## **Tech Neg --- LNG, Factory Farming**

### **Contention 1 is LNG**

#### **Energy independence and the economy is at an all-time high thanks to US LNG.**

**Yergin ’25** [Daniel and Jowdy, Madeline; February; Daniel Yergin is an American author, economic historian, and consultant within the energy and economic sectors. Yergin is vice chairman of S&P Global. He was formerly vice chairman of IHS Markit, which merged with S&P in 2022.[1][2] He founded Cambridge Energy Research Associates, which IHS Markit acquired in 2004; “The importance of US LNG for economic growth and the global energy transition”; Published 02/20/25;<https://www.atlanticcouncil.org/content-series/global-energy-agenda/the-importance-of-us-lng-for-economic-growth-and-the-global-energy-transition/>; DOA 04/11/25] manan

**The emergence of US liquefied natural gas (LNG) is a remarkable story. In less than a decade**, the **U**nited **S**tates has gone from zero exports to being the world’s largest exporter. Moreover, US LNG is at the nexus of the global energy transition, providing affordable and freely traded gas in a global market of some fifty importing countries. This flow promotes security of supply for regions such as Europe and East Asia, supports trade balances with China and India, and serves as a substitute for higher carbon-intensive energy sources in Southeast Asia and elsewhere.

The geopolitical importance and strategic urgency of the industry were demonstrated when Vladimir Putin cut pipeline gas to Europe in an effort to undermine the European economy and shatter the coalition supporting Ukraine. He miscalculated, failing to recognize the potential of US LNG to play a significant role in filling the gap. US LNG replaced 40 percent of the missing Russian pipeline gas. And the Trump administration is looking to US LNG exports to help rebalance trade with other countries.

The critical role of US **LNG is significant both for the domestic economy and on the international stage. For the continued growth of US LNG exports, it is essential that the** **U**nited **S**tates demonstrate, day in and day out, that it is a supplier on which other countries can rely. As US exports are projected to double in the coming decade, the influence of US LNG is expected to grow. However, despite a more favorable policy climate with the new administration, **further success is not guaranteed due to substantial federal and state regulatory, political, and environmental challenges** facing the industry, which will need to be addressed.

As the US LNG sector re-emerges after a year of stagnation caused by the Biden administration’s pause on LNG export authorizations, it is important to recognize the industry’s overall **contribution to US GDP, economic influence, and global LNG trade innovation**. In our new study Major New US Industry at a Crossroads: A US LNG Impact Study, conducted with the US Chamber of Commerce, we found that the US LNG industry is valued at **$34 billion** and has contributed more than **$400 billion** to US GDP since 2016, when the first LNG cargoes were shipped from Sabine Pass, Louisiana.1 The industry has created an average of 273,000 skilled jobs annually since 2016. Its impact penetrates deep into the heartland where gas is produced and transported, and supports supply chain and manufacturing communities in the Northeast, Midwest, and Southeast. What really brings home the industry’s impact is its comparison with other US industries. The value of LNG exports is more than that of soya beans and double those of Hollywood and entertainment exports. It is currently half that of semiconductors, but within a few years, could equal the value of all semiconductor exports.

What has made this unprecedented growth possible is the vast resource base developed during the US shale revolution, compounded by entrepreneurial energy, infrastructure, and industrial skill. Despite a 13 billion cubic feet per day (Bcf/d) growth in LNG feedgas requirements since 2016, **domestic wholesale gas prices have continued their downward trend**, with only temporary interruptions due to rapid post-COVID growth and geopolitical events such as Russia’s full-scale invasion of Ukraine in 2022.

While US LNG exports account for only 12 percent of the domestic gas market, they **supply nearly a quarter of global LNG supplies**, making the United States the world’s largest LNG supplier. This outsized role in the international gas market is supported by the flexibility and reliability of US LNG, which is traded with fewer restrictions on destinations, volumes, or pricing compared to much of the global LNG market. **Additionally, US LNG has significantly contributed to emissions reductions in countries that have replaced more carbon-intensive coal and fuel oil with LNG.**

In terms of trade, US LNG helps offset trade deficits with both Europe and China. In Europe, US LNG is viewed as a reliable and strategic supply mechanism, while in China, it helps mitigate the United States’ largest single trade deficit. US LNG exports to Japan, South Korea, and Taiwan also support energy security for these key allies.

Growth projections for US LNG, as analyzed by S&P Global, align with a global energy system transitioning to lower carbon-intensive modes of production and consumption. **With more favorable conditions under the new administration, US LNG exports are forecast to double by 2030**, with projects currently under construction accounting for approximately 60 percent of that projected growth.

With this anticipated growth, our LNG study projects that US LNG **industry is poised to contribute approximately $1.3 trillion to GDP by 2040 and create an annual average of 500,000 jobs**. On the global front, the US share of the LNG market is expected to exceed one quarter by 2040, supporting a large and liquid gas market that might not exist otherwise.2

#### **Cheap nuclear energy actively trades off with LNG.**

**Petti et al ’18** [Jacopo Buongiorno, Co-Chair Associate Department Head and TEPCO Professor, Department of Nuclear Science and Engineering, MIT Michael Corradini, Co-Chair Professor Emeritus, Engineering Physics, University of Wisconsin-Madison John Parsons, Co-Chair Senior Lecturer, Sloan School of Management, MIT David Petti, Executive Director Laboratory Fellow, Nuclear Science and Technology Directorate, Idaho National Laboratory; Visiting Research Scientist, MIT; “The Future of Nuclear Energy in a Carbon-Constrained World”; Published 2018;<https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf>; DOA 04/11/25 \*brackets og\*] manan

