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THE GERMAN NUCLEAR PHASE-OUT

The true cost in lives, money, and carbon of Germany's Atomausstieg

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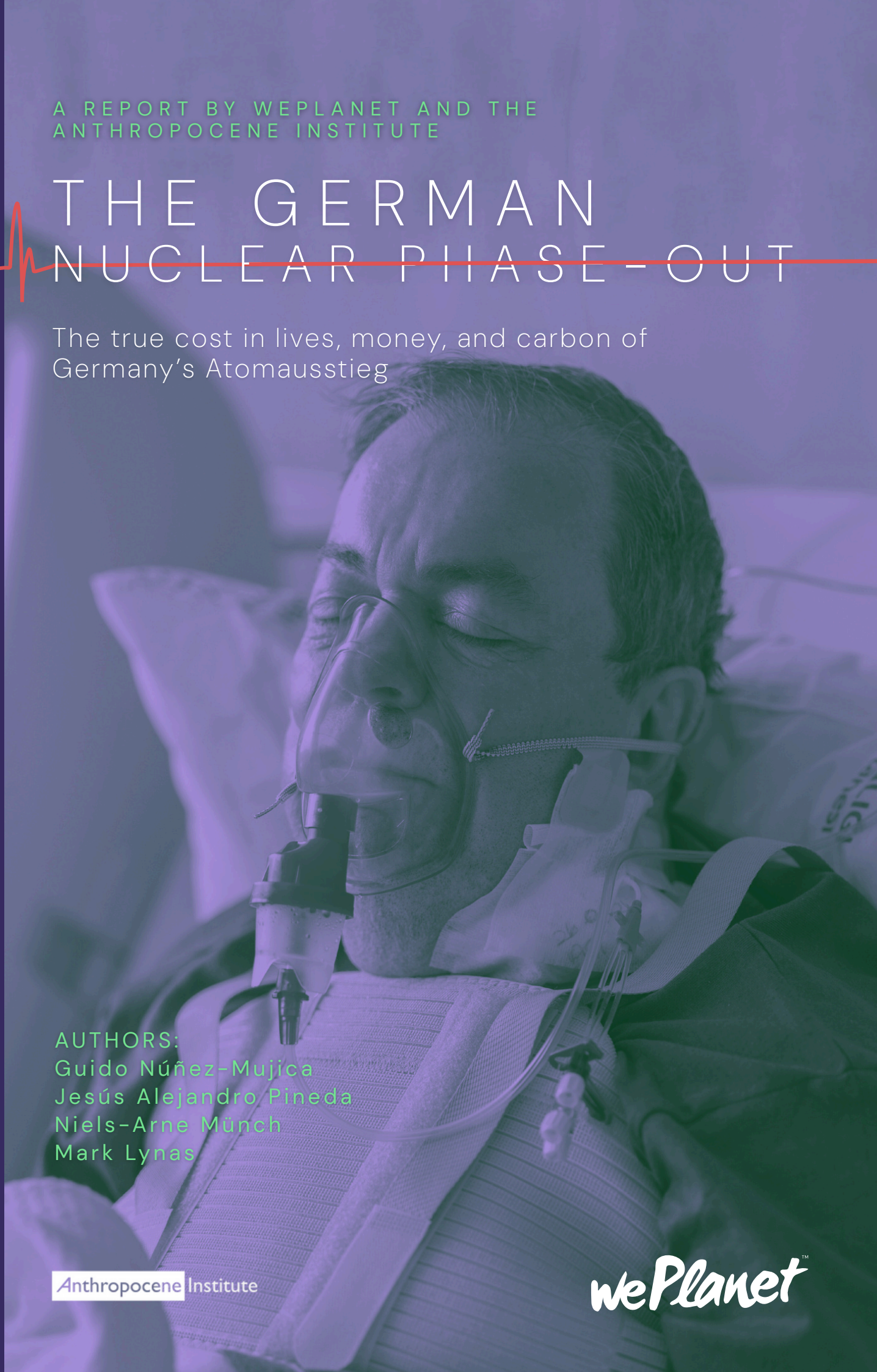

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CONTENTS

KEY FINDINGS

- **Nuclear phase-out:** Between 2011 and 2023, Germany shut down 17 reactors, removing **800 TWh** of zero-carbon electricity — equivalent to about **two years of national demand.**
- **Replacement energy:** The lost generation was replaced almost entirely by fossil fuels **(98% coal, 2% gas)**, rather than by additional renewables.
- **Climate impact:** This substitution caused an additional **730 million tonnes of CO_2 emissions** — more than all of Germany's 2024 annual greenhouse gas emissions.
- **Health impact:** Increased coal burning would have led to an estimated **19,200 premature deaths** and **177,000 serious illnesses** from air pollution, based on WHO health impact factors.
- **Toxic pollutants:** The phase-out also added **4 tonnes of mercury, 2.5 tonnes of cadmium,** and **20 tonnes of lead** to the wider environment.
- **Economic cost:** At early September 2025 EU ETS carbon prices of €78 per tonne, the extra CO_2 equates to roughly **€57 billion**, or about **€1,390 per German household.**

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EXECUTIVE SUMMARY

In the summer of 2011, in the immediate aftermath of the Fukushima nuclear accident in Japan, Chancellor Angela Merkel made one of the most consequential reversals in German energy policy. Only a few months earlier, her government had extended the lifetimes of Germany's reactors. But following the events in Fukushima, she ordered the immediate closure of **eight fully operable nuclear power plants**. This decision, driven entirely by public fears of atomic risk rather than any technical necessity, marked the beginning of the accelerated nuclear phase-out in Germany, a process that had begun with the SPD-Green coalition back in 2000. Between 2012 and 2023, a **further nine reactors** were shut down under the framework of Germany's *Atomausstieg* ("nuclear exit"). By April 2023, all commercial nuclear power plants in the country were offline, ending more than half a century of nuclear generation.

Before the phase-out, nuclear plants had provided around **25% of Germany's electricity supply**. Their closure created a major gap in the power system. While renewables such as wind and solar expanded rapidly during the same period, the loss of nuclear capacity meant that fossil fuels — particularly coal, and to a lesser extent natural gas — were relied on to maintain security of supply. Coal stations that might otherwise have been retired were kept open for longer, and coal burn remained significantly higher than it would have been if renewables had replaced fossil fuels rather than nuclear. In effect, Germany substituted a zero-carbon technology for fossil generation.

