

Review of Decarbonization Policies for Heavy-Duty Transport *In search for a new analytical framework*



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Background

The ERCST project strongly supports the EU's ambition to transition to a net zero energy system and vehicle sector by 2050. Zero emission vehicles are seen as the main technology destination to support this ambition. The project's aim is to consider the proposed legislative pathways from today to reach this ambition. It seeks to assess the robustness of the current policies, the impacts on stakeholders, the economic, environmental, and social consequences of the policy and to explore alternative or additional pathways to efficiently reach the target.

The first report sets the ERCST analytical framework and addresses the following question: what influences the determination of pathways for decarbonization of heavy-duty transport? It identifies the assumptions that were used in defining the current decarbonisation solutions for HDVs, then it outlines changes in the economic, political, and social environment and, finally, determines new desired outcomes that need to be considered under current circumstances.

The next report will analyze the current decarbonization solutions for heavy duty road transport considering the new circumstances and recommendations for new pathways complementary and/or alternative to the existing ones.

KEY TAKEAWAYS

- *Heavy-duty vehicles (HDVs) are essential for the European economy and transportation of goods and people.*
- *The heavy-duty sector is responsible for over 6% of total EU GHG emissions and it should play its role in fighting the climate change.*
- *The HDV market is diverse, with various vehicle types and models, depending on their use, size, and market structure. Purchase costs are also significantly higher than those for LDVs.*
- *Access to charging infrastructure is challenging for HDVs due their diversity, long-distance travel, and high energy consumption.*
- *Formulating decarbonization policies for HDVs must consider their unique characteristics and distinctions from passenger cars.*

- *The main policy driver for the decarbonization of heavy-duty transport is the EU's commitment to reduce greenhouse gas (GHG) emissions, and air and noise pollution.*
- *The policy direction for decarbonization is towards renewables and electrification.*
- *The issue under consideration needs to be articulated as determining the pathways that will ensure a sustainable transition, minimizing social and economic impacts.*
- *Past economic considerations supported the policy choices regarding decarbonization of HDV transport but may have underestimated potential risks, such as the availability of raw materials necessary for technology development, and technological advancement of competitors in the electric vehicle sector.*
- *HDV transport has significant societal context and implications, affecting the access to and affordability of goods and services for citizens, and many jobs.*

- *Unprecedented developments such as the pandemic, geopolitical changes, and climate change have tested the assumptions driving decarbonization of HDV transport.*
- *External competition, particularly from China and the USA, is challenging the European path to net-zero due to the acceleration of decarbonization policies in the USA and China's leadership in battery production.*
- *The volatile geopolitical situation brought on by Russia's war on Ukraine has had an impact on some of the economic assumptions.*

- *Regulation, rather than the market, has been the driving force of change in the EU for decarbonisation policies, overshadowing market-based approaches like the EU ETS.*
- *Enabling economic and political conditions, including the availability of charging and alternative fuel infrastructure, renewable electricity and hydrogen, and raw materials necessary to produce batteries, are necessary for ensuring effective transformation and continuous welfare of society.*
- *Policymaking should focus on resilience, adaptability, security of supply, and ensuring options, while the market and innovation should be in the lead and ahead of regulation to manage and respond to risks.*
- *Economic efficiency and competitiveness should be reconsidered in assessment of various options, including the impact on consumer prices, jobs, and economic welfare.*
- *Effective and credible measurement of emission reduction, climate impact, and energy efficiency is required, considering the incomplete picture of the 'tailpipe approach' to measuring emission reduction and the need for other frameworks.*

1. INTRODUCTION

What are the main features of heavy-duty transport?

Heavy-duty vehicles (HDVs) are essential for the European economy and for the functioning of the EU internal market. Not only the EU is a global leader in HDV manufacturing but above all, it is an essential means of moving goods and people. Road freight is the backbone of trade and commerce on the European continent.

In fighting climate change HDVs is an important element. The heavy-duty sector (trucks, buses, and coaches) is responsible for more than a quarter of the greenhouse gas (GHG) emissions from road transport in the EU, and for over 6% of total EU GHG emissions¹. The sector has achieved significant energy efficiency improvements for fuel consumption. However, emissions are still rising, due to the constant increase of road freight traffic. It is worth noting that in case of HDV transport GHG emissions per tonne km are far lower than in case of passenger cars where the usual payload is a person or two.

The logistics chain, which also includes inland waterways, maritime, aviation and rail transportation, is made up in large part by trucks, which carry 70% of all freight moved over land in the European Union². With over 600,000 businesses across the EU employing almost 3 million people, the road freight and passenger transport sector is predominantly made up of SMEs³.

For the great majority of goods and freight, trucks continue to be the most flexible, cost-effective, and responsive means of transportation. This is even more true, as the model of the economy is changing: there are no longer concentrated industrial clusters connected through railways transporting input (coal, feedstock) and output. Nowadays, HDVs must connect more dispersed points and are increasingly involved in consumer goods, with “door-to-door” and “just-in-time” deliveries. They are crucial to the functioning of the larger, more integrated European logistics and transport system, especially in the increased digitized economy.

Not only most of our daily needs depend on trucks at some point in the distribution chain, but trucks are also essential to a variety of crucial public services, including among others, public transport, construction, fire services, defence, and garbage collection.

