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Greening the economy of Region Zealand (DK)

by
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Greening the economy of Region Zealand (DK)

Abstract

The transition of the European economies towards green economies takes place at the regional level too. This paper examines some of the transformation processes in the Region Zealand of Denmark. From an economic perspective, environmental concerns do not only represent costs, but also important potentials for economic development. Some of the potentials in the Region Zealand are described and discussed in this paper. Realising the green economic potentials may even contribute to reduced income disparities between the north-east and the west and south of the region. The authority delegated to local governments with relevance to industrial change is limited, but the local governments nevertheless play important roles in the transition processes. The expansion of wind energy production and the institutional settings endowing local governments with some authority of relevance for mediating conflicting interests in this transformation process are also discussed.

Acknowledgements

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Scientific disciplines involved

Economics

Keywords

Green economy, resource efficiency, renewable energy, industrial ecology

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1 Region Zealand (Sjælland)

1.1 Geography of Region Zealand

The region covers most of the area of the island Zealand and the small islands around it. The rest of the island – the northeast corner – is the Capital Region.

The region is composed of a sub-region serving as hinterland to the labour and service markets of the Capital Region and a sub-region with peripheral economy characteristics such as specialisation in agriculture and relatively labour and area intensive industrial production and low educational and income levels.

The landscape like the use of biotic resources is dominated by agriculture, whereas the economic value creation in fisheries and forestry is modest.

1.2 Local government in Denmark

The territorial division of Denmark consists of 98 municipalities grouped in 5 regions[1]. The Danish state is a unitary[2] state and the central government has delegated authority as well as responsibilities to the subnational administrative units – regions and municipalities.

The municipalities are mainly responsible for education (primary schools, adult education and cultural services), social services (day-care and elderly care), some social benefits and job-training/activation, integration of immigrants, some prophylactic health services, industrial compliance with environmental law, planning of heat and water infrastructure, local roads and transport services, nature protection and physical and heat-planning, facilitating industrial development. The municipalities also establish non-profit utilities in the energy and water sectors. The municipalities are delegated the authority to collect income and land taxes within narrowly defined limits.

The main responsibility of the regional authorities is the health services, but they also have responsibilities related to physical planning and regional economic development. Moreover, they function as coordinators and catalysts. They do not collect taxes, but are financed by the state.

Region Zealand is a region at the NUTS2-level and has within its geographical area 17 municipalities (LAU2). Region Zealand is a NUTS2 region composed of two NUTS3 regions (DK021 and DK022). These regions, however, do not represent the territory of any administrative body. Rather, the border between them represents the border of the Capital Region before the local administration reform in 2007 and can be useful for historical reference and for analysing the functional Capital Region.

The regional councils are delegated the responsibility for developing regional strategies of the following types:

- Regional development strategy
- Industrial development strategy
- Local Agenda 21

In addition to these strategies the regional councils make thematic strategies unfolding the goals of regional development in fields of high priority.

[1] Until 2007 there was 271 municipalities in 13 regions.

[2] As opposed to a federal state.

2 Regional economy - strengths and weaknesses

2.1 Income levels

Region Zealand belongs to a country with a level of GDP per capita – expressed in Euros with standard EU purchasing power – that is considerably higher than in the rest of the EU. The per capita GDP of Region Zealand, however, is below the EU27 average. This is shown in figure 1 below.

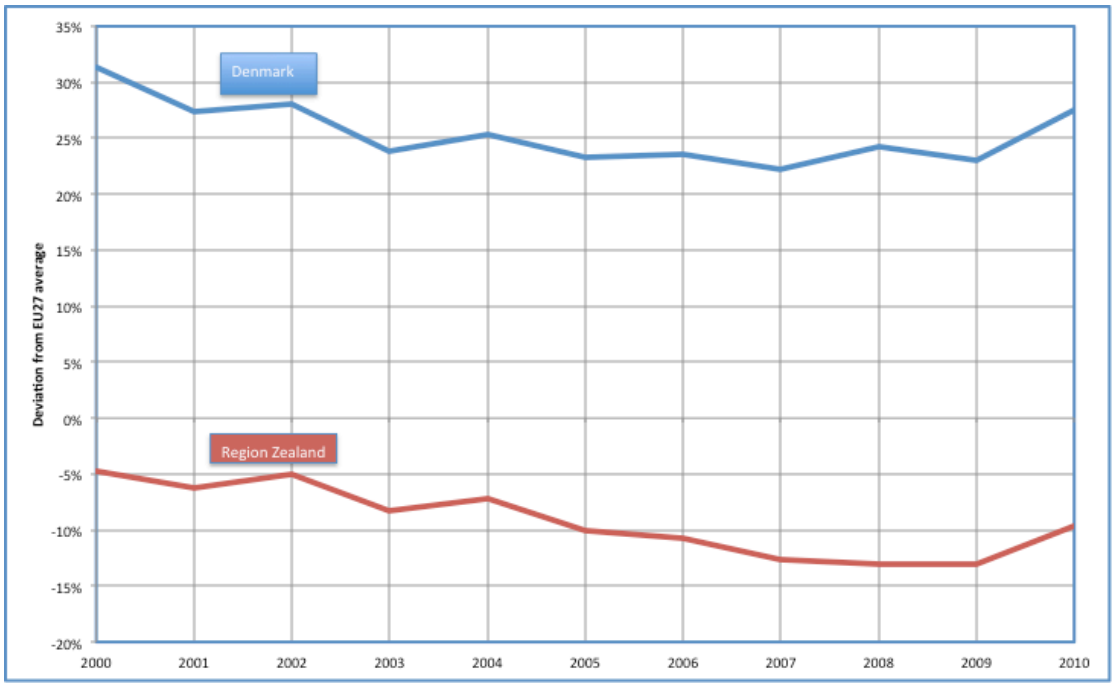


Figure 1. GDP per capita adjusted to EU standard purchasing power. Per cent deviation from EU27 average. 2000-2010.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The gross value added (GVA) per capita is the product of the crude rate of employment and the labour productivity. The crude rate of employment is the ratio of employed persons to resident population of the region.

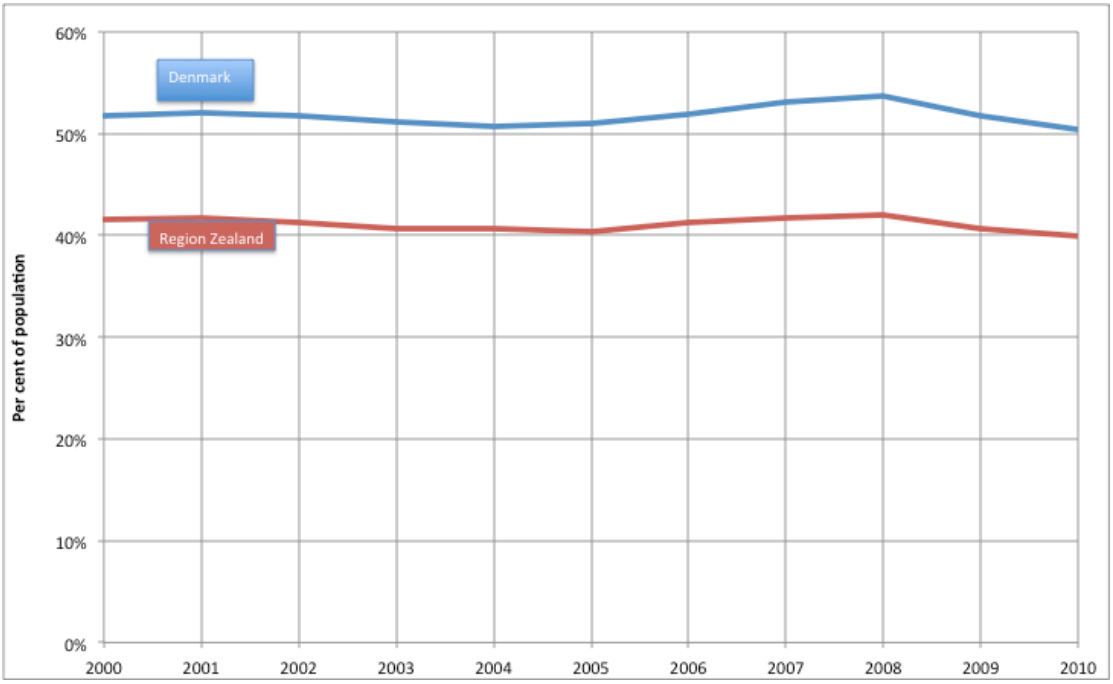


Figure 2. Crude employment rate. Per cent of resident population. 2000-10.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

Figure 2 shows the participation of the population in production of GVA at the regional as well as the national level. The relatively low employment rate in Region Zealand explains part of the low level of per capita GDP. The figure shows only the crude employment rate that is not adjusted for demographic composition of the resident population.

The changes in the economy through the 2000s can be analysed by studying the growth rates in production and employment as well as employment rate and productivity. It is expedient to distinguish between the growth period 2000-08 and the recession period from 2008 onwards.

Table 1 Growth rates of production, employment, population, participation, productivity and per capita production in Denmark and in Region Zealand 2000-10. Per cent per year.

