electricity in the form of black-outs and power-outages in 2022. This can considered to be an achievement in itself given the multi-faceted nature of the challenge posed by the energy crisis. However, the combination of external events and subsequent political decisions which underpinned the EU's comprehensive response did have severe consequences in the socio-economic realm. The IMF measured that the price of electricity and gas had increased 15-fold compared to early 2021 (Zettelmeyer et al., 2022). Think-tank Bruegel has estimated that European member states have spent about 800 billion euros on combatting the economic outfall of the energy crisis in the form of tax reduction and subsidies for both household and industrial consumers of energy (Abnett, 2023).

The rampant emergency-spending and soaring energy costs across the EU fuelled inflation rates to record-levels in the 21st century of 9.2% on average in 2022 (Barrett, 2022).

The capacity of the EU to curb its demand for electricity and gas in 2022 has often been noted as a positive factor contributing to the mitigation of the European energy crisis. Indeed, the demand for electricity dropped with 3% in comparison to 2021 across the EU in 2022 (Cam & Alvarez, 2023). Gas demand was about 12% lower in 2022 compared to the average of 2019-2021 (McWilliams & Zachmann, 2023). This is in line with the EU directive to reduce gas demand with 15% in the winter of 2022, passed in August of that same year (European Council, 2022a). Reduction of consumption was thus a clear strategy of the EU to enhance the security of supply during 2022. The high price of electricity and gas contributed to the willingness of companies and households to behave accordingly. This is the so called 'price-signal effect'. As private consumers are responsible for paying large parts of their electricity and energy bills, despite the emergency measures of the EU, the high prices function as an incentive to lower consumption. But this price incentivised drop in demand is a double-edged sword: although households have the opportunity to lower their thermostat or turn the lights off, industrial consumers are forced to cut into their business operations due to the high prices (McWilliams & Zachmann, 2023).

Europe's aluminium industry is an illustrative example of the struggles that the industrial sector, specifically energy-intensive manufactures, experienced during the European energy crisis (ERT, 2022). Due to the high competitive nature of the global aluminium market, producers cannot pass on their their increased production costs, caused by soaring electricity prices, towards their consumers (European Aluminium, 2023d). Purchasers of primary aluminium are capable of switching to an alternative supplier who sells the same product at a lower price if they are not challenged by increasing production costs. Sector experts indicated in interviews that aluminium producers in China, Indonesia and Egypt are examples of competitors which are currently filling the gap in Europe's aluminium market. Whereas the production output of the EU has decreased with 50% since October 2021, China's output increased in 2022 with 3.5% (Ibid; Liu & Patton, 2023). This is the consequence of primary aluminium facilities closing temporarily, or the decision of big corporations to permanently transform their primary aluminium smelters into downstream facilities in Europe, most notably in Slovenia and Germany (Majumder, 2023; Rani, 2023). Such developments mark a further shift of Europe's aluminium industry from upstream producing to downstream processing. Dependence on third countries such as China for the provision of primary aluminium are expected to increase in the coming years (Home, 2023). This development contradicts EU ambitions in the field of climate and strategic autonomy, as discussed previously.[5]

II. The European Electricity Market Design Reform

Having covered the origins, response, and effects of the energy crisis on the EU and its aluminium industry in specific, this section will outline the process leading to the proposal of the EMD reform and the perception and insights of experts and stakeholders based on conducted interviews.

