

GERMAN ENERGY SECURITY, RAW MATERIALS SUPPLY  
AND SHIFTING GEOPOLITICAL IMPACTS

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## Abstract

Germany, one of the largest energy consumers in the world, is a peculiar case when it comes to energy security and raw material supply. While the country actually has a wealth of natural resources, especially in the area of mineral resources, it is largely dependent on imports of metallic raw materials and energy resources due to high domestic demand and little indigenous production. In light of recent geopolitical events, this import dependency in conjunction with ambitious targets for the country's future energy mix and little willingness to explore domestic energy reserves pose new challenges to Germany's energy security and raw material supply in the long run.

The paper analyzes the dynamics of Germany's energy policies in light of current internal and external developments. The first part overviews Germany's current energy mix, its import sources and raw material needs. The recently adopted Raw Material Strategy is also reviewed. The second part explores the underlying reasons for Germany's current energy policies under the *Energiewende* and how the Russian aggression against the Ukraine might impact the historically close energy relationship both countries have had. The third part highlights potential avenues for exchange and cooperation with the United States and Mongolia in the energy and raw materials trade, respectively.

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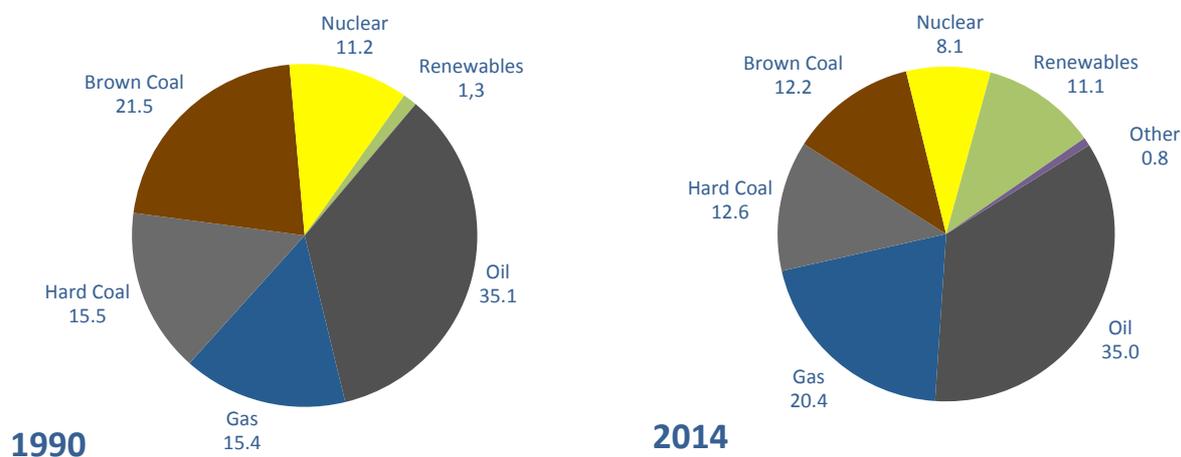
BGR	Federal Institute for Geosciences and Natural Resources / Bundesanstalt für Geowissenschaften und Rohstoffe
DERA	Deutsche Rohstoffagentur / German Mineral Resources Agency
EU	European Union
IEA	International Energy Agency
US	United States

# 1. The State of German Energy and Raw Material Supply

## 1.1 Energy Resources

Germany is the biggest energy consumer in Europe and one of the largest ones in the world. The German energy mix is dominated by fossil fuels, which accounted for about 80% of all primary energy consumption in 2014 (see Figure 1). Oil has traditionally had the largest share, currently 35%, while natural gas accounts for about a fifth and coal a fourth of the energy mix. Nuclear and renewable energy each provide for more or less a tenth of the overall energy mix, with nuclear at 8.3% and renewables at 11.1% share of the overall energy mix. Since 1990, energy consumption from coal-based sources and nuclear power has slightly decreased while the proportion of natural gas and especially renewable energy sources have grown in proportion.

**Figure 1: Primary Energy Mix in 1990 and 2014 (in %)**



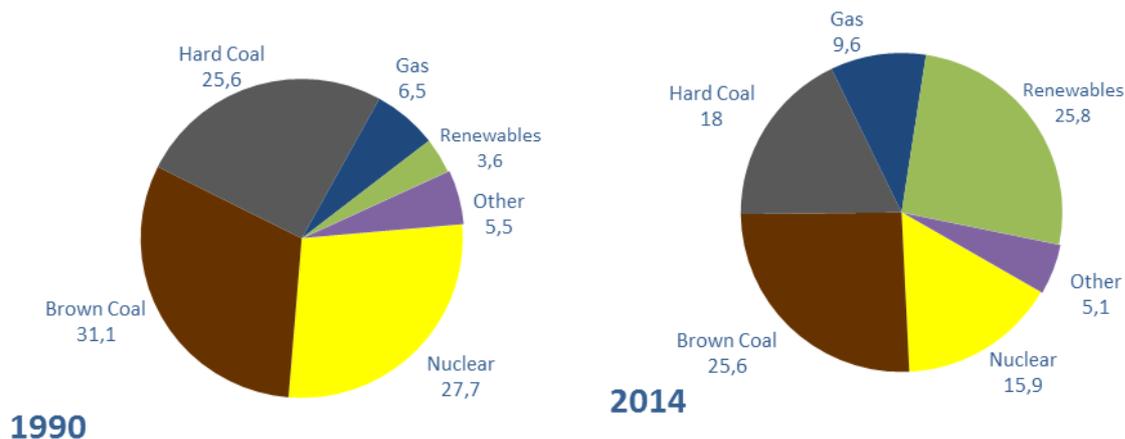
Source: Arbeitsgemeinschaft Energiebilanzen e.V.<sup>1</sup>

In the past coal, and in particular brown coal, have been the most important indigenous sources for electricity generation in Germany. Since the 1960s their share has been on a downward trajectory from around 90% of electricity generation in 1959 to around 50% in 1990. Figure 2 shows the rise of renewable sources from about 3% a quarter century ago to more than a quarter of gross electricity generation in 2014, overtaking brown coal in being the most important source of domestic electricity generation. This is largely the result of ambitious energy policies strongly favoring solar, wind, hydro and other internal renewable energy sources commonly referred to as *Energiewende* (energy transition), which will be

<sup>1</sup> [http://www.ag-energiebilanzen.de/index.php?article\\_id=29&fileName=ageb\\_pressediensst\\_08\\_2014.pdf](http://www.ag-energiebilanzen.de/index.php?article_id=29&fileName=ageb_pressediensst_08_2014.pdf), [http://www.ag-energiebilanzen.de/index.php?article\\_id=29&fileName=ausw\\_10092014\\_05112014\\_ov.pdf](http://www.ag-energiebilanzen.de/index.php?article_id=29&fileName=ausw_10092014_05112014_ov.pdf), accessed 16 January 2015.

explained in more detail in the second part. Over the same time period, the proportion of nuclear energy declined from 27.7% to 15.9% and can be expected to further steadily decrease under the current target of a nuclear phase-out by 2022.

**Figure 2: Gross Electricity Generation 1990 and 2014 (in %)**



Source: Arbeitsgemeinschaft Energiebilanzen e.V.<sup>2</sup>

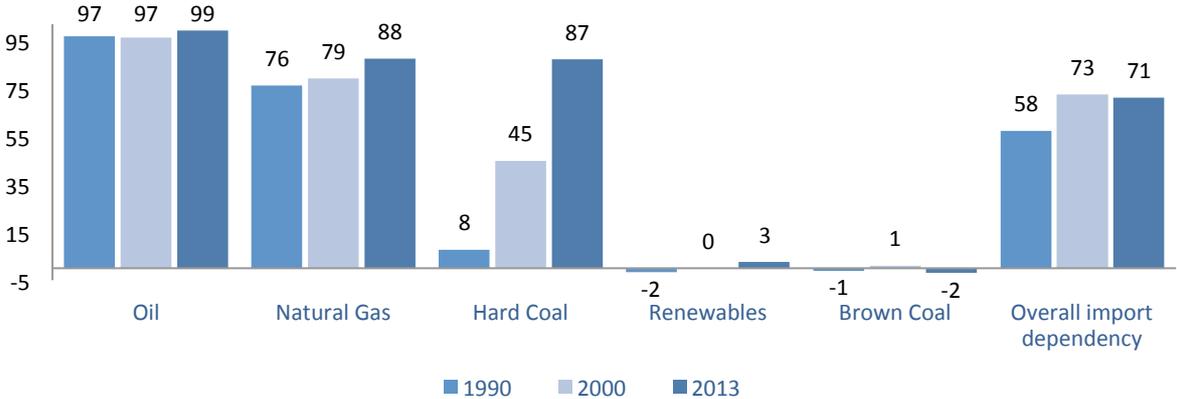
Germany's size and location give it considerable influence over the European energy sector. Similar to many of its European neighbors, the country relies heavily on imports to satisfy most of its energy demands. As highlighted in Figure 3, Germany imports practically all of its oil, 88% of its gas, and relies on imports for 87% of its hard coal needs. These imports make Germany one of the largest markets for natural gas in Europe and one of the three largest net oil-importing countries of the IEA (IEA, 2013, p. 98).

