Research Brief on Energy
Energievende

Office of Senator Win Gatchalian — April 20, 2017

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I. What is the Energiewende?

Energiewende can be translated to "energy transition". The German Energiewende is a long-term program to develop a low-carbon and energy efficient German energy system. It is the codification of Germany's commitment to a structural transition away from conventional fossil-fuel generation technologies and towards renewable energy technologies.

II. What are the Reasons behind the Implementation of the Energiewende?

1. *Fight Climate Change*
   Literature that underpin the Energiewende identify the burning of fossil fuels such as coal, natural gas, and oil as a critical threat to climate sustainability. There is thus a need to reduce the dependence on fossil fuels through the promotion of energy efficiency measures and strategies and the usage of fossil fuels through the promotion of renewable energy technologies.
2. *Reduce Energy Imports*
   Germany imports two-thirds of its energy requirement. Increasing domestic energy supply and reducing domestic energy demand will work towards developing or strengthening Germany's energy independence.
3. *Stimulate Technology Innovation and Develop the Green Economy*
   Given Germany's industrial base and technological expertise, it is uniquely placed to be a leading innovator and exporter insofar as renewable technologies are concerned. As such, Germany is in a position to benefit immensely from the rapidly growing demand for these emerging technologies.
4. *Reduce and Eliminate the Risks of Nuclear Power*
   Germany rejects nuclear power because of its risks, costs, and the unsolved issues surrounding the disposal and management of nuclear waste. The rejection of nuclear power is a fundamental pillar of the German Energiewende. Germany firmly believes that nuclear energy is not a solution. The following are the key issues that underpin its rejection:
   - Risk of a nuclear disaster
   - Risk of weaponized plutonium proliferation
   - Risk of radiation
   - Prohibitive cost
   - Limited availability of uranium resources
   - Incompatibility of inflexible baseload power with fluctuating wind and solar
5. *Promote Energy Security*
   Renewables develops domestic energy supply and, as a result, reduces Germany's dependence on energy imports. This reduced dependence on energy imports, in turn, affords Germany greater insulation from the volatility of fossil fuel imports on the world market.
6. *Strengthen Local Economies and Provide Social Justice*

The dispersion of energy generation provides local communities with the expanded means to generate additional income, economic activity, and jobs. The dispersion of energy generation also provides local communities additional insulation from price shocks in fossil fuels.

III. How Does Germany intend to implement the Energiewende?

1. *Significantly Reduce Energy Consumption*
   Germany recognizes the limitations of renewable energy. As such, it recognizes that the sustainability of a renewable energy grid is contingent on low energy demand. Energy efficiency is thus key to achieving its energy targets – and maintaining the competitiveness of its economy. Germany makes it clear that energy efficiency is indispensable to the Energiewende.
2. *Reduce Electricity from Coal and Nuclear*
   The ambitious renewable energy targets of the Energiewende necessitate the systematic and gradual elimination of coal energy and nuclear energy. Moreover, the relative inflexibility of coal and nuclear constrain the development of a flexible renewable energy grid.
3. *Pivot Towards Wind Power*
   Given Germany's geography and decades of acquired and developed expertise, wind power constitute the cheapest source of new renewable power for the German energy industry. Sustained investments over the past decade have resulted in wind power providing 10% of Germany's energy requirement in 2014 (40 GW). Germany intends to increase this to 30% by 2020.
4. *Develop Biomass*
   Biomass is perceived as the most versatile emerging renewable technology. This versatility, in turn, implies that biomass can be used as a suitable complement to variable renewable energy sources such as wind and solar. The development of biomass also provides ancillary benefits insofar as waste management is concerned.
5. *Further Develop Photovoltaics*
   Germany's decades long commitment to developing photovoltaic technology is starting to bear fruit. Germany has contributed immensely to the development of photovoltaic technology – and to its increasing viability in both the developing and developed country settings. In Germany, solar provides one third of its peak demand – which happens around noon.
6. *Other Renewables*
   Developing Germany's geothermal resources and investing in the development of technologies pertaining to the recovery and usage of waste heat or renewable heat have important implications for both renewable energy development and energy efficiency.
7. *Grid and Power Storage*
   The planned expansion of renewable energy and the inherent volatility of renewable energy require the intensive development of the energy grid and the expansion of storage capabilities. Traditional transmission systems are not designed to accommodate the volatility of variable energy sources such as wind and solar. Moreover, the volatility of variable energy resources require massive storage facilities in order to conform to the actual load demand profile of the German economy.
8. *Flexible Power Production*

