Project co-financed by the European Regional Development Fund

PRISMI

Promoting RES Integration for Smart Mediterranean Islands

Deliverable title	**D3.5.1 Preliminary SEAPs**
Related Work Package:	WP3 - Studying
Related Activity:	Designing of SEAPs for MED islands
Start date of the Project:	1 November 2016
Duration:	18 months
Authors	Giannis Kanaris, Cyprus Energy Agency - CEA Savvas Vlachos, CEA Harris Kordatos, CEA Goran Krajačić, UNIZAG FSB Antun Pfeifer, UNIZAG FSB Boris Ćosić, UNIZAG FSB Tomislav Novosel, UNIZAG FSB Filip Jurić, UNIZAG FSB Viktorija Dobravec, UNIZAG FSB Daniele Groppi, Sapienza University Daniele Bruschi, Sapienza University Davide Astiaso Carcia, Sapienza University Matteo Ernandes, Favignana Municipality Erika Massa, MIEMA Georgios Nomikos, PUAS (University of West Attica) Constantinos Christopoulos, PUAS (University of West Attica) John K. Kaldellis, PUAS (University of West Attica) Emilia M. Kondili, PUAS (University of West Attica) Panagiota Koiliari, PUAS (University of West Attica) Afroditi Zafeiri, PUAS (University of West Attica) Theodoros Tsamis, PUAS (University of West Attica)
Reviewers:	Christoforos Perakis, CRES
Abstract:	5 preliminary Sustainable Energy Action Plans (SEAP) at municipal level (or SEAPs – SEAPs for islands with multiple municipalities) will be developed

.

Versioning and contribution history

Version	Date	Comment	Authors
v.01	29.04.2018	Final version	CEA
v.02			
v.03			

TABLE OF CONTENTS

EXECUTIVE SUMMARY

After the adoption, in 2008, of the EU Climate and Energy Package, initiatives involving the active role of Local Authorities across Europe in the implementation of sustainable energy policies were established. The European Commission launched the Covenant of Mayors to endorse the efforts by local authorities towards the 2020 target.

In the frame of PRISMI project 5 draft Sustainable Energy Action Plans (SEAPs) or Sustainable Energy and Climate Action Plans (SECAPs) has been developed. The aim of developing a SEAP is to help the local authorities of the study areas of each participating country to have a documented understanding of where it is in terms of energy consumption and carbon dioxide emissions. In addition, local authorities with technical support from the project partners can better plan and organize the actions they intend to implement to meet or even exceed the targets for at least 20% reduction in CO_2 emissions by 2020 and / or 40% reduction by 2030.

1. INTRODUCTION

The development of 5 draft Sustainable Energy Action Plans (SEAPs) or Sustainable Energy and Climate Action Plans (SECAPs) comprises part of WP3 (studying) activities, namely "A3.5 – Designing of SEAPs for MED islands".

According to the PRISMI contract, it is possible to use the guidelines and other useful documents created by previous EU Initiatives, therefore, these deliverables refers to the analysis of the results that came from the completion of the template that the Municipalities use to submit their Action Plans through the Covenant of Mayors platform. Moreover, the partners completing the excel-based template will not only be able to create a draft SEAP / SECAP for their study area, which is one of the project's deliverable, but they will also be able to submit it to the Covenant of Mayors for approval if they wish.

The action plan (both SEAP and SECAP) is the key document which shows how the Covenant signatory will reach its vision and target. The plan includes an assessment of the current situation, i.e. a Baseline Emission Inventory for the climate mitigation part (both SEAP and SECAP) and a Risk and Vulnerability Assessment for the adaptation part (For SECAP only); clearly identified goals and targets; and the measures planned together with time frames, assigned responsibilities and estimated impacts.

1.1 INTRODUCTION TO THE COVENANT OF MAYORS

The Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increase energy efficiency and use of renewable energy sources in their territories. By committing, through energy efficiency measures and investment in renewable energy, Covenant signatories aim to meet and exceed the European Union 20% CO2 reduction objective by 2020.

In 2015, the initiative took on new objectives through the new Covenant of Mayors for Climate and Energy which steps up the initial CO2 reduction commitment and includes adaptation to climate change. Signatory local authorities share a vision for making cities decarbonised and resilient, where citizens have access to secure, sustainable and affordable energy. In 2018 the number of signatories was about 7,755 in Europe and the number is constantly increasing.

In Croatia, 75 Sustainable Energy Action Plans (SEAP) and/or Sustainable Energy and Climate Action Plans (SECAP) were submitted, of which 63 SEAPs (SECAPs) were accepted. In 2010 first SEAP was submitted by the City of Zagreb. 8 out of 10 largest Croatian cities have joined initiative and the all developed action plans are covering more than the half of the Croatian population.

Greece has already signed in 156 covenants until 2018 and Italy reached the number of 3184 signatories including some of the country's largest cities. Moreover, Malta already has 24 municipalities that have joined the Covenant of Mayors and have submitted their SEAPs.

In Cyprus, the successful implementation of the 22 local Sustainable Energy Action Plans (SEAPs) made by the committed local authorities, with the assistance of the Cyprus Energy Agency, is expected to contribute to the reduction of CO_2 emissions by 600,000 tons and the energy saving of 2 millions of MWh by 2020.

2. MAIN STRUCTURE OF THE SEAP / SECAP

The development of a Sustainable Energy Action Plan consists mainly of three parts plus an additional part dealing with mitigation and adaptation to climate change. The parts are divided as follows:

- In the first part, a general description of the local authority is given, giving details of population, history, general strategy of development, environmental policy, actions and initiatives of the municipality. At this point also a description of the municipal buildings, street lighting of the municipality, energy consumption in parks and public spaces, municipal fleet, public transport and the road network of each municipality/study area was made.
- The second part focus mainly to what is the situation in the reference year and what the final demand for energy in the study area. A record was made in energy consumption per sector (residential, primary, secondary, tertiary, public lighting, transport) and RES generation. In addition, carbon dioxide emissions were calculated using standard emission factors on consumption based on the energy source and use.
- In the third and most important part, a detailed reference to measures / actions per sector in order to achieve the objective of reducing CO2 emissions was made.
- The fourth part was optional for partners who wanted to develop an action plan including actions for adaptation to climate change (SECAP) as well as climate change risk and vulnerabilities assessment

3. THE DEVELOPMENT OF 5 PRELIMINARY SEAPS / SECAPS

The SEAPs/SECAPs were developed for 5 study areas for each partner and are as follows:

Partner	Country	Study Area
Sapienza University of Rome	Italy	Municipality of Favignana
University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture (UNIZAG FSB)	Croatia	Korčula island
Piraeus University of Applied Sciences (PUAS)	Greece	Tilos island
Malta Intelligent Energy Management Energy (MIEMA)	Malta	Gozo municipality
Cyprus Energy Agency (CEA)	Cyprus	Akamas peninsula

Table 1: PRISMI study areas

Following the report, the action plans of each study area are presented and analyzed as developed by the project partners. The partners throughout the development of their action plans were in constant contact with the local authorities for the data collection while guidelines were also provided by the Cyprus Energy Agency which was responsible for the specific deliverable.

4. SUSTAINABLE ENERGY ACTION PLAN OF FAVIGNANA ISLAND

4.1 MUNICIPALITY OF FAVIGNANA

Favignana island is located on the west coast of Sicily between Trapani and Marsala, latitude 37°55'N longitude 12°19'E, 17 km far from the mainland. Favignana, with its surface of 19.8 km^2, is the main island of the Aegadian archipelago that comprehends the islands of Marettimo, Levanzo and other minor islets like Formica and Maraone. The whole archipelago belongs to the biggest Marine Protected Area of Europe (539.92 km^2).

Figure 1: Egadi Islands, sites of community importance

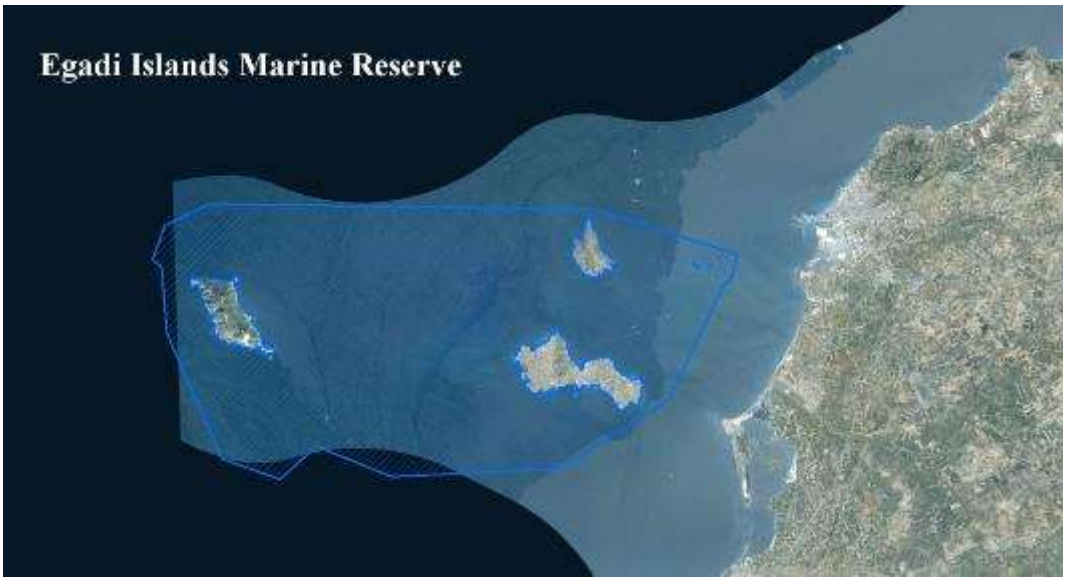


Figure 2: Egadi Islands, marine reserves

Figure 3: Egadi Islands, special protection areas

Main economic sectors in the past were fishing (Favignana was famous for red tuna) and the extraction of tuff. The fishing activity has seen an incredible decrease until 2007 when the fishing of red tuna stopped; moreover, the tuff extraction is continuing in only one cave of the island. Agricultural and pastoralism are still active but do not need a high number of employees, thus today the main income is tourism. Because of the economic issues occurred, the island encountered a strong depopulation process that seems to be stopped in the 21st century, the current population of Favignana is about 3400 inhabitants. Furthermore, because of tourism strong seasonality (touristic fluxes are concentrated in summer months), it is common for many residents to live on the island just during high season periods. This characteristic produces a seasonal feature of all the island needs, including energy.

The climate is the typical South Mediterranean one: hot and dry during summer and mild in winter, while rainfall is moderate and concentrated in coldest seasons. The climate is perfect for the exploitation of the solar resource. Furthermore, Favignana's west shore presents one of the most energetic wave climate in the Italian shorelines.

The energy system is not linked to the mainland and Favignana's stand-alone system strongly depends on fossil fuels. In fact, seven diesel generators with a total power installed of about 12 MW supply the island's load; furthermore, there are 25 PV systems with an overall peak power of about 170 kW_p.

As regard the island needs, the importance of the touristic sector is visible also in the monthly energy consumptions of Favignana, characterized by a strong seasonality. In Figure 1 the monthly electrical load is shown.

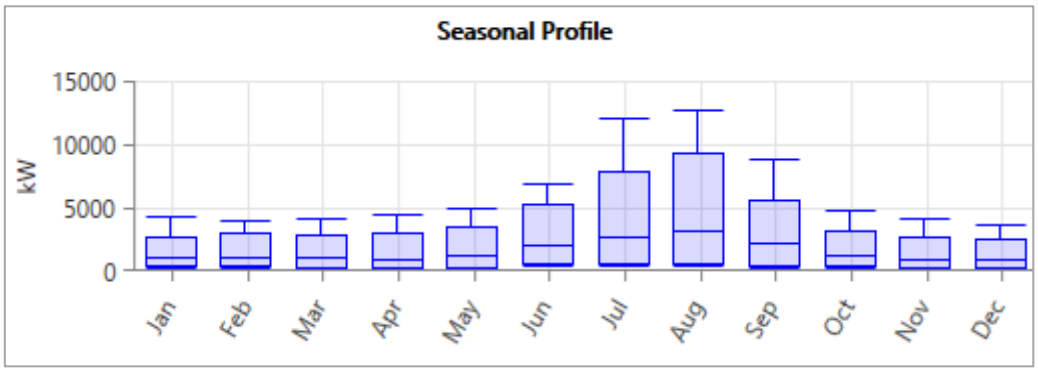


Figure 4: Monthly electrical loads

Electrical load changes significantly during the year. The energy needed in summer months reaches value 3 times higher than winter months. The peak load occurs in August with a value slightly lower than 12 MW while the lowest load is during November's nights and it is about 200 kW.

Electricity is not the only energy vector used in the island as it can be seen in Figure 5 that shows the consumption of end use energy sectors.

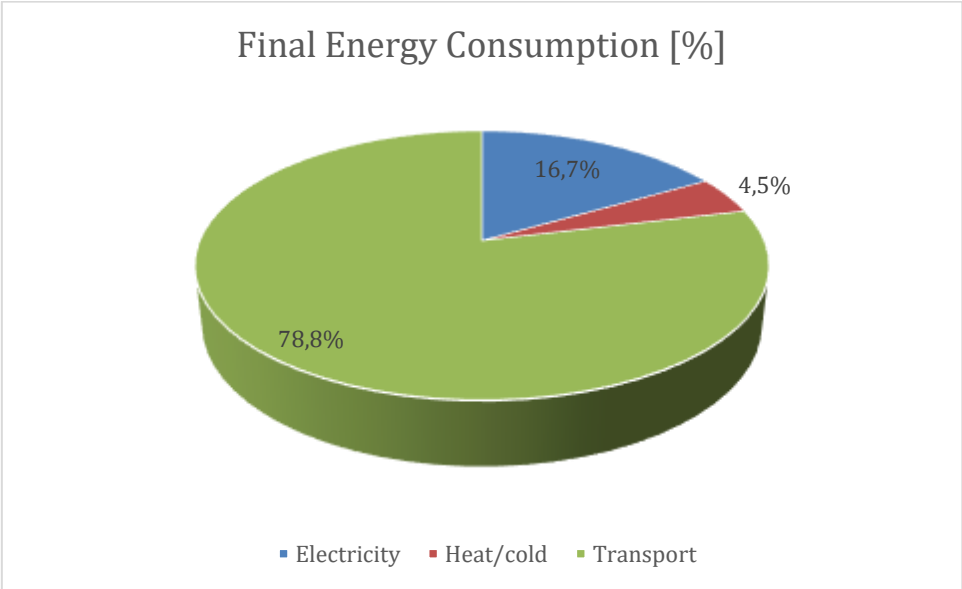


Figure 5: Relative importance for end use energy sectors

Transport represents almost the 80% of the total final demand. In particular, marine transport sector assumes the highest importance covering the 66% of the whole end use energy. This value is due to several reasons: the fishing sector, the common practice for inhabitants of studying/working on the mainland (or vice versa during the touristic season) thus having a big number of daily travelers. Furthermore, the great part of island water demand is met by ships delivery and more energy consumptions are strictly related to summer touristic fluxes. The other two main end use energy consumers are electricity with a 17% and the heating/cooling sector that reaches value of 4.5%. It is important to underline that renewing the electric production sector (entirely diesel-based today) and the public transport sector will affect an important portion of the whole energy consumed.

4.2 CURRENT STATUS AT MUNICIPALITY OF FAVIGNANA

Favignana has different groundwater reservoirs that are exploited thanks to wells distributed all over the island. Just a small part of those provide drinkable water, reason why Favignana is not water self-sufficient, especially during summer. Thus, water needs to be delivered to the island through an underwater pipeline that has very low efficiency and by ship transportation.

Waste management represents an important issue for the island, the high environmental vulnerability, the strongly seasonal trend, the discontinuity of the marine transport due to bad weather conditions and the relatively small territory with a high economic and environmental value makes hard to apply an efficient solution. Currently there is a recycling service that reached an efficiency of 35.5% in 2010; the waste is entirely transported to the mainland where it is treated.

Regarding the transport sector, Favignana has the lowest rate of private vehicle per person (34.3%) of all Italian small islands and the highest value in the category cycling/walking (61.8%). The public transport is constituted by 8 buses, divided in 3 routes that cover 23 km with a yearly distance covered of 186298.5 km. The marine transport sector assumes the highest importance from the energetic point of view, this is due to several reasons: the fishing sector, the common practice for inhabitants of studying/working on the mainland (or vice versa) thus having a big number of daily travelers. Furthermore, the great part of island water demand is met by ships delivery and more energy consumptions are strictly related to summer touristic fluxes.

4.3 INVENTORY OF ENERGY CONSUMPTION IN MUNICIPALITY

Where accurate data is not available, a top-down approach was employed, using statistical analysis based on aggregated data at municipal, provincial and/or higher level. In detail, most of the data referred to the whole Egadi Islands, Favignana is the largest energy user in the archipelago consuming 85% of total electricity production and this value has been used to scale up the consumption data when more detailed data were not available. For water consumption data and public transport one a bottom-up approach was used. In Table 2 the final energy consumption detail is showed, the reference year is the 2011.

Sector		FINAL ENERGY CONSUMPTION [MWh]				
		Electricity	Heat/cold			Total
				Diesel	Gasoline	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES						
Municipal buildings, equipment/facilities		2864.4				**2864.4**
Tertiary (non-municipal) buildings, equipment/facilities		4032.7				**4032.7**
Residential buildings		5125.7	3410.5			**8536.2**
Public lighting		414.6				**414.6**
Industry	Non-ETS	25.1				**25.1**
	ETS (not recommended)					**0.0**
Subtotal		**12462.5**	**3410.5**	**0.0**	**0.0**	**15873.0**
TRANSPORT						

Municipal and private fleet			3775.4	5501.0	**9276.4**
Public transport fleet			330.0		**330.0**
Maritime transport for water delivery			1099.0		**1099.0**
Private and commercial maritime transport			48646.5		**48646.5**
Subtotal	**0.0**	**0.0**	**53850.9**	**5501.0**	**59351.9**
OTHER					
Agriculture, Forestry, Fisheries	100.5				**100.5**
TOTAL	**12563.0**	**3410.5**	**53850.9**	**5501.0**	**75325.4**

Table 2: Final use energy consumption overview

Most of energy produced through combustibles is used for maritime connections between the island and the mainland (about 64.6% for private and commercial transport and 1.5% for clean water delivery) and for the production of electricity (about 16.7%). The lack of methanisation in the area contributes to increase the use of the electric carrier for most of the final uses.
The 2011 data gives a detailed subdivision of the energy sold on the island, 12.563 MWh divided as such:

- 40.8% to residential sector
- 22,7% to accommodation facilities
- 9,4% to bars and restaurants
- 3,3% to public lighting
- 1,4% to municipal facilities
- 7,8% to other public and social utility services
- 0,8% to primary sector activities
- 0,2% to mining and manufacturing activities
- 13.6% others

By converting the electric production (diesel) and the heat/cold consumption (gpl) to the primary energy source the following pie chart is obtained:

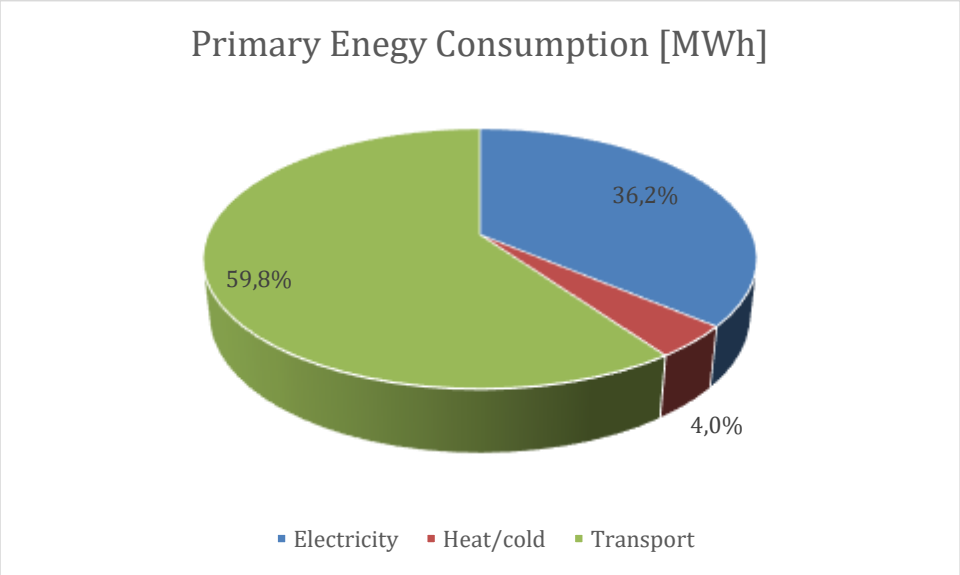


Figure 6: Primary energy distribution

The relative importances significantly change when dealing with the primary energy consumptions, the electricity contributes for the 36.2% to the overall consumption.

Oil and its derivatives account for 100% of the municipality's energy consumption in 2011, for a total of 75325.4 MWh per year for final energy use equal to 99258.56 MWh, of these 89745.22 MWh are from diesel fuel which accounts for 90.4% of the energy balance, being used for electricity generation, maritime connection and for automotive transport.

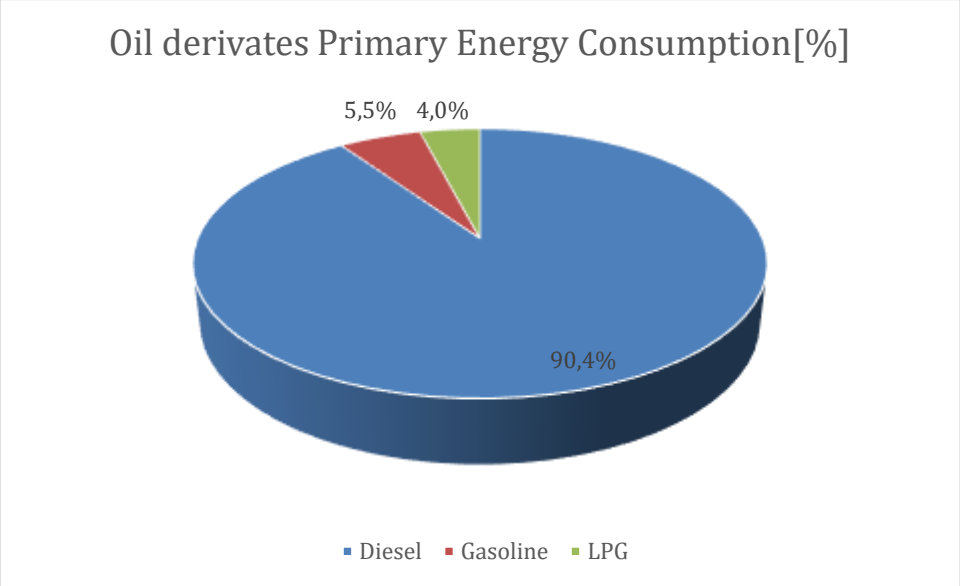


Figure 7: Primary energy - oil derivates

4.4 INVENTORY OF CARBON DIOXIDE (CO2) EMISSIONS

There are two types of emissions due to consumption in the territory:

- direct emissions due to the use of fuel in the construction sector, in installations, in services and in means of transport, public and private;
- indirect emissions caused by the generation of electricity and heat used in the territory

The methodology used for calculating emissions follows the IPCC guidelines and in particular the sectoral, or bottom-up, approach.

Where accurate data is not available, a top-down approach is usually employed, using statistical analysis on aggregated data at provincial and/or higher level.

Sector	CO2 emissions [t]				
	Electricity	Heat/cold	Diesel	Gasoline	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES					
Municipal buildings, equipment/facilities	2185	0	0	0	**2185**
Tertiary (non municipal) buildings, equipment/facilities	3076	0	0	0	**3076**

Residential buildings		3910	911	0	0	**4821**
Public lighting		316	0	0	0	**316**
Industry	Non-ETS	19	0	0	0	**19**
	ETS (not recommended)	0	0	0	0	**0**
Subtotal		9507.31	910.80	0.00	0.00	**10418.11**
TRANSPORT						
Municipal fleet		0	0	1008	1370	**2378**
Public transport		0	0	88	0	**88**
Maritime transport for water delivery		0	0	293	0	**293**
Private and commercial transport		0	0	12989	0	**12989**
Subtotal		0.00	0.00	14378.20	1369.75	**15747.95**
OTHER						
Agriculture, Forestry, Fisheries		77	0	0	0	**77**
TOTAL		**9584**	**911**	**14378**	**1370**	**26243**

Table 3: CO_2 emissions overview

In 2011 the emissions from oil and its derivatives account for 100% of emissions for a total of 26243 tCO2 per year. Most of the CO2 emissions come from fuels used for maritime connections with the mainland and for electricity generation. The distribution within sectors is depicted in Figure 8.

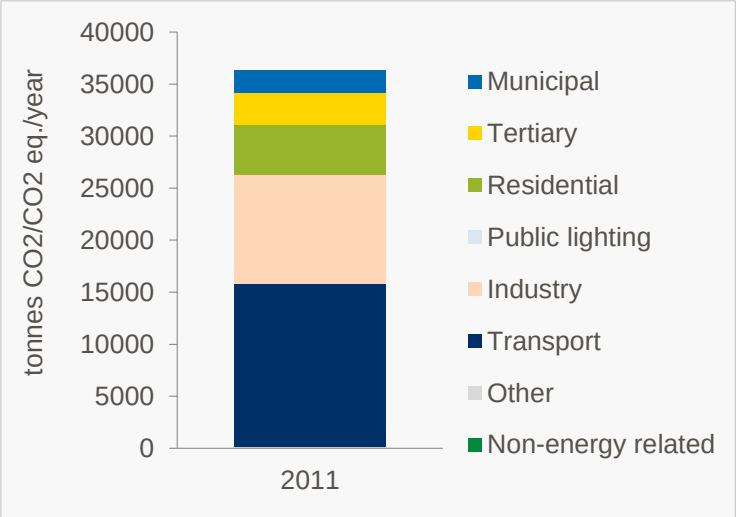


Figure 8: tonnes $C0_2$ emissions distribution

4.5 SUSTAINABLE ENERGY ACTION PLAN

4.5.1 2030 projections: "Business as usual" scenario

In this scenario the administration would not have implemented any policy aimed at changing the energy demand. The analysis of this scenario will focus on the sources that together constitute the overall energy consumption of the Egadi Islands, and therefore the CO2 emission sources of the archipelago, namely:

- Diesel for electricity generation in the island of Favignana

- Diesel for maritime connections with the mainland
- Diesel for local transport
- Gasoline for local transport
- LPG for heating, hot water and kitchen use.

In Fig. 9 the forecasted emissions trend in the BAU scenario.

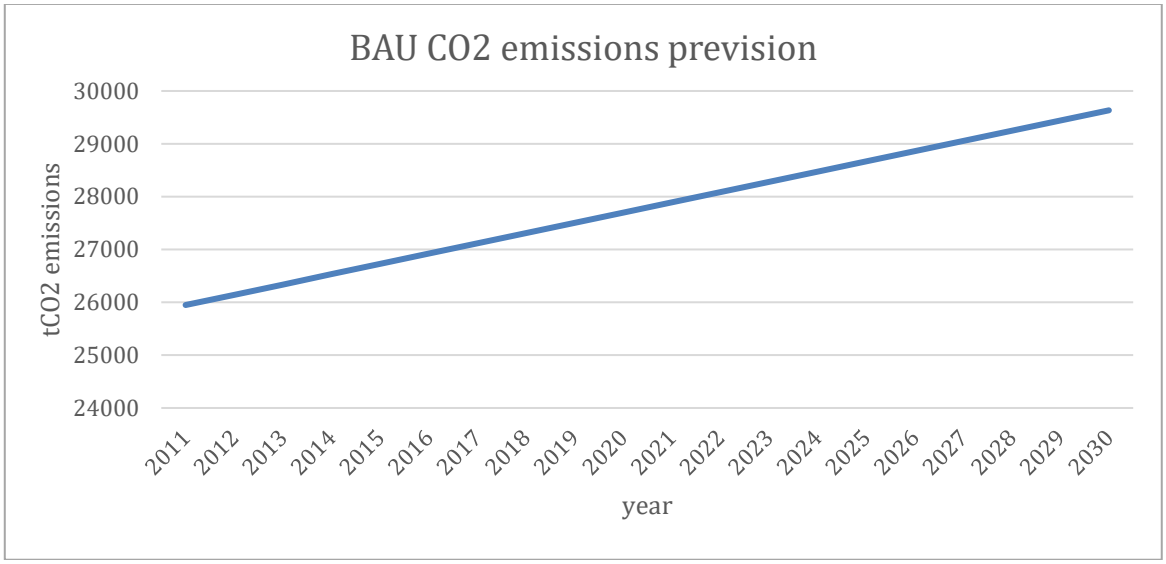


Figure 9. tonnes $C0_2$ emissions - BAU scenario

In BAU scenario in 2030, oil and its derivatives account for 100% of total municipal emissions totaling 29634.1 tCO2 per year, also considering the share of diesel fuel used to produce electricity which accounts for 36.5% of the total, with 10822.4 tCO2 per year produced.

4.5.2 2020 to 2030 projections: Action Plan scenario

The Action Plan scenario show the energy profile to be reached through the fulfilment of the actions included in the Action Plan. Regarding the year 2030, the plan will diminish the CO2 emissions by 40% compared to 2011. Compared with the BAU scenario, CO2 emissions will be reduced by 47% as it is shown in Fig. 10.

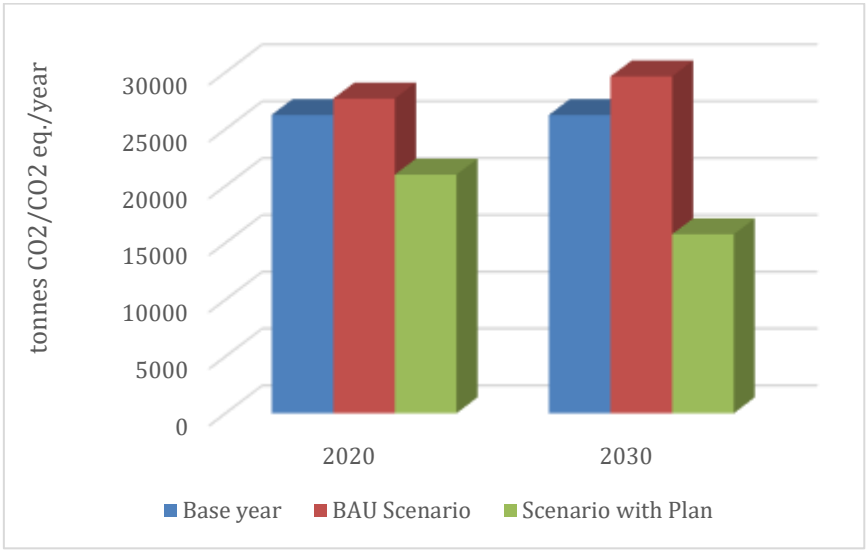


Figure 10. tonnes $C0_2$ emissions: Base year, BAU and Plan scenarios in comparison

4.5.3 Action plan

The main priorities for intervention considered are the following:

1. Distributed production of electricity and heat from renewable energy sources
2. Energy saving
3. Sustainable mobility
4. Use of biofuels

More specifically, the actions relating to the aforementioned priorities are aggregated according to the following preferred areas:

- Residential and tourism sector (RT)
- Public sector (PA)
- Transport sector (TR)
- Centralized power generation (PG)

Furthermore, educational presentations at schools on Renewable Energy Sources, Energy Saving and Sustainability will be done to educate future generations for a more aware use of energy and RES.

4.5.3.1 Residential, municipal and touristic buildings

The use of renewable energy sources such as solar thermal and integration of photovoltaic systems on building envelopes is expected.

The goal is to improve the quality of buildings and to reduce CO2 emissions, through installation of the following systems:

- Energy visits in residential buildings;
- heat pumps for residential heating system (by 2030);
- 400 kWp PV systems (by 2020);
- 3 MWp PV systems (by 2030);
- 1100 m2 of solar collectors for DHW purposes.

The actions proposed will contribute to the overall carbon avoidance with 611 tCO2/y avoided by 2020 and additional 3278 tCO2/y by 2030.

Key Actions by 2020	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates per year		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
RESIDENTIAL & MUNICIPAL BUILDINGS & TERTIARY BUILDINGS, EQUIPMENT/FACILITIES										
400 kWp PV will be installed on municipal and residential roofs	Photovoltaics	Grants and subsidies	Local authority	Favignana Municipality	2018	2020	480000	0	520	397
1100 sm of solar collectors will be installed on residential and tertiary buildings	Other	Grants and subsidies	Local authority	Favignana Municipality	2018	2020	935000	0	847	214
3 MWp PV will be installed between	Photovoltaics	Grants and subsidies	Local authority	Favignana Municipality	2020	2030	3600000	0	3900	2975
All the traditional individual heating systems will be substitued by Heat Pumps	Other	Building standards	Local authority	Favignana Municipality	2020	2030	9000000	1300	0	303.57
Energy visits in residential buildings	Behavioural changes	Awareness raising / training	Local authority	Sapienza University	2020	2030	5000	30		17.1
TOTAL							14020000	1330	5267	3906.67

Table 4: Residential, Municipal and Tertiary Buildings, equipment/facilities sectors' key actions

4.5.3.2 Public sector

For the sector managed by the municipality (general administration, education, public lighting) actions are planned to reduce the energy consumption through the improvement of the energy efficiency of buildings and wiring.

It is envisaged that the electro-generating equipment of public buildings will be enhanced with the widespread installation of integrated photovoltaic panels (this contribution has been already accounted in the previous paragraph). The process has already started thanks to the "Sole e Stelle delle Egadi" project, co-funded by the Ministry of the Environment and the Protection of Land and Sea.

It is planned to replace the public lighting systems with the state-of-the-art LED lighting reducing the power installed by 50 kW thus obtaining a carbon avoidance of 162 tCO2/y.

Key Actions by 2020	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates per year		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
PUBLIC LIGHTING										
Energy efficiency measure: LED lamps will substitue thet current gas-discharge lamp used for public lighting for a 50 kW decrease in load	Energy efficiency	Public procurement	Local authority	Favignana Municipality	2018	2025	500000	212.5	0	162
TOTAL							500000	212.5	0	162

Table 5: Public lighting sector key actions

4.5.3.3 Transport

The main objective in this sector is to promote sustainable mobility with a resolved and concrete introduction of electric vehicles in partnership with major brands in the industry. Partnerships will play a key role in replacing conventional, corporate, and municipal vehicles in favour of 100% electric models while biofuels will be used in the maritime transports. The following measures will be implemented:

- Training of the staff (drivers) on eco-driving;
- sharing services with electric traction vehicles (e-bikes);
- 10% mixing of conventional fuels with state-of-the-art biofuels for private and commercial maritime transport by 2020;
- 30% mixing of conventional fuels with state-of-the-art biofuels for private and commercial maritime transport by 2030
- introduction of HCNG-fueled buses in the public transport sector (this action needs the installation of an electrolyser, a compressor and a storage tank that are beneficial for the central grid) by 2030.

The measures proposed will lead to a carbon avoidance of 1299 tCO2/y by 2020 and an overall value of 3904 tCO2/y by 2030.

Key Actions by 2020	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates per year		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TRANSPORT										
10% of biodiesel for private and commercial transport (maritime transport)	Cleaner/efficient vehicles	Transport / mobility planning regulation	Local authority	Favignana Municipality	2018	2025		0	4865	1299
30% of biodiesel (biodiesel and bioethanol) for maritime transport	Cleaner/efficient vehicles	Transport / mobility planning regulation	Local authority	Favignana Municipality	2025	2030		0	14594	3897

Key Actions by 2020	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates per year		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TRANSPORT										
Hydorgen Compressed Natural Gas (HCNG) fuel in public transport sector	Cleaner/efficient vehicles	Public procurement	Local authority	Tarantola Bus s.r.l.	2025	2030	50000	0	26.37	7
Training of the staff (drivers) on eco driving	Eco-driving	Awareness raising/training	Local authority	Sapienza University	2020	2030	5000	1.5	0	0.4
Sharing services with electric traction vehicles (e-bikes)	Modal shift to walking & cycling	Other	Local authority	Favignana Municipality	2020	2030	15000			
TOTAL							50000	1.5	19485.4	5203.4

Table 6: Transport sector key actions

4.5.3.4 Centralized power generation

Hybridization of power plants will be needed to diversify electricity production in order to better manage future energy scenarios. This will be the required interventions in this sector:

- installation of storage systems capable of improving the efficiency of the system to guarantee the quality of service and the optimal management of variable sources (electrochemical and hydrogen storage systems are currently being considered);
- use of biofuels with sustainability certification, substitution of 30% of the gas currently used to run the central power station with biofuels by 2020;

- use of biofuels with sustainability certification, substitution of 50% of the gas currently used to run the central power station with biofuels by 2030;
- on-site use of renewable energy sources, 500 kWp PV plant will be installed in parallel to the thermoelectric central station.

Thanks to these interventions, 1454 tCO2/y will be avoided by 2020 and 3371 tCO2/y by 2030.

Key Actions by 2020	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates per year		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
LOCAL ELECTRICITY PRODUCTION										
500 kWp PV power plant will be installed by the island electricity operator	Photovoltaics	Energy suppliers obligations	Not possible to say	SEA, Società Elettrica di Favignana S.p.a.	2018	2025	500000	0	650	496
A 30% biodiesel will be used in the central thermoelectric plant in 2020	Biomass power plant	Energy suppliers obligations	Not possible to say	SEA, Società Elettrica di Favignana S.p.a.	2018	2020		0	3589	958
A 50% biodiesel will be used in the central thermoelectric plant in 2030	Biomass power plant	Energy suppliers obligations	Not possible to say	SEA, Società Elettrica di Favignana S.p.a.	2020	2030		0	10768	2875
TOTAL							550000	1.5	34492.4	9532.4

Table 7: Local electricity production key actions

4.6 CLIMATE CHANGE RISKS AND VULNERABILITIES

Specific action is also required on the potential effects of climate change at local level with adaptation actions, also to analyze the inevitable consequences of climate change in place.

In the specific territory of Favignana there is a warm and temperate climate with high rainfall in winter compared to summer. The average temperature is 17.8 °C and the annual average rainfall is 445 mm.

As for temperatures, August's average, the hottest month of the year, is 25.3 °C. The average temperature in February, the coldest month, is 11.6 °C.

The territory of Favignana is in the climatic zone B.

The potential impacts and the vulnerabilities derives from Provincial and Regional data available on the ISPRA geo-viewer and the "Piattaforma cartografica Italia Sicura" because of the missing of a local monitoring system on the island and on the entire archipelago. In 2013, a monitoring station has been installed on Marettimo Island able to gather near real time data about temperature, pressure, relative humidity, precipitations, wind speed and direction. Unfortunately, such data are not available yet.

The potential impacts expected from climate change and the main vulnerabilities are:

- pressure on water resources with potential reductions in water availability
- alteration of the hydrogeological system with the potential increase of the risk of floods
- degradation of soil with the potential risk of soil desertification.
- reduction of agricultural productivity and potential variation in product quality.
- repercussions on human health with the potential increase in disease and mortality due to temperature increases.

4.7 CLIMATE ADAPTATION STRATEGY

After identifying the major risks and vulnerabilities of the territory, adaptation measures have been identified. Those measures aim at reducing the potential impact of climate changes or at least impede it from increasing. It is important to note that the process needs to be flexible and through a constant monitoring it has to be changed and adjusted based on the territory responses and needs.

The adaptation measures identified are the following:

- reducing water consumption and using alternative water resources;
- increase of permeable territory;
- adapting infrastructure resilience;
- sustainable soil management;
- awareness campaigns.

5. SUSTAINABLE ENERGY ACTION PLAN OF THE ISLAND OF KORČULA

5.1. SUMMARY

The island of Korčula is located in the Dubrovnik-Neretva County, which is the southernmost county in Croatia. Administratively, island is divided into one city and four municipalities, which

together have 15,521 inhabitants. The municipalities on the island, from west to the east, are Vela Luka, Blato, Smokvica and Lumbarda, and between Lumbarda and Smokvica lays the town of Korčula, which is the largest local government unit on the island. This action plan is developed according to the Option 2 of the joint Sustainable Energy Action Plan (SEAP), where all municipalities on the island will have one joint Baseline emissions inventory (BEI) and measures aimed to reduce the CO2 emissions. This means that municipalities, as a group of signatories, share CO2 reduction commitment.