Since 2000, almost three quarters of the country's total energy consumption have been sourced from imports. Brown coal is the only energy source where Germany, the world's largest producer of lignite, has traditionally been fully self-sufficient. Despite the fact that energy demand has not risen in recent years, a steady decrease in domestic coal and gas exploration has contributed to a growing import dependency in the energy sector, which increased from 58% in 1990 to 71% in 2013 (AGEB, 2014). Large investments and ambitious future output targets for internal renewable energy sources like solar and wind power may partially weaken these dependencies in the long run. However, domestic hard coal production will also come to an end in 2018 thanks to the phase-out of government subsidies for coal mining. This is not because of dwindling domestic reserves (estimated to last several centuries) but due to a lack of competitiveness of the domestic industry vis-a-vis world

<sup>2</sup> [http://www.ag-energiebilanzen.de/index.php?article\\_id=29&fileName=20141216\\_brd\\_stromerzeugung1990-2014.pdf](http://www.ag-energiebilanzen.de/index.php?article_id=29&fileName=20141216_brd_stromerzeugung1990-2014.pdf), accessed 16 January 2015

market prices since the late 1950s, when the government introduced subsidies to ensure the survival of the German coal industry. In light of the foreseeable depletion of the little remaining domestic gas and oil reserves, the coal phase-out is likely to further increase German import dependencies for fossil sources of energy. Finally, Germany is also entirely dependent on imports for its uranium supply.

**Figure 3: Net Energy Imports as Share of Primary Energy Consumption 1990, 2000, 2013 (in %)**

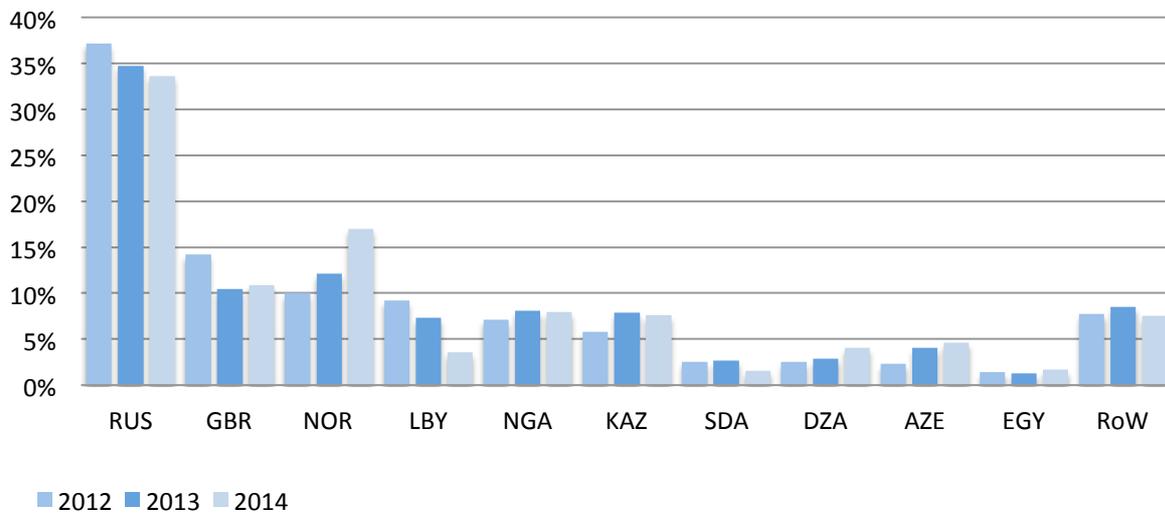


Source: Arbeitsgemeinschaft Energiebilanzen e.V.<sup>3</sup>

About half of Germany’s oil is imported from countries of the former Soviet Union like Russia, Kazakhstan, and Azerbaijan (see Figure 4). Among Germany’s trading partners, Russia is by far the largest supplier and has been providing more than a third of Germany’s overall oil imports in the recent decades, with Norway and the United Kingdom following as second and third biggest trading partners. In 2014, Russian, Norwegian and British supplies covered about 61% of German oil imports. At the same time, about a fourth of oil supplies are purchased from countries in the Middle East and Africa like Nigeria, Libya, Algeria, Saudi Arabia, Egypt, Iraq and Angola, which might not be regarded to be as stable producer countries as Germany’s European neighbors.

<sup>3</sup> [http://www.ag-energiebilanzen.de/index.php?article\\_id=29&fileName=ausw\\_10092014\\_05112014\\_ov.pdf](http://www.ag-energiebilanzen.de/index.php?article_id=29&fileName=ausw_10092014_05112014_ov.pdf), accessed 16 January 2015.

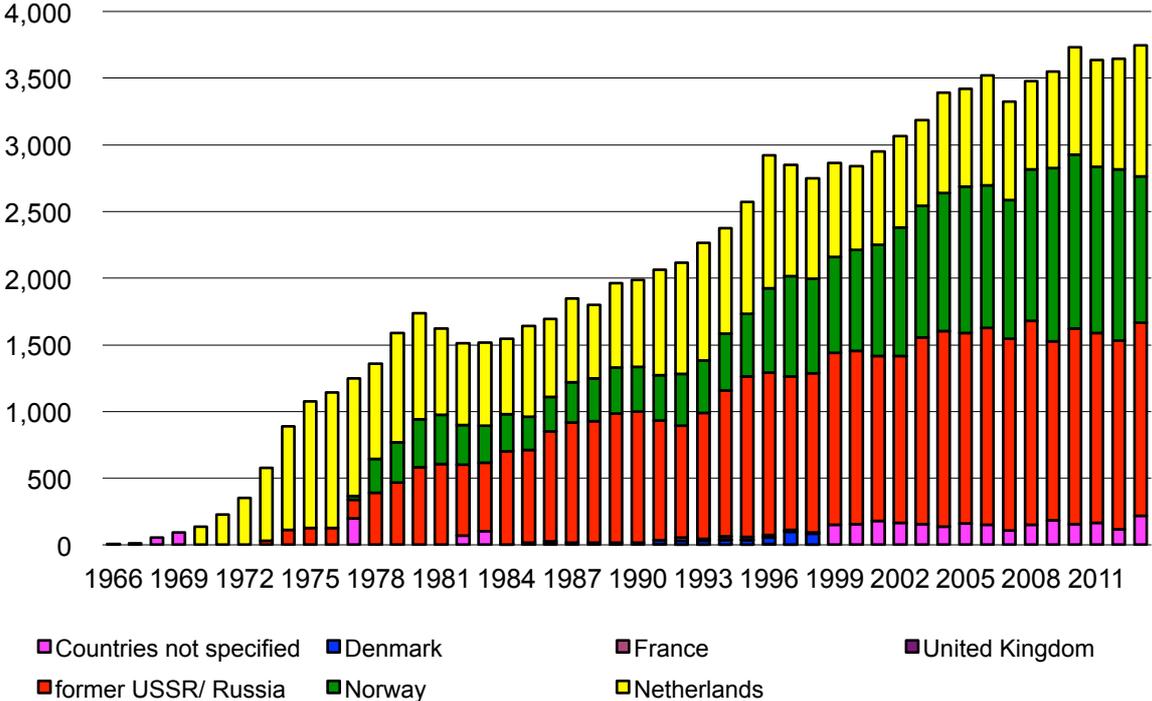
**Figure 4: Share of Crude Oil Imports by Country of Origin 2012-2014 (in %)**



Source: Bundesamt für Wirtschaft und Ausfuhrkontrolle, Amtliche Mineralöl- und Erdgasdaten

In the gas sector, an oligopoly of suppliers has persisted largely due to Germany’s pipeline-based import structure (Westphal, 2014a, p. 39). Similar to the oil sector, Russia is also the principal external supplier of natural gas covering currently 39% of total imports. Other major suppliers are Norway, which provides about a third of all gas imports, and the Netherlands, whose imports account for about a fourth of Germany’s gas consumption (see Figure 5). In addition to its prominent position among Germany’s gas and oil suppliers, Russia is also the top exporter of hard coal and thus provides the country with the largest proportional share of its total fossil fuel needs.

**Figure 5: Natural Gas Imports by Country of Origin 1966-2013 (in thousand Terrajoule)**



Source: Bundesamt für Wirtschaft und Ausfuhrkontrolle<sup>4</sup>

The long-term supply relationship Germany has had with Russia is evident in the structure of natural gas pipelines connecting the two countries as shown in Figure 6. As a central pillar of West Germany’s “Ostpolitik” and rapprochement with the Soviet Union under Chancellor Willy Brandt, the Soviet Union began supplying gas to Germany in 1973 under a “pipes for gas” agreement. The deal was based on a bilateral political and commercial consensus to bind Russian gas suppliers and German buyers together with long-term contracts of 20-35 years and levels of minimum purchase requirements of 75-85%, creating an intentional interdependence in the transnational natural gas value chain (Westphal, 2014a, pp. 40–41).

Although these bilateral market and contract arrangements have eroded since the end of the Cold War due to institutional pressures at the national and European level, this business model and the underlying political bargain have created a strong dependency on a Russia-based gas supply that was further increased by the construction of pipeline projects Yamal (1997) and most recently Nord Stream (2011), which bypasses Eastern Europe and directly connects Russia to Germany via the Baltic sea.