The transition towards an energy grid that is heavily reliant on variable renewable energy requires ancillary support from dispatchable energy sources that can ramp up and down quickly. As such, the pattern of development has to be skewed away from coal and nuclear and towards gas turbines. Flexible backup, in essence, is viewed as a perfect match to flexible renewable energy.

9. *Environment Conducive for Small-Scale Investing in Renewables*
   German energy consumers are encouraged by a legislative and policy framework to invest in becoming "prosumers". As prosumers, they accrue pecuniary benefits from energy savings and the sale of excess energy. Moreover, the focus of the policy framework is on development rather than cost – such as quota systems. Shifting away from an emphasis on cost ensures a more robust development of emerging renewable technologies.

IV. Policy Interventions to Facilitate the Adaptation of the Energiewende

1. *Nuclear Phase-Out*
   Germany is poised to eliminate nuclear energy from its energy mix in 2022. Germany shut down eight of its seventeen nuclear plants in 2014. Germany has replaced the lost nuclear energy with renewable energy, energy from gas turbines, and coal energy. Improved energy efficiency has also allowed Germany to more easily manage its nuclear phase-out.
2. *Renewable Energy Act with Feed-in-Tariffs*
   Germany's Renewable Energy Act is the template for renewable energy laws the world over. It provides renewables priority access to the grid – regardless of the prevailing market prices of energy from other sources. In addition, it provides renewable energy developers guaranteed margins in the form of Feed-in-Tariffs. The underlying strategy is that the higher electricity prices spur more investments in renewable energy development. The increased investments in renewable energy development, in turn, further accelerate the rate at which innovations in the renewable energy industry emerge. Ultimately the higher prices now constitute investments for faster access to cheap renewable energy.
3. *Emissions Trading*
   The Emissions Trading System places a cap on the maximum allowed level of emissions on each sector. The cap on each sector is adjusted downwards every year in order to compel firms to invest in emissions reducing technologies. It is designed as a means to reduce greenhouse emissions in manufacturing industries, the energy industry, and the aviation sector. The institution of the trading system has resulted in the valuation of carbon emissions and the subsequent trading of carbon emission certificates.
4. *Environmental Taxation*
   Germany's environmental taxation system places an emphasis on taxing 'bads' to finance 'goods'. For example, it places heavy taxes on the consumption on fossil fuels in order to be able to secure the revenues necessary for the subsidization of energy efficiency systems and renewable energy systems.
5. *Cogeneration Act*
   Cogeneration occurs when waste heat from a power generator is recovered and reused. The development of cogeneration technology serves two critical functions: (1) it enhances fuel efficiency and (2) improves the reactivity of the energy industry (since heat can be stored more readily and cost-efficiently than electricity, captured waste heat can be deployed for when it is actually needed).

6. *Renewable Energy Heating Act and Market Incentive Program*
   The Renewable Energy Heating Act compels new building owners to secure a certain share of their heating requirement from renewable sources. It also provides subsidies for renovations for owners of older buildings. This guarantees demand for renewable energy sources.
7. *Act on Accelerating Grid Expansion*
   The German Parliament passed this act in order to accelerate the rate at which the German grid is being upgraded. Its passage is part and parcel of the recognition of the immense requirements of a nationwide transition towards renewable energies.
8. *Energy Conservation Ordinance and Financial Support Schemes*
   Germany has put forward a framework of standards to govern the construction of residential houses and commercial establishments. These standards are designed to promote energy efficiency particularly in terms of heat conservation.