Discussions on the need to reform the EU's electricity market design pre-date the outbreak of the European energy crisis at the end of 2021 (Nilsson et al., 2011; Poudineh & Peng, 2017 Conejo & Sioshansi, 2018; Florence School of Regulation, 2020; Roques, 2020; Parr, 2021). Experts and stakeholders have disagreed for a long time whether the various trends and dynamics that pressure the EU electricity system would be better addressed in a different market model. These challenges include the need to roll-out renewable energy resources on a large scale, the rapid increase in electricity demand across the continent, and the capacity of the system to deal with shocks and volatility (Hirth, 2023b). Although a plethora of ideas and suggestions exist regarding the improvement of the EU's electricity market design, two main popular schools can be distinguished: those in favour of an integrated market model and supporters of a so called 'split market model'. The integrated market is represented by the merit order model, with a variety of energy resources competing with each other in the same market and offering electricity at various prices to meet demand. The split market model creates two markets, which in Europe is often understood as a 'green pool' of electricity and a 'grey pool' of electricity (Parr, 2022b). Implementing a spilt market model in the EU would entail a radical transformation of the current integrated market model, but would entail various benefits according to some experts (Fabra, 2022). For example, member states with a high share of renewables in their electricity mix would not be affected by the marginal pricing effect of expensive fossil fuels generators. Assets running on coal, gas, and oil rank last in the merit order model and their operational costs determine the wholesale electricity price when demand requires that these generators are activated. This would not be the case when the markets for renewable energy resources and fossil resources are split due to the different price-dynamics in the respective pools. Supporters of the integrated market model argue for its operational efficiency, the success of the model in the last 20 years, and possible unforeseen complications arising from deep interventions in the electricity market at a critical juncture for the EU's climate agenda (Eurelectric, 2023b; Hirth, 2023).

The divisions between these different schools of thoughts concerning the future EU electricity market design became visible as the soaring electricity prices raised the issue to the top of the political agenda in Europe throughout 2021 and 2022. The European Council tasked the European Commission to work on a reform of the electricity market design in order to fight the high electricity prices in June of 2022, and several member states used the political momentum to propose their idea of what such a reform should look like (European Commission, 2023h). The so called 'Iberian model', implemented at the start of 2022 by Spain and Portugal, was referred to as a popular example for the upcoming reform. The Iberian model focuses on a price cap for gas that is used for power generation. This price cap is activated when the wholesale electricity price peaks above a certain level, caused by the activation of dispatch power during high demand. The subsidy is provided to coal and gas generators and financed through revenues collected from the capture of 'windfall profits' of renewable energy generators, caused by the high gas prices. The Iberian solution has been hailed for its capacity to reduce the costs of electricity for consumers, but an unintended consequence has been the increase in gas demand for power generation in Spain. Spain exported about 80% more electricity to France when the price cap was introduced in June, and thereby effectively contributed to subsidising electricity prices for French consumers. The contradictory price-signal effect and unforeseeable consequences of the Iberian model has been the focal point of criticism opponents of the mechanism (Gumbau, 2022). Another example includes the Greek proposal, presented in July 2022, which featured the idea of split markets (Kurmayer, 2022). The proposal was met with enthusiasm by various member states including Italy and Romania, and set the expectation that the eventual proposal from the Commission would lean towards a substantive restructuring of the current market design (Hancock, 2023).

Ursula von der Leyen, president of the European Commission, underlined that tone in various speeches and addresses in the summer of 2022, when electricity prices reached unprecedented levels and worries over the coming winter increased. In late August of 2022, at the Bled Strategic Forum in Slovenia, Von der Leyen stated that "the skyrocketing electricity prices are now exposing, for different reasons, the limitations of our current electricity market design … The market was developed under completely different circumstances and for completely different purposes. It is no longer fit for purpose … we need a new market model for electricity that really functions and brings us back into balance" (Liboreiro, 2022). She reiterated a similar tone in her State of the Union, the annual address of the President of the Commission towards the European

Parliament with reflections on the previous and upcoming year from the EU perspective. Von der Leyen mentioned the need for a 'deep and comprehensive reform … the current electricity market design - based on merit order - is not doing justice consumers anymore' (European Commission, 2022d). The 2023 working program of the European Commission, adopted in October of 2022, outlined the ambitions on paper: The comprehensive reform, which aimed to include a decoupling effect of gas and electricity prices, was set to be launched in early 2023 (European Commission, 2022e). The 'overhaul of the EU electricity market' also featured in the joint legislative priorities of 2023 and 2024, published in December of 2022 (European Commission, 2023i). This document outlines the shared ambitions and priorities of the European Parliament, Council and Commission for the coming years. The EMD reform is mentioned in the first of six pillars, reflecting the political salience of the topic within European institutions and member states.

