

Inspire policy making by territorial evidence

Territories and low-carbon economy Greater Copenhagen, Denmark

Applied Research

Case Study Report

Version 30/04/2017

This applied research activity is conducted within the framework of the ESPON 2020 Cooperation Programme, partly financed by the European Regional Development Fund.

The ESPON EGTC is the Single Beneficiary of the ESPON 2020 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway and Switzerland.

This delivery does not necessarily reflect the opinion of the members of the ESPON 2020 Monitoring Committee.

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Territories and low-carbon economy

Regional Case Study: Greater Copenhagen, Denmark

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Definitions and glossary

Byen København [20]

Part of Greater Copenhagen. It includes 4 municipalities:

Part of Greater Copenhagen. It includes 13 municipalities:

- 1. København
 - 2. Frederiksberg
 - 3. Drager
 - 4. Tårnby.

Greater

area [20]

It includes the municipalities in Byen København and Københavns Omegn: 1. København

Copenhagen, Copenhagen

- 2. Frederiksberg metropolitan
 - 3. Albertslund
 - 4. Brøndby
 - 5. Gentofte
 - 6. Gladsaxe
 - 7. Glostrup
 - 8. Herlev
 - 9. Hvidovre
 - 10. Lyngby-Taarbæk
 - 11. Rødovre
 - 12. Tårnby and
 - 13. Vallensbæk
 - 14. Ballerup
 - 15. Rudersdal
 - 16. Furesø
 - 17. Ishøj City

Københavns

Omegn [20]

- 1. Albertslund 2. Ballerup
- 3. Brøndby
- Gentofte 4.
- 5. Gladsaxe
- 6. Glostrup
- 7. Herlev
- 8. Hvidovre
- 9. Høje-Taastrup
- 10. Ishøj
- 11. Lyngby-Taarbæk
- 12. Rødovre, and
- 13. Vallensbæk

Region Hovedstaden [20]

Consists of 29 municipalities. It includes:

1. 4 municipalities in Byen København,

- 2. 13 municipalities in Københavns Omegn,
- 11 municipalities in Noordsjælland and 3.
- 4. Bornholm municipality

Regions in Denmark [20]

Denmark consists of 5 regions:

- 1. **Region Hovedstaden**
- 2. **Region Sjælland**
- Region Syddanmark 3.
- 4. Region Midtjylland
- 5. **Region Nordjylland**

IV

1 General description of the region

1.1 Location of region and characteristic

The metropolitan region of Denmark's regional growth and development strategy, namely Greater Copenhagen is based on a vision of creating a green and innovative metropolis with high growth and quality of life. Statistics Denmark (2016) has defined that Greater Copenhagen consists of 17 municipalities: København, Frederiksberg, Albertslund, Brøndby, Gentofte, Gladsaxe, Glostrup, Herlev, Hvidovre, Lyngby-Taarbæk, Rødovre, Tårnby and Vallensbæk municipalities together with part of Ballerup, Rudersdal and Furesø municipalities and at last Ishøj City area and Greve Strand City area [20].

Figure 1.1: Greater Copenhagen's municipalities



Besides, there is also a larger definition of Greater Copenhagen to promote a strong international brand. Greater Copenhagen is defined as a collaboration between Denmark and Sweden in business and politics, to attain a position as one of the most successful metropolises in Europe. It is where Denmark meets Sweden, and Scandinavia meets the world. Through this definition, Greater Copenhagen is consisted of 46 local municipalities from 2 regions; including The Capital Region in Eastern Denmark and 33 local municipalities from 1 region in Southern Sweden [17].

It is the home of 3.84 million inhabitants and the largest recruitment based of high skilled employees in Scandinavia. This international brand promotes a clean and green metropolis, competitive business costs, talent hub, the world's least corrupt countries and a great place to live [4].

The Greater Copenhagen region is more than just urban centers. The efficient commuting options link the surrounding areas of *Hovedstaden* into Greater Copenhagen, and in Greater Copenhagen they are all interdependent. The Capital Region, Hovedstaden, covers Greater Copenhagen, Nordsjælland and Bornholm [20]. Some data of Greater Copenhagen are presented in region Hovedstaden level such as demographic structures, dwelling by type of

buildings and labour force. In this report, we will focus on Greater Copenhagen based on the definition from Statistics Denmark in NUTS 3 level: Byen København and København Omegn.

Greater Copenhagen is located in the eastern part of Denmark which is bordered to the south-west of Sweden, including the island of Bornholm. The various colors in the map represent the five regions of Denmark. The light orange is Nordjylland region, the light green is Midtjylland region, the light pink is Syddanmark region, the light yellow is Sjælland region and the light purple is Hovedstaden or The Capital Region, where Greater Copenhagen is located.



Figure 1.2: Map of the five regions in Denmark including the Greater Copenhagen within Denmark in purple [20]

On 1 January 2016, Statistics Denmark (2016) has recorded that the population of Greater Copenhagen's equals to 1,280,371, which is 22.43% of the total of Danish population 5,707,251 [20].

Ne	Municipa	lities of region Greater Copenhagen	Population
NF.	Code	Name	1 January 2016
1	101	København	591,481
2	147	Frederiksberg	104,481
3	155	Drager	14,142
4	185	Tårnby	42,860
5	165	Albertslund	27,880
6	151	Ballerup	48,224
7	153	Brøndby	35,322
8	157	Gentofte	75,350
9	159	Gladsaxe	67,914
10	161	Glostrup	22,461
11	163	Herlev	28,423
12	167	Hvidovre	52,831
13	169	Høje-Taastrup	49,960
14	183	Ishøj	22,358
15	173	Lyngby-Taarbæk	55,097
16	175	Rødovre	38,002
17	187	Vallensbæk	15,419
Great	er Copenha	igen	1,280,371

Table 1.1: Municipalities and inhabitants (2016) [20]

The population development in Greater Copenhagen from the first quarter of 2008 is presented as follow [20]:

Municipalities	Population at the first day of the quarter by region and time											
	2008Q1	2009Q1	2010Q1	2011Q1	2012Q1	2013Q1	2014Q1	2015Q1	2016Q1			
Copenhagen	509,861	518,574	528,208	539,542	549,050	559,440	569,557	580,184	591,481			
Frederiksberg	93,444	95,029	96,718	98,782	100,215	102,029	102,717	103,192	104,481			
Dragør	13,261	13,411	13,564	13,717	13,692	13,917	13,977	14,028	14,142			
Tårnby	40,016	40,214	40,383	40,835	41,151	41,572	41,992	42,573	42,860			
Albertslund	27,602	27,706	27,730	27,800	27,864	27,824	27,728	27,806	27,880			
Ballerup	47,116	47,398	47,652	47,930	47,994	48,211	48,514	48,355	48,224			
Brøndby	33,831	33,762	33,795	34,021	34,084	34,210	34,580	35,050	35,322			
Gentofte	68,913	69,794	71,052	71,714	72,814	73,360	74,282	74,932	75,350			
Gladsaxe	62,562	63,233	64,102	64,951	65,303	66,030	66,656	67,347	67,914			
Glostrup	20,673	21,008	21,296	21,384	21,650	21,869	22,066	22,357	22,461			
Herlev	26,567	26,635	26,556	26,597	26,608	26,958	27,706	28,148	28,423			
Hvidovre	49,380	49,366	49,724	50,081	50,600	51,341	51,842	52,380	52,831			
Høje-Taastrup	47,158	47,400	47,664	47,753	48,081	48,471	48,807	49,230	49,960			
Ishøj	20,687	20,756	20,606	20,797	21,087	21,131	21,547	22,025	22,358			
Lyngby-Taarbæk	51,449	51,532	52,237	52,754	53,251	53,840	54,237	54,778	55,097			
Rødovre	36,144	36,228	36,233	36,524	36,883	37,351	37,552	37,743	38,002			
Vallensbæk	12,399	13,365	14,045	14,445	14,565	14,797	15,095	15,204	15,419			
Total	1,161,063	1,175,411	1,191,565	1,209,627	1,224,892	1,242,351	1,258,855	1,275,332	1,292,205			

Table 1.2: Annual's first quarter population growth

Figure 1.3 below illustrates the development of the total population listed in Table 1.2.



Figure 1.3: Urban population growth from 2008Q1 to 2016Q1

1.2 Socio-demographic structure and development

Greater Copenhagen is a safe and secure place to live. The society has a high quality of life, trust and good public services, which is a solid foundation to develop modern technologies, health and welfare. It has also created a leading research community with 11 universities, highly specialized in engineering, hospitals, bio-health clusters and a tradition of innovative collaboration environments. In total, there are 906,929 people in the region that are attending education from basic school to higher education including Ph.D students in 2015. It covers 34% of the total Danish population of 30-69 years old. There are currently 22,425 highly educated foreigners living in The Capital Region [5,6,20].

30-69 years- old, place of residence 1 Jan. 2015	Basic school or not known	General upper – secon- dary educa- tion	Voca- tional educa- tion and training	Short- cycle higher educa- tion	Me- dium- cycle higher educa- tion	Bache lor	Long- cycle higher educa- tion/PhD	Un- known	Total
Denmark, total	593,831	139,000	1,093,826	140,596	488,207	46,143	292,295	126,212	2,921,517
Region Hoved- staden	149	60,257	267,569	42,359	153,122	23,609	156,045	53,672	906,929

Table 1.3: Demographic structure – age structure, education levels [20]

In 2016, about 71% of the 30-69 years-old had finished vocational or higher education in Denmark.

Population development of Greater Copenhagen from 2015 to 2035 is projected to increase with 10%, as displayed in the municipalities' population projection figure below. This projection is based on a cautious calculation of births, deaths, migrations among the municipalities and a number of future trends assumptions [20].



Figure 1.4: Number of students in the educational system per 1 October 2016 [29]

¹Higher preparatory examination. ² Higher commercial examination. ³Higher technical examination. ⁴International Standard Classification of Education. ⁵ Enrolled 2015.





