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The Green Ammonia and E-Fertiliser Value Chain in Ukraine:

An Initial Assessment

Imprint

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Content

01. List of Abbreviations

AN	Ammonium nitrate
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon capture and storage
DAP	Diammonium phosphate
EU	European Union
EU ETS	EU Emissions Trading System
GDP	Gross Domestic Product
GHG	Greenhouse gas
HYPAT	Hydrogen Production and Transport Model
IEA	International Energy Agency
IFA	International Fertilizer Association
IFPRI	International Food Policy Research Institute
IRENA	International Renewable Energy Agency
MAP	Monoammonium phosphate
MRV	Monitoring, reporting, and verification
OECD	Organisation for Economic Co-operation and Development
PESTEL	Political, Economic, Social, Technological, Environmental, Legal
REDIII	Renewable Energy Directive III
RFNBO	Renewable Fuels of Non-Biological Origin
SCZ	Special Custom Zones
SMR	Steam methane reforming
SWOT	Strengths, Weaknesses, Opportunities, Threats
TFEC	Total final energy consumption
UAN	Urea–ammonium nitrate
WACC	Weighted Average Cost of Capital

02. Executive summary

Globally, green ammonia is moving from being a niche technology to a future strategic commodity, but demand patterns, cost trends and geopolitical dynamics remain highly uncertain. Projections show that growing demand for green ammonia will come first from fertilisers and then increasingly from maritime fuels and energy storage applications. Costs are expected to decline significantly due to falling renewable and electrolyser prices, but competitiveness will depend heavily on policy incentives, carbon pricing, and global competition. Rival exporters in North Africa and the Middle East already combine favourable renewable resources with active industrial policies creating price competition. On the demand side, the rise of alternative fuels like e-methanol may delay uptake of green ammonia in the shipping industry. These global dynamics create both opportunities and risks for Ukraine.

Ukraine's existing ammonia and fertiliser sector remains strategically important, yet deeply disrupted, and any green ammonia strategy must build on what is remaining. Before the start of the Russian full-scale invasion, Ukraine was a major ammonia producer and a central transit corridor for global ammonia trade. As of 2025, only two of six plants remain operational, import dependence on nitrogen fertilisers has surpassed 60 percent, and infrastructure such as the Togliatti-Odesa pipeline is offline. However, surviving production capacity, strong agronomic fertiliser demand, and extensive distribution networks still offer a meaningful industrial base on which a future green value chain can be built.

Ukraine's renewable and biomass potential create a strong foundation to produce green ammonia at competitive costs in the long term, but near-term production costs remain far above grey ammonia prices. With some of the renewable-richer areas occupied by Russia, high financing rates and risk premia, and hydrogen production technology still maturing, producing green ammonia in Ukraine would still be two to three times more expensive than grey ammonia today. War-related financing costs further raise the hurdle. In the mid-2030s and beyond, however, rising EU ETS prices, lowering capital costs, and improved electrolyser economics could bring Ukraine close to cost parity, particularly if concessional finance is available. Biomass-based ammonia may play a transitional role but is likely to be outperformed by hydrogen-based production in the long run.

Domestic use of green ammonia as e-fertiliser could improve food security but would come with economic trade-offs for farmers. The study finds that, on an aggregated level, e-fertiliser uptake would lead to lower grain output because higher fertiliser costs outweigh the green price premium of low-carbon agricultural products. This result indicates that there is no immediate economic incentive for full-scale adoption of e-fertilisers across Ukraine's agricultural sector. However, the output of selected crops can increase by leveraging higher margins alongside low-carbon price premia benefits, suggesting that the supporting targeted crops to gradually introduce e-fertilisers in their production could be beneficial for the Ukrainian agricultural sector.

Ukraine's competitive positioning is mixed: the country has strong and growing political alignment with the EU and major industrial advantages, but faces important challenges in profitability, foreign competition and war-driven risks. The study's analysis underscores substantial long-term opportunities: EU alignment, large agricultural demand, access to future carbon-priced markets, and the potential to revive existing ammonia infrastructure. Yet, weaknesses are significant: high cost of finance, vulnerability of centralised assets to attacks, competing uses for scarcer renewables, and incomplete regulatory frameworks. Threats include geopolitical uncertainty, emerging competition from other exporters, and the rise of alternative fuels.

The study's overall finding is that the development of a green ammonia and e-fertiliser value chain represents a promising pathway for Ukraine's green reconstruction, but only if the steps forward are phased, sequenced and targeted, avoiding premature scale-up. Early steps in feasibility analysis, skills mapping, legal alignment, and pilot projects will ensure that Ukraine can capture future opportunities once conditions improve. However, facilitating aggressive investment today would carry high risks, given weak economics and competing reconstruction priorities.

Policymakers should therefore focus on preparing the enabling environment now while avoiding commitments that could lock Ukraine into uncompetitive or stranded assets. Key actions for this include:

- **Commissioning a comprehensive feasibility assessment is essential to guide decisions on future development.** This includes evaluating post-war renewable availability, realistic market demand, opportunities to repurpose existing industrial assets and infrastructure, and identifying where new investments would be required. A fresh benchmarking exercise against regional competitors is needed to clarify Ukraine's potential role in the European market.
- **Looking for avenues to improve investment conditions and enhance competitiveness.** Ukraine will require substantial external financing to reduce the cost burden for both investors and the state. Access to EU and international support instruments, coupled with domestic measures such as the development of a tailored investment strategy and lower interest rates, can help narrow the cost gap with fossil-based ammonia and reduce fiscal exposure.
- **Addressing workforce preparedness from the outset.** Developing a green hydrogen and ammonia sector will generate new technical and operational roles, while today's workforce has been significantly reduced by the war. Mapping current and future skill needs is essential to design upskilling programmes and avoid labour bottlenecks that could slow sector growth.
- **Continuing and doubling-down efforts on regulatory alignment with EU frameworks.** Clear definitions of green hydrogen and ammonia, robust carbon-pricing rules, and credible MRV systems will be central for market access, investor confidence, and future compatibility with EU low-carbon value chains. Maintaining this alignment also ensures that Ukraine benefits fully from EU integration once accession progresses.
- **Continuing and strengthening a strong partnership with the EU, as it is a core priority.** Europe is the main demand centre for green ammonia, both directly and indirectly through fertiliser, shipping and energy applications. Deepening cooperation will help secure long-term market access, support joint planning and shield Ukraine's competitive position from neighbouring exporters.
- **Facilitating awareness-raising and capacity building for key stakeholders.** Policymakers, agribusinesses and investors require a clear understanding of the sector's potential, its cost dynamics and its prerequisites. Broader awareness will help enable informed decision-making and foster support for early pilot activities.
- **Carefully navigating priorities given competing reconstruction demands.** Building a green ammonia sector will require regulatory, technical and financial resources. Policymakers must assess trade-offs realistically to avoid over-stretching institutional capacity or creating an uncompetitive sector that cannot scale.

03. Introduction

Green hydrogen is emerging as a critical solution for decarbonising hard-to-abate sectors where electrification may not be feasible. While significant progress in electrification and the declining costs of renewable energy has been driving the global energy transition challenges remain. Certain sectors, such as some industrial processes or long-term energy storage, are difficult to electrify. In these areas, hydrogen can provide a solution as a material input, power source, or storage option. Nevertheless, high production costs, the need for costly new infrastructure, and the energy-intensive processes of compression and liquefaction make hydrogen most effective when produced, processed, and consumed locally.[1] In this context, green ammonia has emerged as one of the most attractive responses to these challenges.

Green ammonia is a versatile derivative that can be used both as an input for industrial processes and as an energy carrier. This makes it a cross-cutting solution, delivering not only climate benefits but also enhancing energy and food security, as well as the reliability of access to essential industrial inputs. As an input for industrial processes, it offers a direct use of green hydrogen to decarbonise conventional ammonia uses: primarily fertiliser production but also for chemicals, plastics, synthetic fibres, and pharmaceuticals. As an energy carrier, its favourable physical properties compared to hydrogen make it a good option for transporting and storing energy, which can then be used in power generation, as a fuel for maritime transport or reconverted to hydrogen elsewhere.[2]

Despite the challenges of the war, Ukraine has specific conditions that could enable the development of a green ammonia sector. The country's strong renewable resource base and decarbonisation commitments have spurred rapid investment in renewables in recent years, a trend expected to continue in the coming decades, creating a strong resource base for green hydrogen production that can be then turned into green ammonia.[3] In addition, Ukraine's longstanding conventional ammonia production sector could provide a strong basis for the development of a green ammonia industry. For Ukraine, leveraging these conditions would not only mean capturing the benefits of decarbonisation, energy, and food security but also playing a key role in the country's green reconstruction, revitalising a critical economic sector.

Despite all this, the development of a green ammonia value chain in Ukraine remains a largely underexplored topic and has received limited research and policy attention. This study takes a first step in closing this knowledge gap, offering an analytical basis for dialogue, further research and future decision-making.

The study is structured in five main sections after the present introduction (Section one). Section two provides an overview of the green ammonia value chain, aiming to introduce the reader to the key concepts necessary to understand its composition. It covers the importance of a strong resource base for the upstream stages of the value chain, the two main production pathways of green

[1] International Renewable Energy Agency (IRENA) (2025). Analysis of the potential for green hydrogen and related commodities trade. Abu Dhabi: IRENA. Link
[2] Balaji, R. K. (2024). Ammonia's evolution and role in global decarbonization. One Earth, 7(4), 327-331. Link
[3] International Energy Agency (IEA) (2025). Unlocking Ukraine's Hydrogen Opportunity: A Roadmap. Paris: IEA. Link

ammonia (hydrogen and biomass-based) along with their associated challenges and costs, and the downstream applications, including green ammonia's decarbonisation potential within them.

Section three examines global developments in green ammonia. It aims to help the reader understand the sector's growth potential, along with the trade-offs and uncertainties in its future development. Additionally, it moves beyond a purely techno-economic perspective, exploring the geopolitical dimensions of the sector and providing a more holistic view. Finally, it analyses the competitive landscape both globally and in the European neighbourhood, identifying key players, benchmarking investment costs, and presenting the policies and tools being used by policymakers to spur growth in this sector.

Section four takes stock of Ukraine’s ammonia value chain to assess how it can be leveraged for green ammonia production and identify potential synergies. It provides a detailed analysis of both the production and infrastructure aspects of the sector, exploring the historical and current relevance of Ukraine's ammonia production to global and regional markets, with a focus on its evolution over the past decade. The section also deep dives into the fertiliser sector, the main downstream application, examining ammonia’s role in fertiliser production, trade dynamics, consumption patterns, and cost structures, alongside the impacts of EU integration and regulation.

Section five provides a first assessment of the potential for a green ammonia and e-fertiliser value chain in Ukraine, focusing on the country’s renewable energy potential, developments in hydrogen plans, and the trade-offs and war-driven challenges for green ammonia production. To evaluate the potential of domestic demand for green ammonia, this section provides preliminary calculations of how e-fertiliser uptake would affect the production and trade of major cereals and oilseeds in Ukraine.

Section six provides an assessment of Ukraine’s competitive positioning for developing a green ammonia and fertiliser sector, using a PESTEL- (Political, Economic, Social, Technological, Environmental, and Legal) based and SWOT framework. It identifies key political, economic, technological, industrial, and regulatory factors that shape Ukraine’s capacity to build a low-carbon ammonia value chain. The section highlights strengths, emerging opportunities, structural weaknesses, and potential risks, offering a comprehensive view of the challenges and advantages in Ukraine’s green ammonia development.

Finally, the report concludes with a reflection on the key insights from the preceding sections and outlines the steps policymakers should consider in enabling a green ammonia value chain, along with the corresponding actionable policy recommendations.

04. Overview of the green ammonia value chain

An introduction to green ammonia

What is green ammonia?

Green ammonia is chemically identical to conventional ammonia (anhydrous ammonia, NH_3); the distinction lies solely in how it is produced.[4] Ammonia is commonly classified by a colour taxonomy based on its production method:

- **Black and brown ammonia:** produced via the Haber–Bosch process, using hydrogen derived from coal (black ammonia) or lignite (brown ammonia) gasification. This method gasifies coal or lignite with steam and oxygen to produce the necessary hydrogen.[5]
- **Grey ammonia:** produced from natural gas via the Haber–Bosch process, using hydrogen derived from steam methane reforming (SMR).
- **Blue ammonia:** produced from the same fossil-based processes as grey ammonia, but with the associated CO_2 emissions partially or fully captured and stored using carbon capture and storage (CCS).
- **Green ammonia**: produced using hydrogen obtained from renewable-powered electrolysis (green hydrogen) or, less commonly, from sustainable biomass or other carbon-neutral pathways.

Regardless of production route, ammonia can exist either in gaseous form or as a liquid (when cooled to a liquefied state), depending on its application. In the fertiliser industry, it is often used in gaseous form at the point of application, while it is typically stored in liquid form for efficiency and safety. Pipeline transport usually employs gaseous ammonia, whereas maritime shipping relies on liquefied ammonia.

Unpacking the green ammonia value chain

The green ammonia value chain spans from renewable energy sources to end use applications, linking hydrogen production, ammonia synthesis, transport, storage, and reconversion where required. It can be broadly divided into an upstream segment (precursors, ammonia production, logistics) and a downstream segment (distribution, potential reconversion, and end-use in fertilisers, fuels, or power). At early stages of development, this chain should be vertically integrated to manage

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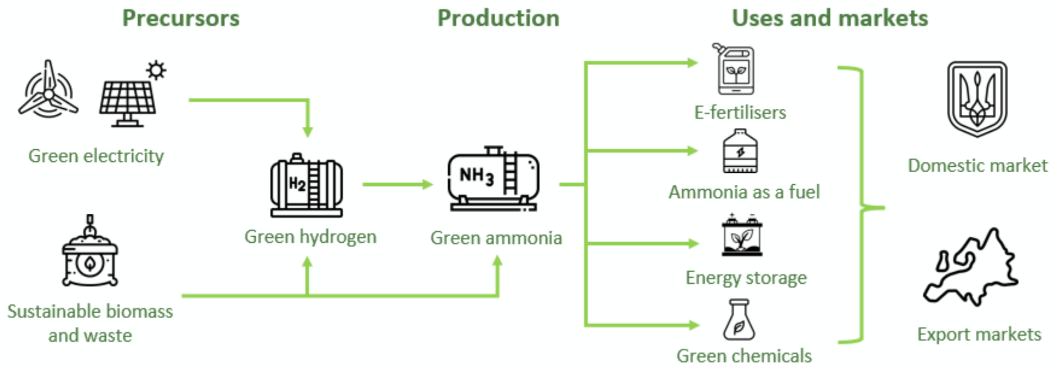
[4] Hatzell, M. C. (2024). The colours of ammonia. ACS Energy Letters, 9(6), 2920–2921. Link
[5] Due to its limited use in Ukraine and its significantly smaller global production volume—roughly one-third that of grey ammonia—black/brown ammonia is excluded from the subsequent analysis.

risk and ensure capital recovery, but as markets expand, greater fragmentation and competition are expected to improve efficiency.[6]

Figure 1: Graphical overview of the green ammonia value chain



Source: Author's elaboration

Precursors that shape the green ammonia value chain

The foundation of green ammonia production lies in its precursors: renewable energy and sustainable biomass. A strong resource base of these inputs is essential for building a viable value chain.

The most common production route begins with renewable electricity, which powers the electrolysis of water to generate green hydrogen. This hydrogen is then combined with nitrogen (extracted from the air) in the Haber-Bosch process to produce green ammonia. In addition, sustainable biomass and waste can serve as alternative inputs. These can either be used to generate hydrogen for subsequent ammonia synthesis, or in some cases, to produce ammonia directly.

Decarbonisation potential across industries

Green ammonia is emerging as an important solution for decarbonising hard-to-abate sectors.[2] By replacing grey ammonia in traditional applications, it can reduce the emissions of key products in the fertiliser and chemical industries.

Currently, around 55% of ammonia use goes to urea, 20% to ammonium nitrate products, and 10% to phosphate-based fertilisers such as diammonium phosphate (DAP) and monoammonium phosphate (MAP), as well as other mixed fertilisers. The remaining 15% is consumed in industrial applications, including explosives, chemicals and plastics.[7]

Since global ammonia production is mainly used for fertilisers, e-fertiliser production is emerging as the main application of green ammonia. E-fertilisers are mineral fertilisers whose key inputs are produced using green electricity rather than fossil fuels. In practice, this often means using green hydrogen to synthesise ammonia (NH_3), which is then used to make nitrogen-based fertilisers.

