nZEB training in the Southern EU countries
Maintaining building traditions

SouthZEB
WP2 – Deliverable 2.1 Report on the Current Situation Regarding nZEB in the Participating Countries

July 2014

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Executive Summary

The SouthZEB project aims to outline the current situation for the implementation of the EPBD and RES Directives within the European Union. It also aims to identify training needs required for a number of targeted Southern European countries (Greece, Cyprus, Italy (south) and Portugal) less advanced on the progress towards Nearly Zero-Energy Buildings (nZEB).

The recast Directive on the Energy Performance of Buildings (EPBD) stipulates that by 2020 all new buildings within the European Union (EU) after 2020 should reach nearly zero-energy levels and after 31st December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

The Renewable Energy Directive (RED) stipulates in article 13 that a) by 31st December 2014 Member States shall, in their building regulations and codes, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation and b) Member States shall ensure that new and existing public buildings that are subject to major renovation, at national, regional and local level fulfil an exemplary role in the context of this Directive from 1st January 2012 onwards.

A number of barriers exist to achieving the goals of the Directives including the barrier associated with the know-how of professionals. This project aims to identify training needs in southern European countries compared to the current situation in front runner countries (United Kingdom, Austria, Germany, France and Italy (north)).

Each EU country is implementing measures to move towards nearly zero-energy buildings by 2020 through the transposition of the Energy Performance of Buildings (EPBD, 2010/31/EU) Directive and the Renewable Energy Sources (RED 2009/28/EC) Directive. However the Central and Northern EU countries are more advanced in implementing a number of articles within the directives, therefore the opportunity exist to develop the training material necessary to assist the Southern EU countries to catch up in their progress toward nZEB. Within the Southern EU countries, there are specific training needs but the overall objective is to reduce the minimum energy performance requirements (i.e. reduce energy demand, improve building envelopes) of southern countries through the training of professionals (architects, engineers) to design and develop nZEB in the near future. The different countries have also different climatic conditions, building traditions (building stock age and characteristics, construction solutions etc.) and building codes that must be considered.

SOUTH ZEB

Co-funded by the Intelligent Energy Europe Programme of the European Union

Project Data

Project Acronym:	SouthZEB
Full title:	nZEB training in the Southern EU countries Maintaining building traditions
Objective:	Support the building sector intermediate and senior professionals (engineers, architects, municipality employees and decision makers) in the Southern European countries (Greece, Cyprus, Italy and Portugal) to keep up to date with the market progression, notably supporting those professionals in their continuous development, particularly in designing and renovating nearly zero-energy buildings (nZEB). This will be achieved through the design and development of training and assessment programmes for the abovementioned professionals, focusing especially on the transfer of successful practices and knowledge from the front runners to the Southern EU countries.
Contract number:	IEE/13/393
Financing:	Intelligent Energy Europe
Budget:	€ 1,023,111 (EU contribution: 75%)
Duration:	1 January 2014 – 31 December 2016
Project website:	-
Coordinator:	Iakovos Kalaitzoglou University of Patras, Patras University Campus, Greece
Participants:	University of Patras (UPatras), Greece Building Research Establishment Ltd (BRE), United Kingdom University of Minho (UMinho), Portugal Cyprus University of Technology (CUT), Cyprus BEST Institut für berufsbezogene Weiterbildung und Personaltraining GmbH (BEST), Austria Instituto Superior Técnico, Technical University of Lisbon (IST), Portugal Vocational Education Training Center EUROtraining (KEK Eurotraining) (KEK), Greece Distretto Technologico Trentino S.c.a.r.l. (DTTN), Italy GARnet Energy Saving Ltd (GARNET), Cyprus

Table of Contents

List of Tables

List of Figures

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1 Introduction

1.1 The SouthZEB Project

The recast of the Energy Performance of Buildings Directive (EPBD-recast, 2010/31/EU) and the Renewable Energy Directive (RED, 2009/28/EC) set out conditions for moving towards nearly zero-energy buildings (nZEB) by 2020. All Member States of the European Union (EU) must integrate these requirements into national legislation as well as setting appropriate market instruments and financial frameworks for widely implementing the ambitious targets. Therefore by 2020 all new buildings will demonstrate very high energy performance and their reduced or very low energy needs will be significantly covered by renewable energy sources.

The SouthZEB project is addressing the Intelligent Energy Europe (IEE) priority on Continuous Professional Development. The action supports a wide-scale roll out of recognised professional development courses for building sector professionals in the Southern European countries. The project aims to contribute in the application and successful implementation of the goals of the Energy Performance of Buildings (EPBD, 2010/31/EU) Directive and of the Renewable Energy (RED, 2009/28/EC) Directive in the Southern EU countries. Both Directives set conditions for moving towards nearly zero-energy buildings by 2020.

The project objectives are as follows:

- The main project objective is to support the building sector intermediate and senior professionals (engineers, architects, municipality employees and decision makers) in the Southern European countries (focusing on Greece, EL, Cyprus, CY, Italy (South), IT, and Portugal, PT) to keep up to date with the market progression;
- To design and develop training and assessment programmes for the abovementioned professionals, focusing especially on the transfer of successful practices and knowledge from the front runners (United Kingdom, UK, Austria, AT, Germany, DE, France, FR and Italy (North), IT) to the Southern EU countries;
- To support a large scale roll-out of the developed programmes, by training specialized trainers in their application for transferring knowledge to the stakeholders;
- To bring together engineers, architects, municipality employees and decision makers as well as their educators and certification authorities in the Southern EU countries, through a unique portal, available in five EU languages (English, German, Greek, Italian, Portuguese).

The project will adopt an end-user-centred methodological approach. The design and development of the training modules, the portal and the workshops will be cyclic, with several phases informed by practice (meetings, Focus Group feedback), to ensure that the end-user perspective is incorporated from the beginning.

The project has been structured into eight work packages, as shown in Figure 1. The figure shows progressive development of the project from developing an understanding of the situation on the implementation of the relevant directives, through development of the training courses and the dissemination and communication necessary to enable their effective delivery.

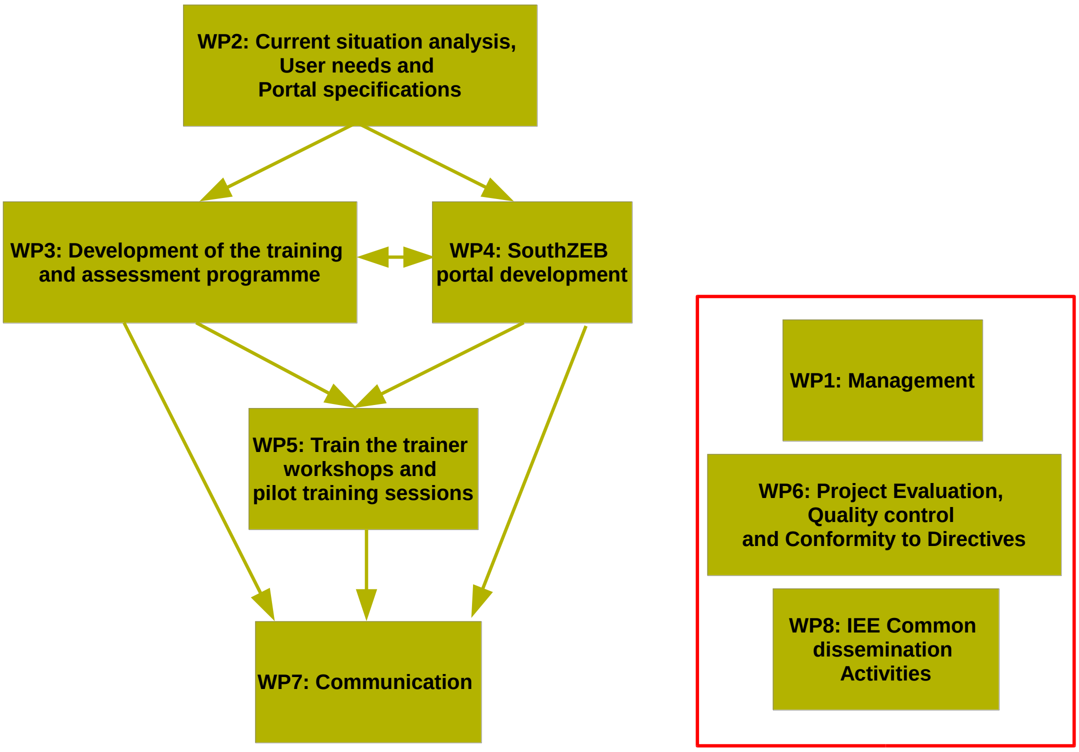


Figure 1 – SouthZEB Project: Work Programme

1.2 Work Package 2: Task 1

Work Package 2 involves an analysis of the current situation in the target countries (EL, CY, PT, IT) and regarding the building sector and specifically the progress versus the nZEB targets (WP2/Task 1.1). The current situation was also evaluated for the front runner countries for benchmarking purposes and for use in the training programmes design (WP2/Task 1.2). Information was also collected regarding the progress in the implementation of the EPBD and RED directives in all participating countries. The specific characteristics of the target countries, climatic conditions, building stock characteristics and building codes, were also assessed (WP2/Task 1.3).

The specific training and certification needs of the selected target groups (engineers, architects, municipality employees, decision makers) have been investigated and categorized. WP2 is the driver work package that will define the starting point for the forthcoming WPs and their tasks. It aims to deliver a detailed report on the current situation in the participating countries, a second report on the specification of the training and certification needs of the target groups and a third report on the specification of requirements for the SouthZEB portal and content.

The aim of this deliverable is to identify the implementation of the EPBD and RES Directives in front runner (i.e. United Kingdom, Austria, Germany, Italy (North) and France) and target countries (i.e. Greece, Cyprus, Italy (South) and Portugal) in Europe; the information gathered is focused on the training and certification possibilities offered, in front runner countries, which will create the benchmark for the training programmes that will be developed for the Southern EU countries less advanced in these areas (i.e. Greece, Cyprus, Portugal and Italy (South)).

A review of national legislation has been undertaken to identify how the EPBD and RES are implemented in each country, and the current situation regarding the progress versus the targets outlined in the Directives. An evaluation of the existing situation regarding the building stock characteristics, climate and regulations was also made. The climatic conditions, the building stock, and the architectural rules/conditions which apply to each one of the target countries were collected.

1.3 Background

A nearly zero-energy building (nZEB) is defined in the EPBD as “a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”.

The recast Directive on the energy performance of buildings (EPBD) stipulates that by 2020 all new buildings constructed within the EU after 2020 should reach nearly zero-energy levels and after 31st December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

Commission Delegated Regulation (EU) N.º 244/2012 of 16 January 2012 supplements the EPBD by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements. This regulation establishes a comparative methodology framework to be used by Member States for calculating cost-optimal levels of minimum energy performance requirements for new and existing buildings and building elements.

The methodology framework specifies rules for comparing energy efficiency measures, measures incorporating renewable energy sources and packages and variants of such measures, based on the primary energy performance and the cost attributed to their implementation. It also lays down how to apply these rules to selected reference buildings with the aim of identifying cost-optimal levels of minimum energy performance requirements.

Member states had to communicate to the European Commission all input data and assumption used for the calculations of the cost-optimal level of minimum energy performance requirements using the Delegated Regulation (EU) N.º 244/2012 of 16 January 2012 as outlined above.

The EPBD makes two provisions for the inspection of boilers. The first requires a regular inspection of boilers with rated output of 20 to 100 kW and for boilers over 100 kW an inspection every two years (or four years if gas-fired). For boilers over 20 kW and older than 15 years, there must be a one-off inspection of the entire heating system, including an assessment of boiler efficiency and size compared with the heating requirements. Advice must be given on replacement of boilers, modifications to the system and alternative solutions. The second option requires Government to ensure there is adequate advice on boiler replacement and other modifications to heating systems so as to improve overall energy efficiency.

The EPBD makes provisions for the inspection of air conditioning plant. Air conditioning systems over 12kW output need to have regular inspections, including an assessment of efficiency and sizing of plant compared with the cooling requirements of the building. The 12kW threshold applies to the total air conditioning plant supplying the premises concerned rather than to individual chillers.

The RES Directive sets binding targets for the Member States so that the EU as a whole will reach a 20% share of energy from renewable sources in gross final energy consumption by 2020 and a 10%

share of renewable energy specifically in the transport sector. Article 13 and 16 of this Directive focuses on renewable energy in buildings and district heating. The RES Directive can broadly be summarized in three categories, RES-Electricity, RES-Transport and RES-Heating and Cooling.

There are a number of over lapping areas between the EPBD Directive and the RES Directive. Increasing the proportion of renewable energy in buildings, covered by Article 13 of the RES Directive, is an issue that is also addressed in the EPBD Directive. A number of over lapping areas include the following:

- EPBD requires minimum energy performance requirements for buildings to be set using a cost optimal methodology,
- RES Directive requires Member States to introduce in their building regulations and codes or by other means with equivalent effect, where appropriate, the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation;
- EPBD requires that Member States should ensure that by 31st December 2020, all new buildings are nearly zero-energy buildings where the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.
- Both Directives require an exemplary role for public sector buildings.

A barrier which has been identified which may prevent the targets outlined in the Directives being met is the gap of know-how of professionals. This gap exists in the number of professionals knowledgeable enough to implement the nZEB requirements for all new buildings in the near future. In practice all professionals are not up-to-date with standards and requirements that have to be fulfilled to build at nZEB levels.

Training programs could overcome the knowledge barrier and this deliverable aims to assist the SouthZEB project to fill this gap and address the need of developing training and assessment schemes for intermediate and senior professionals.

2 State of implementation in the EU

2.1 General description of implementation of EPBD and RED in the EU

Reducing energy consumption and eliminating wastage are among the main goals of the European Union. EU support for improving energy efficiency will prove decisive for competitiveness, security of supply and for meeting the commitments on climate change made under the Kyoto protocol. There is significant potential for reducing consumption with cost-effective measures. With 40% of EU energy consumed in buildings, the EU has introduced legislation to ensure that they consume less energy.

A key part of this legislation is the Energy Performance of Buildings Directive (Directive 2002/91/EC, EPBD), first published in 2002, which required all EU countries to enhance their building regulations and to introduce energy certification schemes for buildings. All countries were also required to have inspections of boilers and air-conditioners.

The introduction of national laws meeting EU requirements was challenging, as the legislation had many advanced aspects. It was a great opportunity to mobilise energy efficiency in EU buildings, but also a formidable and continuing challenge for many EU countries to transpose and implement the Directive.

To support EU countries in this task, the Concerted Action (CA) EPBD (CA EPBD, 2012) was launched by the European Commission to promote dialogue and exchange of best practice between them. The key aim was to enhance the sharing of information and experiences from national adoption and implementation of this important European legislation. An intensely active forum of national authorities from 29 countries, it focused on finding common approaches to the most effective implementation of this EU legislation.

With the adoption of the recast EPBD in 2010 (Directive 2010/31/EU) Member States faced new tough challenges. Foremost among them, moving towards new and retrofitted nearly zero-energy building by 2020 (2018 in the case of Public buildings), and the application of a cost-optimal methodology for setting minimum requirements for both the envelope and the technical systems, the current Concerted Action thus aims at transposition and implementation of the EPBD recast, and it runs from 2011 until 2015. The first part (until 2012) focused on transposition of the recast EPBD, the second part of the Concerted Action shall focus on implementation and lessons learned.

The RES (Directive 2009/28/EC) established a common framework for the promotion of renewable energy sources in the European Union, setting mandatory national targets for achieving a 20% share of renewable energy in the gross final energy consumption and a 10% share of energy from renewable sources in transport by 2020.

Similar to the EPBD, the Concerted Action on the renewable energy directive (CA-RES) is an instrument of the Intelligent Energy Europe (IEE) Programme, which supports the transposition and implementation of the RES Directive.

2.2 United Kingdom

2.2.1 EPBD Implementation

The implementation of the EPBD in England and Wales is the responsibility of the Department for Communities and Local Government (DCLG) (CA EPBD, 2013). Implementation in Scotland and Northern Ireland is the responsibility of the devolved administrations. In Scotland this comprises, the Scottish Building Standard Division (BSD) and for Northern Ireland comprises, the Department of Finance and Personnel (DFPNI).

Figure 2 outlines graphically how the EPBD is split and implemented in the four jurisdictions of the United Kingdom (UK). The format of national transposition and implementation of existing regulations is generally the same for each jurisdiction.

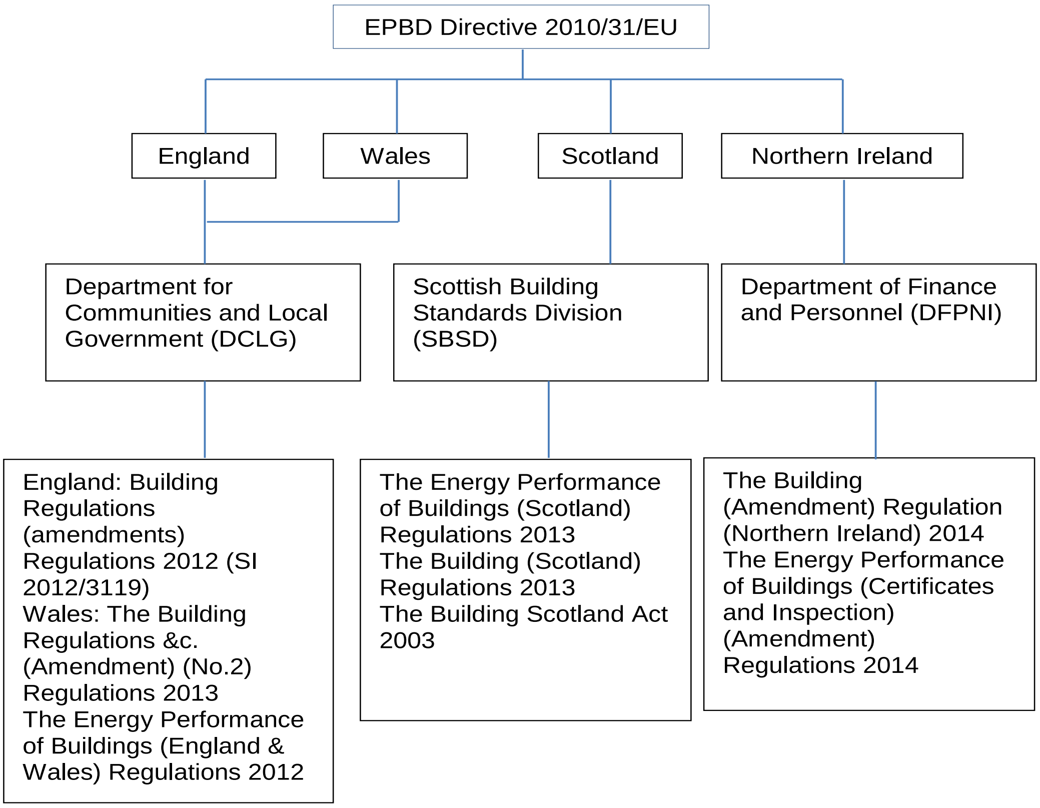


Figure 2 – Implementation of Energy Performance Building Directive (EPBD) in the UK

Energy Performance Requirements

National Calculation Methodology:

The UK calculation methodology consists of two published calculation tools and a procedure for approving alternative software such as dynamic simulation models for use in more complex non-domestic buildings. The calculation tools are the Government's Standard Assessment Procedure SAP for dwellings (with reduced data, RdSAP, used for existing dwellings), and the Simplified Building

Energy Model (SBEM) or equivalent approved Dynamic Simulation Modelling tools for non-domestic buildings.

These tools estimate the level of energy use (in kWh per m² of floor area) and the corresponding amount of CO_2 (in kg per m² of floor area) emitted per year based upon standardised assertions of on the occupancy and use of a building and enable the identification of cost-effective and further energy efficiency improvements.

In England and Wales, both procedures (Dwellings-SAP, non-domestic – SBEM) are based on an asset rating approach i.e. predicted energy consumption based on standard conditions (as outlined above). A separate procedure has been set up to produce Energy Performance Certificates for display. This comprises, the Operational Rating Calculation (ORCalc). This procedure is based on an operational rating approach i.e. a measured energy consumption which has been normalised to allow cross sector comparison of performance. EPCs for display are referred to as Display Energy Certificates (DECs).

The above procedures and software tools have been approved by Scottish and Northern Irish Ministers. Northern Ireland has approved the NCMs outlined above and procedures and software tools are automatically updated in line with England and Wales.

In Scotland the asset rating methodology has been adopted for all EPCs, including certificates for display in public buildings, and has been incorporated in the software packages approved for use in Scotland, including SAP, RdSAP, SBEM and DSMs.

Minimum Energy Performance Requirements:

The EPBD has been transposed in Scotland primarily through the Building Regulations. In Scotland, minimum energy performance requirements for buildings and for building elements are set through Section 06 (Energy) of the building regulations, The Building (Scotland) Regulations 2004, as amended.

Technical Handbooks provide guidance on achieving the standards set in the Building (Scotland) Regulations 2004 and are available in two volumes, domestic buildings and non-domestic buildings. The guidance recognises issues relevant to the EPBD and Article 13 of RES Directive on the promotion of the use of energy from renewable sources.

Scottish Ministers convened an expert panel to advise on the development of a low carbon building standards strategy to increase energy efficiency and reduce carbon emissions. This resulted in 'The Sullivan Report – A Low Carbon Building Standards Strategy for Scotland'. A key recommendation of this report was staged improvements in energy standards in 2010 and 2013, with the aim of net zero carbon buildings (emissions for space heating, hot water, lighting and ventilation) in 2016/17, if practical.

The expert panel reconvened in 2013 to discuss the progress and revisions necessary to the plan. The result was a revision to the recommendation on the dates with 2013 shifting to 2015, and 2016/17 to (most likely) 2020.

In England and Wales, energy performance requirements, for all new and existing buildings (residential and non-residential) are set out in Building Regulations (amendments) Regulations 2012 (SI 2012/3119) (England only) and Wales: The Building Regulations &c. (Amendment) (No. 2) Regulations 2013 in addition to The Energy Performance of Buildings (England & Wales) Regulations

2012. The above regulations include updates outlined in 'recast' of the EPBD and the RES Directive. The Building Regulations typically apply at original point of build, subsequent conversion and renovation, and on replacement of specified fixed components and systems. Part L of the Building Regulations sets requirements for the conservation of fuel and power.

The Government announced that from 2016 all new homes and from 2019 all new non-domestic buildings in England will be built to zero carbon standards. The expectation is that Part L of the building regulations, which already sets limits on the emissions of new buildings, will be the regulatory vehicle for achieving the on-site elements of these zero carbon standard. Changes made to the regulations in 2013 act as an interim step on the trajectory towards achieving zero carbon standards.

In accordance with the RES Directive the UK has committed to generating 15% of its energy from renewables by 2020. Part L has a role in facilitating implementation of the Directive by encouraging an increased share of energy from renewable sources.

The Northern Irish energy performance requirements are outlined through Part F of The Building (Amendment) Regulation (Northern Ireland) 2014 and The Energy Performance of Buildings (Certificates and Inspection) (Amendment) Regulations 2014. On 24th February 2014, the Department of Finance and Personnel introduced new Building Regulations in response to amendments made in EPBD recast.

Cost-Optimal procedure for setting Energy Performance requirement:

The results of a detailed study in UK showed that for new dwellings, current regulations are better than cost-optimal levels, while current regulations for existing dwellings are either at or better than cost-optimal levels. For non-dwellings, current standards fall just short of cost-optimal levels for both new and existing buildings.

Action Plan for progression to nZEB

The UK national plan, 'Increasing the number of Nearly Zero-Energy Buildings', covers all four jurisdictions: England, Wales, Scotland and Northern Ireland. It sets out the national plan for increasing the number of nearly zero-energy buildings in the UK as required by Article 9(1) of the Directive 2010/31/EU.

The plan was submitted to the European Commission and it confirms the UK's legally binding commitment (under the Climate Change Act 2008) to greenhouse gas emission reduction targets of at least 34% by 2020 and 80% by 2050. They meet these targets, the emissions footprint of buildings will need to be almost zero which will mainly be achieved through:

- Reducing demand for energy in buildings, e.g. through heat efficiency improvements, lighting and appliances efficiency improvements, behavioural change;
- Decarbonising heating and cooling supply, e.g. through building and network level technologies.

The UK is committed to successive improvements in new-build energy standard through changes to Building Regulations in England, Scotland, Wales and Northern Ireland.

England has a target for all new homes to be zero carbon from 2016 and an ambition for all new non-residential buildings in England to be zero carbon from 2019 (2018 for new public sector buildings).

In August 2007, the Scottish government appointed an independent panel to advise on the development of a low carbon building standards strategy to increase energy efficiency and reduce carbon emissions. The resulting report, 'The Sullivan report', provided a route map for delivery of very low carbon buildings, setting aspirations for carbon abatement and energy efficiency within building standards. The Report also gave the goal of 'net zero carbon' to aim for by 2016/2017.

The Scottish Government[1] shares the ambition for zero carbon buildings, and has given a commitment to further reviews of the Building Standards in 2016. Revised energy standard have been delivered in 2013 in line with recommendations in the Sullivan Report, 'A low Carbon Building Standard Strategy for Scotland' and the 2013 update.

However, as a result of the recent economic downturn, the implementation of a number of original recommendations proved challenging therefore, a number of the original recommendations have been revisited and updated in 2013 by the Sullivan panel. It has been outlined that the subsequent review of energy standards should be programmed to align with the EU directive requirement for 'nearly zero-energy' new buildings from 2019.

Wales expects all new homes and non-residential buildings to be built to zero carbon (and nearly zero-energy) standards at least by 2020. This will be subject to review in 2015/2016.

Northern Ireland proposes to apply the same standards as England by 2017 for all new homes and all new non-residential buildings in Northern Ireland to be zero carbon from 2020.

Energy Performance Certificates

The England and Wales Government has licensed Accreditation Schemes to accredit energy assessors for the production of output under the EPBD. National Occupational Standards (NOS) specify the qualifications and skills which energy assessors should meet to be accredited to produce regulatory outputs. Different types of accreditation are available depending on:

- the building type, i.e. residential, non-residential;
- the complexity of the building;
- the software to be used;
- the type of regulatory output (EPC, DEC, etc.).

Accredited energy assessors must use government approved software tools to produce regulatory outputs.

EPC's are produced for buildings on construction, sale or rental. DEC (Display Energy Certificates) are produced and displayed in large public buildings. The format and content of residential and non-residential EPCs vary and both types are valid for 10 years. All EPCs become legally valid after they have been lodged on the national register (www.epcregister.com/www.ndepcregister.com).

[1] http://www.scotland.gov.uk/Publications/2013/11/8593

The government introduced Scheme Operating Requirements (SORs) in 2010 (which were updated in 2012) to ensure that all Accreditation schemes achieve a common set of minimum quality standards. Under SOR, accreditation schemes are mandated to undertake Quality Assurance (QA) outputs produced by their accredited energy assessor. Government also carries out QA audits of the quality systems implemented by Accreditation Schemes and compliance with SORs.

For residential buildings the EPC provides a rating of the overall energy efficiency of the building on a scale from A-G, where A is very efficient and G is least efficient based on annual CO_2 emissions per unit floor area. The EPC also contains an environmental impact rating, which is a measure of the homes impact on the environment in terms of CO_2 emissions. The EPC included a list of cost effective recommendations to improve the energy ratings specific to the dwelling and indicates the potential energy efficiency and environmental impact ratings if all cost effective measures were installed.

For non-residential buildings, energy performance is shown as a similarly to domestic on an A-G scale. The EPC for non-residential buildings includes two benchmarks; the energy rating if the property were newly built and the energy rating if it were typical of the existing stock of similar properties. Cost effective recommendations are included in the accompanying recommendations report and for non-residential properties are categorised as:

- short term-payback less than 3 years;
- medium term-payback between three and seven years;
- long term-payback more than seven years.

The provision for producing certificates on the sale and rent of properties in Northern Ireland mirror those for England and Wales with some minor differences.

In Scotland, the national provisions for the production of EPCs are broadly similar to those implemented in England and Wales; however there are a number of key differences. These include:

Administration and quality assurance: The Scottish Government has appointed Approved Organisations which may accredit members to produce regulatory outputs in Scotland. Approved organisations have been tasked with specific QA responsibilities under an agreed operational framework. Approved organisations must have quality assurance procedures in place to check the quality of the EPCs produced by their members and to undertake appropriate corrective action where the required standard is not met. AOs must ensure that a minimum of 2% of the total number of EPCs produced by members are checked for accuracy. Government will audit Approved Organisations to ensure compliance.

Residential EPC: This is very similar to the England and Wales EPC and is also valid for 10 years. The main difference is that an additional scale is included in Scotland to provide an environmental impact rating.

Non-residential: The format of the Scottish EPC in unlike that of the England and Wales EPC. It is valid for ten years and differs significantly. The banding is based on absolute CO_2 emissions rather than the relative approach adopted in the England and Wales (i.e. 'actual building' vs 'reference/notional building'). Absolute primary and delivered energy consumptions are shown on the EPC, which also includes key recommendations for the cost-effective improvement of energy performance. Other pages of the certificate include additional building background information, recommendations for improvement and guidance.

Register: Since January 2013, a new register replaced the old register, the Home Energy Efficiency Database (HEED). The new register (www.scottishepcregister.org.uk) is used for new and existing buildings and is only accessible by the nominated individuals of the approved organisations and enforcement authorities.

Display of Energy Performance Certificates:

In England and Wales Display Energy Certificates have been produced by public authorities and institutions and are issued and displayed in all public buildings frequently visited by the public with floor areas greater than 500 m^2. This threshold will fall to 250 m^2 in 2015.

DECs show the energy performance of a building based on the actual energy consumption for the previous year in the form of an Operating Rating (OR). Information on performance recorded over the previous three years is also shown on the DEC when available. The historic data illustrates whether there has been an improvement in a buildings performance. The OR gives a numerical indicator of a buildings CO_2 emissions on a scale of A to G, with A being the best performance. The buildings performance is compared to a benchmark. For each building category, the benchmark is set at the median performance for all buildings in each category. DECs for buildings with useful floor area of greater than 500 m^2 are updated annually.

An affected organisation must display a DEC in a prominent place clearly visible to the public and have in its possession or control a valid advisory report. The advisory report contains recommendations for improving the energy performance of the building. Where the building has a total useful floor area of more than 1,000 m^2, the DEC is valid for 12 months. The accompanying advisory report is valid for seven years. Where the building has a total useful floor area of between 500 m^2 and 1,000 m^2, the DEC and advisory report are valid for 10 years.

In Scotland, as with EPC's above, the new register began operating in January 2013. In Scotland an EPC for display is not termed a 'Display Energy Certificate' as it is in England and Wales. In Scotland, an EPC must be displayed by fixing it in a visible location to the commercial building if, the total useful floor area is over 500 m^2; the building is frequently visited by the public; and an EPC has already been produced for the buildings sale, rental or construction. In Scotland, the cost of an EPC will depend on the building being assessed; however as with England and Wales they are valid for 10 years. A fine of between £500 and £5000 based on the rateable value of the building can be imposed if an EPC is not made available to any prospective buyer or tenant.

The provisions (including administration, accreditation of assessors, certificate format, penalties) relating to display certificates in Northern Ireland are similar to those in England and Wales. Guidance including 'A guide to Display Energy Certificates and advisory reports for public buildings' was published in 2012 and updated in 2013. The new regulations implement the new display requirements of the recast EPBD.

Inspection Requirements – Heating and Air Conditioning

All UK jurisdictions (England, Scotland, Wales and Northern Ireland) decided to pursue the option to provide advice on boilers, rather than implementing an inspection regime.

In England and Wales, installations of air-conditioning (AC) equipment must be inspected every five years and since 2012 all new AC Inspection Reports must be lodged on the national EPC register.

This aims to ensure reports may be assessed for QA. The approved guidance to undertake AC inspections is set out in Technical Memorandum 44 (TM44) Inspection of Air-Conditioning Systems published by CIBSE. The administration, energy assessors, accreditation and QA process have been incorporated as a separate strand of the EPC process.

In Scotland inspection of air conditioning systems may only be carried out by members of those organisations that have entered into a protocol with the Scottish Government. As for England and Wales, the frequency of inspections is five years and the CIBSE TM44 may be used as guidance to undertake inspections, subject to the provisions set out in the TM44 Scottish addendum.

In Northern Ireland, the national requirements broadly mirror the England and Wales requirements (administration, accreditation, QA, penalty regime). The requirement to lodge the AC Inspection Report on the national register came into force in February 2013. 'A guide to air-conditioning inspections for building' was updated in 2013 and is available on the DFPNI website.

2.2.2 RED Implementation

In the UK mandatory sustainability requirements were implemented on 15 Dec 2011; as an amendment to the RTFO (Renewable Transport Fuel Obligations Order) 2007, the UK biofuels legislation (ECOFYS, 2011). The RTFO is also expected to be the mechanism used to meet the Fuel Quality Directive (FQD), although the FQD is not yet implemented. The system for demonstrating compliance with the sustainability criteria can be classified as a national system, in which ex-post verification of sustainability data is permitted as a way to demonstrate compliance with the sustainability requirements. Voluntary schemes recognised by other Member States (but not recognised by the EC) are not automatically accepted. No differences exist in the requirements for domestic, EU and non-EU feedstocks or biofuel producers.

Compliance with the sustainability criteria has to be demonstrated by the economic operators and the mass balance system are fuel suppliers at the end of the chain. A minimum of an annual report must be provided to the RTFO Unit of the Department for Transport; although they can choose to report more frequently. The items required to be reported include:

- the quantity and type of biofuel supplied;
- feedstock type;
- country of origin;
- GHG performance;
- NUTS-2 region for EU feedstocks;
- degraded land bonus;
- soil carbon accumulation;
- voluntary scheme used; and
- land-use on 1 January 2008 (if voluntary scheme used).

In order to obtain Renewable Transport Fuel (RTF) certificates, reporting on voluntary schemes, degraded land bonus and soil carbon accumulation factor is not mandatory. The RTF certificates are required to meet supplier's obligations under the RTFO, but must be reported and verified at least annually in the form of an annual report. Reporting is done using the RTFO Operating System (ROS). ROS is an online custom made database.

In the United Kingdom the primary support mechanism for RES-E is the Renewables Obligation (RO) and the recently introduced Feed-In Tariff (FIT) (ECOFYS, 2011). The RO is a quota system with tradable green certificates known as Renewables Obligations Certificates (ROCs). The FIT scheme was introduced by the UK Government in 2010 with regulatory aspects of the scheme managed by DECC and administered by the Office of Gas and Electricity Markets (Ofgem).

Between the different jurisdictions of the UK, The legislation is divided into the Renewables Obligation (for England and Wales), the Renewables Obligation Scotland (SRO), and the Northern Ireland Renewables Obligation (NIRO). These schemes are managed by the Department of Energy and Climate Change, DECC, the Scottish Government and the Department of Enterprise, Trade and Investment for Northern Ireland respectively. The scheme is administered by the UK electricity regulator, the Office of Gas and Electricity Markets, Ofgem.

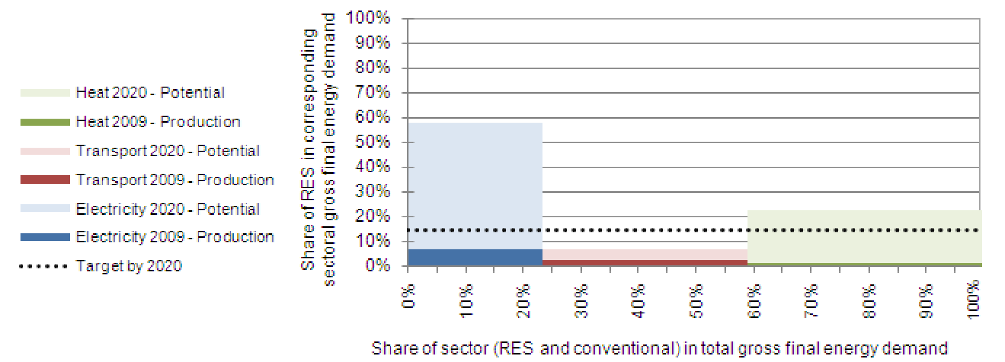
As a result of both support mechanisms, the RO increased the share of RES-E in the UK from 1.8% in 2002 to 6.8% in 2010; and the FIT has seen almost 100,000 installations registering support, 97% of which were solar projects. It has recently been proposed that the government will discontinue the RO from 2017 and introduce an expanded FIT to cover all RES-E generation.

Throughout the UK, initial support for renewable heating and cooling lacked focus. The main support instrument was the Enhanced Capital Allowances (ECAs). There have also been a number of grant schemes available for bioenergy, although most of these are now closed. The Government has forecast that they would need to increase RES-H to 12% of heat demand in 2020 to meet the UK‟s overall RES target under the RED. To achieve this, the Renewable Heat Incentive (RHI) was introduced in November 2011 to boost RES-H deployment. The RHI is a feed-in tariff for heat, which initially targeted the non-domestic sector with the domestic sector following in 2012.

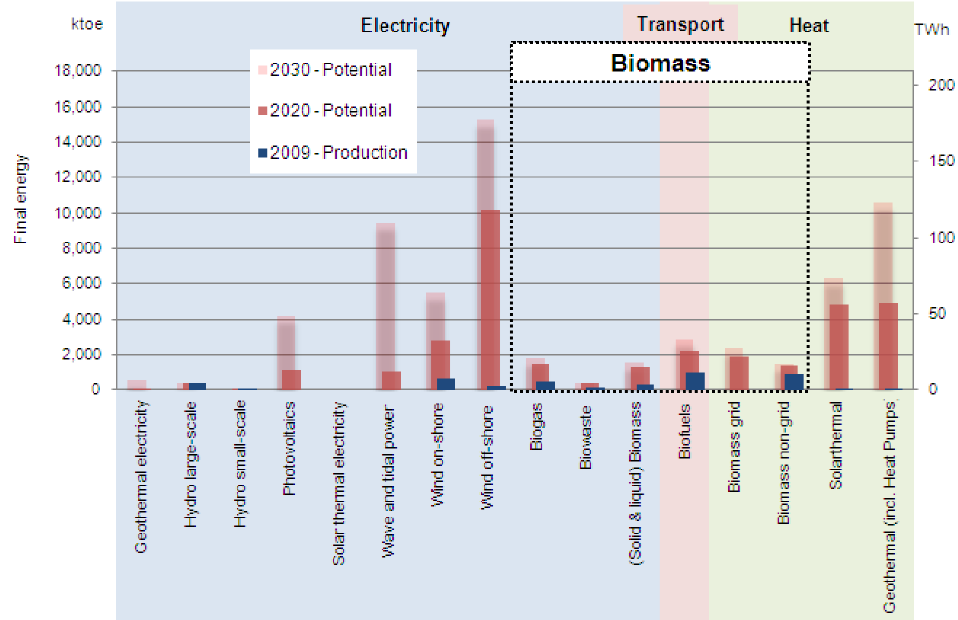
The primary support instrument for renewable fuel in the UK is the Renewable Transport Fuel Obligation (RTFO), which was implemented on 15 April 2008. This is currently accompanied by a £0.20 per litre fuel duty exemption on biodiesel produced from used cooking oil which was in place until March 2012.

The RTFO targets increased incrementally to a 5% biofuels share in road transport (by volume) in 2013/14. The key changes to the RTFO in 2011/12 assimilated it to the requirements of the RED, specifically with regard to mandatory Carbon and Sustainability requirements, but also to implement aspects such as the double counting of advanced biofuels and wastes and residues.

A summary of the RES target, production and potential in UK is available Figure 3.



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	7%	2%	2%	3%
Share of total sector consumption in total final energy consumption	23%	36%	41%	100%
Production 2009 [ktoe]	2,168	968	933	4,069
Production 2007 [ktoe]	1,689	346	725	2,760
Production 1999 [ktoe]	827	0	583	1,410
Average growth 2007-2009 [%/a]	13%	67%	13%	21%
Average growth 1999-2009 [%/a]	10%	-	5%	11%
Realisable potential until 2020 [ktoe]	18,579	2,226	12,992	33,797
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	15%
Realisable potential until 2030 [ktoe]	36,247	2,889	20,726	59,861



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	0	365	68	0	0	0	633	178	481	130	304	967	0	882	25	27
Production 2007 [ktoe]	0	339	63	0	0	0	374	104	445	101	251	345	0	705	9	11
Production 1999 [ktoe]	0	372	17	0	0	0	72	0	182	74	40	0	0	582	0	1
Ø annual production growth 2007-2009	-	4%	4%	-	-	-	30%	31%	4%	13%	10%	67%	-	12%	64%	56%
Ø annual production growth 1999-2009	-	0%	15%	-	-	-	24%	-	10%	6%	23%	-	-	4%	78%	42%
Realisable potential by 2020 [ktoe]	13	371	58	1,116	0	1,013	2,793	10,141	1,430	375	1,270	2,226	1,859	1,403	4,842	4,888
Realisable potential by 2030 [ktoe]	528	374	59	4,215	0	9,461	5,509	15,280	1,760	417	1,511	2,889	2,359	1,473	6,316	10,578

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 3 – RES target, production and potential in UK (ECOFYS, 2011)

2.3 Austria

2.3.1 EPBD Implementation

In Austria Energy Efficiency (EE) is considered to be sound and comprehensive, still with some areas for improvement. The public sector, both at federal, as well as county level, has a leading role in reducing energy consumption, undertaking a series of measures to achieve this objective. EE is pursued actively, especially in the building sector. The national initiative “klima:aktiv” for climate protection constitutes a good practice example, which includes energy consulting, as well as education and training of building professionals and energy advisers.

In the buildings sector, a comprehensive policy package was introduced, which includes almost all relevant elements ranging from legal standards and regulations to available funding and economic initiatives for energy performance certificates (ECOFYS, 2011; AEA, 2010). This National Energy Efficiency Action Plan (NEEAP) is summarised in Figure 4 (CA EPBD, 2013).

Residential Sector - Buildings

Comprehensiveness of policy package	
Minimum Energy Performance Standards (MEPS)	• MEPS exist since the early 1990s, they are adjusted in irregular intervals. • Not clear how compliance with the standards is ensured.
Other regulations	• There is a legal requirement to promote district heating.
Economic incentives	• Long tradition of soft loans & grants for energy efficiency improvement in new and existing residential buildings. • Subsidies for renovation and heating exists.
Financing instruments	• Three instruments for facilitating financing of EE measures have been established.
Energy performance certificates (EPCs)	• EPCs not mentioned in the NEEAP. • According to MURE database, they were in introduced in 2008/2009 (depending on the age of the building).
Energy advice and audits	• Extensive energy advice programmes for households. • Advice and support to businesses, municipalities and individuals is given.
Information tools	• A large variety of measures in the field of information and awareness-raising.
Demonstration projects	• Demonstration projects are not mentioned in the NEEAP nor in the MURE database. Only role model for private sector buildings.
Education and training for stakeholders	• A large variety of measures in the field of education, training are offered.
Adequacy of policy package	• Focus on building sector where large potentials are considered. • Policy mix is well balanced with stringent regulation, financial support, extensive information and advice programmes.

Figure 4 – National Energy Efficiency Action Plan – Austria (CA EPBD, 2013)

In 2011 and 2012, Energy Efficiency Watch (EEW) conducted a quantitative and qualitative survey with national experts on implementation of energy efficiency policies in EU Member States. According to the EEW survey, Austria is among the Member States that has made medium progress in energy efficiency policies since the first NEEAPs. The most important elements which were brought out include on one hand the lack of energy efficiency policy provisions in the transport sector, while on the other the definition and agreement of binding targets for energy savings. It is believed that more policies are needed to reduce consumption. When it comes to positive feedback, the survey demonstrated that a lot of work has been made in the recent years in setting concrete and ambitious energy efficiency standards for residential buildings and housing programmes.

Energy Performance Certificates

The building regulations in Austria fall under the responsibility of the nine Austrian regional states, the Bundesländer/Länder. Starting from different energy requirements in the respective building codes, the Länder and the federal state agreed on the development of a harmonised implementation of the EPBD in 2006. This process is managed by the Austrian Institute for construction Engineering (OIB) and by a working group of representatives of the nine Länder, who agreed on common methods and requirements, fixed in OIB guidelines, which had to be implemented in the respective Länder. In this way, the OIB guidelines serve as the basis for the harmonisation of building regulations and may be used by the Länder for this purpose. The declaration of legal obligation of the OIB guidelines is subject to the Länder. The first guidelines were finalised in 2007 and the regulations in the Länder, and therefore the Energy Performance Certificates (EPC) came into force between January and March 2008.

The EPC for Austria are a prerequisite for selling, renting and/ or leasing a building. The year of construction is not depended upon issuing a certificate or not and it has to be provided by the landlord or vendor. The EPC are issued by an authorized person, according to the relevant rules and regulations, by an accredited inspection authority or by a person who has been certified, on the basis of cooperation in the building sector. The person can be a chartered engineering consultant, with relevant authorization, engineering agency, master builder and master carpenter, legally accredited experts of relevant expertise, as well as technical departments of public bodies. In addition, certification bodies in the Länder can certify people to issue an EPC.

In 2010 approximately 4,000 people were certified to issue EPCs, from chimney sweepers to licensed consulting engineers or architects. Until today, there is no federal register of qualified experts for EPCs in Austria. Nevertheless, the Länder have their own database.

With the adoption of the EPBD recast in 2010, Austria proceeded on its way towards new and retrofitted nZEBs by tightening the OIB guideline 6 “Energy economy and heat retention” (covering the minimum requirements of the Austrian energy performance indicators), as well as the OIB guideline “Energy performance on buildings” (covering the calculation methodology framework). Both documents were amended in October 2011.

In October 2012, the Länder agreed to use the four indicators mentioned below to describe the energy performance of a building:

- Space heating demand;
- Energy performance factor (it relates to the overall final energy demand);
- Primary energy demand;
- CO_2 emissions.

The differences among the Länder when it comes to issuing a certificate are related to:

- The minimum requirements for certification;
- The EPC for major renovations;
- The necessity for display of the EPCs in the public building;
- The exceptions form the requirements (for example in protected areas in Vienna).

By November 2012, the negotiations on the energy performance requirements and milestones for non-residential buildings were not agreed upon yet, nevertheless, they will be designed along the same lines.

In summary, the Austrian efforts towards nZEBs are focused on achieving a combination of the four different requirements mentioned above and which will result in energy efficient buildings, while at the same time taking into consideration a robust building envelope, the overall energy efficiency, resource conservation and climate protection. From 2020 it is expected that for new buildings, not public ones[2], space heating demand will be decreased to "Passive House" level, if not lower. However, the Austrian nZEB requirements are not related to the "Passive House" ones, since the latter allow the application of different standards, under the condition that the overall energy efficiency is the same. Therefore, building according to the 'Passive House" requirements, will not be enough to meet all indicators in every case and, consequently, other measures, such as solar collectors and bioenergy, will also be necessary.

In Austria, every public building[2] with an area of over 1,000m^2 has had the obligation of displaying an EPC at the main entrance since 2008. By the end of 2010, only several hundred buildings were certified, while the number increased constantly. In accordance with the 2011 OIB guidelines, the Länder have implemented stricter rules for the EPBD 2010.

2.3.2 RED Implementation

In Austria, the two main legal implementing documents on RED are the Verordnung Landwirtschaftliche Ausgangsstoffe für Biokraftstoffe und flüssige Biobrennstoffe (Regulation for agricultural raw materials for biofuels and bio-liquids), which was published in July 2010 and has come into force since December 2010; it contains the sustainability criteria and guidelines on how Austrian feedstock can comply and holds the Kraftstoffverordnung (Fuel Regulation), which contains the obligations for fuel suppliers, imported feedstock, RED greenhouse gas threshold and calculation rules as well as details on double counting (ECOFYS, 2011; ECOFYS, 2012). The Kraftstoffverordnung is still awaiting political approval. It is expected that the new legislation will have significant impact on the Austrian renewable electricity market.

Analytically, the criteria for agricultural raw materials in Austria are the following:

- from areas which are cultivated in line with Cross Compliance and GAEC provisions;
- from areas which were agricultural areas already before 1 January 2008;
- not from areas which are under nature protection by the federal countries (exception: production is admitted and does not interfere with the protection purpose).

[2] By public building we mean any frequently building visited by the public, irrespectively of whether it is owned by public or private bodies.

The verification of compliance of sustainability for agricultural raw materials is based on the following principles:

- Origin Austria: material has to be from agricultural holdings which are registered at AMA (Agrarmarkt Austria);
- Origin other Member States: acceptance of certificates out of national systems of other MS - no assessment procedure, but national (bilateral) recognition;
- Origin third countries: assessment procedure for private control bodies or certificates out of systems recognized by the Commission (urgently awaited);
- No voluntary scheme is or will be developed by national authorities.

The federal support policy for electricity from Renewable Energy Sources (RES) is regulated by the Austrian Green Electricity Act (Ökostromgesetz), which has been amended several times since its implementation in 2002 (the last amendment was adopted in 2011). Currently, Austria is in a transition phase from regulations based on the act from 2002 to the new act with elements of the old and new law being effective simultaneously.