	2000-08	2008-10	2000-10	2000-08	2008-10	2000-10
	Denmark			Region Zealand		
Production	1.1%	-1.9%	0.5%	0.8%	-1.8%	0.3%
Employment	0.8%	-2.7%	0.1%	0.7%	-2.5%	0.0%
Population	0.4%	0.5%	0.4%	0.5%	0.0%	0.4%
Participation	0.5%	-3.2%	-0.3%	0.1%	-2.5%	-0.4%
Productivity	0.3%	0.8%	0.4%	0.1%	0.7%	0.2%
Per capita production	0.7%	-2.4%	0.1%	0.3%	-1.8%	-0.1%

Production: GVA (in 2005 prices)

Employment: Number of persons employed

Population: Resident population

Participation: Crude employment rate (employment/population)

Productivity: Labour productivity (production/employment)

Per capita production: Production/population

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The production in the region grew at an average of 0.8% per year in 2000-08 – less than the national level growth of 1% per year. The fall in production after 2008 was in return slightly less drastic. The growth of employment and the employment rate shows the same pattern.

Labour productivity has increased at a faster pace during the recession than during the growth period, but in both periods less than in the rest of the country.

The result of per capita GVA growth through the decade as a whole was a negative compound growth rate of -0.1% in Region Zealand compared to a positive growth rate of 1% for the Danish economy.

Economic growth depended in most of the 20th century strongly on the growth of energy consumption. Although the links between economic and energy growth has been weakened, they are still there.

Table 2 Growth in energy use in production, employment and energy dependency of employment in Denmark and in Region Zealand 2000-10. Per cent per year.

	2000-08	2008-10	2000-10	2000-08	2008-10	2000-10
	Denmark			Region Zealand		
Energy use in production	-0.4%	-0.8%	-0.5%	-0.8%	-2.4%	-1.1%
Employment	0.8%	-2.7%	0.1%	0.7%	-2.5%	0.0%
Energy dependency	-1.2%	1.9%	-0.6%	-1.4%	0.1%	-1.1%

Energy use in production: Final energy use in production

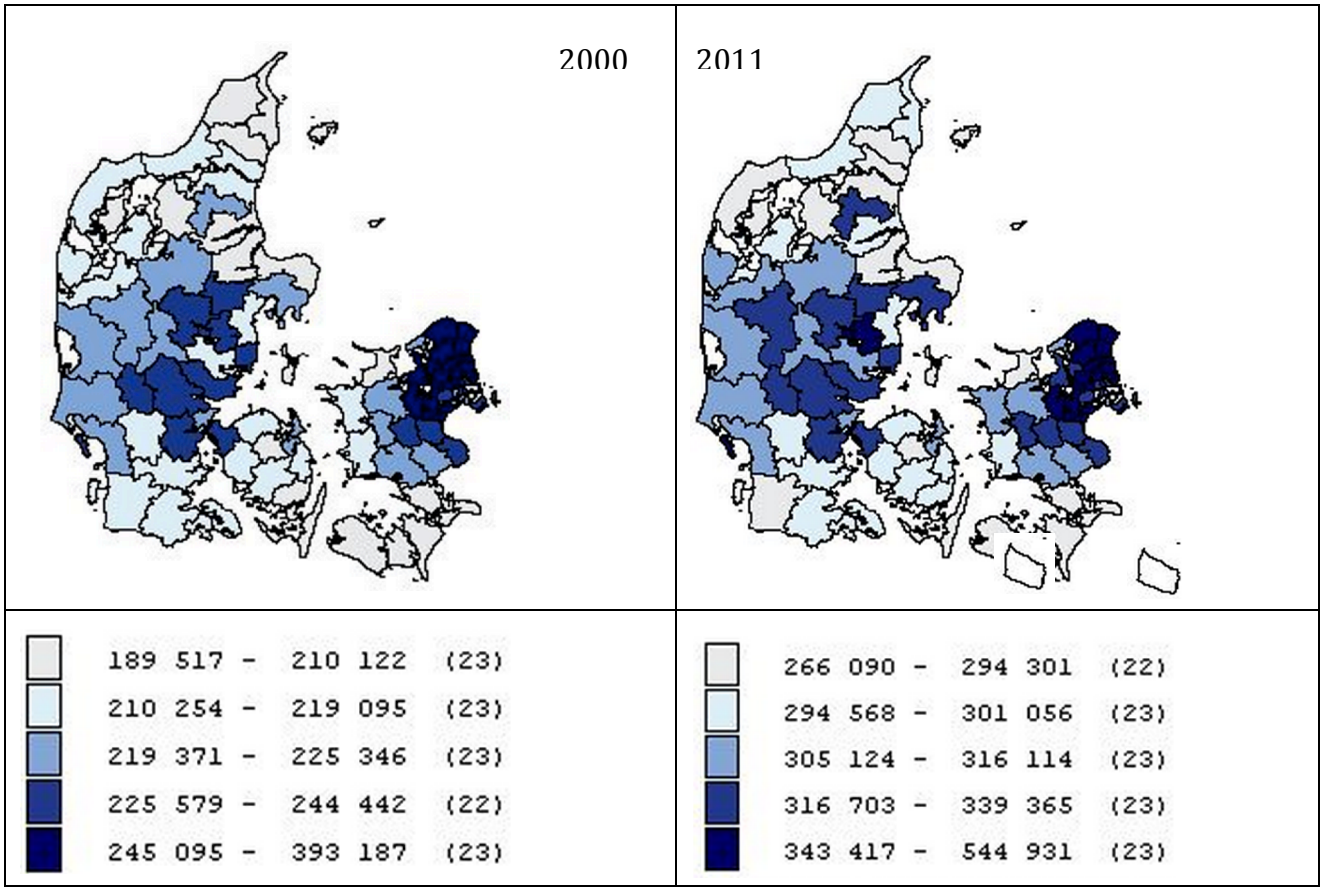
Employment: Number of persons employed

Energy dependency: Energy use in production/employment

Source: Author's calculations based on GREECO datasets.

It appears from table 2 that the energy consumption in production activities declined through the growth period in Denmark as a whole as well as in Region Zealand. Not surprisingly, it declined even more through the great recession – even if the partial recovery 2009-10 is included. Id did, however not decline as much as employment did in thar period. Consequently, the energy dependency of employment declined in the growth years of 2000-08, but rose slightly during the recession. By this metric, the transformation towards a green economy progressed at a high rate through the growth years, but stalled during the recession (see also figure 3).

The relatively good accessibility to the highly productive metropolitan labour market enables families with high incomes to locate in the northeast municipalities. The average income level of the families in other municipalities declines the more distant from the capital region. This pattern has been stable, when compared to the year 2000 as shown in map 1.



Map 1. Average family equivalent income in Danish municipalities. 2000 and 2011 (DKK, current prices)

Note: "Family equivalent" is a unit adjusting for differences in household composition of adults and children.

Source: Author's calculations based on the regional economic database (Statistics Denmark, 2013).

The average family income in Region Zealand is close to the average family income in Denmark. It is below the income level of the Capital Region and above the income level in the other regions.

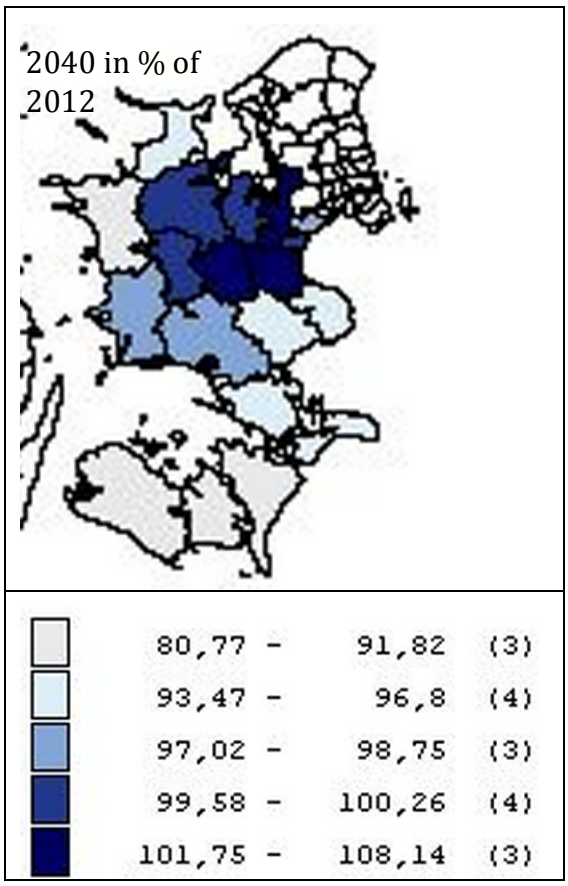
Despite the advantage of being close to the economically strong Capital Region, Region Zealand achieves the lowest GDP per capita among the Danish regions. Whereas the Capital Region in 2011 produced a GDP of T€50 per capita, it was only T€30 per GDP in Region Zealand. The other three regions achieve per capita GDP rates of T€39 (Region North Jutland), T€40 (Region Mid Jutland) and T€38 (Region South Denmark) (Statistics Denmark, 2013).

This statistics is, however, also a result of the fact that the region is commuting hinterland to the labour market of Copenhagen.

2.2 Demographic trends

The patterns of economically strong municipalities close to the Capital Region and economically weaker municipalities the more remote they are from the Capital Region are also reflected in the demographic trends. Projections of the present fertility and migration

patterns lead to declining populations in the more distant and economically weaker regions. Map 2 shows the projection.



Map 2. Population projection for municipalities in Region Zealand. 2040 (% of population in 2012).

Source: Author's calculations based on the regional economic database (Statistics Denmark, 2013).

The projection anticipates an almost 20% reduction of the population in the most distant southern municipality of Lolland whereas the population of Ringsted with its good accessibility to Copenhagen is projected to grow by 8%.

2.3 *Energy dependency*

The development of energy dependence of employment is shown in more detail in figure 3.

