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REGIONE AUTONOMA DELLA SARDEGNA

PACT OF ISLANDS

# ISLAND SUSTAINABLE ENERGY ACTION PLAN

(ISEAP)

***The ISLAND of Sardinia***

**APRIL 2012**

# Executive Summary

## Background

### ISEAP in Regional Planning

The Island Sustainable Energy Action Plan (ISEAP) is part of the broader context of the Autonomous Region of Sardinia planning and direction. It is an instrument of support for both the assessment of climate-altering greenhouse gas emissions and the identification of all potentially more effective actions for achieving EU emissions reduction targets of 20% by 2020 compared to 2005 levels. The Island Sustainable Energy Action Plan development is one of the operational tools developed by the Autonomous Region of Sardinia, representative of the strong political commitment to determine and support sustainable development. Moreover this activity integrate itself into ongoing actions promoted by the Autonomous Region of Sardinia, directed to develop methods and models for the organic and coordinated development of its own territory energy system.

In this context, the Regional Council has approved and formally launched the program "Sardinia CO2.0", in April 2010, with the strategic aim to activate a set of integrated and coordinated actions designed to progressively reduce CO2 emissions, with the aim to make the final budget of the climate-altering emissions tend to zero. Amongst energy planning tools Sardinia Region has promoted the establishment of a new draft Energy and Environmental Plan (PEARS) and the Reference Document on renewable energy sources, in December 2010, with the explicit intention to define the contribution of the Island to achieve the objectives set by the European Union in 202.

By Resolution of the Regional Council n. 12/21 of 20.03.2012, as a result of consultation with the Government and Italian Regions, the Reference Document on renewable energy sources has been approved in order to implement the contents of the Decree Burden Sharing, where addresses, scenarios and strategies for the achievement of units of renewable assigned to the Region are defined. This document is therefore the basis on which the ISEAP is based.

Also as part of the "Sardinia CO2.0", the Region of Sardinia starts formally and approves the project "Smart City - Municipalities in class A", April 2011. The aim of the project is to realize integrated projects consistent with the planning

methodology of the "Covenant of Mayors", aimed at reducing CO2 emissions at the local level.

The main regional planning instruments in the energy sector are completed by formal adherence by the Region of Sardinia to the European program "Covenant of Mayors" and the European project "The Pact of Islands", April 2011. The EU project "The Pact of Islands" directly involves the Region of Sardinia to the achievement of 20 - 20 - 20 by 2020. A commitment signed by the President of the Region of Sardinia in Brussels on April 12 2011, in line with the already strategic approved plans and in line with the European Union.

## Guidelines of the ISEAP Sardinia

The Sustainable Energy Plan of the Region of Sardinia is a living document that, in accordance with the strategic objectives, takes into account the necessary adjustments on the basis of the actions monitoring of the same plan.

A need, however, not only due to market developments and technological innovations but also to the complexity and size of the island energy system.

The Region of Sardinia, together with the choice of NO to nuclear power, attested by the results of the referendum of 2011, promoted the commitment to proceed technological modernization of the island energy system. A process contained in the acts of the regional planning having as interest and overriding objective the economic and social development, together with that of the protection and improvement of environmental quality.

The essential guidelines that form the basis of the ISEAP are summarized as follows:

- The commitment of the European Action Plan objectives, 20-20 - 20, and the respect and improvement of the targets set by the National Action Plan for the region, through the Decree MISE, in March 2012, the so-called "Burden sharing".

In this context, in addition to measures for savings, energy efficiency and development of renewable energy, ISEAP Sardinia takes as its essential elements, but not limited to:

a)The use of natural gas as an essential strategic choice in terms of energy, environment and economy for Sardinia. It is not possible to achieve the objectives set by the EU and the national system, and it is also not

possible to keep up with the other European countries (enterprise development, economy, social system, quality of the environment) without the contribution of methane in various sectors. While, on the one hand the Region of Sardinia is called, and it is committed to achieving the European and national objectives in the field of energy efficiency and renewable energy development, on the other hand the National and European system has to respect the commitment taken in various locations and over time, for the island methanization. In this framework methane use is foreseen in the industrial, civil, transport sectors and in the production of electricity, with particular reference to the generation sites in northern Sardinia. Methane supply will take place in the most appropriate ways, through the international project GALSI, or the national variant Piombino - Olbia or methane boats.

b)The use of coal from Sulcis, also considered a strategic and essential choice for promoting the mix of energy sources and the security of energy supply, in particular by reference to new technologies for efficient use of raw materials. In this context it is planned the construction of a new power plant capacity of approximately 350/400 MW and the creation of an innovative capture and CO2 (Carbon Capture and Storage CCS), the latter also as a result of an analysis technical and economic analysis;

c) The confirmation of the strategic importance of the current industrial poles and all current electric generation sites, including those that currently host reserve technique plants in the production of electricity. In this context, ISEAP Sardinia includes measures to modernize its energy in the system of transport infrastructure and port systems;

d) Particular attention has been paid in respect of environmental more fragile and valuable systems of the island of Sardinia, with specific reference to the smaller islands (La Maddalena, S.Antioco - St. Pietro, Asinara), park areas and marine areas protected. For these systems in particular, ISEAP plans to achieve the goal of energy self-sufficiency from renewable sources, sustainable mobility plans, use of bio-fuels and a strong commitment to the involvement of the people of the territory. Objective: innovation, energy, environmental quality, employment.

The results of the ISEAP Sardinia show that it is possible to reach and go beyond the objectives set by the European and national Action Plans, and simultaneously improve the regional system. In short the results obtained in 2020 are:

- CO2 emissions - 22,31%
- Renewable energies 21,48%
- Bio-fuels in transport sector 7,00%
- Energy saving on inland gross consumption 19,73%
- Energy efficiency of the energy system 8,63%

These data are the results of a series of actions already taken by the Region of Sardinia and largely completed by 2020, they are broken down by sectors (industrial, residential, commercial, agriculture, transport, popular participation) and all included in the ISEAP.

The process of identifying priority actions according to the criterion of "bankable" projects and actions will continue after the formal approval of the ISEAP, taking into account not only the complexity and size of the projects and actions, but also the need for further involvement of all Sardinia'realities. Feasibility studies and project sheets will be attached to the document of the ISEAP, transmitted to regional, national and European level and will be part of the monitoring activities required by this project.

The commitment of the region of Sardinia in joining the European Project Pact of Islands and the implementation of the ISEAP, is combined with a commitment to enhance the insular region system in the broader context of European islands. In this direction Sardinia has worked to give continuity to the same program Pact of Islands and favoured, along with other European partners of the project, the approval of the Declaration of the European Parliament for the program to become official initiative of the European Union (19 January 2012); the Region of Sardinia has also promoted, as President of the Conference of Peripheral Maritime Regions (CPMR), the direct involvement of the President of the European Commission in order to give specific continuity to the project Pact of Islands as part of Europe's energy policies.

The commitment of the Region of Sardinia also exists in the identification of the ISEAP as a technical document aimed at achieving, by 2020, the objectives of the Region in the field of energy efficiency and reduction of CO2 emissions, and therefore it is a instrument whose actions are integral and essential part of the Regional Environmental Energy Regional of Sardinia (EERP-S) and the same ambitious project "CO2 Sardinia" (Del. GR. No. 33/17 of 10.08.2011).

## Introduction

The Sustainable Energy Action Plan (ISEAP) of Sardinia is made in the frame work of the European Project "The Pact of Islands" with the intent to go beyond the objectives set by the European Union in the year 2020, with particular reference to reduction of CO2 emissions into the atmosphere.

The year 2005 has been identified as the year of reference on which calculating the amount of 20% of carbon dioxide emissions to be reduced by the year 2020 (Baseline Emission Inventory).

The ISEAP consists of:

1. Description of local context;
2. Description of general strategy;
3. Description of energy balance and emissions inventory;
4. Description of necessary actions in order to achieve objectives set for 2020;
5. Description of organizational and financial mechanism necessary to implement actions.

In short, the Executive Summary contains Sardinia Region energy balance of 2005 (BER), the energy balance estimated of 2020 related to the Business as Usual scenario (in absence of rational interventions) and the consequent interventions of the implementation aimed at saving, energetic efficiency and development of renewable energy reported in the ISEAP; it presents also the inventory of $CO_2$ emissions into the atmosphere in 2005, in the year 2020, and a summary of the issues raised in the document ISEAP.

The development of the 2005 regional energy balance is consistent with the Reference Document of Sardinia Region for renewable energy and ENEA, ISTAT, GRTN, ENEL, TERNA, ISPRA official data.

Business As Usual scenario (BAU) of 2020 has been defined by assuming, starting from 2005, an annual growth rate of energy demand constant and equal to 1% per year.

## Description

Studies and analyses contained in the ISEAP highlight the important potential of $CO_2$ emissions reduction in the atmosphere of Sardinian regional system. In fact, the combined and synergetic action of the balanced use of energy from renewable sources with the common creation of saving actions and energy efficiency allow us to reach and exceed the goals of the plan 20-20-20 by 2020.

In particular, data and territory potentials analysis in the field of renewable sources in Sardinia has highlighted several important aspects for the purpose of energy planning:

- The objective to reduce by 2020 $CO_2$ emissions of 20% compared to 2005 values is attainable and ISEAP proves it.
- The achievement of such a goal requires the combined synergetic realization of actions in infrastructures destined to improve energy efficiency, management, diversification and security of Sardinian system energy supply.
- The availability of natural gas as a transitional prerequisite necessary to achieve emissions reduction objectives particularly in industrial, domestic and tertiary sectors.
- The increase of relative efficiency, regional energy system, described in terms of reduction of net final consumptions compared to the trend scenario it is equal to 19,73% with room for further efficiency in the field of power generation (combined cycle plants), private building trade and small and medium enterprises to be realized in a greater available time.

In particular, actions implementation under the Sustainable Energy Action Plan allows, according to the identified plan, to achieve the following objectives in Sardinia:

- Reduction of $CO_2$ emissions in the atmosphere equal to **22,31 %** by 2020, compared to 2005, down from 15,49 to **11,83** tons per capita;
- energy production from renewable energy sources by 2020 equal to **21,48%** of final consumption, a value significantly higher than that established for Sardinia (17,8%) by the Decree MISE on the distribution

between Autonomous Regions and Provinces of the rate of uptake of renewable sources by 2020 (Burden Sharing);
- gross inland consumption reduction of **31,32%** by 2020 compared with those estimated in accordance with BAU procedure.
- regional energy system increase equal to **8,63%** in absolute terms (compared with BAU 2020) to be increased in the medium to long term.

## " The Pact of Islands" commitments.

By joining the European project "The Pact of Islands" Sardinia proposes courageously to modernize the regional energy system in a sustainable manner, assuming the commitment to reach and possibly exceed the targets set by the EU for the year 2020 with particular reference to the promotion of actions necessary for the reduction of CO2 emissions into the atmosphere, and the promotion of energy efficiency and the development of renewable energy sources.
The Region Sardinia places its commitment to the ambitious regional program "Sardinia CO2.0", which is the general framework of the regional commitment to sustainable development. In this context, the ISEAP of Sardinia is an operational tool for evaluating actions and impact on the region and implementing Community's guidelines, it is also an over-ordered support for the implementation of the project "Smart City", that now is going through its operative phase.

## Commitments arising from Burden Sharing.

The Decree of the Economic and Development Minister, 15 March 2012, issued under Dlgs.28/11, laying down provisions on the allocation of increased renewable energy sources in the Italian regions, assigns to Sardinia Region the objective to produce energy from renewable energy sources in comparison with its final consumption equal to 17.8% for the year 2020. An objective to overcome as shown by the results of ISEAP, **21,48**%. The ISEAP also shows the overcoming of the contribution required to Sardinia by Decree MISE for renewable energy in electric generation, 55.08% ISEAP, 33.7% "Burden Sharing", and heat production, 213 ktoe ISEAP, 249 ktoe "Burden Sharing". Biomass contribution in the mix of renewable energies is 12.88% before transformation losses.

## Energy balance and CO2 emissions in baseline year 2005

### Table A Gross Inland Consumption

| **Gross Inland Consumption** | Fuel products | Coal | Natural Gas | Centralized thermal energy | Bio-mass | Hydroelectric | Solar Photovoltaic | Solar Thermal | Wind energy | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **[GWh]** | 60446 | 14869 | 889 | 9 | 1217 | 690 | 0 | 1 | 409 | 1194 | 79724 |

| | |
|---|---|
| *Gross electricity production [GWh]* | *13991* |
| *Electric energy import(+)/export(-) [GWh]* | -409 |
| *CO2 emissions in atmosphere [ML/tons]* | 25552 |

## Table A1

## Final consumptions

| | Agricolture | Industry | Civil | Transport | Total |
|---|---|---|---|---|---|
| **Final consumptions [GWh]** | 1187 | 16743 | 9263 | 13778 | 40971 |
| **Electric energy [GWh]** | 202 | 7204 | 4631 | 16 | 12053 |

## Scenario ISEAP: expected energy balance and CO2 emissions in 2020

### Table B – Gross Inland Consumption.

| **Gross inland consumption** | Fuel product | Coal | Natural gas | Central Energy from heat recovery | Bio-mass | Hydroelectric | Solar photovoltaic | Solar thermal | Wind energy | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **[GWh]** | 39734 | 4556 | 6314 | 918 | 1547 | 692 | 1435 | 432 | 2700 | 5509 | 63837 |

| | |
|---|---|
| *Gross electricity production [GWh]* | *12805* |
| *Electric energy import(+)/export(-) [GWh]* | -1227 |
| *CO2 emissions in atmosphere [ML/tonnellate]* | 19866 |

## Table B1 – Final consumptions

| | Agricolture | Industry | Civil | Transport | Total |
|---|---|---|---|---|---|
| **Final consumptions [GWh]** | 1471 | 14414 | 8815 | 13446 | 38146 |
| **Electric energy [GWh]** | 330 | 5183 | 4620 | 231 | 10364 |

## The contribution of natural gas to achieve ISEAP objectives.

The contribution of natural gas as an energy transition vector is a key factor for the improvement of both the mix of primary energy sources and the security strength of Sardinia Region energy supply. Methane availability is one of the elements able to achieve the objective of reducing CO2 emissions in the atmosphere. ISEAP development expects the availability of natural gas to be about 0,71 MLD, of which 42% for the production of electricity, 19% for industry, 38% intended for private use and 1% to the transport sector. The impact on Sardinian energy system of natural gas use instead of fuel oil (which is much more sustainable from an environmental point of view as it is an energy transition and accompanying vector) is relevant as regards the reduction of climate-altering gas. In particular, its applicability has been limited on the basis of an assessment of the distribution networks already realized and under construction and on the time required for the conversion or construction of combined cycle power plants fuelled by more powerful methane gas.

## Renewable Energies contribution in 2020.

The contribution of Renewable Energy Sources (RES) in the achievement of ISEAP goals is essential. Electric energy production from RES will reach, according to ISEAP projections presented in Table C, 55,08% of final energy consumptions in 2020 and 17% in the thermal sector.

## Table C. Sardinian renewable energies electric sector in 2020.

| source | Power installed | Hours per year function | |
|---|---|---|---|
| | [MW] | - | GWh |
| **Hydroelectric** | 466,5 | | 230 |
| **Solar – PV installed Dec.-2011** | 320 | 1.400 | 448 |
| **Solar - Large PV Plants** | 200 | 1.400 | 280 |
| **PV- GSE inferior plants 200 kWp** | 170 | 1.400 | 238 |
| **PV- Decree 28/2011 houses** | 40 | 1.400 | 56 |
| **Concentrating Solar PV** | 150 | 1.800 | 270 |
| **Solar Thermodynamic** | 30 | 2.400 | 72 |
| **Aeolian on shore** | 1500 | 1700 | 2.550 |
| **Biomass in RSU** | 6,8 | - | 44 |
| **Solid biomass different from RSU** | 87 | 5.400 | 470 |

| | | | |
|---|---|---|---|
| **Biogas** | 132,5 | 4.000 | 530 |
| **Hybrid plants (co-combustion)** | 580 | - | 370 |
| **Bio-fuel** | 37 | | 150 |
| **TOTAL** | | | **5708** |
| **Percentage contribution E.R. electricity sector on final electricity consumptions** | | | **55,08%** |

**Table D. Sardinian renewable energies thermal sector in 2020.**

| **Thermal sector [Gwh]** | | |
|---|---|---|
| **Sector** | **Category** | **Energy** |
| **Residential, Tertiary** | Biomass – direct use | 338 |
| | Biomass – District heating | - |
| | Efficiency recovery from residential buildings | 0 |
| | Cogenerazione da Biogas | 145 |
| | PdC residential and tertiary heating | 537 |
| | Heat Pump (HP) - Sanitary Hot Water (SHW) | |
| | Solar thermal SHW | 432 |
| | Solar thermal heating | |
| **Agricolture** | Biomass | - |
| **Industry** | Biomass | 208 |
| | Biogas cogeneration | 148 |
| | Other heat recovery | 11 |
| **Initial indifferentiated contribution** | | 150 |
| **Thermal energy for processing** | | 43 |

| | |
|---|---|
| **Thermal consumptions in production sites** | 464 |
| **TOTAL** | **2476** |
| **Percentage contribution renewable thermal sector on final thermal consumptions** | **17,00%** |

## Contribution of Energy Saving and Energy Efficiency by 2020.

Saving measures and energy efficiency are amongst the priorities of the action plan and their contribution is essential to the achievement of objectives. Interventions focus for the most part on the overall building heritage but also on the industrial system, starting from small and medium enterprises. Noteworthy is the energy saving attainable in residential and tertiary building sector, estimated in 1.567 GWh and 423 GWh. Considering that upgrading interventions of the building regional heritage need a longer time than the date 2020, the estimates made are precautionary. So even in the face of saving potentials around 30-35%, it is estimated that by 2020 achievable interventions will lead to a saving of 19,73% on final consumptions. At present Sardinia has significant potentials in the field of saving and energy efficiency, for the most part identified by the action plan and partially to be evaluated and planned on the basis of monitoring actions and experiences matured during action plan implementation. The efficiency value of civil and industrial structures joined to heating recovery in the industrial sector and cogeneration plants, lead to energy saving equal to 17,12% on final thermal energy consumptions, for the most part concentrated in the residential sector.

Energy efficiency achieved by 2020 is mainly due to the production of electricity deriving from combined cycle plants (ICCG sarlux) and the conversion of two low-power groups from fuel oil to natural gas of the plant in Fiume Santo which, together with the new plant in Sulcis and to renewable sources, will satisfy regional electric requirements.

## Synthetic summary of ISEAP results

| | |
|---|---|
| CO2 emissions | Reduction of **22,31%** compared to 2005 |
| Renewable energies | Increase from **3.80%** in 2005 to **21.48%** in 2020 |
| Energy saving | Gross inland consumption reduction of **31,32**% compared to scenario BAU 2020. |
| Energy efficiency | Absolute increase of the system equal to **8,63%** compared to BAU 2020 |
| Electric energy from renewable sources | Increase from 5.83% in 2005 to **55,08%** in 2020 |
| Contribution requested to Sardinia with Decree MISE for renewable | MISE " Burden Sharing " : **17,8%**<br><br>ISEAP: **21,56%** |
| Bio-fuel in transport sector by 2020 | 10% (5% biodiesel imports on fuel consumption + 5% bio-methane from the agro-industrial sector of Sardinia (Progetto Sardegna Ricerche) |
| Contribution requested to Sardinia with Decree MISE for renewable thermal | MISE " Burden Sharing " : **249 ktep**<br><br>I-PAES: **213 ktep** |
| Mix energy sources | Improvement in the mix of energy sources and security of supply as a result of the availability of natural gas |

## Description of actions necessary to achieve objectives set by 2020.

ISEAP includes the list of actions divided into intervention sectors and implementation periods distinguished in S (Short-Term), M (Medium–Term) and L (Long –Term). The list includes the title of intervention and expected objectives and results in terms of energy saving and CO2 emissions avoided. All the described actions are counted in the ISEAP for the obtainable results. Each intervention will be then concisely description with essential data for the illustration of the action:

description, promoter, expected results, financial channels, construction time. Tables attached to ISEAP are the operational part of the plan and they are summarized per sector.

The significant actions shown are about the interconnection between Africa – Sardinia – Italia for the supply of methane and electricity interconnection, according to strategic plans of European interconnection. They are also related to the conversion of plants from fuel oil/coal to methane and the construction of the integrated coal plant of 300 – 400 MW.

Amongst the significant actions, ISEAP ha also taken into account:

- biomass power plant implementation of 40 MW, foreseen by the project Matrica, Chimica Verde (Porto Torres);
- Green Chemistry impact for the reduction of CO2 emissions in the atmosphere, valued conservatively in 0,538 Ml ton/y, equal to 37% of possible potentials;
- achievement of the European objective of 10% bio-fuels in transport by 2020;
- efficiency increasing in transport management system, urban and suburban, refill and efficiency of the car fleet of 8%;
- efficiency increasing of the industrial system equal to 3%;
- energy saving of regional water system equal to 90 Gwh.

**Organizational and financial mechanisms description necessary to action implementation.**

The Region of Sardinia is divided into Departments, Directorates, Services and Agencies with specific skills. The participation to the community project Pact of the Island and the preparation of the ISEAP have highlighted the need to set up a control centre composed of the President and the Industry and Defence Environmental Department, to coordinate programs put in place by the Region, Sardinia CO2 - Smart City, with other initiative in the field of sustainable energy.

To support the implementation and monitoring of the action contained in the plan it is foreseen the permanence of the control centre to coordinate actions and the establishment of public entities acting in the energy sector as a tool for the operational support of the plan, drawing also on the expertise gained in the same regional authority, regional bodies and agencies and energy agencies that represent local authorities. Operational works will seek to implement measures included in this plan and promote good practice in local authorities, citizens and SMEs, as well as promote the participation in European programmes and funds of the sector, and support the capitalization of economic benefits arising from

the implementation of best practice in the energy market for the benefit of Sardinia Region and the same local authorities.

## Plan tools

The Region of Sardinia sets out to implement the tools currently available for the implementation of energy policies following the principle of cost-effectiveness and efficiency. For this purpose the Region intends to provide itself strategies and operational structures able to self-funding through the recovery of resources deriving from its own actions in terms of energy saving and efficiency.

Tools that Sardinia intends to put in place, at this end and for the monitoring and implementation of actions, must pursue the goal of the wider involvement of local authorities, enterprises and citizens, as well as the need to know the dynamic of actions to better define policies, support stakeholders, monitoring performance, verify the effectiveness of interventions and the same operational tools.

Sardinia is the co-ordinating promoter of implementation and monitoring measures for the plan actions, both either Departments, Directorates-General, Services and Agencies with specific skills available today, either through a control centre consisting of the Presidency and Departments responsible for the coordination of the various programs put in place and planned in the field of energy and environment. The Region is going to adopt and make use of specific organizational and operational tools to give concrete support to the transformation and modernization process of the regional energy system in the coming years in order to reap all the benefits connected.

As part of the overall strategy in the field of sustainable energy where the Region is working, indicated in the programme "Sardegna CO2.0", one of the fundamental aspects for the achievement of the plan goals is related to the wider involvement of Sardinian Municipalities and Provinces that, according to their number, it is respectively 378 and 8, and their fundamental role in the territory.

Region of Sardinia intends, therefore, to promote much more coordination between public actors operating in this sector, with the aim to contribute, in the common interest, to the improvement of environmental quality, the development of new business, energy bills reduction and the creation of new jobs.

For this purpose it could be made use of a consortium able to implement sustainable energy policies using existing premises for the benefit of local bodies,

enterprises and citizens. It will be an expression of the experience gained in the same Region, authorities and regional agencies, embodiment of local authorities. The consortium will also provide support to territorial entities to favour the participation to European programmes and funds and will support and monitor interventions implementation in line with plan actions and with Regional, National and European guidelines. This structure will also act as regional energy observatory, in order to identify: the better solutions, the portfolio of bankable projects, market opportunities related to actions carried out in the region, in particular those carried out by local authorities.

For each ISEAP action it will be identified objectives, operational plans, stakeholders/involved, resources required, direct or indirect interventions implementation timing, as well as costs assessment through financial plans.

# *Contents*

# 1. CONTEXT

## 1.1. Geography and territory

By extension, Sardinia is the third Italian region and the second largest island in the Mediterranean with a total area of 24.090 sq km. Inhabitants are 1,68 million with a population density of 69 per sq km. It is 187 km from the coast of the Italian peninsula, from which it is separated by the Tyrrhenian Sea, while the Sardinia Channel separates Sardinia from the Tunisian coasts located 184 km to the South. To the North for 11 km, the Strait of Bonifacio separates it from Corsica and to the West the Sardinia Sea from the Iberian Peninsula and the Balearic Islands.