Following a decrease of funding and modification, in particular budget restrictions and reduced guaranteed duration of support in the past few years, the development of projects focusing on RES-Electricity has been limited. Consequently, on 23rd September 2009, the federal parliament passed an extensive amendment which included several improvements, notably longer support periods, adjusted tariffs and slightly increased and technology independent overall budget. The changes, along with specific developments related to the cost of renewable technologies, favoured new capacity additions so that the technology caps were reached soon, which resulted in long waiting lists. On 1st July 2012, there was a change in the financing system of RES electricity support schemes due to a new law that entered into force. The new system is financed through network usage charges, metering point charges, network losses charges, costs for guarantees of origins and revenue from the allocation of green electricity at the day-ahead hourly spot market price. In the previous system, the renewable electricity bought by OeMAG (clearing house for green electricity) at the FIT and allocated to electricity suppliers was financed by two price components; settlement prices and flat-rate metering point charges.

In Austria, national support policy for RES-Heating &Cooling projects is provided by the Environmental Support Act (Umweltförderungsgesetz), which promotes RES mainly in the form of investment grants. An extended support structure is effective since 1st October 2009. This national regulation addresses commercial entities, non-profit organizations, public institutions and utilities. Private households receive investment grants for RES-H&C projects at the provincial level. From a financial point of view and also with regard to the observed effectiveness, these programs clearly represent the main promotion scheme for RES-H in Austria.

In Austria, RES in the transport sector are mainly supported in the form of biofuels. The support strategy is twofold. On the one hand, minimum blending obligations guarantee market access for biogenic products and, on the other hand, tax incentives provide financial support for biofuel production. Several pilot projects are currently under way to support the development of e-mobility.

The financing of national energy efficiency support schemes varies. Some states, as well as some energy providers and interest groups, provide subsidies for energy efficiency. The amount and mode of funding vary in mechanism and volume.

A summary of the RES target, production and potential in Austria is available in Figure 5 (ECOFYS, 2011).

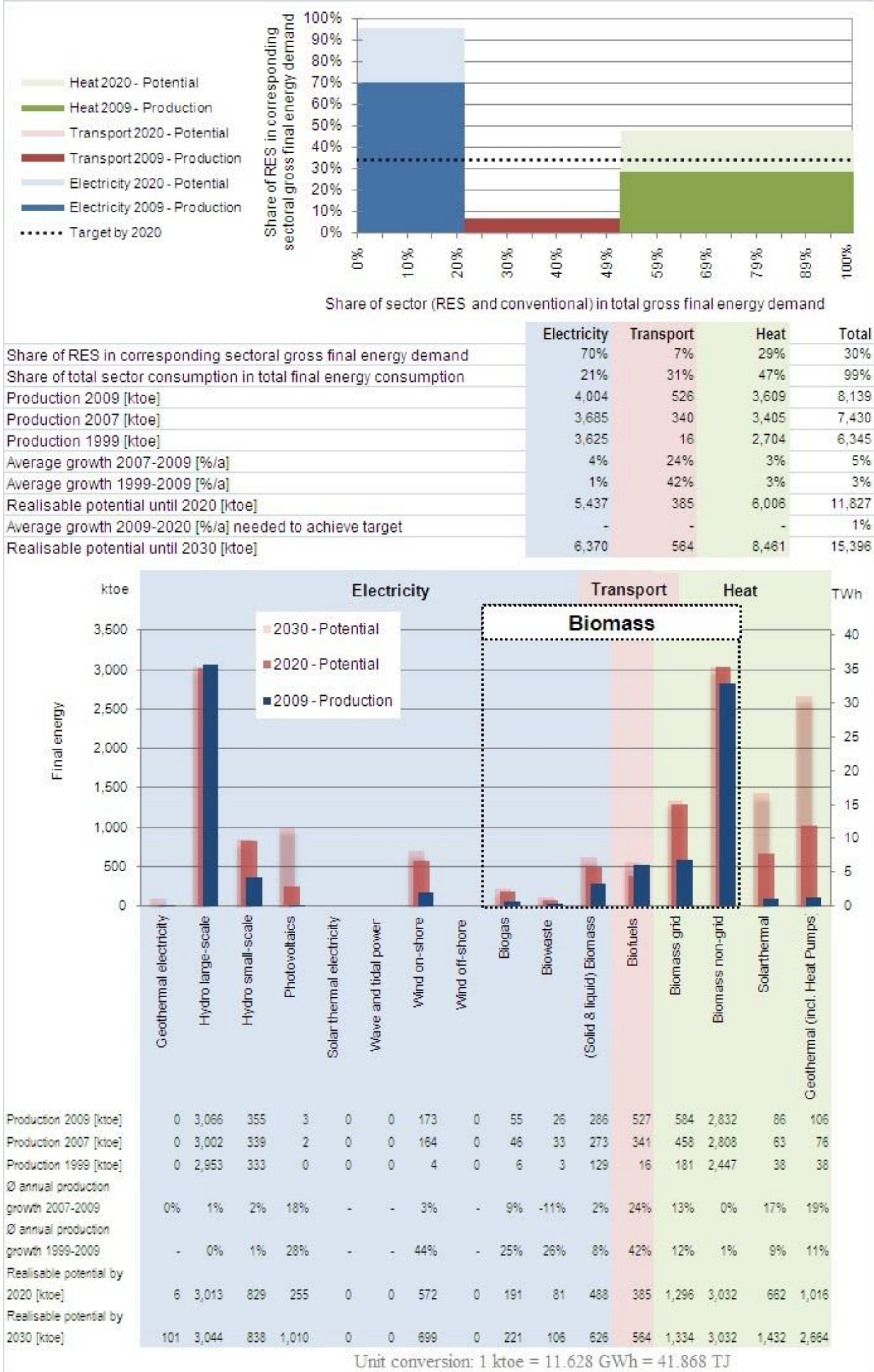


Figure 5 – RES target, production and potential in Austria (ECOFYS, 2011)

2.4 Germany

2.4.1 EPBD Implementation

In 2007, the German government legally implemented the EPBD when the German federal energy saving ordinance (Energieeinsparverordnung, EnEV, 2007) came into effect. The EnEV aims to increase the energy efficiency of buildings and the use of renewable energies.

Germany first introduced regulations to improve the insulation of buildings in 1979 when the government implemented its first heat insulation ordinance (Wärmeschutzverordnung, WSchV). Since the implementation of the EnEV 2002, the primary energy demand of new buildings has been limited; existing buildings which are being renovated or extended also have to comply with specific minimum standards. Upon the implementation of the EnEV 2009 on 1st October 2009, the energy minimum standards were increased by 30 %.

Energy Performance Certificates

With the implementation of the EnEV 2007 on 1st October 2007, energy labelling of existing residential buildings became compulsory by July 2008. Buildings or apartments that are rented, leased or sold must have an energy label. As of 1st January 2009 non-residential buildings also have to have an energy label. For public buildings exceeding 1,000 m^2, the energy label has to be visible. For new residential buildings, energy labels have been issued since 2002; however a former kind of energy label has been compulsory since 1995. The German energy agency (dena) introduced a seal of quality to improve the quality of the energy labels for residential buildings.

Currently, there are two types of energy labels for residential buildings: the label based on energy demand and the label based on energy consumption. The label based on energy demand is obligatory for new and renovated or extended residential buildings and includes the calculated primary and final energy demand. For all existing buildings which contain more than four flats, the label based on energy consumption can be issued. It includes the metered final energy consumption. The energy demand / energy consumption ($kWh/m^2.a$) is published on a chart and spans from green (very efficient) to red (very inefficient). To better appreciate the level of energy efficiency, the chart also includes the energy demand of comparable buildings.

Since many years already, Germany has been pursuing the aim to increase energy efficiency and to enhance climate protection in the building sector (new buildings and existing buildings). This has already now led to an increase of the number of nearly zero-energy buildings. In this regard, the voluntary and cost efficient nature of the measures in connection with the mix of instruments ('Compel, Support, Inform - strengthen market forces') is a key aspect.

Supported by funds from the CO_2 building rehabilitation programme, the German Energy Agency (dena) carries out approximately 450 pilot projects across Germany for highly energy efficient refurbishment of residential and non-residential buildings (municipal infrastructure buildings, especially schools). The refurbished buildings remain below the requirements of the EnEV for a comparable new building on average by approximately 50 %. In addition, dena makes its findings and experience available to planners and craftsmen engaged in the rehabilitation sector via information platforms.

2.4.2 RED Implementation

Significant changes have taken place in the electricity and heating/cooling sectors; transport policies remained unchanged (ECOFYS, 2011; ECOFYS, 2012). In June 2011, the German Bundestag passed a new amendment of the Renewable Energy Sources Act (EEG), which came into effect on December 2012. Being its third major revision, the law aims to make renewable energy more competitive. In parallel to the existing fixed feed-in tariffs, it introduces a market premium that allows power producers to sell RES-electricity on the electricity market. The amendment also revises the tariff structure of several renewable energy technologies, including biomass, geothermal and offshore wind power. For solar photovoltaics a dynamic regression of tariffs based on capacity increase was already introduced in 2010/11.

This mechanism is continued in the EEG 2012. On 1st May 2011 an amendment of the Act on the Promotion of Renewable Energies in the Heat Sector (EEWärmeG) came into effect, implementing the objectives of the Directive on the Promotion of the Use of Energy from Renewable Sources (2009/28/EC). While refraining from introducing strict standards for private buildings, the act adopted norms for heating and cooling in existing public building that undergo major renovations. In the transport sector, no major changes occurred since the last publication of this country profile. As reported in the previous version, the new Biofuels Sustainability Ordinance introduced additional quality criteria for biofuels in order to benefit from tax reductions and to be an eligible source to fulfil the blending target. On 1st January 2011, Germany increased the mandated E5 fuel blend to E10 (10% ethanol) (ECOFYS, 2011).

The German sustainability system is a voluntary scheme based system. Fuel suppliers are required to demonstrate compliance with the sustainability criteria and mass balance requirement by using voluntary schemes. The Federal Office for Agriculture and Food (BLE) approves voluntary schemes. Germany also accepts voluntary schemes approved by the European Commission or other EU Member States. The registration procedure of economic operators who are participants of the voluntary scheme or the national system includes a high level check to assess whether the RED/FQD requirements are covered by their respective scheme or system.

All economic operators in the supply chain, from the first gathering point to the last interface, need to pass sustainability information to the next step in the supply chain or ‘interface’. In the supply chain after the last interface it is mandatory to provide the relevant data about sustainability of each biofuel/bio-liquid consignment by using the electronic German Sustainable Biomass System (Nabisy) administrated by the BLE. BLE can issue a “Proof of sustainability” (Nachhaltigkeitsnachweis) if the producer of the biofuel or bio-liquid who has converted the product to the quality level of its final consumption (last interface):

- Participates in a BLE-recognised voluntary certification scheme, an EU-recognised voluntary scheme or a national system of other MS;
- Has a valid certificate issued by a BLE-recognised certification body or, in case of participants of VS/NS, is under control of an independent third party;
- Has received from the upstream interfaces:
    - a copy of their valid certificate;
    - confirmation that the requirements as to the land-related criteria have been fulfilled, and the value of greenhouse gas emissions from cultivation, transport and processing;
- Ensures traceability back to the cultivation of the biomass through a mass balance system;
- The consignment complies with the greenhouse gas emissions savings potential required;

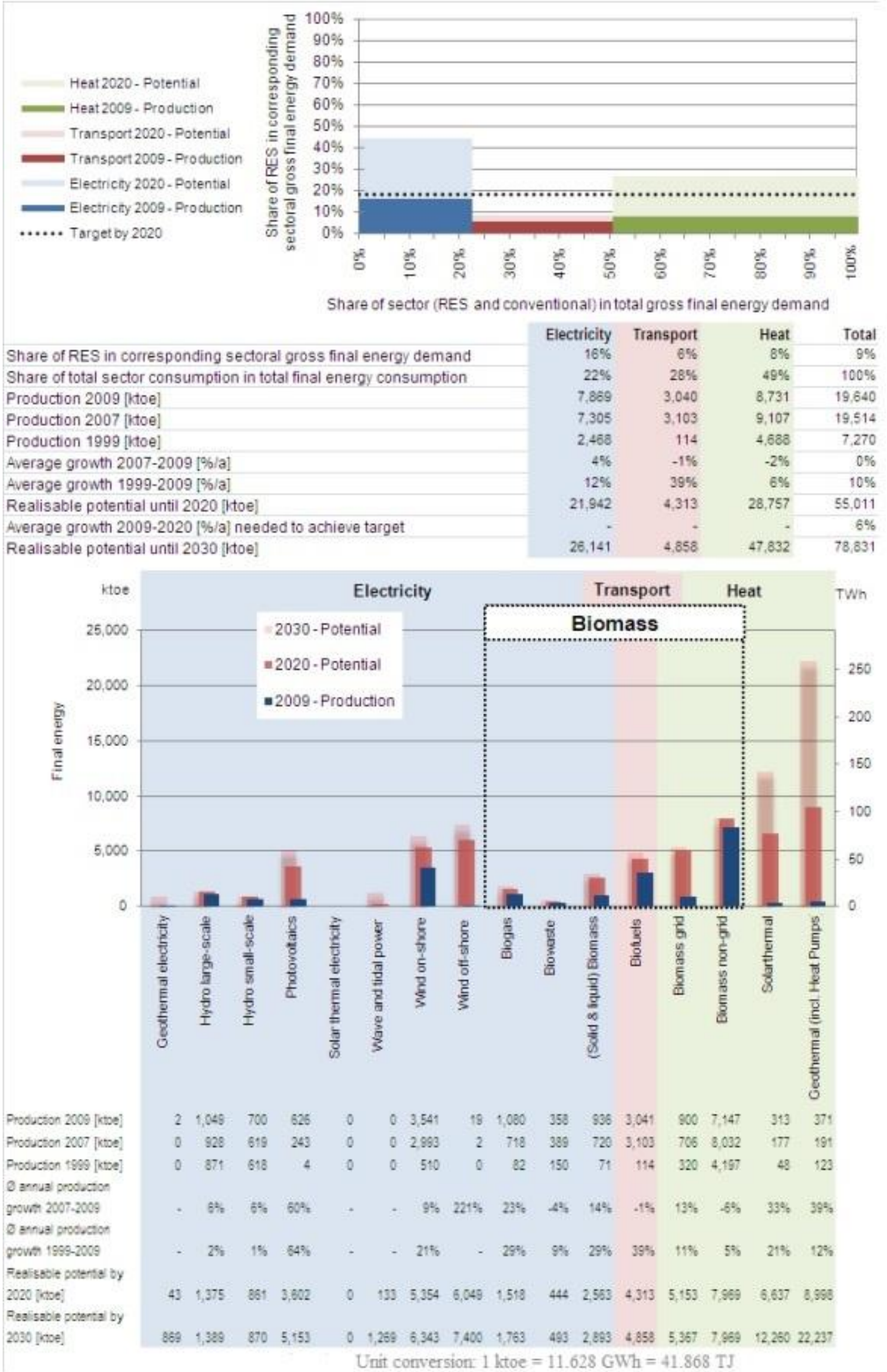
- A proof of sustainability has been issued in accordance with the specifications laid down by a certification system recognised by the BLE, EU-recognised VS or national system of other MS;
- Is the last interface in the supply chain, meaning there will be no further conversion.

Whilst the producer is entering the relevant data of sustainability into Nabisy, the data will be checked for plausibility. The recipient of the consignment will find the proof of sustainability immediately on his Nabisy account. Based on this proof of sustainability and according to the quantity of the delivery the supplier is able to transfer a partial proof of sustainability to the account of his client.

No differences exist in the sustainability requirements for domestic, EU and non-EU feed-stocks or biofuel producers, since only voluntary schemes can be used to demonstrate compliance. However, requirements regarding the control audits of farms/plantations are different. At least 5% of the farms/plantations need to be controlled, while audit controls for at least 3% of the EU farms/plantations have to be carried out.

Germany does not provide additional guidance on mass balance and the calculation of actual GHG values beyond the guidance included in RED and FQD; economic operators have to follow the guidance provided by voluntary schemes.

A summary of the RES target, production and potential in Germany is available in Figure 6 (ECOFYS, 2011).



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	16%	6%	8%	9%
Share of total sector consumption in total final energy consumption	22%	28%	49%	100%
Production 2009 [ktoe]	7,869	3,040	8,731	19,640
Production 2007 [ktoe]	7,305	3,103	9,107	19,514
Production 1999 [ktoe]	2,468	114	4,688	7,270
Average growth 2007-2009 [%/a]	4%	-1%	-2%	0%
Average growth 1999-2009 [%/a]	12%	39%	6%	10%
Realisable potential until 2020 [ktoe]	21,942	4,313	28,757	55,011
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	6%
Realisable potential until 2030 [ktoe]	26,141	4,858	47,832	78,831

	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	2	1,049	700	626	0	0	3,541	19	1,080	358	936	3,041	900	7,147	313	371
Production 2007 [ktoe]	0	928	619	243	0	0	2,993	2	718	389	720	3,103	706	8,032	177	191
Production 1999 [ktoe]	0	871	618	4	0	0	510	0	82	150	71	114	320	4,197	48	123
Ø annual production growth 2007-2009	-	6%	6%	60%	-	-	9%	221%	23%	-4%	14%	-1%	13%	-6%	33%	39%
Ø annual production growth 1999-2009	-	2%	1%	64%	-	-	21%	-	29%	9%	29%	39%	11%	5%	21%	12%
Realisable potential by 2020 [ktoe]	43	1,375	861	3,602	0	133	5,354	6,049	1,518	444	2,563	4,313	5,153	7,969	6,637	8,998
Realisable potential by 2030 [ktoe]	869	1,389	870	5,153	0	1,269	6,343	7,400	1,763	493	2,893	4,858	5,367	7,969	12,260	22,237

Figure 6 – RES target, production and potential in Germany (ECOFYS, 2011)

2.5 France

2.5.1 EPBD Implementation

In France, the overall responsibility of the EPBD rests with the Ministry of Housing (CA EPBD, 2013). The first EPBD has been fully transposed during the period between 2004 and early 2010. In order to comply with the new European requirements of the EPBD-recast, Law 2010/788 of the 12th of July 2010 overhauled the previous French legislation. This law was implemented, so as to significantly improve the Energy Performance Certificate process.

Energy performance requirements

The evolution of the energy performance requirements stem from 1974 when the first thermal regulation was introduced in France. Many legislative developments have been made since to include the building envelope, the type of energy used for heating, cooling and domestic hot water, lighting and types of renewables etc.. Figure 7 shows the evolution of the French legislative requirements. The latest regulations (RT2012) introduced for new buildings from 1st Jan 2013 make the country the most ambitious Member State, as far as new mandatory eco-friendly buildings are concerned. The French government introduced the obligation of each new construction to fulfil the RT2012 which is demanding in terms of primary energy (EP), since it defines a 50kWh/m^2.a target for residential buildings and a 70kWh/m^2.a target for office buildings with no air–conditioning (110kWh/m^2.a for air-conditioned office buildings).

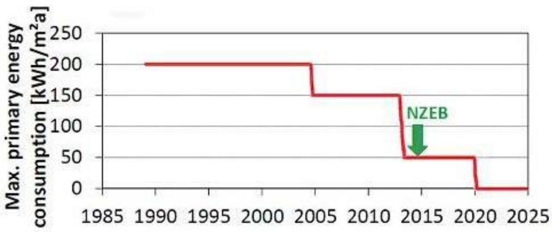


Figure 7 – Evolution of the French legislative requirements

The implementation of requirements for existing buildings has been introduced into French legislation through the Building Code (amended by law in 2005 and decree in 2007).

In May 2007, the French Government adopted minimum requirements concerning the installation of new components during building renovation, and for extensions to existing buildings, which came into force on the 1st of November 2007. In particular, they concern:

- non-renewable liquid or solid fuel-fired boilers;
- electric heating systems;
- air-conditioning (AC) systems;
- Domestic hot water (DHW) production systems;
- windows and glazed walls;
- energy production systems using Renewable Energy Sources (RES);
- insulation materials of opaque walls;
- ventilation systems;
- lighting systems.

In France the methodology used for the cost-optimal procedure for setting energy performance requirements was not the same as the one required by the European Commission's cost-optimal regulation. The French Ministry has analysed the cost-optimality of thermal regulations to comply with the European Directive.

The objectives of the French national action plan towards nZEB include:

- generalise nZEBs by 2012 and "Positive Energy Buildings" by 2020;
- reduce the energy consumption of existing buildings by at least 38% by 2020; and
- support and motivate stakeholders to meet the challenges that arise in relation to recruitment, training, qualification and development of industrial clusters.

In France, nZEBs are called Low Consumption Energy Buildings (BBC), that is, the newly constructed buildings abiding to the latest regulation, RT2012. For existing buildings, ambitious targets in place are difficult to reach and require the latest energy efficiency materials and systems. A number of financial incentives exist currently to encourage the public to the higher energy performance of buildings. All these measures are described under the nZEB national plan, required by article 9 of the recast EPBD.

Energy Performance Certificates

The EPC was introduced in France in 2006, and is called "Diagnostic de Performance Énergétique" (DPE). As this new document has to be presented when one sells or rents a property, it forms part of the already existing real estate diagnosis file. Hence, the EPC's French translation, "Energy Performance Diagnosis".

The EPC defines two aspects of a building: its energy consumption and the impact of its consumption on greenhouse gas emissions. On the first page, it shows the calculated or measured consumption of heating, cooling and DHW, expressed in final and primary energy, and the corresponding annual costs.

The energy label classifies buildings on an energy consumption scale ranging from A (low energy consumption, high efficiency) to G (high energy consumption, poor efficiency). The real benefit of EPCs is in the recommendations given to the building owner. These are summarised on the fourth page of the certificate.

Suggested improvements include a short description, a range estimation of costs, savings and paybacks, and the impact on the energy rating, if all measures were to be implemented. The Qualified Expert (QE) makes recommendations after studying the case of the specific building. EPCs are valid for 10 years.

For new buildings, the results are drawn from the TH-BCE calculation (RT2012). The role of the QE is to certify that what was planned has actually been implemented and that the building meets the regulations. If there is something wrong with the building, the QE is obliged to include it in the report.

A central database holds the EPCs and allows the certification bodies to check the proficiency of experts, through the uploaded reports and collection of complaints.

In compliance with article 13 of the EPBD recast, the display threshold of displaying EPCs has been lowered from 1,000 m^2 to 500 m^2 in 2013, and will be lowered to 250 m^2 in 2015. This will extend the obligation to all buildings frequently visited by the public that already have an EPC.

Inspection Requirements – Heating and Air-conditioning Systems

France has chosen option b) in implementing article 14 of the EPBD, with:

- provision of advice during periodic inspections: for boilers with an output between 4 and 400 kW: advice to users on the replacement of the boiler, other modifications to the heating system and on alternative solutions, given during the required annual maintenance of the boiler;
- for boilers with an output between 400 kW and 20 MW: periodic control, every 2 years, and advice from ADEME (French Energy Agency) on energy management.
- provision of advice on the most efficient heating systems, improvement of the energy performance of buildings, and financial incentives.

The French regulation on AC systems has been in force since the 16th of April 2010. France has chosen to implement article 15 of the EPBD by enforcing the following points:

- inspection of AC systems and reversible heat pumps with an output of 12 kW or more;
- once every 5 years;
- person responsible for the inspection: the owner or the manager of the building; and
- inspectors are certified.

2.5.2 RED Implementation

In France, the sustainability requirements of the RED were implemented in November 2011 and a transition period was in place until May 2012 (ECOFYS, 2012). The implementation of the RED and FQD sustainability criteria is integrated in France and the French system can be classified as a national system with ex-post verification based compliance. In addition to using voluntary schemes recognised by the European Commission, it gives the option for fuel suppliers to provide verified information to the Ministry of Energy and Ecology.

Compliance with the sustainability criteria must be demonstrated by economic operators, fuel suppliers, who benefit from a tax reduction depending on the incorporation rate of biofuels. They report to the Customs Authority; within the framework of the French national system it is the Ministry in charge of energy and ecology that can collect data at each stage of the supply chain as long as the body responsible for the management of the sustainability system has not been identified.

Reporting items include quantity, type and origin of biofuels or feedstock, GHG performance, voluntary scheme use, as well as whether or not the sustainability criteria related to land use are respected. The information is registered on a custom-made database and MS Excel.

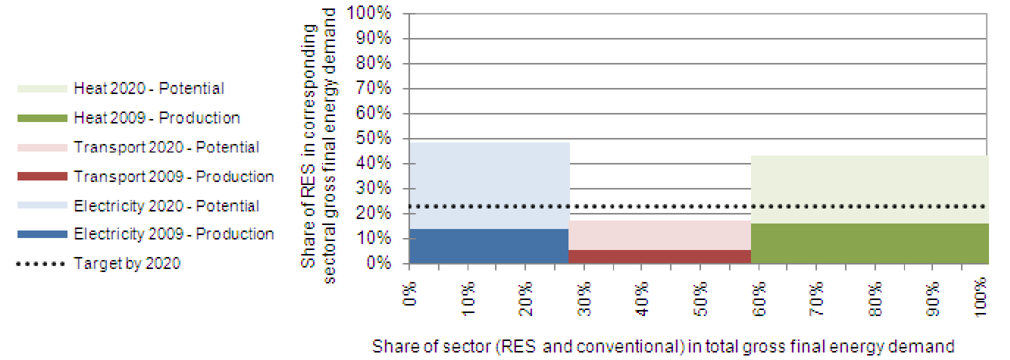
In France, support for the RES-E is provided through a feed-in tariff scheme which is not regulated by its own law but is integrated into the Law on the Modernisation and development of the Public Electricity Supply as Article 10 (ECOFYS, 2011). This law was implemented in 2010, and there is both a purchase obligation as well as a provision on tariffs for renewable energy. The height of tariffs for each technology is regulated in decrees and the last decree was passed in March 2011. Several modifications have been made to the legislation in particular concerning the support of power production from solar photovoltaic, biomass, geothermal and wind energy.

In addition to the fixed feed-in tariff, a public competitive bidding scheme for biomass and offshore wind power plants is another key instrument for RES-E support in France. The feed-in tariff covers all major renewable energy technology and provides support for periods of 15-20 years depending on the technology. Tariffs are differentiated by technology and size of installation. Except for solar photovoltaic and wind power, they are not subject to annual degression; policy makers reduce them on an *ad-hoc* basis every few year. When compliance with certain criteria is met, additional bonuses are paid.

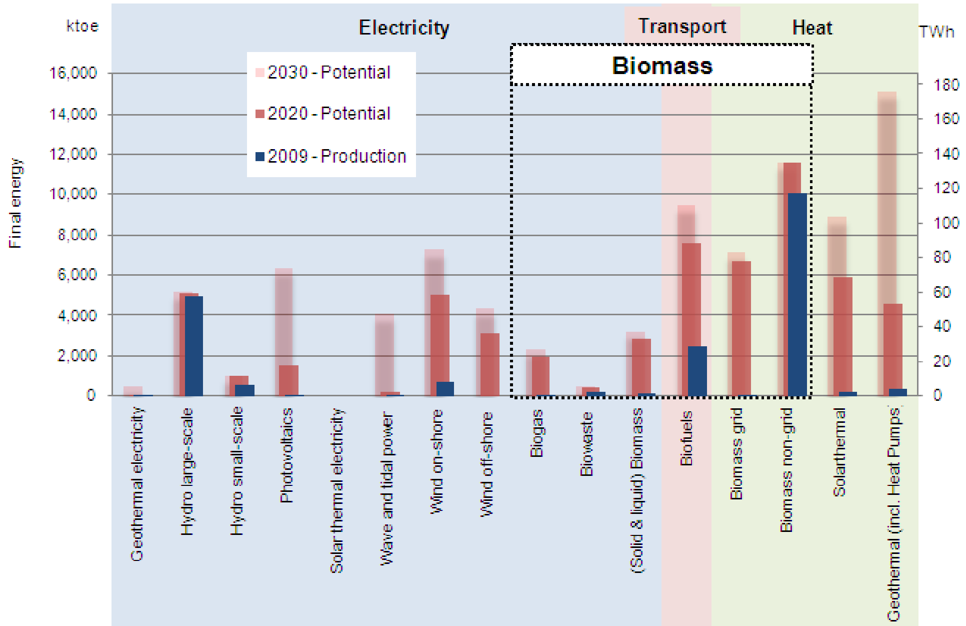
France has three major instruments for the support of renewable energy sources in the heating and cooling sector. The Heat Fund ("Fonds Chaleur") is the most important instrument for large-scale installations. It enables heat producers to receive a region-specific feed-in premium for every MWh of heat they feed into the network. For small-scale installations of households and municipalities two main incentives are in place, which are a zero interest loan (the "Eco-Pret à Taux Zero") and a tax deduction policy (the "Credit d'Impot Developpement Durable"). Some regions provide investors of small scale projects with additional fiscal incentives.

Renewable energy sources in the transport sector receive support through several policies. A quota obligation forces retailers to blend their fuel with a minimum share of biofuels. Blended fuels and pure biofuels also benefit from reduced taxes. There is a bonus malus system, which encourages the replacement of inefficient vehicles with low-emission vehicles. France also provides buyers of electric and hybrid vehicles with a premium.

A summary of the RES target, production and potential in France is available in Figure 8 (ECOFYS, 2011).



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	14%	6%	16%	12%
Share of total sector consumption in total final energy consumption	27%	31%	41%	100%
Production 2009 [ktoe]	6,022	2,454	10,698	19,174
Production 2007 [ktoe]	5,724	1,447	9,723	16,893
Production 1999 [ktoe]	6,494	275	9,329	16,098
Average growth 2007-2009 [%/a]	3%	30%	5%	7%
Average growth 1999-2009 [%/a]	-1%	24%	1%	2%
Realisable potential until 2020 [ktoe]	21,236	7,606	28,797	57,639
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	6%
Realisable potential until 2030 [ktoe]	32,557	9,512	42,787	84,856



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	7	4,981	527	14	0	42	704	0	73	170	110	2,454	84	10,056	214	344
Production 2007 [ktoe]	7	4,876	520	1	0	45	328	0	54	154	117	1,447	250	9,042	161	270
Production 1999 [ktoe]	0	5,413	0	0	0	50	3	0	10	71	120	275	284	8,919	7	120
Ø annual production growth 2007-2009	0%	1%	1%	218%	-	-3%	46%	-	16%	5%	-3%	30%	-42%	5%	15%	13%
Ø annual production growth 1999-2009	-	-1%	-	-	-	-2%	74%	-	22%	9%	-1%	24%	-11%	1%	41%	11%
Realisable potential by 2020 [ktoe]	44	5,116	1,012	1,524	0	226	4,990	3,103	1,954	427	2,839	7,606	6,707	11,609	5,911	4,570
Realisable potential by 2030 [ktoe]	514	5,168	1,022	6,382	0	4,081	7,268	4,349	2,348	474	3,229	9,512	7,133	11,609	8,914	15,131

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 8 – RES target, production and potential in France (ECOFYS, 2011)

2.6 Italy

2.6.1 EPBD Implementation

In Italy, the overall responsibility for the implementation of the EPBD rests with the Ministry for Economic Development (CA EPBD, 2013).

The first decree setting the basis for the national legislative EPBD framework was enacted in 2005. After that, a number of legal acts (legislative, ministerial and presidential decrees) have been issued to progressively define and specify all aspects of the national EPBD transposition.

Except for the inspection of air-conditioning systems, the Legislative Decree n.º 192/2005 has drawn the general framework for the transposition of the EPBD at national level, setting the minimum requirements for the energy performance, and the U-values for windows, walls, floors and roofs, in case of new buildings and major renovations. In 2009, the Presidential Decree n.º 59 extended the calculation methodologies and minimum requirements to the summer energy performance of cooling and lighting systems; it also updated the minimum requirements for the energy performance of buildings and of heating systems.

A draft regulation has been developed to introduce newly defined cost-optimal building performance requirements and the nearly-zero energy concept, as well as the new standard values for cooling, ventilation and lighting; the last one only for non-residential buildings.

According to the Constitution, energy related topics are a shared task between the State and the 21 Regions and Autonomous Provinces. Each regional authority may implement autonomous transpositions of the EPBD, as long as they do not contradict the general principles and requirements provided by national and EU regulations. The national regulation stays in force for those regions which have not published their own legislation.

At the end of 2012 six regions (Liguria, Emilia Romagna, Toscana, Val d'Aosta, Lombardia and the Autonomous Province of Bolzano) had transposed the EPBD recast. At present, 11 Regions and Autonomous Provinces, represented in grey in Figure 9 (Liguria, Emilia Romagna, Toscana, Val d'Aosta and Lombardia, Friuli Venezia- Giulia, Puglia, Sicilia, Toscana and the Autonomous Provinces of Trento and of Bolzano) out of 21 have enacted their local transposition of the EPBD. All the others follow the national legislation.

Thus, there are two levels of standards and regulations, a national level that establishes the national minimum energy performance requirements and a regional or local level that could be more onerous. A different consequence of the regional independence is that a number of regions have not yet implemented a certification scheme. The majority of these regions are in the South of Italy (Sicilia and Puglia are the exceptions) (Figure 9).

Given the level of awareness and effort that the Public Administration places on the EPBD, and the level of diffusion of EPCs within the regional markets, there are just a few exceptions to the general assumption that whereas the northern part of Italy can be counted among the frontrunner countries, the south still suffers from a lack of information and a clear regulatory framework, driving it closer to a target country.

Figure 9 – Application of the EPBD in Italy

Table 1 shows the state of EPBD implementation among Italian Regions and Autonomous Provinces at the end of 2012. According to the CTI report 2011 on the state of implementation of the EPBD in Italy, 1,375,000 EPCs had been delivered in 18 of the 21 Regions and Autonomous Provinces, 710,000 (more than half) of which in Lombardia, creating a marked difference in the level of expertise within the market operators, and also in the level of awareness and trust within the population.

Table 1 – Status of EPBD implementation among Italian Regions and Autonomous Provinces

Regions and Autonomous Provinces	Regional EPBD regulation	Regional EPBD recast regulation	Issued EPCs*	EPC database*
Abruzzo			1,151	○
Basilicata			-	○
Bolzano	●	●	6,364	○
Calabria			334	
Campania			4,000	
Emilia-Romagna	●	●	260,000	●
Friuli Venezia-Giulia	●		12,400	●
Lazio			29,700	○
Liguria	●	●	66,329	○
Lombardia	●	●	710,000	●
Marche			-	
Molise			-	
Piemonte	●		233,931	●
Puglia	●		2,300	○
Sardegna			2,500	
Sicilia	●		3,181	○
Toscana	●	●	16,000	○
Province of Trento	●		1,644	○
Umbria			3,255	○
Valle d'Aosta	●	●	2,854	●
Veneto			19,080	○
			1,375,023	

● active
○ in course of development

*CTI report 2012

Energy Performance Requirements

Calculation methodologies of Energy Performance of buildings:

In Italy the energy performance calculation methodology refers to the National Standard UNI TS 11300, which is an application of the European Standard EN ISO 13790:2008. Regional calculation methodologies refer almost entirely to the National Standard, while only Lombardia and the Autonomous Province of Bolzano adopted standards derived directly from the EN ISO 13790:2008.

The compliance check of minimum requirements is performed systematically by municipal authorities. Building owners are required to present to the municipal authority a technical report showing energy performance and thermal transmittance calculations. The issue of the building permit is bound to such a compliance check. Local authorities may carry out on-site visits during or after the construction works. A final report signed by an engineer confirming compliance with the town planning rules, the construction regulations and the energy performance requirements, is also compulsory.

The Ministries of Economic Development and of Environment, as well as the regional governments, monitor the state of implementation of the EPBD, and periodically provide a report to the Parliament.

New residential and non-residential buildings must fully comply with the minimum energy performance requirements for winter performance, set by the Legislative Decree 192/2005. The new EPBD requirements were introduced in 2006 and have been progressively reduced every two years. A projection towards 2020 outlines an approximate 5% decrease every two years.

Envelope and Systems Requirements

The minimum requirements for existing buildings are differentiated according to the degree of planned renovation. Minimum energy performance of new buildings applies in the case of a demolition, when the whole building is being renovated (for buildings with heated floor area greater than 1,000 m^2) and for building enlargements over 20% of the original volume, only for the newly built section. In the case of any degree of refurbishment, a set of basic requirements applies to single building elements. For heating systems minimum seasonal efficiency criteria must be met similar to new buildings.

As regional governments and autonomous regions can implement their own transposition of the EPBD, stricter minimum energy requirements can be set.

In case of any degree of refurbishment, a set of basic requirements applies to single building elements. Already in 2006, the minimum requirements for systems had been regulated. In case of renovation of the heating system, just as with new systems, the seasonal efficiency should be higher than (75 + 3 log Pn)%, where Pn is the nominal output power of the boiler. In case of boiler substitution, the minimum boiler efficiency (at maximum nominal power) should be higher than (90 + 2 log Pn)%. Today, heat pumps are regulated too. In case of heat pumps, the minimum efficiency should be higher than (90 + 3 log Pn)%, where the heat pump efficiency is the ratio of the delivered energy to the electric energy converted to primary energy, according to the national conversion rate. The efficiency will be higher than 1 whenever the Coefficient of Performance (COP) of the heat pump exceeds the conversion rate.

Public authority buildings are expected to set an example, and to play a leading role. Therefore the energy performance and U-values are set 10% lower than those required for private buildings, the seasonal efficiency for heating systems should be higher than should be higher than (75 + 4 log Pn)% and only centralized heating systems are allowed.

The leading role of public buildings in the progression to nearly zero-energy performance has been emphasized in the National Energy Efficiency Action Plan (NEEAP). In order to promote and support energy efficiency measures in the public sector, the NEEAP foresees that an observatory will be set up. The aim of this observatory will be to build a reference framework on the status of implementation of energy efficiency programs and their effectiveness at local level, as well as to support the process of defining policies and specifying the implementation measures in a system shared among institutions and stakeholders, both public and private.

The Ministries of Economic Development and of Environment, as well as the regional governments, monitor the state of implementation of the EPBD, and periodically provide a report to the Parliament.

Format of national transposition and implementation of existing regulations

Since January 2010, after a transition phase with intermediate requirements, new residential and non-residential buildings must fully comply with the minimum requirements for winter performance, set by the Legislative Decree 192/2005. Energy performance values vary according to building type. Energy performance for residential buildings is expressed in terms of kWh/m^2.a of primary energy, while energy performance for non-residential buildings is expressed in terms of kWh/m^3.a of primary energy, both for heating and cooling, climatic zone, local degree days, and surface area to volume ratio of the building.

The energy performance requirements for a new building have been progressively decreasing. For example for a building with a shape factor of 0.5 in climatic zone E have decreased from approximately 120 kWh/m^2.ya in 1993, to 87.5 kWh/m^2.a in 2006 (when new EPBD requirements were introduced), 80.5 kWh/m^2.a in 2008 and to 71.2 kWh/m^2.a in 2010. Until 2020 it is foreseen a 5% decrease every 2 years.

Furthermore, in case of new buildings and major renovations, the designer is expected to:

- Introduce compulsorily window sun shades, and calculate their contribution to the winter and summer performance;
- Either check that the external walls mass, except North-East to North-West, is larger than 230 kg/m^2, or that their value for periodic thermal transmittance (a dynamic parameter introduced with the Standard UNI EN ISO 13786:2008) is lower than 0.12 W/m^2.K;
- Check that the periodic thermal transmittance for North-East to North- West external walls only, is lower than 0.20 W/m^2.K.

Funding mechanisms and incentives

There is an incentive scheme launched in 2007 and still in operation, based on a tax credit for an amount equal to 55% of the investment in building energy renovation. ENEA provides regular reports on the state of implementation of this incentive. Latest official results, that refer to 2010, show more than 4,600 M€ total investments; more than 2,000 GWh primary energy savings; and more than 430,000 ton CO_2/year avoided emissions.

An extension of the tax rebate mechanisms is proposed by the National Energy Strategy released by the Ministry for Economic Development in October 2012, and under public consultation at the end of 2012. The same document states the resolve to further improve energy efficiency and to promote it with incentives, by:

- Tightening the minimum requirements in building and transport sectors;

- Providing direct incentives for public buildings renovations; and
- Strengthening the White Certificates mechanism, which proved to be effective so far.

The two last items have already been implemented through two ministerial decrees published on the 28th of December 2012.

Action plan for progression to nZEB

The Second National Energy Efficiency Action Plan, issued in July 2011, carried some preliminary milestones for setting a national strategy for Nearly Zero-Energy Buildings (nZEB). Namely, it is stated that:

- New minimum requirements for building energy performance and for building elements will be set: the requirements should be laid down with a view to achieving cost-optimality;
- Economy and Finance, and the Ministry for Economic Development shall join in a task force to program and manage a national incentive scheme;
- Social housing: introduction of an incentive/bonus for projects adopting innovative solutions (cool roof, active building envelope systems, etc.), integration of renewables, use of ecologic components and materials, optimization of local economic resources;
- Introduction of standardization in the use of Building Energy Management Systems (BEMS) for public buildings;
- Residential buildings: focus on the cluster of existing buildings built before 1976 (which sums up to more than 70% of all buildings). Provide incentives through low interest rate revolving fund schemes for renovations leading to a 50% decrease in energy consumption;
- Stakeholders involvement: the National Energy Agency (ENEA) will involve stakeholders in working groups, with the goal of proposing new lines of action;
- An observatory will be set up in order to monitor the effectiveness of the programs and schemes;
- School buildings: simplified procedures to involve Energy Service Companies (ESCOs).

Energy Performance Certificates

According to the Decree 28/2011, in sale and rental contracts (of buildings or single units, e.g., apartments or individual offices), a specific clause must be added confirming that the buyer or manager has received information and documents concerning the building's Energy Performance Certificate (EPC). Up to now, in case of rental, it was not compulsory to produce this certification, unless a certificate was already available (in cases of newly constructed or recently sold buildings). A new draft regulation extends the certification to all buildings when rented. In the Regions of Emilia-Romagna, Lombardia and Piemonte, and in the Autonomous Province of Bolzano, the EPC must be appended to all sale and rental contracts.

The legal validity of an energy certificate is 10 years. The EPC needs to be updated whenever the building envelope or systems are modified.

The buildings energy performance is expressed in terms of primary energy in kWh/m^2.a for residential buildings and in kWh/m^3.a for non-residential buildings, with classes ranging from A+ to G. Recommendations are summarised on the second page of the certificate and for each action proposed specifically for the certified building, the EP, class improvement, and payback time are provided.

Before 2012, it was allowed to omit the certification of a building if its performance was in the lowest class (G). A ministerial decree issued on the 22nd November 2012 has eliminated this possibility.

The cost of an EPC is not subject to predefined tariffs. The average EPC cost for an apartment ranges from 130 € to 300 €, depending on the city and the taxes/costs imposed by the respective regional scheme.

Any public building with a floor area larger than 1,000 m^2 is required to display the EPC in a place clearly visible to the public. In most Regions, public buildings have the same obligation to be certified as all other buildings, but there is no deadline for compliance, nor any fine for non-compliance with this requirement. However, Valle d' Aosta decided that all public buildings had to be provided with an EPC by the 31st of December 2012. Lombardia has also promoted the certification of public buildings by January 2012.

Until 2012 around 1,375,000 EPCs were issued in Italy, in 18 of the 21 Regions and Autonomous Provinces, 710,000 (more than the half) of which in Lombardia, creating a marked difference in the level of expertise within the market operators, and also in the level of awareness and trust within the population (see Table 1).

The structuring of the energy performance classes in the Italian procedure is based on percentage variations in respect to a reference, expressed by the energy performance minimum requirements for new buildings: the class corresponding to the minimum energy performance requirements (and up to 25% less) is class C, while, for example, class B is more than 25% up to 50% less than the minimum energy performance requirements. In some Regions (namely Emilia-Romagna, Lombardia, Piemonte, Valle d'Aosta and the Autonomous Provinces of Trento and Bolzano), the classes are expressed in terms of absolute values, unrelated to the minimum requirements.

The legislation is assessed on regional systems with distinct registries and databases. Six regional EPC databases have been put in place until the end of 2012, while 11 will be implemented in the future, as shown in the map presented in Figure 10.

Figure 10 – EPC databases in Italy (in dark grey are presented the regions with EPC databases, in light grey are presented the regions with oncoming EPC databases)

2.6.2 RED Implementation

The development of renewable energy sources has been one of the priorities of Italy's energy policy for some time, together with the promotion of energy efficiency. The objectives of such a policy are: energy supply security; reduction in energy costs for businesses and individual citizens; promotion of innovative technology; environmental protection (reduction in polluting and greenhouse gas emissions); and therefore, ultimately, sustainable development.

In the medium to long term, Italy aims to redress the balance of its energy mix, which is currently too dependent on imported fossil fuels. This process will also involve significant measures to re-launch the use of new-generation nuclear power.

According to the baseline trend scenario of the PRIMES model, which the European Commission has taken as a reference point, Italy's gross final energy consumption in 2020 could reach a value of 166.50 Mtoe, compared with the value of 134.61 Mtoe recorded in 2005. The 2009 update to the PRIMES model, which also takes into account the effect of the financial crisis, estimates Italy's 2020 gross final energy consumption at 145.6 Mtoe. In a more efficient scenario, which takes into account more energy efficiency measures than the baseline scenario, Italy's gross final consumption in 2020 could remain within a maximum of 133.0 Mtoe.

Italy's primary objective is therefore to make an extraordinary commitment to increasing energy efficiency and reducing energy consumption. This strategy will also be a determining factor in reaching the targets for reductions in greenhouse gas emissions and the proportion of total energy consumption to be covered by renewable sources.

With the Legislative Decree 28/2011 transposing the Renewable Energy Services (RES) Directive, the requirements regarding the share of renewable energy for new buildings and major renovations were increased, establishing a calendar with a progressively larger share of renewable quota for domestic hot water, heating and cooling energy demand:

- 20% renewable quota for all building permits requested between the 31st of May 2012 and the 31st of December 2013;
- 35% renewable quota for all building permits requested between the 1st of January 2014 and the 31st of December 2016;
- 50% renewable quota for all building permits requested from the 1st of January 2017 onwards.

The recent Italian Law No 99/2009 provided for the publication of an Extraordinary Plan for Energy Saving and Efficiency. This will involve various methods: promotion of distributed cogeneration, measures aimed at encouraging small and medium enterprises to produce their own energy, strengthening the energy efficiency credits scheme, promoting new buildings with significant energy-saving measures and energy retrofits of existing buildings, providing incentives for energy service companies, and promotion of new high-efficiency products.

Specifically for renewable energy, Italian Law No 13/2009 provides that the Community targets for renewable energy use will be divided between the Italian regions, with shared methods for achieving these targets. The recent Community Law of 2009 gave the Parliament authority for the implementation of Directive 2009/28/EC, establishing specific criteria for exercising this authority. According to these criteria, a statistical transfer mechanism will be put in place between the regions in order to allow compliance with the aforementioned division of targets.

According to Directive 2009/28/EC, in 2020, 17% of Italy's final energy consumption must be covered by renewable sources. Taking the efficient scenario as a reference point, this means that in 2020 the final consumption of renewable energy must be 22.62 Mtoe.

In order to reach the objectives, there must be a consistent increase in the mobilization of resources available within Italy, and particularly the use of renewable energy sources for heating and cooling and the use of biofuels in the transport sector. As well as promoting renewable sources for heating and cooling and transport uses, the measures to be implemented will principally relate to electricity network management, further streamlining of authorization procedures and the development of international projects. The involvement of and coordination between the various local authorities and bodies will be essential, as will the sharing of information.

As referred previously Italy has already been putting significant emphasis on the mobilization of renewable energies for some time. Numerous support mechanisms are therefore already available, ensuring remuneration for investment in various renewable energy and energy efficiency operations, and encouraging the growth of related industries. Nevertheless, the targets and the scale of Directive 2009/28/EC do require a renewed commitment, based on principles which will ensure balanced development of the various sectors which contribute to reaching the targets defined, and with consideration of the cost-benefit ratio. Equally, there will be increased commitment in terms of infrastructure, research, training and, in general, every element which could contribute to the balanced growth in renewable energy use.

With this in view the Italian Parliament has compiled implementation criteria for the directive. By implementing all these measures effectively, and by combining the effects of individual actions, the goal will be reached. However, it is necessary to bear in mind that:

- national measures alone are unlikely to be enough, and in order to achieve efficiency these should be integrated into international cooperation schemes;
- during this process actions will be needed to overcome potential restrictions and criticalities, modify or improve certain measures, adapt the support schemes to the continually changing economic and energy-use situations, and take advantage of new technological applications. There are numerous support mechanisms already in operation to make up for the insufficient level of remuneration for investment in the renewable energy and energy efficiency sectors, which has so far been provided solely by market mechanisms.

