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HIIUMAA 2020:
SUSTAINABLE ENERGY ACTION PLAN

Executive summary

As a vision for the future, the energy policy is orientated to guarantee security of energy supply, ensure economical and environmental sustainability of the sector and quality of energy services, and to contribute to job creation and regional added value and to the competitiveness of the local economy.

Objectives, targets and expected results

In this plan, objectives and targets were set for the year 2020 and the actions for sustainable energy to achieve these targets were studied.

The specific main objectives of the strategy for sustainable energy in Hiiumaa Island are to:

- **Improve security of energy supply.**
- **Reduce energy dependence from abroad.**
- **Reduce energy intensity in Gross Domestic Product.**
- **Reduce carbon dioxide emissions.**

The targets to achieve in 2020 are to:

- Increase to 80% the local energy resources in primary energy demand.
- Reduce CO_2 by 100% compared to 2005.
- Have a neutral balance of CO_2 emissions.

The expected results in 2020 with the implementation of the action plan are to:

- Increase to 89% the local energy resources in primary energy demand.
- Reduce CO_2 by 102% compared to 2005.
- Have a negative balance of CO_2 emissions (-511 t).

The commitment for Hiiumaa Island with its voluntary adhesion to the Pact of Islands is the reduction of 20% reduction of CO_2 emissions in comparison to 2005 reference year, which will be achieved.

Budget

The overall investment foreseen, to be carried out until 2020, to implement the Sustainable Energy Action Plan of Hiiumaa Island is 79,5 million euros, supported by operators (45,3%), citizen (39,4%), Local Goverment (14,3%) and other entities (1,0%).

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1. CONTEXT

1.1. Geography and territory

Hiiumaa is the second biggest island of Moonsund archipelago and Estonian coast. Hiiumaa island alongside with Kassari island and about other 200 island and islets is a Hiiu County with area about 1023 sq km.

These four geographical locations are determining the position of Hiiumaa: cape of Ristna 22º 2' 22'' in west, peninsula of Sarve 23º 4' 10'' in east, cape of Tahkuna in north 59º 5' 36'', in south cape of Emmaste Rannaküla in south 58º 41' 13''. The distance between Sarve and Ristna is about 60 km, Tahkuna and Rannaküla about 45 km.

Compared to the adjacent islands Hiiumaa is 2,6 times smaller than Saaremaa, 5,1 times larger than Muhumaa and 11,1 times larger than Vormsi. Compared to other Baltic islands Hiiumaa is smaller than Aland (1,4), Gotland (2,9), Oland (1,3) and larger than Rugen (1,1) and Bornholm (1,7).

Hiiumaa is located 22 km west of Estonian coast and 6 km north from Saaremaa. There is 250 km to Sweden coast in west and 120 to Finnish coast in north. The closest towns and cities are: Haapsalu (45 km), Kuressaare (83 km), Tallinn (120 km), Turku (120 km), Helsinki (180 km), Stockholm (240 km) and Riga (270 km).

Considering geological perspective, Hiiumaa is quite a young and flat island, with average height 10 m around the sea. The peak of Hiiumaa and West – Estonia is Tornimägi (68 m), which has been risen above waterline about 10000 years ago. The middle island was risen above the sealevel just 5000 years ago.

The main natural resources on Hiiumaa are: sand, clay, gravel, mud (for medical and cosmetic purposes), peat and mineral water.

The overall population of Hiiumaa is situated along the coast. So are situated the biggest settlements of the island. The mid of island, mostly wet and barren is sparsely populated. Despite of economic activities and the overall rise of island the connection between habitat and sea are still perceptible.

Hiiumaa is the most forest covered county in Estonia, about 70% of island is covered by forests.

In 2010, based on data of Estonian Land Board, the land was used as follows:

- woodland 62 886 ha;
- cultivated 2 891 ha
- natural pastures 7 135 ha
- other 9 728 ha.

1.2. Demography

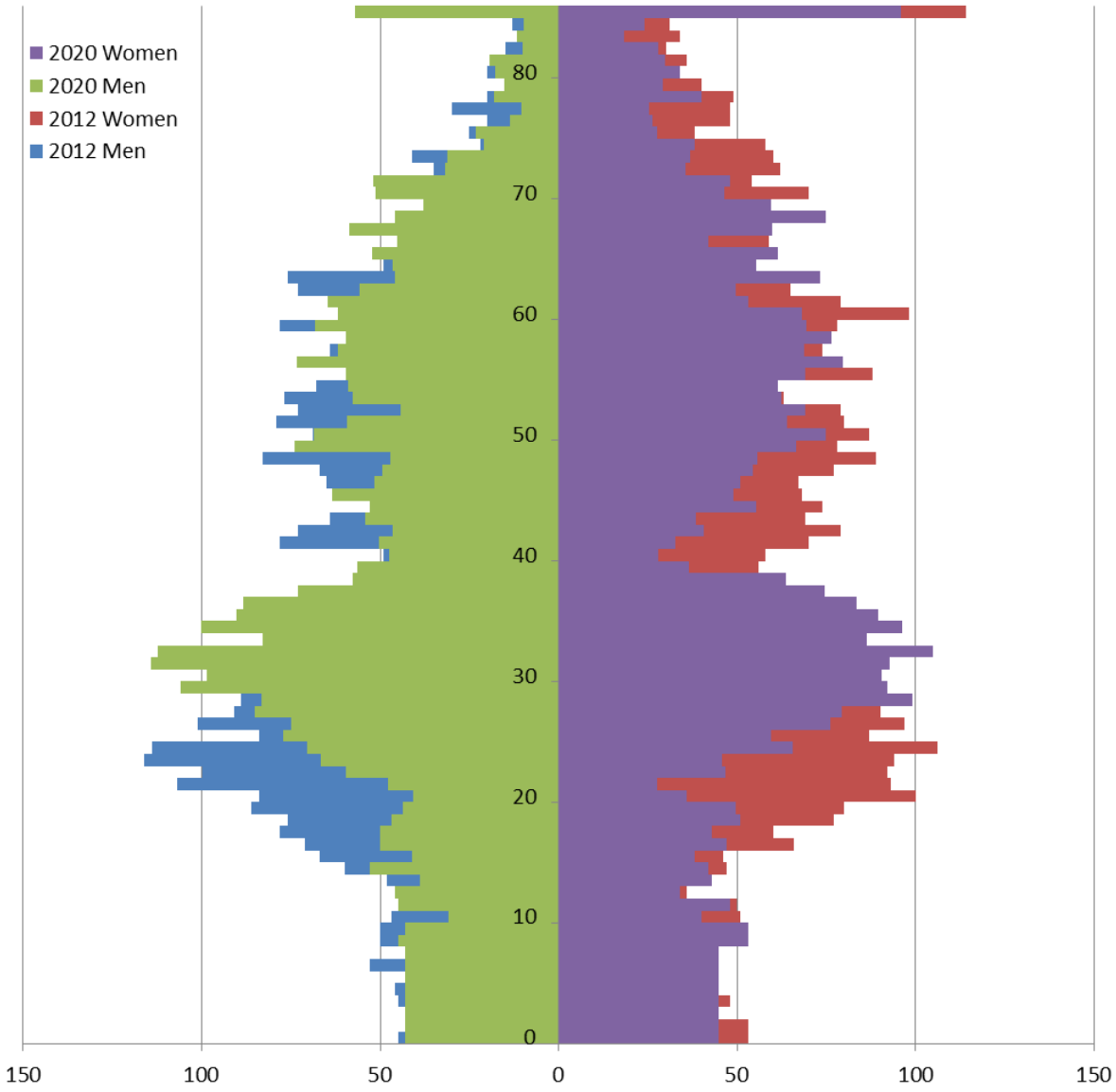
Preliminary data of population census 2012 shows that there are 8470 persons, who's permanent habitat is on Hiiumaa.

Last century the number of population was highest at the end of 30ties, reaching more than 16000 inhabitants. During the Soviet period the population of the island achieved its lowest size in 1972, when there were registered 9975 inhabitants. In 1992 about 12 000 inhabitants were registered,

who's permanent habitat was located on Hiiumaa. The number of inhabitants was declined during the last decades.

The biggest settlements on Hiiumaa are Kärdla town, boroughs of Käina and Kõrgessaare, villages of Emmaste, Suuremõisa, Lauka, Männamaa, Lõpe ja Nurste.

Figure 1: Population age structure 2012 and 2020 without migration



1.3. Economy

The Gross Domestic Product (GDP) of Hiiumaa has been remained in same level except for year 2009 and following years of economic depression. Stability has been achieved despite a significant structural change in economy of Hiiumaa. The GDP of Hiiumaa is about 65,22 million eur, which is about 0,5% of GDP of Estonia (Statistics Estonia, 2009).

In 2009 GDP per capita on Hiiumaa was in current prices 6480 eur, which is about 62,8% of the average GDP per capita in Estonia.

Hiiumaa community is making his own economic accounts on yearly bassis based on public annual reports of companies. Following table is presenting added value by private companies and public institutions on yearly bassis.

Table 1: Added value (miljon eur) by sectors 2006 - 2010

	2006	2007	2008	2009	2010	kasv	osakaal
Agriculture	1,14	1,63	1,42	1,21	1,42	18%	4%
Forestry	1,71	1,78	0,80	0,82	1,86	126%	5%
Fishery	2,44	3,57	2,51	2,23	2,24	0%	6%
Total industry	9,66	11,85	10,69	9,33	11,08	19%	31%
Food processing	0,36	0,55	0,49	0,40	0,33	-18%	1%
Wood processing	1,66	1,74	1,16	0,66	0,91	39%	3%
Plast and assemly	7,04	8,85	8,15	7,30	7,80	7%	22%
Other industries	0,61	0,71	0,89	0,98	2,04	109%	6%
Construction	3,35	4,40	5,13	3,56	2,52	-29%	7%
Retail and wholesale	2,54	2,83	3,03	2,75	2,51	-9%	7%
Tourism	0,83	1,09	0,81	0,84	0,80	-6%	2%
Transport	2,09	3,86	4,25	1,91	2,80	47%	8%
Other	2,15	2,40	2,37	2,28	2,28	0%	6%
State institutions	3,62	4,07	4,72	4,33	4,11	-5%	11%
Local municipalities	3,75	4,27	5,28	4,81	4,39	-9%	12%
Total	33,30	41,75	41,02	34,06	36,01	6%	100%

Most of the value produces on Hiiumaa is created by industry, 31%, transport, which includes local and international road transport. The most important impact have companies, which are producing plastic products or offering product assembly services. There are several products produced on Hiiumaa including medical filters, electrical appliances and differet injection moulded products. We have also solid experience with bioorganic materials.

Traditional sectors like agriculture, food processing, forestry, wood processing, fishery and tourism are producing less added value someone can expect. Those sectors produce bit more than one fifth, 21%, of total value created on Hiiumaa.

The plastic industry is a energy consuming industry. The energy consuming are also a alternatives of making use of local raw materials (ceramic clay, limestone), but other alternate possibilities like data centres. The energy consuming acitivites are supported by singnificant renewable energy sources – biomass and wind energy.

1.4. Political and administrative structures

Hiiu County is one of 15 counties of Estonia. The state functions and policies are implemented by Hiiu County Government, which is managed by Ministry of Internal Affairs, and other state department offices, which are responsible for implementing specific sector policies, on the island.

There are five municipalities: Kärda town and Emmaste, Kõrgessaare, Käina, Pühalepa municipalities.

Previous local elections were participated by 56,45% of total inhabitants, eliglible for voting in 2009.

There were four parties represented in local elections on Hiiumaa:

- Estonian Reform Party;
- Pro Patria and Res Publica Union
- Estonian Centre Party
- Socal Democratic Party

Electoral alliances have central role in local elections. In three of five local municipalities local elections were won by electoral alliances.

Table 2: Results for local elections on Hiiumaa in 2009

Municipality	Party/electoral alliance	Total mandates
Kärdla town	Pro Patria and Res Publica Union Estonian Reform Party Estonian Centre Party Social Democratic Party Tuleviku Kärdla/ Future Kärdla – electoral alliance	4 4 3 3 1
Emmaste	Ausus ja usaldus /Honesty and Trust– electoral alliance Emmaste koostöö /Co-operation in Emmaste– electoral alliance	5 4
Kõrgessaare	Avatus/ Openness – electoral alliance Estonian Reform Party	7 2
Käina	Estonian Reform Party Co-operation - electoral alliance Estonian Centre Party	5 5 3
Pühalepa	Koduvald / Home parish – electoral alliance Tasakaal / Balance – electoral alliance Pro Patria and Res Publica Union	5 5 1

Local elections are held in every forth year. Next local elections will be held in 20th of October, 2013.

2. GLOBAL STRATEGY

2.1. Current framework and vision for the future

Energy is a strategic factor for the development of Hiiumaa, as it bears all the economic and social activities and has a significant weight in the imports and in the economy, with repercussions on the competitiveness, employment and quality of life.

The specificities of an insular small territory imply higher costs for energy supply, due to the transport and size of the markets and infrastructures. These added costs mean that energy efficiency measures and valorisation of renewable energy sources become more interesting from an economic standpoint, in addition to the environmental and social benefits.

The actual situation and future perspectives for socio-economic development and growth of the energy sector require a sustainable energy policy based on efficiency and valorisation of local resources.

The development of energy sector on Hiiumaa till 2020 is focused on local resources and preferably on local ownership based development of biomass, wind and solar energy production. Electricity and biogas produced on Hiiumaa will find its usage on local transport (including ferry transport) and economy. Small size CHP using biomass as energy source will suffice heat demand. The usage of solar energy for electricity and domestic hot water will increase

As a vision for the future, the energy policy is orientated to guarantee security of energy supply, ensure economical and environmental sustainability of the sector and quality of energy services, and to contribute to job creation and local added value and to the competitiveness of the local economy.

