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CEEJME
Central and Eastern European Journal of Management and Economics

ISSN electronic version 2353 - 9119
Central Eastern European Journal of Management and Economics
Vol. 2, No. 2, 93-119, June 2014

Towards a European competence region for renewable energy? Findings from the Danish-German border region

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Abstract: In view of the increasing relevance of renewable energy, Danish and German university partners of the European Future Renewable Energy (FURGY) project developed and conducted a qualitative and a quantitative regional foresight ("Delphi") study which primarily provided the data for this article. Based on the main findings of this regional foresight study and additional data, we present and discuss in this article four different scenarios for the development of the renewable energy sector in the FURGY region until 2030. These scenarios describe four cases: (i) "modest improvement as "most probable future", (ii) "worst case", (iii) "predominantly negative case", and (iv) "best case". We conclude our article with concrete police recommendations which can help regional, national and European policy makers to initiate a transition process from "modest improvement" to "radical improvement" of the conditions for the renewable energy sector in Europe, its member states and regions.

Keywords: renewable energy, sustainability, cross-border cooperation, transition, foresight scenarios
JEL: F50, Q01, Q20, Q47

1. Introduction

1.1 Aim and focus

The Horizon 2020 EU Framework Programme for Research and Innovation focuses on numerous relevant challenges for future well-being of economy and society. Among these

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challenges, energy issues comprise an explicit aspect of societal challenges (European Commission, 2014b: Horizon 2020). To achieve its ambitious climate goals until 2030, the European Union aims to significantly increase the renewable energy share of the total energy production of its member states within the next few years (e.g. European Commission, 2013; 2014a). This strategic objective for the renewable energy sector has heavily influenced the agenda of the European Regional Development Fund in the last years. The Danish/German INTERREG 4A project Future Renewable Energy (FURGY; runtime: 2009-2012) was part of this recent European agenda for environmental as well as economic regional development in Scandinavia and Germany.

The European FURGY project has established a cross-border business and scientific network in the neighbouring regions of Southern Denmark (most southern Danish region) and Schleswig-Holstein (most Northern German state) for the whole sector of renewable energy. This network promotes the development of a European competence region for renewable energy. The University of Southern Denmark and Flensburg University jointly developed four scenarios, which are presented in this article.

The aim of this article is to illustrate the target groups of the FURGY project different scenarios dealing with the opportunities, potentials and challenges for the development of a competence region for renewable energy in Southern Denmark and Schleswig-Holstein. The scenarios are applied in this article to derive specific policy and managerial recommendations. These scenarios focus on renewable electricity, although some heat and energy efficiency topics have been considered as well.

1.2 Target groups

The different target groups of the FURGY project comprise both private and public sector actors:

- Company managers and experts in the whole sector of renewable energy.
- Policy makers on the regional, national and European level.
- Experts from academia, public administration, trade associations, unions and NGOs.
- Experts from different kinds of media.
- Citizens in general.

1.3 Methodology

The scenario development is the result of several subsequent research steps, which combined different qualitative and quantitative interviews, survey and foresight techniques (e.g., Jörß and Wehnert, 2006). As a first step, we identified companies, research institutions and other relevant organisations in the whole sector of renewable energy in Southern Denmark and Schleswig-Holstein and collected them in a database. On applying different methods of qualitative and quantitative research, we could derive economic and technological potentials and challenges for further development of the regional renewable energy sector. This first exploratory phase, which provided the base for the second phase of more in-depth analyses, was labeled "status quo analysis". To be more specific, we applied the following methods in this first project phase:

Status quo analysis:

- Desk research and development of an industry atlas.
- Semi-structured expert interviews.
- Technology screening.
- Cross-sectional company survey.
- Workshops with experts from the different target groups.

In the second project phase ("foresight analysis"), the identified economic and technological potentials as well as challenges were investigated through a combined Delphi study and scenario building methodology. Based on the findings of our status quo analysis, this phase featured the following methods:

Foresight analysis:

- Delphi study (first and second round).
- Scenario building.
- Workshops with experts from the different target groups (companies and business associations, academia, municipalities and other public organisations as e.g. ministries).

The database, which was used to identify the target groups for the expert interviews, the company and municipality survey, and the Delphi study, can be regarded as a visual map. It is accessible via the FURGY homepage (www.furgy.eu).

1.4 Structure of the article

Following these introductory explanations, this article is structured as follows. We briefly describe the cross-border region Southern Denmark/Schleswig-Holstein as starting point for both the status quo and foresight analysis. Section 3 illustrates of the findings of the latter. Section 4 presents the four FURGY scenarios. The article concludes with our specific policy recommendations (section 5) and an overall summary in section 6.

2. Starting point: Current status of the FURGY region

As a descriptive basis for the status quo and foresight analyses, *Table 1* gives a brief overview of basic statistical data of Schleswig-Holstein and Southern Denmark at the time of the project start in 2011.

Table 1. Basic statistical data of Southern Denmark and Schleswig-Holstein

	Southern Denmark	**Schleswig-Holstein**
Area	12,191 km²	15,799 km²
Inhabitants	1.195 Mio.	2.83 Mio.
Inhabitants per km²	98.02	179.13
Municipalities	22	167
Largest city	Odense (187,000 inh.)	Kiel (237,000 inh.) *Capital city*
Governmental Status	Administrative region with political representation (main responsibility: health care)	German state with state parliament
Renewable energy support regimes	Mainly net-metering and premium tariffs	Mainly feed-in tariffs for electricity (EEG, German law regarding renewable energy)

Source: Statistische Ämter des Bundes und der Länder, 2011; EUROSTAT, 2011.

This overview shows that the cross-border partner regions Schleswig-Holstein (as an important region of Northern Germany) and Southern Denmark differ considerably in their political, administrative and population structure, although they are of relatively similar size.

