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The German Energy Transition Towards Renewable Energy Sources: Theoretical and Practical Perspectives

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Abstract

The German energy transition, also called Energiewende, is a significant effort towards the growth in usage of renewable energy sources. Motivated by the need to combat climate change and lessen reliance on fossil fuels, Germany has undergone a thorough transformation of its energy sector. This paper explores the Energiewende within the timeframe of its beginning in the 1990s till the middle of 2022, including its legal and theoretical background, analysis of Germany's current legal framework for renewables and its correspondence with EU renewable energy targets until 2030. The practical part includes several case studies from renewable energy projects in Saarland as an example for good business practices and in order to support the general conclusions on the topic.

The aim of this paper is to review the energy transition process in Germany and to indicate what practices are applicable to other countries such as Bulgaria. Through the usage of literature review and analysis of case studies, the paper outlines key moments for green energy development in Germany as well as practical information from previous renewable energy projects. The results provide valuable insight for similar future projects in Bulgaria, which could support the transition process towards a sustainable and clean future.

Keywords: German energy transition, renewable energy sources, international business environment

JEL: Q42, Q48, Q56, K32, F64

1. Introduction and methodology

The German energy transition has emerged as a remarkable endeavor towards renewable energy sources (renewables), serving as an inspiration for other countries and governments around the Globe. This paper aims to provide a brief examination of this process, encompassing its legal and theoretical underpinnings, the current legal framework for renewables in Germany, and in accordance with renewable energy targets within the European Union (EU), but also to give several practical examples drawn from completed actual renewable energy projects in Saarland. By delving into the historical, legal, and practical dimensions, this study seeks to shed light

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on the multifaceted aspects of the energy transition in Germany, offering insights for policymakers, researchers, and stakeholders engaged in the pursuit of a greener energy future.

The methodology of the research encompasses literature review of various sources about the theoretical part - including the evolution of the Renewable energy law (EEG) and the legal framework in Germany as a whole as well as its correlation with the current targets in the EU until 2030 about renewables. A case study analysis is used for the practical part, where four different examples are given from past renewable energy projects about wind or solar energy plants. It is important to point out that the data, which was used in the research is relevant only till the first half of year 2022 and does not include the following changes in the political, legal and economic environment in Germany and the EU as a whole.

2. Legal and theoretical background about renewable energy in Germany

Germany has a long history of working with renewable energy sources. But before the project developers and the private sector could be truly involved, the need for clear legal and theoretical background was present. Since the energy sector is a major branch of the economy, it was and still is very strictly regulated. Therefore, for successful energy transition in the country the theory had to be put into practice through several changes in the legal framework. For the purposes of this analysis, we will use renewable energy and green or clean energy, renewable energies or green energies, renewable energy sources and renewables as synonyms, even if there exists a difference in their meaning from a theoretical point of view.

In the following pages we describe the main points of the theoretical and legal aspect of renewable energy in Europe, using Germany as one of the best examples. By examining the legal and theoretical past we will be able to comprehend why this century will belong to the new types of energies and why the so-called conventional energy, produced directly from fossil fuels is going to become a thing from the past. But first we should review the renewable energy targets for the whole EU until 2030.

2.1. Renewable energy targets in the EU until 2030

With the introduction of the European Green Deal in 2019 the European Commission started to implement a series of policies in order to make Europe a climate neutral continent by 2030. This includes actions (Fetting, 2020) such as:

- 55% reduction of emissions from cars by 2030;
- 35 million buildings could be renovated until 2030;
- 160,000 additional green jobs could be created in the construction sector by 2030;
- 40% new renewable energy target for 2030 (recently increased from the initial 32%);
- set a benchmark of 49% energy from renewables in buildings by 2030;
- require Member States to increase the use of renewable energies in heating and cooling by +1.1 percentage points each year, until 2030;
- removal of natural carbon (by 310 metric tons);
- and others.

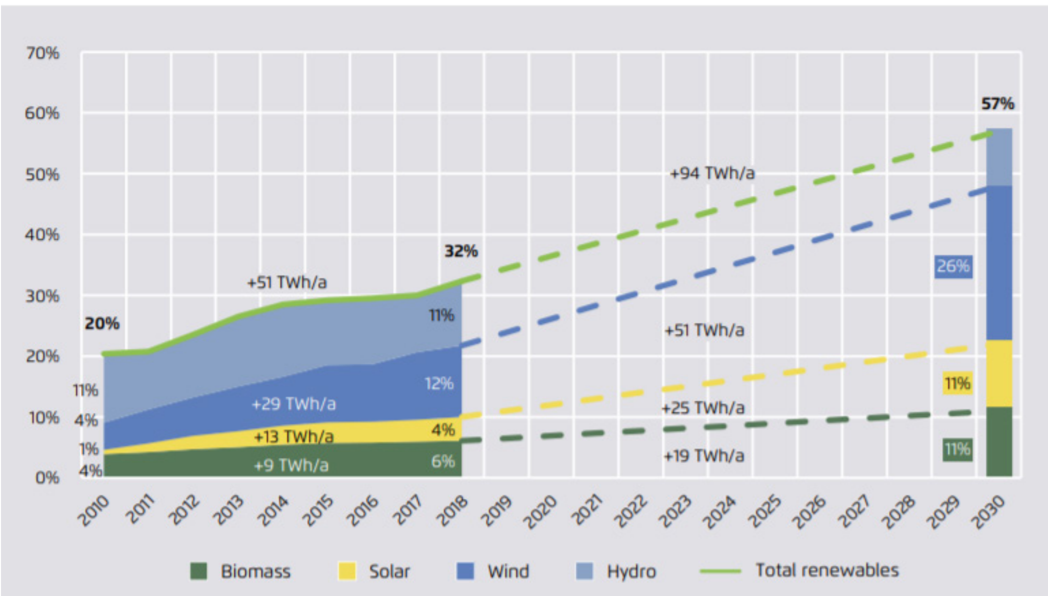
Those targets are subject to revision and could be improved on a yearly basis depending on the current progress of accomplishing the current ones, which are the minimum to be achieved. There is always space for further growth, especially in the field of renewable energies.