As can be seen in Figures 1.4a and 1.4b, which show system cost and system capacities, respectively, **imposing a carbon limit reduces the deployment and use of fossil fueled generation**. The figure shows this impact for Texas, but the result is generalizable to any power system. The effect of a carbon constraint on fossil fuel generation, at the specific level of that constraint, depends on the availability and cost of renewable resources. Reductions in fossil fuel capacity have a direct impact on the value of renewables, even when renewables are paired with energy storage, due to the lack of backup capacity during periods of rapid change in renewable output and the need to move greater amounts of energy from hours with higher renewable output to hours with lower renewable output. This increases system requirements for battery storage and for added renewable generation to act as backup capacity— and results in higher system costs.

Figure 1.4a shows that excluding the deployment of a firm low-carbon generation resource, like nuclear, noticeably increases system costs because it necessitates the deployment of less efficient forms of generation and energy storage to back up intermittent renewables. This effect is most pronounced at carbon emission targets below 50 gCO2/kWh (i.e., at 10 gCO2/kWh and 1 gCO2/kWh). Figure 1.4b also shows that **reductions in nuclear capital cost lead to nuclear deployment** not only in scenarios that feature near-zero emissions limits but also in scenarios with more modest emissions targets (100 gCO2/kWh and 50 gCO2/kWh).

The modeling results for installed capacity (Figure 1.4b) point to a further explanation for the higher system that result when nuclear is excluded as an option in scenarios with carbon constraints. With no nuclear contribution, large build-outs of wind, solar, and battery storage are required to meet a stringent CO2 constraint. This is evident in the 10 gCO2/kWh scenario and even more so in the 1 gCO2/kWh scenario, where total installed capacity in the no-nuclear case is two to three times total installed capacity in the nuclear nominal case. This significant increase in installed capacity comes at a large investment cost, which increases total system cost.

<<<Figures omitted>>>

Another way to understand these results is to infer the ‘marginal cost of carbon’ by looking at changes in system cost in relation to changes in the CO2 target. At progressively lower levels of allowable CO2 emissions, one could expect average electric system costs to increase, since lower cost, fossil fuel generation technologies (coal or **natural gas) are being replaced by higher-cost, low-carbon technologies** (renewables, **nuclear**, or natural gas with carbon capture and storage). The marginal cost of carbon is an equivalent way to characterize the effect of performance-based carbon emissions targets. Table 1.6 shows the estimated marginal cost of carbon based on the ratio of difference in electric system costs to difference in CO2 targets. As one would suspect, the **marginal cost of carbon increases as the emissions target becomes more restrictive**. The relationship is non-linear at less stringent emissions targets (i.e., 100–500 gCO2/kWh) so these values are lower bounds.

#### **Strong domestic LNG reduces Russian influence, limits European dependence, and enhances geopolitical stability**

**Watkins ’24** [Simon; April; former senior FX trader, financial journalist, former head of Forex Institutional Sales and Trading for Credit Lyonnais; Oil Price, “The Four Key Reasons Why the U.S. Will Never Stop Targeting Russia’s LNG Sector,”<https://oilprice.com/Energy/Natural-Gas/The-Four-Key-Reasons-Why-The-US-Will-Never-Stop-Targeting-Russias-LNG-Sector.html>] recut manan

Perhaps even more than its **targeting** of Russian oil exports, the U.S. has been **laser-focused** on its liquefied natural gas (**LNG**) sector as the key area it wants to **effectively destroy** over the long term. Last week’s suspension of Russia’s flagship Arctic **LNG**-2 project by lead operator Novatek is the latest of Washington’s trophies in this regard, but it is very unlikely to be the last. As U.S. Assistant Secretary of State for Energy Resources Geoffrey Pyatt said on 24 April: “[Novatek] has recently had to suspend production at its Arctic LNG-2 liquefaction facility, in part because of sanctions that the Biden administration has led.” He added: “We’re going to **keep tightening** the **screws** […] We’re going to **continue** to designate a **broad range** of entities involved in development of other **key** energy projects, **future** energy projects as well, and **associated infrastructure** including the Vostok Oil Project, the Ust Luga LNG Terminal, and the Yakutia Gas Project.” So, why is the U.S. so concerned about Russia’s LNG sector?

The first of four key reasons is that LNG has become the **most important** swing energy source in an **increasingly insecure** world. Unlike oil or gas that is transported through pipelines, LNG does **not require years** and **vast expenses** to build out a **complex** infrastructure before it is ready to transport anywhere. Once gas has been converted to LNG, it can be **shipped** and moved **anywhere** within a matter of **days** and bought **reliably** either through **short**- or **long**-term contracts or **immediately** in the **spot** market. Around a year before the Kremlin ordered the first Russian troops into Ukraine on February 24, 2022, China foresaw the critical significance of global energy dependency, as extensively discussed in my new book on the evolving dynamics of the global oil market. So, beginning in March 2021, a 10-year purchase and sales agreement was signed by the China Petroleum & Chemical Corp (Sinopec) and Qatar Petroleum (QP) for 2 million tonnes per annum (mtpa) of LNG. This was followed by several other major LNG deals prior to Russia invading Ukraine.

