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**Working Paper**

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# European industry responds to high energy prices: The case of German ammonia production

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## Abstract

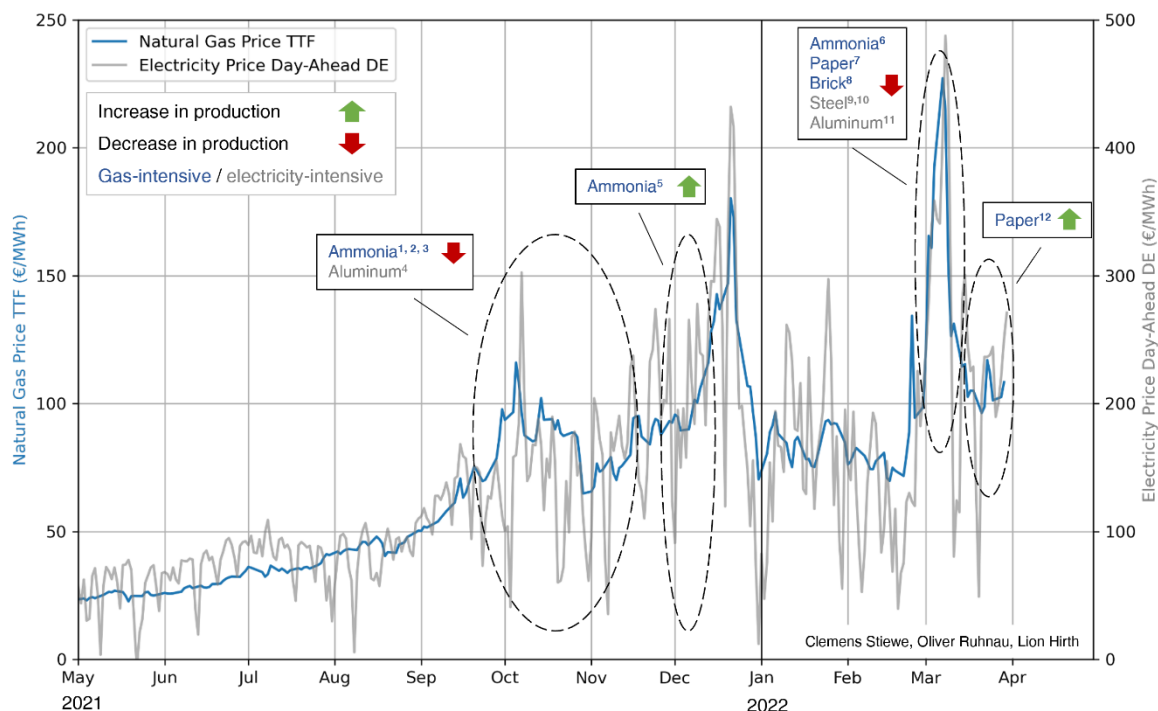
Since September 2021, European natural gas prices are at record-high levels. On average, they have been six to seven times higher than pre-pandemic price levels. While the post-pandemic recovery of global natural gas demand has driven up prices around the world, the most important drivers for European gas prices were Russia's less-than-usual supply since mid-2021 and its invasion of Ukraine in February 2022. Western efforts to abandon Russian gas imports altogether mean that high natural gas prices are likely to stay for longer.

While high gas prices may be the new normal, there is uncertainty about the economic response to this shock. How do energy-intensive industries respond? Do global value chains collapse if intermediate goods produced in Europe become uneconomic because of high energy prices? Our preliminary analysis shows that industry response to has in fact been visible from the very onset of the energy crisis. A closer look at German fertilizer production, which heavily relies on natural gas as fuel and feedstock to produce ammonia as an intermediate product, reveals that increased ammonia imports have allowed domestic fertilizer production to remain remarkably stable.