The shared perception on the necessity to reform the EMD and the stated plans of the Commission to do so ambitiously raised the subject even higher on the political agenda amongst related industries, stakeholders, and member states. Spain published its vision on the EMD reform through a non-paper in January of 2023 (Jimenez, 2023). It was perceived as more significant than the initiative led by Greece in 2022 as Spain boasts more political power within the EU, is a major player in the renewable energy market, and assumes the chair of the Presidency of the Council of the European Union in the second half of 2023. This position would give the country significant agenda setting power during the envisioned negotiating stage between EU institutions in committees and trilogues. Its opinion was thus to be taken seriously, and indicated a preference for closer regulation of the EU electricity market. The proposal focusses on three type of markets, including (1) a short-term market which continues to function on marginal-pricing dynamics as described in the merit order model, (2) a long-term energy market in which liquidity is enhanced and contracts between producers and suppliers are managed through a central regulator, and (3) long-term capacity markets which consist of generators capable of providing dispatch power (Jimenez, 2023; Fabra, 2022). Note that this non-paper is meant to sketch the vision of Spain for the upcoming negotiations and therefore does not outline in detail how these plans should be executed or regulated. Although the non-paper was perceived as a move away from the process of liberalisation of energy markets, it was met with considerable enthusiasm from major member states, including France (Ribeira, 2023).

Consequently, the member states which were opposed to the shared ambition of Spain, Greece, and the Commission to substantially overhaul the EMD, issued a declarative statement in February of 2023. Signatories included Germany, Denmark, Estonia, Finland, Luxembourg, Latvia and the Netherlands (Dutch Ministry of Foreign Affairs, 2023). The statement describes the benefits of the current market design, whilst also recognising the need to reform in light of existing challenges. It steers away from the narrative that the market design is responsible for the high electricity prices, subsequently arguing that a substantial reform of the market model is unnecessary. The declaration rather aims at a targeted reform which retains the benefits of the current design whilst being better adapted to the need to invest in renewables, protect consumers, and ensure efficiency. The political battle lines in the negotiations surrounding the EMD reform are thus drawn between a move towards further regulation or liberalisation, and the scope of the potential reform in terms of redesigning the current model or focussing on targeted reforms (Simon, 2023b). Interviews with relevant stakeholders and actors involved in the negotiations on behalf of member states confirm these differences, which tend to be demarcated along a North-South axis.

The Commission's proposal for a reform of the EU's electricity market design, published early March 2023, was perceived as surprisingly unambitious compared to the announced plans. It does not propose any form of market splitting and does not decouple the gas and electricity price (Simon, 2023a; Bruegel, 2023b; European Commission, 2023h). This seems to suggest that the Commission, both informed by ACER which did not favour a radical reform of the EMD in the first place and the joint declaration of northern European member states, became aware of a lack of support for the initial plans (ACER, 2022). Interviews with involved actors point towards the political incentive to announce large and sweeping reforms in the second half of 2022 in order to calm sentiments surrounding the high electricity prices at the time. Indeed, the price of gas and electricity had significantly decreased in between the time of the State of the Union and the publication of the initial Commission. This could have decreased the political willingness to accept the costs and risks related to a substantive reform of the EMD.[6]

III. Overview of proposed measures

Having covered the process leading to the publication of the EMD reform and the emerging political divisions between involved actors, this section examines the measures and regulations in more detail. Specifically, it will focus on the role of Power Purchase Agreements (PPAs) and Contracts for Differences (CfDs). All respondents identified these measures as essential and impactful in the EMD reform. Additionally, they are also considered as most relevant for the industrial competitiveness of the EU EII. Other measures will be briefly discussed. It shall be noted

[6] Insights, analyses, and expectations are shared and confirmed by industry experts in interviews.

that the legal basis for the EMD reform consists of two separate legislations, the (1) Proposal for a Regulation of the European Parliament and of the Council amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design, and the (2) Proposal for a Regulation (EU) of the European Parliament and of the Council amending Regulations (EU) NO 1227/2011 and (EU) 2019/942 to improve the Union's protection against market manipulation in the wholesale energy market (European Commission, 2023d; European Commission, 2023c).