In order to achieve its own national objectives, Italy intends to strengthen and rationalize the existing support mechanisms, within a framework which integrates:

- efficacy in concentrating efforts along routes which will make the maximum contribution to achieving the objectives;
- efficiency in introducing flexibility in incentives, limiting their contribution to what is strictly necessary to make up for market shortcomings;
- financial sustainability for the end consumer, the element which bears a large part of the burden of incentive schemes;
- careful consideration of all measures to be promoted in the three sectors in which action will be taken: heating, transport, electricity.

There are various mechanisms, including indirect mechanisms, in place at national level for the promotion of renewable energy sources for heating and cooling. The main mechanisms are the following:

- 55% tax relief on costs incurred for the installation of heat pumps, solar thermal systems or biomass systems (in place until the end of 2010);
- the obligation for new buildings, which are not yet fully operational, to cover a quota (50%) of their energy needs for domestic hot water with renewable sources, as well as using renewable energy systems for electricity production;
- tax relief measures for users connected to district heating networks using geothermal sources or biomass;
- the energy efficiency credits scheme, applicable to technologies such as solar thermal systems, biomass boilers and heat pumps, including geothermal heat pumps;
- excise duty exemption for solid biomass used to fuel domestic boilers.

Given the rapid rates of growth expected in the use of renewables for heating, over the next few years the above mentioned mechanisms must be accompanied by further promotional schemes aimed at increasing the consumption of heat from the various sources and types of technology available. The principal support mechanisms in force for electricity production from renewable sources are the following:

- incentive schemes for electricity produced by plants using renewable sources through the green certificate scheme, based on a minimum quota of new electricity production from renewable sources;
- incentive scheme based on fixed all-inclusive tariffs for electricity fed into the grid by renewable energy plants with a maximum power output of 1 MW (0.2 MW for wind energy), as an alternative to the green certificates;
- incentive scheme for photovoltaic and solar thermodynamic plants through the feed-in tariff mechanism;
- simplified means of selling energy produced and fed into the grid at fixed market prices;
- possibility of placing greater value on energy produced through the net metering mechanism for plants with a maximum power output of 200 kW;
- dispatch priority for renewable sources;
- connection to the electricity network within present deadlines and under advantageous conditions for plant operators.

The current incentive schemes have proved capable of supporting constant growth in the sector, guaranteeing a sufficient degree of predictability in the return on investment, despite frequent changes to the regulatory framework, and aiding the financial viability of the projects.

These schemes therefore represent a consolidated mechanism within the national energy system which, the necessary adjustments being made, can be considered an important element of continuity in reaching the new Community objectives, including into the next stage.

Nevertheless, the strong growth predictions, and in particular the specific targets for the electricity sector, call for a long-term vision and, as well as rationalizing the current incentives based on trends in the cost of the various technologies, the ability to promote benefits in a wider production and employment context, using an approach of gradual reduction in charges and ever greater efficiency in comparison to the cost of conventional production.

The Italian Government implements the sustainability requirements of the RED through the relevant Government decree which sets out the national certification schemes and were adopted in January and March 2012 (ECOFYS, 2012). Since the implementation in 2012 there was a transitional period whereby Biofuels produced in 2011 or produced in 2012 with raw or intermediate material produced in 2011 and were placed on the market by the end of August 2012 only had to comply with lighter transitional requirements. However, since January 2012, biofuels counting towards the target needed to comply with the full sustainability criteria.

The implementation of the RED and FQD sustainability criteria is integrated in Italy and the Italian system can be classified as a national system (voluntary scheme based), given the presence of a national certification system allowing for the verification of sustainability information provided to the Italian authorities by economic operators. No differences exist in the requirements for domestic, EU and non-EU feedstocks or biofuel producers.

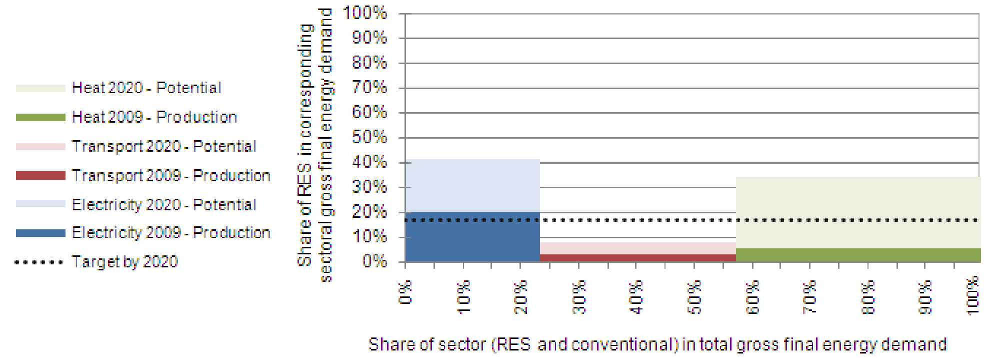
The Italian system of incentives for RES-E is based on the following (ECOFYS, 2011):

- Tradable green certificates (TGC) with technology banding;
- Feed-in tariffs for electricity produced from renewable energy sources with a maximum power output of 1 MW (0.2 MW for wind energy) as an alternative to the green certificates (contract duration is 15 years);
- An incentive scheme (“Conto Energia”) for photovoltaic and solar thermal plants through a feed-in premium mechanism;
- Simplified means of selling energy produced and fed into the grid at fixed market prices for small producers (indirect sale through GSE - “Ritiro dedicato”);
- Net metering mechanism for plants with a maximum power output of 200 kW with the possibility of placing greater value on energy produced.

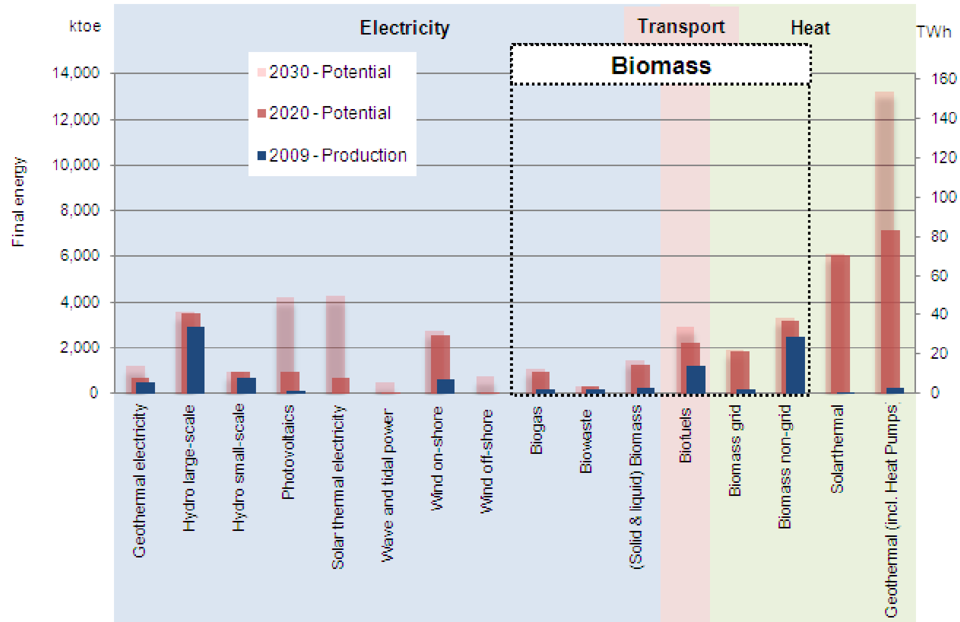
The main measure to support RES-H in Italy is a fiscal policy ruled by central government that allows for the qualification of RES-H systems to white certificates, and energy efficiency certificates (TEE). Investments in RES-H systems (heat pumps, solar thermal systems or biomass systems) qualify for an income tax deduction of 55% throughout 3 to 10 years. The scheme was valid till the end of 2012.

Incentives for biofuels are mainly represented by law 81/2006 which sets an obligation for distributing companies to make available for consumption a quota of biofuels. A certain number of tons is exempt from the excise tax of fossil fuels. Such a tax free biofuel amount is set every year, giving a large uncertainty to the market.

A summary of the RES target, production and potential in Italy is available in Figure 11 (ECOFYS, 2011).



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	20%	3%	6%	8%
Share of total sector consumption in total final energy consumption	23%	34%	43%	100%
Production 2009 [ktoe]	5,838	1,180	2,923	9,941
Production 2007 [ktoe]	4,103	180	1,875	6,158
Production 1999 [ktoe]	4,413	0	1,526	5,939
Average growth 2007-2009 [%/a]	19%	156%	25%	27%
Average growth 1999-2009 [%/a]	3%	-	7%	5%
Realisable potential until 2020 [ktoe]	11,847	2,218	18,194	32,259
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	8%
Realisable potential until 2030 [ktoe]	20,006	2,952	24,579	47,537



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	459	2,950	679	86	0	0	587	0	150	139	243	1,180	164	2,498	23	238
Production 2007 [ktoe]	479	2,916	647	7	0	0	344	0	125	130	198	180	162	1,506	15	192
Production 1999 [ktoe]	379	2,944	578	1	0	0	29	0	50	28	19	0	0	1,313	0	213
Ø annual production growth 2007-2009	-2%	1%	2%	262%	-	-	31%	-	10%	3%	11%	156%	1%	29%	24%	11%
Ø annual production growth 1999-2009	2%	0%	2%	51%	-	-	35%	-	12%	17%	29%	-	-	7%	69%	1%
Realisable potential by 2020 [ktoe]	653	3,504	936	957	656	55	2,535	53	959	284	1,255	2,218	1,803	3,187	6,051	7,154
Realisable potential by 2030 [ktoe]	1,207	3,539	946	4,208	4,296	470	2,756	738	1,082	315	1,490	2,952	1,895	3,301	6,121	13,263

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 11 – RES target, production and potential in Italy (ECOFYS, 2011)

2.7 Greece

2.7.1 EPBD Implementation

The Greek Law 3661/2008 “Measures to reduce energy consumption in buildings and other provisions” integrates the Directive 2002/91/EC. Based on this law, in 2010 the Regulation for Energy Efficiency of Buildings (KENAK) was issued. According to this law, the construction of new buildings and the full renovation of an existing building should be based on the Greek Regulation for the Energy Efficiency of Buildings.

Greek Law 3661/2008 and the Regulation for Energy Efficiency of Buildings (2010) deal with the building energy inspection, labelling of the buildings and the construction of energy efficient buildings.

An Energy Performance Certificates should be issued by Energy Inspectors in case of a new building or in cases of sale or rental of existing buildings. In fact, for the construction license to be issued, a Study of the Energy Efficiency of Building should also be performed. After the construction of a building, an Energy Inspector should audit it and issue an Energy Performance Certificate.

According to the KENAK, each new or fully renovated building should achieve an Energy Performance level of at least “Category B”. However, if the building’s Category is worse than “B”, then changes should be applied so as the building to achieve an Energy Performance Level of at least “B”.

The KENAK and the Greek Law 3661/2008 applies to any building, apart from the following:

- Buildings and monuments which are protected by the Law as part of a designated environment or due to their special architectural or historic value if KENAK compliance would dramatically alter their appearance;
- Buildings which are used as places of worship or for religious activities;
- Temporary buildings, which according to their design, the duration of their use does not exceed two years, industrial buildings, workshops, non-residential agricultural buildings with low energy demand and non-residential agricultural buildings which are in use by a sector covered by a relevant national agreement on energy performance;
- Residential buildings which are intended to be used less than four months annually;
- Stand-alone buildings with a total area of less than 50 m^2.

The methodology that should be followed and the measurements that should be done are defined in the Greek Regulation for Energy Efficiency of Buildings. This regulation, issued as the Ministerial Decision (Official Gazette Bulletin B’ 407/09-04-2010), defines the minimum requirements and thermal transmittance (i.e. U-values) of these buildings.

Envelope and Systems Requirements

The Greek Regulation for Energy Efficiency of Buildings defines the minimum requirements and thermal transmittance (i.e. U-values) of the new or fully renovated buildings. Additionally, this regulation divides the country in 4 different climate zones (A, B, C, D), based on heating degree days (HDD). Climate zone A corresponds to regions in South Greece, whereas Climate zone D to regions in North Greece. The rest of the regions are classified respectively to Climate zone B and C. Consequently, U-values are defined according to the climate zone. The Regulation also determines the minimum characteristics of the Reference Building and the format and contents of the Study of Energy Efficiency of the Building.

The Greek Regulation for the Energy Efficiency of Buildings should be reformed as a consequence of the recast of the Energy Performance of Buildings Directive (EPBD, 2010/31/EU). The recast of the Energy Performance of Buildings Directive has been integrated in the Greek Law 4122/2013 “Energy Performance of Buildings – Transposition of Directive 2010/31/EU”. However, KENAK is still not updated.

Database information and statistics available

Technical Chamber of Greece (TGB) is the official advisor of the State. It has issued guidelines, which comply with the Greek Regulation for Energy Efficiency of Buildings and which are approved by the Ministerial Decision Official Gazette Bulletin B’ 1387/02-09-2010.

These guidelines assist the energy inspectors with their inspection. The Technical Chamber of Greece has also developed a software program (Hellenic software “TEE-KENAK” for Energy and Labeling of Buildings), which comply with the Regulation for Energy Efficiency of Buildings and given the characteristics of the building performs the proper calculations to define the Energy level of a building.

All the Energy Performance Certificates are saved in a database, which is managed and monitored by the Hellenic Energy Inspectorate[3]. In order a file of energy inspection to be accepted in the database, it should have a specific format. Files created by the TEE-KENAK meet these requirements; however there is additional commercial software that meets these requirements too. Nevertheless, neither of these programs is configured properly to accept the characteristics of special building types, such as passive houses. According to the current legislation, there is no other way to characterize a passive building than an Energy Performance Level “A+” label.

The Energy Performance Certificates are issued by the Energy Inspectors, registered in the official catalogues of the Hellenic Energy Inspectorate. Although the EPCs are issued only by certified professionals, the designer of a new building does not need to be certified.

In Greece, EPCs are issued not only for a whole building but also for a part of it. For example, in a block of apartments an EPC can be issued for only one apartment of the building or it can be issued at once for the whole building. Moreover, the use of the apartments in a block of flats can differ. That is, in the same building the use of one flat can be residential whereas another flat can be used as an office. In this situation, different EPCs should be issued for each apartment.

Particularities of the Greek building stock

The main particularities of Greece are the traditional settlements, the islands and the listed buildings. In order the traditional urban planning of the area to be preserved, special construction and morphological rules are imposed. As far as the compliance of these regions with the Greek Law 3661/2008 and the Greek Regulation for Energy Efficiency of Buildings is concerned, both the Energy Performance Certificate and the Study of Energy Efficiency of the Building are performed without any exception. The regional Architectural Control Committee (ACC) is responsible of approving any constructive change of a building, which belongs to the aforementioned categories. If the proposed changes based on the Study of Energy Efficiency comply with the relative Decisions and the special Terms of Construction that are applied to these regions, then the ACC can approve them. However, if the minimum requirements of energy efficiency as determined in the Greek Law 3661/2008 and the KENAK are met through actions that are not compliant to the special Terms of Construction and the relative Decisions, the ACC can

[3] http://www.buildingcert.gr/

approve the non-implementation of the Regulation for Energy Efficiency of Buildings and the Greek Law 3661/2008. Generally, in traditional settlements and in islands, a constructive change is not easily approved.

Another particularity of Greece is the format of the block of apartments. Nowadays, a block of apartments may provide different uses to the owner (or occupier) of each flat. That is, one flat in the same block of apartments may be residential, whereas another flat may be an office. Moreover, a typical flat in Greece usually has a balcony. The balcony and consequently the French windows introduce thermal losses due to the existence of thermal bridges. Additionally, the majority of these flats have an Energy Performance Level worse than “B”. In order to achieve an Energy Performance Level of at least “B Category”, actions such as the installation of a solar heating system or a photovoltaic system face difficulties, as the place where they should be installed is communal. Therefore, every apartment owner of the building has to consent to this installation. This often provokes reactions; therefore the owner of the apartment prefers actions such as the replacement of the frames and the installation of external thermal insulation, which often are more expensive.

Energy Performance Certificates

The statistical data that are available in this topic refer to the period from January 2011 to September 2012. According to these, almost 203,000 EPCs were issued. Nearly 120,000 of them were issued for rental reasons and almost 50,000 EPCs categorize the buildings in “Category Z”. The majority of them were issued for buildings located in greater Athens region and almost 25,000 in greater Thessaloniki region.

Action plan for progression to nZEB

Greece has not yet issued a National Plan with specific actions concerning the implementation of nZEBs. However, the general description of this Plan mentions that:

- The definition of the technical characteristics of the nearly zero emission buildings will be included. The characteristics will be based on national, regional and local circumstances, including a numerical indicator for the use of the primary energy consumption in kWh/m^2.
- The intermediate targets for the improvement of the energy efficiency of new buildings till 2015 will be included.
- Information concerning the policies and the legal or other measures that have been adopted, so as to promote nZEBs, including details regarding the national requirements and measures for the use of the energy from renewable resources in the new buildings and the existing buildings that are renovated will be included.

Moreover, Greece through the Greek Law 4067/2012 provides incentives for the construction of nZEBs. If a newly-constructed building is ranked as “A+”, then the permitted building area (building factor) increases by 5%. However, if a newly-constructed building is a low-energy building, which exhibits extraordinary environmental performance, then the building factor increases by 10%. These buildings should exhibit primary energy consumption lower than 10 kWh/m^2.a and their environmental performance must be verified through Environmental Assessment Methods, such as LEED or any other equal international method.

2.7.2 RED Implementation

The Renewable Energy Directive has been implemented through the Greek Law 3851/2010 "Accelerating the Development of Renewable Energy Sources (RES) to Deal with Climate Change and Other Regulations in Topics under Authority of the Greek Ministry of Environment, Energy, and Climate Change". In this law, specific targets are set for RES electricity share (40%), RES heating and cooling share (20%) and RES transport share (10%), so as to achieve the 20% contribution of the energy produced by RES to the total gross energy consumption. However, there is no suggestion or reference to Article 13, Paragraph 5 of the RED directive, concerning the nearly zero-energy buildings.

Additionally, in Greek Law 4122/2013, Article 9, it is stated that since 1st January 2021 every new building should be a nearly Zero-Energy Building, whereas new buildings owned by public authorities should be nZEB after 1st January 2019. It is stated that the government should develop a National Plan, which will include the technical characteristics of the nearly zero-energy buildings, targets so as to improve the energy performance of the new buildings till 2015 and information concerning the promotion of the nZEBs. However, the National Plan is yet to be defined.

According to the Official Gazette Bulletin B' 1630/11-10-2010, the projected contribution of the installed power per renewable resource technology and per producer and its allocation during the time is defined in Table 2.

Table 2 – Limits for the installed power (MW) per RES technology and per producer

	2014	2020
Hydroelectric power plants	3,700	4,650
Small scale (0 - 15 MW)	300	350
Large scale (> 15 MW)	3,400	4,300
Photovoltaic power plants	1,500	2,200
Installations from farmers by profession	500	750
Other installations	1,000	1,450
Solar thermal power station	120	250
Wind power station	4,000	7,500
Biomass power station	200	320

Incentives were given mainly for achieving the goals as far as the photovoltaic power plants are concerned. Especially photovoltaic power plants of up to 10kW which were installed in the domestic sector and in small businesses (according to special program for buildings) were promoted significantly through a high feed-in tariff and measures to simplify issuing procedures.

On August 10th, 2012 the Official Gazette Bulletin B' 2317/10-08-2012 was issued, which suspended the installation of new large scale photovoltaic power plants and reduced the feed-in tariff of the new power plants that belong to the special program for buildings and would be installed after the implementation of the law. The reason was that the targets concerning the projected installed power for the photovoltaic power plants, which are presented in Table 2, were already fulfilled. The Greek Law 4254/2014 determined a reduction in the feed-in tariffs for the already operating photovoltaic power plants and cancelled the suspension of new photovoltaic power plants. The reduction factor is based on the first date of operation.

As far as the wind power stations are concerned, the Greek Law 4203/2013 mentions the promotion of small-scale wind power stations (of up to 50kW) through a Ministerial Decision that ought to be issued till end June (June 30th , 2014). However, until now no such Ministerial Decision has been issued, thus the implementation of relevant projects is still blur.

The current situation as far as the RES in Electricity is concerned is summarized in Table 2, as well as the divergence between the current state and the targets stated in Table 3.

Table 3 – Installed Power per RES Technology till end March 2014 and divergence of targets (Regulatory Authority for Energy, April 2014)

Technology	Installed Power (MW) on March 2014	Target 2014 (MW)	Target 2020 (MW)
Wind power station	1,847	4,000	7,500
Biomass power station	47	200	350
Hydroelectric power plants	3,238	3,700	4,650
Small – scale (0-15 MW)	220	300	350
Large – scale (>15 MW)	3,018	3,400	4,300
Photovoltaic power plants	2,212	1,500	2,200
Installations from farmers by profession	273	500	750
Other installations	1,939	1,000	1,450
Solar thermal power station	0.00	120	250

Regarding Heating and Cooling Sector, Greece promotes the solar thermal systems in the residential sector mainly. The Greek Law 3851/2010 defines that for each new building or current buildings that are radically renovated the annual needs for hot water should be covered at least by 60% from solar thermal systems. However, this obligation is not in effect when the needs in hot water use are covered through other decentralized energy generating systems that are based on RES, CHP, district heating on a large scale area, as well as heat pumps, whose seasonal performance factor (SPF) is higher than 1.15 x 1/n, where n is the ratio of total gross electricity generation to primary energy consumption for the generation of electricity. The estimated share of renewable energy in the building sector according to the National Renewable Energy Action Plan (July 2010) is given in Table 4.

Table 4 – Estimated share of renewable energy in the building sector, according to the NREAP, 2010

(%)	2005	2010	2015	2020
Residential	15	17	22	27
Commercial	10	14	27	39
Industrial	-	-	-	-
Total	14	16	24	30

As far as the transportation section is concerned, Greece promotes mainly the consumption of biofuels in substitution of fossil transport fuels. Biofuels are liquid or gas transport fuels, which are produced by biomass, according to the Directive 2009/28/EU. The current requirement of the participation of biofuels in transport fuels is 7%. Each year, the Ministry of Environment Energy and Climate Change issues a Ministerial Decision through which a specific amount of Biodiesel is required based on that year's expectations for transport fuels, which correspond to 7% of the total amount of transport fuels.

On July 2010, in the scope of Directive 2009/28/EC, the Greek Ministry of Environment Energy & Climate Change issued the National Renewable Energy Action Plan (NREAP). The Directive 2009/28/EC defines specifically for Greece 18% penetration of the RES in the gross final energy consumption. According to the NREAP, the national energy balance in 2008 was approximately 7.8% of gross final energy consumption and around 16.3% of primary energy production. In order to achieve the European target of 20% share of renewable energy in gross final energy consumption in 2020, a combination of measures for energy efficiency as well as for an enhanced penetration of RES technologies in electricity production, heat supply and transport should be implemented. So as to provide feasible targets, the plan evaluates the required market share for technologies and fuels.

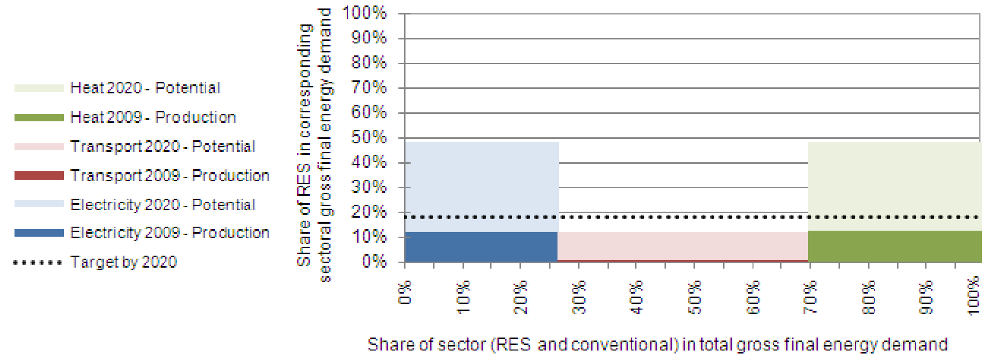
The National Energy System was analysed, different economic development scenarios were developed and energy models were evaluated. The energy models that were used were TIMES – MARKAL and ENPEP and their evaluation was realized with the models WASP and COST. The NREAP is based on the Working Paper “Analysis of the Energy Models for the Penetration of RES technologies in the National Energy System and Achievement of the National Targets 2020, by using MARKAL, ENPEP, WASP and COST models”. The NREAP summarizes the targets and the means to promote RES in Electricity, in Heating and Cooling Systems and in Transport. However, in the electricity generation field, the distinctive features of the Greek electricity system should be taken into account. Greece consists of an interconnected system and the non–interconnected islands, therefore different measures and targets are implemented for each system. The main provisions of the Greek NREAP are the following:

- The National 2020 target and estimated trajectory of energy from renewable sources in heating and cooling, electricity and transport;
- The administrative procedures and spatial planning applied to plants and associated transmission and distribution network infrastructure. The legislative framework concerning RES penetration is analysed and the responsible authorities are presented;
- The national and regional legislation concerning the increase of the share of energy from renewable sources in the building sector. Moreover, measures aiming at a decrease in the energy consumption of the buildings are mentioned, such as the program “Exoikonomo” for energy efficiency in municipal building stock, lighting and transport and the program “Exoikonomo kat’oikon”, under which energy conservation upgrades of residential buildings are eligible for funding. These measures are funded mainly by the National Strategic Reference Framework;
- Ways of disseminating information;
- Development of transmission and distribution grids and the role of information technology tools and intelligent networks;
- Support schemes for the promotion of the use of energy from renewable resources in electricity.

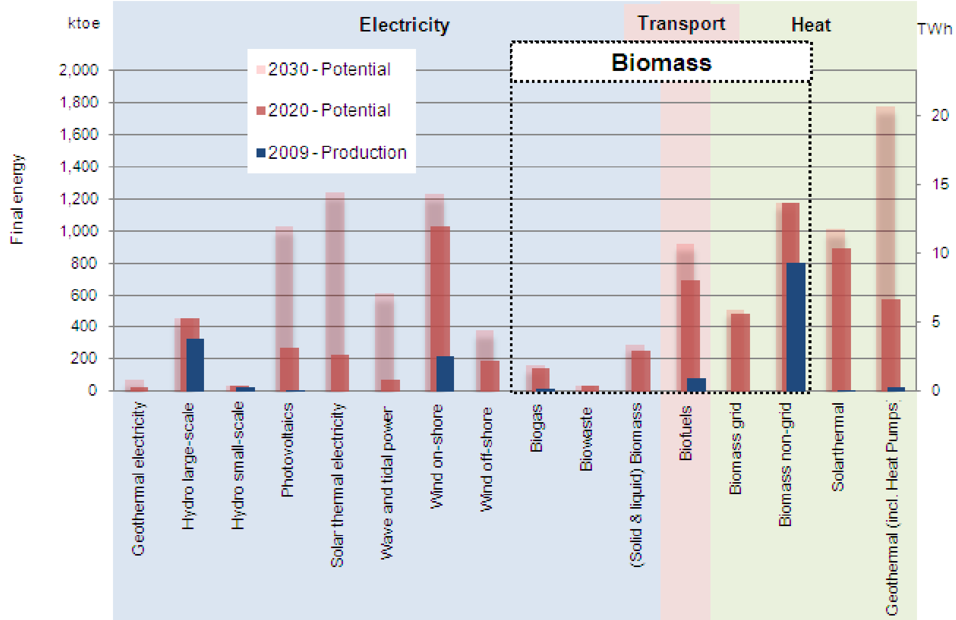
Nowadays, although the economic circumstances in Greece have altered, the National Renewable Energy Action Plan has not been updated yet. According to the EurObserv’ER Report, the percentage of penetration of RES in the gross final energy consumption of Greece has increased. However, it should be stated that due to the Greek financial crisis, the gross final energy consumption is reduced, thus resulting in a higher percentage of penetration of the RES in the gross final energy consumption.

A summary of the RES target, production and potential in Greece is available in Figure 12 (ECOFYS, 2011).

Co-funded by the Intelligent Energy Europe Programme of the European Union



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	12%	1%	13%	7%
Share of total sector consumption in total final energy consumption	26%	43%	30%	100%
Production 2009 [ktoe]	694	78	824	1,596
Production 2007 [ktoe]	395	85	1,020	1,500
Production 1999 [ktoe]	409	0	914	1,323
Average growth 2007-2009 [%/a]	33%	-4%	-10%	3%
Average growth 1999-2009 [%/a]	5%	-	-1%	2%
Realisable potential until 2020 [ktoe]	2,731	690	3,132	6,554
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	9%
Realisable potential until 2030 [ktoe]	5,235	924	4,483	10,641



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	0	329	27	4	0	0	212	0	19	0	0	78	0	799	5	21
Production 2007 [ktoe]	0	336	19	1	0	0	179	0	16	0	0	85	0	1,007	0	13
Production 1999 [ktoe]	0	333	7	0	0	0	11	0	0	0	0	0	0	912	0	2
Ø annual production growth 2007-2009	-	-1%	18%	126%	-	-	9%	-	9%	-	-	-4%	-	-11%	413%	28%
Ø annual production growth 1999-2009	-	0%	14%	-	-	-	34%	-	71%	-	-	-	-	-1%	62%	26%
Realisable potential by 2020 [ktoe]	22	454	38	269	227	69	1,033	191	143	35	251	690	486	1,180	892	575
Realisable potential by 2030 [ktoe]	74	458	38	1,030	1,244	611	1,236	381	160	38	289	924	514	1,180	1,009	1,780

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 12 – RES target, production and potential in Greece (ECOFYS, 2011)

2.8 Portugal

2.8.1 EPBD Implementation

In Portugal, the implementation of the EPBD is the overall responsibility of the Ministry of Economy together with the Ministry of Environment. ADENE, the Portuguese Energy Agency, is the managing body for this process. ADENE designed, developed and currently supports the entire certification system, which is based on a central registry and database.

The Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 concerning the Energy Performance of Buildings, was transposed into national law through the Decree-Law n.º 78/2006 of April 4th, which approved the National System Energy Certification and Indoor Air Quality in buildings, the Decree-Law nº 79/2006, of April 4th, which approved the Regulation of Energy Systems and Air-conditioning in buildings (for office buildings), and Decree-Law n.º 80/2006, April 4th, approving the Regulation of Thermal Performance of Buildings (for residential buildings).

In this context, the government strongly promoted energy efficiency of buildings, and acquired relevant experience in this area, which translated not only on the increasing of the efficiency of the energy certification system, but also on the identification of relevant aspects of its application.

The creation and operation of that certification system, along with the effort employed in its application, have contributed in the recent years to highlight issues related to increasing energy efficiency and use of renewable energy in buildings.

With the publication of Directive 2010/31/EU of the European Parliament and of the Council of 19th May 2010 the regime established by the Directive 2002/91/EC was recast. The 2006 Portuguese Building energy certification system and energy efficiency codes were revised to transpose the 2010 recast EPBD (the process started in 2010 and the technical committees completed their work in 2012). The transposition into national law of the Directive 2010/31/EU has created an opportunity to improve the systematization and scope of the energy certification system and respective regulations, as well as align national requirements impositions.

The transposition into national law resulted in the Decree-Law n.º 118/2013 that ensures not only the transposition of the Directive 2010/31/EU, but also a review of national legislation, including in a single document, the Buildings Energy Certification System (SCE), Rules of the Energy Performance of Housing Buildings (REH) and the Regulation on Energy Performance of Office and Commercial Buildings (RECS).

Envelope and Systems Requirements

The Decree-Law n.º 118/2013 set the values for the thermal transmittance (U-values) of the building exterior envelope (walls, floors and roofs) and the maximum Solar Factor, or Solar Heat Gain Coefficient (g or SHGC). The values are defined accordingly to the building typology: residential and non-residential and with the climate zone (defined for winter and summer depending on the climate severity). The values are defined in the Ordinances n.º 349 B and D.

Energy Performance Certificates (EPCs)

By December 2012, more than 555,000 EPCs were issued since the scheme was launched in July 2007 (Figure 13). About 80% of these were issued since January 2009, for existing buildings, upon sale or rent.

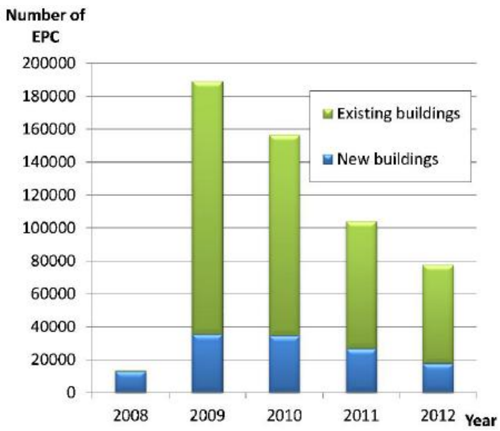


Figure 13 - EPC evolution for new and existing buildings in Portugal (CA, 2012)

Since 2009, around 2,500 EPCs for new buildings and 9,000 EPCs for existing buildings are being issued every month, covering nearly 90% of the licensing and selling processes that take place in the country. This way, a national database of certified buildings is being fed with up-to-date information that will be useful for monitoring the progress of different aspects of the implementation of the owned by private or public entities. This definition is wider than the strict interpretation of the EPBD requirements. Currently, 1% of the total number of EPCs issued corresponds to public buildings.

The database has been used to produce information useful for the revision of the technical regulations, such as tightening of minimum requirements and optimisation of operational rules.

Database information and statistics available

Advertising the Energy Performance indicator was not a requirement before the entrance into force of the Decree-law nº 118/2013 although some real estate agents have advertised the energy performance of A-class buildings.

ADENE together with the Portuguese real estate association (APEMIP) is developing a preferential access to the Portuguese Certification System for buildings (SCE) database for real estate agents, in order to enhance the information exchange between the EPC and the real estate agents. Advertising the energy performance indicator became mandatory in the revised regulations and there will be penalties for those who don´t comply with this requirement (ADENE, 2014).

ADENE's website[4] provides detailed information on the SCE to licensing authorities, professionals of the sector, property owners and developers, and also to the general public. It includes information about training courses, a list of qualified experts, and lists of valid EPCs that can be partially viewed on-line, among other features that can be accessed by users. Detailed brochures, as well as official text, are available on the national websites (ADENE). ADENE presents a monthly report of the number and distribution of EPCs for all Portuguese districts.

In Portugal, information needed for calculating the energy performance certificate and the suggested energy savings measures is stored in a central register. In addition to this, general information about the building and the expert is stored in a central register. Examples of extracted added value from EPC data

[4] www.adene.pt

are: average building stock label; benchmarking for revision of building regulation; dissemination of renewable DHW systems; and most recommended energy-efficiency measures. It has been necessary to change the database structure, in order to include a full ID of each certified building. Use of a standardised database analysing tool is highly recommended, as it makes it possible to follow the development of central data in the EPC database in the form of tables and graphics (CA, 2012).

The EPC is being progressively required for obtaining public funding and tendering processes, e.g., to apply and receive financial incentives from the national Energy Efficiency Fund (FEE) and from the National Strategic Reference Framework (QREN).

In order to promote energy savings and boost the relevance of recommendations identified by the Qualified Experts (QEs), an additional report is produced automatically by the central registry to each EPC issued. This report provides complementary information and further details on how to implement the recommendation, stating the materials, systems performance and possible technical hitches on its practical execution. It is a document produced to bridge the gap between home owners and contractors. The aim is to provide added value information to the home owner in order to enhance the uptake of the recommendations and to define the individual impact of each recommendation before and after its implementation (ADENE, 2014).

Action plan for progression to nZEB

The national action plan for the progression to nearly zero-energy buildings is now under development, and the key targets and milestones defined. The adopted definition of the nZEB, establishes a relation with cost optimal evaluations and nZEBs are defined as buildings that cumulatively offer:

- components compatible with the upper level of the cost optimal evaluations;
- implementation of renewable energy that covers a very significant fraction of the reduced building energy needs. This energy must be produced on site (whenever possible) and/or, alternatively, when the local production may be insufficient, e.g., in urban areas, as nearby as possible. Numerical indicators are also being studied and will be made available following the conclusion of the cost optimal procedures. The primary energy factors, that also play an important role, will be gradually revised until 2020, to incorporate the effort made by Portugal to have clean and renewable electricity.

To support the implementation of the action plan, several measures were identified and will be made operational until 2020. The measures that are related not only to financial aspects but also to policies and campaigns will support the transition towards a more efficient building stock by 2020.

These measures are based both on national strategies, including those envisaged in other action plans (the Energy Efficiency Action Plan and the National Renewable Action Plan), and on European support initiatives that are foreseen to become available throughout the following years. Specific measures include, for instance, training of the building workforce and experts, which will be supported by the promotion of financial incentives and the development of real nZEB case studies (CA, 2014).

2.8.2 RED Implementation

Nowadays, the energy sector plays a structural, integral and fundamental role in society and in the Portuguese economy. Renewable energy sources (RES) play a prominent role in national policies for the sector, owing to their availability and their widespread and endogenous nature. In fact, all agents in the sector have unanimously recognised that there is a very significant potential for developing renewable energy in Portugal. This recognition has been reflected in the growing importance of sources of renewable energy in various sectors of activity: ranging from the transport industry to the domestic sector but, above all, in the production of electricity.

Portugal today has a scheme to access the electricity network which prioritises RES, both with regard to planning and developing the network as well as in relation to everyday management, by giving priority to such dispatches. Moreover, over the course of recent years, Portugal has created a series of financial and fiscal measures to support investment in renewable energy. These measures have been further dynamised with the creation of differentiated tariffs for electricity produced in renewable plants, feed-in tariffs (FIT), according to the degree of maturity of the various technologies that are available in the national market.

These measures have helped to successfully achieve the overall objectives of the national energy policy and renewable energy has become increasingly important and visible in the national strategies that recent governments have approved for the energy sector.

The Cabinet Resolution n.º 29/2010, of 15th April, which approved the latest National Energy Strategy (NES 2020), continues to attribute a pivotal role to renewable energy in the energy strategy and the targets that have been delineated for this sector, with a very significant impact on the Portuguese economy.

Keeping in mind the contribution of RES, the main objectives of the national energy policy include:

- To guarantee compliance with Portugal’s commitments in the context of European energy policies and policies to combat climate change, ensuring that 31% of the gross final energy consumption, 60% of the electricity produced and 10% of the energy consumption in the road transport sector will be derived from renewable sources in 2020;
- To reduce Portugal’s energy dependence on external sources, based on the consumption and importation of fossil fuels, to around 74% in 2020, by means of increasing use of endogenous energy resources (estimated reduction using a Brent reference of 80 USD/bbl);
- To reduce the balance of energy imports by 25% (around € 2 billion) with the energy produced from endogenous sources, making it possible to reduce imports by an estimated 60 million barrels of oil;
- To consolidate the industrial cluster associated with wind energy and to create new clusters associated with new technologies in the renewable energy sector, ensuring a Gross Added Value of 3.8 billion Euros and creating 100,000 new jobs in addition to the existing 35,000 jobs associated with the production of electricity from RES by 2020;
- To promote sustainable development, creating the necessary conditions to meet the commitments that Portugal has made with regard to reducing greenhouse gases, by means of a greater use of RES and energy efficiency.

The NES 2020 has been structured around 5 main axes, one of which is entirely dedicated to RES, establishing targets and strategies to develop and promote the various technologies that are part of the mix of renewable energies by 2020. This is aimed at enhancing the potential of endogenous resources and the capacity to create value, with a view to ensuring a greater diversification for the contributions of the RES.

The development of the national production of renewable energy will be based on an articulated increase in the installed hydro and wind energy capacity. This reinforcement of the hydropower capacity will have benefits in terms of optimising the management of hydrographic basins while simultaneously providing the system with the necessary speed of response to be able to cope with the variations associated with wind production. The increase of reversible hydropower capacity will also contribute towards promoting the viability of wind production during periods of lower consumption, reducing its production costs.

However, special attention will be paid during this decade to developing technologies based on the use of solar energy, both in terms of large-scale applications as well as an emphasis on mini and micro-production and systems for water heating for domestic use.

Other RES, such as biomass, biogas, biofuels, geothermal energy and wave energy will also be important in the future. Specific instruments have been envisaged to promote them and to develop the necessary technologies. Amongst these measures, it is especially important to note the implementation of the pilot zone created by Decree Law n.º 5/2008, to test technologies that serve to harness wave energy, contributing towards Portugal's efforts to dynamise this technology and to promote an industrial cluster linked to maritime activities.

Similarly, the potential of hydrogen as an energy vector that has the capacity to store energy will be assessed as a means of making the large-scale use of renewable energy feasible and promoting innovative solutions in the transport sector (NREAP for Portugal, 2010).

The National Renewable Energy Action Plan (PNAER, 2010) was prepared and written on the basis of the Commission Decision of 30th June 2009, which provides for a template for national renewable energy action plans in the second paragraph of Article 4(1) of Directive 2009/28/EC. The Decree-Law n.º 141/2010, of December 31st, which partially transposed this directive, establishes the national targets for the use of energy from renewable sources in gross final consumption of energy and energy consumption in transport in 2020, representing 31% and 10%, respectively, which are assumed in PNAER. The Portuguese NREAP splits the overall 31% renewable energy target into 55.2% RES-E, 30.6% RESH&C and 10% RES-T. Table 5 presents the reference situation (year 2005) and the overall goals for 2020.

Table 5 – Portuguese overall target for the share of energy from renewable energy sources in gross final energy consumption in 2005 and 2020

A) Share of energy from renewable sources in gross final energy consumption in 2005 (%)	19.8
B) Target of energy from renewable sources in gross final energy consumption in 2020 (%)	31.0
C) Expected total adjusted energy consumption in 2020 ((ktoe)	16,623
D) Expected amount of energy from renewable sources corresponding to the 2020 target (calculated as B x C) (ktoe)	5,153

The National Renewable Energy Action Plan was updated by the Resolution of the Council of Ministers n.º 20/2013. The changes in the National plan are related with the strong focus in the recent past in the production based on renewable energy and combined-cycle natural gas together with the current conditions of shrinkage of demand resulted on an imbalance between the production capacity and power consumption, resulting in an oversupply with very high coverage rates.

However, the consequences for the national economy only became really visible from the end of the last decade, result of the accumulation of macroeconomic imbalances and structural weaknesses over several years. In this scenario, and considering that Portugal has an energy intensity of the productive economy above the European Union average, there is need to intensify efforts at direct action on the final energy under the National Plan for Energy Efficiency (PNAEE) as a result of minor marginal cost of achieving the goals of energy efficiency relative to the marginal cost of achieving the goal of dissemination of renewables in the overall result of the final consumption of energy.

However, despite a predicted reduction of 18% in installed capacity in technologies based on renewable energy in 2020 compared to PNAER 2010, the share of electricity from renewable based on the new PNAER is higher (60% vs. 55%), as the overall goal to achieve, which is expected to stand at around 35% (compared to the target of 31%).

In this context, in the same time horizon (2016) of PNAEE and already regarding the estimated effects of the implementation of this plan, the PNAER 2020 was defined according to the current scenario of oversupply. This new version has as primary objective to review the relative weight of each of the RES in national energy mix and respective goals of incorporation according to its production cost and consequent potential operating under the market.

The NREAP states that Portugal will meet its overall binding target (Table 6). However, APREN predicts, using different energy demand assumptions, that a higher overall target of 34.8% could be met in Portugal. The lack of ambition of the NREAP targets is easily supported by facts:

- For the electricity sector, although the installed power figures set out in the NREAP are in line with those proposed by APREN, except for photovoltaics, the respective electricity production is below expectations, due to too low average annual production hours.
- The second proof of the NREAP's lack of ambition lies in the fact that the RES contribution in H&C decreases between 2005 and 2020 from 31.9% to 30.6%. APREN fears that the NREAP trajectory for the H&C sector does not emanate from a strategy outlined for the sector, but is merely an accounting consequence of the goals set out for the other sectors.
- At the same time the overall energy consumption forecast in the Portuguese transport sector was reviewed at lower levels than those estimated by the industry, thus leading to a smaller amount of biofuel production. Despite ambitious plans for electric vehicles, the main share in RES-T is from biofuels, as they are already a solution in place, yet with several drawbacks.

Table 6 – Projections for Renewable Electricity in 2020
(EREC road Map, 2011)

	MW installed	**RES Electricity Generation (GWh)**	**% in Electricity Consumption**
Large Hydro	8,798	12,562	19.5
Hydro (below or equal to 10 MW)	750	1,511	2.3
Geothermal	75	488	0.8
Photovoltaic	1,000	1,475	2.3
Solar Thermal Electricity	500	1,000	1.5
Tidal, Wave, Ocean	250	437	0.7
Wind Onshore	6,800	14,416	22.4
Wind Offshore	75	180	0.3
Biomass (solid, biowaste, bioliquid)	802	2,991	4.6
Biogas	150	525	0.8
Total	**19,200**	**35,585**	**55.2**

Figure 14 and Figure 15 present the evolution of the energy production and contribution of renewables for energy production in Portugal in the last years.

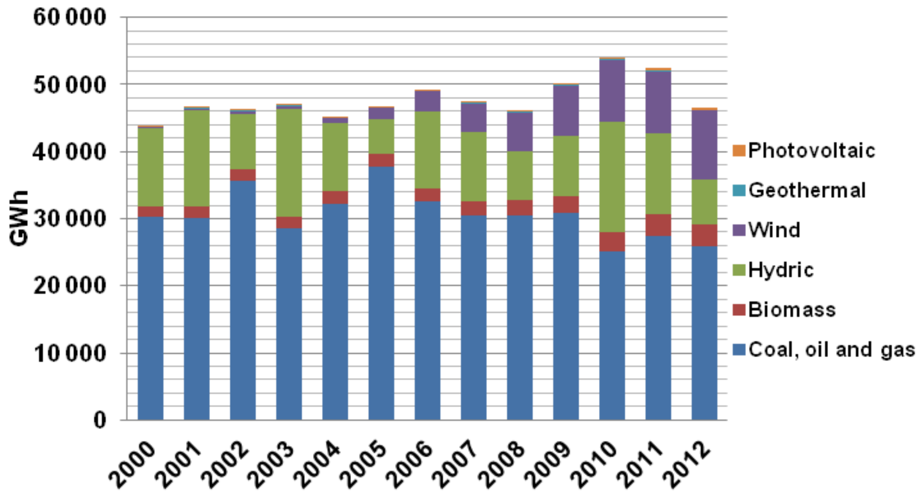
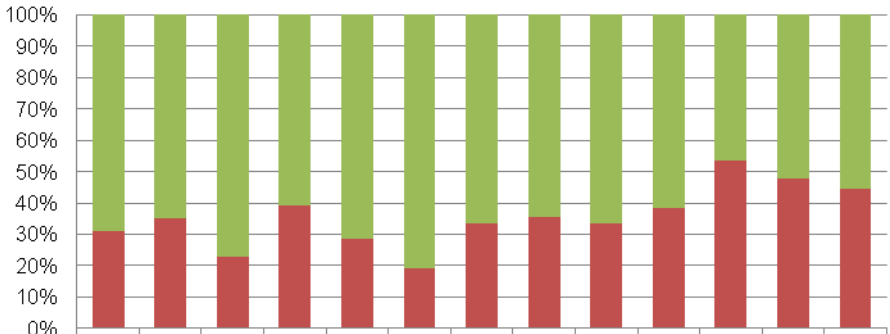


Figure 14 - Energy production sources in Portugal (DGEG, 2012)

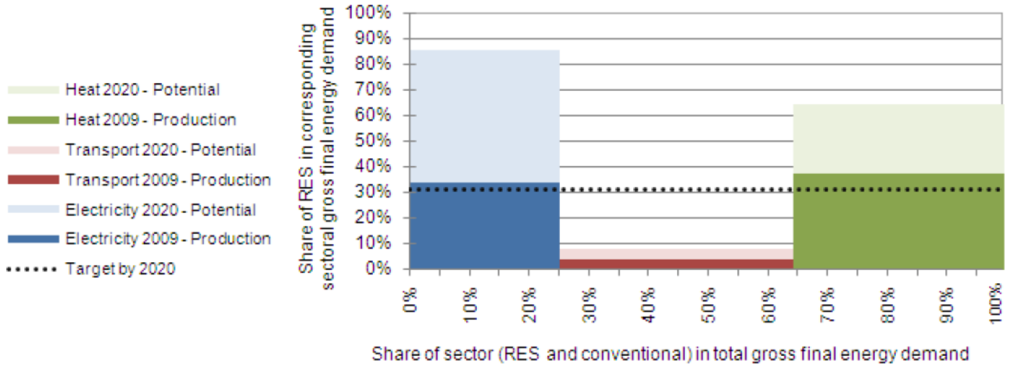


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Renewable	69%	65%	77%	61%	71%	81%	66%	64%	66%	62%	46%	52%	56%
Non-renewable	31%	35%	23%	39%	29%	19%	34%	36%	34%	38%	54%	48%	44%

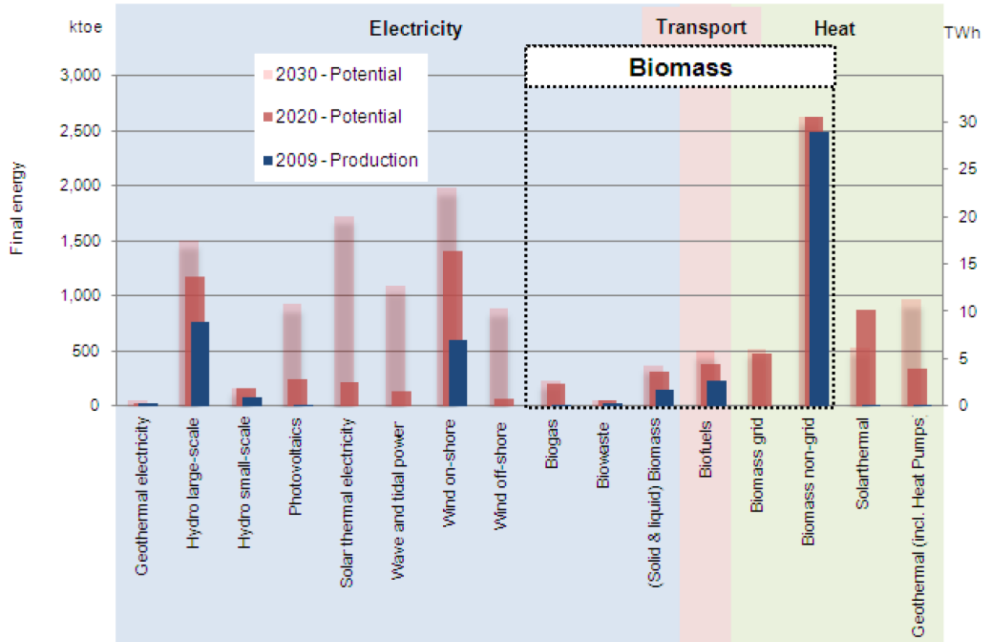
Figure 15 – Renewable Energy production share in Portugal (DGEG, 2012)

A summary of the RES target, production and potential in Portugal is available in Figure 16 (ECOFYS, 2011).

