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National Report for Italy on Energy Efficiency Policy Scenario Analysis for the Buildings and transport Sectors

Edoardo Croci, Federico Pontoni
and Silvio Camaldo

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IEFE - The Center for Research on Energy and Environmental Economics and Policy at Bocconi University
via Guglielmo Röntgen 1, I-20136 Milan
tel. +39.02.5836.3820 – fax +39.02.5836.3890

This report can be downloaded at: http://www.iefe.unibocconi.it

Edoardo Croci (IEFE – Bocconi) Steering Committee member

Federico Pontoni (IEFE – Bocconi)

Silvio Camaldo (IEFE Bocconi)

Prepared by: "*IEFE – Bocconi University*"

NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE RESIDENTIAL, TERTIARY AND TRANSPORT SECTORS

D.4.1

PART OF WORK PACKAGE 4: FORWARD-LOOKING SCENARIO ANALYSIS, FOCUSING ON MACROECONOMIC AND MICROECONOMIC IMPACTS OF ENERGY EFFICIENCY POLICY OPTIONS

NATIONAL REPORT FOR ITALY

DATE: 20 DECEMBER 2016

HERON project

"Forward-looking socio-economic research on Energy Efficiency in EU countries"

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Steering Committee member: *Prof. Edoardo CROCI*

Prepared by: *Edoardo Croci, Federico Pontoni and Silvio Camaldo*

HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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GLOSSARY

ACRONYMS

BAU	Business-As-Usual
BEMS	Building Energy Management System
BEVs	Battery Electric Vehicles
EE	Energy Efficiency
ESCO	Energy Services COmpany
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HEVs	Hybrid Electric Vehicles
ICCT	International Council on Clean Transportation
LEAP	Long-range Energy Alternatives Planning
NEEAP	National Energy Efficiency Action Plan
NZEB	Nearly Zero Energy Buildings
PHEV	Plug in Hybrid Vehicle
yoy	Year over Year

EXECUTIVE SUMMARY

In this report, we present the forward-looking scenario on energy efficiency in the Italian building and transport sectors. For each sector, a baseline scenario ("business as usual", BAU) is developed, presenting a likely scenario reflecting the existing (and certain-to-come) policies and technological developments. The second scenario elaborated for each sector, named EE-0, represents an ideal scenario of full penetration of efficient technologies. All other scenarios take into account the effects of barriers and the introduction of specific policies aimed at overcoming them.

Identified barriers

The quantification of barriers via the HERON DST proceeds in two steps: barrier weighting via an AHP method and total effect quantification by summing weights. In the Italian building sectors, barriers with the highest singular weights resulting from DST/AHP weighting are: 1) socio-economic status of building users (0.144), 2) lack of awareness on savings potential (0.091) and 3) lack of any type of financial support (0.086). If no policies address those barriers, the DST quantification yields that savings can only be realised to some extent. Moreover, the DST simulations show that some technologies will be affected more than others. In Italy, barriers can reduce the saving potential by 56% in Building shell/heat system, by 26% for efficient heating and heat pumps technologies and by 21% in cooling technologies and other home appliances.

In the Italian transport sector, the importance of barriers varies largely. The barriers with highest single impact are: 1) low satisfaction/lack of trust for public transport (0.156), 2) lack or limited financial incentives (0.094), and 3) concerns on reliability / hesitation to trust new technologies (0.081). Also in the transport sector, the DST simulations show that some technologies will be affected more than others. In Italy, barriers can reduce the saving potential by 25% for electric cars, by 20% for biodiesel and they can affect also by 15% to 20% modal shift.

Policy instruments minimizing barriers and allowing the achievement of the policy target

Policy instruments that focus on addressing the described barriers (minimizing them) and allow the achievement of the policy target are either long-term instruments of the action plans, adaptations of the given instruments or completely new suggestions of policy instruments. In this report, we have simulated the impact of different measures, most of which have a long-term perspective, such as awareness campaigns and technological standards. At the same time, we have included some specific monetary measures, such as specific incentives for electric vehicles, as well as, more generous tax deductions for energy efficient investments.