1.3 Settlement type and building stock

Based on the regional analysis of dwelling stock by type of building there are in total 859,915 dwelling stock in The Capital Region (2015), which is 30% of the Danish total. It is categorized into farm and one-family houses detached, terraced or semidetached houses, multifamily buildings, student hostels and other dwellings. The average number of occupants per household in Denmark is 2.14 and the occupied dwellings are 2,628,338. In the whole Denmark, there are 252,856 dwellings that are constructed before year 1900 and 59,115 during 2010 to 2014. Individuals own the most dwellings in Denmark, 1,654,109, covering 59% of the total. Public authorities own 61,232 dwellings, which is 2.19% of the total.

Underground hot water piping networks, district heating, dominate domestic heating in Denmark and covers 1,671,822 of the dwelling stock. Sources for the district heating networks are waste, and biomass, some large scale solar thermal systems. Only recently small and large scale heat pumps are introduced. The production of renewable energy has increased in recent years and now accounts for 27% of the total gross energy consumption. Renewable energy including wind power and solar energy, etc lead to no emissions of greenhouse gases [20].

1 January 2015							
	Farm and one-family houses de- tached	Terraced or semide- tached houses	Multi-family buildings	Student hostels	Other dwellings	Dwelling stock total	
			number of du	vellings			
Denmark, total	1,214,664	407,192	1,083,662	38,332	41,997	2,785,847	
Region Hovedstaden	193,383	108,760	530,688	15,784	11,300	859,915	

Table 1.4: Dwelling by type of building

1.4 Transport system and modal split

Greater Copenhagen lies in a very strategic position. It is the intersection of Scandinavia and Europe, with direct connections to 140 destinations, the Oresund Bridge and the future Fehmarn Belt link. Thus, coordinating and expanding public transportation is necessary for the success of Greater Copenhagen which requires extensive collaboration in the public transport sector. Public transport in Copenhagen is currently managed by DSB, Movia and Metroselskabet. A new umbrella organisation called DOT (DitOffentligeTrafikselskab.dk) was established on 1 January 2015, as a result of the 2014 revision of the Act on Transport. However, DOT, which is headed by a coalition of transport company heads, lacks the democratic legitimacy. As a result, The Capital Region of Denmark, in cooperation with the state, local authorities, transport companies and other relevant stakeholders, will work to establish the basis for political leadership that will be responsible for all public transport in Greater Copenhagen. This includes busses, Metro, S-trains, light rail, the Coastal Line and other regional trains.

In 2014, the majority of commuting in Denmark was by car (77%), 8% by bus and 9% by train. The bicycles or mopeds covered 4%. In recent years, there are more commuting with S-tog, the regional train system in Greater Copenhagen. There were 306,000 journeys with S-tog

and 153,000 journeys with the Metro, which both increased by 2% from the year before. In 2013, the commuters from Copenhagen accounted for the shortest distance. People living in Copenhagen and Greater Copenhagen only commute, respectively 12.2 km and 13.1 km to their work. People who are living in other provinces, commute between 20.5 km and 22,6 km to their work [2,5,20].





Specifically in Copenhagen, an increasing number of people use bike to and from their work or education. It has increased from 36% in 2012 to 45% in 2014. An impressive 1,340,000 km is cycled during a weekday. Travel time for cyclists has been reduced by 7% since 2012. The municipality has a target to obtain its climate goal by 50% of the population taking their bike to work or education in 2025. To reach the goal of 50%, it requires investments of about \notin 260 million during a 10-year period [2,20].

1.5 Regional economic structure and development

Greater Copenhagen plays important role as the Danish growth engine with a global impact. It drives development throughout the country and has a special role to ensure growth and job creation [19,20]. Notably, it:

- Generates around 40% of Denmark's GDP (Gross Domestic Product)
- Attracts around 85% of foreign investment
- Created around 75% of all new jobs in Denmark in the past decade

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- Is home to companies that produce around half of Denmark's exports
- Is the recipient of Denmark's largest private and public investments in research and development
- Capital region has the highest share of job vacancies rate with 2.0% in 2015. The lowest share was seen in Region Nordjylland, as only 1.0 per cent of all vacant and occupied jobs were vacant.

Table	1.5	l abour	force	men	and	women
rabic	1.0.	Labour	10100	men	anu	women

Nov. 2013		Labour force population				Persons outside the labour force			Popula- tion total
	Self-employed persons	Assisting spouses	Employees	Un-employed persons	Total	Temporarily outside the labour force	Pensioners	Other persons outside the labour force	
Region Hovedstaden					Thousar	nds			
Men and women, total	58.1	1.1	805.1	44.4	908.6	53.1	322.0	466.1	1,749.8
Men, total	39.0	0.2	400.8	23.3	463.2	23.6	134.4	235.7	857.0
Women, total	19.0	0.9	404.4	21.1	445.4	29.5	187.6	230.4	892.9

In 2014, the average earned income per household was 495,886 DKK. The total average income from earned income and gross income was 728,523 DKK per household [20].

Table 1.6: Income 2014

2014	1	Region Hovedstaden DKK per household
А	Earned income (B+C)	495,886
В	Wages and salaries, etc.	475,769
С	Entrepreneurial income, etc.	20,117
D	Property income	76,434
E	Private transfers	60,811
F	Transfers from the public sector	83,449
G	Other income and reconciliation	3,628
Н	Gross income (A+D+E+F+G)	720,208
Ι	Capital transfers to the household	8,315
J	Total income (H+I)	728,523
К	Income taxes, etc.	216,188

The GDP annual average real growth in 2008 to 2014 is 0.9%.

	1 0 1				
	GDP 2015	GDP per C	apita 2015	Annual aver-	Average
	Current prices, DKK mio.	Current prices, DKK 1,000	The whole Country = 100	age real growth 2009- 2015 [%]	real growth 2015 [%]
Denmark	2,027,171	357	100	1.3	1.6
Region Hovedstaden	817,166	460	129	2.4	2.3

Table 1.7: GDP in Greater Copenhagen per 2015 [29]

Province København Byen	358,039	488	142	1.5	2.5
Province København Omegn	271,028	508	148	1.0	1.3
Province Nordsjælland	130,766	287	80	0.4	0.5
Province Bornholm	10,207	256	72	1.1	2.7

Denmark's GDP total in 2016 was 49,810 US dollars/capita [28] and it is increased by 1.3% in 2016 [29]. In 2014 the average family income after taxes was DKK 344,800. The wealthiest family incomes were recorded in the municipalities north of Copenhagen. Family income was DKK 628,200 in Rudersdal and 613,500 in Gentofte [17, 18]. The inflation in 2016 was 0.4%.

In the Greater Copenhagen, the GDP per capita was 25% above the national level in 2014 [5,6].





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Figure 1.8: GDP (total and per capita, share per sector) [20]

1-2.1.1 Production and generation of income (10a3-grouping)

Price unit: Pr. capita. Current prices, (1000 DKK.) | Industry: Total | Transaction: B.1GF Gross domestic product at factor cost | Region:

----- Province Byen København ------ Province Københavns omegn ------ Province Bornholm



Table 1.8: Regional economic profile (employment) [20]

Greater Copenhagen								Emplo	yment							
plus Bornholm	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total	751,659	767,261	766,289	760,967	761,172	783,580	797,981	810,886	807,671	800,580	788,415	799,241	796,889	807,140	817,629	832,360
A. Agriculture, forestry and fishing	1,999	1,988	1,879	1,959	1,886	1,793	1,689	1,645	1,617	1,524	1,387	1,345	1,327	1,268	1,312	1,250
B. Mining and quarry- ing	141	151	132	146	150	146	134	138	89	88	96	112	119	85	84	80
C. Manufacturing	49,624	49,815	47,020	46,787	46,590	45,680	45,270	45,843	47,119	44,139	40,934	42,283	42,433	41,743	42,705	43,711
D_E. Utility services	5,528	5,720	5,773	5,670	5,837	5,381	5,600	5,946	6,686	6,212	5,338	5,097	4,036	4,413	4,566	4,389
F. Construction	33,869	32,847	32,460	26,740	28,470	29,969	32,419	32,297	31,146	28,227	28,435	30,372	30,247	28,197	30,668	31,419
G_I. Trade and trans- port etc.	200,054	201,883	198,607	198,300	195,982	200,921	206,067	212,582	213,063	202,677	195,972	202,331	203,922	208,263	210,583	212,554
J. Information and communication	49,532	51,613	52,551	50,551	50,474	50,245	53,129	56,201	55,526	55,544	55,368	54,213	53,630	54,904	55,489	57,816
K. Financial and insur- ance	38,646	39,668	39,699	39,260	38,224	37,767	42,811	41,182	44,053	46,541	44,308	44,584	43,055	41,645	42,042	42,579
LA. Real estate activi- ties and renting of non- residential buildings	5,117	5,397	5,600	6,084	6,454	6,936	7,444	8,288	8,279	7,573	7,787	8,030	7,829	7,793	7,829	7,886
LB. Dwellings	6,649	6,812	6,694	6,689	6,283	6,369	6,253	5,472	6,193	6,619	6,515	6,338	6,389	6,391	6,451	6,513
M_N. Other business services	88,649	93,322	92,551	93,837	95,237	100,421	103,451	106,570	101,467	98,355	95,685	97,755	98,729	103,401	105,820	112,257
O_Q Public administra- tion, education and health	221,261	225,555	228,969	230,026	229,235	236,404	231,865	234,460	236,923	247,309	251,073	249,858	249,321	253,056	253,959	255,866
R_S Arts, entertain- ment and other ser- vices	50,590	52,491	54,351	54,918	56,349	61,550	61,848	60,263	55,508	55,768	55,516	56,923	55,852	55,982	56,118	56,040

Units: Number of persons/1000 hours

The line graph below is illustrating the total employment from Table 1.8.