The energy transition in Europe is ongoing and there is a report from 2019, which makes a prognosis for the electricity from renewables until 2030. It is made by Agora Energiewende, which is one of the leading think tanks in Europe. Their team consists of more than 80 members, who represent an independent body of experts providing advices and professional opinions on specific topics such as the energy transformation in Germany and Europe as a whole. Therefore, their forecast has to be taken into account.

Here is the visual representation of the projection about the renewable electricity share till 2030 (it includes the period between the years 2010 and 2030), which was prepared by the experts in Agora Energiewende:

This figure shows the expected expansion of electricity, produced from renewable energy sources, by the year 2030. The researchers made this prediction two years ago and it is possible that their prediction, which is based on the long-term strategy of the European Commission, to be surpassed. In any case, it is obvious that wind and hydro energy have the biggest part in the total electricity mix of renewables. This does not mean that the PV will be left behind – some very advanced industrial countries like Germany (via EEG 2021) have made steps to further promote and increase the construction of PV installations among the other types.

There is a recent update in the renewable energies' targets in Europe until 2030. It was made by the European Commission on



Source: Agora Energiewende (Buck et al., 2019)

Fig. 1. 2030 projection of renewable electricity share in European Commission's long-term strategy

14 July 2021 via the so called „Fit for 55“ Package, which includes a large number of legislation proposals to achieve within the EU Green Deal’s framework. The main goal is to reduce greenhouse gas (GhG) emissions by 55% by 2030 as the name of this package suggests. According to the European Commission’s statement (2021), Hörmandinger (2021), Mathieu and Gläser (2021), there are additional measures, which include the following:

- application of emissions trading to new sectors (primary heat and transport) and a tightening of the existing EU Emissions Trading System;
- increased use of renewable energies and greater energy efficiency – from the initial 32% in the initial EU Green Deal from 2019, the target’s percentage is increased to 40%;
- a faster roll-out of low emission transport modes and the infrastructure and fuels to support them – via revision on the Directive on deployment of alternative fuels infrastructure and other changes it enforces the role of electrification in transport, more stringent CO2 emissions standards, a ban to the sales of diesel and petrol cars by 2035 and a new target for charging stations along highways – one on every 60 km;
- an alignment of taxation policies with the European Green Deal objectives – via the Effort Sharing Regulation (it sets national targets for emission reductions in different sectors), revision of the Energy Tax Directive (taxation of energy costly products) and Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF);
- measures to prevent carbon leakage and for example the Carbon Border Adjustment Mechanism – it is a proposed carbon tariff on certain products such as cement and others, which are carbon intensive. This rule is proposed to come into force after a few years.
- others and some of them were included later like reducing methane emissions in the energy sector, revision of the energy performance of the Buildings Directive and revision in order to regulate competitive decarbonized gas markets.

The main principles of „Fit for 55“ Package are to:

- ensure a just and socially fair transition;
- maintain and strengthen innovation and competitiveness of the EU industry while ensuring a level playing field in regard to third country economic operators;
- underpin the EU’s position as leading the way in the global fight against climate change.

The new measures from the package „Fit for 55“ are designed to reduce the effects from the Global Warming within Europe until 2030. As we have concluded this policy also includes the renewable energy sources (40% of all energy by 2030) and the energy efficiency in the EU (increased annual energy savings obligations and new rules aimed at decreasing the energy consumption of public sector buildings). As a leading economy in Europe, Germany will have a great impact on the whole effort to achieve the goals until 2030.

Before we continue with the exact history of the energy transition process of Germany, it should be noted that this process is not stand-alone. Denmark is another example of a leading country in Europe with the so-called grøn omstilling, which is the Danish green energy transition initiative. The comprehensive process of energy transformation in Denmark has been thoroughly analyzed in another study (Ropenus et al., 2015) and will therefore not be discussed here in depth. But we have to admit that it has a lot of similarities to the Energiewende in Germany. Since both countries are neighbors and have a good cooperation in many sectors, they learn from each other's best practices also in this energy sector. Moreover, the comparison of energy transformation processes between Germany and Denmark could be of considerable significance for other EU member states and therefore deserves a dedicated research and more detailed analysis.

