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440MW

2003 Germany installed solar capacity

52GW

The 2020 solar goal under Germany's Renewable Energy Law

54.3GW

Installed German solar as of year-end 2020 (estimate)

Clean Energy Trade Policy Case Study: Germany

As the economic opportunities presented by the transition to a lower-carbon economy have become more apparent, individual nations have sought to implement policies specifically intended to subsidize directly their domestic clean energy manufacturers, erect barriers to protect them from foreign competition, or some combination of both. In that context, we examine here Germany's landmark 2004 Renewable Energy Law.

- The Law sparked the creation of the world's first major market for ground-mounted solar photovoltaic (PV) projects and kicked off a global boom in PV equipment manufacturing, briefly in Germany and then longer term in China.
- It aimed to boost installed solar capacity from 440MW in 2003 to 52,000MW by the end of 2020, a level that has been exceeded.
- As a consequence of the law, German consumers today pay some of the highest power prices in Europe, with almost 25% of bills accounted for by renewable energy surcharges.
- A reason the feed-in tariffs have proven politically durable is that many residents either have, or hope to have soon, their own rooftop PV system to benefit from the program.
- The Law has achieved its stated goals. The German government appears to regard it as a successful chapter in the "Energiewende" or energy turnaround, with which Germany aims to prove that major economies can run on renewable energy.
- The German government has generally been in favor of free trade. No explicit goal or mandate for German manufacturing was set in the Law.
- On the manufacturing side, Germany's once-thriving PV wafer, cell and module makers are now largely gone. All have been outcompeted and driven into bankruptcy by the rapid cost reductions achieved by foreign firms.
- However, firms such as German polysilicon producer Wacker-Chemie benefitted greatly from the feed-in tariffs and the explosion of global PV demand and remains a major international supplier.

1. The *Energiewende*

Germany's landmark 2004 Renewable Energy Law is the most important piece of legislation implemented in the last two decades supporting solar development. It established an ambitious program, which sparked the creation of the world's first major market for ground-mounted photovoltaic (PV) projects and kicked off a global boom in PV equipment manufacturing, briefly in Germany and then longer term in China.

One consequence of the Law: German consumers today pay some of the highest power prices in Europe with almost 25% of bills accounted for by renewable energy surcharges. This will begin dropping significantly only in 2024, when the first projects built under the Law come off the tariff.

Despite the high costs, German consumers have voiced relatively few complaints. This may be due to the fact that the country has in recent years benefited from sharply lower PV costs meaning newer plants can deliver power far more cheaply than those erected a decade ago.

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Another reason the feed-in tariffs have proven politically durable: many residents either have, or hope to have soon, their own rooftop PV system and to benefit from the program.

The Law contained no explicit goal or mandate that German manufacturers provide the equipment required to have the country hit its deployment targets. The German government has generally been pro free trade with the implicit assumption that domestic firms can compete against – and beat – any foreign competition.

In 2004, after several smaller experiments, the German government launched the *Erneuerbare-Energien-Gesetz* (EEG) Renewable Energy Law to support major deployment of solar power. This offered a fixed “feed-in tariff” of at least 457 euros per MWh for 20 years to all solar power plants, with very few barriers. This was, as far as we know, the first time a government wrote the solar industry a blank check and one of the first incentive schemes to reward generation rather than installation. The price was about three times the average price of electricity to consumers at the time, but solar modules then cost about \$4.20 per Watt (compared with about \$0.20/W today). In addition, German development bank KfW made relatively low-interest loans available to households and businesses through local banks, making financing these projects extremely easy.

2. Policy goal

EEG aimed to boost installed solar capacity from 440MW in 2003 to 52,000MW at the end of 2020. At the time, solar installed capacity stood at 2,970MW *globally*, so the German target was enormously ambitious and groundbreaking. The 52GW goal was intended to help Germany meet its target of 39% renewable electricity generation by year-end 2020.

The EEG was not in any way described as a manufacturing-support policy and contained no provisions explicitly aiming to grow German equipment production. The German government is generally a pro-free-trade voice in the European Commission and therefore does not try to set barriers on foreign firms entering the German market.