### 1.1.1. Mountains, hills and plains

Sardinia territory is mainly hilly. The average height can be calculated around 380 m above sea level and only 15% of the territory rises to 1.500 m. In the northern part of the Island stands the granitic massif Mount Limbara that, with the Punte Balistreri, raises 1.359 metres. The highest peaks are located in the Massif Gennargentu with its peak Punta La Marmora that reaches the height of 1.834 m. The lowlands are limited and originated by erosion rather than by the transport and sedimentation of water. The most important plains are Campidano, located in the central-south of the Island, the upper and middle valley of the Tirso, which occupies the central area, and the plain of Nurra in the north-western part of the island

### 1.1.2. Coasts and islands

Many other islands rising from the surrounding sea also form part of Sardinia's territory. Sant'Antioco, the largest island (108,9 km²), and San Pietro Island comprises the arcipelago of Sulcis, located in the south western part of Sardinia. Sant'Antioco is connected to th main island Sardinia through a bridge. The second largest island is Asinara (52 km²), now National park, it is located in Sardinia's north-western part, delimiting the wide homonym gulf. In the north-eastern area lays the archipelago La Maddalena consisting of a series of islands amongst which the most important are La Maddalena, Caprera, Santo Stefano, Santa Maria, Razzoli, Budelli, Spargi as well as some other smaller. The beauty and unique environment of the archipelago led to the establishment in 1994 of the National Park of the Maddalena Archipelago. Other small islands, as well as major just mentioned, are scattered off the coast of Sardinia.

### 1.1.3. Climate

The Mediterranean climate is typical of most of Sardinia. Thanks to the presence of the sea, coastal areas, where the large part of the population lives, have mild winters with temperatures that rarely drop below freezing. Summers are hot and dry, characterized by a considerable

breeze. The low humidity and sea breezes, allow you to withstand the high summer temperatures that normally exceeds 30 °C, and also reach 35 °C

Also interior plain and hilly areas have typically Mediterranean climate, although due to the greater distance from the sea there are lower winter temperatures and higher summer temperatures than the coastal areas. The climate is on the whole fairly mild, but during the year temperature values move from minimum degrees below zero in winter to maximum even more than +40° in summer. In the most internal areas, such as the highlands and valleys often set amongst mountains, the climate becomes similar to that of the mainland, with strong thermal excursions; here minimum temperatures are particularly low in the event of thermal inversion, and temperatures may drop even below -10°C, while in summer there are also torrid days with frequent peaks higher than +41°C. On the other hand on mountain massifs in the winter months it snow frequently and temperature fall below zero. Summers are cool, especially during the night hours, and rarely it is hot for many consecutive days

Prevailing winds are Mistral and Scirocco. The first is cold and often violent during the winter, while in summer moderates temperature, but due to its high speed, (which easily exceeds the 100 Km/ora) it may cause not indifferent damage to agriculture, encourage the spread of fire and create problems for sea transport; the second often makes the heavens "reddish" due to the dust from the deserts of Africa and is particularly harmful in late spring when evapotranspiration is intensified causing water stress to not irrigated crops. The constant breeze favoured the installation of many wind turbines on the ridges of some hills and industrial areas

### 1.1.4. Parks and nature reserves

Sardinia is very rich in parks and nature reserves. These latter are: La Maddalena Archipelago, Asinara Island, Orosei Gulf and Gennargentu National Park. There are several regional natural parks such as Porto Conte, Molentargius – Saline, and parks being set up at Limbara, Sette Fratelli - Monte Genis, Sulcis, Marghine – Goceano, Sinis – Montiferru, Monte Arci, Giara di Gesturi, Monte Linas – Marganai, Tacchi d'Ogliastra – Montarbu. Marine natural protected areas are: Capo Caccia - Isola Piana, Capo Carbonara, Sinis peninsula - Mal di Ventre Island, Tavolara - Punta Coda Cavallo; and the mountain protected natural area of Taccu - Ulassai .

It also adds to the list the Sanctuary for marine mammals extended into a portion of the Mediterranean involving three Italian regions (Liguria, Tuscany and Sardinia), France and Principality of Monaco.

### 1.1.5. Rivers and lakes

The only natural lake in Sardinia is the lake of Baratz, near the town of Alghero. All other lakes of the island territory were created by artificial barriers in order to provide a reservoir of drinking water or for agricultural use. Some dams are equipped with turbines for the production of electric energy

The most important and largest basin is the Lake Omodeo, originated by the damming of the river Tirso near Busachi. In the southern sector of the lake are Mulargia and Upper and Lower Flumendosa. Lake Coghinas is in the north. Smaller lakes are Gusana, near Gavoi, Cucchinadorza and Benzone. All the three have a hydroelectric plant. Rivers have a predominantly torrential character. Sardinia longest river is the Tirso (152 km), followed by the Flumendosa (127 km). Among the many tributaries of the Tirso it would be mentioned the Taloro, along the course of which some dams have been made giving rise to the lakes Gusana, Cucchinadorza and Benzone. Another important river is the Coghinas, which scope is inferior only to that of the Tirso. As with many other rivers in Sardinia also the Coghinas was crossed by a dam that gave rise to the lake Coghinas. The only Sardinian navigable river is the Temo, which runs through the town of Bosa. The Cedrino, crossed by a dam that created another lake with the same name of the river, is powered by the springs of Su Gologone. The most important river in the south is the Flumini Mannu, 90 km long, it flows into the pondo f Santa Gilla, after receiving the waters by the river Cixerri eand the stream Leni.

## 1.2. Demography and population

The population of Sardinia, in the census of 2001, was just over one million and six hundred thousand

The demographic configuration shows that the incidence of infant population as well as Sardinia's aging index are below the national average, anyway the aging process is accelerated in Sardinia

The evolution of the demographic composition has defined a socio-demographic profile characterized by a low birth rate and a progressive lengthening of life. Structural indicators - aging index (116) and dependence (43) - point out values still below national average. However, there is still strong attention to the close relationship between low birth rate (the average number of children per woman is 16% lower than the national average, that is among the lowest in the world) and the increase in life

## 1.3. Economy

### 1.3.1. Productive activities

#### 1.3.1.1. Agricolture

In 2010 the regional agriculture production was in further decline compared to that measured by Istat in the previous two years. The trend reflected the lower contribution from the crops and the continuing challenge of commercial livestock sector. The number of farms in the region has remained fairly constant from 2009.

According to provisional data from Istat, the amounts collected have continued to decline in all major crops: the decline on an annual basis was approximately 4 percent. Exports of agricultural products decreased compared to the previous year.

### 1.3.1.2. Industry

The economic situation in the region, strongly deteriorated in 2008 and 2009, has been getting worse over the last year, following the closure of the main petrochemical industries.
The structural problems in the sector have exacerbated the crisis, the suspension of some major productions and uncertainty about basic future industrial structures have increased difficulties associated with smaller players active in downstream and traditional sectors. The competitive deficit was amplified by falling demand, causing the release of the sector of a growing share of firms and workers.

Table 1. Number of industrial enterprises in Sardinia
Source: Movimprese

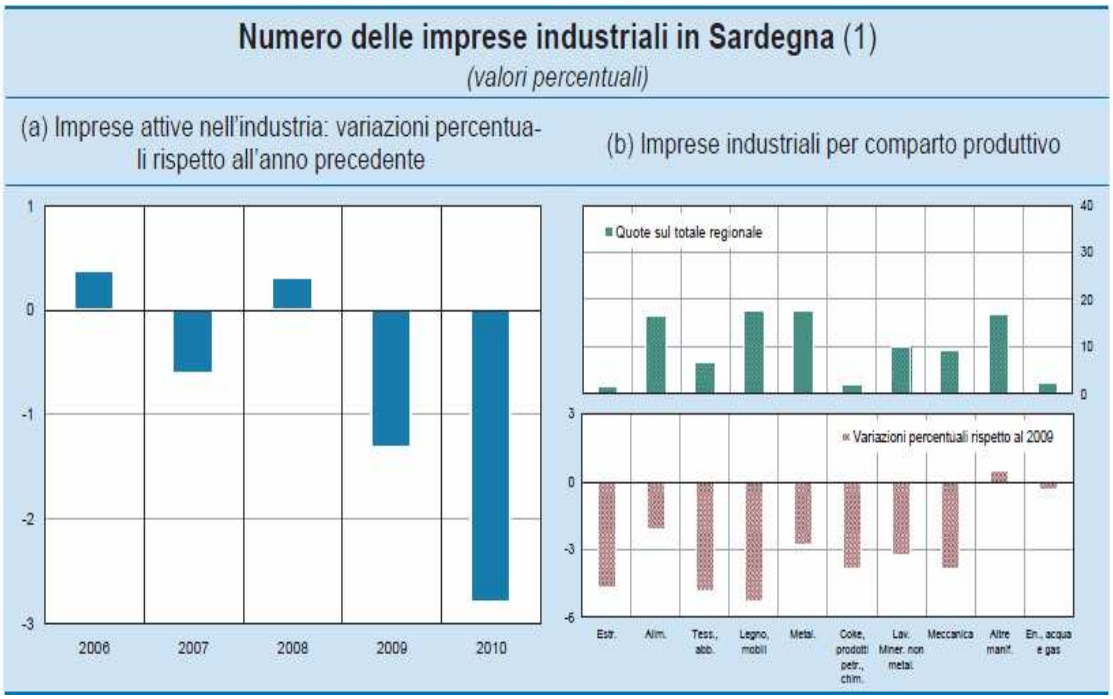
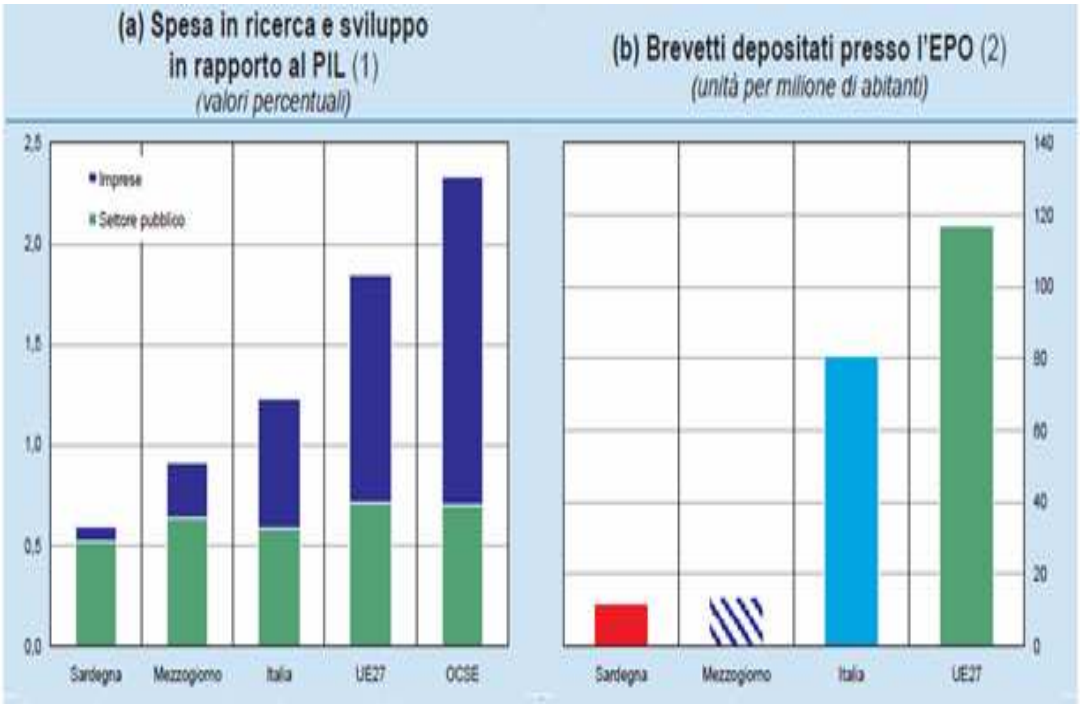



Table 2. GDP ratio and expenditure in development and research.




Source: Elaboration on Jstat, Eurostat and Ocse data.

Considering other indicators of R&D activity, such as the number of workers in the sector, it is also clear that Sardinia has value equal to half the national average: 2.0 employees per thousand inhabitants in the region, compared with 4.0 (4 , 9 the EU27 average). The number of graduates in science and technology per thousand population aged between 20 and 29 years, is in the region of 8.2 units, in line with the average in the South and lower than the national average (12.1) , the figure is also lower than the European average (13.9). Whereas, considering finally an indicator of innovative output, ie the number of patents filed in 2007 at the European Patent Office, Sardinia has a value (12 patents per million population) in line with the average for the South and well below the national average (81 patents, 117 the EU27 average).

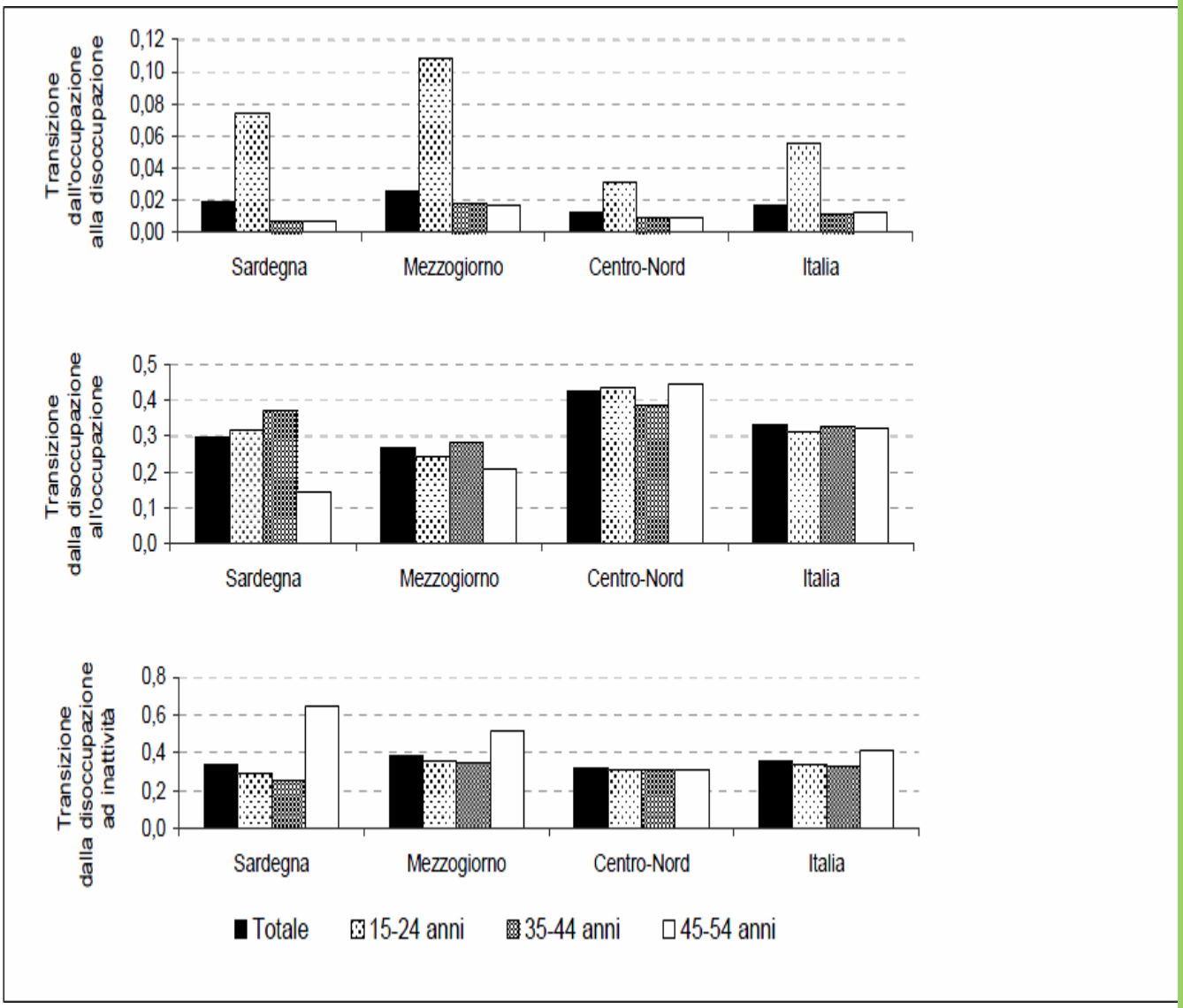
## 1.3.2. Labour market

### 1.3.2.1. Employment

Increasingly worrying and negative signs come out from the analysis of the labour market. The negative trends of the past two years cancel the great strides emerged from the analysis in recent years. It is worth noting in particular the recent rise in unemployment, which went from 12.2% in 2008 to 13.3% in 2009, and the reduction in the rate of activity: from 59.9% to 58.7%. It is also true that Sardinia is in a relatively more favourable situation than the South for some key indicators (female participation in the labour market, in fact, in 2009 the female employment rate was 47.9% compared to 36, 1% of the South, the rate of overall activity in 2009 was 58.7% against 51.1% in the South, it also indicates a relatively limited role of the effects of discouragement in determining the rate of inactivity: South: 4 , 8% versus 4.4% in Sardinia).

Some "hidden" news in detailed statistics are particularly interesting. If it is true that the probability of transition from unemployment to inactivity is fortunately lower than other areas in the South, it is noted, however, that the probability is much higher for the class of the population between 45 and 54 years: it is equal to 64% in Sardinia, while it is 51% in the South.

Graph 1. Transition rate from employed to unemployed, from unemployed to employed and




from unemployed to inactive by age group, 2007-2008

Source: CRENoS elaboration on Istat data, FDL.

This figure indicates the difficulty of the regional economy to take back workers more frequently expelled from the production system during the business restructuring process nourishing in this way particularly low levels of participation for the age group between 55 and 64 years (when the 30% in 2008).

### 1.3.3. Conclusions

La nostra competitività è bassa, e così la produttività, soprattutto perché la Sardegna continua a presentare carenze nei cosiddetti "fattori di produttività di lungo periodo": infrastrutture, capitale umano, capacità tecnologica e innovazione. L'insistenza con cui in questi anni gli investimenti in conoscenza sono stati messi al centro dell'agenda europea deve spronare la Sardegna ad un maggiore impegno nel ridurre il divario con le regioni virtuose dell'Unione Europea.

## 1.4. Political and Administrative Structures

### 1.4.1. Regional Government

Sardinia is one of five autonomous regions with special status in Italy. and one of the two regions, but the only special status, (apart from the Valle d'Aosta in the old Statutory Regional Law n. 1/2008 gives effect to those standards and in particular the Statute of the Autonomous Region of Sardinia

The Region is chaired by the President of the region, which forms the Regional Government, and to whom are entrusted the task of representing the region in all areas. The President is elected directly by the citizens.

The Regional Council is the governing body of the region. It is made up of twelve councilors, appointed directly by the President. The main tasks are to address the various aspects of economic and social life of the Region.

The Regional Counsel is the legislative body of the Region. It approves the proposed laws by the Regional Council, it may amend the regional Statute and checks the work of the Council. It consists of 85 councilors elected every five years.

### 1.4.2. Historical regions and sub-regions

Sardinia is divided in historical regions deriving directly, both in their naming and extension, from administrative, judicial and electoral districts of judicial kingdoms, the Curatorie (Sardinian curadorias or partes), which territories were probably divided according to a far more ancient territorial division made by the Nuragic Tribes.

Some names are no longer in use, while others have survived from the Middle Ages until today and are still commonly used. Here are the most popular: Anglona, Barbagia, Barigadu, Baronie, Campidano, Logudoro, Gallura, Goceano, Mandrolisai, Marghine, Marmilla, Meilogu, Monteacuto, Montiferru, Nurra, Ogliastra, Planargia, Quirra, Romangia, Sarcidano, Sarrabus-Gerrei, Sulcis Iglesiente, Trexenta.


Table 5, Sardinia historical regions.

## 1.4.3. Historical territorial subdivisions and current provinces

At present Sardinia is the Italian region with the most provincial capitals (12, compared to 8 provinces and 377 municipalities). According to the data of the 2001 census in the island there is a province every 203,985 inhabitants, and the average of inhabitants per capital is approximately 42,493 residents. The current administrative division of Sardinia is therefore made up of: Province of Cagliari (71 Municipalities); Province of Carbonia-Iglesias (23 Municipalities); Province of Medio Campidano (28 Municipalities); Province of Nuoro (53 Municipalities); Province of Ogliastra (23 Municipalities); Province of Olbia-Tempio (26 Municipalities); Province of Oristano (88 Municipalities); Province of Sassari (66 Municipalities).

Sources:

Banca d'Italia, Economie Regionali. Economia della Sardegna, June 2011, Cagliari.

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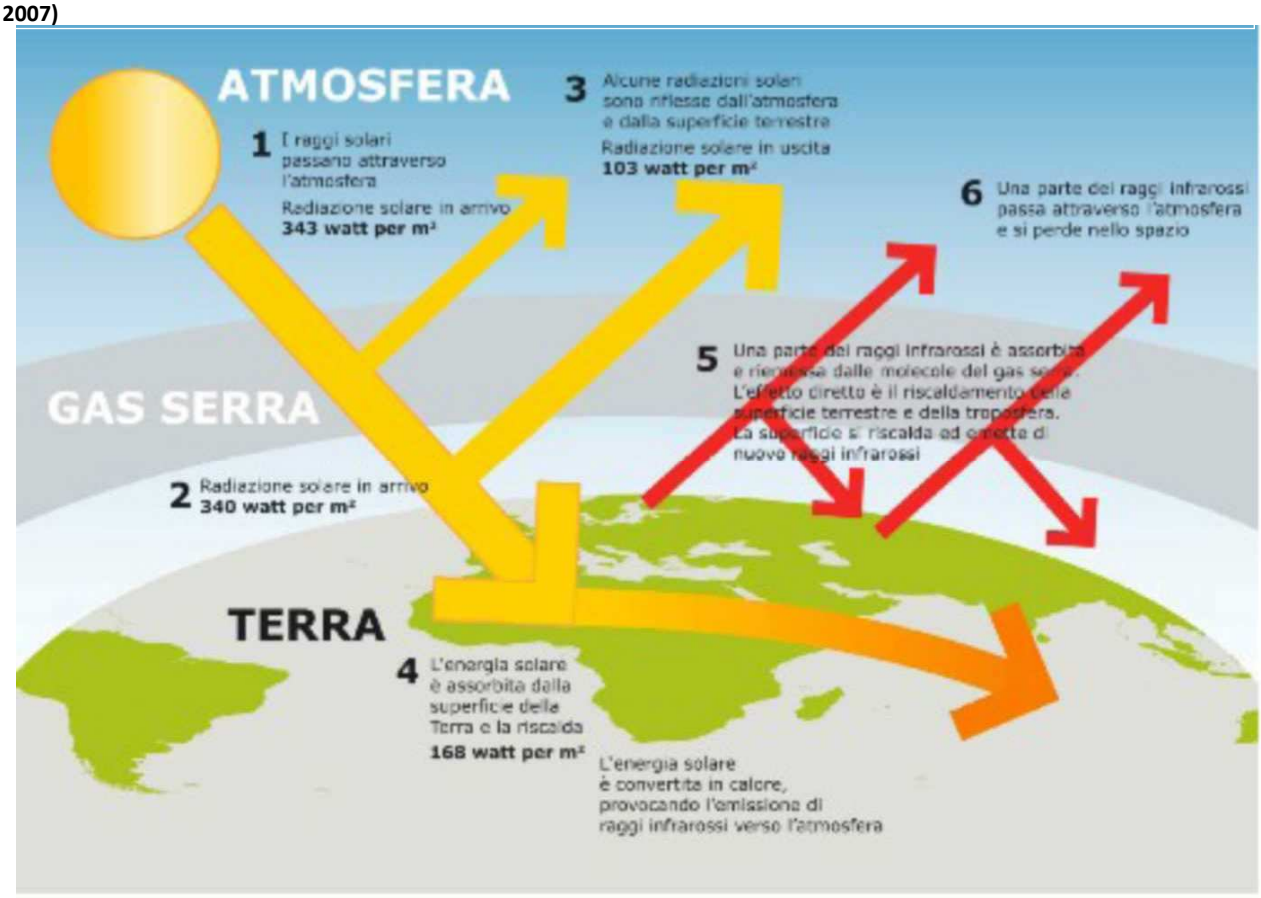
# 2. OVERALL STRATEGY

## 2.1. Current frame work and vision for the future

Variations in the concentration of green house gases and aerosols, solar radiations changes and modifications in the use and characteristics of souls and land surfaces, have altered the energy balance of the climate system. Changes are expressed by scientists in terms of "radiative forcing"[1], a measure of the influence of a factor altering the incoming and outgoing energy balance from the Earth's atmosphere. This parameter is used to compare natural and human factors to determine the heating or cooling of the global climate.

**Figure 1 – The natural green house effect censure a mild average temperature on the Earth (around 15°C) which provided , at the beginning of time, the presence of water on Earth and thus the development of life. (Source: Oltre Kyoto, Muzio Editore 2007)**




One of the main factors that determine climate changes related to green house effect is carbon dioxide emissions in the atmosphere produced by the combustion of fossil fuels.

1 The "radiative forcing" is an important indicator of the climate change. Positive trend in the "radiative forcing" implies the warming of the Earth surface, while the minus sign expresses the cooling. In RES of IPCC the radiative forcing, expresses 2005 values and is measured in W m $^{-2}$.