First, the absolute population number and the population density of Schleswig-Holstein are much higher compared to Southern Denmark. Second, the number of municipalities, which are import actors in the renewable energy sector of the cross-border region, is more than eight times higher in Schleswig-Holstein than in Southern Denmark. However, many of the municipalities in Schleswig-Holstein are rather small in terms of population and overall budget. Third, Schleswig-Holstein as a federal German state with an own state parliament has a different political status than Southern Denmark as Danish administrative regions merely responsibility for health care issues. Schleswig-Holstein can pass state laws with relevance for renewable energy (e.g. regulation for wind parks), which is not possible for Danish regions. Furthermore, Schleswig-Holstein can launch initiatives in the upper house of the German parliament ("Bundesrat"), which represents all German states ("Bundesländer") and can have an impact on national German legislation.

Apart from the summarised differences in size and governmental status, both regions are affected considerably by national and EU legislation in the whole area of renewable energy. Particularly feed-in tariffs for wind, solar and bio energy, tax regulation, public subsidies, and technical regulation are mainly or completely decided on national respectively EU level. Furthermore, there are considerable differences in the way renewable energy sources are supported. Denmark promotes renewable energy through a premium tariff and net-metering. In Germany electricity from different renewable energy sources is mainly supported through a consistent feed-in tariff system. The renewable energy sectors developed quite different due to differently funding regimes. (e.g., Agentur für Erneuerbare Energien, 2012; IHK Schleswig-Holstein, 2012).

Particularly for Southern Denmark, but partly as well for Schleswig-Holstein, the administrative borders of the FURGY region are not aligned with economic boundaries in the perspective of regional companies. As we learnt from the expert interviews conducted at the beginning of the project, many German firms regard Denmark as one current or future market, while Danish companies rather differentiate, e.g. between Northern, Southern and Eastern German markets. Large firms, both in Denmark and in Germany, sometimes differentiate solely between Central, Northern (Scandinavian) and Southern European markets. In the last case, the FURGY region could represent a Danish-German "transition" region between Northern and Central Europe. Such differences between administrative borders and economic boundaries will

be considered in this report as far as possible. In particular for the Southern Danish side, we will often refer also to the Danish framework on the national level and not solely to Southern Denmark as administrative region (see e.g. as well IHK Schleswig-Holstein, 2012).

Southern Denmark and Schleswig-Holstein both represent leading European regions concerning wind energy production. As well within other subsectors of renewable energy (PV (photo voltaic) and bio energy), several activities are existent. The production of renewable energy within the region has increased considerably in the last years. Meanwhile the electricity production from renewable energy sources reaches 49% in Schleswig-Holstein and 40% in Southern Denmark (energymap.info, 2012; Danish Energy Agency, 2010; 2012).

Figure 1 illustrates the development of the main renewable energy sources within the electricity sector of Schleswig-Holstein. Particularly wind power has increased in the last decades. Furthermore, bio energy and solar power were increasing in the last years significantly. Further applications, such as hydro power, are limited due to a lack of resources.

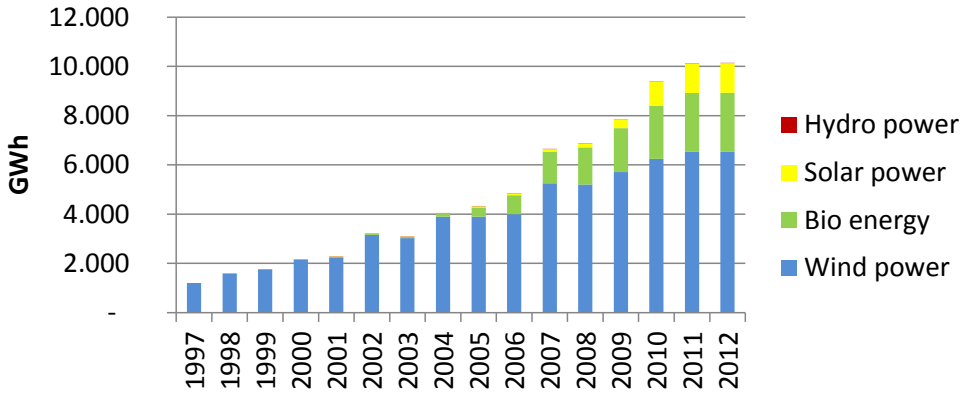

Figure 1. Development of renewable energy production in Schleswig-Holstein

Data for 2012 represents preliminary values according to actual registered capacities till May 2012.
Source: own figure, based on energymap.info 2012

Figure 2 shows the estimated development in Southern Denmark. Particularly wind energy and bio energy have been increasing within the last years, beside of that solar energy is practically not existent.

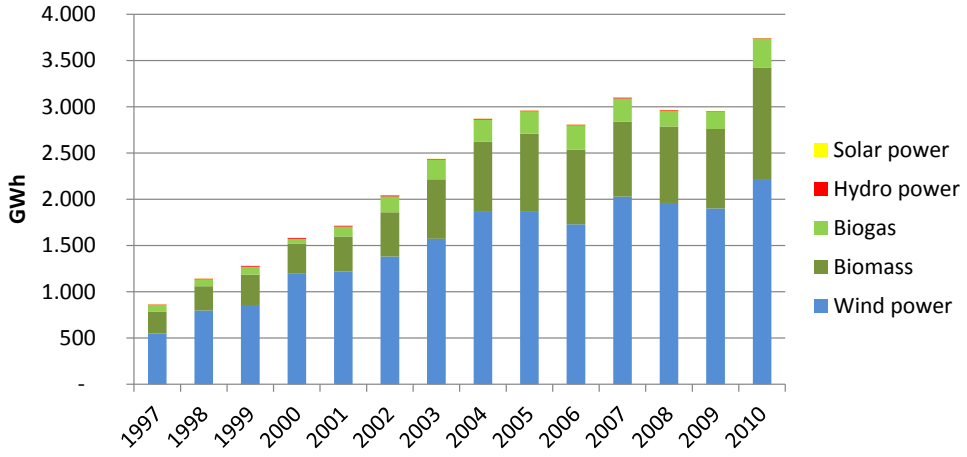

Figure 2. Development of renewable energy production in Southern Denmark

Source: Own estimation based on Danish Energy Agency, 2010

Being the most important step of estimating the current technological competency of the FURGY region in the whole area of renewable energy, the content of the FURGY Company Database is formally described in this section. All in all, the FURGY database contained 690 companies (mainly) and a few other organisations (educational institutions, public-private networks) in October 2012 (Table 3).