2.2. Objectives and targets

The specific main objectives of the strategy for sustainable energy in Hiiumaa Island are to:

- Improve security of energy supply.
- Reduce energy dependence from abroad.
- Reduce energy intensity in Gross Domestic Product.
- Reduce carbon dioxide emissions.

The targets to achieve in 2020 are to:

- Increase to 80% the local energy resources in primary energy demand.
- Reduce CO_2 by 100% compared to 2005.
- Have a neutral balance of CO_2 emissions.

The commitment for Hiiumaa Island with its voluntary entry to the Pact of Islands is the reduction of 20% reduction of CO_2 emissions in comparison to 2005 reference year.

2.3. Strategic guidelines

In order to fulfil the specific objective, and taking into account the targets for 2020, four strategic guidelines are established, that aim to guide the implementation of sustainable energy actions in Hiiumaa Island:

1. Improve energy efficiency.
2. Increase the contribution of local energy resources.
3. Diversify energy sources.
4. Promote energy products and services that encourage economic development and local added value.

3. ENERGY BALANCE AND EMISSION INVENTORY

3.1. Baseline situation

The baseline situation of the action plan reflects the state of the energy demand and of carbon dioxide emissions (CO_2) before the preparation of the plan and constitutes the reference basis for the scenario drafting for 2020 and setting of objectives and targets.

The base year, for the elaboration of energy demand scenarios, is 2009, which is the most recent year with detailed data available. For the carbon dioxide emissions, the year 2005 was adopted as the base year in order to keep in line with the objectives set for the European Union and with the criteria established in the scope of the Pact of Islands

For the analysis of the baseline situation, a survey was carried out on the energy demand per energy carrier and per activity sector, as well as the energy conversion per product and per source, to respective suppliers and producers.

Based on the information gathered, an energy balance for 2009 was drawn up, taking into consideration the final energy demand, energy conversion and primary energy demand. The carbon dioxide emission inventory was determined for the years 2005 and 2009.

3.1.1. Final energy demand

The final energy demand, per energy carrier and per sector, in Hiiumaa Island, in 2009, is presented in a summary form in the following table and figures.

Table 3: Final energy demand in 2009

Energy carriers		Residential [MWh]	Primary sector [MWh]	Secondary sector [MWh]	Tertiary sector [MWh]	Transports [MWh]	TOTAL [MWh]
Centralized energy services	Electricity	17 206	1 092	11 745	13 312		43 355
	Heat	4 380		958	3 026		8 364
	Subtotal	21 586	1 092	12 703	16 338		51 719
Fossil fuels	Fueloil	469					469
	Diesel		5 158			20 435	25 593
	Gasoline					21 078	21 078
	LPG	12					12
	Subtotal	481	5 158			41 513	47 152
Renewable energy sources	Wind						
	Geothermal						
	Biomass	45 550		1 000	11 150		57 700
	Subtotal	45 550		1 000	11 150		57 700
TOTAL		**67 617**	**6 250**	**13 703**	**27 488**	**41 513**	**156 571**

Figure 2: Final energy demand per sector in 2009

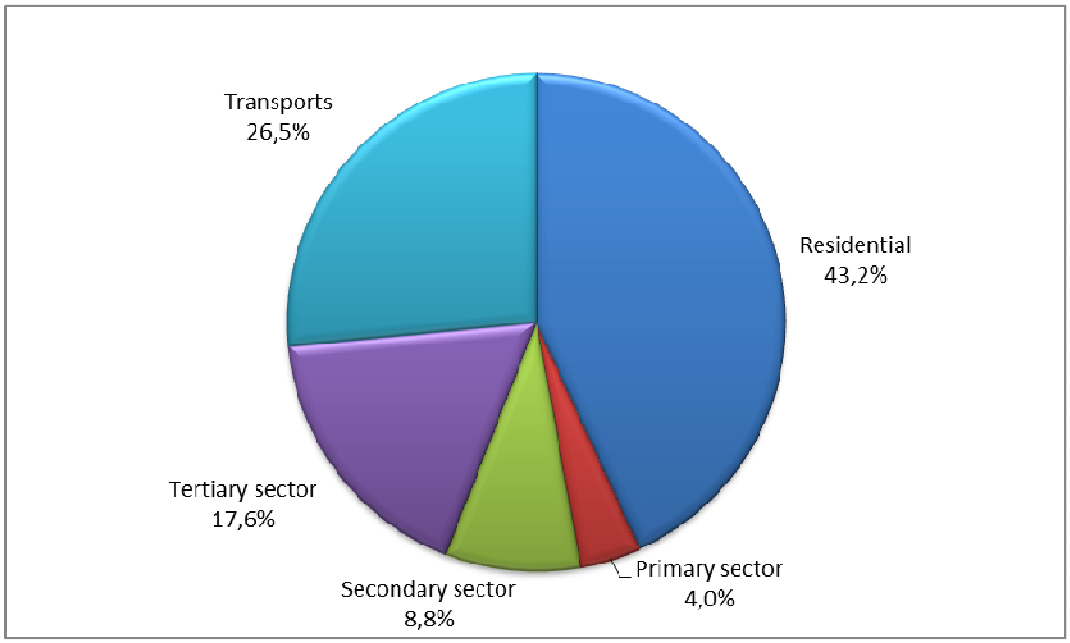
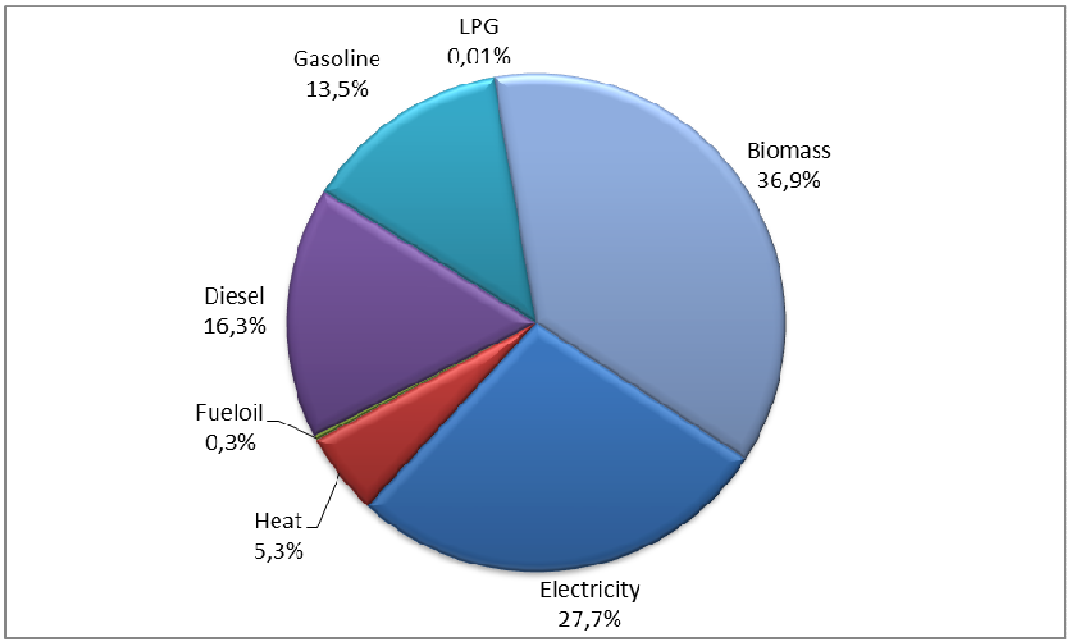


Figure 3: Final energy demand per energy carrier in 2009



From the analysis of the final energy demand, it's worthy to note the significant weight of the land residential sector, with a 43,2% contribution, followed by the transport and tertiary sectors. The share of renewable energy resources accounted for 44,8% of the total final energy demand in 2009. Regarding the energy carriers used by the final consumer, biomass represents the highest share in percentage terms.

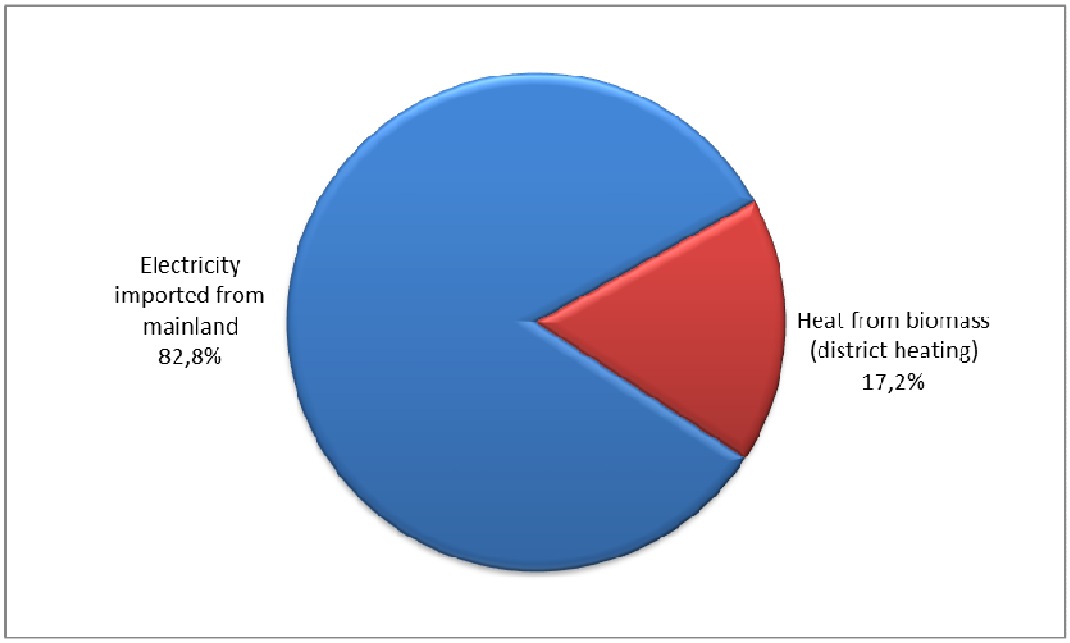
3.1.2. Energy conversion and energy fluxes

In Hiiumaa Island, energy conversion refers essentially to heat production for district heating, based on biomass. Electricity is imported and using cable connection with Saaremaa. There is no industrial scale energy production on the island.

Table 4: Energy conversion and energy fluxes in 2009

Energy carriers		Electricity [MWh]	Heat [MWh]	TOTAL [MWh]
Renewable energy sources	Wind			
	Biomass		10 006	10 006
	Energy recovery			
	Subtotal		10 006	10 006
External connection	Import to island	48 172		48 172
	Export from island			
TOTAL		**48 172**	**10 006**	**58 178**
Distribution losses and self-consumption		4 817	1 642	6 459

Figure 4: Energy conversion and energy fluxes in 2009



The electricity import from the mainland trought the electric cable represented 82,8% of total secondary energy and local heat production from biomass for district heating represented 17,2% in 2009.

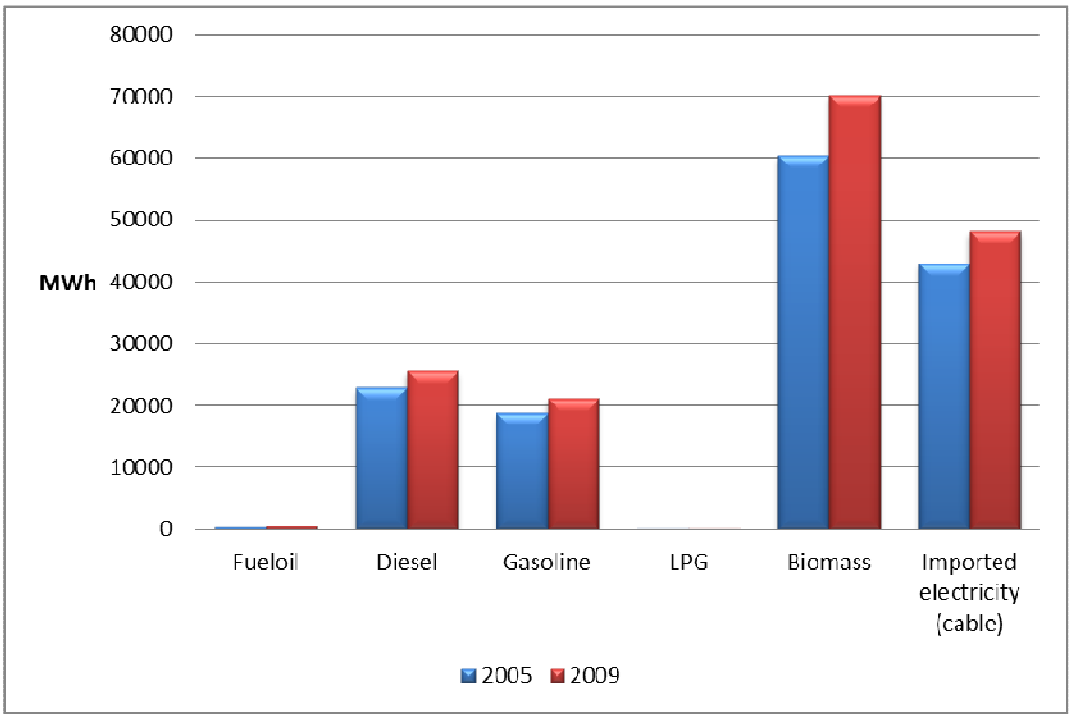
3.1.3. Primary energy demand

The primary energy demand is determined, through an energy balance, by the final energy demand, the use of energy resources for energy conversion into heat and electricity import.