Figure 1.9: Annual employment in Greater Copenhagen plus Bornholm

In general, the service sector accounts, by far, for the highest number of persons employed in Denmark. The largest industry groups are thus *public administration, education and health* employing 865,000 persons (corresponding to 31.8 per cent of persons employed) and *trade and transport etc.* employing 658,000 persons (24.2 per cent of persons employed).

	2003	2013	Change
	Th	ousand perso	ns
A Agriculture, forestry and fishing	87	72	-15
B Mining and quarrying			
C Manufacturing			
D Electricity, gas, steam and air conditioning supply	420	311	-109
E Water supply			
F Construction			
G Wholesale and retail trade	631	649	±1 8
H Transportation and storage	051	049	+10
I Accommodation and food service activities			
J Information and communication	100	101	+1
K Financial and insurance activities	78	79	+1
L Real estate activities	36	45	+9
M Professional, scientific and technical activities			
N Administrative and support service activities			
O Public administration and defence	826	971	+15
P Education	020	0/1	745
Q Human health and social work activities			
R Arts, entertainment and recreation	114	120	+6
S Other service activities	235	287	+52
T Activities of households as employers			
U Activities of extraterritorial organisations and bodies			

Table 1.9: Number of persons employed in Denmark from 2003 to 2013 [20]

2 Energy strategy, energy consumption and regional renewable energies

2.1 Regional highlights and challenges

Highlights

• New growth

In order to create new growth in Denmark, Greater Copenhagen conducts some initiatives by taking advantage of the high quality of life, knowledge and adaptability in areas such as energy, digitization, environment, health and welfare technology. Each year 5% of Denmark's GDP is invested in research and development in this region. In practice, Greater Copenhagen wants to improve the quality of life goal by having high-quality drinking water, cleaner soil and air, low carbon emissions and a high capacity for climate adaptation.

• Green economy program

Denmark has a success story of applying Green economy in term of energy use and energy efficiency.

- (a) Environmental subsidies
- (b) Environmental taxes
- (c) Green Tax burden of 4.1% of GDP
- (d) Sales of environmental goods and services

In 2014, 174 billion DKK are generated on environmental goods and services. The most extensive production of environmental goods and services was related to energy, partly to the production of renewable energy and partly for energy saving initiatives. The production in the energy area had a value of DKK 110 billion in total [4,7].



Figure 2.1: Environmental goods and services. Turnover 2014 [20]

• Research and development

The success in the energy areas is supported by significant investments in research and development. Greater Copenhagen is ranking first among more than 200 metropolises worldwide of registered patents including the energy areas. It has 59% of all national patents.

The Challenges

• Transport sector

The challenge in The Capital Region comes from the transport sector that is responsible for the significant share of the region's carbon emissions. To achieve the region's fossil free goal, ongoing investments will be made to reduce carbon emissions. Improvement in the public transport is required to make it more efficient, smarter and more attractive. Besides, cycling may reduce carbon emissions and congestion. Car sharing and carpooling programmes must be expanded.

· Industry and household

Industry and household are also the main cause of CO_2 , SO_2 , NO_x and CO emissions, and other air pollutants. In practice, some emissions are also related with fertilizer application and use of solvents and acids, etc. These non-energy related emission such as N2O and CH4 as well as for NH3 and NMVOC are significant for the greenhouse gases [20].

2.2 Energy strategy of the region

Greater Copenhagen has an ambitious political vision of creating a green and innovative metropolis with high growth and quality of life. The quality of life goal is an ambition to one of the world's best and most attractive environmental metropolises with high-quality drinking water, cleaner soil and air, low carbon emissions and a high capacity for climate adaptation. The outcomes of growth goal and quality of life goal are:

- To reduce the travel time with 20% on selected priority routes by 2025.
- To reduce noise and air pollution by 40% from the transport sector by 2025.
- To create fossil-free transport sector by 2050.
- To increase access to public transport to and from Copenhagen airport with 35% by 2025.
- To improve international connections by 2025.

The current implementation strategy in Denmark is by applying green economy. Denmark has had a special focus on developing and using green technologies including renewable energy technologies and environmental protection solutions. For example, green tax is applied to move the economy in a more environmentally, friendly and resource-saving direction. In addition to regulation by green taxes, every year, the government provides subsidies to motivate environmental action. These subsidies and transfers include aid for environmental protection, such as waste management, and to reduce the exploitation of exhaustible natural resources and better utilization of renewable energy resources. These programmes apply to industries,

international organizations and households and amounted to 9.4 billion DKK in 2014. It is a little under half a % of GDP and has more than doubled since 2010. The energy related subsidies are primarily support for wind power production and other renewable energy technologies financed by a Public Service Obligation (PSO) tax, and accounted for 75% of the total environmental motivated subsidies in 2014.

2.3 Regional and local energy infrastructure

For the type of heating installation, district heating is dominated in Denmark, and covers 1,671,822 dwellings. The proportion of dwellings with district heating has increased since 1981, from 34% to 64%, while the %age of oil-heated dwellings has decreased from 53% to 10% during that period. Central heating from own units: oil boilers, natural gas boilers and others heat 807,931 dwellings. 142,942 dwellings are using biomass heating stoves and 5643 dwellings are without heating installation or not known.





2.4 Patterns of energy consumption

Denmark population both urban and rural has 100% access to electricity. The electricity consumption per capita in Denmark shows a slightly decline in this recent years. It was reported that the electric power consumption in Denmark was at 5859 kWh per capita in 2014 [27].

2010	2011	2012	2013	2014
		kWh per capita		
6,327.5	6,166.0	6,038.6	6,039.4	5,858,8

Table 2.1: Electric power consumption (kWh per capita) [27]

The production of renewable energy has increased in recent years, and now accounts for 27% of the total gross energy consumption, which is calculated as the consumption of oil, natural gas, coal and renewable energy [20].



Figure 2.3: The production and consumption of renewable energy (Pj)

The determination of actual energy consumption relates energy use to the municipalities and regions where the energy consumption has actually taken place. In the calculation gross energy consumption has been adjusted such that the energy supply and energy consumption have been attributed to the municipalities and regions where the consumption of their products, such as electricity and district heating, takes place. In addition, energy consumption is adjusted for net imports of electricity [7].

Table 2.2: Energy consumption by sectors 2000-2016 [7]

Greater Copenhagen	Actual Energy Consumption (GJ)								
	2000	2001	2002	2003	2004	2005	2006	2007	
Households	43,146,830	44,433,048	43,459,163	44,052,894	43,681,362	43,032,574	42,834,455	42,221,820	
Agriculture, forestry and fishing	722,246	775,187	746,684	676,150	628,805	694,846	713,261	911,248	
Mining and quarrying	74,334	44,016	160,137	295,899	292,942	317,415	213,085	135,558	
Industry	9,240,449	9,478,275	8,965,001	8,487,443	8,523,659	8,921,893	8,962,901	9,174,040	
Utilities	68,752,171	72,153,335	80,729,511	83,885,790	83,750,938	73,003,350	86,912,758	74,728,501	
Construction	3,275,142	3,343,658	3,609,290	3,775,688	3,899,178	4,213,646	4,388,370	6,588,437	
Trade and transport etc.	19,970,766	20,296,458	20,341,830	20,994,922	20,760,172	21,871,416	22,653,031	26,296,744	
Information and communication	2,352,243	2,441,717	2,546,206	2,428,950	2,548,325	2,635,758	2,697,526	2,796,120	
Finance and insurance	1,113,747	1,145,255	1,197,687	1,258,350	1,176,905	1,217,617	1,316,501	1,338,633	
Trade of property and commercial property	534,129	501,939	600,608	664,699	619,432	679,831	757,013	975,441	
Housing	253,482	266,730	240,127	299,661	265,930	283,511	274,021	225,061	
Business Service	2,902,573	3,122,551	3,357,208	3,618,520	3,816,470	4,128,300	4,264,486	4,799,337	
Off. Managing, education, health	6,562,902	6,975,407	6,548,113	6,955,060	7,424,651	8,250,498	8,324,620	8,428,603	
Arts, entertainment, other service	2,015,513	2,117,847	2,104,638	2,246,608	2,297,440	2,498,124	2,550,648	2,551,234	

Table 2.2: Energy consumption by sectors 2000-2016 [7] (continued)

Greater Copenhagen	Actual Energy Consumption (GJ)								
	2008	2009	2010	2011	2012	2013	2014	2015	
Households	42,852,809	42,735,033	46,561,551	42,659,301	42,699,652	42,316,208	39,413,910	40,185,855	
Agriculture, forestry and fishing	775,994	667,281	793,159	850,792	758,249	681,842	697,956	692,628	
Mining and quarrying	162,851	92,576	105,247	96,462	102,438	114,599	129,272	129,392	
Industry	8,931,897	7,857,452	8,342,228	9,055,417	8,377,517	7,610,488	6,786,310	6,726,372	
Utilities	69,888,054	73,595,124	80,732,982	84,013,854	72,911,890	86,463,004	63,551,206	56,939,749	
Construction	6,171,787	4,840,319	5,559,573	6,336,305	5,546,683	4,295,859	4,970,391	4,975,842	
Trade and transport etc.	26,568,890	23,836,945	25,400,408	23,154,542	22,311,531	23,408,967	22,869,858	23,056,828	
Information and communication	2,773,096	2,613,135	2,687,255	3,174,739	3,218,097	2,780,299	2,671,061	2,718,016	
Finance and insurance	1,524,540	1,267,781	1,326,084	1,405,501	1,355,746	1,221,676	1,124,574	1,143,058	
Trade of property and commercial property	889,233	835,668	976,122	536,442	559,390	470,004	451,805	463,274	
Housing	205,005	201,482	222,140	283,314	315,433	286,838	274,700	282,083	
Business Service	4,686,965	4,141,688	4,438,852	4,371,218	4,195,110	3,760,526	3,801,401	3,892,735	
Off. Managing, education, health	7,799,946	8,117,647	8,541,926	8,081,074	8,360,135	8,347,734	7,931,438	8,078,438	
Arts, entertainment, other service	2,582,830	2,336,481	2,572,781	2,053,727	2,071,150	1,901,314	1,785,304	1,817,929	

