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A PLANNING PERSPECTIVE

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Region Zealand Energy strategy

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Region Zealand Energy Strategy

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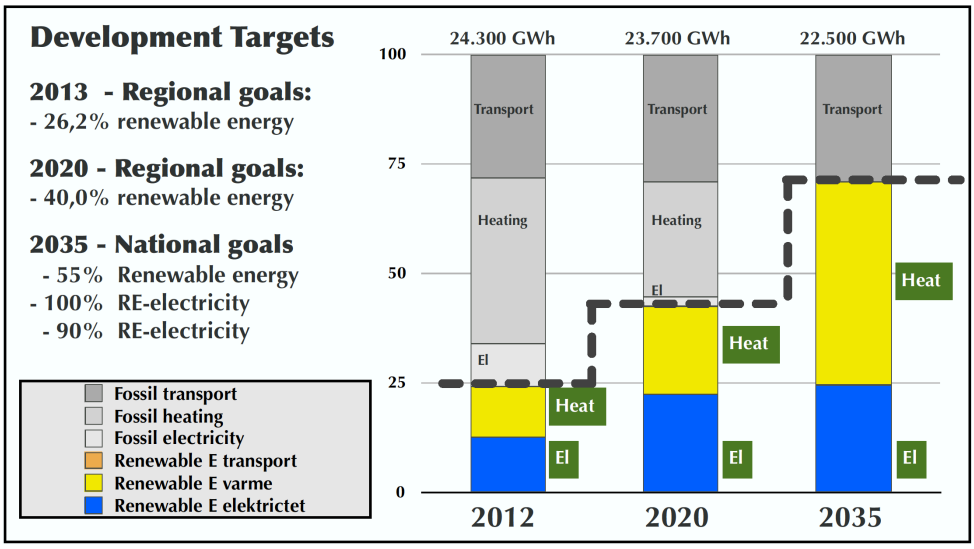
Region Zealand Energy Strategy

1. Introduction to the energy strategy

The purpose here is to outline an energy strategy for Region Zealand, based on the targets for the amount of renewable energy, formulated by the Regional Council. The figure below summarizes the key decisions for renewable energy:

Figure 1: The objective for the development of the renewable energy's share in the energy supply in Region Zealand.



The development target for Region Zealand for the share of renewable energy is set at 40% by year 2020. This target is higher than the national target at 30% in year 2020. The figure shows that it is expected that the goal will only or mainly be achieved within heat and electricity con-sumption and production.

The figure also shows the national targets for 2030, as formulated by the new national energy agreement from 2018.[1] Here, renewable energy is expected to account for 55% of the total energy consumption; The electricity supply must be based on 100% renewable energy and 90% of the district heating must come from renewable energy sources. The target for the electricity company on 100% renewable energy assumption that the use of coal for electricity production will be phased out until 2030.

We must expect that the national target should also fully apply to Region Zealand in 2030. It implies that we can note the following targets for Region Zealand in short and longer term:

[1] Energiaftale af 29. juni 2018 [Danish Parliament's energy agreement for the periode 2020-24].

• ***Short term:*** 40% renewable energy with focus on heat and electricity in year 2020.
• ***Longer term:*** 55% renewable energy with focus on all energy areas in year 2030
• **Long term:** 100% renewable energy in year 2050.

How has the development been so far? The tables below provide an overview of the development in the production and use of renewable energy in Region Zealand:

Table 1: Production and consumption of renewable and fossil energy in Region Zealand in the period 2012-2015.

Region Zealand	Energy **2012**	Energy **2013**	Energy **2014**	Energy **2015**
Numbers in GWh	i GWh	i GWh	i GWh	i GWh
Total consumption				
• Total consumption: el, heat, transport	23.762	22.822	23.394	24.298
• Consumption renewable energy	5.758	5.742	6.363	6.975
Renewable energy consumption:	**24,2%**	**25,2%**	**27,2%**	**28,7%**
Self-sufficiency	**71,0%**	**73,6%**	**70,5%**	**66,3%**
Total production:				
• Production: Fossil energy	11.119	11.061	10.123	9.146
• Production: Renewable energy	5.758	5.742	6.363	6.975
Total production:	16.877	16.803	16.486	16.121
Renewable energy in production:	**34,1%**	**34,2%**	**38,6%**	**43,3%**

Source: See Appendix, Tables 1 and 2.

The table shows two important numbers, namely the share of renewable energy in the consumption and share in the production.

Percentage of consumption: The table shows a producer of ***28.7%.*** Preliminary calculations show that it has increased to approx. 32% in 2017. It is this percentage that, according to the objectives of the Regional Council must be increased to 40% by 2020. There is a need for a considerable acceleration of this development.

Percentage of production: Renewable energy production is increasing and now accounts for 43.3% of energy production. This percentage is rising for two reasons: Firstly, more renewable energy has been produced, although growth is not overwhelming. Secondly, there has been a greater decrease in fossil energy production - in fact, a decrease of almost 18% over the period 2012-2015.

These two trends together cause a fairly increasing percentage of produced renewable energy. It is, however, more a statistical effect than a real effect. The real effect of this development is a declining self-sufficiency, which in the period falls from 71% to just over 66%.

1.1. Main issues for the energy strategy

According to the different objectives, the Danish energy system - and not least the energy system in the region of Zealand - faces major challenges in the coming years. On the mid-term - year 2030 - there are significant restructuring requirements which will only be met with far-reaching changes in the production as well as in the consumption. As shown above in table 1, there is a need to ***accelerate*** the transition to renewable energy if the objectives of regional targets in 2020 and the national goal in 2030 is to be achieved. There is also a need to restructure and increase the production capacity of the renewable energy in the region.

Large ***scale investments*** are needed. There is a need for mobilization of investments and there is a need to create a common implementation effort. The experience clearly shows that the will be very different from municipality to municipality.

The appendix in this report contains an overview of the supply situation in three different municipalities: ***Firstly,*** Køge Municipality, which is very much bound to natural gas, but has considerable wind and biomass resources, which can very much contribute to the local conversion to renewable. ***Secondly,*** Lolland Municipality, which has already changed to a high level of renewable energy with production from wind and biomass, which is almost three times larger than their actual energy consumption. And the ***thirdly***, Roskilde Municipality with high population density and with a small production of renewable energy and a strong limited resource-based to convert to renewable energy (se Appendix, Figure 1-3).

Despite the difference, the common assumption is that the municipalities, their utilities and other energy companies will benefit from mutual resources, investment and the consumption of renewable energy resources. But it is important to recognize the diversity, not least for the sake of creating broad popular support for the implementation of renewable energy.

Acceleration and large-scale investment are important, but more important is the ***involvement*** of the various energy actors and energy stakeholders. It is necessary in the energy strategy to focus on how to involve authorities (the municipality), the utilities, municipal as well as private, and interested citizens in the transition of the regional energy system.

1.2. The elements in the energy strategy

The strategy and its elements must be adapted to the individual municipality according to their resource potentials, the need for technical change and the financial and decision-making resources that are in place in ***each municipality.***

The strategy and its elements must be adapted to the individual municipality according to their resource potential, the need for technical change and the financial and decision-making resources in each of the municipalities.

The regional energy strategy could benefit from the following elements:

(1) The goals and translation of the goals to the sub-goals for each of the municipalities and for the different sectors (agriculture, industry, housing, etc.). It is seen as very crucial that regional targets translated into operational targets for individual municipalities - not as a dictation, but as a result of extensive cooperation between the region and the municipalities.