The HDV sector is complex because of the diversity of its modes and means. HDVs are used to move goods or people, regionally or interregionally, over medium, or long distances. Therefore, the challenges differ depending on how HDVs are used.

- Urban buses follow established routes along the accompanying infrastructures and are easier to charge overnight, if electrified.
- Coaches are used for moving people. It is often for interregional long haul with short breaks, which make them more difficult to recharge, if electrified. It also presents unique challenge as the breaks at tourist locations differ from typical truck stops.
- Trucks varies in application and models. They transport goods regionally or inter-regionally and range in size from 6 to 50 tons, which adds to the variety, since complexity increases with weight.

¹ European Commission. *Reducing CO₂ emissions from heavy-duty vehicles*. from https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en

² European Commission (2017), EU transport in figures – statistical pocketbook 2017, https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en

³ European Commission, Directorate-General for Climate Action (2018); *Impact Assessment accompanying the proposal for a Regulation of the European Parliament and of the Council setting CO₂ emission performance standards for new heavy-duty vehicles*.

While choices regarding passenger cars are to a large extent personal (including the acceptance for higher prices) and could be replaced with other alternatives (e.g., by public transport), HDV sector is mainly cost driven, and challenging in terms of interchangeability. This is because of cost-competitive nature of the HDV sector with low margins. HDVs and commercial transport operators invest in vehicles based on profitability considerations for their operations, considering the total cost of ownership (TCO).

It is important to stress that the cross-border nature of HDVs and the long distances involved make the accessibility of charging infrastructure demanding. As HDVs require significantly more energy and time than a light vehicle to recharge, they will strongly rely on energy availability and efficient charging infrastructures throughout the route.

Today, the capacity of batteries for HDV long-haul applications is 400 kWh and could soon reach 700 to 1000 kWh, while it is only 40 to 100 kWh for passenger cars. As a result, the access to charging infrastructure for HDVs will be essential in the functioning of European single market. Thus, to avoid differing business opportunity resulting from fragmented access to charging infrastructures across the EU, one major challenge will be to coordinate their deployment in each Member State.

In conclusion, the specificity of the HDV market makes it impossible to simply replicate the policies used for passenger cars. This is because the HDV market is very different, particularly due to the broader variety of vehicle types and models depending on the use made of the HDVs, as well as the size and the market structure, with SMEs making up the majority of HDVs buyers. HDV purchase costs are also significantly higher than those for LDVs. In addition, the typical annual distance of long-haul vehicles amounts to 120,000km⁴, which is significantly higher than for LDVs. While formulating decarbonisation policies for HDVs, these important distinctions must be taken into consideration.

2. ASSUMPTIONS behind decarbonisation of HDV transport

What factors influenced the current decarbonisation policies for heavy-duty transport?

Climate & environment

The current decarbonization policies for heavy duty transport have been influenced by assumptions, many of them political in nature. The main policy driver, which is also common to other EU decarbonization policies, relates to climate and environmental considerations. It is connected to the EU commitments under the Paris Agreement to hold the increase in the global average temperature to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The success of COP-21 in 2015 was followed by the political will of the EU to lead by example, to set and implement ambitious decarbonization target. It was accompanied by the political decision to phase out fossil fuels in the EU.

The objective of reducing GHG emissions from industry and transport plays a critical role in the EU policy framework. The communication “Clean planet for All” (2018) sets the main

⁴ T&E (2020); Comparison of hydrogen and battery electric trucks. (n.d.). Retrieved May 5, 2023, from https://www.transportenvironment.org/wp-content/uploads/2021/07/2020_06_TE_comparison_hydrogen_battery_electric_trucks_methodology.pdf

⁵ European Commission, (2018); *A Clean Planet for all, A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy* from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0773>

policy assumptions to pursue the EU net-zero commitments. It made energy efficiency and reduction of energy consumption in absolute terms one of the main drivers for decarbonization. Among other desired outcomes, more specific for road transport, was the reduction in air and noise pollution as a major cause of health problems, especially in urban areas, where lives 75% of the EU population.

Based on such assumptions it followed that the general direction that was adopted for decarbonization of the EU economy was based on renewables and electrification as most energy efficient solution. This brought implications also for road transport, both LDV and HDV, as it is acknowledged that battery performs best in terms of efficient flow of energy between the point of energy supply and the powertrain.

Another aspect which affected the technological preferences for LDV and HDV was the experience with biofuels of 1st generation. While biofuels were initially promoted as a clean alternative to fossil fuels, concerns have been raised about their environmental impact, namely potential to cause deforestation and other land-use changes, particularly in developing countries, and competition with food production.

As a result, there has been a shift towards advanced biofuels which are produced from non-food sources, like biomass waste and residues and have lower environmental impact. However, the argument was put forward that there would not be enough biomass to decarbonize all transport modes – including aviation and maritime – which, although disputed⁶, helped to ensure the policy shift towards electrification of road transport and phasing out of internal combustion engine (ICE) in the EU.

Economic considerations

The assumptions for decarbonization of HDV transport stemming from the EU climate agenda were supported also by **economic considerations**. Fulfilment of net-zero objectives requires de-facto an industrial revolution which entails massive investment and cost for businesses and society.