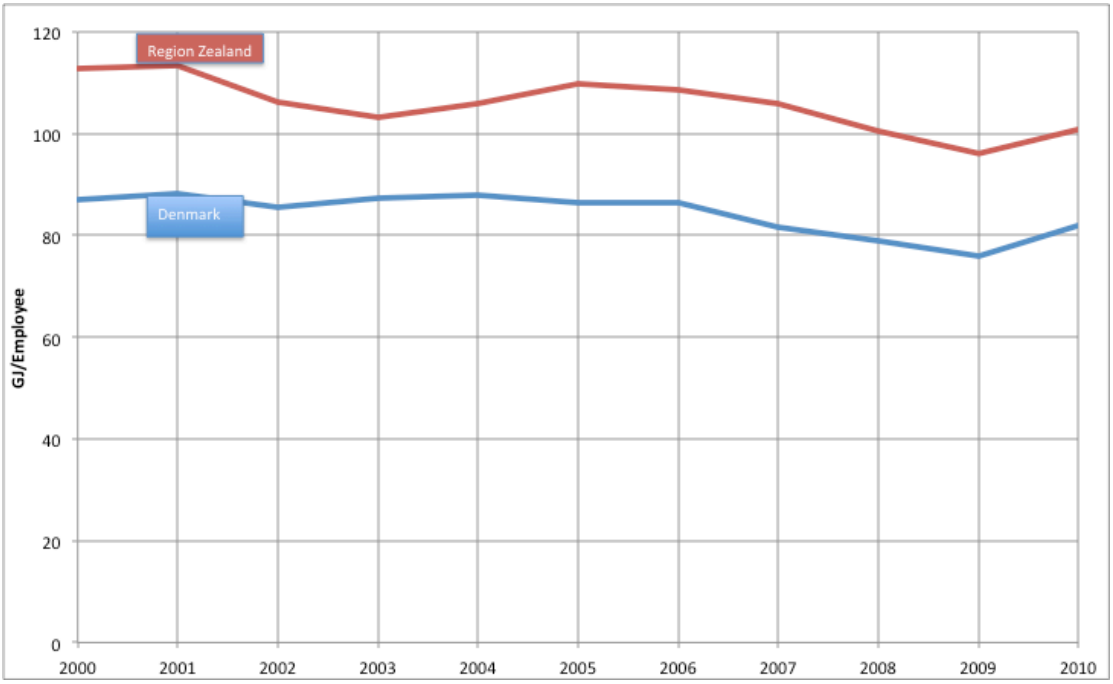


Figure 3. Energy dependency of employment in Denmark and in Region Zealand. 2000-2010.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The region is characterised by a higher dependency on energy consumption in production (i.e. excluding residential and transport energy use) per job than what applies to the rest of the Danish economy. This is what could be expected from the industrial structure with a higher weight of energy intensive branches cf. table 3.

The residential energy use per resident, however, is not much different from the national average as shown in figure 4.

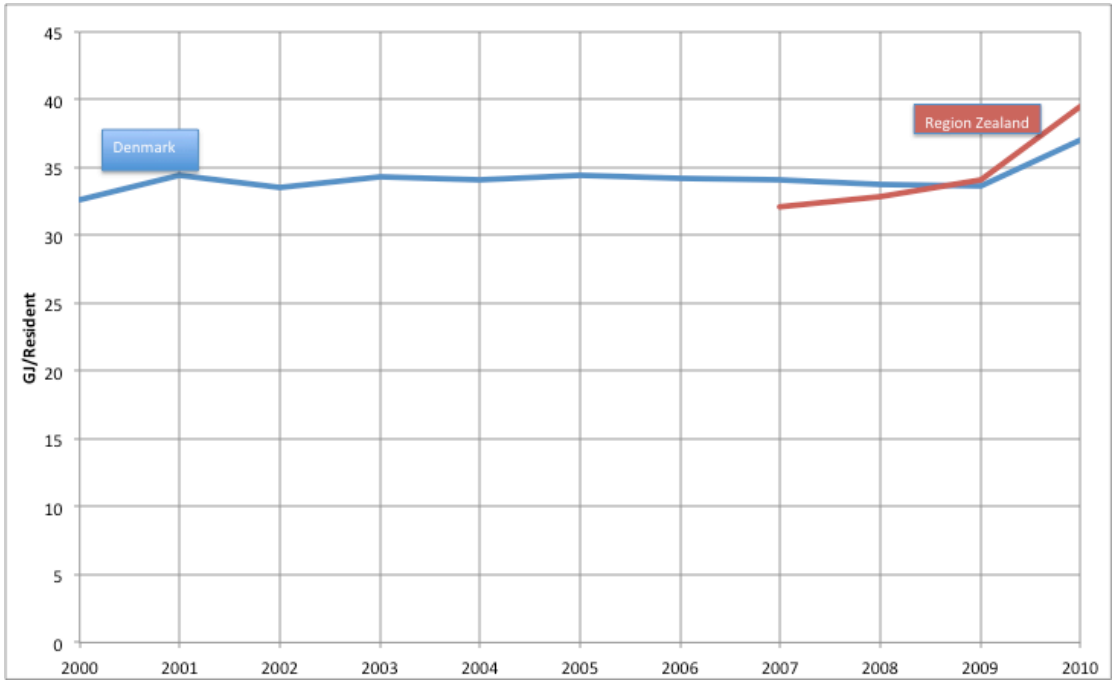


Figure 4. Residential energy use (final energy use) per capita in Denmark and in Region Zealand. GJ per resident. 2000-2010.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The potentials of reconfiguring and refurbishing the buildings, plants, vehicles, machines and lighting arrangements in the region are also potentials to boost the value added in the region by saving costs of energy inputs.

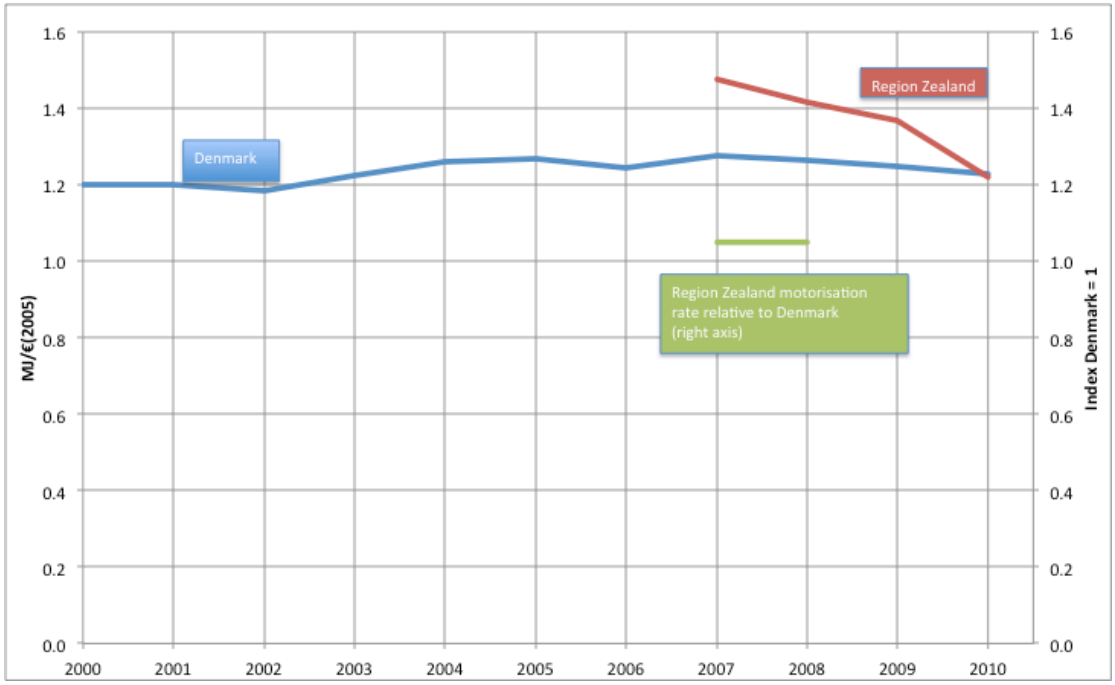


Figure 5. The ratio of transport energy use to production in Denmark and in Region Zealand (MJ/€(2005)) and the relative motorisation rate (index Denmark =1) 2000-2010.

Source: Author's calculations based on GREECO datasets.