Final energy consumption was calculated for the whole island and 2012 was used as the reference year. The energy consumption and CO2 emissions were divided by sectors: public buildings, communal facilities, public lighting, residential buildings, services sector buildings, transport and local energy production with RES potential was also analysed. For the reference year of the calculation, final energy consumption amounted to 176 335 MWh. Divided by sectors, the transport sector consumes most energy on the island of Korčula, without taking into account public vehicles and public transport. Its share is 44.62%, with consumption of 78 788 MWh. Next sector is the residential sector with 37.48% and services sector with 15.27%. Among the energy sources, the largest share of final energy consumption (33.01%) is supplied by electricity. Behind it, follows diesel with a share of 27.96% and gasoline with 17.64%.

In 2012, the total emissions of the island of Korčula for the analysed sectors were estimated at a total of 42 923 tCO2, of which 1 328 tCO2 was emitted in the public sector, resulting in the share of public sector emissions 3.09%. Nearly half of the emissions come from the sector of other road transport, followed by the residential sector with 30.39% share in total emissions, and the services sector with 18.8% emissions.

A total reduction of CO2 emissions that can be achieved by given actions and measures is 29 919 tCO2 which is 70% lower than the base year. Emission reduction measures should be implemented in all mentioned sectors, and a total of 27 measures were prescribed. Most of the measures, 7 of them are prescribed in the public, residential and transport sectors. In services sector, 4 measures are prescribed, and one measure is given for public lighting and one for local electricity production.

New measures in this SEAP are proposed on the basis of analysis implemented in the project “Promoting renewable energy integration for smart Mediterranean islands (PRISMI)” , which aims at tackling this key challenges by supporting the transition of MED islands to an autonomous, cleaner, secure, low-carbon energy system – in line with the overall EU Energy Union package and EU2020 Strategy – through the development of an integrated trans-national approach to assess and exploit the renewable energy sources (RES).

Such model was be developed through a studying project bringing together academia, public authorities and local communities with a view to fully empower end-users in the take-up of project outputs. Among these, the main ones constituting the key innovative value of the project are:

- An integrated toolkit for assessing and mapping the local potential of RES and their exploitation in new energy systems
- A Sustainable Energy Action Plan drafted for each case study area with recommendations and strategies for developing integrated RES
- The establishment of a PRISMI Network of Stakeholders to support exchange of knowledge and best practices in RES integration in MED islands. These outputs will represent a reference framework supporting end-users in driving and intercepting

economic initiatives aimed at increasing the penetration of RES in MED islands energy mix – thus contributing to sustainable development and inclusive growth throughout the Programme area.

Detailed modelling method and results are described at the beginning of the chapter 5.6

5.2. ISLAND OF KORČULA

The island of Korčula is located in the Dubrovnik-Neretva County, which is the southernmost county in Croatia. It stretches in the east-west direction, with its length of 46.8 km, with a width of 5.3 to 7.8 km having an area of 279.03 km^2 and is the sixth largest island in Croatia. The larger settlements on the island, except ones mentioned above, are Pupnat, Žrnovo, Čara and Račišće. The island is recognizable to its mild Mediterranean climate, clean sea, rich cultural material and immaterial heritage, making it an attractive tourist destination.

Average island temperature in January is 9.8 °C, and in July it is 26.9 °C. The average rainfall is about 1,100 mm, and the number of sunny hours on the island is 2,671, which is the highest in the entire Croatian part of the Adriatic Sea. The most frequent winds are the bura, the south and the summer maestral.

The municipalities of Vela Luka, Blato and Smokvica and the City of Korčula joined the Covenant of Mayors as a part of the IEE Meshartility project. They developed Sustainable Energy Action Plan, according to the option of independent accession to the agreement. This action plan is developed according to the Option 2 of the joint SEAP.

5.2.1 The city of Korčula

The area of City of Korčula occupies the eastern part of the island and consists of 5 settlements, of which the largest is Korčula with 2,856 inhabitants. Other settlements in the administrative area of the City of Korčula are Čara, Pupnat, Račišće and Žrnovo, and the number of inhabitants living in Korčula according to the 2011 census is 5,663.

The state road D-118 goes through the whole island connecting the town of Korčula, on one side of the island and Vela Luka on the other side. There are several county and local roads to connect all the places on the island. With the Dominče port the city is connected to the mainland, while there are several local ports and ACI Marina Korčula. Water supply is provided through the regional Neretva-Pelješac-Korčula-Lastovo-Mljet water supply system, while electricity supply runs over 110 kV and 35 kV cables from Pelješac peninsula and 110/35 kV transformer in Blato and a series of smaller transformers in the island and city area.

The main economic branch of the City is tourism, which, due to the extremely favourable climate, rich history and cultural heritage, attracts an increasing number of visitors. There is a rich cultural and historical heritage in the city, which is manifested in urban areas of Korčula and settlements, walls, palaces, sacral buildings, castles, archaeological sites, parks and as well as in the intangible heritage made up of folklore, fraternities, events, museums, galleries etc. The vision of tourist development of the City of Korčula is to become a globally recognized Mediterranean destination that offers its guests a rich history and enjoyment of cultural heritage, island life, its tradition and innovation, and gastronomic riches form the authentic experiences for its guests, which will emphasize the identity and features of the space and the people living on it.

5.2.2 Municipality of Lumbarda

The municipality of Lumbarda is located on the eastern tip of the island of Korčula and borders the town of Korčula. It is 10.77 km^2, and according to the latest census in 2011, there are 1 213 inhabitants. Lumbarda is a small island town that gravitates towards the town of Korčula as the largest administrative and economic centre on the island with which it is connected by road and has further links with the rest of the island, Dubrovnik and Zagreb.

Administrative bodies in the Municipality of Lumbarda are the Municipal Council, consisting of 11 Councilors, the Mayor and the Deputy Mayor, and the working bodies of the Municipal Council: The Election and Appointment Commission, the Statute, Rules of Procedure and Normative Activity Commission, the Mandate Commission and the Budget and Finance Commission. The two companies are owned by the municipality, Lučica - Lumbarda d.o.o. which runs the business of the marina and the catering facility Maestral, and K.T.D. Mindel d.o.o., a utility for communal affairs and management of the waste landfill Kokojevica.

The infrastructure in the municipality is in most cases satisfactory, but there are occasional problems during the tourist season in the supply of water through the Neretva-Pelješac-Korčula-Lastovo-Mljet supply system. Electricity, telecommunications and road infrastructure are considered satisfactory, and in public lighting there is a further possibility of improvement by incorporating LED lighting. Sewage disposal is solved only for hotels and several houses in the centre.

The economy of the municipality is predominantly oriented to tourism and agriculture. There is an Entrepreneurial Zone Humac in the municipality with all the necessary infrastructure, but currently there are no companies operating there. The number of tourist arrivals in Lumbarda Municipality in 2012 amounted to 18,731, and the number of overnight stays in the same year was 145,404.

5.2.3 Municipality of Smokvica

Municipality of Smokvica consists of four settlements: Smokvica, Brna, Vinačac (Vinašac) and Blace (Blaca). The main settlement is Smokvica, where lives about 2/3 of the inhabitants, followed by Brna. The Vinačac and Blace settlements have only a few permanent residents.
Smokvica is located in the very centre of the island of Korčula, on the slopes of the Vela and Male Obala hills. In the area of Smokvica there are several fertile fields, and the largest are Kruševo, Prapratna, Stiniva, Banja, Sitnica, Livin dol and Čipojino field. The village of Brna is located southwest, four kilometres of road distance from Smokvica. It is located in the bay of the same name and on the plateau of Mali Zaglav, and spreads to the smaller northern bay of Istruga. In this bay, the large "Aminess Lume" hotel is located, which represents the largest accommodation capacity in the municipality.
According to the latest census from 2011, Smokvica has 916 residents living in 357 households. The continuity of the population of the area of Smokvica can be traced back to ancient times. There are numerous remains of antique ceramics, old-fashioned presses for wine and olive oil, remains of old Greek villas, etc. The 12th century Korčulan statute mentions the Smokvica settlement and recommends and orders the editing of guard and defence in five old Korčula settlements: Blato, Smokvica, Čara, Pupnat and Žrnovo.

The most important branches of the economy are tourism and agriculture, which takes place mostly in these fertile fields, and is mostly focused on the cultivation of vines and olives. The development of tourism will be facilitated by the construction of pedestrian and cycling trails, as well as the olive and wine roads, with the maintenance of numerous existing ones, the construction of port with 200 yacht

places, the construction of the Silver and Gold Museum of Smokvica and the Korčula Airport in Smokvica. Beautiful beaches and the development of rural tourism facilities are the main source of attraction for attracting new tourists to Smokvica.

5.2.4 Municipality of Blato

Like the whole island and the Municipality of Blato, it is located in the Adriatic-type region of a pleasant Mediterranean climate characterized by long, peaceful, dry and hot summers with bright days and a short mild and damp winter, which makes it a part of climate-attractive areas. Throughout the year, average temperatures below 10 °C were recorded only in January and February, while in June, July, August and September they averaged above 20 °C. The precipitation regime is typically Mediterranean with the maximum at the end of autumn and in early winter and with minimum in July.

Blato is the oldest settlement on the island. It is located in the middle of the western part with the eastern karst field, Blatsko polje which gave the settlement name. Until 1911, Blatsko polje was a periodic lake that was drained by the construction of tunnels, melioration channels and drainage of water into the sea on the north coast.

In the middle of the place there is a flat area "Zlinje" with a large park and a long linden tree alley on the main road. On the north coast, Blato stretches from the Sprtiška bay on the west to Lovornik in the east. On the southern shore, Blato stretches from the Slatina bay on the west to Vinarac in the east. The length of the coast is 31.42 km. The length of the islet is 20.8 km. The total area of the municipality is 66.57 km^2.

The area of the municipality is dominated by large cultivated fields, which alternate with dry walled fenced slopes planted with olive and grapes. According to the latest census of 2011, Blato municipality had 3,593 inhabitants, divided into two settlements: Blato and Potirna.

Ever since its inception, the life and development of Blato was based on the production of wine, as the most important product, and the production of oil, carrots, figs, and legumes and cereals for their own needs. Along with the strong development of agriculture over the centuries, numerous other service, crafts and shops have been opened in Blato, and in recent times tourism is becoming more important economic branch. Plans for increasing tourist arrivals include the opening of the Kumpanija House, the construction of a gallery and a local museum by redeploying one of the buildings in the heart of the settlement, the construction of pedestrian and cycling trails, olive and wine roads, and the development of rural tourism facilities.

5.2.5 Municipality of Vela Luka

Vela Luka is located on the western part of the island of Korčula, in a 9.2 km long bay, one of the best anchors on the eastern Adriatic coast. In the wider surroundings are picturesque islets, deep coves, steep cliffs and fertile gentle plateaus, making this location a place suitable for life and unlimited vacation opportunities.

Today, Vela Luka is a peaceful Mediterranean town, facing traditional farming, fishing and tourism. The beauty of the landscape and untouched nature are suitable for tourism. For further development of tourism, a number of projects are planned: a port of nautical tourism with 150 to 200 berths, the redeployment of a special hospital Kalos and the increase of capacities for health tourism, the Vela Spilja archaeological park, the new 3 and 4-star tourist resort with about 700 units, constoction of road to Vele Spilje.

The area is characterized by a shallow, hilly terrain, and the highest hill is Hum (376 m). In the area of the Vela Luka municipality there are no larger agricultural areas, except for a dozen karst valleys, with the exception of Blatsko polje, a few square miles of spacious plateau, important, among other things, for water supply.

According to the latest census of 2011, in Vela Luka lives 4,137 inhabitants in 1,503 households. Since the area of the municipality is relatively small, only 43.27 km^2, Vela Luka has a population density above 96 inhabitants per km^2.

The climate of the island of Korčula, and thus its western part, is extremely Mediterranean with an insolation of 2,600-2,700 hours per year and a mean annual temperature of about 16 degrees. Annual amplitudes are small and only about 16 degrees. Windmill is an outstanding feature of this area. Because of the longitudinal shape of the bay and the configuration of its hinterland, airflows are regular, and their direction is determined by the orientation of the Vela Luka cove.

Apart from the developed social and cultural life, Vela Luka owns, for island opportunities, a high degree of infrastructure arrangement. There are also primary and secondary school, kindergarten, health center, Kalos hospital, pensioner's home, culture centre, regular ferry, catamaran and bus lines, Luško lito, Regatta of St. John, Dalmatian klapa, Kumpanija, athletic clubs, etc.

5.3. CURRENT STAUS AT ISLAND OF KORCULA

Municipal buildings are divided into 4 groups in order to calculate their energy consumption and emissions: education, which includes kindergartens, secondary and primary schools, culture and sports, which include houses of culture, museums, galleries, sports facilities, etc., administrative buildings and other buildings. All the buildings covered by this analysis are listed in this section.

1) Education:
    - Primary School Žrnovo
    - Primary school of Petar Kanavelić
    - Kindergarten Korčula
    - Petra Kanavelić Elementary School - Račišće Regional School
    - Žrnovo Elementary School - Pupnat Regional School
    - Primary and secondary school Blato
    - Smokvica Elementary School
    - Kindergarten Vela Luka
    - Vela Luka High School
    - Primary school Vela Luka
2) Culture and sport:
    - The House of Culture of Liburna Korčula
    - Dom kulture Žrnovo
    - Covered swimming pool Gojko Arneri Korčula
    - The City Museum of Korčula
    - House of Culture Cara
    - House of Culture Pupnat
    - House of Culture Smokvica
    - House of Culture Vela Luka
    - Vela Luka Cultural Center

3) Administrative buildings:
    - City Hall of Korčula
    - Mediterranean Shipping Building d.d.
    - Government Building Lumbarda
    - Smokvica Municipality Building
    - Vela Luka Municipality Building
4) Other buildings:
    - Archival collection centre of Korčula
    - Restaurant Maestral Lumbarda

Street lighting on the island has large possibilities for the reduction of energy consumption. The municipalities of Vela Luka, Blato and Smokvica has started with the modernisation of their public lighting and have installed energy efficient bulbs. More progress can be achieved by installing LED lighting. In the City of Korčula detail study of the public lighting was done and it was found that most of the lights need to be replaced. The settlement of Čara was identified as the best location for the first investment, since it was calculated that 90% of energy can be saved by installing LED lamps. Analysis showed that on the level of the city the minimum savings to the current status can be 40% and this includes installation of new poles in the areas where adequate lighting doesn't exist.

Public vehicles on the island are divided according to the institutions which use them in 4 groups: local government vehicles, municipal utility vehicles, health care vehicles and voluntary firefighters' vehicles (DVDs). Vehicles use petrol and diesel as fuel and are predominantly diesel engines. This is due to the fact that most of the vehicles used by utility companies and firefighters are diesel powered trucks.

Waste management system on the island is currently changing since waste management is now organised on the municipal level and in the future will be organised on the county level. Regional centre for the waste management Lučino razdolje is on the way and on the island of Korčula are planned 2 stations for waste manipulation. One should be built in Sitnica, covering the municipalities of Blato and Vela Luka and the other in Česvenica covering City of Korčula, Lumbarda and Smokvica.

5.4. INVENTORY OF ENERGY CONSUMPTION IN MUNICIPALITY

In the PRISMI project, method of island energy planning consists of four steps, of which the first is mapping the community needs. This step corresponds to making an inventory of energy consumption and uses of other needs (such as water).

Therefore, needs and consumption of the island of Korčula have been described in this chapter in detail. PRISMI methodological guidelines, following the RenewIslands methodology, also suppose the qualitative assessment, which is presented here and described in D3.1.1. Common methodological guidelines on RES assessment and mapping.

Needs	**Level**	**Geographical Distribution**	**Code**
Electricity	Medium	Concentrated	ElectMC

Heat	Low	dispersed	HeatLD
Cooling energy	Low	dispersed	ColdLD
Fuel for transportation	Low	Short dist.	TranLS
Water	Medium	dispersed	WaterMD
Processing waste	Low	dispersed	WasteLD
Wastewater treatment	Low	dispersed	WWTLD

Table 8: Mapping of the needs of the community on the island of Korčula

Final energy consumption was calculated for the whole island and for the reference year was used in 2012. Data on final energy consumption are analysed and presented by sectors. The energy consumption is shown by sectors and energy sources used. This chapter also presents the potential of renewable energy sources on the island of Korčula.

5.4.1 Public Buildings, Equipment and Facilities

Public buildings, equipment and facilities include the consumption of final energy by buildings owned or managed by local governments, municipal buildings and public buildings, and public lighting. The division was therefore divided into two parts, a building in which the consumption of previously mentioned types of buildings was analysed and public lighting

5.4.1.1 Public Buildings

Energy consumption was analysed in buildings owned by the local administration on the island of Korčula. In total, energy consumption of 26 buildings in the island of Korčula was analysed, of which 10 were divided into education, 9 in the group of cultures and sports, 5 in the administrative building group, and 2 buildings were in the group of other buildings. Consumption of individual groups of buildings is shown in Figure 11, showing that the most energy is spent in buildings used for education, then in buildings used for culture and sports and administrative buildings. The direct energy consumption of public buildings is 1,240 MWh, of which most is electricity, 595 MWh, then the fuel oil 336 MWh, and the LPG 309 MWh. Fuel oil is used for heating the space of educational institutions, UNP is used for heating the Gojko Arneri pool, and electricity is consumed in all types of buildings.

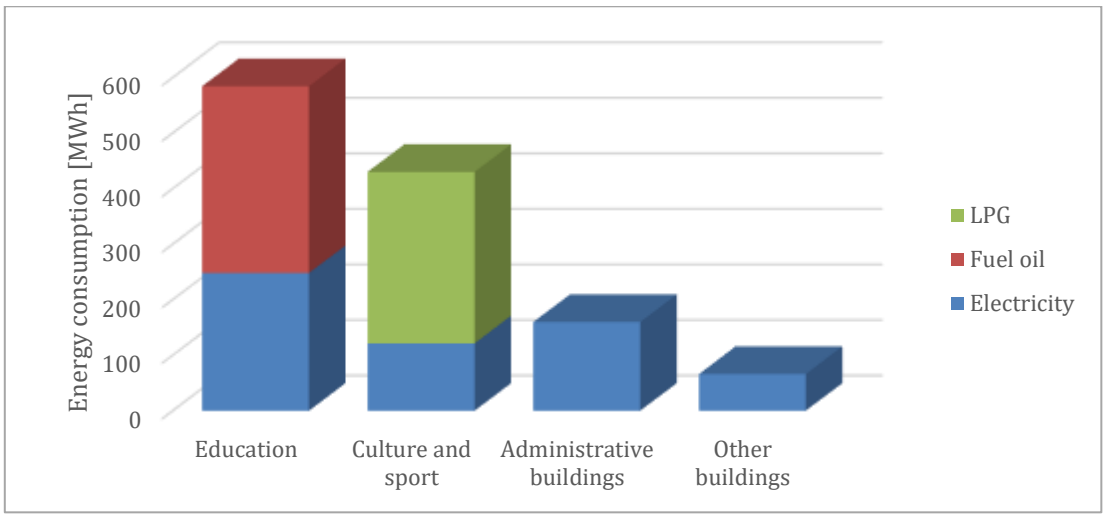


Figure 11: Final energy consumption in public buildings

Consumption of a single type of energy source in the consumption of buildings owned by local administrations on the island of Korčula is shown in Figure 12. Half of the energy consumption in buildings refers to electricity, while a quarter of the consumption is spent on fuel oil and LPG.

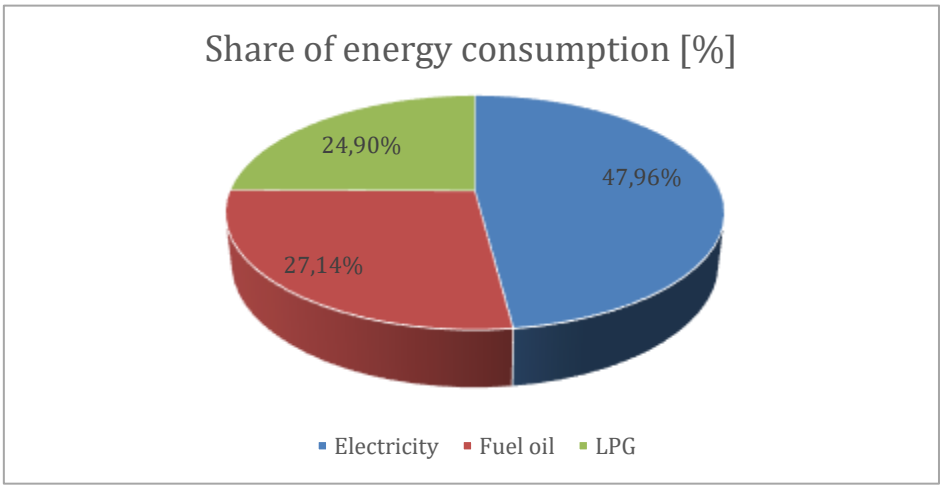


Figure 12: Share of the energy consumption

Estimated costs for energy sources for each building group is shown in Figure 13. Costs are shown in euros and in percentages. The total estimated costs for energy companies in the local government buildings on the island amount to 118,451 €.

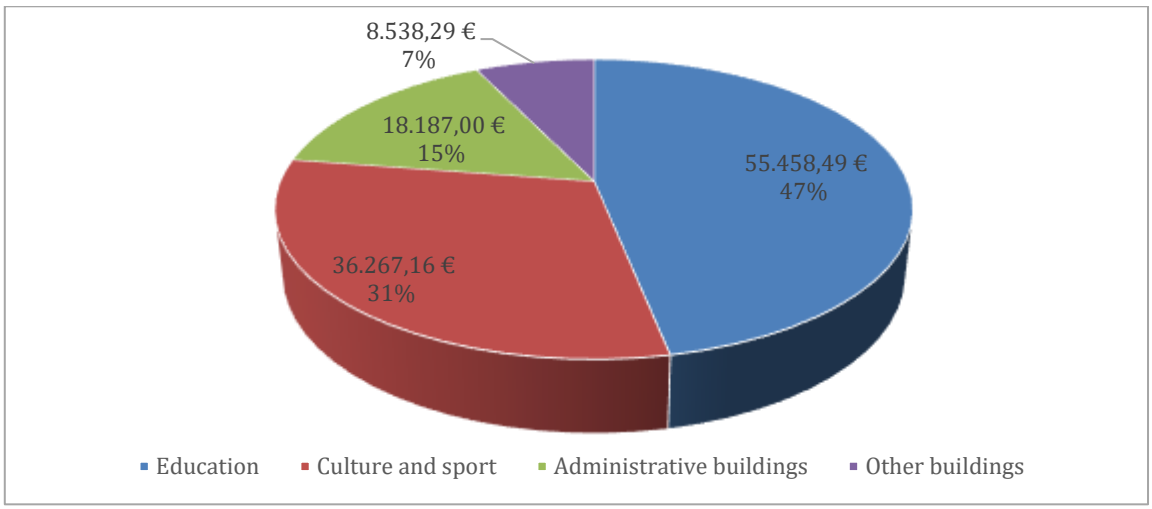


Figure 13: Estimated costs for energy for different building types

5.4.1.2 Public Lighting

The estimated electricity consumption for public lighting on the island of Korčula in 2012 amounts to 1,680,107 kWh, and the total estimated cost is 153,616 €. Figure 14 shows the estimated monthly electricity consumption for public lighting on the island of Korčula for three years, 2010, 2011 and 2012. The total estimated consumption in 2010 was 1,656,668 kWh, in 2011 1,699,526 kWh, and in 2012 consumption was, as already stated, 1,680,107 kWh. The actual data obtained from HEP ODS Elektrojug Dubrovnik were used for the municipalities of Vela Luka, Blato and Smokvica and City of Korčula, and for Lumbarda Municipality the consumption was estimated based on the consumption of other municipalities and the size of the urban area. From the data and from the diagram it can be noticed that the electricity consumption for public lighting is almost the same in the three years shown with little growth or falling between years. From the diagram it can also be concluded that consumption is higher in winter months than in summer, which is expected due to the shorter duration of winter time.

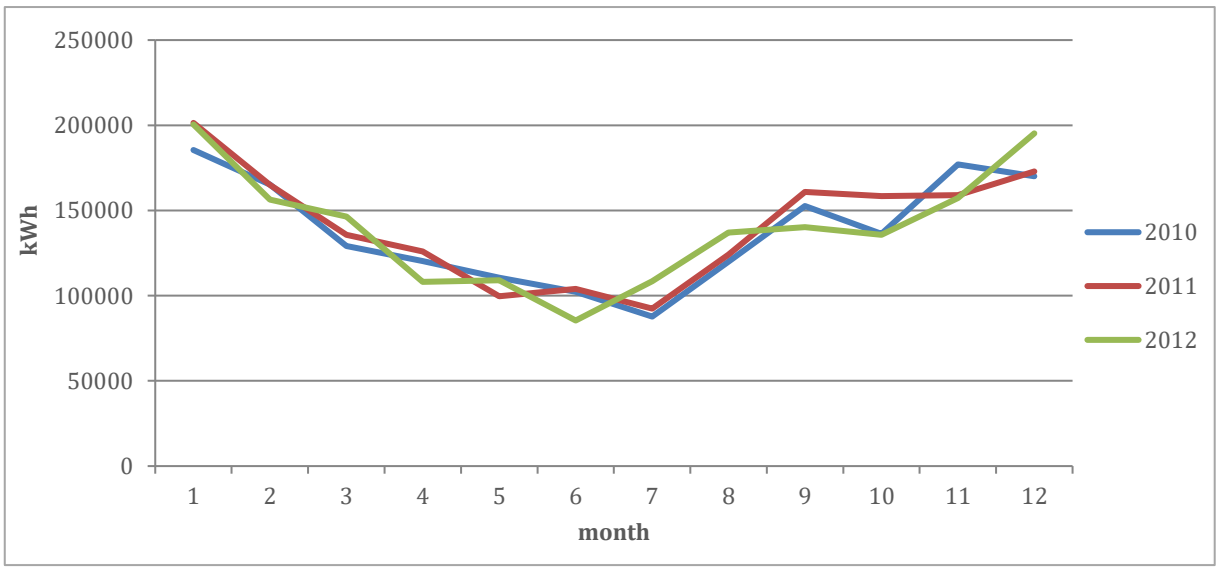


Figure 14: Monthly electricity consumption in public lighting

In addition to public lighting and construction in the sector of public buildings, equipment and facilities, energy consumption is also analysed in the water supply and drainage and waste management sectors. The data on energy consumption in the water supply and drainage were only available for the municipality of Blato and are not separately allocated but are included in the consumption of electricity in the services sector. The total consumption in 2012 was 660 MWh.

5.4.2 Residential Buildings

In the residential sector, used energy sources are electricity, fuel oil, liquefied petroleum gas (LPG) and biomass. Consumption of each energy source is shown in Figure 155.

According to the last census conducted in 2011 on the island of Korčula there are 5,449 households in which lives 15,521 inhabitants. On average, there are 2.85 inhabitants per household, which is slightly lower than the county average of 2.94.

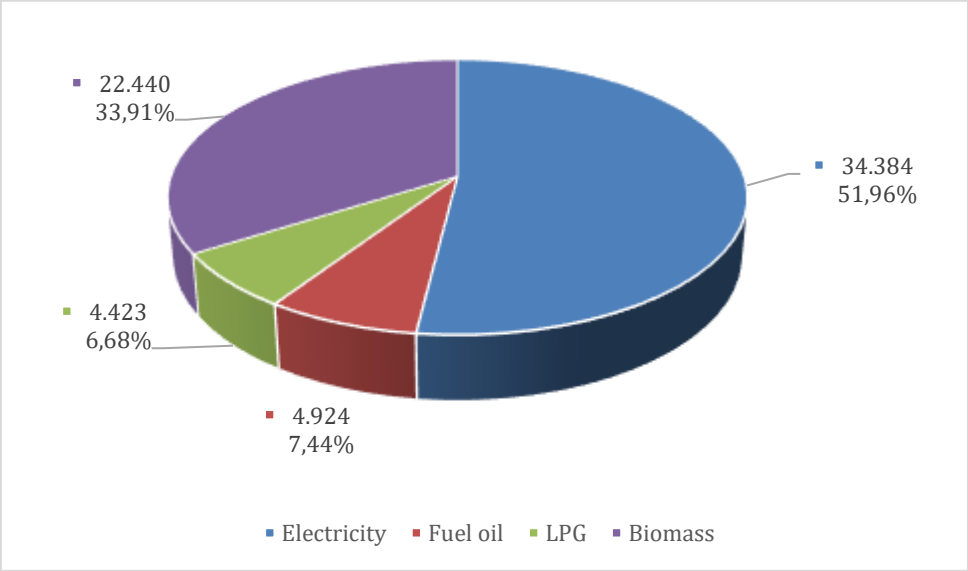


Figure 15: Energy consumption in the residential sector

The figure shows that electricity is the dominant energy source in households on the island of Korčula with a share of 51.96%, while biomass consumption is also very large, and its share is 33.91%. Consumption of the remaining two fuels is very similar, fuel oil consumption is 7.44% and LPG consumption is 6.68%. The total energy consumption in this sector is 66,171 MWh in 2012. From the above it can be concluded that the greatest potential for energy savings in this sector is related to reduction of electricity consumption.

5.4.3 Services Buildings, Equipment and Facilities

All of the local government units on the island of Korčula have their further development of the economy based on the growing tourism, as well as the entire Dubrovnik-Neretva County. Two most developed sectors of the economy on the island are agriculture and tourism. Tourism sector can greatly affect the final energy consumption. In 2012, there were 771,085 tourist nights in the island of Korčula according to the data of tourist boards operating on the island, and in the coming years it is expected that the number of arrivals and overnight stays will further increase.

Estimated final energy consumption in 2012 in this sector by type of energy sources is shown in Figure 166, and total direct energy consumption is estimated at 26,733 MWh. It is apparent from the figure that the most representative energy source is electricity with a share of 80.2%, the fuel oil consumption is 16.1% and the LPG is only 3.7%. From this, it can be concluded that the biggest savings in this sector are possible in reducing electricity consumption.

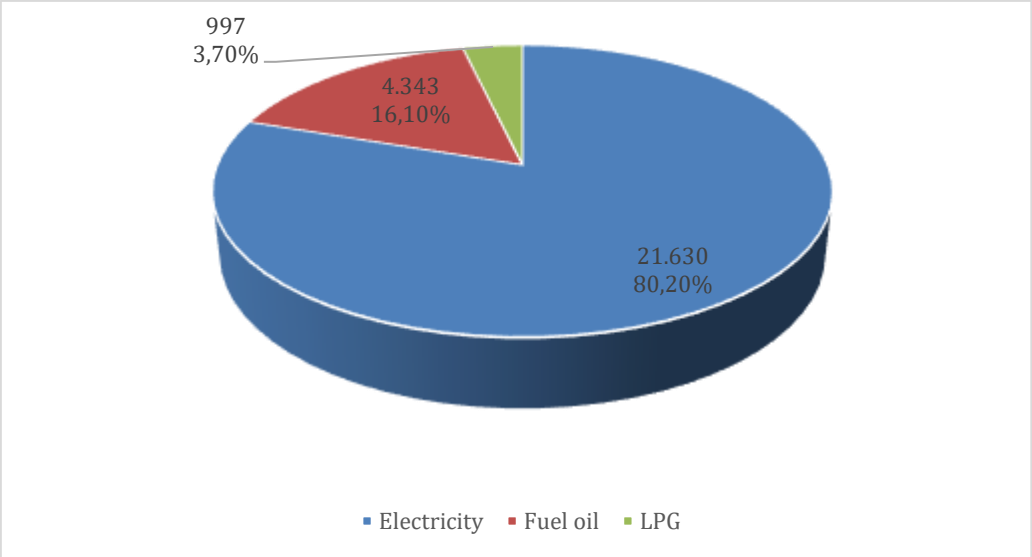


Figure 16: Energy consumption in the services sector

5.4.4 Transport

In transport sector only road transport was analyzed. In road transport, vehicle consumption is divided into three sectors, public vehicles, which analyses the consumption of vehicles owned by local government and municipal companies, public transport, carried out on the island by company Autotrans, and on other vehicles, i.e. vehicles owned by private companies and persons.

5.4.4.1 Public Vehicles

Public vehicles on the island are divided according to the institutions which use them in 4 groups: local government vehicles, municipal utility vehicles, health care vehicles and voluntary firefighters' vehicles (DVDs). Vehicles use petrol and diesel as fuel and are predominantly diesel engines. Fuel consumption in 2012 was 46,574 litres, of which gasoline was 6,100 litres, and diesel fuel 40,474 litres. It follows that the gasoline share is 11.67% and diesel 88.33%. The fuel consumption for each vehicle group and the total is shown in Table 9 and Figure 1717.

	Gasoline [l]	Diesel [l]	Total [l]
Local government vehicles	598	4 218	4 816
Municipal utility vehicles	3 086	17 757	20 843
Health care vehicles	2 416	14 993	17 409
Voluntary firefighters vehicles	0	3 507	3 507
Total	6 100	40 474	46 574

Table 9: Fuel consumption of public vehicles

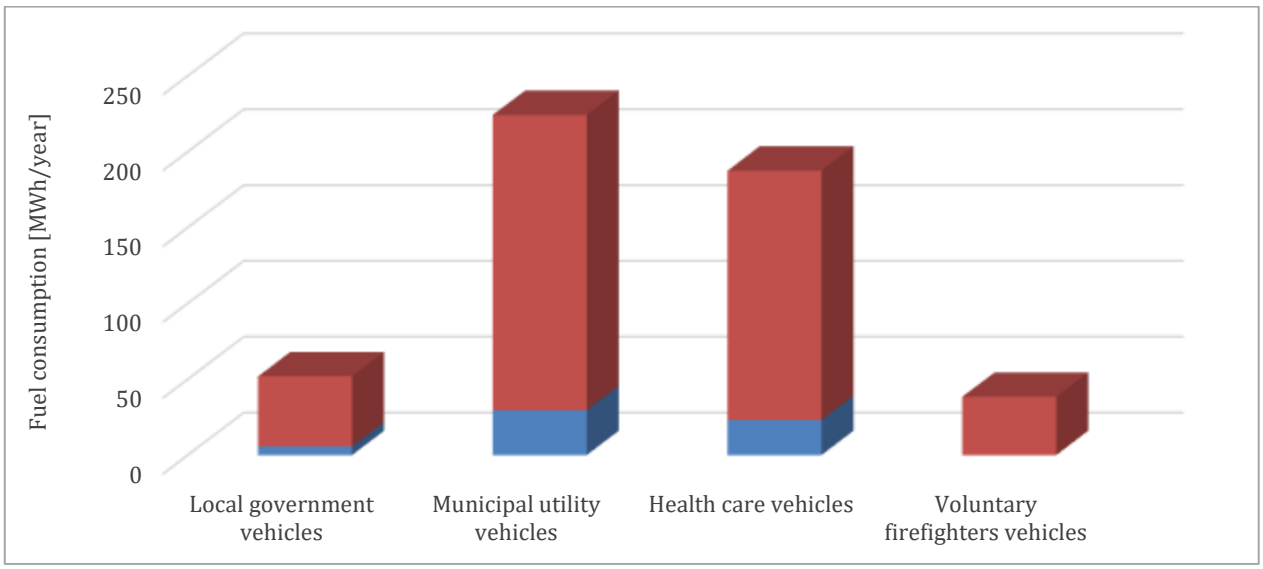


Figure 17: Fuel consumption of public vehicles

Estimated total costs attributable to local governments for fuel per year are 60,988 €, and costs per share of a given group of vehicles are shown in Figure 188. The highest fuel cost is for utility vehicles, vehicles for health care, and for others, it is 10% and less for local government's vehicles and voluntary firefighters.

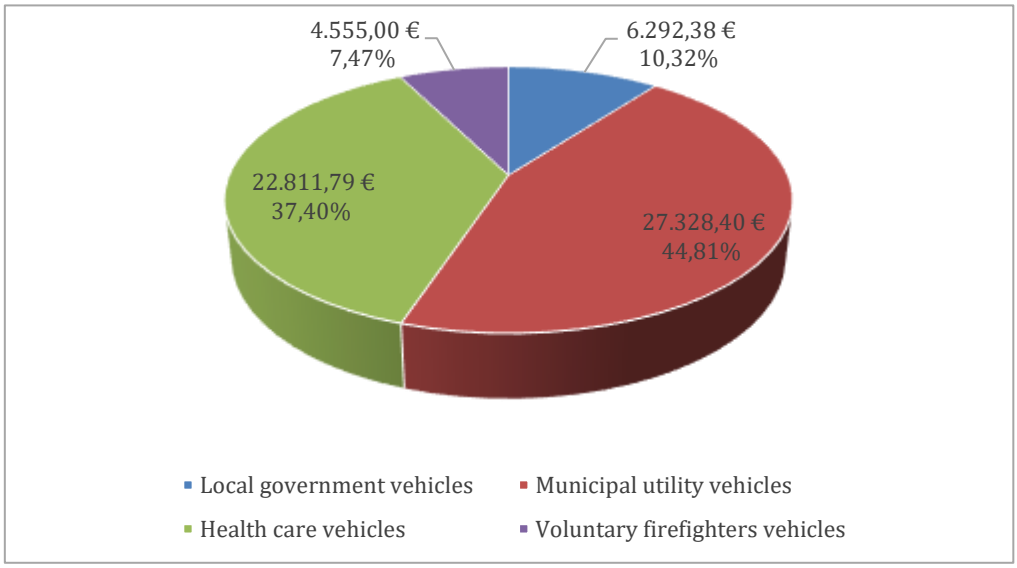


Figure 18: Cost of fuel for public vehicles

5.4.4.2 Public Transport

The public transport service on the island of Korčula is carried out by the company Autotrans, which uses 15 buses for the transportation of passengers. On the island there are 9 public transport lines:

1) Korčula – Lumbarda;

2) Korčula – Vela Luka;
3) Korčula – Račišće;
4) Korčula – Pupnat;
5) Vela Luka – Dubrovnik;
6) Vela Luka – Zagreb;
7) Blato – Vela Luka;
8) Blato – Prižba;
9) and Blato – Prigradica,

on the last three lines operate minibuses, and for the lines Vela Luka - Zagreb and Vela Luka - Dubrovnik, only part of the line transport on the island was taken into account when calculating fuel consumption and CO_2 emissions. All vehicles operating on the island are using Eurodiesel, and the estimated consumption for 2012 is 111,345 litres or 1,220 MWh. Annual fuel costs are estimated at 144,602 €.

5.4.4.3 Other Vehicles

Calculated energy consumption in other vehicles is divided according to vehicle types and the fuel used and shown in Figure 199. The diesel consumption is estimated at 4,352,272 litres or 47,701 MWh and the gasoline consumption is 3 234 918 litres or 31 088 MWh. Total fuel consumption in the other road transport sector is 78 788 MWh. It is visible from the picture that the largest fuel consumption in this sector is realized by cars.

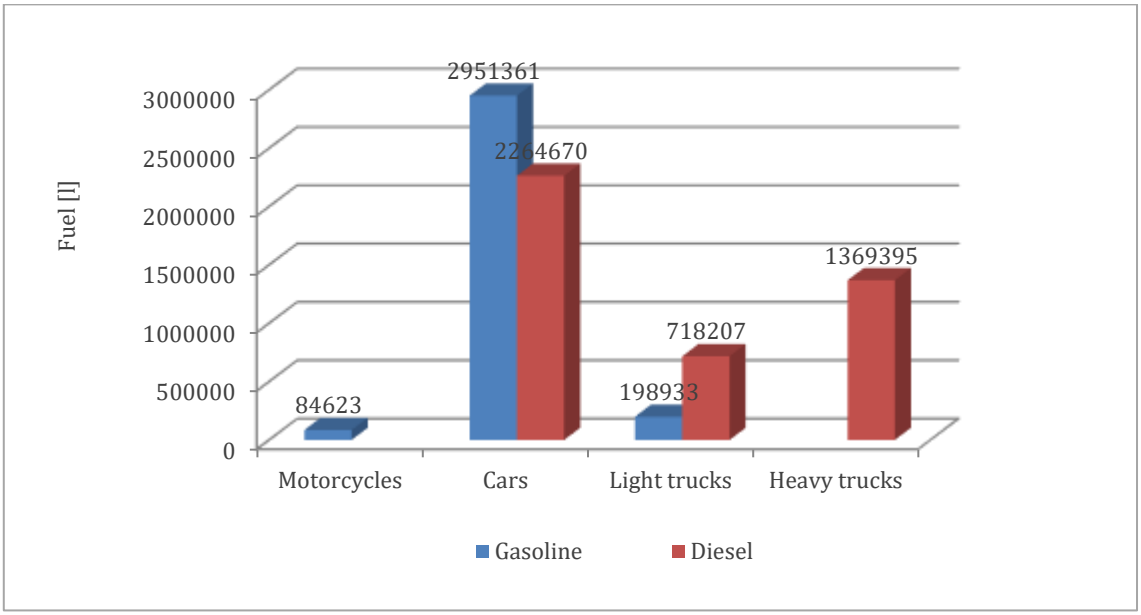


Figure 19: Fuel consumption in litres per vehicle type and fuel

5.4.5 Local Energy Production

In this chapter, apart from the already installed energy production capacities, the potentials of the locally available sources are described. This corresponds with the second step of the PRISMI method: mapping the resources of the location.

