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# The Paths of German Energy Transition: An Institutional Analysis

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*The Germany energy transition has been enabled by continuous institutional evolution. The institutional development has continued while party coalitions have repeatedly changed. This study analyzes the institutional progress of the German energy transition under different political settings and extrinsic incidents. Institutional path generation of German energy transition was actualized by political and social responses to the global energy crises as well as the Chernobyl nuclear accident. The participation of the Green Party in the ruling coalition, with the introduction of EFA, played a significant role in launching the energy transition. The reinforcement of this institutional path was formed due to the replacement of the EFA with the EEG in 2000, under a strong political will for sustainable energy development. The Fukushima nuclear accident, and the continued support from the political coalition contributed to the institutional path maintenance for this energy transition. The progressive social and political environment changes in energy transition were prior conditions for setting up institutional strategies. External impacts were prime movers for the implementation of institutional methods or revisions. The institutional durability, in the face of critical alterations of internal and external circumstance, has provided a successful path to energy transition.*

*Keywords: Germany, energy transition, renewable energy, nuclear, political parties*

## 1. INTRODUCTION

Germany has implemented *Energiewende* (hereafter referred to as 'energy transition') as the institutional system for sustainable energy development.[1] This German energy transition was enabled through continuous institutional evolutions, along with political shifts, which lasted while party coalitions recurrently changed. This institutional progress is also reflected in several external shocks and incidents. For instance, the oil crises in 1970s raised the need for energy independence. The Chernobyl nuclear accident in 1986 brought about a turning point in the active promotion of renewable energy development. EU's policy for renewable energy promotion contributed to the strengthening of further renewable expansion. The Fukushima nuclear accident in 2011 provided a tangible reason to plan for nuclear phase-out by 2022.

This study begins with the question of how the institutional progress of the German energy transition evolved under different political settings and extrinsic incidents, and specifically how these internal and external factors influenced this institutional development. The following section reviews the previous literatures on German energy transition and

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[1] Germany has recorded constant economic growth, even with the reduction of primary energy consumption from 1989. The use of renewable energy showed a stable growth after the 1990s. For example, the portion of renewable energy in total electricity generation increased from 3.6% in 1990 to over 30% in 2015 (Federal Ministry for Economic Affairs and Energy, 2016).

provides a theoretical framework, based on historical institutionalism and path dependence. Subsequently, the institutional changes in German energy transition during the phases of path generation, reinforcement and maintenance are also analyzed. The last part concludes with the essential elements for effective institutional framework for energy transition.

## 2. LITERATURE REVIEW ON GERMAN ENERGY TRANSITION

Energy transition to enhance energy security and climate change responsiveness has been pursued in many countries. The German experience has been widely studied as one of representative cases to demonstrate the effective implementation of energy transition. Previous researches on German energy transition have been conducted in diverse disciplines such as institutional analysis, social and business development, energy technology and resources and international-domestic relations.

Fischer et al. (2016), Knaut et al. (2016) and Han (2016) discussed the targets and expected outcomes of energy transition in Germany. Furthermore, regarding the policy framework of German energy transition, Pegels and Lütkenhorst (2014) provided a cost-benefit analysis of the major objectives of German solar photovoltaic (PV) and wind energy policies such as competitiveness, innovation, job creation, emissions and cost reduction. Quitzow et al. (2016) explained the causes and effects of policy shifts in German energy transition, following the Fukushima nuclear accident.

A series of studies examined the social and business aspects in German energy transition, which provided the basis of public acceptance of related policies. For instance, Sühlsen and Hisschemöller (2014) examined the lobbying strategies of German renewable energy companies during energy transition. Kungl (2015) compared the responses of major German energy companies to deal with internal and external changes, such as the liberalization of the power market and the Fukushima nuclear accident. Nordensvärd and Urban (2015) examined Germany's feed-in tariff and other low carbon policies for achieving a socio-technical regime transition. Morton and Müller (2016) pointed out the importance of a social process in the energy policy framework. In addition, Guidolin and Guseo (2016) evaluated the social effects of transition from conventional nuclear energy to renewable ones.

From a regional and comparative perspective, Gullberg et al. (2014) assessed the potential cooperation of renewable energy, especially focusing on the pumped-storage hydropower between Germany and Norway. Furthermore, Mulder and Scholtens (2016) examined the effects of Germany's energy transition in the electricity market of Netherlands, while Lutz et al. (2017) analyzed the implementation factors of renewable energies in 18 sub-regions in Germany. Regarding technology and resource development, in German energy transition, Viebahn et al. (2015) evaluated the significance of the crucial minerals related to renewable energies, and Schmid et al. (2016) analyzed the decarbonization of the German electricity system from technical viewpoints.

In most of these literatures, the elements and consequences of the German energy transition have been widely mentioned. However, the evolutionary process of energy transition needs further elaboration from the institutional perspectives, which constituted the foundation of successive policy measures. This study provides a more focused analysis of this institutional evolution, based on the path dependence model.