PPAs are long-term contracts between an electricity producer and buyer, most often a supplier or industrial consumers (European Commission, 2023h). Contracts range from five to twenty years. This means that both the consumer and producer have agreed upon the price for the traded electricity, which gives both parties a clear picture of their future costs and profits. Producers of renewable energy can use this financial security as leverage to increase their investments in new projects (Halm, 2022; McIntyre, 2022). Buyers can operate with decreased risks related to price volatility. A potential problem for both parties is a lack of clarity concerning the reliability of the other actor. If a buyer is not capable of fulfilling payment obligations, generators end up with problems on their balance sheets. If a producer cannot deliver the agreed electricity, buyers face unaccounted business risks (European Commission, 2023h). Other barriers to the growth of the PPA market include the high volatility of electricity prices, limited knowledge on the availability of PPAs amongst potential buyers, an absence of standardisation of contracts (European Investment Bank, 2023). Volatile electricity prices, or uncertainty whether the price will significantly increase or decrease in the future, reduces the willingness of both producers and buyers to commit to a long-term contract. In case of rising prices, producers could find themselves missing out on profits due to their obligation to deliver electricity at the pre-determined price. In case of decreasing prices, buyers are happy to procure their energy on the 'spot market'. The lack of standardisation and uniform contracts necessitates the extensive legal and technical knowledge on the buyer's side to construct and sign a PPA (Baringa, 2022). It shall be noted that, given the long term duration of the contract, PPAs are often tailor-made to specific preferences on the side of the producer and buyer. Large companies are capable of having in-house experts who engage in this work and are also perceived as credit-worthy by producers. This explains why the current European PPA market is dominated by large tech companies and industrial firms. It shall be noted that the European PPA market is relatively small, accounting for 8 GW in 2021 on a total amount of 2 900 TwH generated electricity. This is also the case in America, which has a PPA market of 17GW in 2021 on a total generated amount of 4 240 TwH (Halm, 2022; pveurope, 2022).

The EMD reform aims to stimulate the growth of the PPA market in Europe due to its potential to contribute to price stability and market-driven investments in the deployment of renewable energy resources across the continent (European Commission, 2023f). To do so, it proposes legislation which requires member states to provide the required financial instruments to relevant actors and stakeholders in order to circumvent previously described barriers and obstacles for the market. This includes regulation which addresses default risks, guarantee schemes to incentivise the growth of PPAs in immature markets, and enabling space for project financing through PPAs. It shall be noted that these constitute directives in the form of guidelines which are left at the discretion of member states to work out (European Commission, 2023d; European Commission, 2023c).

Contracts for Difference (CfDs) are public support policies meant to provide stable and secure revenues to energy producers. CfDs are particularly useful in stimulating the growth of RES in underdeveloped markets (Ibid). Regulatory authorities agree a ‘strike price’ with the producer. If the electricity price drops below this level, the state pays the difference between the strike price and the market price. Note that this specific situation is referred to as a one-sided CfD. A two-sided CfD entails a situation where the state collects the excess revenues of renewable energy producers if the market price rises above the strike price. These revenues can be transferred to consumers, both households and industrial, as compensation for high electricity prices. The EU electricity market currently experiences a wide variety of CfD’s, although two-sided CfDs are increasingly popular (Ibid). The difference between one-sided or two-sided CfDs has a significant impact on the business case of renewable energy producers. In a one-sided scheme, producers are capable of collecting excess revenues when electricity prices are high. Their capacity to do so, which is underpinned by the low operational costs of RES and amplified by current high electricity prices, is decreased in a two-sided CfD scheme. A sudden switch in Europe to two-sided CfDs, or the obligation on member states to impose these, would thus surely affect the current market. Such a problem can be mitigated by agreeing on a ‘price corridor’ instead of a strike price, which allows for a certain margin between which revenues can be collected (Ibid). When prices drop below or above the corridor, the CfD arrangement is activated. Other potential problems include budget risks for economies in case of low electricity prices due to their obligation to compensate producers, the possible incentive for producers to constantly deliver electricity without taking demand into consideration due to consistent support, and the development of the PPA market as CfDs entail higher revenues for producers (Ibid).