On the island of Korčula local energy production in the form of large power plants and similar plants does not exist. According to available data, the only energy produced in 2012 was heat energy from solar collectors used for hot water heating. The production of heat energy from solar collectors for DHW in 2012 was almost insignificant and was estimated at 78 MWh. In the

town of Korčula there is a solar power plant on the roof of Gojko Arneri swimming pool with a power of 50 kW, but it was not connected to the grid, so it did not produce electricity in the reference year.

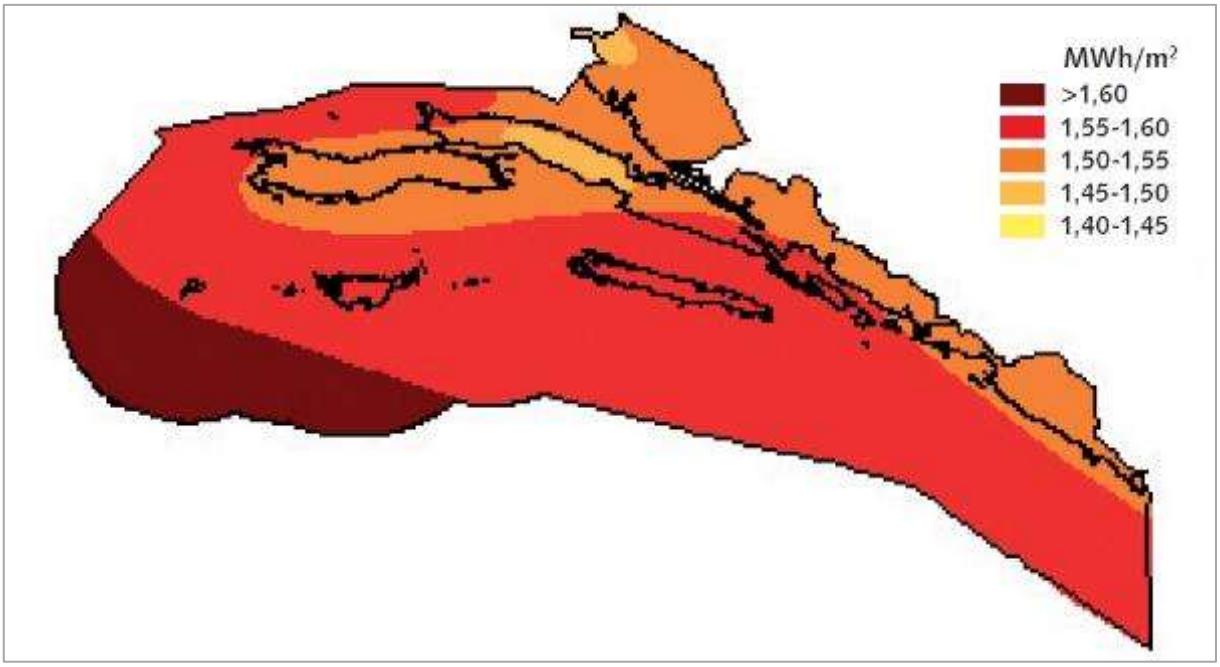


Figure 20: Solar potential in the Dubrovnik Neretva County

All the islands in the Dubrovnik-Neretva County have great potential for producing energy from renewable sources of energy, primarily from sun and wind. The island of Korčula has a great potential for exploiting solar energy in solar thermal systems and solar photovoltaic systems. The mean annual irradiation on the flat horizontal surface of the entire island is between 1.50 and 1.55 MWh/m² and is shown in Figure 20. The mean annual irradiation on the plane at the optimum angle, which is between 34° and 36° for the island of Korčula, is between 1.69 and 1.93MWh/m² depending on location on the island and the source of data used. The optimal angle for the City of Korčula is 34°, and the mean annual irradiation on the flat surface is between 1.48 and 1.57 MWh/m², and for the optimal slab surface these values are between 1.69 and 1.81 MWh/m². The optimal angle for Vela Luka, a village on the other end of the island, is 36°, and the mean annual irradiation on the flat surface is between 1.55 and 1.65 MWh/m², and for the planes at an optimum angle these values are between 1.83 and 1.93 MWh/m².

Resources	Level	Code	Resources	Level	Code	Resources	Level	Code
Local primary energy			**Infrastructure for energy imports**			**Water**		
Wind	Medium	WindM	Network connection	Normal	GridN	Rainfall	Low	H2OPL
Solar	High	SolarH	pipeline natural gas	n/a	NGplN	Groundwater	Low	H2OGL
Water potential (altitude drop)	Medium	HydroM	Terminal LNG	n/a	LNGtN	Water supply	Yes	AquaY

Biomass	Medium	BIOMM	Oil terminal / refinery	n/a	OilRN	Seawater	Yes	H2OSY
Geothermal potential	Low	GeothL	Terminal petrol. production	n/a	OildDN			

Table 10: Mapping the resources on the island of Korčula

In deliverables D3.3.1 and D3.3.2, relevant data on RES potential in the study areas was collected and stored in the PRISMI GIS database. For the island of Korčula, an example is illustrated in figure 21 representing the solar energy potential in this study area.

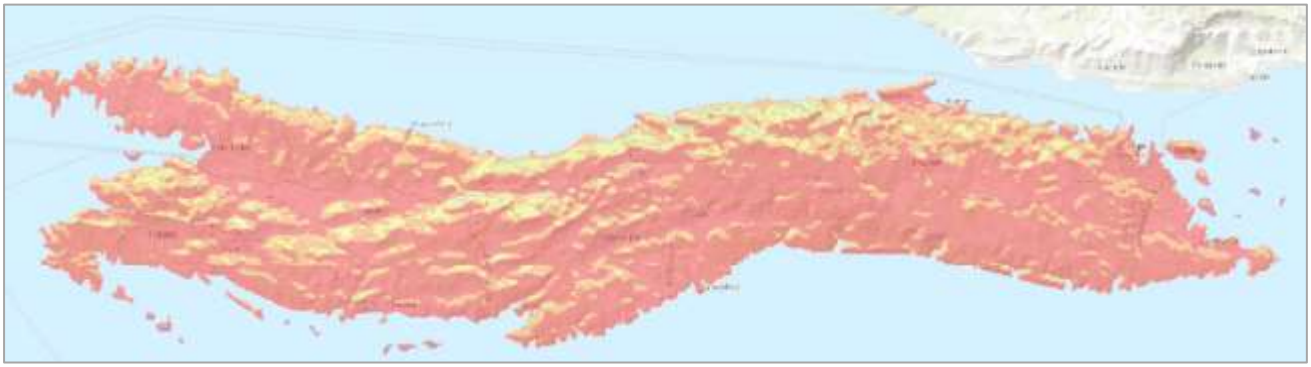


Figure 21: Solar potential of the island of Korčula mapped in PRISMI GIS geo-database

Also, suitable locations for integrated solar installations can be found in the areas where existence of buildings and good potential of solar irradiation converge. For this purpose, GIS geo-database can be used, with its layer covering the existing buildings. This is illustrated in Figure 22.

Figure 22: Buildings layer of the PRISMI GIS geo-database

The construction of wind power plants on the islands is governed by the Law on Construction and the Law on Spatial Planning (OG 153/13) and it is prohibited in the area of ZOP, extending 1,000 meters from the coastline. The island of Korčula has a great wind potential, primarily its southern part, as can be seen in Figure 23. With a load factor greater than 40%, there is a possibility to build wind farms on the island.

The potential of wood biomass on the island is largely exploited, as more than 30% of the energy consumed in households is wood. Since agriculture on the island is one of the most important activities, especially the cultivation of vines and olives, it is necessary to explore the possibility of energy exploitation of the residues from the production process.

Geothermal energy in the whole territory of the County has no significant potential, on the island of Korčula as well. The geothermal gradient is relatively low and ranges from 10 to 20 °C/km, however geothermal energy can be used as a heat source for heat pumps.

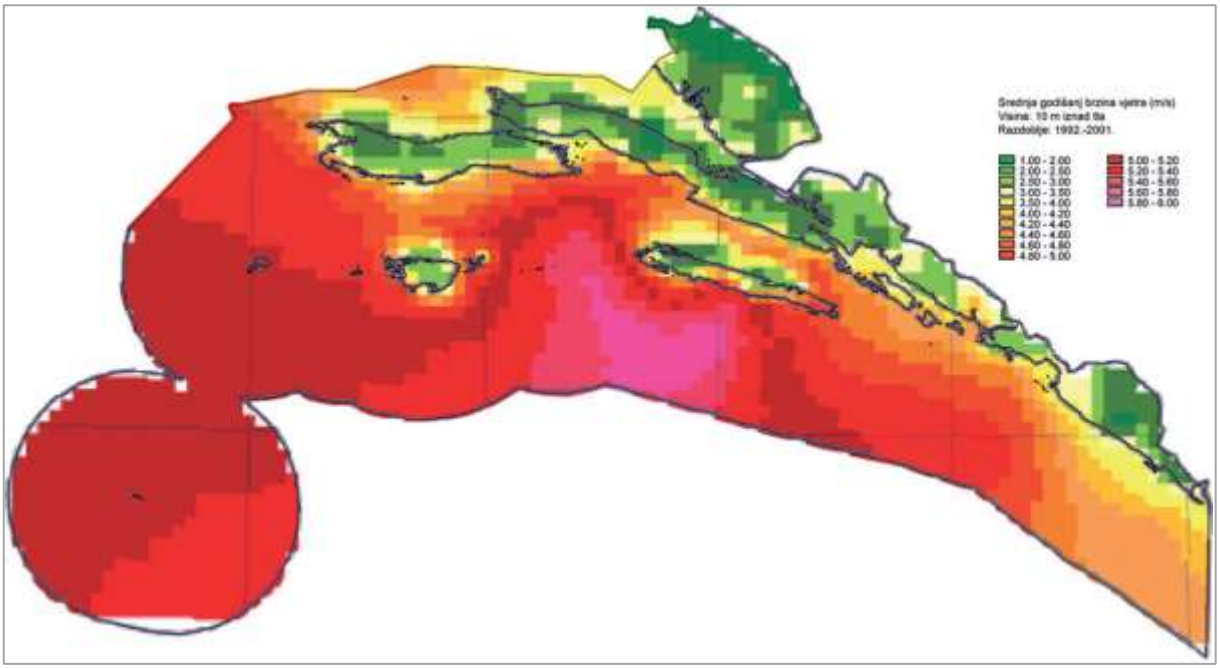


Figure 23: Wind potential of Dubrovnik Neretva County

5.4.6 Total Final Energy Consumption

The total final energy consumption for the island of Korčula is shown according to the sectors in Figure 24, and Figure 23 shows the share of individual energy sources in total consumption. For the reference year of the calculation, direct energy consumption amounted to 176,335 MWh. If distributed by sectors, the highest energy consumption on the island of Korčula has a transport sector, without public vehicles and public transport. Its share is 44.62%, and its consumption is 78,788 MWh. Followed by households, 37.48% and services sector with 15.27%, while public sector sectors have a share of total energy consumption of less than 1%. All municipal public buildings, municipal buildings and vehicles, public lighting and public transport together share 2.63% of the total energy consumption of the island of Korčula.

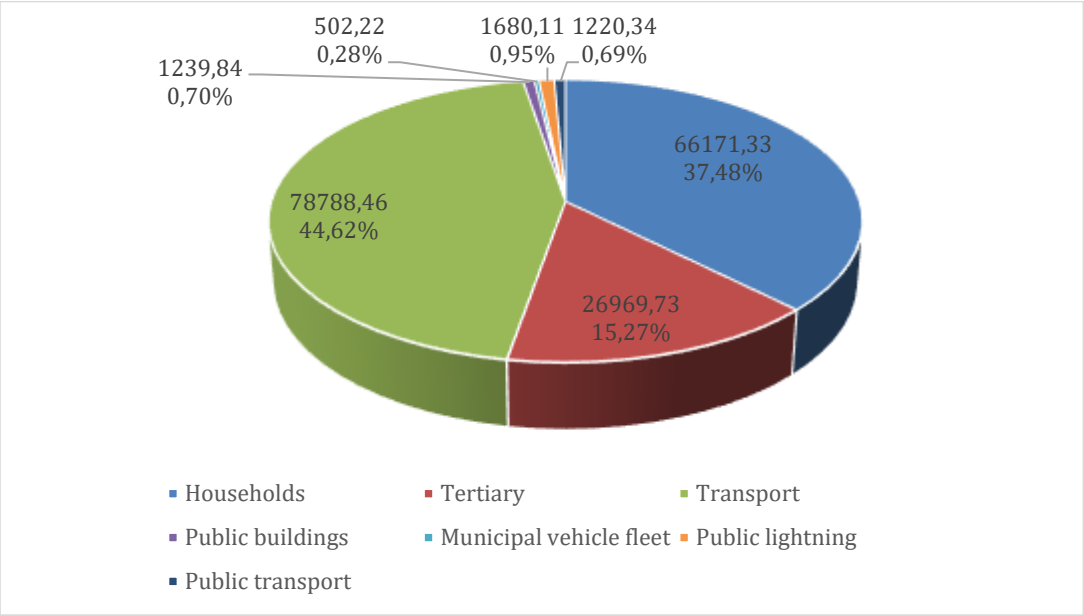


Figure 24: Total final energy consumption for the island of Korčula by sectors

Of the energy sources, the largest share of final energy consumption of 33,01% occupies electricity. Behind it, follows diesel with a share of 27.96% and gasoline with 17.64%. The total of these fuels has a share of 45.6%, which is slightly less than half the total consumption of the island. From this it can be concluded that the transport sector is the largest energy consumer and that it will be necessary to take measures that will significantly contribute to saving energy and reducing CO_2 emissions. The share of wood, i.e. biomass of 12.73% in total consumption is significant. The lowest shares have fuel oil and LPG of 5.45% and 3.25% respectively.

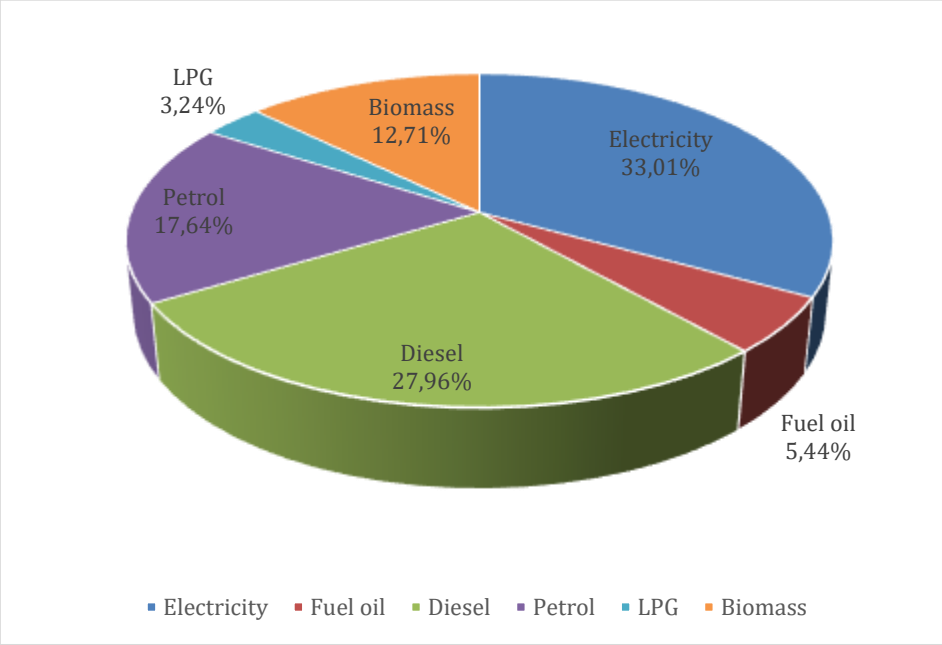


Figure 25: Total final energy consumption for the island of Korčula by fuel type

5.5. INVENTORY OF CARBON DIOXIDE (CO2) EMISSIONS

In this section it will be show the CO2 emissions that are generated from the energy consumed on the island, and by sectors analysed in previous chapter. The emission analysis is divided into 4 sectors:

- the public sector, which will show emissions from buildings and vehicles owned by local governments, public lighting and public transport
- the residential sector
- the services sector
- the sector of road transport

At the end of the chapter, an overview of total emissions of the island by sector and energy source is given.

5.5.1 Public Sector

Public sector emissions by individual sub-sector are shown in Figure 26, and the total emissions in this sector for 2012 on the island of Korčula amounted to 1 328 tCO2. Their share of the total emissions on the island was 3.09%.

Since the public lighting sector emits the highest emissions of 39.23%, and partly modernized and replaced by lighting systems, the greatest potential for emission reductions remain in the public buildings sector, whose share is 26.23%, and in the public transport sector emission share 24.52%. Also, a significant part of emission can be saved in the public vehicle sector if it is replaced by electric vehicles, assuming the use of the RES for electricity generation. In the public lighting sector, additional savings can be made by replacing all current lights with LED lighting.

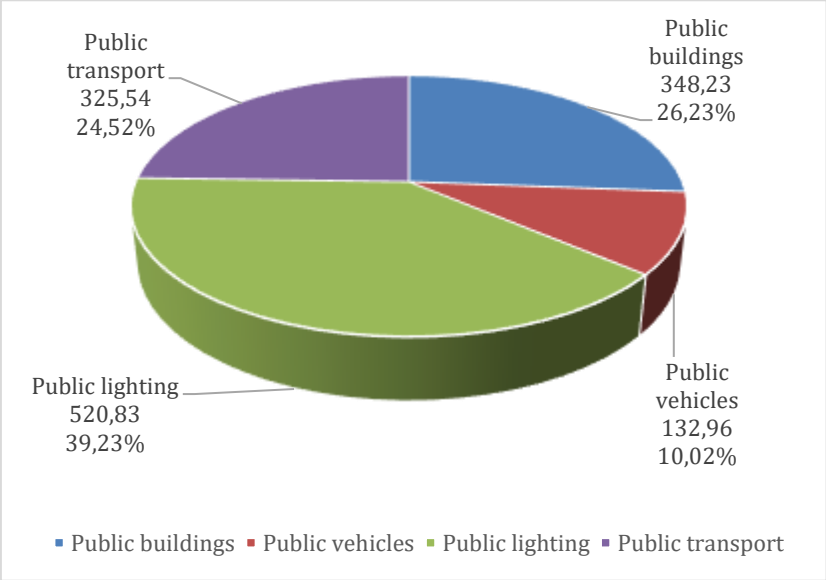


Figure 26: CO2 emissions of public sector on the island of Korčula

Emissions by fuels are shown in Figure 27, showing that more than 50% of the emissions come from electricity, and is therefore the energy source for which the largest emission reduction can be achieved. It should be borne in mind that the bulk of electricity consumption in public lighting has been partially modernized. Significant opportunities to reduce emissions also exist in diesel fuel with 33.44% emissions. Emissions from fuel oil and liquefied petroleum gas make up 7.06%

and 5.28% of public sector emissions and can be affected by modernization of heating systems in buildings. The lowest share of emissions in the sector has petrol fuel, 1.1%, and its emissions can be reduced or eliminated by the introduction of electric vehicles.

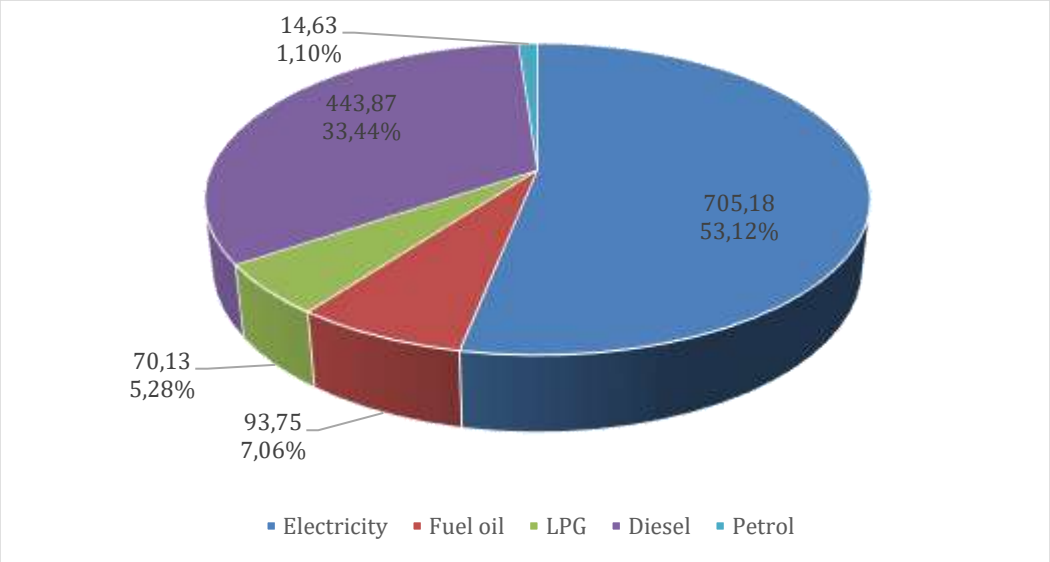


Figure 27: Emissions of CO2 of public sector by energy sources

5.5.2 Residential Sector

In the residential sector on the island, four energy sources are used: electricity, fuel oil, liquefied petroleum gas and biomass. The shares that the energy sources have in the sector emissions are shown in Figure 28, and the total emissions of the sector in 2012 are estimated at 13,046 tCO_2. 81.7% of the emissions come from electricity, and it is the energy that can achieve the greatest savings by 2020. Emissions from oil fires are 1,372 tCO_2, and their share is over 10%, while emissions from UNP have a share of 7.7%. Emissions from fuel wood (biomass) are negligible, and it is necessary to maximize the full potential of biomass on the island, primarily heat and, if possible through cogeneration, and electricity.

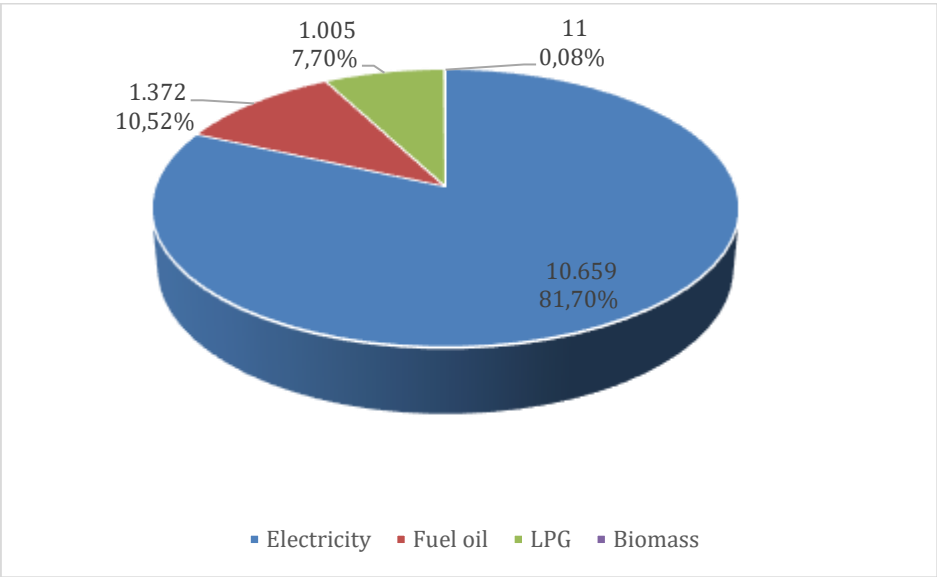


Figure 28: CO2 emissions of the residential sector

5.5.3 Services Sector

In the services sector on the island are used three energy sources: electricity, fuel oil and liquefied petroleum gas. The shares of the emissions by different energy sources are shown in Figure 29, and the total emissions of the sector in 2012 are estimated at 8,068 tCO_2. The highest emissions in this sector come from electricity with amount of 6,632 tCO_2, and their share is 82.2%. Emissions from fuel oil are 1 210 tCO_2 and their share is 15%, while emissions from LPG have a small share of 2.81%. The largest reduction of greenhouse gas emissions in this sector can be achieved by reducing electricity consumption and fuel oil fired boilers.

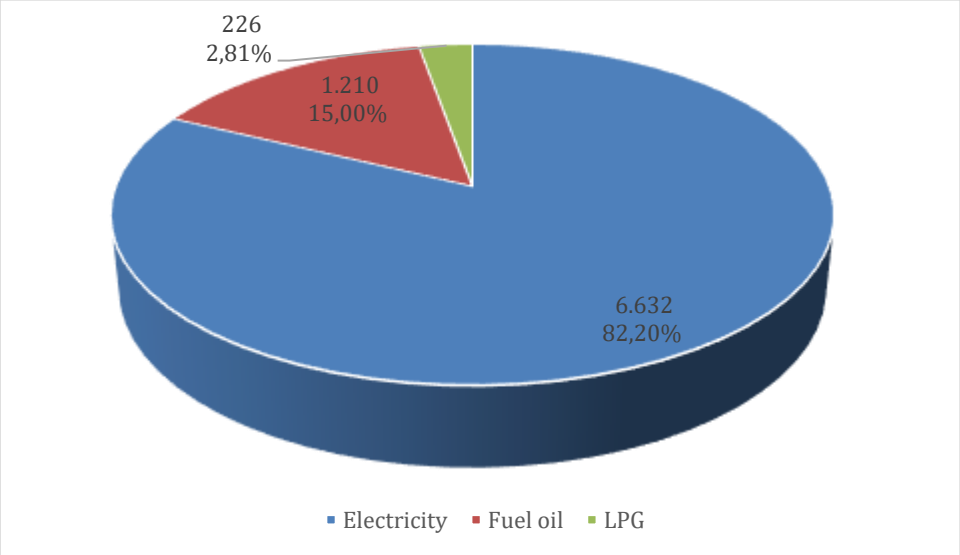


Figure 29: CO2 emissions of the services sector

5.5.4 Road Transport

Estimated total emissions in other road transport on the island for the base year are 20,480 tCO_2 and are presented according to the types of fuel in Figure 30. Vehicles using diesel fuel emit 12,725 tCO_2, i.e. 62.13%, and vehicles that use gasoline 7,756 tCO_2, and their share in the emissions of this sector was 37.87%.

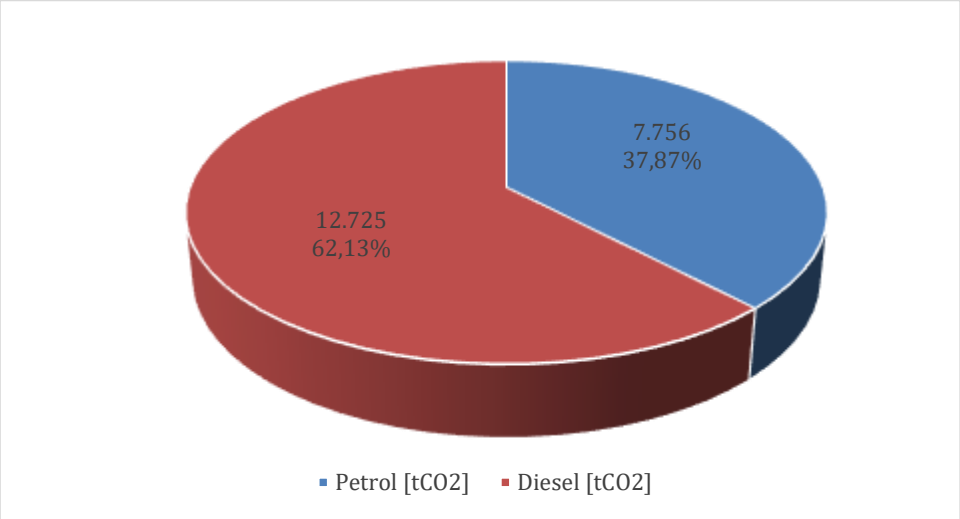


Figure 30: CO2 emissions from road transport

5.5.5 Total CO2 Emissions of the island of Korčula

In 2012, the total emissions of the island of Korčula for the analysed sectors were estimated at a total of 42,923 tCO_2, of which 1,328 tCO_2 was emitted in the public sector, resulting in the share of public sector emissions 3.09%. For each sector, the share of emissions is shown in Figure 31. Nearly half of the emissions come from the sector of other road transport, followed by the residential sector with 30.39% share in total emissions, and the services sector with 18.8% emissions. If the sector of the rest of the road transport accounted for public transport and public-owned vehicles owned by the municipality, then the share of road transport emissions would be 48.78% of the total emissions.

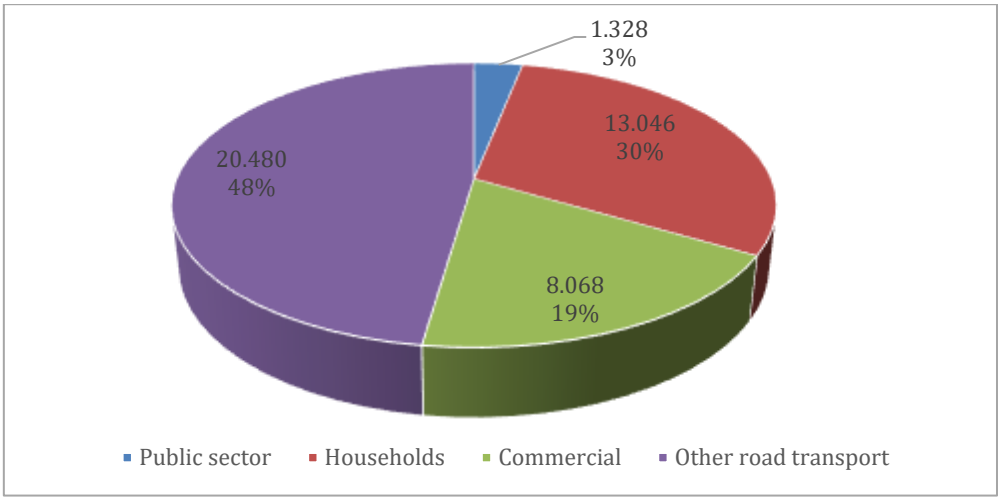


Figure 31: Total CO2 emissions on island shown by sectors

5.6. SUSTAINABLE ENERGY ACTION PLAN

5.6.1 Modelling of Energy System

In general, the PRISMI approach is comprehensively outlined in Figure 32, describing the logical flow of actions when using the PRISMI toolkit and overall approach.

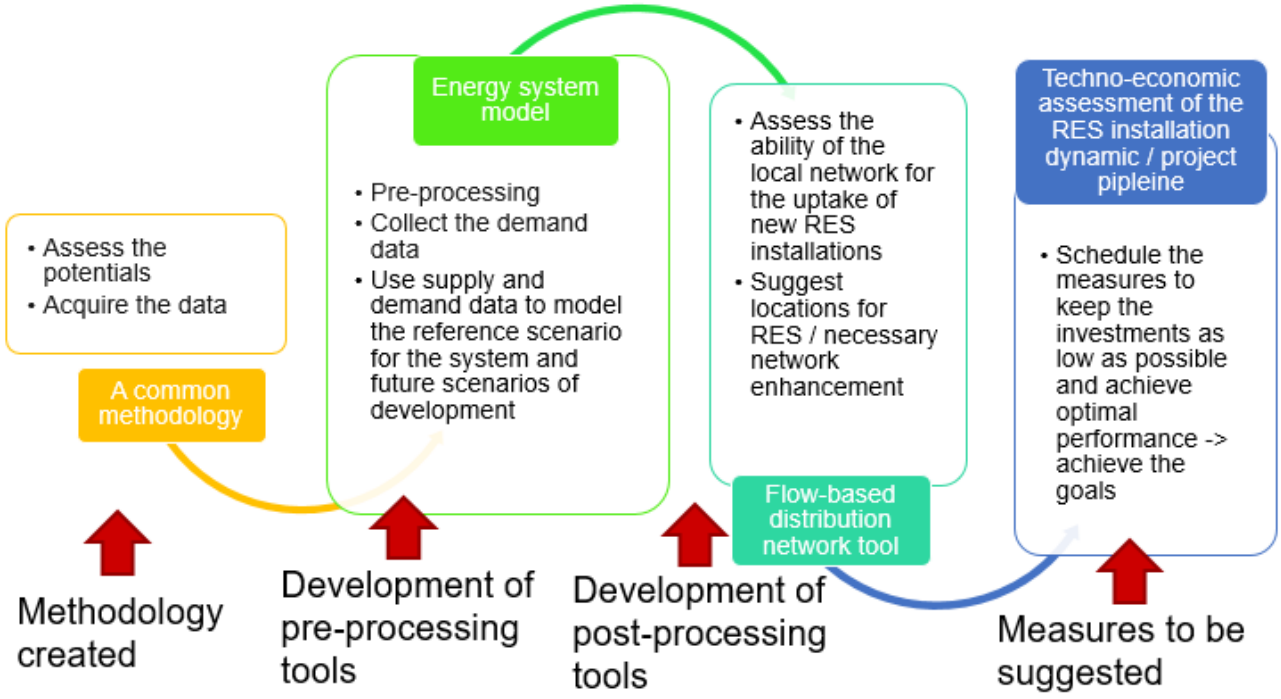


Figure 32: The PRISMI approach step by step

In PRISMI deliverable 3.4.1 SWOT analysis has been conducted for the island of Korčula. The results are presented in the following table.

SWOT Analysis for RES implementation - KORČULA ISLAND - CROATIA	
ENERGY SYSTEMS STRATEGY	
STRENGTHS	**WEAKNESSES**
The City of Korčula is connected with the mainland power energy system of Dubrovnik-Neretva County with the 110kV cable to the Pelješac peninsula. The city is also connected to the electrical substation in Blato and with power line to the Hvar island.	Old electric power infrastructure
Load is relatively low during the whole year expect during the summer	Voltage drop during winter season in the area of Pupnat and Žrnovo
Geographic information system of the City of Korčula	Existing electrical substation is not sufficient for the planned development of tourism
OPPORTUNITIES	**THREATS**

Investors are interested in building a solar photovoltaic power plant in the City of Korčula, municipality of Vela Luka	Deterioration of existing electric power infrastructure
Island inhabitants are interested in mutual RES projects	
EU funds are providing a support for the improvement and the development of the energy systems and in general development of rural areas	
Possibilities of energy export and decreasing losses of electrical grid	
The EU is highly supporting the idea of developing a 100% energy independent island community	
Energy efficiency measures funded by The Environmental Protection and Energy Efficiency Fund, Dubrovnik - Neretva County	
Energy consumption is concentrated on the relatively small surface areas	
Very positive European attitude towards shift to renewables	
Self-sustaining communities	
ECONOMICS - FINANCIAL RISKS	
STRENGTHS	**WEAKNESSES**
Development of citizen cooperatives	Revenues of the Vela Luka, Blato and Smokvica municipality along with the public utilities are not sufficient to cover the expenses for the recruiting the staff which would work on the development project
Great potential for the development of eco-tourism and exploitation of renewable energy sources	Unsatisfactory creation of additional value in the island economy
	Municipal and utility companies' income is not sufficient for recruiting staff to work on development projects

OPPORTUNITIES	**THREATS**
Legislative framework which stimulates development of tourism sector, family farming, etc.	Stagnation/shutdown of industrial production
New job opportunities	Large distance of regional centres
Promoting Development in the Tourism Sector	
RES RESOURCES AVAILABILITY AND TECHNOLOGICAL OPTIONS	
STRENGTHS	**WEAKNESSES**
Favourable Mediterranean climate, big number of sunny days during the year	Unused potential of renewable energy sources
Average annual value of irradiation on a flat horizontal surface on the island is between 1.50 and 1.55 MWh / m2	
Investor interest an interest of residents for the projects	
OPPORTUNITIES	**THREATS**
Geographic location is favourable for the exploitation for the RES (wind, solar, biomass and thermal energy of the sea)	
Wind and PV investments are based on mature technologies without any particular risk	
The possibility to include RES facilities in the strategic plan for RES exploitation of the county	
SOCIETY - SOCIAL IMPACTS - PUBLIC AWARENESS	
STRENGTHS	**WEAKNESSES**
Existing awareness of islanders for the need of protection and preservation of the environment and for the rational end efficient exploitation of energy sources.	Citizens are insufficiently informed and they lack of knowledge on possibilities for the exploitation of renewable energy sources

Positive attitude of islanders about saving resources	Uncoordinated legislative framework hiders efficient planning and implementation of plans, once they are in force. Islands are the subject of many laws, ordinances, strategies and plan in Croatia, but all those national and local level strategic documents are not coordinated and, sometimes, in dispute
OPPORTUNITIES	**THREATS**
Island's administration has signed the adhesion to the Smart Islands Initiative, which will foster their involvement in best practice exchange, awareness raising and provide future funding opportunities	Vertical coordination of the head of state, county and city development policy
	Exact time to obtain a license is legislative set but always much more time is needed. Especially spatial planning related to permits can take many years
	State, county and municipal development policy and restrictions on the Law on Construction and Legislative Acts
	Ageing population and depopulation
ENVIRONMENTAL IMPACTS	
STRENGTHS	**WEAKNESSES**
RES have much less impacts than any other form of conventional energy at least as far as emissions are concerned	The old city centre of the Korčula city is under the conservation protection which prevents increase of energy efficiency through reconstruction of outer part of the house with the additional installation of solar systems
	Korčula is a bird's migration route. Therefore, the siting of the project needs a lot of attention in order to avoid some excessive environmental impacts (NATURA)
	Significant part of the island is protected under the NATURA and that caused difficulties in licensing procedures
OPPORTUNITIES	**THREATS**

	Strict conditions for construction, construction of the wind power plants is not allowed on the protected coastal area.
	Restrictions in development plans due to cultural and historical heritage
	Strategic Environmental Impact Study
LOCATION - TERRITORY - ACCESIBILITY	
STRENGTHS	**WEAKNESSES**
Close to the mainland and grid connected	Property legal disputes - for many areas, there are long unsolved disputes, which makes it unavailable for any investments
The geographic position is advantageous for exploitation	
OPPORTUNITIES	**THREATS**
	Poor transport connection affects poor market offer, opportunity for maintenance of the equipment.

Table 11: SWOT analysis of the energy system of the island of Korčula and its development

PRISMI methodological guidelines were comprehensively described in PRISMI deliverable 3.1.1

In accordance to the PRISMI method, 4 steps of energy planning of the energy system of the island of Korčula are observed:

1) Mapping the needs of the island community
2) Mapping the resources available
3) Technologies overview for use in scenarios of energy system development

From the step two of the method, one of the resources is rated as high potential on the island of Korčula: solar energy. Initial step is to calculate the available area for solar PV installation. Calculations were made according to the total area size of all dwellings including dwellings for permanent residence, dwellings used occasionally and the ones for business activity only. Furthermore, it was assumed that on an average level, buildings are having two floors; therefore, the total amount of square meters is divided in half. Apart from that, other restrictions were taken into consideration. Above mentioned area size was multiplied by a coefficient of 0.7 which represents the correction factor which includes buildings with more than two floors. In order to account rooftop objects such as windows, chimneys, slopes and antennas, which can reduce available space, a coefficient of 0.85 was used. The calculated surface was considered the net area for the installation of photovoltaic panels. The nominal power of 1 kW for PVs requires 6.5 to 7 square meters obtained surface. These conditions are applicable for the Croatian islands.

Other relevant resource is wind power, which is restricted in the terms of legislative framework and made difficult for the implementation due to the island being mostly covered by the NATURA 2000 network and protected. This is in particular true for the locations with some wind potential.