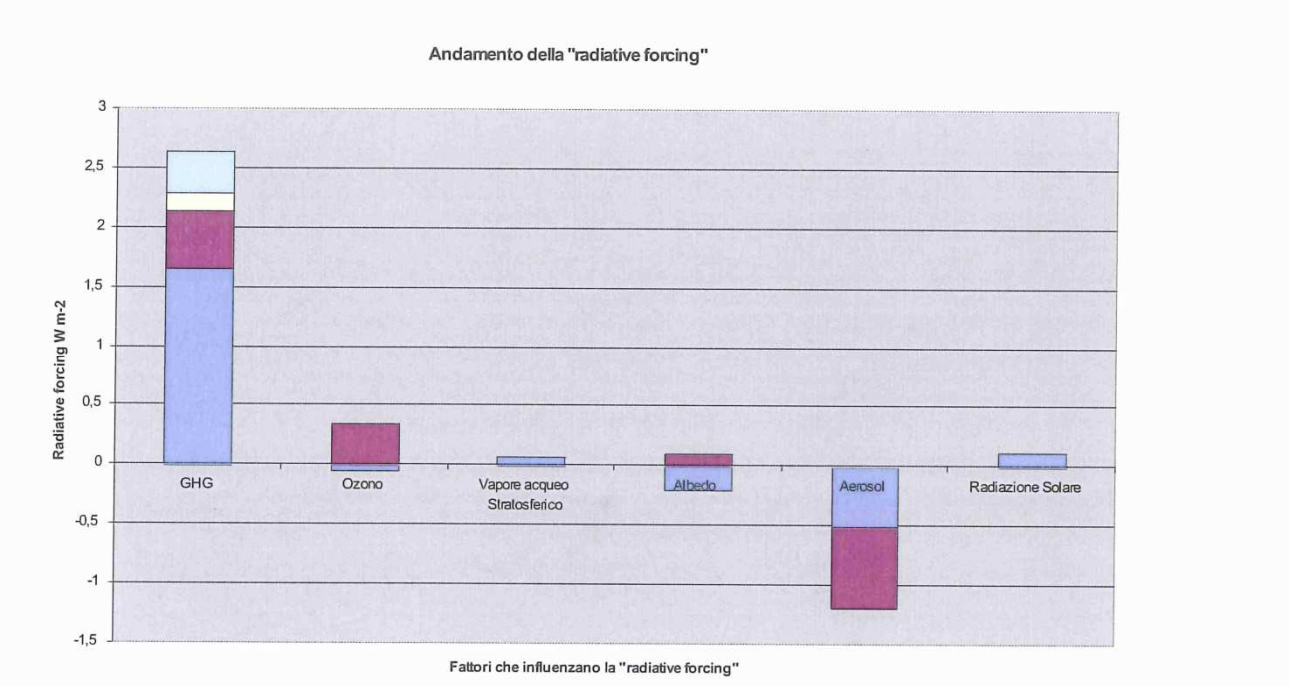
## 2.2. IPCC Fourth Assessment Report on climate

The Fourth Report on climate status - "Fourth Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC)"- presented in February 2007 in Paris is the result of over 5 years of work by more than 2000 scientists from all around the world.
This report shows the first result on the determination of the temporal evolution in the concentration of carbon dioxide ($CO_2$) in the atmosphere. As it is well known, in fact, $CO_2$ is the main greenhouse gas; analysis of these data shows that this one has remained, since 1720, around 280 ppm[2], a value slightly higher than the average of 265 ppm of $CO_2$ recorded in the pre-agricultural age, rising to about 280 ppm in the pre-industrial age

As a result there has been a rapid growth in $CO_2$ produced by human activities: from 1720 to 1840, in 120 years, the growth was +3.6% from 1840 to 1950, in 110 years, the increase was between 8% and 12% from 1950 to 2000, in 50 years, the growth has been between 16% and 30%. In 2006, as specified in the report, the concentration of $CO_2$ in the atmosphere has reached 379 ppm.

The average growth rate of $CO_2$ has increased by 1.9 ppm in the decade 1995-2005, while, if we consider the period 1960-2005, growth is 1.4 ppm. According to the IPCC, 95% of this growth is due to emissions from fossil fuels started with the industrial revolution of the 1800's and then associated to human activities. The impact of these activities and the effects of climate change will take at least a thousand years, but only if we act immediately to reverse the trend, otherwise the inertia of the phenomenon of global warming could prolong their effects for much longer.

**Figure 2 – Contribution of different components to "radiative forcing" that determines climate heating or cooling.**
*Source: Fourth Assessment Report of the IPCC – 2007*




per milione di molecole di aria secca.

The combination of "radiative forcing", due to increased emissions of carbon dioxide, methane, and nitrous oxide, is +2.3 Wnr2, this is the worst since the last 10,000 years. The only radiative forcing due to CO2 has increased by 20% in the period 1995-2005, recording the highest growth in the last 200 years.

By the end of the century IPCC envisages an increase in the terrestrial surface with temperature between 1,8 and 4° C.
In the ranking of the twelve warmest years since instrumental records of the Earth's surface temperature were made, from 1850, eleven of these years are those ranging from 1995 to 2006. The linearized representation of the increase in temperature over the last 100 years, from 1906 to 2006, records an increase of 0.74 ° C, far higher than the trend estimated by the IPCC Third Assessment Report, from 1901 to 2000, it was 0, 6 ° C in a hundred years. The total change in temperature from the period 1850-1899 to the period 2001-2005 was 0.76 ° C.

Anyway, the most worrying data are about meteorological observations that show unequivocally long term trends in the regime and in the distribution of precipitation. From 1900 to 2005, the amount of precipitation has changed in various parts of the Earth: increase of rainfall in the eastern areas of North America and South America, northern Europe and northern and central Asia; very pronounced drought in the Sahel desert, the Mediterranean, southern Africa and in parts of South Asia. The incidence of extreme weather events is increasing. The general trend is an increase in the frequency and intensity of rainfall. The Mediterranean will be, according to the IPCC, one of the most sensitive areas to climate change both in the marine and in the terrestrial part.

It's clear that from 2020 on, the power supply will need to be provided through the use of renewable energy, hydrogen technologies and fuel cells, clean technologies highly efficient. Lawmakers are seriously considering the problem of implementing renewable targets or "portfolio standards" in order to reach the Kyoto targets and levels of independence from fuels. In our society, however, the model according to which the adoption of renewable energies in the sources mix increases the cost of production therefore still remains since, in a first approximation, the renewable energy seems to be more expensive and suitable mainly to an isolated plant.
However, if the legislators weighted up benefits and additional profits (economic and environmental) arising from "Tradable Renewable Energy Certificate (TRECs)" or any other good energy, such as a cancellation certificate for the pollution deriving from greenhouse gas emissions, it would be possible to implement, at the local level (city) but in a global market (energy and energy goods), such an energy mix (including energy efficiency) to harmonize international financial systems with the existing distribution system implemented at the local level.
At the local level (from the region to the city) a lower portfolio costs/risks can be developed through an adjustment of the conventional mix, through the inclusion of greater amounts of renewable energies and the use of "carbon finance".

## 2.3. Energy planning

Local energy planning is one of the main instruments through which local Authorities can, at different scales, plan and direct territory interventions, also the structural ones, in the energy field, and regulate the functions of local Authorities by harmonizing the relevant decisions that are taken at national, regional, provincial and local level always adhering to the European-inspired principle of subsidiarity: decisions relevant to the management and the government of a territory are to be taken essentially by the decision maker closer to the communities, which must implement regulatory and administrative planned measures.

Local energy plans are the frameworks for public and private actors who are taking energy initiatives in the area covered using providing addresses, strategic objectives in the long, medium and short term, operational guidance, tools, normative references, financial opportunities, implementation guidelines, restrictions, rights and obligations for traders in all sectors.
In fact with resolution no. 43/31 of 6 December 2010, the Sardinian Regional Council has given a mandate to the Industry Ministry to initiate activities aimed at the preparation of a new Regional Environmental Energy Plan consistent with the new addresses of regional planning, national and community and prepare the Policy Document on renewable energy sources that individuals with respect to the effective potential scenarios to 2020. In implementation of this provision in Resolution 31/43 of 20.07.2011 was approved Directive of the political in the preparation of the Regional Environmental Energy Plan and the subsequent resolution 21/12 of 20.03.2012 as mentioned in the introduction, it has been approved the "Policy Document of renewable energies".
The purpose of the Sustainable Energy Action Plan of the Region Sardinia (ISEAP), according to official documents mentioned above, is to support the development of the Energy Plan with regard to the reduction of CO2 in order to lead the sustainable development of the territory and minimize emissions with a time horizon until 2020.

In addition to that, the local energy planning, as a result of major liberalization now actually completed (by 2014 even natural gas, ready to land also in Sardinia, will be completely liberalized with the separation of the ownership between ENI and SNAM RETE GAS) since 2007 (every citizen is "eligible customer" for the free purchase of electricity from any qualified provider), can be useful to address the full implementation of the interventions determined by the "new" free market incorporating Community rules as stipulated by Decree n. 79/99 and Legislative Decree no. 164/00.

The ISEAP, as well as identifying energy opportunities, will be structured to allow, by its implementation in Sardinia, environmental benefits (reduction of atmospheric pollution with particular reference to the six greenhouse gases regulated by the Kyoto Protocol that Italy has transposed into its national legislation with the Law 120/2002, land protection), economic benefits (growth of local businesses, sustainable tourism) and social benefits (employment, cultural offerings, sustainable development).

The ISEAP will also be a model and a support for the subsequent drafting of a set of ISEAPs by Pioneer Communities and their bankable projects and actions, as part of the projects Smart City and Covenant of Majors, they will be admitted to obtain funds (POR / ERDF 2007-2013 with the mechanism Jessica, Elena, Bei, others) for carrying out policies and measures

identified in the SEAP following a specific chronoprogram and its monitoring and review with the purpose of getting improvement (if necessary).

## 2.4. Objectives and targets

### 2.4.1. Action Plan objectives and targets

Objectives dealing with the ISEAP of the Region of Sardinia are:

1. respect natural limits of unique island ecosystems and its overall environment (including the social sphere) using \"*ecosystem approach*" established by the United Nations system (UNDESA), developing the energy sector and maintaining the environmental carrying capacity, without exceeding in the harvesting of natural resources and land use;
2. reduce the overall fossil fuels or non-renewable energy demand in particular by the structures of the Region Sardinia, public bodies that have joined the "Project Smart City – class A municipalities" and those, and they are numerous, who have joined the Covenant of Mayors European Programme with an extension to private virtuous structures that want to contribute concretely to the "Programma Sardegna CO2.0";
3. rational use of energy and energy efficiency (electric and thermal energy) in the territory of Sardinia, production processes, services, tourism and in all sectors;
4. reach the minimum reduction of 20% on gross final consumptions relative to predicted values, 20% use of renewable sources, 20% reduction in greenhouse emissions and achieve the binding goal of 10% from RES in the transport sector (particularly on the fleet of buses for public Regional transport and SAREMAR ships) so that Sardinia will become a "laboratory of best practices" to be transferred to the National and European territory, able also to generate new wealth[3];
5. use of renewable energy sources, with mini and micro production suitable for proximity use (generation distributed as shown in figure 2),to develop locally based electric and sustainable thermal energy production;
6. quantify RES according to the territory natural potentials, bio-energies, mini-aeolic, mini-hydroelectric, solar thermal, photovoltaic, low enthalpy geothermal;
7. promote a small-scale and widespread economy for the development of the territory, the sea and the Island's coast;
8. effective and efficient use of EU financial resources (7PQ 2007-2013, etc..), National and Regional (POR/FESR, etc.) to achieve benefits equally spread on the Sardinian territory and to reduce energy dependence from fossil fuels, increasing URE, EE e FER .
9. promote economic and social development in Sardinia;
10. guide the development of Energy infrastructures;
11. evolution monitoring of ISEAP actions.

3 The proposed European Directive dated 23 January 2008 aims to establish a general binding target: increase of energy efficiency by 20% (stabilizing energy consumption by 2020), 20% of the share of energy by renewable sources on energy consumption, $CO_2$ emission reduction by 20% (with the availability to achieve 30 with an international agreement) and the minimum target of 10% for the share of bio-fuels in the transport sector that each Member State must achieve. Binding national targets will correspond to this general target by 2020.

## 2.4.2. Action Plan Tools

The Region of Sardinia intends to implement the tools currently available for the implementation of energy policies following the principle of economy and efficiency, which means to have strategies and operational structures capable of self-funding through the recovery of resources from the shares, under its responsibility, about energy savings and energy efficiency.

To this end and for the implementation and monitoring of the ISEAP actions, the tools that the Region of Sardinia intends to carry out will be adhering to the objective of wider involvement of local authorities, enterprises and citizens, as well the need to know the dynamics of the shares, to better define the policies, support the stakeholders, performance monitoring, and verify the effectiveness of the interventions and the same operational tools

The Region of Sardinia is the coordinator of implementation and monitoring measures of the actions plan, either through the Departments, Directorates-General, services and agencies with specific skills, either through a control centre consisting of the Presidency and the Departments responsible for the coordination of various programs put in place and planned in the field of energy and environment. The Region will also use organizational tools and operational requirements, which the Region should equip itself with being included under the same plan, and give concrete support to the process of transformation and modernization of the regional energy system in the coming years to fully reap the connected benefits.

As part of the overall strategy in the field of sustainable energy in which the Region of Sardinia works, as indicated in the "Sardinia CO2.0", one of the key aspects for the achievement of the objectives of the plan relates to the wider involvement of municipalities and Sardinian provinces, taking into account the number of, respectively, 378 and 8, and their fundamental territorial role.

So Sardinia intends to promote greater coordination among public entities operating in this sector, with the aim to contribute, in the common interest, to the improvement of environmental quality, the development of new business, reducing energy bills and creating new jobs
For this purpose a consortium may be formed so to implement sustainable energy policies to the benefit of local bodies, enterprises and citizens. It will be an expression of the experience gained in the same body region, organizations, agencies and regional energy agencies expressions of local authorities. The consortium will also provide support to the territorial entities to encourage participation in the programs and European funds, it will support and monitor the implementation of actions in line with the action plan, in connection with Regional, National and European indications. The structure will also act as a regional energy observatory, in order to identify: the better solutions, the portfolio of bankable projects, market opportunities related to the actions that are carried out in the region, and specifically those carried out by local authorities.

For each of these actions of the ISEAP, objectives, operational plans, stakeholders/involved, resources required, time of realization of the direct or indirect intervention will be defined, as well as the assessment of costs through a financial plan.

## Methodological choices

Energy planning and listing choices will be considered in the ISEAP to be implemented by the Region, summarized as follows:

1) Choices of direction, in the sense that choices are not exclusive jurisdiction of the Region but involve the participation of multiple actors who will be appropriately involved in a "table grid" for the participated implementation involving local Communities, trade Associations, consumer Associations, environmental Associations and all stakeholders involved operating in and for Sardinia. The aim of these choices is to outline the possible synergies to be developed between the ISEAP and local actions (ISEAP, plan Agreements, use of the funds POR, ERDF, etc);
2) Planning options, as choices directly due to Regional Planning;
3) Management choices, as choices of exclusive and direct competence of the Region;
4) Design choices, made up of specific initiatives aimed at the realization of certain energy choices by the Autonomous Region of Sardinia (micro-co-tri-generation distributed, "renewable energies DOC" - which means energy production with a predominance of products, components, national and/or regional know-how - wind, bio-energies, biodiesel production, feed-in tariff implementation to promote photovoltaic plants, sustainable transport, low energy consumption buildings, etc…) to be implemented on the territorial and fixed heritage (that is regional property).

L'I-PAES nel percorso metodologico seguito, anche per la peculiarità di svilupparsi all'interno del territorio insulare sardo, dove vi sono elementi di pregio da salvaguardare, per poter attuare delle politiche e misure concrete, innovative deve allineare preliminarmente, lungo i tre assi portanti del piano, gli obbiettivi strategici da perseguire secondo principi di priorità e con gli strumenti indicati, da verificare poi sul campo, sulla base dei vincoli esistenti e proposti dal territorio, dalle strutture di governo locale, dai sistemi di produzione tipici, dal sistema delle imprese e dagli abitanti/utenti finali. Tali azioni concrete dovranno essere finalizzate a contribuire allo sviluppo sostenibile del territorio della Sardegna attraverso l'adozione di sistemi efficienti di conversione ed uso dell'energia nelle attività produttive, nel turismo, nell'agricoltura, nei servizi e nei sistemi residenziali.

Resulting actions will also have to promote a strong policy of energy conservation in all sectors, particularly in the construction sector, by organizing active involvement of organizations, enterprises, and citizens, it is also necessary to promote a diversification of energy sources, in particular in the electricity and thermal sector through decentralised production for a "Sardinia Carbon free" with low use of fossil fuels and low emission of greenhouse gases.

Development of Renewable Energy Sources and takeoff of industrial sectors through the establishment of new energy technologies manufacturing industries could help a sustainable competitive growth ensuring the conditions for the security of supply in the free market of local sustainable energy.

## 2.5. Strategic guidelines

### 2.5.1. ISEAP strategic guidelines: energy saving, energy rational use (ERU) and energy efficiency (EE), use of renewable energy sources (RES)

ISEAP is organized around three main areas which should guide all administrative actions, development projects and actions on the territory, following the overall fundamental objective of implementing local actions to achieve the European objectives 20-20-20 embraced for a long time by the Government and the Council of the Autonomous Region of Sardinia. It is obvious now the interconnection system existing between local choices and international context in the energy, economic, social and environmental field as confirmed by the success of the Covenant of Mayors and programs dedicated to "Smart cities".

The Kyoto protocol is an obligation to be observed, a bond unfortunately not fully respected by Italy in the first baseline years 2008-2012, but it is actually also a great opportunity for innovation in cultural, economic and energy field. It has represented an important opportunity for renewal and development that will continue even after 2012. The three pillars on which Sardinia ISEAP will be based and which could bring significant savings targets for the territory, revitalization of renewable energy sources and light economy in harmony with the broad development of a particular historical, cultural and natural insular area, are:

1. energy saving and reduction in use of fossil fuels;
2. rational energy use (REU) and energy efficiency (EE);
3. use of renewable energy sources (RES).

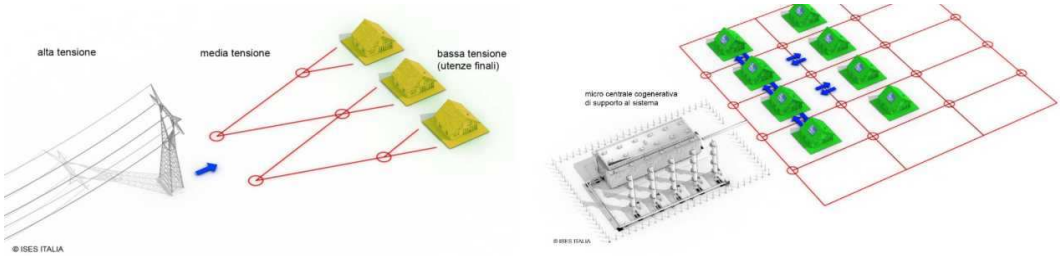
Energy saving, energy rational use, energy efficiency and renewable energy sources use are strategic energy policy that offers different development opportunities to territories: reducing dependence on foreign energy and fossil fuels, improving environmental quality, usability and life on the island, developing new decentralized industrial activities, technological innovation and services through skilled labor jobs.

According to the Ministry of Economic Development (MED) estimates the trend growth of energy consumption is expected to be around 1,4% per annum, if the estimates of economic growth will amount to around 1,7%, therefore the demand for energy Italian primary level by 2020 is expected to rise by about 25% compared to current consumption. The document of the Presidency of the Council of Ministers dated September 2007 provides a potential of electricity from renewable by 2020 of about 104 TWh and 12 Mtoe of thermal energy from endogenous sources (mainly biomass) and 3.6 Mtoe imports of biofuels.

In this scenario we would estimate to reduce final energy consumption of about 9.6% by 2016 compared to the consumption in 2005. To 20% reduction in the primary energy consumption expected by 2020 we need to save, with measures for the rational use of energy, energy saving and efficiency, at least 45.9 Mtoe, with a saving of about 435,000 GWh of primary energy, which will achieved by actions of "economy and efficiency" in the residential and tertiary sectors (-8.5 Mtoe electrical, thermal -10.5 Mtoe), industrial (-9 Mtoe electrical, thermal -4 Mtoe), transport (media efficiency and vectors -7.9 Mtoe, new ways for people and goods -6 Mtoe). Actions on energy efficiency and savings provide management actions of efficiency demand in energy production and especially in the end-use

A substantial effort should be necessary also on renewable sources with attention to heating and cooling which should bring a change of 19 Mtep by 2020 with supplied thermal energy over 215.000 GWh, while the electricity sector is supposed to be more than 20 Mtep with a 120.000 GWh production and an incidence of renewable on the necessary primary energy over 39 Mtep by 2020. The supply of energy from renewable sources must favour the decentralized micro production (co-tri-generation) with micro nets system appropriate for the demand (figure 5).
The ISEAP of the Region Sardinia, through the EU project Pact of Islands, contributes to the National and European commitment for the achievement of 20-20-20 by 2020.

**Figure 5 – Generation system evolution and electric Energy, heating (cooling) distribution through distributed micro-co(tri)-generation going to replace the unsustainable system of mega power plants.**



# 3. ENERGY BALANCE AND INVENTORY EMISSIONS

## 3.1. Introduction – overall framework

The following chapters analyze Sardinia energy balance for 2005 (BER), energy balance trend, in the absence of rational interventions (business as usual - BAU), and energy balance by 2020 (ISEAP), by means of interventions for savings, energy efficiency and renewable energies development.

The 2020 scenario has been identified assuming an annual growth rate of consistent energy demand equal to 1% per year from the year 2005.

The development of regional energy balance in 2005 is consistent with the Reference Document of the Region of Sardinia in renewable energy and with ENEA, ISTAT, ISO, ENEL, TERNA and ISPRA official data.

The content of this study has highlighted the vast potential of the regional system, both in terms of the development of renewable energy, both in terms of its potential to realize actions for savings and energy efficiency and the consequent CO2 emission potential reduction in the atmosphere.

As things stand now, the analysis of the data and the territory's potentials in the field of renewable energies have highlighted two significant aspects which allow for regional planning:

- CO2 emission reduction of 20% by 2020 is possible and ISEAP is proof of that, in a context of increased efficiency of the regional energy system natural gas availability. The availability of natural gas is a requirement that, in addition to promoting the security of energy supply, improve the mix of energy sources in the region, with benefits for all sectors (this aspect is important, considered the choices made by the Region of Sardinia and commitments already made by the Community).
- Regional energy system increase equal to **8,63%,** with scope for further action in private building and small medium companies to be increased in the medium long term.

The final result is that Sardinia, on the base of the Sustainable Energy Action Plan, can reach the following objectives:

- CO2 emissions reduction in the atmosphere equal to **22,31%** by 2020, compared to 2005, down from 15,49 to 11,99 tons per capita;
- Increase in renewable energy sources of almost **21,48%**, on final consumptions, a value significantly higher than that established for Sardinia (17.8% from MISE Decree on the distribution between regions and autonomous provinces of the rate of uptake of renewable energy by 2020 (Burden Sharing). A value destined to grow in the presence of additional saving measures and efficiency and new applications in the field of distributed generation

- The final net consumptions reduction compared to the trend scenario is equal to **19,73%**
- Gross Inland Consumptions reduction by 2020 of **31,32%** compared to those estimated according to BAU procedure.

Before the analysis of base detail it's better to present the following short note indicating briefly the basic assumptions on which ISEAP scenarios were developed:

Gross Inland Consumption by 2020

- **Bunkers and stock changes:** increasing by virtue of the greater refinery availability;
- **Petroleum products** (electric production): decreasing in favor of coal in the trend scenario (BAU) and decreasing for the contribution of renewable sources and natural gas in the ISEAP scenario;
- **Coal** (electricity production): increasing of coal contribution (BAU), substitution hypothesis of fuel oil groups with coal plants; in the ISEAP the contribution of coal decreases in favor of natural gas and increase of renewable sources;
- **Natural gas:** methane contribution (ISEAP) following the completion of the methane pipe-line GALSI and its interconnection with local distribution nets already operating in the area and ready to the transition to methane gas. The contribution of fuel products decrease in the same sectors;
- **Non-energy use of fuel products**: their contribution is decreasing (ISEAP) as a result o fan expected lower incidence of the chemical industry in the regional territory;
- **Export of energy products:** they are increasing considered the greater efficiency of the system

Final consumption by 2020

- **Agricolture:** following the use of renewable energy sources in the companies thermal energy is increasing in the agricolture sector (ISEAP);
- **Industry:** energy used in industry is significantly decreasing as a result of the reduction by the major industry but also because of the improved production technologies and quality management;
- **Civil:** on the whole, energy in the civil sector is increasing, with a slight escalation of electric energy (ISEAP) lower than the value reported in the BAU 2020 scenario, as a result of savings in public and private lighting, new appliances, quality management and methane use.
- **Transport:** global consumption remains almost constant compared to 2005. The improvement of network and systems management and operations of sustainable mobility (evidenced by a reduction in fuel consumption compared to the BAU scenario), will produce an improvement in the general conditions of mobility. The use of electricity in transport is growing due to the introduction of electric vehicles in different sectors. The use of natural gas marginally affects the total energy in transport. It will tend to increase with the increase of CNG infrastructure·

Grid Electricity Efficiency

An increase in the electric grid (ISEAP) is expected from 89,79% to 90,52%.