The EMD reform proposes a guideline which complements the current principles laid out on the Renewable Energy Directive concerning the implementation of national support schemes. Two-way CfDs should be implemented to boost RES in underdeveloped markets. This applies to new electricity generating assets or investments concerned with expanding the lifespan of existing assets. Energy producers should not fully rely on CfDs for covering their financial expenses, the design of national support schemes should therefore allow a role for PPAs. Revenues collected above a strike price are to be reverted back to consumers. Producers should be penalised through incorporating a clause in the CfD contract for early termination of the arrangement in order to decrease the incentive to do so under high electricity prices. Retroactive imposition of CfDs are to be avoided due to market risks (European Commission, 2023d; European Commission, 2023c).

Other measures include (1) expanding the integration and liquidity of forward markets to allow both consumers and suppliers to hedge their electricity contracts; (2) establishing regional hubs to complement that process, as infrastructure and regulations are necessary to support activities on the forward markets; (3) providing hedging obligations on electricity retailers to boost the demand on the forward markets or via PPAs. This would decrease the dependencies of actors on the spot market, thereby reducing the volatility of the electricity price when supply shocks occur on the short term markets; (4) establishing an Offshore Transmission Access Guarantee, which provides off-shore wind parks with investment security as their access to the national grid is ensured by regulatory authorities alongside compensation schemes in case access is denied due to congestion in the grid; (5) decreasing the difference between the cross-border intraday gate closure time and real time to allow for supply of electricity on a short notice which enables actors to balance their positions and boosts the liquidity on the spot markets, thereby contributing to price stability; and (6) institutionalising a supplier of last resort, which provides both household and industrial consumers with the security of continuous access to electricity even if their supplier fails to deliver or goes bankrupt. Additionally, the Commission has set out expectations for member states regarding policies on energy poverty, energy sharing, and demand response issues (Canestrini, 2023; European Commission, 2023d; European Commission, 2023c; European Commission, 2023f).[7]

[7] Insights, analyses, and expectations are shared and confirmed by industry experts in interviews.

Chapter 4. Analysis

Having covered the state of the EU manufacturing industry, the aluminium industry specifically, the evolution and structure of the EU electricity market and the critical components of the EMD reform, this section will merge the insights into an analysis related to the research question. It shall be noted that respondents of interviews had an overall negative assessment of the added value of the EMD reform. The design and implementation of measures which could bring about the largest changes, such as those related to PPAs and CfDs, are left at the discretion of member states. The EMD reform is thus perceived as setting streamlined guidelines and principles, but the most important step in the implementation will be left to the member states. The process will be influenced by political orientations, policy priorities, and differing energy mixes.

The measures included in the EMD reform are primarily concerned with encouraging price stability. Examples include encouraging the PPA market, two-sided CfDs, hedging obligations for suppliers, and stimulating liquidity in the forward market. Price stability, however does not imply a lower electricity price for industrial consumers, and thus not a significant benefit from a competitive perspective. Although the Commission and various member states laid out ambitious plans in regards to splitting the gas and electricity prices, the EMD reform does not entail any measures which realistically achieves this goal. This means that high electricity prices will persist as long as supply issues with Russia persist and subsequent emergencies, such as demand reduction and attracting expensive LNG, remain necessary (Schülde et al., 2023). This will continue to harm the competitiveness of EU manufacturing firms, particularly in the aluminium industry. Industry experts warn that a further reduction of primary production capacity is likely as Europe's energy prices are not expected to drop drastically in the coming years (Holman, 2022). The EMD reform is therefore assessed to be unlikely to significantly contribute to EU industrial competitiveness in the mid to short term.