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[6] Zhao, H. (2023). Green ammonia supply chain and associated market structure: An analysis based on transaction cost economics. Faculty of Technology, Policy and Management, Delft University of Technology. Link

[7] International Renewable Energy Agency (IRENA) & Ammonia Energy Association (AEA) (2022). Innovation Outlook: Renewable Ammonia. Link

Beyond established fertiliser uses, green ammonia is opening new cross-sectoral applications:[2]

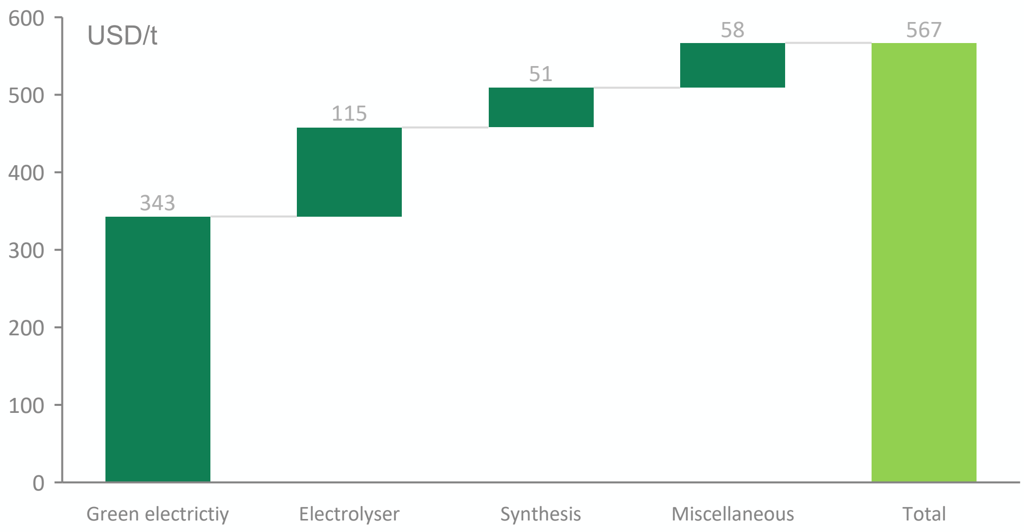
- **As an energy storage solution and hydrogen carrier:** with higher energy content than hydrogen and lower ignition risks, transporting and storing green ammonia is more cost-efficient than doing so with hydrogen.
- **In power generation:** Countries like Japan are testing ammonia co-firing in coal power plants to reduce emissions, similar to the ongoing development of hydrogen co-firing in gas power plants.
- **In maritime shipping:** where its high energy content makes it a leading candidate for decarbonising merchant fleets, with several companies already investing in its potential as a future fuel

Green ammonia production paths

Hydrogen-based green ammonia

Hydrogen-based green ammonia is primarily produced through water electrolysis, followed by ammonia synthesis using the Haber-Bosch process. The technology requires high capital expenditure, with renewable energy sources accounting for about 60% of the total investment and electrolysers representing around 20%. To illustrate this cost breakdown, Figure 2 presents an estimate of average ammonia production costs in Australia in 2030, using a combination of on-site solar PV and wind power generation.[8] Limited renewable energy availability may increase the need for hydrogen storage, potentially raising production costs by an additional USD 35–150 per tonne.

Figure 2: Levelized costs of hydrogen-based green ammonia in 2030



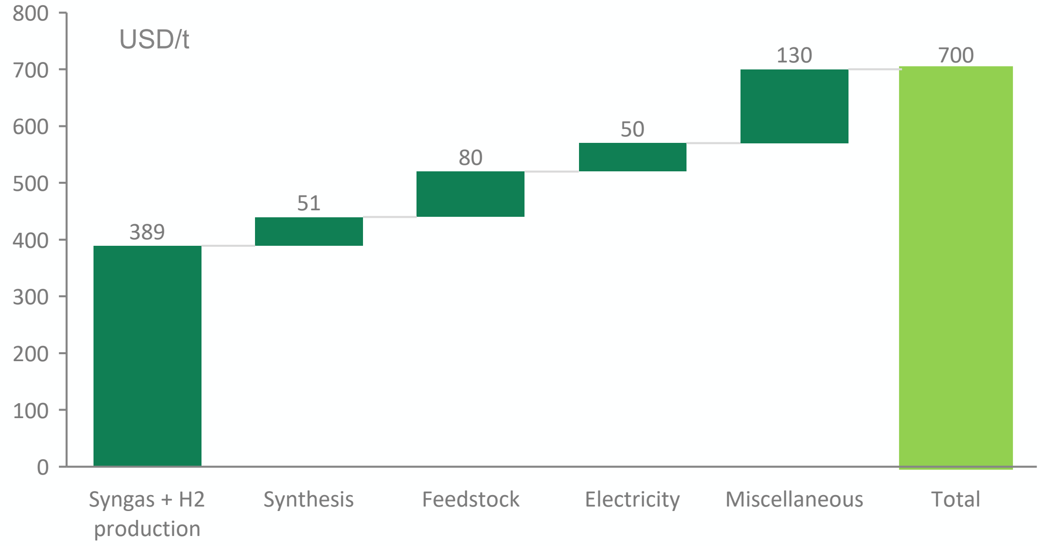
Source: Egerer et al. (2023). Note: cost considerations for 2030 in a renewable-rich area with low cost of capital

[8] Egerer, J., Grimm, V., Niazmand, K., & Runge, P. (2023). The economics of global green ammonia trade – "Shipping Australian wind and sunshine to Germany." Applied Energy, 334, 120662. Link

Biomass-based green ammonia

Biomass-based ammonia production can be particularly relevant in areas with abundant agricultural and forestry residues that can serve as feedstock. For this, different feedstocks can be used, such as straw, corn stover, rice husks, and forestry residues.[9] Such projects are especially relevant in regions with established biomass industries, as is the case in Ukraine. This production route involves gasifying biomass into a hydrogen-rich syngas[10] and then feeding it to Haber–Bosch synthesis stage to produce green ammonia.

Figure 3: Levelized cost of biomass-based green ammonia



Source: Arora et. al. (2017)

Straw-based ammonia production, which is particularly relevant for Ukraine, is estimated at around USD 700 per tonne. S&P estimates that, if produced domestically, this would make it approximately 15 to 25 percent cheaper than importing green ammonia from high-RES potential areas today.[11] Of this cost, roughly 55% is attributed to the production of syngas and hydrogen. Since biomass-based production of syngas is a mature technology, cost reductions are not expected to be as significant as those for electrolysis. As a result, it is anticipated that straw-based ammonia will eventually be outperformed by hydrogen-based ammonia. A cost breakdown of straw-based ammonia is provided in Figure 3.

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[9] Arora, P., Hoadley, A., Mahajani, S., & Ganesh, A. (2017). Multi-objective optimization of biomass-based ammonia production: Potential and perspective in different countries. Journal of Cleaner Production, 148, 1–15. Link

[10] There are multiple established pathways for producing syngas through gasification. This paper bases its price references exclusively on the widely used double fluidised-bed gasification process.

[11] S&P. (2025). Platts ammonia price chart [Graph]. Retrieved from Link

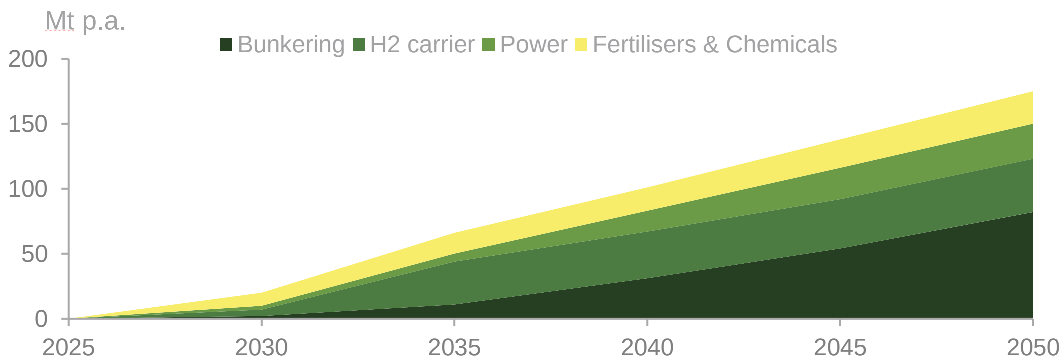
05. Global developments in green ammonia

Market outlook

Rising global demand for green ammonia

Currently, demand for green ammonia remains limited. High production costs, driven by maturing electrolyser technology, uncertainty and the absence of established markets, along with many projects still in the early stages or yet to reach final investment decisions, make green ammonia non-competitive in terms of cost for the time being. However, global decarbonisation efforts are expected to drive a significant expansion in demand over the coming decades. According to S&P estimates,[12] global demand for clean ammonia[13] could reach around 20 million tonnes per year by 2030 and rise to about 175 million tonnes by mid-century. By that time, around 30-35% of production is expected to be directed to export markets, while 65-70% is expected to serve the domestic markets at the point of production.[1]

Figure 4: Projected demand for clean-carbon ammonia



Source: S&P (2025).

Demand for clean ammonia is projected to evolve differently across applications over time. In the near term, it will be driven primarily by fertilisers, accounting for about 50% of total use, followed by hydrogen carriers at 25%, power generation at 15%, and bunkering at 10%. By mid-century, this composition is projected to shift, with bunkering accounting for 47% of demand, hydrogen carriers

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[12] Georgy Eliseev (2024). The Ammonia Market Today and a Bridge to the Future. Fertecon / S&P Global Commodity Insights, 2024 Annual Conference, November 11–13. Link

[13] The term "clean ammonia" encompasses both green and blue ammonia. S&P's statistics do not differentiate between the two, as the development of CCSU and purely renewable-based approaches remains competitive and uncertain across countries.

25%, power generation 15%, and fertilisers only 14%. Figure 4 illustrates the projected shares of clean ammonia use from now until mid-century.[5]

Green ammonia's competitive price shift

Currently, the production cost of green ammonia is two to three times higher than that of grey ammonia,[14] mainly due to the electrolyser costs and, in regions with less competitive renewable energy, higher power costs. However, the economic case of green ammonia is projected to significantly improve in the decades to come.

Key drivers of this shift include:

- **Electrolyser technology improvements:** Global electrolyser prices have fallen by more than 70% since 2015 and are projected to drop a further 60% by 2030 as manufacturing capacity scales up and efficiency increase.[15]
- **Falling renewable power costs:** Levelized costs of solar PV and onshore wind have decreased by roughly 80% and 60%, respectively, since 2010. Continued expansion of renewables will directly reduce the cost of hydrogen and, consequently, green ammonia.[16]

In countries with strong renewable energy potential, production costs are expected to fall to between USD 310 and USD 610 per tonne by mid-century, roughly aligning with the current cost of grey ammonia.[1]

The competitiveness of green ammonia can be further enhanced by a variety of tools, including carbon pricing, emissions policies and strategic subsidies. In regions with strong policies incentivising industrial decarbonisation, green ammonia will become competitive sooner. The European Union is leading this transition.

By some estimates, rising EU ETS prices[17] and falling green ammonia costs could result in both falling within the same price range by the end of the decade in the European Union.[18] As production costs decline and carbon prices rise, grey ammonia could become roughly twice as expensive as green ammonia by 2050. Figure 5 illustrates the expected price trends for both green and grey ammonia from 2020 to 2050, as well as the cost effects of carbon pricing in the EU.

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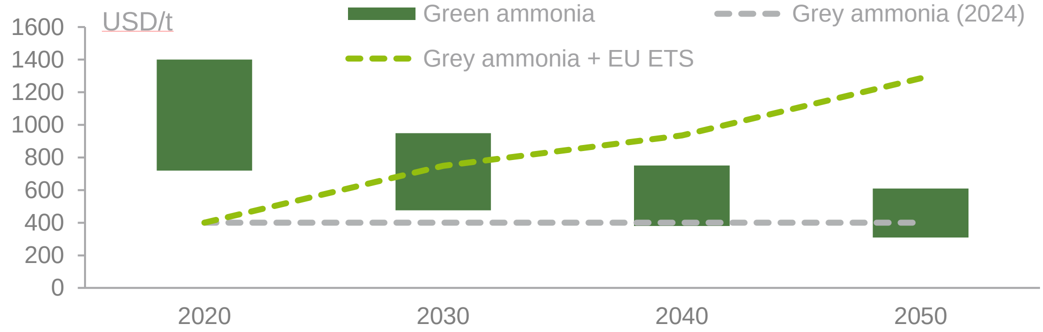
[14] Cost comparison from a purely technical perspective, assuming the same Weighted Average Cost of Capital (WACC).
[15] International Energy Agency (IEA) (2023). Global Hydrogen Review 2023. Link
[16] International Renewable Energy Agency (IRENA) (2022). Green Hydrogen Cost Reduction: Scaling up Electrolysers to Meet the 1.5˚C Climate Goal. Abu Dhabi: IRENA. Link
[17] Pahle, M., Quemin, S., Osorio, S., Günther, C., & Pietzcker, R. (2025). The emerging endgame: The EU ETS on the road towards climate neutrality. Resource and Energy Economics, 81, 101476. Link
[18] Considering the price developments of green ammonia from IRENA (2022) and the central scenario of EU ETS prices from Pahle et al. (2025).

Figure 5: Projected price developments of green ammonia

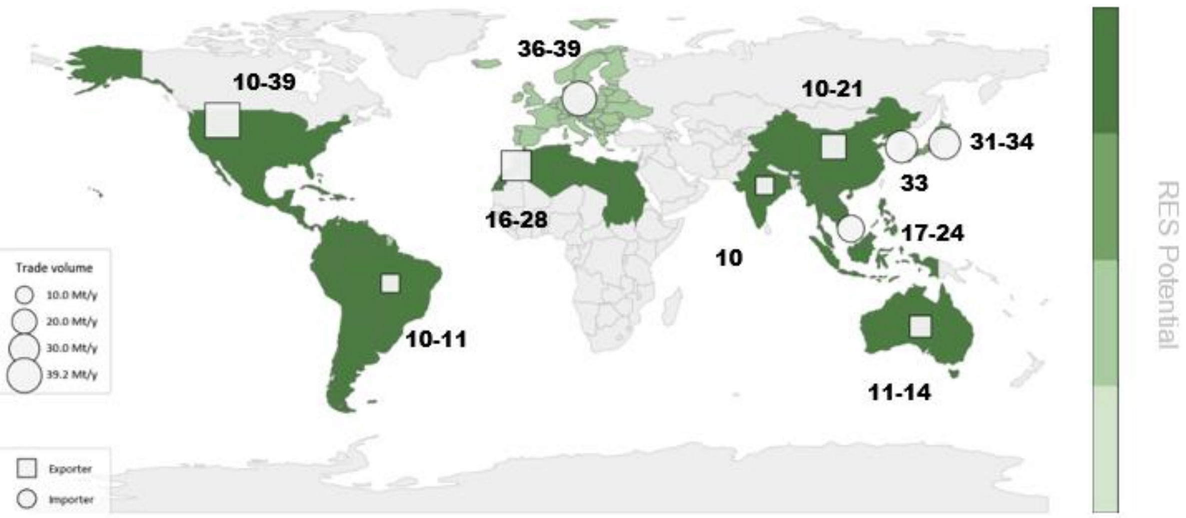


Source: IRENA (2022), IEA (2021), S&P (2025), Pahle et. al. (2025). Author's calculations.

The multifaceted drivers of future green ammonia trade

Several factors will shape green ammonia trade in the coming decades.[3] Renewable energy potential is the most important factor in determining whether a geographical region will become an importer or exporter. However, other elements also significantly influence a country's position in the green ammonia market.

Figure 6: Major exporters and importers of green ammonia by 2050



Source: Own illustration based on IRENA (2025). The potential for green hydrogen and related commodities trade.