However, there was hope in Germany that growing domestic demand would foster local manufacturing. The country was home to companies with technological expertise in PV, such as Schmid GmbH, which made the manufacturing equipment to produce solar panels, and PV equipment makers Solarworld, Solar Fabrik, Conergy, Aleo Solar and Q-Cells.

3. Implementation

Under the law, solar feed-in tariff rates were to be reviewed annually, and reduced by not more than 10%. However, as volumes installed grew far faster than anticipated, the government scrambled to make emergency cuts. Figure 3 depicts the tariffs that were made available to owners of the largest rooftop systems (the government cut tariffs for smaller systems at a similar pace).

Figure 1: Germany's target for final energy consumption under its Renewable Energy Law

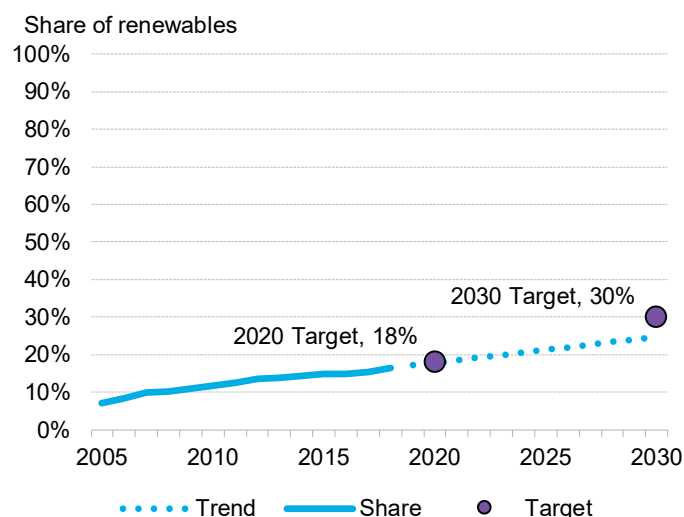
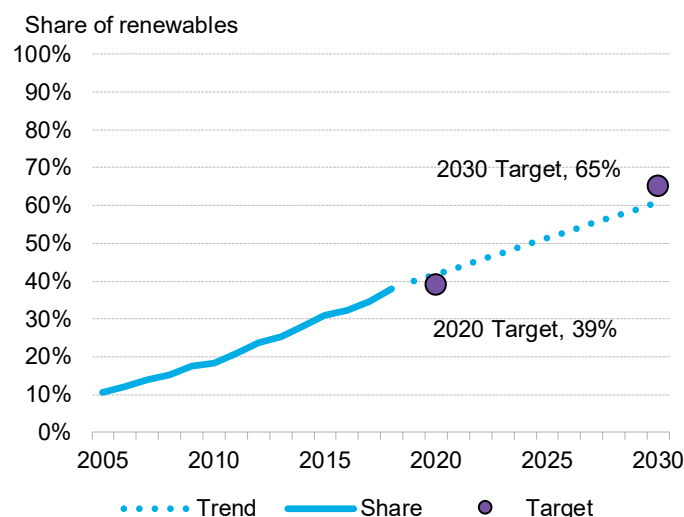


Figure 2: Germany's target for electricity consumption required under its Renewable Energy Law

