Energy analysis of the buildings stocks. Scaling from national to regional and urban contexts

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The present doctoral thesis entitled *Energy analysis of the buildings stocks. Scaling from national to regional and urban context* has been carried out at Environmental Applied Physic in the Department of Energy Information Engineering and Mathematics Model at Università degli Studi di Palermo

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tudor
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Aknowledgements

“This work is dedicated

to my family,

who always supported me“

Resume

The research started in the framework of the wide debate about energy planning and monitoring system at different territorial scale to achieve the energy EU targets.

In the first section, the problem is approached of verifying whether the background of the existing legislation is suitably viable to outline a pattern of actions that, by referring to an appropriate set of indicators, can utilize the more efficient available procedures and databases in sight of a better governance of a given region.

In the second section, it has been studied how to evaluate energy performance for a complex system like municipality, region or nation; there are many problems related to get appropriate data and manage the big number of interacting variable. The lack of suitable tools and methods to select and elaborate all the inputs available from different sources makes the assessment long and complicate, often providing output data that are difficult to be interpreted. In this framework, a methodology for collecting information and providing elaboration and assessment of the energy performance referring to a large building stock was developed, taking a case study of Sicilian region. It is also carry out a comparison to European and National standards to evaluate the variance of the parameter and verify the homogeneity level results in residential buildings.

At the end it has been carry out a comparison efficacy of various financial supporting methods for renewable energy and energy efficiency action in the programming 2007-2013.

The aim of the work is give; at different territorial scale, to a public-maker an instruments to evaluate the heat energy demand in residential sector and managing potential energy savings and CO_2 reduction pathways, reflecting the EU's 20% energy saving target for 2020, as well as the EU's long term 80-95% GHG emission reduction target for 2050 by using financial instruments.

Preface

This doctoral thesis was developed within the research group on Environmental Applied Physics at the Department of Energy Information Engineering and Mathematics Modelling (DEIM) of the University of Palermo (UNIPA) from January 2012 to December 2014. The research presented the result of a collaboration between DEIM and the Centre de Recherché Public Henri Tudor in Luxembourg

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PART I of the dissertation includes **Chapter 1** which focused on the role of indicators at different territorial scale for monitoring and assessing the status of achievement Energy Masterplan. Specifically here there is examining the case of Sicilian Energy and Environmental Masterplan. The dissertation addressed the problem to verify the effectiveness of general validity parameters, proposed according top-down model by European Commission, in describing the progress of the implementation of the plans.

PART II of the dissertation includes two chapters which present characterization and energy analysis of residential building stock for energy purpose. **Chapter 2**, starting the available data of the whole building stocks in residential sector, proposed a methodology used to develop and assess the energy performance scenarios for the buildings sector in Europe at different territorial scale. **Chapter 3** presents a comparison between European standard and national standard. It has been analyze Luxembourg, The Netherlands and Italy standards. In this way it has been evaluate the homogeneity level results as request by European Energy Performance of Buildings Directive 2002/91/EC (EPBD).

PART III of the dissertation includes **Chapter 4** which presents policy and programs for the energy efficiency at different territorial scales. The dissertation presents an efficacy comparison of various financial tools in the programming 2007-2013.

The dissertation is essentially based on the following research papers, which have either been published, or will be submitted for publication.

1) L.Filogamo, G. Rizzo

I piani energetici ambientali regionali: sono utilizzabili gli indicatori proposti a scala nazionale (ISPRA) ed europea (EUROSTA)?

Il Progetto Sostenibile, Edicom Edizioni 2014.

2) L.Filogamo, G. Rizzo

The applicability of the indicators proposed by the European and national regulatory framework for the verification of the advancement of the plans: the case of the Energy and Environmental Masterplan of the Sicilian Region.

Economics and Policy of Energy and the Environment, 2014 (1): 145-166.

3) L. Filogamo, G. Peri, A. Giaccone, G. Rizzo

A Method for Analysing Heating Demand and Energy Saving Actions for Regional Residential Building Stocks

Book of abstracts, pp. 265. ISSN: 1847-7186, Published by Faculty of Mechanical Engineering and Naval Architecture, Zagreb, 2013.

4) L. Filogamo, G. Peri, A. Giaccone, G. Rizzo

A bottom-up method for evaluating the whole energy demand of large residential building stocks: an application to a regional scale.

Digital Proceedings of 8th Conference on Sustainable Development of Energy, Water and Environment Systems – September 22-27, 2013, Dubrovnik, Croatia, 0316-1/0316-10, ISSN 1847-7178.

5) L.Filogamo, G.peri, A.Giaccone, G.rizzo

_On the classification of large residential buildings stocks by sample typologies for energy planning purposes__._

Applied Energy 2014; 135: 825-835.

6) L.Filogamo, L. Lo Coco

Gli strumenti incentivanti per l'efficienza energetica in edilizia

in “La certificazione energetica per l’edilizia sostenibile – Efficienza Energetica, Compatibilità Ambientale e Nuove Tecnologie nell’Edilizia” a cura di Marco Filippi, Gianfranco Rizzo e Gianluca Scaccianoce. Dario Flaccovio Editore, Palermo, 2014.

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“If you cannot measure it,

you cannot improve it”

Introduction

Buildings are at the center of our social and economic activity. Not only do we spend most of our lives in buildings, we also spend most of our money on buildings. The built environment is not only the largest industrial sector in economic terms, it is also the largest in terms of resource flow. Buildings are intrinsically linked to Europe's societies, Europe's economies, and their future evolution.

Energy security and climate change are driving a future that must show a dramatic improvement in the energy performance in Europe's buildings. The 27 Member States have set an energy savings target of 20% by 2020, mainly through energy efficiency measures. The European Union has also committed to 80-95 % GHG reduction by 2050 as part of its roadmap for moving to a competitive low-carbon economy in 2050. Buildings currently represent almost 40% of total final energy consumption and, therefore, can make a crucial contribution to these targets.

In the Energy Efficiency Plan, the European Commission states that the greatest energy saving potential lies in buildings. The minimum energy savings in buildings can generate a reduction of 60-80 Mtoe/y in final energy consumption by 2020, and make a considerable contribution to the reduction of GHG emissions. This will be achievable only if buildings are transformed through a comprehensive, rigorous and sustainable approach.

The European policy framework for buildings has been evolving since the early 1990s. A wide array of measures has been adopted across individual Member States to actively promote the better energy performance of buildings. After 2002, the issue gained strong momentum when the Directive on Energy Performance of Buildings (EPBD) [Directive 2002/91/EC] was adopted. The EPBD was recast in 2010 to make the goals more ambitious and to reinforce the implementation. As the Commission stated in its Communication proposing the 2010 revision: "The sector has significant untapped potential for cost effective energy savings". Realizing this potential will depend crucially on the commitment of Member States, and the involvement of stakeholders from government, industry and civil society.

The European Union stretches over many different climate zones, landscapes and cultures. Some 501 million inhabitants spread over 27 countries 7 reside in a wide array of building types with an equally wide range of thermal qualities, in a constantly expanding building stock. From styles of living – single-family dwellings or multi-family dwellings, for example – to policies for the construction of buildings, there are significant differences between countries.

National approaches to monitoring the building stock have also evolved separately. Information is not only needed to track the progress of policy implementation, better information and data are required to help develop a European pathway and roadmaps to more energy efficient buildings. In order to define the energy and CO_2 reduction potential, we need to study and evaluate the technical and economic opportunities, feasibilities and limits. Indeed, it is a major obstacle to strong policy making at EU level that there is a lack of data on the building sector for Europe as a whole. There has been significant Europe-wide legislation on buildings and there are several forthcoming initiatives underway to improve the energy performance of new and existing buildings. Yet, much of this is done with only a minimum of fact-based knowledge, analysis and evidence. As strategies for the energy performance of buildings evolve and become more complex, policy makers need more concrete and precise facts to be able to make cross-country comparisons and to put in place the monitoring systems that permit measurement of the progress of the various policy instruments.

To create a sound basis for political debate and policy making at EU and Member State level, it is important define develop a vital picture of the European building stock, one that is as detailed and correct as possible. It is fundamental for the effective policy making starts with an accurate picture of the challenge. This report is a first attempt at such a comprehensive approach.

Improved energy efficiency could make a positive contribution to solutions in many policy areas while actually increasing rather than decreasing available resources. Supporters of energy efficiency need better arguments which will encourage both the private and public sectors to take more interest in improving energy efficiency and to explain how this paradigm shift can occur. The main objectives of this study are to give policy-makers the facts and offer the arguments to make the case persuasively, and to provide useful data input to researchers who should base any political discussion upon science-based insights.

The thesis presents a general vision of energy planning problems related to use of a general model at different territorial scale to design, monitoring and financing Energy Masterplan.

Cities play a crucial role as engines of the socio-economic growth however they are places of high environmental pressure (European Union, 2011). Globally, with a population share of just above 50% but occupying less than 2% of the earth's surface, cities concentrate 80% of economic output, over 75% of the world´s resources use, between 60% to 80% of total energy consumption, and approximately 75% of global greenhouse gas (GHG) emissions (Ash et al., 2008; Kamal-Chaoui and Robert, 2009; Pacione, 2009; UN Population Division, 2010; Lazaroiu and Roscia, 2012). This pattern reflects the concentration of particular activities within individual cities and urban areas. Predominantly, buildings, transport, and industry contribute 22% to 25% each to global GHG emissions (Herzog, 2009; UNEP, 2011a).

Given the scale of resource consumption, energy use and contribution to climate change driven by rapid urbanization, there is an emerging consensus on the importance of promoting integrated strategies for making cities thriving centers of sustainable development and innovation (UN, 2013). In Europe, particularly, cities are considered instrumental elements for the successful achievement of the headline targets defined by the European 2020 strategy (European Commission, 2010a) through which it is aimed at contributing to transition the European Union (EU) into a smart, sustainable and inclusive economy. The European 2020 energy and climate targets for sustainable growth are aimed at reducing GHG emissions by 20 % from 1990 levels; increasing the input from renewable energy sources in the EU's overall final energy consumption to 20 %; and moving towards a 20% increase in energy efficiency.

The building sector can contribute significantly to mitigating climate change while delivering many other societal benefits. Political courage and will, innovative investment tools and societal awareness are key factors for transforming the sector. Existing EU policies have to be implemented in a best practice manner to achieve the intended energy savings, while new instruments are needed to stimulate a deep renovation wave across Europe and its Member States at different territorial scales. Good policy making requires good knowledge about the status quo of building performance and the management of many data.

The study carry out from this thesis has shown that data gaps exist which make it difficult to develop targeted programmes, to monitor policy implementation and to evaluate progress. The top -down approach to monitoring energy planning with Headline indicators show that it has needed a stronger coherence of indicators to check with the requirements of the local plan The EU and its Member States should make significant efforts to define methodology useful at different territorial scales and to harmonize monitoring and evaluation of the energy plans. This is a tentative to give to policy makers the instruments for the optimal budget allocation in energy efficiency policy measurements

PART I

INDICATORS AS A CRITERIA FOR ENERGY PLANNING ASSESSMENT

For strong policy making at EU and Member State level
it is key to establish an efficient monitoring system

Summary

Each plan/program (P/P) acts in a public decision-making process that consists of a variety of instruments (policies, plans, programs and projects), with its own procedural autonomy but related with different sectors and levels of detail. The changing of the examined zone depends on all the effects, even synergistic, arising from the choices of all the instruments of decision making: In fact, only a coordinated approach can help increase the overall sustainability of the planning choices; strategies for sustainable development to be taken therefore become an instrument of defining, coordinating and monitoring the implementation of policies that, by means of the monitoring phase, ensure consistency and comparability of assessments at different territorial scales. The method of the Strategic Environmental Assessment (SEA) and the use of the system of environmental indicators indicate and identify how to address these issues and allow it to be replicated in different regions [16].

Indicators are essential operational tools for the preparation of plans, to monitor their progress and for the ex-post verification of the results achieved. As it is known, there is a large corpus of indicators, both at Community and national Italian level, to which designers and planners can refer. However, it remains to verify the effectiveness of general validity parameters in describing the progress of the implementation of plans, which must be necessarily compared with more limited territorial situations.

In this chapter, the problem is approached of verifying whether the background of the existing legislation is suitably viable to outline a pattern of actions that, by referring to an appropriate set of indicators, can utilize the more efficient available procedures and databases in sight of a better governance of a given region. The Sicilian region is here considered for a field application.

Chapter 4 addresses this problem, with reference to the Energy and Environmental Plan of the Sicilian Region (PEARS), comparing the themes proposed at European (Eurostat) and the Italian national (ISPRA) levels with those adopted for the preparation of PEARS. The aim of this chapter is the applicability of the indicators proposed by the European and national regulatory framework for the verification of the advancement of the plans: the case of the Energy and Environmental Masterplan of the Sicilian Region.

The instrument here used for verification is just composed by the indicators (Headlines) present in the Eurostat topics, of which the actual applicability at regional level has been monitored in order of verifying the degree of achievement of the objectives proposed by PEARS. The comparison shows the not perfect usability of the top-down scheme, for the singling out of the indicators, which must be rather declined in greater detail, according to a bottom-up scheme of intervention that is able to understand with the suitable specificity the needs of the area under examination.

Chapter 1

Tools for the energy planning: using the european indicators

1.Introduction: the regulatory scheme of the land policy government

As it is known, plans/programs (P/P) act as a single part of a public decision-making process (COM, 2001), while the evolution of an area depends on the synergic effects of each choice of the decision making process (Kagiannas, 2003). Strategies for Sustainable Development (Ministry of Economic Development, 2007) are therefore becoming important tools for defining, coordinating and monitoring the implementation of policies (Labandeira, 2009) to different territorial scales (Learmonth, 2007). Regulatory compliance required by the EU (COM, 2009) and the regulatory framework that is emerging for the EU 2014-2020 programming framework, suggest to convey the efforts of programmers and involved actors towards an effective and efficient integration of all environmental information, to ensure a desirable overall performance of Programs (Chen, 2011).

In recent years the European Union (EU) has integrated sustainable development in a large number of policies, taking globally a leading role in the fight against climate change, thereby committing itself to promoting a low-carbon economy.

Most public policies, particularly in the energy field, are not only affecting the efficiency but also show distributed effects on other areas of economic and social life.

In Italy, for example, the regional development policy could make a strong contribution to the recovery of competitiveness and productivity of the whole country, so reducing the persistent under-utilization of resources in the South part. In order of achieving these results, the policy at the regional, national and community levels, must take timely lessons from the past, according to the strategic documents developed in previous years by various institutions, with the goal of translating this information into strategic and operational guidelines (Ministry of Economic Development Department for Development Policy and Cohesion, 2007).

Nowadays, the regulatory framework is fragmented and there are still persistent delays in the implementation of national directives and their application; the framework of responsibilities for environmental management and land, as attributed to the Regions and Local Authorities, shows a strong need for coordination. In fact, the sector planning is now poor, even in terms of adequacy of the underlying technical and scientific knowledge

In Italy, the unitary regional strategy (but a similar situation can be encountered in other countries), the priorities and the general and specific targets that comprise territorial and/or industry level, are implemented and achieved on the basis of a planning process consisting of three levels of implementation:

a. the programming level of specific strategy (land and/or sector oriented);

b. the sharing level of institutional of priorities, objectives and instruments;

c. the implementation level and the specific tools by which the unitary regional strategy is realized.

The above cited levels contribute to establish an unified and iterative process involving the identification of objectives and operational decisions. For each level specific tasks are assigned, by means of which decision and implementation strategies of the regional policy are pursued. Environmental issues must be adequately considered in the assessment activities carried out at the different stages of programming in order to ensure the actual integration of environmental concerns into development policies and to create awareness of the environmental effects of the interventions. Regarding the evaluation activities in support of planning actions, the Strategic Environmental Assessment (SEA) of plans and programs, as required by Directive 2001/42/EC, along with the associated participatory processes, represents a tool aimed at improving the quality and transparency of decisions. Specifically, the need to activate a monitoring system is made explicit in Article 10 of that Directive, in order to promptly identify any unforeseen adverse effects and to take appropriate corrective measures. These assessments, as defined in Article 47, "General Provisions", are aimed at improving quality, effectiveness and consistency of interventions, taking into account the objective of sustainable development and of the relevant legislation on environmental impact. The importance of monitoring programs is further underscored by the Directorate General (DG) Environment of the European Commission (EC) in note n°. 009432, 30 September 2008 addressed to the Managing Authority of the Operational Programmes.

The Directive does not provide, however, further technical indications and does not establish the ways in which the significant environmental effects, in particular, should be controlled. The EU charges individual Member States to decide about the mode and monitor the significant effects.

Even the Italian national legislation, such as that of the Community, provides a form of control on the impacts resulting from the implementation of a plan, as defined in Article 18 of the Legislative Decree 152 of April 3rd 2006, as amended by Legislative Decree of 16 January 2008 n°. 4 and by the Legislative Decree of 29 June 2010, n°. 128. In addition, in paragraph 8 of Article 34 of this Decree, reference is made to the Environmental Agency and the Higher Institute for Environmental Protection and Research (ISPRA), which ensures the collection of data on structural indicators or those especially chosen by Community competent authority. The legislation thus identifies, in the system of "environmental agencies" (ISPRA, 2011a), the subject "catalyst" of monitoring activity.

As part of the strategic actions identified at the regional level, it would be useful flanking the usual efficiency/productivity goals with governance tools able to cope with and to adapt to modifications occurring during time Of course, assigning new targets implies that it may be possible assessing their levels of achievement that, on turn, requires the possibility of interpreting the activities of the regional structures in terms of responsiveness to the considered problems. As a consequence, it would be important to assess a well-defined correlation between the system of regional indicators and the set of the European ones.

Indicators for measuring and monitoring over time phenomena of interest have become an indispensable tool for programming with the aim to better describe and define the transformations and changes that the policies aim to induce. These indicators should be able to monitor the program in the so called *Ex ante and Ex post* phases, in order of leading the program toward the desired goal (COM 2009, 400).

Starting with the guidelines outlined by the regulations, within the framework of the strategic actions identified at the regional level, it is useful to approach the objectives of efficiency/productivity, its regional structures, and including governance objectives to interpret so the ability to respond to the problems by regional structures themselves.

It is crucial to take the road of integration of systems of indicators for each sector, with a view to their correlation with the reference set at national and European level: this represents in fact a guarantee of a correct description of the transformations and changes that policies intend to produce.

From the data base of indicators available today, with the aim of achieving better governance of the region, in the present work is then checked on the background of the existing legislation, the actual applicability of the set of indicators available to the various territorial contexts.

On this purpose, the usability of sustainability indicators Eurostat will be verified at the regional scale and it will also make reference to the experience gained under the Convention ISPRA/APPA/ARPA, which has produced significant guidelines containing the monitoring of the level of implementation of the plans on a regional scale. Moreover, indicators candidates to represent the status of plan implementation, will ultimately are taken into account, both at European and national level Italian. Then, we will present an application to a real case, consisting of the Environmental Energy Plan and the Region of Sicily, which required the use of a high number of such indicators. From this critical reading of the method, relevant considerations concerning the transferability of the procedure to a wider audience of Plans/Programs (P/P) will be assumed.

2. Sustainability indicators as a tool for energy and environmental management

The EU and its Member States are shifting their policies toward a long-term sustainability, since the convergence is growing between the strategy for sustainable development and the Lisbon Strategy for Growth and Jobs (The European Council, 2000). In doing this, evaluations were conducted mainly on:

- monitoring reports of Eurostat;
- progress reports of the Member States on the implementation of the EU strategy for sustainable development;
- periodic reports of the European Agency for the Environment.

As it is well known, sustainability indicators, apart measuring the phenomena and their evolution in comparison to the proposed targets, are therefore able to monitoring economic, social and environmental performance of a given plan/program.

At the methodological level, the process of selecting indicators in Europe, therefore, follows a logical sequence that includes:

1. the identification of an initial list of indicators, based on international studies and lists of specific actions of European programming;

2. analysis of their availability and feasibility (when indicators are not available);

3. the revision of the list on the basis of relevance, communicability, scientific validity, applicability to the context.

At international level, the Organization for Economic Cooperation and Development (OECD) and the EU use sets of indicators:

- for monitoring progresses concerning sustainable development;
- as a tool for checking the state of economy and environment;
- to evaluate the performance of policies;
- to clarify objectives and set priorities.

As the EU and its Member States are shifting their policies toward a long-term sustainability, since the convergence is growing up between the strategy for sustainable development and the Lisbon Strategy for Growth and Jobs. In doing this, evaluations were conducted mainly on:

- Eurostat monitoring reports;
- progress reports of the Member States on the implementation of the EU strategy for sustainable development;
- periodic reports of the European Agency for the Environment.

At European level, Eurostat has developed a set of indicators for monitoring the objectives and commitments contained in the European strategy for the sustainable development that has been adopted by the European Commission in 2001 and renovated in 2006. In this context the European Commission has developed the European Common Indicators, ECI that are already widely in use for years.

Currently there is a periodic review of the system of indicators for sustainability in Europe that is focused on:

- retrieval of basic data;
- organization of a rational and coherent system of indicators;
- development of indicators for the integration and benchmarking.

3 The Headlines indicators of Sustainable Development of the European Union (Eurostat)

As previously reported, sustainable development is one of the fundamental missions of the European Union in sight of improving the quality of life, the environmental protection and the social cohesion. This goal must be achieved by sustainable communities that are able to manage resources efficiently and to tap the potential ecological and social innovation economy.

The monitoring of the progress towards these targets is an important part of the sustainable development strategy (SDS). So, Eurostat, together with Member States, has developed a series of 140 sustainable development indicators (SDI), in turn subdivided into 10 subjects. These indicators are up-to-date and published by Eurostat every two years.

The sustainable development indicators (SDI) are organized into themes that reflect the major challenges of sustainable development strategy (SDS) according to a gradient that ranges from economic to social, to environmental and institutional dimensions.

Table 1 – Example of indicators referring to each Eurostat theme

THEMES	SUB-THEMES	HEADLINES INDICATORS
Economic	1. Socio-economic development	Real GDP per capita, growth rate and totals
Environmental	2. Climate change and energy	Greenhouse gas emission
	3. Sustainable consumption and production	Research productivity
	4. Natural resources	Biodiversity
	5. Sustainable transport	Energy consumption of transport relative to GDP
Social	6. Public health	Healthy life years and life expectancy at birth by sex
	7. Social inclusion	People at risk of poverty or social exclusion
	8. Demographic changes	Employment rate of older workers
Institutional	9. Global partnership	Official development assistance as share of gross national income
	10. Good governance	(no indicators associated, so far)

These themes are further divided into sub-themes that reflect the operational objectives and actions of the SDS. The set of SDI is flexible: new indicators can be further added in relation to changes in priorities of the SDS, bearing in mind that new problems occur from time to time.

There are different levels of sustainability indicators that meet the various needs of users (Table 2) for each sub-theme defined in Table 1 that shows the corresponding indicators that, according to the levels at which they act, have the following names:

a) Key indicators to monitor the general objectives relating to the key challenges of the SDS:

1. gross domestic product;
2. emissions of greenhouse gases;
3. resource productivity;
4. bird index;
5. energy consumption of transport relative to GDP;
6. years of life in health and life expectancy at birth by sex;
7. people at risk of poverty or social exclusion;
8. the employment rate of older workers;
9. the official development assistance as a share of gross national income.

b) Operational indicators, related to the operational objectives of the strategy:

1. economic development, innovation, competitiveness and eco-efficiency, employment;
2. climate change and energy, transport and mobility, transport and impacts;
3. resource use, waste, consumption patterns, production patterns;
4. globalization of trade, financing for sustainable development, management of global resources;
5. biodiversity, freshwater resources, marine ecosystems and land use;
6. and health inequalities in the social, health determinants;
7. Monetary poverty and living conditions, access to the labor market, education;
8. demographics, age and income adequacy, sustainability of public finances;
9. coherence policy and effectiveness, openness and participation, economic instruments;
10. further infringement procedures, environmental taxes.

c) explanatory indicators related to the actions outlined in the strategy and that, for each sub-theme, are, for examples:

1. net national income, energy intensity of the economy, employment rate, by gender;

2. global average temperature of Earth's surface, electricity produced from renewable sources;

3. internal consumption of materials, final energy consumption by sector, Ecolabel licenses;

4. firestate surfaces damaged by defoliation, biochemical oxygen demand in rivers;

5. consumption of energy for transport mode, emissions of oxides of nitrogen (NOx) emissions from transport;

6. mortality rate, Urban population exposure to air pollution by ozone;

7. people at risk of poverty by age group, people with a low level of education by age group;

8. average exit age from the labor market, the rate of migration;

9. EU imports from least developed countries by product group, official development assistance, by income group;

10. transposition of Community law by sector, e-government.

d) contextual indicators, which are part of the set, despite not directly controlling a specific objective of the strategy; these indicators are provided only for 3, 4, 5, 7, 8, 10 sub-themes:

3. number of people in households, final consumption expenditure of households, consumption functions;

4. population living on less than 1USD per day;

5. price indices for transport;

7. Public spending in education;

8. costs of care for the elderly;

10. citizens'confidence level in EU institutions.

Eurostat also provides a quality profile for all sustainable development indicators (SDI) that includes information on the significance, timeliness, accuracy, comparability and relevance, as well as information on how the indicator could be improved. In Table II is reported a summarization of such organization of the indicators.

Table 2: Summarization of such organization of the indicators referring to challenges of sustainable development

Table 2 – Example of the indicators referring to each theme of sustainable development strategy(SSS)

Themes		Economic	Social	Environmental	Institutional
Example of sub-themes		1)Socio economic development	7)Social inclusion	2)Climate change and energy	9)Global partnership
Indicators	Key	Real GDP per capita, growth rate and totals	People at risk of poverty or social exclusion	Greenhouse gas emission	Official development assistance as share of gross National income
	Operational	Employment	Education	Climate change	Financing for sustainable development
	Explanatory	Employment rate by sex	People with low educational attainment by age group	Global surface average temperature	Official development assistance by income group
	Contextual	/	Public expenditure on education	/	Official development assistance by inhabitant

4. Indicators for evaluating and monitoring plans and programs at the Italian country level (ISPRA)

With the aim to harmonize the operational modalities of the monitoring systems adopted in different regional areas of legislation, the Convention (ISPRA, ARPA, APPA, 2009) established in 2009 between ISPRA and fifteen Italian Environmental Agencies, has developed guidelines for the implementation of the monitoring activities.

The Convention is based on a methodological framework which tends to facilitate the use of the instrument at different spatial scales, and is also aimed at sharing the choices and the use of indicators for creating monitoring systems which results can be comparable. For example, Italy must meet a share of 15.9% of RES use, as defined by the decree of burden sharing.

The database and metadata cards (ISPRA, ARPA, APPA, 2009) represent a first experiment of building a shared knowledge between national and regional levels of environment monitoring. A first application to verify the consistency of the indicators at different spatial scales was implemented as part of the Convention instituted in 2009 between ISPRA and fifteen Environmental Agencies (ISPRA, 2011). The Convention, is based on a methodological framework which tends to facilitate the use of the instrument at different territorial scales, and is also aimed at sharing the choices and the use of indicators for creating monitoring systems with comparable results. The database and metadata format (ISPRA, 2009) represent a first experiment of building a shared knowledge framework between national and regional levels for environment monitoring.

The monitoring system is often not sufficiently developed within the documents, where it is sometimes merely suggested. Furthermore, in the monitoring phase, indicators, if any, are often unrepresentative and lacking in clear links between the analysis, the objectives of the P/P, the necessary actions to achieve them, the environmental effects thereof.

Starting from this situation, it's important to start, for the definition of an initial core set of indicators to be used in SEA, from a common framework of sustainability, which can be declined at every land levels, and to be used for deriving consistent and coherent analyses of the context. As that, it has been decided to support the analysis of the plans, with a survey of sustainability targets established at European, national and regional levels, in order of properly identifying the environmental issues.

The ISPRA document (ISPRA, ARPA, APPA, 2011) developed a strategy that defines a set of specific objectives of sustainability with the proper context indicators, for each of the 11 considered environmental issues. These themes must be implemented through direct actions, as reported in Table 3.

Since the objectives of sustainability are the points of reference for all the SEA processes, the monitoring becomes the instrument that checks the extent to which the implementation of P/P is consistent with the achievement of sustainability targets.

Of course, monitoring is possible if common rules are properly defined, that is:

- a relationship between sustainability objectives of the strategy and the objectives of the plan/program is assessed;
- a common core of indicators is established and is also shared by all the P/P;
- methods and tools are defined to build and share a common knowledge base of plans and programs at different levels and for different regional systems.

Table 3: Example of environmental issues identified in the ISPRA/ARPA/APPA Document

ISPRA themes	*Specific objectives*	*Indicators of environmental context*
1. Climate and energy factor	Increased electricity production from renewable	renewable Energy production; total electricity production
2. Transport	Reduction of greenhouse gas emissions from transportation	Emissions in the atmosphere from transport sector
3. Waste	Prevent and reduce hazardous waste	Generation and production of hazardous substances
4. Health	Reaching levels of air quality that do not involve significant adverse impacts to human health	Percentage of resident population for each quality area
5. Non-renewable natural resources	not contemplated	Sites of extraction of energy resources (oil, geothermal)
6. Environmental certification	NOT EXPECTED TO ISPRA not contemplated	Number of licenses issued with national eco-label for national products
7. Cultural heritage and landscape	NOT EXPECTED TO ISPRA not contemplated	Surface areas of archaeological bound
8. Atmospheric and physical agents	Achieving levels of air quality that do not involve significant adverse impacts to human health and ecosystems	Emission of pollutants
9. Water	To protect territorial and marine waters and to prevent and eliminate marine pollution	Trophic state index
10. Ground	Ensuring the protection and remediation of soil and subsoil, the hydrological restoration of the area	Percentage of surface under geological risk
11. Flora, fauna and ecosystems	Reduce the rate of biodiversity loss	Surface of protected areas

Figure 1 shows a diagram of the verification process of the integration of environmental concerns regarding the sustainability strategy, decision making and monitoring.

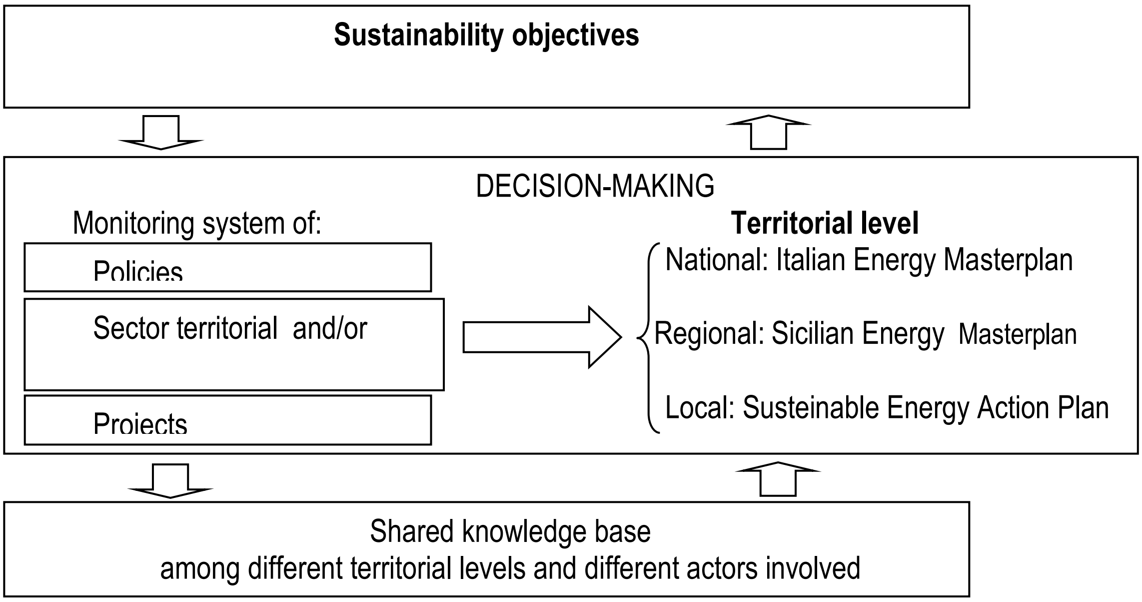

Figure 1 - The process of verification of the integration of environmental concerns regarding the sustainability strategy, decision making and monitoring (After [16])

From a methodological point of view, monitoring may be described as a three step process (ISPRA, ARPA, APPA Resolution of Federal Council, Seat No. 3, November 2011), which supports and monitors the implementation of the P/P results that must be included in periodic reports. The three steps are the analysis, the diagnosis and the therapy, that are more in detail described in the following.

- Step 1_ANALYSIS

It consists in a continuing acquisition of:

information and data, both from external sources and through measurement campaigns; these data allow the computation of indicators that, apart other uses are intended to compare the expected trends with the actual situation.

- Step 2_DIAGNOSIS

It consists in the identification and description of the causes of deviations from expectations.

- Step 3_THERAPY

It identifies if (and what) actions must take in order of re-orienting P/P toward sustainability targets.

In Figure 3 an operational scheme is reported of the steps of the monitoring process just described.

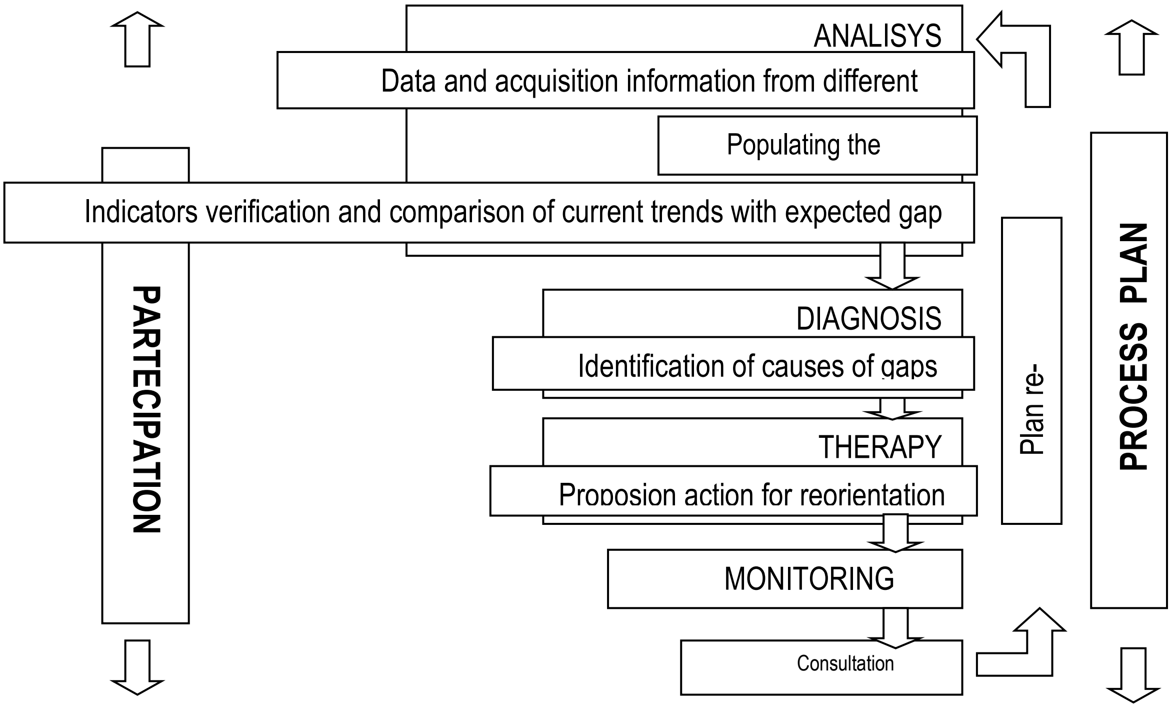

Figure 2 - Outline of the by steps scheme adopted by ISPRA for the joint monitoring (After [16])

For the definition of an initial core set of indicators for use in SEA, representative of the fifteen involved Environmental Agencies at Italian country level a common framework of sustainability has been assessed and declined at various regional levels which context analysis to derive consistent and coherent. They then decided to support the analysis of the plans with a survey of sustainability objectives and targets as set, by the main Strategies, Directives, Norms of European, national and regional levels in order to identify, for the various components and environmental issues.

Table 4 shows the correspondence between the strategic themes and the European environmental components ISPRA/ARPA/APPA: it allows stating the very close correspondence between the themes proposed by the EU and those identified by the Convention ISPRA/ARPA/APPA core.