Biomass is used in households for heating and hot water in individual stoves. Solid biomass potential is too low for use in energy production, but potential can be identified in use degradable portion of waste for biogas production. Water potential for pump hydro plants can be observed but is restricted by the environmental protection regulations. Other technologies, such as tidal energy and wave energy have not been sufficiently explored and mapped to be taken into consideration.

4) Division of scenarios

Final, fourth step of the method is the division of scenarios. Energy system development of the island of Kočula has been examined in three scenarios:

- LowRES – following the same dynamics of RES use, as already proposed in actual SEAP-s
- RES – Increase of RES use, with taking into consideration environmental constraints and legislative framework
- HighRES – Modelling for a 100% RES energy system of the island

Detailed analysis of the data gathering can be found in PRISMI deliverables 3.3.3 and 3.4.2.

Having in mind the method for solar power, described in the description of the study area and input data, the possible installed capacities of PV are calculated.

2030	**LowRES**	**RES**	**HighRES**
PV [MW]	4.59	44.59	42.05
Wind [MW]	0	0	10
EV [no. of vehicles]	0	1,849	5,222
EV connection [MW]	0	9.892	38.642
EV demand [GWh]	0	7.975	12.533
EV battery [MWh]	0	72.11	203.658

Table 12: Input data for the modelling

Further considerations will be elaborated having in mind the year 2030. For two scenarios, LowRES and HighRES, demand is different, and this difference is exactly the amount of demand for the electric vehicles.

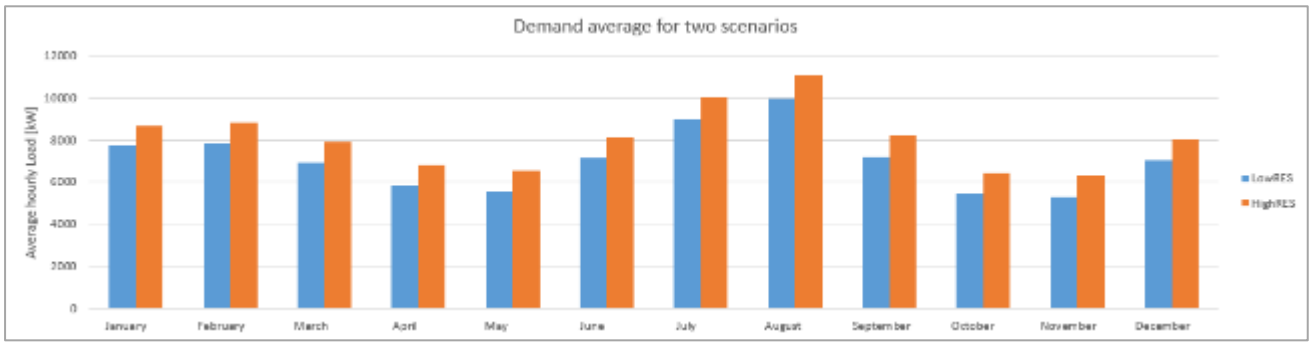


Figure 33: Monthly average hourly load of the island of Korčula in 2030 for two scenarios

5.6.1.1 Resulting of modelling and discussion

Results of modelling are presented in single figures for all three scenarios, to be easily comparable.

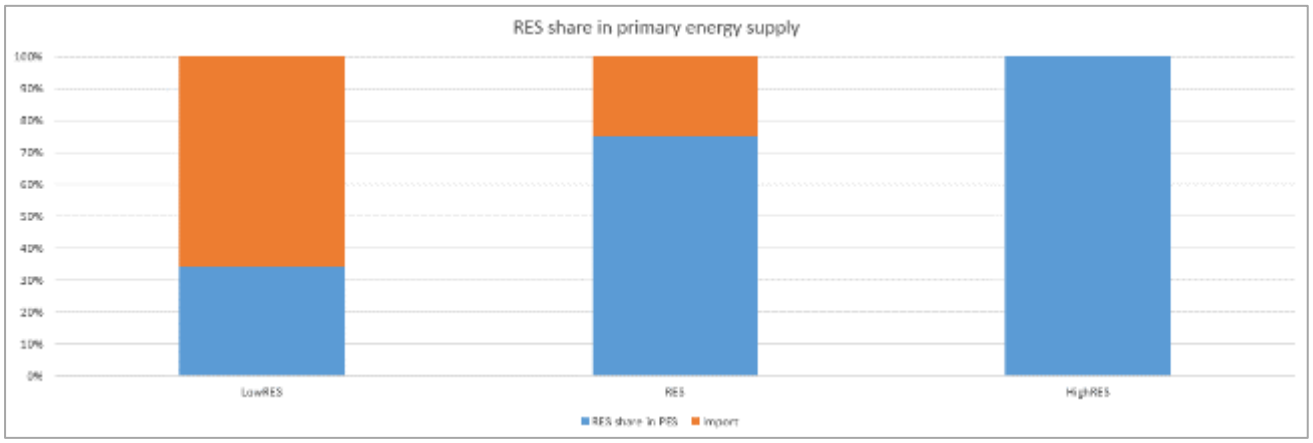


Figure 34: RES share in primary energy supply

For each scenario, the combination of RES sources is used, as presented in table.

LowRES		
RES prod.	6.84	GWh/year
Solar	6.84	GWh/year
Wind	0	GWh/year
Tidal and Wave	0	GWh/year
Hydro	0	GWh/year

RES		
RES prod.	66.46	GWh/year
Solar	66.46	GWh/year
Wind	0	GWh/year
Tidal and Wave	0	GWh/year
Hydro	0	GWh/year

HighRES		
RES prod.	73.97	GWh/year
Solar	62.67	GWh/year
Wind	11.3	GWh/year
Tidal and Wave	0	GWh/year
Hydro	0	GWh/year

Table 13: Results of modelling - energy production

Also, following these amounts of generated energy, the following figure represents the RES share in electricity production.

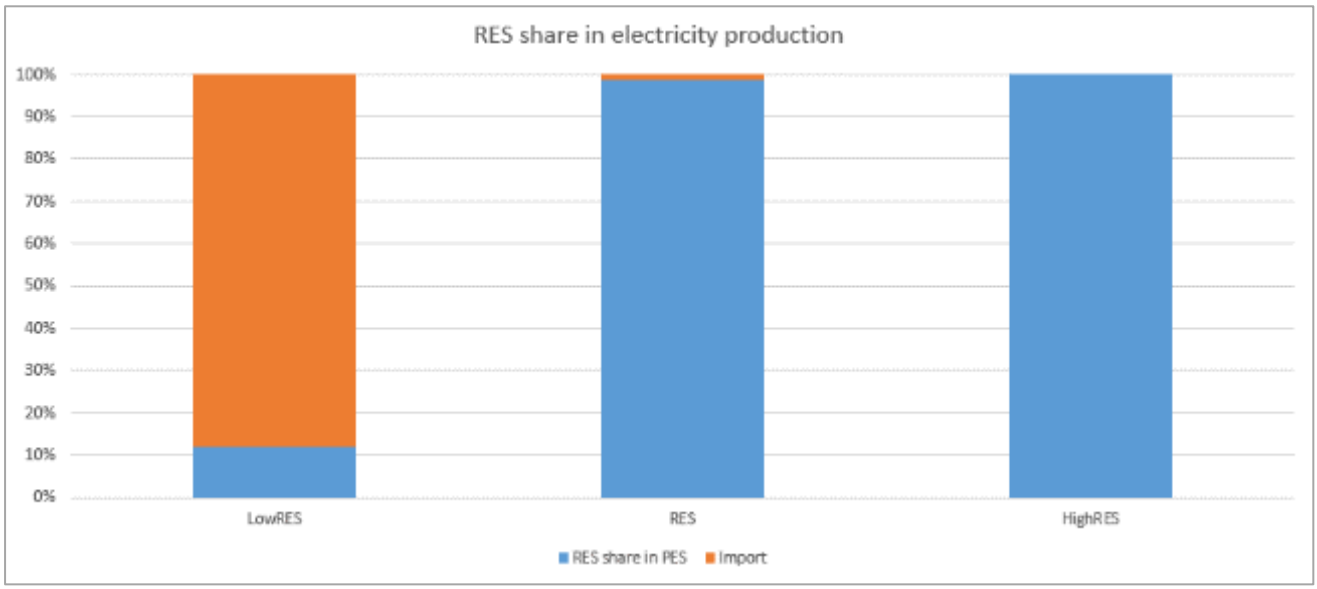


Figure 35: RES share in electricity production

It can be observed that RES scenario already covers very high percent of energy production, due to large solar energy potential on Korčula, but share in primary energy supply is 25% lower. Therefore, in the HighRES scenario, all vehicles are substituted by electric vehicles. For the purpose of proposing the measures in this SEAP, the RES scenario is considered further.

Vehicle-to-grid (V2G) represents the discharge from EV batteries, which is represented as additional supply in RES and HighRES scenario.

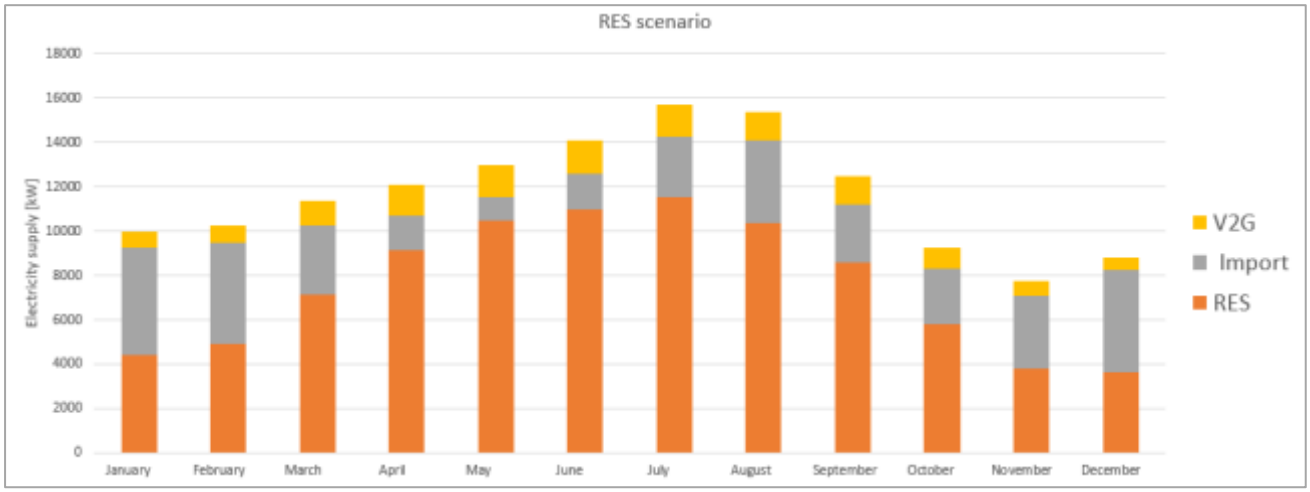


Figure 36: Share of RES in monthly average hourly production for the RES scenario

Regarding the socio-economic feasibility of adopted solutions, input data for all scenarios, regarding the prices of technologies implemented, are given in the table.

2030	Investment	O&M	Lifetime
PV [kEUR/kW]	1.1	2%	20
Wind [kEUR/kW]	1.375	3%	20
EV[kEUR/unit]	37.85	6.50%	10

Table 14: Inputs - technology costs

Results of modelling for all scenarios, in terms of investment costs, are given in the following figures. In figure 37, the share in costs for production technologies is given.

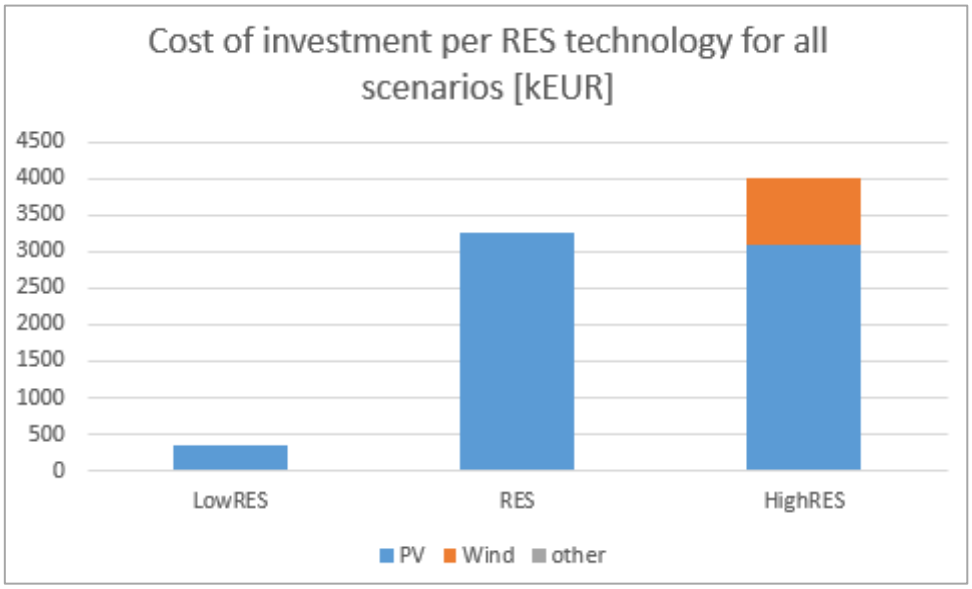


Figure 37: Share in costs for production technologies

In figure 38, the cost of technologies for storage and balancing is given.

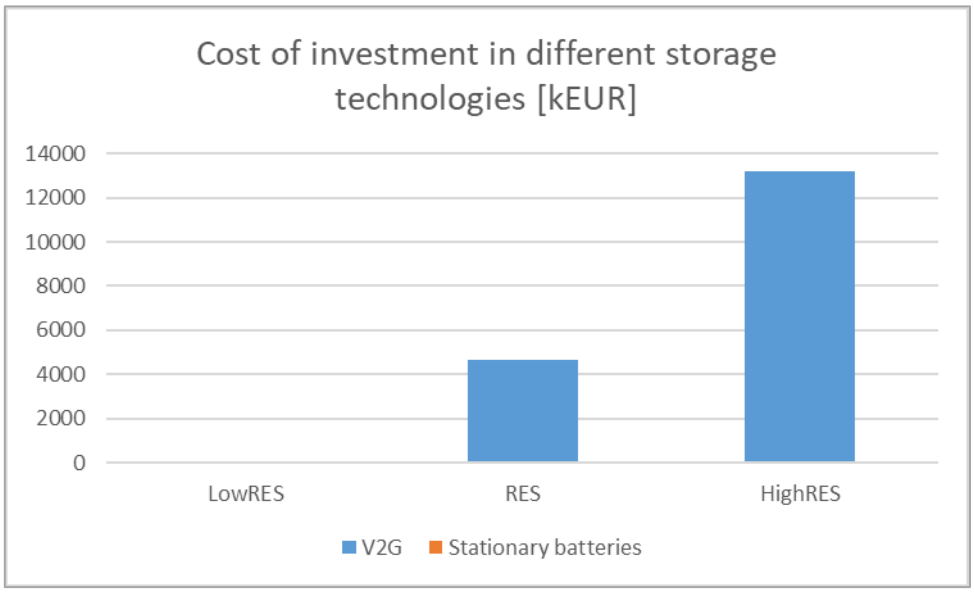


Figure 38: Cost of technologies for storage and balancing

In modelling and feasibility analysis of future development of island's energy system, the number of newly created jobs related to the photovoltaic industry was studied. The implementation of photovoltaics and wind turbines on the island of Korcula would create the need for new jobs related to the management and maintenance of these systems, design and

installation of the PV systems and wind turbines. Table 10 shows the need for new jobs each scenario in the number of full time equivalents (FTEs).

2030	LowRES	RES	HighRES
Engineering	17	164	167
O&M	1	11	13
Installation	12	116	122

Table 15: Number of full time equivalent jobs per scenarios of development of the energy system on the island of Korcula

Calculated for the last year of the analysis, 2030, FTEs need to be also taken in the context of dynamics of the transition, which includes yearly rates of installation for solar and wind power. For example, if 44.59 MW of solar PV are to be installed by 2030, with dynamics of roughly 10% being installed yearly from 2020 to 2030, local community would create roughly 28 jobs (FTEs), which would remain stable throughout this period. Further on, O&M jobs remain stable for the next 20 years period, with engineering and installation jobs occurring again during the repowering period (and also according to the dynamics set in motion in the period of this analysis).

In order to analyse the environmental impact, basic outline of considered influence of scenarios on environment was addressed on two levels:

1) Reduction of GHG emissions

In the figure 39, GHG emissions are presented, for each scenario. Also, for comparison, emissions in the base year are given.

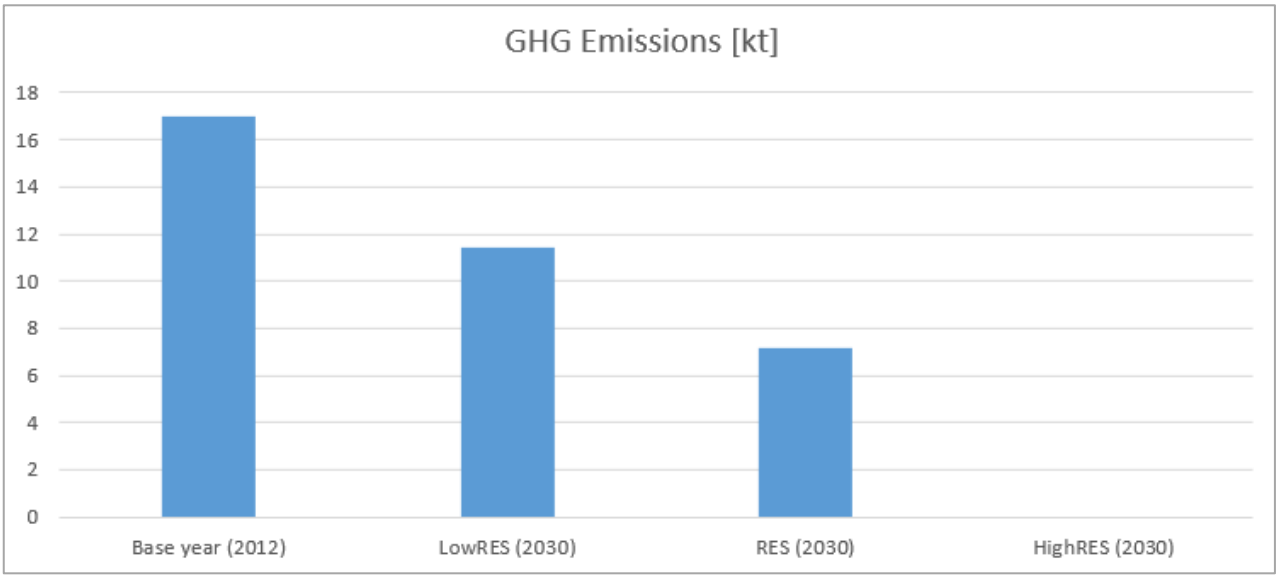


Figure 39: Comparison of emissions for all scenarios and compared to the base year

Since all fuel use in transport is replaced with electricity use for EV's and solar thermal collectors replaced the use of fuel oil and solid biofuels in households and services, the emissions in HighRES scenario completely reduced.

2) Environmental constraints in the case study area, which influence the feasibility of scenarios

The figure 40, taken from the PRISMI GIS database, illustrates how much of the area of island of Korčula is included in NATURA 2000 network, which constraints the installation of any larger production facility.

Figure 40: Natura 2000 network on the island of Korčula

Further limitations are considered, taking into account the recent Strategic study of Environmental Impact of the Plan for the Use of Renewable Energy Sources in the Dubrovnik-Neretva County [IRES, 2014].

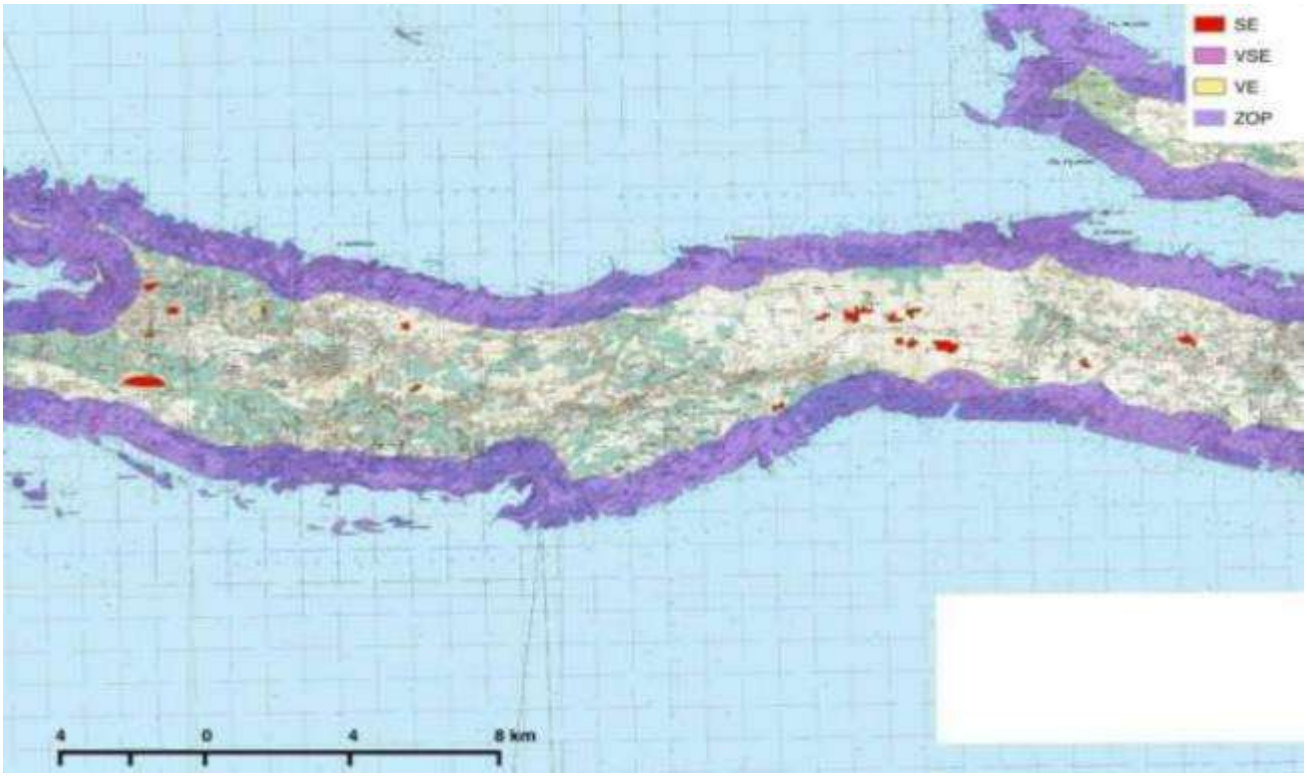


Figure 41: Illustration of coastal protected area and possible locations for solar power

From figure 41, it is visible that there is a number of potential locations, in particular for PV power plants, which could be exploited.

Figure 42: Locations for PV which are suggested by the Strategic study

After all rigorous conditions have been examined in [IRES 2014], recommendation has been given for the locations presented in figure 42. These locations remain in the plan for RES use and are available for investments.

5.6.1.2 Conclusions of the modelling

Conclusion of modelling of the Korčula energy system, based on the RES scenario, is that there are possibilities and potential for larger integration of renewable energy sources, in particular solar PV technology. Also, to support the future integration of renewable energy through storage and balancing option, but also through achieving synergies between sectors, electro-mobility was introduced and analysed in scenarios. This transition in transport and energy production sectors includes some measures financed by the local government, in order to serve as a lighthouse and best practice example and also some support measures, which aim to help the local community in this transition. Measures are described in chapter. 5.6.2.

5.6.2 Proposed Measures

This chapter describes the actions and measures that need to be implemented in order to achieve the desired reduction of emissions by at least 40% by 2030 in the area of the island of Korčula. These measures are described in the tables according to the following parameters:

- number of measure
- the name of the measure
- a brief description of the measure
- the body responsible for the implementation of the measure
- start and end of measure implementation
- estimated cost of the measure
- estimated energy savings achieved by measure
- the estimated reduction of CO_2 emissions

A total reduction of CO_2 emissions that can be achieved by listed actions and measures is 29 919 tCO_2 which is 70% lower than the base year. Emission reduction measures should be implemented in all mentioned sectors, and a total of 27 measures were prescribed. Most of the

measures, 7 of them are prescribed in the public, residential and transport sectors. In services sector, 4 measures are prescribed, and one measure is given for public lighting and one for local electricity production.

5.6.3 Municipal buildings, equipment and facilities

Number	**5.6.3.1**
Name of the action	Replacement of the lighting bulbs with LED
Brief description	In accordance with EU regulations regarding incandescent light bulbs, it is envisaged that by the year 2030 100% of the lighting bulbs will be replaced with LED in public buildings, and each lighting system is expected to save 85% of the electricity in relation to the replaced bulb.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	1.50-10.00 EUR/bulb
Estimated energy savings [MWh]	97.05
Estimated reduction of CO_2 emissions [tCO_2]	30.09

Number	**5.6.3.2**
Name of the action	Installation of solar thermal collectors for hot water and heating
Brief description	In public buildings where, heated hot water is heated by electricity, solar hot water heating systems will be introduced and, where possible, the heat generated from solar collectors will be used to help the heating system. It is anticipated that from 2015 until 2030, in at least 18 buildings, the system for the preparation of solar power will be installed.
Body responsible for implementation	Local authorities

Start and end date of implementation [year]	2012-2030
Estimated costs [EUR]	61,000.00 EUR
Estimated energy savings [MWh]	148
Estimated reduction of CO_2 emissions [tCO_2]	46

Number	**5.6.3.3**
Name of the action	Replacement of fuel oil with biomass boilers
Brief description	7 schools on the island have a boiler for a fuel oil that needs to be reconstructed and converted to use biomass as fuel (pellets, briquettes, firewood, etc.). The aim is to replace at least 3 fuel oil boilers in schools by 2030 with the heating system on biomass.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	81,000.00 EUR
Estimated energy savings [MWh]	0 (fuel replacement)
Estimated reduction of CO_2 emissions [tCO_2]	40.18

Number	**5.6.3.4**
Name of the action	Insulation of public buildings envelope
Brief description	By isolating the buildings envelope and roof, savings in heat energy consumption will range from 40 to 60%. At least 10 buildings will be isolated by 2030.

Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	30.00 EUR/m^2
Estimated energy savings [MWh]	99.19
Estimated reduction of CO_2 emissions [tCO_2]	30.75

Number	**5.6.3.5**
Name of the action	Education and awareness raising of the employees in the public sector
Brief description	Organize workshops, seminars, etc. for employees and users of public buildings to educate them on ways to save energy. By changing the way of behaviour e.g. by not heating in the winter above 20 °C and in the summer not cooling below 27 °C, by extinguishing lighting, by using natural lighting, by switching off devices in the standby mode, etc. it is possible to realize savings in energy consumption of 5 to 10 %.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2016-2030
Estimated costs [EUR]	24,000.00 EUR
Estimated energy savings [MWh]	62
Estimated reduction of CO_2 emissions [tCO_2]	19.22

Number	**5.6.3.6**

Name of the action	Installation of 1500 kW of integrated PV on public buildings
Brief description	Local authorities will investigate the possibilities of installing photovoltaic systems on roofs of public buildings and how to connect to the grid and obtain a connection license. It will also help the head of the public building institution to collect the documentation and facilitate their acquisition of photovoltaic facilities. It is anticipated that by 2030 on roofs of public buildings will be built a minimum of 1.5 MW of photovoltaic power.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	1,600,000.00 EUR
Estimated energy savings [MWh]	2,022
Estimated reduction of CO_2 emissions [tCO_2]	627

Number	**5.6.3.7**
Name of the action	Replacement of windows and doors
Brief description	By replacing the doors and windows on at least 10 public buildings by 2030 with the windows and doors whose total coefficient of heat transfer is less than 1.4 W/m^2K will achieve savings of at least 10% on heating costs.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	200-250 EUR/m^2
Estimated energy savings [MWh]	24.8

Estimated reduction of CO_2 emissions [tCO_2]	7.7

5.6.4 Services Buildings, equipment and facilities

Number	**5.6.4.1**
Name of the action	Replacement of the lighting bulbs with LED
Brief description	It is assumed that 80% of the companies can save 80% of the energy that is consumed for lighting. For detailed data, detailed analysis of profiles and characteristics of the companies in the island area is required, and it is proposed to conduct a survey by the end of 2019.
Body responsible for implementation	Local authorities, Tourist agencies
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	-
Estimated energy savings [MWh]	2,395
Estimated reduction of CO_2 emissions [tCO_2]	742.54

Number	**5.6.4.2**
Name of the action	Insulation of buildings envelope
Brief description	It is assumed that in the services sector, annual energy will be renewed by at least 2% of buildings by thermal insulation of the outer shell and roof and will thus save 40% of the energy required for heating. Local authorities and Dubrovnik Neretva County regional development agency will inform entrepreneurs about savings opportunities and project financing opportunities and reduce communal contributions for energy-efficient buildings, B or higher category on energy certificate.

Body responsible for implementation	Local authorities, Regional agency
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	25-35 EUR/m^2
Estimated energy savings [MWh]	1334.5
Estimated reduction of CO_2 emissions [tCO_2]	402.78

Number	**5.6.4.3**
Name of the action	Replacement of windows and doors
Brief description	It is assumed that in the services sector will be renewed annually at least 2% of the building by replacing the outdated windows and doors and saving 10% of the energy required for heating. Local authorities and Regional agency will inform entrepreneurs about savings opportunities and project financing opportunities and reduce communal contributions for energy-efficient buildings, B or higher category on energy certificate.
Body responsible for implementation	Local authorities, Regional agency
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	200-250 EUR/m^2
Estimated energy savings [MWh]	333.63
Estimated reduction of CO_2 emissions [tCO_2]	50.35

Number	**5.6.4.4**

Name of the action	Installation of 9000 kW of integrated PV on hotels and other services buildings
Brief description	Local government units will encourage the installation of solar photovoltaic modules on roofs of commercial buildings for their own consumption. It is estimated that by 2030, 9 MW of solar panels will be installed on the roofs.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2020-2030
Estimated costs [EUR]	1.1 EUR/W
Estimated energy savings [MWh]	12,276
Estimated reduction of CO_2 emissions [tCO_2]	3,806

5.6.5 Residential buildings

Number	**5.6.5.1**
Name of the action	Replacement of the lighting bulbs with LED
Brief description	Since the European Union withdraws from the use the incandescent bulbs and encourages the use of energy efficient lights, it is to be expected that by 2030 all households on the island of Korčula will use a LED lights which will save up to 80% energy compared to ordinary light bulbs. Local government units will allocate subsidies for the introduction of LED lights in accordance with the possibilities in the budget.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	550,000.00 EUR
Estimated energy savings [MWh]	7,388

Estimated reduction of CO_2 emissions [tCO_2]	2290.3

Number	**5.6.5.2**
Name of the action	Co-financing of installation of solar thermal collectors for hot water and heating in residential buildings
Brief description	According to the energy efficiency plan of the county, up to 2016, the county would need to install from 50 to 80 solar heating systems for hot water and the addition of a heating system. It is planned to install at least 12 solar systems on the island of Korčula annually. It is anticipated that by 2030 30% of households will have installed solar thermal collectors for DHW preparation.
Body responsible for implementation	Local authorities, County
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	5,500,000.00 EUR
Estimated energy savings [MWh]	2,600
Estimated reduction of CO_2 emissions [tCO_2]	806

Number	**5.6.5.3**
Name of the action	Co-financing of installation of heat pumps for hot water and heating in residential buildings
Brief description	It is recommended to use the heat pump for which a heat source is water, for heating the space and DHW. Due to the current high investment cost, the installation of such system in a household will be further co-financed. It is recommended to install this type of system in low temperature floor and panel heating, and it is necessary to ensure that such a technical solution is promoted when renovating and building

	new buildings. It is anticipated that by 2030, in the homes on the island, 30 heat pumps will be installed.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	180,000.00
Estimated energy savings [MWh]	176
Estimated reduction of CO_2 emissions [tCO_2]	54.5

Number	**5.6.5.4**
Name of the action	Co-financing of insulation of residential buildings envelope
Brief description	As part of this measure, the Environmental Protection and Energy Efficiency Fund and the County co-finance the cost of installing energy-efficient external facades in accordance with the Rulebook on Promotion of Energy Efficiency Measures on Residential Properties of Private Persons in the Dubrovnik-Neretva County, which defines all the necessary criteria for the successful implementation of this measure. Local government units will encourage and educate citizens to apply for this measure by predicting that by 2020, a minimum of 25 facilities will be renewed.
Body responsible for implementation	FZOEU, Local authorities, County
Start and end date of implementation [year]	2015-2020
Estimated costs [EUR]	200,000.00 EUR
Estimated energy savings [MWh]	317
Estimated reduction of CO_2 emissions [tCO_2]	98.17

Number	5.6.5.5
Name of the action	Co-financing of replacement of windows and doors
Brief description	As part of this measure, the Environmental Protection and Energy Efficiency Fund and the County co-finance the costs of changing the windows and doors in accordance with the Rulebook on Promotion of Energy Efficiency Measures on Residential Properties of Private Persons in the County of Dubrovnik-Neretva, which defines all the necessary criteria for the successful implementation of this measure. Local government units will encourage and educate citizens to apply for this measure by predicting that by 2020, a minimum of 25 facilities will be renewed.
Body responsible for implementation	FZOEU, Local authorities, County
Start and end date of implementation [year]	2015-2020
Estimated costs [EUR]	200,000.00 EUR
Estimated energy savings [MWh]	105.55
Estimated reduction of CO_2 emissions [tCO_2]	32.72

Number	5.6.5.6
Name of the action	Awareness raising campaign and sustainable info day
Brief description	It is envisaged that educational activities will cover 50% of the inhabitants of the island who will, on the basis of acquired knowledge, save considerable amount of energy in their own households. The planned channels are: seminars, workshops, info days, campaigns, surveys.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2030

Estimated costs [EUR]	100,000.00
Estimated energy savings [MWh]	0
Estimated reduction of CO_2 emissions [tCO_2]	0

Number	**5.6.5.7**
Name of the action	Installation of 18 MW of integrated PV on residential buildings
Brief description	Regional agency and local authorities will inform citizens about the possibilities of installing photovoltaic systems on their roofs and how to connect to the grid and obtaining a connection license. It will also help citizens to collect documentation and facilitate their acquisition of photovoltaic system. No co-financing by local government units is envisaged because the photovoltaic system is co-financed by the FZOEU, and in the Dalmatia, electricity produced by the system is cheaper than electricity from the grid. It is anticipated that citizens will build up to 2500 photovoltaic systems between 4 and 10 kW on roofs of their buildings by 2030. In total 18 MW.
Body responsible for implementation	Local authorities, Regional agency
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	19,500,000.00 EUR
Estimated energy savings [MWh]	24,552
Estimated reduction of CO_2 emissions [tCO_2]	7,611

5.6.6 Public lighting

Number	**5.6.6.1**
Name of the action	Modernisation of the street lighting
Brief description	In the municipalities of Lumbarda, Smokvica and Vela Luka public lighting is partially or completely modernized, and this process needs to be continued. The next step in modernization would be the introduction of LED lighting that could further reduce electricity consumption. In the town of Korčula, a public lighting audit was carried out and it was found that it is currently in an inadequate state and that the entire system in the city needs to be modernized. It was concluded that the first step in modernization is in the Čara settlement, where savings of 90%, and on city level of 40% can be achieved.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2020
Estimated costs [EUR]	405,000.00 EUR
Estimated energy savings [MWh]	672
Estimated reduction of CO_2 emissions [tCO_2]	20.,3

5.6.7 Transport sector

Number	**5.6.7.1**
Name of the action	Fuel switch in the public transport
Brief description	The Law on Biofuels for Transportation (OG 65/2009, 145/2010, 26/2011, 144/2012) and National Action Plan for the Promotion of Production and Use of Biofuels in Transport for period 2011-2020. (2010) prescribe the share of OIE in fuels for transport to 10% in 2020 of which a biofuel share should be 9.22%.
Body responsible for implementation	Local authorities

Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	-
Estimated energy savings [MWh]	0 (fuel switch)
Estimated reduction of CO_2 emissions [tCO_2]	130.21

Number	**5.6.7.2**
Name of the action	Promotion of car sharing for citizens and tourists
Brief description	Local authorities will conduct seminars and workshops to present citizens, tourists and legal entities the benefits of car sharing.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2020-2030
Estimated costs [EUR]	-
Estimated energy savings [MWh]	588.14
Estimated reduction of CO_2 emissions [tCO_2]	152.88

Number	**5.6.7.3**
Name of the action	Promotion of EVs
Brief description	Local government units will inform citizens and legal entities on the island about the possibilities of purchasing electric vehicles and the incentives they can make with the Environmental Protection and Energy Efficiency Fund (FZOEU). It will also inform citizens about the savings they can make by purchasing an electric or hybrid vehicle. It is

	anticipated that 1849 electric vehicles will be on the island by 2030.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2030
Estimated costs [EUR]	-
Estimated energy savings [MWh]	13,953
Estimated reduction of CO_2 emissions [tCO_2]	3,433

Number	**5.6.7.4**
Name of the action	Construction of new bike lanes
Brief description	The group of measures to improve bicycle transport in the island area includes the following activities: • Construction of cycling trails throughout the island; • Continuous maintenance of cycling trails. • Within the implementation of the measure it is necessary to: o Edge and mark cycling tracks; o Make planks with maps of marked cycling paths; o Reduce the number of possible bicycle disasters by separating cycling trails from motorways intended for motor vehicles wherever they can; o Provide servicing and provision of private bicycles in the garage; o Promote and encourage the use of bicycles as a means of transportation especially at short distances; o Continue to implement programs and education on the benefits of cycling transportation in gardens, schools, public spaces.