2.2. History of the German energy transition process – summary

The ongoing process of the German energy transition, known as Energiewende, continues to be driven by political determination for change. While the term Energiewende was initially introduced in the 1970s as part of the anti-nuclear movement (Evans, 2016), its widespread recognition and popularity emerged in the 2000s, primarily due to growing concerns surrounding global warming. Notably, legislative changes in Germany's energy sector commenced in 1990, with the introduction of the Electricity Feed Act on December 7th, 1990 (StromEinspG). It was implemented at the start of 1991, marking a significant milestone in the country's energy transformation. This law on the supply of electricity from renewable energy sources into the public grid (or Law on the feed-in of electricity from renewable energies into the public network) was the first step to the rise of the renewable energies. According to this law of the Federal Republic of Germany, electricity supply companies were obliged to purchase and pay for electricity in the grid, supplied from third parties and from renewable sources. The electricity suppliers had to pay a fixed price to the small providers. Funding was limited to systems with a maximum capacity of 5 megawatts. For each kilowatt-hour fed in, the price for produced electricity was set. The suppliers were allowed to pass the costs on to the electricity bills of the consumers. This means that the Electricity Feed Act is the forerunner of the Renewable Energy Sources Act (EEG) passed in 2000.

The Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz - EEG, 2000) from the year 2000 represented a new step in the promotion of renewable energies in Germany. The need for such a law arose from the obligation under the Kyoto Protocol (an international agreement that aimed to reduce carbon dioxide (CO2) emissions and the presence of greenhouse gases in the atmosphere) to reduce greenhouse emissions by 21 percent by 2012, as well as the coupling of the tariff rates for renewable energies applicable through the previous law - StromEinspG for the development of electricity prices. The first EEG had twelve paragraphs. Section 1 of the EEG postulates the goal of doubling the share of renewable energies in electricity consumption in Germany by 2010. Sections 3 and 11 of the law rewrites the purchase and remuneration obligations by standardizing a five-level structure - connection, purchase, remuneration and grid expansion obligations along with nationwide equalization regulations. Sections 4 to 8 consist of the legally prescribed minimum remuneration for electricity from different sources. The level of remuneration for individual energy sources was designed differently and also fluctuated according to the precise energy source. In the case of biomass, wind energy and photovoltaics, there was a nominally degressive annual reduction in the remuneration rates. Section 9 specifies the minimum remuneration payments for a period of 20 years. We can summarize the most important principles in the law during its initial stage:

- Guaranteed feed-in tariffs and connection requirement;
- The remuneration payments were not considered as subsidy payments (they do not come directly from taxation, but rather from the surcharge on electricity consumers);
- The feed-in tariffs were scheduled to decrease after certain periods of time, since this way it was expected due to technological innovations that the costs for plant operators and manufacturers would decrease (also known as degression). There was also a differentiation between scale and electricity yield.

The first change to the EEG standardized a fixed target for the expansion of renewable energies to 12.5 percent by 2010 and at least 20 percent by 2020. It was made in 2004 and included several changes (EEG, 2004). The next amendment was made in 2009-2010 (Gesetz zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich und zur Änderung damit zusammenhängender Vorschriften, 2008) and the main reason for its existence were the lower investment costs for photovoltaic (PV) systems due to the dynamic development of this new technology and the expansion of production capacities. Its focus was the lowering of the subsidy rates for new PV systems, which have been reduced in two stages. Also, a national Energy Concept was started in September 2010, which discussed the nuclear power as a bridging technology in the energy transition (Federal Ministry of Economics and Technology, 2010). But after the news from the Japanese plant of Fukushima, the German government decided to phase out the nuclear energy before the end of 2022.

Another update of EEG happened in 2012, when it was decided that the share of renewable energies in electricity consumption should be at least 35 percent by 2020 at the latest, in 2030 it should be at least 50 percent, in 2040 at least 65 percent and in 2050 at least 80 percent. The remuneration system for bioenergy has also been fundamentally changed. Further adjustments concerned the exemption of storage facilities from the EEG surcharge in order to avoid double taxation, the introduction of a “flexibility premium” to promote the construction of gas storage facilities, the lowering of the “green power privilege” of the electricity supply companies from the EEG surcharge (limit to 2 cents per kilowatt-hour) and the introduction of a minimum share of fluctuating renewable energies of 20 percent (from wind and sun). In other words, the market premium is the difference between the tariff and the average spot market price. Its purpose was to support demand-oriented electricity production. The amendment from 2012 also included several important changes about the PV, which included its remuneration, expansion, new market integration model, inclusion of plants in feed-in management, exemption of specific storage facilities from the EEG surcharge and others (Bundesministerium für Wirtschaft und Klimaschutz, 2012).