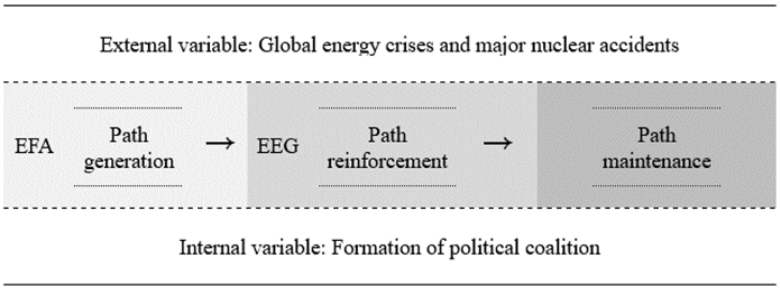
## 3. HISTORICAL INSTITUTIONALISM AND PATH DEPENDENCE

New institutionalism considers institutions as independent variables, at an equal to or higher status than individuals, to help explain social phenomenon (Amenta and Kelly, 2010). It can largely be divided into rational choice institutionalism, sociological institutionalism and historical institutionalism. Rational choice institutionalism highlights the individuals' preferences and interests to maximize utility within the boundaries of institution (Hall and Taylor, 1996). In sociological institutionalism, the institutional shift explains the process of structure building of the organization and the pursuit of the individual's rationality (Schmidt, 2009). Historical institutionalism assumes that institution is a historical product and concentrates on the historical process in a macroscopic context. It emphasizes historical causation and path dependence as well as the timing and sequence of events (Thelen, 1999). Path dependence can explain the creation of institutions and its changes, and how an institution can continuously be implemented in the current time from the past. It is defined as the tendency through which institutional selection within a certain period of the past, continuously restricts institutional selection in the present and future—an institution of the past could impose a constraint on the creation of future institutions (Hall and Taylor, 1996). Furthermore, historical institutionalism argues that a past institution affects institutional formations in the present and future.

While applying the path dependence theory to the analysis of the energy policy, Hake et al. (2015) explained the political developments in the German energy transition. Eikeland and Inderberg (2016) analyzed changes in the energy system and policies in Demark, using public choice and path dependency perspectives. Moncada et al. (2017) explained the development of German biofuel production using the path dependence theory, and analyzed the effects of institutional shifts on a biodiesel value chain in the Germany. Lee and Gloaguen (2015) investigated the perception of nuclear energy development in France, in terms of path dependence and lock-in effects. Nilsen (2017) investigated Statoil's environmental decisions using path dependence and structural inertia. All these studies showed the utility of path dependence in explaining the long-term development of energy policies, reflecting institutional continuity or regime shift as well as external impacts.

The form of path dependence is classified through self-reinforcing and reactive sequences. Self-reinforcing sequences refer to a situation in which the path selected using critical junctures is maintained by its continuous reproducing, until another accidental impact (David, 1985). Reactive sequences refer to the formation of a path in which multiple events connect

**Figure 1.** Analysis model of German *Energiewende*



under necessary and sufficient conditions. Mahoney (2000) and Martin as well as Simmie (2008) presented subsequent stages of path dependence.

This study analyzes how continuous institutional evolution of German energy transition has occurred from the path dependence perspective. This institutional analysis focuses on Electricity Feed-in Act (EFA) and the Renewable Energy Sources Act (EEG), which have been implemented as the backbone of the institutional system, to promote effective energy transition. An analytical framework of this research is presented in Figure 1.

## 4. INSTITUTIONAL CHANGES IN GERMAN RENEWABLE ENERGY

### 4.1 EFA: The beginning of institutional progress in German renewable energy

The EFA began with Eurosolar's and Förderverein Solarenergie's proposal in 1989, which focused on a guarantee of minimum feed-in payments and was largely advocated by wind power industries in Northwestern states and by operators of small-scale hydropower plants in Southeast and Southwest Germany (Jacobsson and Bergek, 2004). The German Research Ministry implemented a test program for 100 MW, large-scale wind power in the late 1980s, which was followed by 250 MW large-scale wind power in 1991 (Klaassen et al., 2005). The EFA was passed unanimously in the national parliament on December 1990, and it came into effect on 1 January 1991.[2]

The core idea of the EFA was to regulate the purchase and the price of electricity from certain types of renewable energy sources in Germany such as wind, landfill gas, biomass, hydropower, solar and sewage gas. The EFA assured a renewable energy feed-in tariff and a connection to the power grid. For example, 80% of the retail price in electricity, generated by specific types of renewable energy sources was paid by grid operators as a feed-in tariff. However, a capacity above 5MW of electricity produced by biomass, biogas and hydro were excluded from the EFA. Moreover, it could not cover a share of over 25% electricity generated by a public electricity utility, a Federal state or the Federal Republic of Germany (Gipe, 2015).

The first revision of the EFA was made in 1994, and it concentrated on a modification on the proportion of compensation. The most notable changes in the second revision in 1998 was the 5% cap, or a so-called hardship clause, on the purchase responsibility of grid firms (Bechberger, 2000). The hardship clause in the EFA in 1991 noted that electricity utilities had the authority to be exempted from the purchase responsibility when immoderate technical, economic or legal burdens were unduly imposed on them.

### 4.2 The institutional driving force of energy transition (EEG in 2000, 2004 & 2009)

The expansion of institutional support for German renewable energy begun with the replacement of the EFA with the EEG. The unbalanced development of renewable energy under the EFA was supported by the amendment of tariffs under the EEG in 2000. The

[2] In fact, enactment of the EFA was not so controversial issues in German electricity sector (Suck, 2008). German electricity market for supply and distribution was monopolized by a small numbers of major companies such as REW (Rheinland Westfalen Energie), EnBw (Energie Baden Württember), E.ON, and Vattenfall Europe.

majority of wind power operators in North Germany had already achieved a twofold 5% cap in the late 1990s, and therefore, the obligation to buy electricity produced by wind power was not applicable (Mendonça, 2007). In the late 1990s, most of remuneration proportions were increased in the EEG to enhance price competitiveness of renewable energies in the liberalized electricity market. The criteria for tariffs of the EEG was established based on the production costs of renewable energy sources. The electricity produced by methane gas from abandoned mines and geothermal resources were also covered under the EEG. The purchase guarantee and the feed-in tariffs for 20 years, from the beginning of the operations of all newly qualified power plants of renewable energy were fixed in the EEG, except for hydropower.