(2) Underlying objectives and system requirements for the local energy system. What kind of environmental and energy benefits should the converted energy system provides? The triangle.

(3) Planning process and planning conditions. The strategic energy planning and the spatial planning. Business support and innovation support to contribute to the realization of the regional energy strategy.

(4) Collaboration and implementation.

The contents of the four elements of the regional energy strategy shall be described in more detail below.

2. Region Zealand energy strategy

It is often an expectation that there is a close relationship between goals and means; or a close relationship between renewable energy share targets and the available support schemes. This connection is not always present.

Experience has shown that conditions and situations are much more dynamic - soon investments can be made, soon support schemes are not sufficient - As a consequence, it is necessary to be prepared for situations where the conditions are under constant change.

The detailed description of the various elements of the energy strategy is based on the description of the current energy situation in Region Zealand, which is explained in more detail in the appendix to this report.

2.1. The targets and translation of the targets to action

As a result of EU policy, there are three binding targets, which in principle must be included in the formulation of goals and efforts, namely the following triangle: [2]

- ***Greenhouse gases:*** Reduction of greenhouse gas emissions with a reduction of 20% from 1990-2020 and 40% from 1990-2020.
- ***Energy efficiency:*** Efficiency improvements of 20% by 2020 and further efficiency improvements of 27% from 2020-2030.

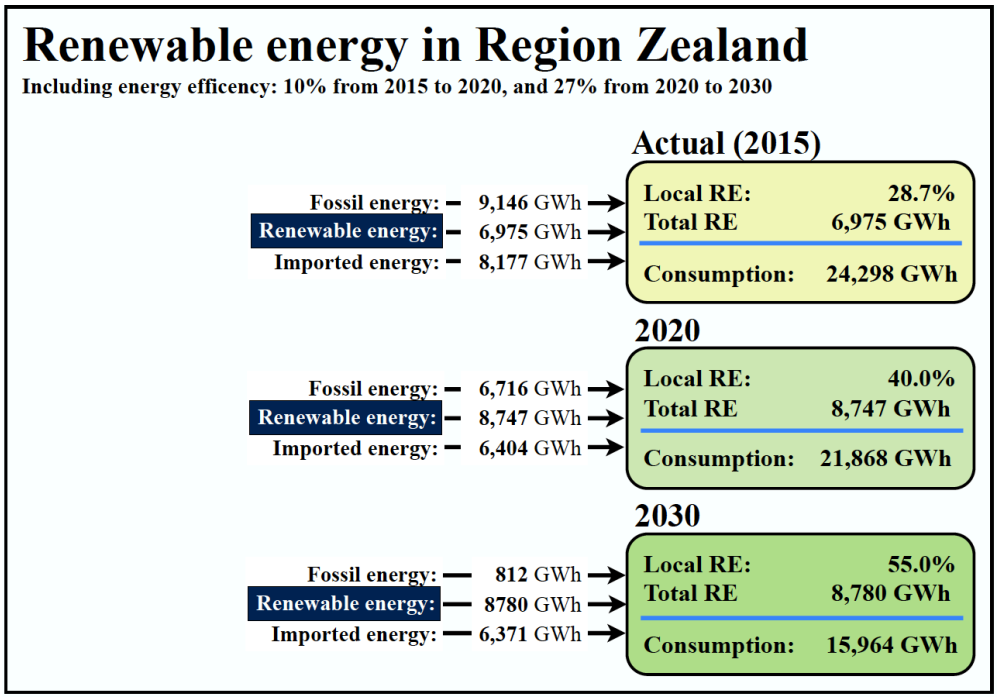
[2] Cf. the respective directives. It is noted that the objective of renewable energy is a collective objective. Each country formulates its own goals in the elaboration of a national energy and climate plan within the generally specified framework; see article 3 in Directive 2018/2001 on the promotion of the use of energy from renewable sources; The European Parliament and The Counsel, 11 December 2018.

- ***Renewable energy:*** Increase by 20% by 2020, and an increase of 32% in the period 2020-2050.

There is an import link between the level of energy efficiency and the target for renewable energy, formulated as a %-target.

Figure 2 below shows how large an increase is needed to meet the 40% renewable energy target in 2020 and 55% renewable energy in 2030. The increase in renewable energy depends on whether energy efficiency is simultaneously implemented. The greater increase in energy efficiency, the smaller the amount of renewable energy is needed to ensure the fulfilments of targets.

Figure 2: Calculation om the amount of renewable energy in year 2020 (40%) and year 2030 (55%), when energy efficiency is increased with 10% from 2015-2020 and with 27% from 2020-2030.



The figure shows the following: If energy efficiency increases by 10% in the period 2015-2020, the goal of 40% could be met by increasing the amount of renewable energy by almost 26% or to 8,747 GWh. Similarly, for the period 2020-2030, the target fulfilment of 55% could be achieved by only increasing the renewable energy to 8,780 GWh.

As a consequence: If energy efficiency is not increased, renewable energy must be increased further to reach the %-targets. For instance, has the amount of renewable energy to be increased 9,719 GWh (or around 92%) in 2020 and to 13,364 GWh (or around 117%) in 2030.

It is an absolute advantage that the EU has set ***binding targets*** for the amount of renewable energy. Previous experience has shown that the so-called indicative, non-binding targets does not lead to expected increase in renewable energy. However, the use

of binding targets requires that these targets can be »translated« into the multi-level governance system going from the EU to the national state to the regions and to the different municipalities.

Target at action level: In order to make the regional targets operational and to work efficiently, the following assumptions are made:

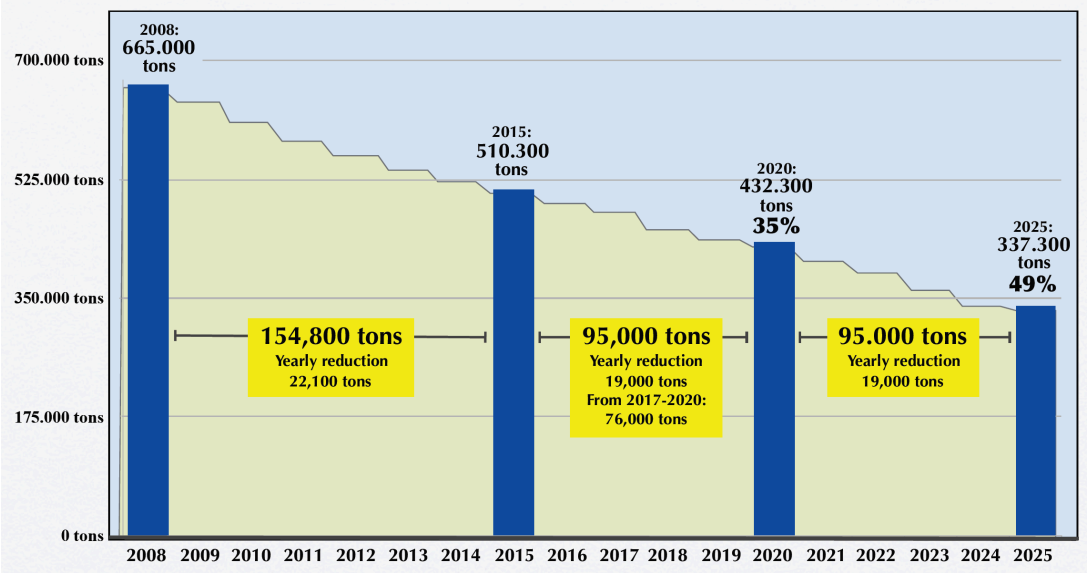
- Region Zealand sets goals that are in line with or better than the national targets: They already set 40% by 2020, and then 55% by 2030.
- The individual municipalities basically assume the same goals. The specific target for each municipality is modified according to possibilities (renewable energy resource and actual framework conditions). If a given municipality has not contributed to a full increase in energy efficiency, the amount of renewable energy being implemented must be increased to achieve the targeted percentages.