A major reform of EEG was prepared two years later (EEG, 2014). It was seen as a restart of the energy transition in the country. The effects of the law were planned to noticeably slow down the further rise in costs, managing the expansion of renewable energies systematically and bringing renewables closer to the market. One thing was clear: the price of electricity is a key competitive factor for energy-intensive companies. The main goals at the time were:

- the competitiveness of the electricity-intensive industry, which already pays high electricity prices compared to international competition, must not be jeopardized;
- added value and jobs in Germany must be preserved;
- to keep within agreed deployment corridors for renewable energies.

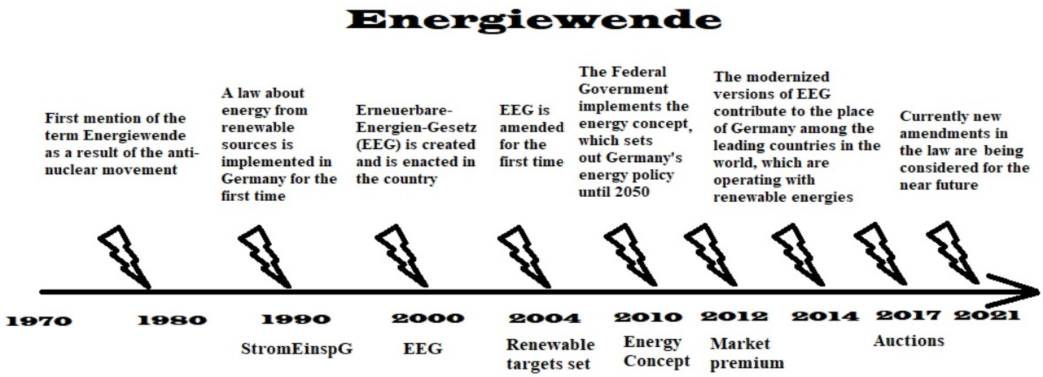
This law regulates the preferred feed of renewable electricity into the grid and guarantees firm revenues to its producers. Due to the effects from the updated EEG Germany confirmed its position among the pioneers of electricity production from renewable energy sources (Quitzow et al., 2016). The country at that time was just behind China and the USA in the ranking by these criteria.

In 2017 there was another major change in EEG - the level of remuneration for renewable electricity will not be set by the state as before, but will be determined through auctions on the market. Other changes (Gesetz zur Einführung von Ausschreibungen für Strom aus erneuerbaren Energien und zu weiteren Änderungen des Rechts der erneuerbaren Energien, 2016) were connected with the further promoting of renewable energies, they synchronize the expansion of renewable energies with the expansion of the grid, development of wind energy projects in the sea (offshore wind turbines), a new auction model and the promotion of tenant electricity surcharge (electricity that is generated in solar systems on the roof of a residential building and delivered to end consumers in this building without a grid connection and consequently without grid fees, grid-side surcharges, electricity tax and concession fees).

Germany is one of the leading economies in the world and therefore the country is paving the way for a green energy future for Europe. As a summary the history of the German energy transition included several changes in the country's law with precise targets, which are to be accomplished. It was a very important part of the rise of renewables, because without the goodwill of the government, the companies, operating with renewable energies would not have been so advanced and so numerous. Furthermore, the levels of the CO2 emissions would have been even higher.

The different measures and feed-in tariff promoted the usage of electricity, which was produced from renewable energy sources. All this leads to the logical conclusion that the renewable energies improvement in Germany during the previous 30 years would have been very hard to accomplish without strong political will and support for it. Here is how this information can be represented:

The research of the whole process of energy transition in Germany deserves a separate comprehensive study on its own. It was already done in articles like the ones from Ortwin and Marshall (2020), Pescia et al. (2015), Hansen el al. (2019), therefore we will not repeat their findings. Instead, we focus on the simplified version of the Energiewende as our goal is to emphasize that it took a lot of time and efforts in order to implement the renewables in the energy mix of Germany and did not happen over a short period of time. Otherwise, it is obvious that in the previous 10 years the process gained momentum and



Source: Author's own work, based on StromEinspG and EEG

Fig. 2. Simplified timeline with the whole process of energy transition in Germany

the changes were happening over shorter time intervals. Certainly, the growing support from the public and the businesses helped to speed it up. Nowadays, the renewables are considered to become the main source of electricity in the near future not only in the selected country, but in the whole EU.

2.3. Short overview of the current legal framework for renewables in Germany

As we have established so far, the legal framework in Germany has been continuously and gradually updated. From the initial law about renewables from 1990 (StromEinspG) to the modern changes in EEG. EEG has also faced a lot of criticism and controversy, about whether it is state aid or not. In fact, on several occasions the European Commission was investigating it and the content of the EEG was submitted to several lawsuits. Other concerns are connected to the cap for wind and sun energy, exemptions for energy intensive industry, taxing self-consumption of solar PV, quota system instead of feed-in tariffs and their surcharge. Despite all that, EEG was and still is a major stimulus for the development of renewable energy sources in Germany. The German model of EEG could be successfully adopted in countries which are in the early stages of renewable technology development because it is considered as a way to bring good profitability for new installations and is effective in the promotion of renewables.