Scenario Building Approach and key results

The forward-looking scenario exercise for Italy presented in this report analyses the two sectors buildings and transport each with two principal sub-sectors (residential/tertiary buildings and passenger/freight transport). For each sector, a baseline scenario (BAS; or "business as usual", BAU) is developed presenting a likely scenario reflecting the existing (and certain-to-come) policies and technological developments. In addition, for both main sectors, we defined a number of scenarios that reflect the implementation of additional policy measures and consequent effects on energy demand.

All other scenarios are elaborated using the DST. At first, we test the effect of the barriers on the cost-effective scenario. In a second step, we elaborate scenarios, which overcome the effect of some of the barriers, by introducing additional policies. Figure 1 below gives a graphical representation of the sequential proceeding within the HERON quantifications.

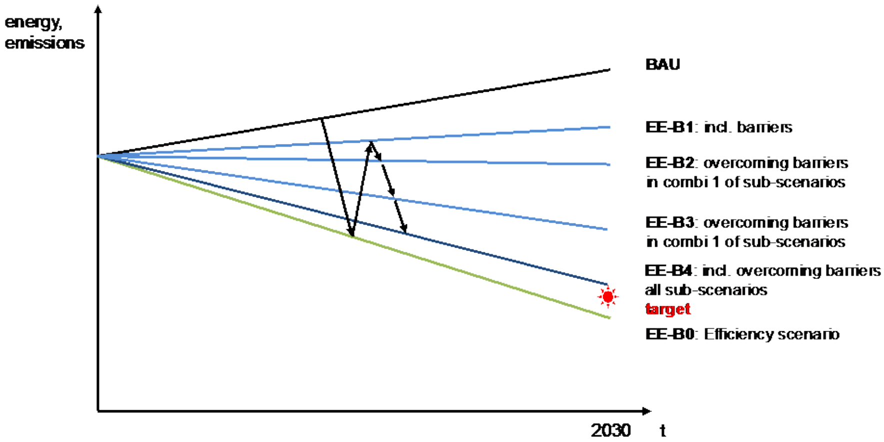

Figure 1: Overview of HERON scenarios – source: Germany National Report.

The scenario analysis shows (see Figure 2 – Figure 4), that if barriers are accounted for in calculations, EU energy and climate targets for Italy will probably be missed in the building sector, but not in the transport sector. However, if policies are enacted that effectively overcome (most of) the existing barriers, then also the residential sector can almost achieve its targets.

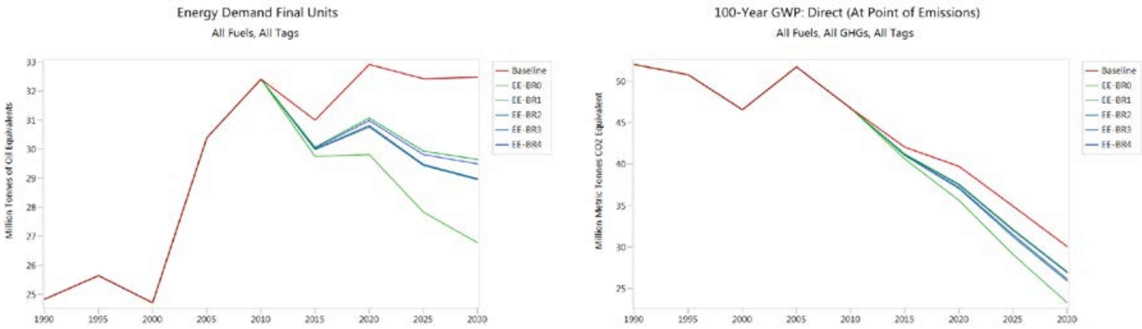

Figure 2: Residential building energy demand and GHG emissions by DST-scenarios.