In this study, we set out to quantify the consequences of this decision. Using real-world generation data from 2011 to 2023, we calculated how much electricity would have been produced had all the reactors remained in operation, and how much fossil generation was instead required to fill the gap. Our results are stark. We estimate that **800 terawatt-hours (TWh)** of nuclear output was lost over this period — close to two years of Germany's total electricity demand.

The environmental and health consequences are profound. We calculate that the additional fossil generation led to **730 million tonnes of greenhouse gases** being released into the atmosphere. To put this into perspective, Germany's entire emissions in 2022 were about 750 million tonnes — meaning that the nuclear exit added the equivalent of an extra year of national emissions. Coal combustion also produces toxic air pollutants such as fine particulates, sulphur dioxide, and nitrogen oxides. Using standard World Health Organization health impact factors, we estimate that this additional coal burning resulted in around **19,200 premature deaths** and **177,000 serious illnesses** due to air pollution.

This finding is striking when compared with the legacy of nuclear accidents. The near-20,000 deaths attributable to air pollution from Germany's nuclear exit are roughly **five times higher than even the most pessimistic estimates of the death toll from Chernobyl**. By phasing out nuclear in the name of safety, Germany inadvertently exposed its population to far greater risks from coal. And while Chernobyl was a one-off disaster of a particular time and reactor type, coal pollution is a part of normal operation. Beyond climate and health effects, coal plants also emit toxic heavy metals. We estimate that the nuclear phase-out led to an additional **4 tonnes of mercury**, **2.5 tonnes of cadmium**, and **20 tonnes of lead** being released into the environment over the past decade.

There are also major economic implications. Because Germany's power sector is part of the EU Emissions Trading Scheme (ETS), every tonne of CO_2 emitted must be covered by purchasing carbon allowances. At a current (beginning of September 2025) ETS price of €78 per tonne, the extra **730 million tonnes of emissions** corresponds to a cost of nearly **€57 billion**. Spread across 41 million German households, this equates to around **€1,390 per household** in higher costs — a burden ultimately reflected in higher electricity prices. Indeed, Germany now has among the highest household electricity prices in Europe, a factor that has contributed to rising concerns about industrial competitiveness, deindustrialization, and job losses.

The irony is that this outcome was driven by the political party most committed to fighting climate change. The Greens, whose roots lie in the anti-nuclear movement of the 1970s and 1980s, were the strongest advocates of *Atomausstieg*. Yet by achieving this long-sought goal, they unintentionally locked Germany into at least a decade of higher emissions, greater air pollution mortality, and higher costs for households — outcomes at odds with their central claim that climate change is the defining challenge of our time. This contradiction highlights the broader dilemma of the German energy transition: the pursuit of one ostensibly environmental goal (the end of nuclear) has undermined progress on another, arguably far more urgent one (the reduction of greenhouse gas emissions).

INTRODUCTION

Germany's nuclear phase-out is one of the most remarkable policy shifts in modern energy history. It is both admired and criticized, both hailed as visionary and condemned as reckless. Few other decisions in postwar Europe have shaped a country's energy, climate, and economic trajectory so profoundly. The policy is even more striking because it represents a conscious *Sonderweg* — "special path" — that runs counter to international trends. At a time when many countries are extending the lifetimes of their reactors, planning new units, or even reconsidering nuclear power in the face of climate change, Germany has moved in the opposite direction. This divergence raises pressing questions: why did Germany, once home to a technologically advanced nuclear program, choose to dismantle it? What historical, political, and cultural forces drove this choice? And what have been the consequences for energy security, the climate, and society at large?

The decision to abandon nuclear power did not occur in a vacuum. It was the outcome of a complex interplay of factors: deep cultural traditions sceptical of industrial modernity, the legacy of post-war politics, the rise of the Green Party, the economic interests of the coal industry, public fear of radiation amplified by Chernobyl and Fukushima, and repeated failures in industry management and communication. Together, these forces created a uniquely German context in which nuclear power, despite being low-carbon and extremely safe, was gradually delegitimized.

Understanding the chronology of reactor closures is essential for grasping the broader story. The timeline reflects not only technical decisions but also moments of political drama. According to the initial decision to phase out nuclear power made by the Schröder government (SPD) in 2001, the remaining lifetime of the nuclear power plants was determined by "electricity quotas". However, until 2010, only two of the oldest reactors had actually been shut down. The Merkel government (CDU) initially sought to reverse the phase-out decision, deciding in November 2010 to extend the operating life of the remaining 17 nuclear power plants — only to perform an about-turn three months later in the wake of the Fukushima accident. Eight reactors were immediately shut down in a moratorium that was later extended to a permanent decision, while the rest were left operating for the time being with shortened periods. In 2023, despite an ongoing energy crisis and rising public support for nuclear power, the final units were switched off.

Merkel's decision after Fukushima was driven by fears about the risks of atomic power, even though the Japanese accident occurred under conditions impossible in Germany – this is a country that does not experience tsunamis at inland nuclear sites, and reactor designs were also different. However, between 2012 and 2023, a further nine plants were closed as part of the legislated Atomausstieg ("nuclear exit"). By April 2023, every nuclear power plant in the country had been shut down, ending more than half a century of German nuclear energy production.