In the **zero-sum** game of **emergency global** energy supplies, China’s hoarding of LNG prior to the 2022 invasion meant that Europe – critically dependent on Russian gas and oil – would be even more **exposed** if these supplies **suddenly stopped**. Russia had been banking on this to produce the same response from Europe to its 2022 invasion of Ukraine as had occurred after its 2008 invasion of Georgia and its 2014 invasion of Ukraine and subsequent annexation of Crimea. That is, Russia **expected** Europe to do **absolutely nothing** meaningful to sanction its aggression. The Kremlin was nearly right in its calculations, with the effective leader of the European Union (**E.U.**) – Germany – only **concerned** about ensuring its **own continuity** of gas and oil supplies from Russia in 2022 at **all costs**, as also analysed in detail in my new book on the new global oil market order. Its **acquiescence** to Russian hostility yet again was only **stopped** when the U.S. with U.K. support in Europe and the Middle East worked to **establish new** emergency supplies of LNG from **elsewhere**. This determination to never again allow the **E**uropean **U**nion states to just **roll over** in the face of Russian **aggression** due to their **over-reliance** on Russian energy is the second **key** reason why the U.S. **continues** to mercilessly target its LNG sector.

The third reason is that energy exports remain the **foundation stone** of Russia’s essentially **petro-economy** and that it was intending to counterbalance the reduction of income from pipelined oil and gas with rises in LNG supplies. Indeed, according to comments from its Deputy Prime Minister Alexander Novak on 22 November last year, Russia **intended** its LNG market share to **rise** to **20 percent** (at least 100 million tons per year) by **2030**, from the current 8 percent (around 33 tons in 2023). As also analysed in my new book on the new global oil market order, Russia **earned** nearly US **$100 billion** from oil and gas exports during the first **100 days** of the war in **Ukraine**. Overall, **revenues** from the higher **post-invasion** oil and gas prices were **much greater** than the cost for Russia of continuing to fight the war. However, as prices started to weaken again and sanctions increasingly hit Russia, its finances and ability to secure an outright military victory have been significantly reduced. So desperate has the situation become for President Vladimir Putin that he risked arrest in December to visit Saudi Arabia’s Mohammed bin Salman, and the UAE’s Mohamed bin Zayed al Nahyan, to plead for greater cuts in OPEC oil production in order to push prices up. Again, in the zero-sum game of the global energy market, Russia’s LNG losses from sanctions will be a gain for the U.S. and those LNG suppliers it regards as allies, which now includes Qatar. As it stands now, the Emirate will account for about 40 percent of all new LNG supplies across the globe by 2029, according to comments from its government. The U.S. has **seen** its LNG exports go from **zero** before 2016 to around **124 billion** cubic metres (bcm) this year, and it is expecting another **124** bcm to come **online** by **2030**. Meanwhile, according to the International Energy Agency, Russia’s share of **internationally traded** natural gas is forecast to **fall** from just around **30 percent** in the year before it invaded Ukraine to about **15 percent** by 2030. Its revenue from natural gas sales is projected to drop from around US$100 billion in 2021 to less than US$40 billion by 2030.

The fourth and final reason why Washington is so **determined** to **effectively destroy** Russia’s LNG sector over the long term is that it is an industry so **closely associated** in Russia with President Vladimir **Putin** personally. He has **long seen** LNG – particularly from the country’s huge gas resources in the Arctic – as the key to Russia’s **next major phase** of energy growth, rather as shale oil and gas was for the U.S., as also detailed in my new book on the new global oil market order. The Russian Arctic sector comprises over 35,700 billion cubic metres of natural gas and over 2,300 million metric tons of oil and condensate, the majority of which are in the Yamal and Gydan peninsulas, lying on the south side of the Kara Sea. According to comments by Putin, the next few years will witness a dramatic expansion in the extraction of these Arctic resources, and a corollary build-out of the Northern Sea Route (NSR) – the coastal route of which crosses the Kara Sea - as the primary transport route to monetise these resources in the global oil and gas markets, especially to its key geopolitical and financial ally, China. Such was Putin’s determination to move ahead with Russia’s Arctic LNG projects that various heavyweight Russian entities were inveigled around the time the U.S. imposed its 2014 sanctions to finance key parts of them. The Russian Direct Investment Fund, for example, established a joint investment fund with the state-run Japan Bank for International Cooperation with each contributing half of a total of about JPY100 billion (then US$890 million) to it. The Russian government itself bankrolled Arctic LNG 1 from the beginning with money from the state budget. It then supported it again when sanctions were introduced by selling bonds in Yamal LNG (the first part of the Arctic LNG programs), and then by providing another RUB150 billion of backstop funding from the National Welfare Fund.

#### **Weakness greenlights Russian military aggression and funds Putin’s war machine---nuclear war.**

**Fridman ’24** [Ofer and Vera Michlin-Shapir; June 12; Professor of War Studies at King’s College London, Ph.D. in Politics from the University of Reading; Professor and Visiting Research Fellow at King’s College Russia Institute; Deciphering Russian Enigma, “The Military,” p. 105-136] recut manan

Notwithstanding the above evidence and indicators of Russian military weaknesses, a dialectic approach may reveal that reality appears otherwise, and that Russia remains a mighty bear. First, despite widespread corruption in the army, the military **budget** is still **high** and **growing**. **High oil prices** and militarisation of the **econ**omy could allow Putin to **continue invest**ing in his **war machine**. Second, Russia invested in the **development** of **tactical nuc**lear weapon**s**, as well as **lowered** its **threshold** for the use of **nuc**lear weapon**s** in ways that may challenge NATO’s nuclear strategy. Third, Russia’s personnel and leadership problems are overstated. It still has potential for **significant mobilisation** from the Russian **periphery**, and the military command has been battle-hardened by the war in Ukraine. In a potential conflict with NATO, morale is likely to be higher, as Russian people will feel more affinity to the cause. Lastly, the Russian military **build-up** is organised to **fight short**, **high-intensity** wars, which was not the case in Ukraine, but can still be threatening to certain NATO member-states on Russia’s borders. These factors should be a cause for concern for **NATO**.