Table 2.3: Share of energy carriers by sector 2000-2016

Total supply (= total use)			Energy accoun	ts for Denmar	k in specific u	nits. 2014 [20]	1	
	Crude oil and refinery feedstocks	Coal and coke	Oil products	Natural gas – extraction and imports	Natural gas - consump- tion and exports 2	Renewable energy etc3	Electricity	District heat
		1000 tonnes		mill.	nm ³	τJ	GWh	Ţ
Exports	4,813	167	5,602		1,984	6,514	10,603	
Changes in inventories	112	77	1,369		16	423		
Distribution losses etc				85	4	2,359	1,974	24,091
Households		0	2,033		613	42,233	10,104	62,051
Total industries	6,940	4,353	14,819	4,985	2,092	166,277	21,591	33,739
Agriculture, forestry and fishing		42	482		36	3,002	1,859	1,585
Mining and quarrying		4	21	582	17	887	92	9
Manufacturing	6,940	169	902		702	6,316	8,086	3,460
Utility services		4,137	142	4,403	1,163	150,404	1,362	1,131
Electricity, gas, steam and air conditioning supply		4,137	93	4,403	1,156	121,541	745	
Water supply, sewerage and waste management			49		6	28,863	618	1,131
Construction			386		12	881	357	
Trade and transport etc.			12,539		61	2,778	5,365	10,204
Wholesale and retail trade			262		43	709	3,302	7,061
Transportation			12,262		4	2,028	1,319	640
Accommodation and food service activities			15		15	41	744	2,504
Information and communication			16		8	46	590	1,397
Financial and insurance			12		5	33	190	807
Real estate activities and renting of nonresidential buildings			22		2	62	156	318
Dwellings			9		2	28	46	336
Other business services			97		17	296	592	3,101
Knowledge-based services			36		9	109	413	1,630

Total supply (= total use)		E	Energy accoun	ts for Denmar	k in specific u	nits. 2014 [20]	1	
	Crude oil and refinery feedstocks	Coal and coke	Oil products	Natural gas – extraction and imports	Natural gas - consump- tion and exports 2	Renewable energy etc3	Electricity	District heat
		1000 tonnes		mill.	nm³	TJ	GWh	ТJ
Travel agents, cleaning, and other operational services			61		8	187	178	1,471
Public administration, education and health			164		57	1,453	2,384	9,415
Public administration, defense and compulsory social security			111		9	368	311	1,273
Education			26		22	431	847	3,782
Human health and social work			28		26	654	1,226	4,359
Arts, entertainment and other services			27		11	91	512	1,977
Arts, entertainment and recreation activities			11		9	46	427	1,559
Other service activities			16		2	45	85	418
Activities of households as employers of domestic personnel								
Of which Danish ships bunkering abroad1			9,584					
Of which Danish planes bunkering abroad1			645					
Of which Danish vehicles bunkering abroad1			714					

1 Danish operated ships, planes and vehicles bunkering abroad is included in the industry transportation.

2 Includes gas works gas. 3 Includes non-renewable waste.

Greater Copenhagen Actual energy consumption (GJ)									
	2000	2001	2002	2003	2004	2005	2006	2007	
Total	43,146,830	44,433,048	43,459,163	44,052,894	43,681,362	43,032,574	42,834,455	42,221,820	
Fossil fuels (oil, coal, gas)	21,408,571	21,515,301	20,801,524	20,819,499	20,444,332	19,760,721	19,422,181	18,911,502	
Renewable energy	1,604,225	1,624,751	1,637,039	1,795,294	1,884,671	2,103,021	2,307,522	2,703,656	
Electricity	5,669,355	5,594,556	5,639,173	5,650,753	5,684,799	5,713,842	5,768,174	5,636,906	
Heating	14,464,680	15,698,439	15,381,427	15,787,348	15,667,559	15,454,991	15,336,577	14,969,756	

Table 2.4: Total energy consumption of households by end-use (final energy) 2000-2016

Table 2.4: Total energy consumption of households by end-use (final energy) 2000-2016 (continued)

Greater Copenhagen	hagen Actual energy consumption (GJ)									
	2008	2009	2010	2011	2012	2013	2014	2015		
Total	42,852,809	42,735,033	46,561,551	42,659,301	42,699,652	42,316,208	39,413,910	40,185,855		
Fossil fuels (oil, coal, gas)	19,236,778	18,838,274	19,644,615	18,194,526	17,718,450	17,343,328	16,207,597	16,252,113		
Renewable energy	2,694,064	2,706,078	3,008,362	3,051,260	3,209,149	3,202,463	3,034,964	2,931,002		
Electricity	5,592,357	5,491,779	5,624,487	5,508,923	5,444,987	5,623,185	5,616,411	5,595,632		
Heating	15,329,610	15,698,902	18,284,086	15,904,592	16,327,065	16,147,232	14,554,938	15,407,108		

The line graph of household energy consumption by end-use is displayed in the following figure.



Figure 2.4: Households energy consumption by end-use (final energy) in GJ

2.5 Regional potential of renewable energy

Denmark is one of the European Union's countries that has substituted the most fossil fuels and therefore was able to avoid the most greenhouse gasses (GHGs) in proportion to total domestic fossil fuels use and GHG emissions [10]. Since 1976, a green energy cluster has developed in Denmark, consisting of wind power, solar energy and biomass technologies and energy conservation technologies.

In one decade from 1992, the export of these technologies has increased 540 million ECU to around 5000 mill. ECU in 2002. Besides, the employment has increased to around 25,000 persons. It has consequently become one of the main reasons why Denmark has a balance of payment surplus 4800 mill. ECU in 2002 and a low unemployment rate [12].

Annual reductions of CO_2 emissions from energy production (electricity and heating) based on renewable resources such as wind and biomass correspond to 16% of total emissions, leading to a total of 3.3 tons CO_2 per capita in Copenhagen [City of Copenhagen]. The region has potential for producing the renewable energy. The production of renewable energy in Greater Copenhagen has increased 76% from year 2000 to 2015. Biomass was the largest source of production of renewable energy and has the potential to be implemented in other countries. The consumption of renewable energy in Greater Copenhagen has increased over the years.

		Production of renewable energy (TJ)														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Denmark	89,858	91,647	100,401	112,158	115,672	121,856	120,607	134,150	139,696	140,838	142,277	145,346	149,668	147,363	153,955	154,620
Region Hovedstaden	8,879	9,638	10,686	11,940	12,297	14,015	16,266	16,315	17,264	16,236	15,760	14,462	14,754	14,006	15,712	15,700
Firewood	875	1,294	1,027	1,417	1,569	1,271	1,966	2,362	2,490	2,658	2,351	1,861	1,750	2,099	1,798	1,694
Scrap wood*	606	245	561	759	720	123	970	1,168	984	500	1,153	1,035	1,001	1,008	1,020	973
Straw	634	576	783	816	700	811	771	747	931	1,098	851	800	999	752	760	717
Waste	6,424	6,898	7,582	8,216	8,514	11,001	11,689	10,934	11,806	10,964	10,417	9,646	9,814	9,106	10,797	10,894
Biogas	190	198	154	112	138	185	232	265	247	289	229	264	326	244	371	350
Windpower	150	428	581	621	656	624	637	837	804	726	758	857	866	797	967	1,071
Hydropower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.5: Renewable energy production in capital region which includes Greater Copenhagen, Nordsjælland and Bornholm [7]

* Scrap wood covers wood waste, wood chips and wood pellets

2.6 Use of renewable energy in the region

In recent years, the renewable energy consumption in Denmark has been rising and accounts for 27% of total gross energy consumption [20]. A geothermal demonstration project was officially opened on 05/05/2006 to produce warm water to the district heating system in Copenhagen. The capacity of the plant is equivalent to the heat consumption in 4,000-5,000 housing units, which accounts for 1% of the district heating demand. Another project of renewable energy, which is the conversion from coal to biomass was initiated in 2010 and has been completed at all major CHP plants in the city by 2015. Based on CEESA 2050 scenario, the capacities of onshore and offshore wind power and solar PV can provide almost 80% of the gross electricity consumption in Denmark.

The consumption of renewable energy in Greater Copenhagen has almost doubled from 9,36% in 2000 to 17,45% in 2015. The year 2012 followed by 2013 was recorded as the largest percentage increase of consumption compare with all Denmark during the period of 2000 to 2015.

Renewable energy actual consumption (GJ)									
Years	Denmark	Greater Copenhagen	Greater Copenhagen in %						
2000	78,532,828	7,349,305	9.36						
2001	84,980,549	7,704,720	9.07						
2002	90,996,290	9,700,415	10.66						
2003	104,060,113	11,933,472	11.47						
2004	114,562,348	15,892,715	13.87						
2005	122,030,581	17,787,372	14.58						
2006	124,275,104	15,847,004	12.75						
2007	137,740,508	17,461,512	12.68						
2008	139,286,905	18,238,452	13.09						
2009	142,010,642	19,035,672	13.40						
2010	168,214,083	28,956,132	17.21						
2011	172,500,624	31,799,690	18.43						
2012	180,149,360	34,874,764	19.36						
2013	186,084,916	35,743,802	19.21						
2014	191,176,606	33,864,158	17.71						
2015	195,719,935	34,154,765	17.45						

Table 2.6: Consumption of renewable energy 2000-2016 [7]

The actual consumption of renewable energy is illustrated in Figure 2.5 below.