During the design of the European Green Deal, which drives the sustainable mobility strategy, the economic and political situation was perceived as sufficiently stable and allowing to set ambitious targets. The inevitable economic effort of businesses and citizens stemming from transition, for example related to expected gradual increase of energy cost at least until 2030, was addressed by the promise of future economic prosperity resulting from the first mover advantage and the technological leadership of the EU, including electrification of LDV and HDV transport.

Potential risks, for example, those related to availability of raw materials necessary for technology development, now would seem to have been underestimated. The trust in globalization, trade and long value chains had started to erode, but for the EU, they were still important pillars of the economy. Growing geopolitical unrest was reflected by increased economic and/or political rivalry between the US, the EU, China, and Russia.

Technological advancement of main competitors in the electric vehicles sector was another risk factor. Whereas the EU has been a global champion in production of trucks, the US and

⁶ FuelsEurope, *Sustainable biomass availability in the EU, to 2050*. from <https://www.fuelsEurope.eu/publications/publications/sustainable-biomass-availability-in-the-eu-to-2050>

China were already in the lead of two major trends underpinning the future of the vehicles manufacturing: information technologies and batteries production.

HDV transport operators' choice of fleet is based on the 'total cost of ownership' (TCO), including cost of purchase, fuel, maintenance, servicing, residual value, durability, etc. Therefore, a reduction in operating costs for HDV transport operators and for consumers has been also a major economic argument in favor of energy efficient vehicles and electrification as the choice⁷, along the argument about increased energy security stemming from reliance on the own EU production of renewable energy.

Two other arguments favoring battery- and hydrogen-based powertrains in HDV were that of limited deployment of existing technologies to increase fuel efficiency - which would reduce costs and emissions - and that of avoiding distraction of investment for too many options.

The deployment of heavy-duty vehicles driven by renewable electricity and renewable hydrogen also required an assumption of sufficient production of renewable energy and building the necessary power distribution network, as well as charging and alternative fuel infrastructure⁸.

In consequence, the preference for electric and other zero-emission HDV transport has been presented as having sound economic basis.

Societal context

Heavy-duty transport also has significant **societal context and implications**.

First and foremost, it affects the access to and affordability of goods and services for citizens. HDV transport operators in the EU consist primarily of SME whose ability to invest and to bear increased operational costs is much lower and vulnerability to shocks is much higher than in case of large companies. Also, trucks and buses manufacturing and heavy-transport operations sustain a long and complex value chain and many jobs.

There has been a soft assumption that certain mobility habits will evolve, for example towards less inclination for long-distance travelling or towards more use of sustainable, public, and alternative means of transportation. However, such behavioral aspects have limited impact on HDV which is less dependent on personal choice and is more based on the rational business calculation.

Also, given the sensitivity of access to and affordability of mobility exposed e.g., by the massive 'yellow-vests' movement in France triggered in 2018 by a new tax on fuel, the official political line of the EU has been that "curbing mobility is not an option". However, it was accompanied by the acknowledgment that the main condition to switch to sustainable transport option is that cost, availability, and speed are not less favorable than existing ones⁹.

⁷ European Commission, Directorate-General for Climate Action (2018); *Impact Assessment accompanying the proposal for a Regulation of the European Parliament and of the Council setting CO₂ emission performance standards for new heavy-duty vehicles*.

⁸ Those two aspects were delegated to other pieces of legislation, namely the revision of Renewable Energy Directive and the Alternative Fuels Infrastructure Regulation.

⁹ European Commission (2020), *Sustainable and Smart Mobility Strategy*: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789>

The societal implications of technology shift towards electrification also include those, one, related to the risk of energy poverty in transitioning to renewables and two, the decline in jobs related to less labor-intensive processes in the automotive sector. They were addressed by a) the projections of reduction of overall energy consumption, b) increasing economic welfare resulting from a shift to new technologies and c) creation of new jobs, as well as d) reskilling combined with retirements of older workers involved in the HDV manufacturing and operations.

One last factor needs to be highlighted as its contribution to the technological shift cannot be overlooked. In 2015 the “Diesel-gate” scandal came to light and shook the credibility of vehicle manufacturers as drivers for decarbonization. It also created the space for a deep regulatory intervention. The fact that this incident concerned only passenger cars and not trucks was overlooked and tainted manufacturers of both LDVs as well as HDVs.

Outcomes

All above mentioned factors, with the addition of the climate and environmental considerations following the Paris Agreement, with optimistic economic and societal assumptions, as well as the limited trust in the market-led transformation, contributed to the broad policy implications concerning decarbonization of HDV transport. These were ambitious emission reduction targets, and deep regulatory intervention, which resulted in the preferred solution being electrification and zero-emission technologies.

The main policy tool which allowed to realize those assumptions and pushed the car industry towards electrification has been the CO₂ standards regulation for light-duty and heavy-duty vehicles. Current legislation on CO₂ standards from 2019¹⁰ requires manufacturers to reduce the emissions of new trucks by 15% by 2025 and 30% by 2030. The new legislation proposed by the European Commission in February 2023¹¹, increases the target to 45% emission reduction in 2030, 65% in 2035 and 90% in 2040. It is important to mention that while these targets have been increased, the effects of the previous 2025 target on the EU economy and industry have not been assessed. In fact, the recently proposed legislation is motivated by the need for further revision to align the regulation with the ambitions of the EU Green Deal.