Russia’s military expenditure is the fourth highest in the world, at $62 billion.60 This means that even when accounting for corruption, there are still great **funds available** for **investment** into **capabilities**. While unable to close the gap in the sphere of microchips, Russia has made decisive improvements in electronics 61 and modernised weapons and equipment.62 Furthermore, despite the **wealth** of **funds** at their **disposal**, they have made **cost-effective** military developments such as the Orlan-10 drone, a cheap and simple drone that exploits gaps in air defences.63 Russia has been able to **sustain** this **military expenditure**, despite the Western sanctions, as it demonstrated the willingness to bear the high costs for defence even during harsh economic conditions.64 Since the beginning of the war, Putin has militarised the economy, with defence industry factories working three shifts a day.65 As long as money from sales of **natural resources** is **flowing** into the budget, with the help of China and other non-aligned countries, Putin will be **willing** and **able** to **sustain very high levels** of military **spending**.

High Russian military **spending** means that the Kremlin has amassed a **vast** and **asymmetric nuc**lear **arsenal**. Russia has the most nuclear warheads in the world, with 6255, compared to the United States’ 5550.66 With the general absence of effective nuclear defence capabilities in the world, the implication of this arsenal is that Russia can inflict mass destruction on any country it chooses, something that warrants NATO’s attention and fear, especially given the lower threshold for use of nuclear weapons amongst Russian strategists in comparison to their Western counterparts.67 In addition to this, Russia has created an asymmetry with NATO in the sphere of nuclear weapons by developing an arsenal of tactical nuclear weapons, which NATO would struggle to find an appropriate response to.68 Ultimately, this puts the Kremlin in a position where it may be able to leverage nuclear weapons more effectively than NATO, which may struggle to find a suitable opportunity to use them at all.

#### **Extinction.**

**Farquhar ’17** [Sebastian, John Halstead, Owen Cotton-Barratt, Stefan Schubert, Haydn Belfield, Andrew Snyder-Beattie; 2017; associate member Senior Research Fellow at OATML Oxford at the University of Oxford; Ph.D., Agricultural and Applied Economics; DPhil in mathematics from the University of Oxford; PhD in philosophy and an MA in political science; research Associate and Academic Project Manager at the University of Cambridge's Centre for the Study of Existential Risk; PhD/DPhil in Zoology from the University of Oxford; Global Priorities Project, “Existential Risk: Diplomacy and Governance,”<https://www.fhi.ox.ac.uk/wp-content/uploads/Existential-Risks-2017-01-23.pdf>] recut manan

The bombings of Hiroshima and Nagasaki demonstrated the unprecedented destructive power of nuclear weapons. However, even in an all-out **nuc**lear **war** between the **U**nited **S**tates and **Russia**, despite horrific casualties, neither country’s population is likely to be completely destroyed by the direct effects of the blast, fire, and radiation.8 The aftermath could be much worse: the burning of flammable materials could send massive amounts of **smoke** into the atmosphere, which would **absorb sunlight** and cause sustained **global cooling**, severe **ozone loss**, and **ag**ricultural **disruption** – a nuclear winter.

According to one model 9 , an all-out exchange of **4,000 weapons**10 could lead to a drop in **global temp**erature**s** of around **8°C**, making it **impossible** to **grow food** for 4 to 5 years. This could leave some survivors in parts of Australia and New Zealand, but they would be in a very **precarious situation** and the threat of **extinction** from other sources **would be great**. An exchange on this scale is **only possible** between the **US** and **Russia** who have more than 90% of the world’s nuclear weapons, with stockpiles of around 4,500 warheads each, although many are not operationally deployed.11 Some models suggest that even a small **regional nuc**lear **war** involving 100 nuclear weapons would produce a nuclear winter serious enough to put two billion people at risk of starvation,12 though this estimate might be pessimistic.13 Wars on this scale are **unlikely** to lead to outright human **extinction**, but this does suggest that conflicts which are around an order of magnitude larger may be likely to threaten civilisation. It should be emphasised that there is very large uncertainty about the effects of a large nuclear war on global climate. This remains an area where increased academic research work, including more detailed climate modelling and a better understanding of how survivors might be able to cope and adapt, would have high returns.

It is very difficult to precisely estimate the probability of existential risk from nuclear war over the next century, and existing attempts leave very large confidence intervals. According to many experts, the most likely nuclear war at present is between India and Pakistan.14 However, given the relatively modest size of their arsenals, the risk of human **extinction** is **plausibly greater** from a conflict between the **U**nited **S**tates and **Russia**. Tensions between these countries have increased in recent years and it seems unreasonable to rule out the possibility of them rising further in the future.