The idea is not that the region should dictate renewable energy targets for the individual municipalities. On the other hand, the idea is that the Region should create a binding cooperation on the objectives. Most of the region's municipalities are members of the Covenant of mayors, and it can be an opportunity to set goals together for renewable energy and energy efficiency.

2.2. The underlying objectives - the triangle

The objective can also be formulated based on the third mentioned element - reduction of greenhouse gas emissions. It can be illustrated with the figure below.

Figure 3: Target-setting based on reducing greenhouse gas emissions; example from Roskilde Municipality.



There is a triangle between renewable energy, energy efficiency and the reduction of greenhouse gas emissions. The formulation of the objectives can therefore be based on

a target for reducing greenhouse gas emissions. Roskilde Municipality has formulated a target for a reduction of greenhouse gas emissions of 35% by 2020. Following on from this target, projects and activities have therefore been formulated on energy efficiency and renewable energy investments that ensure the fulfilment of the greenhouse gas target.

If targets are formulated as an increase in renewable energy, it is considered necessary to supplement this target with an assessment of the climate pressure, so as to ensure fulfilment of the target of a reduction of 20% in the period 1990-2020 and 40% in the period 1990- 2030. This necessity arises because it is not necessarily so that an energy efficiency always results in a parallel effect on the reduction of greenhouse gases.

2.3. Planning process and planning conditions. Strategic energy planning, the spatial planning and the local development

In addition to the central issues of binding targets, it is necessary to pay attention to a number of issues that are linked to the regional energy strategy and to the realization of this strategy. The most important issues are:

(1) Support for strategic planning in the municipalities: The transition is so challenging and contains so many uncertainties that it is necessary for each of the municipalities to develop strategic planning.

In light of the regional objectives, it is obvious that Region Zealand supports the development of the local strategic planning. Strategic planning can be implemented in many different ways. An obvious approach would be to apply a principle of ***backcasting.*** The starting point will be the previously mentioned binding targets for the each of the municipalities. On the basis of the municipal targets for instance for 2030 one can use a backcasting method, i.e. return to the present to discover how the specific targets can be met - step by step - during the period 2018-2030.

Experience has shown that the framework conditions are constantly changing for political reasons or for market reasons. This implies that the framework conditions do not always support the various projects at a given time. It is therefore necessary to have several projects ready for implementation. Backcasting methods are used to develop multiple simultaneous project opportunities.

(2) The spatial planning: The regional energy strategy can with advantage be linked to and supported by the municipal spatial planning.

The region has no role in spatial planning in the Danish planning. Spatial planning is only a task for the municipalities. However, the region can support municipal spatial planning in two ways:

Firstly, by contributing with inputs to the municipally planning activities. Prior to the spatial planning, the municipalities must prepare a so-called ***plan strategy,*** which specifies themes and issues as a prerequisite for spatial planning. Energy planning is a very common issue in the plan strategy.

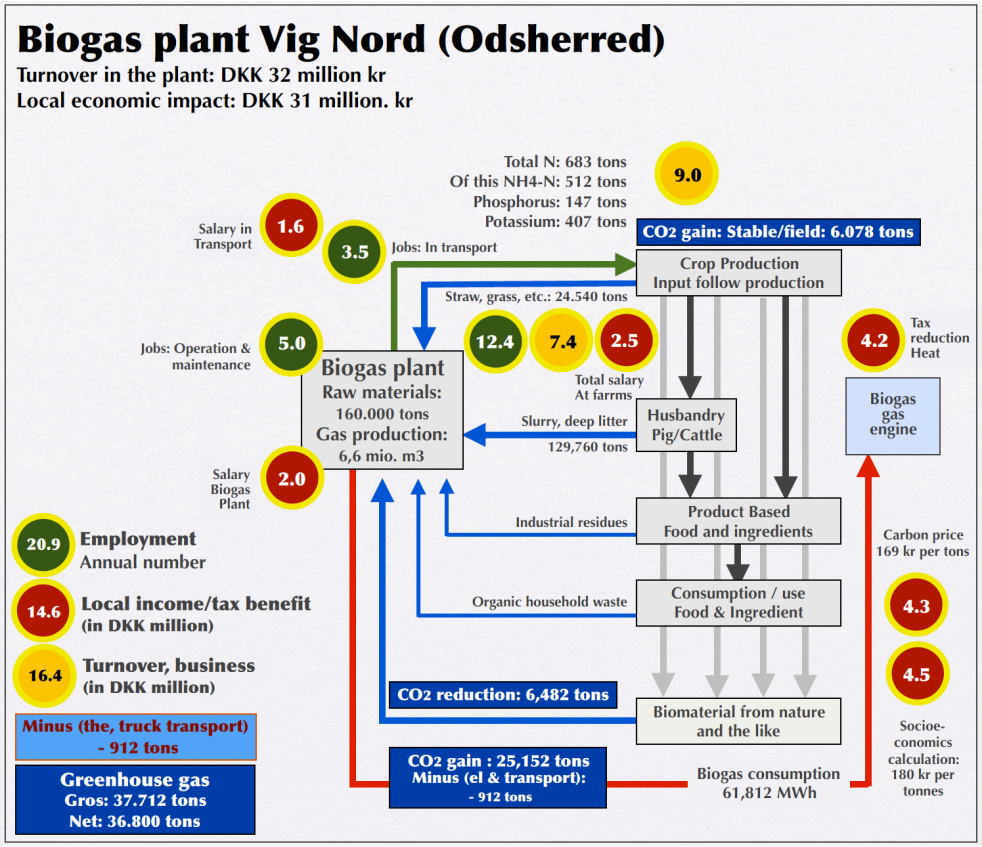
The region can support this process through the region's target setting and thereby contribute to a targeting of spatial planning. Secondly, the region could support the realization of the municipal plans through financial support to the renewable energy projects through the regional business promotion and innovation programs.

(3) The local development: It is important that the concrete projects contribute to the green energy transition with local economic growth and employment.

It is a quality om the implementation of the renewable energy that it largely focuses on local resources and local energy plants. It is important that the regional energy strategy is developed in such a way, so it supports multi-faceted effects, not only an energy supply, but also contributes to local development.

This might be illustrated by the local effects from the case study that has been implemented in the project: [3]

Figure 4: Biogas in Odsherred. The local economic and environmental effects of a renewable energy plant.



The figure illustrates how to achieve a triple effect, namely: Production of renewable energy, recycling of nutrients and reduction of greenhouse gas emissions.

[3] Cf. Odsherred Biogas. Biogas plant at Vig North. Case study in BEA-APP; Roskilde 2018, p. 34.