The EEG in 2004 and 2009, pursued a balanced but constant renewable energy growth. The EEG in 2004 set up a new goal for the share of renewable energies, with total electricity generation at least 12.5% by 2010 and 20% by 2020 (IEA, 2016a). A new hardship clause was also introduced in the 2004 EEG, which loosened the obligation to buy electricity generated by renewable energy sources for price competitiveness of energy-intensive firms, in order to protect them in the international market. The 2004 EEG brought in the change of feed-in tariffs for different types of renewable energy sources and aimed to stimulate the development of technologies, preventing the moral hazard of depending on the subsidies of feed-in tariffs. In the 2009 EEG, the target amount of electricity to be produced by renewable energy sources increased from 20% to 30%, in total electricity production by 2020. The period for feed-in tariffs was extended to a minimum of 20 years but the standard for minimum prices would be applied differently. The change of remuneration in the 2009 EEG was focused on the wind and solar power sectors (see Table 1).

### 4.3 From state-led to market-oriented energy transition (EEG in 2012 & 2014)

The extent of decrease in tariffs and the introduction of market-friendly regulations, demonstrated the change of institutional direction towards supporting renewable energy in the German energy transition. The decrease in tariffs (see Table 1), market integration model and the grid connection system were adopted in the EEG of 2012.[3] Even with market-led support policies, ambitious but practical goals for renewable energy growth was maintained. The renewable energy growth in the EEG of 2012 aimed to reach 35% in total energy production by 2020. The category of renewable energy sources was further expanded in the 2012 EEG to include biogas, landfill gas, sewage treatment gas, bio-methane and biodegradable municipal and industrial waste.

In EEG 2014, the share of renewable energy in total electricity consumption was targeted to reach 40–50% in 2025, 55–60% in 2035 and 80% in 2050 (IEA, 2016d). The growth corridors or floating caps for newly installed renewable energy were annually set at 2.5GW for onshore wind and solar PV energy, 6.5–7.7GW for offshore wind until 2020 and 100MW in terms of biomass (IEA, 2016d). A contract for difference (CFD) replaced the feed-in payment. As the financial burden of the suppliers could be increased through obligatory

[3] Market integration model was an optional system to deliver electricity generation through renewable energy sources, from suppliers to consumers, without stages of distribution (Jankowska, 2014). The grid connection system enabled producers of electricity generated by renewable energy sources, to allow the use of preferential grid connections with payment of surcharge (Schomerus, 2012).