### **Contention 2 is Factory Farming**

#### **Resource overuse makes factory farming unsustainable.**

**Timms '16** [Matt Timms; American promoter of food events; 07-16-2016; "Why **factory farming is no longer sustainable**"; World Finance; https://www.worldfinance.com/strategy/why-factory-farming-is-no-longer-sustainable; accessed 03-27-2025] leon

This same **dependence on animal protein feeds into much more prescient issues concerning land use, resource scarcity and climate change, all of which threaten to** unseat China as a shining beacon of prosperity and **wreak havoc on its population’s health and wellbeing**. As damning a situation as China’s is, it is but a glimpse of the long-term implications associated with industrialised meat production, and the practice itself could well become the next big risk for investors.

Steven Heim, Director of ESG Research at Boston Common Asset Management, cites methane emissions and antibiotic use as the two issues most deserving of attention on the investor front. Speaking to World Finance, he emphasised that these risks and others must be taken into account if investors wish to avoid future damages. More than anything, **the scale of the industry and the extent to which it has been allowed to grow unchallenged should give people** – investors in particular – **reason to feel anxious**. The industrialisation of farming has only recently been subjected to the same pressures as items such as fossil fuels.

To date, **more than 70 percent of the world’s farm animals reside in factory farms**, and larger feedlots are known to contain upwards of 100,000 cattle or 500,000 broiler chickens living in close proximity. The share in the US is closer to 99 percent, and as demand for animal products in developing countries increases at a rapid pace, **we should expect to see the global percentage climb higher still**.

**A number of** ‘**advances**’ in farming since the mid-1970s in particular **have made the practice itself more** ‘**efficient**’ **and effectively transformed the old image of farming into something that resembles a sprawling, windowless machine**. The use of antibiotics from that point onwards has facilitated the crowding of animals into tighter and tighter spaces, and the realisation that these same drugs facilitate faster growth again means antibiotics have become an integral part of the process.

These ‘innovations’ and others mean the average US dairy cow today provides more than 2,300 gallons of milk a year, compared to 665 gallons in 1950. Chickens now reach slaughter weight at 47 days of age as opposed to 70. **As much as profit-hungry companies have welcomed these** ‘new and improved’ **methods, they carry a number of risks for investors**.

**A recent report by FAIRR outlined these risks on the investor side**, which – willingly or not – have a stake in factory farming and could lose out to its very many uncomfortable truths. **On a macro level, the livestock sector accounts for 14 percent of global GHG emissions** – more than the transport sector – and, in the US, 80 percent of all antibiotic use. It is the number one consumer of water in drought-stricken California and the topmost reason for the spread of bird (H5N2) and swine (H1N1) flu – **with the former responsible for a staggering $3.3bn in industry losses**.

On a smaller – albeit still significant – scale, the **issue of antibiotic overuse has investors rightly concerned about the rise of drug resistant bacteria**. The farms in question provide the perfect conditions for new strains to develop and spread, and without measures to protect against the spread of disease, large-scale epidemics and human infection could ensue.

What to do?

All in all, th**e FAIRR report identified 28 ESG issues that threaten to exert a negative financial impact on any company with connections to factory farming**. **The repercussions can be colossal**, ranging from safety scandals to environmental fines and an overreliance on government subsidies. **Regardless of this, however, the risks tied to factory farming seldom register with offending companies, and efforts to raise awareness in the past have largely come up short**.

#### **Energy shortages limit farming.**

**Benoit '23** [Marc Benoit; Senior Researcher; Anne Mottet; Researcher specializing in livestock; February 2023; "Energy scarcity and rising cost: Towards a paradigm shift for livestock"; Science Direct; https://www.sciencedirect.com/science/article/abs/pii/S0308521X22002219; accessed 03-27-2025] leon

The current **global energy scarcity is leading to a sharp increase in its price and indirectly in the price of feed**. Therefore, **the large part of animal production** that relies on cereals, pulses and cultivated forage **will experience a sharp loss of competitiveness**. The low energy efficiency of animals makes these arable land-based (ALB) livestock systems very vulnerable to the current energy crisis. The **increase in production costs could lead to a sharp rise in the price of animal products**. If entirely reflected in product prices, **this increase in production costs would lead to a significant drop in consumption** in the context of reduced purchasing power. Therefore, the risk of a drop in income for farmers is real. To avoid this scenario, we proposed that two consequences seem unavoidable for livestock farming systems: i) the reduction of arable land dedicated to the production of animal feed, as other markets will be more profitable, and ii) a switch to feeding strategies based on low opportunity land and raw materials from which livestock production is most likely to benefit, i.e., low-quality resources that are difficult to harvest. **This would result in a reduction in animal numbers and a redistribution of livestock in agricultural landscapes**, a change in the types and traits of farm animals, an adaptation of supply chains and a rebalancing of diets. Such an evolution of livestock farming should also respond to other major challenges, such as climate change and feeding humanity.