We can point out some of the most important aspects of the EEG and the legal framework in Germany as follows:

- the past feed-in tariffs are nowadays being replaced by the auction system;
- the remunerations supported the stable income and eased the financing of renewable energy project (with bank loans for example);
- degression is a measure to increase energy effectiveness;
- the role of the citizens' cooperatives (Genossenschaft) is considered to be a key reason for the increase in public acceptance of renewable technologies in Germany. This is how regular people have the opportunity to invest in renewable energy projects;
- timeline for reaching the targets from the law and the Energy Concept about the usage of renewables;

- priority access to the power grid for renewable energy sources and a fixed price per kWh in order to ensure a return on investment;
- sharing of extra cost among all energy users by the EEG surcharge means that end consumers could expect to pay a specific amount for each kWh of used electricity;
- the growth of renewable energies plants as a consequence of the feed-in tariff has also led to a rapid increase in the need of specialists in this industry;
- An important impact of the EEG is that it supports decentralized, democratic and people-oriented energy transition with the example that some communities in Germany have already achieved their target for 100% energy supply from renewable energy sources.

On January 1, 2021 the amended Renewable Energy Sources Act (EEG 2021) came into force. With it the German government aims to further promote the expansion of renewables. The new amendments and targets in the EEG (2021) include the following (Appunn, 2021):

- increase in auction volumes for wind energy, and primarily for solar power;
- privileged treatment of green hydrogen producers when procuring electricity;
- the entire electricity consumption in Germany before the year 2050 is planned to be greenhouse gas neutral, which means that gas neutrality in the power sector becomes part of the law;
- initially by 2030 exactly 65% of German electricity consumption is planned to be covered by renewable energy sources, but nowadays there are talks that this should be set at 80% in alignment with a more ambitious EU climate target;
- two new segments to promote electricity generation from solar radiation energy (ground-mounted systems is the first and the second is installations on constructions, which are not residential buildings or noise barriers);
- introducing an auction regime for biomethane plants;
- measures for grid reinforcement - a “southern quota” will be introduced to promote onshore wind energy and biomass in southern Germany;
- new target quantities - by 2030, 8.4 GW of biomass, 20 GW of offshore wind, 71 GW of onshore wind and 100 GW of photovoltaics should be installed in the country;
- financial participations for municipalities with new wind turbine sites and the framework conditions for tenant electricity concepts will be improved;
- new changes in the remuneration for PV installations, there is also a new auction category created and named “roof systems” for the photovoltaic;
- the “flexible cap”, which results in a cost reduction for solar power systems, is being relaxed;
- ground-mounted systems along motorways and railways will be eligible for auctioning up to a bigger distance (200 metres instead of the previous 110 m);
- The EEG surcharge is to be partly financed using the federal budget by introducing carbon pricing in the heat and energy sectors under the German Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz);
- the market premium for new plants will now be calculated on a (calendar) yearly basis from 2023;

- tariff for electricity generated from renewable energies plants will be significantly restricted in the event of negative stock market prices for new plants – in the past the market premium and the feed-in tariff were only reduced to zero in case that the electricity prices in the exchange-based day-ahead auction had been negative for at least six consecutive hours (the so called six hours rule), but the value to be applied will now be reduced to zero if the spot market price is negative for a period of four consecutive hours;
- The EEG plant operators were entitled to compensation amounting to 95% of lost revenue if the grid operator has reduced the plant's feed-in capacity as a result of grid congestion, now it is increased to cover 100% of lost revenue;
- gradual increase in mostly PV and onshore wind plants, but also other changes.

After the elections in 2021, Germany has a new government. This fact also resulted in some changes in the targets for renewable energies. The new German coalition (Bundesnetzagentur, 2021) plans to boost the energy transition, to reduce the EEG surcharge from 6.5 ct/ kWh to 3.723 ct/ kWh from the beginning of 2022, to increase the volumes of new added energy capacities, to expand the usage of electric cars, to lower the gas emissions and to phase out coal (by 2030 year). The major renewable targets from the coalition agreement could be summarized in the following table:

Before we continue with the practical part of the current study, we have to note the current trend of implementing more and more smart energy systems in Germany. The essence of smart energy systems is that advances in digitalization are used in order to harness surplus energy from various sources and thus minimize energy waste. For example, the excess heat could be converted into electrical energy (Mathiesen et al., 2015). Additionally, such systems help to store energy for a longer period of time and therefore can be used during periods of fluctuations and shortages. But for the purposes of the current analysis, we will use the findings from the case studies from energy projects in Saarland exclusively.