Export countries are expected to be the USA, China, and North African nations, influenced by factors such as:

- **Strong resource base**, including abundant high-quality renewable energy, fresh water, and land availability
- **Access to capital and affordable financing** enable competitive production and scale production capacity
- **Market access** influenced by geographical and regulatory proximity to major demand centers
- Governmental support providing stable regulation, and targeted subsidies directed at enhancing export competitiveness in the initial stages

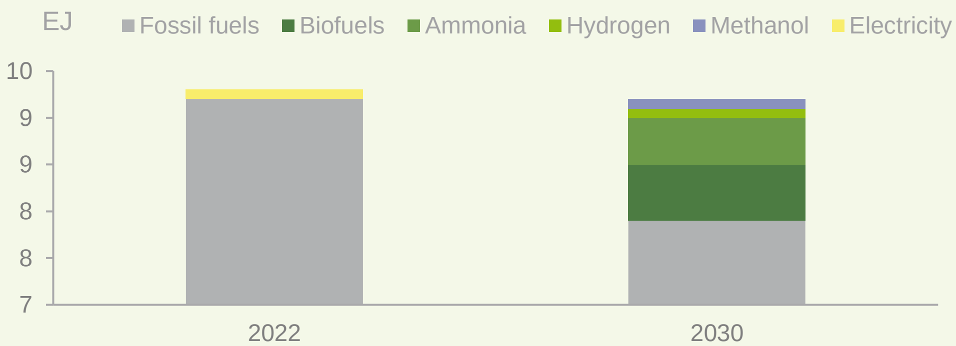
Importing countries are expected to be primarily in Europe and East Asia, with key influencing factors including:

- **Strong demand for low-carbon goods**, driven by decarbonisation and energy and food security objectives
- **Industrial demand and infrastructure capacity**, especially in fertiliser, chemical, and shipping sectors with established import, storage, and distribution networks
- **Robust policy frameworks** providing price signals alongside risk-sharing mechanisms for long-term offtake agreements

Info Box 1: Cross-sectoral applications: Maritime fuel

Ammonia is gaining attention as a fuel for decarbonising shipping. It has high energy density, contains no carbon, and can be handled using existing infrastructure with safety adjustments. The IEA estimates that it could account for about 5% of total maritime fuel use by 2030,[19] as shown below. Further decarbonisation in the sector is expected to be driven by biofuels (6%) (e.g. biomethanol and biomethane), and hydrogen (1%) and e-methanol (1%) 6% of in the sector is expected to be decarbonised via biofuels, including bioethanol and biomethane

Energy consumption in international shipping by, 2022 vs 2030



Source: IEA (2023). Net Zero Scenario

Demand for low-carbon maritime fuel is currently driven by the European Union. The EU Emissions Trading System (EU ETS) requires ships to fully cover their emissions, and vessels arriving at or departing from EU ports required to cover 50% of the emissions corresponding to the entire voyage.[20] This system will fully phaseout free allowances by 2026, further increasing the cost of fossil-based fuels and strengthening the case for switching to green fuels.

In the short-term e-methanol is emerging as a strong competitor of green ammonia. While not yet reflected in IEA's projections, recently dual-fuel vessels running on e-methanol and conventional marine fuels have attracted the interest of shipping companies, as they

[19] International Energy Agency. (2023). Energy consumption in international shipping by fuel in the Net Zero Scenario, 2010–2030 [Data chart]. Link
[20] European Parliament & Council of the European Union. (2023). Directive (EU) 2023/959 amending Directive 2003/87/EC on the EU Emissions Trading System. Official Journal of the European Union, L 130. Link

provide a cost-effective way to reduce emissions in the short term without fully depending on a still-nascent technology, since they can alternate between the two fuel types.[21]

In the long-run green ammonia is still considered essential for achieving full decarbonisation of the maritime sector. Since sustainable e-methanol production depends on Direct Air Capture, a costly technology, blue e-methanol produced with CCS remains the most common type in use, though it still entails some emissions.[22] Achieving full decarbonisation of the shipping industry will therefore require net zero fuels such as green ammonia, which are expected to become viable once production costs decline.[23]

The interlink between geopolitics and green ammonia

The development of the global green ammonia sector has broad implications, impacting agriculture, energy security, and geopolitics. Its potential to enhance food security and diversify energy sources adds new benefits and therefore also arguments to the shift away from fossil fuels. Additionally, green ammonia could alter global influence, with countries potentially transitioning from importers to exporters. Policy regulations will also play a crucial role, strongly affecting the competitive positioning of countries within regions.

Enhancing food security

Fertiliser access is a significant geopolitical issue. The 2022 rise in global food prices demonstrated the vulnerability of fertiliser supply chains,[24] particularly following disruptions in ammonia production and exports due to the Russian invasion of Ukraine.[25] Green ammonia offers a reliable, zero-carbon alternative that can help mitigate these risks by:[26]

- Providing a sustainable and localised fertiliser source
- Reducing reliance on international supply chains
- Insulating farmers from global shocks and market volatility

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[21] Wissner, N., Healy, S., Cames, M., & Sutter, J. (2023, March). Methanol as a marine fuel: Advantages and limitations. Öko-Institut e.V., Berlin. Link
[22] International Renewable Energy Agency (IRENA) & Methanol Institute. (2021). Innovation Outlook. Abu Dhabi: IRENA. Link
[23] Kumar, R., Sebe, M., Yao, F., Virto, L. R., Salo, K., Al-Hajjaji, S., Booge, D., Marandino, C., Matz-Lück, N., & Rutgersson, A. (2025). Shipping fuel pathways in a changing climate: A prospective foresight study for 2050. Marine Policy, 182, 106868. Link
[24] World Bank Group (2022). Commodity Markets Outlook: The Impact of the War in Ukraine on Commodity Markets, April 2022. Washington, DC: World Bank. Link
[25] Jones, D., & Deuss, A. (2024). Understanding the resilience of fertiliser markets to shocks: An overview of fertiliser policies (OECD Food, Agriculture and Fisheries Paper No. 208). OECD Publishing. Link
[26] Quitzow, R., Balmaceda, M., & Goldthau, A. (2025). The nexus of geopolitics, decarbonization, and food security gives rise to distinct challenges across fertilizer supply chains. Link

Enabling energy resilience through diversification

Beyond its role in agriculture, green ammonia is key to improving global energy security by:[27]

- Acting as an efficient hydrogen carrier, enabling long-distance energy trade and supporting the integration of renewable energy into global markets
- Reducing reliance on imported fossil fuels, mitigating exposure to price volatility
- Strengthening national and regional energy resilience by diversifying energy portfolios

Contributing to shifts in global influence

The rise of green ammonia could shift the global energy balance, particularly as countries with abundant renewable resources, such as solar and wind, emerge as major exporters. This shift will have wide-reaching geopolitical implications, including:[15]

- Redistribution of influence away from traditional fossil fuel exporters
- Formation of new strategic partnerships focused on green energy trade and technology transfer
- Potential for changes in global diplomatic relations and power dynamics16

Spurring regulatory and standard alignment

As the EU positions itself as the main demand centre, alignment with its regulatory frameworks is becoming increasingly important. Particularly relevant for green ammonia are the Carbon Border Adjustment Mechanisms (CBAM) and the third version of the Renewable Energy Directive (REDIII) standards that determine how emissions from industrial goods are measured and priced.[28] [29]

- Carbon Border Adjustment Mechanism (CBAM): This framework sets carbon pricing for ammonia and fertiliser imports, applying to products with high embedded emissions starting in 2026.
- Renewable Energy Directive (RED III): Defines criteria for recognising Renewable Fuel of Non-Biological Origin, exempting them from carbon pricing in the EU.

The implications for green ammonia are clear: countries that align their standards with those of the EU from the outset will gain significant advantages in accessing this key market. From a broader geopolitical perspective, such regulatory alignment enhances long-term cooperation, strengthens trade relationships across sectors, and improves a country's ability to attract investment and technology transfer.

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[27] Eicke, L., & De Blasi, N. (2022, October). The future of green hydrogen value chains: Geopolitical and market implications in the industrial sector. Environment and Natural Resources Program, Belfer Center for Science and International Affairs, Harvard Kennedy School.

[28] European Parliament and Council of the European Union. (2023). Regulation (EU) 2023/956 … establishing a carbon border adjustment mechanism. Official Journal of the European Union, L 130, 52–104. Link

[29] European Commission. (2024). Guidance on the targets for the consumption of renewable fuels of non-biological origin in the industry and transport sectors laid down in Articles 22a, 22b and 25 of Directive (EU) 2018/2001 on the promotion of energy from renewable sources, as amended by Directive (EU) 2023/2413 (C/2024/5042). Publications Office of the European Union. Link

Info Box 2: Germany's demand for hydrogen and ammonia

Germany is poised to become a leading demand centre for green fuels. The country's goal of achieving climate neutrality by 2045 will require large volumes of green hydrogen and its derivatives, as outlined in the German National Hydrogen Strategy.[30]

Importing green hydrogen will be crucial to economically decarbonise Germany's large industrial base. With limited land and weather conditions constraining renewable energy expansion, Germany is expected to import around 70% of its hydrogen needs after 2030.[31] Cheaply produced green fuels from abroad will be vital to power industry while phasing out fossil fuels. Hydrogen demand is projected to reach 95–130 TWh by 2030 and 360–500 TWh by 2045, with an additional 200 TWh potentially required for derivatives such as ammonia.[21]

Ammonia is increasingly favoured as an import option. It is considered a strong energy carrier because it is easier to transport than liquid hydrogen and already benefits from a well-established logistics chain.

Infrastructure development is central to Germany's hydrogen transition. Terminals in Brunsbüttel and Wilhelmshaven are being adapted to handle ammonia and hydrogen imports,[21] while international hydrogen partnerships with Canada,[32] Namibia, Saudi Arabia, and Australia aim to secure future supply corridors.

For Ukraine, Germany represents a strategic demand hub for green hydrogen and ammonia in Europe. Geographic proximity, existing infrastructure links, and the broader EU integration agenda create opportunities for cooperation and export alignment.

[30] Federal Ministry for Economic Affairs and Climate Action (BMWK) (2020). Die Nationale Wasserstoffstrategie. Berlin: BMWK. Link

[31] Federal Ministry for Economic Affairs and Climate Action (BMWK) (2024). Import Strategy for hydrogen and hydrogen derivates. Berlin: BMWK. Link

[32] Federal Ministry for Economic Affairs and Climate Action (BMWK) (2022). Joint Declaration of Intent between the Government of the Federal Republic of Germany and the Government of Canada on establishing a Germany-Canada Hydrogen Alliance. Berlin: BMWK. Link

International project experience

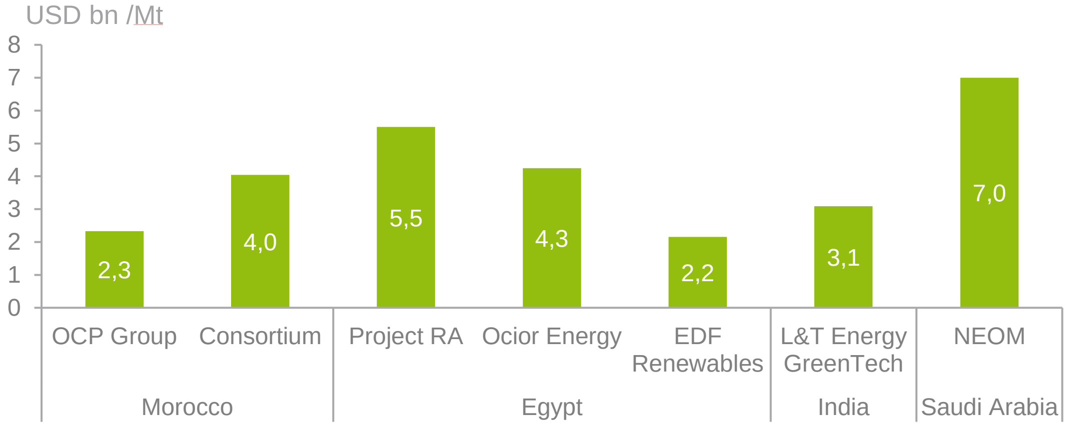
Global investments in green ammonia are beginning to accelerate.[33] Several projects are being announced in countries geographically close to Europe, such as Saudi Arabia, Oman, Egypt, and Morocco, many of which are targeting European markets. In Asia, China and India are also announcing several projects for mainly for domestic and regional demand. While Australia and South American countries target exports to both Asian and European markets.

Below, selected countries with relative proximity to the European Union, where significant green ammonia investments are occurring, are analysed to provide benchmark of announced production capacities, project cost ranges, and government incentives driving these developments.

Significant variations in investment costs

Investment costs range from USD 2.2 to 7 billion per million tonnes of capacity. Variation between projects is expected due to differences in economies of scale, renewable energy mix, financing terms, and government support. However, the significant variation, with a twofold difference in the most extreme case, signals that the technology and market are still evolving. This results in uncertainty between announced investment costs and the actual costs incurred.

Figure 7: Investment cost of selected projects



Source: Njovu, G. (2025, June 13), Atchison, J. (2024, December 12), Atchison, J. (2025, August 1), Atchison, J. (2025, August 18), Atchison, J. (2024, July 15), SIEMENS (n.d.), OCI (n.d.). The above-mentioned projects are announced projects, except for NEO, which is in the construction phase.

The relevance of policy support

All these countries are unlocking investments in green ammonia through policy support, yet remarkably without relying on direct subsidies. A combination of tax and customs incentives, land and infrastructure concessions, and regulatory and market enablers were identified as the main policy tools used by the respective governments.

[33] Ammonia Energy Association. (2025, August). LEAD: Low-emission ammonia plants. Ammonia Energy Association. Link

Table 1: Policy support for developing green ammonia projects in selected countries[34]

	Morocco[35] [36]	Egypt[37] [38] [39]	India[40]
Announced capacity	3.2 Mt p.a.	4.7 Mt p.a.	4.2 Mt p.a.
Tax & custom incentives	Tax breaks	Tax breaks, VAT removal for exports, SCZ*	SCZ*, custom exemptions
Land & infrastructure	Land allocation, fast-tracked gov. approvals	Port fee concessions	Waived grid fees, port-based hubs
Regulatory and market enablers	N/A	N/A	Off-take contracts, green certification

Source: Njovu, G. (2025, June 13), Atchison, J. (2024, December 12), Atchison, J. (2025, August 1), Atchison, J. (2025, August 18), Atchison, J. (2024, July 15), SIEMENS (n.d.), OCI (n.d.). *Note: Special Custom Zones (SCZ)

Info Box 3: Green ammonia developments in Europe

Green ammonia production in Europe is starting to take off. Currently, there are five operational commercial-scale green ammonia projects in Europe. These projects have an aggregated installed capacity of 104 kt of green ammonia p.a.

Costs have been steadily decreasing. Newer plants show investment costs per kiloton of installed capacity at around half the level of Iberdrola's first commercial project in 2022, reflecting growing efficiency and technological improvements in RE and electrolyser manufacturing.

Government backing has been crucial for green ammonia projects in Europe. To reduce risks and production costs, BASF received 83% public financing for its project, while Yara, and the Topsoe–Vestas–Skovgaard consortium each obtained about 40% in public funding.

[34] Saudi Arabia was excluded from the policy support analysis, as no publicly accessible information could be identified.
[35] Njovu, G. (2025, June 13). RFNBO pre-certification for Morocco-based renewable ammonia project. AmmoniaEnergy.org. Link
[36] Atchison, J. (2024, December 12). Project Dhakla: one million tons per year from Morocco. AmmoniaEnergy.org. Link
[37] Atchison, J. (2025, August 1). ACME: $641 per ton for renewable ammonia in India. AmmoniaEnergy.org. Link
[38] Atchison, J. (2025, August 18). Larsen & Toubro, ITOCHU: renewable ammonia in Kandla. AmmoniaEnergy.org. Link
[39] Atchison, J. (2024, July 15). $37 billion in Egyptian ammonia investments. Link
[40] SIEMENS (n.d.). Siemens Energy joins Project Ra. AmmoniaEnergy.org. Link

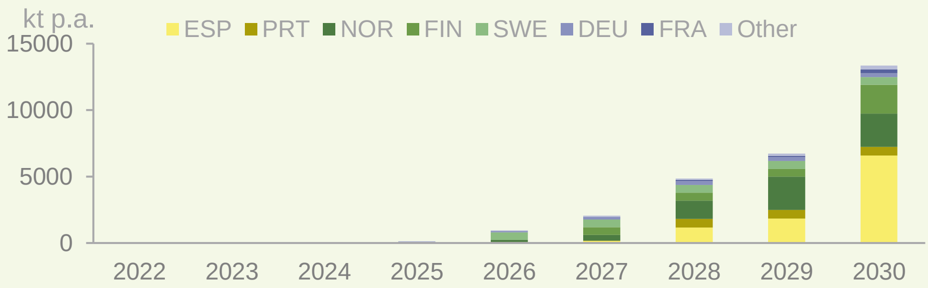
Commercial-scale green ammonia projects operational in Europe as of 2025[41 42 43]

Company	Online since	Country	Capacity (kt NH3/y)	Investment (EUR m)
Iberdrola	2022	ESP	17	150
YARA	2024	NOR	20	60
Topsoe, Vestas & Skovgaard	2024	DNK	5-10	27
BASF	2025	DEU	45	149
Maxam	2025	ESP	12	N/A

Source: Ammonia Energy Association (2025), IEA (2025)

Green ammonia production in Europe is set to expand further. Installed capacity could reach around 13,000 kt per year by 2030, with growth largely driven by countries in the Iberian Peninsula (ESP and PRT), benefiting from excellent solar and wind conditions, and Nordic countries (NOR, SWE and FIN), leveraging its extensive hydropower resources.