Graphical abstract

Keywords

Competitiveness; Efficiency; Diet; Animal feeding; Services; Public policies

1. Introduction

**Humanity has been drawing on easily accessible terrestrial resources, including oil, constituted over hundreds of millions of years**. The Russo-Ukrainian war highlights the challenges of this dependence on fossil fuels (Jagtap et al., 2022) as well as the tensions between the demand for food products and the availability of agricultural land. Globally, **this is leading to a significant increase in the price of raw materials** (Benton et al., 2022). **Agriculture is indeed an integral part of the food-energy nexus**. **Energy is an essential production factor in agriculture**, and agricultural land can also be dedicated to the production of energy. In the long term, the substitution of renewable energies for fossil fuels cannot be achieved without the more or less direct use of solar energy, part of which can be captured via photosynthesis on agricultural land, or more directly, by photovoltaic cells or heat collectors. **The Earth's emerged area will therefore be subjected to increased competition for land use**: plant production for human food and animal feed, **industrial use, infrastructure** (e.g., mobility), housing **and energy production**. Arable land, which can produce biofuels (corn, sugar beet, sugar cane, palm trees…) and biomass for anaerobic digestion (methane), is the most concerning. Other energy production methods, such as photovoltaic electricity, wood energy, or even hydraulic energy, can use areas with less agronomic potential (Fig. 1a). The **scarcity and increasing cost of energy along with competition for the use of land** - arable land in particular - **will lead to a lower profitability and competitiveness of the livestock sector** for these production systems that rely on cultivated feed. **This is likely to lead to the contraction of this sector** (Fig. 1b and c). In this article, we focused on livestock whose feed is based on arable land. We will thus refer to “arable land based” (ALB) animal or livestock systems. These systems cover beef feedlots, industrial broilers, layers and pig production, which together account for 43% of global livestock protein production, and mixed ruminant systems (using both pasture and arable land), which account for 30% of global livestock protein production; the remaining 26% are produced by grazing and backyard systems (Mottet et al., 2017). ALB livestock systems consume approximately a quarter of global cereal production and use 26% of global arable land. We proposed that the adaptation of ALB livestock farming systems, forced or anticipated, is unavoidable. We analysed the agronomic and economic mechanisms at work and present possible adaptation pathways while reconsidering the notion of production efficiency.

#### **Nuclear energy boosts industrial agriculture.**

**Bertsch ‘21** [Paul Bertsch; 30 years of experience in soil science and hydrobiogeochemistry + former professor of environmental and soil chemistry @ University of Georgia and former Director of Tracy Farmer Institute for Sustainability and the Environment; 08-16-2021; “How clean power can transform the “food-energy-environment trilemma””; Australian Water Association; https://www.awa.asn.au/resources/latest-news/technology/innovation/how-clean-power-transform-food-energy-environment-trilemma; accessed 03-27-2025] BZ + leon

While the current economic challenges to upfront infrastructure and energy costs have led the emerging industry to focus on high value fruits and vegetables, a recent study demonstrates that even wheat **production would be several hundreds-of-times higher per ha when produced in vertical CEA, with all of the accompanying environmental benefits outlined above** (Asseng et al, 2020).

**The largest obstacle for CEA to totally disrupt traditional agriculture is the relatively high cost of energy and access to readily available renewable energy from** wind, solar, and green hydrogen and other zero emission energy sources, such as **advanced nuclear technologies and small modular reactors** (SMRs).

The green energy transition: reimagining the nexus and solving the trilemma

To transform our food production system and reap the environmental and climate benefits will require a transformation of our energy system. **Creating more affordable zero-emissions energy sources will drive the cost of electricity down and make these new food production systems economically feasible, especially when factoring in the carbon and biodiversity credits that will accompany this transition**.

#### **Reform won’t happen.**

**Torrella '25** [Kenny Torrella; Journalist at Vox; 01-09-2025; "4 reasons why **factory farming still exists**"; Vox; https://www.vox.com/future-perfect/393738/factory-farms-meat-dairy-production; accessed 03-27-2025] leon

1) **It’s efficient** — by some measures

**For all of factory farming’s problems, it can claim superiority on a few key metrics when compared to more traditional farming**, where slower-growing animals are given ample space and outdoor access.

In factory farms, **the animals are packed indoors or on feedlots, so they require less land, and breeding them to grow bigger and faster on less food has brought down meat’s carbon footprint on a per-pound basis**. These aspects — combined with the other ways the industry cuts corners on animal welfare, and sustainability and labor protections — have made meat cheaper. **And price is often priority number one for consumers**: Look at recent discourse over inflation and the cost of eggs, or the 1910 and 1973 nationwide meat boycotts over rising prices.

But for all the efficiency gains the meat industry has made in recent decades, they have been partly squandered by Americans eating a lot more meat and dairy than previous generations. It’s what’s called the Jevons paradox: Increased efficiency can lead to increased consumption.

And this takes a narrow view of efficiency. Plant-based protein, such as lentils, tofu, beans, and plant-based meat, typically require less land and have much smaller carbon footprints than animal-based protein.

**Factory farming has also created a new set of problems** — what you could call inefficiencies — that Americans, and animals, ultimately pay for.

2) **Agriculture plays by its own set of rules**

Packing thousands or millions of animals together in one facility creates concentrated air and water pollution that harms rural Americans’ health and fouls US waterways. **Slaughterhouse workers risk losing a finger or limb every day they go to work**. The millions of pounds of antibiotics used to keep factory-farmed animals alive puts us all in danger by making these lifesaving drugs less effective. Certain practices, such as locking animals in cages for years or slicing off their body parts without anesthesia or even painkillers, are considered standard “animal husbandry” when done to farmed animals, but torture when done to pet dogs or cats.

**The livestock industry gets away with all of this because of a concept called agricultural exceptionalism**: **the idea that because food is essential, the agriculture sector should be exempt from the laws** that other industries must follow.