The transport energy consumption relative to the production of the regional economy seems to have approached the national level through the recession as it appears from figure 5. There

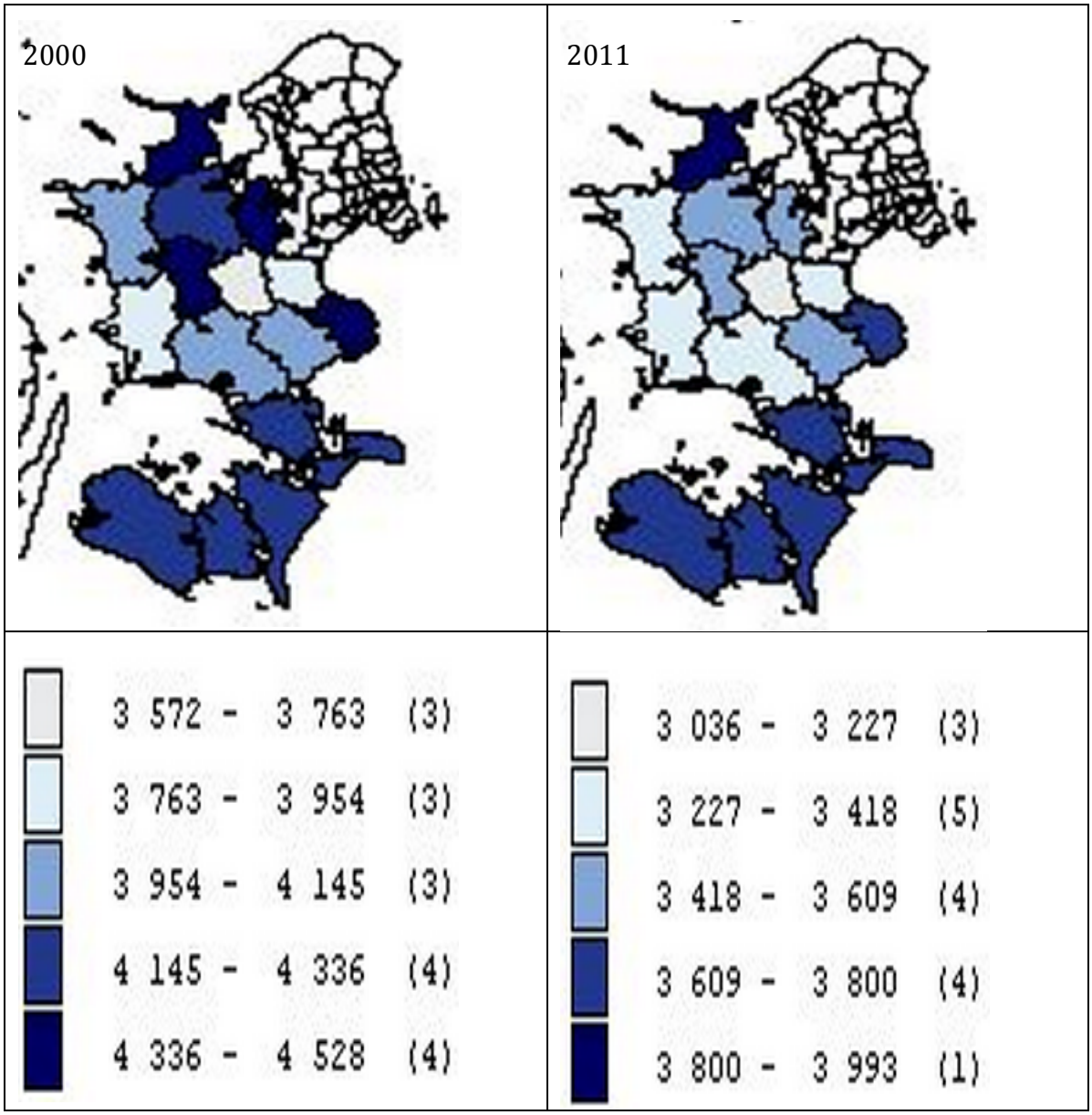
are efforts to transform the transport system to a system delivering mobility with lower energy and in particular lower oil based fuel consumption, but it would be premature to attribute the fall in the ratio in Region Zealand to these efforts.

The motorisation rate of the region is higher than in the rest of the country. It is shown in figure 5, as an index higher than 1. This is probably a feature that will persist in the transformation towards a green transport system due to the low population density in many parts of the region.

2.4 Greenhouse gas emissions

The greenhouse gas emissions from municipalities are very different in different parts of the region. This has to do with the location of power plants and other large emitters. In the maps below, the emissions are split between household emissions and industrial (including agriculture and services) emissions.

The per capita emissions from households vary only moderately between municipalities.



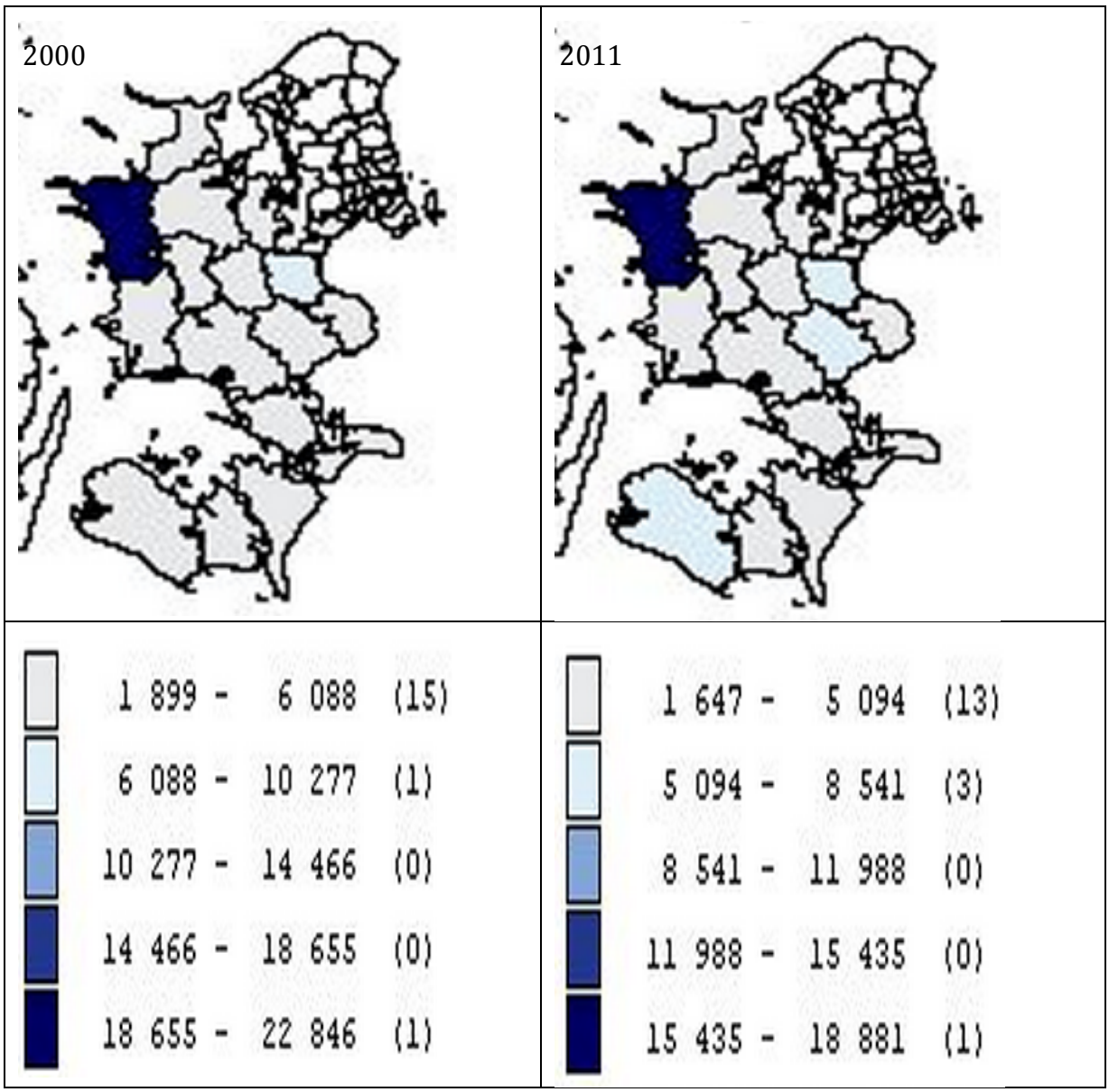
Map 3. Greenhouse gas emissions from household consumption* by municipalities in Region Zealand 2000 and 2010. Kg per capita.

** Gross inland consumption, that is, including the conversion and transport losses in the energy sector delivering electricity, heat and fuels.*

Source: Author's calculations based on the regional economic database (Statistics Denmark, 2013).

The small variations between the municipalities are in line with the small differences between the region and the rest of the country in per capita energy consumption for residential purposes.

The industrial GHG-emissions vary much more than the emissions from households.



Map 4. Greenhouse gas emissions from industrial sources by municipality in Region Zealand 2000 and 2010. Kg per capita.

Source: Author's calculations based on the regional economic database (Statistics Denmark, 2013).

In most of the municipalities, emissions of greenhouse gasses per capita from production are comparable to the greenhouse gasses per capita from households. The Kalundborg municipality, however, is specialised in energy intensive industries emitting greenhouse gasses at several times the per capita rates of the other municipalities. In particular, a central coal power plant emits large amounts of CO_2 compared to the number of residents in the municipality.

2.5 Industrial structure

The industrial structure of Region Zealand differs from the national average in some respects. The share of employment in construction and social institutions exceed the national average, whereas the manufacturing of machines, trade, accommodation and food services, advertising and other business services and education employ a smaller share.

A well-known pattern of industrial specialisation is that headquarter functions and services supporting corporate and government decisions locate in the metropolitan centres leaving the other regions with the more executive units. Only 41% of the employed in Region Zealand – compared to 44% at the national level - belong to the well-paid group of self-employed, top managers and upper and medium level employees.

The industrial specialisation of the region is analysed below with location quotients indicating the share of the group of branches in regional GVA relative to the similar share in the EU27 or in Denmark as a whole. The results are shown in table 3.

In a European perspective, the region is specialised in public services and agriculture. This is, however different in the eastern part of the region (Østsjælland, NUTS3), which as noted above, is part of the commuting hinterland of the metropolitan region of the capital.

Table 3 Location-quotients of the Zealand Region (Sjælland, NUTS2) and its NUTS3 regions Østsjælland and Vest- og Sydsjælland.