**Table 1.** A comparable change in tariffs under EEG 2009 and 2012

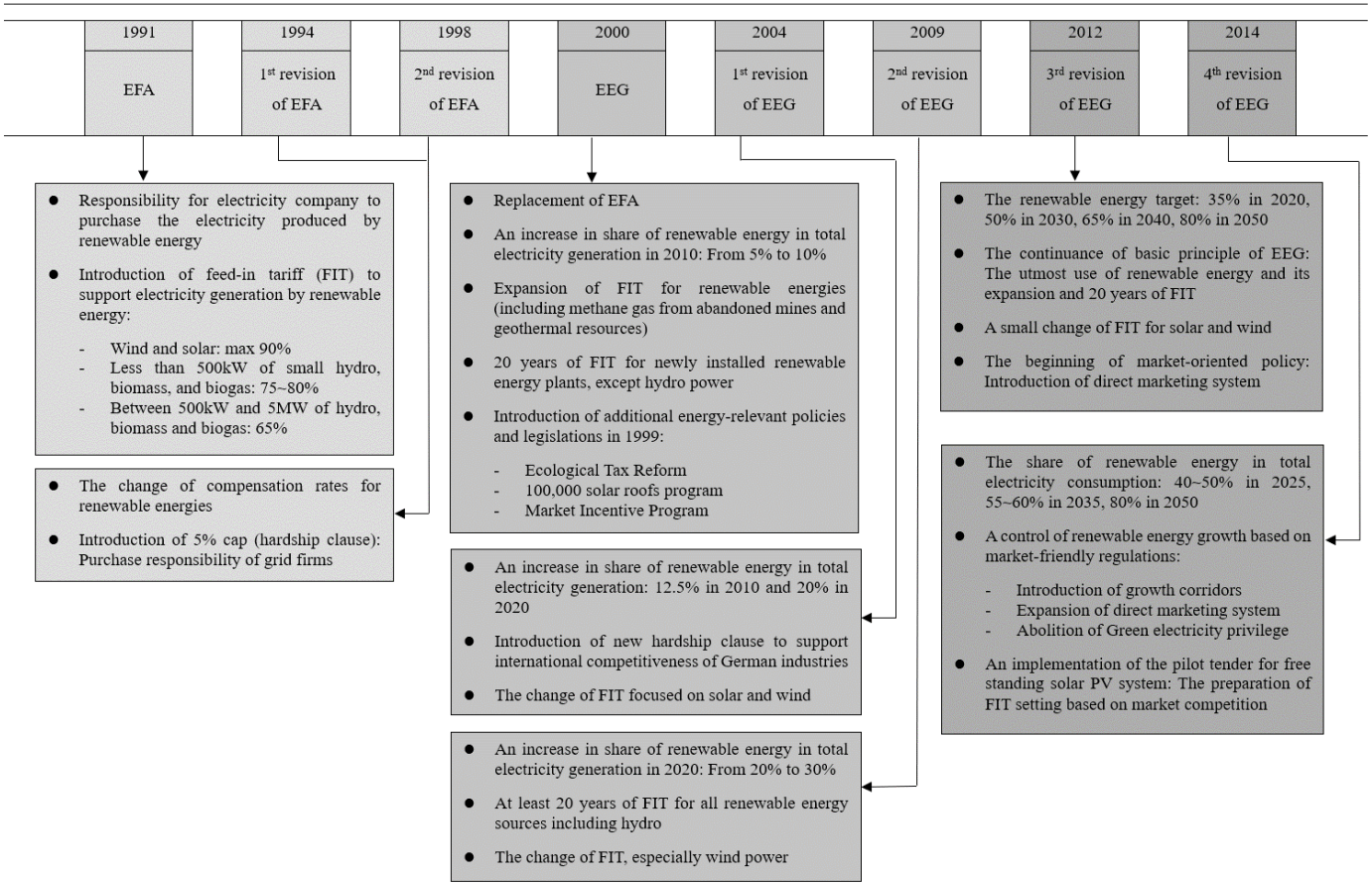
| | EEG 2009 | | EEG 2012 | |
|---|---|---|---|---|
| Onshore wind | • First 5 years operation: From EUR 8.03 ct/kWh to EUR 9.2 ct/kWh<br>• After 5 years operation: EUR 5.02 ct/kWh<br>• Degression of new installation: From 2% to 1% | | • Initial tariff: EUR 8.93 ct/kWh<br>• Degression of new installation: From 1% to 1.5% | |
| Offshore wind | • Initial tariff: EUR 15 ct/kWh until 2015<br>• Since 2015, new installation EUR 13 ct/kWh and annually 5% degression | | • Initial tariff: 15 cent/kWh<br>• No degression for new installation until 2018<br>• Since 2018, annually 7% degression<br>• Conditional feed in tariff: From EUR 15 ct/kWh for 12 years to EUR 19 ct/kWh for 8 years | |
| Solar | Roof top | Below 30kW: EUR 43.01 ct/kWh | Below 30 kWh: 28. 74 ct/kWh | Since 2013, annually 9% degression |
| | | 30~100kW: EUR 40.91 ct/kWh | | |
| | | 100kW~1MW: EUR 39.58 ct kWh | | |
| | | Over 1MW: EUR 33 ct/kWh | | |
| | Free standing | EUR 31.94 ct/kWh | EUR 22.07 ct/kWh | |

Source: Created by authors based on IEA, 2016b and IEA, 2016c.

direct marketing, a market premium was also introduced for the producers.[4] The fixed legal tariff was changed, and about 40% of the EEG surcharge was newly applied.

[4] This premium is computed using the difference between the average monthly wholesale price in electricity exchange and the compensation for the production of electricity using renewable energies, a mentioned in the legislation.

**Figure 2.** Major change of EEG




Source: Created by authors based on https://www.iea.org/policiesandmeasures/pams/germany/

## 5. INSTITUTIONAL PATHS OF GERMAN ENERGY TRANSITION

### 5.1 Path generation: Global energy crises and *Die Grünen*

The institutional path generation in German energy transition was pushed due to an increase in civil awareness of the dangers of atomic energy and environmental damages. The idea of German energy transition was developed from the anti-nuclear energy campaign, led by the New Social Movements in 1973. Technical issues from nuclear power plants, such as atomic power waste and warming of river temperatures, raised attention about the risks of nuclear power in German civil society. Experts and academic scholars also began becoming involved in the anti-nuclear energy movement. The Institute for Applied Ecology (Oko-institut) was established as a green think tank in 1977. The term *Energiewende* was introduced for the first time in 1980, in the book *Energy transition: Growth and prosperity without oil and uranium* (Jacobs, 2012). Moreover, fossil-fuels-based power plants could not be free from this energy transition. The destruction of Germany's southern forests due to acid rain in the early and mid-1980s, brought about a stronger voice for environmental movement and the use of safe and environmentally friendly energy sources in power plants and industrial sectors.

However, institutional path generation for renewable energy deployment did not fully emerge due to existing political support for nuclear power. The Federal Republic of German government promoted nuclear development for continuous economic growth at the expense of the environment. Additionally, the Federal Ministry for Nuclear Affairs was established in 1955, and the first national nuclear program was launched with the German Atomic Commission in 1956. Furthermore, the loss of competitiveness in the German coal industry through price reductions of imported coal in the 1960s allowed nuclear power to maintain its status as a dependable energy supply source. The coalition between the CDU (*Christlich Demokratische Union Deutschlands*), CSU (*Christlich-Soziale Union in Bayern*) and the SPD (*Sozialdemokratische Partei Deutschlands*) (1966–1969) pursued a policy of nuclear power expansion, despite the recognition of risk from the nuclear development.[5] The coalition between the SPD and FDP (*Freie Demokratische Partei*) (1969–1982) made environmental regulations along with the establishment of an advisory council for the environment in 1971 and the Federal Environment Agency in 1974. However, these environmental policies focused on pollutant management and still enabled continuous nuclear development.