Table 5: Primary energy demand in 2005 and in 2009

Energy carriers		2005 [MWh]	2009 [MWh]
Fossil fuels	Fueloil	418	469
	Diesel	22 828	25 593
	Gasoline	18 800	21 078
	LPG	11	12
	Subtotal	42 057	47 152
Renewable energy sources	Wind		
	Geothermal		
	Biomass	60 390	70 207
	Energy recovery		
	Subtotal	60 390	70 207
Electricity	Imported electricity (cable)	43 040	48 172
	Exported electricity (cable)		
TOTAL		**145 487**	**165 531**

Figure 5: Primary energy demand in 2005 and in 2009



3.1.4. Emissions of carbon dioxide

The carbon dioxide emissions were determined according to the IPCC (Intergovernmental Panel on Climate Change) methodology, which considers the carbon content of fuels or fractions of non-renewable energy resources used in the combustion and carbon content of imported electricity production.

Table 6: CO_2 emissions per sector in 2009

Energy carriers		Residential [t]	Primary sector [t]	Secondary sector [t]	Tertiary sector [t]	Transports [t]	TOTAL [t]
Centralized energy services	Electricity	8 794	558	6 003	6 804		22 159
	Heat						
	Subtotal	8 794	558	6 003	6 804		22 159
Fossil fuels	Fueloil	131					131
	Diesel		1 377			5 456	6 833
	Gasoline					5 248	5 248
	LPG	3					3
	Subtotal	134	1 377			10 705	12 215
Renewable energy sources	Wind						
	Geothermal						
	Biomass						
	Subtotal						
TOTAL		**8 928**	**1 935**	**6 003**	**6 804**	**10 705**	**34 375**

For biomass, assuming a sustainable exploitation of the resources, a neutral balance of emissions was considered.

Figure 6: CO_2 emissions per sector in 2009

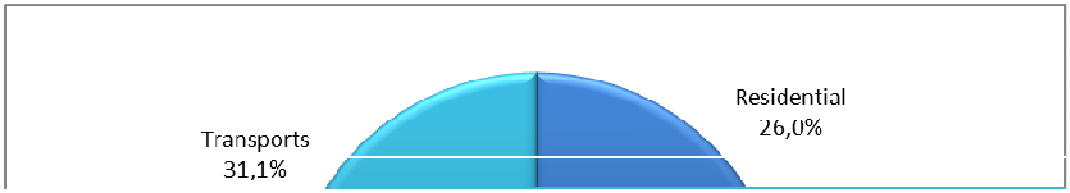
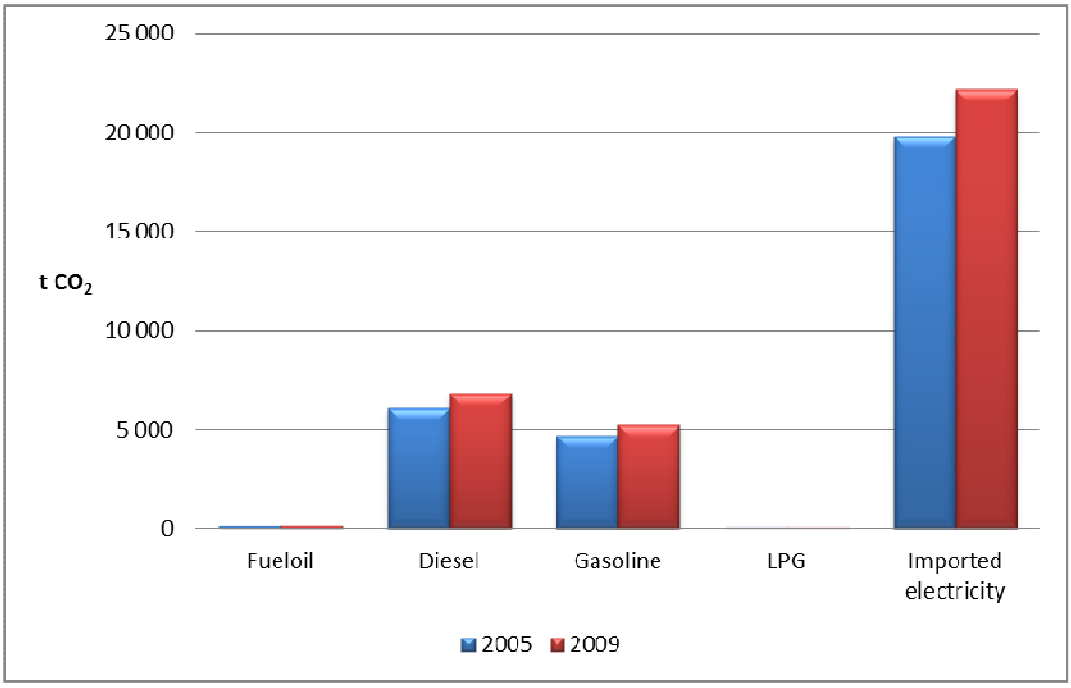


Table 7: CO_2 emissions per primary energy carrier in 2005 and 2009

Energy carriers		2005 [t]	2009 [t]
Fossil fuels	Fueloil	117	131
	Diesel	6 095	6 833
	Gasoline	4 681	5 248
	LPG	3	3
	Subtotal	10 896	12 215
Renewable energy sources	Wind		
	Geothermal		
	Biomass		
	Energy recovery		
	Subtotal		
Electricity	Imported electricity (cable)	19 798	22 159
	Exported electricity (cable)		
TOTAL		**30 694**	**34 375**

Figure 7: CO_2 emissions per primary energy carrier in 2005 and in 2009



Comparing the emissions in 2005 and in 2009, a slight increase can be verified due to the increase of consumption of diesel, gasoline and imported electricity.

3.2. Projections to 2020 – Business as usual scenario

The business as usual (BAU) scenario corresponds to the evolution of the energy demand and carbon dioxide emissions until 2020, based on the year of reference (2009), considering that the conditions of the baseline situation are maintained and that measures to improve energy efficiency and the valorisation of renewable energies are not implemented as advocated in the action plan.

The evolution of the energy demand and CO_2 emissions results primarily from socio-economic dynamics and external factors. Thus, for the elaboration of this scenario, the recent evolution of the energy demand in the various sectors, the current macroeconomic environment, the perspectives for development of some relevant activity sectors and the population growth, among other factors, were taken into account.

The evolution of energy efficiency results from the normal aquisition of new equipment and to the "ageing" of existing equipment, therefore it was considered practically constant during the plan's duration. The use of renewable energy by the final consumer followed the evolution trend of the energy demand until 2020.

With these presuppositions, the energy balance and the calculations of the carbon dioxide emissions were carried out for each year, until 2020. In the following figures, graphs are presented that reflect the expected evolution of the primary energy demand and emissions until 2020.

Figure 8: Primary energy demand until 2020 – BAU scenario

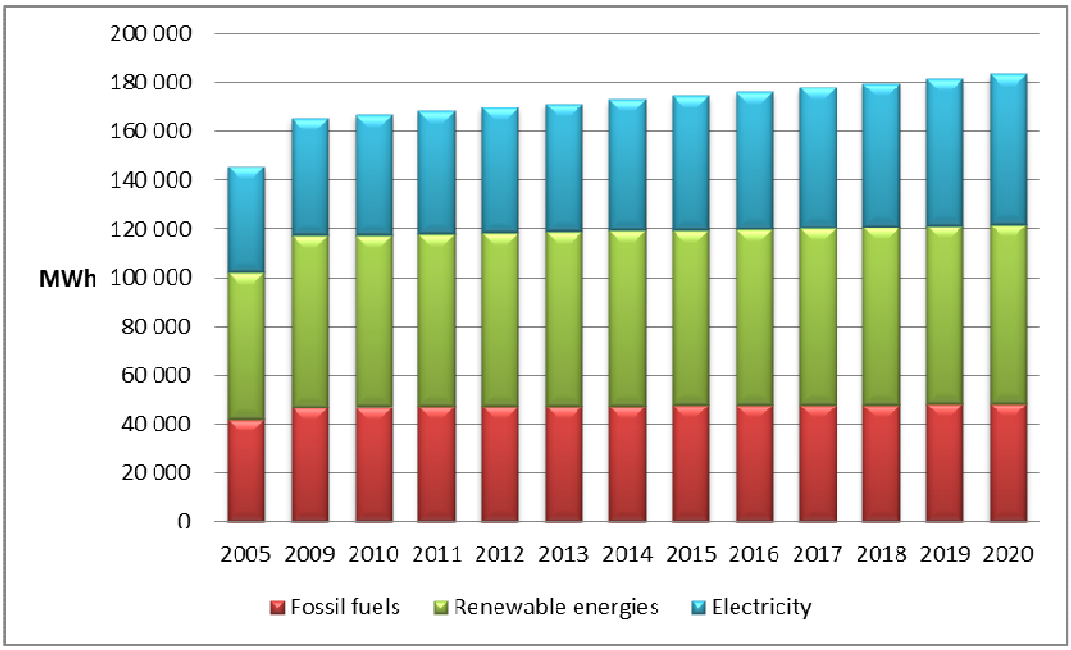
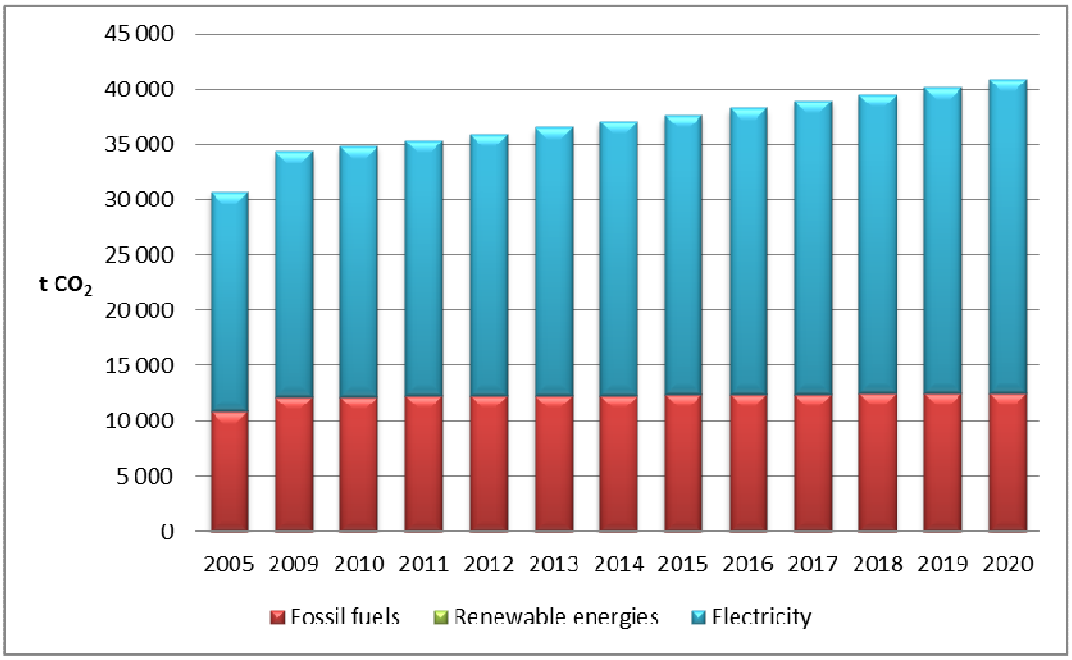


Figure 9: CO_2 emissions until 2020 – BAU scenario



In this scenario, the carbon dioxide emissions increased by 33%, when the target set, in the scope of the Pact of Islands, points to a reduction of at least 20% of emissions.

3.2.1. Final energy demand

The final energy demand in Hiiumaa Island for the BAU scenario, in 2020, per energy carrier and per sector, is presented in a summary form, in the following table and figures.