Figure 2.5: The consumption of renewable energy in Greater Copenhagen 2000-2015 [7]

3 Governance and important regional policies

3.1 Regional governance system

The Greater Copenhagen has a high energy demand that is generated by the high population density. The high energy demand is a tough challenge and requires a significant investment in green solution of renewable energy. The implementation of renewable energy technologies is a joint responsibility between several actors [1]. The local authorities and local utilities are the main important actors.

The regional policy regarding low carbon has developed through the regional governance system, and in Greater Copenhagen it is formed under the structure of The Capital Region. There are 8 main priorities as the focus of The Capital Region:

- (1) Healthcare services
- (2) Research and innovation
- (3) Education
- (4) Businesses
- (5) Traffic
- (6) Environment
- (7) Politics
- (8) Greater Copenhagen.

A Low Carbon policy is developed under Environment and Greater Copenhagen priorities. Figure 3.1 displays the regional structure regarding low carbon. There are four main focuses of Environment, and one of it, is the climate strategy.

The Capital Region and its municipalities have the vision to be the most energy-efficient region in Denmark and best-prepared region in terms of climate change through solid collaboration with government, private sector and knowledge institution. This collaboration form is well known as triple helix governance approach (Figure 3.2).

The climate change has five main areas that have been given regional political priorities:

- (1) A climate-change ready region
- (2) A climate-friendly transport system
- (3) Transition to a fossil-fuel-free energy system
- (4) Energy-efficient buildings
- (5) Climate-friendly consumption and procurement

Furthermore, there two strategic initiatives are being prepared by the municipalities and The Capital Region:

- (1) To be the leading electric car region
- (2) A coherent energy system based on renewables

To monitor the realization of the strategy, a Climate-Policy forum has been established for this purpose. The municipalities have appointed five politicians to the forum, which are represented by Fredensborg, Helsingør, Copenhagen, Albertslund and Frederiksberg. The climate strategy is followed up by the climate conference and seminar. The first conference in 2012 addressed a common vision for coherent energy planning of The Capital Region.

The next area beside Environment, is related to Greater Copenhagen. As mentioned in chapter 1, The Capital Region is also part of Greater Copenhagen together with Southern part of Sweden. The low carbon policy is derived from the efficient and sustainable mobility framework. It has resulted in the green growth initiatives.

Many green projects are implemented under this structure and it has a coordination line with the climate-policy forum [17].

Figure 3.1: Greater Copenhagen regional structure



The organization structure in Greater Copenhagen's project provides a responsive structure as the key competence to support the implementation of low-carbon economy. Greater Copenhagen employs a collaborating main actor of triple helix approach that involves government, industry and research institutions and also involves local community and NGOs. NGOs are mainly concentrated on the issues related to environmental, sustainability that are related with each specific project. The traditional triple helix governance architectures usually conduct partnership activities related to "co-ordinating" and the more successful ones emphasizing on "co-operating", while the Greater Copenhagen governance structure can be defined as "collaborating". Collaborating means making compromises and forming a jointly commitment to achieve a defined goal.





In practice, it looks like a simple structure but it is challenging during the process, as each collaborator requires a participative contribution to the whole concept. This structure emphasizes on a strong commitment, collaboration and integration of good governance process in multi-disciplinary areas and inter-sector solutions. Industry plays a big role because utilities are the core actors in the energy efficiency activities and innovation. According to Danish Energy Agency, utilities are responsible for more than 50% of the annual energy savings in Denmark. NGOs and local communities are involved in the energy and green growth agenda. For instance, the creation of "Cycling Embassy of Denmark" is a joined force of six local authorities, bicycle NGOs and Danish bicycle association to promote cycling and communicate cycling solutions. Another example was a five years collaboration of Copenhagen Cleantech Cluster (CCC) consortium, which is an implementation of triple helix approach of university-industrygovernment. The funding of CCC was one of the largest European Union (EU) structural funds project with a budget of € 19,477,000, European Regional Development (ERDF) contributing € 9,738,500 through the "Innovation and Knowledge" Operational Programme for 2007-2013 programming period. The financing derived 50% from EU, 25% from Region Sjælland and Hovedstaden, where Greater Copenhagen is included and 25% from the founding partner organizations.

Greater Copenhagen has also started a project called City of Knowledge, which is funded by The Capital Region's ReVUS Fund. It takes place within the framework of the collaboration platform *"Greater Copenhagen – the shortcut from science to business"* [26].

The utility, Copenhagen Energy, supports the Copenhagen climate goal of becoming a CO₂neutral capital by 2025 by focusing on development and testing of future greener supply solutions through an active partnership with not only the municipality, but also with businesses and developers. On the energy side, they work to establish smart energy systems. A foundation of this is the district heating (Copenhagen has 98% supplied by district heating), which is produced by combined heat and power plants based on biomass and waste. This CHPDH (combined heat and power district heating) is an important power source and a core Danish competence and export product. This system is now being complemented by the introduction of a novel district cooling system in Copenhagen.

Public-private collaborations, inter-municipal and regional co-operation are seen as essential for the contribution to innovative solutions, a strengthening of green industrial competitiveness, and green growth. This regional agenda is not aimed at replacing local efforts but rather supplementing, supporting and inspiring local environmental initiatives. The collaborations inter-municipalities were aimed to benefiting each municipality and all municipalities in the Greater Copenhagen have prepared local climate plans. As Copenhagen is the capital, more well-known internationally and many world leading Danish companies are situated in Copenhagen, then the City of Copenhagen municipality becomes the heart of Greater Copenhagen activities. Each partner has empowered the city to develop the key competences in order to attract economic growth, both foreign direct investment (FDI) and new export markets [14].

Specifically for the role of a green city model, Copenhagen together with the Greater Copenhagen in a green platform were developing partnerships from businesses, knowledge institutions, NGOs, other municipalities and regions. Many ambitious ideas and projects regarding energy and green initiatives were carried out together with partners thus they have had resources in the execution [11]. The region work hard to engage citizens, local communities and NGOs actively in the process and result. Such as Nordhavn project, it will counteract the trend towards increasing levels of commuting in the region by creating new local homes and workplaces. Beside in the research, educational institutions are also involved into the sustainable solutions that have been integrated into classroom teaching. For instance, "in math, pupils learn about the energy use of the school. In science, they use the new learning terrace to explore how the school handles rainwater locally. And in their breaks they play in outside environments designed with a focus on sustainability," [2].

A partnership at North Harbour Energy is an important collaboration of the City's green growth strategy and aims to engage businesses and citizens in innovative partnerships. An example of this approach is the North Harbour Energy Partnership. The North Harbour Energy Partnership is between the City of Copenhagen, City & Port Development, DONG Energy, Copenhagen Energy and the Ministry of Climate and Energy. The partnership comprises nine specific projects which will all help ensure that the North Harbour becomes an urban area with innovative green energy solutions. These will be solutions which enhance and develop the initiatives which have to be taken at all events in connection with urban development in the North Harbour, in close interplay with a wide range of enterprises. The partnership focuses on innovative solutions which also have:

- A significant CO₂ impact
- Significant growth potential
- High cost effectiveness
- Considerable market maturity in both the short and long terms
- High branding value The specific projects in the North Harbour Energy Partnership are:
- Smart Energy
- Intelligent housing
- Street lighting
- Onshore power supply
- Electric cars
- Low-temperature district heating
- District cooling
- Heat storage
- Geothermic

The collaboration process will be conducted through several steps. For example, a five-step process for urban improvements is required in Copenhagen a climate-adaptation project and it is carried out like this:

- Climate-adaptation statement: This statement details the status of the current climateadaptation efforts and suggests future projects.
- Political negotiations: On the basis of the climate adaptation statement the City's elected officials discuss and prioritize between the suggested projects.
- Prioritized projects and waste-water plan: The political discussions result in a list of prioritized projects that are introduced into the waste-water plans.
- Citizen Involvement: When the prioritized projects are ready, the public is invited to comment and make suggestions. It is also in this phase that ideas for urban improvement initiatives related to the climate-adaptation projects are presented.

Budget proposal for urban improvement initiatives: At this final stage the elected officials pass the suggestions for urban improvements in the climate-adaptation projects [3].

Greater Copenhagen also has cooperation with other regions, as Denmark has five regions administered by the national government namely Væksthus ("Growth house"), strong project partnerships with universities and businesses from other regions. Besides, the two largest utilities in Denmark: DONG Energy and Copenhagen Energy are situated in Copenhagen, where they have collaboration projects with other regions within energy supply and energy efficiency, also innovation in energy, waste and water [14].

The specific added value of the collaboration is also to improve quality of life for citizens, improve the city itself and even to develop markets for better solutions. Through participative sharing and collaboration, the region may capture new potentials and challenges. This kind of governance structure may attract and build investment opportunities more frequent and stronger as governments create the supporting policy. Research institutions or universities deliver the state of the art and applicable solutions, and businesses drives the investment projects.

3.2 Involvement of private sector partners

The region needs all the help from key partners, including government, private sector and research institutions to make the transition towards a green economy. The utilities and companies such as HOFOR, VEKS, CTR, ARC, HMN, Vestforbrænding and Nordforbrænding are the example of the experience and involvement with private sectors.

As the European Green Capital 2014, Copenhagen has created a green partnership, which includes private sector partners and co-creation platform in Greater Copenhagen. This platform resulted in many projects that contributed to the city development with [11]:

- Establishment of more than 90 new green thematic partnerships
- Execution of more than 250 events, conferences, guided tours and other activities through the year.
- Co-creation of one point entry for green visits to Greater Copenhagen
- More than 60 guided green tours in the year.
- More than 4,800 Copenhageners or tourists took a free electric boat trip through the European Green Capital
- A range of related reports and publications regarding green initiatives and climate were carried out.
- A boost to a range of green start-ups.
- The creation of new full time "green jobs".

In context of energy performance, Copenhagen has an excellent example as a result of the city's district heating, showing what the concept of "District Heating" actually is in partnership with private sector partners. The lesson is that the expansion of the district heating has created substantial reductions in the gross energy consumption. It means that this solution can

result in both environmental and economic benefits less pollution and lower prices of heat and electricity [8].