	Agri-culture, forestry and fisheries	In-dustry	Trade, transport and commu-nication	Financial sector, real estate and professional services	Public ser-vices	Manu-factu-ring
	Relative to EU27					
Denmark	0.87	0.85	1.01	0.95	1.22	0.75
Sjælland	1.18	0.81	0.80	0.88	1.54	0.83
Østsjælland	*0.38*	*0.70*	*0.96*	*0.92*	*1.50*	*0.70*
Vest- og Sydsjælland	*1.52*	*0.86*	*0.73*	*0.86*	*1.56*	*0.89*
	Relative to Denmark					
Sjælland	1.35	0.95	0.79	0.93	1.27	1.11
Østsjælland	*0.43*	*0.82*	*0.95*	*0.97*	*1.23*	*0.94*
Vest- og Sydsjælland	*1.74*	*1.01*	*0.72*	*0.91*	*1.28*	*1.18*

The location quotients are computed as the ratio of the share in GVA generation of each sector to the corresponding share at the national or EU level.

Source: Author's calculations based on the GREECO datasets (Hansen, 2013).

Table 3 also shows that compared to the Danish economy, the region is also specialised in manufacturing. This property should be seen against the background that the Danish economy is not specialised in manufacturing when compared to the EU27 average.

3 The national transformation context

The transformation of the economy to a green economy comprises all branches. As will be seen below even coal power plants until they retire.

The transformation of the production in each of the branches proceeds along broad lines of technological change:

- Substitution of fossil fuels, hazardous chemicals, scarce metals etc by alternatives with less source, sink and area scarcity
- Harvesting of biotic resources at a sustainable and efficient level
- Reduction of energy and materials waste
- Recovering and recycling of energy and materials waste
- Production of equipment, raw materials and intermediate goods designed for above uses

Two sectors comprising a range of branches will be reviewed below. The first is the energy economy – the production and use of energy. The second comprises complexes or clusters of manufacturing industries.

The transformation of the energy economy with renewable energy and energy efficiency as core components began to take shape after the rejection of a nuclear power based strategy at a referendum in 1984 and the subsequent recognition of the unsustainability of coal based electricity generation.

The strategy evolved through to 2010-12, when parliamentary consensus was reached on transforming the economy to a state of "independency" of fossil energy in 2050. In other words, Denmark is heading for a 100% renewable energy economy.

The energy agreement of 2012 and the follow-up legislation in 2014 are expected to achieve a 40% reduction of greenhouse gas emissions by 2020 relative to 1990. 50% of the electricity consumption will be delivered from wind-power and 84% from renewable energy. Renewable energy will supply 35% of total final energy consumption. (Klima- og Energiministeriet (Danish Ministry of Climate and Energy), 2012)

This is obviously a revolution of the energy economy compared to the almost 100% fossil energy supply before 1990.

Regional and municipal spatial planning and permits for installation of renewable energy plants and related infrastructures are key factors in the implementation of the policies. Planning of district heating – often in competition with natural gas provision – is also a key factor. Integrated urban and transport planning making it easier to use bicycle-public transport combinations and park-and-ride commuting are examples of local planning efforts that are key to the transformation.

The manufacturing sector is greening by containment of flows of materials, in particular those that affect human and environmental health negatively. These flows are regulated by EU policies such as REACH, the water framework directive and a host of other regulations. In addition to this, national regulation limits or eliminates the throughput of other substances to the environment. The municipalities are entrusted the regulatory authority to control and permit the emissions of pollutants to the environment according to law.

A third important dimension of the green transformation is the securing of areas for natural ecosystems and the protection of nature values. The EU policies on biodiversity, NATURA 2000 etc. and national programmes for protection of environmental values, afforestation, water planning etc. are the primary drivers for this transformation. Regional and municipality planning are entrusted the responsibility to enforce EU and national legislation and use the

instruments for nature restoration, afforestation etc placed at their disposal by EU and national law.

This national context for the regional greening of the economy implies that the primary driving forces of the transformation are the national government and the municipal administrations. The role of the regional councils is more coordinating and catalytic. The regional councils, however, are assigned direct responsibility for soil pollution problems and raw materials extraction, which in the case of Region Zealand primarily concerns sand and gravel.

4 Region Zealand policies aiming at a green economy

As noted above, the regions are responsible for regional development and industrial development strategies as well as Local Agenda 21. The regional and industrial development strategies will in the future be merged to one and the Agenda21 strategy has evolved to a Sustainable Development Strategy and a Climate Strategy.

The development strategy of Region Zealand defines a range of operational targets and timeframes moving the regional economy closer to a green economy.

Table 4 Indicators and targets in the Regional Development Strategy 2012-15of Regional Zealand.

Indicator	Timeframe	Target
GDP growth	No timeframe	≥ national growth
Per capita income	No timeframe	= national level
CO_2-emission reduction relative to 1990	2020	≥ 20% Renewable energy ≥ 20% Long-term: Based on renewable energy
Renewable energy in % of energy use	2020 (Long-term)	≥ 20% (close to 100%)
Rate of increase of education level	2020	≥ any other region
Tourism turnover relative to 2010	2015	MioDKK 600 (M€80)
Rate of increase in income level in every municipality	2012-15	≥ 0
Change in the share of regional employment in every municipality	2012-15	= 0
Share of growth-entrepreneurs	2014	= national (10.5%)
Further demonstration facilities for energy and environmental R&D	2014	1
Change in number of firms with international cooperation agreements	No timeframe	≥ 0

Source: Adapted from the regional development strategy (Region Sjælland, 2012a).

The indicators and targets shown in table 4 demonstrate how some of the principles of sustainable development can be operationalized. The climate related targets, however, have become obsolete after the adoption of the much more ambitious national targets. If the region only succeeds in achieving the EU-level ambitions, it will underperform according to the national targets.

The regional development plan takes account of the economic strengths and weaknesses of the region. It is neighbouring the Capital Region with its high levels of income and productivity, it is situated as a connecting link between Sweden and Germany and between Copenhagen and the rest of the country.

Considerable investments are planned at Zealand in the 2010s including the Femern Belt Connection, the Copenhagen Metro, rail and highways as well as "super-hospitals" and prisons. The region works for supporting firms in the region to get a high market-share of this and the derived demand.

The region has a good basis in energy and environmental technologies, pharmaceutical and health technologies, agriculture and food manufacturing technologies and experience economy and it has led to the focus on these four areas of industrial development. The potentials for renewable energy are considerable and so are the potentials for reallocating land towards a larger share for natural ecosystems. The latter can make the region more attractive to potential residents and tourists.

An important instrument in implementing the regional development strategy is the public-private partnership "Growth Forum", which has adopted the Industrial Development Plan (Vækstforum Sjælland, 2011). Similar partnerships are established in the other regions.

As mentioned above, the regional councils are entrusted with limited instruments to promote industrial development in the region. They don't collect taxes and can almost only invest in hospitals. They do not regulate or tax the environmental pressure and influence land-use only at a general level. They cannot provide guarantee for industrial development projects.

The instruments available include networks, promoting awareness on innovating opportunities, co-ordinating activities, dialogue with local industries etc.

The action plans accompanying the regional and industrial development strategies (Region Sjælland, 2012b; Vækstforum Sjælland, 2012) include activities that support the participation of firms in international innovation projects and raise the level of awareness on new opportunities for innovation. The pharmaceutical and health industries as well as energy and environment industries are in focus here. These activities are carried through in the framework of the Copenhagen CleanTech Cluster.

Region Zealand also supports the development of a second-generation biofuel cluster in Kalundborg (West Sealand) and a transport cluster in Mid Zealand focusing on sustainable transport.

Innovation in energy-efficient buildings is supported through the management of the buildings owned by Region Zealand as well as through support of innovation in the building and construction sector of the region.

Another goal is to assist reduction of energy consumption and increase value added in small and medium size firms in the region. The intention is to increase competitiveness and reduce CO_2-emissions simultaneously.

The region hosts many test and demonstration facilities for clean-tech innovation. They include technologies such as outdoor lighting and wind-tunnel experiments at the Danish Technical University, a biofuel centre in Kalundborg and hydrogen grid, an algae innovation centre and wave technology demonstration at the southern island Lolland. The regional development plan foresees that these centres can attract innovative activities to the region and eventually production units based on this innovation. The plan is to engage in more demonstration and test centres in the region.

The regional council sees good growth opportunities in the expected high growth of investments in wind energy. Thus, the region facilitates the development of competence-networks of suppliers of wind turbines and parts for wind turbines. This will help the formation of competitive consortia and the participation of firms from the region in these consortia when bidding for tenders.

Job creation in the field of wind energy technology requires educated specialists in the technologies involved. The region thus supports the establishment of new educations in these technologies and upgrades the education of at least 500 persons in the region in wind technologies.

Similar plans are pursued for agriculture and food industry technologies, health and welfare technologies and tourism and experience economy.

The regional council and the municipalities of the region have focused policies on development of industrial symbiosis, renewable energy, aspects of the bio-economy and the experience economy. They have also coordinated their policies as to climate mitigation and adaptation as well as ecosystem protection and restoration. The coordination of energy and climate planning takes place in the regional "Energy Cluster Centre" and in cooperation networks dedicated to waste recycling and biogas-plants.

Almost all municipalities are signatories to the Covenant of Mayors and national green economy commitment arrangements. These commitments include not only commitments to reduce energy waste and emissions in the service institutions of the municipalities, but also to help the private sector in the territory of the municipality to become more resource efficient.