## European industry responds to high energy prices

Since gas prices began to surge in September 2021, news emerged that energy-intensive industries were adjusting their production. Our mapping of press releases and news articles shows that these self-reported production adjustments are closely associated with European energy prices (Figure 1). Ammonia and aluminum industries were the first to reduce production in September-November, when natural gas prices rose above 50 €/MWh. Ammonia production re-increased in late 2021, which we discuss in more detail below. In March 2022, when natural gas prices increased above 200 €/MWh, more industries reported production cuts. Shortly afterwards, the paper industry reported to have ramped-up production again, when natural gas prices returned to a level of about 100 €/MWh.

While the ammonia, paper, and brick industries use natural gas as an input, steel and aluminum industries use electricity, of which prices were also rising as natural gas power plants are often setting electricity prices. However, electricity prices are much more volatile because of the variable generation from wind and solar energy. This becomes partly apparent in Figure 1, where daily averages are displayed, but prices fluctuate even more within days. Some steel and aluminum producers reported to exploit this volatility by responding to high electricity prices on a daily or shift-wise basis.



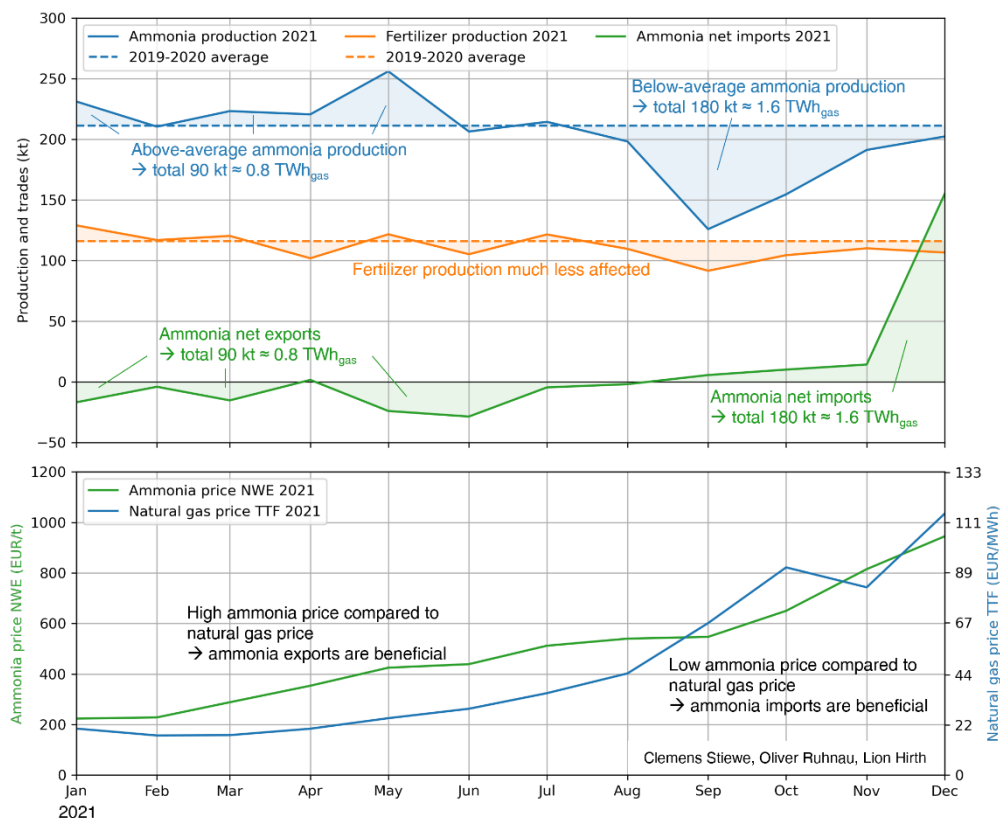
**Sources:** press releases of companies and associations, news articles. **1:** Yara reduces ammonia production in Europe by 40% due to high gas prices and imports ammonia instead, keeping the downstream fertilizer production running as usual; **2:** BASF reduces ammonia production in DE and BE due to high gas prices; **3:** SKW Priesteritz reduces ammonia production in DE by 20% due to high gas prices; **4:** Trimet reduces aluminum production by 30%; **5:** Yara re-increases ammonia production in Europe; **6:** Yara reduces ammonia production in Europe; **7:** Norske Skog stops paper production due to high gas prices; **8:** Several members of the German brick industry association reduce their production due to high gas prices in DE; **9:** Stahlwerke Lech stops steel production due to high electricity prices on a daily basis in DE; **10:** Salzgitter reduces steel production due to high electricity prices on a shift-wise basis; **11:** Trimet reduces aluminum production by 50% in Essen (DE); **12:** Norske Skog re-increases paper production.