TABLE 1: GERMAN NUCLEAR POWER STATIONS AND DATES OF SHUTDOWN

Plant	Reactor type	Net capacity (MWe)	Final shutdown date	Off grid (if different)
Biblis A	PWR	1167	6 Aug 2011	18 Mar 2011 (moratorium)
Biblis B	PWR	1240	6 Aug 2011	18 Mar 2011 (moratorium)
Brunsbüttel	BWR	771	6 Aug 2011	Idle since 2007; off-grid 2011
Isar 1	BWR	878	6 Aug 2011	17 Mar 2011
Krümmel	BWR	1346	6 Aug 2011	Idle since 2009; off-grid 2011
Neckarwestheim 1	PWR	785	6 Aug 2011	Idle since 2005; 17 Mar 2011 (moratorium)
Philippsburg 1	BWR	890	6 Aug 2011	17 Mar 2011 (moratorium)
Unterweser	PWR	1345	6 Aug 2011	17 Mar 2011 (moratorium)
Grafenrheinfeld	PWR	1275	27 Jun 2015	
Gundremmingen B	BWR	1284	31 Dec 2017	
Philippsburg 2	PWR	1402	31 Dec 2019	
Brokdorf	PWR	1410	31 Dec 2021	
Grohnde	PWR	1360	31 Dec 2021	
Gundremmingen C	BWR	1288	31 Dec 2021	
Isar 2	PWR	1410	15 Apr 2023	
Emsland	PWR	1335	15 Apr 2023	
Neckarwestheim 2	PWR	1310	15 Apr 2023	

Because nuclear plants had previously generated roughly a quarter of Germany's electricity, their loss had to be compensated. In terms of pure electricity volume, this was achieved primarily through the rapid expansion of renewable energies, especially wind and solar. Politically, however, the decisive factor was the retention of fossil fuels, as reducing their use would have been the alternative to phasing out nuclear power. In practice, coal-fired power plants now ran longer than needed, and coal consumption remained high in order to stabilize the electricity grid.

Natural gas, much of it increasingly imported from Russia despite Vladimir Putin's aggression in Georgia and later Ukraine, also became more important. Thus, while renewable capacity rose sharply during this period, nuclear's absence meant that it was largely replaced by fossil fuels. Germany's carbon emissions thereby remained higher than they would have had nuclear continued to operate alongside renewables, and the country became more dependent on fossil gas imports at a time of rising geopolitical tension.

The story of the closures can be divided into three phases. The first phase came in March 2011, when Fukushima triggered a swift political response. Merkel's government declared a three-month moratorium, immediately idling eight reactors — Biblis A and B, Brunsbüttel, Isar 1, Krümmel, Neckarwestheim 1, Philippsburg 1, and Unterweser. In August 2011, these were permanently removed from the grid. Many were still in good condition and could have run for years, but political considerations outweighed technical ones.

The second phase unfolded between 2015 and 2019. Grafenrheinfeld was closed in June 2015, Gundremmingen B at the end of 2017, and Philippsburg 2 in 2019. These shutdowns followed the formal Atomausstieg schedule negotiated between the government and utilities in 2011. The third and final phase came between 2021 and 2023. On 31 December 2021, Brokdorf, Grohnde, and Gundremmingen C were permanently shut down. The final three reactors — Isar 2, Emsland, and Neckarwestheim 2 — were originally due to close at the end of 2022, but the Ukraine war and energy crisis led to a short extension. Even so, on 15 April 2023 they were switched off, marking the end of nuclear power in Germany.

A closer look at the plants themselves helps illustrate the magnitude of the change. In 2010, Germany's 17 reactors had a combined capacity of more than 20 gigawatts and generated about a quarter of its electricity. By 2023, that figure had fallen to zero. Some reactors, such as Isar 2, were among the most modern and efficient in the world, capable of supplying millions of homes. Their closure represented not just a shift in energy mix but the loss of decades of technological expertise and infrastructure.

GERMAN POLITICAL CONTEXT AND HISTORY OF THE NUCLEAR EXIT

Germany's decision to phase out nuclear power represents a unique Sonderweg that contrasts with the global trend of expanding nuclear energy. While countries such as Japan and Ukraine, directly affected by major accidents, continue to rely on nuclear energy, Germany has abandoned it. As this report shows, this choice has cost more lives through increased coal use and pollution than Chernobyl and Fukushima combined. However, understanding this path requires looking at the historical, cultural, political, and economic roots of the German anti-nuclear movement.

The intellectual foundations of German anti-nuclearism trace back to Romantic conservatism in the 19th century, which distrusted industrial modernity and technology.

After World War II, conservatism was reshaped, but on the left, a scepticism of technological progress emerged through criticism of the military–industrial complex and the Club of Rome's Limits to Growth. Anti-nuclear movements fused leftist critiques of capitalism with a conservative romanticism of nature, finding their political home in the Green Party. Early anti-nuclear activism was also linked to controversial groups, including former Nazis, though this influence quickly faded, leaving behind a lasting anti-technology current.

By the late 1970s and 1980s, the anti-nuclear movement broadened, reinforced by fears of radiation and aligned with peace movements opposing nuclear weapons. Popular culture and literature, such as Gudrun Pausewang's Die Wolke, embedded these fears into the cultural imagination. At the same time, mismanagement and secrecy in Germany's nuclear industry, such as an embarrassing post-Chernobyl cover-up at the Hamm-Uentrop pebble-bed thorium reactor, eroded public trust further.

Economics further shaped this trajectory. Germany's powerful coal industry long resisted nuclear expansion, and alliances between coal miners, trade unions, and the political left protected coal by mobilising against nuclear. The SPD, rooted in coal-mining constituencies, joined the Greens in their fight against nuclear, first by promoting coal as such, later as a "clean" or "ecological" alternative by hyping CCS (carbon capture and storage), until this option was banned in 2012.

Even into the 2000s and 2010s, prominent politicians justified extending coal and gas dependency as preferable to nuclear, showing that the phase-out served entrenched fossil fuel interests as much as ecological ideals. For example, Sigmar Gabriel, SPD leader and the minister responsible at the time for Germany's energy transition, wrote to the Swedish prime minister in 2014 acknowledging that "we cannot simultaneously quit nuclear energy and coal-based power generation".

The 2000 *Atomkonsens* ("nuclear consensus") under the SPD–Green coalition officially committed Germany to nuclear phase-out, presenting it as a renewable energy transition. Yet, in the years to come, the policy was never systematically reviewed, even as evidence mounted that nuclear was safer than feared, while coal and gas imposed enormous health and climate

costs. Scientific reassessments of radiation risks, the failure to develop carbon capture for “clean coal”, and the trend to ever more ambitious climate targets were ignored.