In the initiative of Sharing Copenhagen, the region has collaborated with companies and research institutions in a public-private innovation partnership in order to test and develop new intelligent traffic solutions on the basis of early feedback from citizens and the users themselves [3].

Experience to involve the private sector¹ for unlocking low-carbon investments

One of the experiences that involves private sector is the Sharing Copenhagen initiative, especially in climate adaptation and cloudburst management. Total investments in this project will be a bit in excess of DKK 10 billion over the next 20 years, to be split between the publicly-owned utility companies HOFOR, the City of Copenhagen and private landowners. Another private sector involvement is in the establishment of Copenhagen Solution Lab (CSL) that will be the venue for innovation of Smart City. The public-private partnership between researchers, private companies and the City of Copenhagen has also been formed for the project of new technologies for better plastic-waste separation. In the climate adaptation, the region together with private companies: Orbicon, Wawin, Per Aarsleff A/S, has installed four curb extensions in the suburb of Husum [2].

The region has also experience with international private sector partners from energy efficiency project: EcoGrid EU. It is a large scale demonstration of a real-time market for demand side participation. Similar energy efficiency projects have also involved private building or house owners.

Financed by the private sector

Some example projects that co-financed by private sectors are Energi på tværs I and II. It is a common energy vision agreement within The Capital Region and the municipalities. The goal is to meet the vision of a low carbon energy system by 2035 and a low carbon transport system by 2050. The private sectors involved are HOFOR, VEKS, CTR, ARC, HMN, Vestforbrænding and Nordforbrænding. Municipalities contribute co-financing in the form of hours [25].

Stakeholders and factors were decisive for implementation

The stakeholders which were decisive for the implementation are the local authorities, utilities companies, research institutions, and local communities, local citizens and NGO. Furthermore, the influencing factors in the implementation were:

• The high energy demand in the region requires a solid green solution of renewable energy.

¹ Private sector defined as the profit oriented part of a country's economic system, run by individuals and companies.

- The comprehensive regional governance structure and green growth organization structure. The region employs a collaborating main actor of triple helix approach that involves government, industry and research and also involves the local community and NGOs.
- As the governance structure is emphasized on participative collaboration, resources and high priority agenda are important considerations.

Learnings and recommendations by the involvement of private sector partners

The collaboration with the private sector partners is very promising not only as a means to achieve the project aim. For instance, in the case of new intelligent traffic solutions are to improve traffic flows and reduce carbon emissions. It can also improves quality of life for citizens, improves the city itself and even develops markets for better solutions.

It is recommended to make efforts to develop a good dialogue for influencing a strong commitment of the aims and for facilitating strong partnerships.

3.3 Regional policies

Local authorities have a significant role in order to implement the national and regional agenda to form and improve a green growth economy. As mentioned, all municipalities in the Greater Copenhagen have prepared local climate plans. The quantitative goals of Greater Copenhagen are [17, 21]:

- (1) Fossil-free electricity and heating by 2035
- (2) Fossil-free transport sector by 2050.
- (3) Capital region widely recognised internationally as being climate-prepared by 2025
- (4) Capital region resource efficient with at least 80% of its waste recycled by 2035
- (5) 80% of ground-water resources safeguarded by 2025 against contamination from high risk areas, thus protecting the quality of drinking water
- (6) 8% annual growth in the green business and clean-tech sector by 2025
- (7) 2.5% annual increase in light railway passengers by 2025, in addition to 1% annual increase in related job creation by 2025

The ambitious goal to be the world's first fossil free metropolitan region makes it wanting to be the leader in the development of green solutions.

Greater Copenhagen is the center of green growth activities in Denmark and The City of Copenhagen is the center of Greater Copenhagen's growth. The frontrunner could be when Copenhagen City Council has passed an ambitious climate strategy in August 2009, which is called Copenhagen Climate Plan to enforce low carbon development. They had been working on reducing greenhouse gas emission for many years and the new plan rose the level of ambitions. The plan has specified 50 initiatives to achieve this objective. More than 75% of the reduction in CO_2 emissions is concerning the changes in the energy production and 10% is concerning energy savings. This plan has also set an objective for the city to be carbonneutral by 2025. For this, there is a wide-ranging action plan, the 2025 Copenhagen Climate Action Plan that will lead the city to carbon neutrality by 2025. It requires the collaboration from other municipalities in Greater Copenhagen, especially in transport and mobility aspects.

There are two strategic areas under Copenhagen's carbon-neutral target which are particularly challenging but potentially create economic opportunities:

- (1) Energy supply and demand
- (2) Transport and mobility

It should also be mentioned that to reduce emissions from electricity supply a decarbonisation national policy of the national electricity grid is required.

3.4 Membership in low carbon programs and initiatives

The municipalities' involvement with the low carbon associations helps to strengthen low carbon solutions' role in planning and influence the policies made in the fields of energy. Based on the interview, having the same vision and goal, sharing inspiration and methodology, and most of all implementing the local innovative programs, are the reasons why municipalities in the Greater Copenhagen joined these associations.

As the representative of Climate Policy Forum in The Capital Region, Albertslund and Copenhagen are also the most members from Greater Copenhagen among the associations or initiatives below:

(1) ICLEI [http://www.iclei-europe.org]

ICLEI is an association with over 1000 local governments. It expresses that the global challenges require local solutions and global governance. There are 5 municipalities and 1 institution from Denmark who joined the association. Albertslund and Copenhagen are the municipalities from Greater Copenhagen. ICLEI emphasizes on supporting, developing and implementing through membership fees and sharing experience.

(2) Covenant of Mayors [http://www.covenantofmayors.eu]

The Covenant of Mayors has a shared vision for 2050 to accelerate the decarbonization of signatories' territories, strengthen capacity to adapt unavoidable climate change impact and allow citizens to access secure, sustainable and affordable energy. It is clear that Greater Copenhagen has the same vision and commitment as this initiative. The signatories of this program from Greater Copenhagen are Albertslund and Copenhagen.

(3) Climate Alliance [http://www.climatealliance.org/]

Climate Alliance has about 1700 members of municipalities and districts as well as NGOs and other organizations are actively combating climate change. Albertslund is the representative of Greater Copenhagen in this association. Some benefits of joining it are to get advice on local climate change policies, have good network throughout Europe, learn the supporting tools, be inspired by the experience, stay up to date with news and publications, raise re-

gional profile, find financial support opportunities and have local voice heard in important EU decisions.

(4) C40 [http://www.c40.org/]

C40 is a network of megacities that are committed to address climate change. It provides support for collaboration, sharing knowledge and driving meaningful, measurable and sustainable actions. Most of the members are the capital of each country. Copenhagen is one of the steering committee members. Some benefits to join C40 are to have a strong capacity in tackling emissions and to have a solid network in a leading force in climate change. C40 is also working with ICLEI.

4 National and European policy background, complementarity

4.1 Relevant national low carbon policies, interrelation with regional policy

Historically the Danish government has been strong in developing alternative energy policies. Denmark is the only country which did not cut R&D investments in energy technologies when the oil price dropped in the 80s. The R&D investment was an important factor for developing a strong energy technology sector, mainly the wind sector. At the same time Denmark was also able to develop strong capabilities on developing and designing biomass, fossil fuel and waste to energy plants. Danish energy technologies have a very strong position at the international market and also politically Denmark has played a positive role in developing the renewable energy sector internationally and CO_2 reduction policies.

The renewable energy sector has been promoted by a fixed price scheme with favourable tariff for decades in Denmark. A successful penetration of wind power was a result of this policy. Furthermore, the political agenda has prioritized the change of scheme into a quota-based system with tradable green certificates since 1999. However, it has turned out to be more complicated than anticipated regarding the implementation of an efficient operational system for trading in green certificates. Although, it has been postponed several times, the national green certificates market was fully in operation, in the beginning of 2003 [14].



Figure 4.1: A macro perspective of the conditions influencing the implementation of wind power [18].

A macro perspective figure above is embedded within a national policy making, and can show a balanced interplay of elements that guarantee a stable economic condition, smooth planning and administration, and positive impacts to the local development level. In this case, local impacts to regions and municipalities.

The strong focus in the national policies in the 80s was not initiated because of international climate change policies. That came later when climate change became a political topic in Denmark. The Danish Government was relatively fast to set strong CO₂ reduction targets. It should, however, also be mentioned that the energy sector in Denmark was coal based when the transition started in the 80s. Denmark had no hydropower or nuclear power. Nuclear power was forced of the agenda by strong environmental movements in 80s and has never returned to the political agenda. That means that the only way Denmark could achieve a transition to fossil fuel free energy production would be with wind power, solar power/thermal and solid biomass and biogas from agricultural waste.

The financial benefit has helped the changing governments to maintain a strong energy policy even when right wing governments were in powerThus, the Danish energy policy has been formed by the result of a process of conflicts. This process then led to implementation of radical technological changes in terms of efficiency and innovation. The energy objectives and plans have been developed through a constant interaction between parliament and public engagement, which showed that the new technologies and alternative energy plans played a vital role. Finally, Denmark has been able to show remarkable results [13]. The numbers were the proof that it created new business, new jobs and supported the Danish trade balance [16].

Initially the government focused on regulating the energy market thereby forcing utilizes to switch fuel. Especially the power sector was much centralised and district heating networks were not wide spread at the time. From the 90s there came a stronger focus on the energy sector in particular driven by development of the district heating networks. To make that happen the government introduced strong regulative policies and used both carrots and sticks to make the local energy companies invest in district heating systems. The challenge, though, was that the government had already in the 80s invested in a national natural gas network. Thus, initially the district heating companies were forced politically to use natural gas as fuel. That decision has up to the day today been a challenge for especially some of the smaller district heating networks because they are not allowed to switch from natural gas to cheaper subsidized fuel like biomass – and they have recently been discouraged to invest in large scale heat pumps via strict tariff structures.