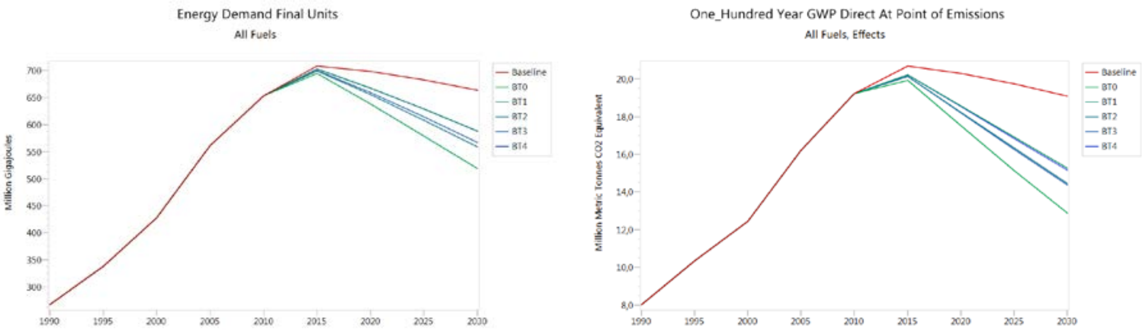

Figure 3: Tertiary building energy demand and GHG emissions by DST-scenarios.

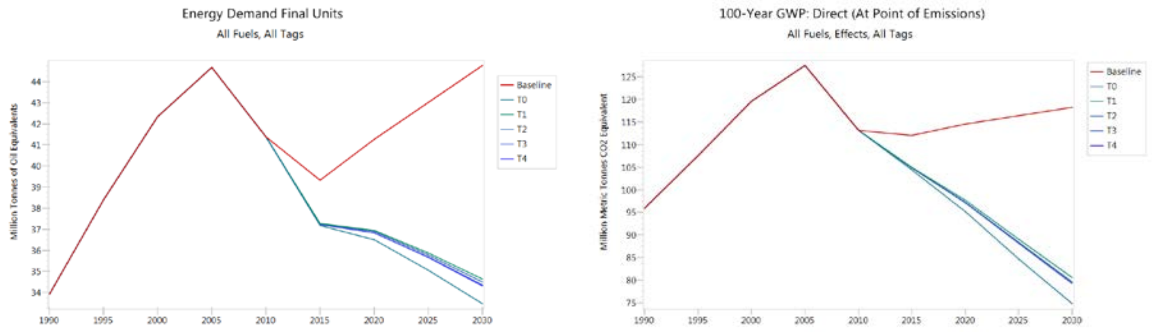

Figure 4: Transportation sector energy demand and GHG emissions by DST-scenarios.

CHAPTER 1: NATIONAL ENERGY EFFICIENCY AND GHG IN ITALY

1.1 NATIONAL ENERGY EFFICIENCY AND GHG REDUCTION TARGETS FOR BUILDINGS

Objectives

The Italian Energy Efficiency objectives are set in two main national official documents (see for more details Deliverable 1.1 of the HERON Project):

- **Italian Energy Efficiency Action Plan** (NEEAP), first published in 2007 and reviewed in 2011 and 2014;
- **National Energy Strategy** (Strategia Energetica Nazionale - SEN), launched in 2013 by the Italian Ministry of Economic Development.

In relation to the targets, Italy aims at reducing by 42 Mtoe its primary energy consumption, under the EU Directive 2012/27/EU.