Admittedly, buyers that enter into a longterm PPA can acquire access to the electricity at a discounted rate. But the difference between the market price and discount price is unlikely to be big enough to have a significant impact on the competitiveness of industries. This is explained by the financial interests of renewable energy producers given the current market design, who would undermine their business potential by committing to signing cheap PPAs with industrial consumers in present circumstances. Renewable energy producers are currently able to make significant profits and revenues if they sell their electricity on the spot market: since they produce electricity at a low operational costs, and the price will be set by the high operational costs of fossil-fuelled generators, their profits increase. European member states have tried to offset these so called 'windfall profits' for infra marginal generators in 2022. It is unclear whether this measure is will be permanent. Given this persisting uncertainty, combined with expected high electricity prices in the future, it is unlikely that renewable energy producers will provide the necessary supply if demand for PPAs were to grow. If they were to enter into a PPA, it would be in their interest to agree upon a high price in the contract, and the market design grants them a good negotiation position vis-a-vis industrial consumers to make that happen. The agreed electricity price between producer and consumer is thus likely to be lower than current market prices, but unlikely to be low enough to provide a significant boost to the competitiveness of industrial consumers. This is theoretically possible, but practically unlikely given the business interests of energy producers. A strong role of regulatory authorities would be required to incentivise energy producers to sign cheap PPAs which can significantly contribute to competitiveness of industrial consumers. The current proposal does not specify such a preference on the side of the legislators, or a mechanism to enable such processes. Respondents indicated in their interviews that current uncertainty on the long term development of European electricity prices also function as a constraint on both producers and consumers to commit to long term contracts. These concerns, based on price dynamics and clashing interests between market actors, are not addressed in the EMD reform.

Standardising two-way CfDs in the European electricity market constitutes a measure which has the potential to significantly contribute to EU industrial competitiveness. But this potential positive contribution is dependent on the design, implementation and execution of national authorities. It can therefore not be stated that the current proposal does enough to merit the judgement of a potential positive contribution. Time will tell how the member states engage with the policy choices provided to them through the EMD reform. There is a risk that CfDs might crowd out to the use of PPAs by renewable energy producers as it constitutes a support system which fully covers the producers against financial risks. The state will compensate them if the market price drops below a strike price after all. This is different from PPAs, where risks and reliability are seen as a business constraint. The suggestion of the Commission to set a European standard, to be implemented by member states, of utilising two-ways CfDs adds another layer to this support scheme. If the price of electricity rises above an upper strike price, the revenues of the producers will be channeled back to consumers of electricity. National policymakers would be enabled with the technical space to create a system which is similar to a 'price shock absorption mechanism'. This measure was suggested by European Aluminium and would significantly alleviate current concerns and worries within the sector regarding high energy prices (European Aluminium, 2023c). Concretely, it entails that revenues from infra marginal generators would be channeled back to consumers when the market price exceeds a strike price. This would mean that aluminium firms in Europe could operate with the knowledge that the costs made during a severe price crisis would eventually be compensated. The two-ways CfD schemes enables the construction of such an arrangement, a complicating factor arises when considering that the design, implementation and execution of such compensation schemes are left to the member states within the current proposal. The various EU member states operate within differing budget constraints and political priorities. Consequently, it is possible that the incorporation of a price shock absorption mechanism within the two-ways CfDs might differ in their design across the member states. The manufacturing industry might thus face different guarantees, risks, and opportunities in different EU member states, which undermines the potential effectiveness and impact of this measure.

The principles underlying the significant measures of the proposed EMD reform hint at a move towards further regulation of the EU electricity market rather than liberalisation whilst keeping the current market model intact. This issue had been identified as a major political battle line between stakeholders, together with the scope of the reform. The scope of the reform is limited compared to stated ambitions as the current proposal does not qualify as an 'overhaul of the electricity market'. It is however clear that regulating authorities gain a more prominent role due to the necessity to design, implement and execute the targeted reforms in an effective manner. This includes the role of authorities in creating a business friendly environment in the PPA markets, providing Transmission Access Guarantees for off-shore wind farms, and enforcing hedging obligations on electricity suppliers. The enhanced role of regulating authorities is particularly relevant in the creation of a possible price absorption mechanism for industrial consumers through the implementation of two-way CfDs for producers of renewable energy. Electro-intensive industries will argue in favour of setting a low level at which such a mechanism will be triggered. They would 'secure' a wider range of their electricity related production costs if they are compensated at the lowest price possible. But such a measure would be dependent on the upper strike price agreed upon between regulating authorities and renewable energy producers. When the market price exceeds this strike price, the revenues of the renewable energy producers will be channelled back to consumers through the price-absorption mechanism. Renewable energy producers are thus naturally interested in setting the level of the upper strike price as high as possible to maximise the price range in which they can secure profits without these being channeled back to consumers. The regulating authorities will play a pivotal role in deciding whose interests are weighted as most important through negotiations with both parties. A possible risk in this particular case constitutes the scenario in which the various national regulating authorities do not coordinate their decisions. The result would be differing legislations per member state, thereby contributing to a fragmentation of the EU electricity market and in turn the wider internal market.