The following tables show the most significant values relative to gross domestic consumption and end use. To be highlighted in a particular way it is data on gross consumption of the ISEAP that is 31.64% lower than the BAU. This is due to interventions aimed at improving the energy efficiency of the overall system

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**TAB. 3.1.1 - Gross inland consumption**

| Gross inland consumption (GWh) | 2005 | 2020 (BAU) | 2020 (ISEAP) |
|---|---|---|---|
| Fuel products for industrial sector | 8557 | 9927 | 7568 |
| Fuel products Other sectors | 4360 | 5055 | 1428 |
| Fuel products consumptions and losses | 4223 | 4900 | 4930 |
| Coal for the industrial sector | 77 | 89 | 92 |
| Coal for other sectors | 29 | 33 | 35 |
| Natural gas for other sectors | 61 | 71 | 2421 |
| Natural gas for industrial sector | 889 | 1031 | 1204 |
| Renewable energy for industrial sector | 7 | 8 | 208 |
| Renewable energy for other sectors | 1167 | 1353 | 1307 |
| Renewable consumptions and losses | 696 | 807 | 407 |
| Heating industrial sector | 9 | 10 | 159 |
| Heating other sectors | | 0 | 145 |
| Heating consumptions and losses | | 0 | 464 |
| Coal for electric energy | 14763 | 25943 | 4429 |
| Fuel products in electric energy | 16640 | 10957 | 7659 |
| Fuel products in other processing | 61 | 71 | 61 |
| Natural gas for electric energy | - | 0 | 2626 |
| Renewable energy for electric energy | 1536 | 1781 | 9094 |
| Renewable energy in other processing | 44 | 51 | 53 |
| Heating in other processing | | 0 | 150 |
| Fuel products for transport sector | 13762 | 15965 | 12207 |
| Natural gas for transport sector | - | 0 | 63 |
| Renewable energy for transport sector | | | 945 |
| Fuel products for non energy use | 12843 | 14897 | 5881 |
| Coal for non energy use | - | 0 | 0 |
| Natural gas for non energy use | - | 0 | 0 |
| Renewable energy for non energy use | | 0 | 301 |
| Gross inland consumption 2005 | 79724 | 0 | |
| Gross inland consumption 2020 (BAU) | | 92949 | |
| Gross inland consumption 2020 (ISEAP) | | | 63837 |
| | | | |
| Fuel products in bunker | 2099 | 2435 | 2541 |
| Electric energy export | 409 | 475 | 1227 |
| Electric energy importation | | | |

Annotations:

- The scenario for 2020 is made on the base of a demand growth of 1% per year;
- The increate use of coal (BAU) is due to the possible replacement of fuel oil groups of the Fiumesanto plant with a coal group ;
- The ISEAP scenario for 2020 is made taking into account natural gas availability

### TAB. 3.1.2 – Primary energy associated to electricity produced from renewable sources

| Primary energy (GWh) | 2005 | 2020 (BAU) | 2020 (ISEAP) |
|---|---|---|---|
| Hydroelectric | 1776,52 | 2059,73 | 1781,67 |
| Wind | 1053,04 | 1220,39 | 6951,6 |
| Photovoltaic | | | 3694,64 |
| Solar thermodynamic | | | 205,97 |

Annotations:

- For the evauation of primary energy we have considered the same conversion efficiency of existing fuel oil power stations, equal to 38,84%.

### TAB. 3.1.3 – Final use

| Energy Final Use (GWh) | 2005 | 2020 - ( BAU ) | 2020 ISEAP |
|---|---|---|---|
| | | | |
| Agriculture | **1187** | **1375** | **1471** |
| Industry | **16743** | **19421** | **14414** |
| Civil | **9263** | **10743** | **8815** |
| Transport | **13778** | **15984** | **13446** |
| Final use 2005 | **40971** | | |
| of which electric | 12053 | | |
| | | | |
| Final use 2020 (BAU) | | **47523** | |
| of which electric | | 13981 | |
| | | | |
| Final use 20020 (ISEAP) | | | **38146** |
| of which electric | | | 10364 |

Annotations:

- Agriculture: electric energy in agriculture for 2005 was equal to 17,01% of the sector. It is expected with an incidence of 22,43% by 2020.
- Transport: the improvement of networks and management system is accompanied to an increase of mobility and the increasing use of electric vehicles, with an incidence equal to 1.45% of the total demand.

**TAB. 3.1.4 – Renewable energies electric sector in Sardinia by 2020.**

| source | Installed power | yearly hours functioning | |
|---|---|---|---|
| | [MW] | - | GWh |
| **Hydroelectric** | 466,5 | | 230 |
| **Solar – PV installed Dec.-2011**[1] | 320 | 1.400 | 448 |
| **Solar - PV Large Plants** | 200 | 1.400 | 280 |
| **PV- GSE inferior plants 200 kWp** | 170 | 1.400 | 238 |
| **PV-Dlgs 28/2011 homes** | 40 | 1.400 | 56 |
| **Solar PV concentration** | 150 | 1.800 | 270 |
| **Solar Thermal** | 30 | 2.400 | 72 |
| **On shore wind** | 1500 | 1700 | 2.550 |
| **Biomass in municipal solid waste (MSW)** | 6,8 | - | 44 |
| **Solid biomass different from MSW** | 87 | 5.400 | 470 |
| **Biogas** | 132,5 | 4.000 | 530 |
| **Hybrid plants (co-combustion)** | 580 | - | 370 |
| **Bio-fuels** | 37 | | 150 |
| **TOTAL** | | | **5708** |
| **RE Percentage contribution electric sector on final electric consumptions** | | | **55,08%** |

1 Source Atlasole GSE

**TAB. 3.1.5 – Renewable energies thermal sector in Sardinia by 2020.**

| Thermal sector [Gwh] | | |
|---|---|---|
| **Sector** | **Category** | **Energy** |
| **Residential, Tertiary** | Biomass – Direct use | 338 |
| | Biomass - District heating | - |
| | Efficiency recovery from residential building | 0 |
| | Biogas cogeneration | 145 |
| | PdC residential and tertiary heating | 537 |
| | PdC ACS | |
| | Thermal Solar ACS | 432 |
| | Thermal Solar heating | |
| **Agriculture** | Biomass | - |
| **Industry** | Biomass | 208 |
| | Biogas cogeneration | 148 |
| | Different heating recovery | 11 |
| **Overall initial contribution** | | 150 |
| **Thermal energy from transformation** | | 43 |
| **Thermal consumption in production sites** | | 464 |
| **TOTAL** | | **2476** |
| **Renewable percentage contribution thermal sector on final consumptions** | | **17,00%** |

## Situation base year 2005

The basic situation for 2005 has been written developing data related to ENEA and Terna Regional Energy Balance. The following table shows a characterization of production and consumption in line with the particular insularity of the territory. The efficiency value of the global energy system should be emphasized, below the National average, mainly due to the presence of "traditional" low efficiency electric stations. The summary energy financial statement for 2005 is as follows:

**Table 3.2.1: Summary financial statement of the Region of Sardinia**

**Bilancio di sintesi dell'energia della Sardegna - 2005**

| | Gwh | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Combustibili solidi | Petrolio | Gas | Nucleare | Rinnovabili | Calore | Energia elettrica | Energia termica | Totale |
| Produzione interna | 893 | 180.495 | 940 | | 3.104 | 9 | *13.879* | *20.082* | 185.441 |
| Saldo import-export | 13.976 | -118.975 | 10 | | 346 | | *-409* | | -104.643 |
| Bunkeraggi internazionali | | 2.099 | | | | | | | 2.099 |
| Variazioni delle scorte | | -1.025 | | | | | | | -1.025 |
| **Disponibilità interna lorda** | 14.869 | 60.446 | 950 | | 3.450 | 9 | *13.470* | *20.082* | ***79.724*** |
| **Ingressi in trasformazione** | 14.763 | 16.701 | | | 1.580 | | *32.939* | *105* | 33.044 |
| Centrali elettriche | 14.763 | 16.640 | | | 1.536 | | *32.939* | | 32.939 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 61 | | | 44 | | | *105* | 105 |
| **Uscite dalla trasformazione** | 5.361 | 7.876 | | | 724 | | *13.879* | *82* | 13.961 |
| Centrali elettriche | 5.361 | 7.815 | | | 703 | | *13.879* | | 13.879 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 61 | | | 21 | | | *82* | 82 |
| **Consumi e perdite** | | 4.223 | | | 696 | | *1.417* | *4.926* | 6.336 |
| **Disponibilità interna netta** | 106 | 39.522 | 950 | | 1.174 | 9 | *12.053* | *15.156* | 53.814 |
| **Usi non energetici** | | 12.843 | | | | | | | 12.843 |
| **Consumi finali** | 106 | 26.679 | 950 | | 1.174 | 9 | *12.053* | *15.156* | **40.971** |
| **Industria** | 77 | 8.557 | 889 | | 7 | 9 | *7.204* | *9.539* | 16.743 |
| Industria manifatturiera di base | 31 | 7.291 | 889 | | 7 | | *6.658* | *8.218* | 14.876 |
| Industria manifatturiera non di base | 46 | 1.246 | | | | 9 | *546* | *1.301* | 1.847 |
| Costruzioni | | 20 | | | | | | *20* | |
| **Trasporti** | | 13.762 | | | | | *16* | | 13.778 |
| Stradali | | 11.944 | | | | | | | 11.944 |
| Altre modalità di trasporto | | 1.818 | | | | | *16* | | 1.834 |
| **Altri settori** | 29 | 4.360 | 61 | | 1.167 | | *4.833* | *5.617* | 10.450 |
| Residenziale | 29 | 2.961 | 61 | | 1.165 | | *2.244* | *4.216* | 6.460 |
| Agricoltura, Silvicoltura e Pesca | | 985 | | | | | *202* | *985* | 1.187 |
| Altri settori | | 414 | | | 2 | | *2.387* | *416* | 2.803 |
| **Produzione di energia elettrica - GWh** | ***5.361*** | ***7.815*** | | | ***703*** | | | | **13.879** |
| **Produzione di calore – GWh** | | ***61*** | | | ***21*** | | | | **82** |
| | | | | | | | *Efficienza Sistema* | | 51,39% |

Fonte: Agenzia Nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA)

### 3.2.1. Final Energy demand

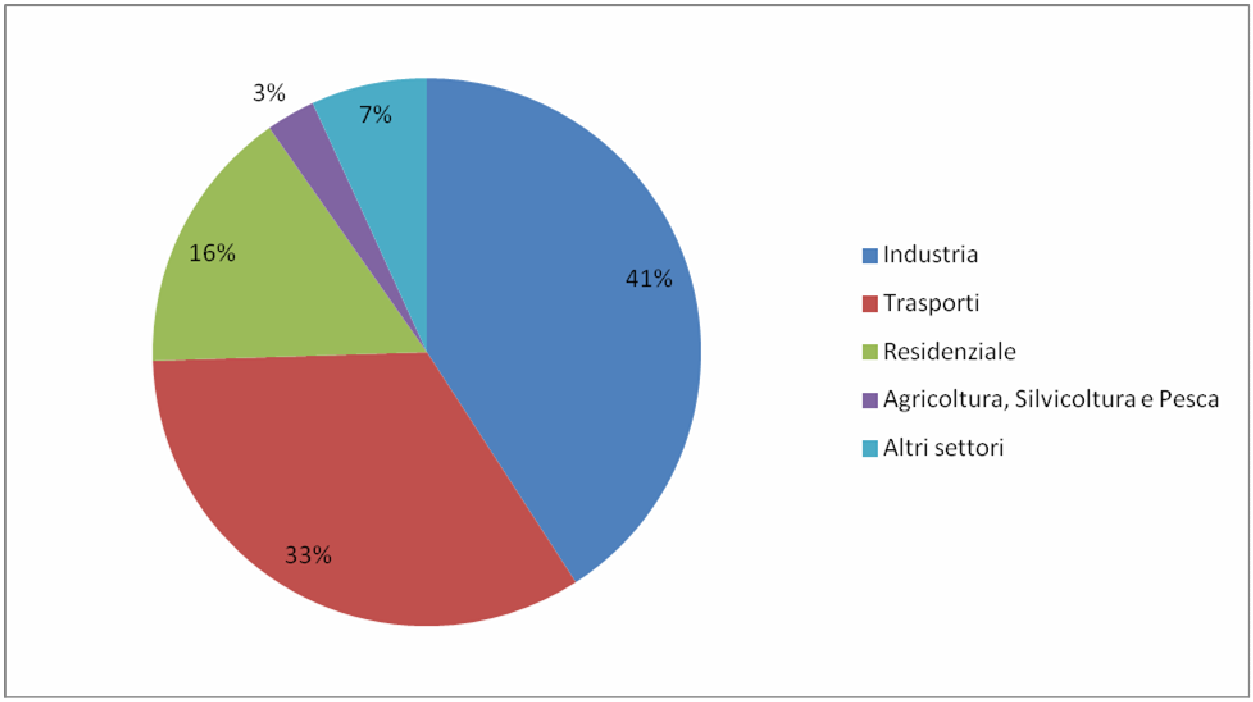
Energy demand, shown in Table 3.2.2, by the end user by sector and by type of energy in 2005, shows that the secondary sector is the Island's largest user of fossil fuels (industrial sector). In terms of application, the secondary sector is followed by the transport sector which occupies a large part of the energy needs, confirming the need to restructure the sector deeply in order to achieve the desired goals.
The residential sector, third in the energy demand, is subject to the same considerations noted in the transport sector: energy efficiency increase is a need so to reach the desired targets.

**Table 3.2.2: Final energy demand year 2005**

| | Solid fuels | Oil | Gas | Nuclear | Renewable | Heating | Electric energy | Thermal energy | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Final consumption** | **106** | **26.679** | **950** | **0** | **1.174** | **9** | ***12.053*** | ***15.156*** | **40.971** |
| **Industry** | 77 | 8.557 | 889 | 0 | 7 | 9 | *7.204* | *9.539* | 16.743 |
| Baseline manufacturing industry | 31 | 7.291 | 889 | 0 | 7 | 0 | *6.658* | *8.218* | 14.876 |
| Non-baseline manufacturing industry | 46 | 1.246 | 0 | 0 | 0 | 9 | *546* | *1.301* | 1.847 |
| Building | 0 | 20 | 0 | 0 | 0 | 0 | *0* | *20* | |
| **Transport** | 0 | 13.762 | 0 | 0 | 0 | 0 | *16* | *0* | 13.778 |
| Street | 0 | 11.944 | 0 | 0 | 0 | 0 | *0* | *0* | 11.944 |
| Other modes of transportation | 0 | 1.818 | 0 | 0 | 0 | 0 | *16* | *0* | 1.834 |
| **Other sectors** | 29 | 4.360 | 61 | 0 | 1.167 | 0 | *4.833* | *5.617* | 10.450 |
| Residential | 29 | 2.961 | 61 | 0 | 1.165 | 0 | *2.244* | *4.216* | 6.460 |
| Agriculture, Forestry and Fishing | 0 | 985 | 0 | 0 | 0 | 0 | *202* | *985* | 1.187 |
| Other sectors | 0 | 414 | 0 | 0 | 2 | 0 | *2.387* | *416* | 2.803 |

Figure 1 shows final consumptions divided by sector. The mainly sector is the industrial one, followed by transport, confirming Sardinia's territorial peculiarities.

**Figure 1: Final energy demand year 2005**

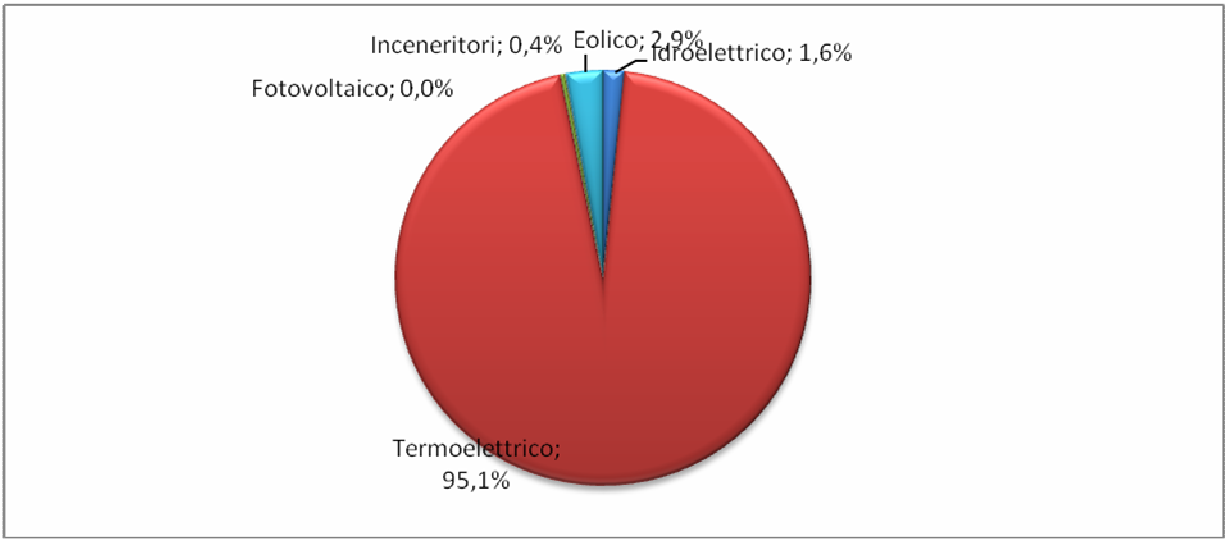


### 3.2.2. Energy conversion

As evidenced by Figure 2, electric energy production in 2005 is characterized by a strong component of primary energy deriving from fossil fuels combustion. Conversion system efficiency from thermal energy to electric energy in the current thermoelectric plants is behind the National average.

Centralized cogeneration system are practically inexistent in the territory. Thermal energy recovery is marginal and limited to a unique industry sector.

**Figure 2: production of electricity by sources year 2005**




As evidenced by Figure 3, electric energy production from fuel products is equal to 59,6%, while coal is present at about 40%. Renewable sources contribution is marginal.

**Figure 3: production of electricity from thermoelectric plants year 2005**

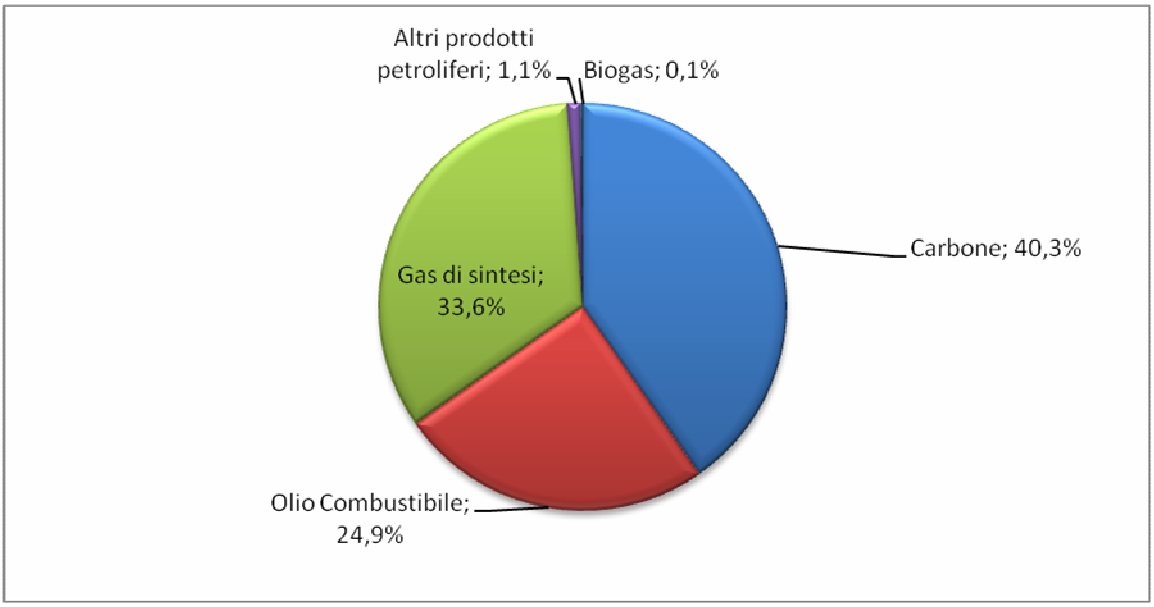



**Figure 4: thermal energy production divided by sources year 2005**

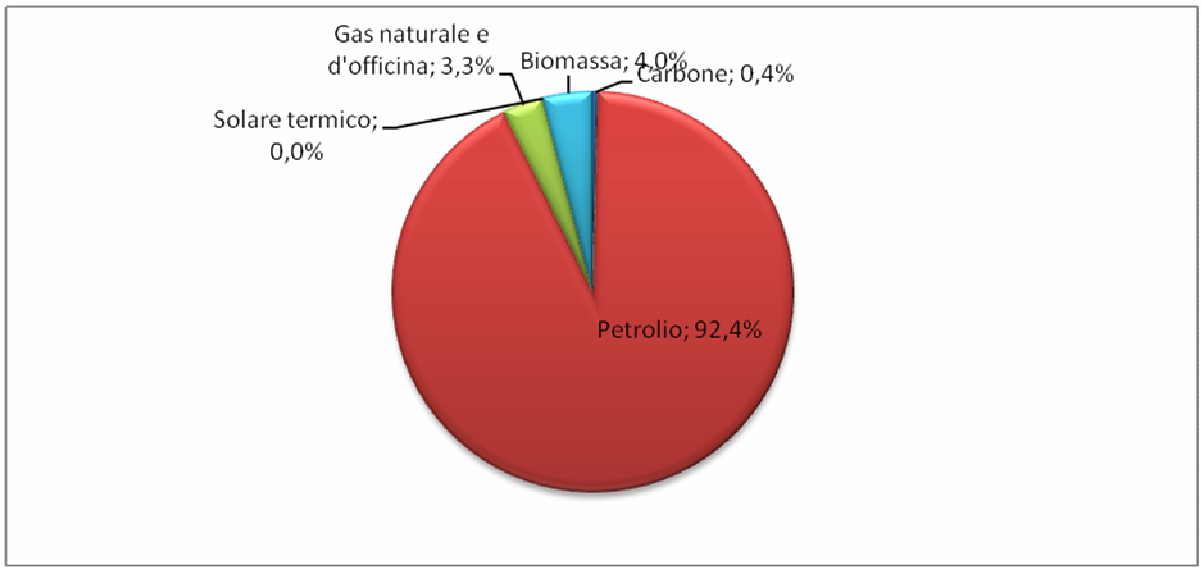
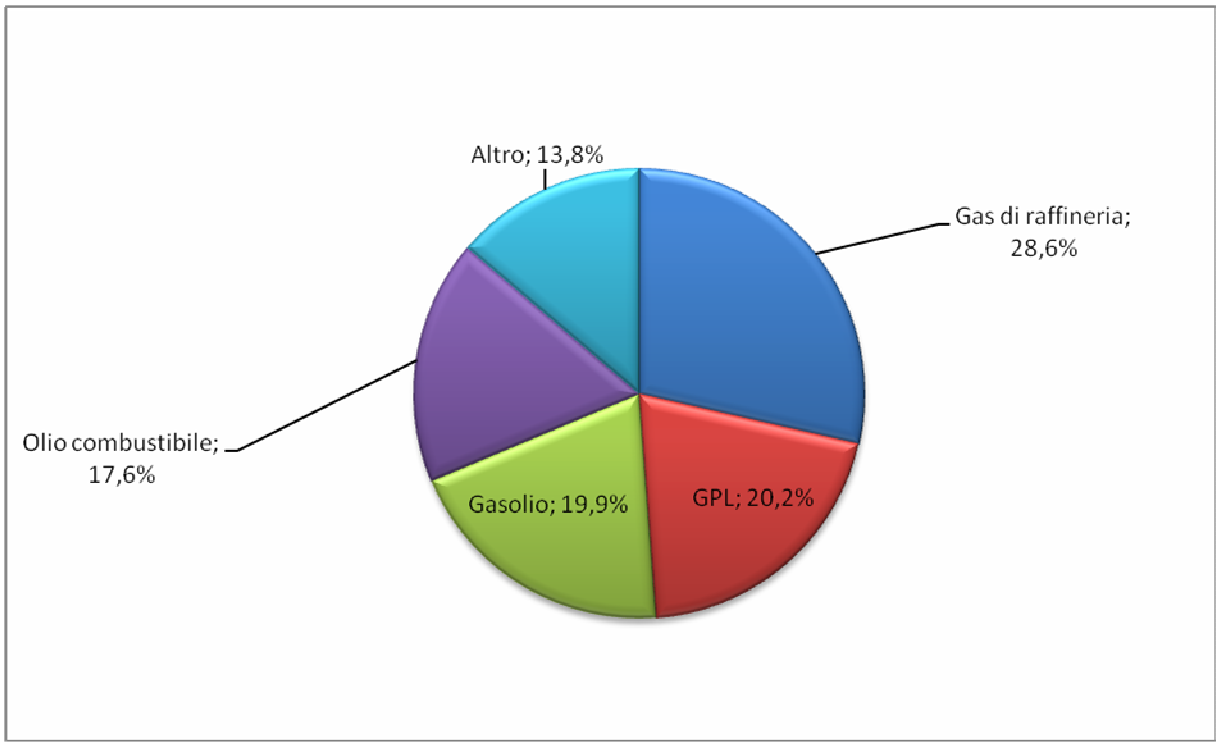



Figure 5 shows a substantial equilibrium of heating supply from fuel products. This enhances a lower energy vulnerabilityt to satisfy thermal needs.