Table 8: Final energy demand in 2020 – BAU scenario

Energy carriers		Residential [MWh]	Primary sector [MWh]	Secondary sector [MWh]	Tertiary sector [MWh]	Transports [MWh]	TOTAL [MWh]
Centralized energy services	Electricity	21 393	1 092	14 478	18 468		55 431
	Heat	5 446		1 191	3 789		10 426
	Subtotal	26 839	1 092	15 669	22 257		65 858
Fossil fuels	Fueloil	469					469
	Diesel		5 158			21 719	26 877
	Gasoline					21 078	21 078
	LPG	12					12
	Subtotal	481	5 158			42 797	48 436
Renewable energy sources	Wind						
	Geothermal						
	Biomass	45 550		1 000	11 150		57 700
	Subtotal	45 550		1 000	11 150		57 700
TOTAL		**72 870**	**6 250**	**16 669**	**33 407**	**42 797**	**171 994**

Figure 10: Final energy demand per sector in 2020 – BAU scenario

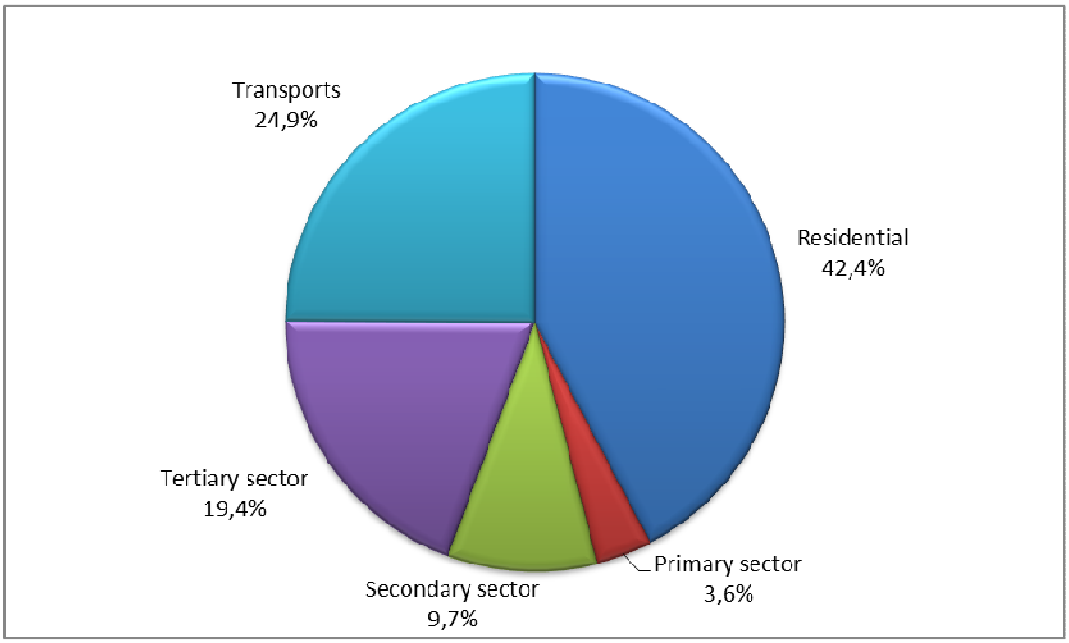
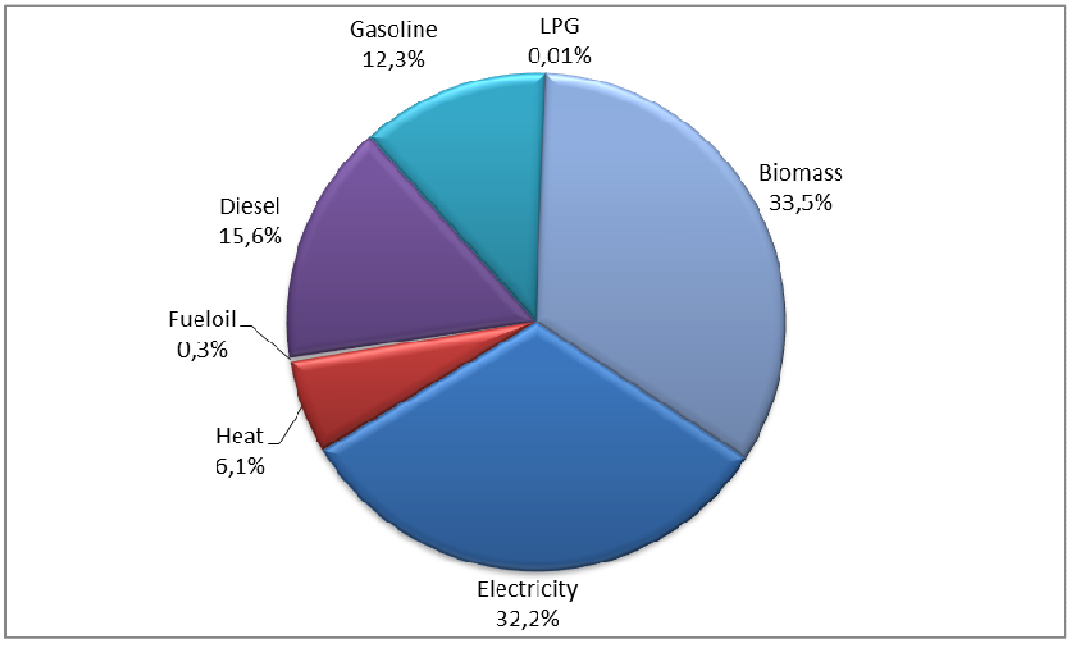


Figure 11: Final energy demand per energy carrier in 2020 – BAU scenario



From the analysis of the final energy demand, it can be highlighted the permanence of a significant weight in the residential sector, although with a lower percentage than the base year, whilst the contribution of the transport, tertiary and secondary sectors increased. Per energy carrier, one can point out the percentage growth of the electricity demand and a decrease on biomass.

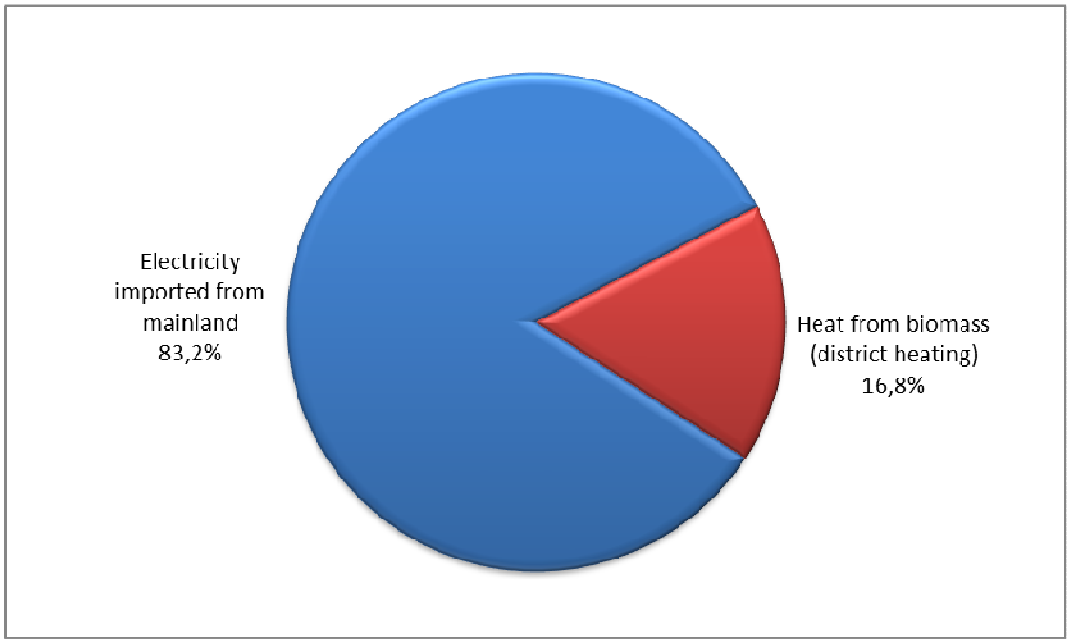
3.2.2. Energy conversion and energy fluxes

In this scenario, the energy conversion refers essentially to heat production. Electricity is imported as in the base year and local prodution is only done as a backup in case of cable failure.

Table 9: Energy conversion and energy fluxes in 2020 – BAU scenario

Energy carriers		Electricity [MWh]	Heat [MWh]	TOTAL [MWh]
Renewable energy sources	Wind			
	Biomass		12 473	12 473
	Energy recovery			
	Subtotal		12 473	12 473
External connection	Import to island	61 590		61 590
	Export from island			
TOTAL		**61 590**	**12 473**	**74 064**
Distribution losses and self-consumption		6 159	2 047	8 206

Figure 12: Energy conversion and energy fluxes in 2020 – BAU scenario



In this scenario, the local demand of imported electricity increased of 28%, from 48 172 MWh in 2009 to 61 590 MW in 2020, and heat for district heating increased 25%, from 10 006 MWh in 2009 to 12 473 MWh in 2020.

3.2.3. Primary energy demand

The primary energy demand for the present scenario is determined, through an energy balance, by the final energy demand, the use of energy resources for the conversion into heat and electricity importation.

Table 10: Primary energy demand in 2005, 2009 and 2020 – BAU scenario

Energy carriers		2005 [MWh]	2009 [MWh]	2020 [MWh]
Fossil fuels	Fueloil	418	469	469
	Diesel	22 828	25 593	26 877
	Gasoline	18 800	21 078	21 078
	LPG	11	12	12
	Subtotal	42 057	47 152	48 436
Renewable energy sources	Wind			
	Geothermal			
	Biomass	60 390	70 207	73 292
	Energy recovery			
	Subtotal	60 390	70 207	73 292
Electricity	Imported electricity (cable)	43 040	48 172	61 590
	Exported electricity (cable)			
TOTAL		**145 487**	**165 531**	**183 318**

Figure 13: Primary energy demand in 2005, 2009 and 2020 – BAU scenario

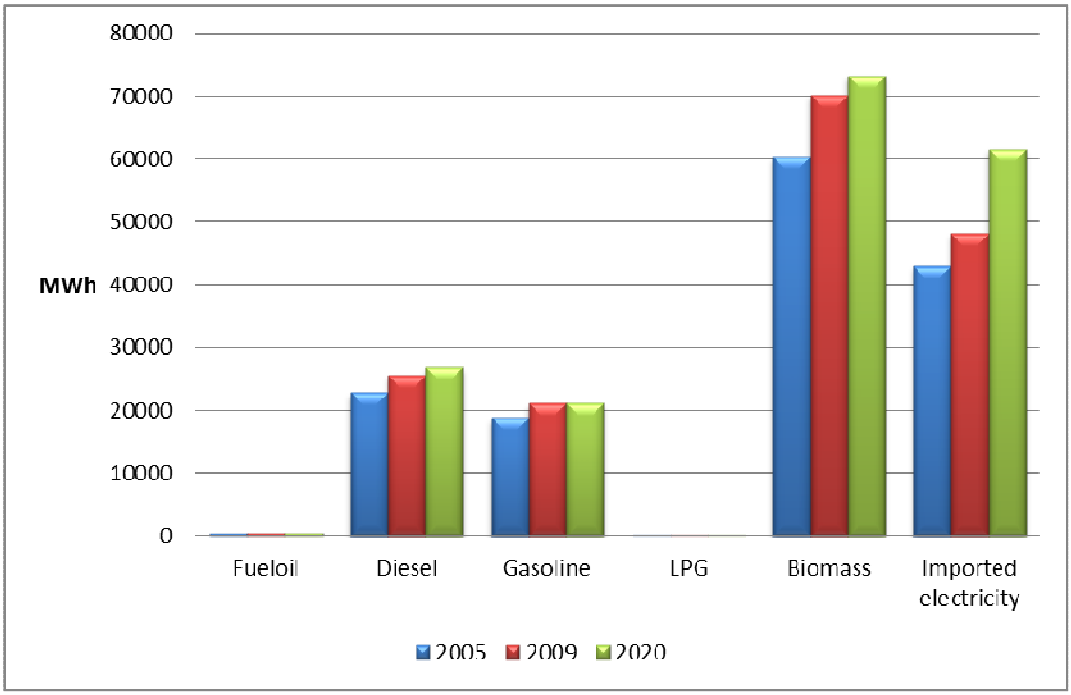
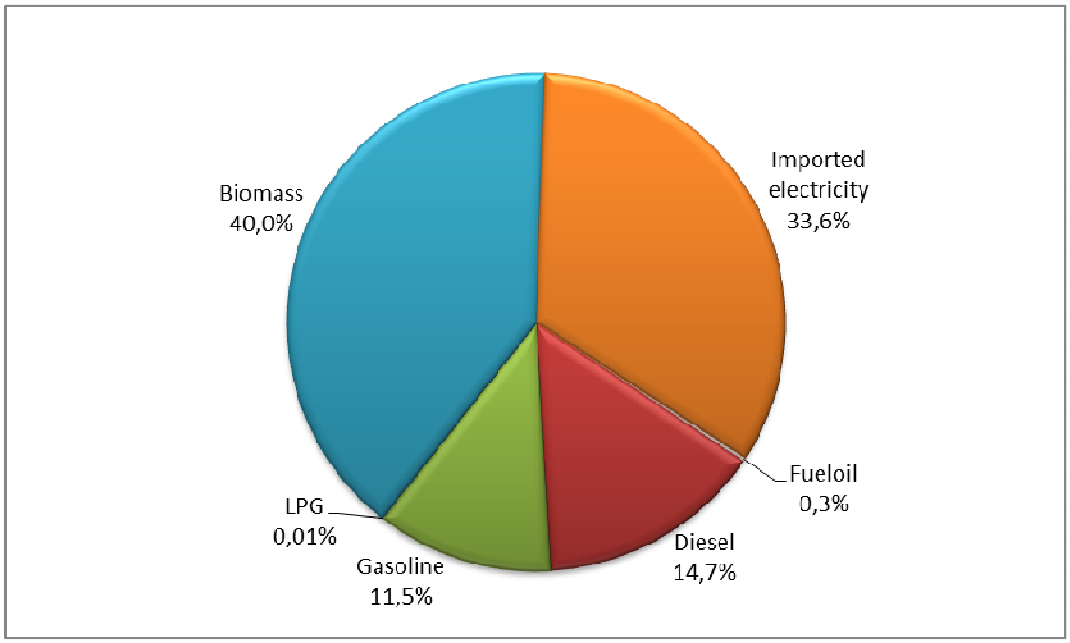


Figure 14: Primary energy demand in 2020 – BAU scenario



The BAU scenario leads to a 40,0% share of renewable energy resources in the total primary energy demand in 2020, which was 42,4% in 2009 and 41,5% in 2005.