The local economic impact is also evident as shown in Figure 4. The expected turnover of the biogas plant is DKK 32 million. DKK. The accompanying local economic impact is estimated at 31 million. DKK. Thus, a local economic effect in line with the plant's turnover.

The example points to an issue that is very important for the regional energy strategy. Not only should energy production be optimized, but a comprehensive perspective on the renewable energy plant's multi-faceted benefits should be sought, and search for an overall optimization.

2.4. Collaboration and implementation

There is hardly any doubt that the municipalities are the most suitable institution for implementing the renewable energy projects in the Danish political system. The municipality will have easier access to local involvement and involvement of local actors and local stakeholders. However, Region Zealand has an important role to play by supporting the municipalities implementation efforts. There are two issues in particular:

(1) Investment support: Mobilizing investments and coordinating investments to ensure a building of a coherent energy system in the region.

Investments in renewable energy plants lead to a number of issues, where ***information, coordination and collaboration*** across the municipalities will be very supportive for the development of the coming renewable energy. Particular following should be mentioned: Coordination and use of renewable energy resources (especially biomass), ensuring the expansion of the energy system so that the fluctuating sources (wind and solar) can be exploited on a large scale, and thereby contributing to maximum security of supply.

Furthermore, through mutual information exchange on investments and project economics, contribute to developing cost-effective and coordinated implementation of renewable energy projects in all interested municipalities.

(2) Implementation: Contribute to the exchange of experience among the various energy actors.

The transition to an energy system, based on renewable energy, requires a great deal of effort from a number of stakeholders with new tasks and with the need for new knowledge. It is an independent task to involve all relevant energy actors. The primary actors are the municipalities; however, The Region Zealand could also play an important role by supporting a ***cross-municipal exchange of experience*** between utilities, private energy companies, potential new owners of renewable energy companies, etc.

3. Conclusion:

Target setting: The central element of the regional energy strategy is the objectives. The region has formulated a target for a supply of 40% renewable energy up to the year 2020. It is assumed that the regional target setting will follow the national targets

up to 2030. This means the following targets up to 2030: 55% renewable energy, 100% electricity generation and 90% of district heating on renewable sources. These objectives must be implemented on the basis of three binding target settings, namely the reduction of greenhouse gases, increased energy efficiency and the increase of renewable energy.

Assuming the implementation of the targets for energy efficiency, the regional targets can be formulated as follows: An increase in renewable energy from 6.975 GWh in 2015 to 8.747 GWh in 2020 and to 8.780 GWh in 2030. If energy efficiency (energy savings) is not increased, implementation of 9,719 GWh in 2020 and 13,364 GWh in 2030 will be needed.

Municipal support: Region Zealand sets goals that are in line with or better than the national targets: They already set 40% by 2020, and then 55% by 2030. The Each of the municipalities in the region basically assumes the same goals. The specific target for each municipality is modified according to possibilities (renewable energy resource and actual framework conditions). If a given municipality has not contributed to a full increase in energy efficiency, the amount of renewable energy being implemented must be increased to achieve the targeted percentages.

It is further assessed that Region Zealand can play a positive role in a number of issues: Supporting the strategic planning in the municipalities, supporting spatial planning, ensuring multilateral benefits in the implementation of the renewable energy plants, investment support and support for the implementation processes in the individual municipalities.

4. Appendix:
Region Zealand energy production and supply

The purpose of this appendix is to inform about the current supply situation and supply opportunities for Region Zealand as a background for the formulated strategy.

There are no readily available statistics on energy consumption and production in the region. In order to obtain as secure information as possible, bottom-up statistics have been used, in other words, statistics that can be returned to the specific manufacturer and the specific consumer. This approach also implies that the statistics prepared can also be subdivided into the individual municipalities in the region. However, these figures should not be presented in this context.

The intention is to provide an overall picture of the energy supply and possible development trends. It should be noted, however, that so far it has not been possible to prepare a reliable estimate of the energy consumption for transport. Previous calculations and estimates have been used here.

4.1. Energy consumption and production in Region Zealand

It is important to distinguish between consumption and production, especially because an increasing share of the energy consumed comes from outside as a result of declining electricity production in the region. The main features of the development can be summarized in the following:

- ***Consumption of renewable energy:*** Consumption of renewable energy has increased from 24.2% in 2012 to 28.7% in 2015 (see Table 1 in this appendix). The reason for this development is increased consumption of renewable energy, namely an increase in consumption of 21%, but also a decrease in consumption of fossil energy of just under 4%.

An important result of the development is a declining degree of self-sufficiency. This is not due to a sharp increase in energy consumption. The increase in consumption has been calculated as 2.3% over the period 2012 to 2015. The degree of self-sufficiency has changed as follows:

- ***Self-sufficiency ratio:*** Self-sufficiency was at its highest in 2013 of just under 74% and falling to around 66% in 2015 (see Table 1 in appendix). Although the production of renewable energy has increased, it has not increased to the same extent as fossil energy production has fallen.

4.2. Production statistics

Production statistics show an improvement for all types of renewable energy, which may be illustrated by the following numbers (see also Table 2 in the annex):

- ***Collective supply of renewable energy*** (cogeneration, district heating) and motor installations on biogas - increased by just over 21% from 2012 to 2015.

- ***Individual heat production on renewable energy*** (typically solid fuel, wood chips, etc.) has increased by 17% from 2012 to 2015.
- ***Wind turbine production*** has also increased from 2012 to 2015 with a slightly smaller percentage, namely just under 16%.

There is also no doubt that the production of electricity from solar cells has increased, but there are only figures for the last two years. The overall picture also includes that production of fossil energy has decreased by just over 18% overall.

4.3. The supply situation

Natural gas is the fossil energy source that plays the greatest role in the region's energy supply. The consumption of natural gas was thus 298 million m^3 in 2014, falling to 295 million m^3 in 2015. The figure for 2015 corresponds to 3,244 GWh or to just over 35% of the fossil energy production in the region of 9,146 GWh. The remaining supply is divided into different types of gas oil, coal and the non-organic part of the waste combustion.

For most fossil energy sources, there are alternative supply options via the market. However, this does not apply to natural gas. Here is the current supply opportunity related to the production of natural gas in the North Sea.

The Danish Energy Agency forecasts for the natural gas from the North Sea have for some years been very optimistic. In the past, the Danish Energy Agency assumed that up to and including 2023, both would be self-sufficient in natural gas and would have a net export of natural gas. This perception, however, has radically changed with the latest forecast from the Danish Energy Agency, after which already in 2019, natural gas will be lacking for the Danish supply. See table in Table 3 in the appendix.

The issue - a future shortage of natural gas - is well known and already announced in the Energy Agreement from 2012. Here it is stated, among other things, that »… From 2013, a stop will be introduced for the installation of oil and natural gas fires in new buildings. Exceptions will be possible where there are no suitable alternatives...« The energy agreement's contracting parties have not doubted that the natural gas should be phased out. It is further states in the agreement that »… Before the end of 2013, an analysis will be made of the future use of the gas infrastructure - both during the transition phase with continued use of natural gas and in a future where biogas and other RE gas take over«.[4]

Perhaps highly optimistic forecasts from Danish Energy Agency for the natural gas supply, which were first withdrawn in August 2016, have contributed to the fact that the conversion from natural gas has not been sufficiently on the agenda in the region. Based on Table 3 in this appendix, the following consumption pattern on natural gas can be demonstrated:

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4 Danish parliament's energy agreement for the periode 2012-2020: »Aftale mellem regeringen (Socialdemokraterne, Det Radikale Venstre, Socialistisk Folkeparti) og Venstre, Dansk Folkeparti, Enhedslisten og Det Konservative Folkeparti om den danske energipolitik 2012-2020.« Den 22. marts 2012.