Table 4 –Correspondences between the themes proposed by UE and the environmental issues ISPRA/ARPA/APPA

EUROSTAT	ISPRA/ARPA/APPA
Strategic themes at the European level	**Components and environmental issues at Italian country or regional levels**
Climate change and clean energy	1.Climatic factor and energy 2. Environmental certificate
Conservation and management of natural resources	3.Non renewable natural resources 4.Atmosphere and physical agents 5.Water 6.Soil 7.Biodiversity, flora and fauna
Sustainable consumpition and production	8.Waste
Sustainable transportation	9.Transportation
Public health	10.Health
Cultural research and landscape	11.Architectural and acheological heritage landscape

The set of indicators can highlight the environmental and spatial characteristics of the area potentially affected by the plan, to assess specific measurable objectives, to evaluate the significant effects due to the planned actions and to monitor the level of achievement of targets. As that, *core set* of indicators are declinable at different territorial scales, since they can be used for plans at regional, provincial and local levels.

Suitable indicators, to be populated at different territorial scales, should be significantly representative of the environmental issue being considered and homogeneous and comparable at all territorial levels.

In a certain regions where sufficient data are not available to suitably populate the core set of indicators, other indicators are used, called "variables", which allow to indirectly obtaining the needed information.

A similar process was applied in the case of utilization of a given indicator from the regional level to the provincial and/or municipal one.

In the study conducted by ISPRA/ARPA/APPA, a "core set" of indicators was shared, gathered in a catalog, identified for the main components and environmental issues, starting from the sustainability objectives of the European and national strategies, thus defining a first point of reference for national and regional level plans.

Regarding the cited study of ISPRA/ARPA/APPA, the choice of indicators allowed to:

- identify relevant aspects of the current state of the environment and its likely evolution before the implementation of the plan and/or program has taken place;
- describe the environmental characteristics of areas likely to be significantly affected;
- monitor the significant environmental impacts resulting from implementation of plans and programs, so determining whether a P/P is proceeding in the desired direction.

To define at what extent a P/P is close to its objective, it is necessary to define another set of indicators, the so called "related to plan objectives" ones, that are divided into “process indicators” and “indicators of context changing”. The role of indicators of process is to describe the status and degree of implementation of triggered actions, for defining the link with the other planning tools that insist on the same territory.

The indicators of context changing are capable to record and evaluate the extent of impacts induced by the actions.

In Figure 1 is reported a summary of the monitoring system with regards to the relationship between objectives and indicators, both at the general and local levels.

From a methodological point of view, monitoring may be described as a three steps process: *analysis, diagnosis and therapy* (ISPRA, 2011). To the three cited phases an "input phase" must be added in the process, in order of updating the battery of indicators, the environmental frame of reference and the assignment criteria and priority actions to be monitored.

5. The repeatability of the method in Sicily applied to the monitoring of PEARS Masteplan

In this section we will verify the applicability of the Headline indicators of the European Union at the Regional Environmental Energy Plan (Albanese, 2011) of the Sicilian region.

In Sicily, the regional environmental policy (Regione Siciliana, 2009c) has identified, by means of the PEARS (Regione Siciliana, 2009a) Masterplan, proper actions in order of achieving effective results concerning climate change and energy use issues. The system is structured on three levels; starting from directives and decrees established at country level, it implements provincial and, to a smaller scale, local action plans.

The above described scheme concerning the use of indicators at local levels, is here checked with regards the PEARS Masterplan of the Sicilian Region (Regione Siciliana, 2009b). This verification, by the way, presents a specific relevance in sight of the application of the strategic environmental assessment (SEA) of the plan (Federico G. Lascari, G., La Gennusa M., Rizzo G., Traverso, M ., 2006).

The PEARS consists of informative sheets (Regione Siciliana, 2009d) referring to each specific action related to the so-called “Action Plans”. These sheets represent suitable case-studies for given regional situations, starting from the definition of proper energy basins, from the assessment of the potential introduction of renewable energy sources (RES) and from the energy savings achievable through the improvement of the energy end-uses efficiency.

The procedure also provides for the introduction of a monitoring system that, as defined in the Directive 2001/42/EC (Directive, 2001), has not been designed as a tool to simply collecting and updating territorial data. It was, in fact, intended as an active, complex and detailed system, which also contemplates assessment activities, support decision, data interpretation and elaboration of recommendations for the possible re-routing of PEARS (Fig. 3).

This three levels scheme requires the definition of some specifications and in particular:

1) the establishment of a target P/P related to the overall sustainability, as defined by Directive 2001/42/EC;

2a) the singling out of the P/P measures

or

2b) the singling out of the measures defined at higher-level plans;

3) the singling out of proper “process” indicators (see Section 4), able to account for the degree of implementation, by means of information referring to:

   a. the type of relationship between the degree of implementation of the measure and their effects;

   b. the link with the higher and lower levels planning;

4) the identification of proper indicators referring to “change of context” (see Section 4);

5) the control of the congruency between the general sustainability targets and the local ones.

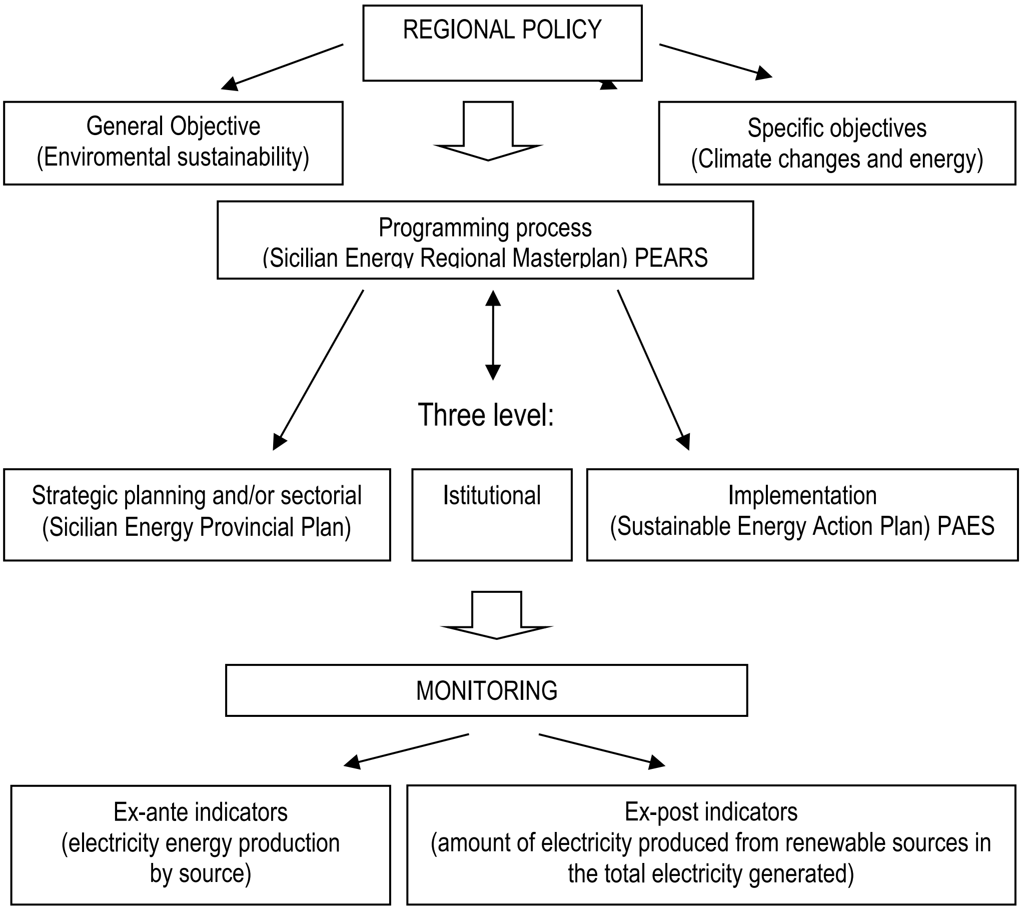

Figure 3 – The general governance model of the Sicilian environmental Masterplan

In order to check the consistency between the planning approaches at the Sicilian regional, Italian country and European levels, a first comparison has been assessed between the EU topics, ISPRA themes and the Sicilian components related to PEARS Masterplan. Table 5 synthesizes the above cited process of correspondence.

Apart the correspondences established at the three cited levels, it's also important to note that the link among the Masterplan and other planning tools, operating at the Sicilian regional level, must be properly considered...

Table 5 - Correspondences between the strategic topics proposed by UE, the environmental issues proposed by ISPRA/ARPA/APPA and the components proposed at regional in the PEARS

EUROSTAT	ISPRA/ARPA/APPA	SICILY (PEARS)
Strategic themes at the European level	**Components and environmental issues at Italian country level**	**Components at Sicilian regional level**
Socio-economic development	*n.c*	*n.c*
Sustainable consumption and production	8.Waste	Waste
Social inclusion	*n.c*	*n.c*
Demographic changes	*n.c*	*n.c*
Public health	10.Health	Inhabitants and health
Climate change and energy	1.Climate change and energy 2.Enviromental audit	Atmosphere
Sustainable transportation	9.Trasportation	Trasportation
Management of natural resources	3. Non-renewable natural resources 4.Atmosphere and physical agents 5.Water 6.Soil 7.Biodiversity, flora and fauna	Energy
Global partnership	*n.c*	*n.c*
Good governance	*n.c*	*n.c*
Cultural research and landscape	11. Architectural and archaeological heritage landscape	Landscape and Architectural and archaeological heritage

n.c. = no correspondence

Starting from the general compatibility among the cited planning levels, in the following we will verify the applicability of specific indicators belongings to EU topics, at the local regional level, with a specific attention to the case of the PEARS Masterplan monitoring. In doing this, three more specific levels of coherence have been established; each of them has been characterized by a proper symbol that will be used in the aim of quantifying at which extent the EU indicators are able to feature the performances of PEARS in relation to the established goals. This verification will act as a monitoring phase of the Masterplan, in this way investigating whether the corpus of EU indicators is able to monitoring or it is needed a further implementation of the set of indicators. To this end, it has been suggested a "direct coherence", in the event that there is a complete matching between EU topics and themes of the PEARS; an " indirect coherence" when, although a direct correspondence is not encountered, there is an evident link between objectives of the PEARS and EU topics; an "indifferent correspondence" when no correlations can be found between the objectives of the PEARS and EU topics.

In table 6 the above definitions are summarized, together with the assigned symbols.

Table 6 – Definition of coherence levels adopted for comparing the PEARS objectives with the UE topics

Coherence levels	Symbols
Direct coherence	X
Indirect coherence	Δ
Indifferent correspondence	○

The identification of the level of coherence between the EU indicators and those of PEARS was carried out starting from the definition provided by Eurostat for each indicator.

Here below, some of the definitions of the Eurostat indicators are reported, in the aim of clarifying how they are utilized for checking the level of correspondence.

- GDP per capita

Percentage changes over the previous year, in terms of euro per inhabitant; GDP includes goods and services on the market.

- Resource Productivity

The value of GDP divided by domestic material consumption (DMC). DMC measures the total amount of materials used directly by a national economy.

• Number of people at risk of poverty or social exclusion

This indicator is the summation of people who are at risk of poverty or severe material deprivation or living in households with low labor intensity.

• Employment for older workers

It is calculated by dividing the number of employed people aged between 55 and 64 years for the total population of the same age group.

• Life expectancy at birth and year's life expectancy in good health, by sex

It measures the number of years in good health which a person at birth is expected to live.

• Emissions of greenhouse gases

Total emissions of greenhouse gases (CO2 equivalent), referred to 1990. This indicator shows the evolution of total anthropogenic emissions in relation to the 'reference year of the Kyoto protocol"(1990 for non-fluorinated gases and 1995 for fluorinated gases).

• Consumption of energy in transportation sector with reference to GDP

This indicator is defined as the ratio between the consumption of energy in the transportation sector and GDP in a given year.

• Biodiversity

It is 'an aggregate index that integrates the abundance and diversity of the population of a given species associated with a specific habitat.

• Official development assistance (ODA), as a share of the gross national income

ODA consists of grants or loans that are awarded in the public sector for the promotion of economic development and welfare in recipient countries.

The application of this matrix, corresponding to the objectives of PEARS and to EU Headlines indicators, is given in Table 7. Table does not contain the EU theme "Good Governance" since it is not associated with any Headlines indicator. This matching scheme allows to achieve an integrated assessment of the effectiveness shown by Eurostat indicators in capturing the needs of the objectives of PEARS.

Table 7 –Matrix of the coherence evaluation between the PEARS objectives and the Headlines sustainable indicators

	“Headlines Sustainable Indicators”								
PEARS objectives	**Real GDP per capita, growth rate and totals (€/ab.)**	**Research productivity - (€/kg.)**	**People at risk of poverty or social exclusion – (%)**	**Employment rate of older workers - (%)**	**Healthy life years and life expectancy at birth by sex - (years)**	**Greenhouse gas emission – (CO2 equal.)**	**Energy consumption of transport relative to GDP**	**Biodiversity - (%)**	**Official development assistance as share of gross national income - (%)**
1. Contributing to the sustainable development of the region through the adoption of efficient conversion and use of energy in productive activities, services and residential systems	Δ	Δ	○	Δ	○	X	Δ	Δ	X
2. Promoting a strong policy of energy conservation in all sectors, particularly in the construction sector, organizing the active involvement of organizations, businesses, and citizens	Δ	Δ	○	Δ	○	X	Δ	Δ	X
3. Promoting diversification of energy sources, particularly in the electricity sector, with decentralized production	Δ	Δ	○	○	○	X	○	Δ	Δ
4. Promote the development of renewable energy sources and assimilated in the island of Sicily and in the smaller islands, developing energy technologies for their exploitation	Δ	X	○	○	○	X	X	Δ	○
5. Encouraging the take-off of industrial supply chains, the establishment of manufacturing industries of new energy technologies and the competitive growth	X	X	Δ	Δ	○	X	Δ	○	Δ
6. Fostering the conditions for security of supply and the development of a free market	X	X	○	○	○	Δ	Δ	○	Δ
7. Promoting technological innovation with the introduction of cleaner technologies, energy-intensive industries and sustaining the diffusion in SMEs	X	X	○	X	○	Δ	Δ	○	Δ
○8. Ensuring the use of regional resources of hydrocarbons, encouraging research, production and use in a manner compatible with the environment	X	X	○	Δ	○	Δ	○	○	Δ
9. Faciliting the restructuring of the basic thermoelectric plants, taking into account the coordinated programs at the national level	Δ	Δ	○	○	○	X	○	Δ	○
10. Promoting the implementation of energy infrastructure, with particular emphasis on large networks of electric transportation	Δ	Δ	Δ	○	○	Δ	Δ	○	Δ

Table 8 shows for each Headlines indicator the numerical value of coherence with the objectives of PEARS. This numerical value is computed as the ratio between the numbers of correspondences (direct, indirect or indifferent) of each PEARS indicator with the pertinent UE Headlines indicators. This allows us to infer that the indicators "gross domestic product", "energy consumption of transport relative to GDP" and "official development assistance as a share of income" have a prevalence of indirect coherence with the objectives of PEARS; indicators "people at risk of poverty or social exclusion", "employment rate of older workers" and "birth rate and life expectancy by sex" have an indifferent correspondence; while the only indicator "greenhouse gas emissions" shows a direct coherence. Finally, the indicator "biodiversity" has the same degree of coherences, indirect as well indifferent; moreover, for the indicator “resource productivity” the same degree of direct and indirect coherence with the objectives of PEARS has been found.

This simple comparative scheme allows establishing that the Eurostat indicators do not seem to be particularly effective in intercepting the requirements of the objectives of the Plan, since a low coherence between them and PEARS seems to prevail.

Table 8 – Numerical values of the coherence levels between UE Headlines indicators and the PEARS objectives.

Sustainable Headlines UE indicators	Coherence with the PEARS objectives		
	Direct X	Indirect Δ	Indifference ○
Real GDP per capita, growth rate and totals	4/10	6/10	None
Research productivity	5/10	5/10	None
People at risk of poverty or social exclusion	None	2/10	8/10
Employment rate of older workers	1/10	4/10	5/10
Healthy life years and life expectancy at birth by sex	1/10	4/10	5/10
Greenhouse gas emission	6/10	4/10	None
Energy consumption of transportation relative to GDP	3/10	6/10	None
Biodiversity	None	5/10	5/10
Official development assistance as share of the gross national income	2/10	5/10	3/10

Here below is presented and proposed a scheme of possible indicators, defined at local level for the PEARS

To describe each environmental component, it is defined and related a context indicator.

As an example, in table 9 is synthetize the scheme of monitoring indicators for one of the component, called “climatic factor and energy”. Table is divided into 5 columns that contain:

- the first, the sustainability objectives declined in general and specific indicators;
- the second the Masterplan objectives also declined in specific and general ones;
- in the third the action schedule grouped in category;
- in the fourth the process indicators, that evaluate the fulfilment of the actions;

the fiveth the context indicators;

Table 9 – Example of indicators for the environmental component “ Climatic factor and energy”_ Sicilian Energy Masterplan

EU		PEARS			Sicilian Masterplan indicators							
Sustainability objectives		Masterplan objectives		PEARS SCHEDULES Action to achieve the sustainability objectives	Process indicators				Context indicators			
GENERAL	SPECIFIC	GENERAL	SPECIFIC									
Energy production increasing by renewable energy sources	Energy production increasing by renewable energy sources (eolic and photovoltaic system and biomass)	Increasing the production of electric, heat and biofuel energy production by renewable energy sources	1. Contribute to the sustainable growth of Region’s territory by the application of energy efficiency systems of energy conversion and use in production activities, services and residential systems. 3.Promote the diversification of the energetic sources, particularly in the electric field through the decentralize and “decarbonisation” 4. Promote the advancement of renewable energy sources in Sicily and in the minor Islands; development of energetic technologies. 5. Support the new energy technologic industries and the sustainable growth; 6. Promote the security energy supply to free energy trade; 12. Create the basis to the production and the diffusion of the fuel-cell by hybrid systems, according the Eu policy	R.04 installation of FVT system	N° systems installed and surface occupied	19.862	Stimulating tools supplied (Meuro)	a) Fiscal reduction b) Energy account	Power installed (MW)	865,7	Electrical energy producted (GWh/y)	1835
				R05. Installation of eolic system – short period	N° systems installed and surface occupied	82	Stimulating tools supplied (Meuro)	b) Energy account	Power installed (MW)	1680,9	Electrical energy producted (GWh/y)	6490
				R06. Installation of eolic system – medium period	N° systems installed and surface occupied		Stimulating tools supplied (Meuro)	b) Energy account	Power installed (MW)		Electrical energy producted (GWh/y)	
				R09 installation of mini eolic system	N° systems installed and surface occupied		Stimulating tools supplied (Meuro)	b) Energy account	Power installed (MW)		Electrical energy producted (GWh/y)	
				R10. Using of forestry agricultural biomass systems	N° systems installed and surface occupied		Stimulating tools supplied (Meuro)	b) Energy account	Power installed (MW)		Electrical energy producted (GWh/y)	
				R11. stimulating the production and utilization systems related the cogeneration from livestock remain	N° systems installed and surface occupied	34	Stimulating tools supplied (Meuro)	-	Power installed (MW)	53,9	Electrical energy producted (GWh/y)	246

6. Conclusions

The environmental policy highlights the important role of Public Administration in environmental policy.

The main goal of this work is to verify the applicability of the indicators of the European regulatory framework, the so-called Headlines, to plans operating at the regional levels. Indeed, these indicators are important since they play an essential role in the control of the ongoing progress of the plans.

In doing this, we referred here to the Italian national methodology for the identification of the indicators, as proposed within the ISPRA Convention of 2009. Specifically, the verification process has been applied to the case of the Sicilian Regional Environmental Energy Masterplan (PEARS). In this regard, it has been here conducted a critical analysis of the ISPRA methodology for the evaluation and monitoring of the plans and the system of indicators.

The comparison, developed in two phases, has led to the preliminary identification for each EU topic and subtopic, of the corresponding indicators of sustainable development (Eurostat) to be applicable to PEARS.

In the first phase, to highlight the top-down structure of the process, as proposed by the EU and by ISPRA, it has been undertaken an analysis of the correspondences between the issues referred to the EU Headlines indicators and the issues referring to the ISPRA environmental components. This allowed us to verify that there is some coherence matching for six out ten EU topics.

In the second phase, according to the cited top-down framework, we preceded with the verification of the applicability of the Eurostat indicators to PEARS Masterplan.

This two-phases verification process allowed us to draw some interesting conclusions about the features of Headlines indicators and their applicability for the monitoring of a plan.

First of all, as it was expected, Headlines indicators are not directly characterized with respect to the territory specifications, since they were designed for a general European global level. In other words, despite showing an intrinsic structure that allows some applicability to a local territorial level, actually they do not exhaustively intercept the specificity of these local areas.

Thus, in the meanwhile of a more appropriate specifications of the indicators Eurostat (in order to render them closer to the local situations), it is here suggested that the energy and the environment planning processes of, of a given territorial area should proceed by following a bottom-up approach. This, in fact, will allow to directly single out indicators to be utilized that, in this way, could show a stronger applicability to local plans, so leading to a better governance process of the given territory.

In conclusion, while it is confirmed the full validity of a policy scheme that relies the government of a given land to a suitable grid of indicators (relating to issues defined at European level), it here suggested that these indicators, at least at the present state of their definition, should not merely derived from those proposed at the central European level, since they instead should require a stronger coherence check with the requirements of the local plan. It is fundamental the definition of indicators that characterize various territory at different scale from local to national.

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LIST OF ACRONYMS

APPA = Provincial Agency for Environmental Protection

ARPA = Regional Agency for Environmental Protection

ODA = Official Development Assistance

EC = European Community

DMC = Domestic Material Consumption

DG = DG

EUROSTAT = Statistical Office of the European Union

ISPRA = The Institute for the Protection and Environmental Research

OECD = Organisation for Economic Co-operation and Development

GDP = GDP (Gross Domestic Product) Gross Domestic Product

PEARS = Sicilian Regional Environmental Energy Plan

PO FESR = OP ERDF Operational Programme European Fund for Regional Development

P / P = Plan / Programme

SDS = SSS = (Sustainable Development Strategy) Sustainable Development Strategy

SEA = Strategic Environmental Assessment

EU = European Union

List of figure

List of table

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PART II

CHARACTERIZATION AND ENERGY ANALYSIS OF RESIDENTIAL BUILDING STOCK AT REGIONAL, NATIONAL AND URBAN SCALES

For strong policy making at different territorial level

it is key assuring good data availability and data quality

of the building stock

Summary

Local and central administrations are often called to properly allocate economic resources intended for the territorial energy planning, on the basis of the performances achieved by implementing energy conservation measures. Particularly in the residential sector, that represents one of the most relevant sector for the energy demand, effective and reliable evaluation tools are required for this aim. Unfortunately, building stocks are characterized by a very large number of buildings that are referred to different construction periods and are equipped with a variety of appliances and tools, other than with different heating and cooling systems.

For the residential sector, it is very difficult an analysis due to the huge splitting of the building stock into buildings and single housing units, and to the lack of detailed information about such a wide and inhomogeneous set of samples to be investigated. This means that the whole energy consumption of a large territorial context cannot be obtained by simply summing up the energy requirements of each single dwelling and building. A procedure is therefore needed that, by means of a suitable characterization of the building stock and of the structure of the energy consumption, allows to assess the whole residential energy requirements and the effects induced by energy conservation measures.

To provide a contribution in this direction, in chapter 8, a methodology is proposed for the disaggregation of a given building stock into proper typologies that are representative of the different construction practices characterizing different periods of time. The climatic properties of sites are accounted for in this methodology as well. Furthermore, the whole energy consumption is assessed using different approaches for heating, cooling, lighting and other electric appliances.

In more detail the method aimed to:

a) set up a lay-out model of an overall regional residential estate into a certain number of different building;

b) calculate the energy needs of every single type according to the procedures established by the national and European regulations;

c) evaluate and establish hierarchy on intervention referring to action list on Masterplan

In fact, the method is particularly designed to evaluate the possible energy savings from the implementation of different interventions concerning the envelope and the HVAC systems to the various building types.

This multiple approach relies on statistical data and on the application of well-established calculation tools for the energy demand of buildings. In this way “virtual” sample buildings are defined as representative of the considered building stock.

This method has been applied to the entire building sector of the Sicilian Region that with its 1,717,000 dwelling units constitutes one of the larger and populated regions of Italy. Its reliability has been checked against real data. The found value of the overall energy demand of the residential sector is 1100 ktoe/y, while the actual value coming from official statistics was 1192 ktoe in the year 2011; this signals the fair reliability of the method.

The method shows to be reliable enough and is also characterized by a simple structure easily adoptable by planners and technicians in their attempt to lead regional energy policies toward more sustainable paths.

To testing the applicability of the calculation methodology in other context and at different territorial scale is important understand how to apply the algorithm can be used respecting compliance with the specific regulation.

For this reason in chapter 9 is conducted a wide analysis of the EN 13790 European standard and how it was adopt at national level by Member State.

The EN 13790 European standard document has been prepared under a mandate given to CEN by European Commission and the European Free trade Association, and support essential requirements of EU Directive 2002/91/CE on the energy performance building (EPBD). It forms part of a series of standards aimed at European harmonization of the methodology for the calculation of the energy performance of building.

Three national standards that are the implementation of European standard are taking into account to compare with European standard. The aim is to highlights the variance introduced by different way to describe physical phenomena’s that contribute to building energy balance. To conduct this study, it is chosen the same building a detached house in order to assess the different values produced by the various parameters.

The main structure of calculation procedure is summarized below into six steps.

Step 1 - Choose the type of calculation method.

Step 2 - Define the boundaries of the total of conditioned space and unconditioned space

Step 3 - Define the boundaries of different calculation zone

Step 4 - Define the internal condition for the calculation, the external climate and other environmental input.

Step 5 - Calculate the energy need for heating $Q_{H,nd}$ for each Standard.

Step 6 - Compare the National standard result to European's one.

From the result of this analysis is needed before assuming the scheme as a general one, take into account the variance concerning the national standard because there isn't an homogeneity level results as request by European Energy Performance of Buildings Directive 2002/91/EC (EPBD).

Chapter 2

Classification of large residential building stocks by sample typologies forenergy planning purpose

1. Introduction

Energy planning at national and/or regional scale is more and more devoted to enhancing the role of the residential sector by a sustainability point of view. This sector, in fact, accounts for significant amounts of the whole energy balance of a given territory. In the EU Member States, for example, the existing building stock is responsible for more than 40% of the final energy consumption, 63% of which is aimed at residential buildings (that is 25% of the total) (Constantinos A, Balaras A, Gaglia A G, Georgopoulou E, Mirasgedis S, Sarafidis Y, Lalas D. P., 200). In terms of final energy uses, the share of energy consumption in residential buildings is approximately given by 68% for space heating*, 17% for electric appliances and lighting, 9% for domestic hot water (DHW) production and 6% for cooking (German Federal Statistic Authority, Bauen und Wohnen – Wohnsituation, 2006 ; Enerdata,2003; Energy Efficiency Trends in Buildings in the EU - Lessons from the ODYSSEE MURE project, 2012).n Figure 1 shares of the residential energy consumption in 28 European countries are reported, where the air conditioning purposes are included in the "electricity" item, apart for Bulgaria, Cyprus and Coatia for which separate data were available.

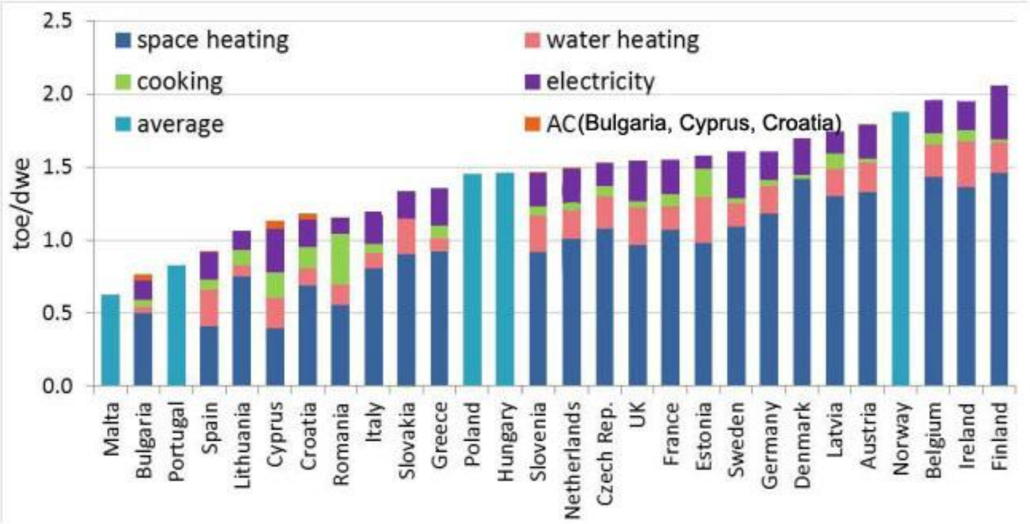


Fig. 1 - Share of the final uses in residential buildings (year 2009) in the E.U..

The importance of this sector for the national economies is also fully justified by the continuous release of new laws and technical standards devoted to the improvement of the buildings energy efficiency (Directive 2002/91/EC of The European Parliament and of The Council of 16 December 2002 on the energy performance of buildings, 2005). Among these standards, the recently released recast directive (Directive 2010/31/EU of The European Parliament and of The Council of 19 May 2010 on the energy performance of buildings, 2010) on the energy performance of buildings pushes Member States to increase the number of the so-called nearly zero energy buildings (NZEB) (Baetens R, De Coninck R, Van Roy J, Verbruggen B, Driesen J, Helsen L, Saelens D., 2012).

This situation calls for the availability for policy makers and technicians of useful tools (McKenna R, Merkel E, Fehrenbach D, Mehne S, Fichtner W., 2013) to evaluate of the effects produced by the implementation of energy efficiency actions on the building envelope and the HVAC system. Clearly, at the scale of the energy policy actions, these analyses cannot be conducted with reference to a single building (Koo C, Park S, Hong T, Park H. S.) but are addressed to a large set of buildings located in a specific territorial contexts. In this sense, a large building stock is here meant as the number of buildings belonging to considered territorial context, on which the policy actions are intended to operate. For example, in the case of a regional energy plan, the “large” stock of buildings is composed by the totality of the buildings belonging to that region. By another point of view, a general knowledge of the energy performance of a given building stock is the fundamental starting point for classifying it within overall quality awarding schemes (Peri G, Rizzo G.,2012; Franzitta V, La Gennusa M, Peri G, Rizzo G, Scaccianoce G.,2011). The Covenant of Mayors (http://www.covenantofmayors.eu/index_en.html,2013), whose implementation scheme requires a methodology for the evaluation of the energy balance of existing buildings, along with the estimation of the energy savings resulting from the application of energy conservation measures (ECMs), can be usefully cited here as a typical example of this need. Another important example confirming the need for a detailed knowledge of a given building stock and of its energy behavior is represented by the preparation process of energy and environmental plans at large territorial scales. These plans require, in fact, a very accurate recognition of the real energy consumption in the different sectors (industry, agriculture, transportation, tertiary, residential) contributing to the overall energy demand of the given territory they refer to.

Unfortunately, the energy consumption of a whole building stock cannot be obtained by simply summing up the consumption of each single building. Two reasons can be posited for this: the generally wide number of the buildings in the stock and the commonly poor knowledge of the energy consumption of these buildings. This implies that regional and country analyses (Zhou Y, Clarke L, Eom J, Kyle P, Patel P, Kim S H, Dirks J, Jensen E, Liu

Y, Rice J, Schmidt L, Seiple T.,2014) can be conducted on a statistical base by defining suitable typical buildings, assumed as representative of homogeneous classes. These classes are usually singled out by taking into account the most important features of buildings that is: typology, thermal and physical characteristics, heating, ventilating and air conditioning plants, energy performances and climatic characteristics of the sites where the buildings belonging to the given class are located. Clearly, the energy consumption of buildings is generally affected by the occupants use's profile that, in fact, can largely vary depending on different behaviours and habits of people. In the present study, we adopted a mean user profile, as resulted from an analysis performed by the Sicilian Region (Energy and Environmental Masterplan of Sicilian Region, 2009).

Another important question is represented by the evaluation of the number and types of appliances present in each building representative of a given class. These tools, generally fed by electric energy, constitute in fact, an important source of energy consumption: in Europe, for example, the appliances-related energy consumption is resulted to be 28.8% (Bertoldi P, Atanasiu B.,2006) of the whole building energy final uses.

Starting from these considerations, a tentative procedure is described in the following, that has been developed and applied to analyse the residential building stock of Sicily that, with approximately 1,710.000 dwelling units and nearly five million inhabitants, constitutes one of the larger and populated regions of Italy. On the other side, the energy consumption of the island (7.51 Mtoe in the year 2012, of which 1.06 Mtoe in the residential sector) further indicates its importance in the whole energy context.

The procedure here introduced, that can represent the basis to analyse future energy scenarios, shows an easy applicability to other regional contexts, provided that the needed data are available.

In the following, after a critical review of the state of the art in the field, a method is introduced for suitably singling out sample buildings representative of given typologies. It relies on five subsequent steps that, starting from the suitable statistical analysis of the building stock and by means of the proper identification of thermal, envelope and equipment characteristics of such buildings, allows the allocation of these building clusters to the climatic zones of the considered territory.

2. Methods for the singling out of building sample typologies

In the scientific literature the issue of singling out suitable representative buildings of a given stock has been widely treated (Corgnati S P, Fabrizio E, Filippi M, Monetti V.,2013; Spiekman M, Westerlaken N.,2009; Attia S, Evrard A, Gratia E.,2012; Panayiotou GP, Kalogirou SA, Florides GA, Maxoulis CN, Papadopoulos AM, Neophytou M, Fokaides P, Georgiou G, Symeou A, Georgakis G.,2010; Theodoridou A, Papadopoulos M, Hegger M.,2011; Shimoda Y, Yamaguchi Y, Okamura T, Taniguchi A, Yamaguchi Y.,2010). Several works, in fact, exist aimed at assessing the energy consumption, emissions and potential energy savings of building stocks. In these studies a method for the classification of building stocks in suitable categories is presented.

For example, Balaras *et al*. and Dascalaki *et al.* (Dascalaki E G ∗, Droutsa K G, Balaras C A, Kontoyiannidis S.,2011; Dascalaki E, Droutsa K, Gaglia AG, Kontoyiannidis S, Balaras C.A.,2010) examined Hellenic residential buildings. The classification of the residential stock was carried out using the construction period (*pre* 1980, 1981-2001 and 2002-2012), type of building (low-rise buildings with one or two floors, high rise buildings with more than two floors) and climatic zone (four zones). As a result, they identified 24 different categories of residential buildings. Specifically, buildings considered are continuously occupied and the study does not include summer (vacation) dwellings. Additional sub-categories were defined with common characteristics including: the level of building envelope thermal insulation, type and age of space heating installations, central space heating control systems, air conditioning equipment, solar collectors for sanitary hot water production, and type of lighting. The methodology adopted to establish these categories of residential buildings assigns to each of them a real existing building considered to be representative of all buildings in the given class.

Furthermore, a wider analysis on the energy consumption of 193 residential buildings stocks involving five European countries has been conducted in Balaras *et al. (*Balaras CA, Droutsa K, Dascalaki E, Kontoyiannidis S.,2005*)*. Tommerup and Svendsen (Tommerup H, Svendsen S.,2006) examined Danish residential building stock. They referred to two typical buildings: single family house and a multi-family building. Theodoridou *et al*. (Theodoridou I, Papadopoulosb AM., Heggera M. A,2011) examined Greek residential buildings stock. The classification proposed is based on only the construction period, unlike Balaras *et al* and Dascalaki *et al.* specifically, they identified five classes, that are: class A (1919-1945), class B (1946-1980), class C (1981-1990), class D (1991-2010) and class E (2010 -2011). Such a choice relies on the consideration that the building age provides further information about the buildings typologies, the building materials, plants and appliances used and the construction practice applied. Researchers actually followed similar characterization schemes adopted in countries like Germany and Switzerland (Hassler U.,2009).