<sup>4</sup> [http://www.Bundesamt für Wirtschaft und Ausfuhrkontrolle.de/Bundesamt für Wirtschaft und Ausfuhrkontrolle/de/energie/erdgas/ausgewaehlte\\_statistiken/egashist\\_xls.xls](http://www.Bundesamt für Wirtschaft und Ausfuhrkontrolle.de/Bundesamt für Wirtschaft und Ausfuhrkontrolle/de/energie/erdgas/ausgewaehlte_statistiken/egashist_xls.xls), accessed 16 January 2015.

Figure 6: Natural Gas Pipelines connecting Russia and Europe



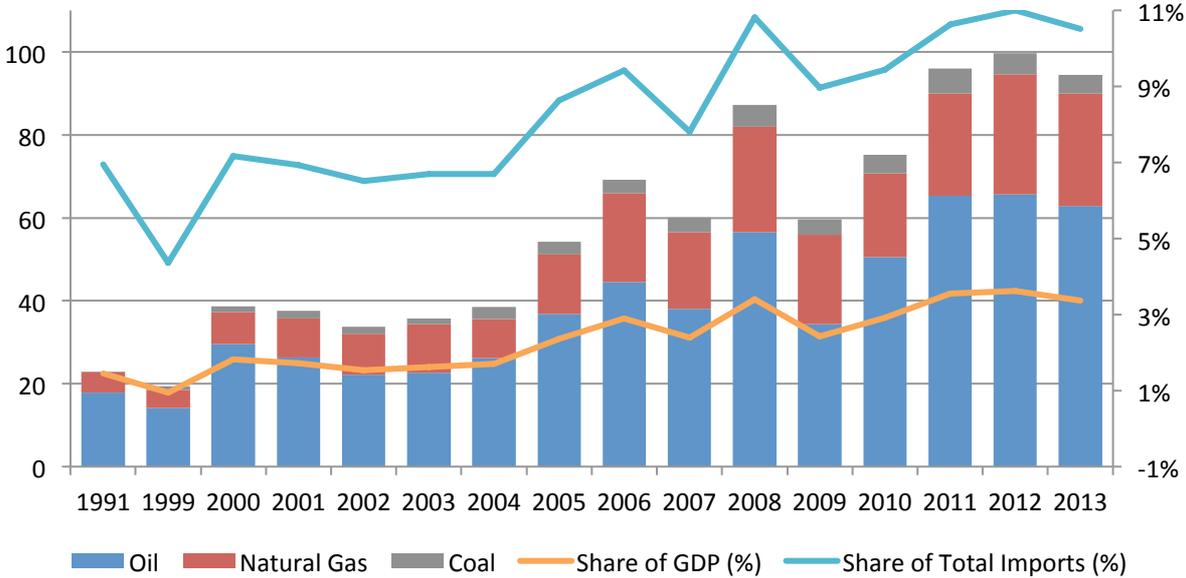
Source: Wikipedia/Samuel Bailey<sup>5</sup>

The cost of these enormous energy-related imports relative to the German GDP and its total imports are mapped in Figure 7. It becomes clear that although Germany’s strong economic output and external trade surplus have enabled the country to afford rising import costs as prices for fossil fuels have multiplied since the 1990s, the bill for its energy imports has reached an unprecedented height in 2012/2013. While these expenditures accounted for 4.4% of Germany’s total imports in 1991, this share had more than doubled to 10.5% in 2013. During that period of time, the cost of energy imports compared to GDP also more than doubled from 1.5% to 3.6%. In relative terms, this is equal to more than half of Germany’s entire current account surplus, which stood at 7% of GDP in 2013. The energy import bill

<sup>5</sup> [https://en.m.wikipedia.org/wiki/File:Major\\_Russian\\_Gas\\_Pipelines\\_to\\_Europe.svg](https://en.m.wikipedia.org/wiki/File:Major_Russian_Gas_Pipelines_to_Europe.svg), accessed 27 January 2015.

thus easily exceeds public expenditures in areas like defense and research and development, which amount to 1.3% and 2.9% of GDP, respectively.<sup>6</sup> In absolute terms, Germany is currently paying 99.5 billion Euro for its fossil fuel imports, almost ten times the size of Mongolia’s GDP. These expenditures might decrease in the near future in the context of a falling oil price (and oil-indexed gas prices), but apart from a significant drop in energy consumption or a rapid increase in energy efficiency, the cost level will most probably stay the same.

**Figure 7: Fossil Fuel Imports (in billion Euro) as Share of GDP and Total Imports 1991, 1999-2013**



Source: Statistisches Bundesamt, Statistik der Kohlenwirtschaft e.V.<sup>7</sup>

**1.2 Raw Materials**

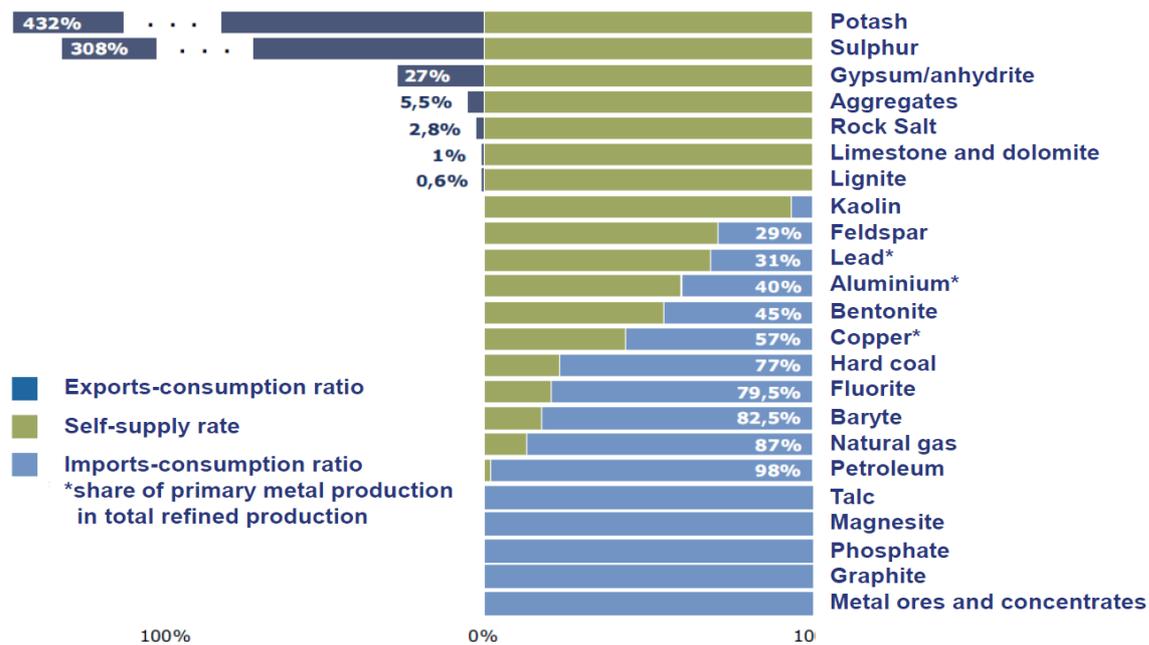
Similar to Germany’s high demand for energy resources, its position as a leading industrial and high-tech economy make the country one of the world’s largest consumers of raw materials and mineral resources. With regard to non-metallic mineral resources that are essential for the construction sector and certain consumer products, domestic production is able to satisfy most needs for potash, rock salt and the large majority of industrial minerals and rocks. In fact, Germany is the world’s third-largest producer of kaolin, number four in the production of rock salt and ranks fifth among potash producers (BGR, 2013, p. 13). However,

<sup>6</sup> Statistisches Bundesamt / World Economic Outlook Database, October 2014.

<sup>7</sup> <https://www.destatis.de/DE/ZahlenFakten/Indikatoren/LangeReihen/VolkswirtschaftlicheGesamtrechnungen/lrvgr02.html>; [http://www.kohlenstatistik.de/files/kohlenwirtschaft\\_silberheft\\_final\\_150dpi.pdf](http://www.kohlenstatistik.de/files/kohlenwirtschaft_silberheft_final_150dpi.pdf), accessed 16 January 2015.

metallic mineral resources that are essential for the iron and steel industry as well as many high-tech industries relying on precious metals and rare earths are entirely acquired through foreign sources (see Figure 8).