Table 2. Content of the FURGY Database

	Southern Denmark	**Schleswig-Holstein**	**In total**
Wind energy	185	106	291
Solar energy	36	80	116
Bio energy	58	89	147
Geothermal energy	4	43	47
Energy efficiency	70	19	89
All segments	353	337	***690***

Source: FURGY Database content, partly based on membership information from relevant business associations
See as well www.furgy.com

The renewable energy sector companies in Southern Denmark mainly represent wind and bio energy, and energy efficiency companies. In Schleswig-Holstein, wind energy is as well the largest renewable energy sector segment, covered by the FURGY database, followed by bio energy and solar energy. While the wind energy segment in the FURGY region also comprises a small number of large firms, are the bio and solar energy, and energy efficiency segments clearly

dominated by SMEs. The solar energy segment is still small in Southern Denmark, compared to Schleswig-Holstein.

On the one hand, the regions Southern Denmark and Schleswig-Holstein as one "cross-border region" share several specific challenges, potentials and innovation options. On the other hand, looking on the FURGY "region", it becomes obvious that we are talking about two renewable energy regions, which are embedded in two energy systems and which currently face differing challenges, opportunities and trends when it comes to the legal, political, technological and economic details. Nevertheless, Southern Denmark and Schleswig-Holstein share several specific challenges. Some of the interviewees perceive the FURGY region merely as a peripheral EU area of minor relevance. Both Southern Denmark and Schleswig-Holstein are located at the border of their respective national state and therefore receive mainly limited political attention by their national governments in Copenhagen and Berlin. Most important for the companies and cooperating further actors in the FURGY region, the public subsidies and other incentives for supporting the development of the renewable energy sector differ considerably between Southern Denmark and Schleswig-Holstein.

Unlike Germany, in Denmark, and hence as well in the region of Southern Denmark, there exists no overall, "holistic" feed in tariff and support system for companies and private households, which produce electricity and/or heat from renewable energy resources. The government treats the different groups of producers (private firms, private households, public and private utility companies etc.) and different segments of renewable energy (especially wind, bio and solar energy) very differently in terms of feed in tariffs, tax conditions and reductions and direct public subsidies (e.g. for R&D projects or test and demonstration plants; The Danish Government, 2011). Despite the electricity sector focused on in this report, the development of the heat sector had more priorities in Denmark compared to Germany. In this field, there exist numerous learning options for Schleswig-Holstein (e.g. district heating activities; Holm, 2012).

In Schleswig-Holstein, the German wide renewable energy feed in tariff system is a direct support for electricity production from renewable energy sources and feeding renewable energy in the public energy grid. Under this general framework, different technologies get different incentives according to their cost development. Behind this German strategy, a broad range of renewable energy technologies are boosted, not only already economical ones. Therefore different technologies develop and follow their learning curves (e.g. the cost reductions in the

field of photovoltaic). Particularly for the German heat sector there are specific market incentive programs and credits with relatively low interest rates (by the public "KfW" development banking group / "Kreditanstalt für Wiederaufbau") to change from an old heating system to a more efficient or renewable ones and to increase energy efficient modernisations.

3. Basic issues of the Delphi study

The overall technological, political and economical framework for energy system transformation and the facts about the FURGY region the Delphi study focused on three areas:

- *political*, *economic*, and *technological framework conditions*,
- regional conditions for *research and development* in the field of renewable energy for universities, research institutions and companies,
- conditions for *cross-border cooperation* between Southern Denmark and Schleswig-Holstein.

While the conditions under the first bullet point can merely partly – and often only indirectly – be influenced by the actors in the regional energy sector, the regional actors have considerably more influence on the conditions under the second and third bullet point. Related to the three focal areas of the Delphi study, which were defined based on the findings of the company and municipality survey, qualitative expert interviews and desk research, the following research questions guided the development of the Delphi questions:

- Which technological and economic potentials can be developed by regional companies (existing firms, start-ups, firms outside the region) in the different sub segments of renewable energy in the next three decades?
- Which technological, political and administrative framework conditions can support the successful exploitation of these potentials?
- Which scientific and technological potentials can be developed by regional universities and public research institutes (including universities of applied sciences, non-university research institutions) in the different sub-segments of renewable energy in the next three decades? Which technological, political and administrative framework conditions can support the successful exploitation of these potentials?

- In which ways can cross-border cooperation between Southern Denmark and Schleswig-Holstein support the exploitation of scientific, technological and economic potentials by regional companies, universities and research institutes?

These research questions focus on a period of three decades (featuring 2020, 2030 and 2040 as future milestones). Additionally to these questions, the Delphi study considered a number of specific short-term suggestions and recommendations for policy makers in Southern Denmark and Schleswig-Holstein with experts from the private and public sector. These suggestions and recommendations had been expressed in the company and municipality survey as well as in the expert interviews:

- Simplification of planning and building permissions for new plants in the whole area of renewable energy.
- Intensified and systematic support for interested companies in finding adequate locations (advice regarding construction permission, grid access, financing models, specific subsidies).
- Additional commercial/industrial real estates, which are specifically tailored for needs of companies in the different segments of renewable energy.
- Enforced development of unused areas (e.g. former military or industrial areas) for renewable energy process.
- Check of the possibility of specific business/start up parks or centers for entrepreneurs in the renewable energy sector.
- Intensified allocation of test locations for prototypes.
- Start-up financing for the development of new education and training programs (e.g. onshore/offshore wind energy engineering programs, offshore security training, courses for small, handicraft-like companies).
- Simplification of the identification and designation of new locations for wind energy production for speeding up the extension of onshore wind energy parks.
- Check of the possibility of citizens' wind parks for new onshore wind parks.
- Construction and further development of adequate harbor infrastructure as support for building, maintaining and service of offshore wind parks as public-private partnerships.
- Simplification of the regulations for feed in of bio gas in the (public) gas grid.