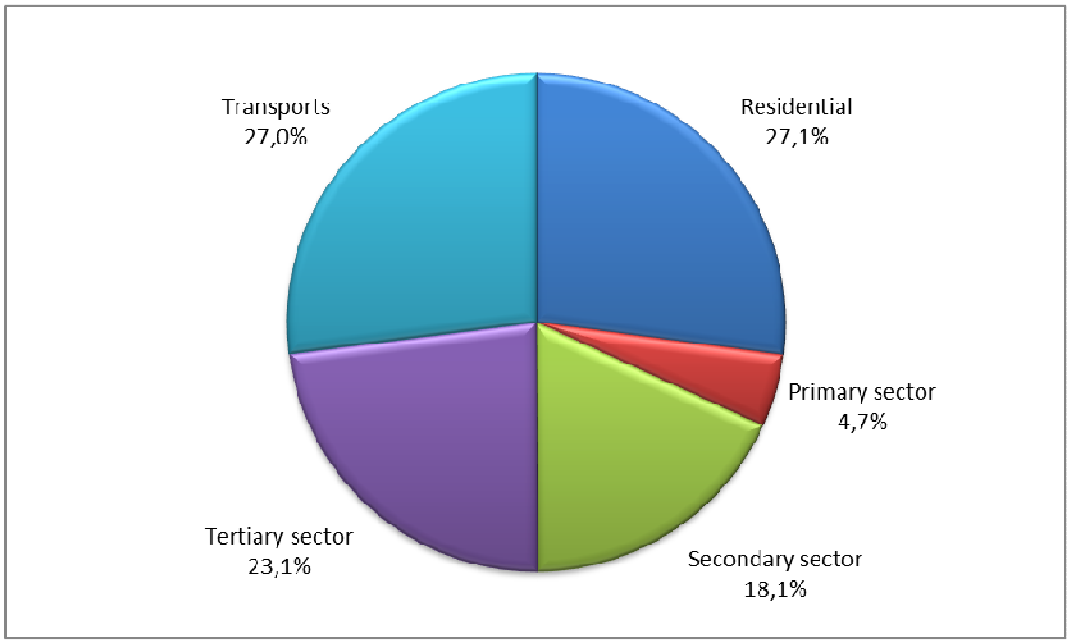
3.2.4. Emissions of carbon dioxide

Adopting the same methodology as for the base year, the carbon dioxide emissions were calculated for the year 2020, from results of the energy demand projections obtained in the BAU scenario.

Table 11: CO_2 emissions per sector in 2020 – BAU scenario

Energy carriers		Residential [t]	Primary sector [t]	Secondary sector [t]	Tertiary sector [t]	Transports [t]	TOTAL [t]
Centralized energy services	Electricity	10 934	558	7 400	9 439		28 332
	Heat						
	Subtotal	10 934	558	7 400	9 439		28 332
Fossil fuels	Fueloil	131					131
	Diesel		1 377			5 799	7 176
	Gasoline					5 248	5 248
	LPG	3					3
	Subtotal	134	1 377			11 047	12 558
Renewable energy sources	Wind						
	Geothermal						
	Biomass						
	Subtotal						
TOTAL		**11 068**	**1 935**	**7 400**	**9 439**	**11 047**	**40 890**

Figure 15: CO_2 emissions per sector in 2020 – BAU scenario



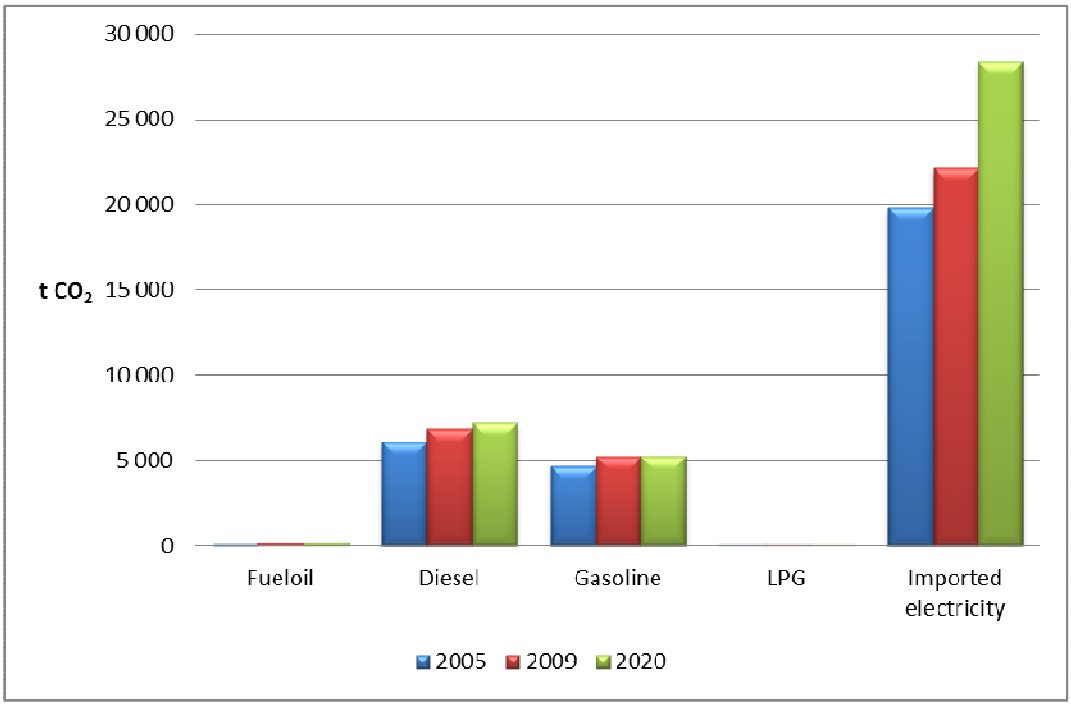
In this scenario, in comparison to 2009, there is a considerable increase of emissions in the tertiary sector. This factor is mainly due to the increase in electricity consumption.

Analysing the emissions per energy carrier, a significant increase of carbon dioxide emissions can be verified.

Table 12: CO_2 emissions per primary energy carrier in 2005, 2009 and 2020 – BAU scenario

Energy carriers		2005 [t]	2009 [t]	2020 [t]
Fossil fuels	Fueloil	117	131	131
	Diesel	6 095	6 833	7 176
	Gasoline	4 681	5 248	5 248
	LPG	3	3	3
	Subtotal	10 896	12 215	12 558
Renewable energy sources	Wind			
	Geothermal			
	Biomass			
	Energy recovery			
	Subtotal			
Electricity	Imported electricity (cable)	19 798	22 159	28 332
	Exported electricity (cable)			
TOTAL		**30 694**	**34 375**	**40 890**

Figure 16: CO_2 emissions per primary energy carrier in 2005, 2009 and 2020 – BAU scenario



In comparison to the emissions in 2005, an increase of 33%, mainly due to the increase of imported electricity.

3.3. Projections to 2020 – Action plan scenario

The action plan scenario corresponds to the evolution of the energy demand and carbon dioxide emissions until 2020, based on the year of reference (2009), considering the implementation of actions to improve energy effiicency and valorization of renewable energies.

The evolution of the energy demand and CO_2 emissions, result, cumulatively, from the socio-economic dynamics and external factors considered in the BAU scenario and from the implementation of the action plan. Thus, for the preparation of this scenario, the recent development of energy demand in the various sectors, the current macroeconomic context, the perspectives for development of relevant activity sectors and the population expected evolution, among other factors, were taken into consideration, as well as the reductions in energy demand and in carbon dioxide emissions expected from the implementation of sustainable energy actions that constitute this plan.

The evolution of energy efficiency results mainly from the adoption of more efficient practices and of the aquisition of equipment and systems with better performance. The use of renewable energy by the end user had a higher growth than the evolution of energy demand until 2020. The renewable energy sources for heat and electricity production had a significant growth, associated to the construction of a windpark and biomass cogeneration power plants, which reduces substantially the electricity imports and carbon dioxide emissions.

With these presuppositions, the energy balance and the calculations of carbon dioxide emissions were carried out for each year, until 2020. In the following figures, the graphs presented reflect the expected evolution of primary energy demand and carbon dioxide emissions until 2020.

Figure 17: Primary energy demand until 2020 – Action Plan scenario

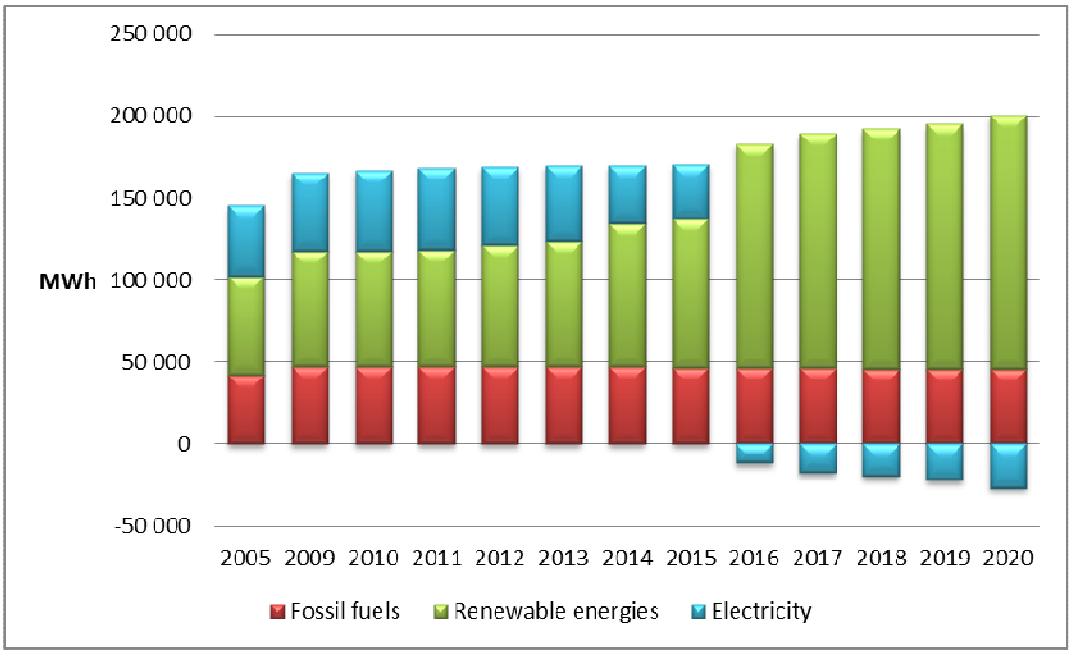
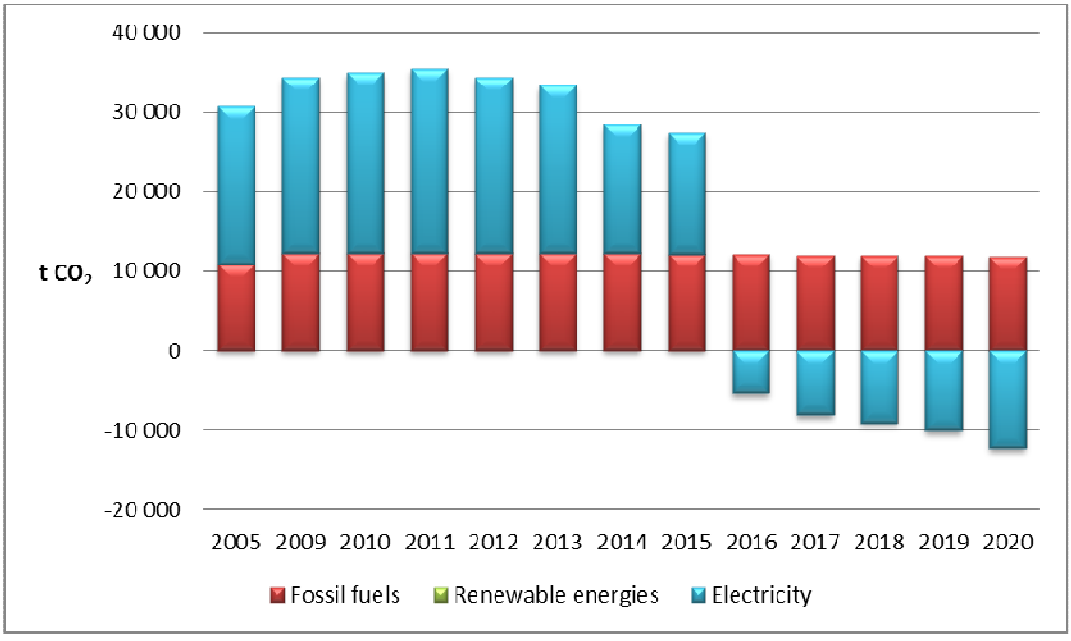


Figure 18: CO_2 emissions until 2020 – Action Plan scenario



In this scenario, the carbon dioxide emissions have a 102% reduction, which is higher than the 20% target set in the Pact of Islands.

3.3.1. Final energy demand

The final energy demand in Hiiumaa Island for the action plan scenario, in 2020, per energy carrier and per sector, is presented, in a summary form in the following table and figures.