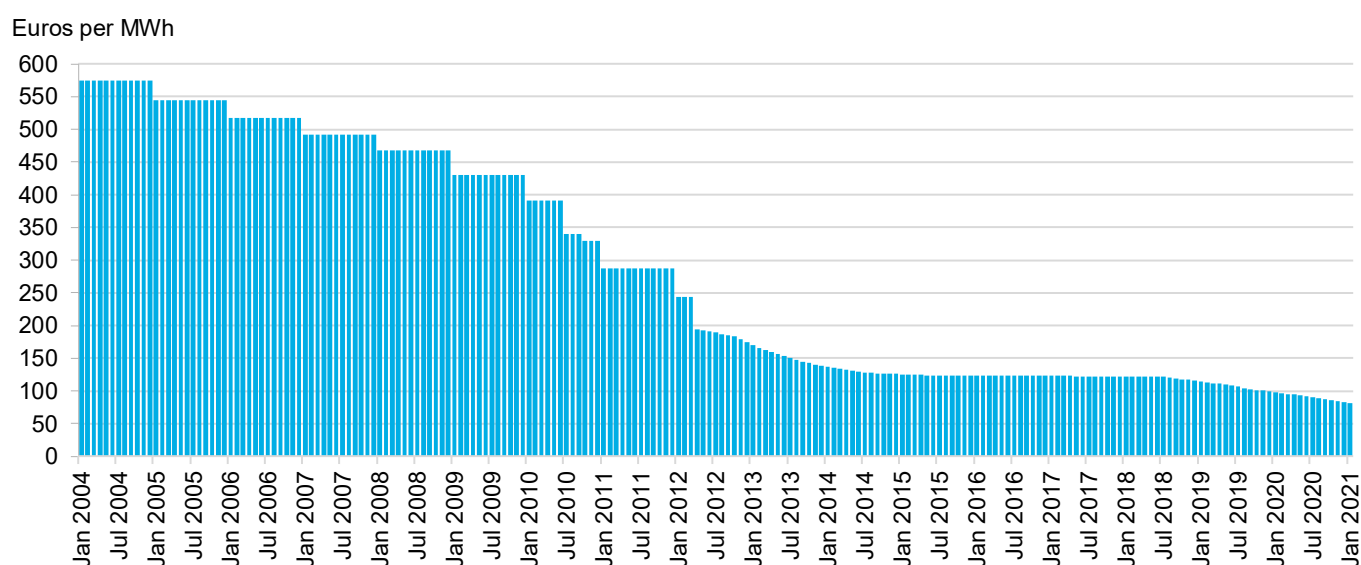


Source: BloombergNEF, European Environment Agency, Eurostat, member state NREAP and NECP. Note: Trend lines are linear projections using historic data 2004-18

Policymakers made other changes as well. They added a requirement that all solar projects have remote shutoff capabilities so as not to damage the grid. A second feed-in tariff option, a lower market premium for systems selling most of their power to the grid, was also offered.

Starting in April 2012, Germany began ratcheting the tariffs down monthly by using installation rates over the trailing six months as a guide. When trailing installations exceeded a 1.9GW/year "corridor", the tariff would fall. If they fell below the threshold, the tariff remained constant.

Figure 3: German feed-in tariffs available for residential rooftop solar systems



Source: Bundesnetzagentur, BloombergNEF

The feed-in tariffs are funded through surcharges on German power bills. In 2020, the average charge was 6.756 euro-cents per kWh. It falls in 2021 to 6.5 euro-cents/kWh. This means that German residential power consumers pay some of the highest prices in Europe at around 28 euro-cents/kWh.

There has been some pushback against these rates but not enough to significantly affect the program, though nearly all stakeholders agree this cannot continue rising rapidly. After 2024, Germany's first projects will reach the end of their guaranteed periods and will no longer be paid the feed-in tariff. Instead, they will be forced to sell into the spot market, or to decommission if there is a higher-value alternative for the land. This surcharge covers the spread between the feed-in tariff and the spot power price, so if the spot power price rises the surcharge falls. It is no longer growing consistently, because the new tariffs are much lower.

In 2017, Germany decided to cut the costs of new capacity further by holding auctions to build new solar and wind capacity and removing feed-in tariffs for solar systems bigger than 750kW on roofs or 100kW on the ground. These auctions have been a success, attracting competition and allowing larger projects to be built at prices below the former feed-in tariffs. In late 2020, Germany held its first auction for co-located solar and storage projects, tendering 650MW with an average winning price of just 45 euros/MWh.