The combination of short-, medium- and long-term directed questions in the Delphi study provided the basis for the formulation of scenarios and a roadmap for the FURGY region, which cover the entire period from the year 2013 to 2040. The results of the Delphi foresight study are summarised and discussed in chapter 4. Based on this summary the next chapter also presents four scenarios for the future development of the renewable energy sector in the FURGY region.

4. The four scenarios derived from the Delphi study

Four different scenarios have been developed. The first one is about the expected developments by the regional renewable energy experts, the "probable Future". This scenario is based on the results of the Delphi study. The likelihood of occurrence as seen by the participating experts is shown in Figure 4.

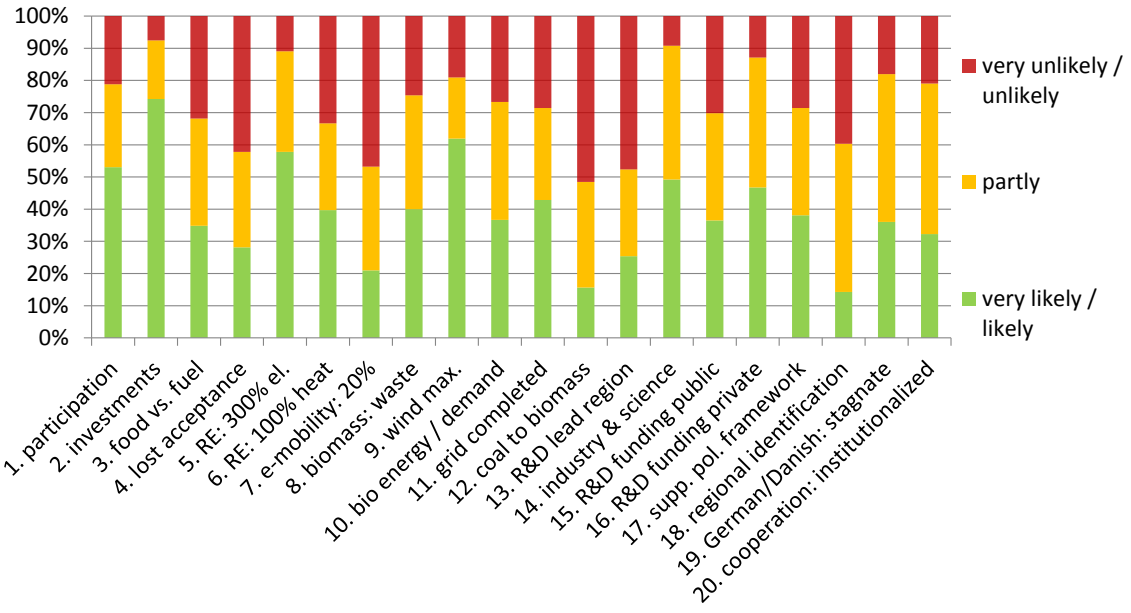

Figure 4. Likelihood of occurrence of stated developments by energy experts in Southern Denmark and Schleswig-Holstein
N=66.
Source: own figure based on Delphi data

For a clear description of the expected scenario, the most probable future, the Delphi-statements are evaluated and aggregated into different categories. The estimated likelihood of

occurrence by the regional renewable energy experts is the base of the scenario. Each positive development is ranked, based on the rated likeliness of occurrence (*Table 4*). The percentage of people who estimate the positive development as very likely or likely is multiplied with 100%. All estimates, who argue that the development is partly likely, are multiplied by 50%. All answers, who estimate that the positive interpretation of the development is unlikely or very unlikely, are multiplied by 0%. The arithmetical average of all rated answers sets the final ranking, ranging from +++ (very likely) to - - - (very unlikely). Further aspects are interpreted based on main survey results.

Table 3. Evaluation of Delphi-Survey

Ranking	Interpretation	Arithmetical average
+++	Very likely	>= 75%
++	Likely	>= 65%
+	Slightly likely	>= 55%
"+" / "-"	Partly likely	<= 54%
-	Slightly unlikely	<= 49%
--	Unlikely	<= 39%
---	Very unlikely	<= 29%

Source: Authors' own elaboration

Additional information is interpreted due do relating events expected by expert interviews and Delphi data. Furthermore a "worse-case-scenario", a scenario with "limited progress" and a "best-case-scenario" have been developed.

4.1 Scenario 1: "Modest improvement"

In general, the national volume of investments in the field of renewable energy in Germany and Denmark will further increase in the future (2) and the renewable energy sector therefore will become more and more important within the next decades. This development has already occurred and is further going on. 74% of the asked experts regard this development as most likely or likely. This development is also seen as the most important development for the region by the regional renewable energy experts (75%) think, that this development is most important).

Despite of that public funding for researching renewable energies will only partly increase in the region compared to 2012 (15). Private funding for research and development of renewable energies will increase compared to 2012 instead (16). A national leadership in research and development (R&D) of renewable energy technologies is generally not expected by the experts (13). This statement is especially critically reflected by renewable energy experts in Schleswig-Holstein.

The further application of renewable energy production plants is quite successful. The maximum of possible onshore-wind energy production plants will be installed in the region between 2020 and 2030 (9) (62 %) and renewable electricity production will be further increased and reach 300 % of the regions calculative electricity demand (5) (58 %). It is expected, that the goal of reaching 300% of the regions electricity supply will be reached in Schleswig-Holstein at least till 2020 (62% agree to this statement), in Southern Denmark till 2030 (67%). The majority of experts in both regions state that reaching 100% renewable heat takes more time and will be finished mainly till 2030 (59% in SH; 61% in SD).

Direct public participation (e.g. financial) in renewable energy projects is still used and will be a standard in energy projects (1) (53 %). This helps to keep acceptance so the construction of new sites to produce renewable energy will be further accepted by the population (only 28% of the expert's state that the acceptance will likely or most likely be lost). But, especially in Southern Denmark the topic of missing acceptance gets important till 2030 or earlier.