**Figure 8: Germany's Export/Import Ratios of Raw Materials (2010)**



Source: Bundesanstalt für Geowissenschaften und Rohstoffe<sup>8</sup>

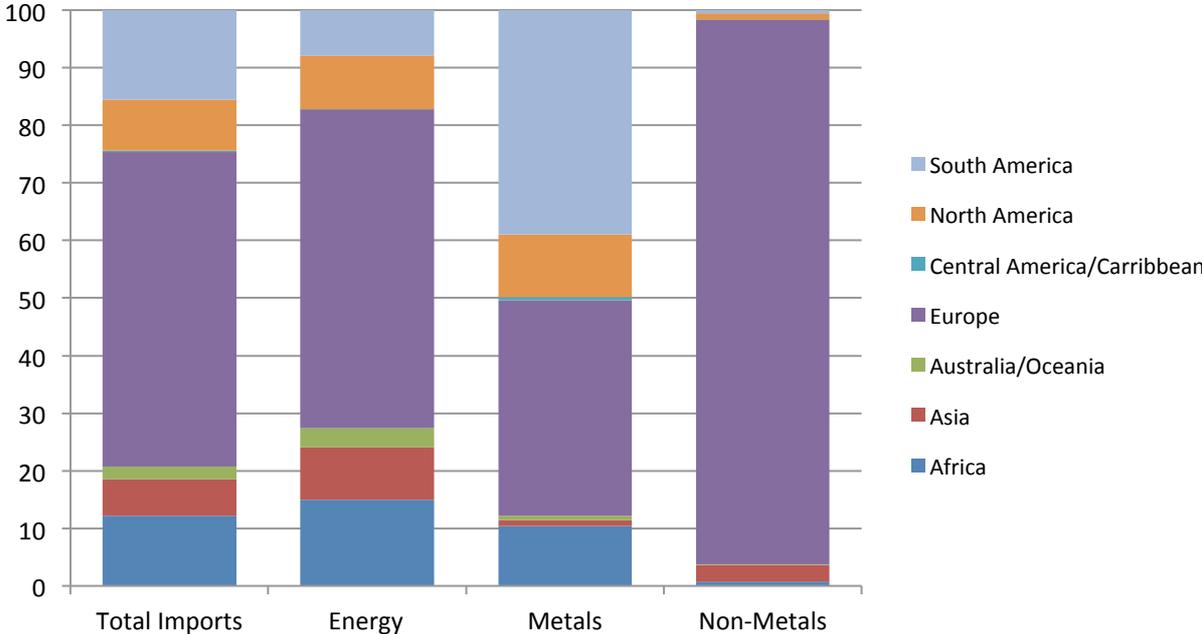
A secure supply of raw materials is not only an issue for common industrial metals, however, but also increasingly crucial for renewable energy sources and future technologies. The production of wind power plants and electric cars, for example, will require a multiple of the current German need for rare earth metals like neodymium, terbium, dysprosium. Other future technologies like thin-film solar cells, desalination plants or solar thermal power stations also need raw materials like indium, platinum and silver. The German industrial base and its high-tech sectors are thus reliant on sufficient supplies of these raw materials to maintain its competitive advantage (Steinbach, Buchholz, Elsner, & Wilken, 2011). As the head of the Energy and Mineral Resources Department at the Federal Institute for Geosciences and Natural Resources (BGR), Volker Steinbach, pointed out in 2013:

*“The sufficient supply with raw materials is an essential precondition for Germany’s technological competitiveness in the medium- and long-term and a key challenge. The secure access to raw materials is and will be the Achilles heel of the German economy.”* (BGR, 2013)

<sup>8</sup> [http://www.deutsche-rohstoffagentur.de/DERA/DE/Downloads/pdac\\_2014\\_bgr\\_steinbach.pdf?\\_\\_blob=publicationFile](http://www.deutsche-rohstoffagentur.de/DERA/DE/Downloads/pdac_2014_bgr_steinbach.pdf?__blob=publicationFile), accessed 23 January 2015.

The current expenditures for raw material imports are not as high as in the energy sector but substantial nonetheless. In 2013, Germany imported a total of metallic raw materials worth 41.1 billion Euro. Purchases of non-metallic raw materials were around 2.3 billion Euro, making for a total of 43.4 billion Euro in raw material imports. Adding the costs for fossil fuel purchases detailed in the previous section, the total German energy and raw materials imports in 2013 reached 142,8 billion Euro – around 5% of its GDP.

**Figure 9: Origin of German Resource Imports in 2013 (in %)**

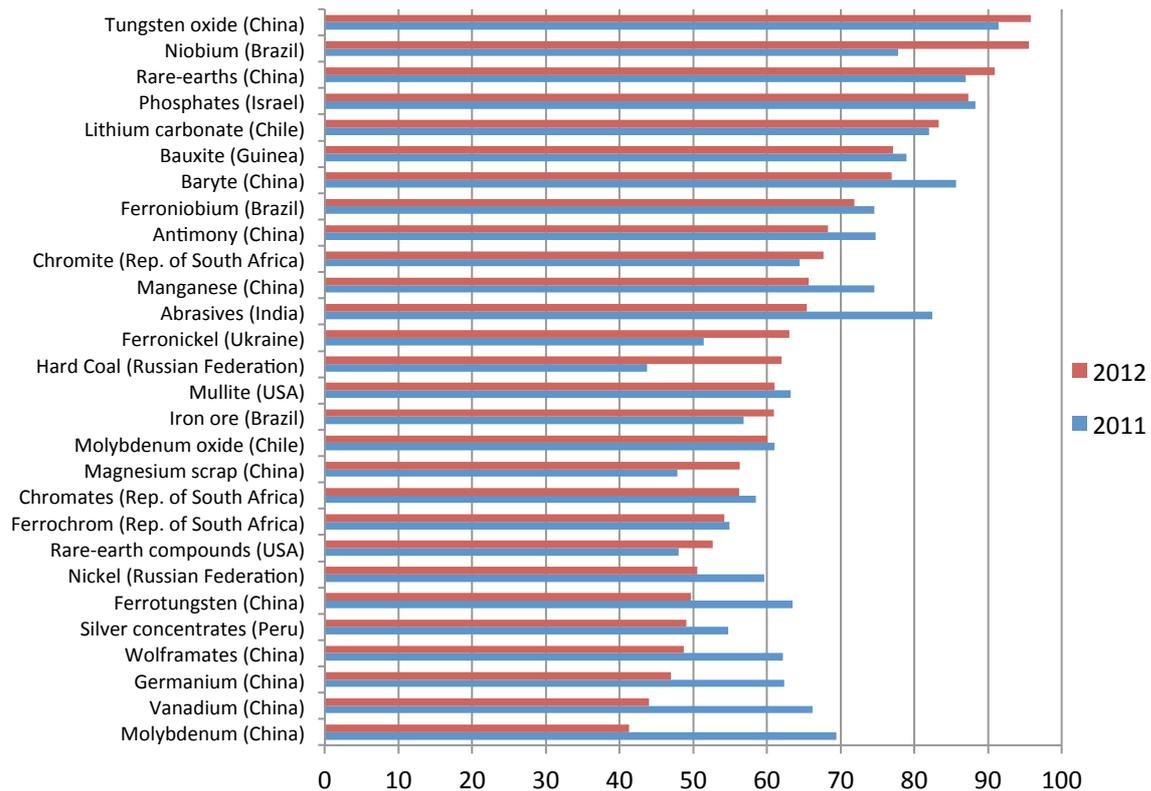


Source: Bundesanstalt für Geowissenschaften und Rohstoffe

Germany’s supplier countries are spread around the world, although more than half (55%) of overall energy and raw materials imports are bought from European countries, including Russia (see Figure 9). This is followed by South America (15.6%), North America (8.9%), Asia (6.3%) and Australia/Oceania (2.3%). Latin America is a crucial supply region for metallic raw materials, with countries like Brazil (niobium, iron ore) and Chile (lithium carbonate, molybdenum) being important exporters to Germany (see Figure 10). Almost all (95%) of non-metallic resources are purchased from European countries.

More problematic are raw material imports with a dependency of over 80% on countries that are generally associated with higher risk and not seen as entirely reliable suppliers. This may be due to internal problems, general regional instability or a proven record of politically motivated export restrictions. Two prominent examples are Guinea (85% of bauxite supply in 2013) and especially China (90% of rare earths supply in 2013) in the field of metallic resources (BGR, 2014a, p. 20).

**Figure 10: Import Dependencies by Raw Materials with Import Shares >40% in 2011/2012**



Source: Bundesanstalt für Geowissenschaften und Rohstoffe

The high import dependency in the area of metallic raw materials has accentuated the need for using and recycling secondary metal raw materials. The German refining and crude steel production uses more than 55% of aluminum, 42% of copper and approximately 44% of crude steel from secondary resources, a rather high share in international comparison. Germany also tries to alleviate its total import dependency for metal ores and metallic products through recycling of metal raw materials and the purchase of scrap and waste metal from its EU neighbors (BGR, 2014a, p. 22).

Germany is now dependent on a secure and steady access to raw materials on the world market given the lack of domestic capacities. Similar to the fate of its coal mining industry, the once large-scale domestic processing of mineral resources in the 1970s and 1980s in Germany has come to an end in the 1990s. These capacities were either closed down or relocated abroad due to rising energy and labor costs as well as comparably high

environmental standards in the context of an increasingly globalized resource production chain (Federal Ministry for Economics and Energy, 2010, p. 15).

The contemporary challenges faced by German companies and industries in the raw materials and energy market generally relate to high price volatility, high price levels and a difficult access to certain raw materials. These are compounded by the usual risks of currency and economic risks when trading globally. Companies can use different instruments to secure their resource supply, e.g. the use of spot markets, fixed long-term contracts with suppliers, decreasing resource needs by using alternative materials or developing different product specifications, or backward integration in the supply chain. All options, however, differ in relation to the degree of supply security and required investments (Erdmann, Behrendt, & Feil, 2011, p. 101).

After German companies got out of the mining business – a prominent example was the traditional mining company Preussag AG, which is now a global enterprise in the service and leisure industry – and sold their shares in international raw materials mines in the 1990s, backward integration has become too costly. Most companies in the metal and raw materials market are simply too small to afford the large-scale investments necessary to acquire direct shares of mining operations. Moreover, there are problems of time lags between recognizing imminent supply shortages and taking suitable measures;<sup>9</sup> a general lack of transparency and information asymmetry in the raw materials market about availability and pricing of various resources; a rising number of stakeholders and interests from other policy fields, i.e. environment, development, and security (Beißwenger, 2013, pp. 10–13).