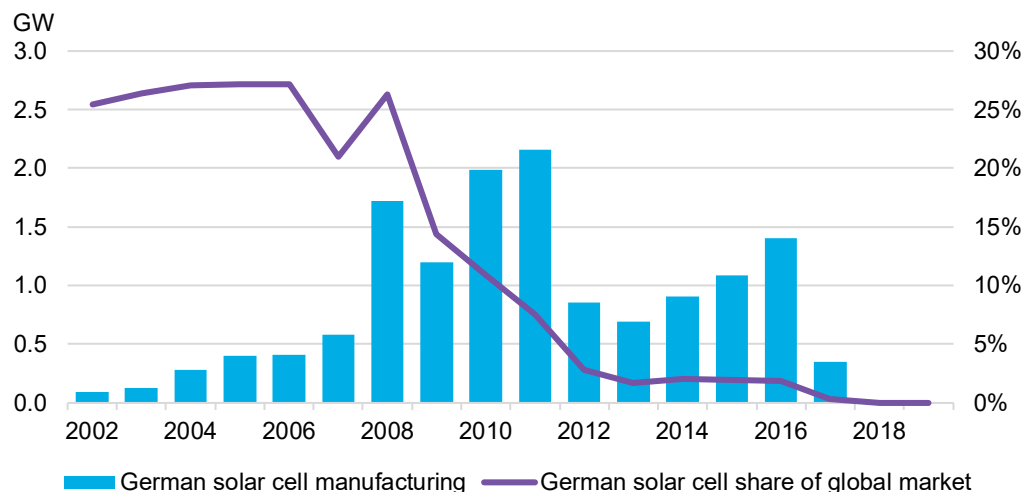
German solar cell and module manufacturers supplied over 25% of the global market in 2004 (Figure 4), with Japanese manufacturers dominating the rest of the market. As demand ramped at home and abroad, German firms scaled up, but Chinese solar companies like Suntech and Trina Solar expanded much faster. Chinese firms began to gain market share from 2008 with large-scale, low cost manufacturing bases.

In the early years after the boom began, German firms continued to thrive because they had secured polysilicon feedstock under long-term contracts with manufacturers at below spot prices. Chinese firms, by contrast, were limited in their ability to source polysilicon. The situation was not sustainable, however as new polysilicon factories were ramping up worldwide and prices for the key commodity would soon plummet.

In April 2012, German giant Q-Cells went bankrupt for the first time, partly because it had secured polysilicon at long-term contracted prices above \$50/kg, which had seemed competitive in 2004-2008 but was by then well above market rates. In 2012, Q-Cells was competing with Chinese competitors who not only had newer factories with more modern (often German-made) machines and cheaper labor, but were also paying the spot price for polysilicon, which was below \$30/kg.

Germany also has a major polysilicon manufacturer, Wacker-Chemie, which scaled up in response to the increased demand (Figure 5). Wacker-Chemie today remains a major exporter of polysilicon to Asian ingot and wafer makers.

In 3Q 2012 a group of European solar cell and module manufacturers called EU ProSun brought anti-dumping (AD) and anti-subsidy (AS) complaints to the European Commission, which can set compensating measures across the European Union. EU ProSun was led by German cell and module manufacturer SolarWorld (all other members refused to be identified), and alleged a dumping margin of 60-90% of Chinese solar cells and modules. The Commission initiated investigations into anti-dumping and anti-subsidy complaints in September and November 2012, respectively.

Figure 4: Germany's solar cell manufacturing industry development

Source: BloombergNEF, European Commission PV Status Report using PV News data. Note: Some approximations and estimates have been made by BloombergNEF as there is no single consistent data source over this period.

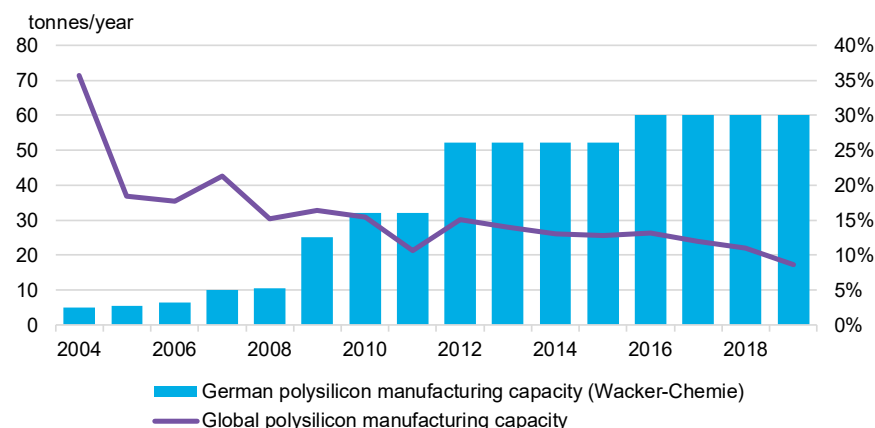
European installers and project developers – representing a strong majority of European solar jobs – set up an opposing lobbying group called AFASE. The German government is also understood to have taken a position against the imposition of anti-dumping and anti-subsidy tariffs, but on such matters is bound by the judgment of the European Commission.