The reduction emission levels are measured based on the ‘tailpipe approach’ which considers only emissions generated while driving, leaving out those related to the type of fuel used (e.g., fossil vs. biomass-based fuels and synthetic fuels), carbon-intensity of electricity charging the battery or the emissions related to a whole life cycle of a vehicle, including production of batteries. This approach favors electric battery vehicles and zero-emission technologies, like renewable hydrogen.

¹⁰ Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO₂ emission performance standards for new heavy-duty vehicles, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1242&qid=1681985737527>

¹¹ European Commission (2023), Q&A on the revision of the CO₂ emission standards for Heavy-duty vehicles, from: https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_763

3. REALITY CHECK – ISSUES FOR CONSIDERATION

What are the changes having an impact on the assumptions made in relation to decarbonization of road HVD transport?

The assumptions and pre-conditions outlined above which have driven decarbonisation policies in HDV transport have been seriously tested by reality. Since the inception of the European Green Deal in 2019 many unprecedented and totally unexpected developments took place, which re-shaped the world and tested assumptions locally, regionally, and globally.

Among those main events that should be mentioned are the pandemic, the war in Ukraine with reactions from many governments that led to global and regional geopolitical implications, impacted the economy, and led to high energy prices and inflation. However other developments were the acceleration of the decarbonisation policies in the USA and China as well as the experience of intense law-making in the EU translating the European Green Deal vision into regulation. In essence these circumstances led to a significant increase in decarbonization ambition.

Also, climate change has increasingly become centre-stage in the public discourse, eclipsing other considerations that would need to be accounted for, especially economic and fiscal considerations. These shocks could not have been without impact on at least some of the initial assumptions driving decarbonisation of HDV.

External competition

Europe has a long tradition in HDV and ICE manufacturing. This is the result of high levels of investment in R&D and high technical competence in engineering, design, and manufacture. The development of ICEs to continually improve efficiency whilst meeting ever tightening emissions legislation has produced world class innovations adopted across the globe. Historically these technical innovations in ICE drivelines, to improve efficiency, have been the cornerstone of competitive advantage between market players. EV technology is less reliant on technical advantages (due to lower technical complexity and higher overall efficiency) and is more reliant on cheap labour and commodity availability.

In recent years it has become increasingly evident that the European path to net-zero has been under pressure from external competition. The EU has been exposed to alternative economic, decarbonisation and political models, particularly those of China and the USA.

The model of decarbonisation pursued in the USA is based primarily on market-led innovations and technological choices and is driven by efficient public financial incentives which apply different model than the EU for variety of reasons, including governance arrangements. This is reflected by the Inflation Reduction Act adopted in 2022.

The amounts of green subsidies under the IRA are comparable to those available in the EU¹² but they are more easily accessible (in the form of tax-breaks or, if no taxable profit is recorded, in the form direct payments in initial period), more effective and technologically neutral as amount of subsidy is dependent on the level of emission reduction. It is worth noting that some IRA subsidies discriminate against foreign producers, requiring local content, and as such are at odds with the WTO.

¹² Bruegel (2023), How Europe should answer the US Inflation Reduction Act from https://www.bruegel.org/sites/default/files/2023-02/PB%2004%202023_0_1.pdf

The IRA subsidies are available, inter alia, for purchases of clean vehicles, production of batteries and components used in renewable electricity generation and production of carbon-neutral electricity, as well as hydrogen and other non-fossil fuels. Rather than supporting innovation, the IRA subsidies will have the effect of massive deployment of decarbonization technologies, which will bring down the emission down by additional 10 p.p. and will likely allow the US to meet their Paris Agreement commitments¹³.

The IRA incentives will overall negatively affect the competitiveness of Europe and may even slow its decarbonization by attracting investments in clean tech to the USA. Its impact specifically on HDV industry could be more nuanced, given the fact that HD vehicles tend to be manufactured closely to customers, because of high cost of shipment, as well as different regulatory requirements in each region and various needs of customers. However, this is not an absolute rule, which is reflected by the growing penetration of the EU market by buses manufactured in China (ca. 25%)¹⁴ which win the public procurement bids in many Member States by offering lower prices. The IRA's local content requirement along with the high tariffs on trucks (25%) will continue to shield the US market and contribute to redirecting trade to the EU.

China represents another end of the spectrum in terms of economic and political model. It is a deeply interventionist state economy, capable to adapt its short- and mid-term targets, with massive subsidies for development and deployment of new technologies, having decades long experience in batteries and EVs, low cost of labor, and the biggest internal market in the world ensuring economy of scale and room for growth for Chinese companies.

The Chinese state also actively supports foreign economic expansion as part of the strategy to become a global leader in the renewable energy sector. As a result, China already proved in the past that it can take over markets created in the EU by means of regulation. One example is the solar energy industry which was boosted by the policy of feed-in tariffs in Germany and was followed in other EU Member States. Currently China de facto controls the value chain in the solar industry and expands its presence in the EU wind energy market¹⁵.