	• Develop and implement the campaign "The bike is healthy!"
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2015-2030
Estimated costs [EUR]	10,500.00 EUR
Estimated energy savings [MWh]	49.74
Estimated reduction of CO_2 emissions [tCO_2]	12.93

Number	**5.6.7.5**
Name of the action	Co-financing of public transport tickets
Brief description	Local authorities on the island, in co-operation with the provider of public transport services in the island area, Autotrans company, will arrange co-financing of bus tickets to increase the share of citizens using public transport by 2030. It is anticipated that at least 10% of tourists and at least 5% of citizens will use public transport and consumption and transport emissions will be reduced by 4%.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2020-2030
Estimated costs [EUR]	-
Estimated energy savings [MWh]	2,353
Estimated reduction of CO_2 emissions [tCO_2]	612

Number	5.6.7.6
Name of the action	Sharing of the electric bikes
Brief description	Local authorities will procure 132 electric bicycles that will be charged on solar power stations that will be installed in all municipalities on the island as part of this measure. Bicycles will be used for the transportation of citizens and tourists in the very centre of the settlement and will serve as a demonstration tool and incentive for citizens to also purchase electric bikes for short distance transport within the location. It is anticipated that this will affect 2% reduction in fuel consumption and emissions. The bikes will be located in settlement centres and attractive tourist locations and will be used for a tourist tour.
Body responsible for implementation	Local authorities
Start and end date of implementation [year]	2018-2025
Estimated costs [EUR]	180,000.00 EUR
Estimated energy savings [MWh]	1,576
Estimated reduction of CO_2 emissions [tCO_2]	409.6

Number	5.6.7.8
Name of the action	Eco driving campaign
Brief description	Based on the experience of advanced cities, with continuous education of citizens it is possible to save 5% of the fuel in transport, i.e. achieve a reduction of 5% of greenhouse gas emissions. The measure involves the distribution of promotional materials (leaflets, posters, campaigns) and seminars. The survey is also planned among the drivers.
Body responsible for implementation	Local authorities

Start and end date of implementation [year]	2018-2020
Estimated costs [EUR]	15,000.00
Estimated energy savings [MWh]	3,939
Estimated reduction of CO_2 emissions [tCO_2]	1,024

5.6.8 Local Electricity production

Number	**5.6.8.1**
Name of the action	Construction of solar PV power plants on the island
Brief description	According to the Plan of Use of the Renewable Energy Sources in the Dubrovnik Neretva County on the island of Korčula there are 11 potential locations for the construction of large solar power plants. Due to the lower cost of solar plants it is assumed that at least one half of the sites will be occupied by a power plant of at least 3 MW. The total power will be about 16 MW.
Body responsible for implementation	Local authorities, County
Start and end date of implementation [year]	2020-2030
Estimated costs [EUR]	1 EUR/W
Estimated energy savings [MWh]	23,360
Estimated reduction of CO_2 emissions [tCO_2]	7,241.6

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES										
Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Energy management	Local authority	Local authorities	2015	2030		97.05	0	30.09
Installation of solar thermal collectors for hot water and heating	Renewable energy for space heating and hot water	Public procurement	Local authority	Local authorities	2012	2030	61000	0	148	46
Replacement of fuel oil with biomass boilers	Renewable energy for space heating and hot water	Public procurement	Local authority	Local authorities	2018	2030	81000	0	0	40.18
Insulation of public buildings envelope	Building envelope	Third party financing. PPP	Local authority	Local authorities	2018	2030		99.19	0	
Education and awareness raising of the employees in the public sector	Behavioural changes	Awareness raising / training	Local authority	Local authorities	2016	2030	24000	62	0	19.22
Installation of 1500 kW of integrated PV on public buildings	Other	Public procurement	Local authority	Local authorities	2018	2030	1600000	0	2022	626.82
Replacement of windows and doors	Building envelope	Third party financing. PPP	Local authority	Local authorities	2018	2030		24.8	0	7.7

TERTIARY BUILDINGS, EQUIPMENT/FACILITIES										
Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Other	Not possible to say		2015	2030		2395	0	742.54
Insulation of buildings envelope	Building envelope		Other (national, regional,...)	Regional agency	2018	2030		1334.5	0	402.78
Replacement of windows and doors	Building envelope		Other (national, regional,...)	Regional agency	2018	2030		333.63	0	50.35
Installation of 9000 kW of integrated PV on hotels and other tertiary buildings	Other	Grants and subsidies	Local authority	Local authorities	2020	2030		0	12276	3805.56
RESIDENTIAL BUILDINGS										
Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Awareness raising / training	Local authority	Local authorities	2015	2030	550000	7388	0	2290.3
Co-financing of installation of solar thermal collectors for hot water and heating in residential buildings	Renewable energy for space heating and hot water	Grants and subsidies	Other (national, regional,...)	Local authorities, County	2015	2030	5500000	0	2600	806
Co-financing of installation of heat pumps for hot water and heating in residential buildings	Renewable energy for space heating and hot water	Grants and subsidies	Local authority	Local authorities	2015	2030	180000	176	0	54.5
Co-financing of insulation of residential buildings envelope	Building envelope	Grants and subsidies	Other (national, regional,...)	FZOEU, Local authorities, County	2015	2020	200000	317	0	98.17

Co-financing of replacement of windows and doors	Building envelope	Grants and subsidies	Other (national, regional,…)	FZOEU, Local authorities, County	2015	2020	200000	105.55	0	32.72
Awareness raising campaign and sustainable info day	Behavioural changes	Awareness raising / training	Local authority	Local authorities	2015	2030	100000	0	0	0
Installation of 18 MW of integrated PV on residential buildings	Other	Awareness raising / training	Local authority	Local authorities	2018	2030	19500000	0	24552	7611.12
PUBLIC LIGHTING										
Modernisation of the street lighting	Energy efficiency	Third party financing. PPP	Local authority	Local authorities	2015	2020	405000	672	0	208.3
TRANSPORT										
Fuel switch in the public transport	Cleaner/efficient vehicles	Public procurement	Local authority	Local authorities	2018	2030		0	0	130.21
Promotion of car sharing for citizens and tourists	Car sharing/pooling	Awareness raising/training	Local authority	Local authorities	2020	2030		588.14	0	152.88
Promotion of Evs	Electric vehicles (incl. infrastructure)	Grants and subsidies	Local authority	Local authorities	2018	2030		13953.07	0	3433.31
Construction of new bike lanes	Modal shift to walking & cycling	Other	Local authority	Local authorities	2015	2020	10500	49.74	0	12.93
Co-financing of public transport tickets	Modal shift to public transport	Grants and subsidies	Local authority	Local authorities	2020	2030		2352.58	0	611.53
Sharing of the electric bikes	Modal shift to walking & cycling	Public procurement	Local authority	Local authorities	2018	2025	180000	1576	0	409.6
Eco driving campaign	Eco-driving	Awareness raising/training	Local authority	Local authorities	2018	2020	15000	3939	0	1024

LOCAL ELECTRICITY PRODUCTION										
Construction of solar PV power plants on the island	Photovoltaics	Land use planning	Other (national, regional,…)	Local authorities, County	2020	2030		0	23360	7241.6
TOTAL							**28606500**	**35463.25**	**64958**	**29888.41**

Table 16: Overall proposed measures

6. SUSTAINABLE ENERGY ACTION PLAN OF THE ISLAND OF TILOS

6.1. SUMMARY

Tilos Island as a municipality has already signed in 2012 the “Covenant of Mayors” agreement in order to achieve the EU sustainability targets for 2020. In particular, the municipality of Tilos agreed to join the Covenant of Mayors and submit a joint Sustainable Energy Action Plan (SEAP).

The population of Tilos community is 733 inhabitants (2012).

The year 2014 was set as the reference / recording year for energy consumption and CO2 emissions for the local authority. According to the actual consumption data collected by the Piraeus University of Applied Science – Coordinator of TILOS Horizon 2020 project, the total energy consumption in the study area of Tilos in 2014 has been 5,560 MWh. The largest energy consumer in the area is the residential buildings sector with 2,442 MWh, followed by the transport sector with 1,978 MWh and the tertiary sector with 571 MWh.

The emissions of carbon dioxide in 2014 that correspond to the total energy consumption in the area are 2.1 tons. The environmental strategy reflects the vision of the municipality of Tilos for sustainable development targeting to an overall CO2 emission reduction of 23% by 2020. Environmental protection and improving citizens' life are considered as priority objectives of the Local Authorities.

The measures proposed are divided into the following categories:

Description
Municipal Buildings, equipment/facilities
Tertiary Buildings, equipment/facilities
Residential Buildings
Public Lighting
Transport
Local Electricity production
Smart grid

The budget of the Action Plan for the period 2016 to 2030 amounts to €600,000. Funding for the implementation of the Energy Action Plan is expected to be found from the following resources:

- Municipality budget.
- Municipal green tax.
- Savings that will result from energy reduction measures in buildings, vehicles and street lighting in the Municipality.
- Revenues originating from Municipality investments on Renewable Energy technologies.
- Potential funding from other European programs.
- Public-Private partnership.

6.2. MUNICIPALITY OF TILOS

Tilos island, comprising the demo-site of TILOS system, is located at the south-eastern part of the Aegean Sea and belongs to the far-remote complex of Dodecanese (~220 nautical miles from the central Greek mainland port of Piraeus). The island size is approximately 63km^2 and its coastal perimeter is almost 63km, with its terrain being basically semi-mountainous and mountainous, except for a long valley extending from the island center to its south. On the island, there exist two main communities, namely Megalo Chorio (north part of the island) and Livadia (south-eastern part of the island), with the total island permanent population reaching approximately 733 habitants and increasing considerably (even tripling) during the summer period due to tourists' arrivals.

Similar to the majority of Aegean Sea islands, the island of Tilos appreciates high-quality solar potential (~1800kWh/m^2 on the horizontal plane) and mild Mediterranean climate conditions. At the same time, its wind potential may be determined as of medium-high quality (>6m/sec for the greatest part of the island territory) (see also Figure 43). Recapitulating, Tilos comprises a typical small-scale Aegean island region that although appreciating respectable RES potential relies on the operation of the Kos island oil power station for covering its electrification needs.

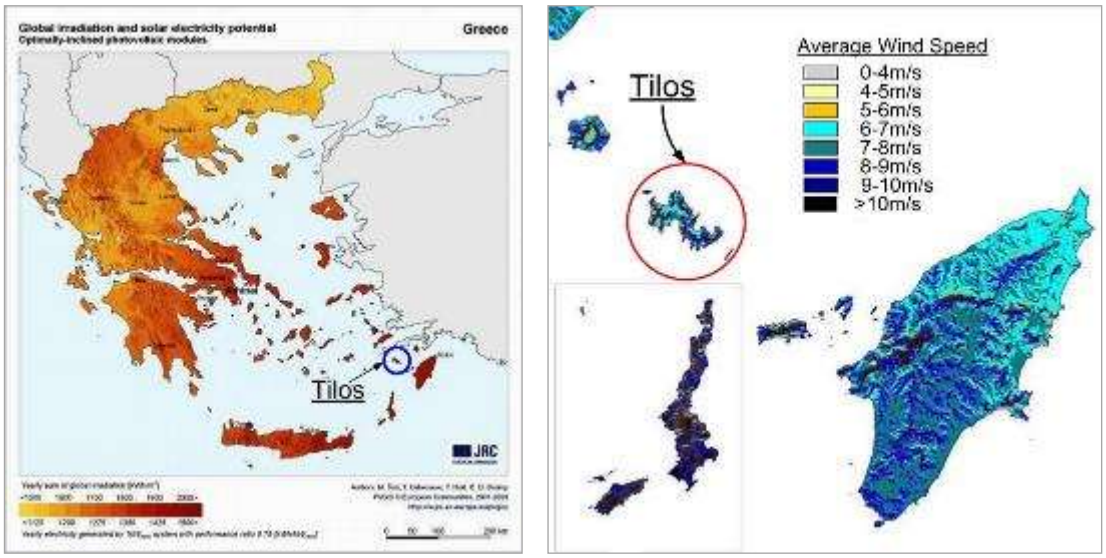


Figure 43: Solar and wind potential quality for the island of Tilos

The environmental restrains for the area of Greece and specifically the case of Tilos island can be obtained using the "Geoadata.gov.gr" which is providing open geospatial data and services for Greece, serving as a national open data catalogue, an INSPIRE-conformant Spatial Data Infrastructure, as well as a powerful foundation for enabling value added services from open data.

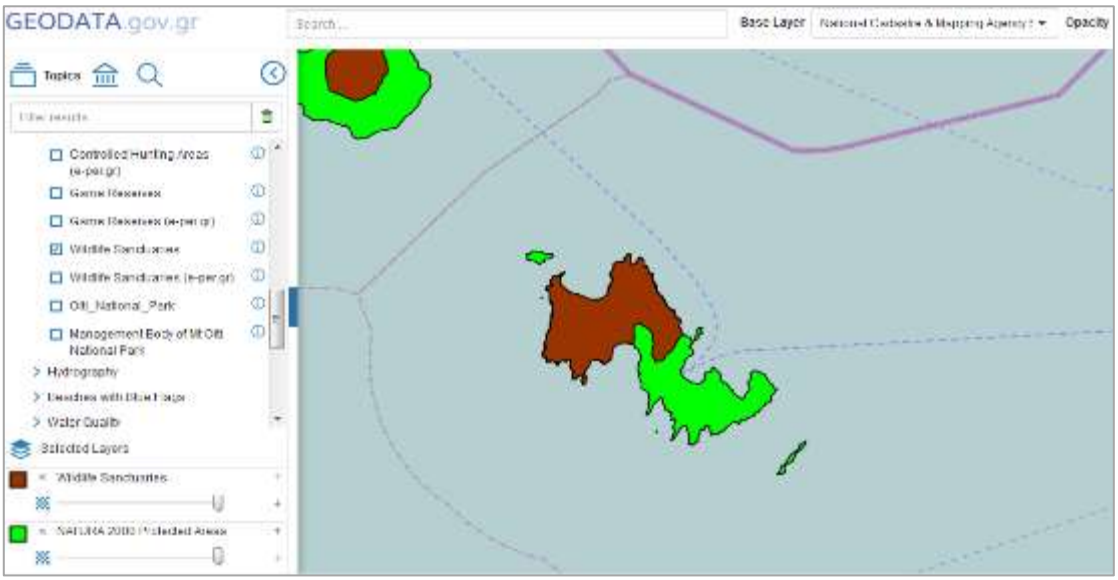


Figure 44: visualization tool of environmental restrains for Tilos, (source: geodata.gov.gr)

For a better overview of the environmental restrains it would be adequate to have an analytical map indicating the several land uses as the one shown for the island of Tilos in Figure 45.

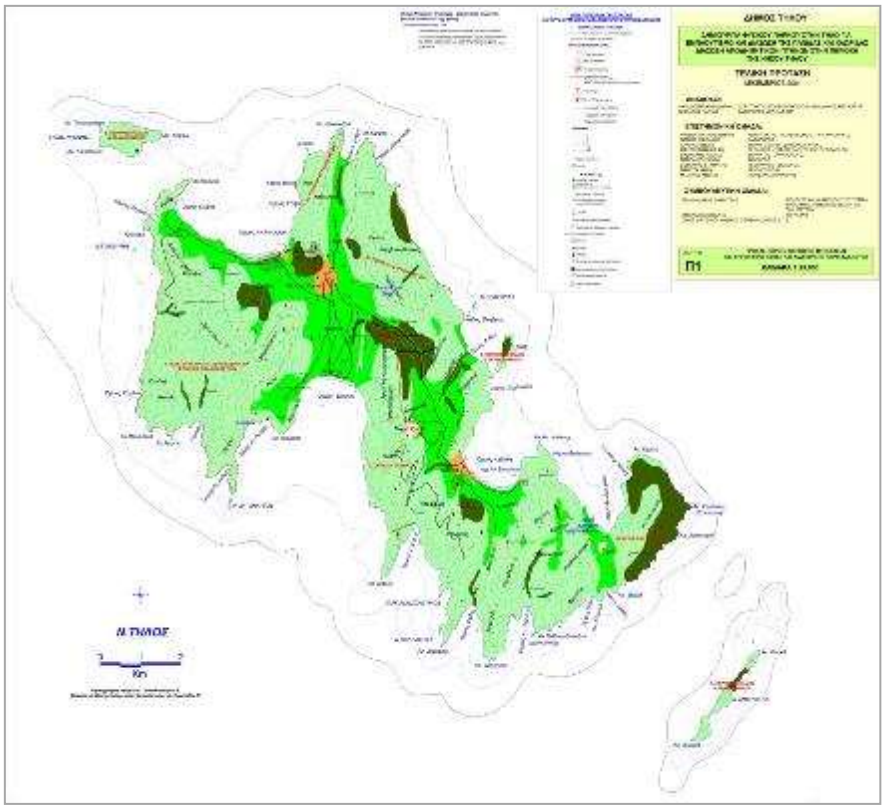
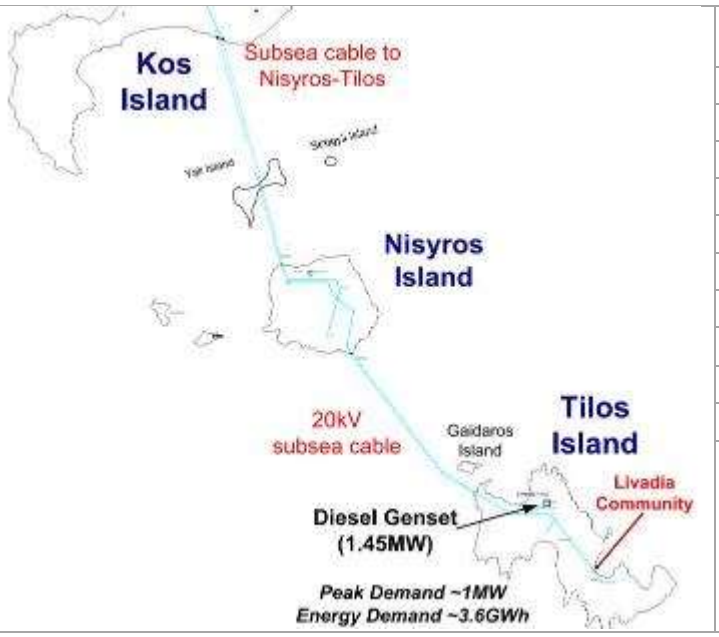


Figure 45: Environmental restrains and land uses for Tilos Island

The current electricity needs of Tilos (in the order of 3.2GWh per year – annual peak demand of approximately 1MW) are covered exclusively by the operation of the oil-fired power station of Kos

island (in the north of Tilos), through an interconnector (undersea cable of 20kV) that reaches the north side of the island after first crossing through Nisyros island (Figure 46).



	Residential Sector	Tertiary Sector
Domestic Hot Water (DHW)		
Electrical heater	92	43
Solar collector	177	93
Space Cooling		
Air conditioning	213	105
None	56	31
Space Heating		
Central-oil heating	1	0
Air conditioning	213	105
Fireplaces	171	83

**The peak demand of the entire island complex-system covered by the Kos power station exceeds 100MW.*

Figure 46: Interconnection of Tilos island to the island of Kos, through Nisyros (Source: HEDNO, 2013), and characteristics of DHW and space heating/cooling in the building sector of the Livadia community (south part of the island) (Source: Municipality of Tilos, 2013)

Power distribution on the island is achieved with the use of a local, overhead line power grid comprising of 24km medium-voltage and 20km low-voltage lines as well as 36 transformers along it. Owed to persistent faults of the undersea cable, the island often suffers from black-outs that can last for time periods even in the order of 15-30 min (especially during the summer period). To this end, despite the fact that a back-up diesel generator of 1.45MW does exist on the north part of the island to face similar events, it cannot be directly dispatched since it is manually operated.

6.3. INVENTORY OF ENERGY CONSUMPTION IN MUNICIPALITY

Acknowledging the security of supply problems faced by the islanders due to the insufficient grid interconnection with the electricity system of Kos, as well as the high-quality solar potential and the medium-high quality wind potential of Tilos, the proposed energy solution suggests application of the TILOS system through the development of a microgrid in the south part of the island that will mainly serve the community of Livadia (annual energy consumption in the order of 1.5GWh and peak demand in the order of 450kW, Figure 47).

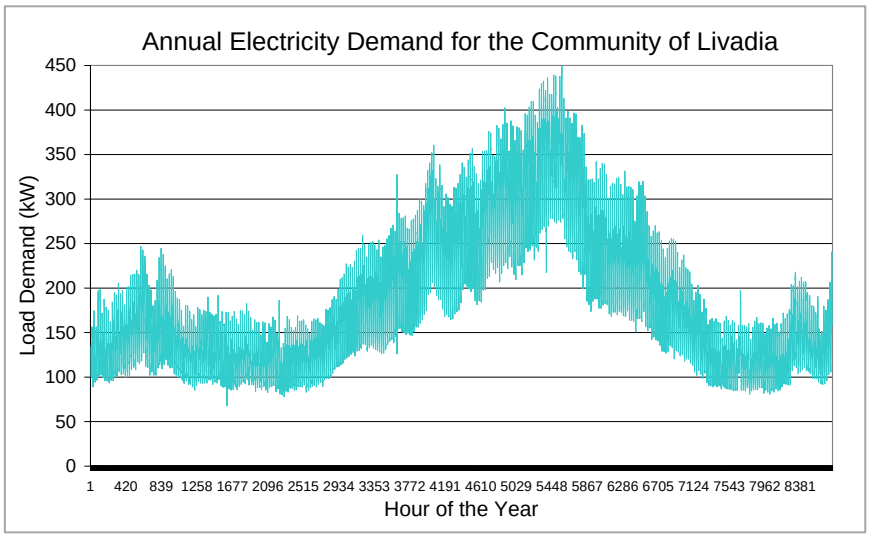


Figure 47: Hourly load demand of the Livadia area (Source: HEDNO, 2013)

The year 2014 has been selected as the inventory year.

In the following table the final energy consumption in MWh per year can be seen concerning the Tilos municipality.

Sector		FINAL ENERGY CONSUMPTION [MWh]						
		Electricity	Fossil Fuels			RES		Total
			Liquid gas	Diesel	Gasoline	Other biomass	Solar thermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES								
Municipal buildings, equipment/facilities		100		51				**151**
Tertiary (non-municipal) buildings, equipment/facilities		520		21			30	**571**
Residential buildings		1859	48	220		209	106	**2442**
Public lighting		14						**14**
Industry	Non-ETS							**0**
	ETS (not recommended)							**0**
Subtotal		**2493**	**48**	**292**	**0.0**	209	136	**3178**
TRANSPORT								
Municipal and private fleet				364	40			**404**
Public transport fleet								**0**
Private and commercial transport				1256	722			**1978**
Subtotal		**0.0**	**0.0**	**1620**	**762**	0.0	0.0	**2382**
OTHER								
Agriculture, Forestry, Fisheries								**0**

TOTAL	**2493**	**48**	**1912**	**762**	209	136	**5560**

Table 17: Final energy consumption in MWh per sector for 2014

In accordance to the above table, the deriving following graphs provide information about the energy consumption of Tilos island schematically.

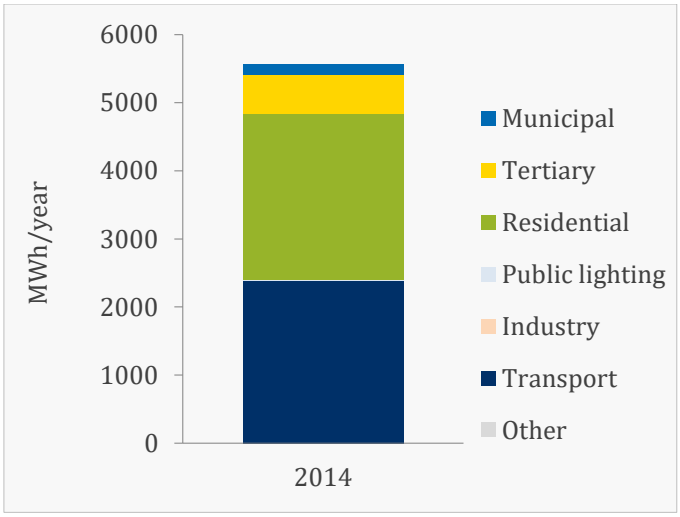


Figure 48a: Share of final energy consumption by sector for 2014

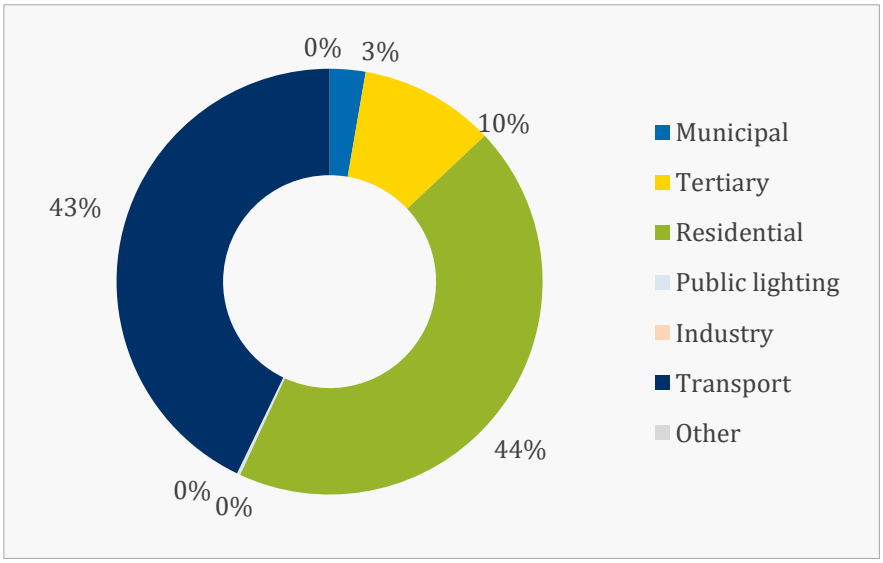


Figure 48b: Share of final energy consumption by sector for 2014

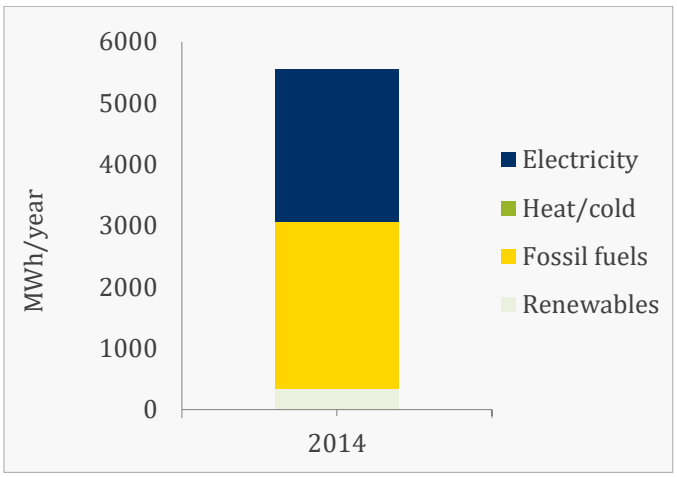


Figure 48c: Share of final energy consumption per energy carrier for 2014

6.4. INVENTORY OF CARBON DIOXIDE (CO2) EMISSIONS

Carbon dioxide emissions were calculated using standard emission factors on final energy consumption according to energy source and use. Renewable energy sources based on these factors are considered to have zero carbon dioxide emissions.

The greenhouse gas emissions per capita for Tilos residents is estimated at 2.8 t CO_2 (eq.)/capita. The following figures indicate the tonnes of CO_2 in annual basis for each sector.

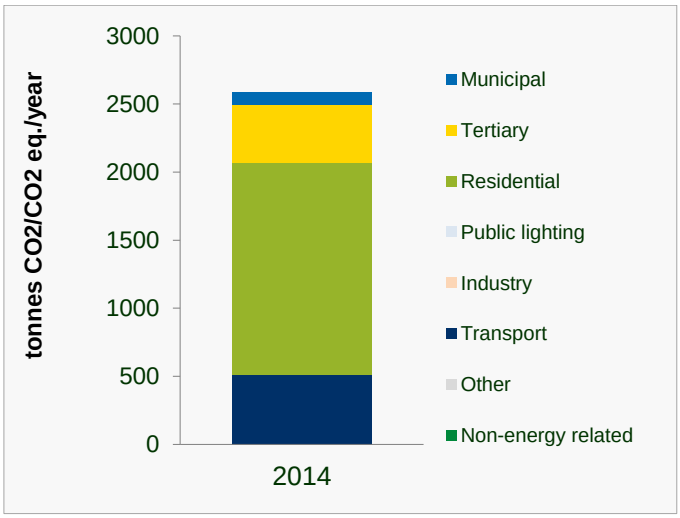


Figure 49a: Greenhouse gas emissions per sector

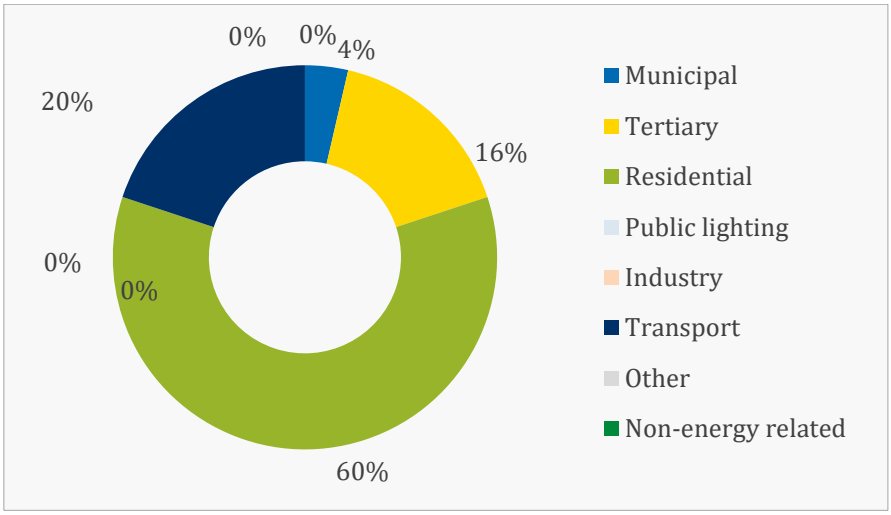


Figure 49b: Greenhouse gas emissions shares per sector

As it can be observed, the residential sector has the main contribution in GHG emissions for the island of Tilos, as the activities of transport and industry are not advanced in the area.

6.5. SUSTAINABLE ENERGY ACTION PLAN

Sustainable energy action plan deals with measures that will be taken by the Municipality in addition to the national measures in order to overcome the target of reducing CO_2 emissions by at least 20% by 2020 compared to the reference year in 2014.

Key Actions	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe	
					Start	End
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES						
Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Energy management	Local authority	Local authorities	2017	2030
Education and awareness raising of the employees in the public sector	Behavioural changes	Awareness raising / training	Local authority	Local authorities	2016	2020
TERTIARY BUILDINGS, EQUIPMENT/FACILITIES						
Installation of smart meters on hotels and other tertiary buildings	Behavioural changes	Grants and subsidies	Other (national, regional,…)	Local authorities	2016	2019
RESIDENTIAL BUILDINGS						

Installation of smart meters on residential buildings	Behavioural changes	Grants and subsidies	Other (national, regional,…)	Local authorities	2016	2019
TRANSPORT						
Promotion of Evs	Electric vehicles (incl. infrastructure)	Voluntary agreements with stakeholders	Other (national, regional,…)	Local authorities	2018	2020
PV charging station for Evs	Electric vehicles (incl. infrastructure)	Voluntary agreements with stakeholders	Other (national, regional,…)	Local authorities	2018	2020
LOCAL ELECTRICITY PRODUCTION						
Construction of 160 kW solar PV power plant on the island	Photovoltaics	Land use planning	Other (national, regional,…)	Local authorities, HEDNO	2015	2018
Installation of 800 kW wind turbine on the island	Wind power	Land use planning	Other (national, regional,…)	Local authorities, HEDNO	2015	2018
Installation of 2.88 MWh energy storage system	Smart grids	Energy suppliers obligations	Other (national, regional,…)	Local authorities, HEDNO	2015	2018

Table 18: Mitigation action plans for Tilos Municipality

Many of the above action plans are taking place through the ongoing TILOS HORIZON 2020 project. TILOS is a European research project engaging 13 participating enterprises and institutes from 7 European countries (DE, FR, EL, UK, SE, IT, ES). The project's main goal is to demonstrate the potential of local / small-scale battery storage to serve a multipurpose role within an island microgrid that also interacts with a main electricity network. Among others, the project aims to achieve large-scale RES penetration and asset value maximization through the optimum integration of a hybrid RES (wind and PV) power station together with advanced battery storage, distributed, domestic heat storage, smart metering and DSM.

Project objectives will be accomplished through the development and operation of an integrated, smart microgrid on the island of Tilos. The figure 50 below shows the multi-perspective approach of TILOS project.

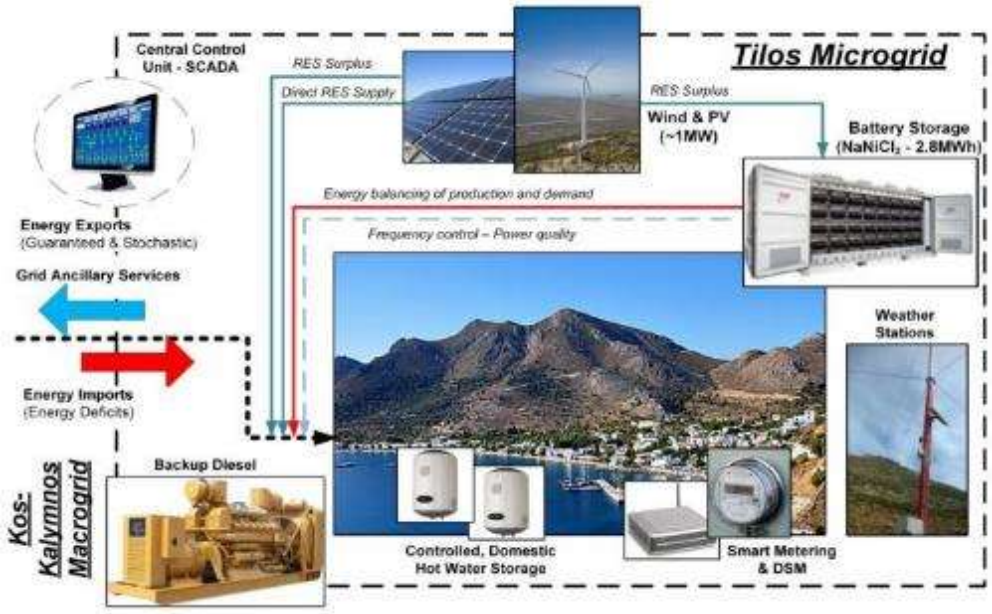


Figure 50: TILOS project configuration

7. SUSTAINABLE ENERGY ACTION PLAN OF GOZO ISLAND

7.1 SUMMARY

In 2009 the Ministry for Resources and Rural Affairs (current Ministry for Sustainable Development, the Environment and Climate Change - MSDEC) has presented the first National Strategy for Policy and Abatement Measures relating to the reduction of Greenhouse Gas emissions. The Strategy has sought to prioritise each action – on the basis of financial cost, ability to implement, clear economic and environment impact, immediate positive impact and whether an abatement measure stems from a specific EU and/or UNFCCC requirement. The GHG Strategy, alongside with the updated National Energy Efficiency Action Plan (2014 - NEEAP) and the National Renewable Energy Plan (NREAP -2015) constitutes the main policy framework that collects efforts and targets to lead to substantial decarbonisation of the energy sector by 2050 and reducing energy consumption by 2020. In this framework, the SEAPs in Malta and Gozo were adopted for the first time in the 2010. To the present date the Covenant of Mayors initiative has been taken up by 25 Local Councils in Malta, of which 6 in Gozo, with a commitment by signatory towns and cities to go beyond the objectives of EU energy policy in terms of reduction in CO2 emissions through enhanced energy efficiency and cleaner energy production and use.

The SEAPs action plans proposed on the national territory attempt to include those measures presented in the National Strategy that can be implemented at local level. Given the limited jurisdiction and budgets of Local Councils, many of such actions shall require financial and administrative support of the Central Government. This, on a methodological level, should not be a strenuous feat as such actions performed by the Local Council shall be in line with the national strategy and shall be deemed to be contributing to the achievement of the national targets.

With specific regards to the island of Gozo, in 2010 the Government presented the “Eco-Gozo Action Plan”, which set strategic targets included in the ambitious ‘Vision 2015 for the Maltese Islands’. The main target is to transform the island of Gozo into an ecological island, a model of

sustainable development. The action plan Eco-Gozo is updated every 2 years until 2020. Presently 2 plans have been released with specific measures until 2018. The Eco-Gozo plan is a comprehensive document that highlights the strategy for whole island, to be more economically and environmentally sustainable. The plan promotes specific measures on all the sectors including energy related issues. The overall strategy is outlined by the Government and has specific funds allocation for the implementation of the actions.

Due to its tangible effects the Eco-Gozo has been so successful that, in a certain way, substituted the SEAPs and limited the adoption of the Covenant of Mayor initiative on the territory. As mentioned previously, due to the restricted jurisdiction and budgets of Gozitan Local Councils, the measures promoted in the SEAPs were often economically unviable and did not reach enough critical mass to be seen as great achievement. Nonetheless, we believe that the technical and specific features of the SEAPs can help local councils in planning their actions and build up a set of requirements to be addressed to the central government in order to seek for funding opportunities. Moreover, the SEAPs and the Covenant of Mayor initiative have the capacity to empower the local councils administrative staff through the share of knowledge and bring the community together, through the mapping of their needs and addressing specific issues on the territory.

Finally, it can be said that SEAP is a necessary tool in order to establish the targets for the energy and environmental sustainability at the local and community level and can serve as basis to draw up other targets for national or regional strategies such as the Eco-Gozo.

7.2 MUNICIPALITY OF VICTORIA (Gozo)

Malta is an archipelago of islands in the Mediterranean Sea, which includes the islands of Malta, Gozo, Comino as well as several little islets. The archipelago is located around the 36th latitude, 81 km south of Sicily and 350 km north of Algeria's harbor city Al Khums. Its overall land area embraces 316 m^2. Only the main island Malta (246 m^2) and the two islands Gozo and Comino are populated. Gozo is found in the Northwest part of the Maltese archipelago. The total area of Gozo is about 69 km^2. The island of Gozo stretches about 14 km from the Northwest to the Southeast and roughly 7 km from West to the East. Malta, and consequently Gozo, is a EU Member State characterized by the smallest area, the smallest population and the highest population density of the whole European Union.

According to the census of March 2015, the population of Gozo is concerned to be about 31,443 inhabitants representing approximately 8% of the entire national Maltese population, with a density of 540 inhabitants/km^2.

Gozo has separate environmental and cultural assets, whose sustainable exploitation could be used productively for the development of the island region as well as the national economy.

The main land use in the islands of Malta so as in Gozo, is agriculture which covers almost the half land area, when the other half is covered by Natural habitats and urban/developed areas, consequently a large proportion of the population of Gozo deals with farming and agriculture. In general, 32% of agricultural land is found within Natura 2000 sites throughout the Maltese Islands. Moreover, Gozo has significant protected areas, which includes two Areas of Ecological Importance / Sites of Scientific Importance (AEI/SSI), one Special Area of Conservation (SAC) of International Importance and one Special Protected Area (SPA).

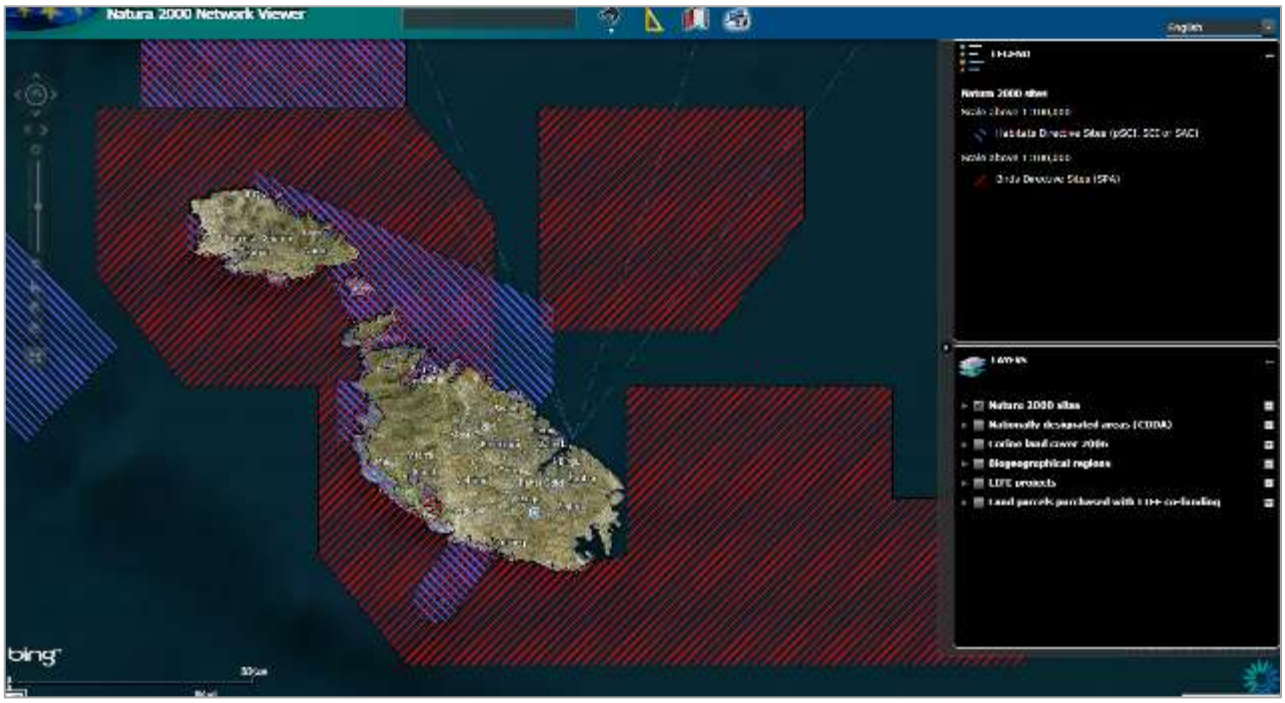


Figure 51: Natura2000 Network viewer

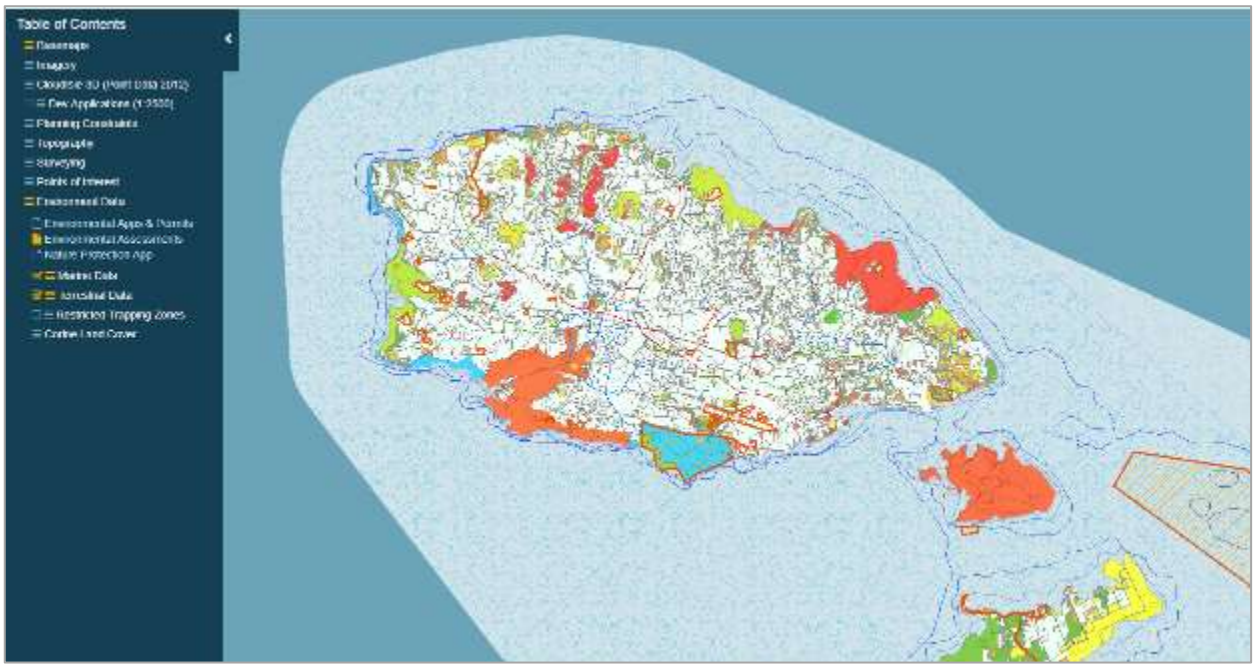


Figure 52: Geographic information on Protected environment areas in Gozo

Concerning the electricity production for Gozo Region, there are no power stations in Gozo and the area is supplied with electricity from Malta via three submarine cable circuits which pass over the island of Comino. Average electricity consumption for the Island of Gozo is about 420 GWh/year.