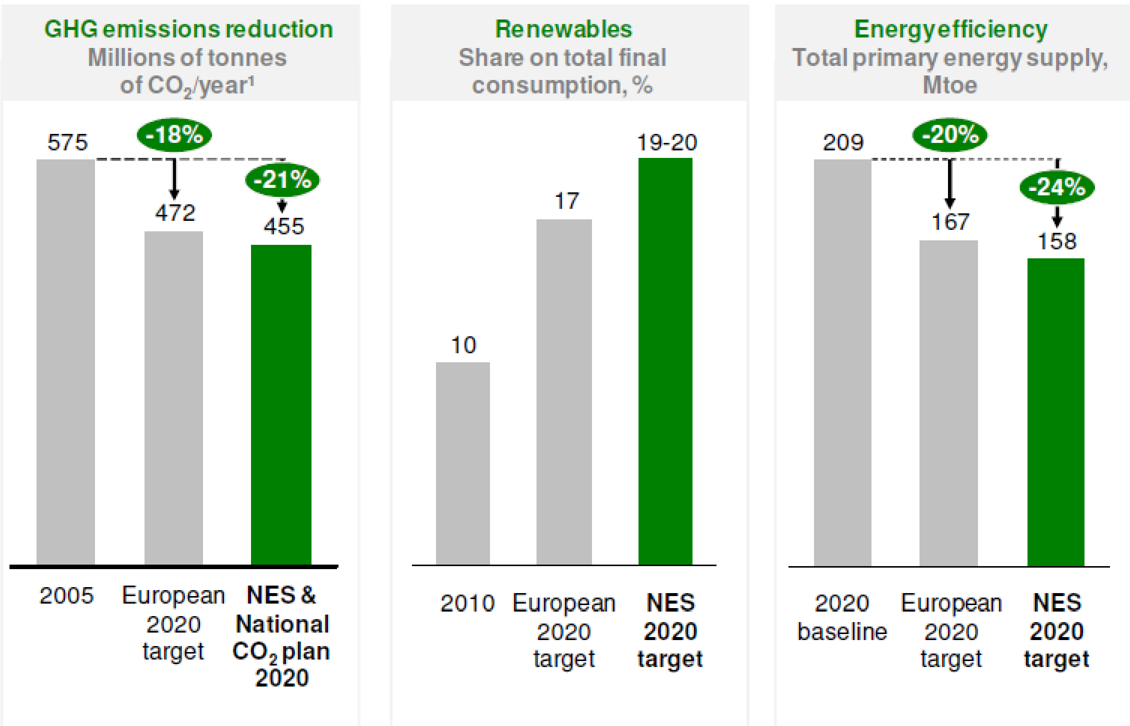

Figure 5: **Italy targets for 2020 as set by the Italian Energy Strategy**

Following the SEN, Italy aims to reduce by a further **9 Mtoe** its primary energy consumption by 2020, outperforming its target.

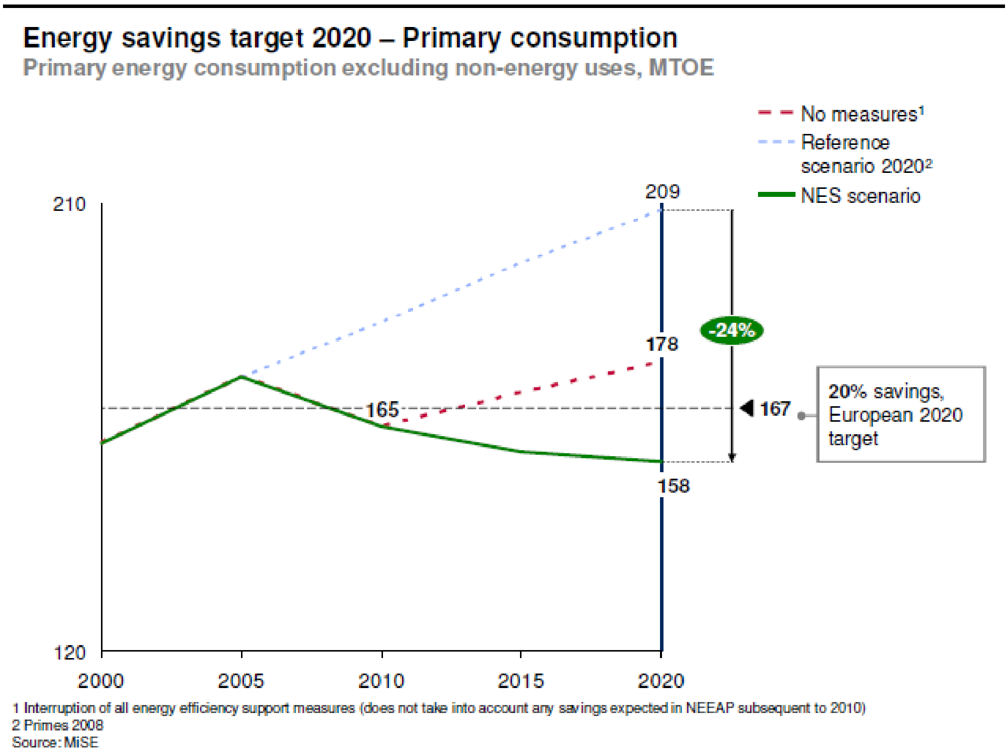

Figure 6: **Italy energy efficiency targets and reference scenario (primary energy consumption).**