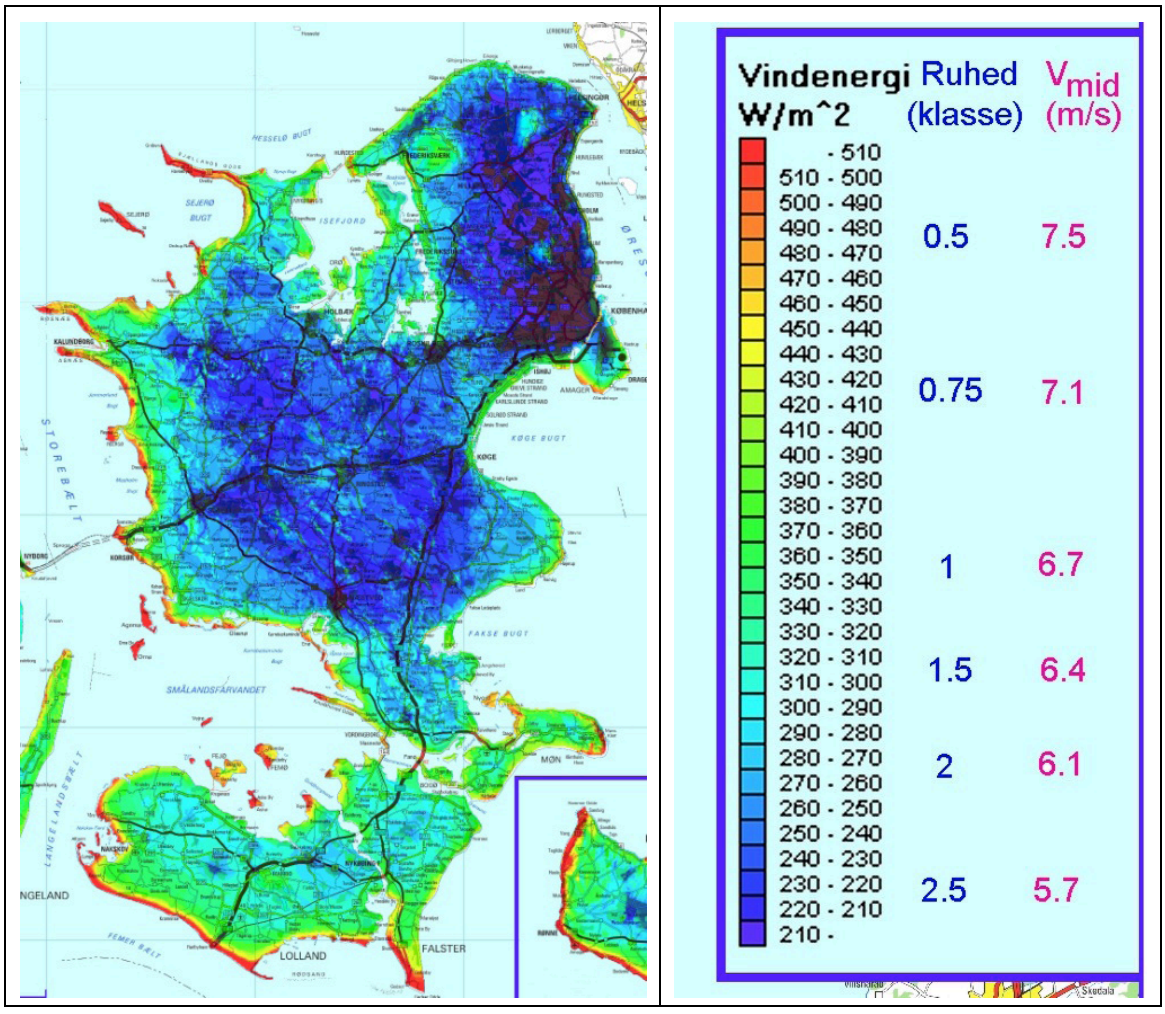
They pursue their own climate and energy programmes focusing on development of wind energy, district heating based on biomass and gasification of manure and other industrial waste and other transformation processes towards a green economy.

Over the period 2007-2013 the Region Zealand and Growth Forum Zealand have supported 43 climate change mitigation projects with a total of M€27.5 of which M€15.1 were granted from the EU Regional Fund, M€1.5 from the Social Fund and M€11 from regional sources (Lars Edward Tomlinson, Region Zealand, 2013).

5 Renewable energy

The green transformation of the energy economy of region Zealand is a conversion from coal and natural gas based electricity and heat generation, oil and natural gas based heating and oil-based transport to energy from renewable and primarily non-combustible sources.

The wind resources of the region are good, in particular if the offshore and near coast wind potentials are included.



Map 5. Wind resource map of Zealand and the surrounding islands.

Source: (Energi- og Miljø Data, Aalborg, 2001)

The physical potential of wind energy shown for Region Zealand at map 5 is the basis for assessments of the wind energy that it is economic and technologically feasible to generate in an area. The GREECO project has made an assessment of the wind energy potential of all the European NUTS2 regions.

The results of the spring 2013 version of the assessment is shown in table 5.

Table 5 Onshore wind energy potential of Region Zealand

Feed-in price	10c/kWh	8c/kwh
Per capita wind energy potential *(Mwh/yr/person)*	22	18
Potential rent to GVA (2009) ratio *(per cent)*	3%	2%

Meso-scale assessment assuming uniform wind energy density at wind energy compatible areas. Rent = feed-in price – levelised cost of electricity generation. No account of specific installation and grid connection costs.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

Realising the good wind potential of the region has made wind energy one of the most expansive sectors in the economy of the region since the early 1990s.

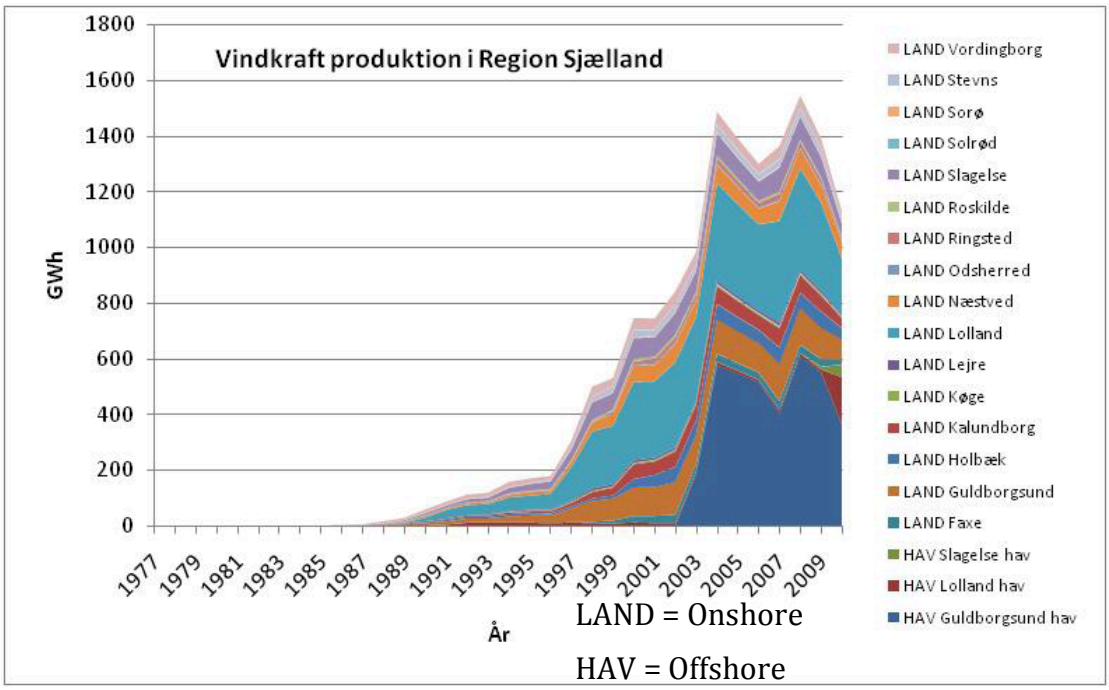


Figure 6. Wind energy production in Region Zealand 1977-2009. GWh.

Source: Author's calculations based on the Energy Agency Wind-Turbine Database (Danish Energy Agency, 2012).

Figure 6 shows that the excellent wind potential at the southern island Lolland (cf. map 5) has been developed to a wide extent. It contributes with around half the onshore wind energy generated in the region. The offshore wind energy at the coasts of the region contributed in 2009 approximately as much as the onshore wind energy and this is expected to be the most expansive wind energy source in the 2010s and 2020s.

The Danish Renewable Energy Act provides incentives to invest in renewable energy plants as well as schemes and rights that facilitate the local process of mediating conflicting interests in wind farm planning.

The renewable energy is supported to varying degrees depending on technology maturity and type by price subsidies, feed-in tariffs, investment subsidies, tax allowances and exemptions and for investments in household wind turbines and solar panels by deducting the electricity delivered to the grid from the electricity bill. These incentives enable investors to invest in renewable energy.

The wind energy resource rent is shared between the owner of the wind turbine and the owner of the land. It is, however, not only coal or nuclear power plants that imply loss of landscape values. Other large technical installations such as wind farms do also in many locations make landscapes less attractive. The loss of landscape values, however, is born by the neighbours and other stakeholders in the particular landscape.

The municipalities are responsible for the planning process and the government has formed a task force on local wind energy planning to assist the local planning.

Wind farms are often established by local *windmill-guilds*, but they have difficulties financing the pilot studies, establishing whether the project is feasible or not. These pilot studies are in the nature of the case very risky investments and a government wind energy security fund has been established for provides security for financing pilot studies, but the uncertainties relating to potential conflicts with landscape interests add to these risks.

Thus, it is necessary for the authorities to make compensation arrangements that can mediate this interest of conflict. In Denmark they are provided by the Renewable Energy Act, which equips local planners with a set of instruments that can be used in resolving these conflicts.