Germany faced severe long-term costs from this path: higher emissions, economic costs, and increased reliance on fossil fuels, particularly Russian gas, resulting in a huge shock to Germany following Putin’s full-scale invasion of Ukraine in 2022 and the resulting drop in Russian gas exports to Europe. Public opinion has shifted in favour of nuclear, but political inertia, strong anti-nuclear NGOs, and fear of social polarization have so far blocked any reversal. Whether this stance can endure amid worsening climate crises, European nuclear expansion, and economic stagnation remains an open question, although continuing decommissioning of shuttered nuclear plants makes restarts increasingly unlikely.

Germany’s nuclear phase-out, once framed as progress, increasingly appears as a historically contingent choice with devastating unintended economic, health, and environmental consequences.

METHODOLOGY

We used the year 2010 as the baseline for electricity generation by nuclear power in Germany. To estimate the yearly generation loss, we subtracted the actual electricity generated by nuclear energy in each year from 2011 to 2023 from the 2010 baseline. Summing these yearly losses provided an estimate of the total nuclear generation lost due to plant shutdowns across the period (see Table 2).

Since this lost generation had to be replaced by other sources, we then identified which fuels filled the gap and in what proportions. Based on a more detailed hourly analysis described in a previous upcoming publication by two of this report's authors, we determined that 98% of the lost nuclear output was replaced by coal generation, while 2% was replaced by natural gas generation.

For the hourly analysis in this earlier study, the primary source of generation data was the European Network of Transmission System Operators for Electricity (ENTSO-E). Because ENTSO-E data only exist after 2015, we replaced them with annual electricity generation data from the International Energy Agency (IEA) to cover the full 2010–2023 period. The earlier study found that for an overlap period 2015–2021, ENTSO-E and IEA data diverged by at most 2%, so comparability for the full period is assumed.

From the calculated total of nuclear generation lost and the estimated replacement fuel mix, we derived the total energy supplied by coal and gas as substitutes. To quantify environmental and health impacts, we then applied:

- **Emission factors** from the European Environment Agency (EEA) Air Pollutant Emission Inventory Guidebook (2023) to calculate CO_2, particulate matter, and heavy metal releases.
- **Health impact indicators** published in The Lancet to convert pollutant emissions into statistical health outcomes, including premature deaths, serious illnesses, and minor illnesses attributable to the increased coal and gas combustion.

This approach provided a consistent framework to estimate the climate, health, and economic impacts of Germany's nuclear phase-out, based on observed generation data and widely used emissions and health assessment factors.

RESULTS AND DISCUSSION

Taken together, the top-line consequences of the German nuclear phase-out are stark:

- **Lost generation:** 800 TWh of low-carbon electricity (≈ two years of German demand).
- **Additional CO_2 emissions:** 733 million tonnes (more than Germany's entire 2024 GHG-emissions, expressed in CO2-equivalents).
- **Health impacts:** 19,200 premature deaths and 177,000 serious illnesses.
- **Financial costs:** €57 billion, or ~€1,390 per household.

Our analysis begins with the decision to use 2010 as a baseline year for nuclear power generation in Germany. In that year, nuclear plants provided 132.9 TWh of electricity, roughly a quarter of the country's supply. From 2011 onwards, following the policy reversal by Chancellor Angela Merkel in response to the Fukushima disaster, reactors were progressively shut down. By comparing the actual yearly nuclear generation in 2011–2023 against the 2010 baseline, we calculate the lost generation attributable to the phase-out. Summing across these years, the loss amounts to approximately 800 TWh of clean, zero-carbon electricity (Table 2).

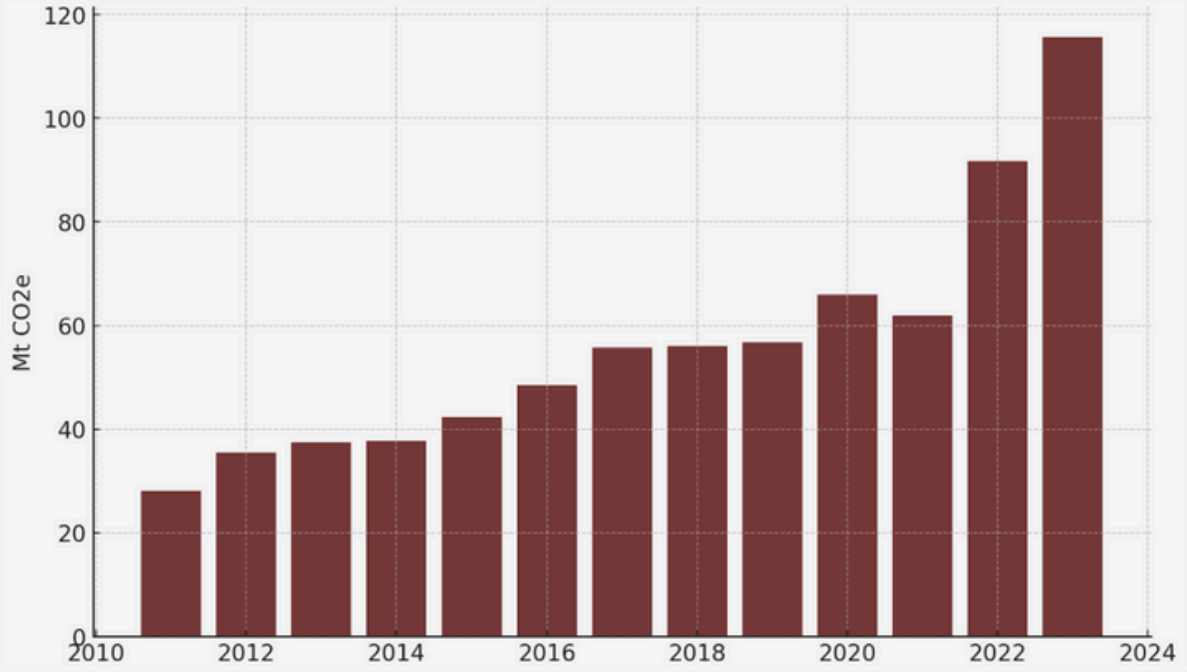
The next step is to identify how this lost generation was replaced. Based on hourly analysis of Germany's grid, we assume that 98% of the lost nuclear energy was replaced by coal and 2% by natural gas. This aligns with the observed persistence of coal in Germany's generation mix and the limited contribution of gas-fired power plants to baseload replacement. Renewables grew significantly in the same period, but their expansion displaced fossil fuels only partially; without the phase-out, they could have displaced coal more directly. Applying standard European Environment Agency emissions factors, we estimate that replacing 800 TWh of nuclear power with fossil generation led to an additional 733 Mt of CO_2 emissions (Table 2, column 4).