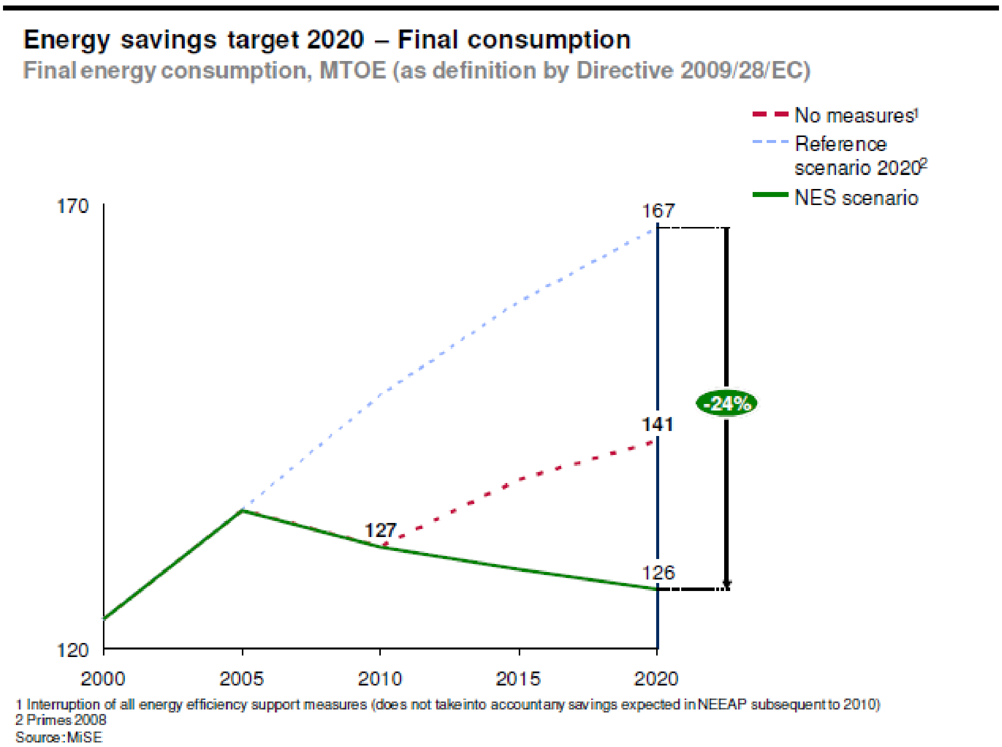

Figure 7: **Italy energy efficiency targets and reference scenario (final energy consumption).**

The 2050 target instead is not defined in the Italian NEEAP. However, the SEN declares “primary consumption will have to fall in the range of **17-26%** by 2050 compared to 2010, by decoupling economic growth from energy consumption. In particular, efforts in building and transport will be critical” (SEN, 2013).

As for the building sector specifically, subsequent NEEAPs have entrusted almost two-thirds of the total Italian energy savings to the residential, tertiary and public sectors (De Paoli, 2013).

In the 2011 NEEAP, the original targets for the residential sector was set at 6.63 Mtoe/year of expected savings by 2020; the target for the tertiary sector, instead, was set at 2.55.

After four years, the targets have been revised (NEEAP, 2014):

- For the residential **final energy consumption** the target for 2020 has increased by 3.67 Mtoe/year of expected savings, totaling **10.3 Mtoe/year**;
- For the tertiary **final energy consumption** the target for 2020 has increased by 1.23 Mtoe/year of expected savings, totaling **3.78 Mtoe/year**;

With reference to the energy savings target of the residential sector, the 2014 NEEAP highlights as “for the residential, services and industry sectors, the overall savings were estimated to be electricity for more than one fifth, and heat for the rest (assumption supported by the monitoring performed on the incentive instruments)”(NEEAP, 2014).