Starting in March 2013, Chinese products (including modules assembled in third countries using Chinese cells or wafers) had to be registered on import to the European Union, raising the possibility that duties would apply retroactively.

In June 2013, provisional tariffs were published in response to the anti-dumping (AD) investigation. The initial level of 11.8% for the first two months was significantly lower than had been anticipated but the average duty then rose to 47.6%, with a range of 37.2% to 67.9% depending on the individual company. A majority of European Union country members opposed the AD duties, but their votes were not binding until the decision on definitive ones.

In July 2013, the Commission announced that it had reached a settlement (or "undertaking") with China, whereby no import tariffs would be applied to the first 7GW of Chinese modules entering the EU at a minimum price of 56 euro-cents (\$0.74) per Watt, roughly the spot price at the time, for two and a half years. The minimum price was to be adjusted regularly based on BloombergNEF's monthly price survey.

A result of the negotiated undertaking on cells and modules was that German polysilicon maker Wacker obtained a similar settlement when China retaliated with import duties on polysilicon in late 2012. Consequently, Wacker has done better than its U.S. peers REC Silicon and Hemlock Semiconductor, which have suffered badly from Chinese retaliatory tariffs on U.S. polysilicon after the U.S. set import tariffs on Chinese modules.

Figure 5: Germany (Wacker-Chemie)'s polysilicon capacity development

Source: BloombergNEF

In March 2017, duties were extended an additional 18 months. However, SolarWorld's German subsidiaries filed for insolvency in May 2017. They were then re-bought in August 2017 by SolarWorld founder Frank Asbeck and Qatar Solar Technologies, a new investment firm. The new SolarWorld Industries GmbH filed for insolvency again in March 2018. Several other of EU ProSun's 30 manufacturers have since been identified; they are smaller players and have not continued the trade fight as a group.

In August 2018, the European Commission decided against extending tariffs on Chinese PV products on the basis that companies were no longer lobbying for them. In September 2018, the tariffs expired.

As of November 2020, Germany still has a few small module manufacturers such as Heckert Solar and Sonnenstrom Fabrik. These firms mainly use Chinese cells to make bespoke module designs and custom modules as replacements for older models in established solar projects. However, the country is no longer a major global supplier of PV cells or modules.

4. Market impact

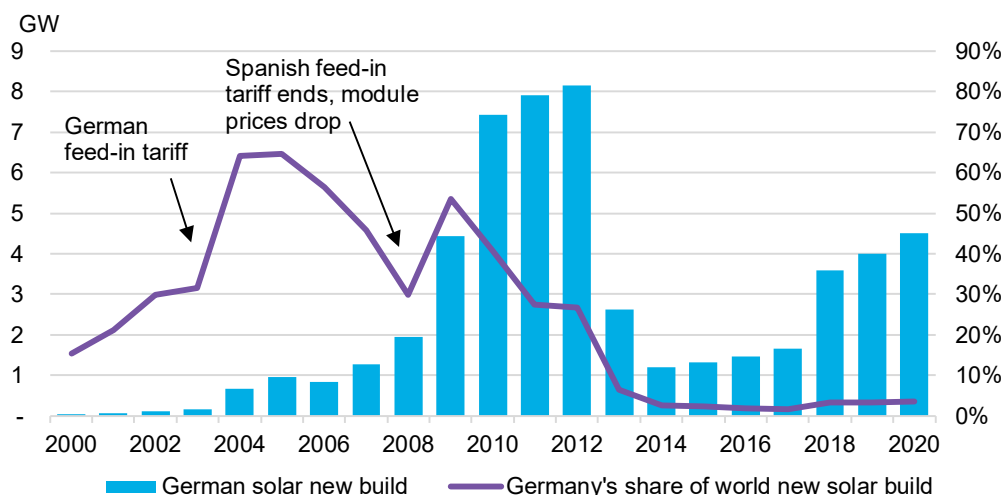
Germany's solar market was super-charged by its feed-in tariffs, which drove a global spike in demand for PV equipment. The country accounted for near two-thirds of global PV module demand in 2004 and 2005 (Figure 6). Other European countries, particularly Spain but also Italy, the Czech Republic, Romania and Bulgaria, followed Germany's lead in implementing feed-in tariffs or similar incentives, creating other national solar booms. During this period, the only restraint on even faster growth was a global shortage of processed polysilicon and a dearth of factories to produce it. As a result, polysilicon prices spiked to over \$400/kg in 2005 from approximately \$25/kg in 2000-2004.