Pipeline of commercial-scale green ammonia projects operational in Europe[44]



Source: Ammonia Energy Association (2025), IEA (2025)

However, imports of green ammonia will remain essential for meeting decarbonisation goals. The EU 27, EEA countries (ISL, LIE and NOR) and the UK consume nearly 20,000 kt of ammonia,[45] around 6,000 kt more than the production capacity expected from announced projects. Because many announced projects may not reach completion and new uses for green ammonia are likely to grow, Europe will still need significant imports to fully decarbonise ammonia consumption in line with mid-century climate targets

[41] Ammonia Energy Association (2025) LEAD: Low-Emission Ammonia Plants. Link
[42] International Energy Association (2025) hydrogen production projects data base. Link
[43] Note: Investment figures are based on information published by the respective companies or financing institutions
[44] Note: Only projects with completed feasibility studies and announced expected commissioning
[45] International Fertilizer Association (2025). IFASTS portal. Link

06. Ukraine's conventional ammonia value chain

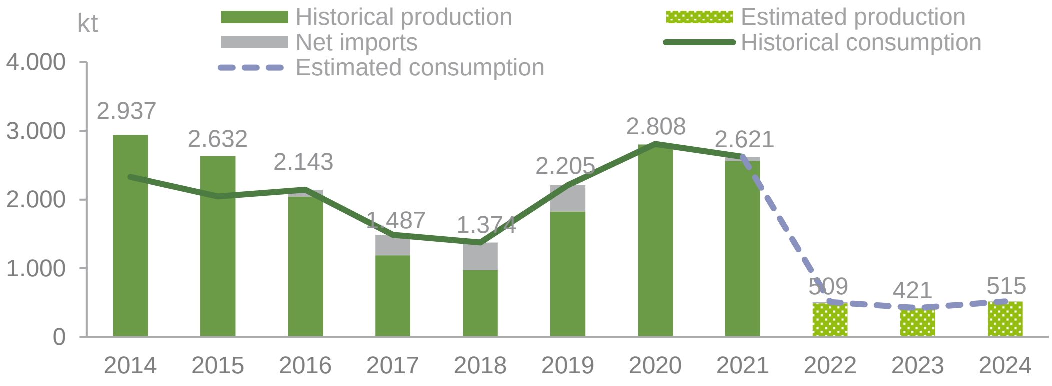
Ammonia production

Regional and global relevance of Ukraine's ammonia sector

Ukraine's ammonia sector has long played a pivotal role in both regional and global markets. A decade ago, the country was not only a net exporter of domestically produced ammonia but also one of the most important transit routes for Russian ammonia, handling roughly 15–18% of global ammonia exports.[46] The sector experienced a downturn between 2016 and 2019 due to rising gas costs and low fertiliser prices but recovered afterwards and was again on a solid footing on the eve of the war. By that time Ukraine was no longer exporting ammonia, yet the sector remained highly significant, as domestic production met a large share of agricultural demand.

The war brought an end to Ukraine's role as a transit corridor and led to a sharp decline in domestic ammonia production. These disruptions had Europe-wide repercussions for the ammonia value chain, as Ukraine was the EU's fourth-largest supplier of agricultural goods, accounting for about 7% of total agri-food imports in 2021.[47] Today, Ukraine's ammonia production sector is still functioning despite the war, but it has been severely affected financially. Figure 8 illustrates the evolution of Ukraine's ammonia sector over the past decade.

Figure 8: Historical ammonia production volumes



Source: Author's calculations based on UKRSTAT and UNCOMTRADE data (2025)

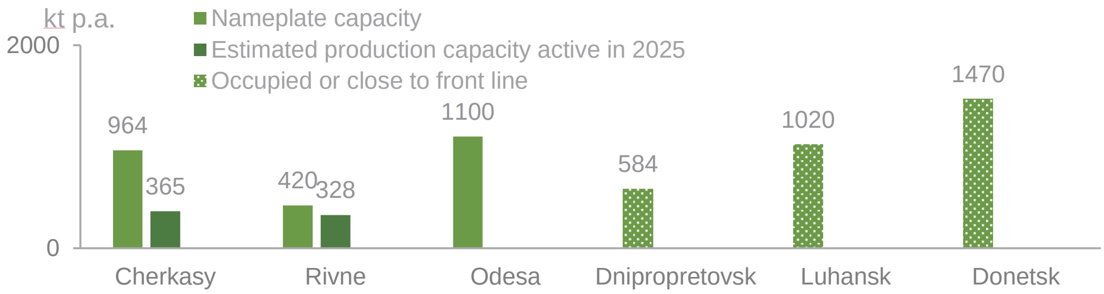
[46] UN Comtrade Database [Data set]. Retrieved October 23, 2025, from Link Author's calculations
[47] Régnier, E., & Catallo, A. (2024, June). The Ukrainian agricultural sector: An overview and challenges in light of possible European Union enlargement (IDDRI Study No. 03). IDDRI. Link

Past and current ammonia infrastructure in Ukraine

Ukraine's total installed ammonia production capacity amounts to around 5.6 million tonnes per year, which, at full utilisation rate, would account for roughly 3.6% of global output.[48] In 2025, however the war has had dire repercussions on the sector. Today, only two of the six major production facilities remain operational, with a combined active capacity of about 0.8 million tonnes per year accounting for just 14% of the installed base. A further 2.2 million tonnes (41%) are idle, while 2.5 million tonnes (45%) are either damaged or situated in occupied territories.

Currently, there are only two active facilities. The Cherkasy plant with an active capacity of 365 kilotons per year, or 38% of its original capacity. And the Rivne is operating at estimated 328 kilotons per year, or 78%. The plants in Odesa and Dnipropetrovsk are idle because of ageing infrastructure and high input costs, while those in Luhansk and Donetsk are in occupied territories. Figure 9 shows the nameplate and currently utilised capacity of ammonia production plants in Ukraine.[49]

Figure 9: Past and current ammonia production capacity



Source: Adapted from Ivanenko, N. P., & Stanytsina, V. (2024).
Note: Estimated production capacity in March 2025, adapted from news articles.

Ammonia transport infrastructure in Ukraine is also significant. Before the war, the Togliatti–Odesa pipeline offered a cost-efficient transit route, enabling Russian ammonia exports to reach international markets through the Black Sea. With a capacity of around 2.5 million tonnes per year, it supplied exports through the Odesa terminal.[50]

The suspension of the pipeline and shipping terminal has had significant repercussions for global fertiliser supply chains.[51] Buyers in Europe, Africa, and other regions have had to shift to more distant suppliers, which increased costs and added to volatility in fertiliser markets.[52]

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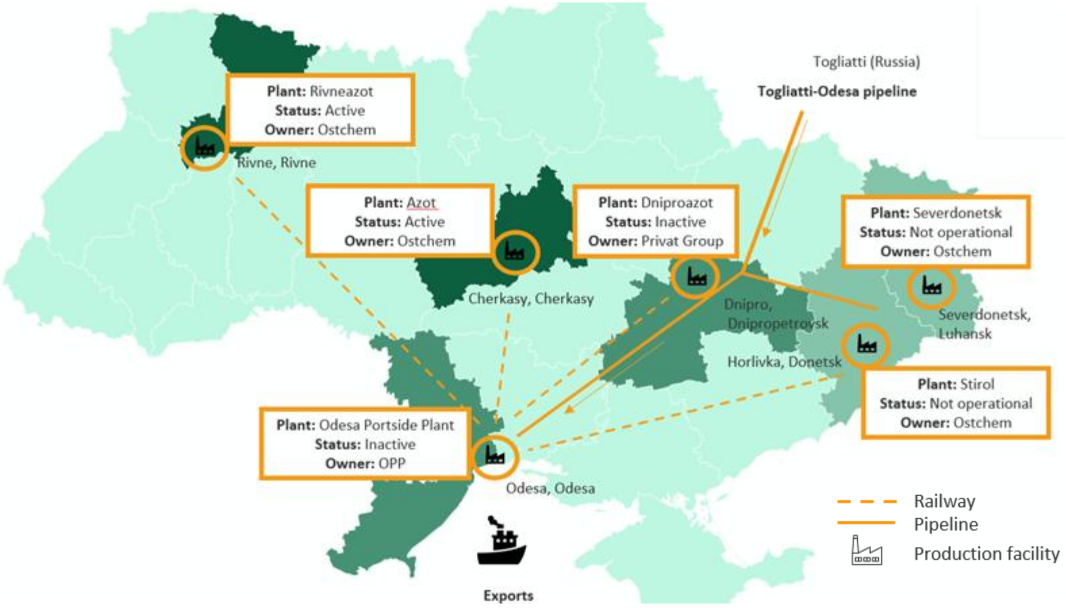
[48] U.S. Geological Survey. (2025, January). Mineral commodity summaries: Nitrogen (fixed) - Ammonia. U.S. Department of the Interior. Link
[49] Ivanenko, N. P., & Stanytsina, V. (2024, December). The postwar perspective of ammonia production in Ukraine. IOP Conference Series: Earth and Environmental Science, 1415(1), 012119. Link
[50] Reuters. (2023, June 7). Explainer: Why would pipeline damage threaten Black Sea grain deal? Reuters. Link
[51] World Grain (2023). Global fertilizer market remains unstable. World Grain, 27 July 2023. Available at: Link
[52] International Food Policy Research Institute (IFPRI) (2023). The Russia-Ukraine war after a year: Impacts on fertilizer production, prices, and trade flows. Available at: Link

Figure 10: Overview of ammonia infrastructure in Ukraine



Source: Author's elaboration based on a compilation of industry reports, information from official plant websites, and industry news

Fertiliser production as main downstream application

The interlink of fertiliser demand in Ukraine and global food security

Ukraine holds a strategic position in global agricultural production and trade, shaped by its vast land resources, fertile soils, and export-oriented crop mix. Before the full-scale invasion in 2022, Ukraine was widely regarded as one of the world's top ten agricultural exporters: 1st in sunflower oil, supplying nearly 50% of global exports; 3rd in barley exports; 4th in maize (corn) exports, accounting for 10–15 %of global trade; 7th-10th in wheat exports, with an average of 20–25 million tons annually.[53]

This agricultural output was not only central to national GDP (9-11% of GDP pre-war and 41% of Ukraine's total export revenues in 2021) but also to regional and global food security, as the country acted as a stabilising supplier in global grain and oilseed markets. This was particularly important for importing countries in the Middle East, North Africa, and South-East Asia.[54]

Such export-driven sector, given the projection of global population growth, requires maintaining or increasing crop production. By 2021, Ukraine's arable land area had already nearly approached its expansion limit, staying relatively stable in the last decade despite global agricultural commodity price increase, shifting the focus of agricultural growth toward yield improvement rather than land expansion.[55] For this, fertilisers play a crucial role.

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[53] ITC Trademap (2025). Database of trade at HS2-6 level. Available at: Link
[54] State Statistics Service of Ukraine (2025). Database on macroeconomic and trade indicators. Available at Link
[55] KSE Agrocenter (2023): Market Analysis and Outlook of Ukraine 2023. Available at Link

Fertilisers are essential for maintaining soil fertility and ensuring stable crop yields. The three primary macronutrient fertilisers - nitrogen (N), phosphorus (P), and potassium (K) - each play distinct roles in plant development and are applied in varying proportions depending on crop type, soil condition, and regional practices. An overview of the share of these fertilisers in total fertilizer use in Ukraine alongside the main fertilizer products can be seen in Table 2.

Table 2: Main fertilisers used in Ukraine

	Share in total weight of fertiliser use	Most common products
N fertilisers	70%	• Ammonium nitrate • Urea • Urea ammonium nitrate
P fertilisers	17%	• Superphosphate • Monoammonium phosphate (MAP) • Diammonium phosphate
K fertilisers	13%	• Potassium chloride (KCl) • Potassium sulphate (K_2SO_4)

Source: Author's elaboration based on FAOSTAT (2021)

Nitrogen fertilisers are the cornerstone of Ukraine's input structure. They promote leaf and stem growth, accelerate tillering in cereals, and enhance protein formation in grains. N fertilisers are widely used in major grain-growing regions, particularly in central, northern, and eastern oblasts, where wheat, barley, and maize dominate rotations.[56]

Phosphorus is vital for root development, seed formation, and energy transfer. Many Ukrainian soils, especially in the forest-steppe zone, are deficient in available phosphorus, making supplementation necessary to achieve optimal yields. P fertilisers are typically applied before planting or during early growth.[46]

Potassium enhances water retention, enzyme activity, and disease resistance, supporting plant stress tolerance. Ukrainian soils generally contain moderate to high natural potassium reserves, particularly in chernozem regions; however, intensive cropping gradually depletes these stocks.[46]

Growing application rates of nitrogen-based fertilisers

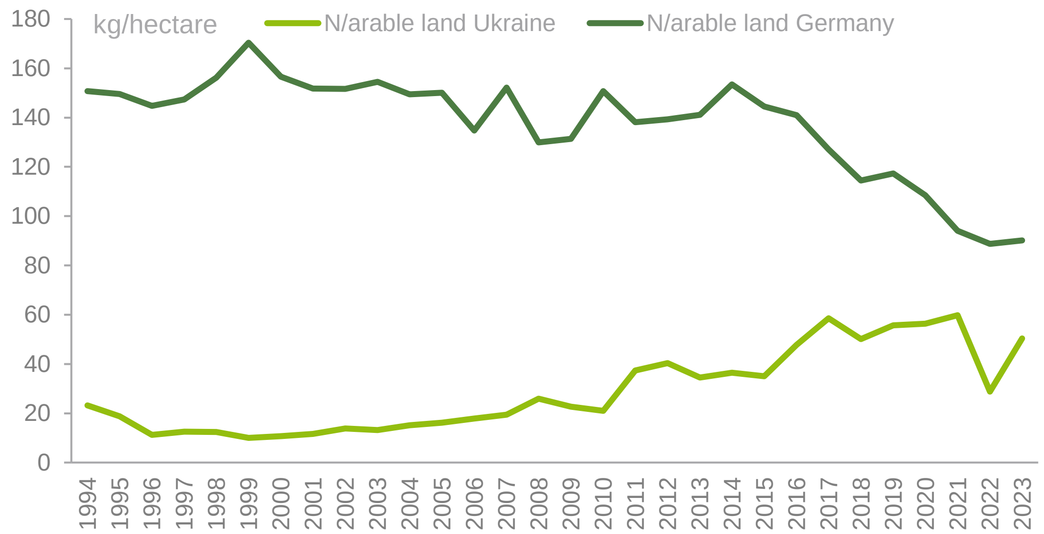
Fertilizer application rates have been steadily growing before the war. Ukrainian farmers applied on average around 60 kg of nitrogen per hectare in 2021, a nearly double increase since 2011. Although

[56] FAOSTAT (2021): Fertilizers by Nutrient (Country: Ukraine). Dataset providing annual fertiliser consumption by nutrient (N, P_2O_5, K_2O) for Ukraine. Available at: Link

this rate has been significantly lower than in the EU, e.g., 120 kg/ha in Germany, this trend reflected Ukraine's gradual shift toward more input-intensive, yield-oriented production systems.