- ***Consumption in Eastern Denmark*** (the whole Zealand, where Region Zealand is only a part): Consumption of natural gas has been reduced by almost 43% throughout Zealand from 2008 to 2015 - see Table 3 in Appendix.
- ***Consumption at production facilities in Region Zealand:*** Here, consumption of natural gas has been reduced by just over 48% from 2008 to 2015. The reason for this is in particular the falling electricity prices, which have made it unprofitable to produce CHP on natural gas to a greater extent on the 45 natural gas fired engine CHP-systems in Region Zealand. Cf. Table 3 in Appendix.
- ***Individual consumption:*** The trend is reversed: Consumption of natural gas for individual heating has increased by just over 5% from 2011 to 2015. This is mainly due to an inappropriate utilization of the energy saving support scheme (gas-burners are more energy efficient than oil-burners). It should be noted that the individual natural gas consumption for heating accounts for almost 77% of natural gas consumption. See also table 3 in appendix

It is obvious that the future supply situation for natural gas does not look particularly bright. This is stated in the Danish Energy Agency's figure in Appendix 3 in the Appendix, where it must also be emphasized that the figure's more long-term supply pattern must be characterized as extremely optimistic.

4.4. The opportunities

What is the basis for a continued transition to renewable energy? On the production side, it is about utilizing the three renewable energy resources: wind, solar and biomass. On the consumer side, it is about reducing consumption through an increase in the efficiency of the various energy services.

Energy savings. The energy saving potentials are - especially in the energy consumption of buildings - very large, but also very expensive for the majority of opportunities. This implies that a significant part of energy savings in buildings must be based in particular on new buildings. The EU-defined savings requirements from 2012 to 2030 correspond to almost 42% savings (20% in the period 2012-2020, and 27% in the period 2020-2030)

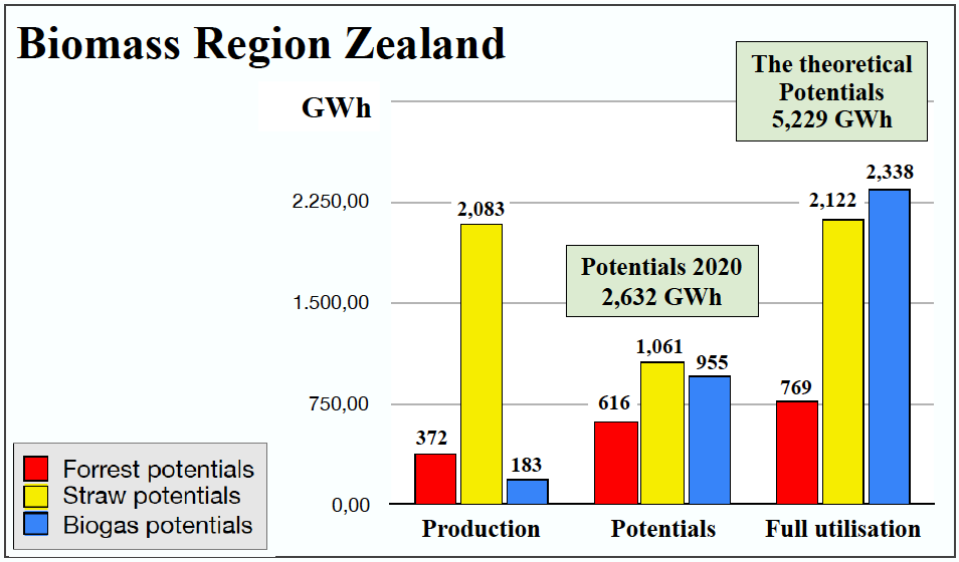
Wind. There is considerable potential for the expansion of wind power, both as land mills and as coastal offshore wind farms. The current capacity of just over 900 MW is expected to increase in the near future with another 600 MW offshore wind turbines (Krigers Flak). Analyses of onshore wind turbine potentials show that there are significant potentials in Region Zealand. The utilization of this potential requires relatively high turbines (100-150 meters total height), which implies a number of spatial planning difficulties for onshore windmills.

It is a common assumption that the wind turbines shall cover up to 70% of the electricity requirement in future. Today, the wind turbines cover approx. 42% of consumption. It is also expected that electricity production and consumption will increase over the next 15 years, especially for transport (electric cars), individual heating, etc.

It is assumed that the electricity consumption in the Region will increase to 8,000-9,000 GWh. A 70% wind turbine supply will correspond to a wind power production of 5,600 to 6,300 GWh, which represents at least a doubling of wind turbine production, distributed on onshore as well as offshore windmills.

Solar. The sunshine hours are limited (1,600-1,800 hours per year). Analyses show that it is economically possible to cover up to 19% of the heat in a district heating system with solar heat. This means that the potential will be in the order of 1,000-1,500 GWh per year. Electricity-producing solar cells also have a potential, but are very much dependent on adequate support schemes.

Biomass. The use of biomass is to a large extent expected to contribute to a circular economy, among other things through recycling of nutrients. This means that the prioritization will point to the fermentation technologies and to a lesser extent to the thermal solutions. Analyses of the biomass potentials show that there will be the following potentials:



The figure shows that the forest, straw and biogas potentials are expected to be 2,600 GWh on short term (some of this potential are already utilized). The full potentials are estimated på be 5,200 GWh (the theoretical potentials).

In summary: The total energy consumption is 24,300 GWh. In round figures, renewable energy covers 7,000 GWh. The rest of 17,300 GWh is covered by fossil energy, either produced in the region or imported from outside. The region thus has a fossil production of 9,100 GWh and an import of 8,200 GWh (primarily fossil fuels).

In the foregoing, it has been estimated that wind, solar and biomass resources could cover up to 9,200-13,000 GWh. It leaves two significant and are very important for the development if the regional energy strategy:

- ***Investment:*** Large investments are needed, as more than 80% of the energy consumption must be produced with new, renewable sources.

- ***Savings:*** There is also a need to develop large-scale energy savings if the restructuring is to follow the political priorities.

The following tables illustrate in more detail the current energy situation. The tables also account for the data sources used.

4.5. Tables and figures in the appendix

Table 1: Energy consumption in Region Zealand
- Share of renewable energy in consumption
- Self-sufficiency

Table 2: Production statistics for Region Zealand
- Total production
- Renewable energy as a percentage

Table 3: Natural gas consumption and production
- Natural gas consumption in Zealand and in the region
- Natural gas production in the North Sea

Table 4: Straw consumption and production in Region Zealand
- Consumption of straw
- Straw production in the Capital Region of Denmark and Region Zealand

In the appendix, an overview of energy plants and production facilities in two municipalities is included to illustrate the large difference in transition challenges from municipality to municipality. One municipality is Køge, which is to a high degree supplied with natural gas; the other municipality is Lolland, where renewable energy in shape of straw already plays an important role in the energy supply.