TABLE 2. LOST NUCLEAR GENERATION AND RESULTING EMISSIONS, 2011–2023

Year	Nuclear Generation (TWh)	Lost Generation (TWh)	Emissions ($MtCO_2$)
2011	102.2	30.7	28.2
2012	94.2	38.8	35.5
2013	92.1	40.8	37.4
2014	91.8	41.2	37.7
2015	86.8	46.2	42.3
2016	80.0	52.9	48.5
2017	72.2	60.8	55.7
2018	71.9	61.1	56.0
2019	71.0	62.0	56.8
2020	60.9	72.1	66.0
2021	65.4	67.5	61.9
2022	32.8	100.2	91.8
2023	6.7	126.2	115.7
Total (2011–2023)	928.0	800.6	733.5
2010 Baseline: 132,971 GWh or 133 TWh			

The annual emissions from lost nuclear electricity generation are displayed in graphical form in Figure 1 below. The height of the bar in each year is the amount of CO_2 emitted during the year as a result of Germany's nuclear phase-out by that time, as compared to a counter-factual of no phase-out based on 2010 generation baseline data.

FIGURE 1: ANNUAL EMISSIONS FROM LOST NUCLEAR POWER PRODUCTION
GERMANY 2011-2023



As well as CO_2, large quantities of sulphur dioxide, nitrogen oxides, particulate matter, and heavy metals are emitted by burning fossil fuels. These pollutants impose severe health costs, which we quantify using health impact factors as shown in Table 3 (from Markandya and Wilkinson, 2007). Metals are not shown for clarity, though the factors are available at EEA.

TABLE 3. CALCULATION FACTORS FOR HEALTH IMPACTS FROM ADDITIONAL COAL AND GAS GENERATION, 2011–2023

Fuel	Deaths (per TWh)	Serious Illnesses (per TWh)	Minor Illnesses (per TWh)	CO_2 (Mt/TWh)	SOx (g/MWh)	NOx (g/MWh)	$PM_{2.5}$ (g/MWh)	PM_{10} (g/MWh)
Coal	24.5	225	13.3	0.924	2952	670.1	13.6	26.2
Gas	2.8	30	703	0.531	0.96	419.4	3.6	3.6

These results suggest approximately 19,200 premature deaths and 177,000 serious illnesses from 2011–2023 as a result of higher air pollution (Table 4).

TABLE 4: HEALTH IMPACTS FROM ADDITIONAL COAL AND GAS GENERATION, 2011–2023

Fuel	Deaths	Serious Illnesses	Minor Illnesses
Coal	19.223	176.535	10,425,775
Gas	45	480	11.257
Total	19,2687.5	177,015.6	10,437,0321.2

In addition to CO_2, 2.3 million tonnes of sulphur pollution and 526,000 tonnes of nitrogen oxides were also emitted, alongside 30,000 tonnes of PM_{10} and $PM_{2.5}$, particulates with serious impacts in terms of lung disease and respiratory impacts (Table 5).

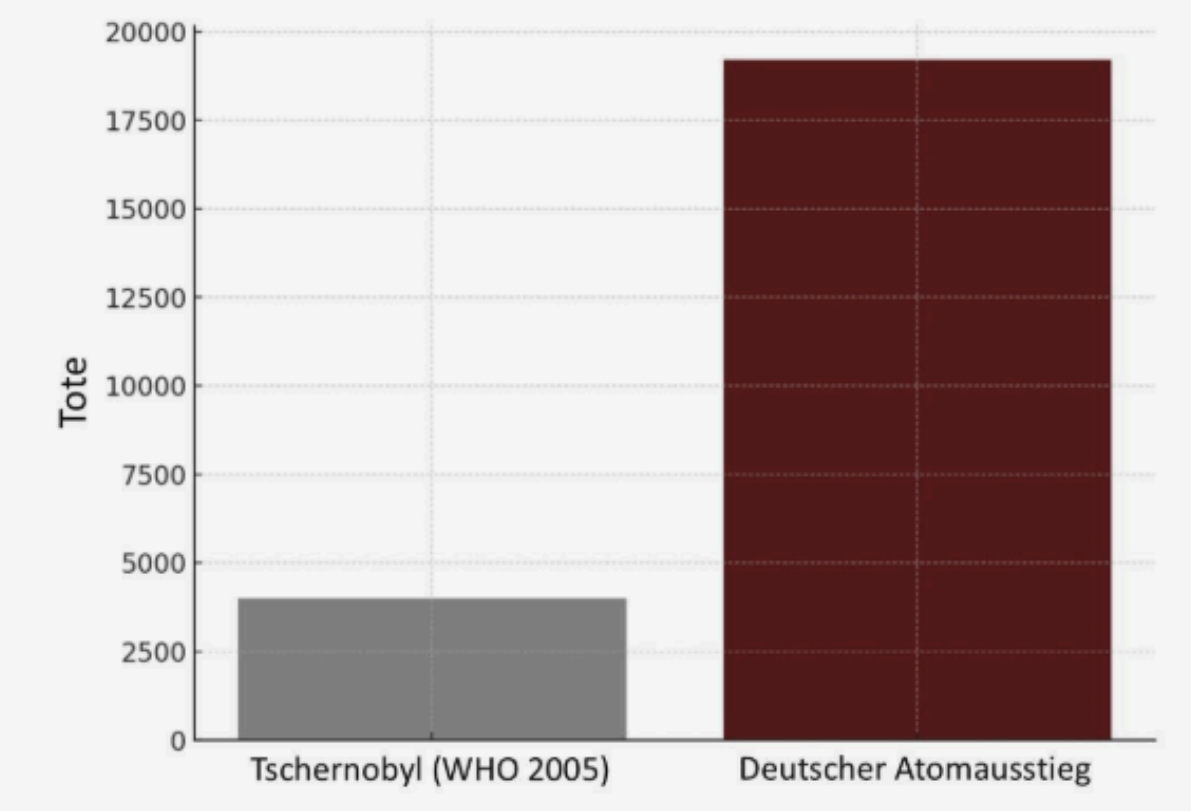
TABLE 5. POLLUTION FROM ADDITIONAL COAL AND GAS GENERATION, 2011–2023

Pollutant	Coal	Gas	Total
CO_2 (Mt)	724.97	8.50	733.47
SOx (t)	2,316,141.40	15.40	2,316,156.80
NOx (t)	525,721.70	6,715.50	532,437.20
$PM_{2.5}$ (t)	10,662.70	57.30	10,720.00
PM_{10} (t)	20,548.70	57.30	20,606.00
Mercury (t)	3.92	0.01	3.93
Cadmium (t)	2.51	0.00	2.51
Lead (t)	20.64	0.00	20.64