Co-funded by the Intelligent Energy Europe Programme of the European Union



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	34%	4%	37%	23%
Share of total sector consumption in total final energy consumption	25%	39%	36%	100%
Production 2009 [ktoe]	1,573	224	2,495	4,292
Production 2007 [ktoe]	1,395	135	2,573	4,103
Production 1999 [ktoe]	744	0	2,404	3,148
Average growth 2007-2009 [%/a]	6%	29%	-2%	2%
Average growth 1999-2009 [%/a]	8%	-	0%	3%
Realisable potential until 2020 [ktoe]	3,973	383	4,313	8,669
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	4%
Realisable potential until 2030 [ktoe]	8,546	501	4,641	13,688



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	16	759	80	12	0	0	602	0	7	25	147	224	0	2,486	0	9
Production 2007 [ktoe]	17	753	81	3	0	0	352	0	5	24	132	136	0	2,563	0	10
Production 1999 [ktoe]	7	752	62	0	0	0	10	0	0	7	93	0	0	2,403	-	1
Ø annual production growth 2007-2009	-4%	0%	0%	119%	-	-	31%	-	20%	3%	6%	28%	-	-2%	22%	-5%
Ø annual production growth 1999-2009	9%	0%	3%	61%	-	-	51%	-	56%	14%	5%	-	-	0%	-	25%
Realisable potential by 2020 [ktoe]	27	1,177	165	246	208	127	1,404	67	199	47	305	383	481	2,626	867	339
Realisable potential by 2030 [ktoe]	58	1,505	167	925	1,728	1,096	1,985	890	230	52	371	501	514	2,626	537	964

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 16 – RES target, production and potential in Portugal (ECOFYS, 2011)

2.9 Cyprus

2.9.1 EPBD Implementation

The local authority of Cyprus responsible for the application of EPBD and responsible for the Energy Performance Certification is the Cyprus Energy Service (CES), is a department of the Cyprus Ministry of Energy, Commerce, Industry and Tourism. CES is responsible for drafting the necessary legislation for the application of energy related European Directives (such as EPBD & RED), which is subsequently voted by the Parliament, addressing the general topics of each directive. Technicalities are resolved through regulations, issued under ministerial orders (Regulatory Administrative Actions).

Envelope and Systems Requirements

A regulation came into effect in the 21st December 2007 requiring that the building envelope, for buildings to be constructed from this date onwards, to be thermally insulated.

In the 1st January 2010 a regulation came into effect requiring that an Energy Performance Certificate (EPC) is to be issued for any building applying for a construction permit from this date onwards. For application approval, an Energy Performance level of at least “Category B” has to be achieved, amongst other requirements.

In December 2013 regulations regarding the building envelope elements’ (walls, columns, floors, roofs, windows and doors) U-values were tightened by 15%. In addition to that, for all new residential buildings, a solar thermal system for hot water production should be installed. Finally, all new non-residential buildings must satisfy 3% of their total energy consumption from RES.

In September 2012, the Ministry of Energy, Commerce, Industry and Tourism submitted the Nearly Zero-Energy Buildings Action Plan to the European Commission. For the purpose of setting the definition of the nZEB in Cyprus, the Energy Service ordered an in depth study of the potential of energy saving in the three most commonly used categories of residential buildings (detached two-storey house, terraced house, apartments on building blocks). This study covered all four climatic zones, as defined in the Methodology for Calculating the Energy Performance of Buildings.

Currently there is public consultation about the Ministerial Order that will define the minimum requirements that a nZEB has to comply with. This Ministerial Order is ready and it is expected to be issued by the end of 2014.

Regulations and minimum requirements for nZEB is expected to be issued by late 2014, early 2015. These will come into effect in 2018 for non-residential buildings and 2020 for residential buildings.

With the 2010 recast of the EPBD a new legislation came into effect regarding the inspection of boiler based heating systems as well as HVAC systems. The regulations for the inspection of HVAC systems requiring the inspection of HVAC systems at specified time intervals (depending the type system) by qualified inspectors (qualification requirements: Mechanical Engineers, members of the Scientific and Technical Chamber of Cyprus, registered in the “HVAC Systems Inspectors Catalogue” of the Cyprus Energy Service). Regulations for the inspectors of boiler based heating systems are expected to be issued shortly.

Database information and statistics available

No significant data are really available to the general public. The only information that is available are the legislation and regulations, the official catalogue of technical experts that are allowed to issue an EPC and all the training material (methodology, guidelines, regulations, legislation, software tutorials and examples) preparing the prospective technical experts for the corresponding exams.

Energy Performance Certificates

Current legislation in Cyprus specifies that EPCs can be issued only by qualified technical experts registered in the catalogue of technical experts for the issue of Energy Performance Certificates.

The legislation is in place which requires that a valid EPC must be in place in order for someone to acquire a construction permit for a new building (residential or non-residential) and also a valid EPC should exist in order to rent or sell a property (the unique EPC registration number should be clearly seen in an advert regarding property rental or sale).

However, statistical data availability is very limited. The only data available at the moment are the numbers of issued EPCs for residential (17.814 EPCs issued) and non-residential buildings (1.825 EPCs issued).

Action plan for progression to nZEB

The action plan for progression to nZEB in Cyprus is summarized in the following points:

- Preparation of a technical guide based on the results of the study on the energy saving potentials in nZEBs. The Technical Guide shall include the minimum requirements for nZEB in Cyprus and technical and construction guidance in order to facilitate the design and construction of the building. The application of the Technical Guide will be on a volunteer basis and will be upgraded continually. It will remain in use even after the enforcement of the application of nZEB by law;
- Support research programs for the development, improvement or advancement of construction techniques;
- Compare the existing national methodology of the certification of the Energy Performance of Buildings with the certification of nZEB. Further parameters are to be accounted for in the latter, thus the existing methodology should be further developed in order to include the nZEB category. Once this is done, the software now in use for the certification of buildings will have to be improved or replaced in order to reflect the new methodology for the certification of nZEB;
- Informing the qualified technical experts and the engineers of the building industry,
- Raising the awareness of the public,
- Design and announcement of a linear tightening of the minimum energy performance requirements leading to the 2020 nZEB.

2.9.2 RED Implementation

A new national Law (N.112 (I)/2013) for the promotion and encouragement of the use of energy from renewable sources has been active since September 2013 transposing the provisions of the European Directive 2009/28/EC.

The main provisions of the new Law for the promotion of the use of energy from renewable energy sources are the following:

- National Renewable Energy Action Plan (NREAP), adopted In conforming to article 14 of the national Law n.º 112 (I)/2013;
- The NREAP describes all measures to be taken in order to achieve the above mandatory targets, including energy efficiency and energy saving measures. In the action plan it is estimated that in order to achieve the target of 13% of RES to the gross final energy consumption by 2020, the contribution of RES must increase to 16% for electricity, 23.5% for heating and cooling and 4.9% for transport;
- Access to and operation of the grids;
- According to Article 35 of the Law, priority access to the grid system of electricity produced from renewable energy sources must be provided by system operators (TSO and DSO). Also, when dispatching electricity generating installations, transmission system operator (TSO) shall give priority to generating installations using renewable energy sources in so far as the secure operation of the national electricity system permits and based on transparent and non-discriminatory criteria.

Based on the Cyprus National Action Plan on the use of Renewable Energy Sources of 2009 (NREAAP 2009), a target for installations producing electricity out of Renewable Energy Sources of a total nominal capacity of 211 MW was set. At the end of 2013, based on data from the Cyprus Regulatory Authority (CERA), slightly more than 190 MW were installed, out of which photovoltaic systems and wind power-generators dominated the whole picture with installations of nominal capacity amounting to 34.6 MW and 146.7 MW respectively, as can be seen in Table 7.

Table 7 – Projections and actual electricity installations out of renewable in 2013 (Cyprus Ministry of Energy, Commerce, Industry and Tourism)

Technology	**Nominal Capacity installation Projection for 2013 (MW)**	**Nominal Capacity installed in 2013 (MW)**
Wind-power Generators	165	146.7
Solar Thermal	25	---
Photovoltaic	14	34.6
Biomass	4	9.7
Biogas	3	---
Total	**211**	**191**

Installation of RES in Cyprus began around 2005 with small on-grid and off-grid installations of PV systems up to 7 kW ,on residential and holiday homes that were quite far from the electricity grid. This continued up until 2008 where major installation on biomass systems took place at the time. Things spiked up in 2010 when the first and yet largest wind farm in Cyprus had been installed, amounting 41 Vestas wind-generators and a nominal capacity of 82 MW. Since 2011 also, with prices falling rapidly, PV systems installations are increasing every year. The cumulative installed power of RES up until today can be seen in Figure 17.

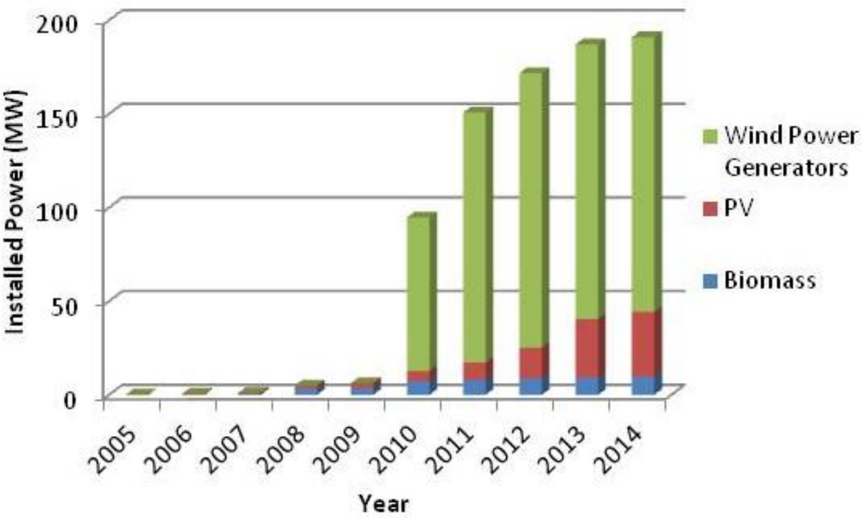


Figure 17 – Nominal Installed Power of RES per technology in Cyprus, 2005-today (CERA)

The above installations of RES produce today more than 200 GWh of electrical energy per annum and have produced around 1,000 GWh of electric energy since 2005. The cumulative production of energy from the installed RES in the country since 2005 can be seen in Figure 18.

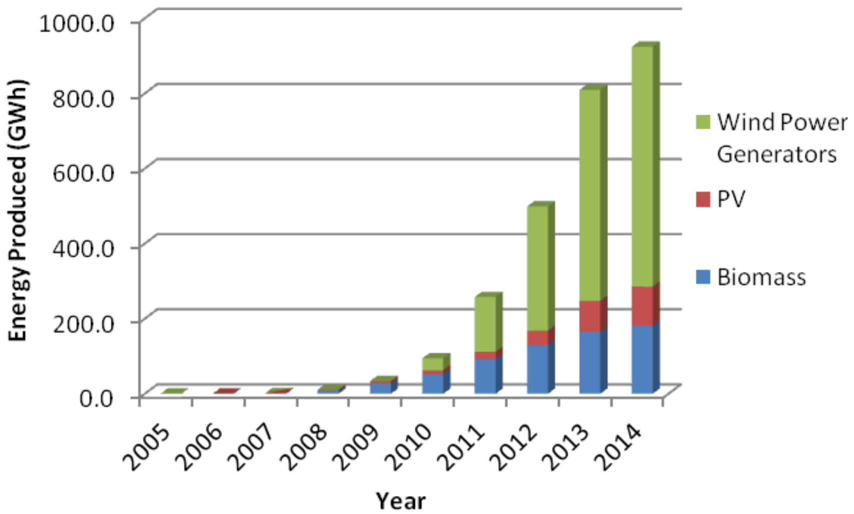


Figure 18 – Cumulative energy production from RES per technology in Cyprus, 2005-today (CERA)

As a result of the above installations, Cyprus achieved a 9% production of electricity out of renewables, thus over achieving substantially its indicative target trajectory, which according to the provisions of the RES Directive, was 4.92% for the years 2011-2012, 5.93% for the years 2013-2014 and 7.45% for the years 2015-2016, since the share of RES in the gross final energy consumption reached 9%, in 2013 (Figure 19).

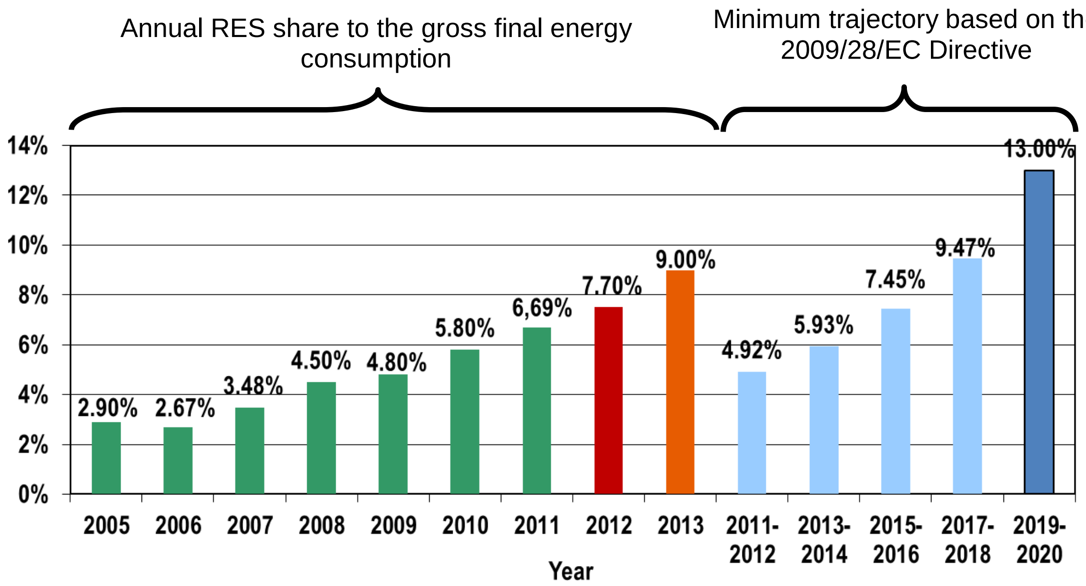
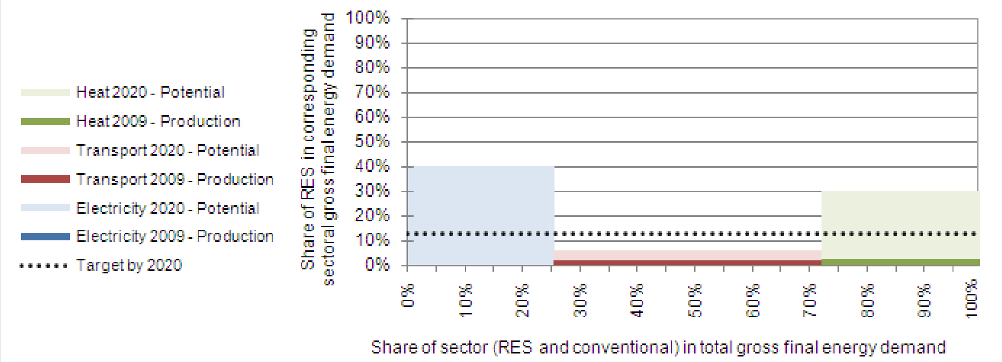


Figure 19 – Annual RES share and minimum trajectory defined on the Directive 2009/28/EC

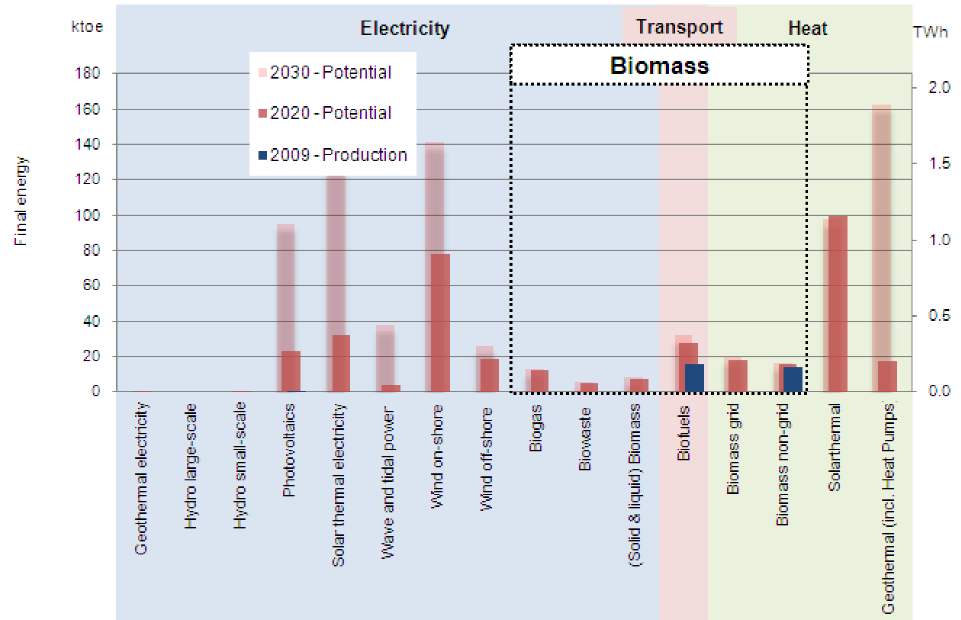
In addition to the above, more than 720,000 m^2 (equivalent to approximately 500 MWth) of solar thermal collectors for Hot Water production applications (households, hotels, hospitals, etc.) are installed in the island, making Cyprus the leader in installed solar thermal capacity per capita in Europe.

Finally, according to the provisions of the relevant national legislation, the suppliers of automotive fuels are obliged to mix automotive fuels (gasoline and diesel) with sustainable biofuels to at least 2.4% of energy content. In 2012, the share of RES to the final consumption of energy in all forms of transport was 2.42%.

A summary of the RES target, production and potential in Cyprus is available Figure 20 (ECOFYS, 2011).



	Electricity	Transport	Heat	Total
Share of RES in corresponding sectoral gross final energy demand	0%	2%	3%	1%
Share of total sector consumption in total final energy consumption	25%	47%	28%	100%
Production 2009 [ktoe]	0	15	14	29
Production 2007 [ktoe]	0	1	6	7
Production 1999 [ktoe]	0	0	2	2
Average growth 2007-2009 [%/a]	22%	287%	53%	102%
Average growth 1999-2009 [%/a]	-	-	21%	31%
Realisable potential until 2020 [ktoe]	180	28	150	357
Average growth 2009-2020 [%/a] needed to achieve target	-	-	-	21%
Realisable potential until 2030 [ktoe]	424	32	297	753



	Geothermal electricity	Hydro large-scale	Hydro small-scale	Photovoltaics	Solar thermal electricity	Wave and tidal power	Wind on-shore	Wind off-shore	Biogas	Biowaste	(Solid & liquid) Biomass	Biofuels	Biomass grid	Biomass non-grid	Solarthermal	Geothermal (incl. Heat Pumps)
Production 2009 [ktoe]	0	0	0	0	0	0	0	0	0	0	0	15	0	14	-	0
Production 2007 [ktoe]	0	0	0	0	0	0	0	0	0	0	0	1	0	6	-	0
Production 1999 [ktoe]	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-	0
Ø annual production growth 2007-2009	-	-	-	100%	-	-	-	-	-100%	-	-	287%	-	53%	-	-
Ø annual production growth 1999-2009	-	-	-	-	-	-	-	-	-	-	-	-	-	21%	-	-
Realisable potential by 2020 [ktoe]	0	0	0	22	32	4	78	19	12	5	7	28	18	15	99	17
Realisable potential by 2030 [ktoe]	0	0	0	95	128	38	141	26	13	5	8	32	20	16	98	163

See page 4 for explanation. Unit conversion: 1 ktoe = 11.628 GWh = 41.868 TJ

Figure 20 – RES target, production and potential in Cyprus (ECOFYS, 2011)

3 Certification and Training in the EU

3.1 United Kingdom

3.1.1 Certification, training & QA requirements of energy performance

In England and Wales government has licensed Accreditation Schemes to accredit energy assessors for the production of outputs under the Energy Performance of Buildings Regulations such as EPCs, recommendations reports, etc.. National Occupational Standards (NOS) specify the qualifications and skills which energy assessors should meet to be accredited to produce regulatory outputs. Different types of accreditations are available to would be energy assessors, depending on the building type (residential or non-residential), the complexity of the building and software to be used, and the type of regulatory outputs to be produced

Accredited energy assessors in England and Wales must use Government-approved software tools to produce regulatory outputs. A suite of software tools (including free Government-sponsored and proprietary tools) are available to accredited energy assessors to produce regulatory outputs. Regulatory outputs are lodged on a national register, and may be retrieved from the register.

In England and Wales the government introduced Scheme Operating Requirements (SORs) in 2010 (which were updated in 2012). Under the SORs, Accreditation Schemes are mandated to undertake QA of the outputs produced by their accredited energy assessors. Government also carries out QA audits of the quality systems implemented by Accreditation Schemes and compliance with the SORs. These provisions ensure that a statistically significant percentage of certificates is checked by independent experts for QA purposes.

The provision for producing certificates on the sale and rental of properties in Northern Ireland mirror those for England and Wales with some minor differences.

In Scotland, the national provisions for the production of EPCs are broadly similar to those implemented in England and Wales; however there are a number of key differences. These include:

- Administration and quality assurance: The Scottish Government has appointed Approved Organisations which may accredit members to produce regulatory outputs in Scotland. Approved organisations have been tasked with specific QA responsibilities under an agreed operational framework. Approved organisations must have quality assurance procedures in place to check the quality of the EPCs produced by their members and to undertake appropriate corrective action where the required standard is not met. AOs must ensure that a minimum of 2% of the total number of EPCs produced by members are checked for accuracy. Government will audit Approved Organisations to ensure compliance.

- Register: Since January 2013, a new register replaced the old register, the Home Energy Efficiency Database (HEED). The new register (www.scottishepcregister.org.uk) is used for new and existing buildings and is only accessible by the nominated individuals of the approved organisations and enforcement authorities.

3.1.2 Certification, training & QA requirements of heating/air-conditioning systems

All jurisdictions (England, Scotland, Wales and Northern Ireland) decided to pursue the option to provide advice on boilers, rather than implementing an inspection regime.

Government developed a UK annex to the CEN standard designed to assist Member States to implement option (a). This annex corresponds closely to the Government boiler checklists and guidance produced with industry to provide advice on boilers. Government also held discussions with industry on how advice may be provided under a competent persons' scheme. Therefore, as the checklists form part of industry recommended good practice guidelines, existing service visits may be regarded as meeting some of the inspection requirements of option (a).

The EPBD makes provisions for the inspection of air conditioning plant. Air conditioning systems over 12kW output need to have regular inspections, including an assessment of efficiency and sizing of plant compared with the cooling requirements of the building. The 12kW threshold applies to the total air-conditioning plant supplying the premises concerned rather than to individual chillers.

In England & Wales, the inspections of air-conditioning (AC) equipment was phased between 2009 (for systems >250 kW) and 2011 (for systems >12 kW). Installations must be inspected every five years which is the validity of an inspection report.

From 2012, all new AC Inspection Reports must be lodged on the national EPC register (SI 2011/2452). This replaces the previous voluntary lodgement approach, and aims to ensure reports may be assessed for QA. It is the first step in a series of proposals to improve compliance, and will also support the development of future policies.

The approved guidance to undertake AC inspections is set out in the Technical Memorandum 44 (TM 44) Inspection of Air-Conditioning Systems published by CIBSE.

The administration, energy assessor's accreditation and QA processes have been incorporated as a separate strand of the EPCs processes.

In Northern Ireland the national requirements broadly mirror the England and Wales requirements (administration, accreditation, QA, penalty regime). The requirement to lodge the AC Inspection Report on the national register came into force in February 2013. 'A guide to air-conditioning inspections for building' was updated in 2013 and is available on the DFPNI website.

In Scotland inspection of air-conditioning systems may only be carried out by members of those organisations that have entered into a protocol with the Scottish Government. As with England and Wales, the frequency of inspections is five years and the CIBSE TM44 may be used as guidance to undertake inspections, subject to the provisions set out in the TM44 Scottish addendum.

3.1.3 Training Routes

To carry out assessments of a building and produce EPCs and DECs, an energy assessor must be accredited by a scheme that's been approved by Government. The same applies for AC inspection in the UK. To become accredited, the individual must either have a qualification or prove they have the appropriate knowledge, as defined in the National Occupational Standards (NOS).

The National Occupational Standards (NOS) define the skills and knowledge required to join an accreditation scheme and become licensed. There is also a framework within which applicants can become accredited called APEL – Accreditation of Prior Experiential Learning. This accreditation method is for people who already have the skills to do the job and just require some extra training for additional knowledge. An example of this would be a refrigeration installer requiring further training to undertake AC inspections in line with the EPBD requirements. This route would require that all applicants have a minimum of 2 years out of the last 5 in building services and air-conditioning designing installing or maintenance. The training would then explain how to undertake such inspections in line with CIBSE TM44: Inspection of Air-conditioning systems and the occupational standard. Following the training they would then be accredited by the accreditation scheme to undertake such inspections.

With regards to the implementation of the RED, the same procedure applies for the installation of renewable energy technologies. Under article 14 of the RED Directive, "*Member States shall ensure that certification schemes or equivalent qualification schemes are available by 31 December 2012 for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal systems and heat pump."*

The Microgeneration Certification Scheme (MCS) certifies microgeneration products and installers (organisations/people) wishing to become certified.

3.2 Austria

3.2.1 Certification, training & QA requirements of energy performance

In Austria, since the 1st January 2009, it is mandatory to submit an energy performance certificate of a building or building units when it is being sold or rented out. The certificate is based on the different but harmonised regulations in the nine *'Länder'*, while the obligation to submit the certificate is provided for in a federal law.

In order to produce an energy performance certificate, a person must be authorized in accordance with the relevant rules and regulations, by an accredited inspection authority or by a person who has been certified on the basis of cooperation in the building trade. They can be chartered engineering consultants with relevant authorisation, engineering agencies within their trading license, master builders and master carpenters, general legally accredited experts of relevant expertise, as well as technical departments of public enterprise bodies. In addition, the certification bodies in the *'Länder'* may certify people for the purpose of issuing EPCs.

In all Austrian '*Länder*' comprehensive information campaigns for the public and professionals are undertaken. Representatives and experts of all the *'Länder'* governments, regional energy agencies, as well as of the chambers of commerce and the chambers of engineers attend events, fairs, seminars and workshops, disseminating information on the certification process and the EPCs.

Information and training activities, like calculation courses, were addressed to different target groups; these activities are continuing. All the *'Länder'* provide corresponding websites, brochures etc.. The same applies for the chamber of commerce and for trade associations.

3.2.2 Certification, training & QA requirements of heating/air-conditioning systems

In Austria, inspection obligations for boilers have existed for more than 15 years. The frequency of inspections depends on the energy source and the size (power output) of the heating system. Basic and full inspections are required based on the power output up to 400kW and 400kW and above.

Heating systems with a power output above 400 kW also need to undergo a basic inspection at least once a year. This basic inspection is only waived in the year when a full inspection is carried out.

After each inspection, a report has to be prepared by the auditor. Basic inspections have to be carried out by an official expert, or an organisation or expert who can show detailed expertise in this field. A basic inspection can be carried out by authorised craftsmen, licensed consulting engineers or architects (*'Ziviltechniker'*), and accredited inspection authorities. Full inspections can be implemented only by official experts or organisations fulfilling the requirements of S14 of the 'anti-pollution law'.

At present, the detailed training requirements for experts who will be authorised to carry out basic and full inspections are under discussion within local and regional authorities.

Up to now, a quality control system for heating inspections has not been implemented. The mandatory inspection report includes very little information, but local and regional authorities have to be informed if basic requirements (emission, performance or safety requirements) are not entirely fulfilled.

In Austria since the 1st January 2009 there is an obligation for the inspection of air-conditioning systems. Requirements in regard to inspection reports for AC systems were introduced together with the obligation of the inspection itself.

The legislation concerning the inspection of AC systems is within the power of each regional 'Länder'. Common inspection intervals are three, five, ten or twelve years, or a combination depending on the scope of the inspection. In some regions, a short inspection every three years is combined with a more comprehensive one every 12 years. In all nine *'Länder'*, AC systems from a 12 kW total rated output in a single building (refrigerating capacity) are to be inspected. If there are several systems in one building, their rated outputs are added up to establish if the 12 kW limit is exceeded.

There are annual inspections only in Upper Austria (rated output of more than 50 kW) and in Styria (all AC systems from a 12 kW rated output). Lower Austria introduced only one kind of inspections for all systems above 12 kW, where all inspections need to be conducted only once every 10 years.

The inspection is to be carried out according to ÖNORM EN 15240 (AC systems) and ÖNORM EN 15239 (Ventilation). Currently, ÖNORM H 6041, a supplement to these two standards focusing on the assessment of the energy efficiency of an AC system, was published in 2013. Inspections for all AC systems have to be paid by the end user or by the owner of the building.

Regional governments are in charge of compliance and control of AC inspections. In most provinces, the qualification of the experts responsible for carrying out the inspections is based on the Austrian trade law. According to this law, experts are allowed to carry out AC inspections provided that they possess a trade license for planning, installing, modifying, maintaining and auditing AC systems.

Inspectors can also be accredited by auditing bodies, public authorities or engineering firms with relevant competencies. Training for inspectors is currently offered by private and public training institutes, as well as by the chamber of commerce.

3.2.3 Training Routes

The Austrian educational system offers a large variety of opportunities following compulsory education (9 years) and three of four possible education paths on secondary level II offering opportunities for vocational training. Besides the possibility to attend a secondary academic school (Allgemeinbildende

Höhere Schule, AHS), which provides general education in the humanities, science and languages and leads to university entrance, students can choose one of the following types of vocational schools[5]:

- the five-year full-time vocational education and training (VET) colleges (Berufsbildende Höhere Schulen, BHS), which both provide vocational training (various branches of technology, business and commerce) and allow their graduates university entrance;
- the three to four-year full-time vocational education and training schools (Berufsbildende Mittlere Schulen, BMS), which also offer specialised vocational training in the technical or economic field, but do not provide access to university;
- the two to four-year part-time vocational schools (Berufsschulen) combined with apprenticeship training in enterprises ("dual vocational training system").

Apprenticeship training in Austria, similarly to Germany, is organised in a dual system. This means that young people who have concluded an apprenticeship training-agreement with a company authorised to train apprentices are obliged to attend part-time vocational schools while receiving their practical training directly with the companies. The length of the apprenticeship training varies according to the trade, but is usually three years. Currently there are over 250 recognised apprenticeship trades.[6]

Austria has concluded that, in principle, it is not necessary to establish completely new systems for what relates to energy issues, especially in the constructing sector; however, a structural improvement of the education and training system would be crucial. This includes, inter alia:

- clarification on examination rules;
- coordination of search engines for courses;
- development of modular systems in education and training;
- improvement of content and methods in coordination with the construction industry;
- larger diffusion of the procedure of acceptance of construction work;
- establishing quality managers on the building site ('on-site quality coach');
- clear quality requirements in public tenders.

[5] BEST Institut für berufsbezogene Weiterbildung und Personaltraining GmbH, *New Teachers for New Competencies, Best Practices*

[6] http://www.bildungssystem.at

3.3 Germany

3.3.1 Certification, training & QA requirements of energy performance

EPCs in Germany can be grouped into two categories according to the type of assessment method; certificates on the basis of calculated demand and certificates on the basis of metered consumption. In doing so, all new buildings and cases of major renovation must have an EPC based on a calculation methodology. The simpler metered energy consumption method only applies for:

- existing residential buildings with at least 5 apartments, where the influence of individual user behaviour is statistically balanced by the large number of users;
- smaller existing residential buildings, which at least conform to the first German Thermal Insulation Ordinance for thermal insulation (1977);
- all existing non-residential buildings.

Information campaigns and specialist handbooks play an essential role in the German implementation strategy. In this case, the offers are adapted to the different levels of knowledge and needs of the interested groups (tradesmen, building owners and tenants, as well as engineers and planners). The acceptance of and familiarity with the EPCs should be further encouraged, especially for building owners and tenants. With regard to the next Energy Saving Ordinance, many guidelines will be revised and adapted to the situation. Such information is published mostly free of charge for citizens. An official website provides information about the understanding of recommendations.

A system for authorising the issuing of energy certificates, which does not require any additional bureaucracy, was introduced in Germany in 2007.

Authorisation to issue certificates is based on the qualification of the persons concerned. For new buildings, the assessors’ requirements are defined by regional law. These experts are also entitled to issue certificates for existing buildings of similar use and size. Other experts intending to issue energy certificates for existing buildings must identify their personal qualifications and check whether they meet the conditions set out in the Energy Saving Ordinance and fully described in the 2010 EPBD German report. There is no official approval and certification. A person who issues an energy certificate and who is not entitled to do this breaches the regulations and can be punished by a fine. Due to the large number of certificates required, there is a need to make the circle of certificate assessors as wide as possible to keep the prices low.

As for the enforcement of the regulation in general, the federal states are also responsible for controlling the issuing of EPCs. This task is generally delegated to the local building control authorities.

A commissioned and authorized body (‘Deutsches Institut für Bautechnik’) holds a central EPC register without collecting the contents of the EPC. The register collects data from each assessor in relation to the number of EPCs issued per type and location of the building. Each certificate gets an individual registration number and can be part of the random quality check. Checks will be organised in accordance with the three options of the recast EPBD. The first step of plausibility checks will be mainly carried out automatically on behalf of the local authorities by the same organisation that handles the registration. Further and more detailed controls are the responsibility of local authorities, as they are also enabled to impose fines in the case of breaches of the regulations e.g., incorrect issuing of certificates, refusal to issue or to submit a certificate, or deliberately include incorrect information in energy certificates.

3.3.2 Certification, training & QA of heating & air-conditioning systems

In Germany, regular inspection of boilers has been mandatory for many years and, in fact, to a much greater extent and at shorter intervals than foreseen by the first EPBD. Energy aspects concern the flue-gas losses of the boilers, the proper insulation of pipes in unheated spaces and the boiler temperature control, which should take into consideration the outside temperature and the hour of the day. If a boiler does not comply with the prescribed requirements, it must be replaced. If compulsory insulation or controls are missing, penalties can be issued.

The inspections are carried out by a chimney sweeper chosen by the building owner. On behalf of the responsible authorities, the district chimney sweeper in charge of the region keeps track of the compulsory inspections using a register of all boilers. Thus, thousands of boilers have to be modernised every year, which results in a reduction of the average age of the boiler stock in Germany and normally also covers the replacement or technical upgrade of pumps, controls and hydraulic connections. Furthermore, boilers installed before 1978, which do not comply with the status of low temperature boilers, must generally, be taken out of operation. For most cases, the deadlines for this obligation have already expired.

Many energy saving features of heating systems have been the subject to compulsory requirements, in many cases since 1978. As a result, most of the easily detectable means of improvement (control equipment, pipe insulation, efficient pumps) are already common standard in German heating systems.

Furthermore, the vast majority of heating systems are subject of contracts for yearly maintenance, which are signed by the owners on a voluntary basis. Thus, a simple and affordable inspection scheme would normally not lead to sufficient results, whereas a more sophisticated system would be too expensive to be economically reasonable.

The German Energy Agency conducts a campaign in order to inform citizens about possible improvements to heating systems. There are also promotional programmes, as well as information campaigns by third parties.

Since the 1st of October 2007, regular inspections are mandatory for AC systems. In addition, the regular maintenance of energy-related components of AC and ventilation systems by a professional technician is mandatory. The intervals should be taken from the guidance manuals and must consider the needs of the individual installation. Every AC unit with a thermal output of more than 12 kW must also undergo an inspection by a specialist engineer every 10 years. In particular, the engineer must inspect the appliance, to check whether it meets the individual demands of the building and whether it requires modernisation. The inspector must provide recommendations for improving the system efficiency or replacing the system, according to the EPBD. The inspection report is subject to an independent control system run by the regional authorities in the same way and using similar means as the control system for energy certificates. For this purpose, the experts, as well as their reports, will be registered by the 'Deutsches Institut für Bautechnik (DIBt)'. This authority will also provide statistically representative samples of inspection reports issued in a certain year for the purpose of control by the regional authorities.

3.3.3 Training Routes

Education in Germany takes place in parallel at school/college and on the job in a company as apprenticeship (in Germany and also Austria this is also referred to as the 'dual system'), and is completed after an examination, whereby the Journeyman level (qualified worker) is reached. To advance from Journeyman to Master craftsman, an advanced training of approximately 1,800 hours (leading to an examination and a certificate) is needed. The craftsman can follow several directions and reach various intermediate levels: it is e.g., possible to follow a CVET programme to become expert in renewable energy sources, or in technical management, or to reach the intermediate levels of Foreman (head of a team), or Site Foreman (head of all the teams of a site). After some years, she/he can try to reach the Master craftsman level, receiving a certification as Certified Foreman. The career can finally reach the level of Master craftsman level + Certified Energy Performance Consultant, where the craftsman is authorised to issue energy performance certificates.

The career perspective described above will attract qualified skilled workers with the ambition to improve and achieve higher qualification levels. The building sector will benefit from this development in terms of availability of qualified workforce, either already trained in energy efficiency in buildings, or having the basic qualification to enter a specific vocational training.

3.4 France

3.4.1 Certification, training & QA requirements of energy performance

In France, issuing an EPC involves a QE visiting the property and assessing the thermal efficiency of the building, taking the construction envelope (walls, windows, insulation, thermal bridges, ventilation and air-tightness, etc.) and the type and quality of Heating, Ventilation and Air-Conditioning (HVAC), as well as DHW systems into consideration.

Two guidebooks have been published to help experts in preparing an EPC in order to make EPCs more reliable: the first is titled 'Recommendations Guide', and the second 'On-site Inspection Guide'. Using these two books as guides, experts are able to propose appropriate solutions for improving the energy performance of buildings. As the regulation has just been changed, a new guidebook is being prepared.

To deliver an EPC, experts have to be certified by an accredited body, but did not need any background skills, up until 2012. This body is accredited by the French committee of accreditation (COFRAC). It establishes the reference content that each certifying body has to respect.

The training of experts is assessed in two exams: a theoretical exam (multiple-choice questionnaire) and a practical exercise. A certification is valid for five years. Thus, every five years the expert has to be re-certified.

A directory of the 8,000 persons certified to issue EPCs has been set up to make this information available to the public. In this way, it becomes possible for someone who needs an EPC to find a certified expert and to also have the validity of their certification checked.

The minimum requirements for becoming and continuing to practice as an expert are:

- initial education: 2 years after the French High School Diploma in the field of construction;

- on-going training: 3 days' training every 5 years in the field of EPC.

A mandatory QA scheme has been set up by the government, and since the recast of the EPB a new QA process has been established as outlined in Figure 21.

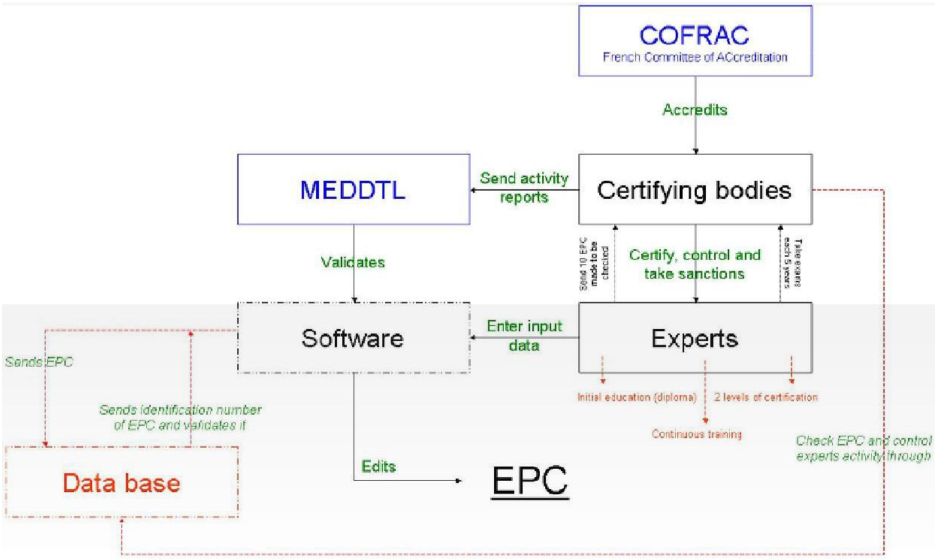


Figure 21 – French QA Scheme (CA EPBD, 2012)

3.4.2 Certification, training & QA requirements of heating/ air-conditioning systems

In order to perform the periodic maintenance of boilers with an output between 4 and 400 kW, professionals must be qualified, according to the law of the 5th of July 1996.

The decrees specify what the professional must do:

- check the boiler and, if necessary, clean and tune it;
- measure the concentration of carbon monoxide (CO);
- evaluate the energy and environmental performance of the boiler, through:
  - evaluation of the energy efficiency of the boiler, which is compared to the energy efficiency of the best boilers available on the market today;
  - evaluation of the polluting emissions of the boiler, which are compared to the emissions of the best boilers available on the market today (NO_X for gas and oil boilers, VOC and particulates for biomass boilers);
- provide recommendations: most efficient use, improvement of the boiler and of the heating system in place and, if necessary, advice on the replacement of the installation.

A certificate of maintenance should be issued within 15 days from the visit. The certificate includes the results of the measurements and evaluations listed above, along with recommendations on best use and the improvement of the heating system in place and, if necessary, advice on the replacement of the installation. The reports are not collected on a central database.

In order to perform a periodic control of boilers with an output between 400 kW and 20 MW, the professional must be qualified according to ISO standard 17020 'General for the operation of various types of bodies performing inspection'.

The professional must check whether the requirements applicable to boilers with an output between 400 kW and 20 MW are met; these include:

- compliance with minimum efficiency values;
- control devices required in connection with the boiler equipment;
- the boiler room manual.

An inspection report should be issued within 2 months from the inspection. The reports are not collected on a central database.

For Air-conditioning Systems inspections a report is issued within one month from the inspection and includes the results of the inspection and advice on best use, improvement of the AC system in place and, if necessary, advice on the replacement of the installation. Standard EN 15240 was used as a basis for the methodology. The inspection methodology is described in detail in the decrees. The inspection should include:

- inspection of documentation;
- assessment of system performance, at the time of on-site inspection;
- assessment of the size of the system in relation to the cooling requirements of the building, at the time of on-site inspection;
- provision of the necessary recommendations concerning proper use of the system in place, possible improvements to the installation as a whole, any benefit from its replacement, and other potential solutions.

Figure 22 outlines the process of certification for the inspection of air-conditioning systems.

To perform an inspection of AC systems, experts have to be certified by an accredited body, according to ISO standard 17024 'General requirements for bodies operating certification of persons'. This body is accredited by the French committee of accreditation (COFRAC). It establishes the reference content that each certification body has to respect.

There are two levels of certification of the AC systems:

- the 'simple systems' level, for the inspection of AC systems and reversible heat pumps with an output between 12 kW and 100 kW;
- the 'all systems' level: for the inspection of all such systems, large or small.

Experts have to pass a theoretical and a practical exam, in order to be certified and these exams evaluate experts' ability to perform inspections and their knowledge of AC systems. The certification is valid for 5 years. During this period, the certification body has to:

- perform a check on at least two reports per year;
- verify whether the expert performs enough inspections;

- accompany the certified inspector during at least one on-site inspection.

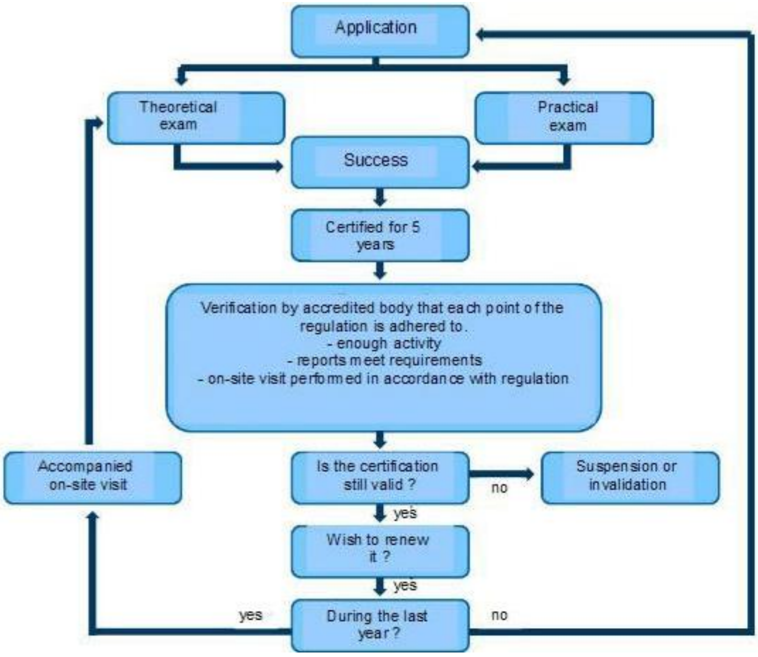


Figure 22 – Process of certification (CA EPBD, 2012)

The inspector must verify that each point of the regulation is adhered to. If not, the certification body can temporarily or permanently withdraw the expert's certification. If a member of the public, who requests a certified inspector, becomes aware of the fact that the inspection was not carried out according to the appropriate procedure, the certification body can be notified, and can, in turn, apply sanctions, if the complaint is justified.

3.4.3 Training Routes

Currently through the National Energy Efficiency Action Plan (NEEAP) and the National Renewable Energy Action Plan (NREAP) in France a number of mechanisms have been put in place at the initiative of professionals and/or public authorities to help develop training and education routes. Examples of these programs supported by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie – French Energy Agencie) include:

- Housing Improvement Club – implemented a training mechanism dedicated to the basics of building renovation crafts: it involves an online learning management system for construction professionals;
- PRAXIBAT programme – helps regions to allocate equipment to training centres to implement solar thermal, photovoltaic, wood-burning and heat-pump energy;
- BEEP (Built environment – professional space) network – since 2006 this network has sought to pool knowledge and know-how;
- PREBAT2 - Launched in 2010 to cover the period 2010-2015;

- National mechanism to coordinate and be responsible for public research concerning energy in buildings;
- The Construction-Energy Foundation aims to provide financial support, over at least five years for research operations.

3.5 Italy

3.5.1 Certification, training & QA requirements of energy performance

Regional authorities may implement autonomous transpositions of the EPBD, and regional energy performance certification schemes, as long as these do not contradict the general principles and requirements provided by national and EU regulations.

The Italian EPC administration system is based on regional systems with distinct registries and databases. Six regional EPC databases had been put in place at the end of 2012, while 11 were due to be implemented in the future.