### 1.2.1 The National Raw Materials Strategy

The German government has been aware of these challenges and the need to address competing goals across policy fields and departmental limits in a whole-of-government approach. After several years of consultation across ministries and with industry associations, labor unions and companies, Germany finally published a dedicated Raw Material Strategy in October 2010. Its key goals are:

- reducing trade barriers and distortions of competition;
- helping German commerce to diversify its sources of raw materials;
- helping commerce to develop synergies from sustainable economic activity and enhanced materials efficiency;

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<sup>9</sup> This problem is exacerbated by different time horizons across interconnected industries. For example, the product cycle in high-tech industries is often less than two years, while mining companies operate on timescales of 20 to 30 years.

- developing technologies and instruments to improve the conditions for recycling;
- establishing bilateral raw materials partnerships with selected countries;
- doing research into substitution and materials in order to open up fresh options;
- focusing research programs relating to raw materials;
- creating transparency and good governance in raw materials extraction;
- integrating national measures with European policy on raw materials.

The government moreover seeks to implement these goals and measures in a balanced fashion in accordance with principles of sustainable development and equal attention to the economic, ecologic and social aspects of its resource strategy. (Federal Ministry for Economics and Energy, 2010, p. 7).

One of the first measures stemming from this new strategy was the creation of the German Mineral Resources Agency Creation (DERA) as part of the BGR in 2010. DERA was set up to further pool knowledge and skills for providing advice and consulting services on raw materials to the German government and German companies, in particular small and medium-sized companies (Federal Ministry for Economics and Energy, 2010, p. 20). The agency, among other things, provides detailed raw materials risk analyses, conducts workshops tailored for industry participants, provides specific advice and recommendations through its publications and is currently developing a web-based raw materials information database for commercial, public and individual users.

Another initiative is the Federal Government Exploration Support Program intended to improve the supply for Germany and the EU of critical non-energy mineral commodities as specified by the EU Raw Material Supply Group (Antimony, Beryllium, Cobalt, Fluorspar, Gallium, Germanium, Graphite, Indium, Magnesium, Niobium, PGMs (Platinum Group Metals), Rare Earths, Tantalum and Tungsten). The instrument seeks to stimulate German companies to invest in national and international activities for the exploration, extraction and processing of natural resources in Germany and abroad. Effective since January 2013, it has 27,5 million Euros for the first 3-year term and is disbursed through conditionally repayable loans.<sup>10</sup>

Finally, the government has begun to establish bilateral resource partnership agreements with resource-rich (developing) countries that seek to provide mutual benefits for both German companies seeking better access to raw materials and the partner country looking for

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<sup>10</sup> [http://www.deutsche-rohstoffagentur.de/DERA/DE/Foerderprogramme/Explorationsfoerderprogramm/explorationsfoerderprogramme\\_node.html](http://www.deutsche-rohstoffagentur.de/DERA/DE/Foerderprogramme/Explorationsfoerderprogramm/explorationsfoerderprogramme_node.html), accessed 16 January 2015.

investments and support in their resource sectors. So far, four agreements with Kazakhstan, Mongolia, Chile and Peru have been signed. The status of the partnership with Mongolia will be reviewed more closely in the third part of the paper.

While it is still too early to assess the impact of the country's new raw materials strategy and related measures to enhance national resource supply, it should have become clear that German resource policy is focused on creating an appropriate framework at the national and international level for the raw materials supply of German companies. This is in contrast to other major economies that seek to secure their resource supply through state-owned or state-influenced resource companies, i.e. China, South Korea and Japan, or a strategic storage approach as practiced by China and the United States (Gandenberger, 2012, p. 198). As regards the internal dimensions of German raw materials policy, there is a strong focus on improved resource and material efficiency, better recycling to enhance the availability of secondary raw materials, as well as intensified efforts of research and development in these and other related areas (Heitzer, 2012).

At the international level, recent market developments in the commodity sector have eased concerns among German companies about threats to their raw materials supply. Most prominent has been China's decision at the beginning of 2015 to end its quota system limiting the exports of rare-earth minerals after it was declared illegal by the WTO. This policy had stoked fears in Germany and other Western countries about the supply of these strategic minerals after China cut its export quotas dramatically in 2010 (Yap, 2015). This is compounded by a global demand drop for rare-earth metals thanks to demand shifts to technologies that use much less or no rare-earths (i.e. the shift to LED lighting from phosphors) and improved recycling. While China will remain the biggest supplier in the near future, its share of global supply already decreased from 95% to 85% as the global supply base has begun to gradually widen (BGR, 2014b).

## **2. The Energiewende and Geopolitics**

In the previous chapter we showed that Germany has relatively few domestic sources for energy production and raw materials by itself and is thus greatly dependent on the import of such resources. To a certain degree this is the consequence of political decisions based on a social consensus that accepts comparatively high energy prices in order to advance the deployment of renewable energy sources and achieve a sustainable energy system in the long run. In this chapter, we explain this planned energy transition and discuss how recent

developments, in particular the actions of Germany's single most important energy supplier, Russia, might affect German energy policy.

## 2.1 *Energiewende* explained

A key part of Germany's *Energiewende* is the planned nuclear phase-out by 2022. Shortly after the Fukushima Daiichi nuclear disaster on March 11<sup>th</sup> 2011, German Chancellor Angela Merkel decided for the *Atomausstieg*, or the speedy end of nuclear energy in Germany. Eight older reactors were shut down almost immediately after the announcement of a country-wide safety inspection of all nuclear power plants and a moratorium on nuclear energy on March 14 (without consulting the European Commission or European neighbors). In June 2011, government and parliament decided that all remaining plants will be phased out by 2022. Although the likelihood of an incident comparable to the one in Japan is for geological reasons highly unlikely, at this time opposition in the German electorate to nuclear energy production was so adamant that no other political option seemed viable. The imminence of three state elections – one of them in Baden-Württemberg, one of the largest and economically most important German states – two weeks after the nuclear disaster in Japan played a major role in this fundamental policy shift of the Merkel government. The nuclear phase-out had already been enacted in 2002 under a Social Democratic-Green governing coalition that foresaw the decommissioning of the last nuclear reactor around 2022. Merkel's Christian Democratic-Liberal coalition, however, passed a 12-year life extension of nuclear power plants in spite of much public opposition in 2010. Under the impression of a strongly anti-nuclear public sentiment post-Fukushima and a dramatic decline in electoral support before the approaching state elections, this decision was completely retracted almost a year later (Jahn & Korolczuk, 2012).

This second nuclear phase-out became one of the three pillars of the *Energiewende*, Germany's energy policy strategy that serves to achieve a low-carbon, sustainable energy system by 2050. This policy is encapsulated in the Energy Concept of 2010 and rests upon three major pillars: (1) enlarging the share of renewable energy sources for energy and electricity production, (2) investments in energy efficiency and energy savings, and (3) phasing out of nuclear power by 2022 (Federal Ministry for Economics and Energy, 2012). The strategy sets forth ambitious targets for the next forty years for these three areas. For example, the proportion of renewable energy sources is intended to from 18% of total energy consumption (2020), to 45% (2040) to finally 60% in 2050 (see Table 2). While the country is on track to meet its 2020 goal for renewables, the trajectory for both the reduction of Green

House Gas (GHG) emissions and energy efficiency improvements is currently behind target (Rutten, 2014, pp. 14–15).

**Table 1: Targets of the Energy Concept**

	2012	2020	2030	2040	2050
Reduction in GHGs (base year: 1990)	-27%	-40%	-55%	- 70%	-80%
Share of renewable energies in total final energy consumption	10%	18%	30%	45%	60%
Share of renewable energies in electricity consumption	20%	35%	50%	65%	80%
Reduction of primary energy consumption (base year: 2008)	-5%	-20%			-50%
Reduction of electricity consumption (base year: 2008)	-1%	-10%			-25%
Reduction of final energy consumption in the transport sector (base year: 2008)		-10%			-40%

Source: Bundesministerium für Wirtschaft und Energie

Large-scale national investments in green energy and electricity already began under the Red-Green government of Gerhard Schröder in 2000 with the passing of the national Renewable Energy Act (EEG), which has been amended numerous times since but remains a cornerstone of German energy policy. Introducing significant subsidies in the form of guaranteed feed-in tariffs, the EEG gave renewable energy sources preferential access to the electricity grid and fixed their price for the duration of 20 years. Each renewable energy source receives a different guaranteed price related to its generation costs and capacity. These subsidies made wind and particularly solar energy technologies economically viable in a country whose average amount of sunlight is comparable to that of Alaska (Rutten, 2014, p. 18).