Uihlein and Eder (Uihlein A and Eder P.,2010; Uihlein A , Eder P.,2010) examined European (EU27) residential building stocks proposing for each of the countries a model representing the development of the relative building stocks. In more detail, three different building types have been identified, that is: Single-family, Multi-family, and High-rise. These classes have been further divided in historical and new buildings types from 1900 up to 2060 (Nemry F, Uihlein A, Makishi Colodel C, Wittstock B, Braune A, Wetzel C, Hasan I, Niemeier S, Frech Y, Kreißig J and Gallon N, 2008).

Fracastoro and Serraino (Fracastoro GV, Serraino MA.,2011) examined the energy performance of the residential building stocks of two large Italian regions, Piedmont and Lombardy. The survey was carried out on the basis of the data collected by the Italian census, so that 72 different building geometries were considered, along with 4 different construction age categories, 11 heating system efficiencies and a variable number of degree-days (DD) categories with a chosen step of 100 DD. As far as climatic zones the method aims at defining a performance scale for building energy certification and supporting the definition of mandatory measures and incentives for building energy retrofits.

TABULA (www.building-typology.eu/tabula.html, 2013), a project, supported by the Intelligent Energy Europe (IEE) program, collects experiences with building typologies in 13 European countries. It is aimed to pursuit a harmonized structure to create building national typologies able to facilitate cross country comparison of building stocks. In other words, TABULA refers to a typology approach for building stock energy assessment.

As a result of this European study, 13 national building typologies have been generated, each representative of the corresponding residential building stock. Each national typology is, in turn, divided in two sub-typologies: “building types” and “system types”.

With reference to the Italian building typology, data used in the “building types” section have been provided by ISTAT (National Statistic Institute) and ENEA (Agency for New Technologies, Energy and the Environment), particularly those referred to size, construction typology, system typology and energy consumption.

“Building types" have been classified, basically based on size, construction period and climatic zone. As far climatic zone, three climatic zone have been identified representative of the six Italian climatic zones. As regards the construction period, eight classes have been identified ranking from 1900 up to after 2005. As far size, four general building sizes in the national residential building stock have been proposed, that is: single family house, terraced house, multi-family house and apartments block.

These data have been organized in a matrix whose columns represent the construction period while rows represent size. A generic cell of the classification grid represents an “example building” (Corrado V, Ballarini I, Corgnati SP, Tatà N, 2011) that is the one most representative of a specific size and construction period in a given climatic context. Further specification of each building type is provided based on supply system types, heating system and DHW system.

Other researchers have also approached this issue, either to assess a methodology for the energy performance classification of buildings stocks at an urban scale (Dall’O’ G, Galante A, Torri M.,2012), to report field data concerning sample buildings for a given stock of buildings (Caldera M, Corgnati SP, Filippi M.,2008; Arumägi E, Kalamees T., 2014), to refer to a proper modelling of the final energy consumption in residential buildings (Swan LG, Ugursal VI. ,2009) or to pay attention particularly to the ECMs measures to be implemented in a group of buildings (Ballarini I, Corrado V.,2009; Hachem C, Athienitis A, Fazio P., 2014). The building stock has been also approached as a research object (Kohler N, Hassler U., 2002), or with a special attention to its long-term management (Kohler N, Yang W., 2007).

Anyway, the problem of the availability of proper data needed to build up a representative construction still remains, particularly when the behaviour of people living inside buildings remarkably affects the final energy consumption.

To overcome these problems, a tentative procedure is here introduced that refers to census data, in order to assess the envelope and plant characteristics. For each period characterized by given construction techniques and use of typical materials, representative building typology data are obtained. On the other hand, the number and types of appliances present in buildings are further indirectly estimated, starting from the Italian national data that are scaled on the basis of the mean income of the zone where the building is located.

This procedure that differently approaches the building envelope and the appliances, singles out a “virtual” building by each representative class, and is seemingly different from those available in literature. In more detail, by means of this procedure the obtained “virtual” building, along with its appliances, is assumed as the sample for the energy consumption of all buildings belonging to the relative class.

3. A new method for singling out buildings representative of large stocks

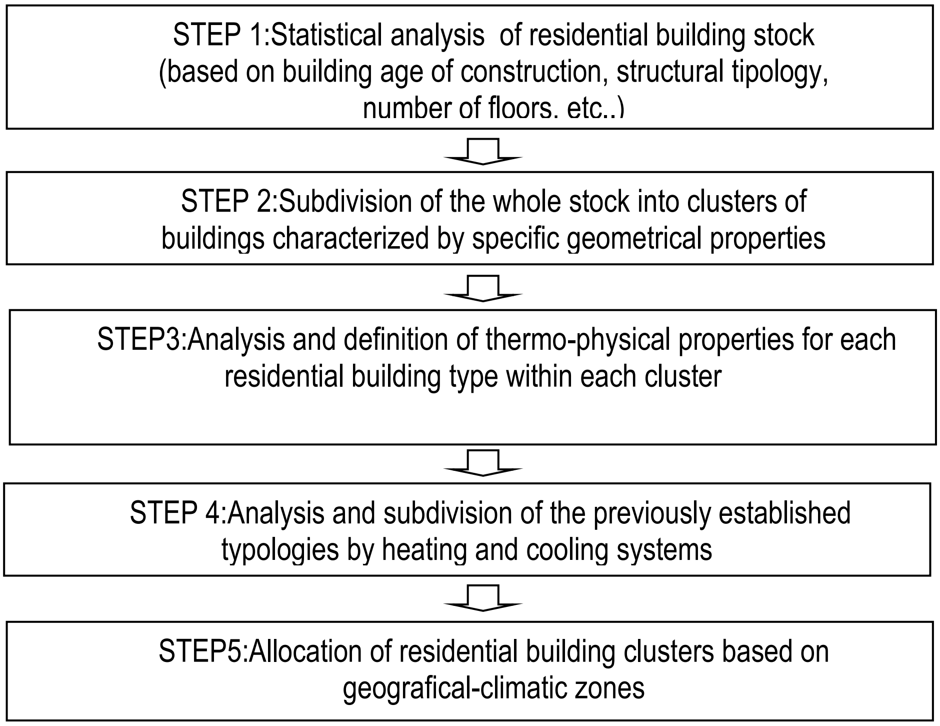
Generally, methodologies for singling out building typologies requires the definition of sample buildings characterized by their geometrical and thermo-physical features (Kragh J, Wittchen K.B., 2014; Ballarini I, Corgnati SP, Corrado V., 2012).

This is due to the fact that, to accurately analyze the energy demand of the residential sector and of the achievable energy savings by means of ECMs interventions, the mere determination of the overall number and volume of a whole building stock is not sufficient. In fact, final energy uses in the residential sector are generally referable to several purposes, such as space heating, space cooling, indoor lighting, domestic hot water production, cooking and electric appliances. Some of these uses, especially winter heating and summer cooling, that represent the most relevant part of the buildings energy demand, depend on complex factors such as:

- the geometrical and thermo-physical characteristics of the building;
- the heating and cooling system type;
- the climatic zone of the building.

In Italy such data are collected with a decade-long cadence through the General Survey of Population and Housing by the National Institute of Statistics (ISTAT). Here these data constitute a relevant part of the proposed methodology.

The procedure here introduced, that properly accounts for all these features, consists of five main steps, as illustrated in figure 2.



STEP 1:Statistical analysis of residential building stock (based on building age of construction, structural tipology, number of floors. etc..)

STEP 2:Subdivision of the whole stock into clusters of buildings characterized by specific geometrical properties

STEP3:Analysis and definition of thermo-physical properties for each residential building type within each cluster

STEP 4:Analysis and subdivision of the previously established typologies by heating and cooling systems

STEP5:Allocation of residential building clusters based on geografical-climatic zones

Fig. 2 - Description of the steps which the procedure relies on.

Step 1 refers to the statistical analysis of the considered building stock, by means of which important data of the envelopes can be derived. This step is essentially conceived with the subdivision of the whole stock into suitable construction periods, since different construction and typology features are likely to be identified over the years.

Step 2 concerns the subdivision of the whole stock into clusters of buildings characterized by specific geometrical properties, in this way obtaining a group of typologies that represent the entire building park.

Step 3 refers to the definition of thermo-physical properties of the selected typologies, mainly based on the different construction periods.

Step 4 concerns the subdivision of the considered building stock into the previously established typologies based on heating and cooling systems. In this step, the percentage of presence of appliances is attributed to each class, also on the basis of considerations regarding the mean income of the population of the considered area.

Step 5 allows the proper allocation of the previously obtained building classes by climatic zones, characterized by the degree days number.

3.1 Step 1: construction period of the building stock

This step is aimed at the classification of the whole building stock on the root of the construction period of buildings, since this time-based classification corresponds to different typology and structural features. For Sicily, this is particularly important because, like in many other Mediterranean sites, the building park still utilized presents a relevant mean age.

The information needed in this step can only be obtained by means of statistical databases that are developed and up-to-dated by means of recurrent census inquiries. Particularly, the Italian Institution for Statistical Analysis, ISTAT, classifies each building according to important features (http://www.istat.it/it/archivio/3758, 2013) such as number of building floors, number of dwellings in the building, neighbouring with other buildings, by each considered period of construction. Table 1 synthetically reports the main relevant data for the Sicilian Region to which the method is here applied.

- **Table 1 Number of residential dwellings in Sicily by construction period**

Construction period	Number of dwellings
Until 1919	122,654
From 1919 to 1945	189,203
From 1946 to 1961	262,601
From 1962 to 1971	387,782
From 1972 to 1981	383,341
From 1982 to 1991	261,407
After 1991	110,011
Total	1,717,000

3.2 Geometrical properties

Other important buildings characteristics are the shape (Peri G, Foresta F, Inzerillo L, Rizzo G.,2013; Wan KSY, Yik FWH., 2004) and the neighbouring with surrounding buildings: this factor, in fact, deeply affects the energy balance of buildings and dwellings.

Figure 3 reports the schematic illustration of the typologies by means of which the whole Sicilian building stock is represented.

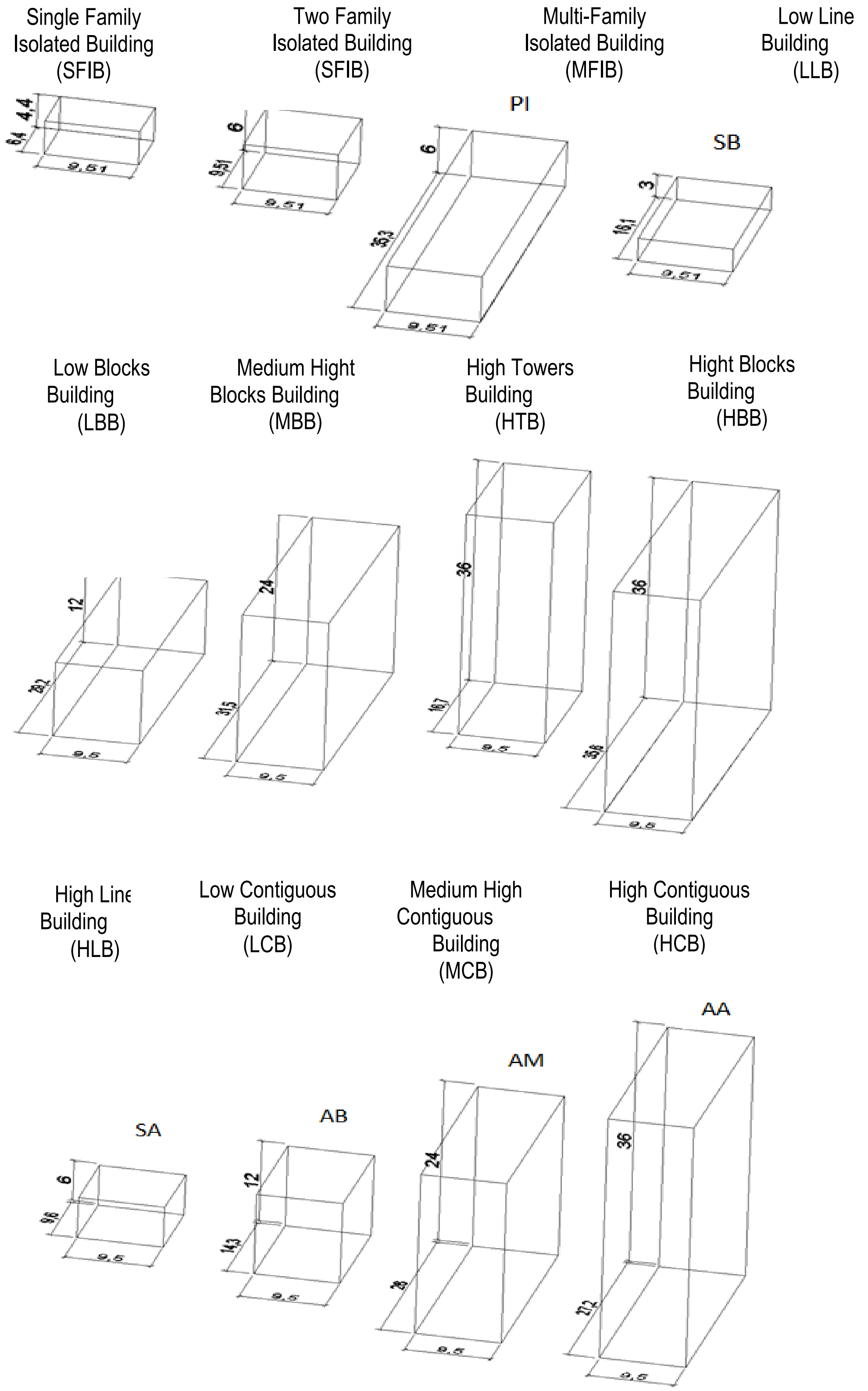


Fig. 3 - Schematic representation of the main typologies constituting the Sicilian regional building stock

Likewise, statistical data obtained by means of the census are conveniently used here.

The situation referred to Sicily for isolated (2a) and contiguous (2b) buildings (Filogamo L, Peri G, , Giaccone A, Rizzo G., 2013) is described in table 2.

Table 2a - Main features of typologies referring to isolated buildings, with the indications of the proper code

Floors	**Number of dwellings**				
	1	**2**	**3 - 15**	**16 - 30**	**>30**
1	(SFIB)	(TFIB)	(MFIB)		
2					
3-5	/		(LBB)		
6-10	/	/	(MBB)		
>10	/	/	/	(HTB)	(HBB)

Table 2b - Main features of typologies referring to contiguous buildings, with the indications of the proper code

Floors	**Number of dwellings**						
	1	**2**	**3 - 4**	**5 - 8**	**9 - 15**	**16 - 30**	**>30**
1	(LLB)						
2	(HLA)						
3-5	/		(LCB)				
6-10	/			(MCB)			
>10	/				(HCB)		

The information reported in table 2, along with the number of dwellings belonging to each building constitute the starting point to build up the above cited sample “virtual” buildings representative of the whole stock.

The percentage distribution in Sicily of twelve identified geometrical typologies is illustrated in Figure 4.

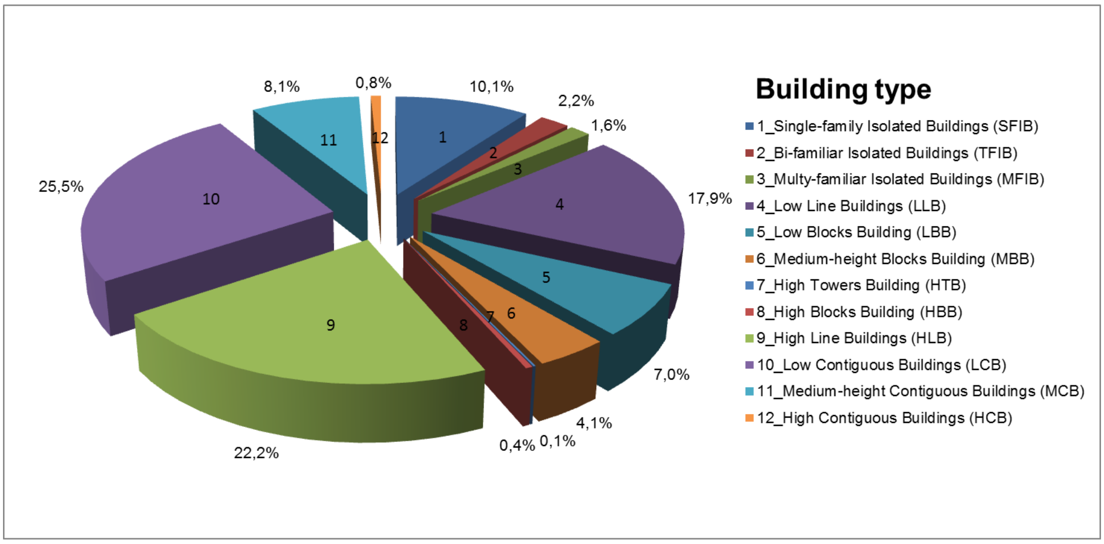


Fig.4 -. Percentage number of dwellings for each building type in the Sicily stock

For each geometrical typology indicated in figure 4, the average number of floors and dwellings and the peculiar dimensions (width, depth and height) of the sample building have been defined. The value of the so-called “shape ratio” S/V (m^{-1}), that is the ratio between the external building surface S and the heated volume V that this surface envelopes, has been indicated as well. This shape ratio is an important thermal characteristic of buildings, since it denotes the compactness of the construction and, in turn, its tendency to lose the internal heat.

To do this, a building has been assumed to be a parallelepiped resulting from the aggregation of a certain number of dwelling units, each of them having a square plan equal to 90.48 m^2, that is the average plan area of a dwelling unit as noted by the ISTAT survey [6], and a typical floor height of 3 m, leading to a dwelling volume of 271.44 m^3.

Moreover, since each dwelling unit is composed, on the average, by 4 rooms plus 1 bathroom, a typical area of the window surface can be defined as equal to 8.82 m^2 per dwelling, according to the Italian standard for the light in residential buildings. On the basis of this simplifying scheme, the overall glazing area S_g, the external wall area S_w and the roof area S_r of each building type have been calculated. In Table 3 average geometrical properties of each introduced building typology are shown.

Table 3 - Mean geometrical properties of selected building types

Building type	SFIB	TFIB	MFIB	LLB	LBB	MBB	HTB	HBB	HLB	LCB	MCB	HCB
Floors	1	2	2	1	4	8	12	12	2	4	8	12
Dwellings	1	2	7	2	12	26	21	45	2	6	22	34
S (m^2)	263.7	409.1	1,212.0	461.2	1,487.3	2,572.1	2,211.5	3,930.7	299	616.2	1,746.2	2.483
V (m^3)	271.3	542.6	2,019.5	460.9	3,340.1	7,204.9	5,742.9	12,209	549.9	1,634.7	5,946.9	9,339.6
S/V 1/(m)	0.9	0.7	0.6	1	0.4	0.3	0.3	0.3	0.5	0.3	0.2	0.2
***Sw (m^2)**	132.5	210.6	473.1	139	822.1	1,737.4	1,705.8	2,855.5	97.7	290.6	1,057.3	1,660.5
****Sg (m^2)**	8.8	17.6	65.6	14.9	108.5	234.2	186.6	396.9	17.8	53.1	193.3	303.6
*****Sr (m^2)**	61.1	90.4	336.5	153.6	278.3	300.2	159.5	339.1	91.6	136.2	247.7	259.4

* Sw is wall surface; **Sg is glazed surface; ***Sr is roof surface

3.3 Thermo-physical properties

According to the Italian census investigation the structure (either masonry walls or reinforced concrete walls) is another significant criterion to rank buildings. In the present study mean thermo-physical characteristics of the sample buildings have been identified by their construction age. In more detail, based on the building design practices typically adopted in Sicily, thermal transmittance values for opaque and glazed surfaces have been hypothesized here. Specifically, it has been assumed that masonry frame walls have a density of 1,900 kg/m^3, a thermal conductivity of 1.15 W/m K and a thickness varying with the building height; while concrete frame walls in buildings constructed prior to 1971 are made by natural stone with a density of 1,500 kg/m^3 and a thickness of 0.25 m; concrete frame walls in buildings built up after 1971 are made by light concrete blocks with a thickness of 0.25 m. As far roofs, a thermal transmittance of 0.5 W/m^2 K has been assumed for buildings previous to 1945 in small towns with less than 20.000 people (this circumstance is caused by presence, in such situations, of unheated attics located directly under the tilted roof), alternatively a transmittance of 1.7 W/m^2 K has been considered. As far ground floors, a thermal transmittance of 0.65 W/m^2 K has been considered in case of continuity with unheated basement spaces or when floors have been built upon a rock and gravel bed.

As regards glazed surfaces (Asdrubali F, Baldinelli G., 2009), it has been considered that if the building was built up after 1981 there are double glazed windows with a thermal transmittance of 3 W/m^2 K, whereas if the building dates back prior to 1981 then there are single glazed windows that are characterized by a thermal transmittance of 5 W/m^2 K; the presence of shutters contributes to decrease the overall mean thermal day-night transmittances at 2.5 W/m^2 K for double glazed windows and at 4 W/m^2 K for single glazed windows.

Figure 5 reports on a time line the mean properties of the most relevant components of the building envelopes in Sicily.

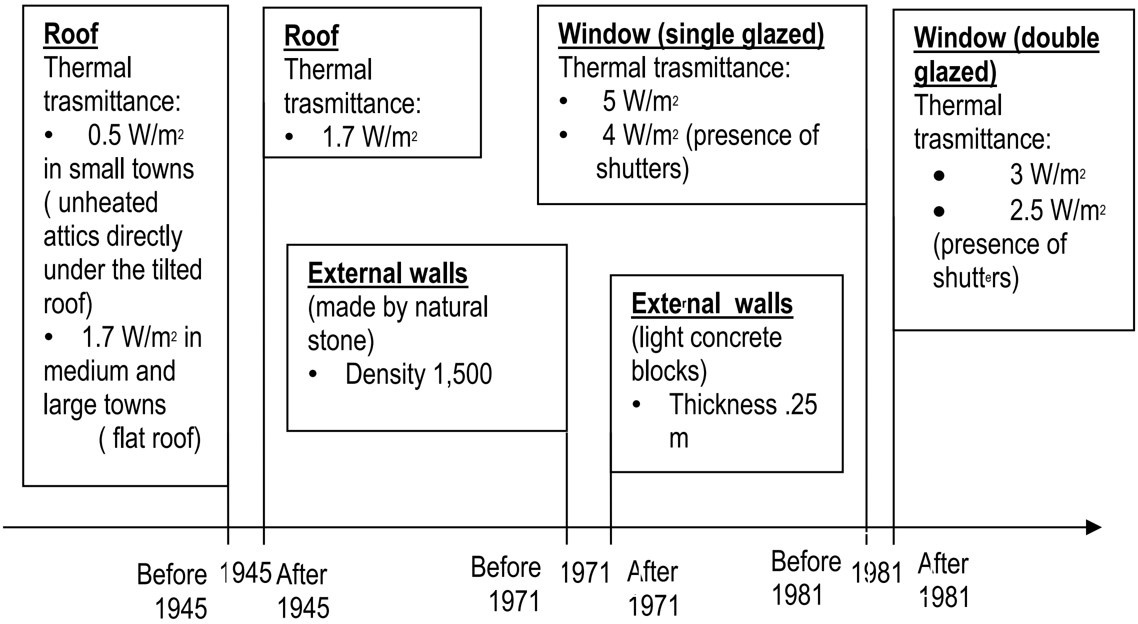


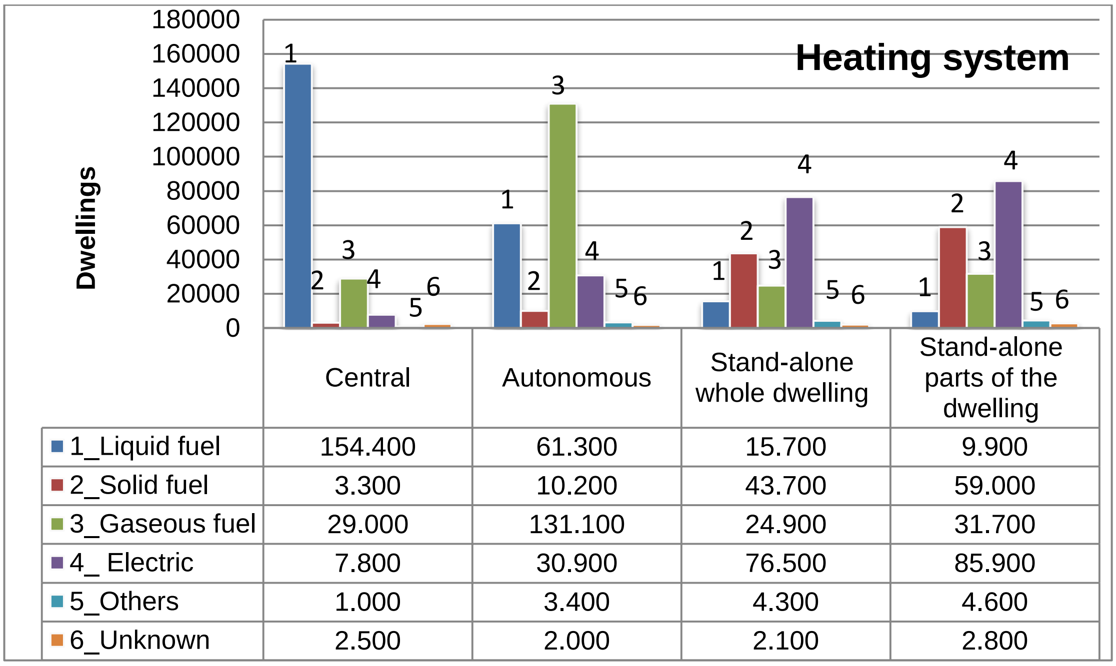
Fig. 5 - Temporal visualization of mean thermal properties of building envelope components in Sicily

Some considerations about figure 5 must be reported. In fact, the thermal properties of the building components, although certainly depending on the date of construction of the building, could be subjected to changes with time, due to retrofit interventions. Particularly, glazed surfaces are often modified by owners, as new more efficient technologies are available, in this way improving the thermal performances of the windows. For properly taking into account this dynamic trend of the thermal properties of the building envelope, in the energy plans an assigned percentage of changes is usually assumed: in the case of the Regional Energy

Masterplan of Sicily, this percentage for glazed surfaces was 30%. As that, in the present study, the thermal transmittance of the 30% of windows replaced by owners was considered to be the half of the original value.

3. 4 Heating system and appliances

The Italian census differentiates the building heating systems based on the energy source (solid, liquid or gaseous fuel and electric energy) and the heat supply mode (central system, autonomous dwelling systems and individual stand-alone heaters). In Figure 6 the distribution of dwelling units in Sicily, according to energy source and heat supply mode, is shown. It has to be noted that approximately 53% of dwellings do not have a proper heating system.



	Central	Autonomous	Stand-alone whole dwelling	Stand-alone parts of the dwelling
■ 1_Liquid fuel	154.400	61.300	15.700	9.900
■ 2_Solid fuel	3.300	10.200	43.700	59.000
■ 3_Gaseous fuel	29.000	131.100	24.900	31.700
■ 4_ Electric	7.800	30.900	76.500	85.900
■ 5_Others	1.000	3.400	4.300	4.600
■ 6_Unknown	2.500	2.000	2.100	2.800

Fig 6 – Number of dwellings by energy source and heat supply mode

National regulations for heating calculations divide the heating installations into two main categories, that is: combustion systems and heat pump systems. According to these indications, survey data were rearranged, as shown in Figure 7, introducing nine different heating system types.

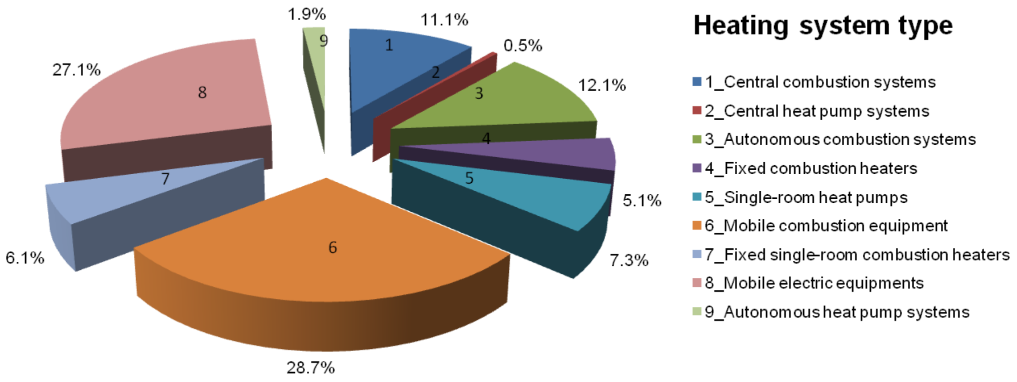


Fig. 7 - Percentage of dwellings by heating system type

Dwelling units for which no heating system has been declared in the survey, have been assumed here to be heated through mobile electric ~~(~~heaters~~)~~ as well.

Another important part of the method refers to the number and types of appliances that are present in the real building and that must be attributed to the virtual ones here singled out (Bartusch C, Odlare M, Wallin F, Wester L., 2012). The approach adopted here is based on using the percentage of presence of each appliance in dwellings, as reported by the national census for the average Italian situation. This percentage has been scaled at the Sicilian regional level using the ratio between the national mean income and the Sicilian ones. In fact, the relationship between the presence of appliances in buildings and the social economic level of people is a well-known issue (IEA, 2008. Final Report of Annex of the International Energy Agency's Energy Conservation in Buildings and Community System Programme, 2008); in 2012 for example, in Italy the lower mean income induced by the recent world economic crisis resulted in a diminution of 5.8% of appliance's buying (Italian National Institute for Statistics, 2013). The average electric energy consumption of each appliance has been also attributed on the basis of the mean efficiency of tools present in the market at the date.

Table 4 - General framework of the Sicilian situation concerning the presence of appliances in dwellings with the relative yearly energy consumption.

	Diffusion		Demand per user (kWh/y)	Overall demand	
	%	Users		MWh/y	%
Refrigerator	100%	1,777,654			
- without freezer	30%	533,296	321	171,188	3.2%
- with freezer	70%	1,244,358	572	711,773	13.2%
freezer	30%	533,296	464	247,449	4.6%
REFRIGERATION				**1,130,410**	**21%**
Cloth washing	97.3%	1,729,657	358	619,217	11.5%
Dish washing	14.6%	259,537	361	93,693	1.7%
WASHING				**712,910**	**13.2%**
LIGHTING	100%	1,777,654	434	**771,502**	**14.3%**
Tv set	136.6%	2,482,275	219	531,792	9.9%
Video recorder	57.2%	1,016,818	95	96,598	1.8%
Hi-fi set	46.8%	831,942	95	79,034	1.5%
Computer	31.9%	567,072	91	51,604	1%
ELECTRONIC APPLIANCES				**759.028**	**14.1%**
Electric boiler (primary)	38.0%	675,509	1,171	791,020	14.7%
Electric boiler (secondary)	10%	177,765	293	52,085	1%
ELECTRIC BOILERS				**843,106**	**15.7%**
IRONING	90%	1,599,889	150	**239,983**	**4.5%**
Electric cooker	50%	888,827	100	88,883	1.7%
Micro-wave oven	20%	355,531	110	39,108	0.7%
COOKING				**127,991**	**2.4%**
Split systems **AIR CONDITIONING**	36.6%	650,621	230	**149,643**	**2,8%**
Electric stoves (primary)	5%	88,883	5,000	444,414	8.3%
Electric stoves (secondary)	28.8%	511,964	120	61,436	1.1%
SPACE HEATING				**505,849**	**9.4%**
OTHER	100%	1,777,654	80	**142,212**	**2.6%**
TOTAL				**5,382,635**	**100%**
		462.90		**Ktoe**	

3.5 Geographical localization of buildings

All of the sample buildings must be properly located in the island's territory on the basis of their percentage of presence in each climatic zone. Sicilian territory is divided in four climatic zones established by the Italian regulation, characterized by degree-days values. Here below is reported in Figure 8 the subdivision of the Sicilian territory in climatic zone characterize by the degree days number.

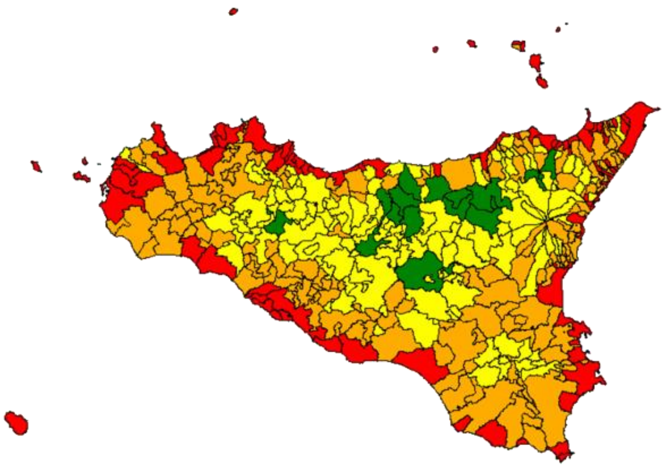


Figure 8 - Subdivision of the Sicilian territory in climatic zones characterized by the degree days number.

For each climatic zone the weighted average value of degree-days is also shown in Table 5, while in Table 6 are reported average values of temperature and solar radiation used in calculations.

Table.5 - Average outdoor temperatures [°C] for each climatic zone

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Zones A-B	11.0	11.4	13.0	15.4	18.9	23.0	25.9	25.9	23.8	19.8	16.0	12.6
Zone C	9.8	10.4	12.4	15.3	19.7	24.8	27.8	27.6	24.4	19.6	15.5	11.3
Zone D	6.8	7.4	9.5	12.7	16.9	22.1	25.3	24.8	21.7	16.9	12.4	8.5
Zone E-F	4.1	4.7	6.7	10.3	14.5	20.2	23.5	22.8	19.5	14.1	9.4	6.0

Table. 6 - Average daily solar radiations [MJ/m2]

Orientation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horizontal	8.2	11.4	15.9	20.9	25.3	27.9	27.9	25.3	19.7	13.7	9.6	7.3
Vertical W-E	6.2	8.3	11.1	13.8	16.2	17.5	17.7	16.6	13.6	10.0	7.3	5.6
Vertical N	2.5	3.3	4.3	5.9	8.5	10.3	9.5	6.8	4.6	3.6	2.7	2.2
Vertical S	11.7	12.7	12.5	10.8	9.3	8.5	9.0	11.1	13.4	14.2	13.6	10.8

Synthetically, dwellings units belonging to each climatic zone are subdivided as follows:

- one half (50%) of dwellings are included in the B zone (600<DD≤900)
- the 33% of dwellings belongs to the C zone (900<DD≤1,400)
- and the 14% of dwellings belongs to the D zone (1,400<DD≤2,100)
- while less than 2% of dwellings is included in the E zone (2,100<DD≤3,000).

In other words, 97% of dwellings is included in the B, C and D climatic zones, approximately 2% is located in the E zone, while less than 1% is included in zones A (DD≤600) and F (DD>3,000).

The method presented here uses a weighted mean value of degree days number to compute the energy consumption of the sample dwellings; the weighting factor is given by the number of dwellings belonging to each climatic zone. Table 7 reports pertinent data.

Table 7- Percentage of dwellings for each climatic zone

Climatic zone	B	C	D	E
Average degree-days	766	1,150	1,649	2,250
Dwelling units (%)	51	33	14	2

4. Discussion

From the above described approach to build-up sample typologies representing a given building stock, it’s evident that the method relies on the evaluation of three main categories of energy consumption (Olofsson T, Mahlia TMI, 2012; Kilpatrick RAR, Banfill PFG, Jenkins DP., 2011), that is: 1) heating, 2) cooling, lighting and electric appliances, 3) DHW and cooking. This subdivision has arisen from the circumstance that clusters of buildings rather than single buildings must be here evaluated to assess their energy consumptions.

The winter energy demand and consumption of these sample buildings can be suitably assessed by means of well-established calculating methods; this kind of energy requirements, in fact, are governed by a well-known behaviour of people and, more important, by a simpler physical behaviour of the buildings that, with less simplifications, can be assumed as a steady-state one.