Figure 1: Køge Municipality
- Significant natural gas provided municipality

Figure 2: Lolland Municipality
- Significant straw provided municipality

Table 1: **Energy consumption in Region Zealand**

The table should give an overview of the total energy consumption in Region Zealand. The consumption is based on gross consumption, ie. the amount of energy used for the production of the various energy products for heating, electricity and transport. Consumption is divided into three main categories:

- **Electricity consumption:** Electricity consumption is calculated by electricity supplied over the network. Thus, the figures do not include share of the net loss over the network.
- **Heat consumption:** Consumption is calculated as the sum of the raw materials used for the production of heat in the individual supply systems, and as the heat production (output) of the collective supply plants (district heating, surplus heat from power stations, engine systems and similar plants.
- **Transport:** Der er ikke nye oplysninger om forbrug af energi til transport. Der er antaget et uændret forbrug over perioden.

Energy consumption in Region Zealand 2012-2015

Numbers inGWh	Consumption **2012** i GWh	Consumption **2013** i GWh	Consumption **2014** i GWh	Consumption **2015** i GWh	
Electricity consumption					
• Electricity, incl. el-heating:	4.878	5.433	6.051	6.740	[1]
Heating consumption					
• Individual / collective heat:	11.999	10.504	10.458	10.673	[2]
Transport					
• Estimated (previous studies):	6.885	6.885	6.885	6.885	[3]
Total consumption					
• Total, el, heat & transport:	23.762	22.822	23.394	24.298	
• Consumption renewable energy:	5.758	5.742	6.363	6.975	
Renewable energy in percent:	**24,2%**	**25,2%**	**27,2%**	**28,7%**	[4]
Regional self-sufficiency					
Production of energy (fossil og VE):	16.877	16.803	16.486	16.121	
Consumpion of energy:	23.762	22.822	23.394	24.298	
Self-sufficiency	**71,0**	**73,6**	**70,5**	**66,3**	[5]

Sources: The figures are based on many different sources, and for that reason there may be inaccuracies in the statistics

[1] Electricity consumption is based on information from the region two utilities - DONG and SEAS; however, the figures for 2014 and 2015 are estimated.

[2] The heat consumption is based partly on the producer count statistics and partly on the individual heat consumption, cf. the notes to Table 2.

[3] The energy consumption for transport is estimated on the basis of previous inventory, cf. the report »Drivhusgasserne i Region Sjælland«, Roskilde Universitet 2011. Transport records include energy consumption for passenger cars, goods and trucks, buses, trains, motorcycles, etc.

[4] It should be noted that the figures have changed slightly for 2012 and 2013 compared to previous numbers. Previously, the share of renewable energy was estimated at 24.2% in 2012. This figure is unchanged. For 2013, the figure was previously estimated at 26.2%. It has now changed to 25.2%. The change is linked to a changed source use in the inventories.

[5] The degree of self-sufficiency is calculated as the ratio of energy produced to consumption. For example, the figure for 2015 says that the region produces 68.2% and 'imports' 31.8% of energy consumption.

Table 2: **Production statistics for Region Zealand**

The table should give an overview of the total energy production in Region Zealand, which includes the following types of productions:

- **Thermal plants and engine systems:** ie. plants based on [1] natural gas, gas oil, coal and waste (except only the non-biological part) and [2] on waste (only biological part), biogas, straw, wood chips, wood pellets and solar heat.
- **Individual heat-producing plants**: ie. plants based on [1] natural gas, oil and similar raw materials, and [2] wood chips, wood pellets, straw and the like.
- **Wind turbines: H**ousehold turbines, onshore and offshore windmills in the region.
- **Solar cells (electricity-producing):** Solar cells that are connected to the grid and thus appear in Energinet.dk's register.

Production in Region Zealand 2012-2015

Numbers in GWh	Production **2012** i GWh	Production **2013** i GWh	Production **2014** i GWh	Production **2015** i GWh
Thermal systems, engine systems, etc.				
• Fossil energy	5.571	5.563	4.712	3.815 [1]
• Renewable energy	2.761	2.865	3.057	3.356 [1]
Thermal facilities in total:	8.332	8.428	7.769	7.171 [1]
Individual plants - heat production:				
• Fossil energy	5.548	5.498	5.411	5.331 [2]
• Renewable energy	635	665	694	743 [2]
Individual plants in total:	6.183	6.163	6.105	6.074 [1]
Windmills:				
• Renewable energy	2.362	2.212	2.474	2.737 [3]
Solar cells (electricity production):				
• Renewable energy	[4]	[4]	137	139 [4]
Total production				
• Fossil energy	11.119	11.061	10.123	9.146
• Renewable energy	5.758	5.742	6.363	6.975
Total production:	16.877	16.803	16.486	16.121
Renewable energy in percent:	**34,1%**	**34,2%**	**38,6%**	**43,3%** [5]

Sources: The figures are based on many different sources, and for that reason there may be inaccuracies in the statistics

[1] Based on the producer counting scheme, see also the tables in »Oversigt over energiproduktionsanlæg. Anlæg i Region Sjælland«; Roskilde Universitet, september 2016.

[2] Information from Statistics Denmark. Statistics Bank; February 2017.

[3] »Stamdataregister for vindkraftsanlæg« form December 2016; The Danish Energy Agency, 26. January 2016.

[4] Data from Energinet.dk, from their market data. The inventory includes Zealand as a whole; Region Zealand's share is estimated on the basis of the region's area in relation to the area for the Capital Region. Regions Zealand's area is 73.9%, which is used as a distribution key. The figures are only The figures are only available from 2014 in market data from Energinet.dk .

[5] Renewable energy as a percentage of total energy production in Region Zealand. In the inventory two relative inventories are used, one a *production percentage* in this table, and one consumption percentage, calculated in Table 2.