The grid-extension is of special concern in Schleswig-Holstein (11). The majority of renewable energy experts in SH state, that the grid will mainly be finished till 2030 or earlier (68%). The majority in Southern Denmark state that this development takes place in 2040 or earlier (65%).

44% of the experts in Schleswig-Holstein agree with the statement, that it is likely or very likely that biomass plants will regulate their production in order to fulfill the demand requirements. The majority state, that this development could occur till 2040 or earlier. In contrast, the majority in Southern Denmark sees this development in general as more unlikely.
Despite of that, most of the experts in Southern Denmark state that energy production from biomass sources will be concentrated on waste materials (63% of the experts in Southern Denmark state that this development is very likely or likely). Only 40% of the experts in Schleswig-Holstein agree to this statement. Also, the Danish experts rate this development more

early as in Schleswig-Holstein (64% of the experts in Southern Denmark rate that this development will come till 2020 or earlier). The majority of the experts in Schleswig-Holstein estimate, that the development will come in 2030 or earlier.

Cooperation between regional scientific institutions and companies in the field of renewable energies will be intensified compared to 2012 (14). Increasing amount of cars will be fuelled with bio methane produced in regional biogas plants. In the year 2020 gasoline stations of biogas will be technological competitive. Also biomass as base for liquid technologies" (Btl) will be established at least in the mid-term (2020).

The cross-border framework conditions stay more or less at the level of 2012: Regional companies of the renewable energy sector will not identify themselves with a common German-Danish cross-border region (18); the time of occurrence is therefore not viewable. Cross-border-cooperation projects will partly stagnate (19). It is also expected that cross-border-cooperation in the field of renewable energies will only partly be institutionalized (German-Danish competence centers) (20).

The development of cross-border-cooperation is seen as a long-term task in both regions. Danish renewable energy experts see the developments of cross-cross-border topics only slightly more optimistic than the experts in Schleswig-Holstein. The substitution of coal by wood in conventional existing coal-fired-power plants will not be finished in the region in the next decades (12), 53% of the regional renewable energy experts state a complete substitution is unlikely or very unlikely. Also electric mobility lacks further development: it is not foreseeable when the market share of 20 % by electric cars will be reached in the region (7). The experts in Schleswig-Holstein expect that the development of electric mobility is more successful. The majority expects that electric cars will reach a market share of 20%. 30% of the experts in Schleswig-Holstein regard this development as very likely or likely. In contrast, merely 8% of the experts in Southern Denmark state that this development is very likely or likely.

The increase and growth of the renewable energy sector leads to an additional need for qualified workers, especially in the field of technicians, academics and skilled workers. In most of the questioned areas these shortages is already discussed, but demographic changes and increasing demand lead to further shortages in 2020. An exception is the need for unskilled workers, where the growth of renewable energies does not lead to increasing demand.

The challenge of attracting future workforce seems to be more relevant in Schleswig-Holstein than in Southern Denmark. Especially the need of skilled workers is valued differently: 90% of the questioned experts in Schleswig-Holstein agree with the statement, that the growth of the renewable energy branches will lead to additional needs for skilled workers. In Southern Denmark, only 72% agree to this statement.

Also the timeframe is valued quite different. The majority of experts in Schleswig-Holstein state that a shortage of academics, technicians and skilled workforce has already occurred. Beside of that the experts in Southern Denmark state that a shortage of academics, skilled workers and technicians will become relevant in 2020.

The expected development of the renewable energy branches is in this scenario coupled with the economic potential. The majority of the asked experts assume that onshore wind energy and photovoltaic will be at least economical in the year 2020 and will not need further financial incentives then. At latest in that time, the development in DK will lead to further demand and installers in the region will be activated, new actors arise. In the biomass, biogas, biofuel, offshore wind and electric mobility sectors the views are more differentiated. The majority states, that the development will develop till 2030 and that at that time no more incentives are needed. Deep geothermal electricity production is the latest expected economic development, in the year 2040 a cost-competitiveness is expected. The result of the scenario is summarised in Table 4.

Table 4. Summary of scenario "Modest improvement"

Indicator for the Region	Ranking	Criteria used according to Figure 3	Legend
Investments in the region	++	2, 15, 16, 17	+++ = very positive development -/+ = status of 2012 --- = very negative development
Technological competence (R&D)	+	15, 16, 17, 13, 14	
Application of RE	++	5,6,9	
Acceptance kept	+	1, 3,4	
System coordination (grid & storage)	+	11,1	
Cross-border-activities	-/+	18, 19, 20	

Source: Authors' own elaboration

4.2 Scenario 2: "Worst case" (stagnation)

Based on the findings of a Delphi/foresight study with two rounds in 2011 and 2012, "stagnation" of the renewable energy sector in Southern Denmark and Schleswig-Holstein is the

adequate label of the identified "worst case scenario" for the FURGY region. "Stagnation" would imply the following developments between 2013 and 2040 (latest point of time considered by the questioned expert): The upward trend of the last years in terms of (i) number of companies and employees, (ii) number of plants, (iii) (newly) installed capacity for renewable energy production, (iv) number and volume of research projects and education/training programs, and intensity of cross-border cooperation projects severely slows down or even stops between 2017-2020 after a few more years of further extension.

Legal, political and economic incentives (e.g. feed in tariffs, subsidies etc.) for companies, municipalities, universities and private households to invest in renewable energy activities (installation of production capacity, R&D, test and demonstration, public information, education/training) are reduced drastically due to limited financial resources.

Planning reliability for renewable energy companies in the region turn out to be a short period. A starting point for increased uncertainty is a public financial crisis of budgets in Schleswig-Holstein and Southern Denmark. After ongoing discussions about energy prices again an "Exit, of the exit, of the exit" of the decision to shut down nuclear power plants in Germany is decided in 2018. Further discussions about energy prices and ongoing changing political frameworks lead to increasing uncertainty for investors. The ongoing long discussions have led to a considerable reservation of potential investors for the region. This becomes particularly evident with respect to the lack of investments in modern infrastructure (e.g. investments in grid-infrastructure, smart-grid-systems, load shifts).