The Decree 115/2008 establishes the requirements for assessors. The energy performance assessors' must be building and system designers registered in their professional association. Regional Governments and Autonomous Provinces may include other professionals among those able to deliver EPCs, after training and final examination.

In the Regions of Liguria, Lombardia, Puglia, Valle d'Aosta and the Autonomous Provinces of Bolzano and Trento, attendance of a training course is mandatory. Piedmont accepts as assessors engineers and architects registered in their professional associations, and require a mandatory course and exam for the other categories of experts. Bolzano has adopted a continuous training scheme. Lombardia and Emilia-Romagna are also implementing a similar training configuration scheme.

The Autonomous Province of Bolzano has adopted EPC delivery and quality assessment procedures which are significantly different from other regions: the EPC may be only delivered by the CasaClima Agency, which manages calculations, controls, and assessment and delivery procedures.

Regional information campaigns are launched autonomously. Emilia-Romagna and Valle d'Aosta have recently published guidelines explaining and promoting the use of the EPC

The management of a quality assessment system for the EPC is the responsibility of the Regions, which have to guarantee the compliance with the national quality standard. In the case that the EPC is not compliant with the allowed methodologies, or is falsified, the author of the EPC is sanctioned with a fine (the national legislation indicates an amount corresponding to 30% to 70% of the EPC cost, calculated according to the standard professional tariffs). In case of a falsified EPC, the authority enforcing the sanction communicates it to the professional association for further disciplinary measures.

Lombardia, Piemonte, Liguria and Valle d'Aosta have adopted different legislative solutions in terms of sanctions (actual amounts of fines according to the floor area of the building). In Lombardia, sanctions have been applied with success.

In the CTI Report 2012, there were 42,200 registered assessors in 8 Regions. Assessors should have no direct or indirect involvement in the design or construction process of the assessed building, nor with material and component suppliers, nor with any sort of benefit possibly obtained by the owner.

In case of a simple boiler substitution, the renewal of the certificate may be issued by a technician from the boiler supplier, or by the installer. The management of a quality assessment system for the EPC is the responsibility of the Regions, which have to guarantee the compliance with the national quality standard.

3.5.2 Certification, training & QA requirements of heating/ air-conditioning systems

Boiler inspections campaigns were launched in Italy in 1993, as required by the Law 10/1991. The new inspection decree on boiler and air-conditioning systems published in 2013 changed the periodicity of inspections and foresees that control checks on inspection reports may fully substitute on-site visits for gas systems with power lower than 100 kW.

According to the existing national inspection scheme, the building owner/user is responsible for the periodic maintenance of the heating system, which has to be performed by qualified maintenance staff. The measurement of combustion efficiency, among other maintenance operations and safety checks, is carried out according to the National UNI Standard 10389. Maintenance and energy efficiency assessment are compulsory, their frequency varying according to fuel used, boiler nominal power, age, and specific safety requirements.

An inspection report is filled out by the maintenance staff and is delivered to the Local Administration, which is in charge of the compliance control. The control consists of documental checks on the received reports, and of on-site verifications on a sample of the systems.

Regions and Autonomous Provinces have further detailed the national rules. Local Administrations are in charge of implementing a report inventory.

Regions and Autonomous Provinces can establish methods for gathering the data needed to set an inventory of their heating systems. Local authorities can assign the control procedures to external qualified bodies meeting the requirements of independence fixed by law. The control staff can be trained by public and private organisations, according to a programme defined by ENEA (the Italian national body for environment, energy and innovation); this staff must also pass an examination. On the other hand, maintenance operators are trained through entrepreneurial associations.

So far, no required inspection of AC systems is in place. But, according to the new decree, published in 2013, cooling system inspections shall follow the same procedures set for heating systems inspections. The periodicity for mandatory energy efficiency checks, and for control procedures has been established however as the operational phase has not started yet, no impact assessment can be provided.

3.5.3 Training Routes

Currently in Italy the Interregional operational plan provides information programmes accompanied by training programmes for designers, manufacturers, maintenance technicians, installers, administrators and technicians working for the public administrative bodies.[7]

[7] http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm

Regions have the responsibility for the management of the QA aspects of Energy Certification of Buildings, as follows:

- Training/examination organized by provinces, no universal regional coverage (8 out of 21 regions);
- Certificates can only be issued by Qualified Experts (QE). QEs may be architects, engineers, and technicians with a secondary school technical degree, duty qualified and recognised by their professional associations;
- Qualified Experts, who make up the control staff (for boiler inspection) are trained by public and private organisations, according to a programme defined by ENEA and have to pass an examination. The maintenance personnel are usually trained through entrepreneurial associations.

At the moment education official plans are not active. The available training materials are provided only by private subjects (front-runner industries) and specialized magazines/portals.

3.6 Greece

3.6.1 Certification, training & QA requirements of energy performance

The Energy Performance Certificates are issued by the Energy Inspectors, registered in the official catalogues of the Hellenic Energy Inspectorate. Although the EPCs are issued only by certified professionals, the designer of a new building need not be certified.

There are three categories of Energy Inspectors:

- The Energy Inspectors for Buildings;
- The Energy Inspectors for Heating Systems;
- The Energy Inspectors for Cooling Systems.

A person can be certified for one or more or all the above categories. There are two categories of Energy Inspectors in Greece (in each of the above-mentioned category): Those who have B-Level License and those who have A-Level License.

In order for a person to acquire a B-Level License, he/she must hold an accredited diploma in the field of Engineering and be a member of the Technical Chamber of Greece. He/She should also have successfully attended standardized seminars, whose syllabus is determined by the Technical Chamber of Greece and he/she should achieve a passing grade in the corresponding exams, which are implemented by the Technical Chamber of Greece. This person can perform energy inspections in buildings of any use and any heating and cooling power.

The A-Level License is provided to the person who holds an accredited bachelor's degree from a Technological Educational Institute in the field of Engineering. He/She should also have successfully attended standardized seminars, whose syllabus is determined by the Technical Chamber of Greece and he/she should achieve a passing grade in the corresponding exams, which are implemented by the Technical Chamber of Greece.

The main difference between the two levels is that the person who holds A-Level License is eligible to perform inspections only in residences and the total heating and cooling power should be less than 100 kW. After 4 years of proven experience in performing energy inspections, their License can be updated to B-Level.

3.6.1 Certification, training & QA requirements of heating/ air-conditioning systems

Technical Chamber of Greece (TGB) is the official advisor of the State. It aims at developing Science and Technology in sectors related to the disciplines of its members, in accordance with the principles of sustainability and environmental protection. It carries out research and studies as well as guidelines, regulations and contracts, for the improvement of the quality of life and the protection of the environment.

Additionally, it contributes to making programs on technical education and to developing local research and technology. It conducts examinations and awards professional licenses. Due to the fact that TCG is the official advisor of the State, it has issued guidelines, which comply with the Greek Regulation for Energy Efficiency of Buildings and which are approved by the Ministerial Decision Official Gazette Bulletin B' 1387/02-09-2010.

These guidelines assist the energy inspectors with their inspection. The Technical Chamber of Greece has also developed a software program (Hellenic software “TEE-KENAK” for Energy and Labelling of Buildings), which comply with the Regulation for Energy Efficiency of Buildings and given the characteristics of the building performs the proper calculations to define the Energy level of a building.

3.6.2 Training Routes

Any professional engineer in the field of Architectural Engineering, Civil Engineering or Rural and Surveying Engineering is eligible to design a new building up to 2 floors height, according to the Greek Law 3661/2008 and the Regulation for Energy Efficiency of Buildings and can issue the Study of Energy Efficiency of the Building, which is necessary for the issue of the construction license and which should achieve an Energy Performance level of at least “Category B”. However, practice shows that 2-floor buildings are designed by architects and civil engineers (both envelope and statics). For greater buildings roles are discrete; architects are responsible for the envelope and civil engineers for the statics. Electrical and mechanical engineers have equivalent professional rights and are both eligible for mechanical and electrical systems. None of the members of TCG has any professional limitation regarding the size of a building.

Furthermore, the courses they have attended in the Polytechnic Schools as undergraduates do not include guidelines or even references in order to design a nearly zero-energy building. Even the current practice of designing new buildings show that engineers use TEE-KENAK software as a means of education, combined with the KENAK and the Greek Construction Laws and they do not acquire a solid knowledge on designing energy efficient buildings.

Additionally, in Greece, EPCs are issued not only for a whole building but also for a part of it. For example, in a block of flats an EPC can be issued for only one apartment of the building or it can be issued at once for the whole building. Moreover, the use of the apartments in a block of flats can differ. That is, in the same building the use of one flat can be residential whereas another flat can be used as an office. In this situation, different EPCs should be issued for each apartment.

3.7 Portugal

3.7.1 Certification, training & QA requirements of energy performance

The national legislation requires that EPCs have to be issued by qualified technical experts (QE). To become a QE, candidates (engineers or architects) must undergo training and pass an exam.

The National System for Energy and Indoor Air Quality Certification of Buildings is based on a central registry and database supported by the Portuguese Energy Agency (ADENE). The quality of the EPC is guaranteed by training the qualified experts, performing periodic quality assurance assessments of their work and support them through a telephone and e-mail helpdesk. The QEs are also technically supported by guidance documents available online, namely FAQ's and manuals to issue the certificates using the central registry's online platform.

Recently, complementary training sessions were promoted by ADENE to improve the qualifications in specific areas such as lighting, Heating, Ventilation and Air-Conditioning (HVAC), renewable energy systems and building simulation programs. New training and formation courses were also promoted to qualify the actual and new qualified experts in the new Portuguese thermal legislation.

The Portuguese quality assurance system is based on the assessment of a random sample of the EPCs issued daily. Besides an automatic input data control a simple and a detailed quality check is performed. Until the end of 2012 about 14,000 EPCs have undergone a QA assessment.

In general when the QE does not comply with the regulations is required to correct the calculations and issue another EPC (supporting the costs). The QA process can also lead to a fine or in the worst case scenario, for severe wrong doings, to fines and the impossibility to act as a QE during two years (being is name being removed from the QE list). Additionally the professional association is informed.

3.7.2 Certification, training & QA requirements of heating/ air-conditioning systems

The QE is responsible for the validation and supervision of inspections to boilers and air-conditioning systems that are usually performed by boiler and AC technicians.

Due to the small amount of time that these systems operate, due to the cultural habits and climate characteristics of the country, the real energy consumption is very low, and this hardly makes the regular inspections a cost effective strategy.

After the transposition of the EPBD until the transposition of the EPBD-recast into the Portuguese law the inspections of boilers took place every 1, 2, 3 and 6 years, depending on the fuel used and on its power. The AC inspections took place every 1 or 3 years depending mainly on the power of the system. The inspections were paid by the end user or by the owner of the building.

After the transposition of the recast EPBD Portugal no longer impose regular inspections to boilers or AC systems and the campaigns options was preferred.

The QE must define a Maintenance Plan with the description of the maintenance and timing for the maintenance and cleaning procedures and the level of expertise of the technician that must perform the work. A registry of the preventive maintenance operations performed, indicating the technician that performed the tasks, the results and other relevant information must be kept.

3.7.3 Training Routes

The Law n.º 58/2013 establishes the requisites that a qualified expert and a building systems installation and maintenance technician must fulfil as well as competences and fines.

The Qualified Experts (Peritos Qualificados – PQ-I, PQ-II) are architects and engineers registered in their professional association with the following additional qualifications according to their intervention area:

- Residential buildings and small commercial or office buildings (with system less 25 kW) – architects, engineers (civil, mechanic or electrical) and acclimatization and energy engineering specialists with five years of experience in the building's sector approved in an exam developed by ADENE – PQ-I;
- Commercial or office buildings – mechanic or electrical engineers and acclimatization and energy engineering specialists with five years of experience in design, installation or maintenance of HVAC systems or building's energy audits approved in an exam developed by ADENE – PQ-II;

There are two types of building systems installation and maintenance technicians (técnico de instalação e manutenção de edifícios e sistemas, TIM): TIM-II and TIM-III. TIM-II, qualified to intervene in buildings with system with less than 100 kW, must have concluded the middle school, 9 years study with three year full-time vocational education and training school with specialised vocational training in the technical area of refrigeration and acclimatization. TIM-III, qualified to intervene in buildings with system with more than 100 kW, must have a High School Diploma (12 years) from a conventional or vocational school and a 6 months professional training in enterprises training in the technical area of refrigeration and acclimatization.

3.8 Cyprus

3.8.1 Certification, training & QA requirements of energy performance

Current legislation in Cyprus specifies that EPCs can be issued only by qualified technical experts registered in the catalogue of technical experts for the issue of Energy Performance Certificates. In order for someone to register in the above mentioned catalogue of technical experts, he/she must hold an accredited bachelor's degree in one of the following fields: Architectural Engineering, Civil Engineering, Mechanical Engineering, Electrical Engineering, and Chemical Engineering. In addition to that, he/she has to be registered with the Scientific and Technical Chamber of Cyprus and also have a number of years of experience in the building's sector. Finally, he/she has to attend the training seminars organized by the Cyprus Energy Service (the regulatory authority responsible for the application of the EPBD directive) and achieve a passing grade in the corresponding exams.

Currently, technical experts for the issue of EPCs are divided in two categories based on level of qualifications:

- Technical Experts for the issue of EPCs for buildings of area less than 1000 m^2, to be used for residential purposes: minimum requirement of at least one year of experience in the building's sector; mandatory attendance of a four day training seminar organized by the Cyprus Energy Service and achieve a passing grade in the corresponding exam.

- Technical Experts for the issue of EPCs for buildings of area larger than 1000 m^2, to be used for non-residential purposes: minimum requirement of at least three years of experience in the building's sector; mandatory attendance of a two-day training seminar organized by the Cyprus Energy Service and achieve a passing grade in the corresponding exam.

3.8.2 Certification, training & QA requirements of heating/ air-conditioning systems

With the 2010 recast of the EPBD a new legislation came into effect regarding the inspection of boiler based heating systems as well as HVAC systems. The regulations for the inspection of HVAC systems requiring the inspection of HVAC systems at specified time intervals (depending the type system) by qualified inspectors (qualification requirements: Mechanical Engineers, members of the Scientific and Technical Chamber of Cyprus, registered in the "HVAC Systems Inspectors Catalogue" of the Cyprus Energy Service). Regulations for the inspectors of boiler based heating systems are expected to be issued shortly.

3.8.3 Training Routes

In Cyprus the technical experts that issue Energy Performance Certificates are qualified technical experts registered in the catalogue of technical experts for the issue of Energy Performance Certificates. They are accredited bachelors in Architectural Engineering, Civil Engineering, Mechanical Engineering, Electrical Engineering, or Chemical Engineering and must have at least one year of experience in the building's sector to issue of EPCs for buildings of area less than 1000 m^2, or at least three years of experience in the building's sector to issue of EPCs for buildings of area larger than 1000 m^2.

Additionally they have to attend the training seminars organized by the Cyprus Energy Service and be approved in the corresponding exams to be allowed to register with the Scientific and Technical Chamber of Cyprus.

The Chamber of Professional Engineers and the Chamber of Industry and Trade also organize training programs that, amongst others, also deal with buildings.

4 Benchmarking training needs in Southern Europe

4.1 Current situation in the target countries

4.1.1 Italy

At present, the adoption of the Energy Performance of Buildings Directive in Italy is in progress but not many regions have already adopted or are currently in the process to require the adoption of this directive. In general the northern regions of the country are more advanced in the nZEB concept and training compared with the southern regions. Overall, the ambition of the energy efficient policies is deemed to be low.

A major issue within Italy is the 'refurbishment market', where training opportunities and needs exist. A large percentage of buildings in Italy require major maintenance works. More than 4.5 million of residential buildings (42% of the total number of buildings in Italy) need refurbishment or maintenance works (estimation Nomisma, data from Ministero del Tesoro). Out of this amount of buildings, more than 50% of the buildings currently need strong emergency maintenance since they are in an alarming state. Utilize innovative approaches and techniques for green design and construction, design according to bioclimatic basics, use natural, renewable, local and recycled materials, use of energy renewable systems, optimize energy performance, and many other strategies to be examined, could drive innovation into the building sector.

The National Energy Efficiency Action Plan and the National Energy Strategy of Italy define a roadmap to tackle the renovation of the existing building stock. It is hoped the performance of the refurbished buildings will get closer to the nZEB definition. Italy has a number of financial incentive programmes to promote retrofitting of the old and less efficient residential buildings.

In addition Italy seems to lag behind in a number of areas of compliance. Energy performance certification is the responsibility of each region in Italy, which has to guarantee compliance with the national quality standard. Currently there is little compliance checks underway to verify the accuracy of the certificates. In addition, there is no deadline for compliance or a fine for non-compliance to the display of EPC for public buildings with a floor area larger than 1,000 m^2. It is not clear if the requirement of inspections of AC systems is currently in place in Italy.

UK certification processes and training programmes could be used as a starting point for the training requirements of AC inspections in Italy.

4.1.2 Greece

The Nearly Zero-Energy Building definition has already been introduced to the national legislation, by amendment, in June 2010 and it coincides with the precise EPBD definition. This definition is also included in the recently elaborated recast of the law for the energy efficiency of buildings. The law specifies that, after 1st January 2015, every new building of the public sector should be nZEB. This obligation is also applied to all new buildings constructed after 1st January 2020. However, the national application of the nZEB definition has not yet been made.

According to the latest country report for Greece made by Energy Efficiency Watch (2013), both, the NEEAP screening and the expert survey indicate that Greece has neither an ambitious nor an innovative energy efficiency policy. Many aspects of the policy package can still be strengthened. According to the NEEAP, the interim saving target for 2010 (2.8%) has been clearly exceeded (savings of 5.1% to 10.9% reached). However, the main reason for these energy savings is the economic recession which has hit Greece very hard during the reporting period. It is not possible to clearly separate the impact of the economic recession and the savings attributable to political measures in the second NEEAP. With regard to ESD target achievement, 45% of the experts surveyed state that the ESD target will not be reached.

Regarding the buildings energy performance and the stakeholders training, which are the key issues addressed by the SouthZEB project, Greece has set minimum energy performance standards for buildings. These are complemented by economic and financial support and energy performance certificates. Innovative systems in buildings are planned to be demonstrated on the basis of voluntary agreements. The NEEAP does not mention audits or buildings specific advice. Furthermore, buildings specific information campaigns as well as education and training for professionals of the buildings sector are not mentioned.

In Greece, legislation requires a shorter professional experience period for permanent auditors of Energy Performance Certificates, as a result training needs exist and an extensive training program is currently underway. Training needs exist as the full implementation of the energy auditing of heating systems and air-conditioning systems started in January 2014.

Since Greek nZEB national criteria do not exist yet, curriculum should be proportionally adjusted, so as trainees could implement Greek relevant directives once published. Curriculum should address how nZEB implementation could overcome obstacles posed by Greek particularities (apartment blocks, traditional settlements, islands, listed buildings). Since members of TCG do not face any limitation on the size of buildings, educational material should not be limited either.

4.1.3 Portugal

The biggest issue in Portugal is the lack of detailed and comprehensive information, regarding the progress of energy savings, including the building. Based on the report produced by Energy Efficiency Watch (2013) for Portugal, only aggregated results have been presented, that makes it difficult to soundly assess the NEEAP.

On the contrary to the NEEAP assessment, however, interviewed domestic experts state that Portugal is among the countries where energy efficiency policies have progressed rather well since the first NEEAP. They see a relatively high overall ambition of energy efficiency policies, as 62% consider it at least ambitious in some sectors. About one third of interviewed experts think that the target will certainly or probably be achieved and report the successful implementation of the EPBD and an upcoming new legislative framework for ESCOs. What is of major concern, also for the here proposed initiative is the fact that, according to the report, there exist no organised education and training schemes on energy efficiency in the Buildings sector.

Portugal has identified a number of strategies to push the market towards the recast EPBD goals, including enhanced control mechanisms to promote the implementation of Portuguese Certification System for building (SCE), training of workforce, promoting nZEB in a cost effective way, strengthening the role of energy labels and proper communication to the public and also the development of real nZEB case studies.

In Portugal there are more than 1600 Certified Experts in the implementation of the Portuguese thermal regulation, but there are not certified nZEB or passive house planers and there aren't any passive house certifiers. Thus there is a lack of expertise in implementing the nZEB requirements in the near future. It is the essential to implement nZEB training, taking into account the challenges related to the Portuguese climate conditions, construction solutions and building traditions.

Additionally, there is a complete lack of information tools, demonstration actions and financial/ economic incentives. The SouthZEB project will address the training issues, focusing on the specific case of Portugal and will also develop a portal that aims (among other goals) in bringing together stakeholders in the targeted countries and facilitate information organisation and sharing.

4.1.4 Cyprus

Based on the official report produced by Energy Efficiency Watch (2013) for Cyprus, the situation is slightly better than in Greece, but there is still significant room for improvement. Cyprus has the target to achieve 10% energy savings by 2016 compared to the ESD reference period. The intermediate target of 3.3% for 2010 has been exceeded (3.57%) and it is expected that also the target for 2016 will be reached on the basis of the measures implemented from 2004-2010. Additional measures that allow exceeding the target will be implemented according to the NEEAP. However, the policy ambition of Cypriot energy efficiency policy can only be assessed as low. None of the policy packages reaches more than a medium result. The policy packages for transport, industry and appliances display particularly high potential for improvement according to the NEEAP analysis.

Regarding the professionals training, the Chamber of professional engineers (a SouthZEB project Associated partner) and the Chamber of Industry and Trade organize training programs that, amongst others, also deal with buildings. Nevertheless, the nZEB concept has not been yet dealt with appropriately. In fact, there is no mention of policies and even the definition of the nZEB has not been made officially. Cyprus has a very particular weather though with respect to central Europe where most nZEB training advancements have been made, and this gap is exactly what SouthZEB comes to fill-in.

Cyprus has produced a national action plan for the progression towards nZEB which identifies a number of actions to be taken until 2015 to increase the number of nZEB in Cyprus. Training opportunities exist to enable Cyprus achieve the following:

- Support research programs for the development, improvement or advancement of construction techniques;
- Compare the existing national methodology for the certification of the Energy Performance of Buildings with the certification of nZEB. Further parameters are to be accounted for the latter, thus the existing methodology should be further developed in order to include the nZEB category. Once this is done, the software now in use for the certification of buildings will have to be improved or replaced in order to reflect the new methodology for the certification of nZEBs;
- Inform the Qualified Experts (QE) and the engineers of the building industry;
- Raise the awareness of the public;
- Design and announcement of a linear tightening of the minimum EP requirements leading to the 2020 nZEB.

4.2 Analysis of the current situation in the target countries

It has been identified that there is a substantial need for professionals such as architects and engineers specifically trained and educated in nZEB design approach who are able to work in integrated multi-disciplinary teams, addressing the integration of sustainable energy in buildings and built environment, not only to produce buildings meeting current EPBD standards but especially for buildings within the nearly zero-energy concept.

The SouthZEB project is targeting southern EU countries and specifically those that have not yet developed certification and training schemes for nZEB professionals. Identified southern European countries include Greece, Portugal, Cyprus and Italy. Especially for the case of Italy, the situation is slightly more advanced than in the rest of the target countries, but only for the Northern part of the country especially the Trento Province.

A number of target groups have been identified within these countries comprising building professionals, authorities and decision makers and property owners with the aim of:

- Increasing the number of the building sector intermediate and senior professionals able to design and build nZEB
- Promoting the development of an ambitious and innovative energy efficiency policy; and
- Establishing a common platform for all nZEB stakeholders in southern EU countries to act as a one-stop point for related training material, certification schemes and authorities and simulation software.

Within the target countries ambitious and innovative energy efficiency policies are mainly absent and as a result the number of professionals able to design and build nZEBs is low; mainly due to the absence of requirements. The following paragraphs outline some specific issues where training needs may be required in the southern EU countries.

The implementation of the RES Directive in the southern EU countries does not seem to require as much attention, as a number of countries have quite high RES 2020 targets compared to front runner countries in this report. This may be due to the fact that the southern EU countries can easily take advantage of technologies such as solar photovoltaic and solar thermal; however training needs can still be identified from countries successfully implementing the RES Directive as not all southern countries have the same high targets.

To summarize, there are a number of specific issues within each country where training needs are identified, but overall, as a result of a lack of ambitious energy performance policies in a number of Southern EU countries, an approach to tightening the minimum energy performance requirements is required. To enable this to be achieved training of the workforce (engineers, architects, municipality employees and decision makers) is required to improve energy performance of buildings, through improved building envelopes, reduced energy demands and through the inclusion renewable energy technologies and systems.

5 Building traditions & architectural regulations in the target countries

5.1 Italy

5.1.1 Location and Climatic Data

Italy has a variety of climate systems. The inland northern areas of Italy (for example Turin, Milan, and Bologna) have a relatively cool, mid-latitude version of the Humid subtropical climate, while the coastal areas of Liguria and the peninsula south of Florence generally fit the Mediterranean climate profile.

The east coast of the Italian peninsula is not as wet as the west coast, but is usually colder in the winter. The east coast north of Pescara is occasionally affected by the cold bora winds in winter and spring, but the wind is less strong here than around Trieste (Figure 23). During these frosty spells from E–NE cities like Rimini, Ancona, Pescara and the entire eastern hillside of the Apennines can be affected by true blizzards. The town of Fabriano, located just around 300 m in elevation, can often see 0.5–0.6 m of fresh snow fall in 24 hours during these episodes.

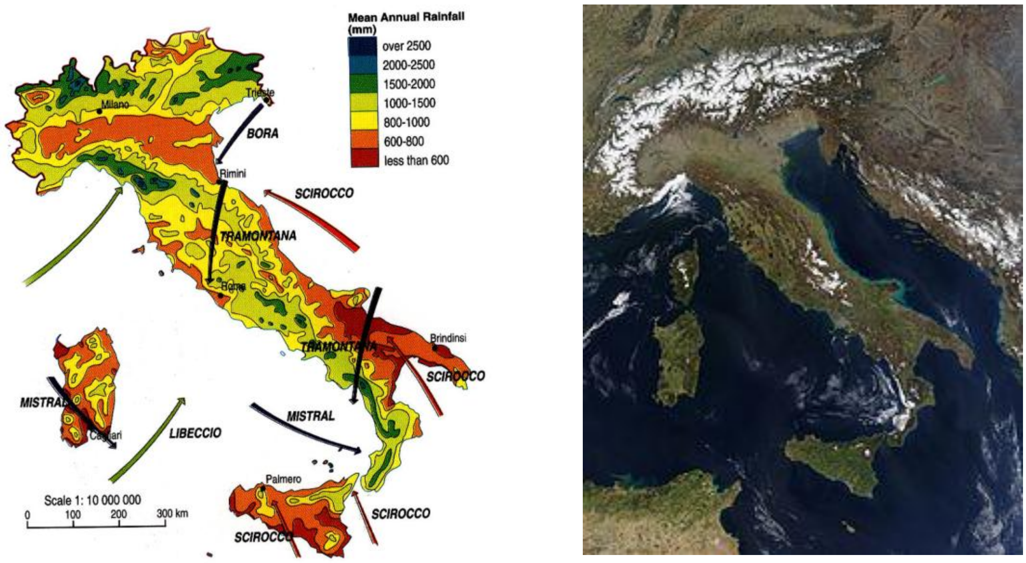


Figure 23 – Mean annual rainfall in Italy (left) and Satellite view of Italy on March 2003 (right) (source: http://www.klbict.co.uk/interactive/geography/italy/cmap1.jpg; http://it.wikipedia.org/wiki/Clima_italiano)

Between the north and south there can be a considerable difference in temperature, above all during the winter: in some winter days it can be −2 °C and snowing in Milan, while it is 8 °C in Rome and 20 °C in Palermo (Figure 23 and Figure 24). Temperature differences are less extreme in the summer.

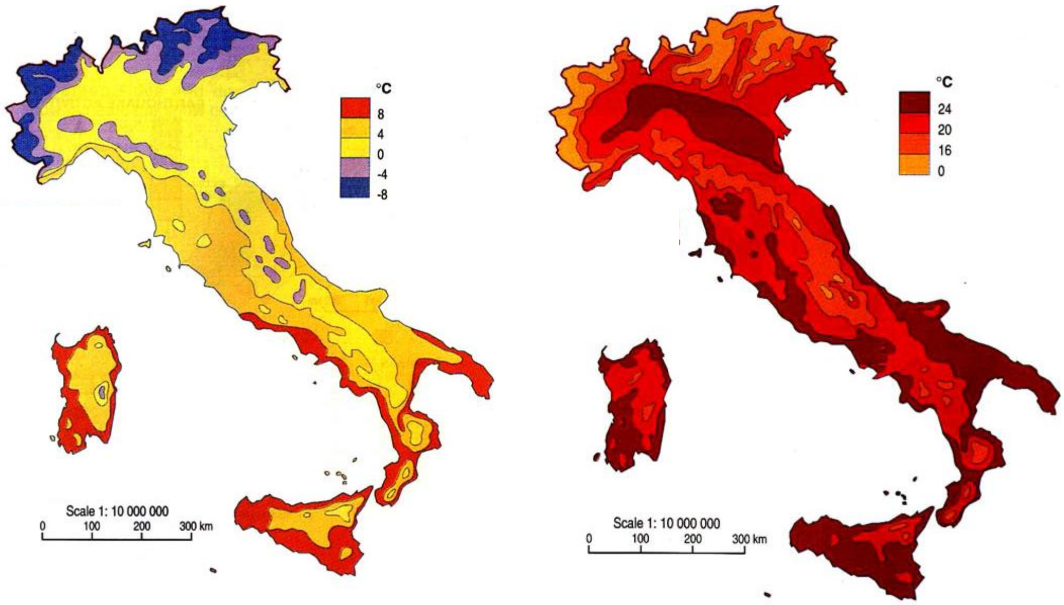


Figure 24 – Average monthly temperature in January (left) and in July (right)
(source:http://www.klbict.co.uk/interactive/geography/italy/cmap1.jpg)

According to Köppen climate classification Italy is divided in the following different climates (Figure 25 and Figure 26):

- Mediterranean climate (Csa) - It is found in all the coastal areas, excluding the north-eastern area, which fits a humid subtropical climate. The winter average varies from 6 °C, in the northern areas, to 11–14 °C in the southern islands. During the summer, averages near 23 °C in the north (Liguria), and sometimes reaching 26–28 °C in the south. Precipitations mostly during the winter. Snowfalls are rare and usually very light in the north, and almost never happen in the south. Summers are dry and hot. Main cities: Cagliari, Palermo, Naples, Rome, Genoa, Pescara.
- Mediterranean mild climate (Csb) - This climate is found inland and at medium and high elevations in southern Italy, around 1,000 meters. It is similar to the usual Mediterranean climate: the summers are dry and the winters wet, but the temperatures are lower in both seasons, around 3 or 5 °C in the winter, and between 17 and 21 °C in the summer. Snowfalls are more common. Main cities and towns: Potenza, Prizzi.
- Humid subtropical climate (Cfa) - A relatively "continental" and "four-season" version of the humid subtropical Cfa climate can be found in the Po and Adige's valleys in the north until low inland central and southern Italy. It's marked by hot and wet summers, while winters are moderately cold. The precipitation is higher and there is no dry season. Average temperatures are around 1 °C to 3 °C in the winter and more than 22 °C in the summer. Main cities: Milan, Venice, Verona, Turin, Bologna, Florence.
- Oceanic climate (Cfb) - It can be found in altitude in the Apennines and in the alpine foothills. Summers temperatures range between 17 and 21 °C. Main cities and towns: Aosta, Campobasso, L'Aquila, Cuneo, Sondrio, Amatrice – mild; Belluno, Breno, Feltre – severe.
- Humid continental climate (Dfb) - This climate is found in the Alps, around 1,200 m in the western side, or around 1,000 m in the eastern side. It is marked by cold winter (between −7 and −3 °C) and mild summers, with temperatures averaging from 13 to 18 °C. Snow is usual from early November until March or early April. Main towns: Brusson, Gressoney-Saint-Jean, Aprica, Vermiglio, Mazzin, Santo Stefano di Cadore, Claut, Resia.

- Cold continental climate (Dfc) - This climate occurs in the alpine valley around 1,600 m to 1,800 m. The winters are very cold, averages between −12 and −5 °C, and summers are cool, usually around 12 °C. Main towns and villages in this area: Livigno, Chamois, Misurina, Predoi, Rhêmes-Notre-Dame.
- Tundra climate (ET) - The tundra climate occurs above the tree line in the Alps. All the months with average below 10 °C. Villages with this climate: Cervinia, Sestriere, Trepalle.

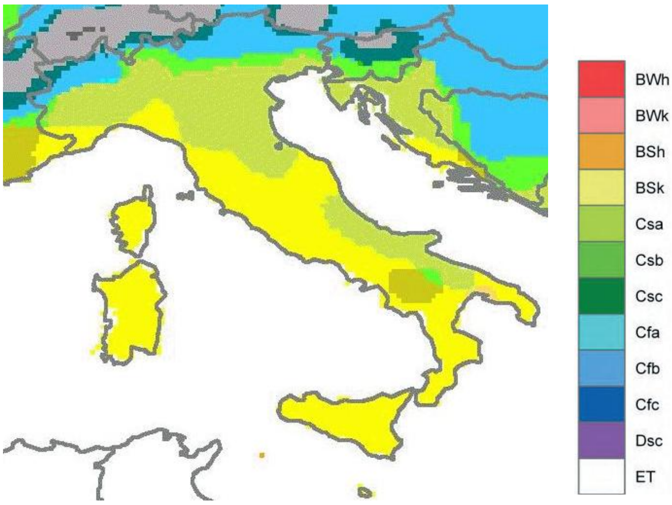


Figure 25 – Italy climate according to the Köppen-Geiger classification

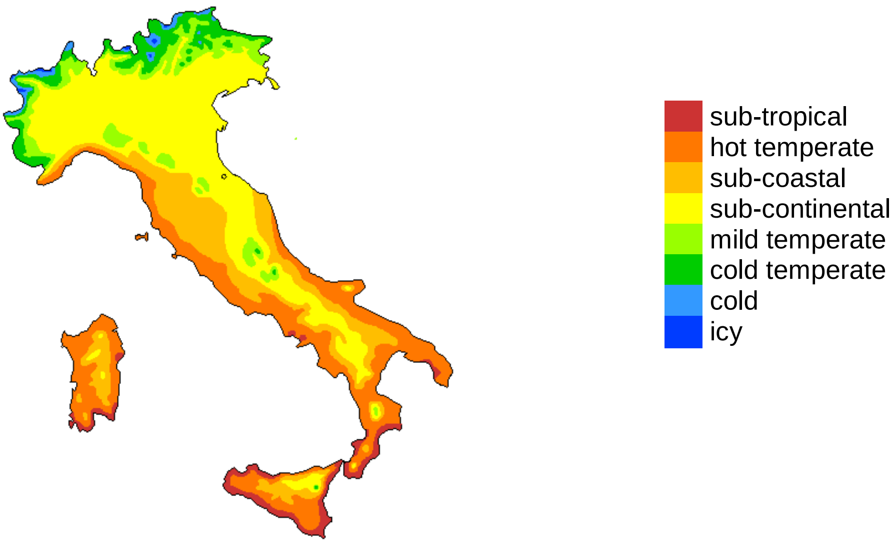


Figure 26 – Italy map of climate classification

The village of Musi having an annual average of 3313 mm of rain is the wettest place in Italy. The maximum rainfall in 24 hours was recorded in Genoa Bolzaneto on 10 September 1970 with a value of 948.4 mm; however there are many daily rainfall records around Italy exceeding 500 mm.

The maximum snow depth was recorded in March 1951 at the meteorological station of Lago D'Avino with a value of 1125 cm. In the snowiest years the snowfall can exceed 20 meters in some places in high altitudes.

The lowest temperature record for an inhabited place is −34 °C in 1967 in Livigno, while the highest temperature of 48.5 °C was recorded in the village of Catenanuova in Sicily during the summer of 1999.

According to the Italian Thermal Regulation (DPR 412/93) Italy has 6 climate zones based on the degree-days (based on 18 ºC), for winter only (see Table 8 and Figure 27).

Table 8 – Criteria for the definition of the climate zone in Italy

Criteria	Degree-days ≤ 600	600 < Degree-days ≤ 900	900 < Degree-days ≤ 1400	1400 < Degree-days ≤ 2100	2100 < Degree-days ≤ 3000	Degree-days > 3000
Climate Zone	A	B	C	D	E	F

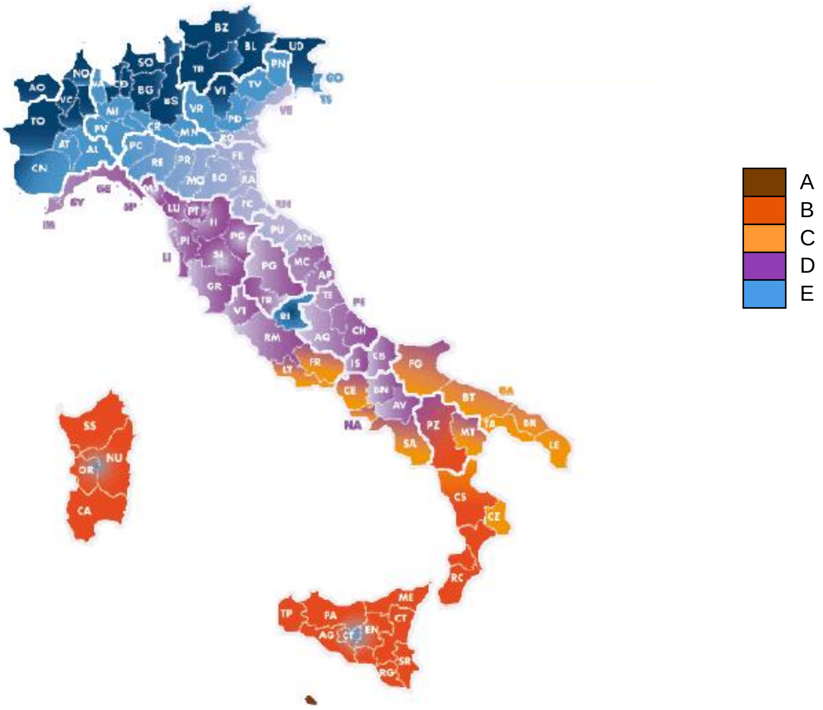


Figure 27 – Italy map of climate classification according to Italian regulation DPR 412/93

The climatic and geographical characteristics of the local had a significant influence in the traditional buildings (see Figure 28) and there are significant differences between the houses from the north and south of Italy. Other aspect that is observed in the traditional architecture was the use of local materials.

From the 1960’s the buildings started to be built without consideration of the local environment and the architectural and constructive solutions adopted throughout the country were similar, except for the regulation exigencies. Until the entrance into force of the first Italian thermal regulation in 1991 (LEGGE 9 gennaio 1991, n.º 10) there were no thermal exigencies and, in general, thermal insulation was not used.

The Italian Thermal Regulation defines different levels of exigencies for buildings according to the severity of the climate where the building is located and thus nowadays there are no significant differences in the architectural design of the buildings throughout the country but the construction solutions and the insulation levels are different, based on the climatic zone defined on the thermal regulation. In addition, the Italian thermal regulation is only focused on winter conditions and service hot water production and does not take into account summer conditions which might be severe in most of the Italian country.

Figure 28 – Ancient alpine palafits, traditional alpine house, ancient roman house and traditional houses in southern Italy (Trulli in Valle d'Itria, Puglia and Dammusi in Pantelleria, Sicily)

5.1.2 Buildings' Characteristics

With regard to the type of construction, the 2001 census reports that the Italian heritage is made up of brick masonry buildings. In 2001, 2,768,205 buildings had reinforced concrete structure (24.66%), 6,903,982 buildings structures consisted of brick masonry walls with concrete or beam and pot slabs (61.50%) and 1,554,408 are other types of buildings (Figure 29).

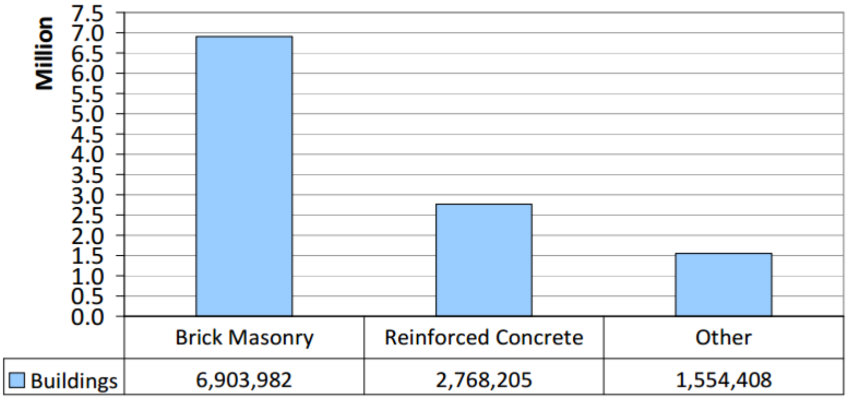


Figure 29 – Number of buildings by construction type (ISTAT, 2001)

The Italian residential stock consists of 11,226,595 buildings, of which 27,291,993 are apartments with an average floor area of 96 m^2. The great majority of buildings were built before 1991 (Figure 30) when the first Italian thermal regulation started to be implemented thus there were no thermal exigencies and, in general, thermal insulation was not used.

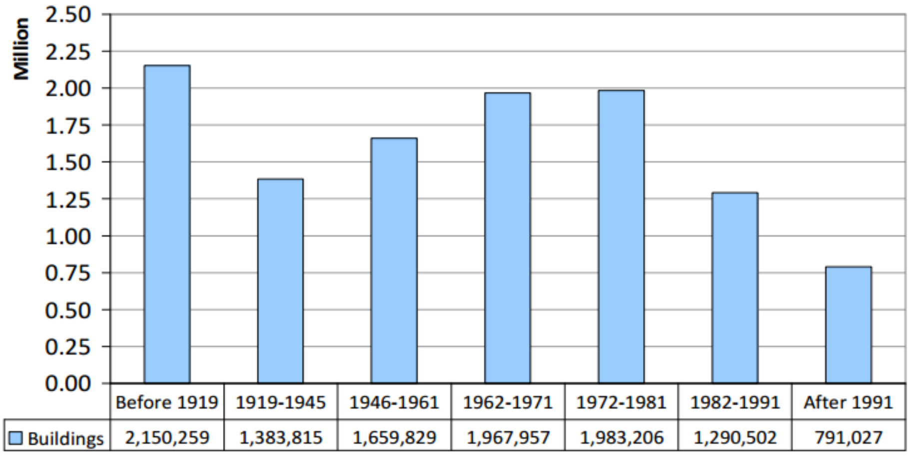


Figure 30 – Number of residential buildings per construction period (ISTAT, 2001)

Most of the Italian buildings have less than four residences (Figure 31), and it is possible to observe a higher incidence of buildings with nine or more residences in the post Second World War period. In the buildings built after 1991 the number of residence within the buildings is more uniform.

Most of the buildings have an individual system per apartment (Figure 32), using liquid or gas fuel. Figure 33 shows the energy consumption in residential buildings, from 1990 to 2010. Natural gas and electricity present the higher share on the energy consumption.

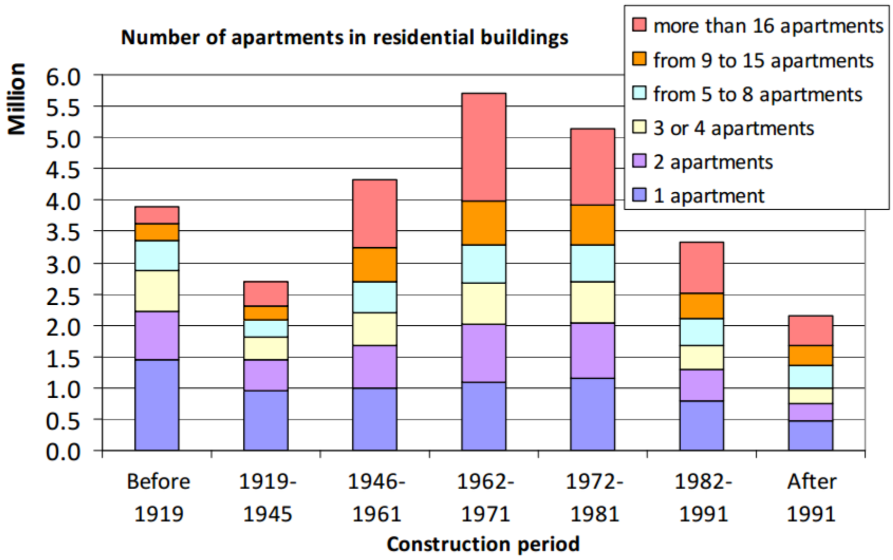


Figure 31 – Number of residential buildings by year of construction and number of homes within the same building

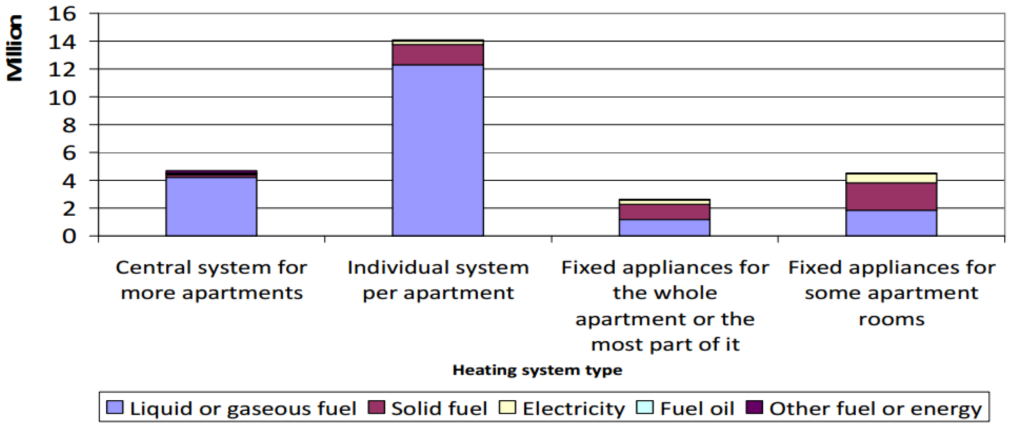


Figure 32 – Homes occupied by residents with heating system by type of fuel or energy source

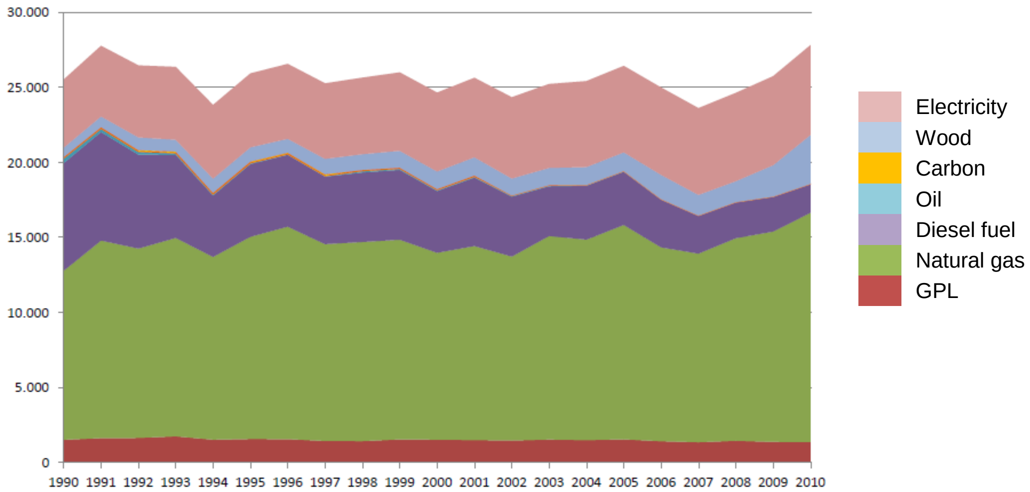


Figure 33 – Energy consumption in residential buildings, 1990-2010 (ktep) (ENEA, 2012)

Figure 34, presents the final energy consumption in Italian residential buildings, shows that most of the energy is for heating, and that gas is the most usual fuel used. Figure 35 shows the electric energy consumption for each worker in commercial buildings where it is possible to observe the high amount of electricity used in commercial buildings and also the significant increase in energy use, especially after 1998.