The full-scale invasion in 2022, however, abruptly reversed this trajectory. Nitrogen application rates fell sharply as a result of reduced access to fertilisers, damaged logistics networks, high global input prices. Despite fertilisers remaining the dominant component of production costs, the surge in nitrogen prices in 2022, both globally and domestically, led farmers to cut back on application rates (Figure 11).[57][58]

Figure 11: Nitrogen-based fertiliser use on arable land



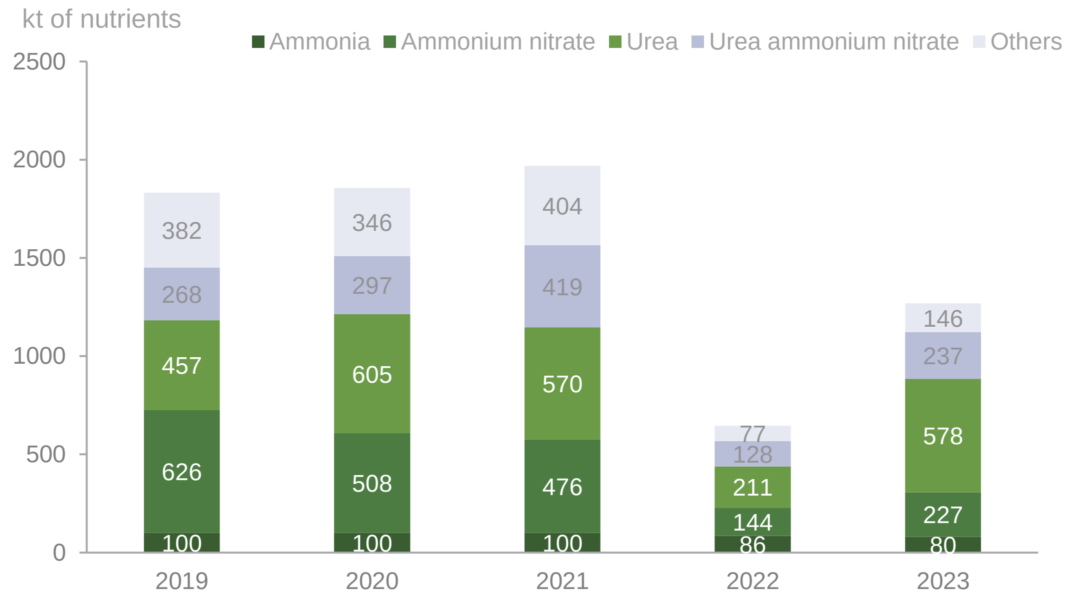
Source: Author's elaboration based on IFASTAT (2025), Ukrstat and GENESIS online da*ta(2025)*

In Ukraine, ammonium nitrate (AN) and Urea (N) are the dominant fertilizers (Figure 12), representing approximately 55-65% of total nitrogen use. Its continued prevalence is explained by its suitability for key grain crops. Urea accounts for an estimated 25-30% of consumption and has become more widely used over the past decade, owing to its high nitrogen concentration and relative affordability. Urea-ammonium nitrate (UAN) solutions comprise roughly 15-20% of nitrogen use, with adoption concentrated among capital-intensive farms equipped with modern liquid-fertiliser application systems.[46]

Between 2019 and 2021, total nitrogen fertiliser consumption in Ukraine remained relatively stable, supported by domestic output and robust agricultural demand. However, the full-scale war in 2022 caused a significant contraction in use, as the loss of arable land, damage to industrial facilities, and a sharp rise in global fertiliser prices limited both supply and affordability. Consumption partially recovered in 2023, aided by alternative import routes.

[57] IFASTAT (2025): Statistical database of International Fertilizer Association. Available at: Link
[58] GENESIS online (2025): GENESIS-Online. The database of the Federal Statistical Office. Available at: Link

Figure 12: Total nitrogen fertiliser consumption in Ukraine



Source: Author's elaboration based on IFASTAT (2025)

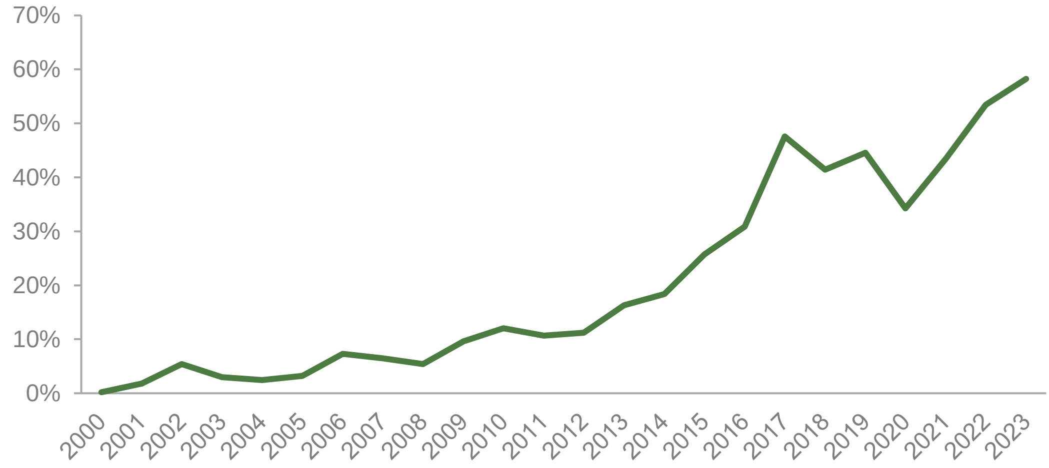
Disruptions in N fertiliser production and import dependency

Over the past two decades, the share of imports in total nitrogen supply has risen from less than 5% in the early 2000s to over 60% by 2023 reflecting a growing exposure to international markets. Steadily expanding agricultural crops production since early 2000s, following favourable policy conditions has pushed for increasing N fertilizer imports as domestic N production could not keep up. The situation has considerably worsened since 2014, when Russia occupied parts of Donetsk and Luhansk oblast and Ukraine faced gas price volatility and disrupted supply chains. In 2014-2016 import dependency rose 12.5 percentage points. By 2018-2019, imports reached 40-45 % of total supply.[46]

The full-scale invasion in 2022 triggered a major structural shock. Key nitrogen plants such as Severodonetsk Azot (OSTCHEM) ceased operations, while Odesa Port Plant faced prolonged shutdowns due to port blockades and gas supply instability. Although Cherkasy Azot (OSTCHEM), Rivne Azot (OSTCHEM), and DniproAzot maintained limited output, overall national nitrogen production fell and despite 22% decrease in cultivated arable land due to occupation and military action, the share of imports surged beyond 60% in 2023.[59] Figure 13 below illustrates the evolution of Ukraine's dependence on nitrogen fertiliser imports from 2000 to 2023.[45]

[59] OSTCHEM web-page, news. Available at: Link

Figure 13: Share of import in the total quantity of nitrogen fertiliser supplied to the domestic market



Source: Author's elaboration based on FAOSTAT data

The composition of import sources also changed significantly. Before 2022, Ukraine relied heavily on supplies from Belarus – 44% of the total imports (the respective trade ties with Russia broke in 2014). The remaining 56% were distributed among EU, Central Asian and Middle Eastern producers, with Poland and Uzbekistan taking 27% and 20% of the total imports, respectively.[60]

To summarise, Ukraine's fertiliser demand has been fundamentally reshaped by its export-oriented agriculture, limited land expansion, and the impacts of war. It remains structurally strong, but externally dependent. EU integration will bring stricter nutrient limits under the Nitrates Directive and the EU Green Deal. These frameworks are expected to impose stricter controls on nutrient management and could limit the growth of nitrogen fertiliser use by up to 20%, potentially reducing average nitrogen application rates from around 60 kg/ha in 2021 to 48 kg/ha, levels last observed in 2016. While such a reduction could constrain short-term yield growth, compliance could drive the adoption of more efficient and environmentally sustainable fertilisation practices, including precision agriculture, site-specific nutrient management, and innovative fertiliser formulations such as green ammonia-based e-fertilisers. Over time, these adjustments are likely to improve nutrient-use efficiency, reduce emissions, and align Ukrainian agriculture with EU sustainability benchmarks.

[60] ITC Trade map (2025). Database of trade at HS2-6 level. Available at: Link

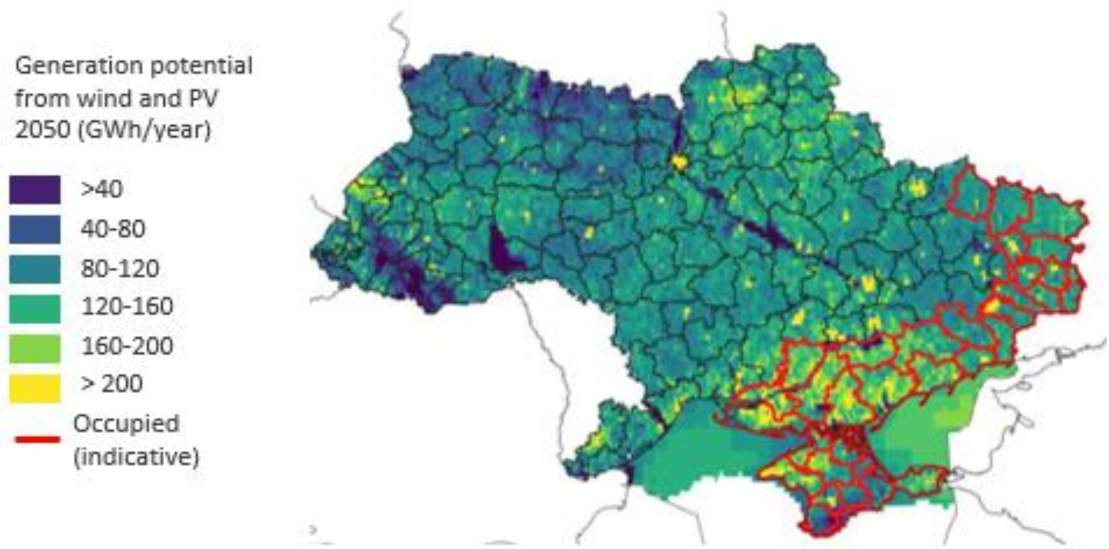
07. Assessing Ukraine's green ammonia potential

Resource base

Renewable energy

Ukraine has significant renewable energy potential. The country's economically feasible generation potential is estimated at up to 2100 TWh per year.[61] High solar irradiation, particularly in the southern and southwestern regions, makes these areas especially suitable for large-scale photovoltaic deployment. In addition, Ukraine has strong wind resources, particularly along the Black Sea coast and in steppe areas, which add substantially to the overall renewable potential. Large tracts of available land outside densely populated areas further support opportunities for solar and wind deployment. However, many of the most renewable-rich regions are currently occupied, limiting the immediate availability of sites for development. Figure 14 provides a geographical overview of solar and wind deployment potential in Ukraine, alongside an illustrative indication of the zones most affected by the war.

Figure 14: Renewable energy potential



Source: Fraunhofer ISI/HYPAT (2023) Ukrainian hydrogen export potential

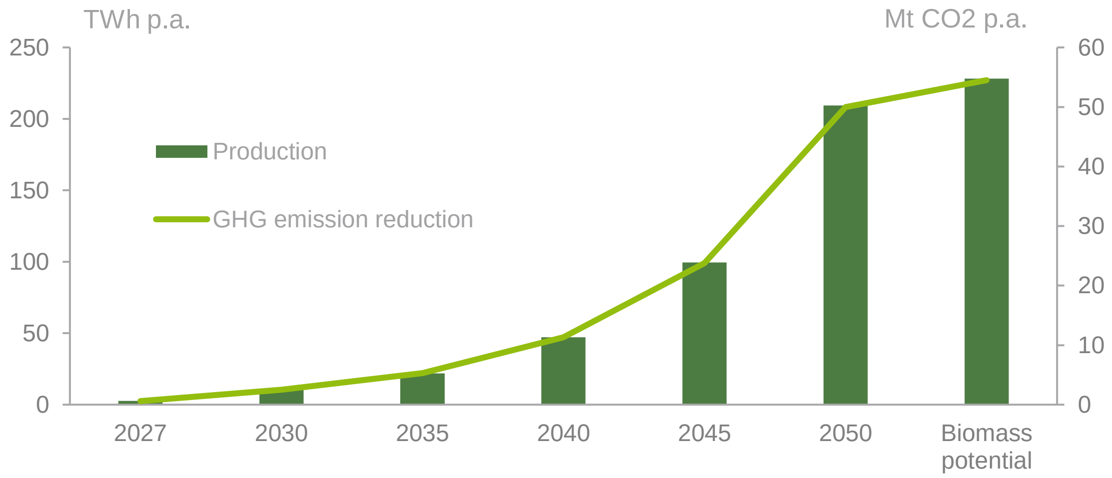
[61] HYPAT (2023). Ukrainian Hydrogen Export Potential: Opportunities and Challenges in the Light of the Ongoing War. HYPAT Working Paper 04/2023. Berlin: Fraunhofer ISI, Fraunhofer IEG, and Fraunhofer ISE. Link

Biomass

Biomass, the second most common green ammonia production pathway, is well developed in Ukraine. With the eighth largest agricultural sector in Europe,[62] Ukraine produces substantial volumes of solid biomass, reaching around 16.2 million tons (equivalent to 4.2 million tons of oil equivalent) in 2021, primarily from agricultural residues and wood biomass.[63] Biomass currently dominates Ukraine's renewable heat generation, accounting for nearly all renewable thermal output, though total installed capacity of the 68 biogas and 24 biomass plants remain relatively modest at 213 MW.[64]

While the biomethane (upgraded biogas) sector in Ukraine is still nascent, the high availability of raw materials combined with increasingly ambitious national decarbonisation goals has sparked growing interest in its development. Some estimates suggest that biomethane production could reach 210 TWh per year by 2050,[65] representing around 35 percent of Ukraine's current total final energy consumption (TFEC). By replacing natural gas, this would reduce GHG emissions by up to 55 Mt CO2 p.a., equivalent to more than half of 2022 total domestic emissions.[66] Figure 15 illustrates the estimated production and greenhouse gas (GHG) emission reduction potential of biomethane.

Figure 15: Estimated biomethane and emission reduction potential



Source: Geletukha, G. (2024). Prospects of biomethane in Ukraine.

Biomethane production facilities are spread across Ukraine, reflecting the country's strong agricultural base.[67] However, this spatial distribution also presents a challenge for scaling biomass-based ammonia production. Transporting large volumes of biomass or biomethane to centralized ammonia plants is logistically complex and expensive. While smaller, distributed biogas plants can

[62] Index Mundi (2019). Agriculture, value added (current US$) - Country Ranking - Europe. Available at: Link
[63] Kotsiuba, V. (2023, March 31). Designing a carbon neutral energy system of Ukraine: Increasing the uptake of biofuels and biomass in Ukraine. UN Economic Commission for Europe. Link
[64] Bioenergy Association of Ukraine. (2024, September 5). Bioenergy in Ukraine until 2030: Analysis of the National Renewable Energy Action Plan. UABIO. Link
[65] Geletukha, H. (2024). Prospects of biomethane in Ukraine [presentation]. Bioenergy Association of Ukraine (UABIO) / BIOMETHAVERSE project, Kyiv. Available at: Link
[66] International Energy Agency (IEA) (2025). Ukraine – Emissions. Available at: Link
[67] Trypolska, G., Kucher, L., Stavytskyy, A., & Volk, O. (2025). Ukraine's biomethane potential for achieving renewable energy goals and energy security. Energies, 18(3), 1212. Link

effectively serve local heat or power needs, large-scale green ammonia production would require concentrated feedstock supply to ensure steady operation.

Green ammonia production potential

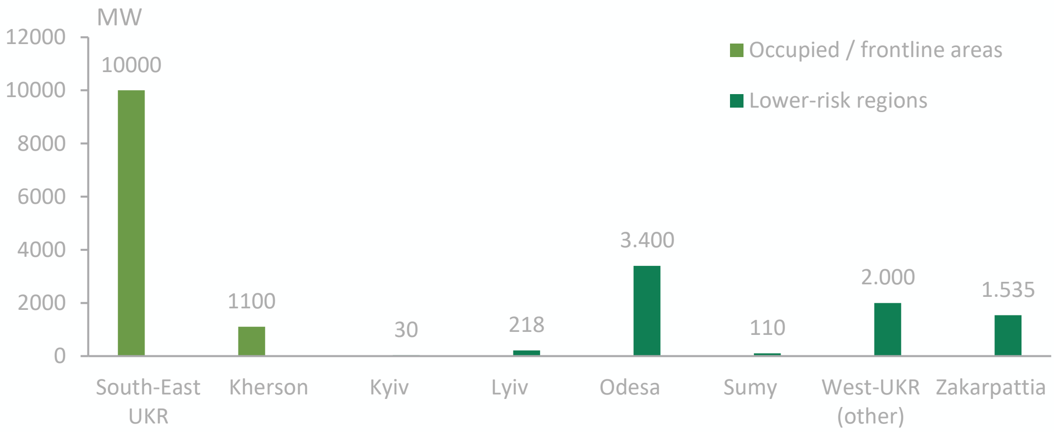
Hydrogen's availability and target market

Ukraine's substantial renewable energy potential, combined with surging demand for low-carbon energy in the European Union, had attracted significant interest in green hydrogen development, primarily targeting exports to EU markets. Before the war, thirteen projects were proposed, with a combined announced initial capacity of 2.3 GW and a long-term envisioned electrolyser capacity of 18.3 GW.[3]

The war has had a major impact on these plans. Around 30% of the territory identified as suitable for cost-effective hydrogen production is now under occupation,[31] affecting nearly all of the initially announced capacity and about 61% of the long-term envisioned capacity. Figure 16 shows the distribution of envisioned hydrogen projects in Ukraine before the war and their relative proximity to areas heavily impacted by the invasion.

The physical impact of the war on Ukrainian territory, combined with elevated financing costs due to risk premiums, is likely to constrain the capacity of hydrogen projects that can realistically be developed. Along with security concerns, including the potential damage to critical infrastructure such as pipelines transporting hydrogen to the EU, these factors call for a reassessment of hydrogen's role in Ukraine and raise the question whether direct export to the EU remains the most efficient option.