Table 13: Final energy demand in 2020 – Action Plan scenario

Energy carriers		Residential [MWh]	Primary sector [MWh]	Secondary sector [MWh]	Tertiary sector [MWh]	Transports [MWh]	TOTAL [MWh]
Centralized energy services	Electricity	4 978	1 092	11 616	10 161	211	28 058
	Heat	8 913		2 076	5 147		16 136
	Subtotal	13 891	1 092	13 692	15 309	211	44 194
Fossil fuels	Fueloil	385					385
	Diesel		5 158			20 548	25 706
	Gasoline					19 497	19 497
	LPG	12					12
	Subtotal	397	5 158			40 045	45 600
Renewable energy sources	Wind	52					52
	Geothermal	2 160		540	3 096		5 796
	Biomass	54 660		1 200	11 858	555	68 272
	Subtotal	56 872		1 740	14 954	555	74 120
TOTAL		**71 159**	**6 250**	**15 432**	**30 262**	**40 811**	**163 914**

Figure 19: Final energy demand per sector in 2020 – Action Plan scenario

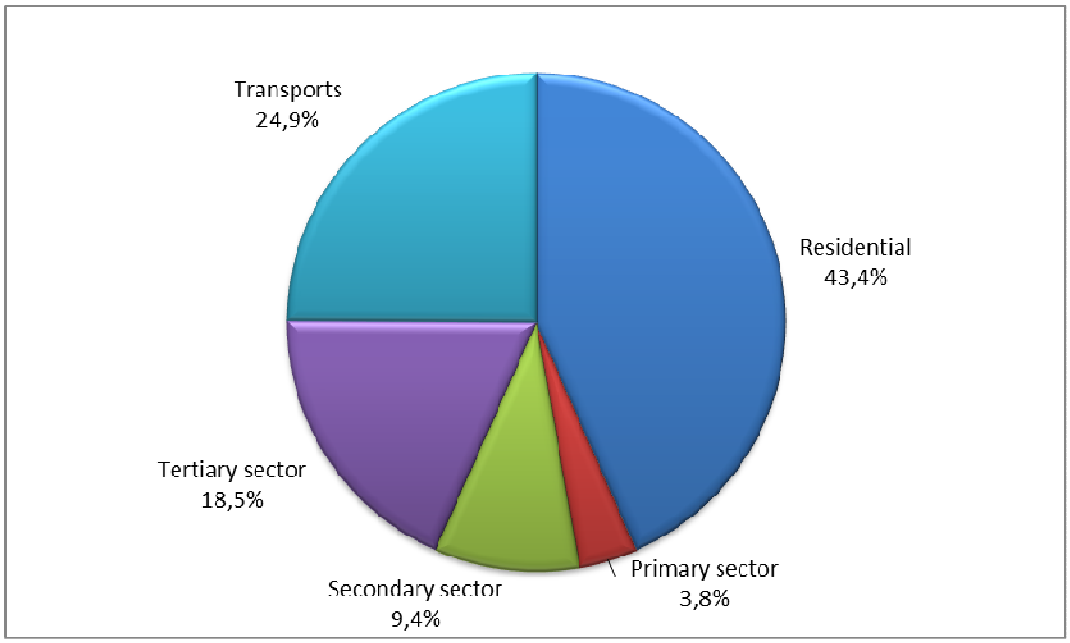
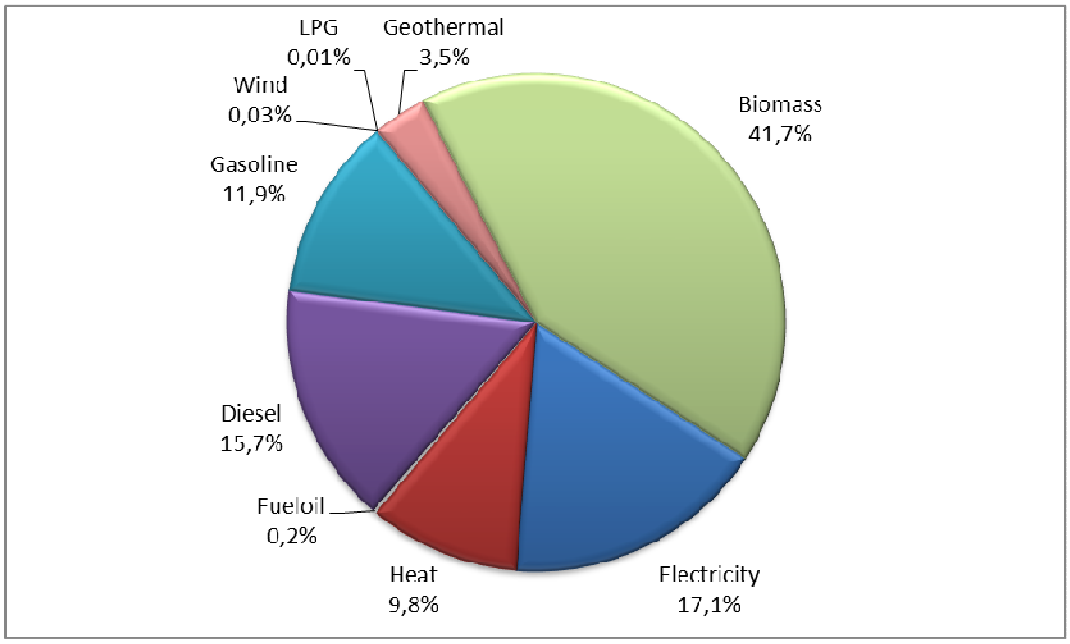


Figure 20: Final energy demand per energy carrier in 2020 – Action Plan scenario



In comparison with the BAU scenario, the sectorial distribution in percentage terms is similar, but, in absolute value, there is a decrease of energy demand. In terms of energy carriers, there is a significant reduction of electricity demand and an increase of biomass and district heating.

The share of renewable energy resources, represents, for this scenario, 72% of the total final energy demand in 2020, including the renewable component in heat and electricity production, while in the BAU scenario, this stood around 47%.

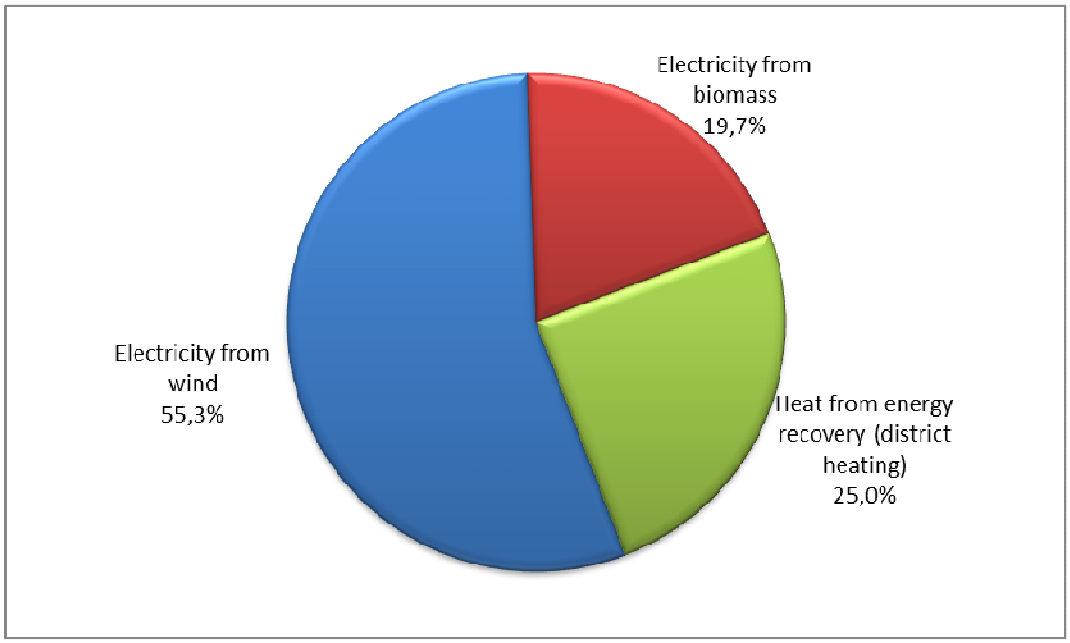
3.3.2. Energy conversion and energy fluxes

In this scenario, it is considered the installation of a 15 MW windpark and small cogeneration plants to produce electricity and heat to local district heating networks in the main urban areas. The energy conversions for electricity and heat are obtained from local renewable energy sources (wind and biomass).

Table 14: Energy conversion and energy fluxes in 2020 – Action Plan scenario

Energy carriers		**Electricity [MWh]**	**Heat [MWh]**	**TOTAL [MWh]**
Renewable energy sources	Wind	42 750		42 750
	Biomass	15 250		15 250
	Energy recovery (biomass)		19 304	19 304
	Subtotal	58 000	19 304	77 304
External connection	Import to island			
	Export from island	-26 824		-26 824
TOTAL		**31 176**	**19 304**	**50 480**
Distribution losses and self-consumption		3 118	3 168	6 285

Figure 21: Energy conversion and energy fluxes in 2020 – Action Plan scenario



In this scenario, the local demand of electricity has decreased 35%, from 48 172 MWh in 2009 to 31 176 MW in 2020, and heat for district heating increased 93%, from 10 006 MWh in 2009 to 19 304 MW in 2020. This results from an increase of district heating network to reduce electric heating. In BAU scenario, the local demand of imported electricity was 61 590 MW and heat for district heatingwas 12 473 MW, in 2020.

The local electricity production from renewable energy sources in 2020 is higher than the demand and the excess is exported. The electric cable works as reversible backup system, importing when production is lower and exporting when production is higher than demand.

3.3.3. Primary energy demand

The primary energy demand for the present scenario is determined, through an energy balance, by the final energy demand and by the use of energy resources for conversion into electricity and heat.

Table 15: Primary energy demand in 2005, 2009 and 2020 – Action Plan scenario

Energy carriers		2005 [MWh]	2009 [MWh]	2020 [MWh]
Fossil fuels	Fueloil	418	469	385
	Diesel	22 828	25 593	25 706
	Gasoline	18 800	21 078	19 497
	LPG	11	12	12
	Subtotal	42 057	47 152	45 600
Renewable energy sources	Wind			42 802
	Geothermal			5 796
	Biomass	60 390	70 207	106 397
	Subtotal	60 390	70 207	154 995
Electricity	Imported electricity (cable)	43 040	48 172	
	Exported electricity (cable)			-26 824
TOTAL		**145 487**	**165 531**	**173 770**

Figure 22: Primary energy demand in 2005, 2009 and 2020 – Action Plan scenario

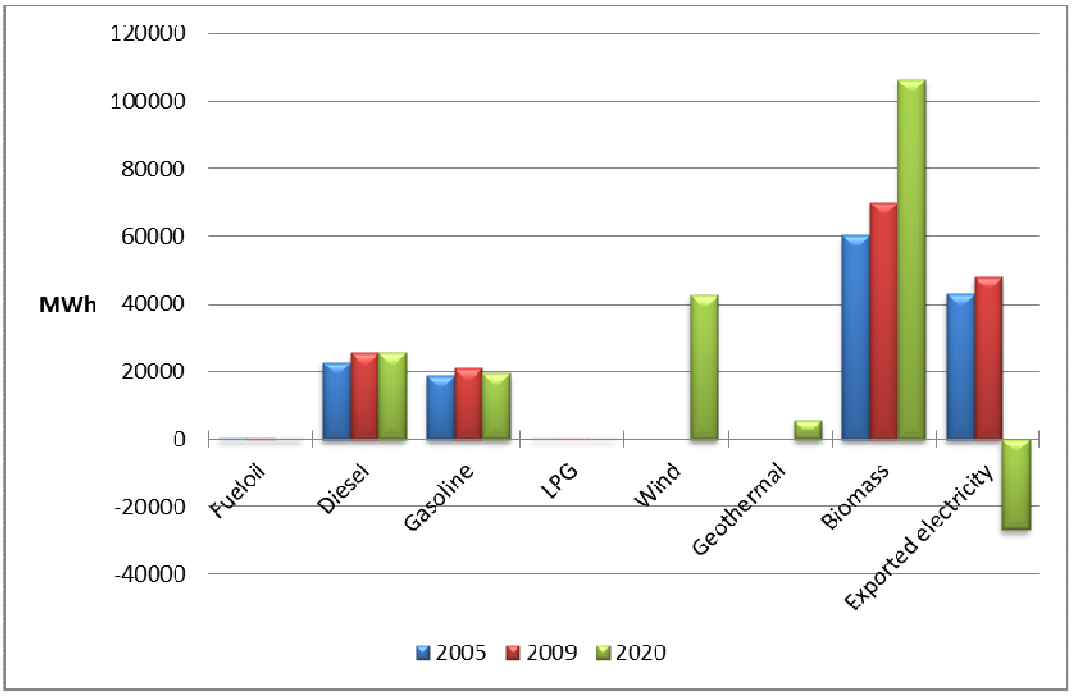
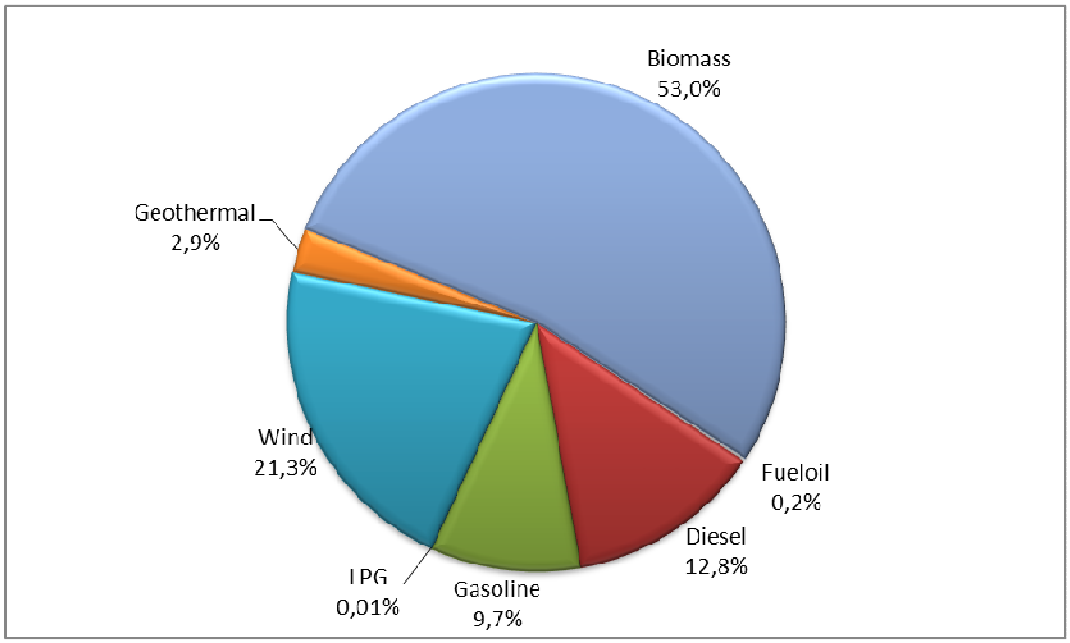


Figure 23: Primary energy demand in 2020 – Action Plan scenario



This scenario leads to a 89,2% share of renewable energy resources in the total primary energy demand in 2020, which was 42,4% in 2009 and 41,5% in 2005. In the BAU scenario, this percentage lies at 40,0%.