The global energy crises in the 1970s, provided momentum for the institutional path generation of German energy transition. The sharp reduction of oil supply by the enforcement embargo of the organization of petroleum exporting countries (OPEC), led to the first oil crisis in 1973.[6] The second oil shock in 1979 was ignited by the Iranian Revolution, from 1978 to 1979. These two crises brought about a decline in oil production in countries around the Persian Gulf, and the unprecedented price hike of OPEC crude oil. The oil crises of 1973 and 1979 were turning points in the path to energy transition, and the first external impacts

[5] The coalition CDU, CSU, and SPD invested around DM 6.2 billion for the 3rd national nuclear program between 1967 and 1972 (Illing, 2012). It was larger than the total investment for the 1st and 2nd national nuclear programs.

[6] Due to the first oil shock, Germany's GDP growth between 1973 and 1975 declined, from 11.4% to 3.8%. However, it rebounded by 8.4% in 1976, as a result of the swift response to the high price of oil (Cooper and Yue, 2008).

to mark the clear beginning of the institutional path generation. Furthermore, technological innovations to develop renewable energy and energy efficiency were accelerated under the framework of energy security.

Even with global oil crisis, the utilization of nuclear energy was still a controversial subject in German society and politics. The anti-nuclear movement began to expand from protests over nuclear power plant constructions at Breisbach in 1971 and Wyhl between 1973 and 1975 (Roose, 2010). Three Mile Island accident and the construction plan of a nuclear waste facility at Gorleben in 1979, led to anti-nuclear campaigns throughout the country. The German national parliament formed the Enquete Commission, "Future Nuclear Energy Policy" in 1980 (Bundestag, 1980). The Commission concluded that nuclear power would not be necessary under the conditions of energy demand reduction and alternative energy development.[7] However, two main political parties—the SPD and CDU—maintained a positive attitude regarding the utilization of nuclear power to improve the national energy security (Gast, 2011).

The Chernobyl nuclear accident in 1986, added another extrinsic impact to strengthen the institutional path generation for renewable energy deployment (Bruns et al., 2009). It changed the perception on nuclear energy and triggered political and social measures for energy transition. The establishment of the Federal Ministry for Environment, Nature Conservation, and Nuclear Safety was a representative example of the direct reaction to the Chernobyl accident in Germany. The German Institute for Economic Research reported the feasibility of stable electricity supply and demand without nuclear power (Ziesing, 1986). Chernobyl's incident helped raise awareness about the perils of nuclear power as an unreliable energy source, and generated the institutional system of energy transition in Germany.

The participation of *Die Grünen* (the Greens) as a coalition partner of the SPD was a turning point in the institutional path generation for energy transition. As a representative political party claiming the importance of environmental protection, the Greens entered the national parliament for the first time in 1983.[8] The political direction of the SPD on the use of nuclear energy began to change following Chernobyl and provided a political motivation to create a coalition with the Greens. These political changes influenced the enforcement of the EFA in 1991, and its subsequent implementation (Stefes, 2016). An institutional shift in energy transition began, following the participation of the Greens in national parliament and the coalition between the Greens and SPD.

The EFA was the first institutional action for the comprehensive development of electricity generation from renewable energies (Bruns et al., 2009). A number of German government officials and municipalities, major political parties and advocacy groups, such as Eurosolar or the Inland Wind Power Association, publicly endorsed the EFA.[9] The increased recognition of energy security and endorsement from key political players, were important factors in decision-making surrounding the EFA. A majority member of the national

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[7] The low level of energy prices in West Germany, accelerated the unnecessariness of nuclear power expansion (Mez, 2009). Furthermore, coal power had also brought about forest destruction through acid rain, in the early and mid-1980s, which strengthened the voice for renewable energy expansion.

[8] The Greens had 5.6% of the national vote and 27 seats (Bomberg, 1998).

[9] The Minister of Environment, Dr. Klaus Töpfer, Dr. Wolfgang Daniels from the Greens and Dr. Hermann Scheer from the SPD, representatively supported the EFA (Bruns, Ohlhorst and Wenzel, 2010). Amongst members of the CDU and the CSU, Matthias Engelsberger and Bernd Schmidbauer endorsed the EFA in 1991 (Brand, 2004).

parliament and government officials representing the Chancellor consented to the revision of the EFA 1994. Angela Merkel, who served as the minister of environment between 1994 and 1998, and Walter Hirche, who was the parliamentary state secretary belonging to the FDP, strongly supported the improvement of the EFA through modifications.

Meanwhile, even though the Federal Ministry of Economics expressed strong opposition to the revision of the EFA, the overwhelming political and public support could not be neglected (Bruns et al., 2011). Additionally, the electricity industry started to make opposing claims about this revision, with one of the organizations that had denounced the EFA—The Association of German Electricity Power Utilities (VDEW; Verband der deutschen Elektrizitätswirtschaft)—raised a counterargument to the consideration of illegality about the EFA, focusing on the principle of a free market and the German constitution (Zitzer, 2009) in the Federal Constitutional Court; the court adjudicated that the EFA is not against the constitution (Wong, 2010). In retaliation, the legally binding compensation rates for electricity generated by renewable energies was cut by a number of utility companies, based on the argument of the VDEW. This reduction resulted in an enormous amount of criticism from the public. Most members of the national parliament and all the political parties showed their displeasure with the VDEW.

The second revision of the EFA was passed in 1998 without noticeable political controversy in the parliament. A coalition between the Greens and SPD obtained the majority in the parliament from 1998 to 2005. However, a number of private sectors still harbored doubts about lawfulness of this amendment and raised legal questions about this revision (Armenteros and Lefevere, 2001). The legitimacy of this amendment was eventually reviewed by the European Court of Justice, and the decision stated that the second revision of the EFA was unchallengeable in terms of EU law.