Figure 16: Envisioned hydrogen projects in Ukraine before the war



Source: IEA (2025) Unlocking Ukraine's H2 opportunity

Green ammonia as value-added H_2 use

Adding value domestically to scarce raw materials is the preferable option for countries, as it not only captures greater capital inflows but also diversifies the economy beyond a few basic raw materials, which are often subject to volatile international prices. It also supports job creation and strengthens economic resilience. However, countries often face challenges in doing so, as capturing higher value from raw materials requires significant investments and expertise along the value chain to produce the final high-value-added product.

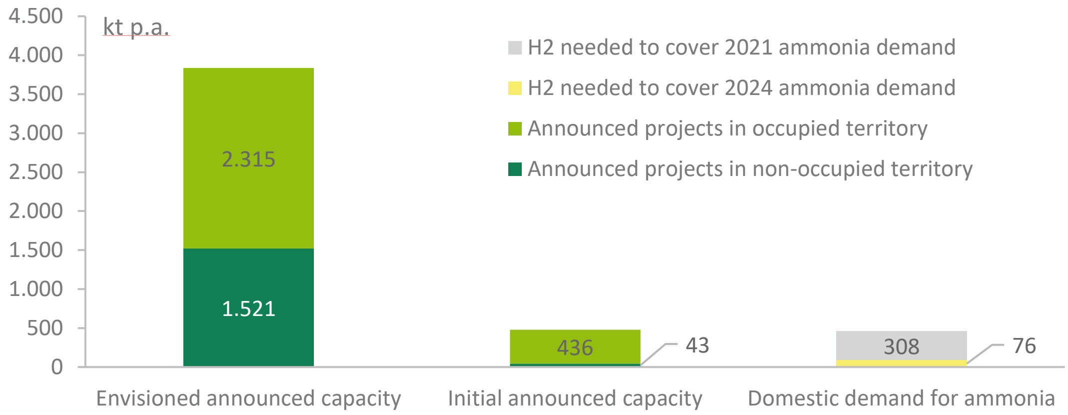
With the war constraining the overall development of hydrogen projects, hydrogen production in Ukraine is likely to scale slower and potentially be less than initially expected. Therefore, strategically leveraging existing value chains is an efficient allocation of additional investments. Building on already established infrastructure is a key approach that should be considered to maximise the returns from green hydrogen projects in Ukraine.

In this context, green ammonia presents a strong case due to several factors:

- Domestic grey ammonia sector is a well-established industry in Ukraine that has managed to continue working despite the war
- The downstream stages of the value chain are in place, and these can accommodate either green or grey ammonia with minimal adjustments
- Revamping ammonia production facilities is an inevitable investment, regardless of the path chosen
- Ukraine's proximity to EU markets is strategic, since there green and grey ammonia prices are anticipated to align by the decade's end, driven by ETS prices
- Ukraine's EU accession prospects further enhance the business case, as ETS prices would also be applicable for the domestic market

To illustrate Ukraine's potential to decarbonise ammonia production, Figure 17 compares announced green hydrogen production capacity in the medium and long term with the sector's hydrogen demand. In the medium term, production could meet around 56% of the sector's current hydrogen needs for ammonia production, or about 12% of pre-war demand. Including projects located in currently occupied territories, green hydrogen could fully cover the demand and even generate a surplus of 171 thousand tonnes per year. In the long term, production is expected to exceed ammonia's hydrogen requirements by a wide margin.

Figure 17: Green H2 production capacity vs H2 demand for ammonia production



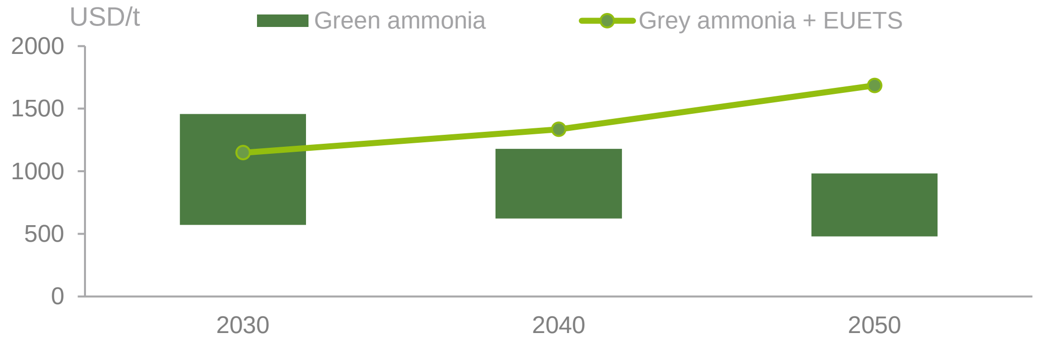
Source: Own calculations based on: IEA. (2025). Unlocking Ukraine's H2 opportunity, UN Comtrade. (2025). Ukraine – Ammonia foreign trade, and UKRSTAT. (2025). Production of industrial goods

Ukraine's path to competitive green ammonia

In line with the global trend, producing ammonia today in Ukraine would still be two to three times more expensive than grey ammonia, making large-scale domestic uptake unfeasible in the near future. The situation is similar for exports to the EU, where the price of green ammonia would be 40-80% higher,[4] even after factoring in EU ETS costs.[9] The already weak business case for green ammonia is further exacerbated by the war. Increased financing costs, driven by war-related risk premiums, and lower electrolyser utilization rates, caused by deployment constraints in areas with limited renewable energy, further undermine the economic viability of green ammonia in the short term.

However, in the mid to long term, increased ETS prices, a general reduction in green hydrogen production costs[68] and the potential access to preferential interest rates, can make green ammonia a cost-effective option for Ukraine, both for export to the European Union and potentially for local consumption once EU accession is realised. In the long term, green ammonia will be the best choice, with a similar price range to grey ammonia but with advantages such as independence from gas prices, versatility for export to all markets without a carbon price, and overall environmental benefits.

Figure 18: Cost of producing green ammonia in Ukraine vs cost of grey ammonia incl. carbon price



Source: Own calculations Note: cost estimations are based on a meta-analysis of projected LCOH in Ukraine from H2-diplo (2024), and synthesis and O&M costs from Erger et al. (2023); Grey ammonia costs are based on 2024 average ammonia prices and EU ETS base scenario from Phale et al. (2023).

Green ammonia as a decentralised fertiliser source

Globally, decentralised applications with integrated ammonia and fertiliser production is gaining attention in recent years. On-site ammonia production could enable farmers to produce their own fertiliser, decoupling crop prices from global commodity fluctuations and supply chain disruptions. This approach offers significant potential for enhancing local resilience and reducing dependence on external factors.[69]

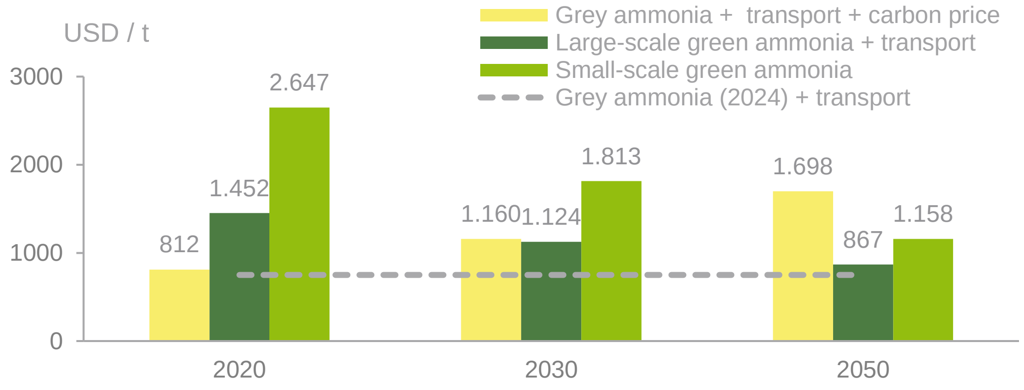
By producing ammonia at the point of use, decentralised facilities also eliminate transport costs, which are an especially important advantage in regions where delivering fertiliser is costly due to inadequate transport infrastructure.[50]

[68] Kirchner, R., Bilek, P., Grinschgl, J., & Hausner, F. (2023, updated 2024, July). Prospects for the Ukrainian green hydrogen sector: A comparative analysis of the state of hydrogen markets and policies in key countries. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Link

[69] Agora Industry (2025): Breaking new ground: decentralised renewable nitrogen fertilisers. Exploring opportunities and barriers. Link

However, economies of scale remain decisive for the cost of producing hydrogen and ammonia. Without centralisation, production costs rise sharply. Currently, decentralised green ammonia production at the point of use is about 82% more expensive than centralised production. As green ammonia costs decline over time, and assuming transport costs remain broadly stable, this gap narrows to around 61% by 2030 and 33% by mid-century.[70] These developments, alongside grey ammonia costs at the point of use for comparison are displayed below.

Figure 19: Cost comparison at the point of use (global average)



Source: Own calculations based on: IEA (2022) and Tonelli et. al. (2024) Note: Carbon price uses EU ETS as reference price, transport cost reflect the global average transport cost of ammonia to the point of use

Trade-offs of on-site vs centralised green ammonia production in Ukraine

In the context of Ukraine, weighing the trade-offs between on-site- and centralised ammonia production facilities is crucial. In the near term, the risks posed by the ongoing Russian invasion underline the vulnerability of centralised infrastructure, which can be directly targeted. However, the question goes beyond immediate security concerns. Looking at the mid to long term, crucial factors to decide whether decentralised production of ammonia makes sense for the country are the overlap between high-potential renewable areas and agricultural areas using nitrogen based-fertilisers, as well as transport infrastructure and costs in the country.

In Ukraine, arable land is widely distributed across the country.[71] However, five oblasts account for 45% of the total arable land, located in the central and southern regions. Four of these oblasts have both a high concentration of arable land and significant renewable energy generation potential. Additionally, the southern and eastern parts of the country, where these oblasts are located, have more prominent pre-existing grey ammonia transport infrastructure. These factors, combined with the clear cost benefits of centralised green ammonia production, make a strong case for centralised green ammonia generation in the southeastern part of the country. Situating production in Odessa would be particularly interesting, as it combines the above-mentioned factors with port infrastructure for potential exports.

[70] Tonelli D, Rosa L, Gabrielli P, Parento A & Contino F. (2024). Cost-competitive decentralized ammonia fertilizer production can increase food security. Nat Food 5, 469-479 (2024). Link
[71] State Statistics Service of Ukraine (2016). Number of agricultural enterprises and area of agricultural land in their use as of November 1, 2016, by region. Kyiv: State Statistics Service of Ukraine. Link

Decentralised production, while less attractive, could be explored in the future in other high-RES potential areas with less arable land, such as the north and northwest, where the transport cost of centralised facilities elsewhere might increase overall costs.

Figure 20: Arable land in Ukraine and its intersection with high RES potential regions

Source: UKRSTAT (2016)

Green ammonia project pipeline

Several green ammonia and hydrogen initiatives have been proposed across Ukraine,[38] reflecting growing interest in leveraging renewable resources for low-carbon production. If materialised, these projects combined could produce roughly 2024 ammonia production in the first stages and even cover the equivalent pre-war levels of ammonia demand after 2050. However, only the Reni project is not in or close to occupied areas and all areas in which the projects are situated have been subject to Russian attacks.

Table 3: Announced green ammonia projects in Ukraine

	Kakhovka	Reni	Danube H2 valley
Investment (USD m)	2,160	324 - 432	108
Electrolyser (MW)	1100	100	50
Ammonia prod. (kt p.a.)	400 in 2030 and 2,700 in 2050	120	5 kt of H2 & NH3 in later stage

Source: IEA (2025), German Energy Agency (dena) (2021). Green Hydrogen in Ukraine: Taking Stock and Outlining Pathways

Potential domestic uptake of green ammonia

Potential for e-fertilizer use in Ukraine

Ukraine's large agricultural sector strongly relies on fertiliser use to maintain stable output. Given the current reliance on fossil-based fertilisers, this creates a direct link between global fossil commodity prices and availability and agricultural output. Since a large share of fertilisers in Ukraine are imported, the agricultural sector in Ukraine is also subject to price volatility and access constraints of global fertiliser markets.

In addition, given the current reliance on fossil-based fertilisers, there is a direct link between global fossil commodity prices and availability and agricultural output. Domestic production of green ammonia, and its subsequent processing into e-fertilisers for domestic uptake, could partially shield Ukraine's agricultural sector from external disturbances, offering benefits for domestic and regional food security while also reducing overall carbon emissions.

However, as green ammonia remains more expensive than its conventional counterpart, the "green premium" of e-fertilisers would directly increase production costs for Ukrainian farmers and, in turn, lead to cost pass-through effects on agricultural products, both domestically and for exports. These impacts could manifest in various ways, including changes in crop yields, shifts in trade patterns, and altered sectoral growth dynamics.

To assess the potential effects of a partial uptake of e-fertilisers by Ukrainian agricultural producers, a modelling exercise was carried out, linking agricultural markets across EU Member States and selected non-EU countries, including Ukraine. The model generates annual projections for key commodities up to 2035, enabling the evaluation of policy and market shocks on production, trade, and prices.

Scenario analysis of the effects of e-fertiliser adoption in Ukraine

Scenario description

Two alternative e-fertiliser adoption scenarios are introduced to assess the sensitivity of Ukrainian cereals and oilseeds markets to different diffusion rates and market recognition levels for "green" production. Both scenarios assume that the shift to e-fertiliser raises production costs (mainly via fertiliser expenditures) and that certified products receive a price premium on export markets.

Two key literature-based assumptions were considered for the modelling exercise across scenarios: [72] 1) a e-fertiliser cost with a 10-25% markup over conventional fertilisers due to higher feedstock costs of green ammonia, and 2) a sustainability-related price premium on low-carbon agricultural products of 3-10%, depending on certification credibility and market saturation.

[72] For the modelled period, constant green premiums for both, e-fertilisers and for agricultural products are assumed. A full overview of the assumptions of the modelling exercise can be found in the annex.

Baseline scenario

The baseline scenario represents the trends in Ukraine's agricultural sector during the war and after the end of the war without the introduction of e-fertiliser or any related policy or market changes. It reflects existing production technologies, costs, and price relationships under macroeconomic and global market assumptions. This baseline serves as a reference trajectory against which the impacts of introducing e-fertiliser are measured. The comparison of the baseline with Scenario 1 (Moderate Adoption) and Scenario 2 (High Adoption) allows the identification of changes in production, trade, and price dynamics attributable solely to e-fertiliser uptake and associated market premiums.

Scenario 1 – Moderate adoption (Moderate)

By 2035, it is assumed that e-fertiliser will be used on 25% of arable land devoted to cereals and oilseeds. Variable production costs for adopters increase by 10%73 74, reflecting higher input prices and changes in production technology. However, "green" grain and oilseeds receive a 5%.75 76 77 price premium on international and domestic markets, consistent with current voluntary low-carbon grain schemes and buyers' modest willingness to pay. This scenario reflects a cautious, early-stage market transition with limited access to low-emission fertiliser supply and uncertain international demand.

Scenario 2 – High adoption (High)

By 2035, 60% of arable land adopts e-fertiliser use, supported by stronger policy incentives and improved supply chains. Variable production costs increase by 15%,73 74 representing full substitution of synthetic nitrogen with green alternatives on this area and reflecting potential changes in production technologies. The price premium rises to 10%,75 76 77 assuming greater recognition of Ukraine's "green grain" by the buyers.

The sections below walk the reader through the main insights emerging from the modelling exercise on three levels: First, the impacts on aggregated crop production; second, specific impacts on grain crop production; and third, specific impacts on oilseeds production. Together, these results clarify both the potential scope of e-fertiliser adoption and its implications for Ukraine's agricultural structure.

Modelling results

Table 4 provides an overview of the modelling assumptions and projected production outcomes under the Baseline, Moderate adoption, and High adoption scenarios. It summarises the key differences in e-fertiliser uptake rates, associated cost increases, and price premiums, alongside the resulting impacts on total output and major crop groups by 2035, compared with the observed 2021 production levels.