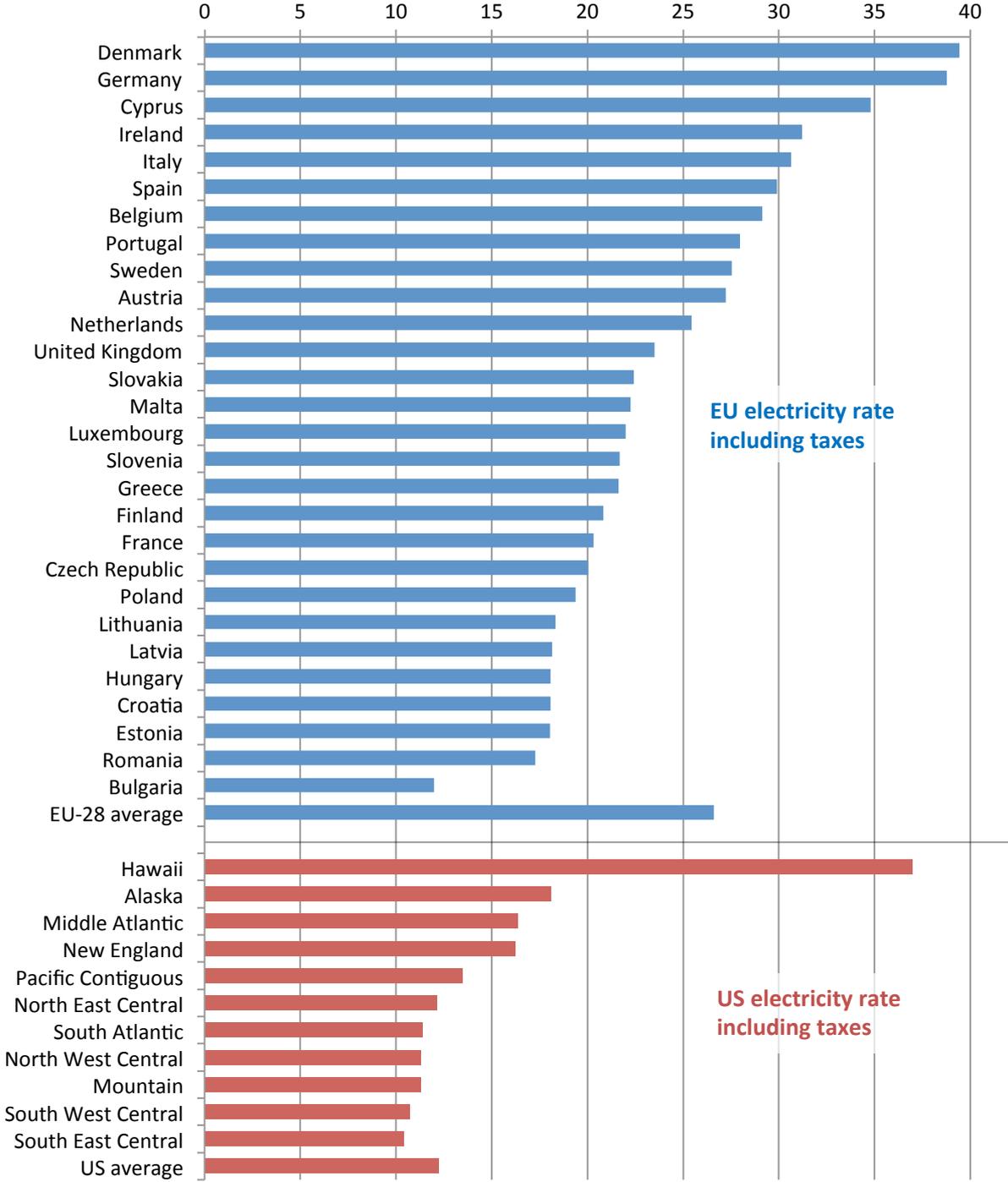
In a context of already volatile and rapidly changing global energy landscape, the political decision for a speedy nuclear phase-out and an accelerated *Energiewende* has introduced more uncertainty and complexity into the German energy sector. Public and private stakeholders now face several challenges to what was hitherto perceived to be a rather stable and satisfying energy system. These include maintaining the stability of the electricity grid as fluctuating renewable energy sources gain more importance; the geographical distance between renewable electricity generation in the northern part of the country and the industrial

centers in the south; the state of large utilities and energy companies that now must adapt to changing regulatory frameworks and develop new business strategies; and, as one of the most important issues, the high cost of the *Energiewende* and the distribution of these costs between households and businesses as well as among industry sectors (Röhrkasten & Westphal, 2012, p. 335; Rutten, 2014, pp. 18–22).

The relatively high cost of electricity in Germany is striking in this regard. The costs of the EEG are borne by electricity consumers paying a fee, the so-called *EEG-Umlage*. This fee accounts for about 20% of the total retail price for electricity for a 3-person household, or about 22 billion Euros in total in 2014. However, certain energy-intensive industries enjoy exemption from the EEG-Umlage, i.e. chemical producers, pharmaceuticals, manufacturers of non-metallic minerals and iron and steel. Other sectors, such as Germany's world famous automobile industry and its small- and medium-sized companies, are not shielded from the costs of the EEG. Overall, the renewable capacity costs are estimated to be at around 185 billion Euros (Rutten, 2014, p. 19).

In regional and international comparison, German households pay a premium for their power due to high national taxes and levies accounting for almost half of retail electricity prices (see Figure 11). In 2013, German residents paid around 38 US cents/kWh, the second highest-rate in the European Union after Denmark. The EU average, which masks wide differences across the Union, stood at around 26 US cents/kWh. There are also large differentials between US states, as Hawaii residents pay about as much for their electricity as German consumers because of the high costs for transporting generation fuel to the island. The US average, however, stood at around 12 US cents/kWh in 2013 and is almost half that of the EU average, with German households paying three times that rate. Only Bulgaria has lower residential prices than the US on average.

**Figure 11: Residential electricity prices in Europe and the United States 2013 (US cents/kWh, weighed average)**



Source: Eurostat, US Energy Information Administration. A conversion factor of 1.328 Euro/USD was used.

In addition to these internal dimensions, existing import dependencies are likely to be exacerbated. While in the past nuclear energy was seen as a necessary (if highly unpopular) bridging technology until sufficient production and storage capabilities for renewable energy were developed, the speedy phase-out brings about the need for a new bridging technology. Given the lack of alternatives, higher imports of fossil fuels like gas and energy efficiency

improvements seem to be the political choice. However, for the time being, a higher dependency on gas imports is more likely. This is reiterated by the BGR's current report on the state of Germany's energy and raw materials situation, concluding that in the current context "a further increase in Germany's import dependency on fossil energy resources is to be expected" (BGR, 2014a, p. 27). The single biggest supplier of choice so far has been Russia. It remains to be seen if the country will be Germany's energy source of choice in the future.

## 2.2 Germany and Russia: A Mutual Energy Dependence

As pointed out earlier, Russia is the leading supplier of oil, natural gas and hard coal to Germany. This relationship is by no means a historic coincidence but the product of a long-standing policy to establish a close interdependence between Germany and Russia in the energy sector. This goal has been articulated through various concepts over the last four decades, beginning with the *Ostpolitik* in the 1970s to a "modernization partnership" under Merkel's first government (2005-2009) and the approach of *Wandel durch Handel* (change through trade) in the years after. In a 2012 survey of German energy experts in the public, private and academic sector, Röhrkasten and Westphal found that the country's dependence on energy imports is still being framed in terms of a positive interdependence in contrast to being seen as a potential national security risk:

*"Most energy experts emphasised that for Germany it has always been a political objective to create and manage mutual interdependencies with the suppliers, but Germany has never sought to achieve autarchy. This corresponds with the approach to frame energy security in commercial rather than strategic terms. Energy is perceived as a commodity and a service, and much less as a strategic and foreign policy tool."* (Röhrkasten & Westphal, 2012, p. 336)

This quote illustrates two key aspects that have pervaded German energy policy for decades: on the one hand, seeing energy and electricity in commercial terms rather than an instrument of foreign and security policy. This is, paradoxically, evident in the policies pursued since the late 1990s to subsidize renewables and the green technology sector at high economic costs to consumers, making electricity a very expensive commodity for households and industry as shown in the previous section. While environmental concerns have largely driven these policies in the past, the consequences of the rather abrupt *Energiewende* under Merkel have increasingly shifted the public debate to issues like grid stability, industrial competitiveness, and other controversial aspects of renewable energy introduction and economic efficiency. At the same time, German governments have for a long time subsidized the domestic coal and nuclear industry due to their domestic availability and Germany's strong position in the

nuclear business. Energy policy has thus also always been closely intertwined with industrial policy (Rutten, 2014). It remains to be seen how the individual parts of so-called “iron triangle of energy policy” – supply security, economic efficiency, environmental compatibility – will be aligned in Germany in the near- and long-term future, especially in light of the falling oil price.

On the other hand, the dependency on Russia for substantial fossil fuel imports has always been framed in positive, mutually beneficial terms in public discourse rather than in terms of a geopolitically disadvantageous dependency. Much to the contrary, Russia has usually been seen by the German political and economic elite as a reliable partner that is as much depended on a secure energy demand and export revenues as Germany is dependent on energy imports. Many experts point out that politically motivated disruptions of energy imports were not even used during the Cold War (Röhrkasten & Westphal, 2012, p. 337).

This is especially interesting because China, on which Germany relies for almost all of its rare-earth minerals, has been viewed as a strategic competitor and a potential threat in the raw materials sector. The concern caused among German government and industry leaders by the Chinese quota cuts in 2010 greatly contributed to the adoption of the above mentioned raw materials strategy and its associated measures to weaken dependencies in that sector. The perception towards Russia, however, has been not significantly altered by its recent politically motivated gas supply cuts in the gas disputes with the Ukraine in 2006 and 2009, which also severely affected several European countries. Surveying German energy experts in 2012, Röhrkasten and Westphal still found that “Russia was seen as much less a source of concern than competition with China” (Röhrkasten & Westphal, 2012, p. 338).