In the context of electrification of HDV transport, the fact of paramount importance is that China is a leader in production of batteries (with 77% of global capacity¹⁶) with much better access to raw materials than the EU¹⁷. It results from China's own extraction, access to key mining resources worldwide, as well as from the efficient recycling policies which secures their leadership in production of key inputs to batteries. Those advantages are reflected by increasing export of electric vehicles to the EU - in the first half of 2022 around 20% of battery electric vehicles sold in the EU were manufactured in China¹⁸. It is worth attention that overwhelming part of those sales comes from the European brands manufacturing in China which is illustrative of investment attractiveness of the EU and China.

¹³ American Progress (2022), How the Inflation Reduction Act Will Drive Global Climate Action, *from*:

<https://www.americanprogress.org/article/how-the-inflation-reduction-act-will-drive-global-climate-action/>

¹⁴ Sustainable Bus (2022), 30% of City Buses Registered in Europe Is Now Zero Emissions. VDL Lead the e-Bus Market in the First Half of 2022, *from* <https://www.sustainable-bus.com/news/electric-bus-market-europe-half-2022-vdl/>

¹⁵ To the extent that the EU has imposed anti-dumping protection against the wind towers producers in China in 2021

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R2239>

¹⁶ Raport Perspektywy Rozwoju - jagiellonski.pl. *from* <https://www.jagiellonski.pl/wp-content/uploads/2023/04/raport-e-mobility-IJ.pdf>

¹⁷ European Commission, RMIS- Raw Materials Information System <https://rmis.jrc.ec.europa.eu/bvc#/p/supply>

¹⁸ T&E (2022), *From boom to brake: is the e-mobility transition scaling?* https://www.transportenvironment.org/wp-content/uploads/2022/10/2022-10_Car-CO2-report-2022-recommandations-corrected.pdf

War and geopolitics

The fundamental change in geopolitical relationship with China and Russia drives most of the narrative. The volatile geopolitical situation brought on by Russia's war on Ukraine and the accompanying economic sanctions on Russia have had a significant impact on the European Union's economy. Geopolitical instability creates uncertainty and increased risk, making it challenging for markets and investors to operate effectively. In particular, the rising energy prices increased even more due to this geopolitical turmoil and had a ripple effect throughout the economy. High energy prices fuelled inflation, already at high levels because of expansionary monetary policy, including due to COVID and the European Green Deal policies, had a considerable impact on the economy, and society as whole.

The transportation industry, specifically the HDVs sector, has also been directly affected by the war. Uncertainty has hit metals-related markets, which are considered crucial to the supply chains of contemporary manufacturing production. As a result, the supply chains of the HDVs industry were disrupted, for example many essential components like cables, aluminium, nickel, and palladium come from Russia and Ukraine¹⁹. The disruption has led to increased costs and delays, further adding to the challenges faced by the industry. The industrial shift required for the ecological transition is significantly impacted by these shortages and price increases.

The conflict is also having significant implications on the European Union's energy sector, revealing the risks of excessive reliance on external energy supply and the dangers of having limited supply options. The war prompted the EU to reduce its external dependence on fossil fuels, increase energy efficiency and diversify its energy sources. It particularly puts pressure on the EU to build its own renewable capacities to promote energy autonomy and security. In addition, the conflict has served to boost public awareness about the need to cut back on energy use to ensure energy security. This has led to renewed consideration to all energy sources as a way to ensure diversification, including through nuclear and biofuels.

Overall, war in Ukraine has forced the EU to reassess its energy policies and focus more on reducing dependence on external energy sources. While this has led to a greater emphasis on renewable and nuclear energy, concerns about the EU's external dependence on its trading partners are now raised more widely.

For instance, in the case of HDVs, the decarbonisation anticipates an increasing demand for electric batteries, yet China, which has moved from being a partner towards being a systemic rival of the EU, is the world leader in batteries manufacturing. This poses a significant challenge and risk in relying on external sources. As the EU continues to navigate these challenges, it will need to find ways to balance energy security with environmental sustainability and economic prosperity.

Pandemic

The impact of draconian measures put in place by governments to address the COVID-19 pandemic has had a profound impact on the European Union's economy and society. It has disrupted supply chains both within and outside of the EU, highlighting the vulnerability of the EU's economy to external shocks. Many factories and services were forced to close, causing significant economic hardship for businesses and citizens.

¹⁹ OECD (2022), *The supply of Critical Raw Materials Endangered by Russia's war on Ukraine*, from <https://www.oecd.org/ukraine-hub/policy-responses/the-supply-of-critical-raw-materials-endangered-by-russia-s-war-on-ukraine-e01ac7be/>

The pandemic has highlighted the dangers of relying too much on offshoring and external supply chains, prompting several businesses to relocate their operations. Indeed, the pandemic has accelerated a trend towards greater control of value chains among both governments and corporations. This trend is likely to continue in the years ahead, as businesses and governments seek to balance the benefits of global trade with the need for greater resilience and security in their supply chains in the context of geopolitical tensions.

The pandemic has also triggered changes in people's and corporate habits, such as using more e-commerce²⁰ which increases demand for commercial transport or adopting new working practices, including remote work and digital communication which can, in turn, reduce transports needs.