9. *Ecodesign/ErP Directive*
   The Ecodesign Directive regulates energy-consuming products, with the exception of buildings and cars. It conducts analysis of energy-consuming products in order to (1) determine their level of compliance with energy efficiency standards and (2) determine the prospective impacts of these products on the environment throughout their lifecycles. The directive essentially cuts off products that do not meet its efficiency and environmental impact standards.

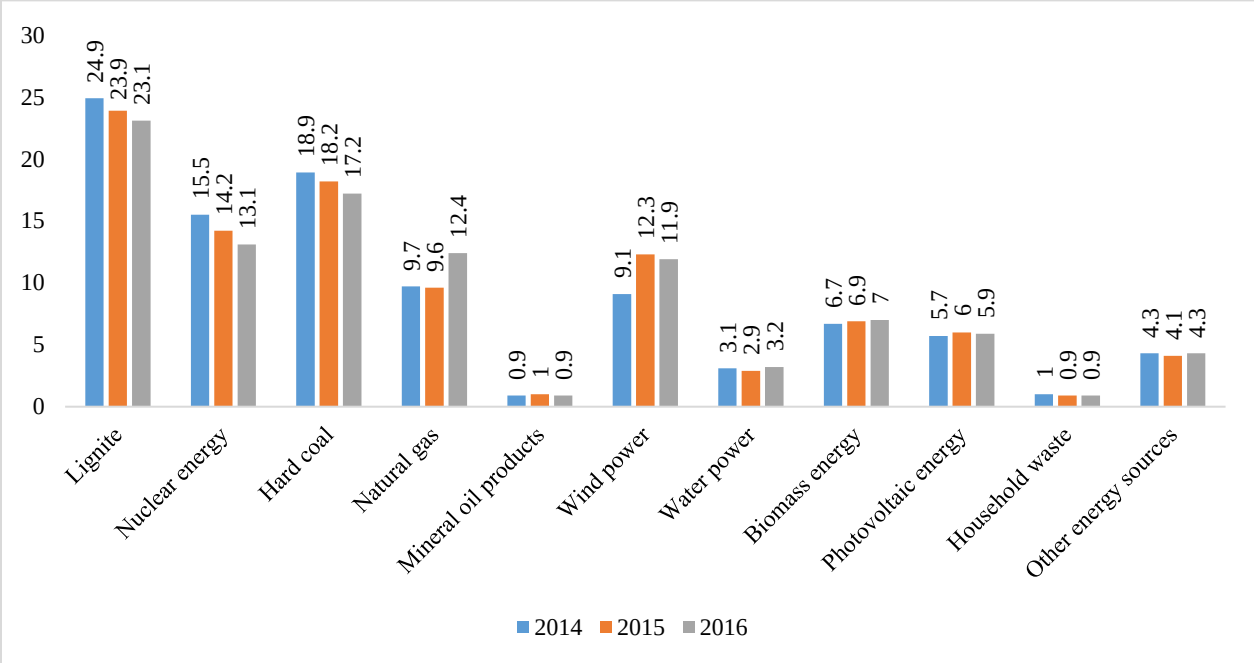
V. History of the Energiewende

- 1974 – The Federal Environment Agency was founded
- 1977 – As a response to the Oil Crisis, the first Thermal Insulation and Heat Operation ordinances were approved. These regulated the maximum energy demand for buildings and efficiency requirements for heating systems
- 1978 – Germany created the Blue Angel label to certify products that satisfied environmental standards. The Blue Angel label was deployed 14 years before its U.S. counterpart.
- 1980 – The Energiewende study was published. The main thesis of the study was that economic growth can be maintained even with lower energy consumption.
- 1983 – German Green Party entered the German Parliament. Their entry provided the springboard for the development of more expansive and extensive environmental legislation.
- 1986 – In response to the Chernobyl Incident, Germany founded the Federal Ministry of the Environment, Nature Conservation, and Nuclear Safety.
- 1987 – Chancellor Helmut Kohl (CDU) speaks of the threat of grave climate change from the greenhouse effect in the German Parliament.
- 1991 – The Feed-in-Act is adopted under Chancellor Helmut Kohl. The act provides feed-in-tariffs and priority dispatch for renewables.
- 1992 – The Fraunhofer Institute for Solar Energy System builds an off-grid solar home in Frelburg to demonstrate the capacity of renewables to meet the energy needs of a family.