In September 2008, the Spanish boom ended abruptly after policymakers recognized what a massive liability had been incurred by the country's generous feed-in tariff. Spain had targeted 400MW PV installed per year starting in 2010 but saw a whopping 3,400MW of PV built by the end of September 2008.

PV demand flattened just as new polysilicon supply was coming online. Prices for global solar modules crashed. The boom in Germany, where feed-in tariffs were only cut once a year, gathered pace from 2009 to 2012 until the government took control and made more drastic and

more frequent cuts to the tariff, to adjust returns from solar projects to more moderate levels and control the cost to consumers.

Figure 6: Timeline of Germany's solar market



Source: Bundesnetzagentur, BloombergNEF

5. Did it succeed?

Germany has exceeded the goal it set for itself in 2004 for installed solar capacity and renewables generation in 2020. The EEG achieved its stated goals and the German government appears to regard it as a success, and a key steppingstone in the “Energiewende” or energy turnaround, with which Germany aims to prove that major economies can run on renewable energy.

Germany is also home to industry-leading engineering, procurement and construction contractors such as juwi GmbH and Enerparc AG, which win business regularly outside Germany. While the country’s residents pay some of the highest power prices in Europe thanks to the costs associates with the feed-in tariffs, there is no debating that the country’s Renewable Energy Law did spur a major scale-up in installed capacity.

On the manufacturing side of the equation, the story is murkier. At the top of the PV value chain, German polysilicon producer Wacker-Chemie (Frankfurt: WCH) benefited greatly from Germany’s generous feed-in tariffs and the ensuing explosion of global PV demand. Similarly, SMA Solar Technologies (Frankfurt: SMA), which makes inverters that enable PV systems, has fared well. Both firms remain major international suppliers.

However, Germany’s once-thriving PV wafer, cell and module manufacturers are now largely gone. All have been outcompeted and driven into bankruptcy by the rapid cost reductions achieved by foreign firms. As of year-end 2019, the solar and storage industry employed about 26,400 people in Germany, according to research firm [EuPD Research](#). That’s down from a peak of about 60,000 in 2008. Most solar jobs continue to be in the installation, project development and design segments of the industry.

6. The current situation

As of 2020, the German feed-in tariffs were still in place. However, large-scale projects are usually built under an auction scheme instead, as the tariffs are no longer available to systems

over 750kW. Some large systems are being built directly by utilities like EnBW, just to sell electricity to their customers. For smaller systems, the feed-in tariffs are well below the power price and so build is driven by self-consumption, with the feed-in tariff acting as an export price.

Nearly all solar modules installed in Germany in 2020 are imported from China, but nearly all installation and engineering work is done by local firms. The German solar market is roughly 4GW/year, and the government has set a new cumulative solar target of 98GW installed by 2030 compared with approximately 50GW today.

It is highly unlikely that the German government would initiate any measures that run against its longstanding pro free-trade stance, or at least do so explicitly in defense of its local manufacturers. Furthermore, the existing German solar industry would oppose any move that would prevent it from accessing modules at the global market price.

Still, there is one trade-related policy possibly on the horizon that would have implications for German solar equipment makers. The European Union could seek to impose "carbon-border adjustments" on imports from countries with higher-CO2 power grids. Under such a scheme, import taxes would likely be imposed on Chinese-made goods, including PV equipment.

That said, European carbon border adjustments are unlikely to be championed by the German government, because despite achieving over 48% renewable electricity in the mix in 1H 2020, Germany's legacy coal fleet makes its grid one of the dirtiest in Europe. German-made PV modules thus have relatively large carbon footprints because the plants that produce them often are powered by coal-fired electricity. In fact, their CO2 profiles would not be much better than those made in China's plants.

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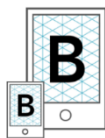
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