These instruments allow for a share of the resource rent to be shared not only by the investor and the landowner, but also by the local community. The rent sharing arrangements are important enablers for local acceptance of the large technical installations.

The Danish wind energy policy is to replace the retiring small wind turbines of the 1990s and before with few, but more powerful new wind turbines. The new generation of onshore wind energy turbines has become very competitive. The largest problem to further expansion of offshore wind-energy is, however, the distribution of the resource rent.

In Denmark a series of mediating arrangements have been laid down in the law. The installation must comply with a series of requirements such as distance to neighbours, noise-level, shadow-effects etc. There is also a hearing procedure and the normal procedures for appeal in disputes on construction and installation. In addition to these arrangements there are three specific types of compensating arrangements.

First, the wind project entrepreneur is obliged to offer at least 20% of the shares in the project to residents within a distance of 4.5 km from the wind turbine. Second, neighbours who experience a drop in the price of their property are entitled to compensation fixed by an independent appraisal committee. Third, the municipality is entitled to remuneration of around €12,000 per turbine to contribute to financing projects that can make the location more attractive.

In addition to these specific arrangements, the normal taxation rules ensures the local community a share in the rent as in any other income earned by the residents of the municipality. There are tax favours to investors in wind energy projects, but they are subject to limitations and the wind resource rent to the land-owner is reflected in a higher property value and thus a higher land-tax.

Against this backdrop the Danish policy is to replace the 1300MW installed wind capacity that is expected to retire in the 2010s with 1800MW new wind energy capacity, that is a net increase of 500MW.

Biomass is another important renewable energy resource of the region. Two areas of biomass processing are of particularly economic importance.

In 2008 a second-generation biofuel factory INBICON was founded in Kalundborg as a joint venture between energy companies. The idea is to use straw and other cellulosic biomass

residuals for bioethanol production. Cellulosic biomass needs to be treated with enzymes to enable access to the sugars, which then are ready for fermentation.

The growth prospects of the factory and the related firms depend on the decisions on future EU use of biomass.

Other biomass residuals and biomass waste are more efficiently used by gasification. Agriculture and food industries in the region can offer flows of waste biomass and the households as well. Most of this biomass has been incinerated, but a new national strategy is being casted and it will aim at processing a high fraction of the biomass waste in biogas plants or bio-refineries producing gas, heat, dry fertilizer and other goods.

The municipalities are responsible for the development of biogas plants and the municipalities with biogas projects have formed a cooperative network for planning the use of the biomass resources of the region.

One particular project in the northeast municipality of Solrød uses seaweed in addition to the land-based biomass. This simultaneously solves the problem of disposal of seaweed cleaned up from the beaches and takes nitrogen out of the marine environment, which is loaded with nitrogen beyond sustainability levels.

The Energy Cluster Centre of the region coordinates a network of municipalities planning to develop biogas plants. It is important that the planned use of biomass is in line with the development of the biomass resources of the region.

6 Manufacturing

6.1 Green innovation

Most of the university and corporate research of the region is located in the northeastern part of the region. The OECD has developed a classification system according to which patent applications are classified in green and other technologies. Figure 7 shows the share of green patent applications in all applications according to the OECD classification.

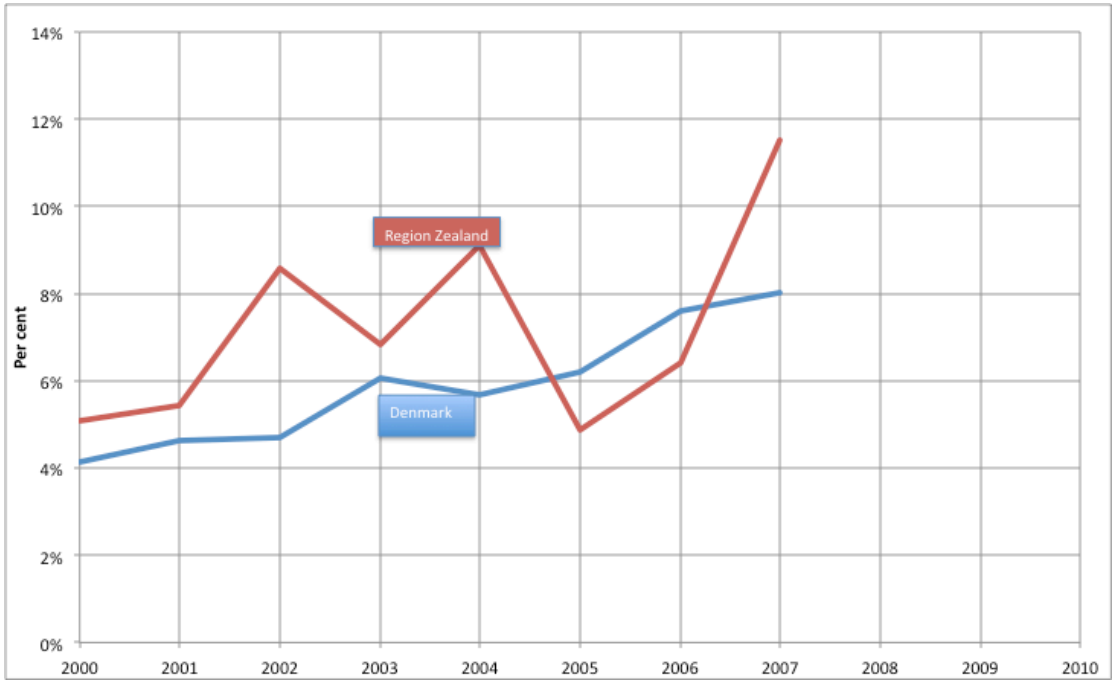


Figure 7. Ratio of green to all patent applications (OECD definition) in Denmark and Region Zealand.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The share of green patent applications has been increasing in the Danish economy through the 2000s and the green share of applications from the region was higher in all years except 2005-06.

This shows that the region has a potential for development of, production of and use of equipment and processes comprised by these technologies.

6.2 Progress and importance of the transformation

The progress towards a green industrial production proceeds in many different forms involving product and process innovation, cooperation networks and individual endeavours and many other efforts.

The manufacturing sector of the region is mainly specialised in oil refining, chemical, pharmaceutical and plastic/glass/concrete industries. It is hardly possible to characterize their transformations towards greener production with a single type of effort. Some of these industries consume large amounts of fossil energy and "green industry" is not the first characterisation that comes into mind. The transformation, however, also involves a gradual process transforming unsustainable production to sustainable. In the following, an important example of such transformation is reviewed.

Many of the industries of the region are to some extent clustered in the west of Zealand around the town of Kalundborg. This has enabled the evolution of an "industrial ecology" network known as *Kalundborg Symbiosis*. The waste products of the production plants serve as inputs in other plants. This system of recycling has evolved through half a century as shown in figure 8.

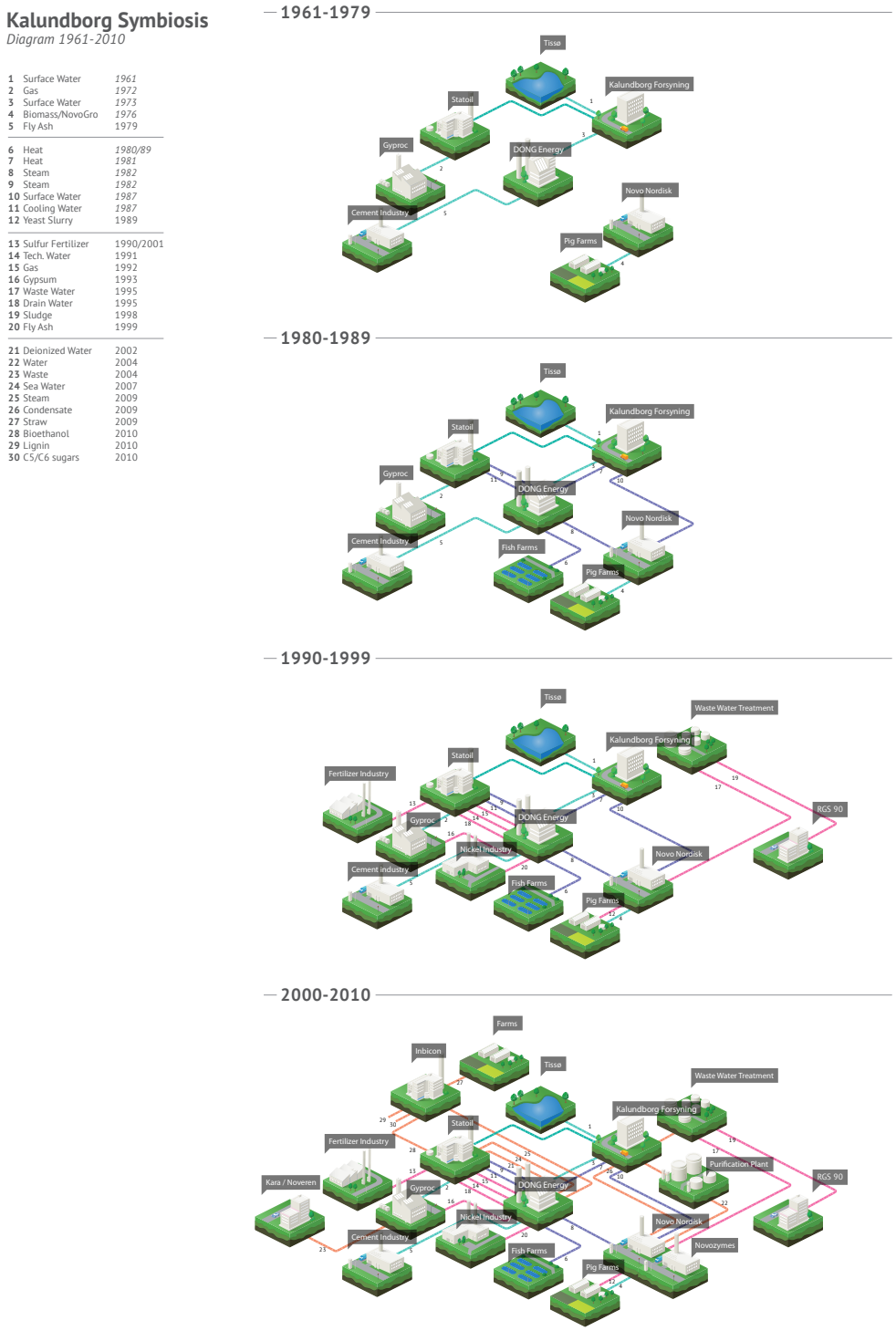


Figure 8. Kalundborg Symbiosis. Flows and participating plants.