The main agents of the development of renewable energy that is now focusing on the Green Energy Clusters were the grass root movements within this area, the parliament, the medium scale production companies and the energy companies. The success of the green initiatives was achieved by an active collaborative work between some politicians through energy policies that promoted necessity and possibility, private construction firms and an energy grass root movement. A set of concrete institutional reforms were established during the eighties and nineties, furthering the "Green innovation" development process [12].

So, where are the regions and municipalities coming in? When the government started to formulate strong CO_2 reduction policies and took decision on them it was difficult to make the implementation without involving the regions, the municipalities and the cities. But it is probably fair to say that the local governments were not involved in the initial policy development.

Recently, the energy and environmental policies that have been initiated at the national level is formulated or implemented at the local level and becomes embedded in long lasting, are highly cost technical infrastructures. Furthermore, the regions, municipalities and local utilities are the keys to the management and innovation of these infrastructures, in interaction with a range of stakeholders.

The role of public policy is essential in the green economy transition, as public policy can provide the incentives and increase certainty for others to act. National low carbon policies play a special role in relation to greenhouse gases and global warming with increasing use of renewable energy. In general this policy is leading to a reduction in greenhouse gas emissions when fossil fuels such as coal and oil are replaced. Renewable energy sources partly include energy such as wind power and solar energy, which lead to no emissions of greenhouse gases and partly of fuels such as straw and wood which during growth absorbs CO_2 from the atmosphere and emit CO_2 again when burnt. Far-sighted government policies are essential to steer the global system to a safer place, including stronger signals to investors

National policies as drivers

National energy policy can drive and influence the region's initiatives and projects. The local urban structure of local regions and municipalities give a significant impact on consumption patterns and sustainable lifestyles.

As an example, in March 2012, a new ambitious energy agreement was reached in Denmark. This should bring Denmark closer to reaching the target of 100% renewable energy in the energy and transport sectors by 2050, by committing to large investments up to 2020 in energy efficiency, renewable energy and the overall energy system [5]. It is a country plan to use 100% renewable energy which allows the continued energy self-sufficiency to coincide with the depletion of the remaining Danish fossil fuel reserves. (Source: Danish Energy Agency 2011) [14].

Denmark's 2020 targets include:

- Approx. 50% of electricity consumption supplied by wind power.
- More than 35% of final energy consumption supplied from renewable energy sources.

In Denmark, a subsidy scheme has been set up to promote energy efficient use of renewable energy in industrial production processes. The new investment scheme will bridge the price gap between renewable and fossil fuels. The state subsidy scheme will support industries in transitioning to renewable energy sources or district heating to power manufacturing processes, thereby replacing fossil fuels with renewable energy such as wind, solar, biogas, or biomass. The third part of the scheme involves support for energy efficiency improvements made in direct connection with the transition to renewable energy or district heating. An exante analysis shows that this would result in a reduction in the use of fossil fuels of approximately 16 PJ/year until 2020. CO_2 reduction is expected to be around 1 million tonne CO_2e /year until 2020.

The success of national policy in deciding and implementing ambitious energy policy objectives has been initiated since the oil crisis in 1973. The high degree of public awareness made it possible to achieve success. It is then why the energy policy that has been conducted in the attitude that "creating choices is possible" was fit with the society. The conditions of awareness can be expressed by:

- A high amount of public participation, first in the protest against nuclear power, then in energy savings, and in building and owning wind power and small CHP stations.
- An intensive agenda of public debate, where the alternatives have been described, discussed and developed.
- A parliament that relatively independent which is able to conduct polies against the interest of the representatives of the old fossil fuel technologies.
- An organization of power companies that was able to survive even when they lose market shares [13].

4.2 Complementarity of regional, national and EU low carbon policies

The greatest successes in promoting renewable energy sources of electricity used in Europe have been obtained by the application of the feed-in system in Denmark, Germany and Spain. In general, most of the political trend in EU favors the use of commercial markets as a driving force for technical change. For a long-term clean energy sources development, this political preference presents a dilemma. A comprehensive planning including the transport sector – with time horizons of 30 - 50 years is required in the cost-effective and sustainable energy solution. This is in conflict with the commercial market characteristics [14].

Based on Kyoto Protocol and the EU's subsequent Burden Sharing Agreement, Denmark has undertaken to reduce greenhouse gas emissions by 21% from 2008-2012, based on 1990 levels. It is one of the most ambitious reduction targets undertaken by any country in the world.

Denmark's Energy Strategy 2050, outlines the aim to achieve complete independence from fossil fuels by 2050, with a minimum reduction in fossil fuel use of 33% by 2020 (compared to 2009 usage), was released in early 2011. In 2007, an Action Plan for Renewed Energy Conservation committed electricity, natural gas and oil companies to achieve specific energy-saving targets by initiating savings among their customers [22]. In the latter half of 2000s, the Danish government has changed ist policy focus which embraced the green growth agenda.

Furthermore, the local planning authorities need to sit and plan renewable energy together at the municipalities level. A positive attitude of the local community, for example in the wind turbines case, needs to be maintained, by e.g. channelling the benefits of wind power to the local citizen [16]. In Greater Copenhagen, the establishment of the Copenhagen Cleantech Cluster (CCC) in 2009, is representative of a new more deliberate era and ambitious green growth policy making and branding. Since 2001, the new Danish government has reinforced this policy line and formulated stronger green growth policies in Denmark [14].

The decisive aspect on changes as the impact of national strategy can be expressed by:

- More numbers of innovation capacity are formed, beside Copenhagen Capacity (Cop-Cap) in Greater Copenhagen.
- Projects and funding to support green growth agenda are increased.
- Economic growth is increased: FDI and new investments.
- More competitive and higher qualification of business environment.

5 The role of cohesion policy for regional low carbon development

Denmark will manage two operational programmes under EU cohesion policy for 2014 until 2020. The first operational program will receive funding from European Regional Development Fund (ERDF) and the second operational program will receive funding from European Social Fund (ESF).





Structural Funds (ERDF and ESF) eligibility 2014-2020

- Less developed regions (GDP/head < 75 % of EU-27 average)
- Transition regions (GDP/head between >= 75 % and < 90 % of EU-27 average)
- More developed regions (GDP/head >= 90 % of EU-27 average)

For this period, Denmark has been allocated around € 553 million (current prices) in total cohesion policy funding:

No	Category of region	Region's name	Amount of fund (€)
1	Transition regions	Zealand	84 million
2	Developed regions	Northern Jutland, Mid-Jutland, Southern Denmark, Capital region and Bornholm	329 million
3	European territorial coop	peration	140 million

Table 5.1: Denmark's Cohesion Policy funding

"Of this, the ESF in Denmark will represent a minimum of \in 206.6 million. The actual share will be set in light of the specific challenges the country needs to address in the areas covered by the ESF." (European Commission) [23].

The investment priorities in Denmark include:

- Improving businesses' competitiveness and growth through support to innovation, energy efficiency and labor market skills and mobility.
- Promoting entrepreneurship.
- Reducing emissions of green-house gases.
- Increasing inclusion of people at the margins of the labor market.
- Promoting an environmentally friendly and resource-efficient economy.

Based on the funding allocation from the Cohesion Policy 2007-2013 period, which was € 613 million, the ERDF has helped Denmark to [23, 24]:

- Over 3500 start-ups and new jobs
- 245 RTD (Research technological development) projects
- 104 renewable energy projects
- Higher number of patents
- Recognized as one of the world's leading cleantech clusters by OECD and UNCTAD

The Research, Technological Development and Innovation (RTDI) policy trend in the region is important to develop a strong innovation capacity. The main focus of this policy in the region includes the development of stronger clusters, more growth and a sustainable development of workforce. The policy mix within innovation may support the hot trend of new environmental solutions. In 2009, the Growth Forum in Greater Copenhagen initiated 10 new projects within the policy area of innovation. The Growth Forum investment in the projects was € 19 million. This equals close to 50% of the total investments by the Growth Forum in 2009. Other investments with innovation include human resources (19% of total investments), entrepreneurship (13% of total investments), and the use of new technology (10% of total investments). Especially the development of the Cleantech Cluster in Copenhagen is a policy focus. For instance, a new cluster program, as mentioned in chapter 3, the Copenhagen Cleantech Cluster was one of the largest investments in 2009 by the Growth Forum, which is amounted € 10 million [8].

The success stories from Cohesion Policy in ERDF projects [23]:

Clean technology

Total cost: € 19.5 million (ERDF contribution: € 9.7 million)

The investment in Copenhagen Cleantech Cluster (CCC), a Greater Copenhagen's green growth program, helps businesses in Denmark's Capital region and the region of Zealand to develop and implement innovative and sustainable environmental solutions. "Cleantech" is described as products or services that improve business performance or efficiency while reducing pollution, costs, inputs and waste.

The CCC project is a clean sweep for tech growth in Denmark where government, businesses, researchers in Denmark, especially Greater Copenhagen, develop a worldleading clean technology cluster for smart and sustainable innovation. It also provides great opportunities for knowledge sharing and collaboration between Danish and foreign companies or institutions which helps to raise awareness of Danish expertise in cleantech internationally.

The ERDF has invested \in 9,738,500 in this project, which helped the cluster to create network of companies and research institutes to spark ideas for new cleantech products and services and develop them into viable businesses. Entrepreneurs, especially start-ups also received direct support from the project in context of business mentoring, opportunities for product testing and demonstration and advice on international branding and marketing. The visible sector provided by the cluster makes the businesses easier to attract investment and top researchers.

Green Ambition

Over 600 companies were included active in many different service and manufacturing industries to develop a world leading cluster of cleantech in Greater Copenhagen and Zealand region. The project's partners and collaborators included the leading Danish universities, a science park, business investors, organizations and the Copenhagen's foreign investment agency. All engaged parties, gave their smart specialization strategies more impact and cut red tape for cross-border ventures.