In sum, the EFA was the first institutional foundation to create a noticeable change in the German electricity market, in terms of provisions of a wide range of opportunities for renewable energy firms with competitiveness. The EFA was replaced by the more comprehensive EEG, which reflected a strong momentum for continuous institutional support for energy transition. This was the beginning of institutional durability in German energy transition (Bruns et al., 2009; Becker, Beveridge, and Rohring, 2016; Stefes, 2016).

### 5.2 Path reinforcement: Political will for *Energiewende* and EU's institutional guidance

The institutional path reinforcement in German energy transition began with the enactment of the EEG in 2000, under the coalition between the Greens and the SPD. It reflected the change of institutional will to improve German energy transition, with an increased target on renewable energy and the expansion of remuneration for various renewable energy sources. A strong political will of the Greens and SPD about energy transition was proved by not only the EEG but by the establishment of additional energy policies and legislations in 1999, such as the Ecological Tax Reform, the 100,000 solar roofs program (HTDP) and the market incentive program. Furthermore, a new plan was presented for phasing out 17 domestic nuclear power plants by 2020, without compensation. This resulted in the enactment of the act for the Orderly Termination of the Use of Nuclear Energy for the Commercial Generation of Electricity in 2002. These institutional actions brought about direct opposition from the CDU, CSU and FDP.

However, a policy instrumental for renewable energy development in the EU, provided

for additional enhancements of the EEG. A guideline from the EU for renewable energy sources in 2001 was a key factor in the EEG revision in 2004. According to the guideline, the EU asks the member countries to implement an overall review of the production, supply and distribution of renewable energy sources (Fräss-Ehrfeld, 2009). The coalition attempted to amend the EEG, based on the decision regarding the necessity of specific and concrete definitions for renewable energies, in order to create continuous outcomes for the supply expansion of renewable energy (Dagger, 2009). The amended EEG in 2004 stipulated that the Federal Ministry of Economics and Technology (BMWi) was required to submit a progress report about the renewable energy market and its cost development. EU's Renewable Energy Roadmap in 2007 suggested 20% of renewable energy within the total share of energy in the EU by 2020 (Commission of the European Communities, 2007). This target was reflected in the further modifications of the EEG in 2009. Thus, EU's renewable energy promotion policies were an external driving force in the evolution of institutional path reinforcement in German energy transition.

Under the grand coalition between the CDU, CSU and the SPD, from 2005 to 2009, the institutional path in energy transition continued, until a major modification in the EEG in 2009. The newly formed grand coalition did not make any notable modifications to the EEG, and the SPD continued its political alliance with the Greens, and formed the grand coalition. However, the CDU and CSU shifted away from critical attitude on the EEG and proposed improvements to the efficiency of its implementation. This led them to win 226 seats, while the SPD won 222 in the 2005 election (Statistische Bundesamt, 2005). The CDU and CSU began to uphold a supportive view on the renewable energy expansion, while maintaining a favorable stance on nuclear power. This coalition emphasized renewable energy expansion for environmental enhancement as well as its economic role in the energy policy. The goal of renewable energy growth and the fundamental structure of the EEG in 2009 were upheld by this coalition.

In conclusion, the institutional path of energy transition was reinforced through active support for the EEG by the coalition between the Greens and SPD and the grand coalition. EU's institutional guidance to promoting renewable energy expansion also enhanced institutional strategies for energy transition in the Germany. These internal and external impacts led to the unceasing evolution of the EEG, until the formation of a second grand coalition and the Fukushima nuclear accident (Jungjohann, 2016; Stefes, 2016).

### 5.3 Path maintenance: Fukushima nuclear accident and political reformation

The institutional path was maintained with the formation of the second grand coalition between the CDU, CSU and the FDP in 2009. All the major political parties, including the FDP, started to assent to the continuous renewable energy expansion through the EEG. The FDP's political shift regarding EEG was made possible through lobbying efforts by renewable industries, such as the Agency for Renewable Energies and the German Solar Industry Association (Gründinger, 2017). The political support for renewable energy from this second grand coalition could be seen in the energy concept plan (Energiekonzept) of 2010 (BMWi, 2010). This was proposed as a long-term plan for energy supply and as a response to climate change up to 2050. The renewable energies, particularly wind power, occupy the largest portion of energy mix in the future. It was suggested that renewable energies should provide 18% of the gross final energy consumption, and 35% of the gross electricity consumption by

2020.[10]

However, the second grand coalition still maintained a favorable attitude towards nuclear power, which was referred to in the Energy Concept of 2010—inexpensive and a bridge to renewable energy (BMWi, 2010). Their institutional strategy for energy transition concentrated on the greenhouse gas emission reduction using nuclear power as well as renewable energies. An agreement of this coalition presented that nuclear power was a necessity to be regarded as a transitional technology, until the stabilization of power demand by renewable energies. This coalition decided to extend the lifetime of the existing nuclear plants—8 to 14 years after 2021—in direct contrast to the major aims of the previous institutional strategies. This lifetime extension was based on the modification of the Atomic Energy Act in 2010 (Bundestag, 2010), and it reflected the concept of energy policy being followed by this coalition. Moreover, it was noted that wind power and solar cells would usher in side effects, such as bird shredding and increased subsidies (Deutscher Bundestag Stenografischer Bericht, 2010). However, further plans for investment, development and construction of nuclear power plants was not embarked upon in the grand coalition. This coalition also adopted the Nuclear Fuel Taxation Act and the Energy and Climate Fund along with the expansion of nuclear lifetimes as part of agreement in 2010 (Gründinger, 2017).