### 2.3 The Russian Aggression against the Ukraine – Business as Usual or Eye-Opener for German Energy Politics?

These perceptions of Russia as a reliable partner in general and a trustworthy supplier of fossil fuels in particular are being put to the test by its continued aggression against the Ukraine. In response to the Euromaidan protests and the fall of the Yanukovych government in Kiev, Russia occupied neuralgic points on the Crimean Peninsula, installed a pro-Russian government and ultimately annexed the territory in March 2014. Since then, the Russian Federation has been fueling an armed insurgency in Eastern Ukraine and conducted operations with regular armed forces inside the country. The Putin government has effectively been waging what some call a “hybrid war” against the Ukraine with officially over 6,000 killed so far, including 298 passengers of a civilian airliner shot down by Russia-backed separatists (Freedman, 2014; Mitrokhin, 2014).

### 2.3.1 The Current Sanctions against Russia

The illegal annexation of Crimea and Russia's ongoing efforts at destabilizing the Ukraine have been regarded by the European Union and the United States as a fundamental breach of international law and a severe violation of multiple post-Cold War agreements signed by Russia. As a consequence, the EU and the US have imposed selective travel bans, asset freezes and economic sanctions against individuals and entities in Russia and Crimea. In addition to an embargo on arms-related and dual use goods and technology, the sanctions also target the Russian energy sector with the following provisions:

*“Exports of certain energy-related equipment and technology to Russia are subject to prior authorisation by competent authorities of Member States. Export licenses will be denied if products are destined for deep water oil exploration and production, arctic oil exploration or production and shale oil projects in Russia.*

*Services necessary for deep water oil exploration and production, arctic oil exploration or production and shale oil projects in Russia may not be supplied, for instance drilling, well testing or logging services.”* (European Union, 2015)

Germany has played a key role within the EU both in creating the present sanctions regime as well as maintaining a steady diplomatic dialogue with Russia. The stern German support for punitive measures seems to have come as a surprise to the Putin government, which probably expected more reluctance by Angela Merkel and German elites in reaction to the Russian incursions into Ukraine. As a result bilateral economic exchange has clearly taken a hit: Germany is Russia's largest trading partner after China and its exports to Russia decreased by 16.6%, or about 4.34 billion Euros between January and August 2014 compared to the pre-year level. Although Russia only accounts for 3.3% of all German exports, the impact was particularly felt in the engineering and automobile sectors, where Russia is the 4<sup>th</sup> and 9<sup>th</sup> largest customer (Rutland, 2014, p. 4). In conjunction with a sharp drop of the Russian ruble, falling Russian shares and the slump of the global oil price, the sanctions have exacted a rather high price on the Russian economy. Whether that will deter further Russian aggression against the Ukraine remains to be seen.

Due to the sanctions Western oil and gas companies are currently siding with caution and have paused or withdrawn new exploration projects in Russia with companies like Rosneft, Gazprom and Novatek. This means less access to much needed Western technologies for deep off-shore and fracking operations that the domestic industry cannot provide. Moreover, the financial sanctions have also created significant hardships for Russian energy outfits to generate sufficient capital for their investment plans and debt service. In return, Russia has greatly increased its efforts to diversify its energy customer base by signing a long-term gas

deal with China and cancelling the long-planned South Stream pipeline (see Figure 6), which will now be routed to Turkey instead (Bradshaw, 2015). While these decisions might follow a certain business logic, it is clear that they were mostly driven by strategic (re-) considerations of the Russian government about its future foreign and energy policy.

### 2.3.2 Potential Effects on German-Russian Energy Relations

In the case of Germany, an asset swap agreed upon in 2012 between the BASF subsidiary Wintershall and Gazprom was cancelled in December 2014. The deal, which had been approved both by the European Commission and the German government before the crisis, would have given Wintershall a 25% stake in the world's second-largest gas field in Siberia. In return, Gazprom would have taken full ownership of the subsidiary Wingas, the owner of Europe's largest gas storage facility in northwestern Germany, and a 50% stake in North Sea explorer and producer Wintershall Noordzee (Gazprom will continue to hold a 50% non-majority stake in Wingas it had already acquired). While both the German government and BASF executives have been keen to insist that it was a business decision taken without political pressure, it is fair to say that the asset swap would have countered the spirit, if not the letter, of the current sanctions regime against Russia (Alessi & Sloat, 2014).

The case of the Wintershall/Gazprom asset swap, despite its cancellation, actually confirms that the mantra of Russian reliability remains strong among a large part of German elites. When the Merkel administration approved the deal in 2013, it expressed no concern that Russia's major state-owned gas company would have gained full ownership of Europe's largest gas storage facility. Much to the contrary, the German Economics Ministry announced that it did not consider this "transaction to be a danger to gas supplies" and emphasized that the country "remains open to foreign investment". In parliament, the deal raised criticism from the opposing Green party as well as Norbert Röttgen, chairman of the Bundestag's foreign affairs committee and a leading CDU member, who said the transaction was "not the right response to the crisis" and that it would be "deepening our dependence on Russia." (Wagstyl, 2014) One might argue that the question of ownership is irrelevant in this case, as German authorities could still (legally or forcefully) gain access to the stored natural gas in case of need. However, an asset swap with, for example, a Chinese state-owned company probably would have been viewed with much more skepticism.

Recent public statements further indicate that the German government does not regard the enormous Russian leverage over the European and German energy supply as a serious strategic vulnerability in the context of increasing antagonism. In December 2014, following

the cancellation of the South Stream pipeline project by Moscow, both Merkel and her Minister of Economics, Sigmar Gabriel, expressed hope that the project will be taken up again in the future. In a visit to Hungary in February 2015, Merkel emphasized that she still wants Russia as an energy supplier for Europe (Rinke, 2015). These statements were likely made in an attempt to show good spirit and encourage cooperation with Moscow at a time when high-level negotiations leading up to the second Minsk agreement of February 12 were taking place. Nevertheless, the one-sided appraisal of the existing energy dependency and complete lack of strategic ambiguity about Germany's long-term energy policies vis-à-vis Russia is rather striking to an outside observer. Regardless of how one is to interpret the aforementioned events, other pre-crisis developments like the completion of the Nord Stream pipeline in 2011, to be operated by Gazprom for a planned operating time of 50 years, will only further exacerbate German dependency on Russian gas imports in the future.

With specific regard to natural gas, a recent study analyzed how European countries would fare in the case of a Russian gas export ban to Europe starting in November 2014 (Hecking, John, & Weiser, 2015). The simulations found that almost all European countries could withstand a three-month embargo by tapping into stored natural gas reserves and increasing imports from other suppliers. However, countries like Finland, Poland and Turkey would already encounter supply shortfalls. A six-month disruption would cause shortfalls in large parts of Eastern Europe as well as Germany. Only few countries like Italy and France would not be affected thanks to their supply diversification. In the case of a nine-month gas export ban from Russia, however, most European countries would be severely affected (this excludes large gas producing countries like Norway, the Netherlands and the UK). Germany would suffer a supply shortfall of around 12 billion cubic meters of natural gas, which is roughly equal to a third of overall natural gas consumption of households for energy and warmth. These findings are dependent on factors like the availability of liquefied natural gas (LNG) imports and gas storage capacities as well as the absence of other external shocks (i.e. a cold spell). While the scenario also estimates that Gazprom's annual revenue would drop by 3.5% per month of gas embargo and thus heavily impinge on the Russian federal budget, such calculations help to underline the dependency of Germany on Russian gas and the lack of viable short-term alternatives should the need arise.

There are of course many economic and political factors that might prevent the Russian government from ever resorting to such extreme measures in case of an escalating confrontation with the EU. Nevertheless, nobody in Western capitals (or anywhere else) predicted the reckless course of action taken by the Putin government against the Ukraine. To

its European neighbors, Russia simply has become unpredictable, unreliable and much less trustworthy. The challenge to German decision-makers is now to assess whether Russian foreign policy has departed from a general partnership with the West towards a position of strategic opposition, and if so, how German foreign and energy policy would adapt accordingly. The national discourse still seems to disregard the possibility of this fundamental shift in the geopolitical landscape and is instead centered on how to achieve de-escalation and rebuild trust towards Russia. Even if one were to follow this reasoning, the basic challenge would remain, as one observer of German foreign policy pointed out, “how to build trust with a government that keeps lying to us with regard to the Ukraine?” (Bilyk, 2015).

### 2.3.3 Alternatives in Sight?

In any case, there are no quick solutions to mitigate the dependency on Russian fossil fuel imports. While there generally seems to be little public discussion about preferable strategies to put Germany’s supply security on a broader footing, some actors like the Green party are calling for more investments in energy efficiency like thermal insulations for households and more public funds to finance energy saving measures in the industry (Petersdorff, 2014). Improving energy efficiency and further increasing the share of renewable energy resources would be very much in line with the *Energiewende* and Germany’s ambitious climate goals. However, a significant impact would only be felt in the long run as the phase-out of nuclear energy and hard coal production in the coming years will likely increase German fossil fuel dependencies in the short run. Other available options mostly relate to the proactive diversification of the gas and oil supply, i.e. through finding new suppliers, the creation of domestic LNG capacities or domestic shale fracking.