**Figure 5: thermal Energy production from oil divided by sources year 2005**



Figures 6 and 7 show the subdivision of thermal needs by sector. Industry is the most energivorous sector.

**Figure 6: electric energy final demand year 2005**

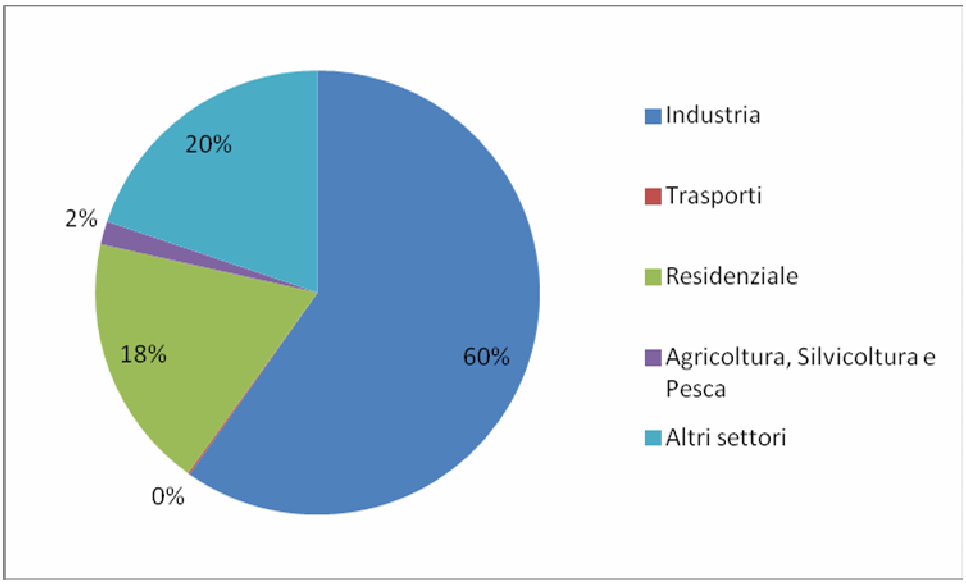
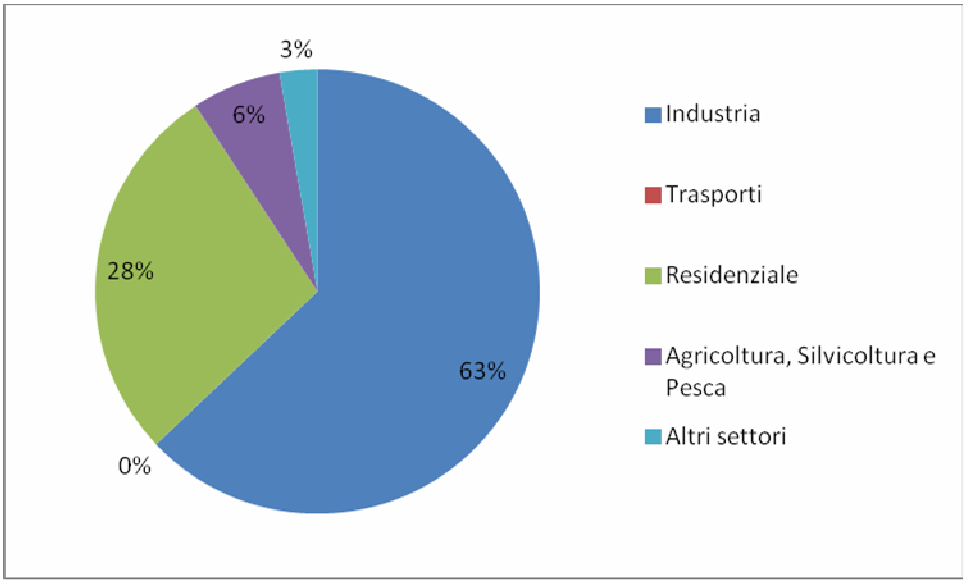



**Figure 7: final demand of thermal energy year 2005**




### 3.2.3. Emissions of carbon dioxide

CO2 emissions calculation methodology, as shown in tables and figures below, reflects European directives for the assessment of climate-changing gases. The reference parameter is the IPCC factor emission for each fuel type. As a starting point, reference has been made to

the production, processing and use of products responsible of green house gas emissions, with exclusion of outgoing products, bunkers and stock changes. The global emission excludes the contribution of forests and CO2 capture systems.

**Tabella 3.2.4 : Carbon dioxide emissions by sources**

| Energy carrier | TOTALE [Gg] |
|---|---|
| Coal | 5231 |
| GPL | 1062 |
| Gasoline | 1299 |
| Coalturbo | 146 |
| Diesel | 2759 |
| Fuel | 3755 |
| Syntesis Gas | 1577 |
| Light distillates | 1660 |
| Other from fuel product | 7037 |
| Natural and non natural gas | 193 |
| From renewables | 853 |

**Figure 8: carbon dioxide emissions by source**

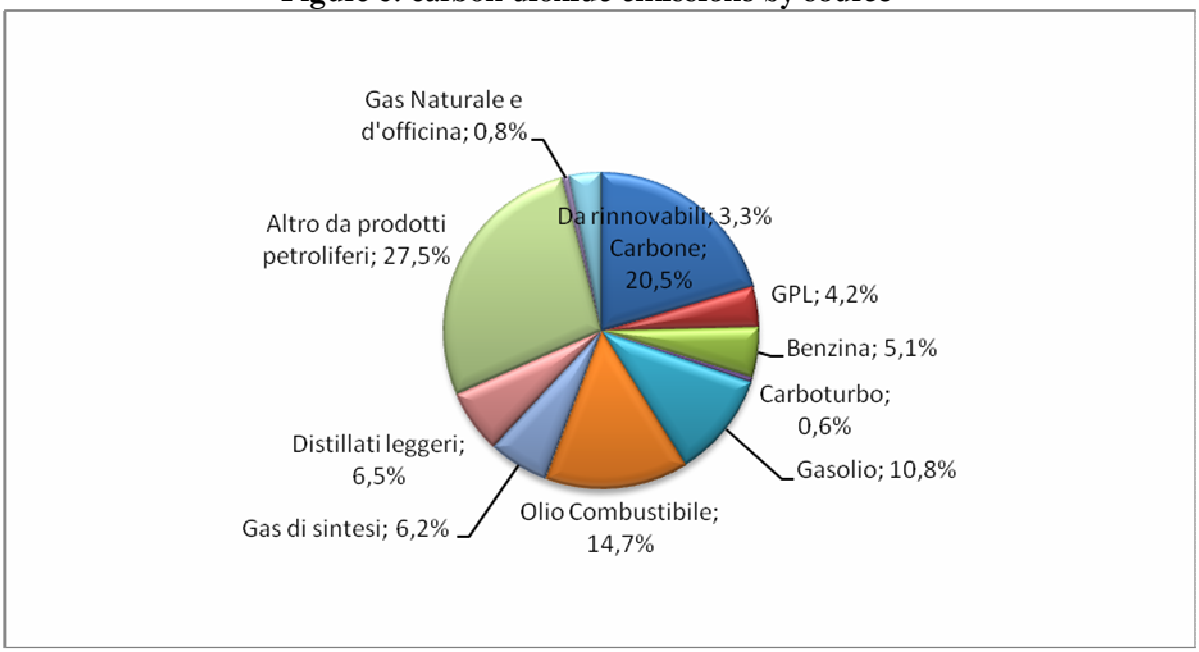
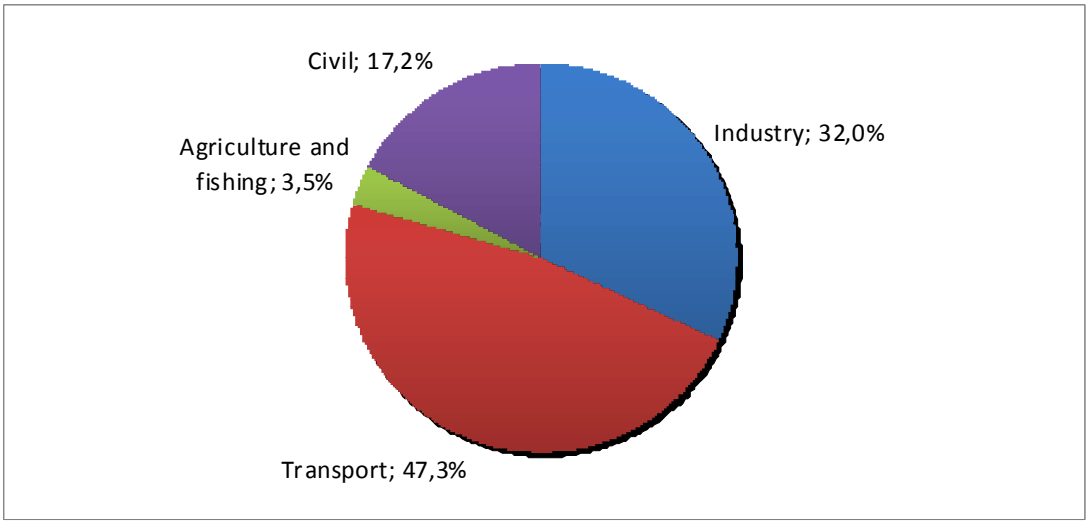



**Figure 9: Carbon dioxide emissions by end-use sector**

## 3.3. Projections to 2020 – "business as usual" scenario.




The situation for the year 2020 BAU has been prepared following a trend of consumption growth by 1% per annum starting from the base year 2005. For electricity production the use of coal according to the main guidelines adopted in 2005 has been emphasized, at the expense of petroleum products and renewable energy sources. The value of Efficiency of the global energy system follows the trend of the baseline year. The summary energy balance of the year 2020 "Business as usual" is as follows:

**Table 3.3.1: Region of Sardinia summary balance BAU scenario 2020**

**Bilancio di sintesi dell'energia della Sardegna – 2020 (BAU)**

Gwh

| | Combustibili solidi | Petrolio | Gas | Nucleare | Rinnovabili | Calore | Energia elettrica | Energia termica | Totale |
|---|---|---|---|---|---|---|---|---|---|
| Produzione interna | 1.036 | 209.377 | 1.091 | | 3.600 | 10 | *16.100* | *23.292* | 215.114 |
| Saldo import-export | 25.030 | -146.355 | 12 | | 401 | | *-475* | | -120.912 |
| Bunkeraggi internazionali | | 2.435 | | | | | | | 2.435 |
| Variazioni delle scorte | 1 | -1.185 | 1 | | 1 | | | | -1.182 |
| **Disponibilità interna lorda** | 26.065 | 61.772 | 1.102 | | 4.000 | 10 | *15.625* | *23.292* | ***92.949*** |
| **Ingressi in trasformazione** | 25.943 | 11.028 | | | 1.832 | | *38.681* | *122* | 38.803 |
| Centrali elettriche | 25.943 | 10.957 | | | 1.781 | | *38.681* | | 38.681 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 71 | | | 51 | | | *122* | 122 |
| **Uscite dalla trasformazione** | 9.458 | 5.898 | | | 839 | | *16.100* | *95* | 16.195 |
| Centrali elettriche | 9.458 | 5.827 | | | 815 | | *16.100* | | 16.100 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 71 | | | 24 | | | *95* | 95 |
| **Consumi e perdite** | | 4.900 | | | 807 | | *1.644* | *5.715* | 7.351 |
| **Disponibilità interna netta** | 122 | 45.844 | 1.102 | | 1.361 | 10 | *13.981* | *17.577* | 62.420 |
| **Usi non energetici** | | 14.897 | | | | | | | 14.897 |
| **Consumi finali** | 122 | 30.947 | 1.102 | | 1.361 | 10 | *13.981* | *17.577* | **47.523** |
| **Industria** | 89 | 9.927 | 1.031 | | 8 | 10 | *8.356* | *11.065* | 19.421 |
| Industria manifatturiera di base | 36 | 8.459 | 1.031 | | 8 | | *7.723* | *9.534* | 17.257 |
| Industria manifatturiera non di base | 53 | 1.445 | | | | 10 | *633* | *1.508* | 2.141 |
| Costruzioni | | 23 | | | | | | *23* | |
| **Trasporti** | | 15.965 | | | | | *19* | | 15.984 |
| Stradali | | 13.856 | | | | | | | 13.856 |
| Altre modalità di trasporto | | 2.109 | | | | | *19* | | 2.128 |
| **Altri settori** | 33 | 5.055 | 71 | | 1.353 | | *5.606* | *6.512* | 12.118 |
| Residenziale | 33 | 3.434 | 71 | | 1.351 | | *2.603* | *4.889* | 7.492 |
| Agricoltura, Silvicoltura e Pesca | | 1.141 | | | | | *234* | *1.141* | 1.375 |
| Altri settori | | 480 | | | 2 | | *2.769* | *482* | 3.251 |
| **Produzione di energia elettrica - GWh** | ***9.458*** | ***5.827*** | | | ***815*** | | | | **16.100** |
| **Produzione di calore – GWh** | | ***71*** | | | ***24*** | | | | **95** |
| | | | | | | | *Efficienza Sistema* | | 51,13% |

Fonte: PEPS

## 3.3.1. Final Energy demand

Energy demand, shown in Table 3.2.2, by end user, sector and by type of energy in 2020, shows also here the prevalence of the secondary sector in net final consumption (industrial sector). In terms of application, the secondary sector is followed by the transport sector, as indicated in the BAU scenario of the year 2020.

The residential sector, the third per energy demand, is subject to the same considerations reported in 2005: consumptions are increasing but efficiency growth is necessary.

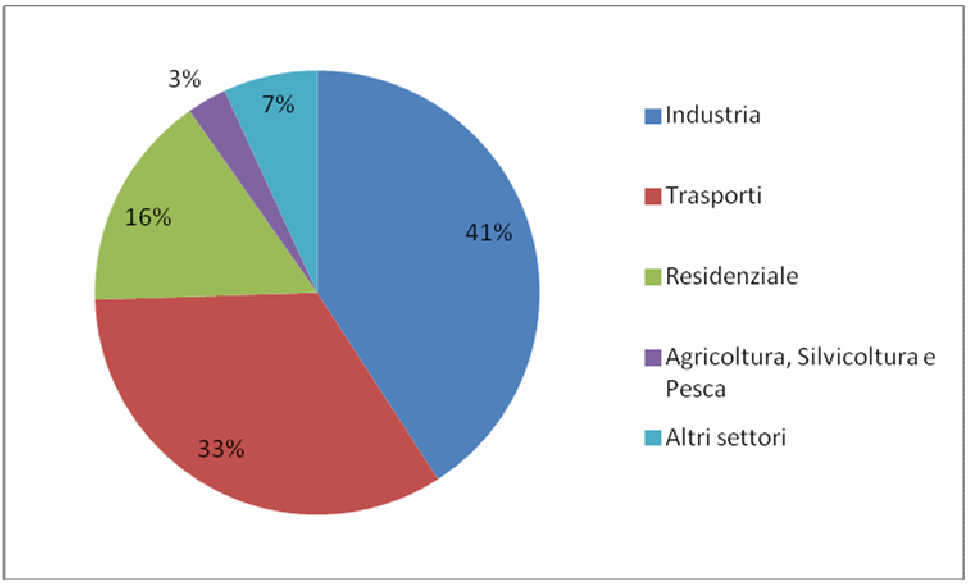
**Table 3.3.2: final energy demand BAU scenario at 2020**

| | Solid Fuels | Oil | Gas | Nuclear | Renewable | Heat | Electric Energy | Thermal Energy | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Final consumptions** | 122 | 30.947 | 1.102 | 0 | 1.361 | 10 | *13.981* | *17.577* | **47.523** |
| **Industry** | 89 | 9.927 | 1.031 | 0 | 8 | 10 | *8.356* | *11.065* | 19.421 |
| Baseline manufacturing industry | 36 | 8.459 | 1.031 | 0 | 8 | 0 | *7.723* | *9.534* | 17.257 |
| Non baseline manufacturing industry | 53 | 1.445 | 0 | 0 | 0 | 10 | *633* | *1.508* | 2.141 |
| Constructions | 0 | 23 | 0 | 0 | 0 | 0 | *0* | *23* | |
| **Transport** | 0 | 15.965 | 0 | 0 | 0 | 0 | *19* | *0* | 15.984 |
| Street | 0 | 13.856 | 0 | 0 | 0 | 0 | *0* | *0* | 13.856 |
| Other transport mod | 0 | 2.109 | 0 | 0 | 0 | 0 | *19* | *0* | 2.128 |
| **Other sectors** | 33 | 5.055 | 71 | 0 | 1.353 | 0 | *5.606* | *6.512* | 12.118 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Residential | 33 | 3.434 | 71 | 0 | 1.351 | 0 | *2.603* | *4.889* | 7.492 |
| Agriculture, Forestry and Fishing | 0 | 1.141 | 0 | 0 | 0 | 0 | *234* | *1.141* | 1.375 |
| Other sectors | 0 | 480 | 0 | 0 | 2 | 0 | *2.769* | *482* | 3.251 |

Figure 10 illustrates the final consumption divided by sector. The industrial sector is mainly followed by the transport sector, confirming the territorial peculiarities of Sardinia

**Figure 10: Final energy demand** BAU scenario




## 3.3.2. Energy conversion

As evidenced by Figure 11, also in this case the production of electrical energy for 2020 is characterized by a strong component of primary energy deriving from the combustion of fossil fuels. The efficiency of conversion of thermal energy to electrical energy of existing power plants in the area is below the national average.

Centralized co-generation systems are virtually absent in the territory. Thermal energy recovery is very marginal and limited to a single industry.

**Figure 11: production of electricity by source BAU scenario 2020**

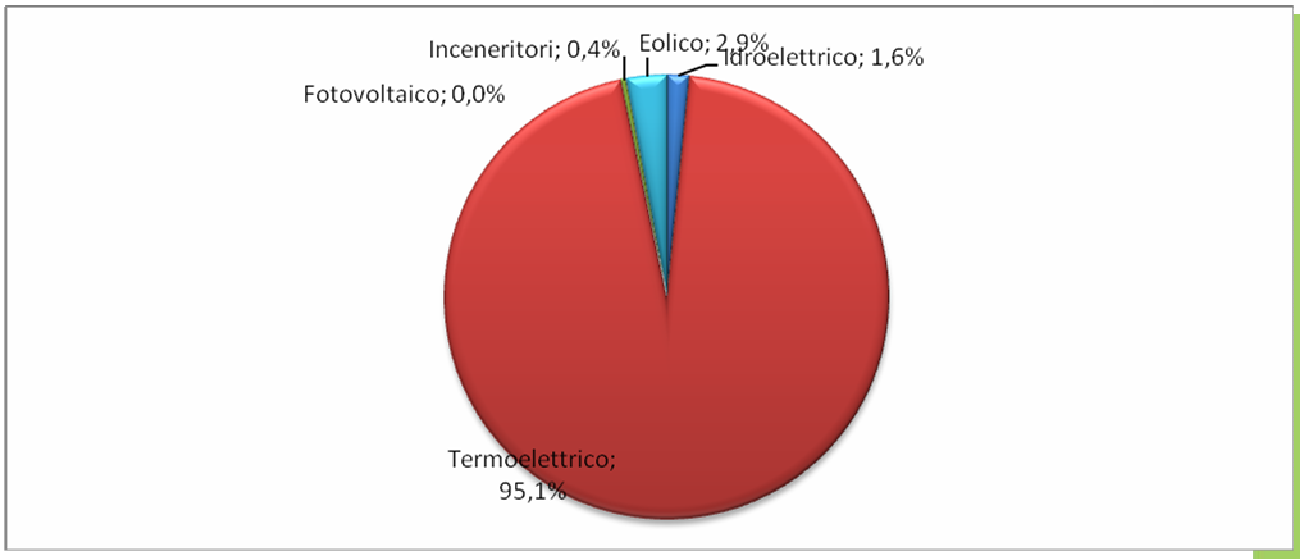
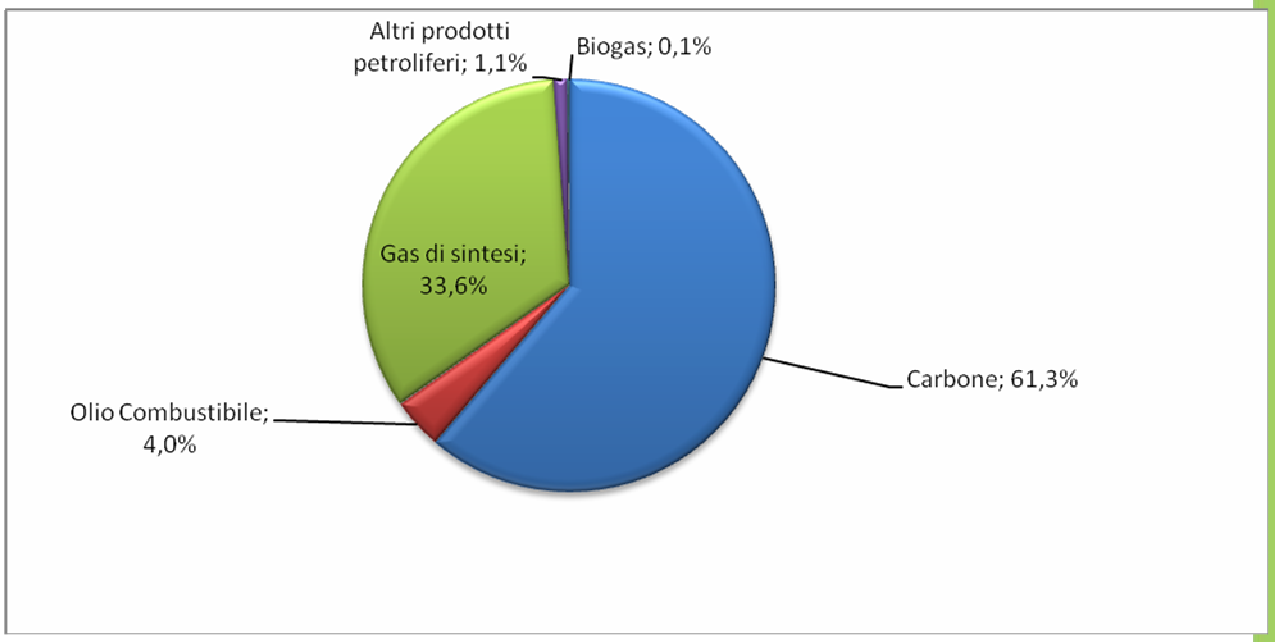



**Figure 12: Production of electricity by thermoelectric plants BAU scenario 2020**




The production of electrical energy, derived mainly from the combustion, shows a marked dependence on fossil fuels.