Inflation, which historically shakes societal economic stability, has been also fueled by the expansionary monetary policy in response to COVID, and the increasing state intervention in the economy.

New economic situation - impact on business and society

The economic prosperity and industrial development of the European Union are critical to the job market and welfare of society. However, the current economic situation, marked by high inflation and energy prices, has led to increased costs and declining purchasing power for consumers, causing a strain on household budgets.

Many businesses are experiencing reduced profitability and investment capacity. For instance, in 2022 the EU invested just €17 bn in new wind farms due to rising costs caused by inflation²¹. That is down from € 41bn in 2021 and the lowest investment figure since 2009. Similarly, trends can be seen in the solar industry underlying the impact of economic challenges on the renewable energy investments necessary for the decarbonisation of the HDVs sector. The scale of investment and time necessary to deploy renewables as well as the necessary infrastructure has been underestimated.

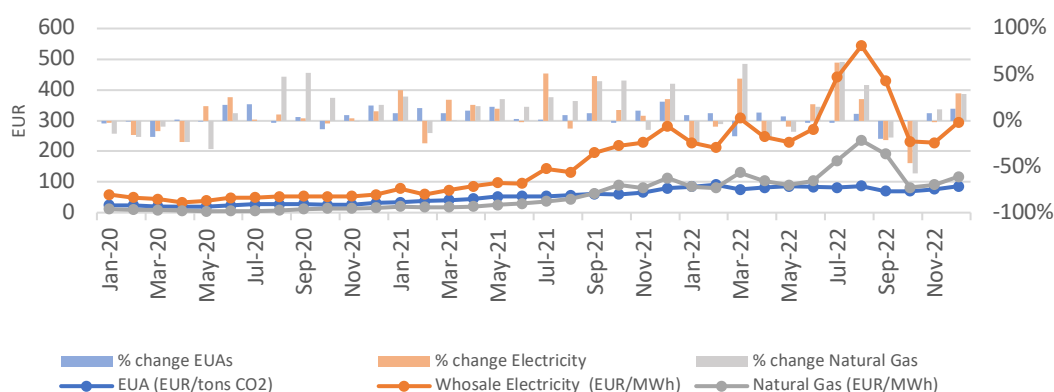
Furthermore, growing sensitivity to transportation costs can be aggravated by limiting transportation options, such as phasing out internal combustion engine vehicles while limiting options to certain technologies, yet to be implemented. As a result, prices will increase on the second-hand market for traditional HDV vehicles, which for SME operators is an important alternative option for purchasing trucks.

The shift towards electric vehicles should be seen also in the context of the cost of electric trucks which are about three times more expensive than conventional trucks. In addition to the high upfront costs of electric vehicles, total cost of ownership (TCO) is also expected to increase due to regulatory requirements such as battery recycling and growing cost of energy and electricity. Since the measure imposed by the EU and allies in response to the Russian invasion, the price of gas and electricity, already on an upswing due to the transition, has been increasing exponentially and has surged more rapidly than the price of carbon and gas (see figure 1 below).

²⁰ Eurostat. *Online sales efforts on the rise due to the pandemic* - from <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220411-1>

²¹ WindEurope (2022), *Financing and investment trends* - from <https://windeurope.org/intelligence-platform/product/financing-and-investment-trends-2022/>

Figure 1: CO₂, Wholesale Electricity and Natural Gas price evolution in the EU (monthly, 2020 - 2022)



Source: Own analysis based on Sendeco2 (CO₂), Ember (Wholesale electricity) and Elexys (Dutch TTF Natural Gas).

Impact of the European policy-making approach

The current European institutional cycle witnessed unprecedented waves of law-making, both in terms of number of pieces of legislation and their profound impact on the citizens and businesses. This period revealed or strengthened several characteristics of the law- and policymaking in the EU which have a significant impact on the design of net-zero policies, as well as in HDV transport.

First and foremost, regulation rather than market has been confirmed as a driving force of change in the EU. The EU ETS, a market-based pillar of the EU climate and decarbonisation policies remains a flagship, but the market approach underlying the ETS has been overshadowed by the political decisions favouring or excluding concrete technological solutions and setting legal targets to create markets for chosen technologies, like BEVs or hydrogen. In this process the political agenda has often prevailed.

This has been especially visible in the period of the pandemic and the lock-down during which the bulk of public consultation on “Fit for 55” took place. This resulted in politically driven decisions with a weak substantive filter on political ideas.

This has been accompanied by some policy making done in silos and political acceptance of risks from different speed of progress in different policy areas. It comes with the assumption that making one policy area dependent on another will create inertia blocking the overall political progress. What might be a convincing argument for policy makers is a danger to the market participants.

One example could be pushing the LDV and HDV manufacturers towards battery and hydrogen power-trains – under the sanction of financial penalties - without a safety net ensuring that necessary enabling conditions would be put in place in time. Among those conditions is availability of the charging and alternative fuel infrastructure, renewable electricity and renewable hydrogen needed to power vehicles and raw materials necessary to produce batteries, for which the HDV players will have to compete with other sectors of the EU economy.