Table 1. German government targets for renewables by 2030 year

Type of target	Previous target	New target to be achieved by 2030
Renewable energies	65% of the energy mix	80% of the total energy
Energy demand	580 TWh/ year	680-750 TWh/ year
Solar energy	100 GW	200 GW
Onshore wind energy	~75 GW	not specifically mentioned (expected to be around 100 GW because 2% of the total land area in Germany will be made available for further wind development)
Offshore wind energy	20 GW	30 GW (70 GW by 2045 year)
Hydrogen production (via Electrolysis)	5 GW	10 GW

Source: Koalitionsvertrag, 2021

3. Case studies and practical examples from past renewable energy projects in Saarland

In order to better evaluate the types of problems from the daily work of the project developers, requests have been sent to them about available case studies from previous projects. The requests included the following features:

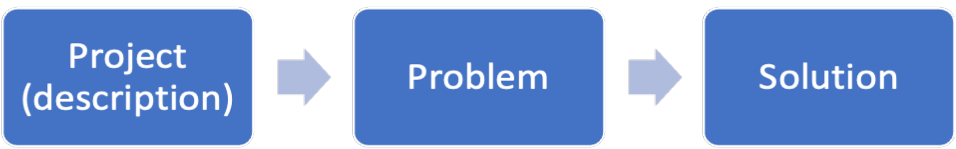
- Target Group: German project developing companies, working with solar PV and/or onshore wind power plants;
- Content: The case study should consist of a short description of a concrete problem(s) the company has faced in the past in its daily work and how it has managed to overcome those difficulties;
- Language of the case study: German or English;
- Aim: To identify the best practices in the development of renewable energy projects in Germany and to support the future implementation of such practices in Bulgaria and East Europe. As in the questionnaire another goal was to find out what new strategies and incentives should be promoted by policy makers in Bulgaria to further encourage the successful implementation of renewable energy projects. The main focus is again only on PV and onshore wind projects.

Requests for case studies were sent to all companies to which the request for a participation in the previous questionnaire was sent. As a result, several companies have agreed to send us information for the requested matter. Some of them explained to us the issue and sent us the information in a written form, one company sent us several documents about a particular case study and other companies have explained only in verbal form the problems which they faced a few years ago. In order to present the collected data, we will use the following algorithm:

3.1. Case study 1

Project: The first case study is from 2018 and its aim was a construction of a photovoltaic installation on the roof of a kindergarten, which is situated in a municipality of Schmelz (in the district of Saarlouis). The company that was going to make the construction was a cooperative from the region with several years of history and around a dozen successful past projects. With the creation of a PV power system the main goal was the kindergarten to have a certain autonomy of energy supply and to be able to sustain its own need or at least to decrease its dependence on energy from the grid.

Problem: A project developing company was tasked with the construction and operation of a solar power system on the roof of the nursery center. But shortly afterwards they received a letter from the state administration office that the development of the project was put on hold due to the lack of funding. The problem was that the municipality of Schmelz was not allowed to have more debt according



Source: Author's own work

Fig. 3. Algorithm for presentation of the collected data from the case studies

to the local legal framework of Saarlouis. The debt which was accumulated in the budget of the municipality at that time was already too high. This was a big problem also for the project developing company, because its management was already counting on the successful completion and maintenance of the solar installation.

Solution: The local policy was included and the company could not do much to solve the issue except to rely on the policy makers and the framework procedures. The important issue is that this was not an isolated case and there were numerous signals about projects for PV installations on rooftops, which were stopped due to the bureaucratic procedures and law restrictions. The local authorities stepped in and made the needed adjustments in the policy, especially since PV power systems on rooftops of buildings are considered as a good investment. So, the solution was simple – change in the legislation. Since the current credit framework was not sufficient, the Minister of the Ministry of the Interior, Construction and Sport in Saarland issued a special order on it. From then on, the PV installations on the rooftops were to be considered as an energy saving measure. Additionally, the funding with borrowed money for such projects will not be considered as a burden to the existing credit line of the local municipality. Basically, this meant that there were no remaining obstacles to completing the project.

This case study is an example of the fact that in the business world, the success factors for renewables and their impact are not limited to individual theoretical categories (which we have already mentioned earlier), but there is a mix of factors. In this particular case there is an interaction between legal and political factors. The legal framework on one hand restricts the increase of the existing credit line for the municipalities, but on the other hand the timely government intervention makes the necessary adjustments in the law and insures the further development of photovoltaic projects in the future. The conclusion is that well-calibrated changes in the policies of the authorities lead to a favorable impact on the renewable energy business.

3.2. Case study 2

Project: The aim of the project was the construction of a 3 MW wind turbine. The BimSchG approval (this is a regulation in Germany for protection of people, animals and plants, the soil, the water, the atmosphere and cultural or other property from harmful environmental effects) of the responsible authority was granted and all technical, legal and nature conservation requirements for the installation of the wind turbine were fulfilled. For the realization of the project, a purchase contract for the delivery of the wind turbine was to be concluded with a renowned manufacturer.

Problem: The selected wind turbine was bound to the BimSchG permit and therefore had to be the same as the approved type of wind turbine for the construction site. But the manufacturer got into an economic predicament and in order to overcome this situation, he reduced its product portfolio and reorganized its production capacities worldwide. One of the consequences of this change was that the selected wind turbine could no longer be delivered to the project developer who was responsible for the completion of the current project.