- 1996 – KfW, a government owned bank launched its Carbon Reduction Program for the refurbishment of housing stock in the former German Democratic Republic (East)
- 1997 – The Power Rebels of Schonau bought back their local grid and significantly increased renewable capacity
- 1998 – The German power market is liberalized – power firms and grid operators have to be separate legal entities. This allowed renewable developers to focus on energy generation.
- 1999 – 100,000 Solar Roofs Program jumpstarts the solar panel market in Germany. Market incentives are given for renewable heating systems.
- 1999 – Eco taxes are imposed on gasoline and fossil fuel based electricity. The measures were perceived to have helped spur the demand for more efficient vehicles.
- 2000 – Social Democrats and Greens under Chancellor Schroeder institutes the Renewable Energy Act
- 2000 – Chancellor Schroeder's coalition reaches an agreement with nuclear power plant owners to phase out Germany's nuclear power plants by 2022
- 2001 - European Court of Justice upholds the legality of Feed-in-Tariffs
- 2002 – Initiative Energleeffizlenz is established to promote energy efficiency in households and commerce.
- 2002 – Heat Power Cogeneration Act is adopted
- 2004 – Photovoltaics is incorporated into the Renewable Energy Act (EEG)
- 2005 – Germany's Network Agency begins overseeing the power grid and gas market – in part to settle disputes related to grid fees for renewable energy.
- 2005 – EU launches emissions trading system
- 2007 – Germany's Integrated Energy and Climate Program defines new targets, policies, and support schemes for energy efficiency and renewable energy.
- 2009 – The EEG is amended to place more emphasis on market instruments
- 2010 – The Sustainability Ordinance for biomass addresses the issue of sustainable biomass production
- 2010 - The Special Energy and Climate Fund, the first German efficiency fund, is created and funded by revenue from carbon emission certificates.
- 2010 – Chancellor Merkel extends the lives of nuclear power plants.
- 2011 – The Fukushima incident prompts Chancellor Merkel to reverse her prior decision regarding Germany's remaining nuclear power plants. As a result, 40% of nuclear power plants are shut down within a week.
- 2012 – Germany's power exports reach new record levels.
- 2013 – Surcharge for renewables increase. German power exports increase further.
- 2014 – Germany amends EEG, adopts a Climate Action Plan, and a National Energy Efficiency Plan