On the other hand, the electric energy consumption for lighting and appliances strongly depends on the behaviour of people living inside buildings: as that, these energy requirements mainly apply to statistical ambits. Moreover, when groups of buildings are in context, the summer cooling energy requirements particularly refer to a mean behaviour of people using the air-conditioning system: this makes less predictable these three components of the energy consumption, leading their calculation to a statistically based framework. This complexity, due to the high number of buildings belonging to a given stock, has to be added to the usual considerations concerning the summer building consumption behaviour (particularly depending on the role played by the sun entering dwellings) and to the frequency with which openings are operated by occupants. For these reasons, electric appliances, lighting and cooling energy consumption (Aydinalp M, Ugersal VI, Fung AS., 2002 is here treated on the basis of statistical considerations and data. Moreover, as mentioned earlier, due to the fact that the energy requirements of a large number of buildings are to be investigated here, the statistical percentage of appliances to be attributed to sample buildings has been also corrected on the basis of the ratio between the mean income of people living in the considered area and the national mean income of the pertinent country. This last issue, in fact, is considered as an important driving factor for the buildings occupants habits.

Finally, the energy consumption for cooking and DHW purposes has been here treated starting from statistical data, generally available, that indicate the mean consumption for these purposes by inhabitant of the considered territorial area.

The structure of the method introduced here, is synthetically reported in table 6.

Based on the previous criteria, the energy consumption for heating is approached here by means of procedures suggested by national and European regulations for residential heating demand calculations. Specifically, we referred to the widely accepted method of the “utilization factors” (Energy performance of buildings -- Calculation of energy use for space heating and cooling ISO 13790:2008, International Standard Organization, 2008). The assigned geometrical and thermo-physical properties and heating system, referring to each building type, have also been taken into account with reference to the pertinent climatic zones.

According to this method, the heating energy demand Q is calculated as:

$$Q_{H,nd} = (Q_{H,ht} - \eta_{H;gn} \cdot Q_{H,gn}) \quad (1)$$

where $Q_{H,ht}$ is the thermal losses for transmission and ventilation (W), $Q_{H,nd}$ is the thermal gains due to solar and internal (W) contributions and $\eta_{H;gn}$ is the “utilization factor” of these thermal gains (dimensionless) that depends on the thermal inertia of the building.

Table 8 - Assessment methods for approaching the components of the residential energy consumption

	Component of the energy demand		
	Heating	**Cooling, lighting and appliances**	**Cooking and domestic hot water**
Assessment method	Application of winter calculation methods (ISO 13790)	Mean percentage per dwellings, corrected on the base of the income level of the population of the site	Average consumption for inh./y

The resulting heat demands have been summed up to find the overall heating demand of the whole regional building stock, which is shown in Table 9, where they are subdivided into different heating system type and climatic zones. As it is reported in Table 9, combustion and electric heat pump systems are contemplated for winter heating.

The calculation of the energy demand for cooling does require a more accurate analysis, since unsteady state phenomena are in this case involved, mainly due to the important role played by the solar radiation hitting and entering the building envelope.

Table. 9 - Primary energy demand for winter heating [ktoe]

Climatic zone	Combustion systems	Electric heat pump systems	Total
A-B	213	91	304
C	147	92	239
D	120	68	188
E-F	23	13	36
Total	503	264	767

The heating energy consumption, separately computed by each climatic zone, has been summed up in order of reconstructing the overall heating demand of the regional building stock. In the calculation for winter heating, combustion and electric heat pump systems have been accounted for, according to the actual share with which they are employed in the region.

In table 7, for each building typology, the total energy consumption for heating purposes (also subdivided for fuel and electric systems) is reported, for the climatic zones characterized by a number of heating degree days up to 900, where about one half of the regional residential buildings are located.

Table 10 - Yearly energy consumption for heating purposes of buildings located in the climatic zones A and B.

Buildings typology	Typology plant		
	Fluel systems (ktoe)	Electric systems (ktoe)	Total (ktoe)
SFIB	2.23E+01	1.27E+01	3.50E+01
TFIB	6.11E+00	2.16E+00	8.27E+00
MFIB	4.39E+00	1.84E+00	6.24E+00
LLB	3.10E+01	2.42E+01	5.52E+01
LBB	2.29E+01	5.07E+00	2.80E+01
MBB	2.12E+01	3.03E+00	2.43E+01
HTB	1.28E+00	6.14E-02	1.34E+00
HBB	2.85E+00	2.33E-01	3.08E+00
HLB	2.64E+01	1.63E+01	4.28E+01
LCB	4.01E+01	1.83E+01	5.84E+01
MCB	3.01E+01	6.58E+00	3.67E+01
HCB	4.37E+00	3.82E-01	4.75E+00

The calculation of the energy demand for cooling does require a more accurate analysis, since unsteady state phenomena are in this case involved, mainly due to the important role played by the solar radiation hitting and entering the building envelope. As that, we decided not to apply a classical calculation method for the energy demand of cooling system, but instead to apply the same approach used for deriving the energy requirement for appliances. Table 4, reports the values of energy need for electric air conditioning, that is 149643 MWh/y (12.87 toe/y), computed by means of the percentage of presence of such kind of equipment in Sicilian buildings, by also taking into account the effect of the different income of the Region with respect to the Italian ones (to which statistical data refer).

For cooking thermal uses, mean regional estimations indicating an average consumption per inhabitant of 0.0059 toe/y, have been applied. Likewise, for domestic hot water (DHW) uses mean estimations suggesting a need of 0.013 toe/y/inh. (Energy Report 2012 – Sicilian Energy data, 2012), have been utilized.

The final values obtained by means of this procedure show in Sicily a yearly energy consumption of 1,100 ktoe, constituted of 638 ktoe thermal and 462 ktoe electric. The share of the consumption by thermal and electric source is given in Table 8.

Table 11 - Yearly energy consumption of the residential sector in Sicily computed by means of virtual sample buildings

	Thermal (ktoe)	Electric (ktoe)
Heating	*503*	*43*
Cooling, lighting and appliances	0	*419*
Cooking	42	
DHW	93	
Total	**638**	**462**

Clearly, the validity of such procedure must be checked by matching real data of energy consumption of the considered stock with those calculated using the sample buildings typologies introduced here.

While the overall value obtained with the present procedure for the residential sector of Sicily is 1,100 ktoe/y, the official value provided by the statistical service of the Sicilian Region indicates an yearly whole consumption of 1,192 ktoe/y . These actual data are yearly detected by the electric energy and natural gas distributors operating in the island (Energy Report 2012 – Sicilian Energy data, 2012),. As it is possible to note, the difference between the estimated values and the real ones is of -7.77%.

The comparison against official consumption data shows also that almost the same percentage of difference with the estimated data is obtained for the thermal (-8.37%) and electric (-6.92%) components of the whole residential energy consumption (Table 9). This comparison is made for the year 2011, that is well representative of the yearly moderate increasing trends of energy consumption in Sicily. In fact, the increase in the consumption over twelve years (2012 compared to 2000) is about 11.00%.

Such relatively low values, candidate the method as a reliable one for the assessment of the energy requirements of a given building stock, despite the assumptions and simplifications assumed. Moreover, it is interesting to note that in Italy, the methods aimed at the calculation of the energy consumption of single buildings are recognized as valid by the current law (National guidelines to buildings' energy certification. Italian Republic official directory, 2009) when the difference between values provided by means of their applications is less than 5% with respect to the values provided by the pertinent national regulations.

By considering this specification referred to single buildings, the difference of approximately 8% obtained here for large group of buildings can be assumed as reasonable.

Table 12 - Comparison between actual (year 2011) and calculated values of residential energy consumption in Sicily

	Thermal (ktoe)	Electric (ktoe)	Total (ktoe)
Real data	696,304	496,337	1,193
Present method	638,000	462,000	1,100
Percentage difference %	-8.37	-6.92	-7.77

The procedure describe in this chapter, based on a suitable disaggregation of the whole regional building stock, can be also assumed as the starting point for possible scenarios concerning the future energy uses in a given regional territory.

Such a detailed analysis is now allowing to calculate the effects of different saving actions on the final energy demand of the building stock.

Staring from the proposed disaggregation, in fact, thermo-physical properties can be usefully modified in order to take into account the effects of thermal insulation on the vertical walls of the building envelope or other parts of it, for example those oriented to the north, for all the building stock or only some specific building types in some specific climatic zones.

In the same way, the replacement of single glazed windows with double glazed windows or actions on the heating system can be easily analysed. As that, new results for the heating demand can be calculated for each possible saving action and each action matched with the others in order to found out the most promising ones, in this way proposing a sort of regional energy scenario for the given region.

The method resulted in some relevant indicators for Sicily, like, for example:

- an energy demand reduction of about 20% is attainable by a proper thermal insulation of roofs;
- an energy demand reduction of about 6% is attainable by the replacement of single glazed windows;
- an energy demand reduction of about 25% is attainable by the replacement of old boilers.

To allocate and monitor the optimal budget it is useful, for the Pubblic Administration, establish an hierarchy of interventions referring to the list of action of the Energy and Environmental Masterplan.

For this purpose the procedure it can be divided into four step that are describe follow:

- Step 1: List of possible intervention (Action list);

- Step 2: Definition of environmental and economic indicator;
- Step 3: Calculation of the energy saving for each interventions;
- Step 4: Prioritization the intervention and establish the hierarchy list.

Here below is descried in more detail the procedure.

For the case study of the Energy and Environmental Masterplan, the list of intervention are subdivided into three type such as building envelope, heating and cooling system and renewable energy system. A range of intervention is defined for each typology of action; for example the substitution of single glazed windows to double glazed windows, the thermal insulation of the external wall and the insulation of the roof it is supposed for building envelope.

Two economic and environmental indicators to quantify the efficacy of intervention are referring to the energy and the CO2 saved. The cost of saved energy equation (C_1) are defined as follow:

$C_1 = \frac{Cost\ of\ intervention}{\Delta E}$ (€/toe/yr)

Where

ΔE= Energy before intervention subtract of the energy after intervention

While the

The cost of saved CO_2 (C_2)are defined by the equation:

$C_1 = \frac{Cost\ of\ intervention}{\Delta CO_2}$ (€/tCO2 /yr)

Where

ΔCO_2= CO_2 emission before intervention subtract of CO_2 emission after intervention

After calculating the energy saving for each intervention of the list Action of the Energy and Environmental Masterplan, it is establishing the hierarchy of intervention.

Figure 8 reported a graphic synthesis of the prioritization of the interventions

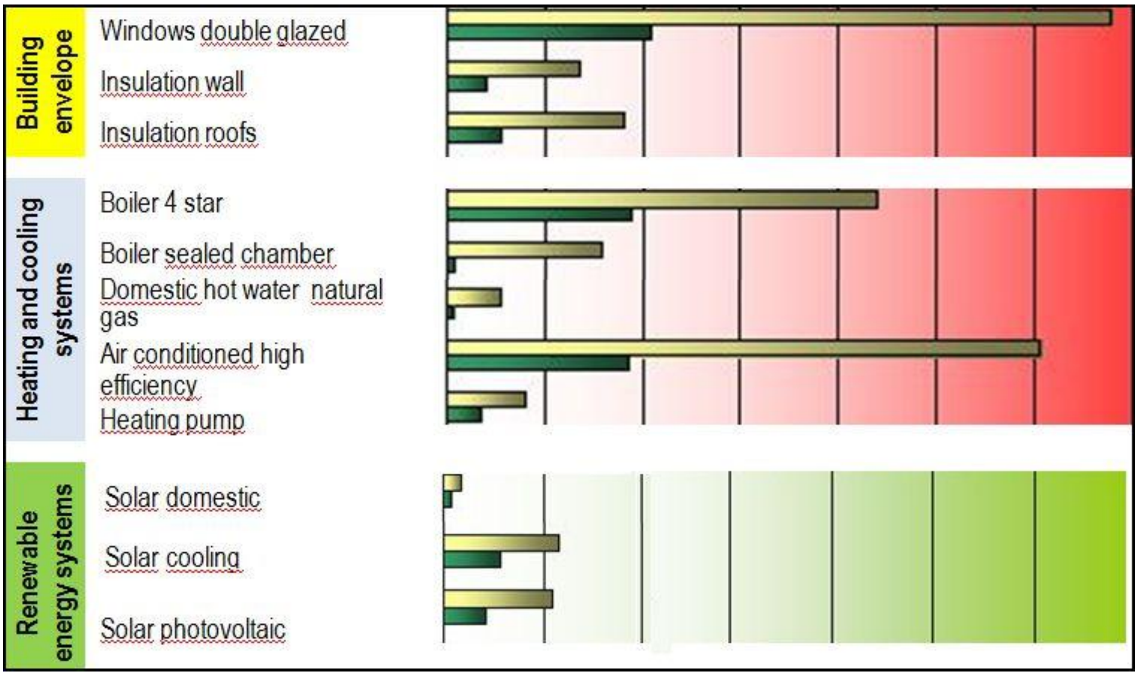


Figure 8 - Hierarchy list for some intervention

In Figure 8 in yellow is reported the value of cost of energy saved while in green the value of cost of CO_2 saved.

For building envelope it is verified that it is more expensive the substitution of windows single glazed with windows double glazed than the insulation of external wall. This last intervention is the best.

The all result of this procedure allows to verify the effectiveness of introduction of energy environmental sustainability measures in the region developing policies.

5. Conclusions

A method has been proposed here to single out typologies of sample buildings that can be considered as representative of large building stocks, in terms of energy consumption for winter and summer climatization and for lighting and other appliances energy requirements. In fact, the method, in addition to the definition of proper typologies of such sample buildings, indicates how to attribute them a suitable number of appliances along with their energy consumptions.

Such sample buildings have to be assumed as “virtual” buildings, whose energy behaviour is representative of a given class of buildings: all of the identified classes define the whole considered building stock.

The building typologies are singled out on the basis of census data of the site, that classify the building park into suitable construction periods. Each period, in fact, is characterized by a typical construction practice of the envelope regarding not only the typology of the employed materials but also their thermo-physical properties.

Moreover, the method identifies the sample typologies also by a proper diversification of the energy consumption structure components. In fact, for the heating evaluations, the application of some well-established calculation methods is suggested, due to the relative predictability of such energy consumption component. For cooling calculations, due to the complexity of this component of the energy building demand (especially when referred to groups of buildings instead of a single one), a statistical procedure is suggested that is based on the mean presence of air conditioning systems in residential buildings; this value is also corrected by means of the ratio between the mean income of the zone to which the building stock belongs and the one derived from the national statistics. Clearly, should not these data be available for the assigned territorial context, a classical method for the calculation of the summer energy demand of building could be applied. Eventually, for cooking and DHW evaluation, it is suggested to refer to statistical data concerning the mean consumption by occupant (kWh/year/inh.), since these data are generally available for large territorial contexts.

The proposed method has been applied here to the whole residential building sector of Sicily, for which twelve sample building typologies have been identified. The comparison of energy consumption data calculated by means of this method has been compared with the actual ones of the island for the year 2011. An interesting matching has been found, with a percentage difference among them of approximately 7.7% for the overall energy consumption; this value is almost replicated for both the components of the energy consumption, that is electric (6.9%) and thermal (8.3%).

As a consequence, the method seems to represent a reliable tool for the prediction of the energy consumption of large building stocks, not only at the overall level, but also for the single components of the consumption structure. The procedure of disaggregation of the whole regional building stock into suitable virtual sample buildings, can be assumed as the starting point to comparatively evaluate possible scenarios concerning future energy uses in a given regional territory, so allowing to calculate the effects of different saving actions on the final energy demand of the considered building stock.

More in general, the method candidates itself as an effective tool for the optimal allocation of economic resources at regional level, at least, by ranking them on the basis of the energy performances of different energy conservation measures.

Chapter 3

The European EN13790 standard at national level: checking the methodology at different territorial scaleS: Luxembourg, The Netherlands and Italy

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1. Introduction

Buildings account for approximately 40% of the total energy consumption in Europe. The high dependence on energy supplied from countries outside the EU and the increase in greenhouse emissions led EU Member State to draw up a common energy policy; a research undertaken by the Intergovernmental Panel on Climate Change shown that appropriate measures are not taken.

The energy performance of the reference building and the potential energy saving were assessed using the methodology provided by European standards supporting the Directive 2002/91/EC (European Union, 2002). The Directive EPBD from 2002 is the main legislative instrument at European Union that set energy performance standard in building. The range of approaches, methods and limits regarding energy consumption used in EU countries prompted the European commission to consider it a priority to have set of standards to uphold the implementation of EPBD; these include EN ISO 13790 (thermal performance of buildings – calculation of energy use for space heating and cooling). In particular, article 3 of the EPBD makes it compulsory for Member States to adopt a methodology at national or regional level to calculate energy performance of building based on the general framework of the Directive.

The energy performance concerns the amount of energy consumed or estimated to satisfy all the needs of the building (heating, hot water heating, cooling, ventilation, lighting). As a consequence, extensive research activities (CEN 15603:2008), both at national and international levels, have been carried out to create a general framework for a calculation methodology of the building energy performance. Many problems have arisen, concerning the definition of energy ratings (based on metered energy – also called operational rating – or on the calculation using standard data – also called asset rating), the accuracy of the calculation methodology (simple or detailed), the discrepancies between an application to new or to existing buildings, the layout of the energy performance certificate, the mutual relation between energy performance and indoor environment quality (in terms of thermal and visual comfort and IAQ) and the opportunity of relating the energy certification to the indoor environment certification.

One of the main topics of interest is the assessment of the energy needs for heating .In order to assure a widespread diffusion of building energy certification (in Italy there are 13 million of buildings, most of which are residential - 86%) it is in fact very important to set up a simplified but sufficiently accurate calculation methodology.

As remarked by Andaloro et al. despite the prompt implementation commitment, the Member States adopted the Directive 2002/91/EC at various times so that the situation, became quite fragmented even if there was a common frame. In fact some aspects were not explained in an exhaustive way, such as minimum requirements for the energy regulation schemes or for calculation methods, so that the Member States decided their own strategy. For example the French transposition of EPBD provides for compulsory requirement for new buildings which are overall energy demand or element minimum performance in case of renovation according to the construction surface, while Germany established some mandatory energetic upgrades for existing buildings to reduce the energy demand. Furthermore strict minimum requirements were established in case of refurbishment, both on the building components and on the energy class to reach. The common aim for the Member States is to estimate the potential energy saving and to find out suitable strategies for the refurbishment of national residential building stock according to the construction typology (Garcıa Casals X., 2010).

A series of standards aimed at defining a common calculation methodology, harmonized throughout different European countries (CEN 2005), is currently under development by CEN (European Committee for Standardization). Those standards can be grouped into three categories. The first category deals with standards that define the different types of energy ratings of a building (design, asset, tailored, operational) and sets general criteria and validation procedures for the calculation models. The second category includes standards that concentrate on the assessment of the thermal performance of the building and provides input data, material properties, boundary conditions and calculation procedures of the net energy needs for space heating and cooling.

The third category includes standards that provide the calculation procedures for system losses and efficiencies for the different energy systems (space heating/cooling, DHW, lighting, ventilation and air conditioning, use of renewables) and allow the annual energy use to be determined in terms of delivered energy-wares and primary energy from the proceedings: building simulation energy needs for heating, cooling, DHW production, lighting.

The most important standard in the second category is ISO 13790 (CEN, 2008) which provides two building net energy calculation methods for space heating and cooling, common boundary conditions and input data. The first method is a quasi-steady state method based on a monthly balance of heat losses and heat gains. The second method is an hourly calculation method. What are the difference between the standard method at European and national level?

The problem of calculation of energy needs for space heating (Magrini A., Magnani L. and Pernetti R., 2012) on the basis of EN ISO 13790 standard in different European countries has already been discussed in the literature. In the previous study the authors generally focused mainly on the monthly method (Corrado V, Fabrizio E, Marino C, Nucara A, Pietrafesa M. 2007) comparing obtained results with detailed simulation programs, like Matlab/Simulink (L. Tronchin, K. Fabbri, 2008). The aim of this paper is evaluate the energy heat demand effect introduced by national standard that adopt EN ISO 13790 European standard.

2. Material and method

In order to achieve the aim of this paper and to define a simplified method (Corrado V. and Fabrizio E. 2006) to calculate the heating energy demand at different territorial scale it is important to evaluate technical and scientific difference between the national standard and the European standard (Andaloro PF, Salomone RE, Ioppolo G, Andaloro, 2010).

It is chosen to analyse the and compare the Italian, Luxembourg and The Netherlands (H.A.L. van Dijk, M.E. Spiekman, 2004) standards (H.A.L. van Dijk, M.E. Spiekman, P. de Wilde, 2005) with the European standard. Standard’s previous analysis show that for the same variables each country choose different parameters to calculate the same value. Here below table 1 explain the comparison between the EN 13790 standard’s formulas and national standard’s one .

Table 1 – Comparison between European and National standard formulas'

Variable	European standard	Italian standard	Luxembourg standard	The Netherlands standard
Total energy demand	$Q_{h,nd}=Q_{h,nd,cont}=Q_{h,ht}-\eta_{H,gn} Q_{h,gn}$	$Q_{H,nd}=Q_{H,ht}-\eta_{H,gn} \times Q_{H,gn}$	$Q_{h,M}=\mathbf{Q_{tl,M}}-\eta_M(Q_{s,M}+Q_{i,M})$	$Q_{h,nd}=Q_{h,nd,cont}=Q_{h,ht}-\eta_{H,gn} Q_{h,gn}$
	$Q_{ht}=Q_{tr}+Q_{ve}$	$Q_{ht}=Q_{tr}+Q_{ve}$	-	$Q_{ht}=Q_{tr}+Q_{ve}$
	$Q_{gn}=Q_{int}+Q_{sol}$	$Q_{gn}=Q_{int}+Q_{sol}$	-	$Q_{gn}=Q_{int}+Q_{sol}$
Heat transfer by trasmission	$Q_{H,tr}=H_{tr,adj}(\theta_{int,set,h}-\theta_e)$	$Q_{H,tr}=H_{tr,adj}(\theta_{int,set,h}-\theta_e)+\boldsymbol{(\sum_k F_{r,k}\Phi_{r,mn,k})}*t$	$Q_{tl,M}=(H_T+\mathbf{H_V})*(\vartheta_i-\vartheta_{e,M})*t_M*\mathbf{f_{Ze}}$	$Q_{tr}=H_{tr,adj,mi}\times \mathbf{f_{int,set,H,adj}\times a_{H,red,night;mi}\times a_{H,red,wknd;mi}}\times(\theta_{int,set,h}-\theta_e)t$
	$H_{tr,adj}=H_d+H_g+H_U+H_A$	$H_{tr,adj}=H_d+H_g+H_U+H_A$	$H_T=\boldsymbol{\sum_T(U_i*A_i*F_{\vartheta,i})+H_{WB}}$	$H_{tr,adj}\boldsymbol{=tr_{T;i}\times(U_i+\Delta U_{for;i})}$
	$H_x=b_{tr,x}(\Sigma A_iU_i+\Sigma_k l_k\psi_k+\Sigma_j x_j)$	$H_x=b_{tr,x}(\Sigma A_iU_i+\Sigma_k l_k\psi_k+\Sigma_j x_j)$	$\boldsymbol{H_{WB}=\sum_i(A_i*F_{\vartheta,i})*\Delta U_{WB}}$	-
Heat transfer by ventilation	$Q_{H,ve}=H_{ve,adj}(\theta_{int,set,H}-\theta_e)\times t$	$Q_{H,ve}=H_{ve,adj}(\theta_{int,set,H}-\theta_e)\times t$	-	$Q_{ve}=H_{ve,adj}\times \mathbf{f_{int,set,H,adj}\times a_{H,red,night;mi}\times a_{H,red,wknd;mi}}\times(\theta_{int,set,h}-\theta_e)t$
	$H_{ve,adj}=\rho_a c_a(\Sigma_k \times b_{ve,k}\times q_{ve,k,mn})$	$H_{ve,adj}=\rho_a c_a(\Sigma_k \times b_{ve,k}\times q_{ve,k,mn})$	$H_V=\mathbf{cPL*V_n*n}$	$H_{ve,adj}\boldsymbol{=(\rho_a c_a)\times q_{ve,k\,mi})}$
	$q_{ve,k,mn}=f_{ve,t,k}\times q_{ve,k}$	$q_{ve,k,mn}=f_{ve,t,k}\times q_{ve,k}$	-	$q_{ve,k\,mn}=f_{ve,t,k}\times q_{ve,k}\,\mathbf{b_{ve,k,mi}})$
Internal heat gains	$Q_{int}=\sum_l\Phi_{int,mn,k})t$	$Q_{int}=\sum_l\Phi_{int,mn,k})t$	$Q_{i,M}=\mathbf{q_{i,M}*A_n*T_n}$	$Q_{int}=\Phi_{int}\times t_{mi}$
	$\Phi_{int,mn,k}=5{,}294\,A_f*-0{,}01557\,A_{f2}$	$\Phi_{int,mn,k}=5{,}294\,A_f*-0{,}01557\,A_{f2}$	-	$\Phi_{int}=\mathbf{230\times N_{woom}+1{,}8\times A_g}$
Solar heat gains	$Q_{sol}=(h_k\Phi_{sol,mn,k})\times t+(\sum_l(1-b_{tr,l})\Phi_{sol,mn,u,l})\times t$	$Q_{sol}=(h_k\Phi_{sol,mn,k})\times t+(\sum_l(1-b_{tr,l})\Phi_{sol,mn,u,l})\times t$	$Q_{s,M}=\mathbf{A_i*g_{\perp i}*F_{h,i}*F_{O,i}*F_{f,i}*F_{w,i}*F_{G,i}*F_{V,i}*I_{S,M,r}*T_M}$	$Q_{sol}=\boldsymbol{\sum_{so}\Phi_{sol,k}\times t_{mi}}$
	$\Phi_{sol,k}=F_{sh,ob,k}A_{sol.k}I_{sol,k}$	$\Phi_{sol,k}=F_{sh,ob,k}A_{sol.k}I_{sol,k}$	-	$\Phi_{sol,k}=F_{sh,ob,k}\times A_{sol,k}\times I_{sol,k}\boldsymbol{-F_{r,k}\times\Phi_{r,k}}$
	$A_{sol}=F_{sh,gl}\,g_{gl}(1-FF)A_{w,p}$	$A_{sol}=F_{sh,gl}\,g_{gl}(1-FF)A_{w,p}$	-	$A_{sol,k}=F_{sh,gl}\times g_{gl}\times(1-F_f)\times A_{w,p}$
	$A_{sol}=\alpha_{sol,c}R_{se}U_cA_c$	$A_{sol}=\alpha_{sol,c}R_{se}U_cA_c$	-	$A_{sol,k}=\alpha_{s,c}\times R_{se}\times U_c\times A_t$

In the previous table the parameter that are added respect the European variable are highlighted in bold type in table 1. Verified the difference is proceeded with the heating energy calculation demand. It is chosen the same building a detached house in order to assess the different values produced by the various parameters (L. Tronchin, K. Fabbri,2010). The main structure of calculation procedure is summarized below into six steps. More details on the calculation procedure are presented in the case study.

Step 1 - C*hoose the type of calculation method*.

There are two basic types of method:

1) quasi-steady-state methods, calculating the heat balance over a sufficiently long time (typically one month or a whole season), which enables one to take dynamic effects into account by an empirically determined again and/or loss utilization factor;
2) dynamic methods, calculating the heat balance with short times steps (typically one hour) taking into account the heat stored in, and released from, the mass of the building.

At national level, it may be decided which of these two types of method are mandatory or are allowed to be used, depending on the application (purpose of the calculation) and building type (V. Corrado, S.P. Corgnati, C. Maga, 2004).

In this paper the quasi-steady-state method for a whole season it is chosen to analyse and compare the heating energy calculation demand of residential building at different spatial territorial level (European ad national). This simplified method is able to compare data calculated by different standard starting the same input data.

Step 2 - *Define the boundaries of the total of conditioned space and unconditioned space*;

The boundary of the building for the calculation of the energy need for heating and/or cooling consists of all the building elements separating the conditioned space or spaces under consideration from the external environment (air, ground or water) or from adjacent buildings or unconditioned spaces.

In this case study it is chosen a detached house without adjacent building or unconditioned space.

Step 3 - D*efine the boundaries of different calculation zone*

It is necessary to partition a building into different zones, with separate calculation of the energy need for heating for each zone. Depending on the conditions:

- the whole building may be modelled as a single zone;
- the building may be partitioned into several zones (multi-zone calculation), accounting for thermal coupling between the zones;
- the building may be partitioned into several zones (multi-zone calculation), taking no account of thermal coupling between the zones.

The boundary of a building zone consists of all the building elements separating the conditioned space or spaces under consideration from the external environment from adjacent conditioned zones, from adjacent buildings or from unconditioned spaces.

A detached house it is considered as a single thermal zone because it is possible applies to spaces within the building the following conditions:

a) Set-point temperatures for heating of the spaces differ by no more than 4 K.

b) The spaces are all not mechanically cooled or all mechanically cooled and set-point temperatures for cooling of the spaces differ by no more than 4 K.

c) The spaces are serviced by the same heating system and the same cooling system.

d) There is a natural ventilation system.

Step 4 - *Define the internal condition for the calculation, the external climate and other environmental input.*

Fort the definition of internal condition for calculation and other input, more detail are explain in the follow paragraph 1.3

Step 5 - *Calculate the energy need for heating* $Q_{H,nd}$ *for each Standard*.

The five principal calculation sub-steps are the follow:

a) Calculation of the characteristics for the heat transfer by transmission Q_t;
b) Calculation of the characteristics for the heat transfer by ventilation Q_v;
c) Calculation of the internal heat gains Q_i;
d) Calculation the solar heat gains Q_{sol}.

Critical analysis of the adoption of European EN 13790 standard at national levels by Luxembourg, Italy and The Netherlands show some different calculation method with resulting different values of the same variable. More detail are explained in the follow paragraph 2

Step 6 - *Compare the National standard result to European's one.*

Specifically it is take into account at national level the Italian UNI 11300 PART 1 standard, the Luxemburg standard and the Netherlands NEN 7120 standard.

2.1 The case study model

An archetype detached house was assumed as case study to develop the methodology at national level for Italy, Luxembourg and the Netherlands (Poel B, van Cruchten G, Balaras C., 2007). The calculation model is developed in an Excel spreadsheet. The geometrical and thermo-physical data input of the model are the same (I. Ballarini, V. Corrado, 2009). Characteristics of buildings and the dataset used for the present study are presented hereinafter.

2.2 The building' geometric characteristics

The analysed object is an archetype detached house, without a cellar. The building is composed of one level cover by pitched roof. The front wall (longer) of the building is oriented in an est/ovest axis. The footprint area of the building is 150 m^2 and the heated area is 133.9 m^2. The total net indoor volume amounts to about 361.5 m^3.

The load-bearing external walls are made of hollow clay blocks and are insulated with 5 cm of glass wool; the U- value is equal to 0.48 W/m^{2}K. Partition walls are made of hollow clay blocks. Windows are double glazed, with wood frames. Exterior door are made of oak wood with a steel core. The ceiling of the attic is made of hollow clay blocks with the U-value equal to 1.59 W/m^{2}K. The floor is in contact with the ground and it is not insulated**.** The building is provided with the natural ventilation and one air exchange within an hour was assumed.

Here below in table 2 is reported the element surfece subdivided for exposition.

Table 2 – Element surface by exposition

Element	**Surface (m^2)**			
	Nord	**Sud**	**Est**	**Ovest**
Door	/	/	1,89	
Glass	2,6	5,2	2,6	3,25
Window	3,36	6,72	3,36	4,2
Side	46,14	42,78	27,75	28,8
Floor	150	/	/	/
Ceiling	150	/	/	/

Table 3 – Detached house's general data

General data		**Unit**
Shape ratio	0,94	-
Gross volume	495	m^3
Net volume	361,5	m^3
High	3,3	m
Net high	2,7	m
Useful surface	133,9	m^2
Losses surface	465	m^2

The values of the parameters describing the physical properties of the materials used and adopted for the calculations were chosen on the base of information of the standard. The design heat transmission coefficients were determined in accordance with Italian standard as also the thermal capacity of the building.

In table 3 in reported the general referring parameter used to calculate heat energy demand.

2.3 Data input

In this article the balance is applied to an archetype detached house, simplified into a single thermal zone. The heat transferred by ventilation and transmission directly depend on the air temperature difference between inside and outside and therefore is part of the firs term; the second term instead is constituted by heat sources.

The climate data input are based on UNI 10349:1994 Italian Standard which is the national reference for outside temperature.

A simplified approach was adopted for the following calculation:

- Seasonal period from 15 th October to 15th april (15724 Ms) ;
- External temperature 4°C ;
- Natural ventilation rate fixed at 0.3 h^{-1}
- neither shading device nor shutters installed on windows
- reduction factor for shading by permanent obstruction fixed at 0.8 for all window
- reduction factor for window frame fixed at 0.2 UNI TS 11300
- internal heat gains fit for residential building according to UNI TS 11300-1 at 9 W/m^2K for kitchen and living room and 3 W/m^2K for other room (for example bedroom)
- thermal bridge pre-determined percentage increase of thermal transmittance
- btrxis equal to 0.45 as reported in UNI TS 11300 standard
- ggl is equal to 0.75 for double glazed window as reported in UNI TS 11300 standard
- 1 – FF I equal to 0.8 as reported in UNI TS 11300 standard

3. The European standard: EN ISO 13790

This standard provides the means to assess the contribution the building product. The international standard is one of a series of calculation methods for the design and evaluation of thermal and energy performance of building. It present a set of coherent set of calculation methods at different levels of detail for energy use, for space heating and cooling of a building and the influence of thermal losses of technical building system such as heating system. ISO ENE 13790 standard is used for comparing the energy performance of various design alternatives for a planned building and display a standardized level of energy performance of existing building.

References are made to national documents for input data and detailed calculation procedure. The mail input that are considered in this paper, for this Standard are:

- transmission and ventilation properties;
- heat gains from internal heat sources, solar properties;
- climatic data;
- description of building (geometry, boundary conditions….) and building component (stratigraphy, U-value…);
- comfort requirements (set-point temperatures and ventilation rates).

The main output is the annual energy needs for space heating of a residential building. The calculating interval is one month or one hour, but for residential building can also be performed on the basis of the heating season. The building is considered as a single zone. The energy (heat) balance at the building zone level includes the following terms:

- transmission heat transfer between the conditioned space and the external environment,;
- ventilation heat transfer (by natural ventilation),
- internal heat gains, for instance from persons, appliances, lighting and heat dissipated in, or absorbed by, heating, cooling, hot water or ventilation systems;
- solar heat gains which are direct (e.g. through windows), or indirect, (e.g. via absorption in opaque building elements).

3.1 Energy calculation

In this paper, building energy demand (or energy need in the terminology of EN-ISO 13790) for space heating was calculated using the monthly method described in EN-ISO 13790. The total heat gains (internal and solar gains) and heat losses (transmission and ventilation losses) are calculated for the heating modes with a corresponding utilization factor (Jokisalo J. and Kurnitski J. 2007). The utilization factors represent the portion of gains, during the heating season, that contribute to the reduction in the heating demand. The non-utilized part of the gains in winter depends on the dynamic mismatch between the gains and losses, which may cause an overheating over the heating set point temperature in winter.

The "energy need" which is necessary for heating is calculated with the following formulas:

$$Q_{H,nd} = (Q_{H,ht} - \eta_{H;gn} \cdot Q_{H,gn}) \text{ (1)}$$

in which:

$Q_{H,ht}$ is the total heat transfer for the heating mode

$Q_{H,gn}$ gives the total heat gains for the heating mode

$\eta_{H,gn}$ is the dimensionless gain utilization factor

In this paper, take into account the data input of the detached house case study, it is calculated the heating energy demand for residential building. The value that are obtain are considered as reference to evaluate the difference produced by the adopt at national level of the European standard.

3.1.1 Gain utilization factor for heating

The dimensionless gain utilization factor for heating, η_M is a function of the heat-balance ratio, Υ_H, and a numerical parameter, a_H, that depends on the building inertia, as given by Equations (/) to (//):

$$\gamma_M = \frac{Q_{H;gn}}{Q_{H;ht}} \text{ (2)}$$

In this case study: $\gamma_M \neq 1$

Therefore

$$\eta_M = \frac{1 - \gamma_H^{a_H}}{1 - \gamma_H^{a_H+1}} \quad 3$$

Where:

$$a_H = a_{H,0} + \frac{\tau_H}{\tau_{H,0}} \text{ (4)}$$

With: $a_{H,0}$ = 1,0 e $\tau_{H,0}$ = 15

In which:

$$\tau_H = \frac{\frac{C_m}{3600}}{H_{tr,adj}+H_{ve,adj}} \text{ (5)}$$

With:

$$C_m = D_m \cdot A_{g;zi} \text{ (6)}$$

In this case D_m is equal ti 350

With:

Υ_M is the dimensionless heat-balance ratio for the heating mode

η_M is the monthly utilization rate of heat gains

a_H is a numeric parameter equal to 1 for monthly calculation method

$a_{H;0}$ is a dimensionless numerical references parameters

$\tilde{\iota}_H$ is the time constant of the accounting zone

$\tilde{\iota}_{H,0}$ is a references time constant is equal to 15 for monthly calculation method

C_m is the effective internal heat capacity of the accounting zone

H_T is the specific transmission heat loss

H_V is the specific ventilation heat loss

D_m is the specific internal heat capacity of element

$A_{g,zi}$ is the surface

Here below is reported a list of each single formula to calculate the heat energy demand.