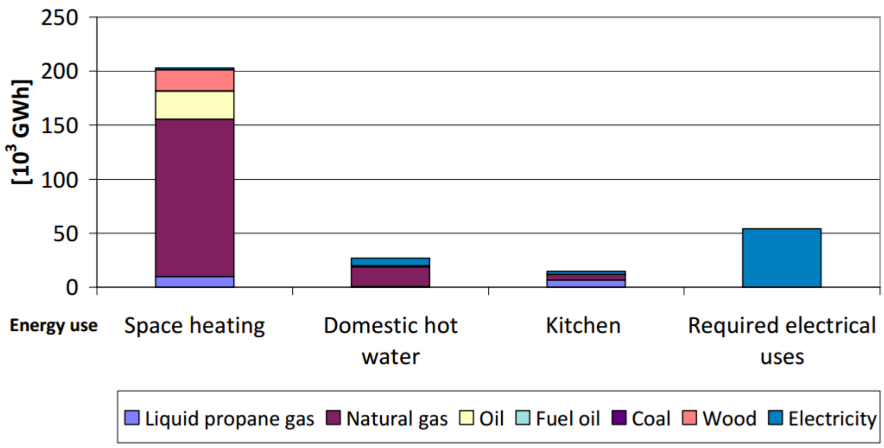


Figure 34 – Final energy consumption in residential buildings by type of use

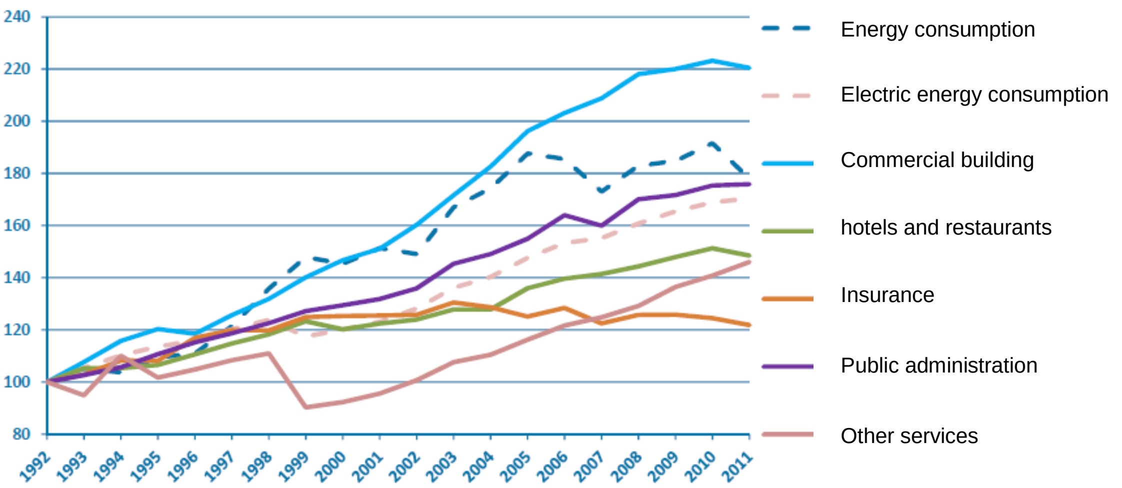


Figure 35 – Electric energy consumption for each worker in commercial buildings (1992= 100), 1992 - 2011 (ENEA, 2012)

Table 9 lists the renewable energy diffusion on the Italian regions. In general the hydroelectric energy is the most usual, Vale de Aosta and Trentino-Alto Adige have the highest incidence and Puglia and Sicily the lower.

Table 9 – Other statistics – Renewable energy diffusion: values by 1mil inhabitants and synthetic index (ENEA with data from Legambiente and GSE)

Region	Hydroelectric	PV	Wind	Geothermal	Bioenergy	Renewable
Piemonte	587.78	314.13	7.32	1.74	40.10	0.16
Vale de Aosta	7032.01	140.80	19.56	1.50	179.91	0.45
Lombardia	512.02	186.33	0.14	0.98	66.91	0.15
Trentino-Alto Adige	3060.77	354.83	4.90	0.48	67.89	0.28
Veneto	227.99	305.01	1.50	0.41	42.96	0.15
Friuli-Venezia Giulia	404.30	331.46	1.31	0.05	62.45	0.19
Liguria	53.67	47.28	30.67	0.05	12.52	0.04
Emilia Romagna	70.13	369.39	3.66	0.71	109.08	0.24
Toscana	92.88	175.48	28.43	239.92	36.34	0.30
Umbria	576.59	469.40	2.60	0.34	40.06	0.21
Marche	154.03	633.59	0.09	1.62	15.53	0.22
Lazio	72.16	192.90	9.18	0.01	28.83	0.10
Abruzzo	763.42	464.00	179.05	0.05	7.85	0.21
Molise	274.46	504.24	1209.54	0.00	150.00	0.53
Campania	59.97	94.80	209.37	0.03	36.45	0.11
Puglia	0.49	603.58	496.94	0.00	56.43	0.34
Basilicata	229.09	569.25	624.79	0.00	56.75	0.35
Calabria	376.87	194.05	578.07	0.00	66.69	0.24
Sicily	30.20	223.40	373.41	0.00	10.78	0.15
Sardinia	285.30	338.34	746.78	0.00	47.31	0.29
Italy	302.99	275.19	145.62	15.28	47.79	0.19

5.1.3 Construction Details

The description of each building construction element, the period of its greatest diffusion and its thermo-physical parameter values (i.e. U-value for opaque and transparent envelop elements, $g_{gl,n}$-value for transparent envelope elements) are shown in Table 10 to Table 17. As Table 10 to Table 17 show the Italian constructions are typically massive structures and the traditional materials which constitute the building components are usually bricks (hollow and solid bricks) and concrete.

The construction period is closely related to the thermal insulation level of the building envelope components. According to the evolution of the national regulations on energy efficiency of buildings it is possible to verify that:

- Insulation materials are not used up to 1976, as no regulations on energy efficiency are in force before that date. In this case, the thermal transmittance of the building envelope is only influenced by the component materials and their thickness;
- A low insulation level of the building envelope is considered between 1976 and 1991 (for example the U-value of a wall was approximately 0.8 W/m^{2}K);
- A medium thermal insulation level of the building envelope is considered between 1991 and 2005 (U_{wall} ≅ 0.8 W/m^{2}K), following the enactment of Law n.º 10/1991 and its implementing decrees;
- The thermal insulation level of the building envelope is determined after 2005 by national regulations (i.e. Legislative Decree n.º 192/2005 and n.º 311/2006) and regional regulations which set maximum values of thermal transmittance (U_{wall} ≅ 0.34 W/m^{2}K).

Table 10 – Conventional construction solutions for roofs (IEE, 2009)

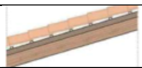
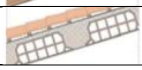
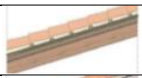
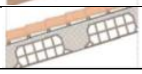
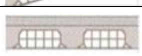
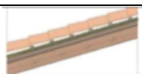
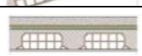
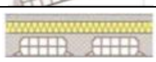
Construction detail	Description	Major diffusion		U-value (W/m^{2}K)
	Pitched roof with wood structure and planking	-	1950	1.80
	Pitched roof with brick-concrete slab	1930	1975	2.20
	Flat roof with brick-concrete slab	1930	1975	1.85
	Pitched roof with wood structure and planking, low insulation	1976	1990	0.95
	Pitched roof with brick-concrete slab, low insulation	1976	1990	1.14
	Flat roof with brick-concrete slab, low insulation	1976	1990	1.01
	Pitched roof with wood structure and planking, medium insulation	1991	2005	0.64
	Pitched roof with brick-concrete slab, medium insulation	1991	2005	0.74
	Flat roof with brick-concrete slab, medium insulation	1991	2005	0.70
	Pitched roof with wood structure and planking, high insulation	2006	-	0.30
	Pitched roof with brick-concrete slab, high insulation	2006	-	0.30
	Flat roof with brick-concrete slab, high insulation	2006	-	0.30

Table 11 – Conventional construction solutions for ceilings (IEE, 2009)

Construction detail	Description	Major diffusion		U-value (W/m²K)
	Vault ceiling with solid bricks	-	1900	2.07
	Ceiling with wood beams and holow bricks	-	1900	2.86
	Ceiling with wood beams and hollow bricks, bamboo reeds finishing	-	1900	1.96
	Vault ceiling with bricks and steel beams	-	1930	2.60
	Vault ceiling with hollow bricks and steel beams	1910	1940	1.88
	Flat ceiling with hollow bricks and steel beams	1920	1945	2.48
	Ceiling with reinforced concrete	1901	1930	2.66
	Ceiling with reinforced concrete slab	1930	1975	1.65
	Ceiling with reinforced brick-concrete slab, low insulation	1976	1990	0.97
	Ceiling with reinforced brick-concrete slab, medium insulation	1991	2005	0.70
	Ceiling with reinforced brick-concrete slab, high insulation	2006	-	0.30

Table 12 – Conventional construction solutions for walls (IEE, 2009)

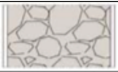
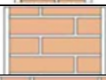
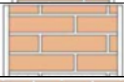
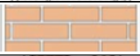
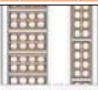
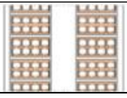
Construction detail	Description	Major diffusion		U-value (W/m²K)
	Stone masonry with plater on both sides (45 cm)	-	1920	2.4
	Stone masonry with plater on both sides (60 cm)	-	1920	2.00
	Masonry with list of stones and bricks (40 cm)	-	1930	1.61
	Masonry with list of stones and bricks (60 cm)	-	1930	1.19
	Solid brick masonry (25 cm)	1900	1950	2.01
	Solid brick masonry (38 cm)	1900	1950	1.48
	Solid brick masonry (50 cm)	1900	1950	1.14
	Solid brick masonry (62 cm)	1900	1950	1.02
	Hollow wall brick mansory (30 cm)	1930	1975	1.15
	Hollow wall brick mansory (40 cm)	1930	1975	1.10

Table 13 – Conventional construction solutions for opaque envelope – walls (Conc.) (IEE, 2009)

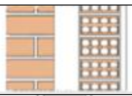
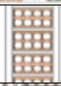
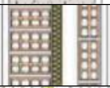
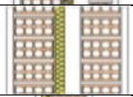
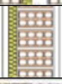
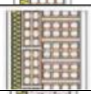
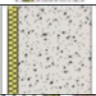
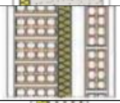
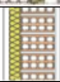
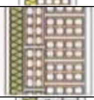
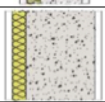
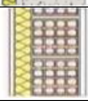
Construction detail	Description	Major diffusion		U-value (W/m^{2}K)
	Hollow wall brick mansory with solid and hollow bricks (30 cm)	1930	1975	1.26
	Hollow brick mansory (25 cm)	1950	1975	1.76
	Hollow brick mansory (40 cm)	1950	1975	1.26
	Concrete mansory (18 cm)	1955	1975	3.40
	Concrete mansory (30 cm)	1955	1975	2.80
	Hollow wall brick mansory (30 cm), low insulation	1976	1990	0.78
	Hollow wall brick mansory (40 cm), low insulation	1976	1990	0.76
	Hollow brick mansory (25 cm), low insulation	1976	1990	0.80
	Hollow brick mansory (40 cm), low insulation	1976	1990	0.76
	Concrete masonry (also prefabricated, 18 cm), low insulation	1976	1990	0.82
	Concrete masonry (also prefabricated, 30 cm), low insulation	1976	1990	0.79
	Hollow wall brick mansory (30 cm and more), medium insulation	1991	2005	0.59
	Hollow brick mansory (25 cm), medium insulation	1991	2005	0.61
	Hollow brick mansory (40 cm), medium insulation	1991	2005	0.59
	Concrete masonry (also prefabricated, 18-20 cm), medium insulation	1991	2005	0.62
	Concrete masonry (also prefabricated, 30 cm), medium insulation	1991	2005	0.60
	Honeycomb bricks mansory (high thermal resistance), high insulation	2006	-	0.34
	Concrete masonry (also prefabricated), high insulation	2006	-	0.34

Table 14 – Conventional construction solutions for doors (IEE, 2009)

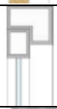
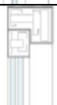
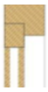
Construction detail	Description	Major diffusion		U-value (W/m²K)	$g_{gl,n}$ (-)
	Wooden door	-	1980	3.00	-
	Glass and metal door	-	1980	5.7	0.85
	Glass and metal door (thermally improved)	1980	2005	3.8	0.75
	Double panel wooden door	1980	-	1.70	-

Table 15 – Conventional construction solutions for windows (IEE, 2009)

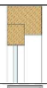
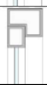
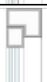
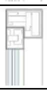
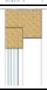
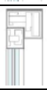
Construction detail	Description	Major diffusion		U-value (W/m²K)	$g_{gl,n}$ (-)
	Single glass, wood frame	-	1975	4.9	0.85
	Single glass, metal frame without thermal break	-	1975	5.7	0.85
	Double glass, air filled, wood frame	1976	2005	2.8	0.75
	Double glass, air filled, metal frame without thermal break	1976	2005	3.7	0.75
	Double glass, air filled, metal frame with thermal break	1991	2005	3.4	0.75
	Low-e double glass, air or other gas filled, wood frame	2000	-	2.2	0.67
	Low-e double glass, air or other gas filled, metal frame with thermal break	2000	-	2.4	0.67

Table 16 – Conventional construction solutions for floors (IEE, 2009)

Construction detail	Description	Major diffusion		U-value (W/m²K)
	Vault floor with solid bricks	-	1900	1.58
	Floor with wood beams and hollow bricks	-	1900	2.04
	Vault floor with bricks and steel beams	-	1930	1.87
	Concrete floor on soil	-	1975	2.00
	Vault ceiling with hollow bricks and steel beams	1910	1940	1.47
	Floor with hollow bricks and steel beams	1920	1945	1.81

Table 17 – Conventional construction solutions for floors (Conc.) (IEE, 2009)

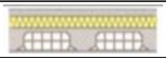
Construction detail	Description	Major diffusion		U-value (W/m^{2}K)
	Floor with reinforced concrete	1901	1930	1.95
	Floor with reinforced brick-concrete slab	1930	1975	1.30
	Floor with reinforced brick-concrete slab, low insulation	1976	1990	0.98
	Concrete floor on soil, low insulation	1976	1990	1.24
	Floor with reinforced brick-concrete slab, medium insulation	1991	2005	0.77
	Concrete floor on soil, medium insulation	1991	2005	0.93
	Floor with reinforced brick-concrete slab, high insulation	2006	-	0.33
	Concrete floor on soil, high insulation	2006	-	0.33

Table 18 lists the conventional heating and cooling systems and renewable energy systems used in Italy.

Table 18 – Conventional Heating and Cooling Systems and Renewable Energy Systems (Politecnico di Torino, 2011)

Year of construction	Type of Emission system	Specifics (rif. UNI/TS 11300-2)
Up to 1900	Radiators	Partially on non-insulated external walls – medium yearly thermal charge between 4 and 10 W/m^3
1901 - 1945		
1946 - 1960		
1961 - 1975		
1976 - 1990	Radiators	Partially on non-insulated external walls – medium yearly thermal charge between 4 and 10 W/m^3
1991 - 2005	Radiating Panels	In the pavement - medium yearly thermal charge between 4 and 10 W/m^3
After 2005	Radiating Panels	Isolated – less than 4 and 10 W/m^3

5.1.4 Architectural Regulations

In Italy planning and building control as well as environmental matters, and so the system of regulation of sustainability aspects of construction, are in the competence of the 20 Regions. Of these, five regions (namely Sardinia, Sicily, Trentino-Alto Adige/Südtirol, Vale de Aosta and Friuli-Venezia Giulia) have a particular degree of legislative and financial autonomy. Trentino-Alto Adige/Südtirol is a special case and consists of two autonomous provinces within the region, Trento and Bolzano-Bozen, which have their own construction regulations (and special climatic factors due to their alpine geography). The Regions are subdivided into Provinces, and these into municipalities (comuni). Each of these comuni implements its own building regulations, with their own sustainable building codes (norme per l'edilizia sostenibile), but based on Regional guidelines. Certain elements are integrated from national laws and decrees, but in principle there is no national system of building regulations.

Building control is enshrined in Regional/Provincial structure plans, and by each comuni in a Piano Regolatore Generale. The towns issue building licenses and permits for each project. There may also be detailed plans for specific areas within a commune, laying down more specific requirements of buildings projects. The mayor of each town is advised on building control matters by a Planning Commission. Some technical regulations are also laid down at national level by Ministerial Decree, for example general criteria on safety and loading; reinforced concrete and steel structures and brickwork and provisions for seismic areas. There are also some rules at the national level for specific types of buildings – e.g. schools, hospitals, public housing.

For sustainability aspects, the Regions and Towns variously introduced their standards for sustainable building over the period up to 2009, driven latterly by the implementation of the EPBD (which is also implemented at the Regional/commune level). They adopted differing methods of evaluation of energy efficiency and sustainability, creating problems for implementation and for the training and certification of inspectors and designers. The requirement for buildings, new homes and homes for sale to have energy certificates was therefore widely ignored, partly because of the lack of assessors and partly in expectation of changes to be introduced at the national level. These 'Norme' are tied in with the Italian system of financial incentives for energy efficiency improvements in housing ('Piano Casa' of 6th March 2009, set at €378 million shared between the Regions). They are not mandatory for existing buildings, but set the minimum standards for buildings to qualify for subsidies for energy efficiency improvements. Since the funds allocated to Provinces for these incentives were generally well below the level of projects submitted for financing, differences in measurement were a problem. All houses put up for sale also require an energy efficiency certificate in line with the EPBD, and may in future require a wider 'quality building' sustainability certificate.

The Italian energy policies and legal framework are (Table 19):

- Law n.º 10 of 9th January 1991: Rules for the Implementation of the National Energy Plan in the field of rational use of energy, energy conservation and development of renewable energy;
- Legislative Decree n.º 311 of 2006 on Provisions corrections and additions to the Legislative Decree n.º 192 of 19th August 2005, implementing Directive 2002/91/EC on the Energy Performance of Buildings, amending and supplementing Legislative Decree 192/2005, implementing Directive 2002/91/EC on the Energy Performance and the Energy Consumption of Buildings. This Decree:
  - makes mandatory the use of photovoltaic panels, solar thermal panels for hot water production and external solar shading, for all new and renovated buildings with a surface area greater than 1000 m^2;
  - imposed new limits, increasingly strict, from 2006 to 2010, for the primary energy demand for space heating of buildings and for the transmittances of all the components of the building envelope;
  - required public buildings with a floor area larger than 1,000 m^2 to display the Energy Performance Certificate in a place clearly visible to the public;
- Decree of the President of the Republic (DPR) n.º 59 from 2nd April 2009: Regulation for the implementation of Article 4, paragraph 1, a) and b) of Legislative Decree no. 192 from 19th August 2005, concerning the implementation of Directive 2002/91/EC on the energy performance of buildings, which completes the legislative framework relating to:
  - the calculation criteria and minimum standards for the systems;
  - the general criteria for energy performance for social housing, public and private;

- the professional qualifications and accreditation for certification.

Table 19 presents the entrance into force of the Italian thermal regulation, Figure 36 shows the implementation of the thermal legislation and Table 20 lists the penetration index of the energy efficiency policies in Italy.

Table 19 – Entrance into force of the Italian thermal regulation

In force	Law 10/91 and Actuate Decrees	Law 10/91 and DM 178	Legislative Decree 192/05	Legislative Decree 311/07	DPR 59/09
From	1991	17th August 2005	9th October 2005	2nd February 2007	25th July 2009
To	16th August 2005	8th October 2005	1st February 2007	24th July 2009	-

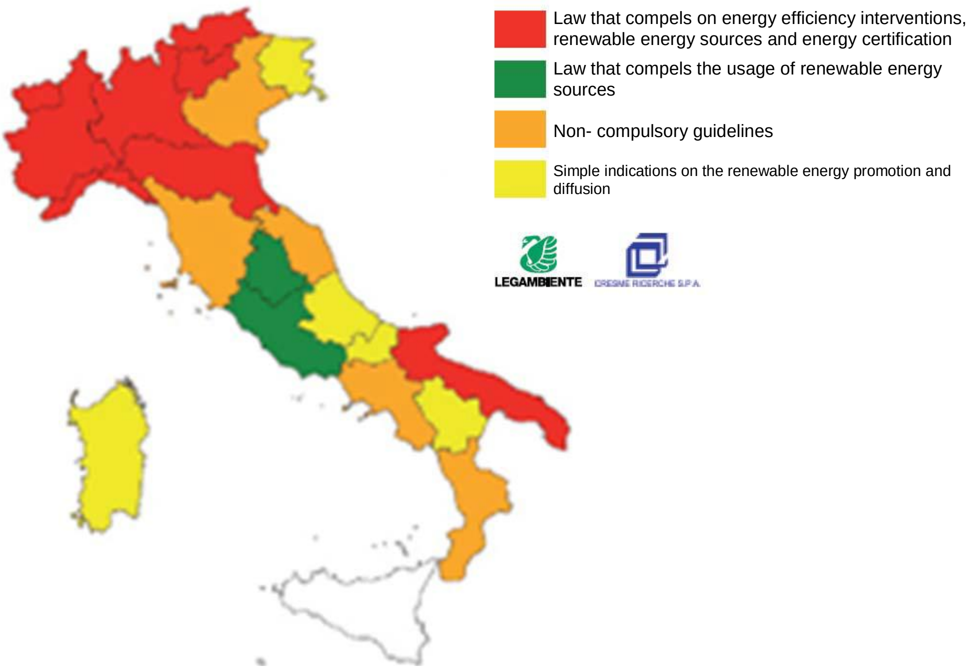


Figure 36 – Implementation of legislation in Italy (ENEA, 2012)

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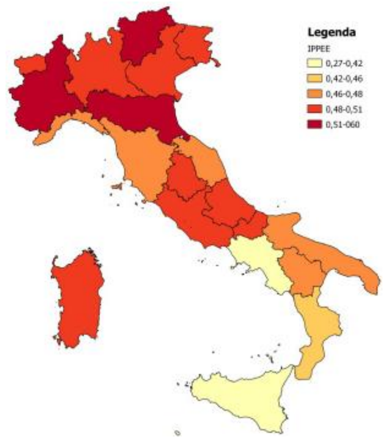
Table 20 – Energy Efficiency policies' penetration index (IPPEE) – normalized values

Region	Normative Instruments	Incentives	Voluntarily	IPPEE penetration
Piemonte	0.50	0.66	0.51	0.56
Vale de Aosta	0.67	0.50	0.22	0.47
Lombardia	0.62	0.36	0.46	0.48
Trentino-Alto Adige	0.82	0.61	0.37	0.60
Veneto	0.64	0.33	0.47	0.48
Friuli-Venezia Giulia	0.71	0.39	0.43	0.51
Liguria	0.25	0.30	0.70	0.42
Emilia Romagna	0.63	0.37	0.69	0.56
Toscana	0.41	0.35	0.58	0.45
Umbria	0.58	0.46	0.49	0.51
Marche	0.52	0.33	0.50	0.45
Lazio	0.38	0.25	0.78	0.47
Abruzzo	0.53	0.29	0.66	0.50
Molise	0.58	0.54	0.47	0.53
Campania	0.33	0.26	0.22	0.27
Puglia	0.43	0.40	0.41	0.42
Basilicata	0.63	0.31	0.44	0.46
Calabria	0.50	0.38	0.18	0.35
Sicily	0.38	0.18	0.24	0.27
Sardinia	0.56	0.40	0.49	0.48
Italy	0.51	0.35	0.47	0.44



Italian energy policies in recent years have been focused on improving the building envelope to reduce energy consumption mainly during the cold season. In this sense, the most widely used technique to improve energy efficiency is making the building as adiabatic as possible. This is achieved through an increase in the level of thermal insulation, workable even on existing structures using the technique of the thermal coat, both internal and external.

However, the application of this technique must undergo an accurate analysis: in fact, while for climate zones E and F can be effective, it is not necessary effective for climate zones D and it is not definitively effective in climate zones A, B and C.

The technologies that can give a significant contribution to the reduction of energy consumption in Italy are:

- high efficiency plants (condensing boilers, micro-CHP systems, heat pumps with compression and absorption systems, integrated with renewable energy sources, etc.);
- materials and products for the reduction of energy losses through the plant piping system or for a better performance of the terminal units (such as radiators high exchange surface);
- innovative bricks, with high thermal insulation;
- thermal insulating materials for the buildings (natural and synthetic organic, inorganic, natural and synthesis, among which are expanded clay, stabilized cellulose fibber, polyurethane

foam, free of HCFCs and HFCs polystyrene extruded expanded, plasters and mortars for thermal insulation and moisture prevention, insulating varnishes, cork, rubber sleeves, sheets and membranes for insulation, wood fibber and natural fibber panels);

- products and systems for the reduction of the thermal losses and heat absorption (such as high thermal performance windows, solar control glasses to reduce the cooling needs, solar screens outside the envelope such as curtains, blinds, solar shading, insulation boards, transparent polycarbonate).

In addition, innovative technologies and systems such as home automation systems, casing running, solar cooling, smart building and cogeneration shall be strongly developed.

The objectives set by the Italian regulatory and technical framework for the National Nearly Zero-Energy Building require increasing levels of performance for components and systems of the building. The aims are essentially of two types: very high performance for static components and promote solutions that make the building envelope as a dynamic system, able to adapt to changing conditions in the external and internal environment.

5.2 Greece

5.2.1 Location and Climatic Data

Greece (Figure 37), with an overall land area of approximately 132,000 km^2, lies in south-eastern Europe between latitudes 34º and 42º N. Four-fifths of the mainland consists of mountainous terrain, with the highest mountain (Olympus) rising to about 3,000 m. Greece is also a maritime country with numerous islands and a coastline of over 15,000 km in length. The bulk (i.e. about 59%) of the country's population lives in urban areas. Most urban centres and the largest of them, including the conurbation of the capital, Athens, with its population of about 4 million, and the second largest city, Thessaloniki, with its population of about 1 million inhabitants, lie on the coast.

Figure 37 – Satellite view of Greece

Amongst the environmental factors that influence building construction in Greece, the seismicity of the ground plays an important role. South-eastern Europe lays at the point where the lithospheric plates of Europe and Africa converge, a fact which results in the frequent occurrence of powerful earthquakes. Greece is one of the most seismogenic areas in the world and has been hit by many destructive earthquakes throughout the course of its history. This reality is reflected in the construction of its buildings.

The Greek Seismic Code came into force in September 1999. The country is divided in four zones of seismic risk, with seismic ground acceleration rates for the design of earthquake proof buildings ranging from 0.12g to 0.36g. These rates pertain to buildings with a very strong supporting structure.

Figure 38 shows the epicentre and depth of the earthquakes (more than 2.0 in Richter scale) registered in the vicinity of Greece (according to the Hellenic Unified Seismic Network, HUSN).

Greece has a Mediterranean climate (Figure 39). According to the relevant climatic data, the annual cycle can be divided into a cold and rainy season (October to March) and a warm and dry season (April to September). Between September and October an important drop (-5 ºC) in the temperature is noted. This drop continues gradually between January and March, the coldest months of the year. From April onwards the temperature starts to increase until July and August, which are the warmest months of the year. The transitional seasons (autumn and spring) are defined by climatic clarity and, in particular, autumn is warmer than spring by 2 to 4 ºC.

Temperatures on the Greek mainland display intense contrasts mainly as a result of geographic factors (Table 21).

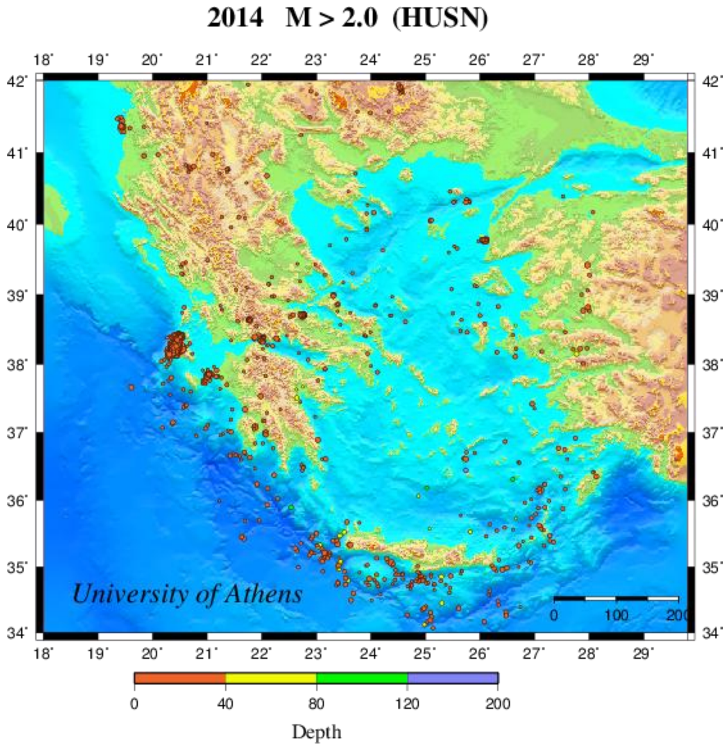


Figure 38 – Seismicity in Greece

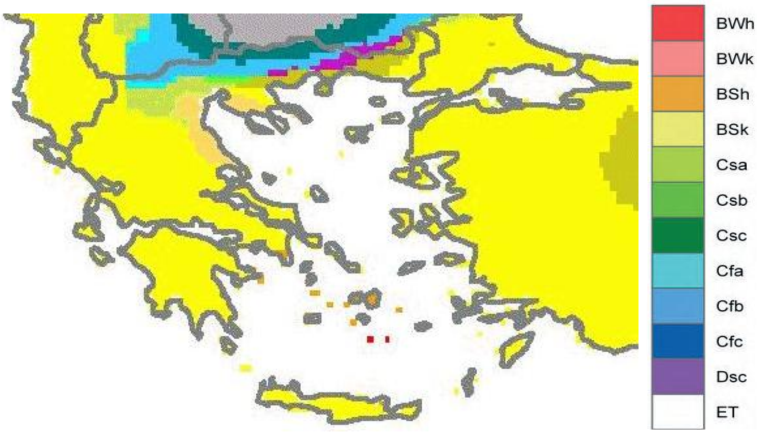


Figure 39 – Greece climate according to the Köppen-Geiger classification

Table 21 – Temperatures in some Greek cities

Station	Lat./Long.	Jan.	Feb.	Apr.	Aug.	Sep.	Oct.
Thessaloniki	40.31/22.68	5.5	7.0	14.6	26.3	22.2	16.7
Larissa	39.38/22.25	5.3	7.0	14.4	27.4	22.6	16.8
Patras	38.15/21.44	9.8	10.4	15.8	26.7	23.4	19.0
Athens	37.54/23.45	9.4	10.3	15.8	27.8	23.9	18.7
Iraklion	35.20/25.11	12.3	12.5	16.8	26.4	23.6	20.3

More specifically, Greece is between the average annual isothermal of 14.5 and 19.5 ºC. The average temperature drops with latitude are about 1 ºC/ºLat. during the winter and 1 ºC/ºLat. during the summer. In winter, temperature generally decreases from the coastline towards the interior. In summer, even if an increase of temperature from the coast to the interior is generally observed, in many regions, due to orography features, the opposite phenomenon is experienced, especially during the day. The extreme temperatures are close to -25 ºC (during winter in the mountainous and northern regions) and +45 ºC (during heat waves on the mainland).

The mean relative humidity ranges from 65% to 75%, according to location. It displays a simple annual fluctuation, with the maximum occurring during the winter months, and depends on the proximity of natural concentrations of water.

In Greece, the general circulation of the atmosphere and the prevailing synoptic systems in the wider area contribute to the prevalence of western and northern wind components and fairly moderate speeds. However, in interaction with them, the complex orography of Greece plays an important role in determining the prevailing wind direction and speed in many regions.

Sunlight data is also of interest to the art of construction. Greece is considered to be, and is, a very sunny country, with the annual amount of incoming solar radiation in the region of 140 kcal/cm^2/a.

The climatic data above relate mainly to the countryside. In urban environments, these data change as a result of the influence of the factors which make up the urban climate.

Climatic variability in Greece affects the regional construction trends regarding the energy performance of buildings. The energy related characteristics of buildings differ according to the prevailing conditions in their geographic location. The new regulation on the energy performance assessment of buildings (KENAK), defines four climatic zones on the basis of the heating degree-days (see Figure 40 and Table 22).

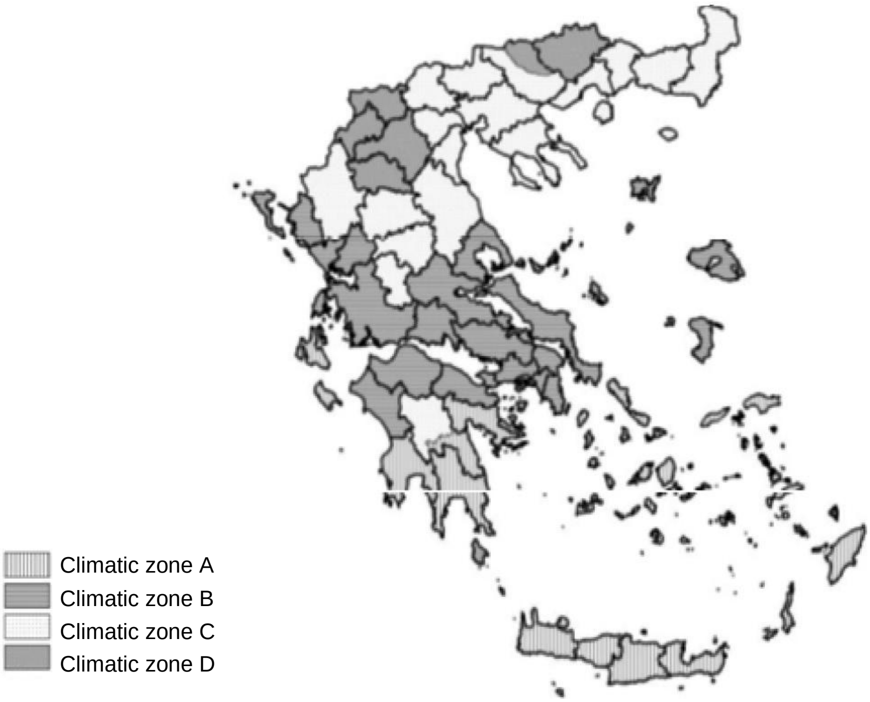


Figure 40 – Climatic zones of Greece (TOTEE20701−3, 2010)

Table 22 – Criteria for the definition of the climate zone in Greece

Criteria	601 < Degree-days ≤ 1100	1101 < Degree-days ≤ 1600	1601 < Degree-days ≤ 2200	2201 < Degree-days ≤ 2620
Climate Zone	A	B	C	D

5.2.2 Buildings' Characteristics

Numerous sources provide with data considering the Greek building stock in general and for the residential use in particular, including the Hellenic Statistical Authority (El.Stat.), the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA). Regarding Greek sources, the main and most important available data are given by El.Stat. and refer to the year of construction per area and for Greece in total, the construction materials, the existence of pitched or flat roofs, the number of floors, the type of building according to its use (whether residential, office, or mixed use building) and the existence of Pilotis.

Buildings according to the year of construction - data concerning the period till 2001

In Figure 41 the large boost in the building sector in the period 1945–1980 is depicted, indicating that the majority of the buildings, namely 71% of the total stock, are uninsulated. It becomes clear that the majority of Greek buildings are built within the period 1946–1980. In Table 23 the early stages of urbanization, with the simultaneous drop of the construction activity in the rural areas can be detected.

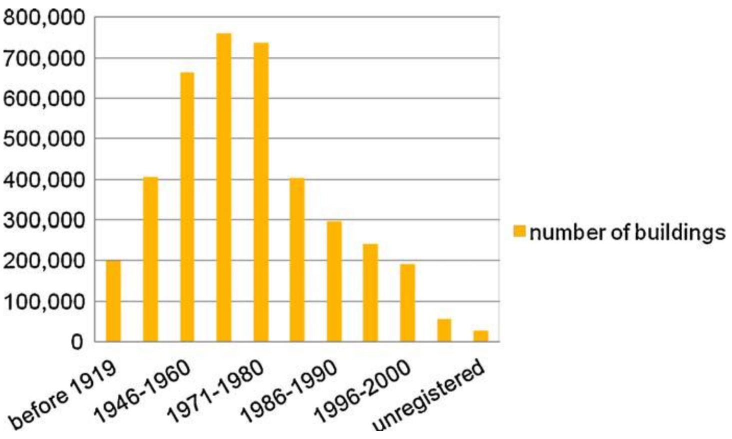


Figure 41 – Number of buildings per year of construction in Greece

Table 23 – Buildings built before and after 1980

	Buildings built before 1980	Buildings built after 1980
Rural areas	1,274,113	627,293
Urban areas	1,496,102	507,712
Total	2,770,215	1,135,005
%	70.93	29.06

El.Stat. provides data by classifying buildings according to their usage, namely dwellings, churches/monasteries, hotels, factories/laboratories, educational buildings, shops/offices, parking blocks, hospitals, and others. These data shows that 89.6% of Greek buildings have an exclusive use and only 10.4% a mixed one (Figure 42).

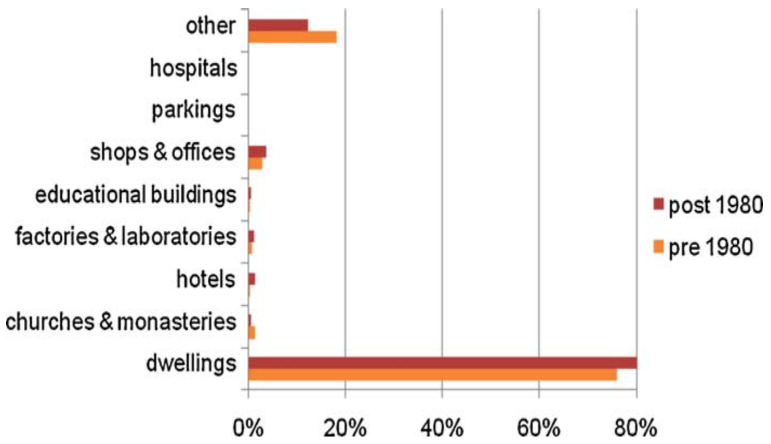


Figure 42 – Typological categorization of the Greek building stock according to use

In 66% of the urban buildings the main construction material is reinforced concrete, used for the load bearing structure according to the Greek anti-seismic regulations (Figure 43). The walls are as a rule double brick walls. In rural areas, brick and stone walls are more common, as the buildings are lower and the anti-seismic requirements are not as strict, whilst stone is in many cases a material in local abundance. Furthermore, some settlements feature landmark protected architecture, which presupposes the use of traditional building materials like stone.

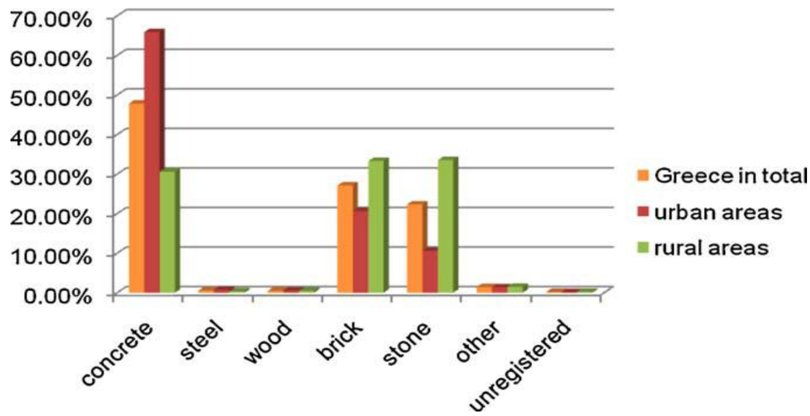


Figure 43 – Main construction material of the Greek building stock

Thus, it becomes clear that Greek buildings especially in urban areas have a large heat storage capacity, a fact that should be taken into consideration when planning insulation interventions as well as passive cooling and heating systems.

It is also of great importance to distinguish between buildings with flat and with pitched roofs, in order to correctly plan intervention scenarios for energy renovation. In Figure 44 the distinction between flat and pitched roofs is being illustrated, for Greece in total, i.e., urban and rural areas.

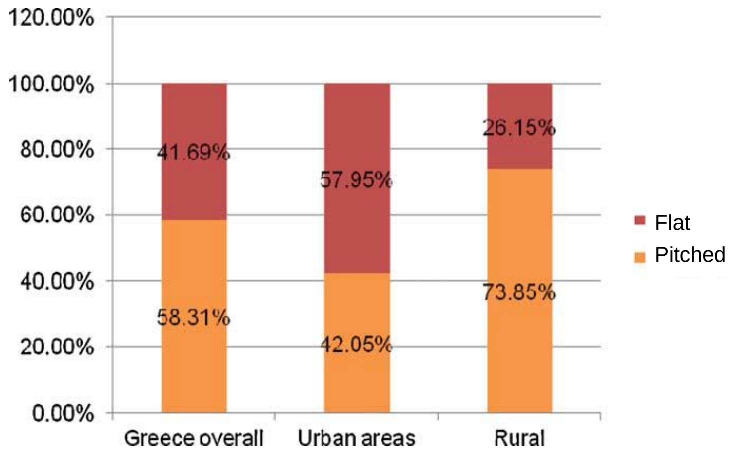


Figure 44 – Flat and pitched roofs

Pitched roofs are characteristic for single-family houses and for buildings in rural areas, whilst they can also be met in cities and villages in mountainous regions with harsh continental climate. The actual amount of surfaces available for the implementation of RES, insulation materials, as well as cool and green roofs, especially in urban areas is subject of a still on-going research.

Data concerning the period after 2001

The last census of the Greek building stock took place in 2001 and, therefore, there are no official data available for the last decade. However, as shown by the most recent data available, the growth of the building sector during this period is depicted in Figure 45.

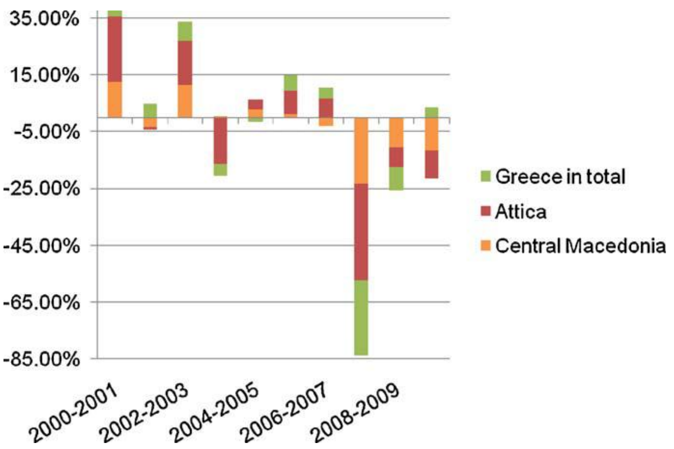


Figure 45 – Development in the buildings' construction sector in Greece after 2001

Socio-economic aspects

The age of the buildings and the density of the urban layout, the lack of green spaces and the materials used, lead to rather poor living conditions in Greek city centers, considering both indoor air quality and thermal comfort. With respect to the building this discomfort is intimately linked to the lack of thermal insulation, the lack of effective shading and also the absence of passive cooling systems. This situation necessitates measures in order to upgrade the building stock in the city centers. Moreover, the lack of a common architectural language is dominant in Greek urban areas, creating the image of an aesthetic anarchy.

Energy upgrading measures could and should contribute to the redefinition of the Greek urban architecture, determined mainly by the "Polykatoikia" typology. Furthermore, related research shows that the lower the income, the worse the indoor conditions, especially during the cooling period. Moreover, private investments in order to upgrade the energy behaviour of the buildings become under these circumstances rather unlikely to be implemented. Based on this fact, the recently announced measures concerning energy conservation in residential buildings, aimed particularly to support low income owners, seem to be reasonable. They include subsidies, low interest loans and tax deductions for retrospective thermal insulation, installation of solar thermal collectors, as well as replacement of windows and balcony doors, boilers and burners.

5.2.3 Construction Details

The main materials used in the construction of buildings in Greece are concrete, for the construction of the supporting structure, and bricks, for the construction of the walls. These materials are produced from local resources in sufficient quantities to meet domestic needs.

The basic method of construction in Greece is monolithic reinforced concrete skeleton of the building, with the manufacture of reinforced concrete seismic-proof pillows, with which it is being built - this is wood - metal casing. The walls are usually ceramic brick or natural stone, with expanded extruded polystyrene as hydro-thermal insulation. Then all line - electricity, telephone, alarm system, water supply, sewerage, heating and other boxes - are installed as well as windows and doors. Plaster is applied in two layers, the first of the river sand and Brown cement and the second from a marble crumb and slaked lime. In the inner walls (where not provided for coating floors) are applied two coats of PuTTY, plaster or other decorative details, marble stairs and window sills, fireplace. The floors finishing is generally of marble, granite or ceramic tiles and parquet. The final phase of construction consists of painting the House or apartment, installing built-in armoires and cupboards in bedrooms and kitchens, radiators, bathroom fixtures, outlets and switches, windows and doors, interior exterior design, installation of meters for utilities.

Categorization of the Greek building stock

Class A (1919–1945)

This period was characterized by the regulations which defined the legal framework for the building sector and urban planning. They were based on German and French architectural influences, leading to the so-called “Neoclassic” trend. During the decade 1920–1930, under the severe pressure driven from the necessity to shelter 1.5 million refugees from Asia Minor after the 1920–1922 Greek-Turkish war, but also due to the urbanization caused by industrialization, a new legislative frame was introduced in order to cover the demand for housing. Furthermore, after 1922 the use of elevators was established, leading to an increase in the number of floors and the height of the buildings, whilst the entrances were restricted to one. Nevertheless the facade structures remained the same, with small balconies, overhangs and openings, all in regular spaces, dealing with the façade as if dealing with a mansion house façade rather than a multi-storey multifamily building façade.

Class B (1946–1960)

During this period the massive use of reinforced concrete resulted in a drastic recast of the construction policies. The prevalence of new building materials and methods and the drastic urbanization led to a steeply increasing need for accommodation in the urban areas and therefore to the construction of multi-family buildings influenced by the Bauhaus style. This new form of apartment buildings, as it emerged in the inter war years, sheltered most families. In addition to this, a large legislative work was introduced regarding the built space’s form, concerning the vertical and horizontal condominium (Figure 46). This regulation led to a massive multi-family building construction based on *quid pro quo*, sheltering many people by spreading the costs to multiple co-owners. Furthermore the General Construction Regulation (GCR) of 1955 defined the form of the cities with the continuous building system for the densely populated centre, the detached type for the suburbs and the semi-detached and stand-alone buildings for rural communities.

Class C (1981–1990)

This class covers a rather blurred period, until the definite consolidation of the insulation regulation. Important for the buildings' typology, was the formal introduction of Pilotis in 1985, where the 1st floor was no longer attached to the ground (Figure 46 and Figure 47). The Pilotis, i.e., the free space in the ground floor usually 3 m high, was mainly used as parking area for multi-family buildings. The vertical and horizontal structural elements were mostly uninsulated, leading to great thermal losses. This building form was used since the 1970s and became vastly popular after 1985, along with the revised Greek Seismic Code of 1954 that came into force.

Figure 46 – Typical buildings for each category (two for Class B, one of Class C, and one of Class D).

Figure 47 – Typical multi-family building with Pilotis floor used as parking area

Class D (1991–2010)

The typological features remained to a great extent similar to those of the previous period (Figure 46). The Thermal Insulation Regulation was now applied to new constructions, though often not as foreseen by the Thermal Insulation Regulation. Furthermore, the new Greek Seismic Codes of 2000 followed by several revisions affected the construction materials, their width and the buildings' envelope in general.

Class E (2010–today)

Since October 2010 the implementation of the Regulation for Energy Efficiency of Buildings (KENAK) has set a new legal framework, which is expected to influence the new constructions significantly, as it imposes new, tighter energy standards (Figure 48).

Figure 48 – Facades of typical contemporary urban residential buildings

The maximum value of thermal transmittance (W/m^{2}K) per climatic zone in Greece according to the Regulation of Energy Performance in Buildings (TOTEE20701-2, 2010) is shown in Table 24.

Table 24 – Maximum U-Values according to KENAK

Exterior Wall Component	**U-value [W/m^{2}K]**			
	Climatic Zone			
	A	**B**	**C**	**D**
Exterior horizontal and slopping Roofs	0.50	0.45	0.40	0.35
Exterior walls	0.60	0.50	0.45	0.40
Exterior floors (Pilotis floors)	0.50	0.45	0.40	0.35
Floors attached to ground and unconditioned rooms	1.20	0.90	0.75	0.70
Exterior walls attached to ground and unconditioned rooms	1.50	1.00	0.80	0.70
Windows and Openings	3.20	3.00	2.80	2.60
Glass facades	2.20	2.00	1.80	1.80

5.2.4 Architectural Regulations

Greece has its own laws, regulations and rules that must to be strictly followed by the designers and builders in the construction of buildings. Anti-seismic safety building during its construction, the use of environmentally friendly construction materials, energy efficiency, good savings on construction and maintenance of the building, the comfort of occupants and the harmonious integration of the building with the environment are the main directions of the present and future development of Greek construction.