The political, public and business interest for renewable energy projects and other activities (e.g. participation in networks, reports of mass and profession media, public dialogue etc.) declines drastically. The increasing cultivation of plants for energy purposes lead to increasing competition with food production. Increasing worldwide speculation and increasing demand lead to increasing prices for land and resources.

North Sea offshore projects are not developed sufficiently, logistic problems are not solved. There is a lack of further investments. The costs for offshore wind energy are still higher than those for solar energy and increase the end consumer prices for electricity. Solar energy prices itself remain at the level of 2012 and are not further declining after major solar cell producers had to give up due to increasing competition and resulting advanced cost reductions.

Pilot projects about smart grids, electricity storages and grid extensions are not extended due to missing financial resources. Decreasing fossil gas prices due to developed fracking methods lead to the situation that private initiatives to store electricity in hydrogen are uncompetitive.

The grid-situation is still disastrous. Despite of first successful projects in 2012, it was not possible to transport the increasing electricity production of renewable energy out of the region. Due to grid shortages, shut-downs of wind energy and solar plants have become routine. Public acceptance in the FURGY region for further renewable energy plants is declining. Negative examples of big biogas production plants and wind energy projects without public participation and excessive corn productions have led to a reduced public acceptance, beside some regions where an early, transparent implementation of citizens was standardised. This missing acceptance makes further projects in the field of renewable energies unlikely, differentiated discussions between opponents and project developers are an exception. As an indicator in 2025 the Northern German action groups like "Gegenwind" ("Opposing Wind") counts more participants than the regional section of the business association for wind energy ("Bundesverband Windenergie").
Remaining political efforts to attract new renewable energy companies to the FURGY region and increase the attractiveness of the region for new actors are not successful. Technologically-oriented companies and scientific personal undertake efforts to exit the region towards competing attractive cluster regions which offer more development possibilities (e.g. offshore specialists go to Bremerhaven). Companies have increasing problems to keep skilled labor and workers in the region.

Due to ongoing missing ability to plan, cross-border cooperation projects are stagnating or decreasing. The main companies are busy at keeping their main business alive; there are not enough resources to take a look on the other side of the border. Scientific actors and network agencies have to concentrate on their main funds and activities and are not able to push further cross-border activities. The estimated developments are summarised in following Table 6.

Table 5. Summary of Worst Case Scenario "Stagnation"

Aggregated Situation	Rating
Technological competence (R&D)	---
Application of RE	+
Investments in RE	-
Grid and storage	---
Acceptance by the population	--
Availlability of employees	---
Cross-border-cooperation	---

Source: Authors' own elaboration

4.3 Predominantly negative scenario: "Limited Progress"

The third scenario for the development of the renewable energy sector in the FURGY region between 2013 and 2040 can be characterized as follows, based on the data from the foresight study. Value creation, (newly) installed capacity for the production of renewable energy, R&D projects, education and training activities, and cross-border cooperation increase considerably less dynamic than in 2009-2012 (run time of the FURGY project). There is still some growth and extension dynamic left, but it is quite limited compared to the development of the last years. The region gets successful in implementing further renewable energy production plants. Wind energy production increases further, when the area extension in Schleswig-Holstein comes finally into place, after a long political discussion between communal, local, and regional politicians, the public and companies.

Public participation projects are limited, due to an uneven distribution of financial resources the creation of further energy projects is financed mainly by big companies. These developments lead to a limited acceptance by the population and in general to a long delay for a realisation of projects. Nevertheless the region stays an energy export oriented country and reaches finally a share of about 150 % renewable energy production compared to its own demand.

The development of companies and technological infrastructure is more negative and decreases. Due to limited public financial resources only private and third-party funded research is kept in the region. The best trained human capital goes to other regions after a successful training is done in the region in the remaining high-schools and advanced universities. After a short period of further installations of biogas-plants, prices rise for resources in 2020. The

problem increases in the long term, when prices for artificial fertilizer rises and prices for food slightly increase. This goes in hand with increasing competition between increasing biogas plants on both sides of the border, when in Denmark further biogas plants are installed and maize exports from Denmark to Germany therefore stops. Many Biogas-plants have to shut down around 2020. Solutions to overcome the shortages of "NAWAROS" come too late for the majority of the actors.

There is limited funding for regional scientific incentives to deal with these tasks and for creating a practical oriented research for finding alternatives. Due to financial restrictions and resulting resource problems also possibilities to raise third-party funds are used insufficiently. Therefore major possibilities and EU-funds are taken by competing actors in other regions. Actors are working to full capacity to get third-party funds and organise finance to overcome the time between funded projects. Working long-term oriented on the main subjects gets not the rule but the exception, no continuity is achieved.

The competition for funds between border regions will not lead to expected further cooperation. Instead each region is concerned about their own economic situation. Synergy-effects are therefore mainly not used. Also destructive crossover competences are not overcome in the region and are defended by the institutions. Legal, political and economic incentives for the different actors in the regional renewable energy sector are partly reduced and partly frozen at the current state. Ongoing business and university activities will be consolidated and slightly extended, but the resulting effects for value creation, employment and further development of education and training programs in the region are rather incremental.

New large scale business, municipality or university renewable energy projects are an exception. This count also for cross-border cooperation projects, which will only be extended and further, developed on a low scale. The financial efforts for companies and project developers to develop and establish new plants for the production of renewable energy will not increase drastically, but the market and competition situation will be distinctly more difficult for the majority of the regional companies compared to 2009-2012. These developments differ considerably between the different segments wind, bio and solar energy. Table 7 comprises the described developments with the different categories.