The total heat transfer, Q_{ht}, is given by Equation (7):

$$Q_{ht} = (Q_{H,tr} + Q_{H,ve}) \text{ (7)}$$

Where:

$Q_{H,tr}$ is the total heat transfer by transmission;

$Q_{H,ve}$ is the total heat transfer by ventilation.

In this case study the value is equal to

The total heat gains, Q_{gn}, of the building zone are calculated using Equation (8):

$$Q_{gn} = (Q_{int} + Q_{sol}) \quad (8)$$

where

Q_{int} is the sum of internal heat gains over the given period;

Q_{sol} is the sum of solar heat gains over the given period.

3.1.2 Total heat transfer by transmission

$$Q_{H,tr} = H_{tr,adj} \cdot \theta_{int,set,h} - \theta_e \cdot t \quad (9)$$

In which:

$H_{H,tr}$ is the overall heat transfer coefficient by transmission;

$\theta_{int,set,H}$ is the set-point temperature of the building zone for heating;

θ_e is the temperature of the external environment;

t is the duration of the calculation step.

$$H_{tr,adj} = H_d + H_g + H_U + H_A \quad (10)$$

where

H_D is the direct heat transfer coefficient by transmission to the external environment;

H_g is the steady-state heat transfer coefficient by transmission to the ground;

H_U is the transmission heat transfer coefficient by transmission through unconditioned spaces;

H_A is the heat transfer coefficient by transmission to adjacent building~~**s**~~

3.1.3 Total heat transfer by ventilation

The total heat transfer by ventilation, Q_{ve}, is calculated as given by Equation (11):

$$Q_{H,ve} = H_{ve,adj} \cdot \theta_{int,set,H} - \theta_e \cdot t \quad (11)$$

where

$H_{ve,adj}$ is the overall heat transfer coefficient by ventilation, adjusted for the indoor-outdoor temperature difference;

The value for the overall ventilation heat transfer coefficient, $H_{ve,adj}$, is calculated as given by Equation (12):

$$H_{ve,adj} = \rho_a \cdot c_a \cdot \quad \Sigma_k \cdot b_{ve,k} \cdot q_{ve,k,mn} \quad (12)$$

Where:

ρ_a c_a is the heat capacity of air per volume 1 200 J/(m3·K);

$q_{ve,k,mn}$ is the time-average airflow rate of air flow element k;

$b_{ve,k}$ is the temperature adjustment factor for air flow element k;

$$q_{ve,k,mn} = f_{ve,t,k} \cdot q_{ve,k} \quad (13)$$

Where:

$q_{ve,k}$ is the airflow rate of air flow element k, determined in accordance with the relevant standard;

$f_{ve,t,k}$ is the time fraction of operation of the air flow element k, calculated as the fraction of the number of hours per day (full time: $f_{ve,t,k} = 1$), determined from the same source as $q_{ve,k}$.

3.1.4 Overall solar heat gains

The sum of the heat gains from solar sources in the considered building zone, Q_{sol}, are calculated by using Equation (9):

$$Q_{sol} = \Sigma_k \phi_{sol,mn,k} \quad \cdot t + \Sigma_l \ 1 - b_{tr,l} \quad \cdot \phi_{sol,mn,u,l} \quad \cdot t \quad (14)$$

Where

Q_{sol} is the solar heat gains;

$b_{tr,l}$ is the adjustment factor for the adjacent unconditioned space with internal heat source l;

$\Phi_{sol,mn,k}$ is the time-average heat flow rate from solar heat source k;

$\Phi_{sol,mn,u,l}$ is the time-average heat flow rate from solar heat source l in the adjacent unconditioned space;

t is the length of the considered month or season.

The heat flow by solar gains through building element k, Φsol, k, expressed in watts, is given by Equation (15):

$$\phi_{sol,k} = F_{sh,ob,k} \cdot A_{sol,k} \cdot I_{sol,k} \text{ (15)}$$

Where:

$\Phi_{sol,k}$ is the heat flow by solar gains through building element k

$F_{sh,ob,k}$ is the shading reduction factor for external obstacles for the solar effective collecting area of surface k.

$A_{sol,k}$ is the effective collecting area of surface k with a given orientation and tilt angle, in the

considered zone or space;

$I_{sol,k}$ is the solar irradiance, the mean energy of the solar irradiation over the time step of the calculation, per square metre of collecting area of surface k, with a given orientation and tilt angle;

The effective solar collecting area of a glazed envelope element (e.g. a window), A_{sol}, is given by Equation (16):

$$A_{sol} = F_{sh,gl} \cdot g_{gl} \cdot \ \ 1 - F_F \ \ \cdot A_{w,p} \text{ (16)}$$

where

$F_{sh,gl}$ is the shading reduction factor for movable shading provisions;

g_{gl} is the total solar energy transmittance of the transparent part of the element;

F_F is the frame area fraction, ratio of the projected frame area to the overall projected area of the glazed element;

$A_{w,p}$ is the overall projected area of the glazed element.

Instead the net solar heat gains of opaque elements without transparent insulation during the heating season is a small portion of the total solar heat gains and are partially compensated by radiation losses from the building to clear skies. However, for dark, poorly insulated surfaces, or large areas facing the sky, the solar heat gains through opaque elements is more important. The effective solar collecting area of an opaque part of the building envelope, A_{sol}, is given by Equation (12):

$$A_{sol} = \alpha_{sol,c} \cdot R_{se} \cdot U_c \cdot A_c \text{ (17)}$$

where

$\alpha_{sol,c}$ is the dimensionless absorption coefficient for solar radiation of the opaque part, obtained from appropriate national sources;

R_{se} is the external surface heat resistance of the opaque part;

U_c is the thermal transmittance of the opaque part;

A_c is the projected area of the opaque part.

3.1.5 Calculation the heat internal gains

The sum of the internal gains from solar sources in the considered building zone, Qsol, are calculated by using Equation (13):

$$Q_{int} = \Sigma_k \Phi_{int,mn,k} \cdot t + \Sigma_l \ 1 - b_{tr,l} \cdot \phi_{int,mn,u,l} \cdot t \text{ (18)}$$

Where

Q_{int} is the internal heat gains;

$b_{tr,l}$ is the adjustment factor for the adjacent unconditioned space with internal heat source l;

$\Phi_{intl,mn,k}$ is the time-average heat flow rate from internal heat source k;

$\Phi_{,int,mn,u,l}$ is the time-average heat flow rate from internal heat source l in the adjacent unconditioned space;

t is the length of the considered month or season.

Following the procedure, an Excel spreadsheet was obtained. In this way it has been possible to control step by step each data input and calculation.

Here below in table 4 is reported the reference value of heating energy demand

Table 4 – Heat energy demand value (European standard value)

Variable	**$Q_{h,nd}$**		**$Q_{H,ht}$**	**$\eta_{H,gn}$**	**$Q_{H,gn}$**	**Q_{tr}**	**Q_{ve}**	**Q_{int}**	**Q_{sol}**
Unit	**kWh/y**	**MJ**	**MJ**	**MJ**	**-**	**MJ**	**MJ**	**MJ**	**MJ**
Value	163	88.231	111.908	0,095	23.796	102.245	9.663	6.756	17.039

This is the reference to compare other methods at different territorial level.

4. The national model

“The EN 13790 European standard document has been prepared under a mandate given to CEN by European Commission and the European Free trade Association, and support essential requirements of EU Directive 2002/91/CE on the energy performance building (EPBD). It forms part of a series of standards aimed at European harmonization of the methodology for the calculation of the energy performance of building”. An overview of the whole set of standards is given in CER/TR 15615 (CER, 2008). At the beginning of October a new revision of the UNI TS 11300, part 1 and part 2 have been revised counting minor revision in the respect to the present dissertation.

In this work we refer to three national standards that are the implementation of European standard.

The aim is to highlights the variance introduced by different way to describe physical phenomena’s that contribute to building energy balance. In more detail the UNI 11300 Italian standard (UNI, 2008) it is choose for the high compliance to EN 13790 European standard; the unique difference regard the parameter called “sky component” in total heat transfer by transmission calculation.

The Luxembourger methodology it is choose for different reason. The firs is the way to calculate the total heat transfer by ventilation, the second the simplified approach to calculate heat internal gains in addition to calculate the heat solar gains take into account detailed parameters referring to shadow component.

The Netherland Standard it is choose for the numerous coefficient also simplified that are used in the calculation of energy heat balance in residential building. Furthermore this method takes into account the sky component in the calculation of heat solar gains.

In substance these three methods represent different mode to understand the EN 13790 European standard and therefore can lead to different result in the energy calculation demand in the residential building.

This is the main aim of this comparison's methods carry out in this study.

4.1 the Italian standard UNI 11300 - 1

At a national level, the application of EN ISO 13790:2008 is completely specified in Technical Sheet UNI/TS 11300:1, which contains, apart from the calculation methodology, some national reference input values used for the calculation to evaluate primary energy to heating. Italian Standard UNI TS 11300, part 1 is the Italian standard to evaluate primary energy to heating and domestic hot water (DHW); this standard is generally applied to the design rating (new buildings and plants), asset rating (for existing buildings and retrofit) and tailored rating (for energy audit). Following the UNI TS 11300 procedure, also an Excel spreadsheet was obtained to control step by step each data calculation. In the follow paragraph are present the technical difference from Italian to European standard and the resulting value.

4.1.1 Energy need for heating

The building energy need for space heating, $Q_{H,nd}$, for conditions of continuous heating, is calculated with the same formula of European standard, as given by Equation (1). In order to calculate the gain utilization factor for heating the procedure is equal to ISO EN 13790 European standard given by the equation (2).

4.1.2 Total heat transfer and heat gains

Also the total heat transfer, Q_{ht}, is calculate with the same formula of European standard, as is given by Equations (7,8). Although the formulas for energy need for heating and to calculate heat transfer and heat gains are equal the value are different because the specific parameter are explain with different formulas.

4.1.3 Total heat transfer by transmission

Specifically, the total heat transfer by transmission, $Q_{H,tr}$ is calculated as given by Equation (xxx):

$$Q_{H,tr} = H_{tr,adj} \cdot \quad \theta_{int,set,h} - \theta_e \quad + \quad \Sigma_k Fr_k \cdot \phi_{r,mn,k} \quad \cdot \ t \ (19)$$

In this case the Italian standard added to a European formulas, the parameter given by the equation $\Sigma_k Fr_k \cdot \phi_{r,mn,k}$ in which:

$Fr_{,\mathbf{k}}$ is the dimensionless form factor k between the structure and sky;

$\Phi r_{,k}$ is the extra heat flow due to thermal radiation to the sky from building element k.

From the comparison to European standard the introduction of this new parameter "sky component" produced an increase of 14% of the European $Q_{h,tr}$ value.

To evaluate the overall transmission heat transfer coefficient, the formula is the same of the ISO 13790

4.1.4 Total heat transfer by ventilation

Also for the total heat transfer by ventilation, Qve, is calculated like EN ISO 13790 as given by Equation (11):

The value for the overall ventilation heat transfer coefficient, Hve,adj, like EN 13790, is calculated as given by Equation (12); the time-average airflow rate of air flow element k, $q_{ve,k,mn,}$ expressed in cubic meters per second, is calculated by using Equation (13).

4.1.5 Overall solar heat gains

Like the European standard formula, the sum of the heat gains from solar sources in the considered building zone, Qsol, are calculated by using Equation (14):

Specifically, the second element $[(1 - b_{tr,l}) \cdot \phi_{sol,mn,u,l}]$ in this case study are equal to zero because the building is isolated and no- contiguous to other unconditioned space.

The solar gains value is equal to European ISO 13790 one.

The heat flow by solar gains through building element k, Φsol, k, is given by the European standard Equation (15):

The same formulas are used to calculate:

- the effective solar collecting area of a glazed envelope element (e.g. a window), Asol, like European standard, is given by Equation (15):
- The effective solar collecting area of an opaque part of the building envelope, A_{sol}, is given by Equation (16,17). The net solar heat gains of opaque elements without transparent insulation during the heating season is a small portion of the total solar heat gains and are partially compensated by radiation losses from the building to clear skies.

4.1.6 Calculation the heat internal gains

The sum of the internal gains from solar sources in the considered building zone, Qsol, is calculated by using Equation (18). The final value is equal to European standard value

Here below in table 5 is reported the reference value of heating energy demand

Table 5 – Heat energy demand value (Italian standard values)

Variable	Qh,nd		QH,ht	ηH,gn	QH,gn	Qtr	Qve	Qint	Qsol
Unit	**kWh/y**	**MJ**	**MJ**	**MJ**	**-**	**MJ**	**MJ**	**MJ**	**MJ**
Value	190	103.108	126.785	0,995	23.796	117.122	9.663	6.756	17.039

4.2 The Netherlands standard NEN 7120

In The Netherlands for the calculation (H.A.L. van Dijk, C.A.M. Arkesteijn, 1987) of the heat energy demand, the general equation is equal to the European formulas as follow:

$$Q_{H,nd} = (Q_{H,ht} - \eta_{H;gn} \cdot Q_{H,gn}) \text{ (1)}$$

Each parameter are defined in previous paragraph; the same calculation procedure regard also the utilization rate of internal and solar heat gains (see the equation n 2), the total heat loss and heat gain (see the equation n.7 and 8)

4.2.1 Calculation rules heat transfer through transmission

For the Netherlands standard some difference to European standard are present in the formulas used to calculate the total heat transfer through the transmission that are explain as follow:

$$Q_{H;tr;mi} = H_{H;tr;adj;mi} \cdot f_{int;set;H;adj} \cdot a_{H;red;night;mi} \cdot a_{H;red;wkndt;mi} \cdot (\theta_{int;set;H} \cdot \theta_{e;mi}) \cdot t_{mi} \quad (20)$$

In this case are introduced by national standard the parameters:

$f_{int;\, set;\, H;\, adj}$ is the correction factor for levelling of the temperature inside a home, between areas with different believed use. For utility applies: $f_{int;\, set;\, H;\, adj} = 1$;

$a_{H;\, red;\, night;\, mi}$ is the reduction factor for night lowering the thermostat setting;

$a_{H;red;wknd;\, mi}$ is the reduction factor for weekend lowering the thermostat setting, or interruption;

These correction and reduction factor generate a difference of value equal to 63% minor than European standard value. Consequently the direct heat transfer coefficient with lump settlement of linear thermal is determined in accordance with:

$$H_{tr,adj} = \Sigma_i A_{Ti} \cdot (U_i + \Delta U_{for;i}) \quad (21)$$

wherein:

$H_{tr,\, adj}$ is the direct heat transfer coefficient between the heated interior space and the outside air;

$A_{T;\, i}$ is the projected area of the opaque plane i or the window or the door of the i external division;

U_i is the heat transfer coefficient of that surface i of the external division;

$\Delta U_{for,i}$ is a fixed charge on the U-value of the field i in settlement of linear thermal bridges equal to 0.1 × 0.25 (U_i - 0.4).

In this formulas the introduction of $\Delta U_{for,I}$ determine an increment of the European correspondent value equal to 51%.

4.2.2 Calculation rules heat transfer through ventilation

To determine the total heat transfer calculation by means of ventilation the equation is the follow:

$$Q_{H;ve;mi} = H_{ve;adj;mi} \cdot f_{int;set;H;adj} \cdot a_{H;red;night;mi} \cdot a_{H;red;wkndt;mi} \cdot (\theta_{int;set;H} \cdot \theta_{e;mi}) \cdot t_{mi} \text{ (22)}$$

wherein:

$f_{int;set;H;adj}$ is the correction factor for levelling of the temperature inside a home, between areas with different believed use; for utility applies: $f_{int;set;H;adj} = 1$;

$a_{H;red;night;mi}$ is the reduction factor for night lowering the thermostat setting;

$a_{H;red;wknd;mi}$ is the reduction factor for weekend lowering the thermostat setting, or interruption;

As for the heat transfer by transmission, in this formulas the correction and reduction factor determine a decrease of the European value equal to 57%.

In order to calculate the heat transfer coefficient through ventilation is necessary use the formula that is here below:

$$H_{ve,adj;mi} = \rho_a \cdot c_a \cdot q_{ve,k,mi} \text{ (23)}$$

In which:

weighted temperature supply air volume flow is determined by:

$$q_{ve,k,mi} = \Sigma_k \cdot (q_{ve,k,mi} \cdot b_{ve,k,mi}) \text{ (24)}$$

wherein:

$q_{ve\ k,\ mi}$ is the time average supply air volume flow for partial volume flows or combination of part of volume flow k;

$b_{ve,k,mi}$ is the temperature correction for partial volume flows or combination of partial volume flows, k, for heating. For the k parts in which the supply air to the accounting zone is supplied directly from the outside applies: $b_{ve,k,mi} = 1$

For this parameter the value is increased of 18% than the European parameter one.

4.2.3 Calculation the solar heat gain

For the calculation of the solar heat gains the formula is given by the equation (25) here below:

$$Q_{sol} = \Sigma_k \cdot \phi_{sol,k} \cdot t_{mi} \text{ (25)}$$

Some difference is possible to evaluate according the heat flow through sun construction k that is determined as follows:

$$\phi_{sol,k} = F_{sh;ob;k} \cdot A_{sol;k} \cdot I_{sol;k} - Fr_k \cdot \phi_{r,k} \text{ (26)}$$

wherein:

$Fr_{,k}$ is the dimensionless form factor k between the structure and sky;

$\Phi_{r,k}$ is the extra heat flow due to heat radiation of the structure k to heaven.

Particular attention is important given to this formula that takes into account the sky component. This parameter in European standard is not considered. In fact the introduction of the sky component in the calculation of the solar heat gains reduces of about a tenth the European value.

The "effective collector area" (A_{sol}) of daylight openings such as windows and doors and also opaque element and the extra heat flow due to heat radiation of a structure to heaven, (Φr), are calculated with the same formula that is reported in EN ISO 13790.

4.2.4 Calculation the heat internal gains

For the calculation of internal gains the equation is the follow:

$$Q_{int} = (\phi_{int} \cdot t_{mi}) \text{ (27)}$$

wherein:

Φ_{int} is the sum of the heat flow of the internal heat production in the considered computational zone;

t_{mi} is the calculated value for the length of the period.

Although the parameter to calculate the heat gains are the same of the European standard, the specific formulas for the evaluation of the sum of the heat flow of the internal heat production is the follow:

$$\phi_{int} = 230 \cdot N_{woon} + 1.8 \cdot A_g \quad (28)$$

wherein:

Φ_{int} is the sum of the heat flow of the internal heat production in the considered computational zone;

N_{woon} is the number of units;

A_g is the surface of use.

This simplified formula determine a difference equal to 471 W that is 1% major than European standard value.

Here below, in table 6 is reported the final value of heat energy demand according the Netherlands standard.

Table 6 - Heat energy demand value (The Netherland values)

Parameter	Qh,nd		QH,ht	ηH,gn	QH,gn	Qtr	Qve	Qint	Qsol
Unit	**KWh/y**	**MJ**	**MJ**	**-**	**MJ**	**MJ**	**MJ**	**MJ**	**MJ**
Value	113	61.090	69.442	0,990	8.435	63.923	5.518	7.406	1.029

4.3 The Luxemburg standard

For Luxembourg, annual heat demand is defined as the amount of heat needed annually to the heated gross building volume on the mean internal temperature. Calculations refer to a standard user behaviour and on standard air conditions.

The monthly heating demand is calculated as follows:

$$Q_{h,M} = Q_{tl,M} - (Q_{s,M} + Q_{i,M}) \quad (29)$$

with:

$Q_{h, M}$ is monthly heating demand;

$Q_{tr, M}$ is monthly transmission and ventilation heat loss;

η_M is monthly utilization rate of heat gains;

$Q_{s, M}$ is monthly solar heat gain through transparent components;

$Q_{i, M}$ is monthly internal heat gains.

Index M corresponds to the period of a month

4.3.1 Calculation of monthly utilization rate of internal and solar heat gains

The degree of utilization factor η_M is possible to calculate as follow:

$$\eta_M = F_g \cdot \eta_{oM} \text{ (30)}$$

Where:

η_M is the monthly utilization rate of heat gains

Fg is the regulations' reduction coefficient

η_{0M} is the monthly utilization rate of heat gains without considering the local heat transmission with optimal regulation of ambient temperature rate.

Monthly thermal gains ratio formulas is the follow:

$$\gamma_M = \frac{Q_{s,M}+Q_{i,M}}{Q_{tl,M}} \text{ (31)}$$

In this case: $\gamma_M \neq 1$

Therefore

$$\eta_{OM} = \frac{a}{a+1} \text{ (32)}$$

Where:

$$1 + \frac{\tau}{15} \text{ (33)}$$

In which:

$\tau = \frac{C_{wirk}}{H_T+H_V}$ (34)

η_M is the dimensionless heat-balance ratio for the heating mode

$Q_{s,M}$ is the monthly solar heat gain through transparent components

$Q_{i,M}$ is the monthly internal heat gains

a is a numeric parameter

$Q_{tl,M}$ is the monthly transmission and ventilation heat loss

τ is the thermal inertia of the building

H_T is the specific transmission heat loss

H_V is the specific ventilation heat loss

C_{wirk} is the Effective heat storage capacity (C_{wirk} is equal to 30 Ve mixed construction)

V_e is the heated gross building volume

4.3.2 Calculation of the monthly transmission and ventilation heat loss

The monthly transmission and ventilation heat loss is defined as follows:

$Q_{tl,M=} 0.024 \cdot (H_T + H_V) \cdot (\upsilon_i \cdot \upsilon_{e,M}) \cdot t_M \cdot f_{Ze}$ (35)

With:

$Q_{tl,\,M}$ is monthly transmission and ventilation heat loss;

H_T is specific transmission heat loss;

H_V is specific ventilation heat loss;

υ_i is the average operative (perceived by the body) internal temperature; arithmetic mean the air temperature and the radiation temperature in the center of the used area;

$\theta_{e,\,M}$ Average monthly temperature;

t_M number of days in the month;

f_{ze} correction factor for time-limited heating.

For this parameter the value calculated is more 22% than the European value.

4.3.3 Calculation of the specific transmission heat loss

To calculate the specific transmission heat loss following calculation formula has its place:

$$H_T = \Sigma_i \; U_i \cdot A_i \cdot F_{\vartheta,i} \; \cdot H_{WB} \text{ (36)}$$

The temperature-related heat loss by linear thermal bridges H_{WB} is simplified determined as follows:

$$H_{WB} = \Sigma_i \; A_i \cdot F_{\vartheta,i} \; \cdot \Delta U_{WB} \text{ (37)}$$

With:

H_T is specific transmission heat loss;

U_i is heat transfer coefficient for the corresponding component;

A_i is area for the corresponding component;

$F_{\vartheta,i}$ is the temperature correction factor;

H_{WB} is the heat dispersion coefficient due to linear thermal bridge

ΔU_{WB} is thermal bridge correction values;

The heat transmission specific value is equal to 486.857 W/K that is major of 42% respect the European value. In this case the difference it can be added to the parameter H_{WB}..

4.3.4 Calculation of the specific ventilation heat loss

The specific ventilation heat loss is calculated as follows:

$$H_v = c_{PL} \cdot V_n \cdot n \text{ (38)}$$

with

C_{PL} is the specific heat capacity of air with 0.34 Wh/m³K;

H_v is the specific ventilation heat loss;

V_n is the heated building air volume;

n is more effective (energy efficient) air changes.

In buildings without air conditioning the are the follow:

$n = 0.35 + n_{50} \cdot e + 0.05$ (39)

with 0.35 the minimum hygienic air change in h-1 and an additional 0.05 air changes per h-1 corresponds caused by improper use of the building, notably opening of windows and doors.

The specific ventilation heat loss value is more than 17% of European standard value.

4.3.5 Calculation of the internal heat gains

For the evaluation of internal heat gains the equation is the follow:

$\mathrm{Q_{i,M}} = \mathrm{q_{i,M}} \cdot \mathrm{A_n} \cdot \mathrm{T_n}$ (40)

$Q_{i,M}$ is the monthly internal heat gains;

Q_{IM} is the specific mean internal heat gains;

An is the energy reference area;

T_n is the number of days in the month.

This value is equal to 7496 MJ that is more 10% of European standard value.

4.3.6 Calculation of the solar heat gains through transparent components

The formulas for the calculation of the solar heat gains through transparent element is reported here below:

$Q_{s,M=} A_i \cdot g_{\perp l} \cdot F_{h,i} \cdot F_{O,i} \cdot F_{f,i} \cdot F_{w,i} \cdot F_{G,i} \cdot F_{V,i} \cdot I_{s,M,r} \cdot T_M$ (41)

If no shading through Building (horizon, overhang or side panel) for individual windows in front, with the following flat-rate factors expected to:

$F_{h,i}$ = 0,95; $F_{0,i}$ = $F_{w,i}$ 0.95;

With:

T_M is the number of days in the month;

$Q_{s,M}$ is the monthly solar heat gain;

A_i is the window area of each window (clear shell mass);

$g_{\perp i}$ is the total energy transmittance of a window (default values);

$F_{h,i}$ is the Partial shading factor of each window according to environmental obstruction;

$F_{0,i}$ is the Partial shading factor of each window according by horizontal overhangs;

$F_{f,i}$ is the Partial shading factor of each window according by lateral projections;

$F_{W,i}$ is the reduction factor due to non-perpendicular incident radiation;

$F_{V,i}$ is the fouling factor of a window;

FG, i is the glass content of each window i based on the clear unfinished dimension;

$I_{S,M,r}$ is the average monthly solar radiation on a direction-dependent surface.

In this case the value calculated is minor than 42% from European standard value.

Here below in table 7 is reported the heat energy value calculated referring the case study.

Table 7 – Heat energy demand value (Luxembourg standard values)

Parameter	Qh,M		Qh,tl	ηH,gn	Qi,M	Qs,M
Unit	**KWh/y**	**MJ**	**MJ**	**-**	**MJ**	**MJ**
Value	246,73	133.238	136.835	0,167	7.496	14.042

5. Discussion

In this section the results of the simulations of the three national standard methods, before analysed, are reported and compared (where possible).

In order to evaluate the contribution of each single parameters, in Table 8 are reported the different percentage values by the comparison to European standard value, expressed in MJ.

Italian standard variance regard only the heat transfer by transmission and is equal to 14%; the Netherlands standard variance regard in particular the heat transmission coefficient which value is increased of 51 %.

Table 8 – Nationals percentage values from comparison to European standard (numerical value in MJ)

Parameters	Unit	European standard	Italian standard	The Netherlands standard	Luxembourg standard
QH,tr=	**MJ**	102.245	+14%	-38%	+22%
QH,ve=	**MJ**	9.663	0%	-43%	
Qint=	**MJ**	6.756	0%	+9%	+10%
Qsol	**MJ**	17.039	0%	-6%	-18%
Htr	**W/K**	328,500	0%	+51%	+42%
Hve	**W/K**	36,150	0%	+18%	+17%
Φsol	**W**	1.079	0%	+3%	-
Φint	**W**	429	0%	+9%	-

Starting by this data reported in table 8, here below is reported in figures, a comparison to European standard's values. For each single parameter are produced a graph show in figure 1, 2, 3, 4, 5, 6, 7, 8. In the same graph for every methodology are explain the different value.

In more detail from the comparison to European standard values, in figure 1 incident to the total heat transfer by transmission, there is an increased values for Italian and Luxembourg standards and a decreased value for The Netherlands standard; in figure 2 relevant the total heat transfer by ventilation display an equal value for Italian standard a decreased value for The Netherlands standard and an increased value for Luxembourg standard; in figure 3 be about the overall internal heat gains The Italian standard value is the same to European one, while The Netherlands and the Luxembourg is greater; in figure 4 that explain the overall solar heat gains there are one equal value for Italian standard and two decreased values for Luxembourg and The Netherlands. The last one value is lower than the other one.

All of these values are expressed in MJ.

The figure 5 and 6 incident to transmission and ventilation coefficients, expressed in W/K, each shows an equal value for Italian standards and a n increased value for Luxembourg and The Netherlands standard.

Figure 7 and figure 8, expressed in Watt, are respectively related to heat flow through incident solar radiation and the internal heat production. The firs show a decreased value and the second show a low increased value for The Netherlands.

In the last two figure the Luxembourg values are not computed because the methodology not defines this parameters Φ_{sol} and $\Phi_{int.}$ The total heat internal and solar gains are calculated referring to others variable.

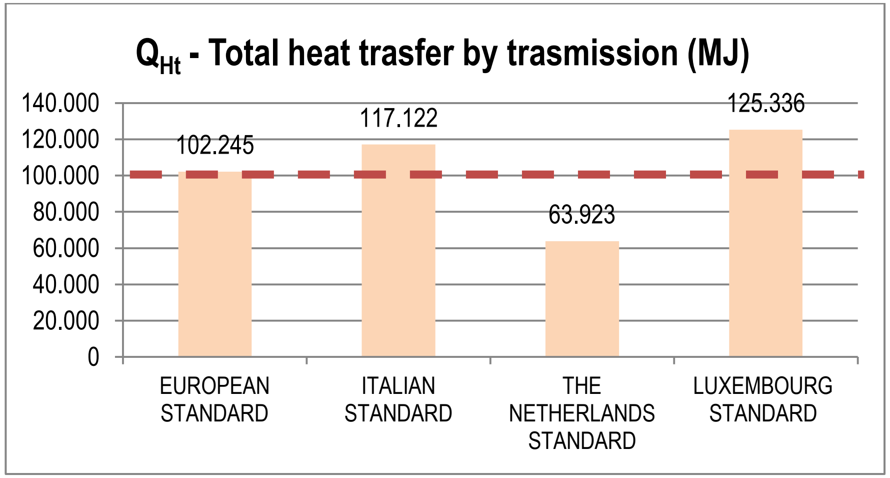


Figure 1 – Total heat trasfer by transmission values

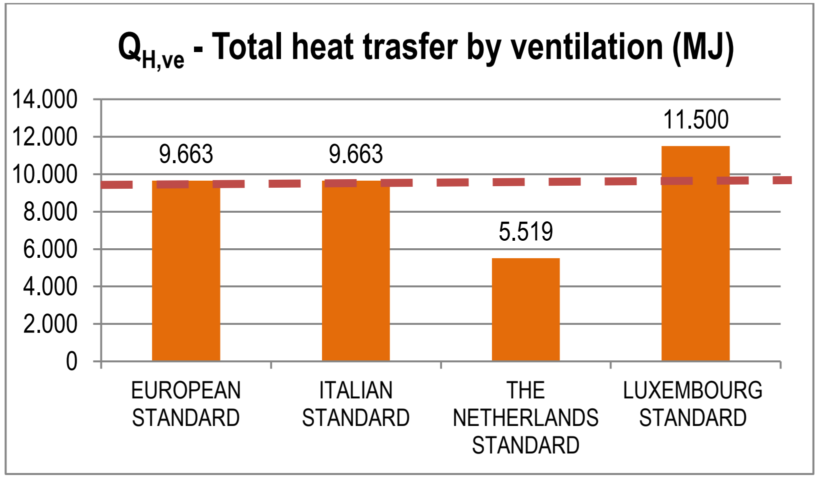


Figure 2 – Total heat trasfer by ventilation values

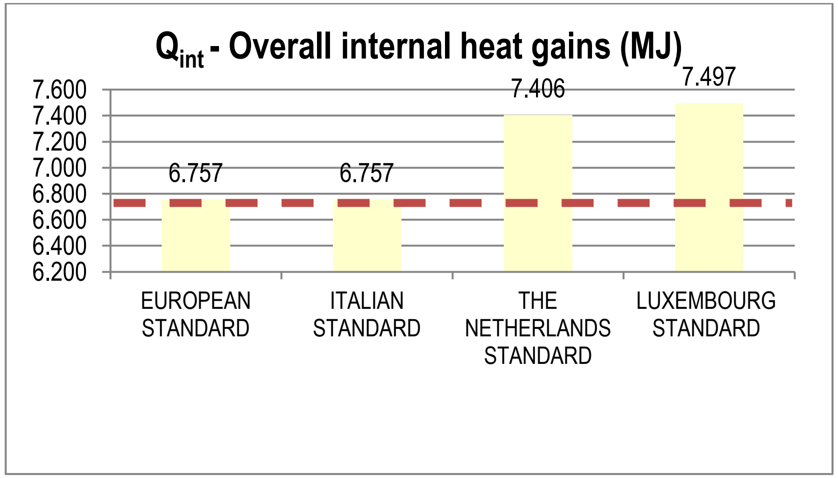


Figure 3 – Overall internal heat gains values

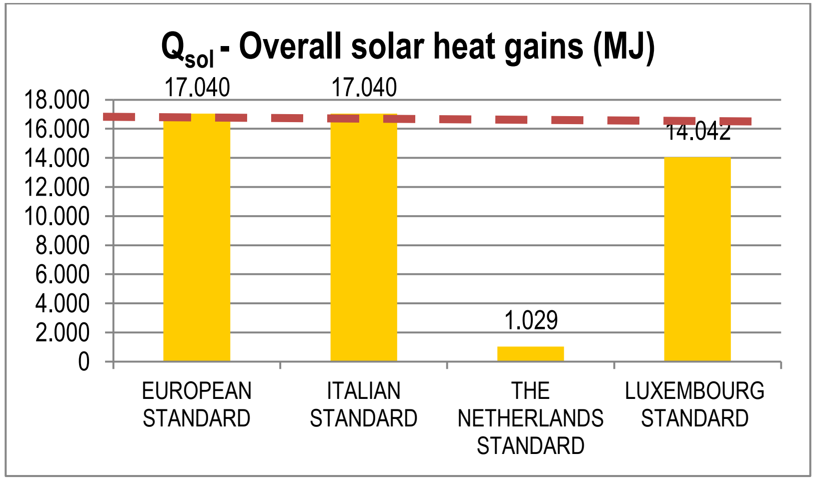


Figure 4 – Overall solar heat gains values

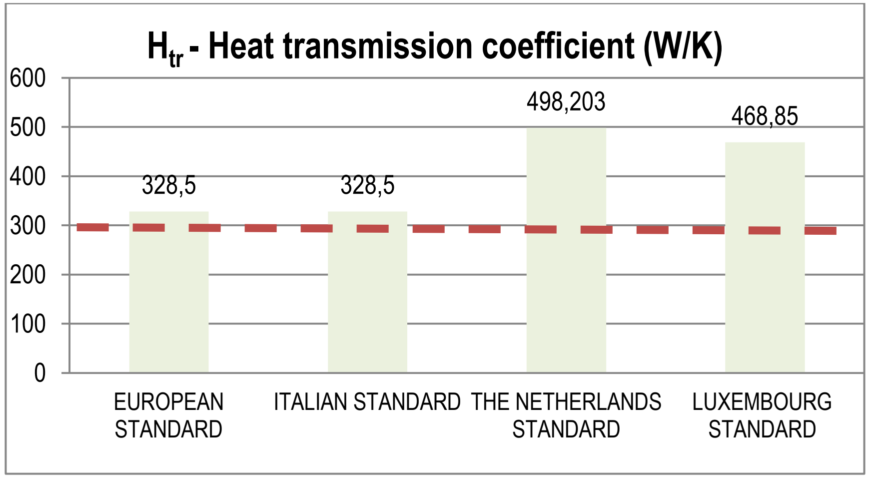


Figure 5 – Heat transmission coefficient values

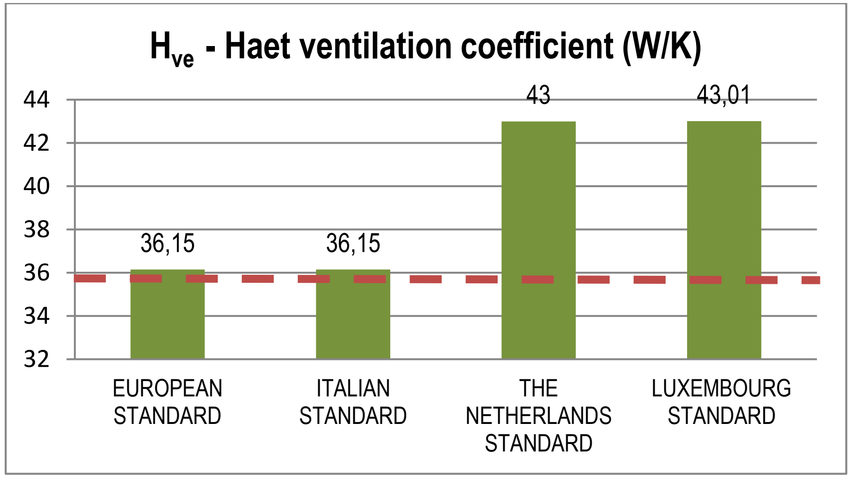
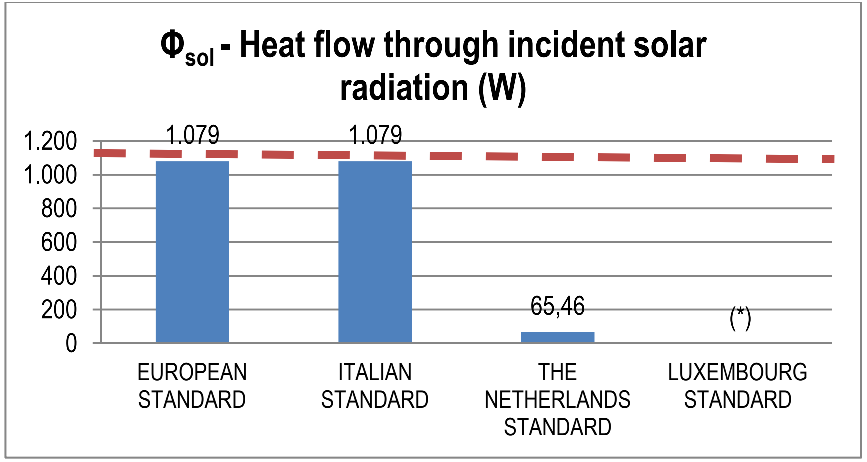


Figure 6 – Heat ventilation coefficient values



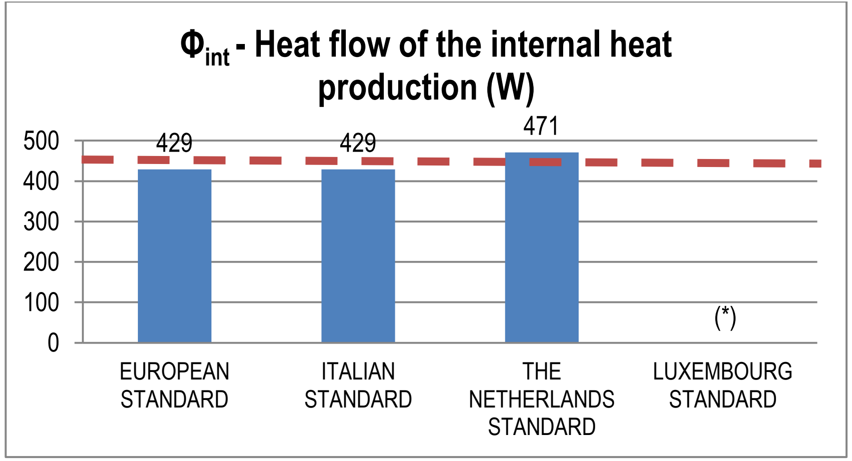


Figure 7 – Heat flow through incident solar radiation values

Figure 8 – Heat flow of the internal heat production values

(*) This value is not taken into account because Luxembourg standard not define this parameter. For general comparison, in table 9 are reported the more significant results of simulation

Table 9 – Energy need comparison values

STANDARD	Qh,nd			Qh,ht	ηH,gn	Qh,gn
	%	Wh/mq	MJ	MJ	-	MJ
EUROPEAN	0	163,391	88.231	111.909	0,995	23.796
ITALIAN	+16	190,941	103.108	126.786	0,995	23.796
THE NETHERLANDS	-31	113,131	61.091	69.442	0,990	8.436
LUXEMBOURG	+51	246,738	133.238	136.835	0,167	21.539

Here below, Figure 9 show that applied the European methodology and the National one put up different result.