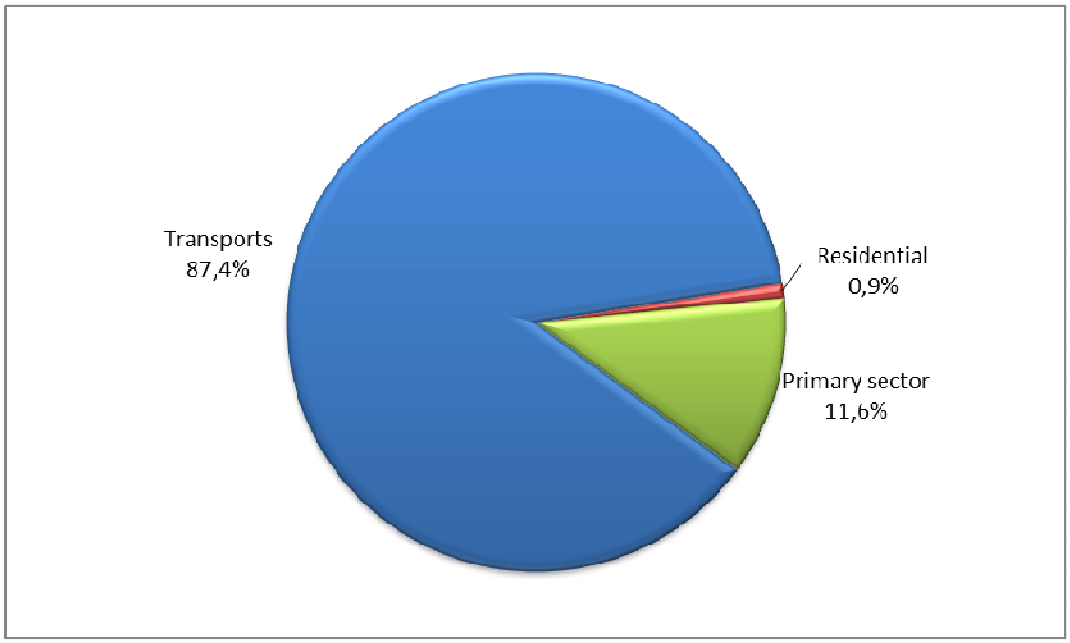
3.3.4. Emissions of carbon dioxide

Adopting the same methodology as for the base year of the BAU scenario, the carbon dioxide emissions were calculated for the year 2020, from the results of the energy demand projections obtained in the action plan scenario.

Table 16: CO_2 emissions per sector in 2020 – Action Plan scenario

Energy carriers		Residential [t]	Primary sector [t]	Secondary sector [t]	Tertiary sector [t]	Transport [t]	TOTAL [t]
Centralized energy services	Electricity						
	Heat						
	Subtotal						
Fossil fuels	Fueloil	107					107
	Diesel		1 377			5 486	6 864
	Gasoline					4 855	4 855
	LPG	3					3
	Subtotal	110	1 377			10 341	11 828
Renewable energy sources	Wind						
	Geothermal						
	Biomass						
	Subtotal						
TOTAL		**110**	**1 377**			**10 341**	**11 828**

Figure 24: CO_2 emissions per sector in 2020 – Action Plan scenario



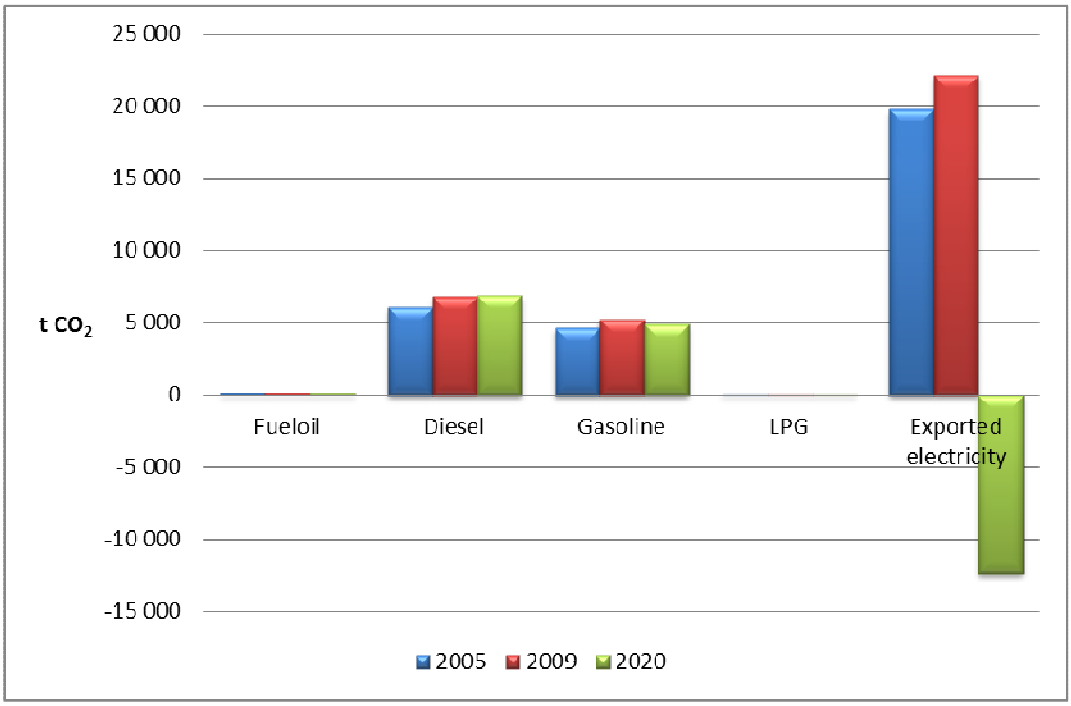
In this scenario, in comparison to 2009, there is a considerable reduction of emissions. The electricity and heat in this scenario have neutral CO_2 emissions in 2020 and for this reason, second some sectors have no emissions.

Analysing the emissions per energey carrier, it can be noted a significant reduction of the emissions from electricity. As electricity is produced from local renewable energy sources and the surplus is exported, there is a negative balance of 12 339 tonnes of CO_2 emissions, which result in an overall negative contribution of 511 tonnes of CO_2 in the island.

Table 17: CO_2 emissions per primary energy carrier in 2005, 2009 and 2020 – Action Plan scenario

Energy carriers		2005 [t]	2009 [t]	2020 [t]
Fossil fuels	Fueloil	117	131	107
	Diesel	6 095	6 833	6 864
	Gasoline	4 681	5 248	4 855
	LPG	3	3	3
	Subtotal			
Renewable energy sources	Wind			
	Geothermal			
	Biomass			
	Energy recovery			
	Subtotal			
Electricity	Imported electricity (cable)	19 798	22 159	
	Exported electricity (cable)			-12 339
TOTAL		**30 694**	**34 375**	**-511**

Figure 25: CO_2 emissions per primary energy carrier in 2005, 2009 and 2020 – Action Plan scenario



In comparison with the emissions of 2005, a reduction of 102% can be verified, while, in the BAU scenario, the emissions increased by 33%.

4. ACTIONS

To achieve the targets set in this action plan, actions were studied to improve energy efficiency and to encourage the use of renewable energy sources. The actions are aimed at various sectors and areas of intervention, which cover the final energy demand, secondary energy production, as well as the intervention of various players, including local authorities, companies and citizens.

The actions were studied through the preparation of scenarios, to simulate the interactions between the various actions and the results to be achieved, in agreement with the set objectives and targets. The actions presented in this chapter result from the analysis of the scenario chosen for the action plan, named in the previous chapter as "Action Plan Scenario".

The expected results in the year 2020 with the implementation of the plan's actions, in terms of energy savings, renewable energy generation and reduction of carbon dioxide emissions, are presented in the following table.

Table 18: Expected results in 2020

Sectors and areas of intervention	Energy savings [MWh/year]	Renewable energy production [MWh/year]	Reduction of CO_2 emissions [ton/year]
Residential	1 079	11 322	7 898
Primary sector	-	-	-
Secondary sector	1 211	740	1 427
Tertiary sector	2 704	3 804	3 941
Transport	1 986	555	599
Secondary energy production	-	77 304	26 680
Other areas	-	-	-
TOTAL	**6 980**	**93 725**	**40 545**

With these results, the action plan allows to comply with the targets set for the year 2020, as presented in the following table.

Table 19: Results against targets for 2020

Targets	Expected results
Increase to 80% the local energy resources in primary energy demand.	89%
Reduce CO_2 by 100% compared to 2005.	102%
Have a neutral balance of CO_2 emissions.	Negative balance of CO_2 emissions (-511 t)

4.1. Residential

The actions for the residential sector fall mainly on the acquisition of more energy efficient equipment, connection to district heating, use of renewable energy sources and behaviour changes concerning energy use.

Table 20: Actions for the residential sector

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Domestic uses	Increase the use of district heating, biomass (firewood, pellets and wood bricks) and geothermal heatpumps for heating and hot water.	Citizen	2012	2020
	Increase of thermal insulation of new and existing buildings.	Citizen	2012	2020
	Installation of high efficiency lamps, light control sensors and temperature regulators; acquisition of energy efficient appliances; and raise awareness about efficient use of electricity, heat and hot water.	Citizen	2012	2020
	Installation of wind micro-turbines, solar panels and collectors for domestic energy production in remote houses.	Citizen	2014	2020

EXPECTED RESULTS IN 2020		
Energy savings [MWh/year]	Renewable energy production [MWh/year]	Reduction of CO_2 emissions [ton/year]
1 079	11 322	7 898

4.2. Primary sector

For the primary sector, that covers agriculture, livestock-breeding, hunting, forestry, fishing and mining, for its low level of energy demand, specific actions were not defined, although some cross-cutting actions, namely in heat and electricity production, biofuel production and transport, also cover this sector.

4.3. Secondary sector

For the secondary sector, the actions focus mainly on the connection to district heating and more efficient equipment, as well as other practices that may contribute to a reduction in energy demand.

Table 21: Actions for the secondary sector

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Manufacturing	Increase the use of district heating, biomass and geothermal heatpumps for heating and hot water.	Operators	2012	2020
	Installation of high efficiency lamps, light control sensors and temperature regulators; acquisition of energy efficient appliances; and raise awareness about efficient use of electricity, heat and hot water.	Operators	2012	2020

EXPECTED RESULTS IN 2020		
Energy savings [MWh/year]	Renwable energy production [MWh/year]	Reduction of CO_2 emissions [ton/year]
1 211	740	1 427

4.4. Tertiary sector

In the tertiary sector, that covers trade, tourism, public and private services, and public lighting, the strategy focuses mainly on the connection to district heating, energy performance of buildings and systems, and in the adoption of more efficient behaviours.

Table 22: Actions for the tertiary sector

Sectors and ares of intervention	Actions	Responsible for implementation	Implementation schedule	
			Starting year	Ending year
Trade, service and tourism	Increase the use of district heating, biomass (firewood, pellets and wood bricks) and geothermal heatpumps for heating and hot water.	Operators	2012	2020
	Increase of thermal insulation of new and existing buildings.	Operators	2012	2020
	Installation of high efficiency lamps, light control sensors and temperature regulators; acquisition of energy efficient appliances; and raise awareness about efficient use of electricity, heat and hot water.	Operators	2012	2020
Public administration, schools and kindergardens	Increase the use of district heating, biomass (firewood, pellets and wood bricks) and geothermal heatpumps for heating and hot water.	Operators	2012	2020
	Increase of thermal insulation of new and existing buildings.	Operators	2012	2020
	Installation of high efficiency lamps, light control sensors and temperature regulators; acquisition of energy efficient appliances; and raise awareness about efficient use of electricity, heat and hot water.	Operators	2012	2020
Other services	Installation of efficient lamps, luminaries and control sensors for street lighting.	Local government	2012	2020

EXPECTED RESULTS IN 2020		
Energy savings [MWh/year]	Production of renewable energy [MWh/year]	Reduction of CO_2 emissions [ton/year]
2 704	3 804	3 941

4.5. Transports

In the transport sector, which is a sector strongly dependent on fossil fuels, the actions to be implemented cover the services of passenger transport, fleets and private transport, focusing mainly on the use of alternative energy sources (biofuels and renewable electricity) and alternative transports (regular bicycle, electric bicycle and electric roller).

Table 23: Actions for the transport sector

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Passenger road transport (public transports, taxi, tourism, school buses, etc.)	Introduction of alternative forms of energy (biodiesel, biogas).	Operators	2015	2020
Other fleet for public and private services, and private transports	Increase use of alternative transports (regular bicycle, electric bicycle, electric rollers and electric cars) for private use, fleets and rental.	Operators Citizen	2012	2020

EXPECTED RESULTS IN 2020		
Energy savings [MWh/year]	**Production of renewable energy [MWhyear]**	**Reduction of CO_2 emissions [ton/year]**
1 986	555	599

4.6. Secondary energy production

The actions in the domain of secondary energy production refer essentially to the production of electricity and heat from renewable energy sources, namely wind and biomass.