The power plant fleet and the distribution of electricity are operated by Enemalta, the state-owned monopole energy entity of Malta. In addition, the Sicily-Malta interconnector operates between the two islands. Here below it is shown the transmission system map with the main grids.

Figure 53: Transmission system grid of Malta

According to the available statistics for all the islands of Malta, the total energy supply is divided in: 43% of electricity and 37% of transport and 15% of fuel - gasoline and diesel - and 5% aviation, as show in the graph below.

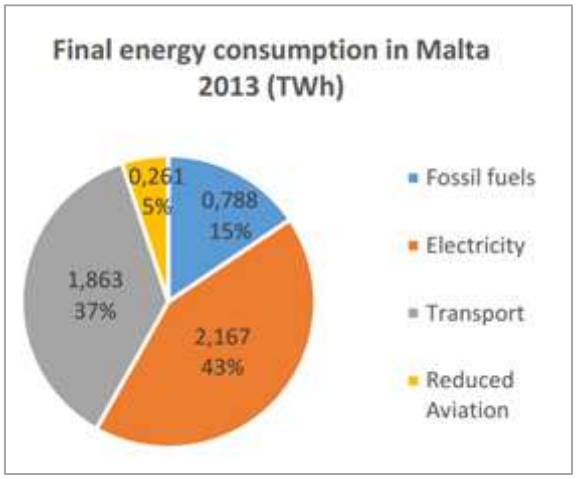


Figure 54: Final energy consumption in Malta 2013

More precisely, road transportation is almost exclusively based on oil products (with only 1,6% of the energy consumption represented by bio-fuels); fossil fuels are used for heating, cooking and industrial purposes. Furthermore, the greater part of the registered 0,79 TWh of fossil fuel is LPG (40%), which is followed by diesel (24%), gasoil (19%) and fuel oil (14%).

Total primary energy supply for Gozo is estimated to be about 420 Gwh/year. Following the figures previously illustrated, the energy supply for Gozo can be divided in: 195 GWh for

electricity, 155.4 GWh for transport and 69.6 Gwh for fuels. It has to be noted that Maltese and Gozitan households most commonly use electricity for water and space heating (AC). Some houses do use portable gas cylinders for space heating.

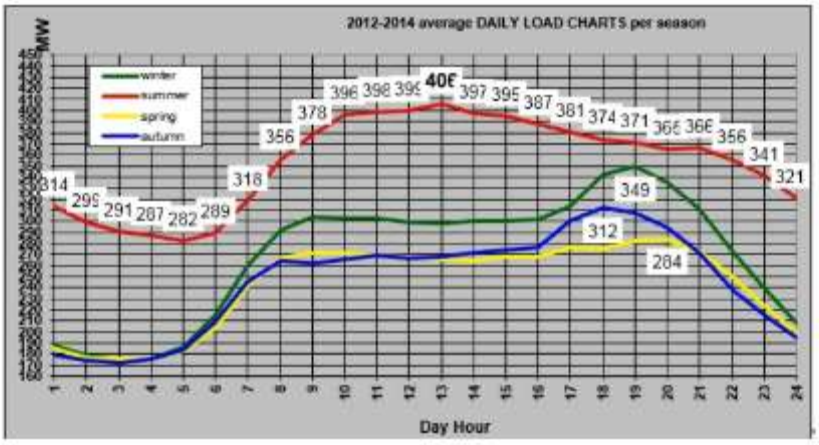


Figure 55: Average daily loads for Malta

From a RES point of view, Gozo is inserted in the context of a country with the highest overall solar irradiation in Europe. PV accounts almost exclusively for all RES power production on Malta so far and is anticipated to be the most relevant contribution to the achievement of Malta's country specific decarbonisation targets.

The map here below shows the total PVs installed in the domestic sector per 1,000 residents 2014 in Gozo and Malta. Moreover, from the statistics of 2015 we can see the stock of PV installations by district (including Malta and Gozo) and year. It is notable to point out how in the last years the PV installations have increased significantly. Thus, it can be said that solar energy is the most exploitable RES in the island. The data provided by the 2015 "Gozo in Figures" Statistics from the NSO, is showing a total of 7,435.9 kWp was produced in Gozo in 2014. If we scale down this figure to the city of Victoria and apply a resident ratio parameter we obtain a total PV generation of 1511 kWp for the whole community, value that can be added to the present SEAP.

On the other hand, wind and wave power is not only temporarily ruled out by politics, but also in the long term, it could be utilized only to a limited extent due to geographical constraints. In addition, strict geographical constraints are given mainly by the scarce land area on Gozo. Finally, the use of biomass produced inland, apart from biodegradable waste, is underexploited due to similar constraints.

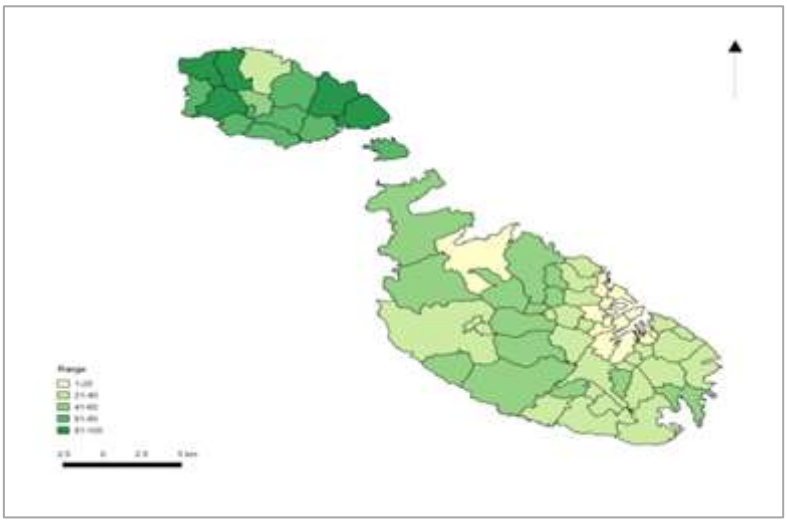


Figure 56: Total PVs installed in the domestic sector per 1,000 residents: 2014

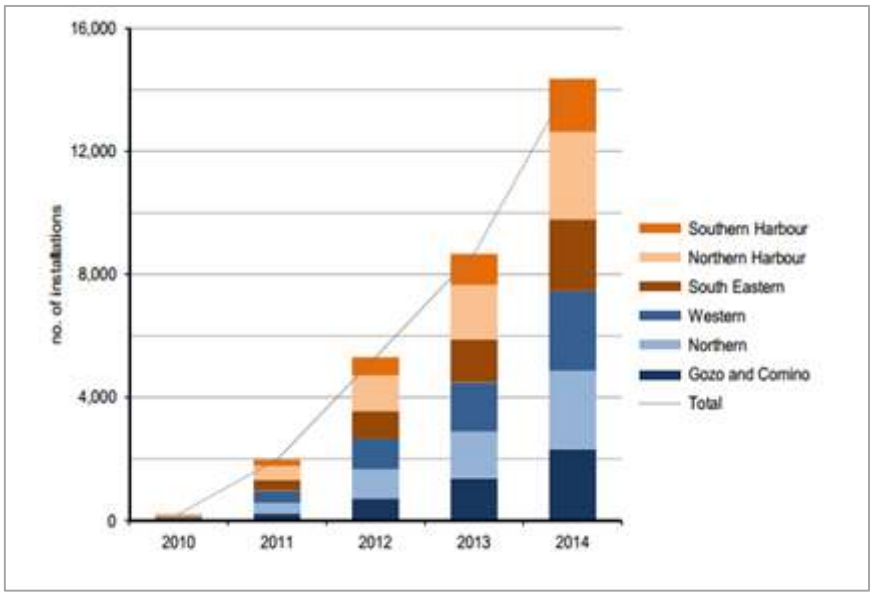


Figure 57: Stock of PV installations by district and year

7.3 CURRENT STATUS AT MUNICIPALITY OF VICTORIA (GOZO)

In 2013, Victoria had a population of 6,229 inhabitants over an area of 2.9 km^2. Victoria is the most populated city in Gozo. The population density of Victoria is 2,000 inhabitants/km^2, which is more than the national average, which stands at 1,308 inhabitants/km2.

The local administrative body is the Victoria Local Council, which is democratically elected and consists of seven members including the Mayor. The office of the Mayor is occupied by the elected Councillor who obtains the highest number of first count votes among the candidates of the political party, which obtains the absolute majority at the elections.

The Victoria Local Council wants to create a healthy, thriving development with increasing concern for its environment and surrounding natural resources. The Local Council has already committed itself by adhering to the Covenant of Mayors since the 16th day of February 2010. In

addition, it has taken an active role by starting the process required in the Covenant of Mayors with its first Sustainable Energy Action Plan presented in 2012. The main aim of the Local Council is to realize its ambitions to reduce the locality's impact on climate change through the reduction of use of fossil fuels and define the commitment to reducing CO2 emissions.

It is evident that due to the limited administrative power of Local Councils in general, the Council has to rely on a number of actions that need to be implemented by the Central Government. Nevertheless, it shall do its utmost to lobby for the implementation of the necessary actions. In its last SEAP the city of Victoria committed to reduce CO2 emissions by 20.52%. This percentage value currently excludes the tertiary sector which, due to the present jurisdiction limitations of Local Councils in Malta. Unfortunately, the SEAP issued in 2012, was done in a context of lack of data, so it is based on different assumptions. For instance, the total electrical energy consumption for municipal buildings equipment and facilities, in the baseline year, was based on an estimation of residential electrical energy consumption, and since the locality does not have any particularly sizeable industries, the amount of electrical energy used in tertiary buildings, equipment and facilities is deemed to be equal to the difference between the locality's total electrical energy metered and the sum of the municipal and residential energy consumption. This may prove to be a slight overestimation of the tertiary energy consumption. The annual energy consumption for municipal street lighting in the baseline year was equal to 393.53 MWh. Since the source of energy for municipal public lighting is electricity, originating from the same source, the equivalent emission factor is identical as for residential buildings, specifically 0.867 tCO2/MWh. This corresponds to an annual CO2 emission for municipal public lighting of 341.19 tCO2. To complete the target of the energy reduction of street lighting, the SEAP 2012 foreseen the installation of intelligent street lighting control systems in the locality. It was predicted that around 25% of energy used for street lighting can be reduced with this system. This would equate to a reduction of 85.30 tCO2 emissions annually.

Another sector which contributes greatly to the energy consumption and air pollution is the transport sector. Considering also the double insularity problem of Gozo, it was estimated that the energy consumption for private and commercial transport for the baseline year 2012 is equal to 45,182.29 MWh divided as 22,976.33 MWh from Gasoline (Petrol), 22,035.67 MWh from Diesel and 170.29 MWh originating from the use of Bio-Diesel. Also, marine transport sector is of high importance from the energetic point of view, due to the fishing sector, tourism and daily commuting. In order to tackle this sector, the Victoria Local council foreseen the activities as the promotion of electric vehicles for the municipal fleet and an increase in use of bio fuels in the locality by means of information campaigns.

Production of potable water in Malta is mainly by means of seawater desalination. Hence, the provision of water is an energy intensive process. For this reason, it has been deemed sensible to include the CO_2 related to the production and distribution of water in the baseline emissions inventory.

From utility billing data, the water consumption for the locality, in the baseline year, was equal to 285,327 m3. According to the Water Services Corporation, the specific energy for the production and distribution of water for 2005 was 5.89 kWh/m3. This means that the energy consumption relating to the production and distribution of water in the locality for the baseline year was equal to 1,680.58 MWh.

7.4 INVENTORY OF ENERGY CONSUMPTION IN MUNICIPALITY

The total energy consumption for the locality, in the baseline year was equal to 123,677.22 MWh. The associated CO2 emissions totalled 74,856.62 tCO2. Emissions due to the Tertiary sector have been included to ensure a comprehensive inventory, with parameters as explain in the previous chapter.

The corresponding annual values per capita are 19.28 MWh/capita and 11.67 tCO2/capita.

Sector		FINAL ENERGY CONSUMPTION [MWh]							
		Electricity	Fossil Fuels					RES	Total
			Liquid gas	Heating oil	Diesel	Gasoline	Other fossil fuels	Biofuel	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES									
Municipal buildings, equipment/facilities			0	0					**0**
Tertiary (non-municipal) buildings, equipment/facilities		57915	912	0			2956		**61783**
Residential buildings		10883	2942	34.6					**13859.6**
Public lighting		393							**393**
Industry	Non-ETS								**0**
	ETS (not recommended)								**0**
Subtotal		**69191**	**3854**	**34.6**	**0.0**	**0.0**	2956	0.0	**76035.6**
TRANSPORT									
Municipal and private fleet					0	0			**0**
Public transport fleet					774.29				**775.29**
Private and commercial transport					22035.67	22976.33		170.29	**45182.29**
Subtotal		**0.0**	**0.0**		**22810.96**	**22976.33**		170.29	**45957.58**
OTHER									
Agriculture, Forestry, Fisheries		1680.53							**1680.53**
TOTAL		**70871.53**	**3854**	**34.6**	**22810.96**	**22976.33**	2956	170.29	**123673.71**

Table 19: Final use energy consumption overview

The below pie chart shows the distribution of energy consumption by sector, in the locality. The largest consumer of energy is the sector of Tertiary (Non-Municipal) Buildings, Equipment and Facilities (49.95%) followed by Private and Commercial Transport (36.53%). This is followed by Residential Buildings (11.21%) and Water Production (1.36%).

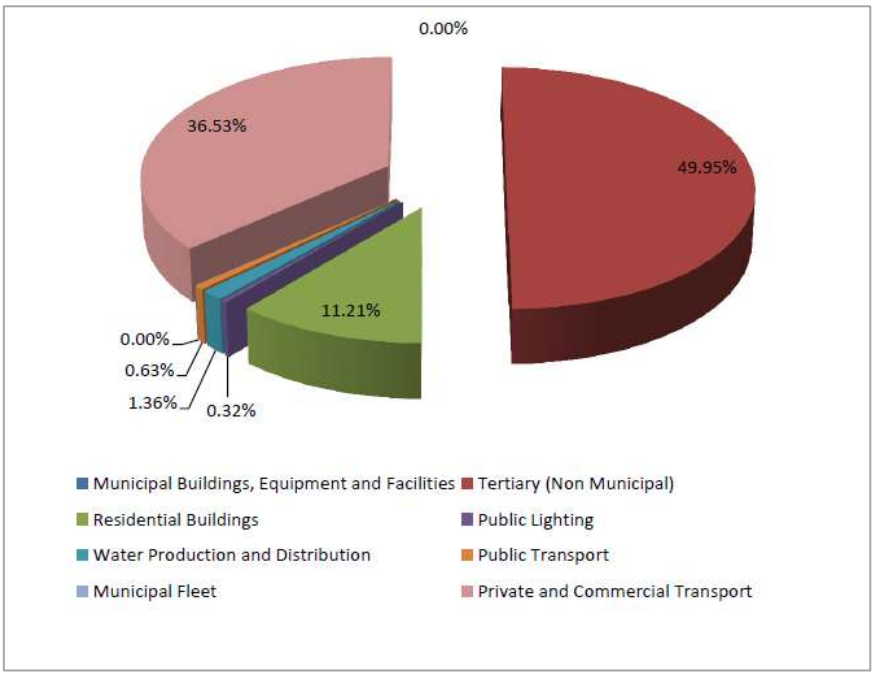


Figure 58: Energy consumption by sector

The sources of energy in the locality are Electricity, Liquid Gas, Diesel and Heating Oil (combined as indicated in Tertiary buildings estimates), Gasoline and Biofuels, distributed as in the following graph. Electricity, mainly consumed in Residential Buildings and Tertiary (Non-Municipal) Buildings, Equipment and facilities is the major contributor of energy. Diesel and heating oil are the next largest source of energy, supplying the Transport sector and to a lesser extent as a source of heat in Tertiary (Non-Municipal) Buildings. The next major contributor is Gasoline, also used in the Transport Sector.

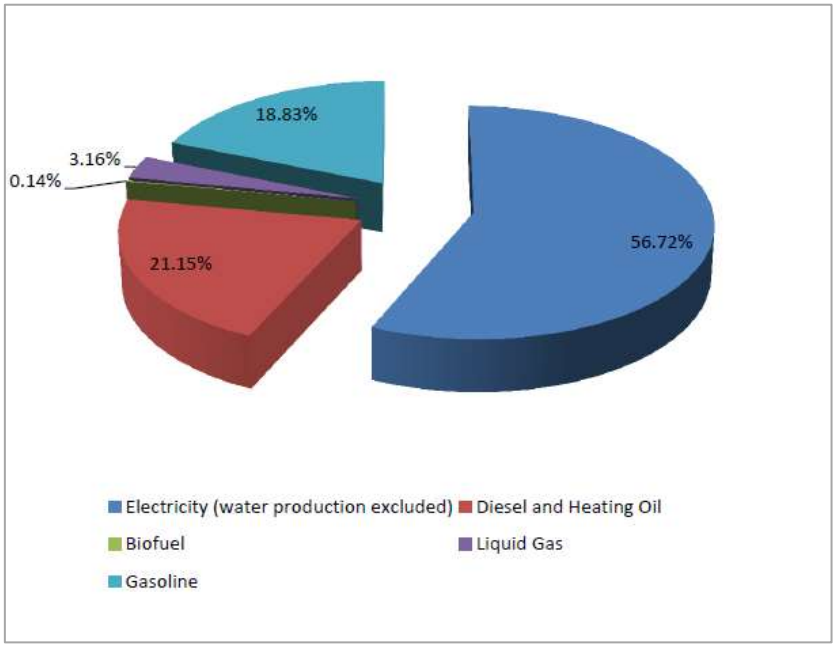


Figure 59: Primary energy: oil derivates

7.5 INVENTORY OF CARBON DIOXIDE (CO2) EMISSIONS

Carbon dioxide emissions were calculated using standard emission factors on consumption based on the energy source and use. CO_2 emission forecasting scenarios (Business As Usual scenario). The information provided here should be related with the information on SEAP excel template. The deliverables produced in previous activities of PRISMI project can be used to provide relevant information.

There are two types of emissions due to consumption in the territory:

- direct emissions due to the use of fuel in the construction sector, in installations, in services and in means of transport, public and private;
- indirect emissions caused by the generation of electricity and heat used in the territory

The methodology used for calculating emissions follows the IPCC guidelines and in particular the sectoral, or bottom-up, approach.

Where accurate data is not available, a top-down approach is usually employed, using statistical analysis on aggregated data at provincial and/or higher level.

Sector		CO2 emissions [t]				
		Electricity	Heat/cold	Fossil Fuels		
				Liquid gas	Diesel	Gasoline
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES						
Municipal buildings, equipment/facilities		0	0	0	0	0
Tertiary (non municipal) buildings, equipment/facilities		50213	0	206	0	0
Residential buildings		9436	0	665	0	0
Public lighting		341	0	0	0	0
Industry	Non-ETS	0	0	0	0	0
	ETS (not recommended)	0	0	0	0	0
Subtotal		59990	0	871	0	0.00
TRANSPORT						
Municipal fleet		0	0	0	0	0
Public transport		0	0	0	0	0
Maritime transport for water delivery		0	0	0	205	0
Private and commercial transport		0	0	0	5839	5675
Subtotal		0.00	0.00	0	6045	5675
OTHER						
Agriculture, Forestry, Fisheries		1457	0	0	0	0
TOTAL		**61447**	**0**	**871**	**6045**	**5675**

Table 20: CO2 emissions overview

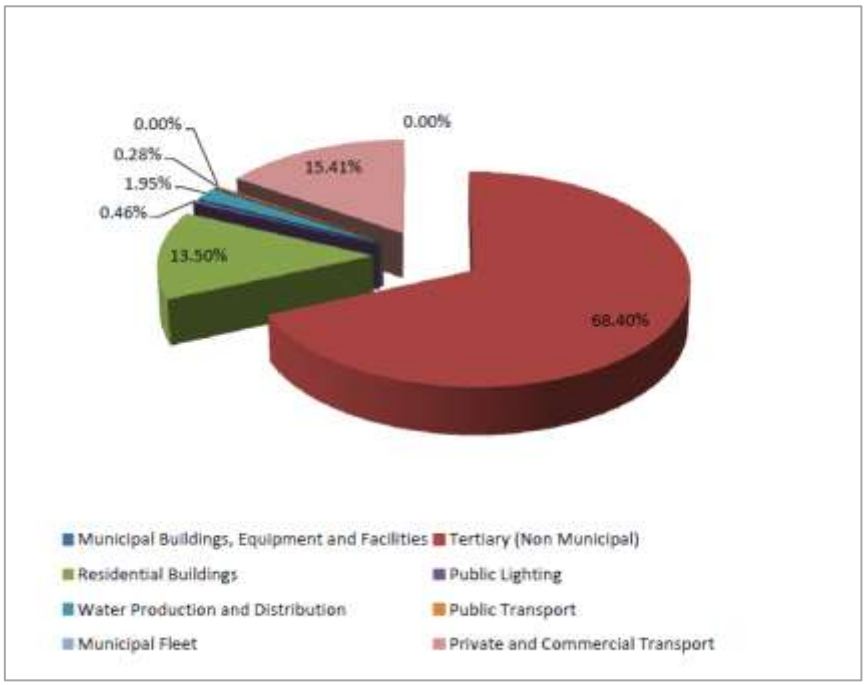


Figure 60: Pie chart of CO2 emissions by sector

The above chart shows the distribution of CO2 emissions by sector. Evidently, the share of CO2 emissions due to residential buildings (13.5%) is larger than the share of energy consumption for the same sector. This is mainly due to the fact that the source of energy for a large proportion of energy used in residential buildings is electricity. Although this percentage is much lower than the benchmark European average contribution from residential buildings of 40%, there remains a potential for reduction in this sector.

The largest sector is that of Tertiary (Non-Municipal) Buildings to be followed by Private and Commercial Transport.

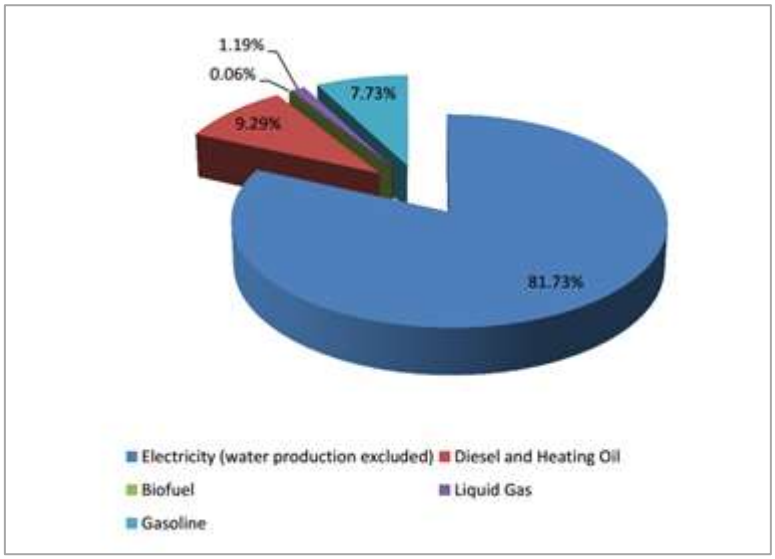


Figure 61: Pie chart for Carbon Dioxide (CO2) Emissions by Source of Energy

The graph above shows the sources of CO_2 emissions by source of energy present in the BEI 2012 of Victoria SEAP. Due to the relatively high emission factor for electricity, the CO2 emissions due to this source of energy are significantly highest even more so since it is the largest energy provider for the locality. This means that any initiative to reduce the consumption of electricity has the highest effect in reducing the CO2 emissions.

7.6 SUSTAINABLE ENERGY ACTION PLAN

Detailed reference to measures / actions per sector in order to achieve the objective of reducing CO_2 emissions. Forecast based on SEAP / SECAP. Tools to monitor the Action Plan. Reference to possible sources of funding for the implementation of the actions. The information provided here should be related with the information on SEAP excel template. The deliverables produced in previous activities of PRISMI project can be used to provide relevant information.

7.6.1 2030 projections: "Business as usual" scenario

This is the chosen scenario for the SEAP of the city of Victoria. In this scenario the administration would not have implemented any policy aimed at changing the energy demand. However, it shall commit in reducing the energy consumption through energy efficiency upgrade measures and shift in behaviours. The action plan proposed seeks to improve the figures that were submitted in 2012 with the SEAP for the city of Victoria and diminish the CO_2 emissions by 40% by 2030**.** The proposed measures will take in account the limited jurisdiction of the local council, so on one hand the plan will focus on awareness campaigns, street lighting upgrading and actions on municipal buildings that can be tackled directly at local council level, while on the other hand the plan proposes further projects and projections that, in order to be realised, need the support and funding of the central Government of Malta. The actions are divided in the following areas:

- Municipal Buildings Equipment and Facilities
- Tertiary (touristic) Buildings Equipment and Facilities
- Residential sector
- Transport sector
- Electricity and RES production
- Environmental measures

7.6.1.1 Municipal Buildings, Equipment and Facilities

- **Action 1.1:** Replacement of the lighting bulbs with LED lighting in Municipal building and facilities
- **Action 1.2:** Conduct an energy audit for Municipal buildings and facilities
- **Action 1.3:** Installation of 4 kWp PV system to serve Municipal Facilities
- **Action 1.4:** Perform energy audits for local council buildings and municipal lighting facilities
- **Action 1.5:** Install solar water heaters in 2 sport complexes
- **Action 1.6:** Change outdated Air conditioning systems with energy efficient heat pumps
- **Action 1.7:** Study the possibility to lease public land to privates to install PV systems
- **Action 1.8:** Public lighting: Install intelligent street lighting control system in all substations
- **Action 1.9:** Public lighting: Install photovoltaic charged lighting stations
- **Action 1.10:** Promote green procurement for the purchase of LED lighting

These measures are planned for the sector managed by the Municipality (mainly general administration, and public lighting). The most significant measures in terms of real reduction of energy consumption will be the ones linked to the solar technologies and the upgrade of the lighting systems, either in buildings and in street lighting.

In the past 5 years, the local council and the Ministry for Gozo have already installed photovoltaic system on the roofs of the premises of the Ministry for a total capacity of a 108kWp. The project was financed by the central Government with ERDF funds and it was developed in 4 main stages. The PV system consists of a mixture of polycrystalline and monocrystalline PV panels, operated through a net metering arrangement and has a total capacity is 108.10 kWp. The PV system generates between 150,000 and 180,000 kWh per year. The building consumes on average 326 MWh of electricity every year, so the PV system generates roughly 50% of the building's energy demand. This means that the annual energy saving measures, if based on a rate of 15c, are between 22,250€ and 27,000€ and the Reduction in Carbon Dioxide is of about 120,400 kg CO_2/year.

From its end the Local Council of Victoria, intends to finance an installation of further 6kWp PV in chosen public premises**.** It is expected that such a system shall cost in the order of € 24,000 and shall reduce annual energy consumption and CO_2 emissions by 9.75 MWh equivalent to 8.46 tCO2. Furthermore, the Local Council shall embark on a project to identify a number of sites that are potentially suitable for installation of further renewable energy systems, possibly employing different technologies. Such buildings may include buildings owned by the central government. The Local council shall enter in an agreement with the owner of the proposed sites to install the renewable energy systems and eventually take over the installation, maintenance and management of such systems.

7.6.1.2 Tertiary Buildings, Equipment and Facilities

Although no specific commitment was made in the previous SEAP on the Tertiary sector, the Council is aware that this shall be included for the future application. For this reason, the Council shall proceed with any actions that can, at present or in future, lead to the overall reduction of emissions in the locality, in accordance with the Covenant of Mayors. The target will be to inform and make aware the stakeholders in the touristic, commercial and leisure sectors that measures for the energy reduction shall be introduced. The enforcement of certain actions however, can only be obtained through directives and policies issued by the central Government. Tax incentives and sustainability prizes can be a good strategy for facilitating the uptake of energy efficiency measure in such sectors.

- **Action 2.1:** Promote energy audits for non-municipal public buildings in the locality such as political clubs, band Clubs and sports clubs
- **Action 2.2:** Seek the possibility to use roofs of industrial areas and farms for PV installations
- **Action 2.3:** Promote incentives for the installation of Cogeneration systems in tourist facilities
- **Action 2.4:** Incentives to change lighting system to intelligent and energy efficient
- **Action 2.5:** Support incentives to change lighting system to intelligent and energy efficient
- **Action 2.6:** Promote scheme to change outdated ACs with efficient heat pumps

7.6.1.3 Residential Buildings

Residential building stock is lacking proper measure for energy conservation. Thus, the main aim in this sector will be to refurbish including the dwellings, through the installation of insulation and double-glazing apertures, and intelligent lighting and A++ appliances. The local council should grow awareness among the population and explain the advantages of doing such refurbishment. Also, the use of renewable energy sources such as solar thermal and integration of photovoltaic systems is key to reduce the use of electricity from fossil flues. The local council can illustrate the grants and the advantages of installing such systems. The proposed actions are:

- **Action 3.1:** Replacement of lighting bulbs with LED and installation of intelligent lighting in condominiums
- **Action 3.2:** Propose incentives for the purchase of A++ appliances
- **Action 3.3:** Promote the uptake of energy refurbishment measures, such as insulation and double glazing
- **Action 3.4:** Conduct a public awareness campaign and organise Energy Days to involve the wider public in the use of renewable energy sources and energy saving measures
- **Action 3.5:** Conclude agreement(s) with a number of suppliers of RE systems to obtain preferential prices for use in residential buildings in the locality

7.6.1.4 Transport sector

The Council is committed to have a good public transport system within the locality. As a result, it shall actively work to persuade the transport authority in this direction. In addition, the Council shall take the initiative to provide as much information as possible to its citizens in order to encourage the use of public transport. It is expected that by 2020, the increase in use of public transport shall reduce the use of private vehicles by 10%. in this perspective it is compulsory to upgrade of the public transport system through the replacement of the existing buses, which are, on average, 20 years old by a modern fleet with a combination of energy efficient engines and a small number of electric vehicles. Public transport routes shall also be optimised to ensure better utilisation of the service. The expected reduction due to such a gross improvement is 30%. In energy and emission terms, this result in a reduction of 232.59MWh and 62.10tCO2 respectively. Actions proposed are:

- **Action 4.1:** Promote carpooling, pedibus, to change transport behaviours
- **Action 4.2:** Support the penetration of electric charging points for electric vehicles
- **Action 4.3:** Conduct a study to improve pedestrian paths and plan the pedestrianization of the city center, to avoid congestion
- **Action 4.3:** Plan and promote safe walking and bicycles routes
- **Action 4.4:** Upgrade the public transport system by introducing electric buses

7.6.1.5 Local electricity production/waste/water

The local council shall commission feasibility studies for the introduction of high RES technologies in the island. A study will be foreseen on the combined heat and power unit with absorption cooling for use in a prominent public building. If the project is deemed feasible, the local council shall attempt to proceed with funding and installation. With the same aim, a study is also proposed on wind turbines installation. The possibility of introducing energy from wind

will contribute greatly in the abatement of C02 emissions. The full range of foreseen feasibility studies is the following:

- **Action 5.1:** Conduct a feasibility study for the installation of a Combined Heat and and Power with Absorption Cooling in Public Building
- **Action 5.2:** Conduct a feasibility study to install 12M of wind power / wind turbine using Public/ Private partnership
- **Action 5.3:** Conduct a study to create an organic waste recycling plant
- **Action 5.4:** Conduct a feasibility study for the collection and harvesting of rain water in a dam or underground public reservoir

7.6.1.6 Environmental measures

Tree planting and green initiatives are key for the $C0_2$ levels reduction and improving quality of air and public health. Tree planting and carbon sequestration actions are intended to make maximum use of spaces available for the planting of new vegetation, especially trees that have the function to capture atmospheric CO2 and offset part of the locality's emissions. Conduct a tree planting exercise in the locality involving as much as possible the general public in participating in such exercise. This can be combined with the Energy Days activities. Furthermore, local council shall organised activities for awareness on the conscious use of tap water, recycling of rain water and the reduction of the use of bottled water, giving information also about the domestic reverse osmosis systems. Water is a scarce and precious resource in Malta and in Gozo, thus it needs a special attention. Moreover, the Reverse Osmosis plant uses a great amount of electricity during its desalination processes. In this theme is also important to raise awareness about organic farming, since this sector is a great user of water and at the moment all the water used in farming cannot be recycled due to the pesticides used. Finally, all tenders for the purchase of equipment issued by the local council shall include a clause giving preference to the equipment, which consumes least energy for the same functions.

- **Action 6.1:** Plant endemic trees in selected areas using indigenous species to reduce heat island effect
- **Action 6.2:** Conduct awareness campaigns for the reduction of the use of plastic bottles, increasing the quality of tap water and/or promoting incentives for the purchase of domestic Reverse osmosis systems
- **Action 6.3:** Build awareness on organic farming
- **Action 6.4:** Green tenders

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES										
Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Energy management	Local authority	Local authorities	2015	2030	63000	32.79	0	28.43
Install 6 KWp of PV system(s) to serve the municipal facilities.	Other	Grants and subsidies	Other (national, regional,…)	Local Authority and Central Government	2018	2030	24000	9.75	0.006	8.46
Perform energy audit for local council buildings, municipal lighting facilities	Integrated action (all above)	Energy certification / labelling	Local authority	Local Authority and Central Government	2019	2020	2500	0	0	0
Install solar water heaters in 2 sport complexes	Renewable energy for space heating and hot water	Public procurement	Not possible to say	Local Authority and Central Government	2020	2025	15000	1.65	0	0.977
Apply energy efficiency measures in public buildings	Building envelope	Public procurement	Not possible to say	Local Authority and Central Government	2020	2030		0	0	0
Change outdated Acs with efficient heat pumps	Energy efficient electrical appliances	Public procurement	Not possible to say	Local Authority and Central Government	2020	2030	7500	40	0	10
Seek the possibility to lease public land to private PV installations	Renewable energy for space heating and hot water	Land use planning regulation	Other (national, regional,…)	Local Authority and Central Government	2020	2030		0	0	0

TERTIARY BUILDINGS, EQUIPMENT/FACILITIES										
Promote energy audits for non municipal public buildings in the locality such as political clubs, band Clubs and sports clubs	Integrated action (all above)	Energy certification / labelling	Local authority	Local Authority and Central Government	2019	2020	1250	0	0	0
Seek the possibility to use roofs of industrial areas and farms for PV installations	Other	Land use planning regulation	Other (national, regional,…)	Local Authority and Central Government	2020	2030		0	0	0
Promote incentives for the installation of Cogeneration systems	Renewable energy for space heating and hot water	Grants and subsidies	Other (national, regional,…)	Local Authority and Central Government	2020	2025		0	0	0
Give incentives to change lighting system to intelligent and energy efficient	Energy efficient lighting systems	Grants and subsidies	Other (national, regional,…)	Local Authority and Central Government	2019	2030	7500	51	0	13
PUBLIC LIGHTING										
Install intelligent street lighting control system in all substations	Energy efficiency	Public procurement	Local authority	Local Authority	2020	2025	190000	98.38	0	85.3
Install photovoltaic charged lighting stations	Integrated renewable power	Public procurement	Local authority	Local Authority	2020	2025	250000	1129.56	0.005	288.37
promote green procurement for the purchase of LED lighting	Energy efficiency	Public procurement	Local authority	Local Authority	2020	2025	1400	0	0	0
RESIDENTIAL BUILDINGS										

Replacement of the lighting bulbs with LED	Energy efficient lighting systems	Awareness raising / training	Local authority	Local authorities	2015	2030	405000	95.2	0	79.82
Propose an incentive for purchase of A++ appliances	Energy efficient electrical appliances	Grants and subsidies	Other (national, regional,…)	Local Authority and Central Government	2019	2030		0	0	0
Promote uptake of energy saving measures in residences, (insulation and double glazing)	Building envelope	Grants and subsidies	Other (national, regional,…)	Local Authority and Central Government	2019	2030		0.00	0	0
Conduct a public awareness campaign and organise Energy Days to involve the wider public in the use of renewable energy sources and energy	Behavioural changes	Awareness raising / training	Other (national, regional,…)	Local Authority and Central Government	2020	2025		0	0	0
Conclude agreement(s) with a number of suppliers of RE systems to obtain preferential prices for use in residential buildings in the locality	Other	Public procurement	Other (national, regional,…)	Local Authority and Central Government	2020	2030		2531.77	0	2201.99
TRANSPORT										
Promote carpooling, pedibus,to change transport behaviours	Car sharing/pooling	Voluntary agreements with stakeholders	Local authority	Local Authority	2019	2030	1600	0	0	518.92
Support the penetration of electric charging points for electric vehicles	Electric vehicles (incl. infrastructure)	Transport / mobility planning regulation	Other (national, regional,…)	Local Authority and Central Government	2020	2030	2000000	1180.92	0	306.64

Conduct a study to improve pedestrian paths and plan the pedestrianization of the city center, to avoid congestion	Road network optimisation	Transport / mobility planning regulation	Other (national, regional,…)	Local Authority and Central Government	2020	2030	1500	0	0	879
Plan and promote safe walking and bicycles routes	Modal shift to walking & cycling	Land use planning regulation	Local authority	Local Authority	2019	2030	3000	0	0	12.93
LOCAL ELECTRICITY PRODUCTION										
Conduct a feasibility study for the installation of a Combined Heat and Power with Absorption Cooling in Public Building. Install unit if deemed feasible.	Combined Heat and Power	Other	Local authority	Local Authority	2019	2023		0	0	0
Conduct a feasibility study to install 12M of wind power / wind turbine using Public/ Private partnership	Wind power	Other	Local authority	Local Authority	2019	2023		0	12	12900
Conduct a study to create an organic waste recycling plant	Other	Other	Local authority	Local Authority	2019	2023	4000	0	0	0
OTHERS										
Plant trees in selected areas using indigenous species to reduce heat island effect	Tree planting in urban areas	Land use planning	Other (national, regional,…)	Local Authority and Central Government	2020	2030				

Conduct a feasibility study for the collection and harvesting of rain water in a dam or underground public reservoir	Waste & wastewater management	Other	Other (national, regional,…)	Local Authority and Central Government	2020	2030				
Conduct awareness campaigns for the reduction of the use of plastic bottles, increasing the quality of tap water and/or promoting incentives for the purchase of domestic Reverse osmosis systems	Other	Awareness raising / training	Other (national, regional,…)	Local Authority and Central Government	2020	2025				
Build awareness on organic farming	Agriculture and forestry related	Awareness raising / training	Other (national, regional,…)	Local Authority and Central Government	2020	2025				
TOTAL							**2563500**	**5171.02**	**12.011**	**17333.837**

Table 21: Mitigation action plan for Victoria municipality (Gozo)

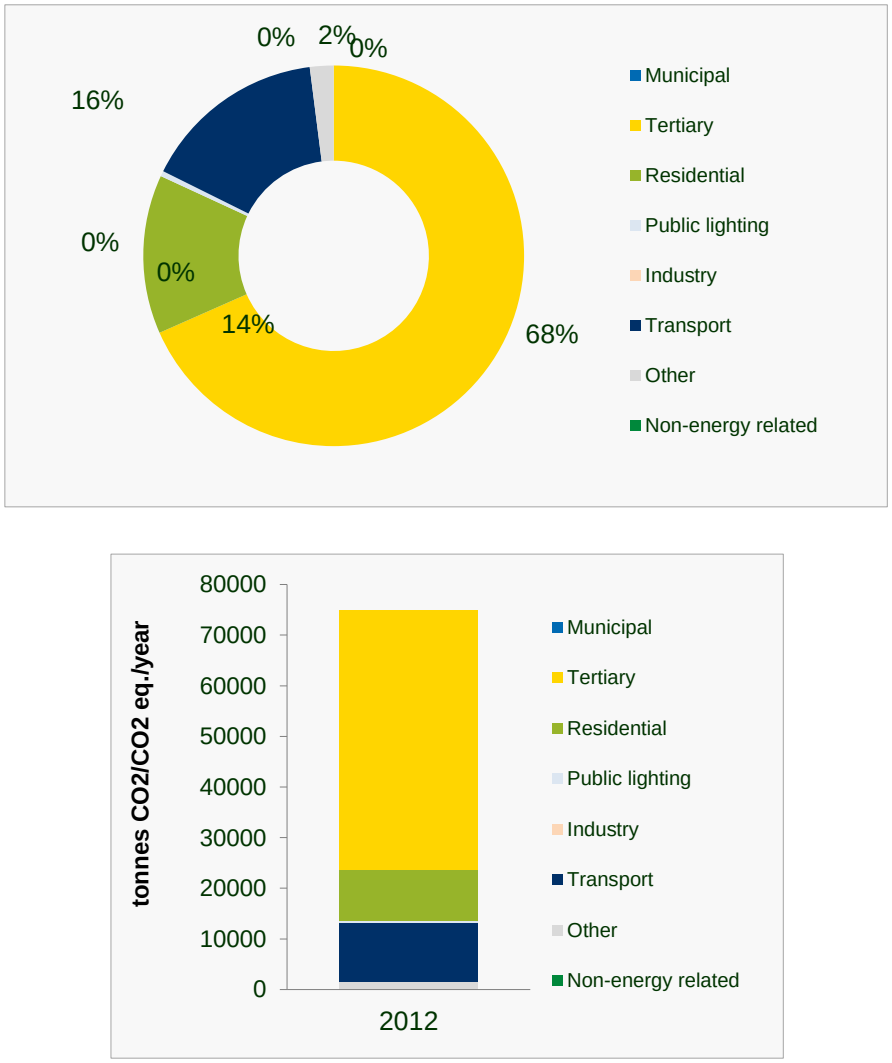
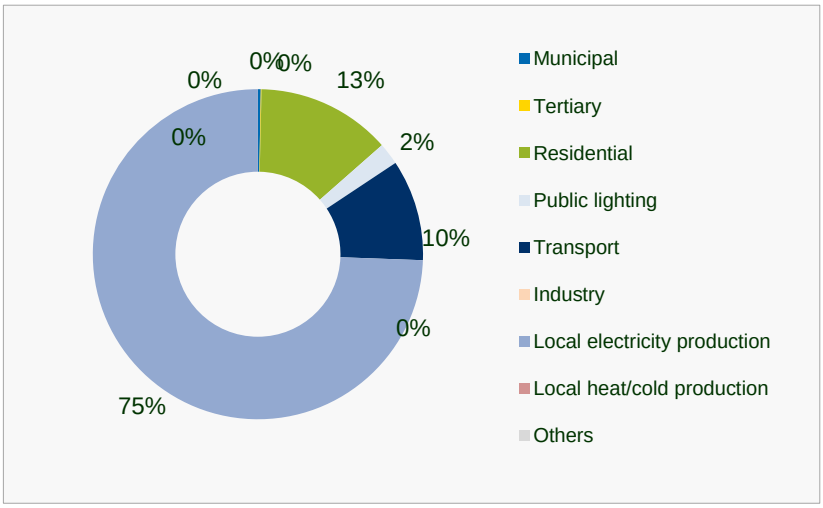


Figure 62: The forecasted emissions trend in the 2012 baseline.