There is a variance equal to +26 KWh/m^2 ; for the Italian standard; a variance equal to -50 KWh/m^2; for The Netherlands standard and finally a variance equal to + 84 KWh/m^2 for Luxembourg standard.

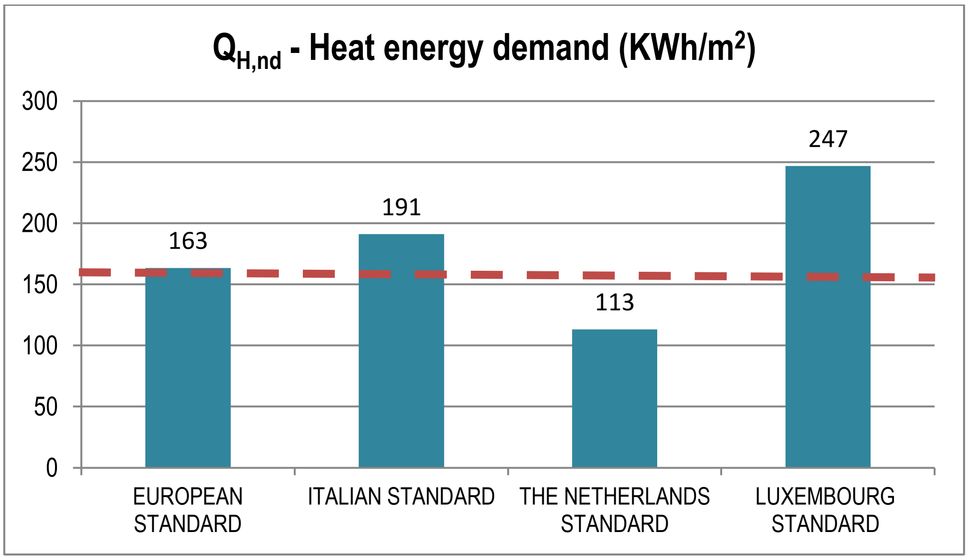


Figure 9 – Compared heat energy demand values

For the total heat transfer from the comparison to European standard, there is an increased values for Italian standard and Luxembourg standard equal respectively to +1,13 and +1,22 percentage, while a decreased value equal to -0,62 percentage for The Netherlands.

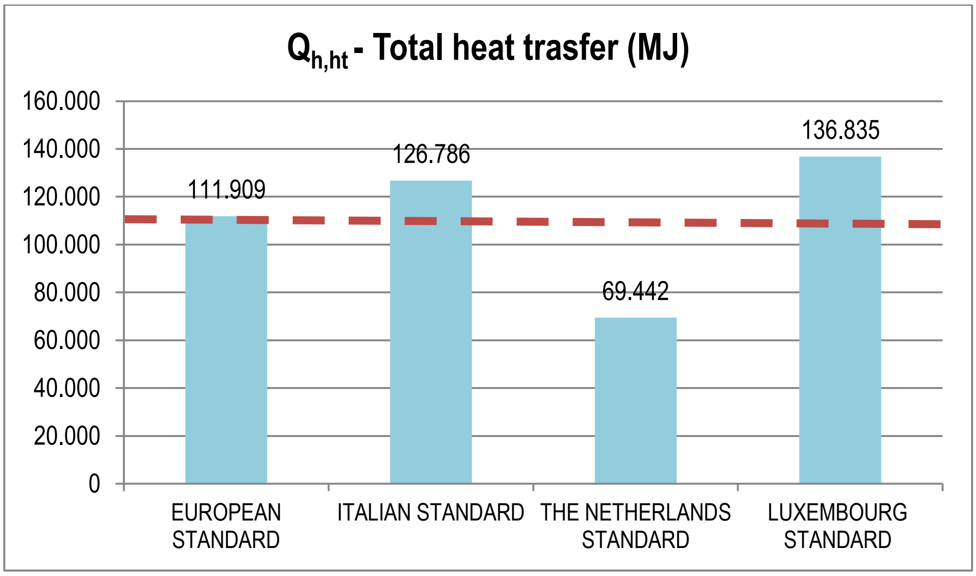


Figure 10 – Compared total heat transfer values

Related to total heat gains, here below in figure 11 show an equal value for Italian standard, a low decreased value for Luxembourg parameter and an high decreased value for The Netherlands.

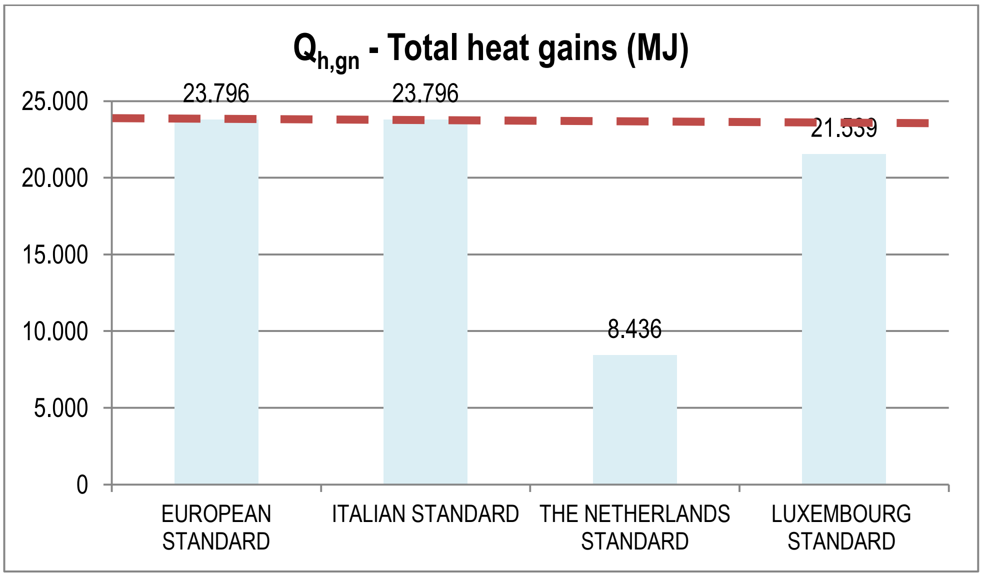


Figure 11 – Compared total heat gains value

6. Conclusion

The management of energy demand is very important since the building sector accounts for the 40% of total energy consumption of the Union, and in order to reach the objectives proposed by the Kyoto protocol.

The European Energy Performance of Buildings Directive 2002/91/EC (EPBD) have been recast throughout the 2010/31/EU of the European Parliament (European Union. Directive, 2010), in order to ensure more clarity and to revise the objectives; it considers both some aspects which have been already analysed by the past directive in order to reassert the base concepts which the energy saving is based on, and new definitions to enlarge its application field building energy performance assessment has become compulsory in Europe after the issue of the European Directive on the “Energy performance of buildings” (EPBD, European Union 2003). The EPBD sets energy performance requirements for existing buildings.

The energy performance concerns the amount of energy consumed or estimated to satisfy all the needs of the building (heating, hot water heating, cooling, ventilation, lighting). As a consequence, extensive research activities (CEN, 2005), both at national and international levels, have been carried out to create a general framework for a calculation methodology of the building energy performance. Many problems have arisen, concerning the definition of energy ratings (based on metered energy – also called operational rating – or on the calculation using standard data – also called asset rating), the accuracy of the calculation methodology (simple or detailed). In order to assure a widespread diffusion of building energy certification it is in fact very important to set up a simplified but sufficiently accurate calculation methodology.

“The European Commission has mandated CEN to produce a set of standards to support Member States for the national implementation of the EPBD. In Europe, the publication in December 2002 of the Energy Performance of Buildings Directive was followed up by a Mandate to CEN to develop a set of standards on energy performance in buildings, to support the EU Member States for the national implementation of the EPBD. More information on the set of CEN standards is given in the so called CEN "Umbrella Document" (CEN/TR 15615, 2008)” (Dijk V.D. † and Spiekman M. 2007)

ISO 13790:2008 gives calculation methods for assessment of the annual energy use for space heating of a residential building. It also provides, for instance, common rules for the boundary conditions and physical input. European standard has been developed for buildings but can be used for other types of building or other types of use (e.g. industrial, agricultural, swimming pool). The input data it may be decided at national level. As verified, normally, for the assessment of the energy performance, a protocol is defined at national level.

This study on the comparison methodology at European and National level standard allow to evaluate the homogeneity level results as request by European Energy Performance of Buildings Directive 2002/91/EC (EPBD).

In this study it was chosen the Italian, Netherlands and Luxembourg Standard that they implemented the European standard at nation level. The application of the calculation method for the energy demand, referring the same residential building, a detached house, highlighted that there isn't a homogeneity of general method. The result of single each parameter and also the general parameters show some different variance. A more systematic comparison of all standard implement by each European Member States can allow to highlight if this variance observed in the previous study is widespread at European level for each Nation or not.

Nomenclature

Definition	Symbol				Unit
	EUROPEAN STANDARD	ITALIAN STANDARD	THE NETHERLANDS STANDARD	LUXEMBOURG STANDARD	
heat demand	$Q_{H, nd}$	$Q_{H, nd}$	$Q_{H, nd}$	$Q_{h,M}$	MJ
total heat loss for the heat demand calculation	Q_{ht}	$Q_{H, ht}$	$Q_{H, ht}$	-	MJ
monthly transmission and ventilation heat loss		-	-	$Q_{tl,M}$	kWh/M
dimensionless utilization factor for heat gain	$\eta_{H, gn}$	$\eta_{H, gn}$	$\eta_{H, gn}$	η_{M}	-
the monthly utilization rate of heat gains without considering the local heat transmission with optimal regulation of ambient temperature rate	-	-	-	η_{oM}	-
the regulations' reduction coefficient	-	-	-	F_{g}	-
dimensionless numerical references parameters	Υ_{M}	Υ_{M}	Υ_{M}	-	-
numeric parameter equal to 1 for monthly calculation method	a_{H}	a_{H}	a_{H}	-	-
dimensionless numeric references parameter	$a_{H;0}$	$a_{H;0}$	$a_{H;0}$	-	
Time constant of the accounting zone	$\tilde{\iota}_{H}$	$\tilde{\iota}_{H}$	$\tilde{\iota}_{H}$	$\tilde{\iota}$	-
References time constant is equal to 15 for monthly calculation method	$\tilde{\iota}_{H;0}$	$\tilde{\iota}_{H;0}$	$\tilde{\iota}_{H;0}$	-	-
Effective internal heat capacity of the accounting zone	C_{m}	C_{m}	C_{m}	C_{wirk}	JK
Specific internal heat capacity of element	D_{m}	D_{m}	D_{m}	-	
total heat gain for the heat requirement calculation	Q_{gn}	$Q_{H, gn}$	$Q_{H, gn}$	-	MJ
the heat loss by transmission	$Q_{H,tr}$	$Q_{H,tr}$	$Q_{H;tr;mi}$	-	MJ
The dimensionless form factor k between the structure and the sky	-	$F_{r,k}$	$F_{r,k}$	-	-
The extra heat flow due to thermal radiation to the sky from building element k	-	$\Phi_{r,mn,k}$	$\Phi_{r,k}$	-	W
the ventilation heat losses	$Q_{H,ve}$	$Q_{H,ve}$	Q_{ve}	-	MJ
internal heat production	Q_{int}	Q_{int}	Q_{int}	$Q_{i, M}$	MJ
solar heat gain	Q_{sol}	Q_{sol}	Q_{sol}	$Q_{s, M}$	MJ
heat transfer coefficient by transmission	$H_{tr,adj}$	$H_{tr,adj}$	$H_{H;tr;adj;mi}$	H_{T}	W/K
correction factor for leveling of the temperature inside a home, between areas with different believed use	-	-	$f_{int;set;H;adj}$	-	-
reduction factor for night lowering the thermostat setting	-	-	$a_{H;red;night;mi}$	-	-
reduction factor for weekend lowering the thermostat setting, or interruption	-	-	$a_{H;red;wknd;mi}$	-	-
set-point temperature for heating	$\theta_{int;set,h}$	$\theta_{int;set,H}$	$\theta_{int;set,H}$	ϑ_{i}	°C
outside temperature	$\theta_{e;}$	$\theta_{e;}$	$\theta_{e; mi}$	$\vartheta_{e,M}$	°C
calculated value for the length of the month under consideration	t	t	t_{mi}	t_{M}	Ms
correction factor for time-limited heating	-	-	-	f_{ZE}	-
direct heat transfer coefficient between the heated interior space and the outside air	$H_{ve,adj}$	$H_{ve,adj}$	$H_{ve,adj}$	H_{v}	W/K
the direct heat transfer coefficient by transmission to the external environment	H_{d}	H_{d}	-	-	W/K
the steady-state heat transfer coefficient by transmission to the ground	H_{g}	H_{g}	-	-	W/K
the transmission heat transfer coefficient by transmission through unconditioned spaces	H_{U}	H_{U}	-	-	W/K
the heat transfer coefficient by transmission to adjacent buildings	H_{A}	H_{A}	-	-	W/K
projected area of the opaque plane i or the window or the door of the i external division			$A_{T;i}$	A_{i}	m^2
heat transfer coefficient of that surface i of the external division	U_{i}	U_{i}	U_{i}	U_{i}	W/m^2K
the temperature correction factor	-	-	-	$F_{\vartheta,i}$	-
fixed charge on the U-value of the field i in settlement of linear thermal bridges			$\Delta U_{for, i}$	ΔU_{WB}	W/m^2K

Definition	Symbol				Unit
	EUROPEAN STANDARD	ITALIAN STANDARD	THE NETHERLANDS STANDARD	LUXEMBOURG STANDARD	
heat flow through ventilation	$H_{ve,adj}$	H_{ve}	$H_{ve;adj;mi}$	H_V	W/m^2
density of air, = 1.205	ρ_a	ρ_a	ρ_a	-	kg/m3;
specific heat capacity of air = 1008	c_a	c_a	c_a	-	J/kgK
the specific heat capacity of air with 0.34 Wh/m^{3}K	-	-	-	c_{PL}	
the heated building air volume	-	-	-	v_n	m^3
more effective (energy efficient) air changes	-	-	-	n	
time average supply air volume flow for partial volume or combination of part of volume flow k	$q_{ve,k,mn}$	$q_{ve,k,mn}$	$q_{ve,k,mi}$	-	m^3 /s
temperature correction for partial volume flows or combination of partial volume flows, k, for heating	$b_{ve,k}$	$b_{ve,k}$	$b_{ve,k,mi}$	-	-
The time fraction of operation of the air flow element k	$f_{ve,t,k}$	$f_{ve,t,k}$		-	-
sum of the heat flow of the internal heat production	$\Phi_{int,mn,k}$	$\Phi_{int,mn,k}$	Φ_{int}	-	W
The time average heat flow rate from internal heat source k	$\Phi_{int,mn,u,l}$	$\Phi_{int,mn,u,l}$	-		W
Specific internal heat gains	-	-	-	$q_{i,M}$	m^3 /s
is the energy reference area	-	-	-	A_n	m^2
Number of unit	-	-	N_{woon}	-	-
surface of use	$A_{g,zi}$	$A_{g,zi}$	A_g	-	m^2
heat flow through incident solar radiation by construction k	$\Phi_{sol,mn,k}$	$\Phi_{sol,mn,k}$	$\Phi_{sol,k}$	-	W
the time-average heat flow rate from solar heat source l in the adjacent unconditioned space	$\Phi_{sol,mn,u,l}$	$\Phi_{sol,mn,u,l}$	-	-	W
dimensionless reduction factor for external surfaces for construction k	$F_{sh;ob;k}$	$F_{sh;ob;k}$	$F_{sh;ob;k}$	-	-
Is the reduction factor for the adjacent unconditioned space with internal heat source l	$b_{tr,l}$	$b_{tr,l}$	-	-	-
'effective collector area "construction k with given orientation and slope	$A_{sol;k}$	$A_{sol;k}$	$A_{sol;k}$	-	m^2
the average amount of energy of incident solar radiation during the calculation period, per m^2 area of construction k, with given orientation and slop	$I_{sol;k}$	$I_{sol;k}$	$I_{sol;k}$	$I_{s,M,r}$	W/m^2
dimensionless reduction factor for movable solar facilities	$F_{sh,gl}$	$F_{sh,gl}$	$F_{sh,gl}$	-	-
dimensionless solar factor of the transparent portion of the light opening	g_{gl}	g_{gl}	g_{gl}	-	-
dimensionless fraction door frame, window frame, the ratio of the projected area and total projected surface area of the daylight opening	FF	FF	FF	-	-
total projected surface area of the daylight opening	$A_{w,p}$	$A_{w,p}$	$A_{w,p}$	-	m^2
dimensionless coefficient of absorption for solar radiation from the outer surf of no-transparent structure	$A_{sol,c}$	$A_{sol,c}$	α_{Sc}	-	-
heat transfer resistance to the outside of the non-transparent structure	R_{se}	R_{se}	R_{se}	-	m^{2}K/W
heat transfer coefficient of the non-transparent structure	U_c	U_c	U_c		W/m^{2}K
projected area of the structure	A_c	A_c	A_T		m^2
heat transfer coefficient by radiation to the outside of the structure	-	-	h_r		W/m^{2}K
time-averaged difference between the temperature of the outside air and the apparent sky temperature	-	-	$\Delta\theta_{er}$		°C
is the window area of each window (clear shell mass)	-	-	-	A_i	m^2
is the total energy transmittance of a window	-	-	-	$g_{\perp i}$	
is the Partial shading factor of each window according to environmental obstruction				$F_{h, i}$	-
is the Partial shading factor of each window according by horizontal overhangs	-	-	-	$F_{0, i}$	-
is the Partial shading factor of each window according by lateral projections	-	-	-	$F_{f, i}$	
is the reduction factor due to non-perpendicular incident radiation	-	-	-	$F_{W, i}$	-
is the fouling factor of a window	-	-	-	$F_{V, i}$	-
The glass content of each window I based on the clear unfinished dimension	-	-	-	$F_{G,i}$	-

List of figure

Chapter 2

Chapter 3

List of table

Chapter 2

Chapter 3

Table 8 – Nationals percentage values from comparison to European standard (numerical value in MJ)

Table 9 – Energy need comparison values

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Chapter 2

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PART III

Policies and programmes for improving energy efficiency in buildings

EU legislation has set out an ambitious legal framework for greening builDings. The challenge will be for Member States to make this happen with the necessary drive, through efficient building policies, codes and attractive programmes addressing the many barriers existing today.

Summary

Many experts agree that the most cost-effective way of meeting climate change targets is through improved energy efficiency. At this point, there is growing acceptance of this principle, but there is still an imbalance between the resources devoted to energy supply options and energy demand-reduction options (European Parliament, 2009). The scenarios usually developed are designed to highlight the potential for improved energy efficiency in buildings making a cost-effective contribution to achieving climate targets (Kappen, J., 2008). Typically, energy efficiency initiatives are crowded out by other more immediate priorities, in part because improving energy efficiency is a long-term policy commitment. In the buildings sector, policies are effective not over two or three years, but two or three decades.

Improving energy efficiency of buildings has important macro-economic benefits and can substantially contribute to all three priorities of the Europe 2020 Strategy, as well as to the EU 2050 roadmap targets. Society as a whole will be better off as a result of investments in energy savings measures for buildings, even before the climate benefits are taken into account. Energy saving renovation programmes developed in countries such as Germany, the UK and Austria have already proved the positive impact in terms of employment and private capital triggered. There are varied estimations about the positive employment effects of energy saving renovation measures, stimulating direct employment in the construction and related industries from the materials supply chain. Energy saving activities in buildings have a great

potential for catalysing the creation of indirect and induced jobs in education, research & innovation, energy services companies, waste management (Roy J., 2013).

The political decision is the key factor in creating a favourable framework for private investors. Strong commitments with clear targets and offering long term predictability are necessary to trigger a step change in renovation practices.

To have long term programmes and associated financing is a must for transforming deep renovation strategies into common practice (Luis Olmos, 2012). More targeted measures are required for fostering the deep renovation of the existing building stock. The Energy Performance of Buildings Directive stipulates the implementation of energy saving measures only in case of deep renovation of the building and without asking for a certain depth of renovation measures. Establishing cost-optimal levels for buildings renovation should

represent an important step forward in establishing minimum requirements for the renovation depths (Rezessy S, Bertoldi P, 2010).

In order to address the challenge of renovating the existing building stock and to keep pace with the ambitious aims of the European Union for reducing and decarbonising the energy consumption and production, further improvements of the EU and national frameworks are needed. Some suggestions are presented on the next page.

At EU level, it is necessary to strengthen the existing legislation with binding measures and to establish a roadmap for the renovation of the EU27 building stock. The renovation roadmap has to be built on a long term basis with binding targets for energy efficient retrofit of the EU27 building stock by 2050. A renovation roadmap must have a clear monitoring and reporting plan with interim targets indicating the renovation rates and the renovation depths to be reached gradually by 2020 and by 2030.

The EU legislation should call upon Member States to prepare detailed deep renovation plans comprising regulatory, financial, informational and training measures.

The EU should support the harmonisation of national data collection systems concerning the energy performance of buildings, ensuring sufficient high quality data availability and closing the gap in existing systems. These data are needed to design and implement properly working policies and incentive schemes that drive the necessary change in

the building sector.

Improving the energy performance of buildings is determined by the decisions of a large number of people. There are literally millions of building owners and also very large numbers of decision makers – managers, developers – who decide what happens in all buildings, but particularly in multi-family, commercial and public buildings. What is important for policy making is to better understand the factors that affect those decisions in order to design and implement policies that will more effectively promote energy efficiency investments and actions.

Chapter 4

Analysis of various financial engineering instruments for renewable energy and energy efficiency in the programming 2007-2013

1. Introduction

Financial instruments are defined in Article 130 of the EC Financial Regulation as “Union measures of financial support provided on a complementary basis from the budget in order to address one or more policy objectives of the Union”.

In fact, the European Union considers energy efficiency (EE) is one of the primary objectives of the EU, as it is considered one of the most cost effective ways to enhance security of energy supply and reduce emission of greenhouse gases (GHG). Yet, so far, only about half of the energy efficiency improvement potential is actually realized due to market barriers and inefficient enforcement of related legislation. Severals programmes have been set up in order to stimulate EE investiments, particulary in the building stock.

Buildings are central to the EU's energy efficiency policy, as nearly 40% of final energy consumption (and 36% of greenhouse gas emissions) is in houses, offices, shops and other buildings. Moreover, the building sector (including both residential and non-residential buildings) provides the second largest untapped and cost-effective potential for energy savings after the energy sector itself. There are also important co-benefits from making buildings more energy efficient, including job creation and retention, health improvements, better energy security and industrial competitiveness and fuel poverty alleviation (the latter being particularly relevant in the current financial and economic situation, where the number of vulnerable customers facing energy poverty is increasing).

The two directive that regulate the energy efficiency financial support in building sector are the EPBD and the EED.

In particulary the Article 10 of the Energy Performance of Buildings Directive recast (2010/31/EU) hereafter called the "EPBD") is focused on:

- the effectiveness, the appropriateness of the level, and the actual amount used, of structural funds and framework programmes that were used for increasing energy efficiency in buildings, especially in housing;
- the effectiveness of the use of funds from the EIB and other public finance institutions;
- the coordination of Union and national funding and other forms of support that can act as a leverage for stimulating investments in energy efficiency and the adequacy of such funds for achieving Union objectives."

The second, the new Energy Efficiency Directive (hereafter called the 'EED') requires Member States to facilitate the establishment of financing facilities or use of existing ones for energy efficiency improvement measures to maximise the benefits of multiple streams of financing. More specifically for buildings, by April 2014, Member States should have establish a long-term strategy for mobilising investment in the renovation of the national building stock, including policies and measures to stimulate cost-effective deep renovations.

2. Structural cohesion funds for energy efficiency in buildings 2007-2013: an overview

In light of the current economic situation, one way the public sector can invest in building energy efficiency is by using European Structural and Cohesion Funds (Francesco Aiello, 2012), financial tools set up to implement the regional policies of the European Union (also known as Cohesion Policy).

The previous regional policy framework, from 2007 to 2013, had allocated €350 billion.

The Structural and Cohesion Funds had offered a good opportunity to bridge the gap between potential and actual energy efficiency investments, as part of the funds is directly dedicated to sustainable energy. The share for energy efficiency and renewable energy had represented about €9 billion, of which €4.3 billion is available for New Member States.

The Cohesion Fund and the Structural Funds (Reggi L., 2014) are financial tools set up to implement the regional policy of the European Union. They aim to reduce regional disparities in terms of income, wealth and opportunities. In more detail the Cohesion Fund will among other support the shift towards a low-carbon economy in all sectors, climate change adaptation and risk prevention and management, and may pursue climate action in relation to transport and environmental investments.

Structural Funds are made up of the European Regional Development Fund (ERDF) and the European Social Fund (ESF).Cohesion Funds are used to fund projects in the environment, transport, infrastructure and renewable energy sectors. More than a third of the European Union budget is used for Cohesion Policy. Structural Funds there are two types:

- The European Social Fund (ESF)will among other support the shift towards a low-carbon and climate-resilient economy through reform of education and training systems, adaptation of skills and qualifications, up-skilling of the labour force, and the creation of new jobs.
- The European Regional Development Fund (ERDF)will among other promote energy efficiency in small- and medium-sized enterprises, housing and public buildings;

production and distribution of renewable energy; low-carbon strategies for urban areas; and resilience to climate change and extreme weather events. Furthermore, the ERDF will support European Territorial Cooperation (ETC), for example cross-border co-operation between Member States, including on climate action.

At EU level, Structural Funds are centrally managed by the European Commission (DG Regio). The European Commission drafts regulations, called Community Strategic Guidelines, outlining the aims and objectives for the funding period. Member states propose a National Strategic Reference Framework (NSRF) which outlines the priorities, strategic framework and available budget for the Operational Programmes (OP) . EU cohesion policy complements national funding so member states also commit some the National budget to the Operational Programmes.

Managing Authorities , appointed by member states, are responsible for managing the Operational Programmes, informing potential beneficiaries, selecting projects and generally monitoring implementation of the Structural Funds at regional or national level. This interactive map details existing Managing Authorities in all member states. In the current programming period, the budget for the Structural Funds is divided among 355 Operational Programmes.

Applications for funding are welcomed from private, public and third sectors who propose projects that deliver on Cohesion policy objectives.

Once an applicant identifies a project opportunity, they need to check the eligibility of the project under the existing Operational Programme and contact the Managing Authority (MA) or an Energy Agency to verify that there is still money left in the Operational Programme to finance the project. Usually funding is allocated through a call for proposals, although some MAs have open calls with no specific deadline.

The contribution of Structural Funds depends on the type of project, on the focus of the Operational Programmes and on the beneficiary. The funds partially finance projects and it is the responsibility of the applicant to get the remaining co-financing, through bank loans, local or regional funds or by private means. In general, EU co-financing rates go from 50% in the more developed regions to 80% in the less developed ones. It can be as low as 20% in Western Europe.

3. *Programs at european levels*

Here is reported a short description of the three main financing mechanisms (World Bank, 2013) which are:

- The grants;
- The debt financing;
- The Guarantees.

Grants are non-reimbursable financial contributions for the implementation of specific SE measures selected by

The final recipient from a pre-defined list. Grants are one of the most common forms of financing for SE projects (Rezessy S, Bertoldi P, 2010), particularly where technologies are pre-commercial or in the early stages of commercial deployment or are otherwise prohibitively expensive.

This instrument is usually conceived to promote new technologies and are more suitable for early stage development including projects below cost-optimal levels.

A grant may cover the cost of technical assistance or may cover the cost of technical assistance to private and public beneficiaries/recipients to support them in the best choice of SE measures. Grants and subsidies may be managed directly through a national administration or, if combined with preferential loans, through a dedicated fund. A grant will often cover only part of the total cost and usual requires some form of co-financing. Rates may vary from 20% up to a maximum of around 75%. Target recipients and measures can be defined through the use of eligibility criteria. Grants can be combined with other financing mechanisms, such as preferential loan schemes, to incentivize the uptake of measures that are less likely to be selected because they have longer pay-back times.

The advantages of this financial instrument are:

- Versatile and can be used to achieve a variety of policy objectives. In the context of SE, grants can be deployed to support innovation and technology development and can also be used to target support at specific end-users to meet social policy objectives such as fuel poverty.
- Can be used for proof of concept and demonstration activities and to encourage uptake of innovative / below cost-optimal measures.
- Enable SE measures identified as priorities by policy makers to be implemented.

- Conditions can be attached to grants to stimulate further private investment (e.g. require the simultaneous installation of other EE measures).
- Represent a flexible mechanism that can be used in combination with other financial mechanisms or technical assistance packages.
- Particularly suitable for economically depressed areas, immature / financially constrained markets.

The disadvantages instead are:

- Risk that desired outcomes are not achieved (e.g. investment in a specific type of measure).
- Risk of overspend if grant distribution process is not carefully communicated and managed.
- Can only be used once (compared with revolving funds for example), therefore limiting the utility and sustainability of public funding.
- Limited leverage and impact, tendency towards overpriced solutions.
- Little transparency and performance control

Relating to the **debt financing**, it is identified by preferential loans and is the simple form of debt. It is an agreement to lend a principal sum for a fixed period of time, to be repaid by a certain date and with interest calculated as a percentage of the principal sum per year and other transaction costs. Soft loan or preferential loan schemes are a mechanism whereby public funding helps to reduce the cost of loans disbursed by financial intermediaries such as commercial banks. The loan configuration varies depending on the borrower/lender and the type of measures to be undertaken. However actual

pay-back time is usually taken into account in the loan.

This instrument is constituted by measures which may include partial refurbishment, major renovation and new construction and preferential loans that are relating to target only the envelope or a specific technology, most support a mixture of measures and technologies that have been previously selected following specific criteria.

Generally a dedicated system of preferential loans is implemented through:

- Selected commercial banks delivering loans;
- A revolving fund managed by a third party;
- A fund managed by the EIB or a national energy agency.

Loan maturity usually matches the actual pay-back time of SE projects in buildings. Depending on the type of measures financed, loan maturity may vary from 5, 10 or 20 years. The interest rates vary across MSs, regions etc. Currently they range from 1% to 5%. Rates at around 3% are considered to be preferential. Typically, the interest rate will be fixed over a certain period of time and will be capped to a maximum throughout the course of the loan. Corporate or project loans can be done under recourse or limited recourse structures:

- Financing with recourse implies that the company stands behind the project or venture and the related debt. This means that financiers recognize the company’s assets in the event of default. The debt holder then reports the loan on its balance sheet as a liability – hence the terms corporate financing or 'on balance sheet' financing. Businesses are often willing to use recourse finance only for core business activity and not for projects in auxiliary areas, such as energy efficiency.
- Limited recourse financing (or project finance) refers to transactions whereby the project is financed largely based on its own merits. Project finance is long-term financing based upon the projected cash flows of the project rather than the balance sheets of the project sponsors. The financing is typically secured by all of the project assets, including the revenue-producing contracts. Project lenders are given a lien (or call) on all of these assets, and are able to assume control of a project if the project company has difficulties complying with the loan terms.

The main advantages are that the final recipients are incentivized to select the most appropriate and cost effective measures; it is a well understood mechanism among project developers, MAs, beneficiaries and final recipients; the money can be reinvested into more projects, since loans are repaid.

The disadvantages are instead are the final recipients do not always see the advantage of a loan with low interest rates and are less incentivized to take part and the EE savings may not always be considered as a project cash flow by some financial intermediaries (possibly due to a lack of sector knowledge), often extending considerably the pay-back period

for the measure.

Guarantees are a type of risk sharing mechanism where the guarantor (e.g. a public body) assumes a debt obligation should a borrower default. For limited or partial guarantees the guarantor is only liable for part of the outstanding balance at the time of default, usually defined as a fixed percentage. This financial instrument can be used to help smaller financial institutions and ESCOs access capital at an acceptable cost. With partial credit guarantees the contracts are between lender and borrower (loan agreement) and between guarantor and lender (guarantee agreement). In partial risk guarantees the contracts are between guarantor and investor/lender and between guarantor and host country government.