Solution: In agreement with the authorities, the permit was amended in accordance with Section 16 (4) of the BimSchG Act to a comparable wind turbine type from another manufacturer. This change delayed the project and caused additional costs for the project developer. Nevertheless, the successful installment and operation of the wind turbine was eventually successful.

In this case the project is about an onshore wind energy system, which was going to be powered by a wind turbine. The financial difficulties of the initial wind turbines manufacturer could be contributed to factors such as the economic situation at that time or even to poor management. Again, there are two categories of impact factors – economy and management. Whatever the reason, the fact is that the original producer has failed to complete its obligations according to the contract. We can presume that there was a clause, which was protecting the buyer (the project developing company, responsible for the construction of the wind plant) from such a situation. Still, the construction time was extended and some compensation was needed to the clients and this took the form of the aforementioned additional costs. It is important to note that we can include the technology as a factor since the precise model of the wind turbine was in the center of the problem. In short, the original manufacturer had an increased financial burden and the project development company had difficulties with the planned time frames of construction. As we have already found out, the projects in Germany depend on a very specific set of rules and regulation, which have to be complied precisely. Any change requires an allowance from the authorities (in this case it was the permit for change of the manufacturer and in the previous it was the extension of the credit line).

3.3. Case study 3

Project: The aim of the project was to build a photovoltaic plant in the less-favored (not suitable for agricultural purposes) area, divided into two separate zones, one north and one south. The feed-in commitment allowed the installation to have a capacity of 14.7 MWp (Megawatt peak or MWp is a measure of the maximum potential output of the solar power for the installation, the real supply may vary depending on the sunlight). Successful participation in the Federal Network Agency's tender process secured two awards of EEG compensation for this project. An urban land planning procedure was carried out to obtain the necessary building permits.

Problem: Within the framework of the participation of public agencies in the urban land plan's usage procedure, a statement was submitted by the General Directorate for Cultural Heritage (GDKE). In this statement, it was stated that archaeological findings from the Roman imperial period are known in the vicinity of the planned photovoltaic plant. Therefore, both areas of the planned site were classified as potential locations for such archaeological discoveries.

The selected site was investigated due to the statement of the GDKE and according to archaeological guidelines by means of magnetic surveying. This has shown that archaeological evidences were present in the southern area of the planned site and that further investigations were necessary. The north area was not affected and there were no archeological findings in it.

Solution: In this case due to the division of the construction site in two areas – north and south and the found evidences in the southern part the need for separate handling of the issue emerged:

- The north area (zone): Due to the realization period resulting from the EEG surcharge, the implementation and possible output of the photovoltaic system in the northern area was not affected by archaeological discoveries. Consequently, in the first construction phase, a photovoltaic plant with an output of approximately 11 MWp was built on the northern area;
- The south area (zone): The exploitation of the southern area was to take place after clarification of the archaeological findings and in coordination with the GDKE. The result was that the archaeological discoveries should remain in the ground, which fact is to be taken into account during construction. In the meantime, an evaluation of alternatives in the construction on the zone with the presence of archaeological remains became necessary. Furthermore, a special construction method was examined for feasibility and economic viability for the case. In principle, the originally planned construction method does not cause any major interference with the ground, but it may still damage sensitive sites. Other building methods would have led to higher investment costs than the originally planned.

Considering all those facts, the project developers have decided on the following course of action: The new planning of the northern area and the parts of the southern area, which were not affected by archaeological discoveries, showed that the capacity of the feed-in commitment has already been exploited (the originally 14.7 MWp). Due to the economic aspects and the already reached feed-in capacity, it was decided to leave the areas with the archaeological findings undeveloped. Other parts of the southern area that are also not affected by the archaeological site are to be built over in a second construction phase after a further investigation and confirmation.

This case is particularly interesting because the problem did not arise from economic, political or other factors such as the management. On the contrary, this time the environment and the law categories of factors were involved in the matter, although some may argue that the technology was also a key factor since the unavailability of a suitable construction method at the time for keeping the historical findings under the ground was present. But we can logically assume that even, if such method existed – it is a moral duty of every human to preserve the cultural heritage from the past ages and its scientific exploration should not be obstructed in any way.

Environment protection has a leading role for the German society and it is among the success factors for the rise of renewable energy. The development and preservation of the environment stimulated the energy transformation (Energiewende) towards electricity from renewable sources. This could serve as an example for the best practices for the Bulgarian policymakers and companies, where the focus towards the environment protection and cultural heritage should be further increased in the upcoming years.

3.4. Case study 4

Project: It is again a PV installation project for the creation of a site with a capacity of 2 MW near the district of Roden on river Saar.

Problem: Every construction site should be checked and investigated before the initial building phase. This is because during the Second World War the whole Saarland region was heavily industrialized and there were many battles in most of the cities. In the case of the project – the initial check found out that there were 140 potential places where there could be mines or remains of bombs.