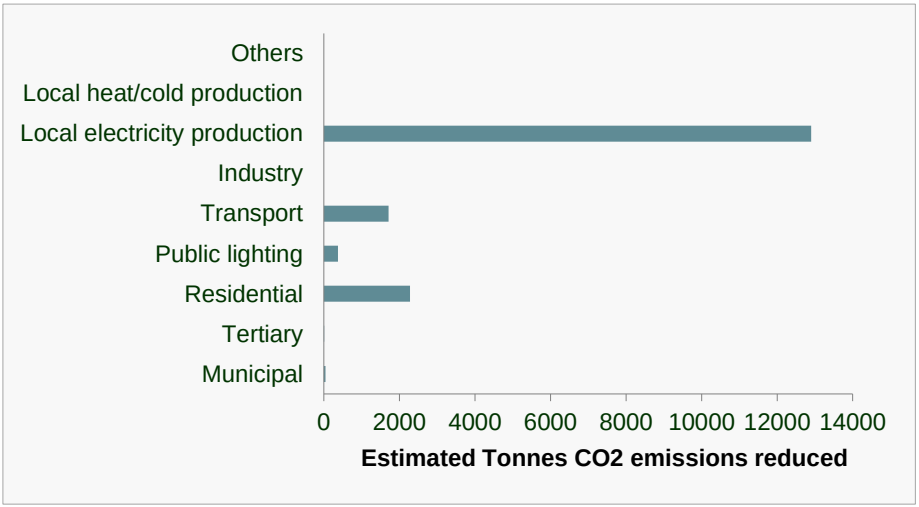
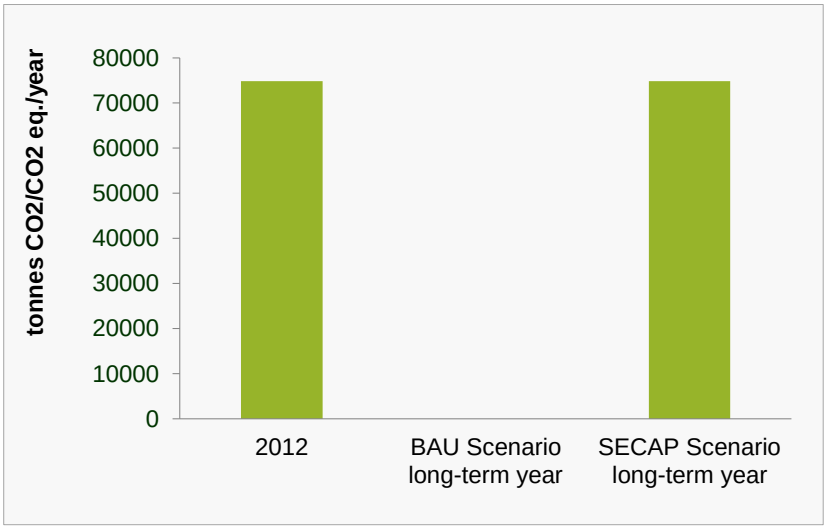


Figure 63: tonnes C02 emissions reduction BAU scenario



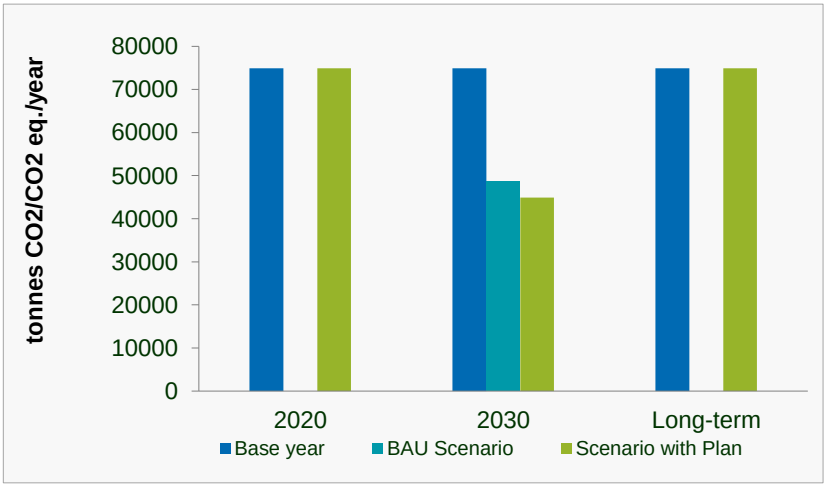


Figure 63: tonnes C02 emissions: Base year, BAU and Plan scenarios in comparison

8. SUSTAINABLE ENERGY ACTION PLAN OF AKAMAS PENINSULA

8.1 SUMMARY

The Cyprus Energy Agency as a participating partner in PRISMI project, has invited the Local Authorities of Akamas peninsula to demonstrate their political commitment by signing the "Covenant of Mayors"; agreement in order to achieve the EU sustainability targets for 2030. In particular, six communities (Neo Chorion, Kato Arodes, Pano Arodes, Drouseia, Pittokopos, Kathikas) and one municipality (Pegeia) in the Akamas peninsula agreed to join the Covenant of Mayors and to submit a joint Sustainable Energy and Climate Action Plan (SECAP). A SECAP does not only introduce actions to reduce energy consumption and carbon dioxide emissions but also proposes measures to address climate change mitigation and adaptation.

The population of all the local authorities in the area is 6,662 inhabitants and they have 8,968 households (2017).

The year 2009 was set as the reference / recording year for energy consumption and CO_2 emissions for the local authorities. According to the actual consumption data collected by the Cyprus Electricity Authority, the oil companies, the Cyprus Statistical Service and other services, the total energy consumption in the study area of Akamas peninsula in 2009 was 256,093 MWh. The largest energy consumer in the area is transport with 162,767 MWh, followed by the domestic sector with 64,155 MWh and the tertiary sector with 20,566 MWh.

The emissions of carbon dioxide in 2009 that correspond to the total energy consumption in the areα are 44,781 tons. The draft joint SECAP prepared for the local authorities of Akamas peninsula includes additional measures / actions to attain at least the European target for combating climate change. In other words, are the measures that the local authorities will take in addition to national measures to overcome the target of reducing CO_2 emissions by at least 40% by 2030 compared to the reference year 2009.

The measures proposed are divided into the following categories:

Description	**Number**
Municipal Buildings, equipment/facilities	5
Tertiary Buildings, equipment/facilities	6
Residential Buildings	7
Public Lighting	4
Transport	11
Local Electricity production	1
Others	14

The budget of the Action Plan for the period 2018 to 2030 amounts to **€13,962,340**. Funding for the implementation of the Energy Action Plan is expected to be taken from the following resources:

- Municipality budget
- Municipal green tax
- Savings that will result from energy reduction measures in buildings, vehicles and street lighting in the Municipality.
- Revenues originating from Municipality investments on Renewable Energy technologies.

- Funding from the Grant Scheme of the Ministry of Energy, Commerce, Industry and Tourism for the promotion of Renewable Energy and Energy Conservation
- Potential funding from the structural funds.
- Potential funding from the Fund created for Emissions Trading Scheme.
- Potential funding from other European programs.
- Public-Private partnership
- Projects implementation with the contribution of Energy Services Companies (ESCO)

The proposed share of each funding source to the SEAP is:

Funding source	**Percentage**
Municipal budget	19%
National Funds	17%
European Funds	57%
Private	7%

8.2 LOCAL AUTHORITIES OF AKAMAS PENINSULA

8.2.1 Pegeia municipality

Pegeia is a town in the Paphos District of Cyprus. In particular, it is a newly founded municipality in the province of Paphos since it was proclaimed a municipality in 1994. It is also noteworthy that Pegeia is recognized as one of the largest in extent of municipalities of Cyprus, as its region covers 4,552 hectares. The administrative area of Pegeia reaches north to the gulf of Lara and to the south to the land of Potim and the dam of Mavrokolympos.

Regarding the geographical location of Pegeia, this is quite favourable. Only 15 kilometres away from the centre of Paphos, and close to the beautiful Akamas, is a point of attendance not only for residents but also for foreigners. The fact that the village is rooted on the slopes of a mountain and built at an altitude of 200 meters, allows its enviable panoramic view both to the west coast of the island and to the centre of Paphos. The combination of mountain and sea and the mild climate of the area is an incomparable advantage.

The main occupation of the inhabitants is primarily tourism and then agriculture and livestock farming. The area of the banana plantations in the area amounted to 119 hectares in 1985 and was the largest not only in the province of Paphos but also in the whole of Cyprus. In addition to agriculture, farming and especially sheep and goat farming have grown to a large extent.

8.2.2 Kathikas community

Located in the Pafos (Paphos) region, at an altitude of almost 700 metres, the small and traditional village of Kathikas has been inhabited since ancient times and offers agrotourism in tranquil environs. Just 23 km north of Pafos, the village can be reached by following the B7 route and then the E711, or by taking the coastal route E701, turning into the E727, and then the E709. Retaining its traditional charm, the village has residences that are over a century old and serve as fine examples of folkloric architecture, whilst it also has many old and interesting churches. The small donkey sanctuary of the village further complements the authentic character of the village

Kathikas is one of the winemaking villages of the Pafos region. Its name is said to either originate from its original owner, or from the verb 'to sit' - 'kathizo' in Greek - due to the perception that the village sits on a level location when looked at from a distance.

[http://www.visitcyprus.com/index.php/en/discovercyprus/villages/item/474-kathikas-village]

8.2.3 Drouseia community

Located in the Pafos (Paphos) region, the pretty little village of Drouseia sits at an altitude of 630 metres in the mountainous area of Laona and is thus named for the cool breeze that carries from the Akamas Peninsula, coming from the Greek word for 'cool' ('drosera').

Just 30 km away from Pafos and 10 km away from Polis, the village can be reached following either the B7 route and then the E711, or taking the E709, and then the F708.

The traditional character of the village is maintained through its stone houses with carved doors and windows, and in its narrow, winding streets that offer stunning views of hillside and coast. The tranquil and traditional environment makes Drouseia perfect for agrotourism, and accommodation is available in many small hotels, as well as the stone houses themselves.

Aside from its pretty views, the village is home to the religiously significant ancient monastery of Agios Georgios Nikoxilitis, which was built in the 15th century, and was rebuilt in 1923 after it was destroyed by a fire.

8.2.4 Pano Arodes community

The village of Pano Arodes dates from the Mycenaean era (c. 1600 – 1100 BC) and is steeped in history. It is situated in the north-western tip of the island of Cyprus, on the edge of the Akamas nature reserve, on the Laona plateau approx. 600m above sea-level.
Immersed in a landscape of vineyards and orchards, the village is tranquil and green, and popular for walks where visitors can discover the various flora and fauna of the area, as well as its little lanes of traditional stone houses.

The village is also religiously significant, thanks to its main church of Pano Arodes, which is believed by some to be the only church in the world dedicated to Agios Kalandionas, who is also the patron saint of the village.

8.2.5 Kato Arodes community

Kato (Lower) Arodes is one of the twin villages of Arodes located in the Paphos wine area Goodwin suggests that Arodes was named after the Greek island of Rhodes where the Hospitallers (who were then owners of the village) had their headquarters. In 1975 (a year after the Turkish invasion of Cyprus), Kato Arodes was abandoned and many of the buildings fell into disrepair. Some houses have now been renovated and made into holiday homes on the provision they be returned to their rightful owners in case of a settlement in the Cyprus dispute.

8.2.6 Neo Chorio community

Neo Chorio is built on the plateau of Laona, at an average altitude of 170 meters and at a distance of two kilometers from the sea. The main geomorphological feature of the plateau is a north-west to south-east direction, coinciding with the ridge of the area. A large part of this ridge

extends into the administrative area of Neo Chorio, in the section occupied by the Akamas forest. The landscape of the village is divided by numerous streams, which spring from the ridge of the plateau and end either to the western coasts of the area or to the bay of Chrysochous.

Neo Chorio receives an average annual rainfall of around 530 millimetres. In its area, olives, carob trees, citrus fruits, grains, forage plants, vines of varieties of wine, almonds, walnuts, chickpeas, few pears and few vegetables are grown. However, the largest area of the village is occupied by the state forest of Akamas. The dominant trees in the region are pine, olive trees and carob trees. The bushy vegetation is also very rich and varied. Quite rich is also the variety of wildflowers that grow in the area, also the the bushy vegetation is very rich and varied.

Neo Chorio is included in the Irrigation Project Chrysochous, which is expected to benefit in the first phase, with the irrigation of a significant area of land. On the other hand, a land reparcelling plan is being promoted to an area of about 170 hectares, which will be irrigated under the irrigation project.

8.2.7 Population

The population of the local authorities based on the 2011 census amounted to 5,489 inhabitants. More information on the evolution of the population and households in the local authorities of Akamas Peninsula is given in the table below.

	2001	**2011**
Population	3,533	5,489
Living quarters (Occupied)	1,345	2,273
Living quarters (Vacant/ Of temporary residence)	1,795	6,568
Number of households	1,345	2,286
Number of Institutions	0	0
Average household size	2.3	2.5

Table 22: Population data – total [Statistical Service of Cyprus - Census 2001, 2011]

	2001						
	Pegeia	**Kathikas**	**Drouseia**	**Pano Arodes**	**Kato Arodes**	**Pittokopos**	**Neo Chorion**
Population	3953	438	405	135	39	0	519
Living quarters (Occupied)	1666	196	142	65	15	0	189
Living quarters (Vacant/ Of temporary residence)	5269	246	270	155	69	0	559
Number of households	1675	199	142	65	15	0	190
Number of Institutions	0	0	0	0	0	0	0
Average household size	2.4	2.7	2.7	2.6	2.5	0	2.7
	2011						
Population	2362	333	386	108	19	0	325
Living quarters (Occupied)	870	146	134	56	11	0	128
Living quarters (Vacant/ Of temporary residence)	1197	146	124	84	71	0	173
Number of households	870	146	134	56	11	0	128

Number of Institutions	0	0	0	0	0	0	0
Average household size	2.7	2.3	2.9	1.9	1.7	0	2.5

Table 23: Population data [Statistical Service of Cyprus - Census 2001, 2011]

8.2.8 Economy

The following figure and table shows employment figures for the broader study area for the economically active population per productive sector and the unemployed. In the more rural areas there is a stronger employment of the population with the primary sector (mainly agriculture and livestock farming) but also with the tertiary (mainly through the provision of tourist services), while in the more urbanized and touristy developed areas of the Municipality of Pegeia and Neo Chorion, employment in the tertiary sector is more developed.

	2011							
	Pegeia	**Kathikas**	**Drouseia**	**Pano Arodes**	**Kato Arodes**	**Pittokopos**	**Neo Chorion**	**TOTAL**
Economically active population	586	74	40	12	6	0	88	**806**
Unemployed persons	80	9	5	2	0	0	5	**101**
Employed persons	506	65	35	10	6	0	83	**705**
In Primary sector (NACE A-B)	9	3	2	0	0	0	1	**15**
In Secondary sector (NACE C-F)	17	1	0	0	0	0	5	**23**
In Tertiary sector (NACE G-U)	456	61	33	9	6	0	74	**639**
Not stated	24	0	0	1	0	0	3	**28**

Table 24: Economic Activities [Statistical Service of Cyprus - Census 2011]

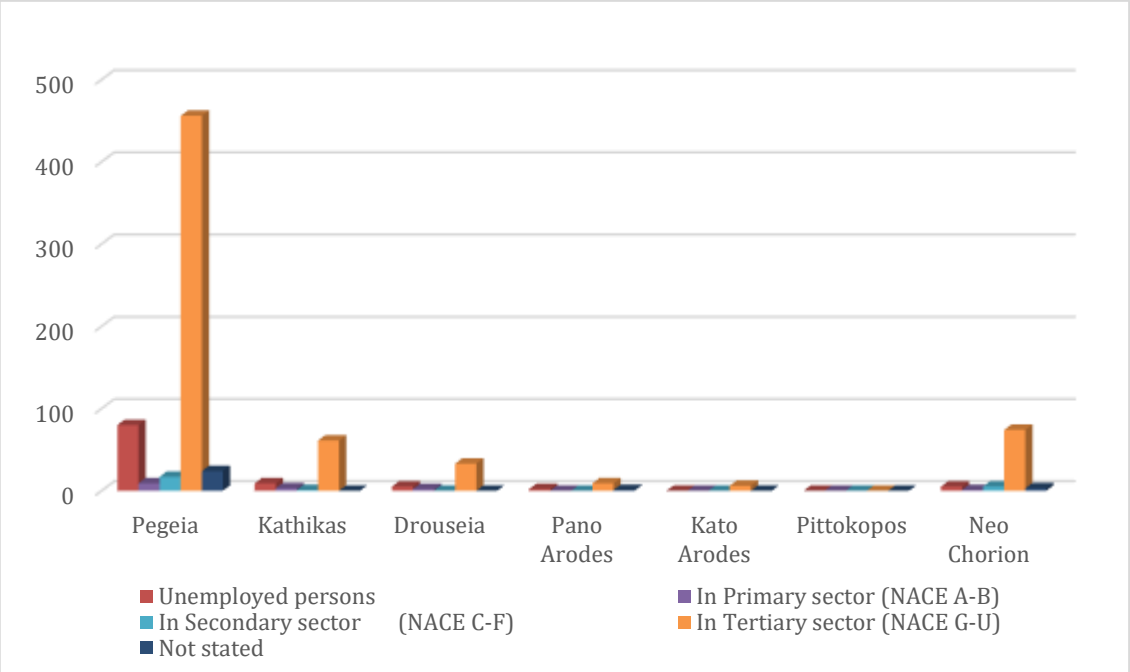


Figure 64: Economically active population over 15 years per production area and per municipality / community [Statistical Service of Cyprus – Census 2011]

8.2.9 Akamas local authorities in photos

Picture 1: Pegeia Town Hall

Picture 2: Coral Bay beach

Picture 3: Kathikas village

Picture 1: Agios Epiphanios Church – Drouseia village

Picture 5: Pano Arodes village

Picture 6: Kato Arodes village community council

Picture 7: Smiges nature trail – Neo Chorio village

Picture 8: Baths of Aphrodite – Neo Chorio village

8.2.10 Akamas Peninsula Plan for the NATURA 2000 area – under construction

The implementation period of the Management Plan is proposed to be in the order of 5 years from 2016 to 2021. After this period, and if significant changes in the physical and anthropogenic environment of the study area have been noted, a review of the terms protection and management of the protected object.

The Local Plan includes the areas of the Municipality of Pegeia and the communities of Kathika, Pano Arodes, Kato Arode, Innia, Drousia, Fasli, Androlikou and Neo Chorio.

The legal framework for the planning status of the study area, which regulates development, stems from the Policy Statement and the relevant urban areas - as they were finally adopted and approved in 2010 - by the Special Settlements of the Communities in the area of Akamas and relevant decrees.

The analysis of the urban areas of the wider area of the Akamas communities clearly shows the prevalence of the Zones of Protection, at 51.5% of the total area of the area. Also, 30.3% are the Agricultural Use Zones. Lower rates of 6.2% are allocated to uses for residential and tourist purposes, 6.9% in Farm Zones.

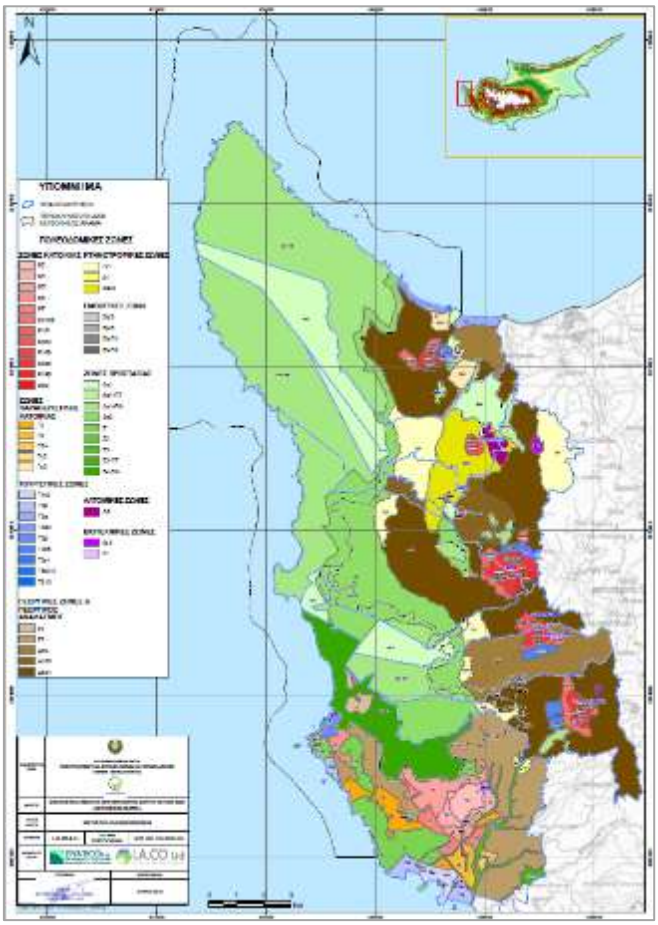


Figure 65: Map of Town Planning Zones [Akamas peninsula plan for the NATURA 2000 area]

The Akamas Local Plan aims to achieve a satisfactory conservation status of the natural environment (habitats, flora and fauna species) and especially those with high ecological but also aesthetic, geomorphological, scientific and pedagogical value.

The following main objectives can be achieved in the long term:

- Protection of important elements of the natural environment (habitats, flora and fauna species) and especially those of ecological value and the Republic of Cyprus has the obligation to ensure their satisfactory conservation status over time.
- Restoration of degraded biotopes and restoration of reduced populations of flora and fauna species.
- Protect and highlight the historical and cultural value of the area.
- Conservation and transfer to the next generations of a natural environment with excellent naturalness, representativeness and aesthetic value.
- Enhance the over-the-top and international promotion of the protected area. The aim should not only be to highlight the important elements of the natural environment and the landscape, but also the status of management and protection of the protected area.
- Establishing the bases for a dynamic protection and management regime based on the vision and general management objectives of the area that can gradually evolve and be upgraded.
- Achieve consensus of the local community about the implementation of the management plan.

- Enable Community funding for protection infrastructures (targeting green infrastructure) and environmental management.
- Sustainable development of the wider region. The over-the-top and international promotion of the important features of the protected area will result in attracting more visitors and stimulating local economies.

8.2.11 Recycling Program

The only local authority to which a collection program for recyclable materials is in place is the Municipality of Pegeia. The collection of recyclable materials within the boundaries of the Municipality of Pegeia is carried out by a contractor of the non-profit organization Green Dot of Cyprus. Green Dot (Cyprus) Public Co Ltd (GDC), was established by the CCCI (Cyprus Chamber of Comerce and Industry) on July 17, 2003, as a non-profit organization, in accordance with the provisions of Law 32 (I) / 2002. The creation of GDC stems from L.32 (I) / 2002 which defines the framework of responsibilities of companies that are considered packaging and must take care of the recovery and recycling of their packaging.

The battery recycling program (AFIS Cyprus) is also implemented in the Municipality.

A/A	Street	Point
K501	Synergatismou	Pegeia primary school
K502	Panagia Zalakiotissa	Green area
K503	Agios Georgios Avenue	Park
K504	Agios Georgios Avenue	CYTA
K505	Coral Bay beach	West kiosk
K506	Coral Bay beach	East kiosk
K507	Lysis	Samisen Japanese Restaurant
K508	Michalakis Kyprianou Avenue	Crossroad
K509	Vrisi Pegeotisswn Square	Public parking area

Table 18: Recycling Bins of PMD, Paper, Glass in the municipality of Pegeia [http://greendot.com.cy]

8.3 INVENTORY OF ENERGY CONSUMPTION IN LOCAL AUTHORITIES

8.3.1 Situation in the inventory year

The year 2009 has been selected as the inventory year. In order to proceed with the Business As Usual (BAU) energy scenario modelling and the Sustainable Energy Action Plan (SEAP) scenario, a detailed, accurate and specific description of the situation in the reference year is required.

A bottom-up computerized approach was adopted by utilizing the available computational tools to calculate the local authority's energy profile. A plurality of input data was used either as a direct energy data information (i.e. final energy demand of the categories exclusively for the local authority, fuel mix for electricity generation, etc.) or as indirect statistical and general information provided to modelling tools (i.e. demand profile energy of different categories of consumers, typical energy efficiency values of used technologies, etc.).

It should be noted that information on energy behaviour and the demand profile of the residential sector was collected from real electricity consumption data and final energy consumption statistics on households on the island in general. Where required, additional data from studies or other research results were used.

Energy data related to the local authority alone (local authority buildings, local authority lighting, local authority facilities and equipment, etc.) were collected in a coordinated way from energy bills (electricity, fuel, etc.) held in the local authorities' archives, thus creating a database for in the past years, beginning from 2009. This process has set the foundations for starting the process of monitoring the local authorities' energy profiles, thus providing the local authorities with a meaningful picture of the demand and energy costs so far.

The information gathered at this stage was presented in 2009, considering the recorded growth rates in recent years.

In addition, energy consumption data for the year 2012 and 2016 has been collected and presented which lead to conclusions on evolutionary trends based on the most recent data. It is important to note that for the year 2011 there is a reversal of the time-consuming upward trend in energy demand for two important reasons. The first reason is the impact of the economic recession on the domestic, secondary and tertiary sectors. The second major reason is the impact of the failure to cover all the electricity needs during the summer period because of a serious accident at the island's main power station (Vasilikos Station). The Demand could not be covered for a few weeks where there was a daily power outage, while the problem gradually narrowed down with calls to save energy and use temporary mobile power plants. The damage caused by the accident has been almost entirely restored in 2012.

8.3.2 Residential sector

In the table below, the results of the base year energy modelling are presented for the household sector. The most consuming energy utilities in the domestic sector are electricity and diesel, with the latter mostly covering residential heating needs. LPG is mainly used for heating and cooking, likewise the biomass, which mainly concerns the consumption of firewood, which in most cases burns in open fireplaces. Finally, solar energy is exclusively used to produce hot water through solar water heaters.

Energy source	2009 (MWh)	2012 (MWh)	2016 (MWh)
Electricity	24,463	25,986	24,997
Heating Diesel	15,756	15,400	17,164
Kerosene	2,556	2,481	1,969
LPG	7,642	8,319	7,820
Biomass (e.g. wood)	3,938	4,204	4,053
Chorcoal (for cooking)	1,521	1,624	1,566
Solar	8,778	8,838	8,520
TOTAL	**64,153**	**66,852**	**66,089**

Table 19: Demand for energy in MWh in the domestic sector [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

The typical energy demand profile for households in Cyprus is given in the graph below.

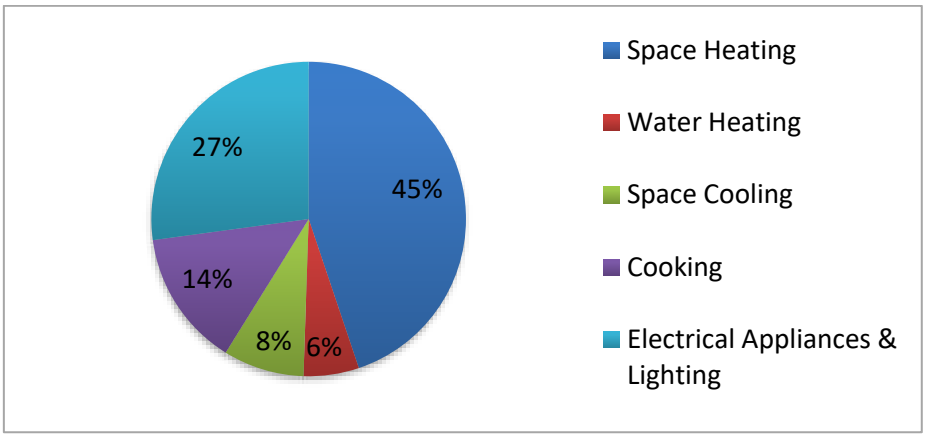


Figure 66: Share of final energy consumption by household use [Source: Statistical Service of Cyprus]

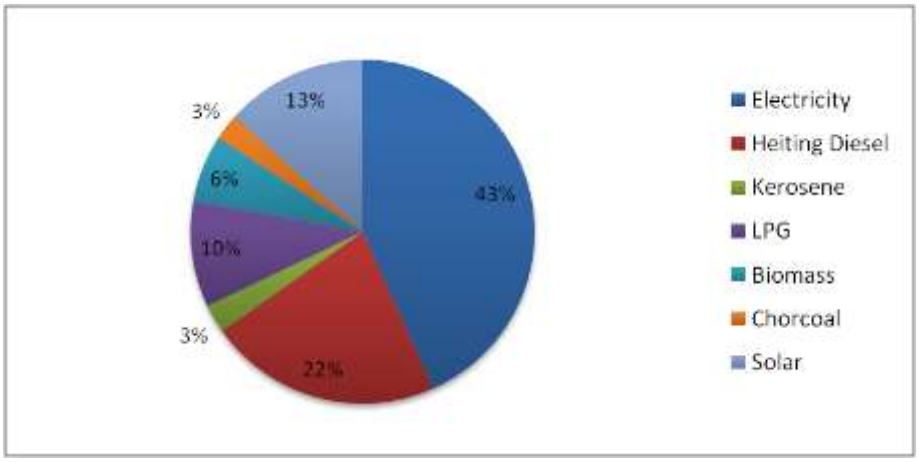


Figure 67: Share of final energy consumption per energy source in the residential sector [Source: Cyprus Statistical Service]

8.3.3 Primary sector

The following table shows the results of the energy simulation in the base year for the primary sector, mainly reflecting agricultural activities. The most commonly used energy carriers are electricity, petroleum and LPG, mostly covering irrigation, heating and cooling needs, lighting and various equipment functions.

Energy source	2009 (MWh)	2012 (MWh)	2016 (MWh)
Electricity	2,347	1,992	2,056
Heating Diesel	1,427	1,150	989
Kerosene	232	185	151
LPG	692	621	599
TOTAL	**4,698**	**3,948**	**3,749**

Table 27: Demand for energy in MWh in the secondary sector [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

8.3.4 Secondary sector

The following table shows the results for the secondary sector for the reference year as well as for the monitoring years 2012 to 2016. The main sources of energy used in this sector are electricity, petroleum products and liquefied petroleum gas. The following charts show the distribution of secondary energy demand in individual energy sources as well as in the individual energy sectors.

Energy source	2009 (MWh)	2012 (MWh)	2016 (MWh)
Electricity	1,460	1,558	654
Heating Diesel	961	970	395
Kerosene	156	156	60
LPG	466	524	239
TOTAL	**3,042**	**3,209**	**1,348**

Table 28: Demand for energy in MWh in the secondary sector [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

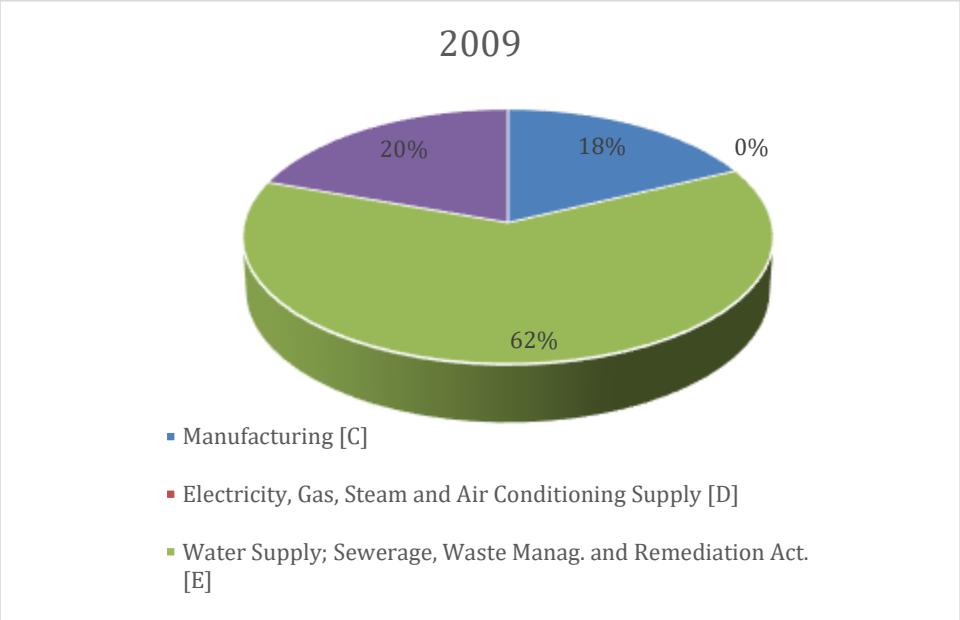


Figure 68: Share of final energy consumption per sector in the secondary sector [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

8.3.5 Tertiary sector

The following table shows the results of the energy consumption for the tertiary sector. The most used energy carriers are electricity petroleum and LPG. Solar energy is used exclusively to meet the demand for DHW from hotels and other tertiary sector buildings. It is estimated that about

50% of the tertiary sector buildings have solar panels for the production of DHW. The following chart show the distribution of tertiary sector energy demand in individual subsectors and energy sources.

Table 29: Demand for energy in MWh in the tertiary sector [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

Energy source	2009 (MWh)	2012 (MWh)	2016 (MWh)
Electricity	10,718	11,376	11,496
Heating Diesel	5,206	5,712	4,801
Kerosene	845	920	732
LPG	2,525	3,086	2,909
Solar	1,288	1,367	1,381
TOTAL	**20,581**	**22,461**	**21,319**

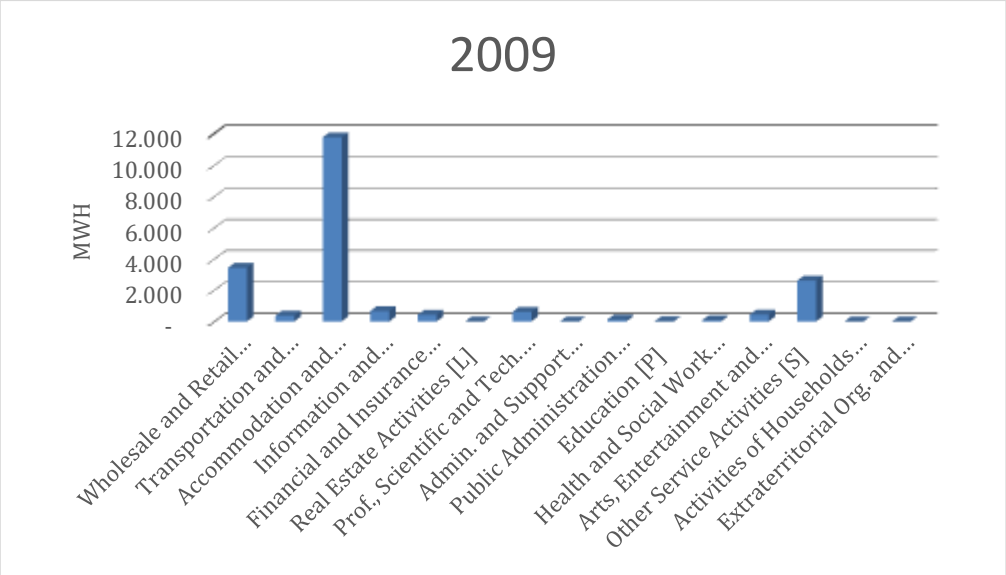


Figure 69: Share of final energy consumption per sector in the tertiary sector [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

8.3.6 Public Lighting

Road lighting is exclusively powered by the grid. The table below shows the consumption of road lighting for 2009, 2012 and 2016 on the basis of the individual categories.