The project has now ended but the success story still continues. CCC has merged with another Danish cluster – the Lean Energy Cluster – to create CLEAN. CLEAN is an organization of more than 170 members and even stronger business involvement [24].

• The 100% renewable city

Total cost: € 667,000 (ERDF contribution: € 333,000)

The investment is helping Frederikshavn, a North Danish city, to achieve the first European city to rely solely on renewable energy by 2015. It is an ambitious goal aims to create a 100% renewable energy system by tapping multiple energy sources rather than only one.

The Cohesion Policy in terms of low carbon development is significantly important for Greater Copenhagen, as it is the way to move forward and bring different parties together. It is a comprehensive approach from all expertise and sectors.

6 Good practices and successful approaches

The region has a comprehensive initiative and approach to reach the low carbon objective and target. It is supported by the fact that there are many communities in Denmark that have the good will and good practice to reduce their climate foot print in a cost effective and sustainable way [16].

Successful initiatives and approaches

(1) The comprehensive and flexible regional governance structure with national policy as a driver.

A responsive collaboration of triple helix plus community based is a success approach that covers the whole process and supports each partner participation, input and inter-sector solution. The strong commitment, collaboration and dedication are the essential keys that make this structure more solid to achieve the goal. The success of the low carbon regional initiative and the support of national policy can be displayed by the figure of CO_2 emission reduction in ton below.



Figure 6.1: CO₂ emission reduction [7]

CO₂ emission in 2015 has recorded a significant decline about 38% from 2007.

(2) Greater Copenhagen's green growth programs

One of the main strategies of Greater Copenhagen is the green growth initiative. The success of this initiative is reflected by the turnover chart below. The turnover in green business has an impressive chart from 2012 to 2015, which is increased 20%. It has increased significantly from 2014 to 2015 by 16%, since the region and national has put the high priority on green growth agenda.



Figure 6.2: Green growth industry turnover in the Capital Region [7]

As a result, despite the financial crises, many local cleantech companies grew their business and over 50% took on more employees. Over half of businesses increased turnover and just under a third expanded exports. New start ups and international cleantech companies were attracted to set up business in the region.

Based on the Cleantech cluster program, the close cooperation between companies and research institution was particularly fruitful, shown by the high number of patents granted across the cluster. The project also hosted many events and brought international delegations. In ist five years program period, the cluster has created over 1000 new jobs, supported 126 startups, 64 research projects and 38 new cooperations between companies. The cooperations with 15 leading international cleantech clusters were formalized [24].

The green growth initiatives were conducted in some activities such as the establishment of more than 90 new green thematic partnerships, execution of more than 250 events, conferences, guided tours and other activities through the year, a boost of green startup.

The Greater Copenhagen program of "Sharing Copenhagen" supports Copenhagen as the European green capital in 2014. This initiative is conducted through some themes that have various approaches and projects in the region. The first approach is in line with energy efficiency: retrofitting, smart city and street lights. There are many projects in this context, such as the future of office buildings, affordable and green housing, getting light without losing energy, new urban development gets gold certification, saving energy with new energy management system, sustainable school, retrofitting with public financial support and shedding new light on the capital. Some success projects are Sankt Annæ square project, Grøndals-vænge-neighbourhood, pakhuset, atp's office building pakhuset (the warehouse), etc.

The second theme is related with energy production, especially renewable energy. Copenhagen has the ambition to make district heating carbon neutral. The projects in this area are climate friendly district heating, wind turbines in Copenhagen, getting value from the capital's plastic and enzymatic treatment of municipal waste. Some implementations from here are plastic Zero project, REnescience technology, etc.

The third theme is mobility. It identifies four main focuses to be implemented: Cycle serpent connects the city, the mailman transportation is electric, dedicated bus lanes and more investment in green transportation. The city has an ambitious goal to use only electric or hydrogen cars (up to 5 persons) in 2025. However, it is already on track as accounted in 2013. It closes to half of all cars were powered by hydrogen or electricity.

The last theme is climate adaptation. Some good projects are implemented in responding to the extreme weather of the future, the first climate resilient neighbourhood, curb extensions combating heavy rain, historic square delays 21 million litres of rain and shopping street prepares for cloud bursts [3].

The other current prominent strategies and projects are the CO_2 neutral in 2025 and the urban development project in local community at Nordhavn. Some past good practice projects are the first zero energy housing renovation in Denmark at Hyldespjældet, Albertslund in 2009. It was introducing prefabricated construction elements from Rockwool and the Solar Prism installation element. Another project is Green Solar Cities in Copenhagen and Valby in 2007.

Some main impacts of the green initiatives programs and approaches are:

- The collaboration approach may stronger and expand the network and capacity in the region and inter-regions.
- Society awareness and sustainable growth mindset are improved.
- Knowledge-transferred is faster and somehow it requires more research and development funding.
- Citizens' quality of life and the region itself are improved.

Specific experiences

Some specific experiences based on the success of regional strategies and realizing projects above are recommended to be identified and shared.

· Environmental and economic benefits

Hence, expansion of the district heating has created substantial reductions in the gross energy consumption. This in turn has resulted in less pollution and lower prices of heat and electricity. Thus, we have shown that solving a coordination problem among large number energy consumers can result in both environmental and economic benefits. We have also found that using waste in the heat and power production is economically viable and reduces greenhouse gas emissions.

• Aesthetics is important

Another lesson learned is that aesthetics is important, in relation securing public support for renewable energy infrastructure. Many places plans to erect wind turbines are met with local resistance as they are thought to spoil the view. In Copenhagen, however, most people find the wind farm at Middelgrunden (close to shore) is beautiful because of the soft curve, the wind turbines draws in the landscape.

Standarization

In context of energy production, the main issue of heating from biomass is to secure that the plants run on biomass from sustainable sources. Currently, there are no national or international standards for sustainable biomass to produce energy. Therefore, it is recommended to check the availability of the standardization and prepare solution to overcome when the area has no formal standardization yet.

Investment

The region experiencing with a temporary on hold project due to the consideration in a big operating cost. Copenhagen has also been investigating the possibility of installing a full-scale geothermal heating facility at Nordhavn, but the risks involved in extracting geothermal energy are still too great.

In relation to mobility, Copenhagen has learned valuable lessons on fleet optimization and reductions in operating costs. Therefore, the City of Copenhagen is now advising other municipalities and authorities in The Capital Region about the benefits and pitfalls when procuring electric vehicles.

• ICT solution

Some smart technology solutions require various software and hardware in different platforms. One of the critical factors is to ensure the interoperability between the automation solutions.

(3) Commitment of world's first carbon neutral capital 2025

Based on the climate project 2015, the city has already cut emissions by 31%. These reductions are mainly due to an increase in the consumption of biomass in Copenhagen district heating system and a greater share of wind-generated electricity as presented in the Table 1.8. The climate projects have four pillars: Climate adaptation, energy efficiency and savings, energy production and mobility. It is continuing the same themes as previous year with only focusing on 11 cases.

In climate adaptation, the case emphasizes on neighbourhood ready for rain and relieving a stream under pressure. Energy efficiency and savings are focusing on the objective to be the Europe's greenest retail store, the world's best residential development, green leases boost energy retrofitting and the project of Energylab Nordhavn where the region is testing the near real time future energy consumption.

In context of energy production, the case of district cooling with seawater is conducted and BIO4 project, which is a capital heating system using sustainable biomass.

Furthermore, mobility is emphasized on the battle for urban space, with some projects such as Drivenow, which is an alternative to own a car. The next projects are harbour circle and collecting trash with.

Specific experiences

Some specific experiences based on the success of regional strategies and realizing projects above are recommended to be identified and shared.

Transition

To achieve the aim of carbon neutral capital, the region must successfully make and prepare for a number of important transitions in the coming years. For example: the changing in the way of people transport such as more cyclists to work, the replacement of municipal fleet with electric vehicles and waste trucks running on biogas.

• Sustainable system

The region still needs to emphasise and ensure that the program and projects are part of a truly sustainable system. For example, in the steps toward a successful district heating system, it is solely running on renewable energy which still needs to ensure that biomass is indeed a part of a truly sustainable system.

· Strong collaboration and citizens' engagement

Since the awareness is increasing, the willingness from citizens and companies to contribute is higher for example in context of sorting and recycling the waste. It means that the region needs to create partnerships and engage citizens even more. Furthermore, a region climate partners such as Copenhagen Climate Partners that was established in 2015 is required to be formed. It is a network of businesses, organizations and knowledge institutions that are committed to contribute their expertise in overcome challenges related to climate change in the city.

• Develop the effective method

In the low carbon projects, the proper solutions need to be identified followed by the effective method for the specific project to avoid of financial risk. For instance, methods to jump-start large-scale retrofitting buildings must be developed because the failure to do so will greatly increase the costs of low-carbon transition road, as it will mean a greater need for energy production capacity.

EU cohesion fund

The EU cohesion fund has the objective to reduce economic and social disparities and to promote sustainable development. In practice, EU supports the innovative low-carbon projects from low-carbon transport solutions and digital tools to make sustainable living easier, to companies, schools and homes producing their own renewable energy. The cohesion fund until 2020 allocates a total of \in 63.4 billion to activities under trans-European transport networks and environment.

The region has a success initiative and good practice to overcome the challenge in the transport sector that is responsible for the significant share of the region's carbon emissions by improving the public transport to be more efficient, smarter and more attractive. This experience can be used to guide EU target state members under this cohesion fund scheme. The region is also well-experienced in environment development and benefit in relation to energy efficiency, renewable energy and public transport. The project can be benefit to the local society of the targeted EU state members by forming the solid partnership from the collaborators that have strong and successful experience.

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List of interviewed persons

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ESPON 2020 – More information

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The ESPON EGTC is the Single Beneficiary of the ESPON 2020 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway and Switzerland.