The developments in these areas are below expectations. For example, the deployment of charging infrastructure for HDV was delegated to the Alternative Fuel Infrastructure Regulation. The co-legislators have recently adopted targets for Member States in this regard

which are widely perceived by industry as not sufficient^{22 23}. Another example is a much slower than needed growth of the capacity in the renewable energy, which is attributed mainly to the inflation, growing costs, and long permitting procedures²⁴. Renewable energy is key for charging battery trucks and buses and for production of renewable hydrogen and these bottlenecks need to be addressed with more urgency.

Another enabling factor is the purchasing power of HDV transport operators, mainly SMEs. To meet the emission reduction targets put on the HDV fleet manufacturers, the operators will have to buy 400.000 battery or hydrogen powered trucks by 2030 and after this date 100.000 every year²⁵. Such vehicles are at least three times more expensive compared to the existing alternative.

This will inevitably bring to the fore the issue of increased capital cost for fleet operators who need to invest in clean HVD vehicles, but face uncertainty related to the deployment of new technologies. Even though 'total cost of ownership' is an important factor driving the decision about purchasing new vehicles, this high initial cost will be an important barrier for meeting decarbonisation targets in HDV.

Currently most Member States provide subsidies or other incentives for purchasing zero-emission vehicles. This will stretch the public budgets and will add to the overall economic cost of zero-emission solutions which needs to be taken into equation. Also, the level of support inevitably will differ among the Member States and will generate inequalities and fragmentation of the market. This might be also true in case of charging infrastructure.

An illustration of the 'silos' phenomenon which can be seen sometimes in policymaking could be conflicting assumptions behind various pieces of legislation affecting HDVs. Whereas the CO₂ standards regulation aims at fast phasing-out of the vehicles with combustion engines, the impact assessment of the recent EURO 7 standard proposal²⁶ assumes that 60% of new registered trucks in 2035 will be powered by ICE. Consequently, it imposes obligation on HDV manufacturers to heavily invest in reduction of fuel pollutants in ICEs. This will likely bring marginal improvements at the expense of investment in zero-emission technologies mandated by other pieces of legislation.

The above-mentioned factors lead to reflection that stakes in the race towards decarbonization are not only about improving the climate but also about the economics and societal implications. Enabling economic and political conditions are necessary for ensuring effective transformation and continuous welfare of the society. These objectives have been increasingly challenged by the external competitors of the EU, particularly China and the US, whose less prescriptive policies and more technologically open incentives seem to better reflect the market reality and their competitive advantages.

Thus, the changed circumstances strengthen the risks which undermine the EU objective of leadership in green-tech and the effective transformation of HDV transport towards more sustainable solutions.

²² European Commission (2023), *European Green Deal: ambitious new law agreed to deploy sufficient alternative fuels infrastructure-* https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1867

²³ ACEA, AFIR: 'Infrastructure gap' will limit CO₂ reductions from road transport, from <https://www.acea.auto/press-release/afir-infrastructure-gap-will-limit-co2-reductions-from-road-transport/>

²⁴ IEA (2022), *Is the European Union on track to meet its REPowerEU goals?* From <https://www.iea.org/reports/is-the-european-union-on-track-to-meet-its-repowereu-goals>

²⁵ ACEA, AFIR: 'Infrastructure gap' will limit CO₂ reductions from road transport.

²⁶ European Commission (2022), *Euro 7 impact assessment study*, from <https://data.europa.eu/doi/10.2873/249061>

4. THE NEW ANALYTICAL FRAMEWORK:

Factors that need to be considered in decarbonisation of HDV transport under the changing geopolitical landscape.

Starting on a general note, the experience of recent years outlined above might be to some degree the illustration of the popular concept of ‘silent risks’ or ‘black swans’. It concerns the events beyond normal expectations which, if underestimated or ignored, have disproportionate impact. The main lesson learned from those developments is that in drafting decarbonization policies the EU should accept exposure to instability, take risks related to external and internal shocks very seriously and ensure many options.

This leads to the necessity of looking at the decarbonization framework of HDV transport through recalibrated lenses – but keep final objectives intact.

First and foremost, the main new focus in policymaking should be **resilience**, that is resistance to crises and changing circumstances. As much as it has become another buzzword in the EU speak, the components of this concept are important. Those are, in broad terms, **adaptability** which requires availability of alternative pathways and various technological options to be able to respond to changing circumstances.

Also, the market players are best suited to assess, manage and respond to risks. Therefore, the **market and innovation should be in the lead** and be ahead of regulation. In principle, in the current circumstances, more than ever, business should be given decarbonization objectives rather than be forced to concrete solutions through political decisions and regulation.

Security of supply is an indispensable aspect of ensuring resilience. It refers to all aspects of value chains necessary for manufacturing and operating of HDV transportation. It starts from access to critical raw materials, through key components, like semi-conductors, to availability of energy driving the vehicles, be it electricity, hydrogen, or other renewable and low-carbon fuels.

Obviously, full autonomy of the EU in any of those areas is not possible. However, more self-reliance of the EU has become a strategic issue and striking the right balance in this regard is needed. But the blend of enhanced autonomy and diversification of supply is crucial to reduce risks related to significantly increased importance of security of supply and value chains exposed by the pandemic and the geopolitical tensions. Therefore, it should be one of key factors driving policy choices in decarbonization of HDV transport.