Table 6. Summary of predominantly negative Scenario: "Limited progress"

Aggregated Situation	Rating
Technological competence (R&D)	---
Application of RE	++
Investments in RE	+
Grid and storage	--
Acceptance by the population	-
Availability of employees	--
Cross-border-cooperation	+/-

Source: Authors' own elaboration

4.4 Best case scenario: "becoming an European competence region for renewable energy"

The fourth and "best case" scenario for the development of the renewable energy sector in the FURGY region can be summarised by the following future trends and changes of actual trends. Value creation, (newly) installed capacity for the production of renewable energy, R&D projects, education and training activities, and cross-border cooperation all prosper and develop very dynamically. There is much more growth and extension dynamic than in the last decade and these developments are also rather unexpected for policy makers and business actors.

Legal, political and economic incentives for the different actors in the regional renewable energy sector are considerably intensified. The grid-infrastructure is developed in a transparent but ambitioned way, options to shift peak load and reduce grid-extensions are well planned and communicated. The lack of investments in this sector is solved till 2015. New large scale business, municipality or university renewable energy projects are quite common. This counts also for cross-border cooperation projects. Political, public and business interest for renewable energy projects and related activities is high and increasing continuously. Private and public investments are considerably higher in the region compared to 2012.

The financial and time effort for companies and project developers to develop and establish new plants for the production of renewable energy are dramatically reduced compared to 2009-2012. Major public and industrial efforts to keep technological competence in the area are taken (e.g., the German island Husum wind energy fair is not moved to another location). Therefore, strong technological competences are kept and continuously further developed in the region.

Agreements and cooperation with bordering regions in Denmark (Mid Jutland) and Germany (e.g. Metropolitan Region Hamburg) lead to constructive inter-regional development. Cross-over competences are limited and cooperation leads to synergy effects instead of a competition for the same funding between actors within the region. The scientific actors are successful in organizing enough third-party funds and also get sufficient regional funds by regional authorities to concentrate on their main business and not on funding bridging between too projects. Offshore harbors are developed sufficiently; therefore the main offshore wind-parks in the region can be supplied by regional actors. The problems of uncoordinated logistics are reduced which lead to reduced costs.

The region positions itself as an attractive, active region also for workers and scientific employees. Shortages of infrastructure due to financial limitations by the authorities are overcome. As an example, the conversion of the "Innovationsstiftung Schleswig-Holstein into the EKSH (Gesellschaft für Energie und Klimaschutz Schleswig-Holstein GmbH)" will be evaluated and the reduced public budget by government of Schleswig-Holstein, which was decided during the conversion process, is reversed. Other well financed lighthouse projects are developed to flank cross-border activities.

Table 7. Summary of Best Case Scenario:
"Becoming an European Competence Region for renewable energy"

Aggregated Situation	Rating
Technological competence (R&D)	++
Application of RE	+++
Investments in RE	++
Grid and storage	+
Acceptance by the population	+++
Availlability of employees	-
Cross-border-cooperation	++

Source: Authors' own elaboration

The "breakthrough" towards a "European competence region for renewable energy" will become more and more visible after 2020 and will be completely reached between 2030 and 2040. Despite of the grid and storage development the breakthrough towards a European competence region leads to additional required employees. Therefore a success in the other segments leads to further challenges in the grid and storage development and also in attracting enough workforces. Table 8 illustrates this last and best case scenario.

5. General policy recommendations

Planning reliability for the actors has to be achieved. A clear vision and decision has to be developed, agreed upon and transparently be communicated around the actors. The question, if the goal is to turn Southern Denmark and Schleswig-Holstein into "technology leading cluster regions" or to a region with a successful implementation of renewable energies but without keeping the technological competence in the region, has to be answered politically. The future role could also be an agricultural, touristic and renewable electricity producing region with stemming some remaining gaps of the technological value chain. Financial limitations to keep and attract technological competence in the region could hinder further developments. In this case internationally leading cluster self-perceptions or promotions, especially on a cross-border-level, are then out of place.

Politically stable frameworks and the ability to plan are essential for companies to invest in renewable energy sources- this major success factor of the German wide renewable energy act (EEG), has to develop on a regional scale. This is not only important for industrial actors. Scientific and institutional actors as well strive for long-term perspectives, so that there is a motivation to establish regional branches of future energy research and bind personal to the region. Additional discussions (e.g. about the adequate time horizon of the system shift) which question the goals of the energy system transformation are therefore counterproductive. Scientific research actors depend also more and more on cooperation with companies. Unstable frameworks and ongoing discussions therefore are doubly negative. The consulted experts mainly see continuity as a crucial precondition and one major success factor. Institutions and qualified personal must have long-term perspectives if these resources should have an incentive to stay in the region. The competition with other regions for skilled human resources is a concern of many actors in the region. A clear priority setting with the limited resources have to be made. For existing competence networks in the region, the wish is to get some additional surplus to third-party-funds, so the time between two projects can be bridged and acquired personal will not leave before the next project starts. Regional competition between regional scientific institutes and actors still exist and should be overcome, due to the fact that the "real" competition is not situated in Schleswig-Holstein, but in other regions.

The answers of renewable energy experts and the literature review show that the best case developments are not arising independently, but depend on several framework conditions. A supportive policy infrastructure, human resources and capacities have to develop in the region-industrial and scientific know-how should be established in the region. Entrepreneurs and early adopters have to have advantages to take the risk of innovative sustainable actions to turn innovative ideas into reality. Other regions show, that if the regions want to develop towards a competence region for renewable energies, technological-scientific-centers are needed. An "active location policy" is necessary to bind such companies and infrastructures to the region. Due to the fact, that the EU-funding regimes will increase, also active monitoring of such options are needed. This goes in hand with an active location policy for conversion areas and other potential places to settle technological companies and scientific institutes in the field of renewable energies in the region. Examples how institutional frameworks can have positive effects are Fraunhofer Institutes, where a base finance lead to continuity and ability to plan for the actors. Examples show that at places where practical scientific institutes are resident, companies and Start-ups are resulting. The major budget for these institutions is in general covered by the German federal budget and industrial partners, therefore the costs for regional actors are limited. Schleswig-Holstein was only able to establish one Fraunhofer Institute (Fraunhofer Institute of Silizium Technology). Beside of best geographical conditions chances were not used in the past to keep and attract leading wind energy research and industry of the offshore sector in the region. The education and training activities should be intensified and politically boosted. Education and training of engineers and qualified employees is a location factor for already existing and also newly created companies. One best practice example how to become successful under these conditions is the region Bremerhaven. An active, comprehensive party consensus has led to a development towards one of the major offshore cluster in Germany. The whole range of the offshore-wind energy is situated at the region Bremen Nordenham, Bremerhaven and Cuxhaven. Two Fraunhofer Institutes (Fraunhofer IFAM and Fraunhofer IWES) are located in Bremen and Bremerhaven (WFB Wirtschaftsförderung Bremen GmbH, 2012). The port infrastructure, scientific institutes and major producers are situated in this region and overall well connected by network agencies (e.g. the WAB).