It shall be noted that this analysis differs when considering the longterm perspective of the electricity market reform in relation to EU industrial competitiveness. This package of legislation functions as an incentive to boost the roll-out of renewable generators across the continent rather, and has been received as positive from that perspective by experts. A significant increase in the share of renewable energy resources in Europe's energy mix is most likely to structurally decrease the high electricity prices currently caused by supply problems concerning Russian gas. Diversifying the energy sources across Europe is the solution to solve the current input problem caused by stressed gas markets. That process will however require several years, and the concerns regarding the competitiveness of the EU manufacturing industry will persist in the mean time. Subsidies, renumeration schemes, and other fiscal solutions will need to be constructed to bridge that gap towards the future without undermining the ambitions of the EU in regards to strategic autonomy and re-industrialisation.

5. Conclusion

This project has researched whether the EMD reform can significantly contribute to the competitiveness of the EU manufacturing industry in the mid to short term. Manufactured goods rank among the EU top export products and preserving industrial capacity has become a key economic and geopolitical objective for the EU. The case study of the aluminium industry demonstrated that the energy crisis has undermined the competitiveness of the EU manufacturing industry. This has accelerated a longer existing trend of decreased upstream industrial activity in the EU as companies shift towards downstream manufacturing. Consequently, EU manufacturing is becoming increasingly reliant on supplies from upstream manufacturers located in other countries. The key to overturning this process is to enhance the competitiveness of the EU in the manufacturing sector. A critical component within such a strategy is lowering the energy price for industrial consumers. The integrated electricity market model is, combined with external shocks and events, the cause behind the high energy costs within the EU. Even though more renewable producers deliver energy into the market, the wholesale electricity price is determined by marginal pricing, meaning the operational costs of the 'last' electricity generating assets in the merit order model. These are generators running on coal, oil, but in most cases gas. Europe's electricity mix features a large share of natural gas, which is why the price spike of gas in 2022 translated into unprecedented electricity prices. Other factors, such as droughts and scheduled maintenance of nuclear plants, decreased the electricity production capacity and thereby added to the price hike. In light of these developments, the EC announced plans to radically overhaul the EU electricity market in a legislative reform, with the goal of decoupling the gas and electricity price. This strong stance was welcomed by member states such as Spain, Greece, and Italy. The eventual proposal did however not deliver what was promised. The EMD reform is rather a targeted improvement of the current market model. The inability of the Commission to address the correlation between gas and electricity prices therefore significantly decreases the capacity of the EMD reform to contribute to the competitiveness of the EU manufacturing industry in the mid to short term. It is also unlikely that PPAs will offer industrial consumers a substantive escape from persisting high electricity prices due to the lack of financial incentives for producers and consumers to commit to long term contracts in the current market state. Two-sided CfDs have the most potential to contribute to EU industrial competitiveness as it could protect manufacturers from high electricity prices. Member states will have the possibility to create a renumeration scheme for industrial consumers based on the excess revenues of energy producers when the market price of electricity exceeds a pre-determined level. This can transform into a de facto 'price absorption mechanism'. Whether this will become a reality is however left at the agency of the member state and is not specified in the EMD reform.

6. Annex

I. List of interviewees[8]

Number	Affiliation
#1	Energy Trading Association
#2	Energy Markets Consultant
#3	Policy Advisor at TSO
#4	Aluminium Industry
#5	Independent energy researcher
#6	Electrical Engineer at TSO
#7	Policy maker at Dutch Ministry

8 Names are not available due to request for anonymity on behalf of the quest of respondents. The topic concerns an ongoing sensitive political issue.

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