The Italian NEEAPs underline the key role of energy efficiency measures in the residential sector as a contributor for a better and stronger Italian economic development. As highlighted in the 2014 NEEAP document, “in these years of crisis, the building sector has managed to remain afloat thanks to the positive contribution of building maintenance (ordinary and, especially, extraordinary), which has partly offset the sector’s steep drop which started in 2008. Nowadays, two thirds of investments in the building sector relate to renovations of existing buildings, showing a by now well-settled trend towards the recovery of the building stock”. As the building sector is one of the most important Italian economic sectors (ANCE, 2012), the energy efficiency policy packages contribute to strengthen general national economic growth.

In its introduction, the 2014 NEEAP highlights also that “Italy’s energy prices are on an average higher than those of its European competitors”. By underlining this aspect in a national energy efficiency plan, it is possible to see the national legislator’s purpose to reduce energy consumption in the building sector not only as an energy efficiency measure, but also as a measure to reduce families’ energy bills and national energy poverty.

Moreover, the Italian 2014 NEEAP emphasizes the importance of the promotion of energy efficiency in public buildings of national, regional and local authorities. In fact, as evidenced in the NEEAP energy efficiency forecast to 2020, the energy upgrading of public buildings at all levels will contribute to an energy saving of **458 GWh/year** from 2014 to 2020.

Table 1 Total energy savings expected by the energy efficiency improvements of existing public buildings by 2020.

Year	Floor area subject to the obligation to improve energy efficiency	Total Consumption	Savings (GWh/y)							Total savings by 2020
	(m^2)	(GWh/y)	2014	2015	2016	2017	2018	2019	2020	(GWh/y)
2014	412,919	**62.8**	17.0	17.0	17.0	17.0	17.0	17.0	17.0	**119.1**
2015	407,090	**61.9**		16.8	16.8	16.8	16.8	16.8	16.8	**100.7**
2016	401,633	**61.1**			16.6	16.6	16.6	16.6	16.6	**82.8**
2017	389,977	**59.3**				16.1	16.1	16.1	16.1	**64.3**
2018	378,671	**57.6**					15.6	15.6	15.6	**46.8**
2019	367,705	**55.9**						15.2	15.2	**30.3**
2020	357,067	**54.3**							14.7	**14.7**
Total	**2,715,061**	**413.0**	**17.0**	**33.8**	**50.4**	**66.4**	**82.0**	**97.2**	**111.9**	**458.7**

Source: ENEA using data from the Public Domain Agency

Achievement of targets for the building sector

Italy has several regulatory policy instruments related to the buildings sector. The main regulatory policy instruments in the building sector are (see, for more details, Deliverable 1.2 of the HERON Project):

- Energy performance in buildings. Transposition of EPBD and EPBD recast EU directives (Dlgs. 19 August 2005, n. 192, modified with Dlgs. 30 May 2008, n. 115; L. 3 August 2013, n. 90);
- Transposition of the Energy Efficiency Directive 2012/27/EU (Dlgs. 4 July 2014, n. 102);
- Rules for implementing the national energy plan in the field of rational use of energy, energy saving and development of renewable energy sources (L. 9 January 1991, n. 10);
- Regulation on Accreditation of Italian Energy Certifiers (D.P.R. 16 April 2013, n. 75);
- Green Public Procurement. Minimum Environmental Criteria for several appliances related to buildings, in particular public lighting and energy services for buildings (D.M. 25 February 2011, D.M. 25 July 2011, D.M. 7 March 2012);
- Energy labelling of households appliances (Dlgs. 28 June 2012, n. 104);
- Simplification/exemption of authorization procedures for some energy efficiency measures (municipal level);
- Regional Regulatory Schemes on energy efficiency in buildings (regional level);
- Municipal buildings regulations (municipal level).

All the Italian regulatory standards on buildings, based on NEEAP 2014 prevision data, are foreseen to produce a total final energy savings in 2020 of 5.23 Mtoe/year.