For this region, this does not mean imitating established actors, but to assign new areas in which the region has comparative advantages compared to other regions. One possibility here is

still to try to establish logistics of big components of the offshore industry in the region. Especially in areas where long road transport are too expensive or impossible (e.g. offshore cable production), chances are to get these activities to the locations near to the planned offshore wind-parks. Also the implementation of adiabatic compressed air energy storages (CAES) is a chance for the region. The heat of the air compression is stored as well as the electricity in form of compressed air. Therefore in times of excessive wind production the overproduction can be stored. In times, when there is no wind, the compressed air can be converted into electricity again. The heat is used to heat up the turbines. This reduces the required grid extension and could help to store wind electricity before it can be transported. The comparable advantage compared to other regions is the availability of salt-caverns, where the construction of storages is possible and the excessive wind energy production. Another advantage of this technology is the low land consumption because the major installations are situated under the surface in geological formations no great interventions in the ecosystem are expected.

Further installation of renewable energies in Schleswig-Holstein seems to be a manageable and minor problem. The wide competence within the region and long-term experience of installing and applying renewable energy technologies plus the overall positive expectancy of the renewable energy branches show that increasing the amount of renewable energies is in general on the way. It has to be acknowledged that foresights in the past were often too pessimistic concerning the further implementation of renewable energy sources. Realistically, the production of renewable energy was higher than some 100 % compared to the official prognoses (Pieptzyk and Rojas Hilje, 2009). In this context, the enormous increase of capacities in the region Schleswig-Holstein has to be seen, due to long-term reliable framework conditions – the EEG. Also official plans by the ministries (e.g. the planned expansion of wind energy areas in Schleswig-Holstein) show in general that positive developments in the installation processes are planned. Nevertheless there are remaining critics by regional actors (e.g. complex rules for installation of navigation lights, speed, excessive demands of public authorities and a lack of political interest in the past). In Schleswig-Holstein, some rules for headway controls, limit of heights and an insufficient grid planning and increase of wind energy are discussed (Diekmann et al. 2008, p. 35). Between 2008 and 2010, Schleswig-Holstein has also declined in the efforts to use renewable energies compared to other German federal states (Diekmann et al. 2010, p. 131), programmes to promote renewable energies are insufficiently at that time. These points should be

reflected, but it is not expected that these things will hinder the development totally. Actual concerns are about increasing the priority areas for wind power is wanted by the company actors. In the bio energy sector, we need to focus on a diversification of substrates, like using beet instead of only maize. PV-production will further increase, at least when the grid-parity is reached. These developments and resulting effects on the electricity grid have to be monitored and managed. Furthermore, the offshore wind energy producers have to prove that costs will decrease and planned capacity developments are manageable. Public participation and transparent project development is necessary so that the policy of increasing renewable energies and grid expansion will be a policy for the population and also noticed as such.

6. Conclusion

Our article focuses on the discussion and interpretation of different forecast scenarios regarding the development of the renewable energy status in the Danish/German FURGY border region. For this purpose, we prepared a database and conducted a Delphi study which led to four concrete scenarios.

Actually, the FURGY Delphi survey has shown that the cross-border aspect is not the main focus of the regional renewable energy actors in the region currently. Beforehand local duties have to be done within the region. When the other aspects are established, we expect that more and more cross-border-cooperation will start and further push the joint regional development. Networking activities and change of views are reasonable and should haven been started earlier, but up to now a cross-border competence center for renewable energy research, development, and application is a pending task.

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W KIERUNKU EUROPEJSKIEGO REGIONU KOMPETENCJI NA RZECZ ENERGII ODNAWIALNEJ? WNIOSKI Z DUŃSKO-NIEMIECKIEGO REGIONU GRANICZNEGO

Streszczenie:

Mając na względzie rosnące znaczenie energii odnawialnej, duńskie i niemieckie uniwersytety partnerskie uczestniczące w projekcie European Future Renewable Energy (FURGY), opracowały i przeprowadziły ilościowe i jakościowe regionalne badania foresight („Delphi"), z których uzyskano dane wykorzystane w niniejszym artykule. Bazując na głównych wynikach regionalnego badania foresight, a także na dodatkowych danych, zaprezentowano i omówiono cztery różne scenariusze rozwoju energii odnawialnej w regionie FURGY do roku 2030. Scenariusze te dotyczą czterech przypadków: (i) „niewielka poprawa jako „najbardziej prawdopodobna przyszłość" ", (ii) „najgorszy przypadek", (iii) „przeważnie negatywny przypadek", (iv) „najlepszy przypadek". Artylkuł wieńczą konkretne rekomendacje dla polityki, które mogą wspomóc decydentów na poziomie regionalnym, narodowym i europejskim w podejmowaniu inicjatyw na rzecz procesu transformacji z „niewielkiej poprawy" w kierunku „radykalnej poprawy" warunków dla odnawialnej energii w Europie, państwach członkowskich UE i regionów.

***Słowa kluczowe*:** energia odnawialna, samopodtrzymywalność, współpraca transgraniczna, transformacja, scenariusze foresight
JEL: F50, Q01, Q20, Q47