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[73] Fertilizers Europe (2023). Pathways to Climate-Neutral Fertiliser Production. Brussels.
[74] International Energy Agency (IEA): Ammonia Technology Roadmap. Link
[75] Rabobank (2023). Green Premiums in Agri-Commodities: Market Signals and Early Lessons. Utrecht. Link
[76] PWC (2024). Consumers willing to pay 9.7% sustainability premium, even as cost-of-living and inflationary concerns weigh: PwC 2024 Voice of the Consumer Survey. Link
[77] McKinsey and Company (2023). From green ammonia to lower-carbon foods.Link

Table 4: Impact of e-fertiliser adoption on the production of major crops in Ukraine

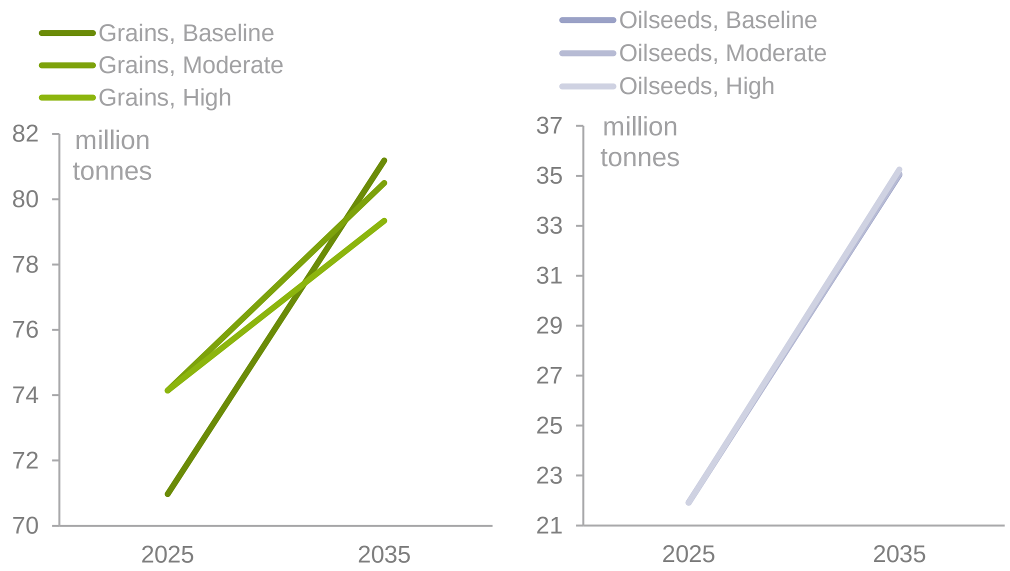
	Baseline	Moderate	High	2021 (pre-war)
Scenario-specific assumptions				
E-fertiliser adoption start, year	NA	2027	2027	NA
E-fertiliser adoption rate, % of arable land for cereals and oilseeds	0%	25%	60%	NA
Extra cost due to adoption of e-fertilisers, %variable cost increase	no change	10%	15%	NA
Price premium received for low-carbon agricultural products, % sellingprice increase	no premium	5%	10%	NA
Scenario-specific results: Production in million tonnes				
Aggregated production	**116.2**	**115.6**	**114.6**	**107.6**
Grains	**81.2**	**80.5**	**79.3**	**84.8**
Soft wheat	19.8	20.4	22.1	32.2
Corn	52.8	51.6	48.7	42.1
Barley, rye and oats	8.52	8.5	8.49	10.5
Oilseeds	**35.0**	**35.1**	**35.2**	**22.8**
Sunflower seed	20.7	20.8	21.1	16.4
Rapeseed	8.2	8.2	8	2.9
Soybean	6.1	6.1	6.1	3.5
Oilseed oils	9.5	9.6	9.8	6.1
Oilseed meals	9.3	9.3	9.5	6.4

Source: Own modelling results

Aggregated impacts

By 2035, total grain and oilseed production in Ukraine is projected to stand above pre-war levels by 7-8%, depending on the scenario, reflecting both the return of land to cultivation and yield improvements. E-fertilizer adoption scenarios result in 1-2% decrease of total production compared to the Baseline, with grains production decreasing by around 1-2%, given higher production costs and oilseeds increasing by 1%, benefiting from green premiums in agricultural products (see Figure 21).

Figure 21: Production of grains and oilseeds 2010-2035 under different scenarios



Source: Own modelling results

Effects on grains

Soft wheat remains the dominant crop among the grains and the clear winner under e-fertiliser adoption. Relative to the baseline, its harvested area expands by roughly 3% under the Moderate and 11% under the High adoption scenario. With yield changes quite close to the baseline, these result in the respective increase in production. Prices decline less than 1% below baseline, indicating that scale gains offset cost inflation.

For corn, the profitability balance is less favourable. The crop sees minor yield changes, but its production falls due to area reduction. Consequently, the production is 2% below baseline for Moderate and 8% below under High adoption. Barley, rye and oats show marginal changes in yield and stable area, leaving production almost unchanged compared to baseline. Overall, the grain complex shows a gradual reallocation of land toward wheat, reflecting both its superior yield response and the stronger market incentives associated with the e-fertiliser price premium.

Effects on oilseeds

The oilseed complex responds differently. Sunflower, Ukraine's flagship oilseed, benefits moderately: by 2035, yield increase by less than 0.5% under both scenarios, and area harvested by 2.2% only under High adoption. Total production under Moderate almost equals to the baseline and exceeds the latter by 2% under High adoption. These gains are mirrored in sunflower oil and sunflower meal, both showing the respective output increases by 2035 compared to baseline. Domestic market prices remain stable or fall very slightly (less than 0.5%), suggesting that productivity gains compensate for input cost increases.

The response of rapeseed is slightly negative. Area and production decline by around 1% under Moderate and 3% under High adoption relative to the baseline, as the crop's lower yield elasticity and tighter margins constrain profitability. Soybeans remain largely unaffected: yields and output vary within ±0.5%, and both domestic use and exports are essentially unchanged from baseline projections. Thus, the oilseed sector shows a divergent adjustment pattern: sunflower slightly strengthens its dominant position, rapeseed retreats very modestly, and soybeans remain stable.

Interpretation of results

The results on an aggregated level suggest that e-fertiliser adoption neither fundamentally disrupts Ukraine's production capacity nor delivers strong output gains. Instead, the overall effect is slightly negative for total supply, driven mainly by increased costs, while certain subsectors benefit where price premiums outweigh these cost increases.

Further, price effects are minor across all commodities, typically within ±1% of the baseline, confirming that the principal channel of adjustment lies in land allocation rather than market distortion. Likewise, trade volumes and domestic use remain broadly aligned with baseline projections, suggesting that Ukraine's export position is maintained as recovery progresses.

On grains, these different responses across grain types imply that farmers' responses are driven primarily by relative profitability rather than technological constraints: crops that can leverage premiums more effectively (such as soft wheat) expand, while those facing tighter margins under higher input costs (notably corn) contract. This suggests that e-fertiliser adoption would reshape crop composition rather than uniformly favour all grains.

On oilseeds, the heterogeneous response across different oilseed types confirms that the economic viability of e-fertiliser adoption is crop-specific. Where yield responses and price premiums sufficiently offset the green cost premium (as for sunflower), adoption becomes economically attractive. Where margins are tighter or yield responses are weaker (rapeseed), contraction occurs, while neutral crops (soybean) effectively remain indifferent.

Conclusions

Overall, the modelling exercise does not point to a broad, immediate economic incentive for full-scale adoption of e-fertilisers across Ukraine's agricultural sector. The net benefits of adoption are commodity-specific and depend on whether achievable market premiums for "green" products are sufficient to compensate for higher fertiliser and production costs.

Further, the results indicate that the principal implication of e-fertiliser adoption is not a significant expansion or contraction of aggregate agricultural output, but a gradual reallocation of land and production toward crops with stronger relative profitability under low-carbon production systems. This suggests that e-fertiliser uptake should be gradual and selective, remaining partial or moderate under current cost and price-premium assumptions and outcomes varying across crops.

From a policy perspective, the model supports the adoption of e-fertilisers in Ukraine only to a targeted and phased extent rather than as a blanket sector-wide requirement, focusing on crops and value chains where premiums can offset input cost increases. The observed differences in crop responses underline that targeted policy support aimed at specific crops or value chains would be more effective than blanket measures in facilitating a transition toward e-fertilisers.

08. Ukraine's competitive positioning

The analysis below summarises Ukraine's competitive positioning for developing a green ammonia and fertiliser sector. It follows a PESTEL-based SWOT framework, identifying key political, economic, technological, industrial, and regulatory factors. Each category highlights current strengths, emerging opportunities, structural weaknesses, and potential risks that could influence Ukraine's capacity to build a low-carbon ammonia value chain.

Political considerations

Ukraine's political landscape is largely favourable for green ammonia developments. The country's alignment with EU decarbonisation policies, such as the Green Deal and REPowerEU, along with existing collaboration frameworks and bilateral support from key EU states, provides a solid foundation for expanding green ammonia and fertiliser capacity. Additionally, Ukraine's EU accession prospects and the growing emphasis on regional food security present opportunities for deeper cooperation.

Political challenges mainly stem from the Russian invasion. Beyond this, the EU's competing partnerships with countries like Morocco and Egypt, which are also aiming to export to the Union, pose relatively low political risks.

Table 5: SWOT analysis of political considerations

Strengths	Weaknesses
• Alignment with core EU policy and instruments (EU Green Deal, REpowerEU) • Ambitious decarbonisation goals • Existing political structures for collaboration with EU states • Bilateral support from key EU states	• Ongoing Russian invasion • Continued issues with rule of law and transparency • Challenging business climate
Opportunities	**Threats**
• Growing importance of regional food security • Leveraging political structures used for the green reconstruction collaboration • Accelerating EU membership • Decarbonisation incentive to design green ammonia/fertiliser capability into assets	• Changes in EU political interest, diverting support for UKR • Competing alliances of EU with other potential exporters i.e. North Africa • Potential post-war uncertainty might affect domestic policy continuity

Source: Author's elaboration

Economic considerations

Economically, the situation is challenging in the short term, mainly due to the still-high costs of producing green ammonia, which currently makes it neither a cost-effective option for domestic consumption nor for export. This is further exacerbated by war-driven high-risk premiums limited access to finance, which is also needed by other sectors. Further, competitors with better renewable resources and comparable proximity to the EU, such as countries in North Africa, along with shifts in projected demand, like the recent rise of e-methanol in the shipping industry, pose potential competition.

However, the outlook can improve in the medium to long term. Several opportunities could strengthen Ukraine's economic position, including carbon price signals under CBAM from 2026, normalised interest rates post-war, and donor support. Once EU accession is completed, price signals from the EU ETS will also create a strong economic case for switching to green ammonia and fertilisers for domestic consumption. However, Ukraine must navigate this process carefully to capture these benefits without over-investing in a sector that currently remains a niche market.

Table 6: SWOT analysis of economic considerations

Strengths	Weaknesses
• Geographical proximity to large demand centers (EU) • Potential domestic demand for agriculture • Large, export-oriented farm base; fertiliser use is rebounding (~1.7–1.8 Mt nutrients in MY-2024/25)	• High WACC prohibitive, limited financial resources, IFI support and cheap financing needed • High price mark-up of green ammonia • Competing sectors to attract (foreign) private investment in green solutions • Green premium vs. grey N-fertiliser and capital constraints slow adoption and uptake • Limited domestic green N-fertiliser supply near term; likely reliance on imports
Opportunities	**Threats**
• Growing EU demand for low-carbon fertilisers • Export of high-value added fertilizers or agricultural products to EU • Reviving the existing ammonia sector • Price signals (CBAM) from 2026 • Donor financing and carbon market instruments to bridge cost premium and de-risk adoption • Potential "green" branding of Ukrainian fertiliser to enhance agricultural exports' sustainability profile into assets	• Ongoing war-related shocks to energy/logistics can disrupt supply and investment • Competing export countries in the region with project pipelines, offtake agreements, and support in place • Increasing interest in e-methanol for shipping can significantly impact overall demand for green ammonia Grey N-fertiliser price swings undermine green adoption without policy/finance support

Source: Author's elaboration

Technological & industrial considerations

In the technical sphere, Ukraine is on the right track to support a green ammonia sector. The country boasts some of the highest renewable generation potential in Europe, supported by vast land availability and a pre-war ammonia industry with existing infrastructure, such as pipelines, ports, and rail.

Further opportunities exist in expanding the hydrogen and renewables sectors, including offshore wind in the Black Sea and using biomass as an additional hydrogen feedstock. Ukraine also possesses the technical expertise to scale biomethane production and could leverage public–private partnerships for pilot projects and R&D in green ammonia.

However, significant technical constraints remain. The competing demand for green electricity to meet domestic needs, limited R&D in precision fertiliser technologies, and the concentration of renewable and hydrogen potential in temporarily occupied areas present major barriers. Short-term risks include the vulnerability of infrastructure, particularly the grid and ports, which further raises supply risks and costs. Additionally, a shift toward decentralised setups could lead to a significant increase in production costs.

Table 7: SWOT analysis of technological and industrial factors

Strengths	Weaknesses
• Some of highest renewable generation potential in Europe and vast available land • Pre-war ammonia production capacity • Active ammonia facilities can uptake biomethane • Active fertiliser production can uptake green ammonia • Existing nitrogen industry and national distribution networks (e.g., Cherkasy Azot, Rivneazot) for drop-in green products • Infrastructure: pipelines (Odessa-Togliatti), port, rail	• Competing use of green power to cover electricity demand • Competing use of H2 (i.e. steel) • RES and H2 potential located mainly in temporarily occupied territories • Infrastructure vulnerability (grid/ports) raises supply risk and costs • Limited domestic R&D in electrolysis, ammonia synthesis, and precision fertiliser technologies
Opportunities	**Threats**
• Significant plans to develop hydrogen sector • RES deployment plans, offshore wind potential in Black Sea in long-term • Competitive biomass/biogas potential as an additional green H2 feedstock • Know-how to scale biomethane production • Public-private partnerships for R&D and deployment of green ammonia pilots	• Attacks to centralized production and transport infrastructure • Preference for decentralized facilities may result in prohibitive costs

Source: Author's elaboration

Legal & regulatory considerations

Ongoing legal and regulatory alignment with the EU is a major advantage for Ukraine. Continuing down this path will support the development of a green ammonia sector. Planned measures such as the transposition of the Electricity Integration Package in 2025 and reforms on carbon pricing reflect this progress and strengthen integration into EU low-carbon value chains. Furthermore, the "law on alternative fuels" will enhance investment predictability, and the aim of improving monitoring, reporting, and verification (MRV) systems will enable needed labelling credibility.

However, significant work remains for policymakers and companies. Challenges include the complexity of fast-tracking alignment with EU standards, as procedures can be difficult to navigate and burdensome. The lack of legal definitions for green hydrogen and ammonia, along with outdated technical regulations, are regulatory issues that need to be addressed to enable the development of a green ammonia sector. Key risks include potential delays in EU accession, which could impose regulatory costs without providing full market benefits, and uncertainty surrounding national incentives, which may slow investment momentum.

Table 8: SWOT analysis of legal and regulatory factors

Strengths	Weaknesses
• Advancing legislative and regulatory alignment with EU • EU accession perspective could accelerate integration into EU low-carbon value chains • Transposition of the Electricity Integration Package in 2025 ETS introduction planned	• Fast-tracked regulatory alignment is difficult to navigate • No legal definition of green hydrogen/ammonia • Outdated technical regulations • Certification and administrative burden for EU-aligned green labels
Opportunities	**Threats**
• ETS/carbon tax reform • Further EU-alignment of "law on alternative fuels" • Revamp of MRV activities essential for green labelling	• Delays in EU accession can place strong regulatory burden w/o fully EU-market benefits • Policy uncertainty (unclear national incentives) or delays in EU alignment could stall investments

Source: Author's elaboration

09. Conclusions and policy recommendations

Ukraine's green ammonia sector should be viewed as a medium- to long-term opportunity, not an immediate growth sector, especially under conditions of war. The fundamentals are strong: vast renewable potential, an established ammonia and fertiliser industry, large agricultural sector, strategic proximity to European demand centres with a well-established transport infrastructure, and ongoing EU policy alignment create a unique platform for integration into European low-carbon value chains.

Yet the economics remain weak. Current production costs are uncompetitive, financing is scarce, and in cross-sectorial applications alternative fuels like e-methanol are gaining traction. Furthermore, domestic demand for green ammonia or fertilisers is unlikely to materialise in the absence of EU accession, since only EU ETS price signals and full market integration would make substitution economically viable. This underscores the risk of stranded investments if scale-up is attempted too early.

However, despite the absence of near-term catalysts, it makes sense for Ukraine to begin taking initial steps now. Early action in regulatory alignment, pilot projects, and infrastructure planning will ensure that the country does not lose momentum in a fast-changing environment and is prepared to scale up rapidly once the political and economic environment improves. This preparatory phase can lay the foundations for attracting investment and securing Ukraine's place in the emerging European green ammonia market when the conditions for expansion become favourable. For this, policy makers in Ukraine should:

Initiate a comprehensive sectoral feasibility study: Conduct a thorough feasibility study to reassess the post-war potential for developing a green ammonia and fertiliser sector in Ukraine, considering market demand and renewable energy availability, but also the possibility to repurpose existing assets, infrastructure, and skills, and where new additions are necessary. An updated comparative analysis of regional competitors is also essential.