As regards the production of thermal energy, the renewable component (Biomass + Solar thermal) is very marginal. It is assumed that the amount of heat produced by the electrical source and from aero thermal RES has not be considered

**Figure 13: Production of thermal energy by sources BAU scenario 2020**

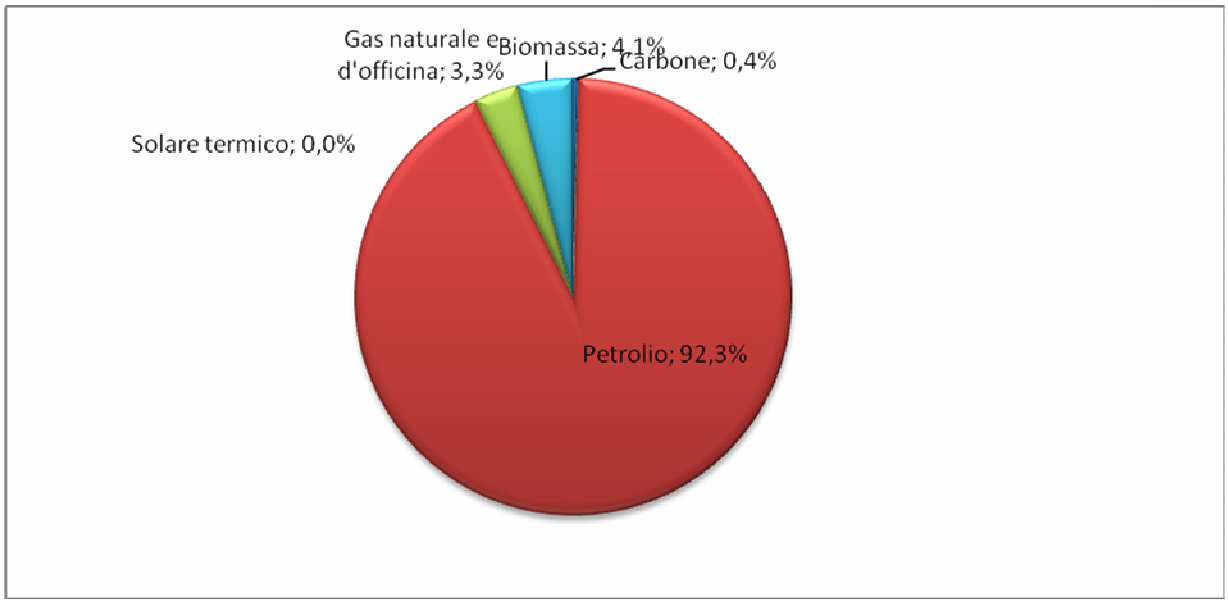



**Figure 14: Production of thermal energy from oil by sources BAU scenario 2020**

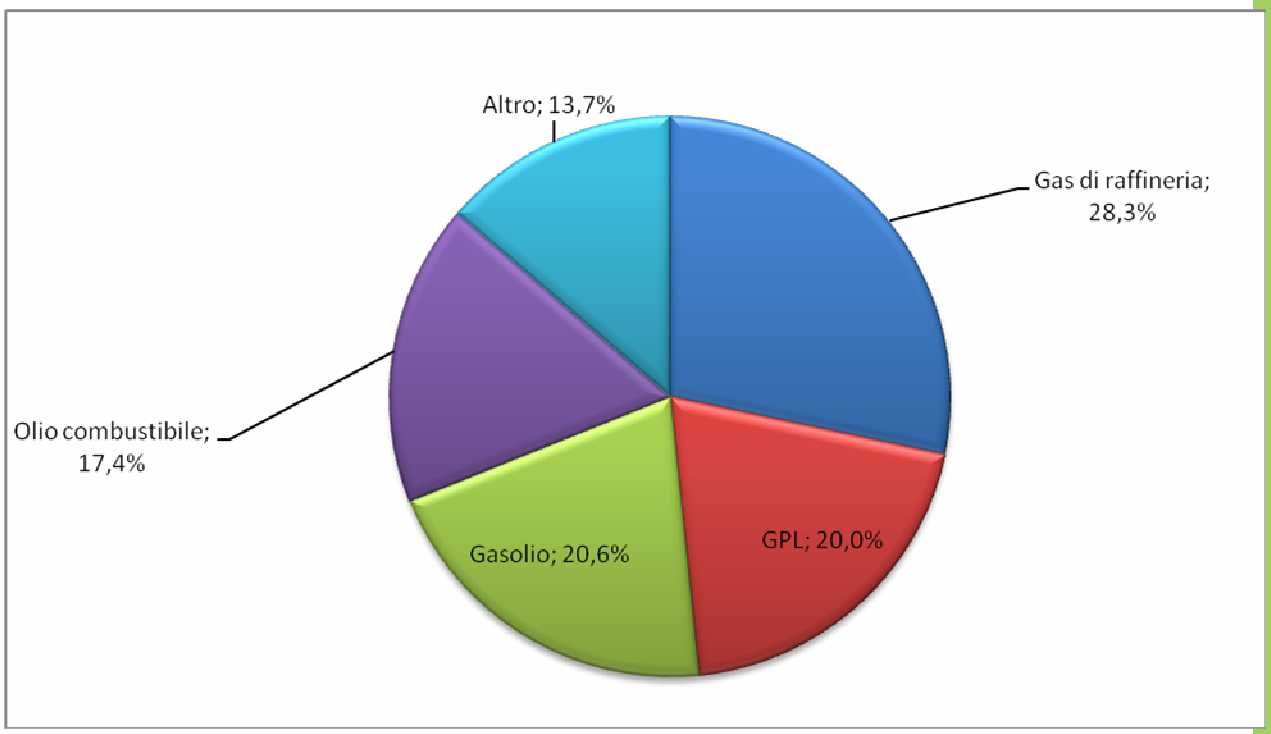


**Figure 15: Final energy demand of electricity BAU scenario 2020**

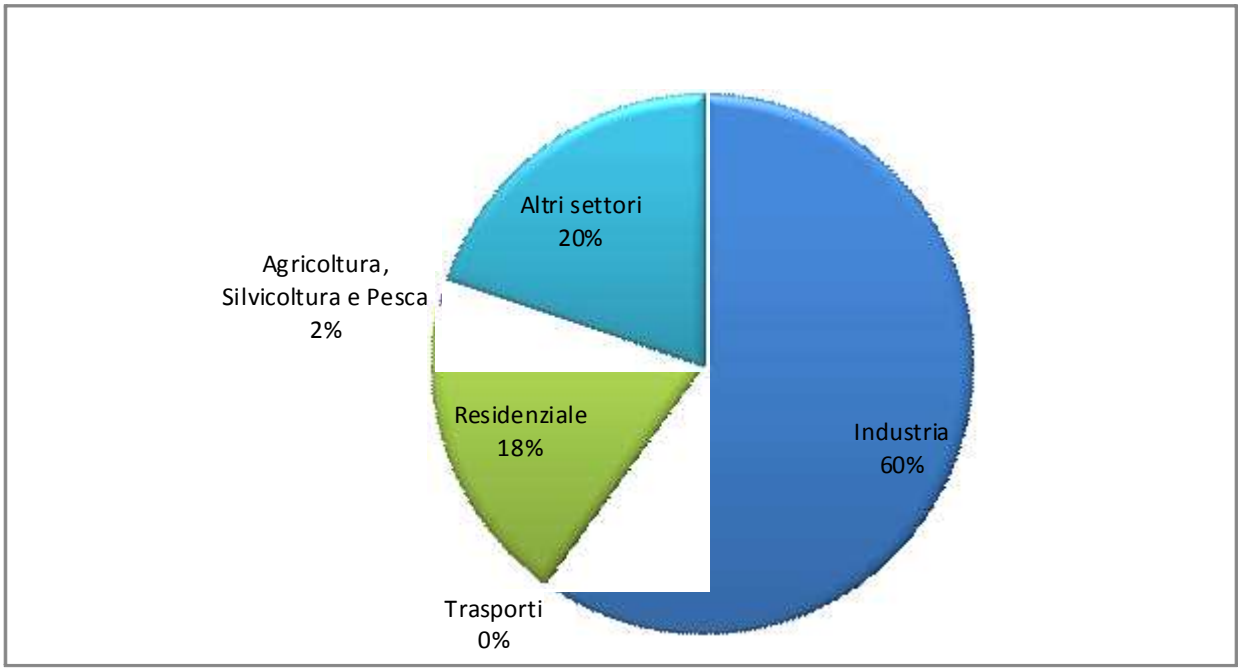
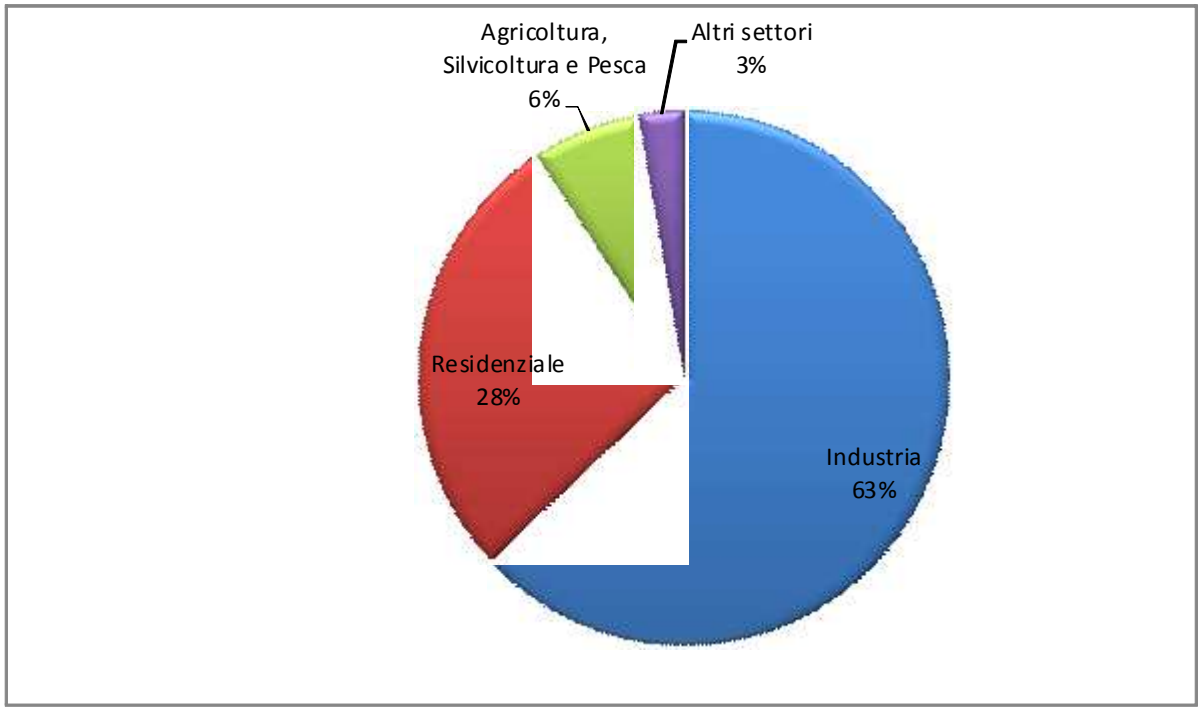



**Figure 16: Final energy demand of thermal energy** BAU scenario 2020



### 3.3.3. Emissions of carbon dioxide

The methodology for calculating CO2 emissions, as indicated in tables and figures below, reflects the 2005 baseline scenario. The reference parameter is the IPCC emission factor for each fuel type. As a starting point, reference has been made to the production, processing and use of the products responsible for greenhouse gas emissions, excluding outgoing products, bunkers and stock changes. The global emission excludes the contribution of forests and CO2 capture systems.

**Table 3.3.4: Emissions of carbon dioxide by source** BAU scenario 2020

| Energy carrier | TOTAL [Gg] |
|---|---|
| Coal | 9190 |
| GPL | 1232 |
| Gasoline | 1506 |
| Coalturbo | 169 |
| Diesel | 3201 |
| Fuel oil | 2027 |
| Syntesis gas | 1829 |
| Light distillates | 1926 |
| Other from fuel products | 8164 |
| Natural and non natural gases | 223 |
| From renewables | 989 |
| TOTAL | **30456** |

**Figure 17: emissions of carbon dioxide by source** BAU scenario 2020

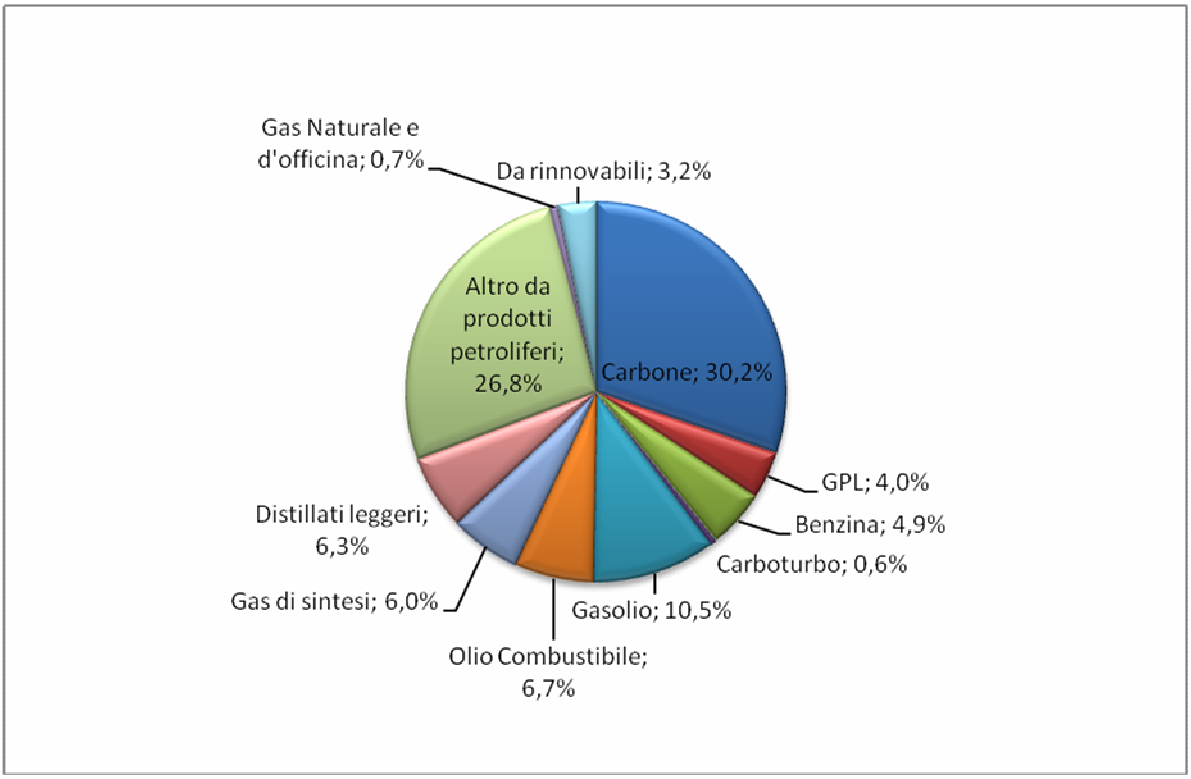
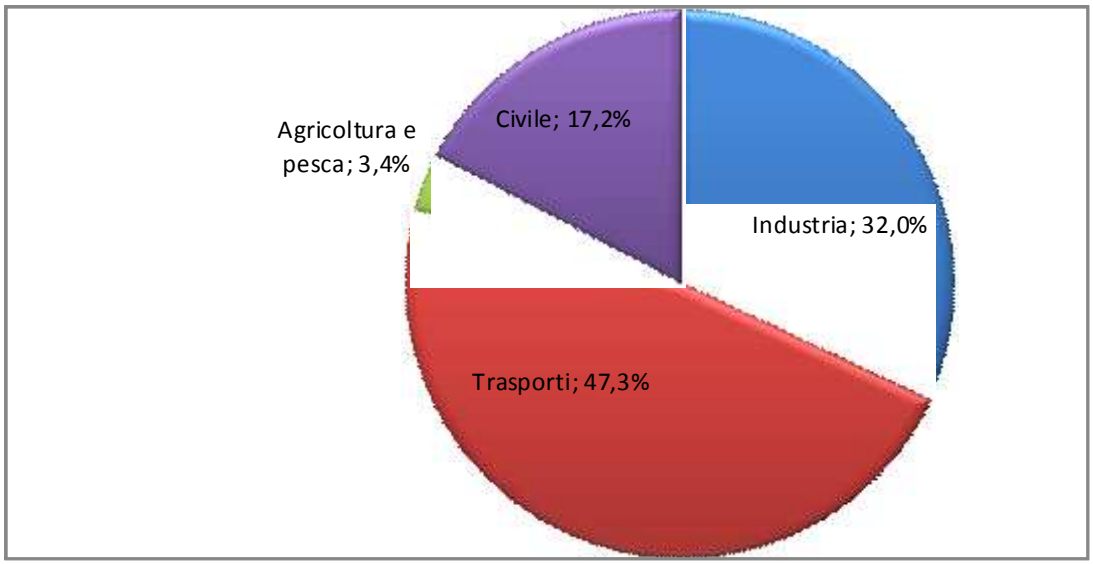



**Figure 18: Final use carbon dioxide emission** BAU scenario 2020



## 3.4. Projections to 2020 – action plan scenario

The ISEAP scenario in the period up to 2020 has been prepared taking into account the following indications:

- Reduction of CO2 to a value greater than 20% in comparison to 2005 as a priority.
- Reduction in net consumptions more than 20% in comparison with the trend scenario.
- The production source has been diversified according to expected future scenarios (natural gas introduction, increase in RES, co-firing, electric vehicles, etc…)
- Energy efficiency increase in comparison to the trend scenario depending on building and plant heritage.

For the production of electricity, both renewable sources, considering their development with an optimistic scenario, and the use of fuel products, that enable a more efficient use (combined cycle IGCC Sarluc,) were privileged, taking into account that by 2020 it will be possible to convert only one combined cycle plant to the use of methane (160 +160 MW x 3800 operating hours per year). The remaining electricity demand has been offset by the use of traditional fossil fuels, according to available domestic energy sources (coal and fuel oil last). The ISEAP energy summary balance for the year 2020 is as follows:

**Table 3.4.1 : Summary balance of the Region of Sardinia** ISEAP 2020

**Bilancio di sintesi dell'energia della Sardegna – 2020 (ISEAP)**

| | Gwh | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Combustibili solidi | Petrolio | Gas | Nucleare | Rinnovabili | Calore | Energia elettrica | Energia termica | Totale |
| Produzione interna | 2.214 | 215.463 | 764 | | 11.394 | 918 | *12.805* | *20.655* | 230.753 |
| Saldo import-export | 2.817 | -174.473 | 5.550 | | 921 | | *-1.227* | | -165.185 |
| Bunkeraggi internazionali | | 2.541 | | | | | | | 2.541 |
| Variazioni delle scorte | 475 | -1.285 | | | | | | | -810 |
| **Disponibilità interna lorda** | 4.556 | 39.734 | 6.314 | | 12.315 | 918 | *11.578* | *20.655* | ***63.837*** |
| **Ingressi in trasformazione** | 4.429 | 7.720 | 2.626 | | 9.147 | 150 | *23.808* | *264* | 24.072 |
| Centrali elettriche | 4.429 | 7.659 | 2.626 | | 9.094 | | *23.808* | | 23.808 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 61 | | | 53 | 150 | | *264* | 264 |
| **Uscite dalla trasformazione** | 1.619 | 4.037 | 1.502 | | 5.751 | 150 | *12.805* | *254* | 13.059 |
| Centrali elettriche | 1.619 | 3.976 | | | 5.708 | | *12.805* | | 11.303 |
| Cokerie | | | | | | | | | |
| Raffinerie | | | | | | | | | |
| Altri impianti | | 61 | 1.502 | | 43 | 150 | | *254* | 1.756 |
| **Consumi e perdite** | | 4.930 | | | 407 | 464 | *1.214* | *6.087* | 7.015 |
| **Disponibilità interna netta** | 127 | 27.084 | 3.688 | | 2.761 | 304 | *10.364* | *14.568* | 44.328 |
| **Usi non energetici** | | 5.881 | | | 301 | | | | 6.182 |
| **Consumi finali** | 127 | 21.203 | 3.688 | | 2.460 | 304 | *10.364* | *14.567* | **38.146** |
| **Industria** | 92 | 7.568 | 1.204 | | 208 | 159 | *5.183* | *9.231* | 14.414 |
| Industria manifatturiera di base | 36 | 6.620 | 1.204 | | 208 | | *4.639* | *8.068* | 12.707 |
| Industria manifatturiera non di base | 56 | 944 | | | | 159 | *544* | *1.159* | 1.703 |
| Costruzioni | | 4 | | | | | | *4* | |
| **Trasporti** | | 12.207 | 63 | | 945 | | *231* | | 13.446 |
| Stradali | | 10.124 | 63 | | 919 | | *212* | | 11.318 |
| Altre modalità di trasporto | | 2.083 | | | 26 | | *19* | | 2.128 |
| **Altri settori** | 35 | 1.428 | 2.421 | | 1.307 | 145 | *4.950* | *5.336* | 10.286 |
| Residenziale | 35 | 293 | 2.216 | | 1.066 | 102 | *2.213* | *3.712* | 5.925 |
| Agricoltura, Silvicoltura e Pesca | | 1.091 | 50 | | | | *330* | *1.141* | 1.471 |
| Altri settori | | 44 | 155 | | 241 | 43 | *2.407* | *483* | 2.890 |
| **Produzione di energia elettrica - GWh** | ***1.619*** | ***3.976*** | ***1.502*** | | ***5.708*** | | | | **12.805** |
| **Produzione di calore – GWh** | | ***61*** | | | ***43*** | ***150*** | | | **254** |
| | | | | | | | *Efficienza Sistema* | | 59,76% |

Fonte: PEPS

### 3.4.1. Final Energy demand

Energy demand, shown in Table 3.4.2, by the end user, by sector and by type of energy at 2020, underlines, even if scaled with respect to the BAU 2020, the prevalence of the secondary sector in net final consumption (industrial sector). In terms of application, the secondary sector is followed also here by the transport sector.

The total energy need is decreased in comparison with the baseline year 2005 by virtue of improved efficiency that allows also a lower gross energy demand.

**Table 3.4.2: Final energy demand** ISEAP 2020

| | Solid Fuels | Oil | Gas | Nuclear | Renewable | Heat | Electric Energy | Thermal Energy | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Final consumptions** | **127** | **21.203** | **3.688** | **0** | **2.460** | **304** | ***10.364*** | ***14.567*** | **38.146** |
| **Industry** | 92 | 7.568 | 1.204 | 0 | 208 | 159 | *5.183* | *9.231* | 14.414 |
| Baseline manufacturing industry | 36 | 6.620 | 1.204 | 0 | 208 | 0 | *4.639* | *8.068* | 12.707 |
| Non baseline manufacturing industry | 56 | 944 | 0 | 0 | 0 | 159 | *544* | *1.159* | 1.703 |
| Constructions | 0 | 4 | 0 | 0 | 0 | 0 | *0* | *4* | |
| **Transport** | 0 | 12.207 | 63 | 0 | 945 | 0 | *231* | *0* | 13.446 |
| Street | 0 | 10.124 | 63 | 0 | 919 | 0 | *212* | *0* | 11.318 |
| Other transport mod | 0 | 2.083 | 0 | 0 | 26 | 0 | *19* | *0* | 2.128 |
| **Other sectors** | 35 | 1.428 | 2.421 | 0 | 1.307 | 145 | *4.950* | *5.336* | 10.286 |
| Residential | 35 | 293 | 2.216 | 0 | 1.066 | 102 | *2.213* | *3.712* | 5.925 |
| Agriculture, Forestry and Fishing | 0 | 1.091 | 50 | 0 | 0 | 0 | *330* | *1.141* | 1.471 |
| Other sectors | 0 | 44 | 155 | 0 | 241 | 43 | *2.407* | *483* | 2.890 |

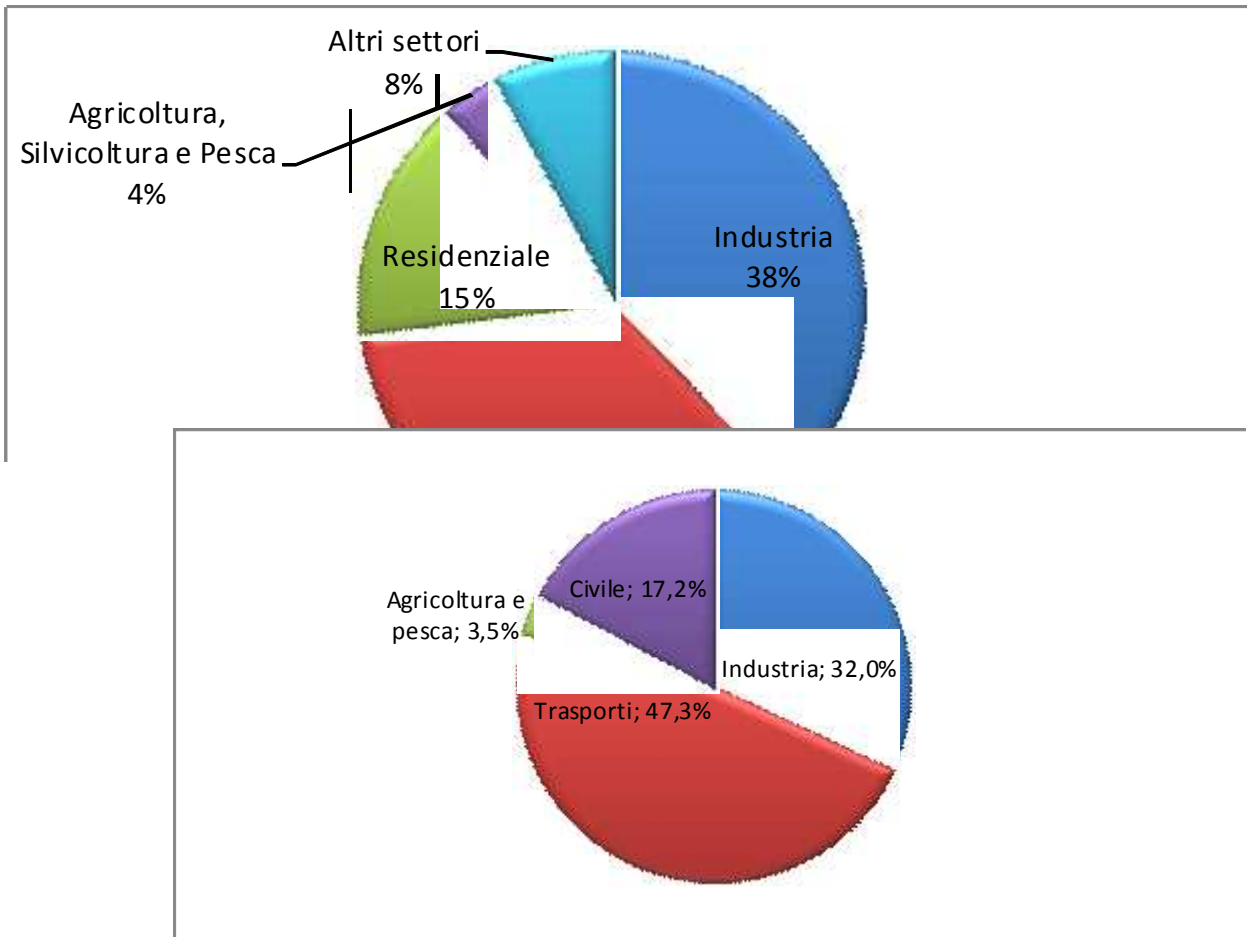



**Figure 19: Final energy demand ISEAP**

### 3.4.2. Energy conversion

As shown by Figure 20, also in this case the production of electrical energy for 2020 is characterized by a strong component of primary energy deriving from the combustion of fossil fuels. The efficiency of conversion from thermal energy to electric energy of existing power plants has been improved so the value is becoming closer to the national average, thanks also to the contribution of natural gas in combined cycle power plants

Centralised cogeneration systems are increased in the territory thanks to biogas production increase. Thermal energy recovery is marginal and limited to the industrial and residential sector. Electric energy production for 2020 is characterized by a component of primary energy deriving from the combustion of fossil fuels.