Building regulations in Greece

The most important piece of legislation with a bearing, either direct or indirect, on building construction methods in Greece was the "Hellenic General Building Code". This code has had legal force since 1985 and, coupled with the "Construction Code for Buildings", which is an annex of the former, contains the basic conditions, restrictions and requirements for constructions within or outside areas of towns or settlements with approved development plans. More specific provisions in this code concern the permissible roof area and building volume in relation to building plot size, the permissible ground coverage rate, permissible building height, balcony surface area, distances between buildings, etc..

This law was replaced by the “Greece's New Building Regulations”, which came into effect in 2012 with law 4067/12 (Official Journal-FEK 79A/12). The most important reforms concern these five categories:

- Issuing building permits - Greece's new building legislation introduced a novel approach to issuing building permits which includes "A Preliminary Building Approval". This is a Certificate that gives the owner the right to build according to the terms and conditions that will allow the issuing of a building permit. In other words this certificate is required in order to apply for a building permit.
- Energy performance of buildings - For new buildings permission conditions have increased due to the compulsory Energy regulation “KENAK”. Independent Energy Inspectors conduct the auditing of building works. The regulation on the energy performance of buildings introduced new principles that set out to improve the energy efficiency of buildings. Another prerequisite for the issuing of a building permit is an energy efficiency study which shows that the potential building will meet the minimum requirements for optimal energy performance. From the beginning of 2012 an energy performance certificate is required for all rented properties or when a change in property ownership occurs.
- Supervision of construction works - Inspection is mandatory and authorized independent inspectors are randomly assigned in every building project. The assigned inspector checks performance at several stages. Once the building starts to take shape, in other words the foundation is laid and the framing is complete. The inspector evaluates the foundation depth, whether or not its layout respects the plot map, the size allowance and its distance from the boundaries. The inspector returns once the structure is complete and the external walls are established. He or she assesses the type of masonry used, heat insulation, the balconies and all plumbing, mechanical and electrical works. Once the building is entirely complete, the inspector checks the final height landscaping and any other outstanding matters.
- Record Keeping - The new legislation introduced a unique record keeping procedure for tracking construction works. A unique identification code is provided to every new building which includes all relevant plans and documents. The Ministry of Environment's online registry shows a virtual tour of the premises and building facilities.
- Tackling illegal building activity - To deal with illegal building activity an initial law set out to legalize "part-open" spaces (i.e. an outdoor balcony that was deliberately closed in) and spaces whose initial purpose was modified (i.e. a storage space turned into a bedroom). A second law (Article 24) came into effect that provided the opportunity to settle illegally built infrastructure by paying a fine, regardless of whether planning permission was granted (Law 4178/08.08.2013, Official Journal-FEK 174 A'/2013).

Other objectives of “The New Building Regulations” also include, addressing environmental problems by reducing emissions, conserving energy and promoting sources of renewable energy, an increase in the number of green and public spaces, support for bioclimatic architectural designs, the creation for energy efficient building and lower energy consumption, the reduction of inefficient buildings.

Another piece for legislation with an important bearing on building construction was the “Thermal Insulation Regulation of Buildings”. This code, since 1979, has served as a basic tool for introducing energy and environmental considerations into building construction in Greece. It was followed by a 30 year hiatus, interrupted by sporadic, fragmented legislative acts, such as the “Regulation on Rational Use of Energy and Energy Conservation” that was published in 1998, though never implemented in practice.

Greece fulfilled its obligations regarding the EPBD (Energy Performance of Buildings) Directive 2002/91/EC implementation fairly lately: it was incorporated into the national legislation with Law 2661/2008 in 2008, but the necessary regulatory and administrative measures were completed as late as the summer 2010, with the publication of the New Hellenic Regulation on the Energy Performance of Buildings (KENAK) and the respective Technical Guidelines.

According to the Regulation of the Energy Performance of Buildings, a set of minimum requirements are applied to new buildings. Therefore, all applications for building permits after the 1st of October 2010 must be accompanied by an Energy Study that proves that the building under planning is in compliance with these minimum requirements. The type and level of requirements are a function of the type building (dwelling, tertiary sector buildings) and cover:

- The design of the building taking into account parameters such as orientation, surrounding area, passive solar systems, natural ventilation, daylight;
- Maximum U-value for walls, windows, roofs etc., for each one of the four climatic zones in Greece;
- Maximum value for the average U-value for the whole building;
- At least 50% heat recovery in the central air-conditioning unit;
- Minimum levels of insulation of the heating and cooling distribution network;
- At least 60% hot water production from solar panels;
- Minimum requirement for lighting installations in the tertiary sector building (55 lm/W).

The general certificate model, which is used in order to categorise the buildings according to their energy efficiency is the A+ to H label. The Energy study must prove that all new buildings are classified at least as B. After the completion of the construction, an energy audit is conducted and the energy certificate is issued. If the constructed building deviates from the design and is not classified at least as B, the owner must perform all necessary improvements within a year. Existing building undergoing major renovation should be upgraded in order to be classified at least as B.

Differences on Building regulations and Architecture depending on location – The case of Cyclades islands

In Greece there are distinctive regional architectural styles, such as the pitched roofs of the Arcadian mountains and the flat, rolled ones of the Cyclades (Figure 49). Specialized regulations and rules have been put into effect by the Greek Ministry of Development in order to ensure the preservation of each locations construction style. Some of the strictest are in the Cyclades. The aim is to protect the environment, local architectural style and aesthetic value of the Greek islands. The most important regulations are classified as the following:

- Houses are unable to exceed 3 floors (surface and primary);
- The first bottom area needs to be equal or a lot less than 1/3 on the ground bottom;
- Constructing some sort of basement should be only allowed away from the city approach.

Figure 49 – Cyclades architecture

Also, one characteristic feature of Cycladic architecture is the colours: blue and white are the dominating colours in all the islands of the complex. The houses in Cyclades are small and have a rectangular shape with a flat roof, as the strong winds do not allow the construction of pitched roofs. They are built with stones and bricks. The houses are meant amphitheatrically, one with top of another. Most capitals in the islands of Cyclades are built on the back side of slopes.

5.3 Portugal

5.3.1 Location and Climatic Data

Continental Portugal is located between 36º92N and 42º22N and between 9º61W and 6º07W in the transitional region between the sub-tropical anticyclone zone and sub-polar depression zone. Madeira Archipelago (located 520 km from the African coast and 1,000 km from the European continent) lies between 32°22.3′N 16°16.5′W and between 33°7.8′N 17°16.65′W. Azores Archipelago (located about 1,360 km west of continental Portugal and about 880 km northwest of Madeira) is located between latitudes 37°N and 40°N and longitudes 25°W and 31°W (Figure 50).

Beside latitude, the most important features affecting the climate of the territory are orography and the influence of the Atlantic Ocean (Santos, Forbes & Moita, 2002). With regard to orography, the highest peaks rise to a height of 1,000 m to 1,500 m, except for the central mountainous area of Madeira island that reach more than 1,700 meters, with Pico Ruivo reaching 1,862 m, the Estrela Mountains, whose highest point is just under 2,000m and Pico Mountain (in Azores, Pico Island) with 2,531 m (the highest mountain of the country).

Portugal is defined as a county with a Mediterranean climate. The northern zone of Portugal is characterized by an average annual precipitation of 991 mm with temperatures influenced by Atlantic air currents and the Spanish Meseta. The southern zone of Portugal has a Mediterranean climate with low annual precipitation and sunny days with weather conditions influenced by the Azorean high pressure systems.

The annual average temperature in mainland Portugal varies from 12 ºC in the mountainous interior north to over 18 ºC in the south and on the Guadiana river basin. The Average temperature ranges in Lisbon are from 8 ºC to 14 ºC in January to 17 ºC to 28 ºC in August.

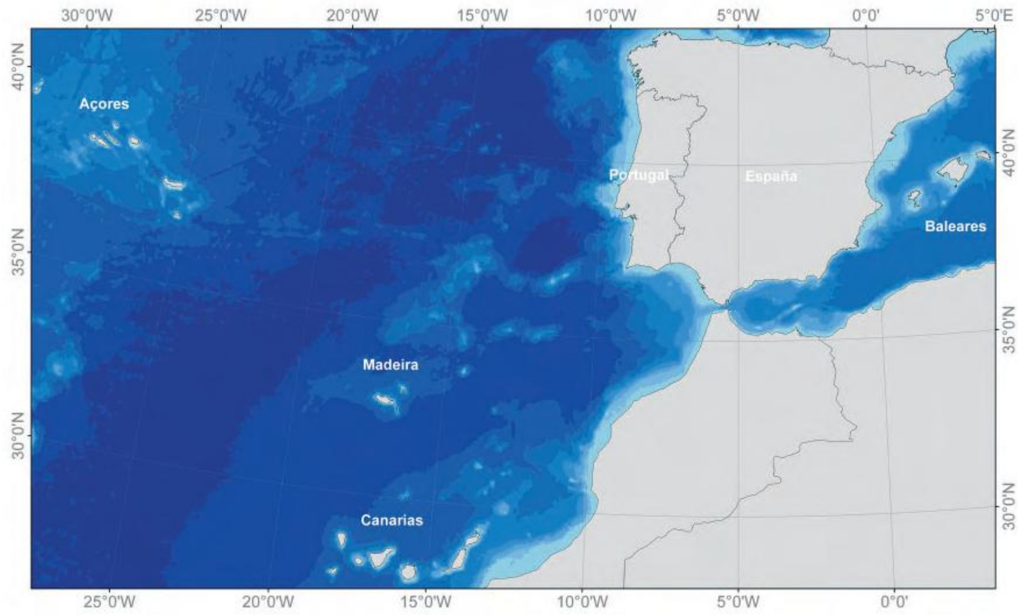


Figure 50 – Geographical setting of Mainland Portugal and the Archipelagos of the Azores and Madeira (AEMET & IM, 2011)

In winter the average minimum temperature varies between 2 ºC in the mountainous interior zone and 12 ºC in the south zone of Algarve (Santos, Forbes & Moita, 2002; IPMA, 2014). But temperatures may drop below −10 °C in particular in Serra da Estrela, Serra do Gerês, Serra do Marão and Serra de Montesinho. In these places snow can fall any time from October to May. In the South of the country snowfalls are rare but still occur in the highest mountains.

In summer the mean maximum temperature vary between 16 ºC in Serra da Estrela and 34 ºC in inner central region and eastern Alentejo (Santos, Forbes & Moita, 2002; IPMA, 2014).

Annual average rainfall in the mainland varies from just over 3000 mm in the northern mountains, to about 500 mm in the eastern part of the territory and to less than 300 mm near Côa, along the Douro River. Mount Pico, in Azores, the country's highest mountain, receives the largest annual rainfall (over 6250 mm per year) in Portugal (Santos, Forbes & Moita, 2002; IPMA, 2014).

The sea surface temperature on the west coast of mainland Portugal varies from 13 ºC to 15 ºC in winter to 18 ºC to 20 ºC in the summer while on the south coast it ranges from 15 ºC in winter and rises in the summer to about 23 ºC, occasionally reaching 26 ºC.

The country has around 2500 to 3200 hours of sunshine a year, an average of 4 to 6 hours in winter and 10 to12 hours in the summer, with higher values in the south-east and lower in the north-west.

According to the Köppen-Geiger Climate Classification, and the climatological normals 1971-2000, the latest available, for most of the mainland territory, the climate is temperate continental, Type C, subtype Cs (a temperate climate with dry summer) (Figure 51).

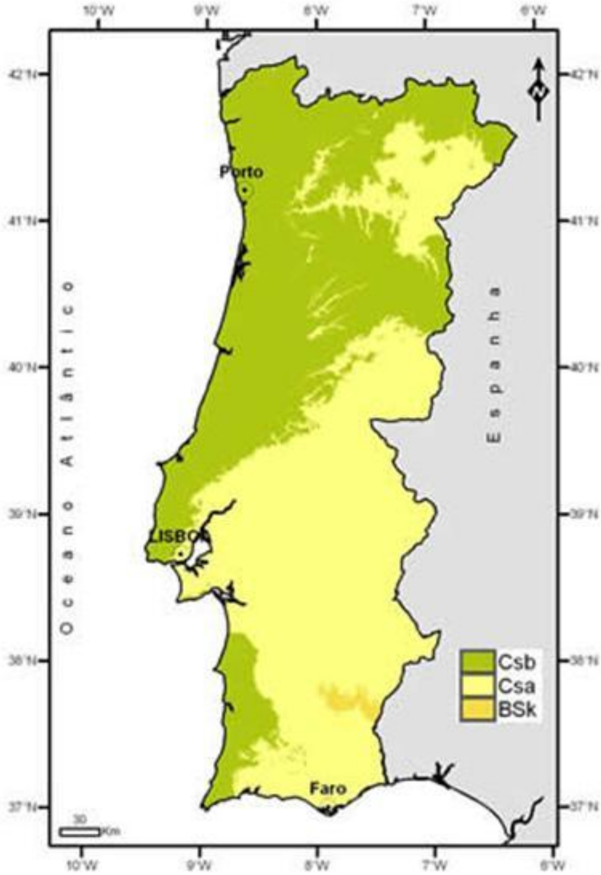


Figure 51 – Portuguese Mainland climate according to the Köppen-Geiger classification (IPMA, 2014)

The interior regions of the Douro Valley (part of the district of Bragança), as well as the regions south of the mountain system Montejunto-Estrela (except on the west coast of Alentejo and Algarve) have a temperate climate with warm and dry summer (Csa).

Almost all regions of the northern mountain system Montejunto-Estrela and the regions of the west coast of Alentejo and Algarve have a temperate climate with dry and mild summer (Csb).

In a small region of Alentejo, in the district of Beja, is Arid Climate - Type B Subtype BS (steppe climate), BSk variety (cold steppe climate of mid-latitude).

Both the archipelagos of the Azores and Madeira have a subtropical climate, although variations between islands exist, making weather predictions very difficult (owing to rough topography). The Madeira and Azorean Archipelagos have a narrower temperature range, with annual average temperatures exceeding 20 ºC along the coast (IPMA, 2014). Some islands in Azores do have drier months in the summer.

The sea surface temperature in the archipelagos varies from 17 ºC to 18 ºC in winter to 24 ºC to 25 ºC in the summer occasionally reaching 26 ºC.

The Azores archipelago has generally a tepid, oceanic, subtropical climate, with mild annual oscillations. Daily maximum temperatures usually range between 15 ºC and 25°C. The average annual rainfall increases from east to west, and it ranges from 700 to 1600 annual millimetres on average, reaching 6300 millimetres on Mount Pico.

The archipelago of the Azores have been identified as having a Mediterranean climate, while some islands are classified as maritime temperate or humid subtropical according to Köppen-Geiger classification. Azores Eastern Group climate is the type Csb, temperate climate with dry summer and mild winter, in the Eastern Group and Central and West Group the climate is Cfb, i.e., oceanic climate, also sometimes called temperate maritime climate which is temperate humid with a summer which occurs in temperate regions away from major landmasses (Figure 52) (AEMET & IM, 2011; IPMA, 2014).

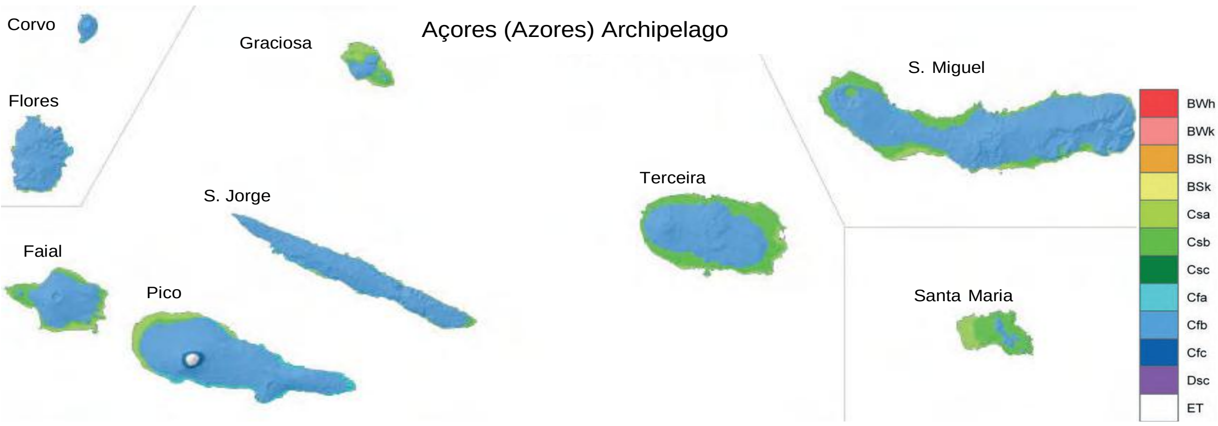


Figure 52 – Azores Archipelago climate according to the Köppen-Geiger classification (adapted from AEMET & IM, 2011)

In the Azores the Cfb type of climate is prevalent in nearly all the islands (Figure 52) (AEMET & IM, 2012). It is only on the islands of Santa Maria and Graciosa that this variety is not seen in most of the territory. On the archipelago of the Azores the Csa climate is observed in coastal areas of the island of Faial and Graciosa, in the west of the island of Pico, in the south and east coasts of the island of Terceira, part of the southern coast of São Miguel and west of the island of Santa Maria. The Csa climate is observed in coastal areas of the island of Faial and Graciosa, in the west of the island of Pico, in the south and east coasts of the island of Terceira, part of the southern coast of São Miguel and west of the island of Santa Maria. In the Azores the Cfa climate is observed in the southern, northern and eastern coastal areas of Pico Island and in small coastal areas of the islands of Corvo, Flores and São Jorge. The Cfc type of climate is only observed in a narrow band around Mount Pico on the island of Pico.

Madeira archipelago has a Mediterranean climate, but there are differences between north- and south-facing regions, as well as between islands, based on differences in sun exposure, humidity, and annual mean temperature. There are also present other microclimates, from the constantly humid wettest points of the mountains, to the desert and arid Selvagens islands. The islands are strongly influenced by the Gulf Stream and Canary Current, giving mild year-round temperatures.

The average annual temperature at Funchal weather station is 19.6°C for the 1980 to 2010 period and, for the 1960 to 1990 period, some regions in the South Coastline exceed 20°C in annual average (IPMA, 2014). On the highest windward slopes of Madeira, rainfall exceeds 1270 mm per year, mostly falling between October and April.

In accordance with the Köppen-Geiger Climate Classification, Madeira's climate is the type Csb, temperate climate with hot, dry summers (Figure 53) (AEMET & IM, 2012). The Csa variety is observed in the coastal zones of Madeira. In the Archipelago of Madeira the classification of the Csc variant is observed in small areas of altitude of Pico Ruivo and of Pico do Areeiro.

Porto Santo Island in Madeira has a semi-arid steppe climate (BSh) in almost the entire island, Csa variety is observed in some places with the highest altitude and Csb type only occurring in areas of higher altitude (Figure 53) (AEMET & IM, 2012).

Figure 53 – Madeira Archipelago climate according to the Köppen-Geiger classification (adapted from AEMET & IM, 2011)

According to the Portuguese Thermal Regulation (Portuguese Mandamus 15793-F/2013, 2013) Portugal has three climatic zones for winter (I1, I2 and I3) and for summer (V1, V2 and V3) based on the class III Nomenclature of Territorial Units for Statistics (NUTS) and on the degree-days (based on 18 ºC), for winter and on the average exterior temperature (Text.) for summer (Table 25, Table 26 and Figure 54).

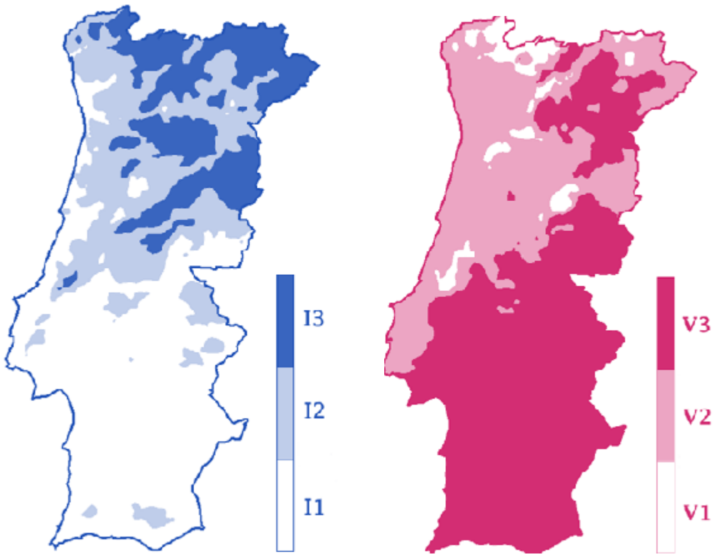


Figure 54 – Portuguese Climate Zone: winter (left) and summer (right) (Portuguese Mandamus 15793-F/2013, 2013)

Co-funded by the Intelligent Energy Europe
Programme of the European Union

Table 25 – Criteria for the definition of the winter climate zone in Portugal (Portuguese Mandamus 15793-F/2013, 2013)

Criteria	Degree-days ≤ 1300	1300 < Degree-days ≤ 1800	Degree-days > 1800
Climate Zone	I1	I2	I3

Table 26 – Criteria for the definition of the summer climate zone in Portugal (Portuguese Mandamus 15793-F/2013, 2013)

Criteria	Text. ≤ 20 °C	20 °C < Text. ≤ 22 °C	Text. > 22 °C
Climate Zone	V1	V2	V3

5.3.2 Buildings' Characteristics

The climatic and geographical characteristics of the local had a significant influence in the traditional buildings (see Figure 55) and there are significant differences between the houses from the north and south of Portugal (see (AAVV, 1980) for more details). Other aspect that is observed in the traditional architectures was the use of local materials.

Figure 55 – Traditional Portuguese architecture (Granite house with glazed balcony in Beira Alta (northeast), Patio house in Évora (southeast), traditional houses in Algarve (south) and in Madeira Island

From the 1960's the buildings started to be built without consideration of the local environment and the architectural and constructive solutions adopted throughout the country were similar, except for the regulation exigencies, for example the seismic that led to the use of concrete floors in the south part of the country instead of the beam and pot slabs that are usual in the north part of the country. Until the entrance into force of the first Portuguese thermal regulation in 1991 there were no thermal exigencies and, in general, thermal insulation was not used.

The Portuguese Thermal Regulation defines different levels of exigencies for buildings according to the severity of the climate where the building is located and thus nowadays there are no significant differences in the architectural design of the buildings throughout the country but the construction solutions and the insulation levels are different, based on the climatic zone defined on the thermal regulation.

5.3.3 Building Statistics

The construction market in Portugal is in crisis due to the country economic crisis and also due to the dimension of the building stock, as the number of existing residential buildings outnumber the number of families, 16% in 1981 and 45% in 2011, corresponding, in 2011, to 1.45 housings per family (INE, 2011). The growth of the residential building stock between 1981 and 2001 was 73.2% and the number of families only grew 38.3% (INE & LNEC, 2013). The country is also observing a small population growth (5.0% between 1991 and 2001 and 2.0% between 2001 and 2011).

The overall built area in Portugal is of around 400 million square meters, with residential buildings occupying around 75% of this area. The residential sector is the most significant both in terms of number of buildings and built area.

Presently there are no national statistics related to existing non-residential buildings. Nonetheless based on the number of new buildings not dedicated to residential uses, constructed between 1999 and 2010 (73,887 of the overall new buildings built on that same decade, 479,431) and based on the data from the latest statistics we can estimate that during the past two decades around 180,000 non-residential buildings have been built and globally exist between 300,000 to 400,000 non-residential buildings in Portugal.

From the 5.9 millions of residences in 2011, 68.1% were for permanent use, 19.3% for secondary or seasonal use and 12.6% corresponded to vacant buildings (in the market for lease or to sell, to demolish and too degraded to be habited) (INE & LNEC, 2013). More than half of the vacant buildings (58.7%) were neither in the market for lease or to sell nor to demolish.

The lease market in Portugal is small and the residential market is directed for sale market instead of the lease market. In 2011 the greatest amount of the permanent residences were occupied by the owner or co-owner (73.2%), 19.9% were leased or subleased and 6.8% were leased for free, occupied by the housekeeper or similar situations (INE & LNEC, 2013).

In 2011, the majority of households that were not occupied by the owner (i.e., leased and subleased or other situations of occupation) were privately owned, and 67.2% belonged to private owners or private companies and 20.7% were owned by relatives of the occupants of the residence. Besides these, the Public Administration (Government, public institutes and companies and local government bodies) held 11.6% of the households, the majority was ownership of local authorities (7.9%). The houses belonging to housing cooperatives were, in 2011, a small amount.

The number of buildings concluded is decreasing, from 114,909 houses (97.5% percent of the permits corresponding to new buildings) in 2001 to 17,464 in 2011 (72% of which were for new buildings).

From the 3.5 million buildings, in 2011, 93.3% were only destined to residential purposes, 6.0% had the majority of the area for housing purpose and 0.7% had the most part aimed for other purposes than housing (offices, retail etc.).

In 2011, 57.9% of the buildings existing in Portugal and 67.9% of residential buildings are located in the coastal areas. This same occurs with the population, more than half of the Portuguese population (65.6% in 2011) lives in the coastal areas.

Of the total classical buildings existing in 2011 (3,544,389), those built from 1971 constituted 63.1% of the housing stock. These buildings were distributed approximately evenly for each decade, being however noted a trend of slight reduction in the number of buildings in recent decades. The buildings constructed between 1946 and 1970 accounted for 22.5% of the Portuguese housing stock and buildings with more than 65 years (i.e., built before 1946) accounted for the remaining 14.4% (Figure 56).

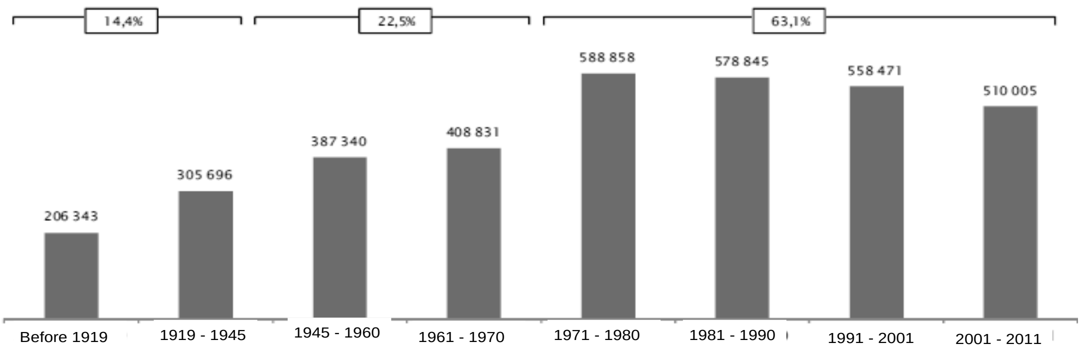


Figure 56 – Number of buildings according to the era of construction (adapted from INE & LNEC, 2013)

Buildings built after the 1970 constitute 63.1% of the classical buildings of the Portuguese existing housing stock in 2011. In average the Portuguese buildings are 37.92 years old (INE & LNEC, 2013). The number of buildings built before 1960 are less than twice the number of buildings built after 2001. The buildings aging index (number of buildings built until 1960 on the total of buildings built after 2001) for Portugal is 176.

The Portuguese building stock comprise mainly small buildings. In 2011, 84.9% of the buildings had one or two floors (39.4% with one floor and 45.5% with two floors), 9.5% had three floors and only 5.6% had four or more floors (INE & LNEC, 2013). The proportion of buildings with one or two floors decreased progressively with time, but remained above 75%. Almost half (47.7%) of the buildings with four or more floors are located in the Lisbon and Porto Metropolitan areas.

In 2011 Portugal had about 3.5 million buildings, of which 87.2% (3,089,935) with one house unit (regardless of the time of construction) and 12.8% (454,454) with two or more house units. Of the latter, 38.2% had two house units, 9.3% had three house units, 8.3% had four house units and the remaining 44.2% had five or more house units.

In Portugal there are only statistics regarding the building type for buildings with one or two house units. Although the proportion of detached buildings and row houses vary substantially in different regions of the country, 60.5% (1,946,604) were single detached houses, 22.7% (730,794) were row houses and 16.8% (542,393) were semi-detached houses (INE & LNEC, 2013).

According to the 2011 census 71.1% of the 3,544,000 existing buildings don't need retrofit works, 24.5% of the existing buildings needed small or medium retrofit works and 4.4% needed large retrofit works. However these values are regarded to the need of retrofit works due to the aging and physical degradation of the buildings and not to retrofit needs to ensure an adequate indoor environmental quality or energy efficiency of the building stock.

Between 2001 and 2011, there was a general improvement in the buildings' condition (40.4% decrease of buildings in need of major repairs and 36.0% decrease in buildings very degraded). Despite the improvement of the conditions, in 2011 there were still about 1 million buildings that needed intervention (uniformly distributed in different regions of the country) (INE & LNEC, 2013). This value decreased gradually and sharply in more recent buildings.

About one third (32.7%) of buildings in need of major repairs or much degraded in 2011 were concentrated in five regions: Porto, Tâmega, Lisbon Metropolitan Area, Algarve and Douro. Over half (58.1%) of the buildings needing major repairs or very degraded had been built until 1945 (Figure 57). In the building stock built later than 1990 the buildings in need of major repairs or very degraded are practically non-existent.

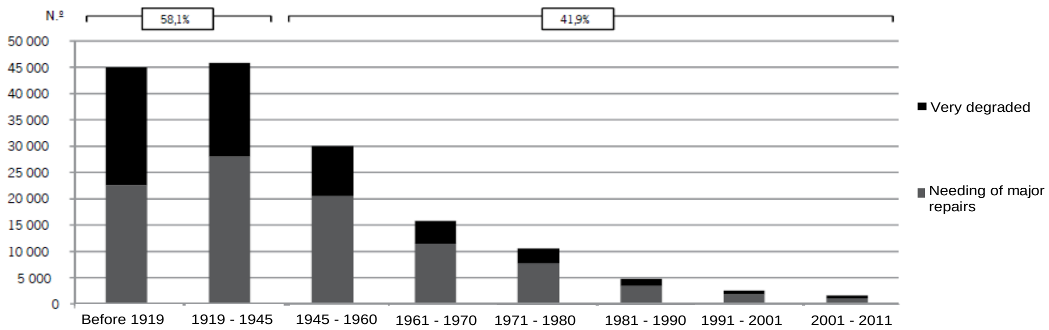


Figure 57 – Number classic buildings very degraded and in need of major repairs according to era of construction (adapted from INE & LNEC, 2013)

Almost all (94.6%) of the buildings in need of major repairs or that were too degraded had one or two floors. Approximately 68.0% of the buildings requiring major repairs or that are too degraded have brick or stone (without mortar) masonry walls or adobe walls, suggesting that most of these buildings were built before 1940 (INE & LNEC, 2013).

Almost all (90.8%) of the permanent residence housings, located in highly degraded classical buildings needing major repairs, are owned by of occupants (46.2%) or are privately owned (42.3%). This may be a result from the financial limitations of the owners, due to residents or tenants with low incomes, and low rents and consequent lack of willingness or ability to the owners and landlords to perform repair works.

The condition of the buildings did not vary significantly depending on type of use. Approximately 70% of the buildings exclusively for housing or with most of the area for housing did not require repair. Buildings with most of the area for other purposes than housing (e.g., commercial or office areas) showed worse state of conservation (66.5% of buildings without need for repairs) (INE & LNEC, 2013).

The construction and real estate sector has a key role in the economic growth of the country, notably the weight that it has in the economic activity, employment and investment. This sector is responsible for 18.2% of GDP and about 610,000 jobs, including activities ranging from construction and maintenance of infrastructure and buildings, to areas as diverse as the production and sale of construction materials, promotion and realtor services and architectural and engineering (MEE, 2013).

The segment of the refurbishment of buildings accounted for about 26% of the productivity (value of all costs that contribute to the execution of works) in the construction sector, in 2011 in Portugal, and the refurbishment of residential buildings accounted for 20% of the productivity of the construction sector, being the segment with minor significance at the national level. These values are considerably below the European average (around 34.9% in 2011).

In 2011, the refurbishment segment represented 15.6% of construction works completed in residential buildings, an increase that has been observed since 2002. This value is due not only to the increased number of refurbishment works, but mainly due to the decrease in the number of new buildings completed (Figure 58) (INE & LNEC, 2013).

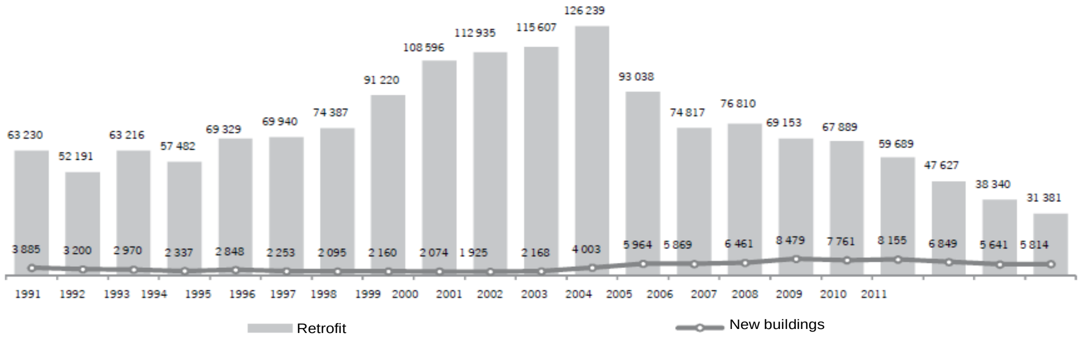


Figure 58 – Refurbishment and new buildings market in Portugal (1991 to 2010) (adapted from INE & LNEC, 2013)

The regions with the highest number of refurbishment works in the last decade, were Porto Metropolitan Area, Algarve and, in particular, Lisbon Metropolitan Area. The refurbishment has consisted largely of “expansion” works, followed by “alteration” works. The “reconstruction” works have a smaller expression than the previously referred works. In general refurbishment has been promoted by individuals or private companies, with the weight of other entities, including public, still very limited.

Despite the increase in the productivity of the construction sector in recent years, from 2004 until 2011 there was a drastic reduction in the businesses linked to the construction sector, about 30,000, from a total of 128,832 companies in 2004 to just 99,179 companies in 2011. The major concern is that this lead to more than 120,000 jobs reduction (from 527,330 in 2008 to 405,928 in 2011).

It is estimated that in the coming years, the decline in productivity in the various segments of the construction sector in Portugal is higher than the European average and that the recovery will be slower (INE & LNEC, 2013). There has been a significant downturn in the sector, with worsening prospects for both the demand and the funding (INE & LNEC, 2013).

According to Euroconstruct it is foreseen a reduction on the number of new buildings, especially residential buildings, until 2015. In the refurbishment sector the reduction expected is smaller, and it is expected a small increase in the productivity, less than 3%, after 2014.

5.3.4 Construction Details

In 2011, almost half of the country's buildings had reinforced concrete structure (48.6%) and roughly one third of the buildings structure consists of brick masonry walls with concrete or beam and pot slabs (31.7%). The other types of buildings are less representative (buildings with brick masonry walls without concrete or beam and pot slabs (13.6%), stone masonry walls without mortar or adobe walls (5.3%) and other types of structures (0.8%) (INE & LNEC, 2013).

Between 2001 and 2011 there was a 77.8% increase of buildings with reinforced concrete structure (over 753,132 buildings), a growth that has been ongoing since the introduction of this type of structure in the country. In the south and the interior center of the country the proportion of buildings with reinforced concrete structure is smaller. The Algarve was the exception to this trend with 57.4% of the buildings with reinforced concrete structure in 2011.

On the coast of mainland Portugal, in particular around the Lisbon and Porto Metropolitan Areas, the proportion of buildings with reinforced concrete structure was larger. In Madeira Archipelago 75.8% of the buildings have reinforced concrete structure. Alentejo (17.7%) and Coastal Alentejo (13.6%) have the higher proportion of buildings with stone masonry walls without mortar or adobe walls (INE & LNEC, 2013). The proportion of buildings with reinforced concrete structure increased with the number of floors, rising from 38.2% in buildings with one floor to 95.6% in buildings with 7 or more floors (INE & LNEC, 2013). In 2011, most part of the buildings in the country (84.0%) had plaster rendering as exterior face finishing. The proportion of other types of exterior rendering was reduced: 11.6% stone, 3.8% in ceramic or mosaic tiles and 0.6% with other coatings (INE & LNEC, 2013).

Between 2001 and 2011 there was an increase of 52.3% (more than 1,022,175) in the number of buildings with exterior cladding of the walls in plaster. In the same period there was a decrease of: 10.7% (less 49,195) buildings with stone cladding; 6.6% (less 9,399) buildings covered with ceramic or mosaic tiles; and 16 6% (less 4,585) of buildings with other types of coatings (INE & LNEC, 2013).

The amount of buildings with plaster rendering as exterior face finishing was 66% or more in all regions of the country, being even higher than 90% in 13 of the 30 Portuguese NUTS III regions. In the north of the country the use of this type of rendering is less usual; the most common finishing is stone. In some regions the buildings with stone cladding (in general granite) exceeded 25% (e.g., Tâmega, Beira Interior Norte, Serra da Estrela and Ave). In the Porto Metropolitan Area and Lower Vouga regions 15% of the buildings are covered with ceramic or mosaic tiles close to 15% (INE & LNEC, 2013).

In 2011, 93.1% of all buildings in the country had pitched roofs covered with ceramic or concrete tiles (90 4% in the Lisbon Metropolitan Area, 89.1% in Porto Metropolitan Area, 79.9%in Madeira and 70.2%in Algarve). The remaining buildings had pitched roofs covered with other materials (1.8%), had tilted and flat roof (2.1%) and had flat roofs (3.0%) (INE & LNEC, 2013).

In the Algarve, 14.4% of the buildings had flat roofs and 13.4% of the buildings had pitched and flat roofs. In Madeira, 9.4% of the buildings had flat roofs and in 9.1% of the buildings had pitched and flat roofs. The buildings located in these two regions concentrated 35.3% of the buildings with flat roofs and 47.6% of the existing buildings with pitched and flat roofs in Portugal (INE & LNEC, 2013). In general residential buildings have curtains and wooden doors (inside), venetian blinds and plastic roller shutters (placed inside or outside the windows) as shading systems.

Table 27 lists the conventional construction solutions for the single and multi-family Portuguese buildings, represented in Figure 59.

Table 27 – Conventional construction solutions for the single and multifamily Portuguese buildings (ADENE, 2013)

Construction period	< 1960	1961 - 1990	1991 - 2012	2013 -
Type of wall (U-value W/m^{2}ºC)	Stone masonry wall with 50 cm (2.00)	Single hollow brick wall with 20 cm (1.76)	Double hollow brick wall (11 cm + 11 cm) with 3 cm of extruded polystyrene (0.92)	Double hollow brick wall (15 cm + 11 cm) with or Single hollow brick wall with 20 cm Insulation level depending on the thermal legislation
Type of window (U-value W/m^{2}ºC)	Wood, single glazed (4.40)	Aluminium without thermal cut, single glazed (4.30)	Aluminium without thermal cut, double glazed (3.30)	Aluminium with thermal cut, double glazed (2.80)
Type of roof (U-value W/m^{2}ºC)	Pitched roof with ceramic tiles, beam and pot slab with 15 cm (2.80)	Pitched roof with ceramic tiles, beam and pot slab with 15 cm (2.80)	Pitched roof with ceramic tiles, beam and pot slab with 15 cm with 3 cm of extruded polystyrene placed over the slab (0.94)	Pitched roof with ceramic tiles, beam and pot slab with 15 cm with the insulation placed over the slab or flat roof with beam and pot slab Insulation level depending on the thermal legislation

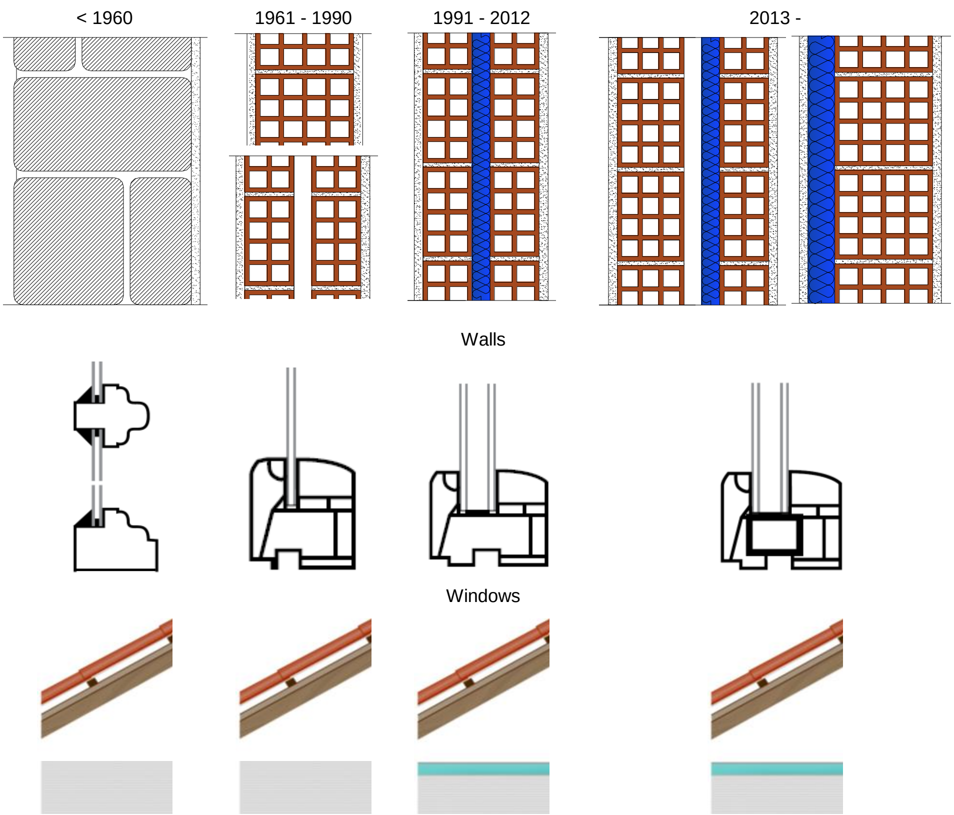


Figure 59 – Conventional construction solutions for walls, windows and roofs for the single and multifamily Portuguese buildings

As previously stated no data exists analysed and systematized about construction solutions for non-residential buildings in Portugal but it is fair to assume that throughout the different decades the same structural materials and techniques are equally used in residential and non-residential buildings although in more recent buildings (especially office buildings) it is usual to have totally glazed façades.

Heating and Cooling Systems and Renewable Energy Systems

In 2011, about 48.7% of conventional permanent housings had heating systems (from fireplaces, movable oil heaters, to centralized systems, air-fluid or air-air, with gas boilers, heat pumps etc.). The open and closed fireplaces are the type of heating system available in 26.6% of the households; 10.7% of households had a central heating system (the gas boilers with water heaters are the most common systems) and only 14.0% of households did not have any type of heating system available (INE & LNEC, 2013).

In almost all regions, more than 84% of the conventional permanent housings have some type of heating system available. In some interior regions, namely Alto Trás-os-Montes, Beira Interior Norte, Cova da Beira and Pinhal Interior Sul over 98% of the households have some type of heating systems, on the other hand in the Algarve, Azores and Madeira there are lower values, respectively 75.2%, 40.4% and 22.0% (INE & LNEC, 2013). The type of heating system available varies substantially in the different regions of the country.

The proportion of households with fixed heating systems and central heating systems is relatively small in most regions, however, has progressively increased in more recent buildings and the number of buildings without heating systems, with open fireplaces or movable heating systems is decreasing (INE & LNEC, 2013).

In 2011, just over half (53.4%) of the house units that had heating systems used electricity as their main source of energy (INE & LNEC, 2013). About a third (34.1%) of the house units still used wood, coal or other solid fuels for the same purpose. The less representative source of energy for heating was gas, used only in 8.6% of the households, but used in 39.7 % of the households with central heating systems (INE & LNEC, 2013).

In 2001 only 10.2% of the house units had cooling systems. This proportion varied significantly in different regions of the country, especially in the regions of Algarve and Alentejo were 20% to 30% of the households had cooling systems (INE & LNEC, 2013).

The proportion of households with cooling systems increased progressively with time of more recent construction (from 3.7% in buildings prior to 1919 and 18.9% in buildings built between 2001 and 2011 (INE & LNEC, 2013). Just over half (52.8%) of the households with cooling systems were located in buildings built between 1991 and 2011.

The use of renewable energy systems, mainly solar thermal systems, has become more common in buildings built after 2009, as they became mandatory. Photovoltaic systems are also installed in some buildings.

5.3.5 Architectural Regulations

The following regulations apply in Portugal with impact on Architectural circumstances, both in terms of new construction and refurbishment.

The General Regulation for Urban Buildings (RGEU – "Regulamento Geral das Edificações Urbanas"), produced in 1951 and last revised in 2001. The RGEU concerns general legislation for new building and refurbishment, with emphasis on structural and constructive safety, sanitation and public circulation. In terms of regulations affecting the bioclimatic performance of buildings, the RGEU is overall satisfactory for common contemporary urban situations – in fact it is quite advanced in some cases, such as the 45º rule for spacing between opposing facades. However, it may be quite ambiguous, and present important inadequacies for special building types, particularly in the case of vernacular architecture, or old buildings located in historic urban centres. In the latter case, the use of RGEU is articulated with other legislation concerning the conservation of the built patrimony – which is coordinated by the public institute tasked with the conservation, preservation, and inventory of the Portuguese architectural archaeological heritage, IGESPAR (Instituto de Gestão do Património Arquitectónico e Arqueológico).

The Thermal Regulation for Residential Buildings (REH -"Regulamento de Desempenho Energético dos Edifícios de Habitação") and the Thermal Regulation for non-Residential buildings (RECS – "Regulamento de Desempenho Energético dos Edifícios de Comércio e Serviços") were produced by decree-law in 2013 (Decree-Law 118/2013) and represent the national transposition of the recast EPBD of May 2010. These sets of regulations establish quality requirements for new residential (REH) and commercial and office buildings (RECS), both in terms of thermal performance (limiting thermal losses and controlling excessive solar gains), but also in terms of the efficiency of technical systems installed and in the cases of office buildings, ventilation and air quality. These new regulations replaced and updated the former Regulation for thermal behavior of Buildings (RCCTE – "Regulamento das Características de Comportamento Térmico dos Edifícios", produced in 2006) and the Regulation of Energy, Heating and Cooling Systems in Buildings (RSECE – "Regulamento dos Sistemas Energéticos de Climatização em Edifícios").

Both REH and RECS impose limits on energy consumption for heating and cooling and hot water production, which is a clear incentive to use efficient systems and energy sources with less impact in terms of primary energy. This legislation requires the installation of solar panels in new constructions, and values the use of other renewable energy sources. However, it is often pointed out by some professionals in the area that both REH and RECS still use inadequate comfort criteria to access thermal performance, often leading to the excessive use of mechanical acclimatization systems, or to low ratings in terms of energy performance. This is particularly evident in the case of old buildings, such as those located in historic city centers. We can also identify some misalignments between legislation in these cases since if by one side the use of solar panels (rightly) required by these regulations could improve the overall rating in terms of energy performance, their usage is also strongly conditioned by regulations concerning historic patrimony, which often prohibits their adoption, such as in the case of Baixa Pombalina, in Lisbon, the UNESCO classified areas of Ribeira in Porto, or the historical centre of Guimarães, just to mention a few.

5.4 Cyprus

5.4.1 Location and Climatic Data

Cyprus is the biggest island in the Mediterranean Sea (except of Sicily) and is located in the eastern Mediterranean region (Figure 60), neighbouring with Turkey, Lebanon, Syria, Israel, Egypt and Greece. It has on average a latitude of 35° North and longitude of 33° East and is considered to currently being the eastern point of the European Union. The fact that Cyprus is surrounded by water, the Mediterranean Sea, due to its nature as an island, plays a major part in the country's climate conditions.