The main features that must be set out include: clear definition of the circumstances which would trigger the guarantee payment; the risk sharing formula; timing and calculation of guarantee claim payment; responsibilities for collections against defaulting borrowers; disposition of recovered monies; maximum single loan guarantee exposures; guarantee approval and issuance procedures; and, guarantee fees.

The advantage of this financial instruments are describes hereinafter. Guarantees help bridge the gap between the credit risk perceived by the lender and the actual credit risk. They can provide additional comfort to financial institutions, particularly local institutions, in relation to technologies or project approaches where they have less experience. The guarantee can therefore help project developers (or loan applicants) to access finance and reduce the cost of capital. Partial-risk guarantees enable the loan repayment period to be extended and the interest level to be reduced, thus improving project cash flow and viability. They can also increase debt to equity ratios, enhancing returns to project developers. The guarantees backed by public bodies help to direct the flow of private funds towards EE projects through risk mitigation, and therefore lever higher levels of private financing.

The disadvantages instead, shown that the guarantees are not appropriate for all market situations and are not necessarily suitable for use in isolation. Where liquidity in financial institutions is considered the main barrier to financing, guarantees are of limited use. However, guarantees can form part of a broader strategy to increase lending among banks with good liquidity but a low risk appetite.Genertally partial credit guarantee schemes do not provide an adequate solution to situations where a project investor has insufficient equity.

As a result of the EU-wide promotion of RE targets and carbon emission reductions, a large number of EU-wide and national initiatives have sprung up in recent years. It is often difficult to keep track of all EU initiatives and policies. However, close interaction with the different stakeholders involved is very important to the successful implementation of an OP. EU-wide initiatives often encourage knowledge sharing and collaboration across different MSs and stakeholders. MAs must maintain awareness of active stakeholders in their area of operation and engage in discussion with them to select OP priorities and funding mechanisms suitable for the activities being planned by municipalities and local players. MAs should launch public consultations with these stakeholders to get their views on the existing needs of a specific area.

Here below is reports a review of some European financial Programmes.

3.1 Covenant of mayors

An interesting example of such an initiative is the successful **Covenant of Mayors (CoM),** a pan-European initiative coordinated by the European Commission DG Energy. It oversees the commitment of the municipalities to achieve and even exceed the EU's CO2 emission reduction target of 20% by 2020. By signing up to the CoM, signatories commit to taking the necessary EE and RE measures through the adoption of "Sustainable Energy Action Plans" (SEAPs). In order to present their SEAP, municipalities are required to prepare a "Baseline Emission Inventory" that quantifies the energy-related CO2 emissions that occurred in the territory of a signatory within a given period of time. This exercise allows the signatories to identify the principal sources of CO2 emissions in their territory and select the most suitable SE measures. Signatories are free to select the format and measures included in the SEAP, such as building sector, transportation sector, production of local electric energy (folic, photovoltaic…).

However, these must cover a series of priority target sectors, including the building sector that has seen the most activities linked to SEAP implementation. This is because smaller municipalities have less responsibility and freedom of action within other sectors such as transport and energy production. The CoM (Georgios C. et all.) is now widely adopted across MSs and has promoted the systematic planning of SE policy for large and small municipalities alike that are now seeking funding to implement their SEAPs. MAs should seek to ensure that they identify both CoM signatories in their areas and the types of project that could be financed to implement their SEAP.

Other similar initiatives through which relevant stakeholders can be identified and local experience leveraged include the Pact of the Islands, which is very similar to the CoM but focuses on the needs of islands, and the SMART Cities and Communities Innovation Partnership.

3.2. The European Energy Efficieny Fund

The European Commission in July 2011, with a global volume of EUR 265 million, launched the fund to finance energy efficiency projects, the European Energy Efficiency Fund (EEE-F) as part of the European Energy Programme for Recovery (EERP), that providing tailor-made debt and equity instruments to local, regional and (if justified) national public authorities or public or private entities acting on their behalf.

The new fund promoted by Deposits and Loans Fund, the European Commission, the European Investment Bank and Duetsche Bank, aims to contribute to the development of energy efficiency projects and renewable energy in the EU. It is a fund that will use unspent resources from the European Energy Programme for Recovery (EERP), the European Energy Programme for Recovery, which financed projects in the energy (carbon capture and storage, offshore wind energy, infrastructure for gas and electricity).At the beginning, the European Union has allocated approximately € 146 million taken from the EEPR program (3.7% of its budget). These were funds that, although committed in 2009, were not disbursed to projects in infrastructure, offshore wind energy and the capture and storage of CO2 (CCS).

EEE F aims at financing bankable projects in energy efficiency (70%), renewable energy (20%) and clean urban transport (10%) through innovative instruments and in particular promoting the application of the EPC. A technical assistance grant support (EUR 20 million) is available for project development services (technical, financial) linked to the investments financed by the Fund.

The fund offers a wide range of financial products such as loans and private equity in projects that involve the participation of public authorities at national, regional or local level. At the beginning, the fund had a financial availability of € 256 million: € 125 million as a contribution from the Commission (budget of € 146 mil, 21 will be devoted to technical assistance), € 75 million from the Bank of Investments European (EIB), € 60 million from the deposits and Loans Fund and € 5 million from Deutsche Bank. Local authorities and public, private companies that manage public services on behalf of public bodies, such as the ESCo or public transport company, can request the funding. The fund finances projects starting 5 M€. The maximum duration of the loan is 15 years, but it could be up to 20 years.

3.3 The Energy Intelligence Europe Programme

The program Intelligent Energy Europe- IEE aims to help achieve the goals set in the "Energy Strategy for Europe 2020" promoting the efficiency, diversification of energy resources and the use of renewable energy. On 24 October 2006, the European Parliament and the Council approved the establishment of a EUR 3.6 billion Competitiveness and Innovation Framework Programme (CIP) (2007- 2013).

The Intelligent Energy Europe II (IEE II) programme was included in this framework programme (with a budget of EUR 730 million) to contribute to achieving the objectives of EU energy policy and to implementing the Lisbon Agenda. More specifically, IEE II's objective is to support the overcoming of non-technological barriers to the innovation, uptake, implementation and dissemination of solutions that contribute to sustainable, secure and competitively priced energy for Europe.

Between 2007 and 2011, IEE II supported more than 300 promotion and dissemination projects, representing more than EUR 300 million, allocated as follows:

- INTEGRATED (projects addressing both energy efficiency and renewable energy): 27%
- STEER (energy efficiency in transport): 17%
- SAVE (energy efficiency in buildings, products and industry): 25%
- ALTERNER (renewable energy sources): 31%

As regards its effectiveness, projects selected in 2009-2011 are estimated to have triggered cumulative investment by European stakeholders in sustainable energy of more than EUR 1500 million. This is mainly due to IEE projects preparing the ground for investment by increasing skills, publishing information for investors, supporting policy implementation, mobilizing decision makers, and funding technical assistance. The estimated fossil fuel energy

savings and greenhouse gas emissions reductions for all those projects were at least 350 000 tones of oil equivalent per year and 1 200 000 tones of CO2 equivalent per year24. Nearly a quarter of IEE II projects have targeted the building sector. An evaluation of the programme in 201125 concluded that "the programme is relevant and useful as it replies to the evolving needs, problems and barriers related to sustainable energy issues that Europe is facing. The combination of the actions which covers a wide spectrum of priorities, the involvement of different type of actors and in particular the combination of market solution oriented projects and projects targeting policy adaptation contribute to the effectiveness of the programme."

Moreover, the evaluation stated: "The assessment of the effectiveness of the actions supported, and taken individually, demonstrates that the activities co-funded/funded by the programme are likely to reach their objectives and to achieve expected results and lasting effects."

3.4 The "ELENA" promramme

ELENA is part of the EIB's broader effort to support the EU's climate and energy policy objectives. This joint EIB-European Commission initiative helps local and regional authorities to prepare energy efficiency or renewable energy projects. Funding for ELENA comes from the European Commission's Intelligent Energy Europe II (IEE) programme, with total commitments so far amounting to EUR49m. The money is used to provide technical assistance to local and regional authorities seeking to implement their energy plans.

Urban areas account for around 70% of the energy consumption of the EU, yet the potential for sustainable energy related investments has until now remained largely untapped. The European Local Energy Assistance (ELENA) facility aims to help public authorities exploit this potential by improving the chances that their plans will be able to attract external finance. Many cities and regions have recently started to prepare major energy efficiency and renewable energy proposals and have signed up to the Covenant of Mayors initiative (www.eumayors.eu), under which they undertake to go beyond the EU's planned 20% cut in CO_2 emissions by 2020. When it comes to implementation, the problem is not so much availability of finance as lack of know-how or capacity to implement large-scale projects.

ELENA aims to encourage authorities to think ambitiously and develop energy..

ELENA funds can be used for structuring programmes, business plans and additionally needed energy audits, preparing tendering procedures and contracts, and paying for project implementation units. The EU contribution can cover up to 90% of eligible costs. Investment programmes can involve the improvement of energy efficiency in buildings or street lighting, the integration of renewable energy sources in buildings or the renovation or installation of district heating systems using combined heat and power or renewable sources. Urban transport programmes relating to enhanced energy efficiency, such as the introduction of energy-efficient buses or increased renewable energy use in transport

(e.g. infrastructure for alternative fuel vehicles), are also eligible.

The aim is to generate bankable investment projects that can attract outside finance, for example from local banks or other financial institutions, such as the EIB. These projects can also be implemented by energy service companies (ESCOs), which are service providers that guarantee future savings made on energy bills and can fund projects upfront that are refinanced through the savings achieved. As the Commission's Energy Efficiency Plan underlines, ESCOs can help public authorities to upgrade buildings by grouping them into scalable projects under energy performance contracts. Elena program was funded under the CIP - Intelligent Energy Europe II (IEE) .

To access the financing is required minimum leverage factor of 25, which must be reached between the investments related to the project and the funding granted to the beneficiary. In accepting the technical assistance, the beneficiary agrees that the amount received will be refunded if the leverage factor not reached. The ELENA aims to stimulate the development of investment programs of a certain size, usually in excess of 50 million euro. Smaller scale projects are supported if integrated into programs of larger scale. ELENA can be combined with other European funds or national. To be supported by the ELENA project presented must last no more than three years.

The investment programs financed with ELENA must fall in one of the following areas:

- Public and Private Buildings: including public buildings, street lighting and traffic, in order to achieve greater energy efficiency. For example: the renewal of the buildings in order to decrease energy consumption (electricity and heating) through the thermal insulation, efficient systems for air conditioning, ventilation, and lighting. Integration of renewable energy sources in buildings. For example: solar photovoltaic, solar thermal and biomass.
- Investments in the renewal, extension and construction of new networks of heating / cooling, including networks combined cycle (CHP), decentralized systems combined cycle.

ELENA does not provide the launch of calls, but the allocation of funding on the basis of the projects submitted, subject to availability of funds. In order to request technical assistance with ELENA must send a preliminary to the EIB a summary description of the investment program with the following information:

- A brief statement of the project, including the type of investment and the arrangements for implementing the program;
- The cost and on schedule;
- The cost, scope and needs to be covered through technical assistance request.

Based on the information provided in this preliminary phase, the Bank assesses the proposed project meets the selection criteria and the financial viability of the project. The EIB in turn submit the proposal to the European Commission for its approval. In the case of a positive assessment by the European Commission you enter the negotiation phase between the EIB and the public authority beneficiary, on the basis of the proposal approved by the Commission. In it are better defined the time, cost and scope of this provision of technical assistance and the methods of management, monitoring and reporting of the project. The approved project must not be longer than three years.

The funding program generally includes:

40% of the funds paid immediately;
30% after approval of the interim report;
30% after approval of the final report.

3.5. The "JESSICA" programme

JESSICA - Joint European Support for Sustainable Investment in City Areas, is an initiative of the European Commission developed in co-operation with the European Investment Bank (EIB) and the Council of Europe Development Bank (CEB). It supports sustainable urban development and regeneration through financial engineering mechanisms.

EU countries can choose to invest some of their EU structural fund allocations in revolving funds to help recycle financial resources to accelerate investment in Europe's urban areas.

It gives Member States the right to choose, to use part of the appropriations of the Structural Funds to make repayable investments in projects forming part of an integrated plan for sustainable urban development. These investments, which may take the form of equity, loans and / or guarantees are made via Urban Development Funds and, if required, Holding Funds.

In order to use this instrument, Member States should enter in their "Operational Programmes 'an' urban component" on action in the urban sector, including, preferably, a statement of the possible use of JESSICA for the realization of such interventions. Member States must also decide what proportion of the Structural Funds which they wish to use right out of JESSICA.

JESSICA promotes sustainable urban by supporting projects in the following areas:

a) **urban infrastructure**, including transport, water/waste water, energy;

b) **heritage or cultural sites** for tourism or other sustainable uses;
c) **redevelopment of brownfield sites**, including site clearance and decontamination;
d) **creation of new commercial floor space** for SMEs, IT and/or R&D sectors;
e) **university buildings** such as medical, biotech and other specialized facilities;
f) **Energy efficiency improvements**.

Contributions from the European Regional Development Fund (ERDF) are allocated to Urban Development Funds which invest them in public-private partnerships or other projects included in an integrated plan for sustainable urban development. These investments can take the form of equity, loans and/or guarantees.

Alternatively, managing authorities can decide to channel funds to UDFs using Holding Funds which are set up to invest in several UDFs. This is not compulsory, but does offer the advantage of enabling managing authorities to delegate some of the tasks required to implement JESSICA to expert professionals. Owing to the revolving nature of the instruments, returns from investments are reinvested in new urban development **projects**, thereby recycling public funds and promoting the sustainability and impact of EU and national public money.

The advantages of use JESSICA are hereinafter described:

- **Sustainability**– Financial engineering instruments such as JESSICA are based on the provision of repayable assistance from the structural funds to investments which should generate returns and in this way pay back investors. This offers a **more sustainable alternative** to the assistance traditionally provided through grants.
- **Leverage** by combining structural funds with other sources of funding that may already exist, JESSICA will boost resources making it easier to provide support to a larger number of projects
- **Flexibility -**JESSICA offers **flexibility**, both in terms of structure, and in the use of funds by way of either equity, debt or guarantee investment, which can be tailored to the specific needs of particular countries and regions
- **Expertise -** JESSICA enables structural fund managing authorities, cities and towns to engage with the private and banking sectors. This helps to leverage further investment, as well as technical and financial capacity in project implementation and management

- **Partnerships -** JESSICA is the result of the partnership established between the Commission, EIB and CEB. It can also act as a powerful **catalyst for** the establishment of partnerships between countries, regions, cities, EIB, CEB, other banks, investors, etc. to address the problems faced by urban areas

The eligibility criteria of investment instrument JESSICA, identical to those governing the use of the Structural Funds in general, should take into account any specific restrictions imposed nationally. Apart from specific non-eligible, listed in the Regulations, such as housing in some Member States, JESSICA may allow more flexible management of the projects, in compliance with the eligibility criteria, provided that the projects concerned fall in plans' integrated 'sustainable urban development. JESSICA could also act as a catalyst in urban areas to enhance the investment market and therefore complement other initiatives or sources of funding that may already exist in Member States. However, the participation of the private sector must always take into account the rules on state aid.

As stated previously JESSICA is an initiative launched by the European Commission and the EIB, in support of a common policy.

3.6 The LIFE+ programme

Environmental protection is one of the key dimensions of sustainable development of the European Union. It is a priority for Community co-financing and should be funded primarily through the Community's horizontal financial instruments, including the European Regional Development Fund, the European Social Fund, the Cohesion Fund...These Community financial instruments do not cover all environmental priorities. Too supply this lack it has been created the (LIFE+). The financial instrument provides specific support for developing and implementing Community environmental policy and legislation.

LIFE+ presents three components:

- LIFE+ Nature;
- Biodiversity +LIFE+ Environment Policy and Governance,
- LIFE+ Information and Communication.

The general objective of LIFE+ shall be to contribute to the implementation, updating and development of Community environmental policy and legislation, including the integration of the environment into other policies, thereby contributing to sustainable development.

Public and/or private bodies, actors and institutions may receive financing through LIFE+. The financial envelope for the implementation of LIFE+ shall be set at EUR 2 143 409 000 for the period from 1 January 2007 to 31 December 2013. Community funding may take the following legal forms as typology of interventions:

(a) grant agreements;

(b) public procurement contracts

For action grants, the maximum rate of co-financing shall be 50 % of eligible costs. In the case of public procurement contracts, Community funds may cover the costs of purchase of services and goods. These costs may include expenditure on information and communication, preparation, implementation, monitoring, checking and evaluation of projects, policies, programmes and legislation. The 78 % of the budgetary resources for LIFE+ shall be used for action grants for projects.

In conclusion funding instruments have been at the core of most EU sustainable energy funding programmes activities with some examples of debt-based financing instruments and hybrid schemes involving loans, equity, and guarantees in attempts to leverage public funds and draw in more private finance.

4. Programs for energy efficiency in buildings at national level: the Italian case study

Rational use of energy is promoted in Italy since the last century. The first measure was the law May 29, 1982 No. 308, which was promoted with the first campaign of incentives for the construction, agriculture and industry, with capital funding and the interest, in support of the national energy policy.

The law was intended to encourage the reduction of energy consumption and utilization of renewable sources. In the construction sector were financed capital, up to a maximum of 30% of eligible, interventions such as the insulation of existing buildings, the installation of new heat generators, installation of heat pumps, systems photovoltaic or other renewable source for the production of electric energy, of integrated control systems able to adjust and account for each user, the energy consumption.

At a distance of about ten years, was later enacted the law 9 January 1991 n ° 10 which confirmed the previous system of law 308/82, with its distinction between interventions imposed on regions and interventions charged to the Ministry of 'industry and Trade. As for the regions, the incentives in the construction sector capital ranged from a low of 20% and a maximum of 40% of eligible, were also included new types of interventions, beyond those already required by law 308/82, such as the transformation of centralized heating systems in single-family gas for heating and production of sanitary hot water, and the installation of high performance systems.

In recent years as a result of the various agreements undertaken in the Community has been increasingly significant commitment to the identification of interventions in the field of energy efficiency. The conclusions of the European Council of 17 June 2010 confirmed that the objective of energy efficiency was part of the priority objectives of the Union's new strategy for smart, sustainable.

In view of the objectives set by the so-called "climate and energy package 20/20/20" (Directive 2009/29 / EC), were enacted two European directives (the 2010/31 / EU and 2012/27 / EU) which engage Member States to prepare the actions aimed at improving energy efficiency of buildings.

Directive 2010/31 / EU implemented in Italy with DL 63/2013 promotes the improvement of the energy performance of buildings, taking into account outdoor climatic and local conditions.

Directive 2012/27 / EU, instead, asks Member States to save energy by setting national indicative targets for energy efficiency. Action of particular relevance under that Directive concerns the commitment of Member States to mobilize investments in the restructuring of the national park of residential and commercial buildings, both public and private. In addition, each year will be renovated and made energy efficient 3% of the surface of the properties owned by the central government agencies. This action should allow to refurbishment the existing building according to the principles of energy efficiency and thereby contribute to the achievement of that fateful 20% in 2020 (Newell, R.G., 2007).

As part of this process, and in order to implement this objective at national level, the Member States undertook to set targets and to indicate in their national reform programs as intended to achieve them (Bonaccorsi, A., 2010).

In this scenario of strong commitment to reducing energy consumption in 2020, in Italy in recent years have developed several mechanisms to encourage efficiency and energy saving. In particular, the financial instruments to support the energy efficiency in force today are: the Energy Efficiency Certificates, the and Tax Deductions for work on existing buildings.

4.1 Tipological financial instruments

Financial instruments can be summarized into 7 typology: Hereinafter is reported a synthetic description of each instruments with the aim to furnish the reader a clear framework of the state of art.

Is not possible define which is the best but it is important an synergy between these financial instrument, here below described, and the European, Natioanl and Regional ones with the goal to create a suffessfull financial strategy in the green economy.

The **capital account or no repayable loan**, is used to realize major works or buy strumental goods. This instrument is disbursement by State or other Autorithy through specific investment financial programs.

To obtain a contribution is required previously a documentation, in which are indicated the cost for the investment. An example of this type of loan are the European financial instruments, particulary the Operating Regionals Programs. In this case the Autorothies (Region or Nation) give a percentage of investment without giving back the capital. This instrument have a low level action, therefore, if exist a contribution equal to 1 M€ with a finanziament of 50% of investment, the capital that will giving back to the territory is equal to 2 M€

The loan in capital account is a good instrument to promote the innovation technology such as photovoltaic, eolic,…and the high the level of research in industries that, at the beginning, have an high level of risk and needed a external contribution.

The **interest capital loan** is a given benefit againist a finalcial taxes, related to a medium or long time, to realize a major work or a service. The contribution can be constituded by a favoured rate loan or by a decresed of rate market that has been assumed. This loan is good for technologies or major work that are a suitable level in the marketplace, low investment cost at the beginning but which have some difficult to access into the credit financial investment, because have an high rate of interest. This instrument have a medium level action. In fact if exist a contribution equal to 1 M€ with a finanziament of 50% of investment, the capital that will giving back to the territory is equal to 4 M€

The Guarantee Fund is a financial instrument that facilitates access to credit for SMEs. The fund intervenes by issuing guarantees for SMEs to allow them access to external financing, in return for a fee to cover the risks and costs of administration and management. Businesses that need capital for their investments to require banks, or to other lending institutions, funding that is directly guaranteed by the Guarantee Fund. The companies will thereby be relieved from the obligation to present collateral (collateral and personal guarantees income, guarantees, insurance policies, etc) usually required by banks. The guarantee instrument is typically used by new business start-ups and innovative companies and growing rapidly. In the context of the energy sector this type of tool could be used for the incentive ESCO.

You can not quantify a priori the leverage effect of this funding instrument because there are several factors that come into play such as the type of investment that must be made, the technical soundness of the company etc

The revolving funds are financial instruments in support of enterprises (Rezessy S, Bertoldi P, 2010). These funds are known as rotary why are fed, as well as by public funds, also from the sums cyclically returned by the recipient companies. This money overseas people come used permanently in time the financial resources to which it is fitted in that, as the beneficiaries return the capital they have received, this becomes available in the coffers of the fund and may be re-used to finance new intervention programs. Generally the funding requested by the beneficiaries of the revolving fund are covered for a certain percentage of the fund itself, without the payment of any accrued interest, and the remaining part is granted by financial institutions under normal market conditions (share capital plus interest). Alternatively, they can be granted concessional funding.

The advantages of revolving funds are self-supply of the fund through the repayment of the benefit of a larger number of companies and the reduction in the interest rate on loans (through public funding at zero interest and bank funding rate agreement).

This tool has been applied in the energy field with the Kyoto Fund, established by the Finance Act of 2007 at the CDP but made active in February 2012. The Kyoto Fund is a revolving fund for the financing of measures to reduce emissions of climate altering, aimed at implementing the Kyoto Protocol. It is a fund of 600 million euro, divided in three annual cycles from 200 million each, to finance a series of measures to reduce greenhouse gas emissions.

From the standpoint of technical and economic, through the Fund can obtain subsidized loans, with a fixed rate of annual interest set - with DM Finance November 19, 2007 - at 0.5%. Loan duration is between 3 and 6 years (between 3 and 15 years only to the public) in relation to the type of investment to be undertaken.

Contribution in energy bills is a type of grants which is supply by the State or other entity facilitation in relation to electricity produced by the plant. In particular, this contribution may vary in relation to the type of plant and the installed power.

In Italy this mechanism was applied initially for Photovoltaics and then with the ministerial decrees Income Electric (DM 06-07-2012) and Income Thermal (DM 28/12/2012). It 'a very interesting and very innovative in the production of electricity and heat from renewable sources; from the technical point of view is the one that rewards better the efficiency of the technology which aims to achieve, as the higher the efficiency of the plant, the higher the revenues are obtained.

The **contribution in tax deductions is a tax break linked to liability tax and not a credit tax**

The facilitation consist in a percentage deduction from cost support, relating the intervention indicate in the law. Thi deduction are subdivided in equal annual shares, for a specific time.

In Italy this instrument is used in order to financing the energy efficiency sector from 2007; during the time this contribution go through a revision that incremented the percentage of deduction.

The mechanism of tax deductions has been a strong driving force for the construction industry related to energy efficiency. Especially with the Law n.90 / 2013 this instrument shall be established in time as early as 1 January 2014.

The **contribution on energy saving** is constituted by securities from State or other Authority such as “GSE”.

This autorithy certificate the measure of saved energy through energy efficiency projects.

In Italy this tool is applied in TEE (Title in energy efficiency also called white certificate) .

This rappresent the more innovative tool in enenergy efficicency sector, because better repay the energy saved. The subsidy is disburse according the type of intervention and the useful life of techonogic system.

There is a large number of financing tools, coming from both the public and the private sector. At national level, the Finance Act allows for tax benefits of energy saving in existing residential and some VAT benefits. This provision applies both to private individuals and to companies. Eligible costs include purchase, installation and other services needed. Italy has a specific priority on sustainable energy in all its OPs under the Structural and Cohesion Funds. Italy has committed itself to develop new solutions against energy dependency, notably through Cohesion policy to the tune of 1.057 billion Euro. The programme for the Southern regions specifically tackles innovation and sustainable energy.

Here below is reported a synthetic scheme with a short description of some financial instrument at National level..

4.1.1 The Energy Efficiency Certificate (DM 28/2012)

In Table 1 is reported a short description of the financial instrument for Italy. This tool is adopted for financing the Public subject in energy efficiency interventions.

Table 1- Energy Efficincy Certificate

Activity	Energy Efficiency Certificate - DM 28/2012
Reference's Regulation	The mechanism of white certificates came into force with the decrees of the Minister of Industry in consultation with the Minister of the Environment April 24, 2001 "Identification of national quantitative targets of energy conservation and development of renewable sources." These decrees defined a new regulatory approach tending to increasing energy efficiency throughout the country with the ultimate goal of achieving energy efficiency improvement measures. The decrees of April 24, 2001 were later modified by the decrees of 20 July 2004, by the Ministerial Decree of 21 December 2007 by legislative decree May 30, 2008 n. 115 and finally by the Ministerial Decree December 28, 2012. With the DM 28.12.2012 were set new objectives for the four-2013-2016 to strengthen the mechanism of White Certificates.
Short description of instrument	With the DM 28.12.2012 were set new objectives for the four-2013-2016 to strengthen the mechanism of White Certificates. The heart of the mechanism is the responsibility of liable parties (companies distributing gas and / or electricity) to the goal assigned to annual improvement in energy efficiency to be achieved at the end customers. Upon implementation of the intervention to improve energy efficiency at an end user, the proponent (which is subject to compulsory or voluntary subject) should initiate a procedure for recognition of qualifications to the GSE. For this purpose, the proponent must first perform the accreditation electronic system to Energy Efficiency at the GSE (if volunteer subject), and once the intervention efficiency has been designed / implemented, fill online forms where it will provide all technical / administrative provisions relating to the intervention itself. The GSE assisted by the National New Technologies, Energy and Sustainable Development (ENEA) makes the inquiry on the proposals. If the result is positive, recognize evidence of energy efficiency to the proponents. If the obligor has obtained in this way TEE, can begin to meet its assigned goal. Other titles can be found on the bag, on which the volunteers have sold their securities or

	through bilateral contracts directly with volunteers in possession of TEE.
Type of financial instrument	securities that certify the achievement of energy savings in end-use of energy through actions and projects to increase energy efficiency.
Beneficiaries	The subject around which rotates the mechanism, are the major distributors of gas and electricity. They become "obligated subject" if the December 31, two years prior to each year of obligation, have connected to its distribution network more than 50,000 end customers. In addition to the parties responsible also other operators can access the mechanism by identifying, creating and obtaining energy efficiency certificates. These individuals are called "volunteers" and can be: - Energy Service Companies (SSE) and companies controlled by the parties responsible; - Distributors of electricity and gas with less than 50,000 end customers; - Subjects with energy manager (SEM).
Type of actions financed	Envelope interventions such as: • Replacing single glazing with double glazing; • Insulation of walls and roofs; • Thermal insulation of walls and roofs for summer cooling in the domestic and tertiary sectors. Plant system interventions such as: • Replacement of electric water heaters with natural gas sealed chamber and piezoelectric ignition; • Replacing gas water heater, open chamber and pilot flame with gas water heater, sealed chamber and piezoelectric ignition; Renewable energy system interventions: • Use of photovoltaic electric power less than 20 kW; Installation of solar collectors for the production of domestic hot water.
Maximum cost for single action	-
Duration of contribution	between 5 and 8 years, according to the type of intervention carried out.
Budget	-
Years of funding	-

period	
Combination with other financial instruments	White certificates are not combinable with other incentives to load in electricity tariffs and gas and other government incentives, subject to access to guarantee funds, revolving funds, interest subsidies, tax exemption of income tax 'company for the purchase of machinery and equipment.
Note	Advantages: • User is the final recipient of the interventions (Public and Private) The incentive is paid in relation to the energy savings achieved regardless of cost Disadvantages: • Access (almost exclusively) through ESCO • For small interventions is inaccessible (minimum 20 toe) • Low contribution for the interventions on the building envelope • Eliminated the cumulation with the tax deduction

4.1.2 Contribution in energy bills called “CONTO TERMICO” (DM 28/2012)

In Table 2 is summarized a short description of the financial instrument for Italy. This tool is adopted for financing the Private or Public subject in energy efficiency interventions both envelope and heating systems.

Table 2- Contribution in energy bills

Activity	CONTRIBUTION IN ENERGY BILLS - DM 28/12/2012
Reference’s Regulation	**DM 28/12/2012** “Incentives for the production of thermal energy from renewable sources and energy efficiency measures small"
Short description of instrument	Provides incentives for measures to increase energy efficiency in existing buildings and for interventions small production of thermal energy from renewable sources and high efficiency systems
Type of financial instrument	Capital contribution or in relation to energy produced depending on the type of intervention
Beneficiaries	• Public Administration • Private
Type of actions financed	• Interventions to increase energy efficiency in existing buildings (insulation, replacement air conditioning systems, shielding) • Interventions small production of thermal energy from renewable sources and high efficiency systems (electric heat pumps or gas, Geoterm., Biomass, solar thermal, solar cooling, heat pump water heaters) • Energy audit
Maximum cost for single action	• Thermal insulation (, floors and walls) €250,00 • Replacement glazed windows from € 45,00 to € 60,00 • ShieldingSystems € 20,00 • Water heaters heat pump from € 400,00 to € 700 • • Other systems the amount max permissible in relation to predefined algorithms
Duration of contribution	2-5 years; 1 year, only contributions of less than 600 €
Budget	900 M€ of which EUR 200 mln for Public Administrations, € 700 million for private parties
Years of funding period	2013-2014

Combination with other financial instruments	For public subject, the incentives are combined, as well as guarantee funds, revolving funds and interest subsidies, even with non-state capital grants, subject to a maximum funding of 100% of eligible expenses . For private parties, the incentives are not combinable with other government incentives, including tax deductions and energy efficiency certificates (white certificates).
Note	Advantages: • Incentive system differentiated on the basis of the type of intervention to be implemented • Access to the incentive regardless of occupancy tax • Access to the ESCO with the mechanism of the FTT • The incentive is paid in 2 or 5 years Disadvantages The private entity can not benefit from the measures relating to the building envelope

4.1.3 The contribution in tax deductions (DL 63/2013 e s.m.i)

In Table 3 is show a short description of the financial instrument for Italy. This tool is adopted for financing the Private sector in energy efficiency interventions both envelope and heating systems.

Table 3- Contribution in tax deduction

Activity	THE CONTRIBUTION IN TAX DEDUCTIONS - DL 63/2013 e s.m.i
Reference's Regulation	DL 63/2013 converted into Law 03/08/2013 n.90 Stability Law 2014 (Law 27.12. 2013, n. 147)
Short description of instrument	Provides for the tax break in a deductions (Income tax or Corporate tax) for interventions that increase the energy efficiency of existing buildings.
Type of financial instrument	Tax deduction
Beneficiaries	• individuals, including trades and professions; • taxpayers who receive business income (individuals, partnerships, corporations); • associations between professionals; • public bodies and private individuals not involved in trading.
Type of actions financed	• Interventions to reduce the energy demand for heating; • Improved thermal building (insulation - flooring - windows, including frames)

	• Installation of solar panels • Replacement of winter heating systems.
Maximum cost for single action	• Energy refurbishment of existing buildings 100.000 € • Building envelope (walls and windows) 60.000 € • Installation of solar system 60.000 € • replacement of heating systems 30.000 €
Duration of contribution	10 years
Budget	-
Years of funding period	65% of incur cost :
Combination with other financial instruments	Not available
Note	Advantages: • Easy to access. Disadvantages: • The incentive is paid on the cost of the intervention and not on the energy savings achieved; • To access the tax deduction you must have sufficient capacity

4.1.4 The energy operative interregional programme

In Table 4 is show a short description of the financial instrument for Italy. This program is adopted in the Convergence Regions,

Table 4 - The energy operative interregional programme

Activity	THE ENERGY OPERATIVE INTERREGIONAL PROGRAMME
Reference's Regulation	DM 5 December 2013
Short description of instrument	Financing of programs aimed at reducing and rationalizing the use of primary energy used in the processing cycles and / or delivery of services provided within the existing production units and located in one of the Convergence Regions, such as Sicily
Type of financial instrument	loan equal to 75% of eligible cost

Beneficiaries	Public or privite companies with particolar requirements
Type of actions financed	• thermal insulation of buildings in which are carried out economic activities (eg. coatings, flooring, fixtures, insulating materials for eco-construction, insulation compatible with the production processes); • rationalization, efficiency and / or replacement of heating systems, air conditioning, power supply and illumination, even if used in the processing cycles functional to the reduction of energy consumption (eg. building automation, low fuel consumption, power factor correction of electric motors, installation of inverters, systems for the management and monitoring of energy consumption); • installation of equipment and functional facilities to reduce energy consumption in the processing cycles and / or service delivery; • the installation, only for purposes of self-consumption of installations for the production and distribution of heat and electricity within the production unit, or for the recovery of process heat from furnaces and / or plants which produce heat, or providing for the re-use of other forms of energy recoverable in processes and plants that use fossil fuels
Maximum cost for single action	Between 30.000,00 € and 3.000.000,00 €
Duration of contribution	Maximun 10 years
Budget	**100 M€**
Years of funding period	2013 until the budget availability
Combination with other financial instruments	Not available except those given through the white certifications
Note	Advantages: • Evaluation criteria: Disadvantages: • They are not eligible for benefits programs consist of investments of mere replacement of plant, machinery and equipment.

5. Finalcial instruments at regional level: the sicilian casy study

Achieving climate policy goals requires mobilizing public funds to bring still immature clean technologies to competitiveness and create new technological options. The format of direct public support must be tailored to the characteristics of technologies addressed. Here below is presented some financial instruments and programs focused on the energy efficiency intervention at local scale.

5.1 O.P. ERDF 2007-2013

The overall objective of the program can be stated as follows:

"To raise and stabilize the average growth rate of the regional economy by strengthening the factors of attractiveness and competitiveness of the context of the system of production activities within a framework of environmental sustainability and territorial and social cohesion"

The distinctive features of the program can be summarized in the opportunity to develop mechanisms of competitiveness of the regional production system focused on business systems, attention to sustainability territorial programmatic action, with specific distinction for urban areas to rural areas and for local systems.

In the energy sector, priority objectives of the program are to reduce dependence on traditional energy sources and promoting the dissemination of renewable sources connected with adaptation of plants, the integration of energy issues with programming in the field of research and 'innovation, the rationalization of energy demand. In the environment you want, in particular, promote the conversion of production systems and techniques towards sustainable modes, improved management of natural resources and the adoption of eco-innovations by micro and SMEs.

Inside the P.O. ERDF are identified various axes of intervention within which is outlined the development strategy to achieve the defined from time to time.

In the energy sector we have tried to translate some basic paradigms of reference of European environmental policy, such as education for sustainable development, initiatives aimed also to guarantee the health, to be interpreted as tools necessary to support innovation management, implementation integrated policies and improving governance.

This strategy is developed within the 'Axis 2 that has the goal of "Ensuring adequate levels of service in the field of natural resources through increased efficiency in terms of sustainability and defense / risk prevention" to order to induce an effective environmental integration, ensuring the promotion of renewable energy, energy saving and rational use of resources, control and minimization of risks, control of legality in the process of resource management, environmental quality and the health of citizens.