Table 3. **Natural gas consumption and production**

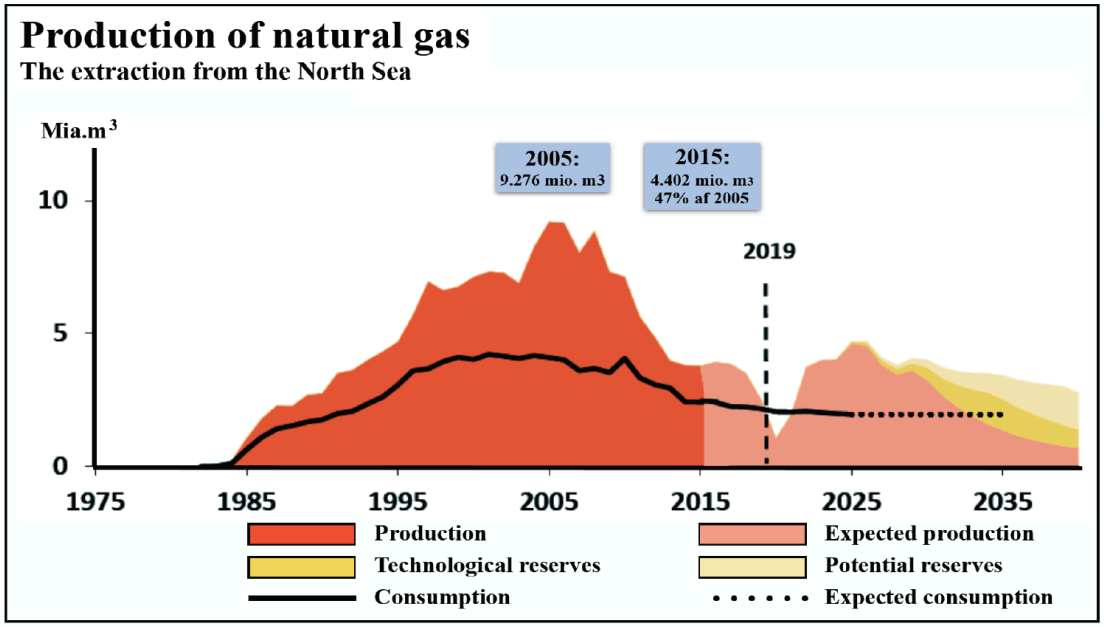
Natural Gas Consumption

Consumption calculated in million cubic meters

In mio. Cubic meter	2008	2009	2010	2011	2012	2013	2014	2015
Whole Sjælland:*	1.591	1.501	1.770	1.407	1.315	1.236	990	1013
Region Zealand:								
• Production plant: **	114	108	131	110	96	92	73,2	68
• Individual consump: **	-	-	-	216	220	223	225	227
Region Zealand i %:	-	-	-	23,2%	24,0%	25,5%	30,1%	29,1%

Sources: *) Natural gas. Monthly statistics. Danish Energy Agency.
**) Energiproducenttællingen, Danish Energy Agency
***) Danmarks statistik

Natural gas production



Sources: Resources and Forecasts. Danish Energy Agency; August 2016, figure 3, p. 7. The specific production figures for 2005 and 2015 are net production figures from the Natural Gas

Net gas production	2008	2009	2010	2011	2012	2013	2014	2015
Gasproduction in mio.m3	8.883	7.351	7.315	6.432	5.709	5.296	4.396	4.402

Sources: Natural gas. Monthly statistic. Danish Energy Agency.

Over the period 2008 to 2015, gas production has fallen by around 50%. Forecasts for the natural gas in the North Sea have been accompanied by extremely optimistic predictions for a number of years. With the last report from the Danish Energy Agency, the exaggerations are recognized. Thus, it is stated that in the previous forecast from last year (2015), net exports were expected up to and including 2023. As can be seen from the figure, it can no longer be expected. Production will fall sharply in the period 2019-21 as a result of the renovation of the Tyra Field's installation after information from the Danish Energy Agency. It can be added that this - yet to be decided - renovation will not only affect the Tyra field, but also the fields associated with the installations at Tyra. Haldan, Tyra SE, and a number of other natural gas fields.

It should be mentioned that the technological reserves and potential reserves are probably not very well-founded. In 2016, the Danish Energy Agency has also reduced these 'reserves' by 33% compared to 2015.

Table 4. **Straw consumption and production in Zealand**

Energiproducenttællingen, Danish Energy Agency (2008-2015)

Consumption of straw for energy purposes. Statement in 1,000 tons

In two regions	2008	2009	2010	2011	2012	2013	2014	2015
Region Zealand:	236	242	275	270	263	268	255	265
Correction: *	20	20	20	20	20	20	20	20
Capital Region:	109	145	268	190	128	201	108	105
Correction: *	5	5	5	5	5	5	5	5
I alt:	370	412	568	485	415	494	388	395

*) Farm facilities with straw firing are not included in the statistics. Consumption is estimated as stated.

Straw production (Danmarks Statistik 2008-2015)

The overall straw production. Statement in 1,000 tons

	2008	2009	2010	2011	2012	2013	2014	2015
Straw production (Danmarks Statistik 2008-2015)								
Region Zealand:	1.299	1.403	1.210	1.174	1.346	1.355	1.426	1.533
Caopital Region:	215	239	214	197	234	232	247	214
Both regions:	1.514	1.642	1.424	1.371	1.580	1.587	1.673	1.747
Straw consumption for energy purposes in the Capital Region of Denmark and Region Zealand								
Both regions i %:	24,5%	25,1%	39,9%	35,4%	26,3%	31,1%	23,2%	22,6%
Region Zealand in %:	19,7%	18,7%	24,4%	24,7%	21,0%	21,3%	19,3%	18,6%

The fall in the use of straw for energy purposes is primarily related to the following:

- Closing the Halmpille factory in Køge, March 2013, owned by Vattenfall. The company was continued as Blue Point Pellets Denmark Aps with production of wood pellets (November 2013).
- Discontinuing the use of wood at Amager Power Station / Hofor in 2013. Straw Pellet consumption was in 2013 at 52,215 tonnes, then it ends with straw consumption.
- Continued small consumption of straw on Avedøre block 2 (AVV2). Main fuel is wood pellets on AVV2; straw is included by around 12-13% and is expected to continue to be used until 2018.