The heavy metal releases, almost entirely from coal, included 4 tonnes of mercury, 20 tonnes of lead, and 2.5 tonnes of cadmium over the period. These substances accumulate in soils and water, posing long-term risks to human health and ecosystems. Unlike radioactivity, which decays and disperses, heavy metals remain in the environment indefinitely.

The environmental burden therefore extends far beyond CO_2. By clinging to coal in order to avoid nuclear, Germany locked in higher levels of air pollution and toxic emissions with significant cumulative effects. The death toll can be compared to the worst-case WHO calculation for deaths resulting from Chernobyl, of around 4,000 total deaths. This is displayed in Figure 2.

FIGURE 2. DEATHS RESULTING FROM GERMANY'S NUCLEAR EXIT AS COMPARED TO CHERNOBYL WORST-CASE ESTIMATES COMPARISON OF ESTIMATED DEATHS



The public justification for the nuclear phase-out rested heavily on concerns about safety and health risks. Yet the evidence demonstrates the reverse: nuclear's risks are minimal compared to those of coal. Even accounting for accidents such as Chernobyl and Fukushima, the mortality per unit of energy generated from nuclear remains far lower than from fossil fuels. Our analysis shows that as of today, the nuclear exit has already caused five times more deaths than Chernobyl by driving continued coal combustion, and this number stands to rise even further in the coming years until the country has completed its coal exit.

Finally, because Germany's power sector is part of the EU Emissions Trading Scheme (ETS), the additional CO_2 must be accounted for financially. At the September 2025 ETS price of €78 per tonne, the 733 Mt of emissions correspond to around €57 billion in costs (Table 6). Spread across households, this equates to roughly €1,390 per household, reflected in higher electricity prices and overall energy system costs.

TABLE 6: COST OF ADDITIONAL EMISSIONS IN THE ETS

Year	Emissions ($MtCO_2$)	Cost (€ billion)
2011	28.2	2.2
2012	35.5	2.8
2013	37.4	2.9
2014	37.7	2.9
2015	42.3	3.3
2016	48.5	3.8
2017	55.7	4.3
2018	56.0	4.4
2019	56.8	4.4
2020	66.0	5.2
2021	61.9	4.8
2022	91.8	7.2
2023	115.7	9.0
Total (2011–2023) at €78/tCO_2	733.5	57.2

The ETS cost of €57 billion is not an abstract figure. It reflects a real burden on German industry and households. The carbon allowances that must be purchased represent resources diverted away from investment in infrastructure, social benefits, or industrial innovation. In practice, this has meant higher wholesale electricity prices, which feed into household bills and industrial competitiveness.

The burden is unevenly distributed. Energy-intensive industries such as steel, aluminium, and chemicals face a structural disadvantage in global markets, prompting some to relocate production abroad. Households, meanwhile, experience rising costs of living. These effects undermine Germany's broader economic model, which has historically depended on affordable and reliable energy as the foundation of its industrial strength.

The consequences of Germany's phase-out are thrown into sharper relief when compared internationally. Japan, which experienced Fukushima firsthand, initially shut down its reactors but has since restarted many, recognizing their role in stabilizing energy supplies. France has reaffirmed nuclear as the cornerstone of its low-carbon system, while the United States and United Kingdom are extending plant lifetimes and commissioning new projects. Even Ukraine, despite the trauma of Chernobyl and ongoing war, continues to rely heavily on nuclear for energy security.

Germany thus stands out as an outlier: the only major industrial country to abandon nuclear entirely, while simultaneously falling short of climate targets and prolonging coal dependence.

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JAPAN / POLITICS

Japan's new leader to make nuclear center of energy strategy

ENERGYWIRE

Gift article

FEDERAL

Japan's new leader to make nuclear center of energy strategy

It's unclear what Sanae Takaichi, the newly elected leader of Japan's ruling party, can do to help accelerate the restart of the nation's idled reactors.

BY: BLOOMBERG | 10/07/2025 06:25 AM EDT

ENERGYWIRE | The woman expected to be Japan's next prime minister is set to keep nuclear power at the core of the nation's energy strategy, while reducing emphasis on readily available renewables like solar.

Sanae Takaichi, the newly elected leader of Japan's ruling party, has pushed to accelerate the development of advanced nuclear technologies, like fusion, and has previously called for making the country 100 percent energy self-sufficient by deploying next-generation reactors.

CONCLUSION

Germany's nuclear exit offers a sobering set of lessons for climate policy:

1. **Evidence-based risk assessment is essential**. Fear of radiation drove the phase-out, but coal's risks are greater by orders of magnitude.
2. **Policy sequencing matters**. Renewables should displace fossil fuels, not nuclear. Removing nuclear first prolongs coal and gas use.
3. **Economic instruments cut both ways.** ETS prices magnify the costs of bad policy as well as rewarding good ones. By forgoing nuclear, Germany imposed a €57 billion penalty on itself.
4. **Cultural narratives can override science**. The persistence of anti-nuclear identity in German politics highlights the need to align public narratives with evidence.

Germany's nuclear phase-out is one of the most consequential energy policy choices of the 21st century. Intended to reduce risks, it increased them; intended to advance climate goals, it undermined them; intended to protect public health, it caused thousands of avoidable deaths. The additional cost of €57 billion underscores the financial burden of the decision, borne ultimately by households and industry.