Assess opportunities for financial support: Decreasing the total cost borne by investors and the Ukrainian government will be key to improving price competitiveness and reducing fiscal exposure and risk. Accessing EU and international financing and support for the creation of a green ammonia sector would be fundamental to improving investment conditions. Conversely, designating green ammonia as a priority sector domestically could be accompanied by helping provide reduced interest rates to investors to increase project feasibility and attractiveness.

Create mapping of existing and required jobs and skills: The development of a green hydrogen and green ammonia sector will create new jobs that will also require new skills. A mapping of these jobs and skills is needed to assess availabilities among today's diminished workforce and to ensure sufficient opportunities and programmes are created to upskill the labour force. This is key due to time lags that could potentially slow down the growth of the sector.

Continue prioritising the development of EU aligned legal and regulatory frameworks: Continue prioritising the alignment of Ukraine's legal and regulatory frameworks with EU standards, particularly in areas such as carbon pricing, green hydrogen and ammonia definitions, and monitoring, reporting, and verification (MRV). This will ensure Ukraine's green ammonia sector is competitive, facilitates EU market access, and attracts investment, while supporting the country's EU integration process.

Continue strengthening partnerships with the EU, as it is a primary (direct and indirect) demand centre for green ammonia. This will ensure continued access to the EU market, foster collaboration, and safeguard Ukraine's competitive position against regional competitors.

Raise awareness and build stakeholder capacity: Build awareness around the potential of green ammonia and educate key stakeholders, including policymakers, (agri-)businesses, and investors, on its benefits and the necessary steps for development. This will ensure broad support, facilitate informed decision-making, and drive collaborative efforts for sector growth.

Consider the trade-offs carefully: Developing a green ammonia sector will require significant support (regulatory, technical, financial) from the government of Ukraine as well as international partners. Within the context of many competing priorities and the broader reconstruction, ensure that adequate capacity, expertise and resources can be allocated to growing the sector to prevent the creation of an uncompetitive green ammonia sector.

Annex

Annex I: Fertiliser demand concentration in medium and large enterprises

Fertilisers have represented the single largest input cost for Ukrainian crop producers, 31-47% depending on the crop, and a key determinant of farm productivity pre- and during the war. Data from Ukrstat (2019–2021) and the KSE Agrocenter own survey of 193 producers conducted in 2023, one year after the full-scale invasion, show that even during the war, when overall production costs rose sharply, by 20-65% depending on the crop, the share of fertiliser expenditures remained remarkably stable, indicating that Ukrainian farmers consider fertilisers a non-substitutable input[78].

Medium and large agricultural enterprises, which together account for roughly two-thirds of total farmland, spend the most on fertilisers per hectare and are strong drivers of fertiliser demand. Their higher spending is linked to greater yield improvements but is constrained by fertiliser market prices. Large agricultural holdings spend less per hectare due to economies of scale, advanced technology, and better market access, while small enterprises spend less because of limited financial resources and restricted access to credit[79]. The details are summarized in the table below.

Fertiliser expenditures per hectare in Ukrainian farms, by farm size

USD / ha	Small <200 ha	Medium 200-500 ha	Big >500 ha	Holdings
Wheat	66.2	84.4	86.5	86.9
Maize	71.1	106.7	110.8	70.3
Soybeans	61.6	88.9	67.3	46.3
Rapeseed	119.5	123.2	123.0	109.9
Sunflower	68.6	72.3	67.9	55.6

Source: State Statistical Agency of Ukraine

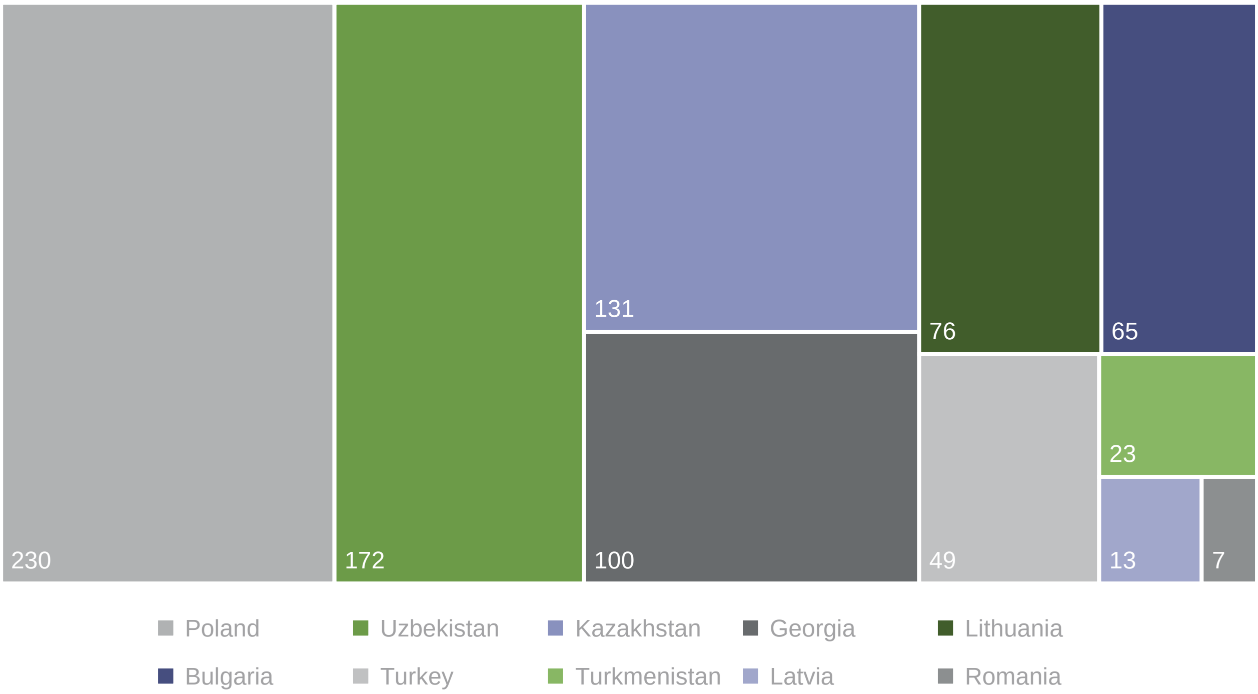
Accordingly, the behavioural responses of these producer groups to shifts in fertiliser technology, market conditions, and policy incentives will be a key determinant of future fertiliser demand in Ukraine.

[78] Stolnikovych, H. (2023): Types of agricultural producers in Ukraine. KSE Agrocenter. Available at: Link
[79] Stolnikovych, H. (2023): Types of agricultural producers in Ukraine. KSE Agrocenter. Available at: Link

Annex II: Nitrogen fertiliser exporters to Ukraine

After the rupture of trade relationships with Belarus in 2023 due to the latter's support of the Russia's invasion, Ukraine rapidly diversified its fertiliser imports. The top three nitrogen fertiliser importers to Ukraine have become: Poland – 28%, Azerbaijan – 22% and China – 21%. The rest 18% of imports were distributed among EU, Central Asian and Middle Eastern producers. This diversification, supported by the opening of EU solidarity lanes and Danube port routes, has ensured supply continuity but at a higher logistical and financial cost[80].

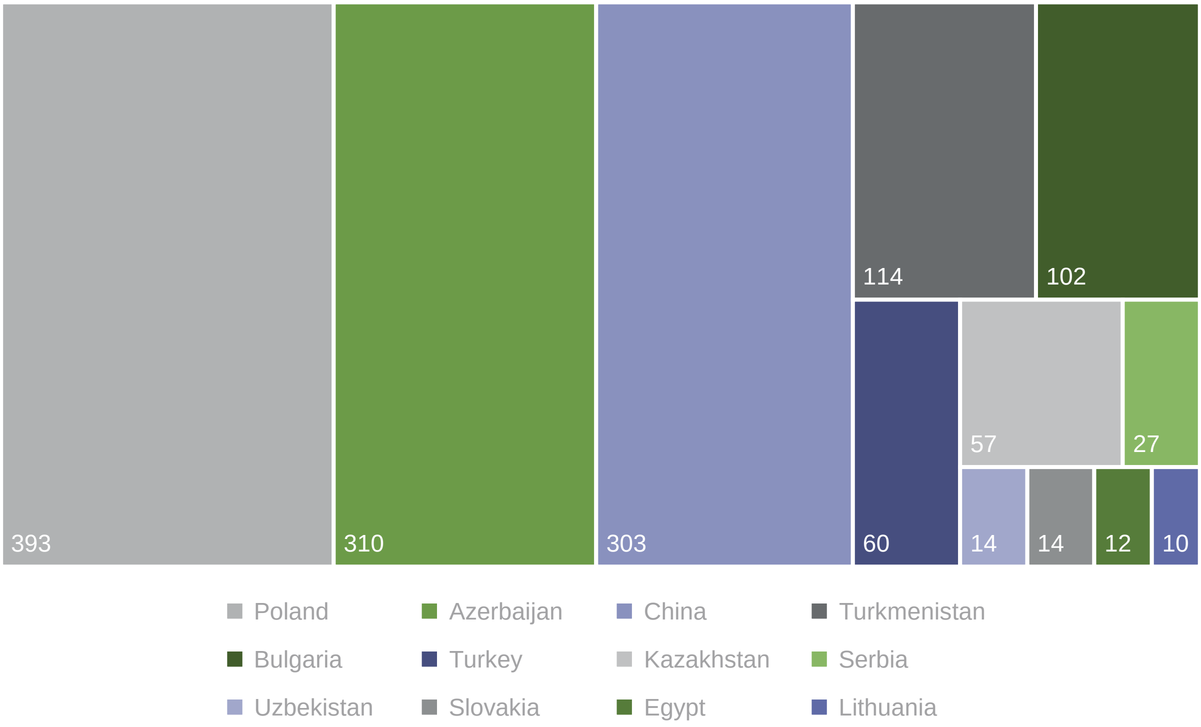
Top 10 nitrogen fertilizer exporters to Ukraine (excl. Belarus), kt, 2021



Source: ITC

[80] ITC Trademap (2025). Database of trade at HS2-6 level. Available at: Link

Top 12 nitrogen fertilizer exporters to Ukraine, kt, 2024



Source: ITC

Annex III: Details of the modelling exercise

To assess how the adoption of e-fertiliser could affect production and trade of major cereals and oilseeds in Ukraine, we apply the AGMEMOD model – an econometric, dynamic, partial-equilibrium framework linking agricultural markets across EU Member States and selected non-EU countries, including Ukraine. The model provides annual projections for key commodities up to 2030, enabling the evaluation of policy and market shocks on production, trade, and prices.

AGMEMOD represents supply, demand, trade, and price formation through behavioural equations estimated from national and international data sources (Eurostat, FAOSTAT, State Statistics Service of Ukraine, etc.). For Ukraine, the model database covers 1992–2023/2024 and includes production, yield, area, trade, and price indicators for cereals, oilseeds, and processed products. Commodity prices adjust to clear markets, with recursive dynamics reflecting lagged effects and interlinkages between crop and livestock sectors via feed demand.

In this study, the livestock sector acts only as a feed-demand component, while the focus remains on the crop sector. The model incorporates production costs – including land, labour, seeds, fertiliser, and fuel – within the supply equations. Projections depend on exogenous assumptions such as GDP, exchange rates, and global prices consistent with the OECD–FAO and EU Agricultural Outlook 2023 frameworks.

Within this setup, scenario simulations introduce higher fertiliser costs due to the shift to e-fertiliser and a corresponding export price premium for certified "green" grain and oilseed products. The model quantifies the net impacts of these opposing shocks on production, trade flows, and producer returns under varying adoption and premium assumptions.

Main assumptions for modelling of e-fertiliser uptake in Ukraine

The projections are constructed under a crucial macroeconomic and geopolitical assumption: the full-scale Russian invasion ends in December 2026, initiating a period of gradual reconstruction and reintegration of agricultural capacity. By 2027, most agricultural land begins returning to productive use, and by 2035 the total arable area has gradually recovered to its 2021 level.

This assumption rests on two key premises:

- First, that Ukrainian farmers will resume cultivation rapidly as security conditions improve, building on demonstrated resilience in recent years despite war-related disruption (FAO 2025).[81]
- Second, that comprehensive land-recovery efforts led or supported by the government and international partners, notably demining, rehabilitation of degraded or contaminated soils, restoration of infrastructure, and investment incentives under the Strategy for the Development of Agriculture and Rural Areas until 2030, will succeed in restoring damaged or abandoned lands to safe, farmable status over time (OECD 2025).[82]

Under this dual assumption, the model reflects a "maximum-impact scenario" and illustrates the realistic upper bound impact.

Further, agricultural land located in Crimea and in parts of Donetsk and Luhansk regions that have remained under occupation since 2014 are not considered in the modelling. This exclusion reflects operational and data-access constraints. Given the prolonged lack of effective administrative control, the absence of reliable, verifiable production statistics, and the uncertainty regarding land access, safety conditions, and infrastructure functionality, it is not feasible to incorporate these areas into forward-looking modelling assumptions.

Another key assumption concerns Ukraine's population trajectory. A population of 34.12 million for 2022–2026 and 40.67 million for 2027–2035 is applied in the model to reflect both current war-related demographic disruption and potential post-conflict recovery. In 2021, Ukraine's population was reported at 41.2 million by the State Statistics Service of Ukraine, providing the pre-war baseline. As of early 2025, approximately 7.1 million people have left the country (UNHCR, 2025)[83], which yields an adjusted resident population of roughly 34.12 million for the near-term modelling period. Meanwhile, evidence from refugee and internally displaced person (IDP) surveys indicates that substantial repatriation remains possible, with a large share of displaced Ukrainians reporting

[81] FAO (2025): Ukraine: Impact of the war on agricultural enterprises. Findings of a nationwide survey, October–November 2024. Link

[82] OECD (2025): Agricultural Policy Monitoring and Evaluation 2025. Making the Most of the Trade and Environment Nexus in Agriculture. Link

[83] UNHCR (2025): Ukraine Refugee Situation. Operational Data Portal, Link. An estimated 1.2 million people reported in refuge-like situation in Russian Federation are included in the assumption.

intentions to return once security, housing, and employment conditions improve (UNHCR 2024)[84]. Consequently, the use of 34.12 million conservatively reflects the immediate wartime demographic contraction, while the projection toward 40.67 million by 2035 represents an optimistic recovery pathway, assuming the return of approximately 93% of displaced populations and stabilization of longer-term demographic trends, thereby supporting modelling of a maximum-impact recovery scenario.

The diffusion of e-fertiliser technology follows the same recovery pattern of arable land, increasing gradually from 2027 onward and reaching the assumed adoption rates of 25 % of arable land under the Moderate adoption scenario and 60 % under the High adoption scenario by 2035. Consequently, the results for 2035 represent a near-steady-state post-war equilibrium, where recovery is largely complete and e-fertiliser use is fully integrated into the production system.

The key economic assumptions are that variable production costs rise by 10 % under the moderate case and 15 % under the high case, while price premia for e-fertiliser-certified crops reach 5 % and 10 %, respectively. Thus, changes across commodities are driven primarily by relative profitability, balancing higher input expenditures against yield improvements and market price advantages.

Table 3: Assumptions introduced into AGMEMOD model

Assumptions	Values
Database update	Up to 2024/2023 depending on data availability
Duration of war	2022-2026
E-fertiliser adoption start	since 2027 gradually to reach the assumed values on e-fertiliser adoption rates by 2035
Export possibility	2025-2026 as of today, 2027-2035 – all ports are available except of the Azov sea ports
Arable land availability	until 2026 – 24,542 thousand ha (based on GIS estimates 2025 considering the occupied territory and the territory under intense military action) 2027-2035 – 31,627 thousand ha, i.e, return to 2021 area
Changes during the war	The changes of expenses for fuel, mineral fertilizer, services, seeds, labour, depreciation and plant protection measures are based on 2023 KSE Agrocenter survey of agricultural producers[85]
World market prices in 2025–2035	OECD-FAO Outlook 2023 with trajectory [86]

[84] UNHCR (2024): Lives on hold: Intentions and Perspectives of Refugees, Refugee Returnees and IDPs from Ukraine #5 Summary Findings. Link
[85] KSE Agrocenter (2024): Overview of Ukrainian agriculture for Lunch time conference with DG Agri. Available at: Link
[86] OECD (2023): OECD-FAO Agricultural Outlook 2023-2032. Link

Crops storage assumption	Storage available
GDP projections 2025-2035	Growth rate projected by ERS (2023)[87]
GDP deflator	According to the ERS projections (2023) [87]
UAH/USD currency exchange rate	According to the ERS projections (2021) [87]
Population	2022-2026: 34.12 million people 2027-2035: 40.67 million people

Source: own elaboration

[87] Economic Research Service's (ERS) International Macroeconomic Data Set 2021-2023. Link

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