Public Lighting	2009 (MWh)	2012 (MWh)	2016 (MWh)
Public Lighting - Urban areas	50	70	111
Public Lighting - Rural areas	796	1,031	972
Public Lighting - Traffic Lights	1	1	1
Public Lighting - Other Lighting	10	63	68
TOTAL	**857**	**1,165**	**1,152**

Table 30: Demand for energy in MWh in street lighting [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

8.3.7 Transport

The following table presents the results of the energy footprint of fuel consumption in the transport sector. The fuel used in the transport sector is gasoline and diesel, and biofuels used as blends in conventional fuels at a predetermined rate also have a small contribution.

Energy source	2009 (MWh)	2012 (MWh)	2016 (MWh)
Diesel	74,628	11,376	11,496
Gasoline	76,767	5,712	4,801
Biomass	3,090	920	732
TOTAL	**20,581**	**22,461**	**21,319**

Table 31: Final energy consumption in MWh in light transport [Source: Statistical Service, Cyprus Energy Agency]

8.3.8 Local electricity production from RES

Electricity generation from small renewable energy systems in the area of Akamas Peninsula is carried out by photovoltaics. The electricity production for the reference year (2009) and for the monitoring years (2012, 2016) is given in the graph below.

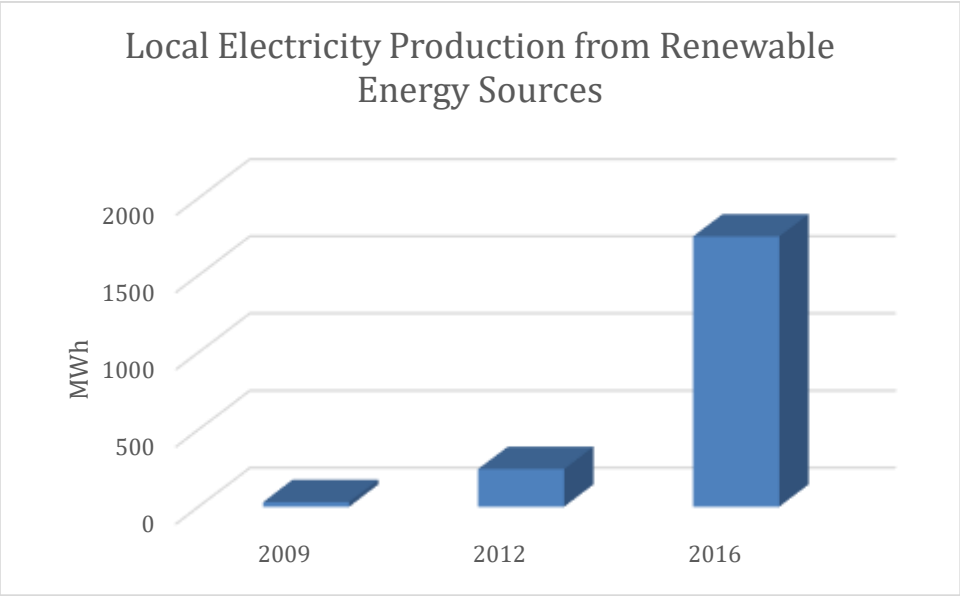


Figure 70: Generation of electricity from renewable energy sources [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

8.3.9 Overall presentation of the results for the local authorities for the inventory year

The following table presents the overall energy consumption footprint of all the local authorities for the inventory year. Diagrams are also provided showing the distribution of total final demand for energy in individual sectors and sources of energy.

	Electricity	Heating diesel	Kerosene	LPG	Diesel	Gasoline	Biomass	Solar	TOTAL
Residential	24,463	15,756	2,556	7,642	0	0	3,938	8,278	**64,153**
Primary	2,347	1,427	232	692	0	0	0	0	**4,698**
Secondary	1,460	961	156	466	0	0	0	0	**3,042**
Tertiary	10,718	5,206	845	2,525	0	0	0	1,288	**20,581**
Public Lighting	857	0	0	0	0	0	0	0	**857**
Transport	0	0	0	0	74,628	74,628	3,090	0	**154,484**
TOTAL	**39,814**[1]	**23,350**	**3,788**	**11,325**	**74,628**	**76,767**	**7,027**	**9,596**[2]	**247,816**

Table 31: Final energy consumption in MWh for 2009 [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

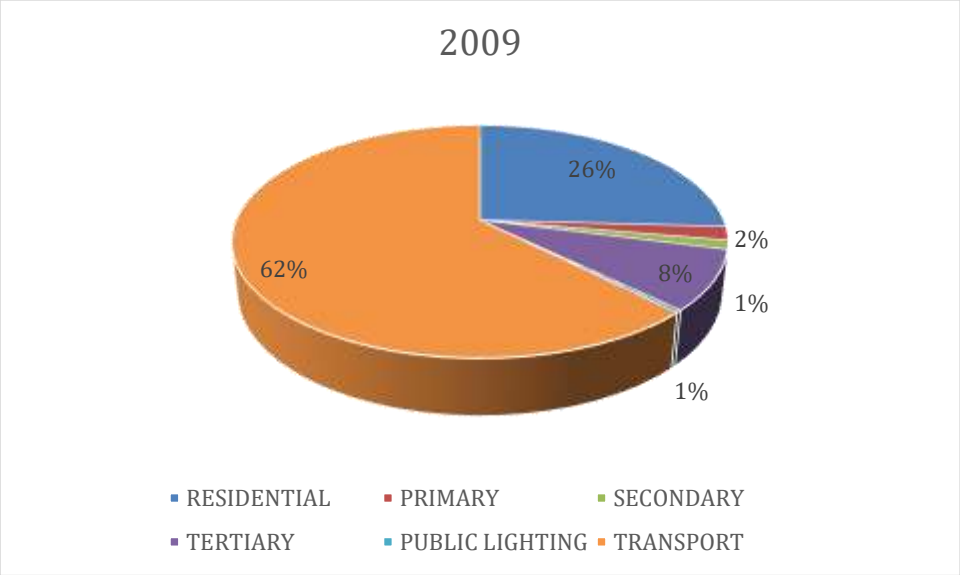


Figure 71: Share of final energy consumption by sector [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

1 The production of electricity from RES of 30 MWh has been deducted
[2] Solar power production of 30 MWh has been included

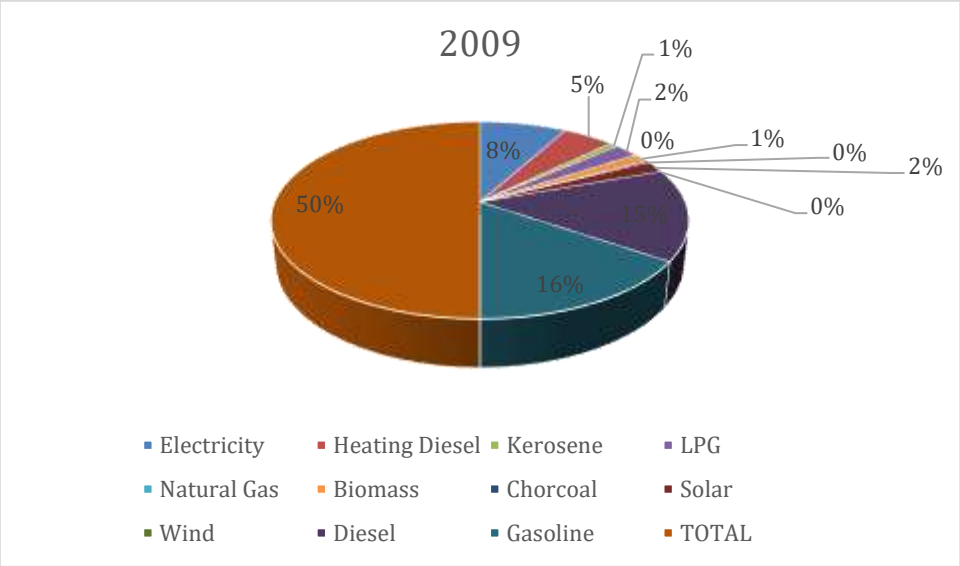


Figure 72: Share of final energy consumption per energy source [Source: Electricity Authority of Cyprus, Cyprus Energy Agency]

8.3.10 Presentation of overall results for 2009, 2012 & 2016

The table and the following graphs show the evolution of energy consumption in the Municipality for the period 2009-2016.

	2009 (MWh)	**2012 (MWh)**	**2016 (MWh)**
Residential	64153	66852	66089
Primary	4698	3948	3795
Secondary	3042	3209	1348
Tertiary	20581	22461	21319
Public Lighting	857	1165	1152
Transport	154484	136878	122540
TOTAL	**247816**	**234514**	**216244**

Table 32: Final energy consumption in MWh per sector for the period 2009, 2012, 2016 [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

	2009 (MWh)	**2012 (MWh)**	**2016 (MWh)**
Electricity	39814	41835	38604
Heating Diesel	23350	23232	23349
Kerosene	3788	12550	2912
LPG	11325	7914	11567
Natural Gas	0	0	0
Biomass	7027	1624	7376
Charcoal	1521	6999	1566

Solar	9596	10448	11653
Wind	0	0	0
Diesel	74628	70795	63167
Gasoline	76767	62373	56049
TOTAL	**247816**	**234514**	**216244**

Table 33: Final energy consumption in MWh per energy source for the period 2009, 2012, 2016 [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

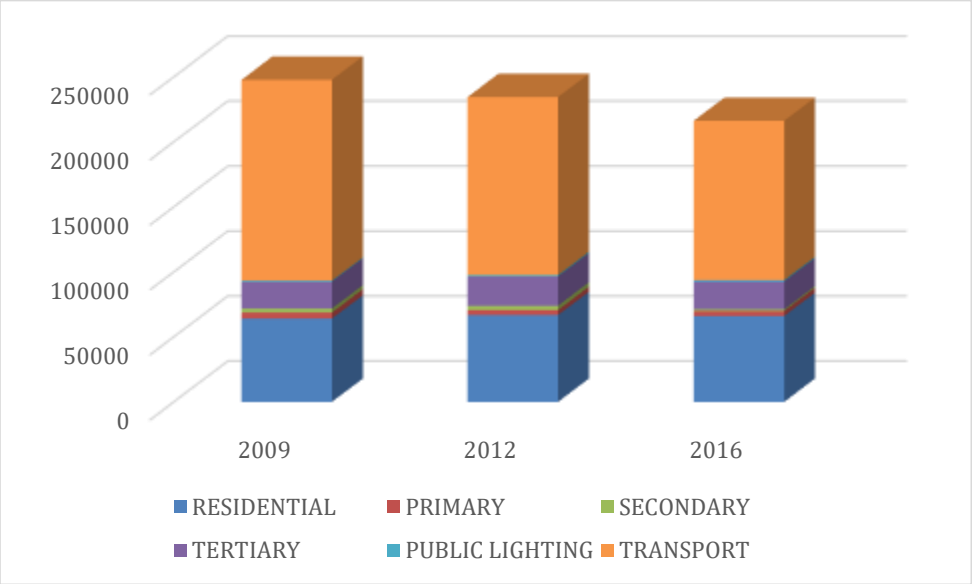


Figure 73: Share of final energy consumption by sector for 2009, 2012, 2016 [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

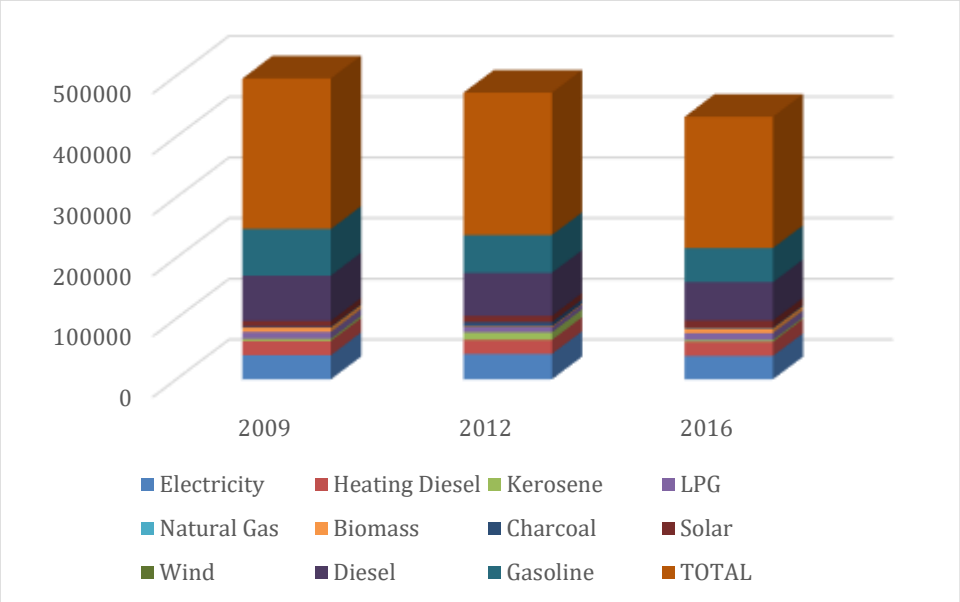


Figure 74: Share of final energy consumption by energy source for 2009, 2012, 2016 [Source: Cyprus Electricity Authority, Cyprus Energy Agency]

8.4 INVENTORY OF CARBON DIOXIDE (CO2) EMISSIONS

For the calculation of carbon dioxide emissions, standard emission factors were used on final energy consumption according to energy source and use. Renewable energy sources based on these factors are considered to have zero carbon dioxide emissions.

	Energy Source	**Emission factors tones CO_2/MWh (IPCC)**
Fossil Fuels	Heating oil	0.267
	Diesel	0.267
	Gasoline	0.249
	Natural gas	0.202
	Liquid gas	0.240
	Electricity	0.874
RES	Wind	0
	Hydroelectric	0
	Solar	0
	Geothermal	0
	Biomass	0

Table 34: CO2 Emission factors

	2009 (tones CO_2)	**2012 (tones CO_2)**	**2016 (tones CO_2)**
Electricity	34798	36564	33740
Heating Diesel	6234	6203	6234
Kerosene	1011	999	778
LPG	2718	3012	2776
Diesel	19926	18902	16866
Gasoline	19115	15531	13956
TOTAL	**83802**	**81211**	**74350**

Table 35: Share of CO2 emissions per energy source in the local authorities for the years 2009, 2012, 2016

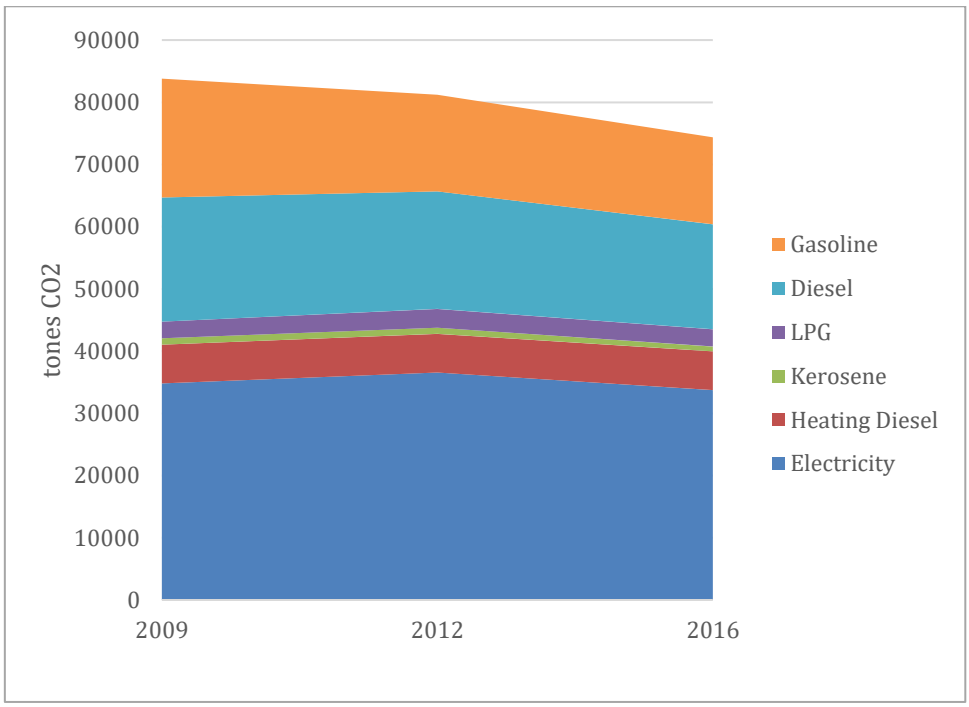


Figure 75: Total CO2 emissions per energy source for the period 2009-2016

CO2 emission forecasting scenario

For the projection of CO_2 emissions in the period 2009 to 2030, the scenario of expected development has been prepared that includes the following main assumptions:

1. Use of annual rates of change in energy consumption by sector based on the available statistical data available to the designers when drawing up the Energy Action Plan.
2. Estimation of the efficiency factor of the Cyprus power stations for the next years taking into account the improvement of the technology, the modernization of the existing equipment.
3. Gradual introduction use and integration into the natural gas system.
4. Standardized annual rates of change were used for the Akamas peninsula local authorities assuming that Pegeia Municipality and Neo Chorion belongs to the category "touristic growing" and the other Communities belongs to the category "village".
5. Including the National Energy Savings Target of Cyprus for savings of 1% per year based on the National Energy Saving Action Plan.

8.5 SUSTAINABLE ENERGY ACTION PLAN

8.5.1 Introduction

The joint Sustainable Energy and Climate Action Plan prepared for the 6 local authorities of Akamas peninsula includes additional measures / actions to attain at least the European target for combating climate change. That is, the measures that will be taken by the Municipality in addition to the national measures in order to overcome the target of reducing CO_2 emissions by at least 40% by 2030 compared to the reference year in 2009. The target adopted for the local authorities is 40% and is equivalent to a reduction in emissions of 13,242 tonnes.

The contribution of national measures is assessed and taken into account in the BAU, but the local authorities can not determine the achievement of the National Objectives. However, many of the measures proposed to be implemented locally will act as supportive and complementary measures to national measures to achieve the objectives.

Measures are divided into the following key areas:

MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES
TERTIARY BUILDINGS, EQUIPMENT/FACILITIES
RESIDENTIAL BUILDINGS
PUBLIC LIGHTING
TRANSPORT
LOCAL ELECTRICITY PRODUCTION
OTHER

8.5.2 Municipal buildings equipment/facilities

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES										
Energy Audits and issue of EPC to Local Authorities Buildings	Integrated action (all above)	Building standards	Local authority	Akamas local authorities	2018	2018	8640	0	0	0
Educational presentation at the Local Authorities office staff on Energy Saving	Behavioural changes	Awareness raising / training	Local authority	Akamas local authorities, Cyprus Energy Agency	2018	2020	200	55	0	48
Internal regulations for recycling in offices	Other	Other	Local authority	Akamas local authorities	2019	2019	1000	70	0	60
Roof thermal insulation in Local Authorities Buildings	Building envelope	Building standards	Local authority	Akamas local authorities	2018	2022	60000	100	0	87
Replacement of existing cooling units in Local Authorities Buildings with high energy efficiency system	Building envelope	Building standards	Local authority	Akamas local authorities	2020	2022	10000	50	0	44

Table 36: Municipal Buildings, Equipment/ Facilities key actions

8.5.3 Tertiary buildings, equipment/facilities

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TERTIARY BUILDINGS, EQUIPMENT/FACILITIES										
Construction of parking space for bicycles in new buildings (5% of the car park) (Special provision in building permit)	Other	Land use planning regulation	Local authority	Akamas local authorities	2018	2025	0	976	0	260
Construction of charging point for Electric Vehicles in new buildings (Special provision in building permit)	Other	Land use planning regulation	Local authority	Akamas local authorities	2018	2025	0	976	0	260
Enhancing the Implementation of the Energy Performance of Buildings Law N.15(I)/2017 (Audits whether the new or existing buildings comply with the law)	Integrated action (all above)	Building standards	Local authority	Akamas local authorities	2018	2025	0	617	0	347
Increase the energy renovation rate of buildings (e.g reduced fee for building permits in buildings	Integrated action (all above)	Grants and subsidies	Local authority	Akamas local authorities	2018	2025	0	617	0	347

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TERTIARY BUILDINGS, EQUIPMENT/FACILITIES										
undergoing energy renovation)										
Establishment of working group between the Local Authorities and representatives of tourism industry	Other	Other	Local authority	Pegeia Municipality, Neo Chorion	2020	2025	0	110	0	96
Promotion of ISO5001 or/and Energy Audits or/and EMS	Other	Awareness raising / training	Covenant Territorial Coordiantor	Pegeia Municipality	2020	2030	0	617	0	347

Table 37: Tertiary Buildings, Equipment/ Facilities key actions

8.5.4 Residential buildings

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
RESIDENTIAL BUILDINGS										
Construction of parking space for bicycles in new buildings (5% of the car park) (Special provision in building permit)	Other	Land use planning regulation	Local authority	Akamas local authorities	2018	2025	0	976		260
Construction of charging point for Electric Vehicles in new buildings (Special provision in building permit)	Other	Land use planning regulation	Local authority	Akamas local authorities	2018	2025	0	976		260
Enhancing the Implementation of the Energy Performance of Buildings Law N.15 (I)/2017 (Audits whether the new or existing buildings comply with the law)	Integrated action (all above)	Building standards	Local authority	Akamas local authorities	2018	2025	0	617		347
Increase the energy renovation rate of buildings (e.g reduced fee for building permits in buildings	Integrated action (all above)	Grants and subsidies	Local authority	Akamas local authorities	2018	2025	0	617		347

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
RESIDENTIAL BUILDINGS										
undergoing energy renovation)										
Providing informative material and guidelines through the Local Authorities websites on the use and proper siting of solar and PV panels	Other	Awareness raising / training	Local authority	Akamas local authorities	2018	2025	0		40	35
Energy visits in residential buildings	Behavioural changes	Awareness raising / training	Local authority	Akamas local authorities, Cyprus Energy Agency	2019	2025	5000	18		10
Promotion of energy renovations through the Ministry of Energy's funds plan "Εξοικονομώ - Αναβαθμίζω στις Κατοικίες"	Integrated action (all above)	Grants and subsidies	Other (national, regional,...)	Akamas local authorities, Ministry of Energy, Commerce, Industry and Tourism	2018	2020	1750000	349	46	305

Table 38: Residential Buildings key actions

8.6.1 Public lighting

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
PUBLIC LIGHTING										
Energy efficient street lighting	Energy efficiency	Public procurement	Local authority	Pegeia Municipality, Cyprus Energy Agency	2020	2030	1000000	557		487
Energy Efficiency Improvement of public places lighting	Energy efficiency	Other	Local authority	Akamas local authorities	2020	2022	750000			
Energy efficient traffic lighting	Energy efficiency	Public procurement	Local authority	Pegeia Municipality, Department of Public Works	2022	2025	20000			
Maintenance of festive decoration lighting (LED lamps for festive decoration lighting is a requirement in public procurement)	Energy efficiency	Public procurement	Local authority	Akamas local authorities	2019	2020	5000			

Table 39: Public Lighting key actions

8.5.6 Transport

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TRANSPORT										
Establishment of Local Authority fleet management office for more efficient use and control of municipal vehicles	Other	Other	Local authority	Pegeia Municipality	2020	2022	20000			
Training of the staff (drivers) on eco-driving	Eco-driving	Awareness raising/training	Local authority	Pegeia Municipality, Cyprus Energy Agency	2019	2020	500			
Utilization of bicycles by Local Authority police (2 bicycles)	Modal shift to walking & cycling	Other	Local authority	Pegeia Municipality	2020	2025	3000			
Improving bus stops infrastructure	Road network optimisation	Other	Local authority	Akamas local authorities	2020	2025	1000	976		260
Park and Ride (Bus station and bike renting facilities)	Car sharing/pooling	Other	Local authority	Akamas local authorities	2020	2025	20000	976		260
Upgrading the network of cycle paths	Modal shift to walking & cycling	Other	Local authority	Akamas local authorities	2020	2025	80000	976		260
Electric vehicle charging stations (10)	Electric vehicles (incl. infrastructure)	Integrated ticketing and charging	Local authority	Akamas local authorities	2025	2030	50000	1628		435

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
TRANSPORT										
Free parking for electric cars in public spaces	Cleaner/efficient vehicles	Integrated ticketing and charging	Local authority	Akamas local authorities	2020	2025	0	976		260
Construction of bicycle parking spaces in squares, parking areas, bus stops and parks	Modal shift to walking & cycling	Other	Local authority	Akamas local authorities	2019	2022	2000	976		260
Implementing measures such as strict fine for illegal parking and obstacles preventing illegal parking, facilitating the movement of pedestrians and promoting walking	Modal shift to public transport	Other	Local authority	Pegeia Municipality	2019	2025	8000	976		260
Events promoting electric vehicles	Electric vehicles (incl. infrastructure)	Awareness raising/training	Local authority	Akamas local authorities, Cyprus Energy Agency	2018	2022	1000	450		120

Table 40: Transport sector key actions

8.5.7 Local electricity production

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
LOCAL ELECTRICITY PRODUCTION										
Installation of photovoltaic systems in Local Authorities buildings (50kW)	Photovoltaics	Other	Local authority	Akamas local authorities	2019	2020	75000		90	79

Table 41: Local Electricity production key actions

8.5.8 Others

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
OTHERS										
Reconstruction of theLocal Authorities Centres	Urban regeneration	Other	Local authority	Akamas local authorities	2018	2025	10000000	3190	0	852
Landscaping public spaces (benches, pedestrian paths, green	Urban regeneration	Other	Local authority	Akamas local authorities	2018	2025	10000	319	0	85

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
OTHERS										
spaces) - promoting walking in the Local authorities Centres										
Planting trees and installing shades and fountains in squares, and outdoor public spaces to improve the pedestrian streets during the summer months	Tree planting in urban areas	Other	Local authority	Akamas local authorities	2018	2030	20000	319	0	85
Development of Green Spaces	Tree planting in urban areas	Land use planning	Local authority	Akamas local authorities	2018	2025	5000		0	8
Reducing the volume of local authority waste - Objective is to reduce solid waste by 15% by 2020	Waste & wastewater management	Other	Local authority	Akamas local authorities	2020	2030	30000	1542	0	1348
Exploitation of green waste for compost and production of biomass products	Waste & wastewater management	Other	Local authority	Akamas local authorities	2020	2030			270	80
Adoption of green procurement practices	Other	Other	Local authority	Akamas local authorities	2018	2030	0	44	0	38
Contact point for energy advices to the public	Other	Awareness raising / training	Local authority	Pegeia Municipality, Cyprus Energy Agency	2020	2030	10000	338	338	593

Key Actions by 2030	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030		
								Energy savings	Renewable energy production	CO_2 reduction
					Start	End	€	MWh/a	MWh/a	t CO_2/a
OTHERS										
Educational presentations at schools on Renewable Energy Sources, Energy Saving, Sustainable transport	Other	Awareness raising / training	Local authority	Akamas local authorities, Cyprus Energy Agency	2018	2030	3000	405	405	710
Establishment of Green Fund in Local Authorities (green taxes)	Other	Other	Local authority	Akamas local authorities	2019	2030	0	0	0	0
Annual sustainable energy day	Other	Awareness raising / training	Local authority	Akamas local authorities, Cyprus Energy Agency	2019	2030	6000	371	371	650
Information and awareness of the citizens on climate change, energy, sustainable transport, recycling through the Local Authorities websites and social media sites	Other	Awareness raising / training	Local authority	Akamas local authorities	2018	2030	2000	162	162	284

Table 42: Other key actions

8.5.9 Summary of the measures

The total energy savings from the implementation of the SECAP are 24,272 MWh and from the use of renewable energy sources 3,072 MWh. The reduction of CO_2 emissions is 13,272 tonnes for 2030 and the total budget of the SECAP is € 13,962, The results are presented in the tables below.

Key Areas	Implementation cost [€]	Energy savings [MWh/year]	RES [MWh/year]	CO2 reductions [tCO2/year]
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES	79840	275	0	239
TERTIARY BUILDINGS, EQUIPMENT/FACILITIES	0	3913	0	1657
RESIDENTIAL BUILDINGS	1755000	3553	86	1564
PUBLIC LIGHTING	1775000	557	0	487
TRANSPORT	185500	7934	0	2115
LOCAL ELECTRICITY PRODUCTION	75000	0	90	79
OTHERS	10092000	8040	2896	7101
TOTAL	**13962340**	**24272**	**3072**	**13242**

Table 43: Summary of measures to be taken by the Local Authorities and included in the Energy Action Plan

8.5.10 Sustainable Energy and Climate Action Plan 2018-2030

The Sustainable Energy and Climate Action Plan (SECAP) scenario has been prepared taking into account the assumptions made in the BAU as well as the reduction of CO_2 emissions from the measures planned to be implemented. The scheduling of the implementation of the SECAP measures can be considered as a long-term.

With the implementation of the joint SECAP, the Local Authorities are expected to achieve energy savings and production from Renewable Energy Sources equal to 27,344 MWh, equivalent to a reduction in carbon dioxide emissions by 13,242 tonnes for the year 2030.

The CO_2 emissions for the year 2030 with the implementation of the SECAP shall be calculated using the equation:

$$SECAP = BAU - SAVINGS$$

Where,

SECAP: CO_2 emissions for 2030 based on the Sustainable Energy and Climate Action Plan in tonnes

BAU: CO_2 emissions for 2030 on the basis of the Business As Usual scenario in tonnes

SAVINGS: Reductions in CO_2 emissions for the year 2030 from the implementation of the Sustainable Energy and Climate Action Plan measures in tons

The CO_2 reduction target for the year 2030, with inventory year 2009, is calculated by the equation:

$$TARGET = 1 - \frac{\text{SECAP}}{\text{BEI}}$$

Where,

TARGET: The percentage reduction of CO_2 emissions for the year 2030 compared to the inventory year

BEI: CO_2 emissions for the reference year 2009 in tonnes

Inventory year emissions 2009 (tones CO_2/year)	Sustainable Energy and Climate Action Plan 2020 SECAP Scenario (tones CO_2/year)
BEI	SECAP Scenario
44,781	13,242

Table 44: Summary of CO2 emissions for BEI and SEAP scenarios

8.6 CLIMATE CHANGE RISKS AND VULNERABILITIES

8.6.1 Recording of observed and future climate changes

From the analysis of the meteorological data of the stations in the island for the periods 1903-2016, was noticed an increase in the average temperature of the atmosphere by 1.5 - 2.3 ^{o}C depending on the area.

According to the future forecasts, the largest decreases in rainfall are expected in the period 2071 - 2100 where the results show that on the Akamas peninsula area, the decrease will be 100 - 130 mm per year. With regard to extreme heat effects, the annual number of very hot days (temperatures above 35 ° C) is expected to increase by 5 days in the wider area of the Akamas peninsula for the period 2021 - 2050.

In addition, climate change has a significant impact on biodiversity. Climate change, together with land use change and the spread of exotic or foreign species, are likely to limit the ability of some endemic species to migrate, leading to an acceleration of species loss.

The assessment of the impact of climate change on the agricultural sector of the study area has highlighted as a priority the impact on crop yield, which is expected to decrease due to a decrease in the availability of irrigation water.

Similarly, the impact assessment of climate change has also been highlighted in the forests of the Akamas peninsula, where they have a high vulnerability to drought, parasite projections and fires

8.6.2 Climate Change Risk and Vulnerability Assessment

The tables below show the climatic hazard types as well as the expected impacts they have or will have on local authorities of the Akamas peninsula.

Climate Hazard Type		Current hazard risk level	Expected change in intensity	Expected change in frequency	Timeframe	Risk-related indicators
Extreme Heat		High	Increase	Increase	Current	for 2020-2050 an increase of very hot days (> 35°C) is estimated in 2-5 days
Extreme Cold		Low	Decrease	Not known	Medium-term	increasing days with a temperature above 40°C and significantly reducing days below 0oC
Extreme Precipitation		Low	Increase	No change	Long-term	reduction of annual rainfall by 17%
Floods		Low	Increase	No change	Medium-term	increased floods
Sea Level Rise		Low	Increase	Increase	Long-term	by 2080 approximately 20% of coastal wetlands will be lost
Droughts		High	Increase	Increase	Current	increase in dry days by 6-10 days in 2020-2050
Storms		Moderate	Increase	Increase	Long-term	worsening of extreme effects
Landslides		Moderate	Increase	Increase	Medium-term	The loss of natural plants and trees from droughts increase the landslides
Forest Fires		High	Increase	Increase	Short-term	for the period 2020-2050 an annual maximum temperature increase of 1.3-1.9°C is calculated
Other	**Dust**	High	Increase	Increase	Current	

Table 45: Climate hazard risks particularly relevant to Akamas peninsula local authorities

Impacted Policy Sector	Expected Impact(s)	Likelihood of Occurrence	Expected Impact Level	Timeframe
Buildings	Increased demand for cooling	Likely	High	Short-term
Transport	damage to transport infrastructure	Likely	Low	Medium-term
Energy	damage to electrical infrastructure (cables)	Likely	High	Medium-term
Water	increased water scarcity need of desalination systems	Likely	High	Current
Waste	damage to waste infrastructure	Unlikely	Low	Long-term
Land Use Planning	desertification of areas, moving to urban centres	Likely	Moderate	Medium-term
Agriculture & Forestry	crop yield degradation, forest health degradation	Possible	Moderate	Short-term
Environment & Biodiversity	species migration, extinction of rare species of flora and fauna	Likely	High	Medium-term
Health	increased disease, reduction of life expectancy	Possible	High	Medium-term
Civil Protection & Emergency	increase in the number of fires, floods	Likely	High	Short-term
Tourism	reduction of agritourism	Possible	Low	Medium-term

Table 46: Expected impacts in local authorities

8.6.3 Climate Adaptation Strategy

To address the impact of climate change on the Akamas peninsula area, the main measures were assessed and selected. This assessment was based on the impact assessment and adaptation capability, stakeholders' views, as well as the risk assessment of the impact of climate change in Cyprus.

The main actions for addressing the impact and adaptation of Cyprus to climate change are presented for each sector.

Sector	Title	Short description	Responsible body/department	Implementation timeframe		Implementation status
				Start	End	
Other	Upgrade the requirements for construction of harbours and small harbours, so that the increase in the sea level would be considered	Review the standards for the construction of harbours in such a way that the changing climate has been considered	Akamas local authorities, Ministry of Transport, Communications & Works,	2019	2025	Ongoing
Other	Ensure the sustainable management of sea fish by considering the climate risks in the Mediterranean Sea	Informative events on new fishing methods, species and their potential use will be disseminated	Akamas local authorities, Ministry of Agriculture, Rural Development and Environment	2020	2030	Ongoing
Other	Ensure an optimal mining and quarrying industry that takes into account climate change impacts	Mining and quarrying activities proceed in line with the climate change impacts	Akamas local authorities, Ministry of Agriculture, Rural Development and Environment	2020	2030	Not started
Land Use Planning	Green parks, spaces	Increase, upgrade and promoting green parks and spaces in the administrative boundaries of the local authorities. Abandoned municipal/community land can by used for the development of green spaces.	Akamas local authorities, Ministry of Interior, Public Works Department	2020	2030	Ongoing

Land Use Planning	Adapting the Spatial Planning Act	Make a requirement in the spatial planning act promoting permeable materials in the planning and building permits	Akamas local authorities, Ministry of Interior, Public Works Department	2020	2030	Not started
Land Use Planning	Adapting the Spatial Planning Act	Make a requirement in the spatial planning act that forbids the further extension of hardened surfaces compared to the baseline both for roads and parking lots	Akamas local authorities, Ministry of Interior Public Works Department	2020	2030	Not started
Buildings	Supporting the local renewable energy solutions for buildings	Increase the local production of renewable energy for buildings (pv, biomass)	Akamas local authorities	2019	2030	Ongoing
Buildings	Promoting green roofs on buildings	Support the installation of green roofs in the local/public/private buildings (Grant schemes or other initiatives - dissemination)	Akamas local authorities	2020	2030	Not started
Water	Support the collection of rainwater	Incentives, such as reduced fees and taxes on the installation of rainwater collection systems in homes.	Akamas local authorities	2019	2025	Not started
Water	Maintenance and repair of water systems	Continuous replacement and repair of all old and poorly maintained water distribution networks and leakage detection	Akamas local authorities, Water Development Department	2018	2030	Ongoing
Water	Screening and avoidance of waterborne developments in areas with insufficient water resources (golf courses, high water consumption crops)	Redefining the authorization and prohibition criteria for high water consumption development	Akamas local authorities	2020	2030	Not started

Water	Strengthening the efficient use of water in buildings, agriculture and industry	Workshops for the use of low water consumption equipment and more efficient household appliances. Informing farmers about new irrigation practices.	Akamas local authorities, Cyprus Energy Agency	2018	2020	Not started
Agriculture & Forestry	Ensure the current level of productive farmland and to introduce new climate resilient crop types	Implementation of new climate friendly practices to protect the soils. Awareness raising.	Akamas local authorities	2020	2030	Not started
Agriculture & Forestry	Training of farmers to use recycled water to irrigate selected crops	Campaigns to inform farmers about (a) the necessity of using the resource and the benefits of its use such as increasing production, (b) the environmental costs of groundwater depletion	Akamas local authorities	2020	2030	Not started
Agriculture & Forestry	Reforestation / rehabilitation of forest areas affected by fires	Selection and use of suitable forestry species with high resistance to adverse climatic conditions	Akamas local authorities, Department of Forests	2018	2030	Ongoing
Agriculture & Forestry	Strengthening fire prevention measures	Strengthen infrastructure to improve fire protection of forests (e.g. fire-fighting lanes, forest roads)	Akamas local authorities, Cyprus Fire Service	2018	2030	Ongoing
Environment & Biodiversity	Conservation and protection of natural habitats and wildlife	Measures for protecting species (plants) from moving to higher altitude due to climate change and eventually to extinction	Akamas local authorities, Department of Forests	2018	2030	Ongoing

Environment & Biodiversity	Conservation and protection of natural habitats and wildlife	Incentives (sponsorship) to landowners to implement measures that contribute to the conservation of habitats and wildlife	Akamas local authorities	2018	2030	Ongoing
Health	Provide instructions for individual protection against the effects of climate change	Information material and training seminars on the impacts of climate change on health and how to deal with them	Akamas local authorities, Cyprus Energy Agency	2020	2025	Not started
Health	Empowerment / creation of local health centres	Create an emergency plan in case of disease outbreaks or extreme weather events. Identification of areas where the vulnerable population groups can be protected from heatwaves, dust, floods etc	Akamas local authorities	2020	2030	Not started
Energy	"Greening" of local authorities	Greening the local authorities to avoid / reduce the thermal isle effect with the aim of reducing energy consumption for cooling.	Akamas local authorities	2018	2030	Ongoing
Waste	Recycling treatment and exploitation of liquid and solid waste	Recycling and treatment of liquid waste, so it can be used in the irrigation of specific crops	Akamas local authorities, Ministry of Agriculture, Rural Development and Environment	2020	2030	Not started
Civil Protection & Emergency	Announcements regarding the dust in the atmosphere and the high temperatures	Frequent prohibitive announcements from the Department of Labour Inspection concerning outdoor work when there are high levels of dust in the atmosphere and heat waves	Department of Labour Inspection, Akamas local authorities-technical department	2018	2030	Ongoing
Tourism	Informing tourists about water save, fires and the protection of the flora and fauna of the area	Informing tourists through various means (flyers, website, social media) about the water save, fire hazard and the protected species in the area	Cyprus Tourism Organization, Akamas Local authorities	2018	2030	Ongoing

Table 47: Adaptation Actions

9. CONCLUSIONS

Sustainable Energy Action Plans (SEAPs) and/or Sustainable Energy and Climate Action Plans (SECAPs) have become a powerful tool for Local Authorities to plan, implement, monitor, and evaluate climate and energy policies, and contribute to global mitigation and adaptation achievements. Through SEAPs/SECAPs, Local Authorities can implement measures in a structured and integrated way, allowing them to systematically monitor their efforts in going beyond national legislation in these fields. A SEAP/SECAP is also an instrument for local authorities to communicate to stakeholders the importance of energy and climate protection, and to encourage citizens and other relevant actors to take part in the city's ambitions.

Cooperation between different levels of governance (i.e. national, regional, local) is critical in order to meet the EU goals for the period between 2020 and 2030, in the area of energy and climate change.

REFERENCES

1. The Covenant of Mayors – *How to develop a sustainable energy action plan*, www.eumayors.eu
2. Sustainable Energy Action Plans by the Cyprus Energy Agency, www.cea.org.cy/LocalEnergy.html