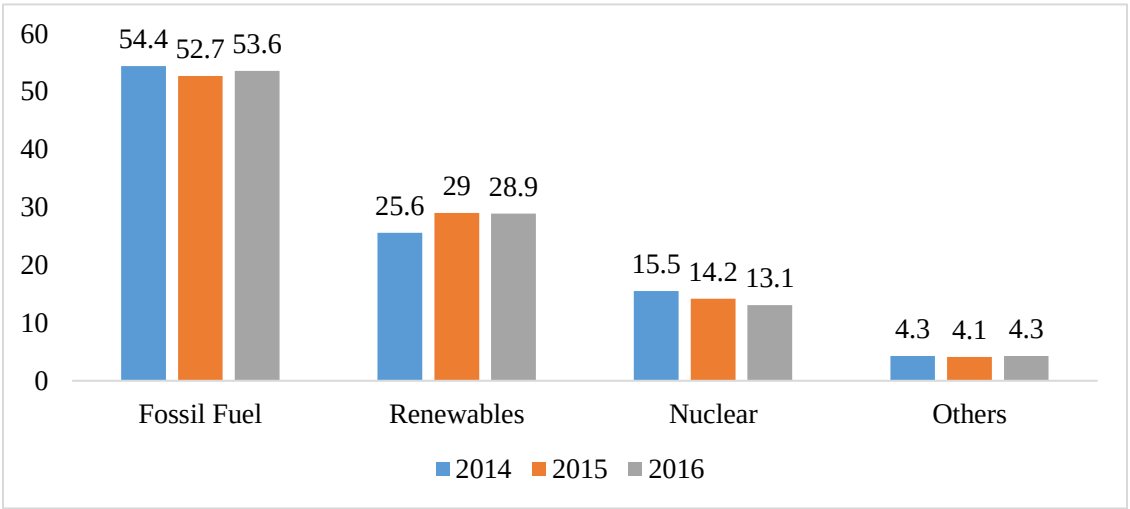
VI. Germany Energy Mix

Figure 1. Germany Energy Mix 2014, 2015, 2016 by Energy Source in Percentages



Source: Federal Network Agency

Figure 2. Germany Energy Mix 2014, 2015, 2016 by Energy Cluster in Percentages



Source: Federal Network Agency

- German fossil fuel energy usage increased slightly from 2015 to 2016. The expansion, however, belies marked decreases in the share of coal in the German energy mix. The expansion was driven by the sustained development of natural gas plants. This is consistent with their plan to complement renewables with fast-ramping natural gas.
    - Lignite decreased in 2015 and in 2016
    - Hard coal decreased in 2015 and in 2016
    - Natural gas increased in 2016

- German nuclear energy decreased from 2014 to 2016. The steep decline in 2011-2012 has stabilized. Given the present rate of decline of nuclear energy and the present rate of increase in renewables, Germany is on pace to phase out nuclear on 2022.
- German renewables more or less maintained its share from 2015 to 2016. This can be attributed to low fossil fuel prices and an expansion plateau insofar as renewables are concerned.

VII. Questions and Answers

- Is the energy transition affordable?
    - Germany argues that the investments towards renewable energy and its complements will pay for themselves within their 20-year life cycle. Laying the groundwork for a renewable energy grid would also insulate Germany from the inherent volatility of the costs of fossil fuels. Moreover, Germany has already developed a robust renewables industry. As such, the costs moving forward would be cheaper. Finally, the displacement of coal energy via renewable energy reduces costs from pollution.
        - The Energiewende costs each household approximately 10 euros per month
        - It would cost approximately 200 billion euros from 2015 to 2025
        - The payback time for a PV array is approximately 1.5 years to 2.5 years
        - The payback time for a typical wind turbine is less than a year
        - Coal usage always constitutes a loss (use it and lose it). Solar energy is a gain if it is deployed (Use it or lose it).
        - (Insight) Analysis ignores the costs of (1) transmission upgrades to accommodate variable renewable energy and (2) the need for fast-ramping energy resources and storage facilities.
- Will Germany import more power from abroad after the nuclear phase-out?
    - Germany's energy exports have been increasing even after the 2011 shutdown of 40% of its nuclear fleet. Germany imports energy to avail of cheap energy whenever it is available.
        - (Insight) Germany's renewables are crowding out the energy generated from conventional plants in other jurisdictions whenever it is in abundance. Power surges emanating from Germany offset fossil fuel energy and nuclear energy in other jurisdictions – inducing deleterious impacts on the sustainability of these plants.
        - (Insight) Germany imports energy to cover renewable downtime and exports energy whenever renewables are abundant. This strategy can be viewed as a negative externality wherein Germany exports the downside of variable renewable energy.
        - (Insight) The preceding point is similar to the manner in which renewables in Negros have curtailed the competitiveness of geothermal energy in Visayas.
- Did Germany (over) react to Fukushima and other related nuclear incidents?
    - The reversal of Chancellor Merkel's stance on nuclear energy in 2011 was actually a reversion to the intended nuclear phase-out conceived in 2000. Chanceller Merkel's decision to prolong the lifespan of Germany's nuclear fleet was a reversal of the original nuclear phase-out. The reversal of the reversal thus constituted a reversion.
        - (Insight) Political pressure emanating from the election influenced Chancellor Merkel's decision in 2011.