Table 24: Actions for secondary energy production

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Wind	Installation of community windfarms.	Operators Citizens Local government	2016	2020
Biomass	Installation of biomass cogeneration power plants in larger settlements (Kärdla, Käina, Kõrgessaare, etc.).	Operators Local government	2014	2020
	Local production of pellets and wood bricks.	Operators	2014	2020
Solar	Extensive usage of solar collectors	Operators Local government	2014	2020

EXPECTED RESULTS IN 2020		
Energy savings [MWh/year]	**Renewable energy production [MWh/year**	**Reduction of CO_2 emissions [ton/year]**
-	77 304	26 680

4.7. Land use planning

The actions in the scope of land use planning integrate measures that lead to a reduction of energy needs, namely in the transport and building sectors, and an optimization of energy infrastructures and of the use of renewable energy resources.

Table 25: Actions for land use planning

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Regional and local strategic planning	Integration of criteria and norms in land use planning and municipal regulations that encourage the connection to district heating and the minimization of energy needs in transports and buildings, for new settlements.	Local government	2011	2020
Transports and mobility planning	Installation of supply infrastructures for electric vehicles.	Operators State government Local government	2012	2020
Energy infrastructures planning	Increase the coverage of the disctrict heating network.	Operators State government Local government	2012	2020
Renewable energy land use planning	Establishment of areas for renewable energies.	Local government	2012	2020

4.8. Public procurement of products and services

The definition of standards and criteria for energy efficiency and use of renewable energy in public procurement of works, goods and services, besides providing better energy performance of public services and facilities, have multiplying effects, as the market dynamics in these areas are fostered, contributing to create a critical mass, improve the quality of energy services and reduce prices, as well as raise awareness of decision makers of companies and society in general.

Table 26: Actions for public procurement of products and services

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Energy efficiency requirements or standards	Definition of standards and criteria for energy efficiency in the specifications of tender documents for procurement of works, goods and services.	Operators Local government	2012	2020
Renewable energy requirements or standards	Definition of standards and criteria for use of renewable energy in the specifications of tender documents for procurement of works, goods and services.	Operators Local government	2012	2020

4.9. Citizen and stakeholders

In order for the strategy advocated in this action plan be implemented satisfactorily and the targets achieved, it is fundamental that all of society participates, which justifies a set of actions to bring about the involvement of citizens and stakeholders in the energy area.

Table 27: Actions for citizens and stakeholders

Sectors and areas of intervention	Actions	Responsible for the implementation	Implementation schedule	
			Starting year	Ending year
Advisory services	Creation of an internet-based sustainable energy advisory service for local businesses and residents.	NGO-s	2012	2020
Financial support and grants	Financial support to infrastructures for sustainable energy, including electric cars charging stations and improvement of electric grid to receive renewable energies.	State government	2012	2020
	Application for infrastructures and sustainable energy projects to national and european support programs.	State government Local government NGO-s	2011	2020
	Promotion of financing and credit instruments for sustainable energy investments (energy service companies and banks).	Operators Local government NGO-s	2012	2020
Awareness-raising and networking	Elaboration of information leaflets about sustainable energy use and efficient appliances and water heaters.	NGO-s	2012	2020
	Development of cooperation projects with governments, civil society and other regions.	NGO-s Local government	2012	2020
	Training operators to introduce new energy-efficient materials in the construction and rehabilitation of buildings.	Operators NGO-s	2012	2020
	Tourist information to promote sustainable energy use during the visit.	Operators NGO-s	2011	2020
Training and education	Development of energy initiatives involving school programs (guides, games, competitions, etc.).	Education facilities NGO-s	2012	2020

5. ORGANIZATIONAL AND FINANCIAL MECHANISMS

In order to implement the action plan, it is necessary to create a coordination and organizational structure, to secure appropriate technical expertise, mobilize the involvement of stakeholders and provide financial means for the actions.To ensure that the objectives and targets are achieved, it is also necessary to establish follow-up and monitoring mechanisms.

5.1. Coordination and organizational structures

The Union of Hiiumaa Local Governments (HOL) is the authority responsible for the formulation and implementation of the energy policy in the Hiiumaa and, in particular, for the implementation of the Sustainable Energy Action Plan of Hiiumaa Island.

To coordinate the action plan's implementation, a steering committee will be constituted by the local government leaders. A consultative committee shall also be constituted, comprised of representatives of stakeholders, to ensure society's involvement and participation and for support in the follow-up and monitoring of the plan's actions.

5.2. Staff capacity

The technical coordination will be assured by the collaborators of Hiiumaa County Government. The technicial staff to develop the work for implementation, monitoring and reporting of the action plan will be provided by: Union of Hiiumaa Local Governments; local government offices; energy service companies; consultants; architects; construction companies; etc.

5.3. Involvement of stakeholders

To catalyse the involvement of stakeholders, periodic meetings with the consultative committee will be held, comprising representatives from various sectors of society with a say or interest in the energy area, in order to inform on the actions and the progress of the plan's implementation, identify existing or possible constraints and analyse measures to optimize the results and correct possible deviations.

To reach a wider public, the media will be used, to date with events, forums and publications, to disseminate information on the actions that constitutes the plan and on the benefits and incentives, raising awareness to the importance of these actions, in the context of local development and the improvement of quality of the environment.

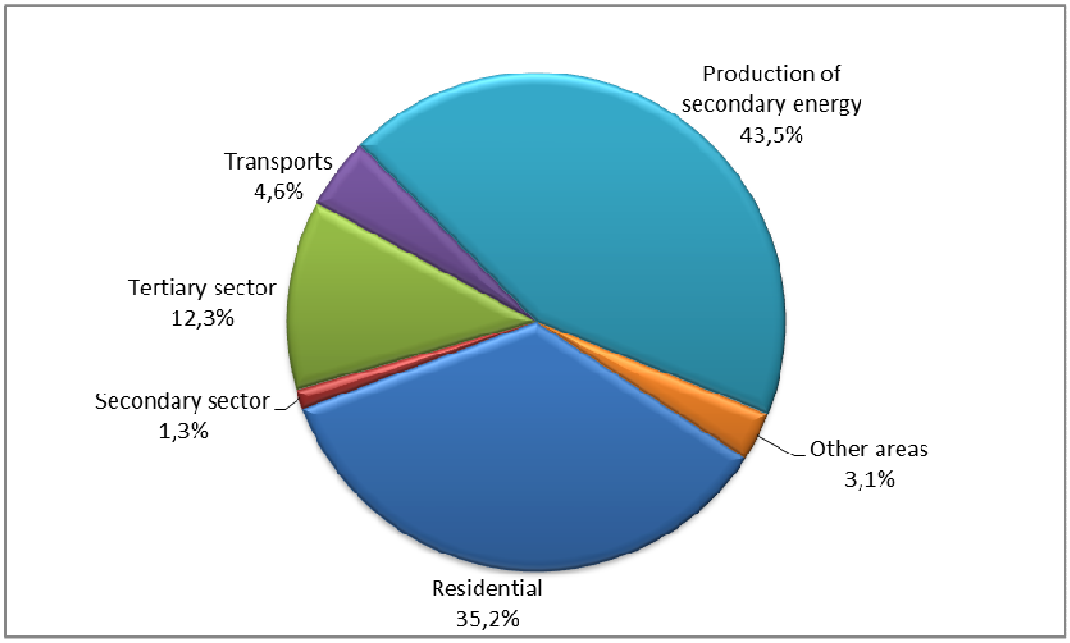
5.4. Budget

The overall investment foreseen, to be carried out until 2020, to implement the Sustainable Energy Action Plan of Hiiumaa Island is 79,5 million euros, supported by citizen, companies, local authorities and other entities. In the following table and figures, a breakdown of the investment per sector and area of intervention is presented.

Table 28: Investments to be carried out until 2020

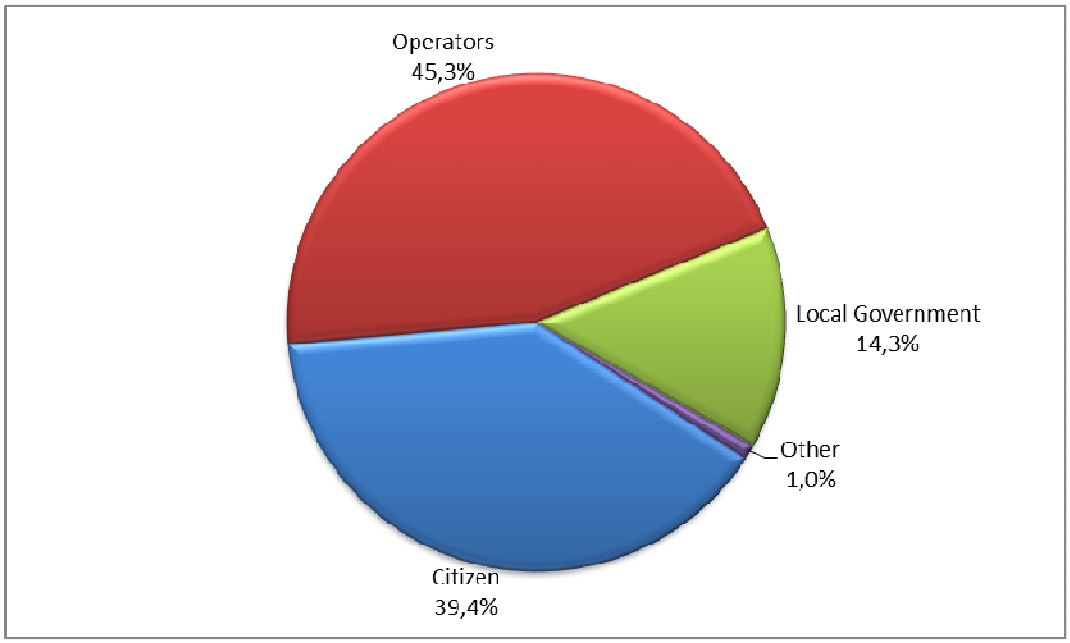
Sectors and areas of intervention	Expected results in 2020			Investiment [Meuro]
	Energy savings [MWh/year]	Production of renewable energy [MWh/year]	Reduction of CO_2 emissions [ton/year]	
Residential	1 079	11 322	7 898	28,0
Primary sector	-	-	-	-
Secondary sector	1 211	740	1 427	1,0
Tertiary sector	2 704	3 804	3 941	9,8
Transports	1 986	555	599	3,7
Production of secondary energy	-	77 304	26 680	34,6
Other areas	-	-	-	2,5
TOTAL	**6 980**	**93 725**	**40 545**	**79,5**

Figure 26: Breakdown of investments per sector and area of intervention



It is found that 43,5% of the investment for the implementation of the action plan is aimed at the secondary energy production sector, which includes the introduction of wind energy and biomass cogeneration. In terms of investment volume, the residential and tertiary sectors follow.

Figure 27: Breakdown of investments per promoter



Analysing the investments per promoter, it is estimated that 45,3% is carried out by the operators, 39,4% by citizen and 14,3% by Local Government. This means that most investment is carried out by private entities, which shows the important role of these actors and the need of awareness raising and favourable legal and incentive framework to catalyse the implementation of the actions.

5.5. Financing sources and instruments

The support instruments and financing sources to implement the plan's actions for each type of promoter are presented in the following table.

Table 29: Support instruments and financing sources

Promoter	Financing sources
Local and State Government	• Pubic Budget • European Investment Bank • Bank loan • ERDF, Cohesion Funds • Environmental Investments Center • Other
Public companies	• Own funds • European Investment Bank • Bank loan • Environmental Investments Center • ERDF, Cohesion Funds • Other
Private companies and organizations	• Own funds • Bank loan • ERDF • Third party financing (ESCO)
Citizens	• Own funds. • Bank loan • KREDEX • Other

5.6. Monitoring and follow-up

For monitoring, data will be collected periodically regarding final energy demand, secondary energy production, use of renewable energy and state of implementation of sustainable energy actions, as presented in the following table.

Table 30: Data collection for monitoring

Data to collect	Information sources	Frequency
Demand of fossil fuels	• Fuel distributing companies. • Operators of public transport and other fleets. • Samples of users from key sectors, when necessary.	Annual
Electricity demand	• Electricity distributor.	Annual
Electricity and heat production	• Electricity producers (windpark and cogeneration plants).	Annual
Installation of renewable energy systems	• Electricity producers (windpark and cogeneration plants). • Installation companies. • Samples of users from key sectors, when necessary.	Annual
Implementation of the plan's actions	• Entities responsible for implementation. • Consultative Committee.	Annual

Based on the information gathered, technical staff will prepare an energy balance and an emissions inventory, to verify the progress of the indicators in relation to the objectives and targets set, in order to evaluate the results of the actions implemented.

The consultative committee analyses the indicators concerning the objectives and targets and the progress of the actions, and meet every two years, to discuss the results and the solutions to optimize the implementation of the Sustainable Energy Action Plan of Hiiumaa Island.

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PACT OF ISLANDS

Author

Union of Local Authorities of Hiiumaa

Local and regional authorities:

Emmaste municipality

Kõrgessaare municipality

Käina municipality

Kärdla town

Pühalepa municipality

Hiiu County Government

Financial support:

EUROPEAN COMMISSION Directorate-General for Energy

GOTLANDS KOMMUN Gotlands Kommun

aream Agência Regional da Energia e Ambiente da Região Autónoma da Madeira

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