Source: (Kalundborg Symbiose, 2013).

The Kalundborg Symbiosis explains that the it came into being as a result of private conversations between a few enterprise managers from the Kalundborg region in the 1960s and 1970s. Since then, the industrial symbiosis has developed based on good collaboration between employees of the businesses involved (Kalundborg Symbiose, 2013).

The oil-refinery of Esso (now Statoil) entered in 1972 into an agreement with Gyproc, a local gypsum production enterprise, on the supply of refinery gas from Statoil to Gyproc. Gyproc in turn used the gas for drying of the produced plasterboard. Today, natural gas is used.

The oil-refinery on its side received from the year after (1973) steam from the cooling water of the Asnæs Power Plant (now Dong Energy).

From this early start, the industrial ecosystem has evolved and includes today also pharmaceutical, enzyme and biofuels production as well as district heating and recycling corporations.

One of the core circuits in the network is the use of surface water rather than ground water in the oil refinery and other plants. This water is recycled as cooling water in the thermal power plant. The cooling water is sent back and to the nearby plants as steam and further to the district-heating grid in a cascading arrangement offering different temperatures throughout the system.

This symbiosis has enabled significant savings of natural gas because waste heat is recovered and re-circulated as steam and district heating. It also enables savings in the costs of water consumption and wastewater treatment for all of the participating firms. Thus, even if the industries are not usually considered "green industries" such green arrangements make the participating firms more competitive and consequently secure jobs (Jacobsen, 2006).

Whereas the early cooperative network can be characterised as "classic symbiosis", the modern network is a diversified "waste market" with firms and units within firms specialised in reprocessing of the materials (and energy).

The industrial symbiosis networks contain circuits of water as well as energy and materials.

6.3 Framework conditions for industrial symbiosis

Cost savings is an important driver and they are amplified by regulatory requirements of wastewater treatment, fees and other aspects of the institutional framework.

The Danish energy and environmental taxes introduced in the recent decades enables profitable investments in resource saving and recycling solutions. In addition to this, firms and households are offered subsidies for energy saving investments.

The municipal administration of Kalundborg is an active player in this industrial ecosystem and has been so throughout its history. The "industrial ecosystem" is, however, not the result of a well-elaborated plan for development of resource efficiency. The municipality stresses the importance of more soft enablers such as a high level of mutual trust and a local spirit of cooperation (Kalundborg Symbiose, 2013).

The Danish government has launched a task force and a fund for industrial symbiosis. It assists firms with a systematic review of their materials, energy and water flows with a view to developing circular supply chain management where appropriate. Following the lessons learned from Kalundborg, the government doesn't try to force firms into any arrangement. It does, however, engage in industrial waste "dating" with the establishment of a "dating-site" and "dating-events".

6.4 Development potentials

The industrial landscape of Kalundborg has in the recent years been enriched with a second-generation biofuels production plant. The future of this plant depends on the future of second generation biofuel demand in Europe.

The Symbiosis Centre in Kalundborg works with the regional and local authorities to develop similar networks in the region. 50 out of 100 firms studied have been identified as potential partners of 6-7 industrial symbiosis networks of which 1 has been initiated with support from the above national fund.

7 Natural ecosystems

7.1 Natural ecosystems and landscapes

The biodiversity in the EU has been in decline at it has been agreed to stop and reverse this decline. At the same time, climate change with its more intense precipitation and cloudbursts calls for restoration of some of natural routes for water to run off and natural buffers for large amounts of water.

Natural ecosystems and landscapes, however, also provide economic services that make locations attractive for residents as well as for tourists. Thus such investments in natural ecosystems may have an economic potential to them as well.

This aspect is important if larger parts of the region shall become more attractive as a commuting hinterland for the capital region. Planned infrastructure investments enabling fast railway travel will enable larger parts of the region to compete for the location of households working in the capital region offering residential areas with easy access to attractive nature.

It is difficult to express the average nature quality of a whole region, but combining land cover and nature designation can be a useful approach. The allocation of land in Europe has been analysed in the GREECO project on the basis of the Corine Land Cover dataset combined with the European databases of NATURA2000 and nationally designated nature areas. Some results for Denmark and Region Zealand are shown in table 6.

Table 6. Areas designated to nature and regional designation rate index (DK = 1).

	Denmark			Region Zealand			
	Designation			Designation			Na-
Areas	Na-ture	Eco-nomy	Total	Na-ture	Eco-nomy	Total	ture des. index
Urban (CLC1-9)	0.2%	5.6%	5.9%	0.1%	5.2%	5.4%	0.69
Green and sports (CLC10-11)	0.9%	0.4%	1.3%	0.3%	0.1%	0.4%	1.06
Cultivated (CLC12-17)	3.9%	61.3%	65.1%	4.9%	69.4%	74.3%	1.10
Extensive agric. (CLC18-21)	2.8%	7.7%	10.4%	1.7%	2.7%	4.3%	1.45
Forest and open (CLC22-34)	4.4%	8.0%	12.4%	2.4%	8.1%	10.4%	0.63
Water (CLC35-43)	3.3%	1.3%	4.6%	3.8%	1.7%	5.6%	0.95
Other and not reg. (CLC44-255)		0.3%	0.3%		-0.4%	-0.4%	#N/A
Total	15.5%	84.5%	100.0%	13.1%	86.9%	100.0%	

Areas are classified according to the Corine Land Cover classification. Nature designation index: The ratio of nature/total in the region to nature/total in the country.

Source: Author's calculations based on GREECO datasets (Hansen, 2013).

The areas designated for nature purposes are protected to various degrees and aimed at different ecosystems, species, landscape values etc. Designation of areas for nature purposes means that economic activities in these areas have lower priority. In the accounts shown in table 6 it is assumed that economic activities take precedence for natural ecosystems in areas

that are not designated nature areas. This is, obviously not always the case, but at least it is a risk.

The urban areas of the region make up a share of the territory that corresponds to the share in the rest of the country. The agricultural area, however, make up a significantly higher share than it does in the country as a whole. This is among other things due to a high soil quality on the islands. Other interesting properties of the land cover statistics is that the forested area and extensive agriculture – that is, economic use with high nature content – uses a smaller share of the territory than in the rest of the country.

The table also shows a regional index of nature designation. It shows that within the individual classes of land cover, a smaller part of the forest area is designated for nature purposes than in the rest of the country.

These properties combined with the high population density of Zealand leads to the possibility that investment in restoration of the natural ecosystems can add value to the region in two ways. The region can become more residential attractive and attract more tourists.

7.2 Shannon Evenness Index

Another indicator that attempts to indicate the quality of landscapes is the Shannon Evenness Index (SEI). The EUROSTAT programme LUCAS quantifies the land-use in Europe with statistical tools. The Shannon Evenness Index of landscape diversity is the Shannon Diversity Index divided by the maximum value in the dataset. The SEI-index varies across European NUTS2-regions from 0.28 to 0.81. The SEI-index of Region Zealand is 0.72, which is in good end of the scale.

8 Conclusions

Region Zealand contrasts the neighbouring Capital Region with a low level of per capita GDP. This average, however, covers a considerable gap between parts of the region. The northeast part of the region adjacent to the Capital Region enjoys a high level of income and education. The more peripheral parts of the region towards the south and the west have levels of income and education that are lower than the national average. The study shows that the potentials of the green economy are also potentials for these parts of the regions to catch up with the more well off parts of the region.

In the south, the expansion of wind energy generation, wind turbine blade manufacturing and demonstration facilities have counteracted the long-term decline in jobs and income following the trends in industrial and regional structures. These trends, however, have been too strong to be offset by these green growth initiatives.

In the west, the innovative industrial symbiosis and the biofuel cluster lay the foundation for competitive industrial production in the future. In both cases, the municipal authorities and local networks have been the driving forces, but backed by the regional council. Large scale production of second generation biofuels is expected to be put into action when the EU regulation ensures a reliable European demand for second-generation biofuels.

Conflicting interests in landscape values and wind resource rents hamper the development of the excellent wind potentials in many parts of the region. These conflicts can often be mediated by arrangements sharing the resource rent from wind generation with the local community. In Denmark such arrangements are instituted by the national government.

Other economic potentials include the investment in energy efficient buildings and in sustainable transport infrastructure. The region hosts a relatively large construction industry and the region supports the coordination of competences related to energy efficient buildings and sustainable construction. This is expected to strengthen the competitiveness and be helpful in achieving a high share of the anticipated booming market in the 2010s.

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