Energy savings and efficiency in the residential sector contribute significantly to the recovery of thermal energy.

**Figure 20: Production of electricity by source** ISEAP 2020

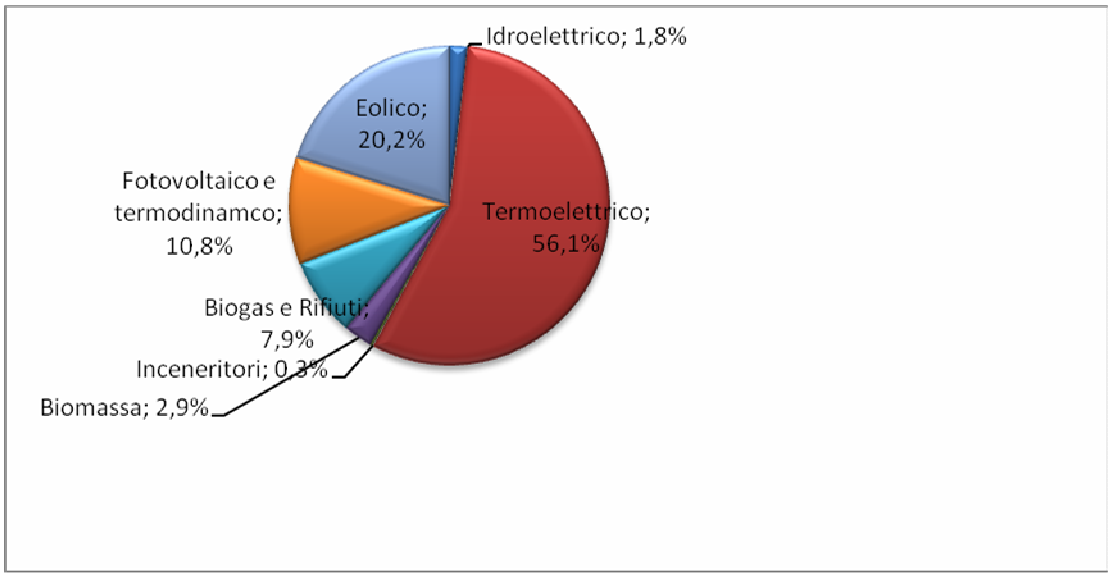
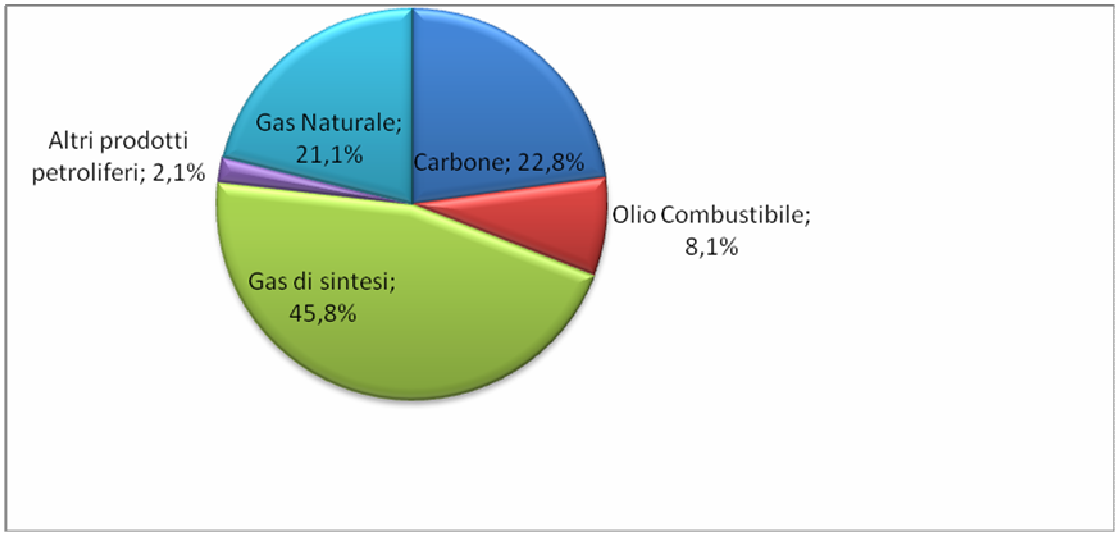



**Figure 21: Production of electricity from thermoelectric plants** ISEAP 2020




Electric energy production from fossil fuels highlights the tendency to employ sources suitable for combined cycle power plants. Most polluting and inefficient sources are used a last resort.

As regards the production of thermal energy, the renewable component (Biomass + Solar thermal) is relevant. It should be considered that most of Biomass is used for the co-firing with existing power plants. It is assumed that the amount of heat produced by the electrical source and from aero thermal RES is not considered.

**Figure 22: Production of thermal energy by sources** ISEAP 2020

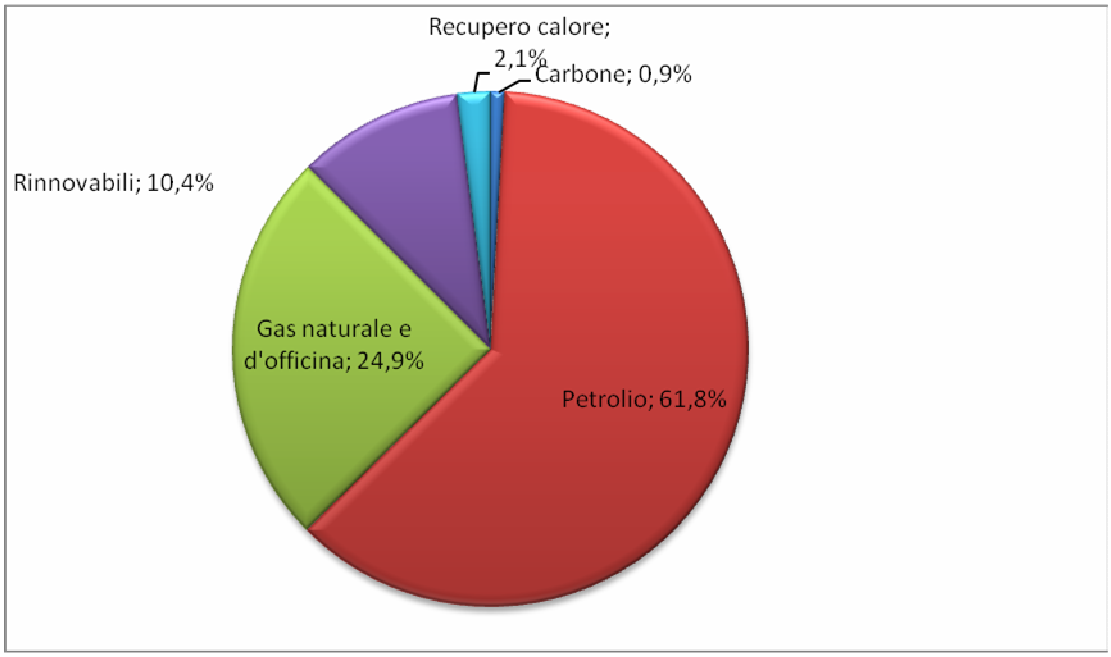



**Figure 23: Production of thermal energy from oil by sources ISEAP 2020**

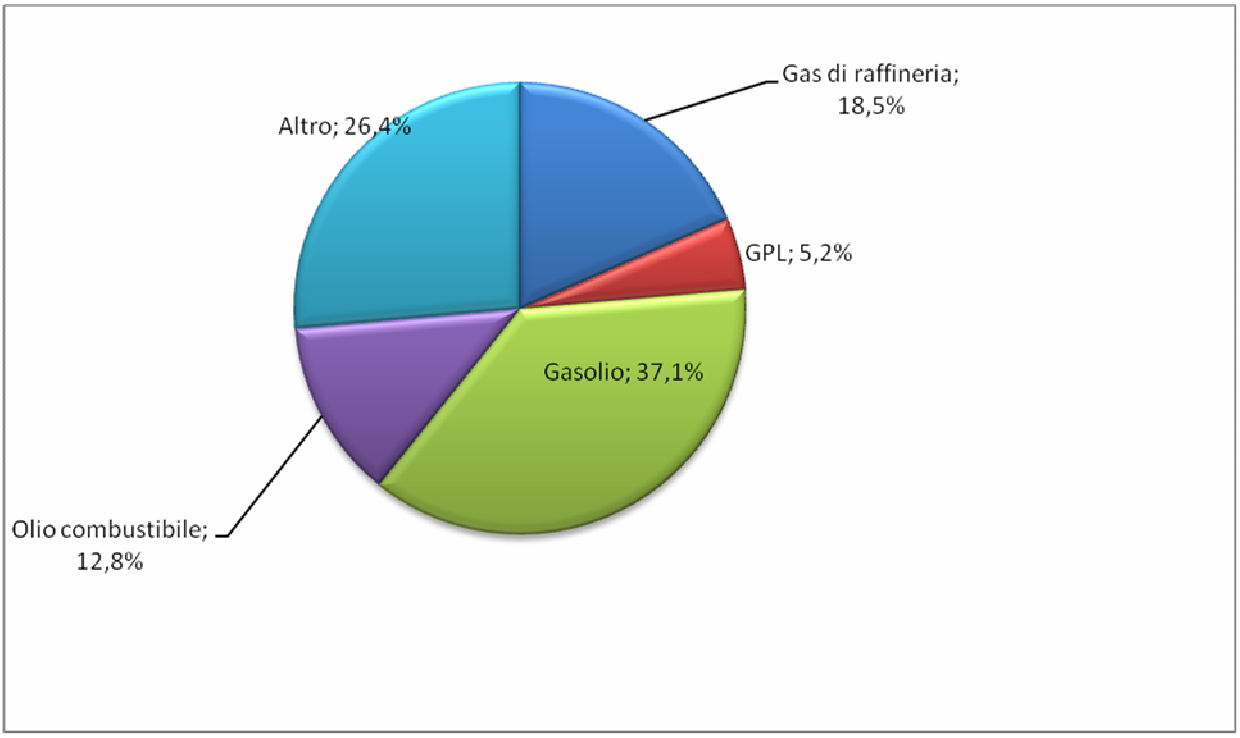


**Figure 24: Final energy demand of electricity** ISEAP 2020

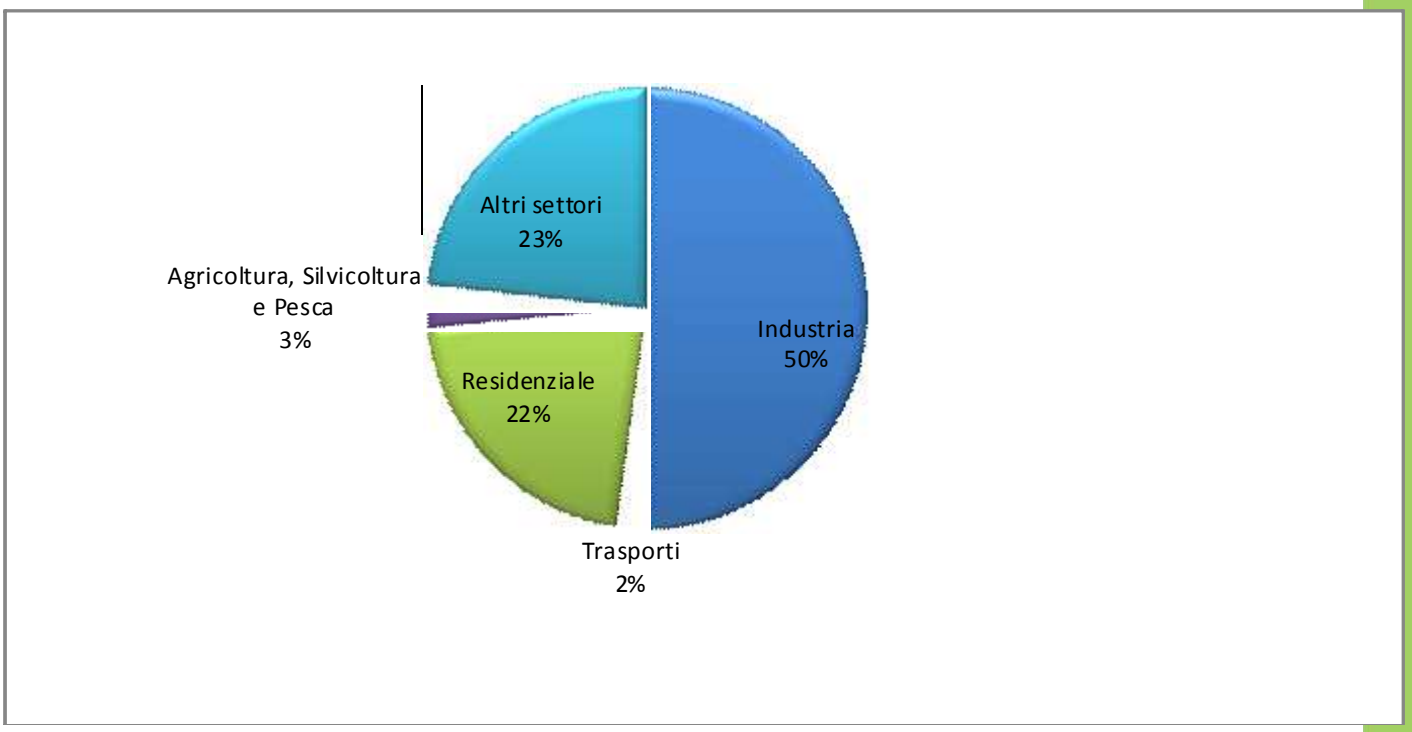
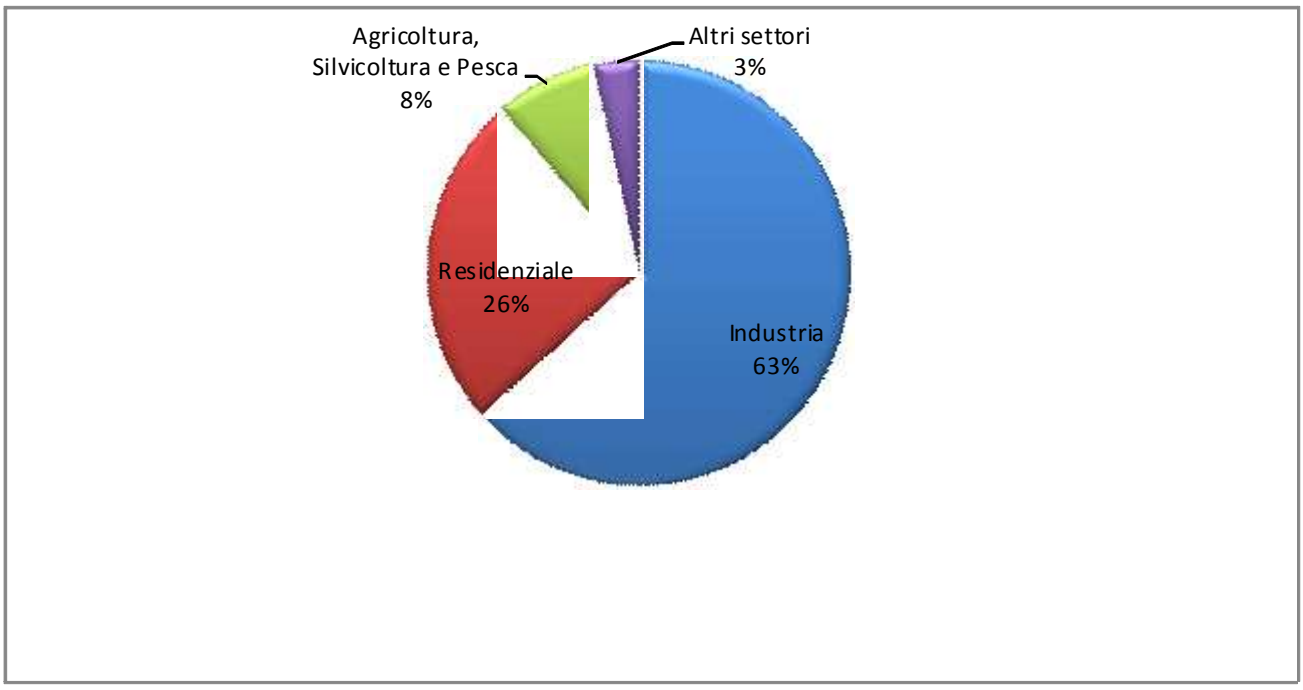



**Figure 25: Final energy demand of thermal energy ISEAP 2020**



### 3.4.3. Emissions of carbon dioxide

CO2 emissions calculation methodology, as shown in tables and figures below, reflects European directives for the assessment of climate-changing gases. The reference parameter is the IPCC factor emission for each fuel type. As a starting point, reference has been made to the production, processing and use of products responsible of green house gas emissions, with exclusion of outgoing products, bunkers and stock changes. The global emission excludes the contribution of forests and CO2 capture systems

**Table 3.4.4: Carbon dioxide emissions by sources ISEAP 2020**

| Energy carrier | | TOTAL [Gg] |
|---|---|---|
| Coal | | 1604 |
| GPL | | 653 |
| Gasoline | | 1138 |
| Coalturbp | | 169 |
| Diesel | | 2145 |
| Fuel oil | | 1748 |
| Synthesis gases | | 1179 |
| Ligth distillates | | 356 |
| Other from fuel oil | | 7579 |
| Natural and non natural gas | | 1276 |
| From rebewables | | 2019 |
| | TOTAL | **19866** |

**Figure 26: Carbon dioxide emissions by sources ISEAP 2020**

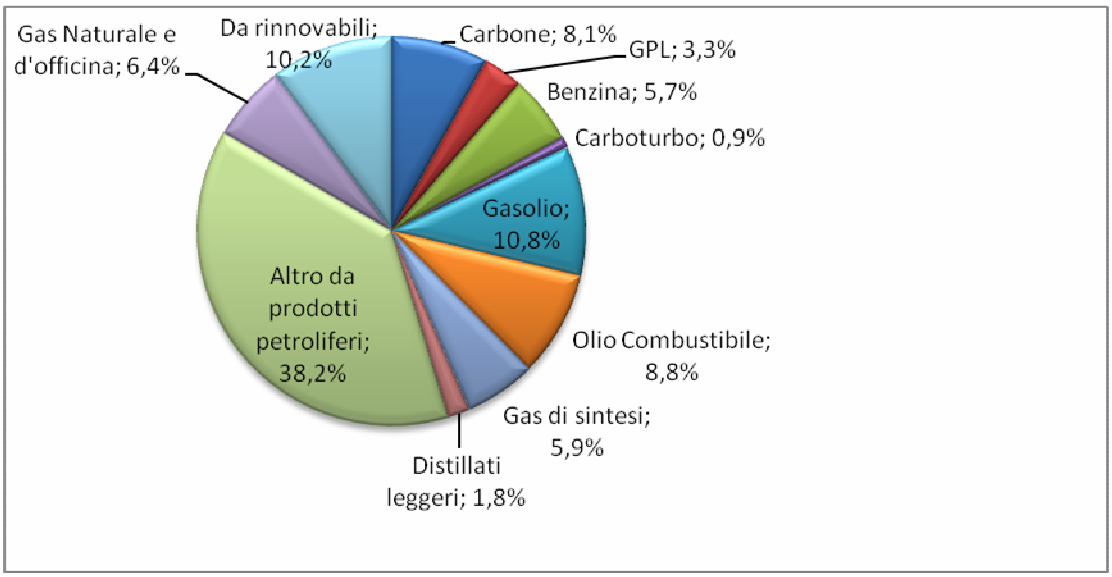
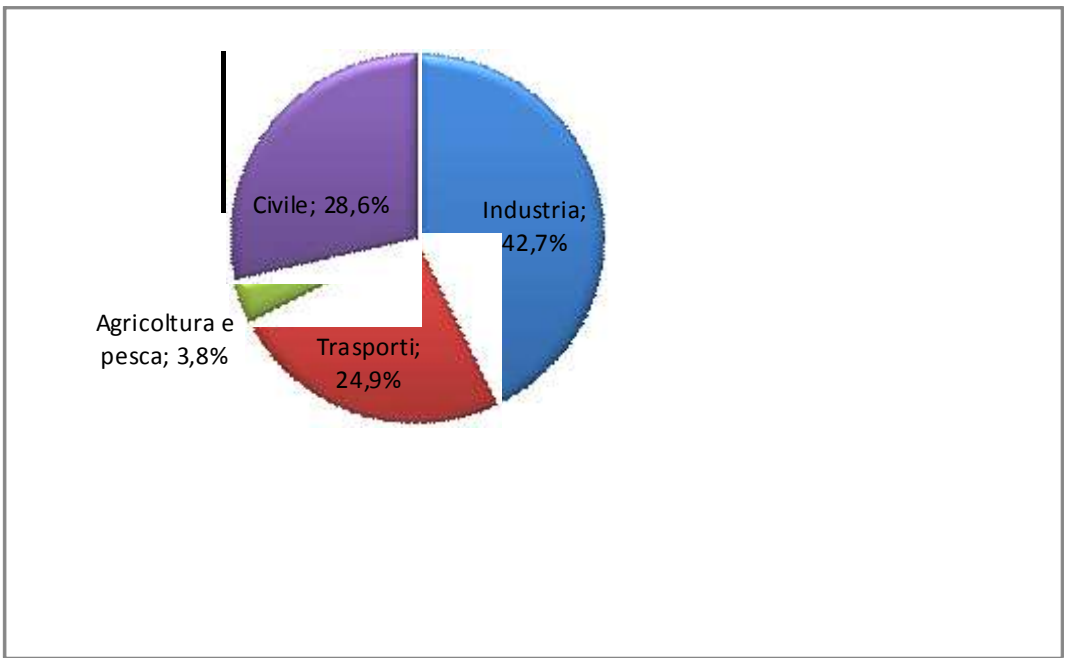


**Figure 27: Final use carbon dioxide emissions by sources ISEAP 2020**




### 3.4.4. Summary of results – expected actions.

Results obtained in relation to the baseline emissions inventory for the year 2005 and scenarios to 2020, make it possible to say that Sardinia can reach 20-20-20 goals set by EU. Sardinia has **21,48 %** of renewable energies, **22,31%** less CO2 emissions in atmosphere, reducing the net final consumption in comparison to the trend scenario of **19,73%,** plus **8,63%** energy efficiency of the whole energy system in absolute terms, with good increment margin in the medium to long term. Results are consistent with the document of guidelines for renewable energies approved by the Regional Council in March 2012 and adhere to the load distribution " burden sharing", positively overcoming the thresholds provided for Sardinia by the Ministry for Economic Development.

These results were made possible, as perspective scenario, following the establishment of a series of concrete actions in different sectors: residential, tertiary industry, transport, participation and contribution of citizens and key stakeholders of the region. It should be added that, as a result of saving measures and efficiency, the results include a decrease in final consumption in all sectors compared to 2005, with a slight increase in the agricultural sector, despite the growth of the entire Sardinian system. Furthermore, so as to the reduction of energy intensity, with the same energy used for gross domestic product, the provision of combined and synergistic use of methane, as energy carrier transition, RES and saving/efficiency, turned out to be essential. Therefore a lower cost of energy bills, improves the competitiveness of the system and the environment and a growing employment sector, estimated to be between 18 to 25,000 units.

# 4. ACTIONS

Actions are divided by sector, with intervention code and implementation period distinction between S (Short-Term), M (Medium-Term) and L (Long-Term). All the measures described are counted in the diagram of the ISEAP for the results obtained in terms of energy savings and CO2 emissions avoided. Each action is associated to an estimated financial value, the result of an economic analysis referred to supposed needs for each specific measure. Financial interventions necessary to actions implementation are distributed among all regional actors, all levels of the government (municipal, provincial, regional, public bodies), companies and private stakeholders. Each intervention will then be presented in a concise description containing the essential data for the illustration: action description, proponent, expected results, financial channels, construction times.