Figure 1: Industry response according to press releases

## The case of German ammonia production

Ammonia production stands out as it already reacts with production cuts in September '21 and thus much sooner than other industries. European ammonia production then seems to be on a rollercoaster ride, ramping up production again before shutting once more in March '22. What has happened?

Ammonia, a key input for fertilizer production, is a gas that becomes liquid at -33 degrees Celsius and can be stored and transported in large cyrotanks, e.g., onboard a ship. Its tradability, as well as the fact that natural gas is the main cost component in its production, make it an interesting case study. We had a look at ammonia production and trade data for Germany, one of the largest EU producers of ammonia.



**Sources:** production and data from German Federal Statistical Office; **Notes:** NWE is the north-western European price for cost and freight (CFR); TTF is the Title Transfer Facility price in the Netherlands; the axis of the natural gas price is scaled by a factor of nine because 9 MWh of natural gas are used to produce 1t ammonia (based on IEA).

Figure 2: Ammonia production, trade, and prices for Germany

The top panel in Figure 2 displays production and trade data, yielding several interesting findings:

- In the first half of 2021, German ammonia production was above the 2019-2020 average; this increased output was exported
- German ammonia production took a massive hit in September 2021 and fell 40% below the 2019-2020 average
- With a 2-3 months delay, there was a massive spike in ammonia imports, making up for the curtailed domestic production
- Despite the significant adjustments in upstream ammonia production, downstream fertilizer production remained remarkably stable

These findings match with natural gas and ammonia prices (bottom panel in Figure 2). Until August 2021, ammonia prices were high compared to European gas prices, making exports attractive. After natural gas prices surged in the fall of 2021, the situation reversed, and domestic German ammonia production became uncompetitive. Put differently, it is the relative prices of natural gas and derived industrial base products that drive industrial demand response.

With approx. 9 MWh of natural gas being consumed to produce one metric ton of ammonia, we estimate a reduction of natural gas demand in Germany by around 1.6 TWh from September to December 2021. If domestic ammonia production was permanently reduced by the 40% observed in September 2021, this alone could save about 10 TWh or 3% of the annual natural gas demand of the German industry.

## Summary and conclusion

In summary, we find that industry is responding to high natural gas prices in the current energy crisis, and that the response of the ammonia industry alone is significant. Downstream industries, such as fertilizer production, do not necessarily need to break down because intermediate products may be substituted by imports. We illustrate how market prices coordinate the reduction but also the increase in the natural gas consumption.

We conclude that industrial demand response plays an important role in the current energy crisis. This role would even increase if supply from Russia was further reduced or cut altogether, because alternative sources of natural gas are limited (price-inelastic supply). Market prices are an effective means of coordinating demand reductions. If necessary, subsidies to the energy-intensive industry should be designed so that they do not dilute price signals.