For other countries, the lesson is clear. Energy transitions must be guided by evidence, not ideology. Zero-carbon firm power sources like nuclear should be preserved and expanded. Otherwise, as Germany's case demonstrates, well-intentioned policies can lock in decades of higher emissions, higher costs, and worse health outcomes including significant avoidable death tolls.

APPENDIX

A brief critical history of Germany's nuclear phase-out

The German nuclear phase-out is a Sonderweg — a special path not taken by most other countries. The decision is striking: while many nations are building or planning new reactors, Germany has shut down its own. How could a nuclear accident in Japan trigger such a dramatic shift in German policy, when Japan itself restarted its reactors only a few years later? And how is it that Ukraine, where the Chernobyl disaster occurred, still relies heavily on nuclear power? Critics argue the German phase-out has indirectly cost more lives than either Chernobyl or Fukushima, due to the increased reliance on coal and its deadly air pollution. Understanding how this happened requires looking at Germany's unique political, cultural, and economic history.

APPENDIX

I. A CONSERVATIVE MOVEMENT IN LEFT CLOTHING

Germany's nuclear policy does not stem from a single cause but from intertwined traditions. One of the deepest roots lies in the 19th-century Romantic movement, which distrusted industrial modernity and technology. Writers like Franz Grillparzer set an anti-technology tone that lingered within parts of Germany's environmental movement.
After World War II, traditional conservatism was discredited due to its association with Nazism. A new "industrial conservatism" emerged, which embraced technology as essential to progress and Cold War competition. Meanwhile, parts of the left shifted in the opposite direction: while Marxism had celebrated technological progress as a driver of liberation, the critique of the "military–industrial complex" and the Club of Rome's Limits to Growth fostered scepticism toward industrial advances. By the 1970s, many on the left viewed technology not as progress but as a threat.
This shift was controversial within leftist circles. Figures like Ernst Bloch argued that anti-technology attitudes were a bourgeois regression. Rudi Dutschke, later a Green Party founder, admitted in 1977 that mass anti-nuclear protests caused him "theoretical and political difficulties". Yet the new spirit of ecological resistance prevailed. As political scientist Sven-Uwe Schmitz observed, roles reversed: leftists became guardians of tradition and nature, while conservatives appeared as technophiles. Out of this reversal, the Green Party emerged — combining left-wing critique of "big capital" with conservative romanticism of nature.

The anti-nuclear movement was not only a story of grassroots protests in the 1970s. Earlier organizations also played a role, including the World Union for the Protection of Life (WUPL), founded in 1960 and dominated by former Nazis and right-wing thinkers. Some of its leaders helped draft ecological manifestos for far-right parties. Though these figures later faded from the Green Party, the romantic distrust of technology remained central to its identity. Over time, scepticism extended beyond nuclear energy to issues like homeopathy, genetic engineering, and naturopathy.
Even renewable energy advocacy carried a conservative tone. Amory Lovins' influential Soft Energy Paths (1977) framed wind and solar as "soft" and "natural", contrasting them with "hard" technologies like nuclear. He argued that abundant cheap energy would be dangerous, because of what humanity might do with it. This romantic vision deeply shaped Germany's Energiewende ("energy transition"). While right-wing extremists eventually played little role in shaping mainstream energy policy, the fusion of left-wing and conservative traditions explains why anti-nuclear sentiment is so deeply rooted in Germany.

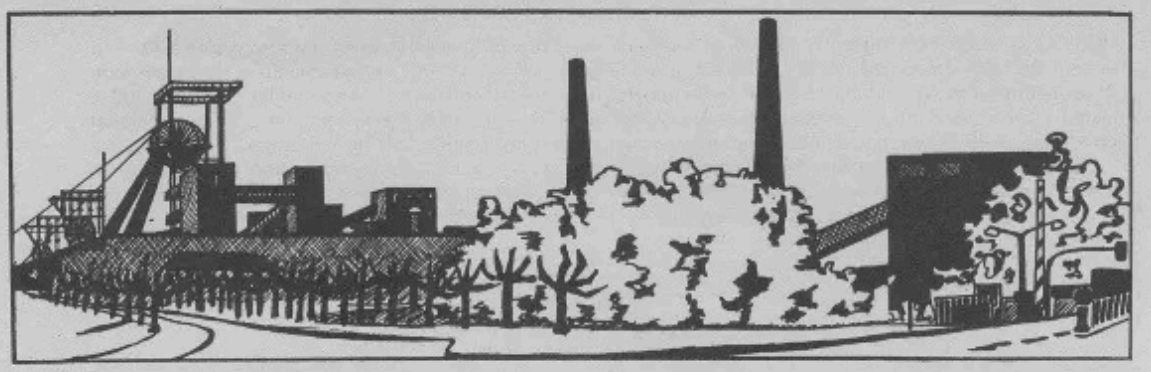
APPENDIX

II. GERMANY: A LAND OF COAL

Germany's coal wealth and powerful coal industry also shaped the anti-nuclear path. Unlike in other countries, energy suppliers were reluctant to embrace nuclear power, since coal remained highly profitable. In the 1960s, utilities like RWE resisted nuclear expansion, preferring to protect coal investments. Only during the oil crisis of the 1970s did nuclear gain temporary support, before enthusiasm waned again in the 1980s when coal prices fell.

This dynamic persisted for decades. Even in the 2000s, energy companies such as RWE and EnBW opposed nuclear revival, not out of concern for public safety but to protect coal interests. Political actors reflected these ties. The SPD, traditionally rooted in coal-mining regions, shifted to anti-nuclear positions in the 1980s. The Greens also courted coal miners, framing coal as "ecological" compared to nuclear and warning that nuclear progress would threaten mining jobs. By the early 2000s, climate change became a pressing issue, yet coal retained political protection. SPD leaders like Sigmar Gabriel and Frank-Walter Steinmeier openly defended coal power as a way to prevent nuclear's return, even proposing new coal plants while dismissing nuclear as outdated. After Fukushima in 2011, the government justified the second nuclear phase-out partly with promises of "clean coal" through carbon capture technologies — promises that were never realized.