Farm pollution is largely exempt from the Clean Air Act and the Clean Water Act, while farmed animals are exempt from the Animal Welfare Act and most state anti-cruelty laws. The few federal laws that do provide some (meager) protections for farmed animals exempt chickens and turkeys, who account for almost 99 percent of the country’s livestock.

Take these exemptions away, and factory farming is suddenly not so efficient nor affordable. In this way, factory farming’s advantages are somewhat of an illusion, as the system relies on the American public, the environment, and farmed animals to absorb its inefficiencies.

**Efforts to remove these exemptions and pass major industry reforms have largely failed** because the meat and dairy sectors have amassed enormous political power on Capitol Hill and in state legislatures to block them.

3) **Animals don’t have rights**

Social progress starts with a problem’s victims sharing their stories and calling for change. But in the case of factory farms, its most immediate victims — chickens, pigs, cows, and fish — obviously can’t do so. While some fight back in their final minutes at the slaughterhouse, and a lucky few even manage to escape, farmed animals can’t lobby Congress, write op-eds, or organize demonstrations to protest their abuse to gain even the most basic rights.

In this sense, **animals are perhaps the most politically disenfranchised group**, which gets at the core of why factory farming is still around: In our legal system, **you can do pretty much whatever you want to an animal so long as they’re raised for food**.

**Animals rely on a tiny, underfunded movement to push for change**. Its efforts to institute common sense reforms, like banning cages, mutilations, low-welfare breeding practices, and overcrowding — and requiring things like more space, outdoor access, and enrichment — face strong pushback from industry.

4) **The meat paradox**

**Consumers also bear some responsibility**.

**Many Americans**, and people in other high-income countries, are avowed animal lovers and say they oppose factory farming yet **continue to eat meat** — virtually all of it from factory farms — anyway. **This seeming contradiction can be explained by the** “**meat paradox**.” A group of Australian psychologists coined the term in 2010, defining it as the “psychological conflict between people’s dietary preference for meat and their moral response to animal suffering.” As I wrote a few years ago in a story about the meat paradox:

When faced with that dissonance, we try to resolve it in a number of ways. **We downplay animals’ sentience or make light of their slaughter**… we misreport our eating habits (or dismiss personal responsibility altogether), **or we judge others’ behavior so as to claim the moral high ground**…

On top of all this, **consumers face a sea of mis- and disinformation**, from meat companies lying about how they treat animals, to Elon Musk falsely stating that agriculture doesn’t contribute to climate change, to industry-funded front groups slandering their competitors — plant-based meat companies — in the court of public opinion.

#### **Factory farms are an s-risk.**

**Browning '22** [Heather Browning; University of Southampton & London School of Economics and Political Science; Walter Veit; University of Bristol & Munich Center for Mathematical Philosophy; 2022; "Longtermism and Animals"; https://philsci-archive.pitt.edu/21572/1/BrowningVeit2022longtermism\_animals\_preprint.pdf; accessed 03-28-2025] leon

**There are vastly more animals on the planet than there are humans**. Even if we only count vertebrates (as these may be the only animals we can currently reliably identify as sentient and thus capable of morally relevant states of pleasure and suffering), **there are over 100,000 animals for every human** (estimated 10^11 and vertebrates and 10^15 ocean to 10^10 humans) (see Bar-On et al. 2018). While many wild populations are shrinking, **numbers of domesticated animals, particularly in agriculture, are rising**. Every year, **somewhere around 90 billion fishes, 70 billion chickens, 300 million cows, 1 billion sheep and goats, and 1.5 billion pigs are raised and killed for food**1, and an additional 1-3 **trillion fish taken** from the oceans2. **This is more annually than the number of humans that have ever existed**. These numbers are hard to even conceptualize, and yet, they would grow even more if we were to consider the human impacts on invertebrates. If **current production and consumption habits were to remain unchanged, it is clear that there would continue to be exponentially more animals than there are humans**. Thus, if the long-term future matters because of the large number of humans it contains, it should equally matter for the even larger number of animals. **Animal welfare concerns will be a high priority simply because there are just so many of them**.

**One way to resist this could be to argue that although there are many animals, they should count for less in our calculations of expected value**. We will take it here as uncontroversial that animal welfare should count for something under most conceptions of value. This is not a conclusion that requires postulating equality between the interests of a fish and the experience of a human, though it can unfortunately often be dismissed on such grounds. **We can accept that species membership may change the strength of interests**, or the total level of pleasure or suffering experienced, such that animals will be weighted differently in calculations to humans. **What is often neglected in making this point, however, is that even if it were granted**, unless we assigned only an extremely low weighting to animals, **the sheer numbers of animals mean that they are still likely to dominate humans by several orders of magnitude**. The failure of comprehension that longtermists try to combat regarding the number and importance of future humans, is seemingly still at play when considering the number of current and future animals. Our arguments here emphasize the urgent need for interspecies comparisons of welfare. It is only through performing such comparisons that we can make the necessary calculations to determine in which cases animal or human considerations will dominate. **The interspecies comparison problem is a complex one** (see Browning forthcoming for some discussion) and research into it should form a priority for any longtermist research program.

One could also counter that although there are undoubtedly currently more animals than humans, that this won’t be the case in the future. For example, we might think that the societal shifts we can currently see in the rise of veganism mean that factory farming will be phased out at some point in the medium-term future, so these animals will not exist in the long term. We will address this concern further when we talk about this intervention, but here we will just note that it is not at all obvious that this will actually be the case, without more action than is currently being taken. Or we might think that the number of wild animals will decrease, as we head into another potential mass extinction event. However, even if such an event does occur, it will be a reduction in species diversity, not necessarily a reduction in total numbers – those animal species that do well in human-altered environments (such as urban pests) are likely to continue to thrive. For example, climate change could alter the distributions of species such that insect populations are able to expand further north and south, increasing the numbers of these animals even if some larger animals decline (Sebo 2022).