Economic efficiency is another element which needs to be reconsidered in the assessment of various options. This aspect influences the overall economic cost of decarbonization of HDV transport, and, therefore, ultimately impacts the capacity of businesses to invest and citizens to carry the economic burden of transformation in this sector. This should concern various aspects, including cost of rapid and massive investment in the HDV fleet by manufacturers and HDV operators, in infrastructure, availability of renewable electricity and other fuels, and cost of capital and productivity losses resulting from extended working hours and downtime due to charging, or potentially increased distance to route via charging network.

(Non-)optimal economic choices are closely related to the **issue of competitiveness**. When making policy decisions the EU must take due account of the external competitors’ advantages and policies affecting the capability of the European economy to compete on its own and foreign markets, especially in the realm of new technologies. USA’s IRA and China’s economic

expansion will remain a challenge for the EU competitiveness when decarbonizing HDV sector. The Net-Zero Industry Act and the Critical Raw Materials Act make some proposals in this regard. Nevertheless, securing the world's leader position in HDV may require deeper adjustments to the EU decarbonization choices and pathways.

Societal impact of extension of ETS to **road transport** has been politically recognized and addressed by various safety nets, for example through the cap on carbon price in the ETS for transport and buildings or the Social Climate Fund. Societal context should be duly taken on board also in other policies decarbonising HDV transport. Firstly, in terms of impact on final price of consumer goods and services, secondly, the potential implications of industrial shift away from ICE for jobs and economic welfare, and, thirdly, how this shift will impact the ability of consumers to finance the transition to decarbonized transport; after all, without a client willing to foot a bill there is no market.

Also, the higher the labour and materials content carried out or sourced outside Europe, the less control the EU has around the social governance of issues like child labour, slavery, bribery, and corruption.

Taking climate issues as the main driving force behind decarbonization of HDV transport requires effective and **credible approach** to measuring **emission reduction, climate impact** and **energy efficiency** of various technological options.

This touches upon the 'tailpipe approach' to measuring emission reduction used in application of CO₂ standards regulation. This approach leaves out of the equation CO₂ emissions generated, for example, to produce electricity, hydrogen or other fuels used to power the vehicle, as well as GHG emitted in manufacturing of batteries. There are pragmatic arguments against departing from this method towards full life cycle assessment as there are objective difficulties in tracing down all GHG emission in the whole value chain of battery and vehicle manufacturing and use.

However, the 'tailpipe' method gives an incomplete picture in terms of emission reduction of different technological choices and of its impact on climate. Therefore, other frameworks could be considered as well to credibly assess various technological options, for example, 'well-to-wheel' or putting a label on type of CO₂ emitted at the tailpipe, which could distinguish between the use of fossils and advanced biofuels. For instance, the differentiation between fossil CO₂ emissions and non-fossil, as well as carbon circularity could be adopted for regulatory purposes to allow non-fossil fuels to contribute to the compliance with the CO₂ targets of new vehicles.

Also, when assessing the climate impact due account should be taken of **remaining carbon budget** and the necessary pace of decarbonization of HDV. In this context it is important to note that the emission reduction targets for HDV put forward in the revised CO₂ standards regulation assumes a straight-line progression. In the real world this is highly unusual, and progress is non-linear. This would predict that the earlier limits will be harder to achieve than the later ones.

The **energy efficiency** needs also to be taken into account in a more nuanced way, for example considering not only energy losses in powertrain but also the overall process of production of energy inputs for HDVs, be it electricity, hydrogen, renewable and low-carbon fuels, or increased weight and space taken by battery in HDV which limits the room for cargo.

Finally, the lessons from the recent **policymaking** experience must be delivered to the European decision makers on the way they shape the reality. A truism that a **stable regulatory environment is necessary** to invest in transformation is holding true more than ever considering the green industrial revolution unfolding in the EU and globally.

If regulation as a means of introducing change proves necessary, the law- and policymakers should regulate minimum, leaving space for market innovations, with maximum clarity. They should also ensure the quality of legislative process and effective reviews of legislation considering lessons learned.

Current longevity of EU legislation is very short, and many important pieces of law are being fundamentally revised every 2-3 years, often before its full implementation, which is extremely challenging for businesses. Given the investment cycle in HDV manufacturing, legislation should allow time of at least two institutional cycles (10 years) for adaptation before significant revisions are proposed.

Avoiding excessive reliance on secondary regulations and reducing delegation of power to Member States in the transposition phase is also important to prevent fragmentation of market in the EU.

Also, more consistency and coordination between the EU policies and institutions is needed to **ensure timely adoption of enabling conditions for required solutions**. Making the binding targets emission reduction targets conditional upon fulfilment of enabling factors (e.g., rolling out a charging infrastructure), is one way of setting a safety net. However, it could be challenging to implement as a list of potential conditions is very long, and it would require monitoring, frequent revisions of targets and clear decision-making process ensuring certainty.

Therefore, instead of adding to existing regulatory complexity and considering many risks described above, the policy space is needed for market-driven solutions and innovations as well as for many decarbonisation options, with more trust put into pragmatism and less into dogmatism.