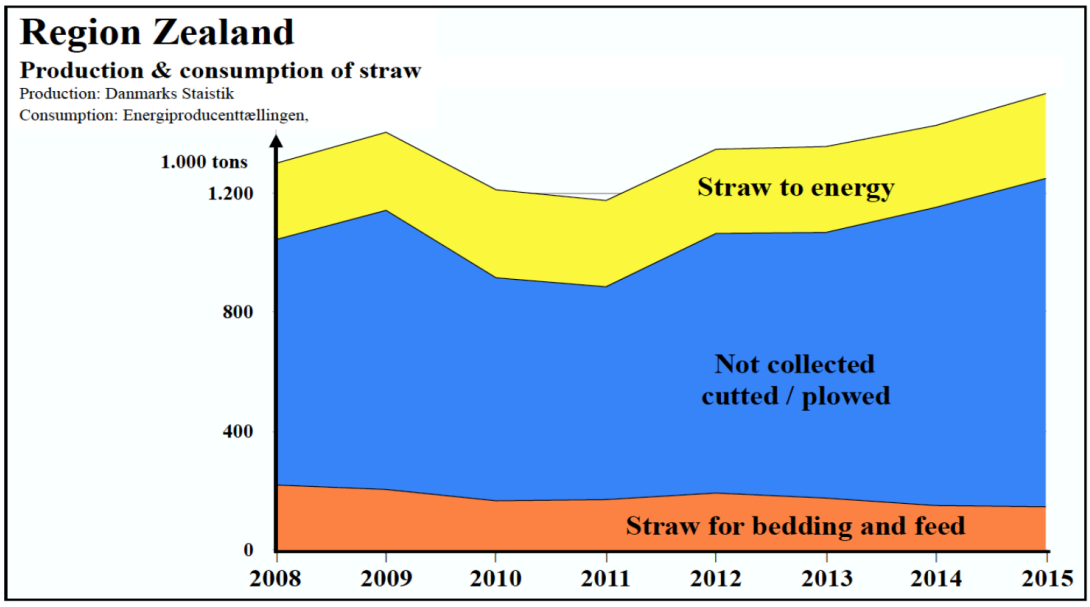


Figure 1: Municipality with high natural gas supply - Køge

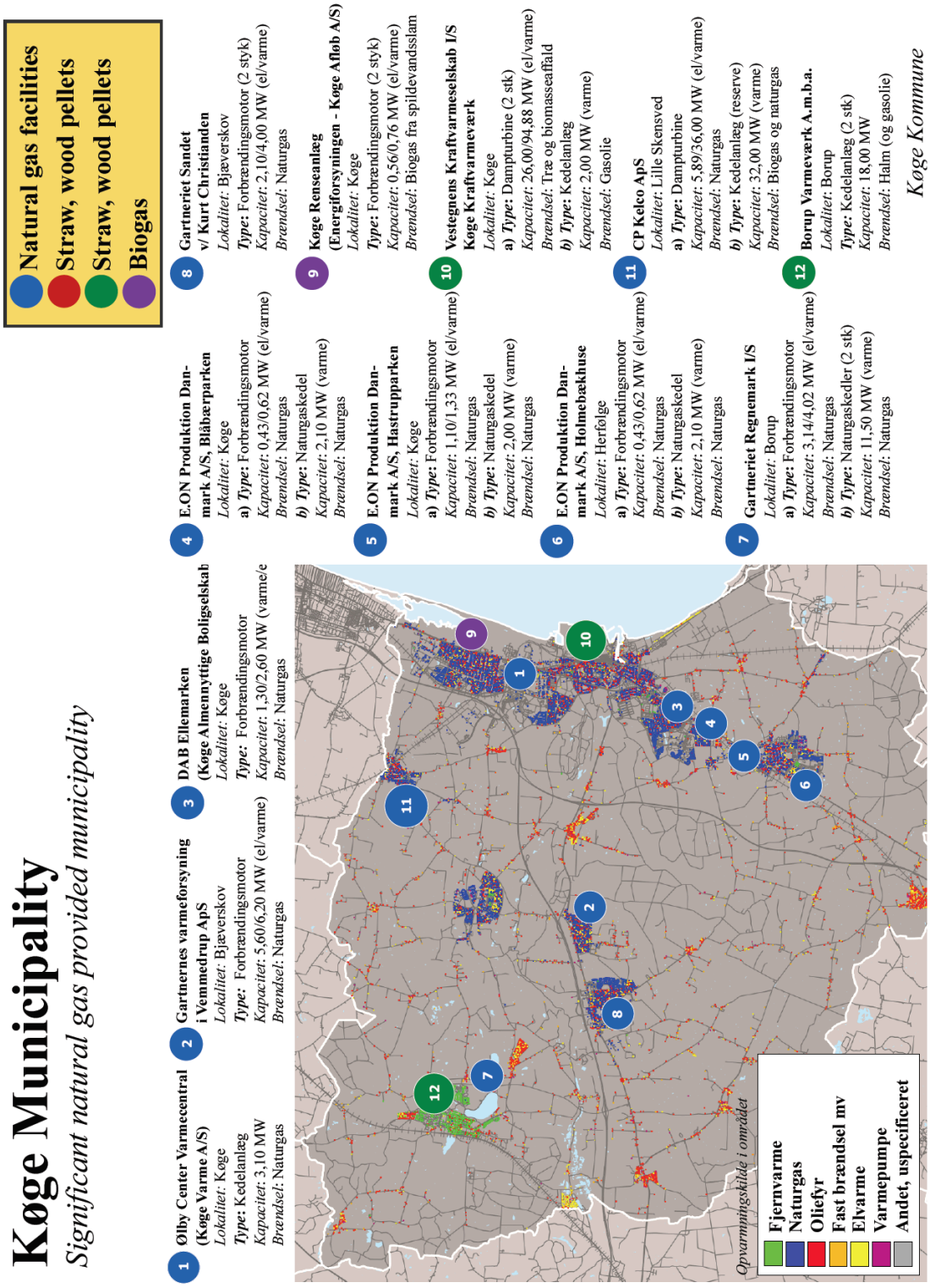


Figure 2: Municipality with high straw energy supply - Lolland

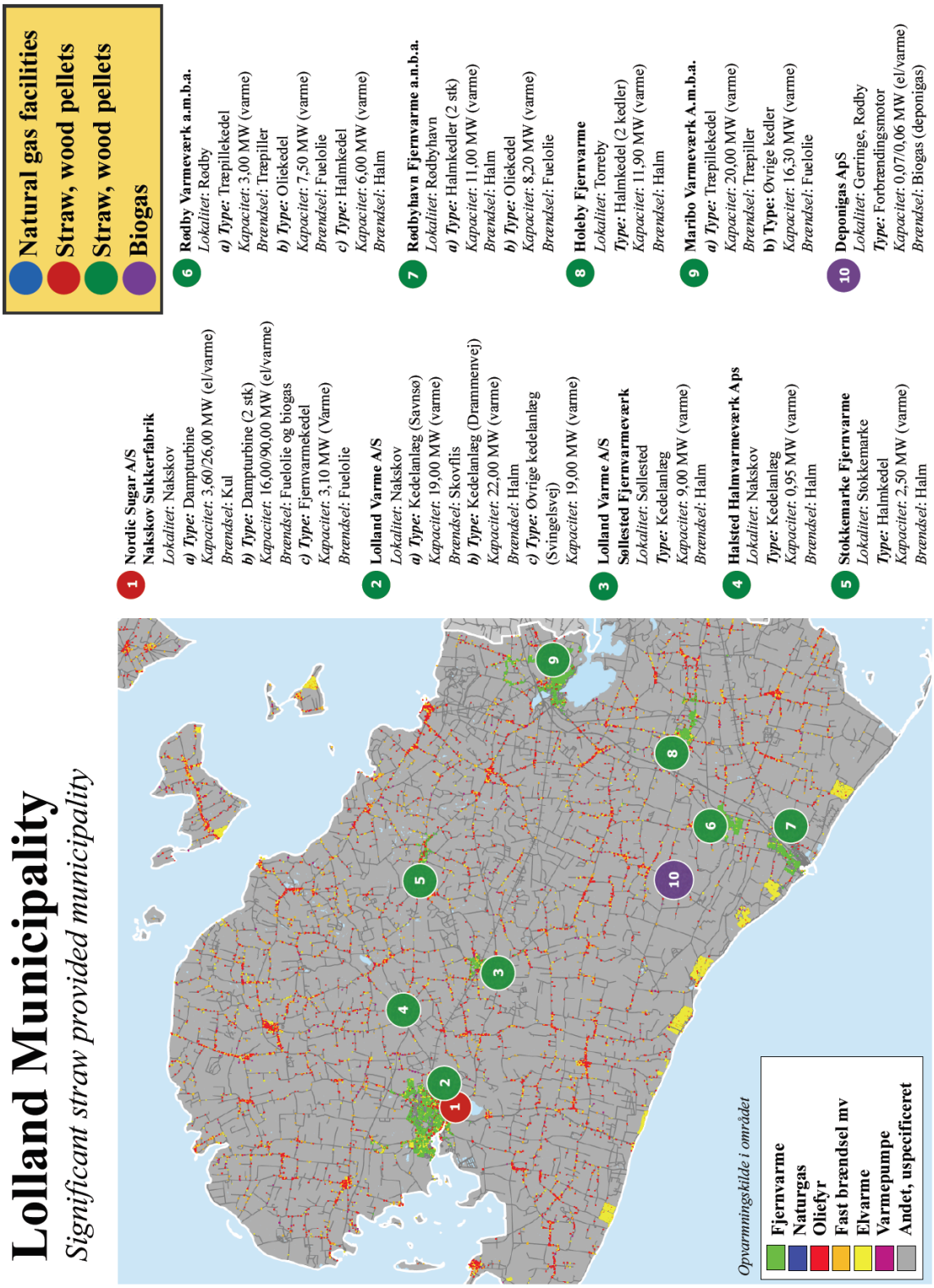


Figure 3: Municipality - few renewable energy resouces - Roskilde