## References

### Figure 1

1: Yara reduces ammonia production in Europe by 40% due to high gas prices and imports ammonia instead, keeping the downstream fertilizer production running as usual	<a href="https://www.reuters.com/business/energy/yara-brings-ammonia-europe-after-gas-price-hike-ceo-says-2021-09-20/">https://www.reuters.com/business/energy/yara-brings-ammonia-europe-after-gas-price-hike-ceo-says-2021-09-20/</a>
2: BASF reduces ammonia production in DE and BE due to high gas prices	<a href="https://www.basf.com/global/de/media/news-releases/2021/09/p-21-327.html">https://www.basf.com/global/de/media/news-releases/2021/09/p-21-327.html</a>
3: SKW Priesteritz reduces ammonia production in DE by 20% due to high gas prices	<a href="https://www.skwp.de/media-center/aktuelles/mitteilungen/presse-detail/skw-priesteritz-drosselt-ammoniakproduktion/">https://www.skwp.de/media-center/aktuelles/mitteilungen/presse-detail/skw-priesteritz-drosselt-ammoniakproduktion/</a>
4: Trimet reduces aluminum production by 30%	<a href="https://www.energate-messenger.de/news/217721/rohstoffknappheit-belastet-industrie-oft-staerker-als-hohe-energiepreise">https://www.energate-messenger.de/news/217721/rohstoffknappheit-belastet-industrie-oft-staerker-als-hohe-energiepreise</a>
5: Yara re-increases ammonia production in Europe	<a href="https://www.yara.com/corporate-releases/yara-ammonia-curtailment-volumeupdate/">https://www.yara.com/corporate-releases/yara-ammonia-curtailment-volumeupdate/</a>
6: Yara reduces ammonia production in Europe	<a href="https://www.yara.com/corporate-releases/yara-curtails-production-due-to-increased-natural-gas-prices">https://www.yara.com/corporate-releases/yara-curtails-production-due-to-increased-natural-gas-prices</a>
7: Norske Skog stops paper production due to high gas prices	<a href="https://industriemagazin.at/news/norske-skog-produziert-wieder/">https://industriemagazin.at/news/norske-skog-produziert-wieder/</a>
8: Several members of the German brick industry association reduce their production due to high gas prices in DE	<a href="https://www.energate-messenger.de/news/220811/gaspreise-ziegelindustrie-faehrt-teilweise-produktion-herunter">https://www.energate-messenger.de/news/220811/gaspreise-ziegelindustrie-faehrt-teilweise-produktion-herunter</a>

9: Stahlwerke Lech stops steel production due to high electricity prices on a daily basis in DE	<a href="https://www.faz.net/aktuell/wirtschaft/klimanachhaltigkeit/lech-stahlwerk-stoppt-produktion-wegen-gestiegener-strompreise-17866947.html">https://www.faz.net/aktuell/wirtschaft/klimanachhaltigkeit/lech-stahlwerk-stoppt-produktion-wegen-gestiegener-strompreise-17866947.html</a>
10: Salzgitter reduces steel production due to high electricity prices on a shift-wise basis	<a href="https://www.faz.net/aktuell/wirtschaft/klimanachhaltigkeit/lech-stahlwerk-stoppt-produktion-wegen-gestiegener-strompreise-17866947.html">https://www.faz.net/aktuell/wirtschaft/klimanachhaltigkeit/lech-stahlwerk-stoppt-produktion-wegen-gestiegener-strompreise-17866947.html</a>
11: Trimet reduces aluminum production by 50% in Essen (DE)	<a href="https://www.welt.de/wirtschaft/article237624811/Hohe-Energiepreise-Alu-Hersteller-Trimet-halbiert-die-Produktion.html">https://www.welt.de/wirtschaft/article237624811/Hohe-Energiepreise-Alu-Hersteller-Trimet-halbiert-die-Produktion.html</a>
12: Norske Skog re-increases paper production	<a href="https://industriemagazin.at/news/norske-skog-produziert-wieder/">https://industriemagazin.at/news/norske-skog-produziert-wieder/</a>

**Figure 2**

Production data: "Monatliche Produktionsdaten des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden", Destatis	<a href="https://www.statistischebibliothek.de/mir/receive/DESerie_mods_00005867">https://www.statistischebibliothek.de/mir/receive/DESerie_mods_00005867</a>
Trade data: "Aus- und Einfuhr (Außenhandel)", Destatis (code 51000-0006)	<a href="https://www-genesis.destatis.de/genesis/online">https://www-genesis.destatis.de/genesis/online</a>
Natural gas intensity of ammonia production: Ammonia Technology Roadmap, IEA	<a href="https://iea.blob.core.windows.net/assets/6ee41bb9-8e81-4b64-8701-2acc064ff6e4/AmmoniaTechnologyRoadmap.pdf">https://iea.blob.core.windows.net/assets/6ee41bb9-8e81-4b64-8701-2acc064ff6e4/AmmoniaTechnologyRoadmap.pdf</a>