In 2011, the strategy of the second grand coalition altered following the Fukushima nuclear accident, which was a crucial external factor in maintaining institutional advancement of energy transition. Angela Merkel's government announced the immediate shutting down of eight obsolete nuclear power plants on June 11, 2011 and a phase-out of nine nuclear power plants by 2022. The plan for a phase-out of the nuclear power plants was enacted, and Federal Council of Germany (Bundesrat) also approved the legislative plans for phase-out by July 8, 2011. There was an overwhelming agreement in the parliament votes regarding the phase-out—513 out of 622 from both major political parties (Spiegel Online International, 2011).[11] The public endorsement on the nuclear phase-out exploded after the Fukushima accident. The social acceptance on the nuclear phase-out contributed to the strengthening institutional path maintenance for energy transition.

An enhanced institutional path of energy transition, following the impact of the Fukushima accident, was directly presented in the amendment of EEG in 2012. For the first time since the EEG of 2000, another institutional evolution of German energy transition began with the EEG in 2012. It outlined ambitious but practical targets for renewable energy expansion, with the consideration of EU guidance.[12] The EEG of 2012 proposed a market-oriented development of renewable energy, through the introduction of a market integration model and the grid connection system. This institutional progress for continuous German energy transition was spurred by the social requirement for nuclear power reduction and renewable energy expansion. Germany has been aware of the huge risk of nuclear power through the experience of Chernobyl, and the Fukushima case evoked the danger further, which led to a phase-out of nuclear power plants again. The private sectors also showed

[10] Targets of renewable energy production in the share of gross final energy consumption and gross electricity consumption would be increased as follows: 30% and 50% by 2030, 45% and 65% by 2040, and 60% and 80% by 2050 (BMWi, 2010).

[11] More than 70% of CDU and CSU supporters showed a positive opinion on the political decision of nuclear phase-out (Allensbach, 2011).

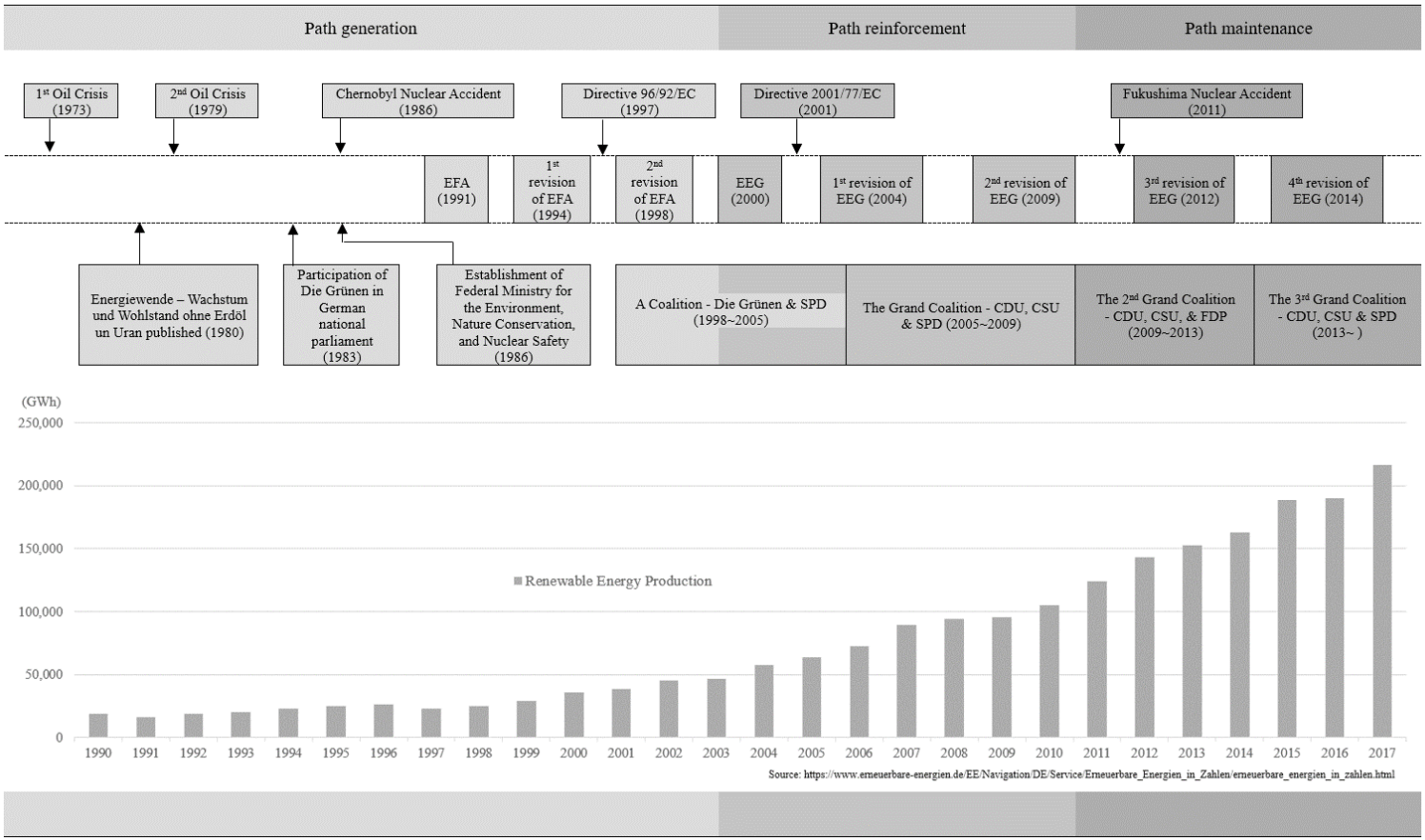
[12] The European directive 2009/28/EC suggests 20% of renewable energy be present in the entire energy generation model (European Commission, 2012).