Other producers within and outside Europe could help diversify the German oil and gas supply. As mentioned before, Norway, the Netherlands and the United Kingdom are already important suppliers of natural gas and crude oil. Although Germany could procure slightly greater quantities from these neighbors, they all seem to have reached their peak oil/gas production. It is difficult to assess how much time and investment would be necessary e.g. by the U.K. to significantly increase its production volume through controversial means like hydraulic fracking. Similarly, Algerian natural gas production has also reached a plateau and is more likely to be directed towards the rising gas demand in Northern Africa (Westphal, 2014b, p. 3).

As regards LNG, earlier plans for the creation of the first German LNG terminal in the city of Wilhelmshaven were shelved in 2008. Under current market conditions, German

energy companies have little economic incentives to build such expensive infrastructure without significant subsidies from the government. Yet Germany could also improve its access to existing LNG terminals in neighboring countries like the Netherlands, Belgium, France and Spain and benefit from an increased LNG supply to Europe indirectly. A clear disadvantage would be the higher price of LNG imports compared to pipeline-based gas supply until greater capacities i.e. from the US and Australia enter global LNG markets in the coming years (Petersdorff, 2014; Westphal, 2014b, p. 4)

Lastly, hydraulic fracking might be used to increase domestic natural gas production. In a large exploratory study in 2012, the BGR estimated that there are up to 2.3 trillion cubic meters of technically recoverable natural gas in Germany (BGR, 2012). This would amount to more than 20 times of the country's annual gas consumption and could easily make up for the decrease in domestic gas production since the 1980s. While it is certain that German reserves are far smaller than the shale gas potential in the US, these are only preliminary estimates and a more exact determination is only feasible through further exploratory drillings. Conventional fracking has been used in Germany since the 1960s, yet unconventional fracking for shale gas and oil is – like in most other European countries – highly controversial and has been under a *de facto* ban in recent years. New legislation currently being drafted by the government foresees the creation of an expert commission by 2018 to assess environmental and public health risks, which could allow for scientific drillings the earliest in 2019/2020. It will hence take probably another decade, if ever, before the systematic extraction of Germany's shale reserves could begin.

Any diversification strategy would therefore take many years to implement. However, similar to how mutual interdependence vis-à-vis Russia was created over the long run, the groundwork can be laid today for a gradual shift away from Russian energy imports – sufficient political will provided. This would also signal Russia that Germany is no longer willing to remain in the current state of self-imposed dependency and is reconsidering essential aspects of their bilateral relationship. Some of the rather hasty policy decisions underlying the *Energiewende* certainly complicated the German energy security in the short run. Yet the long-term transition to a sustainable and climate-neutral energy system might simply be the best way to deal with and ultimately end Germany's energy dependence.

### **3. Options for Bilateral Cooperation in the Energy and Raw Materials Sector**

#### **3.1. United States – New Supply Options through TTIP?**

Given the fact that Germany has a strongly export-oriented economy and is highly dependent on resource imports, it is in the national interest to maintain open trade and non-discriminatory access to energy and raw material markets. Even though the portfolio of imports in energy and raw materials is quite different in the US, its interest in an efficient global market is quite similar to Germany's. It is therefore no surprise that the current negotiations for a Transatlantic Trade and Investment Partnership (TTIP) address these issues accordingly (European Commission, 2013). From an EU perspective, the interest is clearly to reduce export restrictions in the US energy sector in order to create a more common market with a higher tendency of price-equalization than under the current framework. Perhaps as equally important as the creation of a transatlantic market for energy and raw materials could also be the signal towards resource-rich countries to expect a more coordinated approach of the two largest economies towards non-discriminatory access globally.

Since the onset of the Ukraine crisis, the US government has been discussing selectively relaxing existing restrictions on crude oil and natural gas exports to make its European partners more independent of Russia in the long run. The US shale revolution certainly has “the potential to put transatlantic energy relations on a more secure and competitive footing” and increase “energy security and economic growth based on lower, competitive gas prices” (Haug, 2012, p. 365). The question of how much domestically produced gas the US will export as LNG in the next years is of strategic importance for international gas markets. Under current market conditions, however, significant LNG exports to Europe seem unlikely due to high price differentials in favor of the Asian market. It is therefore not regulatory obstacles but at present a commercial rationale that would prevent US gas producers from exporting to Europe (Westphal, Overhaus, & Steinberg, 2014). In any case, it is still too early to assess how far US and European energy markets will be integrated as a result of TTIP.

#### **3.2 Mongolia – Chances and Challenges of the Bilateral Raw Materials Partnership**

Mongolia is one of the ten most resource rich countries in the world and has large reserves of metallic raw materials as well as coal, uranium and oil. Bilateral exchanges in the raw materials sector date back at least 50 years, including recent advisory and support services provided by the BGR and development initiatives to improve sustainable raw materials governance in Mongolia. (Mildner & Dahlmann, 2013, p. 4). In October 2011, Germany and

Mongolia signed a bilateral raw materials partnership agreement. Both countries jointly committed to

- explore, develop, extract and process raw materials;
- build and expand technical infrastructure;
- improve raw materials and resource efficiency;
- implement environmental and social standards in the extraction and processing of raw materials;
- to improve the legal and institutional framework and the administrative procedures in the raw materials sector;
- to educate, train and develop the skills of specialists in the raw materials sector (Federal Republic of Germany & Government of Mongolia, 2011, p. 4).

While the agreement was initially seen both by the government and the industry as an effective instrument to enhance the national economy's resource supply, the high expectation has not been met so far. Aside from several initiatives in the area of development cooperation, the agreement produced hardly any bilateral resource projects in the private sector. A 2012 survey by the Federation of Germany Industries found that although German companies regard resource partnerships as a useful means to diversify their supply base, they regard direct supply contracts, trading in commodity markets and shares in raw materials projects as more important. In fact, only 36% of surveyed companies saw a need for further partnership agreements like the ones with Mongolia and Kazakhstan (Mildner & Dahlmann, 2013, pp. 4–5). Mongolian actors, on the other hand, have been disappointed by the lack of German investments into its national mining sector. German companies do produce equipment and technologies for mining companies worldwide but they are unable to engage in larger direct investments in this sector. Consequently, there is currently no demand for more raw materials partnerships like with Mongolia on part of the German industry (Beißwenger, 2013, p. 21).

The raw materials partnership has apparently not led to a short-term increase in German investments in Mongolia or a significant rise in raw materials exports to Germany. The German processing industry, especially small and medium-sized companies, is more interested in a stable procurement of raw materials rather than acquiring shares of Mongolian mining companies. Nevertheless, the instrument seems to offer more value over the long run and should be reformed instead of entirely discarded (Beißwenger, 2013; Mildner & Dahlmann, 2013).

## 4. Conclusion

Although Germany has greatly increased the relative share of renewables in energy and electricity production since the 1990s, about 80% of all primary energy consumption is still

served by fossil fuels. The country will remain dependent on significant imports of fossil fuels and most raw materials in the medium term. These imports currently amount to 5% of GDP or roughly 142 billion Euros, more than half of which are procured from European countries. With regard to raw materials, the dedicated national strategy of 2010 and related measures represent a first step towards improving the efficient use and supply of critically important raw materials. This includes, amongst other things, the provision of advisory and information services on resources to German companies through the newly founded agency DERA and increased investments in recycling and material efficiency. Recent developments in the global rare earths market have also alleviated concerns about structural supply risks that were much greater a few years ago. The bilateral raw materials partnership with Mongolia, however, has not lived up to expectations on both sides and might offer more value in the long run if properly adapted.

Russia remains the single biggest trading partner in the energy sector and supplies over a third of Germany's oil, gas and hard coal supply. This self-imposed dependency has its historic roots in the rapprochement policy towards the Soviet Union in the 1970s and has not been fundamentally revised since then. The ongoing aggression against the Ukraine might change the prevalent perception of Russia as a reliable partner among German political and economic elites. However, the example of the recently halted asset swap between BASF and Gazprom provides no conclusive evidence for a sustainable policy shift, and it remains to be seen whether the current government is willing to fundamentally change German energy relations with Russia.

At the same time, the *Energiewende* is likely to increase German dependency on fossil fuel imports in the short run due to the parallel phase-out of domestic hard coal and nuclear energy production by 2018 and 2022, respectively. Further planned investments in renewable energy sources and improvements in energy efficiency will only make a major impact in the long run. Other options like increased LNG imports, fracking of domestic shale reserves and oil/ gas purchases from European neighbors (i.e. Norway, UK, Netherlands) would not yield a significant improvement anytime soon. In how far Germany and Europe could benefit from a liberalized transatlantic energy market under a possible TTIP agreement is questionable since US LNG producers seem to have little incentive to export to Europe under current market conditions. There are thus no quick fixes for the diversification of Germany's energy supply. Nevertheless, with sufficient political will a combination of some (or all) of these options could be taken as first steps on the long path to a sustainable and more independent German energy system.

As for the state of Hawaii and its goal to become 100 per cent renewable one must accept the major differences existing when you compare this isolated group of islands with the world's fourth largest economy located in the heart of Europe. While these differences are based mainly in scope and geological differences the need for various engineering and regulation solutions for the *Energiewende* are the same. Therefore, on a research and development level as well as in policy exchange lays a great deal of value in cooperation among these two distant states. This underlines why lowering CO2 emissions to reduce global warming is a common and global challenge that can bring even the most unlikely partners together.

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