- Will the nuclear phase-out increase Germany's carbon emissions?
    - Germany's emissions have been on the decline despite its ongoing nuclear phase-out.
        - (Insight) The impact of the nuclear phase-out on carbon emission reductions is obscured by (1) the impact of renewables on emissions, (2) the promotion of energy efficiency, and (3) the replacement of coal with natural gas.
- Would nuclear power constitute a comparably cost-efficient means to reduce carbon emissions?
    - New nuclear power plants are expensive to develop. Nuclear energy becomes cheap once the costs have been written down. Put differently, nuclear energy requires a long time before it becomes cheap. A nuclear plant has to be in operation for a significant amount of time before it becomes a cheap sources of electricity.
        - Nuclear energy requires state funding.
    - Given the cost trajectory of renewables in the next twenty or thirty years, renewables can be argued to be cheaper than new nuclear plants even in the long run.
        - (Insight) It is of note that the Energiewende in itself is a form of state funding. The funding for the transition towards a renewable grid require substantial investments from the state.
- Will the Energiewende reduce jobs?
    - Germany has generated more jobs from renewables than in conventional technologies. As a leading innovator in renewable technologies, the German labor force has benefitted immensely from the sharp increase in the demand for renewable technologies.
- How can Germany maintain its position as an industrial powerhouse with the Energiewende?
    - The increase in the demand for renewables has proven to be a boon for German manufacturing industries. The value-chains of solar and wind have taken advantage of Germany's extensive and intensive manufacturing capabilities.
        - (Insight) Germany's insistence on promoting green technologies is underpinned by its economic interests. It has placed itself in a position to take advantage of the emerging renewable industry. Its economy will benefit immensely from the continued growth of the demand for renewables.
- How much energy storage will Germany need?
    - Germany will continue to build coal power plants up until 2020. The bulk of these plants were planned prior to the concerted effort to shift towards fast-ramping natural gas plants. Given the growth of renewables, however, it is likely that these plants will become unprofitable at full capacity – and would thus operate at reduced capacity, if they choose to operate at all.
        - (Insight) The development of coal plants in Germany appear to be largely influenced by economics – specifically the price of coal vis-à-vis the price of renewables and natural gas.
        - (Insight) The coal lobby in Germany remains strong.
        - (Insight) Given prevailing economics, Germany is poised to produce 1,055 MW of coal energy up until 2019. This figure constitutes 30.4% or almost a third of incoming supply for the aforementioned time period.
- How does the German strategy compare with the French strategy?
    - Nuclear energy in France comprises almost four-fifths of its entire energy mix. In contrast, nuclear energy in Germany comprises only 17% of the total German energy mix.
    - Given France's massive nuclear fleet and Germany's Energiewende subsidies, French electricity is markedly cheaper than German electricity

        - 2014: GER 0.298 EU vs. FRA 0.159 EU
        - 2015: GER 0.295 EU vs. FRA 0.162 EU
        - 2016: GER 0.297 EU vs. FRA 0.169 EU
        - France electricity costs have been increasing because of maintenance shutdowns on seven of its nuclear plants. Seven more plants are expected to go on maintenance shutdowns in the near future.
    - As a result of the price differential, per capita electricity consumption in France is larger (approximately 7,292 kWh, 2014) than per capita electricity consumption in Germany is (approximately 7,081 kWh, 2014).
    - Given the price differential above, France can opt to use electricity for heating. In contrast, Germany relies on district heating and biomass burning. It has been argued that Germany's avoidance of electrical heating has spurred investments into improving the efficiency of its residential and commercial spaces insofar as heating is concerned.
    - As a result of the differences of their energy profiles, per capita emissions in France (approximately 5.6 metric tons) is lower than per capita emissions in Germany (approximately 9.1 metric tons).

Table 1. CO2 Emissions per Capita of Selected Countries

CO2 Emissions per Capita	2010	2013	2014	2015
China	6.7	7.71	7.82	7.73
France	6.05	5.57	5.05	5.09
Germany	10.09	10.13	9.59	9.64
United States of America	17.81	16.57	16.63	16.07

Source: EU-Edgar