Solution: Further investigation was needed and for the safety of the workers and the local people, it was conducted. The results showed that after six weeks of detailed investigation the specialists located one bomb and had to defuse it. Consequently, the financial burden of hiring such specialists was placed on the project developer alongside with six weeks delay in the initial phase of the project.

This case study is shorter than the previous ones because it was given only in verbal form. It looks similar to case study 3, but it is different because in that case we can point out the role of a completely separated category of impact factors – the one which was titled simply as "Others". In particular this could be considered as force majeure and a direct consequence of military actions from the past.

This case study also confirms the findings from the questionnaire that the project developing companies face most of their difficulties in the initial phase of the project – the planning and site acquisition phase. Furthermore, it is a great example for the project developers in Bulgaria that they should put a lot of efforts in the initial research and planning of the construction site for all types of installations, operating with renewable energy sources.

We can summarize the information gathered from the case studies in the following table:

We should note that all the case studies are about renewable energy projects connected with PV and wind onshore energy sites. The reason is the local geographical and economic conditions, which have made possible the development of exactly these renewables. We should also not forget that in the past Saarland was specialized in heavy industry and coal mines exploitation, which have its own impact even during the ongoing transition towards renewable energy.

Based on the gathered data, the case studies clearly demonstrate the proficiency of project developers in Saarland, Germany, evident in their day-to-day operations. This serves as confirmation that German

Table 2. Findings from the case studies

Case study	Type of energy for the project	Type of problem	Impact factor	Type of Solution
1	Solar	Legal issues and need for extended credit line	Law and Politics	Intervention by the state authorities
2	Wind	Problem with the delivery of the planned wind turbine	Economy and Management	Intervention by the state authorities
3	Solar	Problem with the beginning of the construction work due to ancient remains in the area	Law and Environment	Adjustment in the construction plan and decision from the Management
4	Solar	Problem for the safety of workers and locals	Others (force majeure)	Increase in spending and changes in the time planning

Source: Author's own analysis, based on the available case studies from project developers in Saarland companies possess the necessary expertise to navigate a wide range of challenges, including compliance with local regulations and restrictions, as well as addressing issues such as bomb defusal and site clearance for new projects. Starting from the year 2000, German project developers had the opportunity to adapt to market dynamics and regulatory changes over time. In contrast, Bulgarian project developers have comparatively less experience in working with renewable energy sources than their counterparts in Germany. Therefore, it is crucial to recognize and draw insights from past experiences of other countries in order to facilitate knowledge transfer and avoid repeating mistakes.

Conclusion

The German energy transition, also known as the Energiewende, stands as a pioneering initiative in the global shift towards sustainable energies. This paper provides an overview of the history of the German energy transition process, encompassing its legal and theoretical foundations, the renewable energy targets set by the European Union until 2030, an examination of the current legal framework for renewables in Germany, bul also practical examples derived from past renewable energy projects in the region of Saarland.

The German energy transition emerged as a response to the urgent need to mitigate climate change, reduce reliance on fossil fuels, and foster the development of renewable energy sources. The legal framework supporting this transition has evolved significantly over time, encompassing legislation, regulations, and support mechanisms that incentivize renewable energy generation and promote its integration into the national energy mix. This paper delves into the key legal provisions and policy instruments that have shaped the German energy transition, providing a historical context for its implementation.

Moreover, a critical analysis of the current legal framework for renewables in Germany is presented, shedding light on key regulations, support mechanisms and market structures. Special emphasis is placed on feed-in tariffs, auctions, and grid integration measures that have facilitated the growth of renewable energy projects in Germany. The Saarland region is explored as a case study, showcasing practical examples of successful renewable energy projects, such as wind farms and solar installations. Lessons learned from these projects provide valuable insights into the real-world implementation of renewable energy initiatives.

This comprehensive review of the German energy transition offers a multidimensional perspective, combining legal, theoretical, and practical elements. It contributes to the body of knowledge surrounding renewable energy transitions and provides a valuable resource for policymakers, researchers, and stakeholders interested in the development and implementation of sustainable energy systems. By examining the German experience, this study seeks to inspire and inform energy transitions worldwide, ultimately fostering a greener and more sustainable future.

From a practical poing of view, this paper highlights the renewable energy projects undertaken in the region of Saarland, Germany, with a specific focus on wind and solar photovoltaic (PV) installations. It provides an overview of the development and implementation of these projects, showcasing their contribution to the German renewable energy efforts and measures. The region of Saarland has witnessed a significant growth in renewable energy projects, particularly in the wind and solar PV parts. The local‘s favorable geographical conditions, government support, and the expertise of project developers have played crucial roles in promoting the adoption of these technologies. Additionally, such projects have played a vital role in reducing greenhouse gas emissions and increasing the share of renewable energy in the overall energy mix.

The case studies of wind and solar PV projects in Saarland serve as valuable examples of successful renewable energy implementations. They offer insights into the technical, economic, and environmental aspects of these projects, demonstrating the feasibility and benefits of renewable energy technologies. The experiences gained from these projects can provide valuable guidance and inspiration for future renewable energy initiatives worldwide, fostering the transition towards a sustainable and clean energy future.

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