In practice, Germany's nuclear phase-out functioned as a coal extension program. Rather than replacing coal with nuclear-free renewables, it guaranteed coal decades of continued use. When the red-green coalition came to power in 1998, phasing out coal instead of nuclear was never seriously considered. The alliance between miners and anti-nuclear activists, supported by both SPD and Greens, ensured coal remained central.



Für ökologische Kohletechnologie statt Atomkraft in NRW!

Die Kohlehalden im Ruhrpott erreichen Rekordhöhen. Den Elektrizitätsversorgungsunternehmen ist die deutsche Steinkohle zu teuer geworden. Deswegen wollen sie in den nächsten 10 Jahren die Zahl der Atomkraftwerke verdoppeln.

Atomkraftwerke stellen nicht nur ein gefährliches Sicherheitsrisiko dar, sondern sind außerdem unrentabel: Der THTR 300 in Hamm verschlang zusammen mit dem Schnellen Brüter in Kalkar bereits 10,5 Milliarden DM an Steuergeldern.

Die Atomenergie schafft auch keine Arbeitsplätze

Bei einem weiteren Bau von Atomkraftwerken kann der „Jahrhundertvertrag", der bis zum Jahr 1995 einen etwa gleichbleibenden Steinkohleabsatz in Kraftwerken garantieren soll, nicht eingehalten werden. Weitere Atomkraftwerke bedeuten unweigerlich Zechenschließungen und die Vernichtung tausender Arbeitsplätze vor allem in NRW. Auch die IG Bergbau und Energie muß sich jetzt entscheiden, ob sie weiterhin für mehr Atomenergie ist oder ob sie die Interessen der Bergleute wahrnehmen will.

Geschlossene und ‚abgesoffene' Zechen sind für immer verloren. Deshalb muß jetzt gehandelt werden, um auf Jahre hinaus nicht wiedergutzumachende Fehlentscheidungen zu vermeiden.

Die Losung der 70er Jahre „Kernenergie und Kohle" wird in der Landespolitik zunehmend verdrängt werden durch „Kernenergie *statt* Kohle"!

Der von Ministerpräsidentenkandidat Worms (CDU) geforderte „Mut zu Zechen-Stillegungen" geht eindeutig in diese Richtung.

Wenn, wie geplant, 1990 über 24.000 MW Atomstrom produziert werden, ist nahezu der gesamte Grundlastbereich durch Atomkraftwerke gedeckt. Für den Spitzenbedarf benötigt man Kohlekraftwerde nur noch für wenige Stunden. Da Atomkraftwerke nicht beliebig an- und ausgeschaltet werden können, werden Steinkohlekraftwerke eher abgeschaltet als Atomkraftwerke. Diese Entwicklung hätte unvermeidlich Zechenstillegungen zur Folge:

Atomenergie vernichtet Arbeitsplätze!

III. FEAR OF RADIATION AND MISMANAGEMENT

Public fear of radiation gave the anti-nuclear movement new momentum after the Chernobyl disaster in 1986. Although the movement had peaked earlier, Chernobyl brought fear of contamination to the majority of Germans. The country's central location in Europe and memories of Cold War nuclear tensions made radiation seem an existential threat. The peace movement against nuclear missiles merged with anti-nuclear protests, focusing on facilities like the Wackersdorf reprocessing plant, which many associated with weapons development.

Cultural works amplified this fear. Children's author Gudrun Pausewang published Die Wolke (1987), depicting a devastating nuclear accident in Germany. The book compared nuclear dangers to Nazism and became a bestseller and school text, shaping a generation's view of nuclear energy as catastrophic.

Meanwhile, mismanagement within the nuclear industry eroded what little trust remained. The German Nuclear Commission was disorganized and poorly informed. Operators sometimes covered up incidents, such as a release at the Hamm-Uentrop reactor just days after Chernobyl, hoping to bury it in fallout readings. Such failures confirmed public suspicions that the nuclear industry was secretive and reckless.

Against this backdrop, nuclear advocates stood little chance. Anti-technology sentiment, fossil fuel interests, public fear of radiation, and industry mismanagement combined to create an enduring consensus against nuclear power.

APPENDIX

IV. THE NUCLEAR PHASE-OUT: LEARNING THROUGH PAIN — JUST WITHOUT LEARNING

By the late 1980s, political support for new reactors had collapsed. When the Green–SPD coalition came to power in 1998, they formalized the phase-out with the 2000 Atomkonsens. Although presented as a triumph for renewables, in reality it protected coal and expanded reliance on natural gas.

Defenders argue that, in 2000, climate urgency and gas dependency were less obvious than today. Yet what followed was a striking failure to reassess the policy. Despite rising awareness of climate change, growing reliance on Russian gas, and new scientific findings on radiation safety, the phase-out was never revisited. Studies showed that radiation risks had been exaggerated, while coal's dangers — air pollution and CO_2 — were far greater. Yet policymakers ignored this evidence.

The 2011 Fukushima disaster triggered a renewed phase-out, though Germany's reactors differed in design and no deaths occurred in Japan. Ironically, this political decision caused greater harm by prolonging coal use. By some estimates, additional air pollution deaths exceeded those caused by both Chernobyl and Fukushima combined.

Opportunities to reverse course were missed. In 2022, amid the energy crisis and rising public support for nuclear, the government still shut down the last three reactors. Robert Habeck, economy minister, refused to challenge party hardliners. Although opinion polls and even parliament leaned toward nuclear, political leaders avoided confrontation, fearing renewed mobilization by environmental movements.

APPENDIX

CONCLUSION

Germany's nuclear phase-out emerged from a unique mix of cultural traditions, political compromises, economic interests, and public fears. Rooted in Romantic conservatism but carried forward by the left, strengthened by coal industry ties, amplified by cultural fear of radiation, and cemented by political inertia, the decision diverged sharply from global trends.

While once framed as environmental progress, the phase-out has had unintended consequences: greater coal dependency, higher emissions, reliance on Russian gas, and ultimately, more preventable deaths. Yet the political deadlock persists, reinforced by influential NGOs and a reluctance to polarize society further. Whether Germany can sustain this Sonderweg in the face of climate crisis, economic stagnation, and neighbouring countries' nuclear expansion, remains an open and urgent question.

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