Lastly, we might think that when humans move out to colonise other planets we will do so without other animal species, and thus our future growth will vastly outstrip theirs. In particular, if we think that it is the small probability of this large explosion in human population size that creates most of the expected value of the far future (e.g. Tarsney 2020), then this will be the most important determination of whether or not animals will also count. There is no simple reply to this. The details will depend a lot on the specific methods used in interstellar expansion, which would currently seem to be an open question, dependent on future technology. However, there are a couple of ways in which animals would remain an important source of value in terms of their numbers. The first is if we continue to use agricultural animals as a means of sourcing easy protein, as may particularly be the case when setting up new settlements. The second is if we colonise by way of terraforming, in creating planetary ecosystems to support human and other forms of life. Even if the number of animals taken to begin such processes is small, creation of any flourishing ecosystem is going to very quickly lead to a large number of animals. In the end, there is a lot of uncertainty here and unless we are quite sure of these alternative outcomes, we still have reason to believe that there will be very high numbers of animals in the future. As longtermists like to point out, even small probabilities ought to have a lot of moral impact, if their outcomes are sufficiently bad (or good for that matter).

2.2 **Suffering**

As well as there being lots of animals (both now, and expected in the future), **many of these animals will have bad lives**. In the words of Beckstead there are: “an astronomical number of expected future beings with lives that are suboptimal, and a future whose trajectory is potentially influenceable” (92). Though he was talking about pessimistic estimates of the lives of future humans, the same applies even more strongly for animals. **There is thus a great amount of future suffering that we can potentially prevent**.

From the numbers we presented above, **we can see that almost 75% of land vertebrates live in agricultural systems**, a fact that may surprise anyone who has a different picture of large swaths of nature untouched by humans. **These systems are well-known for the suffering caused to the animals** (Gruen 2011, Harrison 1964, Singer 1975). Most **broiler chickens spend their lives in windowless sheds with under one square foot per bird**; **their beaks are trimmed using hot blades** to decrease the aggression brought on by the crowded conditions. **They frequently suffer leg deformities** and lameness from ongoing selective breeding for rapid growth. **Sows used for breeding are often kept in tiny stalls in which they are unable even to turn around**, with few cognitive or behavioural challenges/opportunities and no access to nesting materials to fulfil their strong drive for nest-building. **For many**, if not most, of these animals, **there are almost certainly ongoing negative experiences and few opportunities for positive experiences** and their lives are highly likely to contain more suffering than pleasure. **If current agricultural practices were to continue like this into the future, there would be ongoing suffering at a large scale**. Again, one may counter that we should not expect high levels of future animal suffering simply based on current circumstances. **If factory farming is going to end, or if conditions are going to vastly improve, then we will not have future suffering of food animals**. As we will argue in what follows, even if this is true we may still see huge benefit in speeding up the trajectory.

#### **Animals feel more pain than humans.**

**Dawkins ‘17** [Richard Dawkins; British ethologist, evolutionary biologist, and author, an emeritus fellow of New College, Oxford, and was the University of Oxford's Professor for Public Understanding of Science, 09-02-2017; “Richard Dawkins: No Civilized Person Accepts Slavery So Why Do We Accept Animal Cruelty?”; transcribed from https://www.youtube.com/watch?v=\_4SnBCPzBl0&feature=emb\_title&ab\_channel=BigThink; accessed 12-15-2020]

**There’s absolutely no reason as far as I can see why a nonhuman animal, a dog or a chimpanzee or a cow, should be any less capable of feeling pain than we can**, when you think about what pain is actually doing. **Pain feels like something primitive, feels like something like seeing color or smelling a rose or something like that**. It doesn’t feel like the kind of thing for which you need intellect. And actually you can go even further than that. You might say **since pain is there to warn the animal not to do that again, an animal which is a slow learner, and animal which is not particularly intelligent might actually need more intense pain in order to deter it from doing that again than a human** who is intelligent enough to learn quickly not to do that again. **It’s even possible that nonhuman animals are capable of feeling more intense pain than we are**. I’m not sure how far I want to push that argument, but I think at least I can say there’s absolutely no reason to suppose that they feel less pain than we do and we should give them the benefit of the doubt.

#### **S-risks from animal suffering comparatively outweighs human extinction**

**Bruers 18 –** Stijn Bruers, Professor in the Department of Philosophy and Moral Sciences at Ghent University, PhD in Physics and PhD in Moral Philosophy, “My Cause Prioritization”, 2-15, https://stijnbruers.wordpress.com/2018/02/15/my-cause-prioritization/

But there is a class of catastrophic risks that is **even worse than X-risks**: S-risks or **suffering risks**, where the future contains huge populations of sentient beings with lives full of misery. **This is worse than extinction**, because an S-risk is **terrible** **both** from a total view as well as from a person affecting view.

An example of an S-risk is space colonization where we **export** wild **animal suffering and livestock farming**: the number of animals with lives not worth living will multiply when other planets are colonized. Before we start with space colonization, we should first adopt veganism and antispeciesist values such that we will not export and multiply animal suffering.