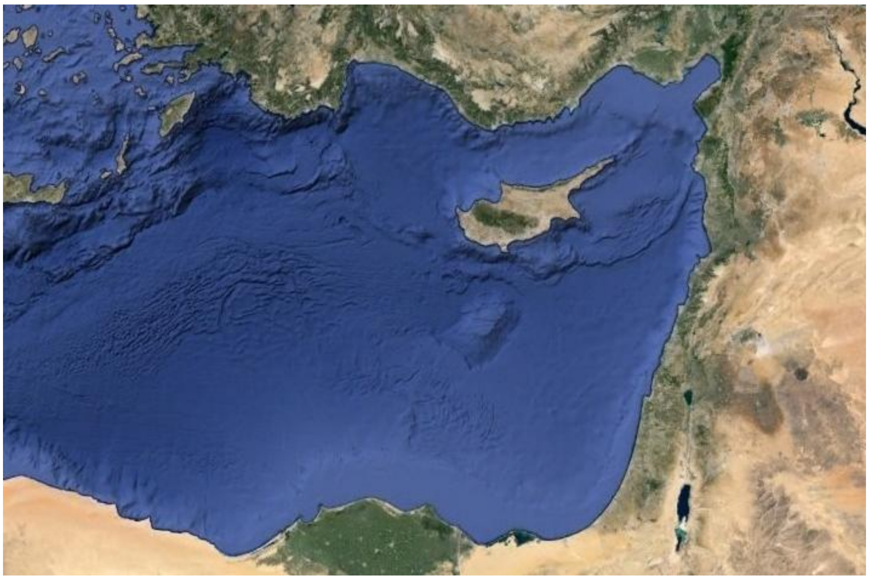


Figure 60 – The eastern Mediterranean Region

Cyprus covers a total area of 9,254 square kilometres and can be divided in four physical areas, due to the geo-morphological characteristics of its ground. These, given by the Cyprus Meteorological Service, are (see Figure 61):

- The Troodos mountain range, which is situated in center-west part of the island, and has a top of 1,951 meters above sea level called Olympos Mountain top.
- The Pentadaktylos mountain range, a relatively long and narrow range spreading along the northern coast of the island, with a top of approximately 1,000 meters.
- The plain of Measoria, which is situated between the Troodos and Pentadaktylos mountain ranges and has a low altitude, not surpassing 180 meters above sea level.
- The plains and valleys, which are spread along the coast line.

Based on the above mentioned morphology, Cyprus is divided into four climatic zones (as can be seen in Figure 62):

1. Coastal climatic zone
2. Inland climatic zone.
3. Semi-mountainous climatic zone.
4. Mountainous climatic zone.

Figure 61 – Morphological Map of Cyprus

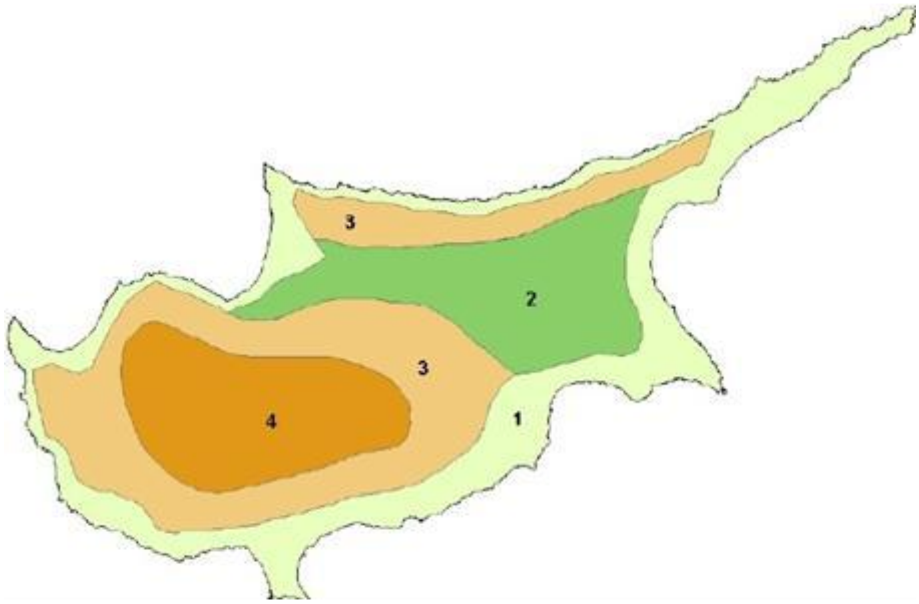


Figure 62 – Climatic Zones of Cyprus (1 - coastal zone, 2 - inland zone, 3 - semi-mountainous zone, 4 - mountainous zone).

Cyprus has an intense Mediterranean climate, or according to Köppen climate classification (see Figure 63) a Subtropical (Csa) climate and partly a Semi-Arid (Bsh) type climate (to the north-eastern part of the island). The main characteristics of Cyprus' Mediterranean climate are the hot and dry summer from mid-May until mid-September, the mild but rainy winter from mid-November until mid-March and the transitional seasons (spring and autumn) in between.

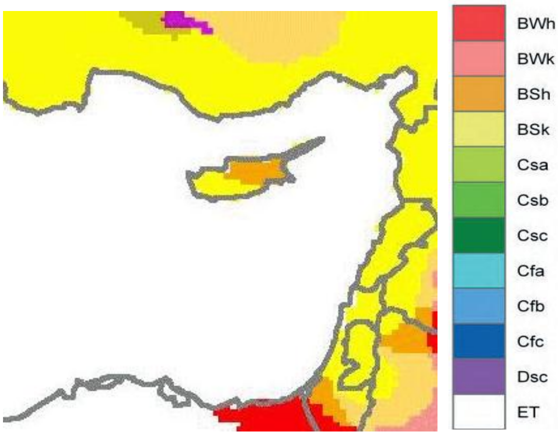


Figure 63 – Köppen climate classification map of Cyprus

During summertime, Cyprus, and the eastern Mediterranean region in general, are under the influence of a seasonal shallow trough of low pressure extending from the great continental depression, centred in southwest Asia. This results in high temperatures and clear sky. Precipitation during this period is pretty low and usually amounts lower than 5% of the mean annual total. In winter Cyprus is near the track of fairly frequent small depressions which cross the Mediterranean Sea from west to east between the continental anticyclone of Eurasia and the generally low pressure belt of North Africa. These depressions give periods of disturbed weather usually lasting from one to three days and produce most of the annual precipitation, the average fall from December to February being about 60% of the annual total.

The central Troodos massif and, to a less extent, the long narrow Kyrenia mountain range, Pentadaktylos, play an important role in the meteorology of Cyprus and the climatic differences observed in different parts of the island. The predominantly clear skies and high sunshine amounts give large seasonal and daily differences between temperatures of the sea and the interior of the island which also cause considerable local effects especially near the coasts.

The seasonal difference between mid-summer and mid-winter temperatures is quite large at 18 °C inland and about 14 °C on the coasts. Differences between day maximum and night minimum temperatures are also quite large, especially inland in summer. These differences are in winter 8 to 10 °C on the lowlands and 5 to 6 °C on the mountains, increasing in summer to 16 °C on the central plain and 9 to 12 °C elsewhere.

In July and August the mean daily temperature ranges between near 30 °C on the central plain and 23 °C on the Troodos mountains, while the average maximum temperature for these months ranges between 37 °C and 28 °C respectively. Even though the average high temperatures are not so bad for summertime, there are quite a few days during July and August where temperatures can reach really high values. In these extreme heat-wave conditions, temperatures can reach as high as more than 45 °C inland and as much as 40 °C along the coast. In the mountain regions, conditions are much better under these circumstances.

In January the mean daily temperature is around 10 °C on the central plain and 3 °C on the higher parts of Troodos mountains with an average minimum temperature near 5 °C and almost °0 C respectively. These values increase slightly in the coast line with an average daily mean temperature of about 12.5 °C and an average daily low temperature of 8 °C. Despite the relatively mild winter conditions, temperature may drop several degrees Celsius below zero in the mountains for a substantial number of days during winter and for quite a few days in the inland region. Along the cost, near 0 °C temperatures are very rare, with minimum temperatures of around 2-3 °C being observed during the coldest winter nights.

The average annual total precipitation increases up the south-western windward slopes from 450 mm to nearly 1,100 mm at the top of the central mountainous regions. On the leeward slopes amounts decrease steadily northwards and eastwards to between 300 and 350 mm in the central plain of Mesaoria and the flat south-eastern parts of the island. The narrow ridge of the Kyrenia/Pentadaktylos range, stretching 100 miles from west to east along the extreme north of the island, produces a relatively small increase of rainfall to nearly 550 mm along its ridge at about 1,000 m. Rainfall in the warmer months contributes little or nothing to water resources and agriculture. The small amounts which fall are rapidly absorbed by the very dry soil and soon evaporated in high temperatures and low humidity.

Autumn and winter rainfall, on which agriculture and water supply generally depend, is somewhat variable. The average rainfall for the year as a whole is about 480 mm but it was as low as 182 mm in 1972/73 and as high as 759 mm in 1968/69 (the average rainfall refers to the island as a whole and covers the period 1951-1980). Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 30 years.

Snow occurs rarely in the lowlands and on the Kyrenia/Pentadaktyos range but falls frequently every winter on ground above 1,000 m usually occurring by the first week in December and ending by mid-April. Although snow cover is not continuous during the coldest months, it may lie to considerable depths for several weeks especially on the northern slopes of high Troodos mountain range.

Another important aspect of the climate in Cyprus is relative humidity. Elevation above mean sea level and distance from the coast has considerable effects on the relative humidity which to a large extent are a reflection of temperature differences. Humidity may be described as average or slightly low at 65 to 95% during winter days and at night throughout the year. Near midday in summer it is very low with values on the central plain usually a little over 30% and occasionally as low as 15%. However, along the south coast line due to the prevailing south-west winds, there are quite a few days during summertime where relative humidity values can reach as high as 90% or slightly more, especially during evening hours. These high values of relative humidity affect to a great extent thermal comfort conditions inside buildings and severely increase cooling load demand.

Over the eastern Mediterranean generally surface winds are mostly westerly or south-westerly in winter and north-westerly or northerly in summer. Usually of light or moderate strength, they rarely reach gale force. Over the island of Cyprus however winds are quite variable in direction with orography and local heating effects playing a large part in determination of local wind direction and strength. Differences of temperature between sea and land, built up daily in predominant periods of clear skies in summer, cause considerable sea and land breezes. Whilst these are most marked near the coasts they regularly penetrate far inland in summer reaching the capital, Nicosia, and often bringing a welcome reduction of temperature and also an increase in humidity. As a matter of fact, these breezes come from a south-west to west direction during evening to early morning hours during summer time. This is exploited mainly for thermal comfort conditions of residential houses. As a result, most bedrooms have a southwest orientation and large window openings facing west direction. This provides a sense of light breeze and cooler conditions during summer nights.

Gales are infrequent over Cyprus but may occur especially on exposed coasts with winter depressions. Small whirlwinds are common in summer appearing mostly near midday as "dust devils" on the hot dry central plain. Very rarely vortices, approaching a diameter of 100 m or so and with the characteristics of water spouts at sea and of small tornadoes on land, occur in a thundery type of weather. Localized damage caused by these has been reported on a few occasions but in general Cyprus suffers relatively little wind damage.

Finally, as far as sunshine is concerned, all parts of Cyprus enjoy a very sunny climate compared with most countries. In the central plain and eastern lowlands the average number of hours of bright sunshine for the whole year is 75% of the time that the sun is above the horizon. Over the whole summer six months there is an average of 11.5 hours of bright sunshine per day whilst in winter this is reduced only to 5.5 hours in the cloudiest months, December and January. Even on the high mountains the cloudiest winter months have an average of nearly 4 hours bright sunshine per day and in June and July the figure reaches 11 hours. In total, Cyprus receives an average of 3,300 to 3,500 hours of sunshine per year. This is about double that of cities in the northern half of Europe (for example London has 1,461 hours). However, in winter there can be more than four times more sunshine (for example London has 37 hours while coastal locations in Cyprus have around 180 hours of sunshine in December, that is, as much as in May in London).

5.4.2 Buildings' Statistics

The general situation regarding residential and non-residential buildings in Cyprus is extracted mainly from data recorded during the latest general population census as well as statistical data regarding building (residential and non-residential) permits for the last decade. All data were collected from the Cyprus Statistical Service (CSS).

During the latest census, a number of 433,212 residential units were recorded. These comprise of single family houses (40%), apartments (28%), semi-detached houses (14%), detached or semi-detached houses in large residential complexes (8%), etc.. The recordings are shown in Figure 64. One can observe that slightly more than 60% of the residential units available at the moment are single detached or semi-detached house and around 30 % are apartments in multi-storey buildings.

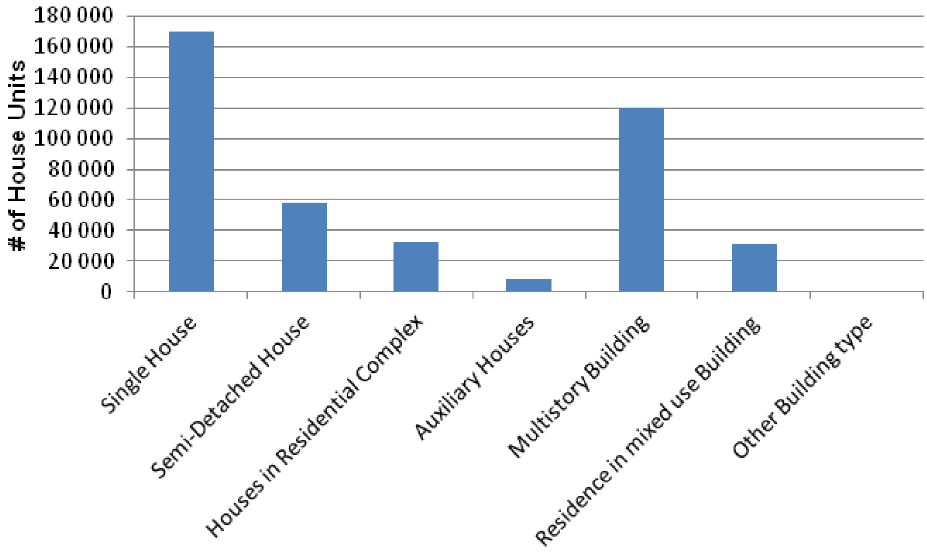


Figure 64 – Number of residential units per building type

The above presented houses were built almost during the last century. Their age ranges from a few months old to almost a hundred years old as shown in Figure 65. Almost three quarters of the buildings were built in the last 40 years (2% since 2011, 19% from 2006-2010, 13% from 2001-2005, 17% from 1991-2000 and 20% from 1981-1990). The booming of the construction sector can be seen from the fact that around a third of the current building stock was built from 2000 onwards. These can be also observed from Figure 66, where one can see the building permits for residential and non-residential buildings for nearly the last decade.

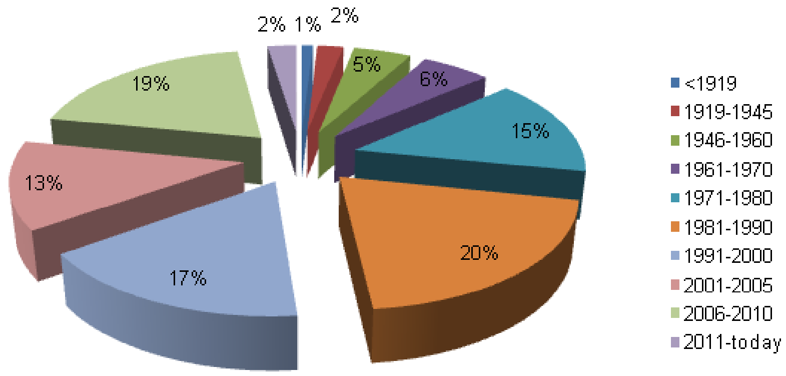


Figure 65 – Residential units' age

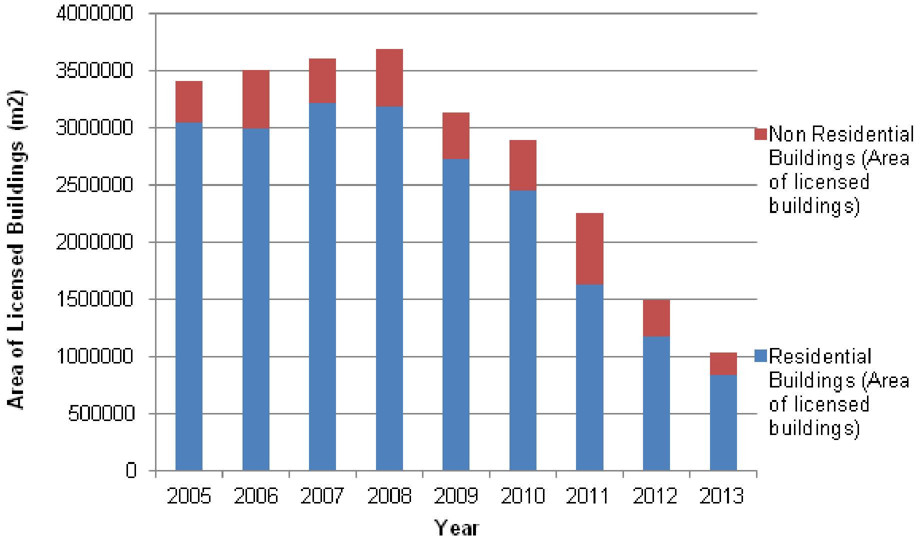


Figure 66 – Area of licensed residential and non-residential buildings in Cyprus form 2005 - today

One can also observe the effects the economic crisis had on the buildings sector. In 2013, building permits issued by the authorities were decreased by more than 70% from the record high of more than 350,000 permits issued in 2007 and 2008. Another significant conclusion can be extracted by observing Figure 67, where one can see the ratio of non-residential to residential permits issued per year since 2005. The first conclusion is that non-residential buildings are gaining ground over residential ones. Nevertheless, the situation seems to be reaching a steady state with non-residential buildings accounting to approximately 20% of the newly licensed buildings to be constructed. The rest 80% remains for residential purposes.

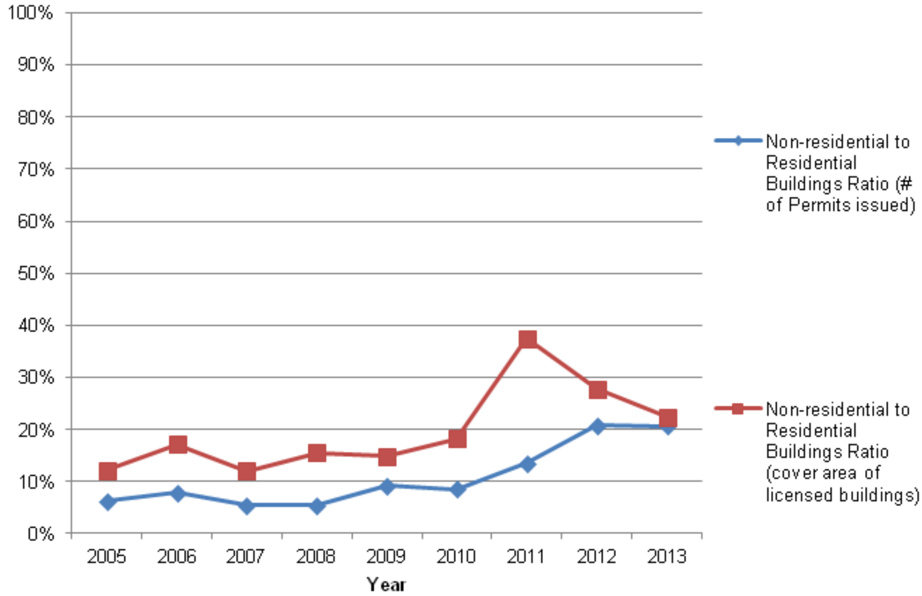


Figure 67 – Non-Residential to Residential Buildings Permit Ratio

Furthermore, another interesting fact is the current state of use of the existing residential building stock. Table 28 summarizes the occupancy of the recorded residences in Cyprus. Around 300,000 units (69%) are used as a permanent residence by the occupants, while another approximately 80,000 units are used as holiday villas or for touristic purposes in general (18%). Furthermore, around 55,000 (12.6%) residential building units remain empty, and therefore available for sale or lease.

Table 28 – Residential building units type of occupancy

Type of residence occupancy	Number of residences	%
Permanent residence	299,275	69.1
Holiday villa	71,942	16.6
Touristic Apartment/house	6,146	1.4
Empty Residence	54,651	12.6
To be demolished/other use	1,198	0.3
Total	**433,212**	**100**

Keeping in mind the above given data and coupling it with the fact that there are just above 300,000 thousands households currently in Cyprus then one can observe that there are 1.35 residential units per household, out of which more than 10% is free up the market. One can then expect that the trend of decreased construction activity in the residential buildings sector, shown in Figure 66, to continue, thus providing a major opportunity in the energy refurbishment of existing building stock.

The existing residential units are spread in all five provinces (controlled by the republic of Cyprus) as shown in Figure 68 and Figure 69, covering all for climatic zones. Around one third of existing residential units are situated in the province of Nicosia, slightly more than one quarter in the district of Limassol, another one third nearly evenly split between the provinces of Larnaca and Pafos and finally the remaining 5% in Famagusta.

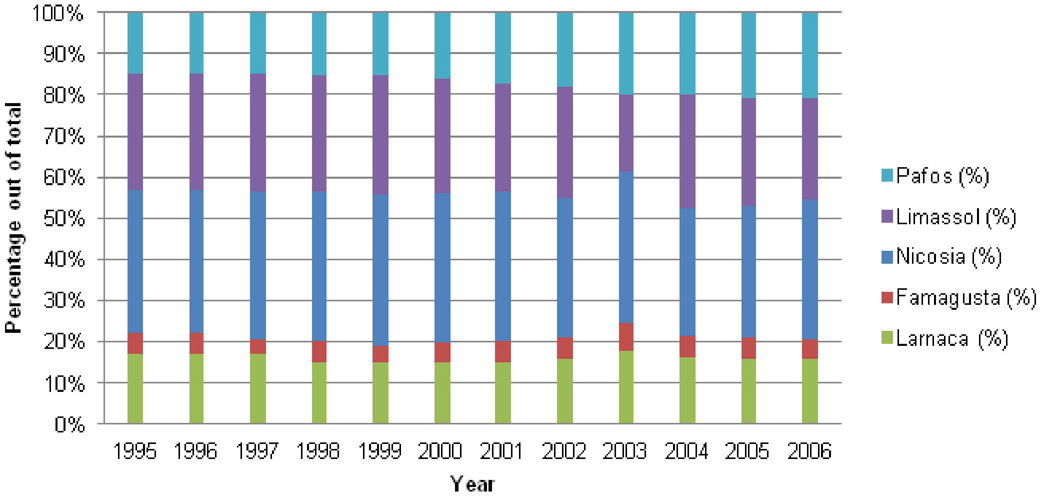


Figure 68 – Distribution of residential buildings per province

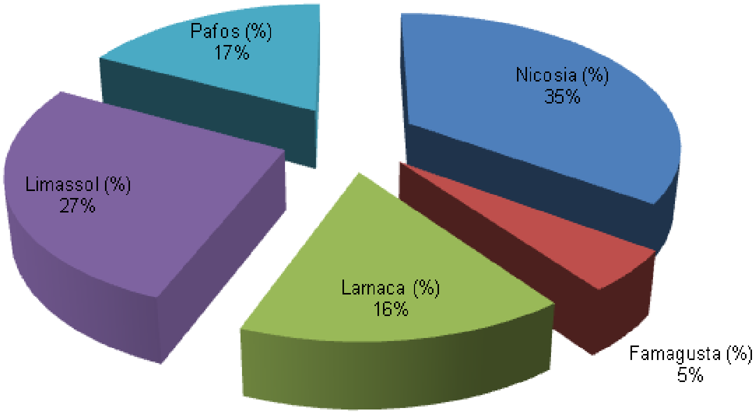


Figure 69 – Average mean of residential buildings distribution per province

Another important characteristic of the residential building stock in Cyprus is based on geographical distribution of residential buildings in urban and rural areas. As shown in Figure 70 and in Figure 71, nearly 65% of residential buildings are situated in urban areas and the remaining 35% in rural areas. Even though there are no available data for the non-residential buildings, one can expect the percentage of non-residential buildings in urban areas to be significantly increased.

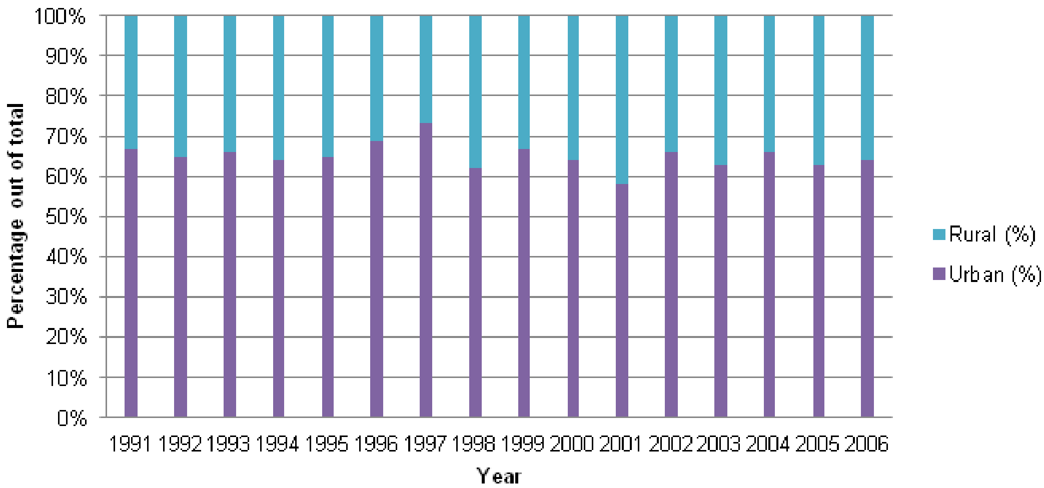


Figure 70 – Distribution of residential buildings in urban and rural areas

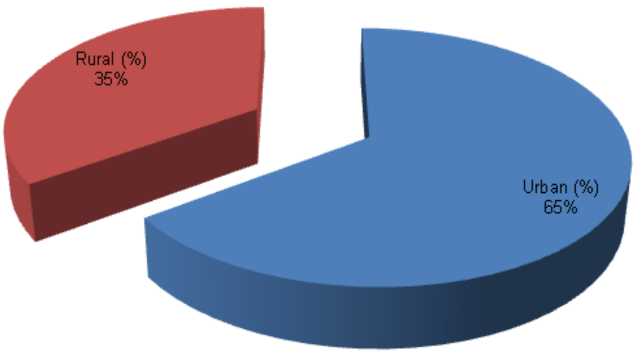


Figure 71 – Average mean distribution of residential buildings in urban and rural areas, throughout the years

In addition, taking into account that all of the urban centers are situated either along the coast (Larnaca, Limassol, Pafos, Paralimni) either inland (Nicosia), and also that most rural areas are spread along the coast as well, one can conclude that the major energy need for the overwhelming majority of residential, as well as non-residential, buildings in Cyprus is demand for cooling load and not so much for heating (especially for non-residential buildings that are usually fully occupied during the hot summer days).

Finally, another important characteristic of the existing residential building stock in Cyprus can be obtained from Figure 72 and Figure 73, where one can see the permits issued per residential building type for the past decade. Even though there is a clear trend of people moving to urban environments, the “single family house” remains the dominant residential building type constructed and amounts around 80% out of the total residential buildings being constructed since 2000 onwards.

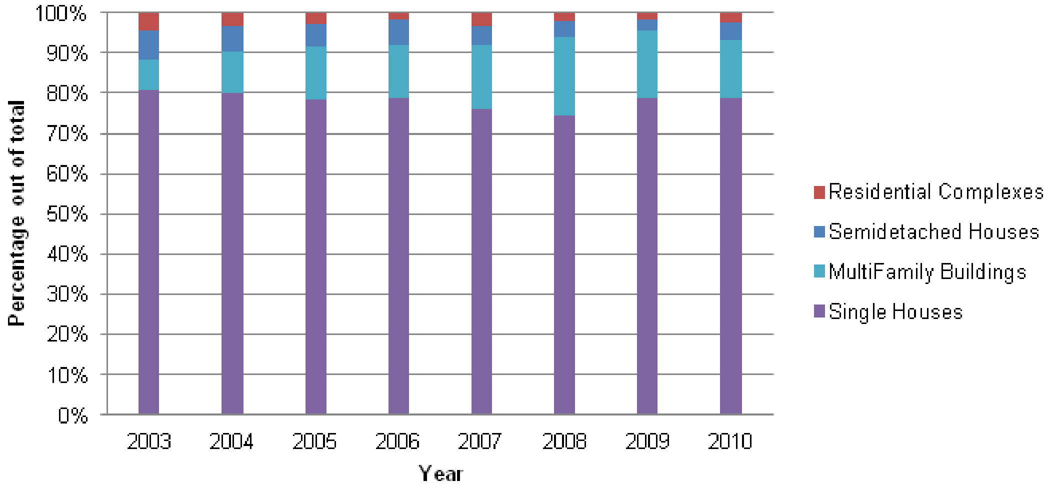


Figure 72 – Construction Permits issued per residential building type from 2003-2010

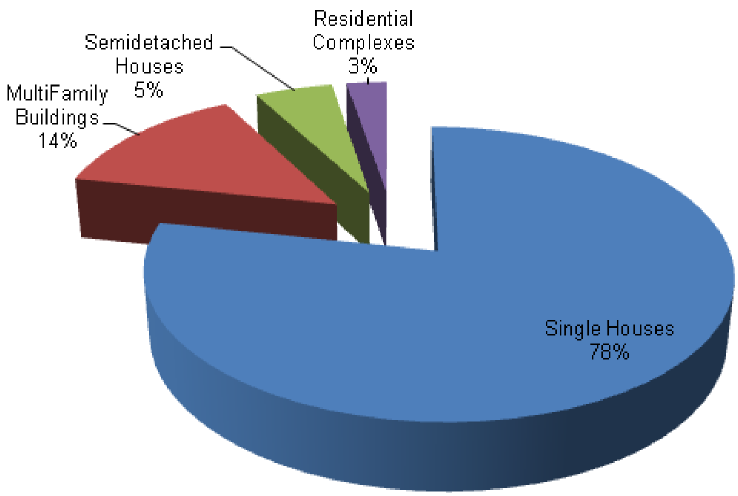


Figure 73 – Average mean Construction Permits issued per residential building type

5.4.3 Construction Details

The market trend for construction techniques and materials used in Cyprus for residential and non-residential buildings the last few decades has been mainly driven by the effort of minimizing construction cost while meeting the minimum legislation requirements. This was not the case up until the sixties (1960) though, where specific traditional building techniques were used for mainly residential buildings construction.

At the time there were two major construction techniques dominant in the construction of walls in residential houses. In mountainous and semi-mountainous areas, the typical wall construction was “stone masonry wall” with raw stone being seen in the external side of the wall and mortar finish in the inside. On the other hand, in the coastal and inland areas, a typical clay/hay mud-brick was used with white lime mortar used as finish both on the external and internal wall surface. In both cases, the typical wall width was around 60 cm. In both of the above constructions, there was no load bearing structure to support the house. The buildings were relatively small comprising of two or three rooms (serving as living room and bedrooms). The kitchen and bathroom were usually a separate entity from the main building.

Roof construction was very similar across the island. In most cases it was a pitched tile roof (especially in the mountainous and semi-mountainous areas where snow during the winter season was a typical occurrence). Nevertheless, there was a significant number of houses in coastal areas with a flat roof. This comprised from tree boles used for support followed by a layer of canes and hay to ensure tightness. Then a layer of clay ground was used to ensure water tightness. Finally, in the case of pitched roofs the finish was done by an array of tiles while in flat roofs by an extra layer of hard mortar to further ensure water-tightness.

With urbanization in the 1960s and the application of seismic regulations, the typical building construction in Cyprus, which prevails up until today, was introduced. This comprised from the characteristic reinforced concrete load bearing structure of the house and clay brick walls with plaster finish in both the internal and external surface of the wall. The typical wall thickness ranged from 22-25 cm, depending on the plaster finish layer thickness. The roof was either a pitched tile roof or flat roof out of reinforced concrete.

With no significant legislation changes and the absence of any legislation or regulations regarding the Energy Performance of Buildings, the same construction technique was used up until 2010 with limited exceptions and variations. The most dominant variation was the use of two rows of clay bricks (instead of a single row brick of width of 20 cm), each of 10 cm width, for the construction of the building walls comprising the building envelope, leaving a 5 cm gap between them. This resulted in the increase of the wall thickness to nearly 30 cm. In addition, a rare exception was the use of polystyrene between the two brick rows, for thermal insulation purposes. This was introduced in the late 1980s early 1990s and was usually found in houses built in mountainous or semi-mountainous regions.

From 2010 onwards, the legislation regarding the Energy Performance of Buildings was brought in effect, which introduced mandatory thermal insulation of buildings in the early stages and specific thermal transmittance values (U-values) for walls, roofs and windows on a second stage. This resulted in a major shift of the market towards much more energy efficient buildings. Thermal insulation of walls and roofs became a standard which resulted in a significant reduction of the overall building mean U-value. The most dominant wall construction techniques are described below:

- *Wall Type A:* Thermal Brick with plaster finish in the internal and external surface;

- *Wall Type B:* Standard Brick (20 cm thickness) with 5 cm polystyrene in the external side of the brick and plaster finish in the internal and external surface;
- *Wall Type C:* Two layers of Standard Brick (10 cm thickness), with 5 cm polystyrene in between, and plaster finish in the internal and external surface;
- *Wall Type D:* Two layers of Standard Brick (10 cm thickness), with 5 cm polystyrene and 5 cm trapped air layer in between, and plaster finish in the internal and external surface;
- *Roofs:* construction of roofs remained pretty much the same (flat or pitched roof) with simply the addition of a 5 or 10 cm thickness of polystyrene layer for thermal insulation purposes.

Even though Cyprus is divided in four climatic zones, no special restrictions regarding thermal insulation levels are applied until now. So the above mentioned construction techniques are widely used all over the island, with the most common options being the first two.

Finally, another important element of the building envelope was windows. These began by single glazing windows on a wooden frame. In larger buildings though (such as schools etc.) it was common for the window frame to be made by steel. Then, the market moved towards aluminium window frames with single glazing and the following upgrade was the use of double glazing. The next innovation introduced in window construction has been the use of insulating materials inside the aluminium window frame in order to minimize thermal bridging effects. Finally, new materials have been introduced in the construction of windows and glazing such as PVC for the frame, low-e coatings for the glazing, argon fill or vacuum between the double or triple glazing. These resulted in the significant reduction of the achieved mean U-value of the windows from a value around 5 W/mK to around 2 W/mk or lower (sometimes even as low as 1.1 W/mK).

The above mentioned construction techniques are summarized in Table 29, in Table 30 and in Table 31 where the usual construction techniques per period can be seen, with the resulting theoretical U-value and schematic diagram of the construction details for each of the wall envelope element.

Table 29 – Construction details of window glazing

Construction Period	**Envelope element description**	**Achieved U-value**
<1980	Single glazed windows with wooden frame.	4.50 W/mK
1980-1990	Single glazed windows with aluminium frame without thermal cut.	5.30 W/mK
1990-2000	Double glazed windows with aluminium frame without thermal cut.	3.60 W/mK
2000-today	Double glazed windows with aluminium frame with thermal cut.	2.40-2.80 W/mK
	Double glazed windows with low-e coating and aluminium frame with thermal cut.	<2.2 W/mK

Table 30 – Construction details of walls and roofs and achieved U-values (until 2010)

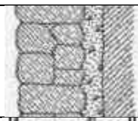
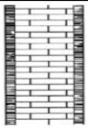
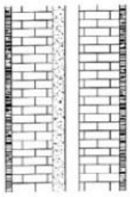
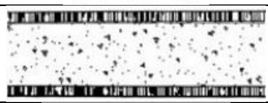
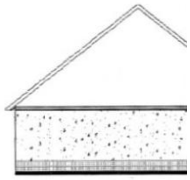
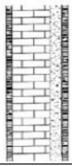
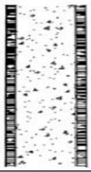
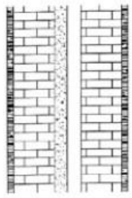
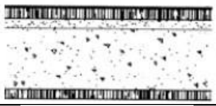
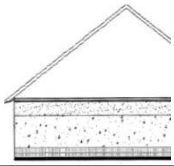
Construction Period	Envelope element description	Construction detail	Achieved U-value
<1960	Stone masonry wall with mortar finish on the internal surface		≅ 1.7 W/mK
	Clay/hay mud-brick with mortar finish in both the external and internal surface.		≅ 1.7 W/mK
1960-2010	Typical non-insulated wall comprising of hollow brick of 20 cm width and plaster finish on the internal and external surface.		1.389 W/mK
	Non-insulated wall comprising of two rows of hollow bricks of 10 cm width, 5cm air gap in between and plaster finish on the internal and external surface.		1.087 W/mK
	Insulated wall comprising of two rows of hollow bricks of 10 cm width, 5cm air gap and 5 cm polystyrene in between and plaster finish on the internal and external surface.		0.467 W/mK
	Flat reinforced concrete roof with no thermal insulation		3.098 W/mK
	Pitched insulated roof, comprised of a horizontal reinforced concrete element, 5 cm thickness of polystyrene and pitched tile section		3.580 W/mK

Table 31 – Construction details of walls and roofs and achieved U-values (after 2010)

Construction Period	Envelope element description	Construction detail	Achieved U-value
>2010	Insulated wall comprising of hollow brick of 20 cm width, 5 cm of polystyrene on the external side and plaster finish on the internal and external surface.		0.516 W/mK
	Thermal insulating brick of 25 cm width with 2.5 cm of plaster, with improved thermal insulation properties, on the internal and external side.		0.680 W/mK
	Insulated wall comprising of two rows of hollow bricks of 10 cm width, 5cm air gap and 5 cm polystyrene in between and plaster finish on the internal and external surface.		0.467 W/mK
	Flat reinforced concrete roof with polystyrene of 5-10 cm thickness for thermal insulation		0.510-0,276 W/mK
	Pitched insulated roof, comprised of a horizontal reinforced concrete element, 5 cm thickness of polystyrene and pitched tile section		0.539 W/mK

5.4.4 Architectural Regulations

There are a number of laws that regulate the construction of buildings in Cyprus. These are the “Regulating legislation regarding roads and buildings” which was inherited from the British during the years they occupied the island, and the “Town Planning and Country Planning” law of 1972. The “Regulating legislation regarding roads and buildings” was first modified in 1959, the first year of independence of the Republic of Cyprus, and its latest modification happened in 2013 with the 60(i)/2013 legislative act. Similarly, the “Town Planning and Country Planning” law has been also modified in 2011, 2012 and most recently in 2013. These two laws provide the framework of designing new buildings, acquiring permits, construction issues etc.. Guidelines on the use of different materials, regulations on the seismic behaviour of designed buildings, the load bearing structure etc. are resolved through regulations, issued under ministerial orders (Regulatory Administrative Actions).

A third law concerning the construction of buildings and related to the Energy Performance of Buildings is the “142(i)/2006 - Regulating the Energy Performance of Buildings” law that was voted initially by the parliament in order for Cyprus to meet its obligations with the European Union after becoming a member State in 2004. This law provides the framework of application for the European Directive regarding the Energy Performance of Buildings – EPBD. It has been modified twice with laws 30(i)/2009 and 210(i)/2012 in order to abide with the recast EPBD. Technicalities regarding the minimum requirements for the Energy Performance of Buildings, minimum U-values of the building’s envelope, inspection of HVAC and heating systems etc. are also resolved through a number of regulations, issued under ministerial orders (Regulatory Administrative Actions).

Finally, the regulations determining the covered area of buildings, minimum and maximum plot and building size, building height, number of floors, façade restrictions, etc. are regulated under the Urban Planning Regulations issued by the "Town Planning Authority", under the Ministry of Interior. There are a number of such regulations, each addressing the specific needs of specific areas, cities or villages in Cyprus. These are:

- Nicosia Urban Planning Regulations;
- Specific Urban Planning Regulations for the historic city centre of Strovolos;
- Limassol Urban Planning Regulations;
- Specific Urban Planning Regulations for the historic city centre of Limassol;
- Larnaca Urban Planning Regulations;
- Pafos Urban Planning Regulations;
- Area south of Nicosia Urban Planning Regulations;
- Athienou Urban Planning Regulations;
- Deryneia Urban Planning Regulations;
- Chrysochou Bay Urban Planning Regulations;
- Annexes of General Urban Planning Regulations;
- General Planning Regulations of Rural Areas;
- Planning Regulations Statement of Paralimni;
- Planning Regulations Statement of Ayia Napa;
- Planning Regulations Statement of Lefkara.

In the above mentioned planning regulations, a number of villages are listed as "villages presenting social, architectural and historical interest". In addition to these villages, there are a number of other areas named as "Areas of special Architectural Character" in the planning regulations of specific cities/villages.

In all of these areas special architectural regulations apply in order to protect the traditional and historical character of the old buildings situated there, which most of them are listed buildings, and the surrounding environment. These regulations have mainly to do with façade issues, materials used in the facades of the buildings and the roofs and not the interior construction of the buildings, unless these are listed. In such a case stricter regulations apply which extend to specific methods and materials used for the construction and preservation of the building.

6 Discussion and Conclusions

The SouthZEB project aims to initiate a wide-scale roll out of accessible and recognised continuous professional development courses, focussing on the needs of the Southern European countries. A key objective is to transfer knowledge and experience from some of the front runner countries.

The status of the implementation of the EPBD in the target countries can be evaluated on the basis of four core aspects: Energy performance requirements; National Plan for progression of nZEB; Energy Performance Certificates (EPCs) and Training.

The Energy Performance requirements are defined for the target countries and the national legislation of each country is adapted accordingly to the 2010 recast EPBD. It is important to highlight that in Italy the EPBD implementation status is different by regions and can be said that in the northern regions the EPBD is well implemented and in some south regions it is in an early implementation stage.

The National Plan for progression to nZEB is defined or under development in each target country and has specific goals to be attended in what refers to the definition of nZEB, national mechanisms to implement it, and main target measures.

The building energy performance certificates (EPCs) are being issued in all target countries and national databases are being fed with information on regions and types of certified buildings. However special attention should be given to Cyprus since the available data could be more detailed. In all target countries the EPCs are issued by experts in building design and building systems area. These professionals were trained by the national energy agencies and evaluated by exam.

It seems that a number of the southern EU counties lag behind on certain issue on the implementation of the EPBD and RES. Through successful actions taken by front runner countries, training material can be developed to be disseminated in the southern countries.

To use an example of one of the front runner countries, France implementation of the EPBD includes some of the most ambitious requirements toward nZEB with the hope of buildings being ‘energy positive’ beyond 2020. As regards the energy performance requirements (primary energy) for new buildings of the most recent legislation (RT2012), defines a 50 kWh/m^2.year target for residential buildings and a 70 kWh/m^2.year target for non-air-conditioned office buildings (110 kWh/m^2.year for air-conditioned office buildings).

As it defines a general target, the French regulation provides architects and engineers with more freedom in designing buildings. It promotes effective bioclimatic design, since parameters such as orientation, accurate climate data concerning temperature and insulation, and the way in which the architectural project addresses the energy needs of heating, cooling and lighting, are now data that are put into the calculation software. Engineers and architects are thus encouraged to work together to obtain a building permit, from the beginning of the process. RT2012 includes the requirement of renewable energy use in houses, and is therefore expected to make the use of solar thermal panels more widespread in the market.

It would appear that French professionals (architects and engineers) have the knowledge and a process in place to help meet the requirements of the EPBD and RES Directives and it is this process and knowledge that can be transferred and applied to Southern EU countries.

Article 14 of the RES Directive outlines information and training requirements of the Member States inclusive of certification schemes or equivalent qualification schemes. These schemes are required for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal systems and heat pumps. *Annex IV* of the Directive outlines the criteria to be followed for these schemes. These criteria outline training requirements and programmes (theoretical and practical parts) for the installation of renewable energy sources such as biomass boilers, stoves, heat pumps, solar photovoltaic and solar thermal.

In what concerns the Renewable Energy Directive implementation, it can be said that the objectives of the renewable share for 2020 are defined for each target country. The set of measures to reduce energy consumption and increase renewable energy source for the sectors of electricity, heating and cooling and transport are established in the NREAP of all target countries. The measures to achieve the Directive goals rely on national programs, economic incentives, legislation, licensing of new projects and other tools. Accordingly to the energy consumption projections for 2020 these measures will contribute to the accomplishment of the Directive target values.

Material developed and used by countries that have successfully implemented the criteria of the RES can be used to prepare training material and courses in the less advanced countries. Austria has the highest 2020 RES target yet the lowest percentage increase required of the front runner countries in terms of the implementation of RES. When compared with the implementation of the EPBD, some southern EU countries are advanced in the implementation of the RES. Portugal has a 2020 RES target of 31%, just a 5% increase on where the country stood in 2009. These figures when compared to the UK show that Portugal has a more ambitious target and a smaller percentage increase requirement by 2020 (ECOFYS, 2011).

Summarily, it can be said that the Directives implementation is good, nevertheless some aspects can be improved in all target countries namely the possibility to provide more specific training on the nZEB area since the training is more focused on the building energy certification process.

The training must consider the climate, buildings and building stock, construction characteristics and architectural regulations of each target country.

As it can be seen, the target countries share common areas (common climate, topography etc.) while others are totally different. These differences are difficult to deal with. One such example is the laws/regulations concerning the architecture. There is a great variety of regulations not only among the four countries, but also within the countries themselves making the establishment of common seminars a challenging task.

Having specified the conditions, the training needs of the target professionals will be evaluated, and the consortium will be in the position of developing the training programmes and assessment methodology for each target group. The training modules will so be adapted to the target countries' needs.

A number of initiatives have already been implemented throughout the EU which provides a platform for the SouthZEB project to build from. CEPH (www.passivehousedesigner.eu) ran from 2008 to 2011 and brought together stakeholders from across Europe with experience in passive house design training. A course was developed in which participants from central and northern European countries attended. Project outcomes included training material which can be used as a starting point for the SouthZEB modules.

The principles of passive house are closely associated with nZEB therefore to help achieving nZEB in southern European countries; this material can be adapted and utilized for southern European training programmes. It can assist in helping Southern EU countries tighten their minimum energy requirements, through improved building envelopes and improved building services including the use of renewable energy sources.

Two other projects recently concluded, ILETE and TRAINERBUILD, can also provide a platform for the SouthZEB project to work from. ILETE set up a common training kit composed by modules adapted for building professional stakeholders. Although not focussed on nZEB, the material and kit will be used in training seminars for the SouthZEB project. TRAINERBUILD designed a comprehensive value chain strategy to generate change in thinking of public and private building owners regarding the link between energy efficiency values related to building ownership. Like ILETE, this did not focus on architect, engineers or nZEB but the toolkits developed for the authorities can be used as a starting point for this project.

IDES-EDU is another IEE concluded project that can provide a platform for the SouthZEB project to work from. The IDES-EDU project aimed to educate, train and deliver specialists, both students and professionals, in Integral Sustainable Energy Design of the Built Environment. This project aimed at contribute to optimised market orientated implementation of the EU directives on EPBD and promotion of renewables and will also facilitate the process to reach the EU targets on longer term through delivering specialists on academic level, trained and educated in integrated sustainable energy design and working in multidisciplinary teams. This enhances the efficiency in the building process and will lead to optimised building concepts in terms of energy efficiency, integration of renewables, thermal comfort and health, and costs effectiveness.

To conclude, each EU country is implementing measures to move toward nearly zero-energy buildings by 2020 through the transposition of the Energy Performance of Buildings (EPBD, 2010/31/EU) Directive and also the Renewable Energy Sources (RES 2009/28/EC) Directive. However the central and northern EU countries are more advanced in implementing a number of articles within the directives, therefore the opportunity exists to develop the training material necessary to assist the southern EU countries to catch up with their progress toward nZEB. As mentioned previously, there are specific training needs and constraints in each country but the overall objective is to reduce the minimum energy performance requirements (reduce energy demand, improve building envelopes) of southern countries through the training of professionals to design and develop nZEB in the near future.

The preparation of Deliverable 2.1 allowed the consortium to gather information regarding the application of the EPBD and RED directives in EU and the progress versus the nZEB targets, allowed to identify training and certification possibilities available in the target countries and the training and certification possibilities offered and allowed to collect and categorise building traditions for the target countries.

This information allowed the consortium to identify the training needs required for the target Southern European countries (Greece, Cyprus, South of Italy and Portugal) less advanced on the progress towards Nearly Zero Energy Buildings (nZEB) and to investigate and categorize the specific training and certification needs of the selected target groups (engineers, architects, municipality employees, decision makers). The current situation was also evaluated for the front runner countries (i.e. United Kingdom, Austria, Germany, North of Italy and France) for benchmarking purposes and for use in the training programmes design.

It has been identified that there is a substantial need for professionals, such as architects and engineers, specifically trained and educated in nZEB design approach. These professionals must be able to work in integrated multi-disciplinary teams, to improve energy performance of buildings and to address the integration of sustainable energy in buildings and built environment, to design buildings meeting EPBD standards and especially buildings within the nearly zero energy concept. It was also possible to verify the need to provide more specific training on the nZEB area since the existing training is more focused on the building energy certification process.

These findings were considered in task 2.2 - Specification of the training and certification needs for the target groups in the target countries and also in the development of the contents of the different training modules, especially Training Module 5 that relates to Local Architectural Regulations, Training Module 6 that focuses on Building Energy Simulation, Training Module 7 that presents the Low Carbon Technologies and Controls, Training Module 8 that deals with Retrofitting towards nZEB. Training Module 9 - Construction Management and Field Supervision and Training Module 10 - Preparation of funding schemes and other incentives for nZEB, focused on the training needs of municipality employees and decision makers. Syllabus also took in consideration the findings of D2.1.

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