**Residential sector**

| Intervention sector | Action code | | | Action title | Total cost (ml di €) | Energy saved (ml di MWh) | CO2 Minors (ml di t) |
|---|---|---|---|---|---|---|---|
| Residential (ED) | ED-EFF | 1 | M | Adapting of municipal building regulations to energy efficiency regulations. Development of regulatory Instruments dedicated to building energy certificates. | 1,5 | 0,250 | 0,1213 |
| | ED-EFF | 2 | L | Start up control of thermal plants and database construction on associated emissions | 1,2 | 0,250 | 0,1213 |
| | ED-EFF | 3 | L | Application of intelligent networks and technologies for an energy rational use in buildings. | 720,0 | 0,276 | 0,1339 |
| | ED-EFF | 6 | M | Application of micro-cogeneration spread by low emissions non renewable sources (methane) | 150,0 | 0,180 | 0,0873 |
| | ED-EFF | 7 | M | Substitution of aero thermal with COP lower than 3 with systems with higher COP | 225,00 | 0,120 | 0,0582 |
| | ED-EFF | 9 | M | Implementation of district heating and cooling networks | 80,0 | 0,113 | 0,0550 |
| | ED-EFF | 10 | L | Urban sustainable development Interventions with improvement of passive energy efficiency of private building (new construction in class A, insulation shutters substitution, etc…). | 900,0 | 0,378 | 0,1833 |
| | | | | **TOTAL EFFICIENCY** | **2.078** | **1,567** | **0,760** |
| | ED-FER | 8 | M | Solar panels installation for ACS production | 350,0 | 0,450 | 0,2183 |
| | ED-FER | 11 | S | Solar panels installation in private buildings | 1.350,0 | 0,630 | 0,3056 |
| | ED-FER | 12 | M | Promotion for the installation of alternative sources and energy saving (green building materials bio-fuels short distribution chain for the supply of small thermal plants dissemination of information material, publicity, mode to access to incentives procedures for the creation of buyer groups, etc…) | 2,3 | 0,690 | 0,3347 |
| | ED-FER | 4 | L | Interventions of sustainable urban development (neighborhood, minor areas) through PUC, FER, URE, EE. | 50,0 | 0,092 | 0,0446 |
| | ED-FER | 5 | M | Application of micro-cogeneration from low emissions renewable sources (biomass) | 167,5 | 1,350 | 0,6548 |
| | | | | **TOTAL RENEWABLE SOURCES** | **1.920** | **3,212** | **1,558** |
| | | | | **Sum** | **3.998** | **4,779** | **2,318** |

S (Short-Term), M (Medium Term), L (Long –term).

| **Transport sector** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Intervention sector** | **Action code** | | | **Action title** | **Cost** (ml - €) | **Energy saved** (ml - MWh) | **Minor CO2 emission** (ml - t) |
| **Transport (TR)** | TR-EFF | 1 | L | projects development of sustainable urban mobility in over 30.000 inhabitants municipalities (car sharing etc…), car parking management for ecologic vehicles access in town centers. | 7,0 | 0,140 | 0,024 |
| | TR-EFF | 2 | S | Creation of soft-mobility - cycle urban areas and car-sharing implementation. | 14,0 | 0,080 | 0,013 |
| | TR-EFF | 3 | S | Electric and bio-fuel engines use for boats in protected marine harbours, energy saving and CO2 emissions reduction emissioni di CO2 in Island harbours | 3,0 | 0,050 | 0,024 |
| | TR-EFF | 5 | S | Design and management of Inland regional transport towards greater sustainability. | 2,0 | 0,690 | 0,230 |
| | TR-EFF | 6 | M | Substitution of joint mobility with low emission public transport (trolleybus, railway, electric bus hybrid taxi, low emission buses) | 11,5 | 0,0017 | 0,0017 |
| | TR-EFF | 8 | L | Vehicles transformation for the use of methane in change of traditional fuels | 4,5 | 0,063 | 0,002 |
| | TR-EFF | 10 | L | Vehicles transformation for the use of electricity in change of traditional fuels | 96,0 | 0,212 | 0,003 |
| | TR-EFF | 9 | L | Handling of goods by rail on the most critical road connection (Cagliari –Olbia- Sassari – Iglesias - Oristano) | 15,0 | 0,002 | 0,001 |
| | | | | **TOTAL EFFICIENCY** | **153** | **1,238** | **0,298** |
| | TR-FER | 7 | M | Sustainable mobility interventions in smaller islands (S.Pietro/S.Antioco/ La Maddalena/Asinara) | 12,0 | 0,050 | 0,010 |
| | TR-FER | 4 | S | Transformation of municipal, provincial, and regional vehicles in low environmental impact vehicles fuelled by bio-methane. | 1,0 | 0,023 | 0,011 |
| | TR-FER | 9 | L | Vehicle transformation for the bio-methane use in substitution of traditional fuels | 69,2 | 0,604 | 0,023 |
| | TR-FER | 10 | S | Photovoltaic plants implementation for cycle - lanes | 7,0 | 0,001 | 0,002 |
| | | | | **TOTAL RENEWABLE SOURCES** | **89,2** | **0,678** | **0,046** |
| | | | | **SUM** | **242,2** | **1,916** | **0,344** |

S (Short-term), M (Medium-term), L (Long –term ).

| **Transport sector** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Intervention sector** | **Action code** | | | **Action title** | **Cost** (ml - €) | **Energy saved** (ml of MWh) | **Minor CO2 emissions** (ml di t) |
| **Industry (IN)** | IN-FER | 1 | L | New mini an micro hydroelectric plants | 2,0 | 0,002 | 0,0007 |
| | IN-FER | 2 | S | Installation of wind plants in areas and measures according to regional planning. | 1.108,0 | 1,884 | 0,9137 |
| | IN-FER | 3 | S | Photovoltaic plants installation greater than 200 KW in areas and measures according to regional planning (see guidelines areas ex Cava, dumping, industrial areas) | 607,0 | 0,630 | 0,3056 |
| | IN-FER | 4 | S | Solar thermodynamic plants installation greater than 200 KW in areas and measures indicated by regional planning (see linee guida aree ex cava, Industrial areas ) | 30,0 | 0,070 | 0,0340 |
| | IN-FER | 5 | L | Renewable energy self consumption production plants in agro-industrial and pastoral areas and incentive of energy autonomy for the ones non connected to the grid | 348,0 | 0,470 | 0,2280 |
| | IN-FER | 6 | L | Pilot plants implementation for the treatment of municipal waste moist fraction for the production of energy and the reduction of climate-changing emissions | 1,5 | 0,001 | 0,0005 |
| | IN-FER | 7 | L | Intervention for energy autonomy from renewable sources in minor Islands (S.Pietro/S.Antioco/La Maddalena/Asinara) | 4,0 | 0,015 | 0,0073 |
| | IN-FER | 8 | L | Co-generation and tri-generation system management and the related district heating. | 12,0 | 0,080 | 0,0388 |
| | IN-FER | 9 | S | Small biogas plants implementation (50 kw - 200 kw) in farms, consortium, factories and small cooperative . | 100,0 | 0,120 | 0,0582 |
| | IN-FER | 10 | M | Green chemistry – Proj. Matrica –Enipower Biomass production plant | 230,0 | 0,200 | 0,0970 |
| | IN-FER | 11 | S | Biogas plants implementation (>200 kw) in existing dumps, purification plants and cooperative of medium and big dimension sector Also in self consumption | 75,0 | 0,454 | 0,2202 |
| | | | | **TOTAL RENEWABLE SOURCES** | **2.517,5** | **3,926** | **1,9039** |
| | IN-EFF | 12 | S | Plants and industrial equipment transformation for heating recovery to be used in self consumption. | 8,0 | 0,080 | 0,0388 |
| | IN-EFF | 13 | M | Interventions for water distribution management – energy collection in duct | 100,0 | 0,090 | 0,0437 |
| | IN-EFF | 14 | L | Conversion from combined cycle plant to methane gas plant | 400,0 | 0,482 | 0,2338 |
| | IN-FER | 1 | M | Green chemistry - Project Matrica - Plants production of bio materials | 230,0 | 1,110 | 0,5384 |
| | IN-EFF | 11 | S | Increasing in energy efficiency Interventions in SME, Increasing in smart grid development | 1,5 | 0,005 | 0,0024 |
| | | | | **TOTAL EFFICIENCY** | **3.257,0** | **1,767** | **0,8570** |
| | | | | **Sum** | **5.774,5** | **5,7** | **2,8** |

**Tertiary sector and Services**

| Intervention Sector | Action code | | | Action title | Cost (ml of €) | Energy saved (ml of MWh) | Minor CO2 emissions (ml of t) |
|---|---|---|---|---|---|---|---|
| Tertiary&Services (TS) | TS-EFF | 1 | S | Management and energy efficiency Interventions for Municipal public lighting | 16,2 | 0,064 | 0,031 |
| | TS-EFF | 2 | S | Traffic light substitution of traditional Lamps with LED | 0,5 | 0,004 | 0,002 |
| | TS-EFF | 3 | M | Efficiency intervention in i Public buildings (schools, hospitals town halls) from class G to class D, With improvement of passive energy Efficiency of hotels and public buildings (insulation, shutters substitution, etc…) | 350,0 | 0,164 | 0,080 |
| | TS-EFF | 4 | S | Energy audit and energy management in public buildings | 12,9 | 0,050 | 0,024 |
| | TS-EFF | 5 | M | Substitution of aero-thermal systems with COP lower than 3 with systems Characterized by a higher COP | 22,5 | 0,070 | 0,034 |
| | TS-EFF | 6 | M | Promotion for the installation of alternative sources and energy saving (building green materials, bio-fuels for the supply Of small thermal plants, information dissemination, publicity, access to funds modality, procedure for the creation of purchasing groups, etc…) creation of an energy database of local bodies. energy management of the building heritage in public bodies. | 2,3 | 0,100 | 0,049 |
| | | | | **TOTAL EFFICIENCY** | **404,4** | **0,452** | **0,219** |
| | TS-FER | 7 | S | Photovoltaic installation plants on sport facilities roofs. | 9,0 | 0,003 | 0,001 |
| | TS-FER | 8 | L | Photovoltaic installation plants (roofs and dismissed or unusable unvalued areas) of the Autonomous Region of Sardinia, Provinces, Municipalities and all public bodies | 448,0 | 0,170 | 0,082 |
| | TS-FER | 9 | S | Photovoltaic plants on school roofs | 12,0 | 0,006 | 0,003 |
| | TS-FER | 10 | M | Solar panels installation for the Production of ACS | 2,4 | 0,012 | 0,006 |
| | TS-FER | 11 | S | Small biogas plants implementation (50 kw - 200 kw) in agritourisms, small hotels . | 42,0 | 0,043 | 0,021 |
| | | | | **TOTAL RENEWABLE SOURCES** | **513,4** | **0,234** | **0,113** |
| | | | | **Sum** | **917,8** | **0,686** | **0,333** |

S (Short-term), M (Medium Term), L (Long –term).

## Organizational tools

| Intervention sector | Action code | | | Action title | Cost (ml - €) | Energy saved (ml - MWh) | Minor CO2 emissions (ml - t) |
|---|---|---|---|---|---|---|---|
| Organizational tools (SO) | SO | 1 | S | Promotion of Energy Agreement Among public bodies of The Region of Sardinia | 0,2000 | | |
| | SO | 2 | S | Consortium between public bodies | 0,4000 | | |
| | SO | 3 | S | Institution of Regional Energy Observatory | ///// | | |
| | SO | 4 | S | Unique Consortium for electricity purchase by Public Bodies. | ///// | | |
| | SO | 5 | S | Regional forum for energy efficiency. | ///// | | |
| | | | | **Sum** | 0,6000 | 0,0000 | 0,0000 |

S (Short-term), M (Medium -Term), L (Long –term).

| **Participation and awareness** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Intervention sector** | **Action code** | | | **Action title** | **Cost** (ml - €) | **Energy saved** (ml - MWh) | **Minor CO2 emissions** (ml – t) |
| **Participation and awareness (PA)** | PS | **1** | S | Communication and trading regional and municipal actions | 2,5 | | |
| | PS | **2** | S | Annual rewarding promotion for energy saving achieved in school buildings selected respectively from primary, secondary and higher schools | 1,0 | 0,0150 | 0,0073 |
| | PS | **3** | S | Establishment of the Energy Week at regional level. | 0,1 | | |
| | PS | **4** | S | - Municipality actions to create awareness on tools for the implementation of Interventions for renewable energies, Saving and energy efficiency<br>- Communication plan with targeted campaigns about energy saving, energy rational use and use of alternative local sources | 1,0 | 0,0200 | 0,0097 |
| | PS | **5** | S | Training and education plan (schools of all levels, population, tour operators, SMEs public bodies and other relevant stakeholder) | 0,5 | 0,0200 | 0,0097 |
| | | | | **Sum** | **5,1** | **0,0550** | **0,0267** |

S Short-term ), M (Medium term), L (Long –term).

## 4.1 Territorial planning

Policies set up by the Region of Sardinia in the field of energy, Environmental Energy Plan (EEPRS), Reference Document of renewable energies, Project "Smart City - Pioneer Communities", Program "Sardinia $CO_2$.0", Sustainable Energies Action Plan (ISEAP), together form a formidable instrument of regional planning for the coming years. Parallel to the development of actions already in progress or planned by the Region of Sardinia and those immediately activated under the ISEAP, there is a further stage of key stakeholders involvement and the use of regulatory, organizational and financial tools for the implementation of the actions included in the ISEAP.

To this end, the period for implementing each activity is defined by each listings and most actions are consequent to general regulatory interventions already made and partially to be made by the Region of Sardinia.

In particular, as regards renewable energies, regional planning has launched incentive policies, promoted the Reference Document of Renewable Energy and approved the Regional Guidelines that define the installation criteria in the area. With regard to savings and energy

efficiency, operational policies support and incentives are already operative both for the public sector and the private one, to be extended to new technologies and facilities provided in the ISEAP; particularly in the field of building planning, regulatory references and organizational support and management tools are to be implemented.

## 4.2 Public procurement of Products and Services

The Region of Sardinia is committed to promoting and improving in regional administration and local authorities, the systems of "green tender procurement" which, while respecting the principle of economy, are inspired by criteria for sustainable development. With Resolution GR 37/16 of 30.07.2009) it was approved the Plan for green purchasing in the public sector that provided the target to achieve, by 2013, no less than 50% of purchases of goods and services and 20% of works contracts based on criteria of environmental sustainability.

In fact, for the realization and promotion of the policy of Ecological Public Procurement: powerful instrument of environmental policy that uses the leverage of public consumption to stimulate a shift to environmentally friendly production and more responsible consumption patterns, first experience at the national level, providing a substantial financial allocation: 3,200 000 euro.

With these resources, information and technical assistance for the preparation of "green" tender specifications are being carried out both at the regional administration and the local government, the activation of 8 GPP provincial branches and funds for 34 demonstrative action plans in municipalities focused on energy conservation, waste reduction and water conservation. Ten of these projects relate to energy efficiency and sustainable mobility.

The action of the Regional Council aims to review the procurement practices of the PA in favour of goods and services that reduce the use of natural resources, waste, emissions, optimizing the "service" offered by the product. The procurement processes therefore must be oriented not only by the monetary cost of the product/service but also on the basis of environmental impact that this can have in the course of its life cycle.

The contribution of GPP to the reduction of greenhouse gas emissions into the atmosphere is indirect, but no less important when applied on a regional scale.

## 4.3 Citizens and stakeholders

Actions involving citizens and stakeholders are part of the strategic planning of the Region of Sardinia, which seeks to promote in all its forms the dialogue and the contribution of "bottom-up" for the purposes of decision-making. The strategy of the regional administration is aimed at bringing people and key regional actors operating in different sectors closer to regional institutions with the aim of encouraging and making the access, acts and decisions transparent.

The process of participation and public awareness is, in the regional strategy, part of the procedures of the various government departments, considered a significant added value and a key resource to enable the process of cooperation and improve the relationship of synergy between all actors in the island. Citizens involvement and participation are particularly

significant in the process of spreading awareness and commitment in direct sustainable development and as an essential contribution to the achievement of the same ISEAP.

In particular it is not possible to directly attribute a specific reducing energy and CO2 emissions consumption value to the citizens participation in the process, but it has a significant effect through the behaviour and the application of good practices.

For this reason it is reasonable to attribute to the participation and awareness process a CO2 emissions reduction value equal to 0,025% of total emissions.

# 5. ORGANIZATIONAL AND FINACIAL METHODS

## 5.1 Coordination

The Region of Sardinia is organized by Departments, Directorates, Services and agencies with specific skills, such as the Energy Service of the Regional Department for Industry. Participation in the European Pact of Islands, for the value of the objectives in the energy and environment, and in general for strategic choices, led to the need to establish a control centre for the coordination of project activities and activities carried out by the regional institution (Sardinia CO2.0 Program, Smart City)

The control centre is composed of the President, the Regional Departments of Environment and Industry. It makes use of a technical working group composed of Presidency and Departments directors, consultancy by experts in the sector and the work of Punto Energia Provincia di Sassari-Multiss spa, a technical partner of the project Pact of Islands and the beneficiary by the EU Commission.

## 5.2 Organizational structures

The definition of the island Sustainable Energy Action Plan (ISEAP) by the Region of Sardinia confirms a strong commitment to the strategies put in place, a commitment that requires the permanence of the control centre for the coordination of the implementation and monitoring of actions plan and other sector activities, and the establishment of executive organizational tools to accompany the set of innovation policies on energy and the environment in the region.

Saving policies, energy efficiency and development of renewable energies are a strategic platform of the Regional Council to create innovation and competitiveness in all sectors, improving the environment and creating new jobs.

Specific voluntary agreements and direct participation of local authorities (378 municipalities and 8 provinces) will be created to this end between organizational tools for the implementation of the plan and a consortium of public bodies operating in the energy sector to support local authorities for the implementation of the energy policies included in the agreement and regional policies other than the commitments undertaken by the municipalities signatories of the Covenant of Mayors and beneficiaries of the program Smart City.

The support consortium of public bodies should be a light tool for the implementation of the measures contained in the ISEAP and for the monitoring of human resources, but also the operational tool of local authorities for the participation in the programs and European funding in this area to encourage the dissemination of good practices for the benefit of local authorities, citizens and SMEs. A database will be created within the consortium (regional energy observatory) in order to favour the capitalization of the economic benefits deriving from the application of good practices in the energy market for the benefit of the Region of

Sardinia and the same local authorities. The activity allows identification of efficiency quotes and renewable energy and the promotion in the energy market.

## 5.3 Staff capacity

The capacity of the system provided by the Region of Sardinia for the implementation of plan measures and regional policies in the field of sustainable energy is held by different institutional and organizational levels. Policy and decision level of the Region; coordination level that is part of the control centre and the technical working group, consisting of Council Members and the heads of the Services sector, the level of support to local authorities, businesses and citizens that pertains to the consortium of public bodies that supports for the implementation of measures in the field of sustainable energy. The experience gained in the sector are sufficiently adequate to support the efforts of the implementation of the ISEAP, at present Sardinia can count on four Energy Agencies, created with the community programs, as well as on the support of Regional Agencies, such as Sardegna Ricerche (Technology Park) and ARPAS (Regional Agency for the Environment).

## 5.4 Stakeholders involvement

The involvement of stakeholders and key players in the various sectors of economic and social life of Sardinia is crucial for the successful implementation of the ISEAP. Activities involving all stakeholders began with the start of the project Pact of Islands on the establishment of the Regional Steering Committee; it comprises, in addition to the Punto Energia Provincia di Sassari that is the regional coordinator of the project, associations (industry, commerce, agriculture, trade, building companies), two University of Cagliari and Sassari, Energy Agencies in the provinces of Cagliari, Oristano and Sulcis, Union of Provinces of Sardinia, Union of Municipalities of Sardinia, Agency for technical assistance in agriculture LAORE, the holding company SFIRS, major manufacturers and distributors of energy ENEL, E.ON, SARAS

The Regional Steering Committee is a body for the consultation and dissemination of information as well as a formidable support for the dissemination of good practices. Its involvement is foreseen also in the future with arrangements to be planned in accordance with the Committee.

In addition to the key stakeholders the Region of Sardinia intends to raise citizens and all schools awareness through programs that provide opportunities for information, training and projects. Their best practices in sustainable energy will be rewarded and valued during annual meetings and energy days.

## 5.5 ISEAP economic analysis

**Total Budget**

| INTERVENTION SECTOR | Total cost (ml €) | Energy saved (ml di MWh) | Minor CO2 emissions (ml - t) |
|---|---|---|---|
| **Residential (ED)** | 3997,50 | 4,779 | 2,318 |
| **Transport (TR)** | 242,22 | FALSO | 0,344 |
| **Industry (IN)** | 5774,50 | 5,693 | 2,761 |
| **Tertiary & Services (TS)** | 917,80 | 0,686 | 0,333 |
| **Participation & Awareness (PA)** | 5,10 | 0,055 | 0,027 |
| **Organizational tools (OT)** | 0,6 | | 0,000 |
| **Total** | **10937,72** | **11,213** | **5,783** |

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**Budget POR 2007-2013 – Axis III Energy**

- Community contribution € 74.873.893
- National counterpart € 112.310.841

**A) Total € 187.184.735**

Funds already committed

- **POR FESR 2007-2013 - Axis 3** - financing of operation aimed at savings and energy efficiency in the buildings of the Government of Sardinia **€ 14,000,000.00 - (Resolution GR n.19/22 dated 14/04/2011)**

- **POR FESR 2007-2013 - Axis 3** - Granting of aid to enterprises for the production of energy from renewable energy sources and to promote the use of efficient technologies and energy conservation and widespread support for cogeneration **€ 12,442,000.00 - (Det.Dir. n.11152 dated 27/07/2011)**

**- POR FESR 2007-2013 - Axis 3** - light pollution reduction and consequent energy saving **€ 34.411.273,56** (**Deliberations G.R. n.10/49 dated 11/02/2009 and n.6/27 del 12/02/2010)**

**- POR/FESR 2007-2013 - Axis III Energy** - Operational objective 3.1.1 **€ 29.075.627,87** (Uvinu and Santu Miali hydropower plants financing) – **(Deliberation G.R. n.55/8 dated 16/12/2009)**

TOTAL COMMITTED FUNDS **€ 89.928.901,43**

Difference between expected cost and expense A) - B) = **€ 97.255.833,57**

## 5.6 Financing sources and instruments

The implementation of the measures contained in the plan will be steady and gradual over the years. A portion of the shares will be financed through participation in National and European programs and part will be supported by the Region of Sardinia through incentives for technology and industry. Most of the actions will be implemented through financial arrangements contained in the various financial instruments and programs available today for projects aimed at savings, energy efficiency and development of renewable energy.

Between European and National programs there are some that support in particular local and regional authorities to carry out large-scale investment in the energy sector, such as the program ELENA (European Local Energy Assistance), particularly addressed to the authorities involved in programs aimed at achieving the objectives 20 - 20 -20 by 2020. The plan will also make reference to other programs and tools that financially support both the public and private subjects.

European Programs:

- ELENA - EIB European Investment Bank > € 50 ML

- ELENA - Kfw Bankengruppe < € 50 ML

- ELENA - CEB

- IEE - Intelligent Energy Europe

- JESSICA-Smart City

- ERDF - European Fund for Regional Development

- ESF - European Social fund

- FC - Cohesion Fund

- INTERREG IVA and IVB

- SEARCH: 7th Framework Programme

Other Programs: - EEE-F - European Energy Efficiency Fund (Deutsche Bank AG)

- C.DD.PP. – Deposit and Loans: Kyoto Fund

Financial Instruments - Financing Through Third

- Energy Service Companies

- Public-Private Partnering

- Leasing

- Credit – Own Funds

National Programs

National Incentives - Income Energy - Green Certificates - White Certificates

Incentive tariffs

Regional Programs and Calling

The list of funding is not exhaustive but, taken the complexity of the initial stage implementing plan into account, including the identification of appropriate financial programs in the necessary time range and the support to various public and private actors, it is necessary to apply specific skills. A fundamental contribution should come from the supporting consortium of public bodies as an instrument of the plan, capable of operating at local, national and EU level.

## 5.7 Monitoring and follow-up

The monitoring of the Action Plan of Sustainable Energy is part of the activities planned by the Regional Energy Agency, which has among its tasks the ongoing verification of the progress of interventions foreseen in the actions program. Periodically, the results of the monitoring activities will be brought to the attention of the Regional Government and every two years, as expected, to the attention of the European Commission. It is an essential tool for monitoring the implementation of the Plan and provides essential elements for any schedule changes and individual goals.

Monitoring is especially important for the positive economic impact of the entire regional system: it allows you to have access, especially the part regarding actions and interventions of local authorities, to the shares of savings, efficiency and renewable energy, as well as to identify the value and put it to good use on the market for the Region and local authorities benefits. So the monitoring of the plan is also a tool of economic value, as well as a guarantee for the development of a program of transformation and innovation in the energy sector for the whole island system.

Identification of methods and procedures for the collection of all data from various sources and actions necessary for the monitoring parameters calculation and the estimation of their future evolution.

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