support for the institutional continuity for energy transition. Representatively, Siemens, which was responsible for all 17 existing nuclear power reactors in Germany, stated that there would be no plans for the construction of new nuclear power plants in the aftermath of the Fukushima accident (Borrud, 2011). Even with a gradual increase of electricity prices, the public opinion about future energy source in Germany has turned towards renewables; particularly, the younger generation is more positive about the transition to renewables (Amelang, 2015).

The SPD joined in the third grand coalition in 2013. The new political structure involved a coalition among the SPD, CDU and CSU, and provided renewed fervor to the institutional path for the maintenance of energy transition. The third grand coalition showed a positive stance towards the nuclear phase-out and renewable energy development, based on economic feasibility (Hirschhausen and Reitz, 2014). The new coalition government agreed that last nuclear power plant in Germany would at least be shut down by 2022, and the energy transition would be continuously implemented. The administrative task for renewable energy policy was transferred from the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) to the Federal Ministry of Economic Affairs and Energy, which signified the political stance on constant energy transition with the consideration of economic practicality. The modified EEG of 2014 showed an institutional will for renewable energy growth, while retaining a market-driven development of renewable energy. An introduction of growth corridors, expansion of direct marketing systems and the abolition of Green electricity privilege mirrored a new direction for the 2014 EEG. An implementation of a pilot tender for free standing solar PV systems in the EEG of 2014, clearly indicated institutional evolution for market-led energy transitions.

A positive attitude of all major parties towards the EEG brought about a turning point in keeping institutional durability for renewable energy development. The Fukushima nuclear accident was the foremost extrinsic factor in maintaining the institutional path for energy transition. It influenced the aggressive changes in the revised EEG of 2012 and the participation of the SPD in the third grand coalition. The amended EEG of 2014 presented a more solid strategy for market-oriented development of renewable energy and nuclear phase-out.

**Figure 3.Institutional path dependence of German *Energiewende***



## 6. CONCLUSION

This study analyzed the continuous institutional evolution of German energy transition, based on three distinct stages of the perspective of path dependence. Figure 2 summarizes the institutional changes of German renewable energy, from the EFA to EEG. The institutional progress of German energy transition began with the EFA in 1991, which became the institutional foundation for feed-in-tariff based renewable energy expansion. The replacement of the EFA with the EEG in 2000, and further revisions in 2004 and 2009, were institutional momentums for renewable energy growth, with an enlarged and strengthened FIT. Moreover, another institutional evolution for German energy transition was reflected in the EEG modifications of 2012 and 2014. The institutional direction for renewable energy expansion moved from state-led to market-oriented, involving direct marketing systems and pilot tenders for solar PV.

Figure 3 summarizes the institutional path dependence of German energy transition. An analysis of each phase demonstrates significant changes in the institutional system for energy transition. The institutional path generation was initiated due to the political and social responses to the global energy crises as well as the Chernobyl nuclear accident. Moreover, the participation of the Green Party in the ruling coalition played a significant role in launching energy transition. Even with major political parties' espousal of nuclear power for constant economic growth and greenhouse gas emission, the launch of institutional progress in energy transition was enabled by the public consensus and political changes. With the establishment of effective institutional strategies for energy transition, the EFA accompanied the progressive shift in social and political circumstances.

The reinforcement of this path was further formed by the replacement of the EFA with the EEG in 2000, under strong political will for sustainable energy development. A profound interest of political affiliations in reducing nuclear power and the expansion of renewable energy facilitated the improvement of an institutional system. Furthermore, the EU's institutional guidance involving the electricity market and renewable energy expansion also contributed to the change of the institutional path and its enhancements. Even with notable changes of political circumstance, the political momentum for energy transition was robust and consistent. It conclusively led to the amendment of the EEG in 2009 and 2012 for constant renewable energy growth.

The Fukushima nuclear accident and the continued support from the political coalitions contributed to the maintenance of the institutional path towards German energy transition. Although the newly formed coalition in 2009 still had a favorable stance towards nuclear power, it did not lead to considerable institutional alteration in the energy transition. All the major political parties held positive attitudes surrounding the renewable development of the EEG, demonstrating the importance of institutional durability. The Fukushima accident brought about a renewed social consensus and a change in the collective consciousness of the coalition, which enabled an institutional evolution from state-led to market-driven strategies for the EEG in 2012 and 2014. Hence, institutional durability, which led to a flexible response to these external and internal changes, was a significant factor in enabling constant energy transition.

This institutional analysis of German energy transition provides crucial implications for other countries that implement strategies for energy transition. The progressive changes in the social and political environment regarding energy transition, were prior conditions for setting up institutional strategies. External impacts were the prime movers for institutional

implementations and/or revisions. Additionally, a strong political will added momentum to the reinforcement of the institutional system. Basically, institutional durability in the face of critical changes of internal and external circumstances, helped pave the successful path to energy transition.

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