Similarly, in reference to the Community strategies to achieve sustainable forms of development, it is considered essential to support the enhancement of productive chains able to grow on the territory entrepreneurial initiatives related to sustainable management of resources, as well as provide new employment opportunities in the energy and environmental, which present growth trend of turnover and employment opportunities among the most significant in the European Union. To help reduce gas emissions and increase energy efficiency in the industrial sector insular, presenting values of energy intensity well above the rest of Italy, it is considered as a priority increasing energy efficiency in end-use and the increase structural share of energy generated from renewable sources, substitution of equivalent share from traditional sources.

Within the ERDF the principles of reference against which are identified and selected priority interventions are as follows:

- Promote energy saving actions with the active involvement of organizations, businesses and citizens;
- To encourage the diversification of energy sources;
- Promote the development of Renewable Energy Sources and assimilated favoring takeoff industrial clusters in the corresponding sectors;
- To promote technological innovation with the introduction of cleaner technologies (Clean Technologies - Best Available) in energy-intensive industries and by supporting the dissemination in SMEs;
- To promote the competitiveness of the territories through a more appropriate application of market rules to energy services, environmental and cultural growth of the awareness of the public administrations and citizens;
- Preserving the quality and availability of energy and environmental resources through the promotion of eco-efficiency and the compendium of environmental issues in the overall development strategy, in particular through the application of the SEA, EIA and impact assessment.

With interventions concerning renewable energy and energy efficiency is allocated a share of 8% of the total resources.

The beneficiaries of Axis II are: Sicilian Region and its agencies, local authorities also associates, Hospital and local Health, other Public Bodies, Public Companies and private Subjects publicly owned regional instrumental, research centers, public and private, as defined SMEs the Community framework also attached, Consortia ASI, productive Districts, Optimal Territorial Authority, Siciliacque SpA, Harp Sicily and park authorities.

Inside the axes are developed several specific objectives including the Specific Objective 2.1 "To promote the spread of renewable energy and promote the rationalization of energy demand, adjust and monitor production facilities" with the aim of enhancing the natural energy resources natural in the area. This is subsequently declined in operational objectives:

- Operational objective 2.1.1: To encourage the production of energy from renewable sources, activating production chains of energy technologies.
- Operational objective 2.1.2: To support the increase in end-use energy efficiency and reduction of greenhouse gas emissions. The strategy of gradual conversion of the model of production and consumption of energy provides for the rationalization of energy demand and is specifically designed to support the increase in end-use energy efficiency and reduction of greenhouse gas emissions in the building sector, through the draw up and implement integrated programs locally.

The goal should be accompanied by concerted actions of information and demonstration aimed at the growth of widespread awareness and promotion of energy efficiency in end uses, as well as actions to support the role of regional coordination of assistance for the development of energy efficiency .

The goal also supports actions targeted energy self-sufficiency and integration of energy production from renewable sources, with actions of demonstration, as part of integrated intervention programs.

In the specific area of energy, within the PO ERDF, are identified the two sublines:

- 2.1.2.1 Support actions to increasing energy efficiency in end-use and the reduction of greenhouse gas emissions also including demonstration projects through incentives to cogeneration and trigeneration.

The line provides for the implementation of measures to reduce consumption by the sectors to greater energy intensity reductions such as thermal and electrical needs of the buildings through restructuring of facilities and equipment and the adoption of innovative public lighting. All certified to the achievement of energy efficiency certificates provided by DM 20/07/2007 (TEE)

- 2.1.2.2 Preparation and implementation of integrated programs locally including demonstration projects for the reduction of greenhouse gas emissions through the pursuit of energy self through the exploitation of renewable energy.

The line includes the preparation of integrated local programs and the implementation of demonstration projects to reduce air emissions from point and diffuse sources. Operations type that can be funded are the acquisition of specialized services for the preparation of plans and energy management and adoption of innovative energy carriers.

5.2 PISU AND PIST

Inside the P.O. ERDF 2007-2013 and the PISU PIST identify measures to be carried out on the territory. The Integrated Urban Development Plans (IUDP) are the main instrument of intervention for metropolitan cities and medium-sized cities (with populations of at least 30,000 inhabitants) that anchored to its reference area are of significance to the downtown site.

The PISU constitute the complex plans aimed at integrating a set of inter-sectoral lines of action designed to create and / or strengthen new centers and high value-cognitive or social synergy between them and aimed at the common goal strengthening joint factors of competitiveness and cohesion in urban areas. In particular the overall goals of the IUDP is pursued through the following urban priorities:

- strengthening of business services, with particular reference to research, training and promotion of culture taking due account of the catchment area optimal in terms of minimizing costs for the provision of such services;
- consolidation of relations with other centers, for example in terms of basins of gravitation or commuting, or as regards the multi-polarity which connotes some urban areas;
- Violation of the main issues and emergencies in terms of inclusion, marginality and social cohesion.

Plans Integrated Territorial Development (PIST) are the main instrument of intervention in support of contiguous territorial systems characterized by a strong identity connotation that in their size large area appear able to create new centers of supra-local significance. Take the form of complex plans aimed at integrating a set of lines of action focused on specific themes / sectors or services to create and / or strengthen new centers in key productive or social, aimed at the common goal of strengthening joint factors attractiveness and social cohesion. The instrument must ensure PIST overcoming previous experience of integrated territorial planning (PIT) while taking into account the changed programming of territorial policies, on the one hand trying not to lose the elements of institutional learning and growth of local governance promoted by this instrument and, secondly, not to fall into problems that emerged during the definition of the strategy and especially in the implementation of the same. In this context, the general purpose of the PIST will be pursued through the following priorities:

- enhancement of specific territorial attractors in sectors that represents actual productive vocations of the local system;
- expansion of urban services on a regional scale (social services, culture and tourism) consisting centers territorially contiguous with poor sector diversification and also differentiated by population and extension;
- high degree of integration inter-axis (within the ERDF OP) and inter-country skiing (with the ESF and the EAFRD) and the lines of intervention FAS.

An element of strong characterization PIST is thus represented by the ability to propose a strategy that can generate a planning with other transverse axes of the ERDF and other EU funds (ESF, EAFRD) as well as with the action lines of the FAS in consistency with the provisions of the Planning Document Unitarian (DUP). The area of intervention for the promotion of a PIST may be constituted by a minimum of four common territorially contiguous with a total population of at least 30,000 inhabitants and have a common centroid at the inside of at least 10,000 inhabitants. In this way it is possible preserved the continuity with previous experience of integrated design but at the same time you can also define different coalitions as long as they have a common reference able to provide services of urban rank. The methods of aggregation of municipalities in the process of defining the PIST may have as a reference coalitions of PIT proposals in the 2000-2006 programming or predict possible enlargements of these coalitions also in line with what happened in the RIP Networks for Local Development, or refer to new coalitions that also include common remained out of vast areas of Strategic Plans. The continuity of territorial area with the experience of integrated planning is therefore an important reference but that can not be the only mode of territorial aggregation. It is more important for continuity strategy and management than previous experiences in order to preserve the skills acquired in terms of territorial governance and development lines of integrated design into being.

5.3 The programme “JESSICA” in Sicily

J.E.S.S.I.C.A. (Joint European Support for Sustainable Investment in City Areas - Joint European Support for Sustainable Investment in City Areas – of Following "JESSICA") is a joint initiative of the European Commission and the

European Investment Bank, to promote engineering instruments financial, such as the Urban Development Funds aimed through the ERDF resources (European Funds for Regional Development) to support urban development projects sustainable in European cities.

Managing Authorities in the Member States may choose to use part appropriations of the ERDF contribution of the Urban Development Funds that turn make loans to support projects of public private, and in general projects promoted by public and private entities, including a integrated plan for sustainable urban development.

JESSICA is not a source of additional resources for the United States, but the instrument alternative to more efficient use of ERDF allocations of Structural Funds for the support of transformation projects and urban regeneration.

The Urban Development Fund is established as a separate legal entity or as a separate part of a Financial Institution and exploits the lever financial to attract additional co-financing by increasing the size and number of interventions feasible.

Established at Iccrea BancaImpresa SpA, the corporate bank of Credit Cooperative, controlled by Iccrea Holding SpA, for a budget of Euro 52.7 million under Axis II - Energy ROP ERDF Sicily 2007-2013 The action of the Fund is carried out in collaboration with strategic partners:

- Sinloc - Local Initiatives System SpA, experienced operator level national processes of strategic and operational planning, support of decision-making and analysis of the structuring of investments in initiatives of the Public Private Partnership in the field of urban development.
- BIT SpA - Services for investment in the area, as part of the active Cooperative Credit in offering consulting solutions for use rational use of energy and renewable energy sources.

Financing of eligible expenditure under the ERDF program 2007- 2013, for investments to improve energy efficiency and energy production renewable source.

Beneficiaries are Regional administrative bodies, municipalities, provinces, universities, hospitals, Public health companies, public food markets, Freight, Structures fairs, Provincial Health Authorities, companies and public bodies also associates with companies and institutions dependent or controlled by that municipal / regional, Company Mixed Public-Private Partnership or Dealers Services contractors also in the form of Energy Service Company ("ESCO") directed to the management of operations of production and / or energy efficiency.

The fund priority projects in rapid launch site. Among the types financed, for example, include:

- renewable Energy
- Generating electricity from solar, wind, biomass and biogas, as well as organic fraction of MSW Cogeneration and trigeneration
- Cogeneration and trigeneration, even high-yield gas powered, for the supply of electricity, heat and cooling Public network municipal lighting
- Upgrading and / or construction of public lighting (network Municipal public lighting) energy efficiency
- Interventions to reduce energy consumption and end-use efficiency Energy Transportation
- Methanisation public car park (installation LPG systems or gas methane)
- Means and electric transportation systems

Financial assistance piuò occur either through a loan / mortgage in the medium term, even subordinate, assisted where necessary by guarantees, to be evaluated from time to time; the provision in one or more solutions to Work Progress (SAL) repayment in equal installments quarterly or half-yearly; the duration in line with the useful life of the investment, inclusive of any grace period if necessary; the fixed interest rate, subject to rules on State Aid. Opportunity to increase funding with private resources Additional Iccrea BancaImpresa for maximum of EUR 40.0 million and Availability Cooperative Credit Siciliano until further Euro 40.0 million.

The structure and conditions of co-financing (interest rate, guarantees, duration, etc.) will be in line with best practice in the market.

The advantages are:

- Duration of the facilities on average above the standard market;
- Reduced demand for capital from the banking system in favor of a more rapid collection of the necessary resources
- Advantageous conditions: Fixed rate during the loan of zero for use on public administration and 60% lower
- compared to the average bank credit lines to enterprises;
- Effect on the Stability Pact, the sole portion derived not Community, amounting to 25% of the loan;

- Cover up to 100% of eligible expenditure;
- Combination / cumulation of ERDF funds with other sources of funding from the private sector (debt capital and venture capital) and public grant to support a larger number of interventions;
- Possibility to provide loans with subordination clauses in benefit of a more balanced coverage of the investment program, with possible consequent lower equity contribution by promoters;
- Synergy between the skills expressed by the Urban Development Fund, the Managing Authority and public and private promoters, for a more Effective activation of local initiatives.

6. Discussions

The financial crisis of recent years has made it necessary to think of new forms of financing, less conventional, in support of renewable energy and energy efficiency, both in the realization that the important stage of research and development. Investment aimed at promoting the development of renewable sources, encounter high barriers to access to traditional financing channels, due to the difficult bankability of projects of small and medium size and the need for forms of support that are able to support the phases development and use of new technologies.

Without financial resources, readily available, are not possible the immediate investments necessary to implement energy efficiency measures. Many investments to improve energy efficiency and depreciable quickly, are not carried out because of the many market barriers and regulations.

The main obstacle is represented by the high investment costs that discourage the use of energy-efficient technologies.

It would be appropriate for the EIB (European Investment Bank) was financing national funds specializing in energy efficiency, which, in turn, should offer financial solutions favorable to SMEs and in particular to the ESCo. Alternatively, these same funds could provide guarantees to facilitate access to credit by private banks. Lower interest on loans, with long payback periods, and the formula "pay as you save" offer of the EIB in cooperation with national banks, could encourage consumers and businesses to install energy efficiency measures.

Each year a large part of the funds made available by the European Community are not required and used by public bodies. This confirms the lack of knowledge of these funding programs that are currently available for businesses, private and public entities.

Studies at the International shares of use of structural funds, shows that the majority of EU countries, while failing to meet the 2020, committed few resources to energy efficiency - even when they come from Europe and therefore not aggravate or budgets nationality and therefore there is a disconnect between formal declarations by the EU and effective commitments. Among the group stands Italy, that in the latter the 2007-2013 was the luckiest country intermini endowment, but with low implementation capacity (less than 20% of production).

It highlights the importance of investing adequate resources in the management structures of the programs in order to avoid that they are burdened by delays in the allocation of resources and difficulties in the management and subsequent monitoring. It is therefore appropriate to report to stakeholders to dedicate this purpose a 3-5% of the funds available.

This shows that, despite the availability of resources, functional and capable administrative structures needed to develop and manage funding programs traditional and innovative that they can be a support to the industry, to Public Amministraioni and citizens to accelerate investment in the energy field.

You need to address the barriers that inhibit the action on renewables and energy efficiency to achieve significant progress in the energy sector. below shows a study of the major barriers to the use of financial instruments.

6.1 Barriers

Developing countries have tremendous potential to increase energy efficiency but face several barriers before the potential can be realised. A lack of access to appropriate financing mechanisms is one of the important barriers.

A depth study in financing systems (World Bank, 2013) highlighted several barriers that can be classified into 4 types:

1) Financial;
2) institutional;
3) referring the organization;

4) related the communication.

The financial barriers are summarized as follow:

- Time to return substantial, in particular for interventions on the building. Considering energy costs even lower and the high investment costs required by a redevelopment global investment costs often can not be repaid by the savings achieved within reasonable payback periods.

- Late payments especially by public administrations, which sometimes dismiss the payment only after 180/240 giorni.12 For ESCo small and modest economic resources is usually unacceptable to remain financially exposed for so long.

- Poor economic attractiveness of small energy efficiency projects. Often for small private or public support the costs of energy efficiency measures is more difficult. Also, many ESCo usually undertake only projects with investment costs above 100 ÷ 200 000 €.

- Difficult access to bank loan. Financial institutions do not apply appropriate tools to evaluate energy efficiency projects. Mainly driven by a precautionary behavior compared to the risks of fraud or insolvency, are still referring to colleterali classics (share capital, loans, guarantees etc.) And do not accept as collateral main future cash flows generated by the energy savings. According to European Directive 2012/27 / EU obstacles to the use of energy performance contracting "include accounting rules and practices that prevent capital investments and annual financial savings achieved thanks to measures to improve energy efficiency are adequately reflected in accounting for the entire duration of the investment. "

To date, banks prefer to finance renewable energy projects with respect to energy efficiency projects. While the first guarantee a cash flow even when the client company is not in production phase (the generation of electricity by the photovoltaic panels does not depend on fluctuations of the energy demand of the production process), the energy savings depend in absolute terms by consumption and in percentage terms of the quality of implementation of energy efficiency measures. Finally, banks typically require the borrower a contribution of 10-20% of venture capital, the condition often too burdensome for small ESCOs.

The institutional barriers are declined here below:

- Complexity of bureaucratic procedures. For example, heating projects and geothermal pumps receive the permissions years after the submission of the application. For this reason, municipalities and individuals usually required to make technology simple and quick to implement, instead of choosing those which would result in greater benefits in terms of energy savings. The European calls are usually considered too complex to allow the participation of small ESCOs and / or small local governments. Also, when the incentives are tied to direct beneficiaries (eg. SMEs or individuals), the intervention of an ESCo in the financial aspects of the contract is strictly limited.

- The legislative instability generates a widespread reluctance towards long-term projects (eg: the installation of condensing boilers is preferred to geothermal heat pumps, which require more complex bureaucratic procedures and passable adjustments as a result of legislative changes). Another critical is the interaction between the various subsidy schemes, which sometimes have generated uncertainties and ambiguities of interpretation.

- Low diffusion certification ESCo. Potential customers of ESCo report two main reasons for distrust: the calculation of the baseline consumption is not uniquely defined, as they are often not clearly delineated the boundaries between the risk borne by the ESCo and risks borne by the customer. A terminological confusion could have further damaged the image of the ESCo. The first ambiguity is generated by "ESCo accredited" as opposed to "ESCo certified". The first expression indicates a company operating in the energy services sector that has been approved by the Authority at least one request for verification and certification of energy savings for attesting the TEE, while the second term describes an ESCo certified UNI CEI 11352. This distinction is not clear enough today among potential customers. In industry the ESCo are then informally divided into "ESCo with iron" and "ESCo without iron", where the first representing the company with internal resources responsible for all phases of an energy performance contract (including installation, management and maintenance), while the latter need of external parties to run in the yard of the interventions of energy efficiency.

- Lack of financial autonomy of the public. Often, the municipalities that invest in the energy efficiency measures, have some problems relating to Stability Pact, which prevented the use of available resources. In some cases, small municipalities have had to give up investment grant covering 80% of eligible costs due to the strict control on the financial budget.

- Vision of short-term public institutions. First public institutions, aware of the instability of the long and tortuous legislative and bureaucratic procedures required by global action, usually opting for technologies simple and fast implementation. Secondly, the authorities wish that the results of energy efficiency measures are visible within the period of their mandate (while investments often involve long-term benefits for the following mandate, can lead to the opposition). Thirdly, there is a general tendency to look for "easy money" (eg. Investment grants), while the energy performance contracting are considered too risky.

The technical barriers are referrinf to:

- No accounting separation between upgrading and supply of fuel. The service contract plus energy described by Decree No. 115/2008 provides for "the reduction in the primary energy for space heating of at least 10 percent compared to the corresponding index shown in the certificate of certification." However, the index of primary energy does not represent the real consumption of the building in question, but its requirement calculated, which is independent of the actual operating mode of the plant (for example does not consider the periods of actual occupation of school buildings). Accordingly, the real reduction in consumption may be very limited. The reduction of energy costs could be so simply by a reduction in the price of fuel (typical of "heat services" energy supply).

- Lack of a common protocol and standardized measurement and verification that adds to the inherent burden of the interventions, the lack of reliable data on energy consumption and the scarcity of measuring equipment in SMEs.

- Lack of common correction factors, which take into account any changes to the climate changes in the use of the building / in the behavior of the occupants.

The communication barriers are reported here below:

- Lack of legal and technical knowledge on energy performance contracting by public administrations. This point is particularly critical for small municipalities, who can not afford the costs of external advice in preparation of the calls.

- Lack of data on actual consumption of energy in the public and private sectors. There is a widespread scarcity / inaccuracy of information for small consumers are often unaware of the potential economic benefits resulting from an energy performance contract. The benefits generated by energy efficiency measures are still considered intangible, less intuitive electrical production of a photovoltaic panel. Adding to this are the lack of information available on completed projects: companies are often very reserved in regard to the data on energy consumption, and detailed plans of the energy efficiency measures are usually in secrecy.

- Lack of an approach to Life Cycle. SMEs typically consider only the initial cost of equipment, regardless of the energy costs and maintenance. In other words, "The Negawatthours still does not exist." When you consider that energy bills reach figures up to 5-

6% of the turnover of an SME, an analysis of the life cycle of the machinery could lead to more rational choices for purchases and the downsizing of the costs.

For each of the four types of barriers in engineerinf financial instruments, here below are proposed some solution.

This dissertation have the aim to overtake the financial barriers and implement the tool to became more effectiveness the energy efficiency end renewable engineering financial instruments.

6.2 Solutions

The development of the market for energy performance contracting requires reproducible and simple solutions that can overcome the barriers presented in the previous chapter. The table below some potential solutions, such as: the creation of revolving funds and guarantee, information campaigns and education, simplification of regulations and the implementation of a more stringent certification process for ESCo.

The financial solutions are here summarize:

- Creation of revolving funds. The revolving funds with guarantees at national or supranational are probably among the most effective tools to stimulate investment in energy efficiency and the development of the market for energy performance contracting as they allow financial institutions to also support projects of a smaller size and / or longer duration than those usually considered sustainable. The loans may be tied to performance indices, according to a logic meritocratic. Access to loan regulate competition in the energy services market, providing a comparison between small and large ESCo increasingly based on the skills and experience rather than financial strength. Revolving funds a financial instrument more effective than a grant. The grant funding may be useful in the case of small interventions in SMEs, wherever that is, it is preferable to act rapidly and extensively on consumption.

- Creation of guarantee funds. A guarantee fund may protect financial institutions and / or the ESCo from late payments, insolvency of customers or by relocation of production plants (resulting in a sudden drop in energy consumption of structures subject to energy performance contracting). The schemes may be directed in particular to work with medium-long return periods (over 6-7 years).

- Co-financing by the customer, when the ESCo can not fully burdened the financial risks of the project. Small ESCOs could thus work simultaneously on several projects, focusing on the technical aspects. Generally it is observed that customers do not want to be involved financially nor distracted from its core business.

- Management of a broad portfolio of energy efficiency measures, including both short-term measures (boiler replacement) and long term (insulation of the building envelope, replacement of windows).

- Incentives based on socio-economic parameters: the subsidy programs should assess the social, distributing incentives depending on the geographical, economic sectors and income groups of beneficiaries. Tax relief could help families of low and middle income or SMEs. This proposal is supported by the guidelines "20-20-20 Energy and Climate".

- Simplification of legislation, preparation of standards and guidelines for the preparation of tenders. This process requires a strong and continuous support of technical and economic institutions (eg: ENEA, RSE, FIRE, CTI, UNI etc.) On the fronts of a preliminary analysis of the potential market and the impact of energy policies.

- Dissemination of certification ESCo at European level: the ESCo market requires qualification to get trust from financial institutions and offer services more clearly defined to potential customers. The standard EN 15900 and UNI CEI 11352 have begun a process of clear definition of the rights and obligations of the ESCo. To date only 40 ESCOs have been certified according to UNI CEI 11352.29 The certification process should be both rigorous and economically, in order to allow access to ESCo small.

- Promotion of Public-Private Partnerships (PPP), characterized by relations generally reliable and durable, facilitated by the integration of public and private resources and the distribution of risk between the partners.

- Financial autonomy of PP.AA. for investments in energy efficiency, with the creation of a channel of action is not subject to the constraints of the Stability Pact.

The technical solutions are here reported:

- Creating simple tools of economic evaluation: all the stakeholders involved in the energy efficiency market, starting from the financial institutions, should be provided with simple tools to quantify the potential cash flows (in terms of avoided costs) resulting from energy savings so he can decide whether an energy performance contract proves or not cost effective.

- Adoption of a common protocol of measurement and verification tool M & V must reconcile cost and accuracy.

-Support To local authorities in the preparation of action plans and calls for tenders.

Another useful tool for local authorities is the legal assistance of a consultant for the eventual management of inconsistent with the supplier of the energy performance contract.

- Creation of scale effects, eg. aggregating neighboring municipalities in order to reach a critical mass that creates an economic interest in companies and financial institutions.

- Creating operators of third party financing, which play a key role as aggregators skills: their responsibility would be to establish the feasibility of an energy performance contract, to structure the financing scheme and support contract risks, the components of which would be operational delegated to construction companies.

Communication solutions can be synthetize as follow:

- Information campaigns and education in companies, public administrations, associations and individuals, in particular to raise awareness of the occupants everyday use energy conscious. These campaigns, conducted by large public institutions, chambers of commerce, agencies, freelancers and universities, should include proposals for evaluation criteria in selecting technologies, clarifications on the legislative framework, quality assurance of products and processes.

-Creating A database of good practice, in which the public information on the experiences of energy performance contracting can be shared and become a source of inspiration for subsequent contracts. The documentation of pilot cases and contract models in different Member States should be translated and adapted to local needs. An intense networking with other government agencies will support the exchange of know-how currently available. Directive 2012/27 / EU confirms that "the contracts, the exchange of best practices and guidelines, particularly with regard to energy performance contracting, can help to stimulate demand."

7. Conclusions

The picture that is emerging from the examination of the European building stock, the existing financial support measures for building renovation and the different market barriers, shows that:

– The situation differs significantly between Member States in terms of their building stock (e.g. age, energy performance, tenure, etc.), the financial support measures in place (e.g. amount of funding, types of measures, effectiveness, etc.) and the relevant

market barriers (e.g. capacity and awareness, support structures, regulatory framework, etc.);

– While the investments in building energy efficiency are increasing and there are many best-practice examples of existing instruments that are delivering cost-effective energy savings, there is only limited information on the effectiveness of the different

financial support measures for energy efficiency in buildings, both at EU and national levels;

– There continue to be important barriers that hamper further uptake of energy efficiency investments in buildings, including a lack of awareness and expertise regarding energy efficiency financing on the part of all actors (e.g. authorities, construction companies, local banks and end borrowers); high initial costs, relatively long pay-back periods and (perceived) credit risk associated with energy efficiency investments; limited availability of funding due to overall deleveraging by banks and increasing capital adequacy requirements; and competing priorities for finalbeneficiaries.

Energy efficiency is a priority in the EU (European Parliament, 2011). However, only about half of the existing potential is being realised due to market barriers and inefficient enforcement of related legislation. Currently, there are many programmes that focus on promoting EE investments, particularly in the building stock. In addition, energy efficiency should be seen as a priority for driving national and EU growth plans. It offers a clear economic stimulus opportunity, now and for years to come.

At the core of most successful programmes are preferential loans, potentially complemented with a grant and/or package, along with measures focusing on behaviour and confidence building among energy users. Furthermore, providing an incentive to invest is essential for a successful energy efficiency programme, especially in the West and the North. Incentives can take the form of grants or regulation, of which regulation is the most powerful. The preferential loans enable the investments and the performance standards drive demand for the loans. In addition to these observations, has been identified the following best practice elements:

1. a simplified, possibly one-stop shop, administrative procedure;
2. A revolving fund;
3. Inclusion of local expertise;
4. Informing citizens;
5. Flexibility in (European) funding conditions;
6. Imposing obligations;
7. Provision of a Technical assistance (project development) package.

However, the analysis of regional specific market barriers and characteristics showed that successful programmes cannot be extrapolated one-on-one to other countries. Therefore, these best practice elements should be catered according to the regional differences identified. While some elements, such as simplified administrative procedures and informing citizens, are important

in all regions; others should be emphasized depending on the region.

Revolving funds should be region specific, given that their complexity requires expertise which is readily available in the West and lacking in the East.

Grants of region specific magnitude (possibly through Cohesion funds) should take into account that Eastern European countries require a larger grant component.

Inclusion of local expertise should be emphasized in Western Europe due to the available expertise. This is also related to capabilities regarding the EPC markets which are starting to develop in Western European countries, but are less developed in the East. The provision of a TA package is especially relevant for Eastern Europe due to their lack of expertise among key actors in public and financial institutions. In the West and North, an important boundary condition is providing an incentive, which is made effective by imposing obligations.

Referring to the strengthening the regulatory framework, with the recently adopted Energy Efficiency Directive (EED), the recast of the Energy Performance of Buildings Directive and the relevant implementing measures under the Ecodesign and Energy Labelling Directives (e.g. for boilers and lighting), a comprehensive regulatory framework for energy efficiency in buildings is now in place at the EU level. Remain the need for a better coordination between different policy areas (e.g. energy efficiency and regional policy) and among policy makers was raised

Relating to the improving access to financing, the analysis of EU funding and the link with national instruments shown, despite many positive experiences, there is still significant scope to improve the uptake and effectiveness of EU financial support.

Although the available financial tools at EU level (including the Cohesion Fund, ERDF (including financial instruments for urban development set up with the support of the JESSICA initiative), ELENA, MLEI, EEE-F and the IEE programme)are a good instruments, many problems are linked to the complex bureaucracy action of the application procedures, and to the lack of awareness about funding opportunities, especially at local level.

Suggestions to improve this situation included building in more flexibility in how cohesion funding is used (e.g. by blending loans with grants) so that solutions can be better targeted to individual Member States' needs, greater bundling opportunities for smaller projects and the establishment of national or regional funds or financing schemes with EU funding that provide loans to the owners or end-users of buildings for investments in energy efficiency.

Moreover, one of the main barriers to scaling up investment in energy efficient building is insufficient demand for such investment from building owners. Identifying and developing a pipeline of financially attractive projects is a key challenge that Member States must work to address. In pursuit of this aim, stakeholders advocated the use of public funds to provide technical assistance, ensure the provision of loans on attractive terms (through subsidies or guarantees).

Public funds can also stimulate the ESCO/EPC market, for example, by providing a source of finance for measures installed in public sector buildings. Moreover, the need to provide investors with more objective, reliable and standardised information on loan performance (e.g. payback periods, Return on Investment, default rates) was cited as being key to scaling up private sector interest in this area.

As regards national financial instruments more generally, stakeholders reported a need for more stable support measures, and a better use of taxation (e.g. reduced property taxes or stamp duties for more energy efficient buildings), state aid and public procurement mechanisms to create sustained demand.

The new EED creates an opportunity for Member States to introduce a step-change in the levels of investment into energy efficient buildings, as it requires the Member States to establish by April 2014 a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private.

Such a strategy will have to encompass;

(a) an overview of the national building stock based, as appropriate, on statistical sampling;

(b) identification of cost-effective approaches to renovations relevant to the building type and climatic zone;

(c) policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;

(d) a forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions;

(e) an evidence-based estimate of expected energy savings and wider benefits.

Moreover, the EED requires Member States to facilitate the establishment of financing facilities, or use of existing ones, for energy efficiency improvement measures to maximise the benefits of multiple streams of financing. Such a strategy should make optimal use of the financial resources available at EU level and should also systematically explore the role of fiscal instruments and public procurement in stimulating energy efficiency in buildings.

EU expenditure for the renovation of the building stock (i.e. by Structural and Regional Development Funds) should introduce the minimum requirement for implementing measures at cost-optimal levels (as will be defined under the EPBD recast). This would be in line with the requirement to “climate-proof the future EU multi-annual financial framework 2014-2020” (a budget for Europe 2020) and to deliver on the principle that “through its operational programmes throughout the EU, cohesion policy has a crucial role to play in stepping up efforts to reach the 20% energy efficiency target”.

In addition, the European Commission could facilitate the development of innovative financial instruments at Member State (Olmos L, 2012) level by elaborating guidelines for financing, by promoting best practice and by stimulating the cooperation between Member States for sharing experience and for implementing common measures and harmonised regulatory measures for deep renovation. Innovative financing schemes should be designed to trigger increased private investment.

In order to foster the deep renovation of the building stock, Member States should develop long-term comprehensive regulatory, financial, educational and promotional packages addressing all the macro- economic benefits. Important components of these programmes should be the faster identification and adoption of ambitious and yet cost-effective renovation levels, the gradual strengthening/introduction of related building code requirements and effective quality control and verification systems.

A better implementation of the buildings energy certification and audit schemes is needed as these schemes are important information and awareness tools which can increase the value of efficient buildings and can stimulate the real estate market towards green investments.

Energy services companies(ESCOs) can play an important role in fostering deep renovation programmes by providing the necessary technical and financial expertise and by triggering third party financing. Hence, removing the market barriers facing ESCOs may facilitate a faster and better development of the renovation programmes. Regulatory frameworks should encourage the set-up and development of a well-functioning energy services market, not limited to commercial buildings.

The success of deep renovation programmes will depend on the creation of appropriate financing schemes, addressing all the categories of private and commercial real estate owners as well as introducing measures using appropriate subsidies, low-interest and longer term loan schemes and other financial incentive schemes.

A proper public financing approach may leverage considerable private capital as has been proven by several successful programmes developed in some European countries. Attracting private capital to invest in building renovation is a key issue of any financing programme that aims to stimulate the economy and to transform energy efficiency measures into a sustainable business activity. Even though the success of each scheme depends on more factors than just the financial terms and conditions, some general conclusions regarding the financial instruments have been drawn.

As outlined above, the Commission is engaged in a variety of initiatives and activities to support these objectives. However, given the nature of the building stock and sector, and their responsibility for implementing the relevant legislation and addressing national market barriers, the Member States are in the driving seat to ensure that more cost-effective investments in building renovation take place.

Moreover, the importance of a tailor-made approach to energy efficiency financing and of a building sector able to deliver high-quality renovations means that close cooperation between public authorities (at national, regional or local level), finance providers (e.g. IFIs, banks, institutional investors, obligated companies under an energy savings obligation scheme, ESCOs) and the building sector (e.g. construction companies, equipment providers, architects) is essential.

Last but not least, building owners (whether companies, public authorities or private home owners) will have to be convinced of the benefits of making their properties more energy efficient, not only in terms of a lower energy bill but also improved comfort and property value. This has not been made easier by the current economic and financial crisis and may well be one of the most important hurdles to overcome in making Europe's buildings more energy efficient. However, the macroeconomic case for doing this is strong41 and targeted incentives and awareness raising efforts to changing attitudes will be necessary. The building renovation roadmaps that Member States will have to establish under the new energy efficiency Directive should explicitly address these issues. Going forward the Commission will continue to engage with Member States and relevant stakeholders on how barriers to energy efficiency investments in buildings can be overcome and how financial support for energy efficiency in buildings could be further improved.

If the EU is to meet its 2020 energy efficiency target and its ambitions for further savings towards 2050, it is imperative to improve the financial support for energy efficiency in buildings. For this to happen it is necessary to ensure that the regulatory framework is

properly implemented, more financing is made available and key barriers are addressed.

To overcome the inefficiencies of the management system especially for Community resources will be necessary to define the expected results in a timely manner, so you have to go from indicating a series of general purpose to be pursued through the projects to be carried out, all'individuare objectives specific and possibly quantifiable. It will also be necessary to identify the actions clearly linked to the achievement of the objectives set and indicate more precisely the times, which must be defined both in relation to the internal composition of each program, and then the individual actions, both with respect to the provision of payments to be made each year.

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General conclusion

In this work the attention has been pointed out on a couple of issue related with the energy efficiency and with the greening of the economic activites with a particular focus on the declination at country and regional scales of stimulating tools assessed by the European Union. More specifically, the energy and economic issues have been analyzed.

As for the energy aspects, a verification has been conducted of the applicability at local levels of the Headlines indicators proposed by the European Union. This check has been done by utilizing the Sicilian Energy and Environmental Masterplan that has been recently released. This comparison has clearly shown that the set of indicators proposed at the European level was poorly effective in catching the specific features of the territory. A typical example is rappresented by “Real GDP per capita, growth rate and totals” that, in order to be applied at the Regional level, was suitable modified. It, in fact, in its original formulations was not able to intercept as far as six out ten of the general objectives of the Sicialian Regional Masterplan.

Several other examples could be presented in order of supporting this statement.

Another important element to be considered when approaching an energy planning at a given regional scale is represented by the knowledge of the actual building stock to be refurbished. This aspects has been also pointed out in the application of the Sicilian Masterplan that required an “ex novo” reformulation of the building park in order to better comply with the actual building stock and in order to identify proper typical building representative of given clusters of sub stocks of buildings. In this case we have totally reformulated the main typologies in which the whole regional building park can be synthetized.

Again with respect to the energy issues the way with which single countries have been implemented the European standard EN ISO 13790 at their National levels has been investigated. Surpraisingly, these different ways of receiping the EU standard resulted in a very spreaded set of different values concerning the energy demand of residential buildings. This obiousvly conflicts with the EU suggestion that required that results at country levels were characterized by a high level of homogeneity.

Concerning the economics issues, clearly emerged that the present European structure of stimulating and financial tools is very well assessed. In fact we have two types of tools, that is direct and indirect. In this way two parallel channels are operative in order to get financial supports at the local levels: the first one in fact is aimed at the accomplishing of local targets while the other one is specifically tuned on the reaching of the European goals.

One of the weak points of this structure refers to the level of accessibility to the financial supporting tools. In this sense, in fact, there are many types of barriers that constrain the easy utilization of these financial supports. The first one is the institutional barrier that acts at the bureocracy level: the grade of complexity required for applying these tools is, were often, definitively too difficult to e easily approached. An other one is constituded by the absence of a standardized protocol for the verification of the results: this determines the impossibility of comparing, in a clear and definitive way, wheather or not the achieved results are complying the European targets.

In conclusions this work has shown that the tools proposed by the European Commision, despite covering a wide range of actions and aspects (ranging from the energy to the economic ones), present some relevant criticisms when applied to country or regional levels. In other words, if the general targets must be assessed at European level, the instruments for their effective application should be tuned at local levels.

This clearly calls for a deep revisitation of these tools in order to be more effective in the aim of getting countries into greener paths.