Italy has several economic policy instruments related to the buildings sector. The main national economic policies in the building sector are (see, for more details, Deliverable 1.2 of the HERON Project):

- Thermal Account (D.M. 28 December 2012[1]);
- Tax deductions (introduced with L. 27 December 2006, n. 296, namely the Budget Law 2007[2] – "Legge finanziaria 2007", and renewed several times with modifications);
- White Certificates (or Energy Efficiency Certificates) scheme and Obligation for national energy distributors (D.M. 20 July 2004[3]);
- Kyoto Fund (introduced with L. 27 December 2006, n. 296, namely the Budget Law 2007 – "Legge finanziaria 2007", and implemented through following acts);
- National Fund for Energy Efficiency ("Fondo Nazionale per l'Efficienza Energetica") (Dlgs. 4 July 2014, n. 102[4]);
- Measures for the energy efficiency in schools ("Misure per l'efficientamento energetico degli edifici scolastici") (D.I. 14 April 2015, n. 66[5]);
- Fund for home purchase and/or renovation ("Plafond Casa")(Cassa Depositi e Prestiti) (D.L. 31 August 2013, n. 102[6], converted into L. 28 October 2013, n. 124[7]).

Finally, Italy has several dissemination and awareness instruments/informative policy instruments related to the buildings sector. The main national dissemination and informative policy instruments in the building sector are (see, for more details, Deliverable 1.2 of the HERON Project):

- Pilot Projects on multi service smart metering (Deliberation 19 September 2013, 393/2013/R/gas of the AEEG)8;
- Transparent billing methods (Deliberation 18 November 2008 – ARG/com 164/08 of the AEEG)[9];
- National Green Procurement Plan ("Piano d'Azione Nazionale per il GPP") (D.M. 11 April 2008[10], updated with D.M. 10 April 2013[11]);
- ENEA website "Obiettivo efficienza energetica" (Target: energy efficiency) [12];
- Several dissemination/awareness campaigns on specific energy efficiency themes (all experiences are mapped in the NEEAP – National Energy Efficiency Action Plan 2014);
- Buildings energy efficiency voluntary certification schemes and environmental voluntary certification schemes (Casa Clima[13], Protocollo Itaca14, LEED….);
- Sustainable Energy Action Plans (SEAPs) (municipal level).

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[1] http://www.gse.it/it/Conto%20Termico/GSE_Documenti/_DM_28_DICEMBRE_2012_CONTO_TERMICO.PDF
[2] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2006-12-27;296!vig=
[3] http://www.autorita.energia.it/it/docs/riferimenti/decreto_040720fr.htm
[4] http://www.gazzettaufficiale.it/eli/id/2014/07/18/14G00113/sg
[5] http://www.gazzettaufficiale.it/eli/id/2015/05/13/15A03601/sg
[6] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto-legge:2013-08-31;102
[7] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2013-10-28;124
[8] http://www.autorita.energia.it/allegati/docs/13/393-13.pdf
[9] http://www.autorita.energia.it/allegati/docs/08/164-08arg.pdf
[10] http://www.minambiente.it/sites/default/files/archivio/allegati/GPP/all.to_3_DI_135_11.04.08_PAN.pdf
[11] http://www.sviluppoeconomico.gov.it/images/stories/normativa/decreto_ministeriale_10aprile2013.pdf
[12] http://www.efficienzaenergetica.enea.it/
[13] http://www.agenziacasaclima.it/it/casaclima/1-0.html
[14] http://www.itaca.org/index.asp

1.2 NATIONAL ENERGY EFFICIENCY AND GHG REDUCTION TARGETS FOR TRANSPORT

Objectives

Since the first NEEAP in 2007, the energy efficiency effort required from the transport sector has steadily grown. This growing effort is deeply related to the high level of energy inefficiency of the Italian transport sector (NEEAP, 2014). Based on the 2014 NEEAP energy efficiency expected savings to 2020, the biggest national effort in terms of national final energy savings has been requested to the transport sector. Also in terms of primary energy savings the contribution required from the transport sector is high.

In the 2011 NEEAP, the original targets for the transport sector was set at 4.23 Mtoe/year of expected savings by 2020.

After four years, the targets have been revised (NEEAP, 2014):

- The new transport **final energy consumption** target for 2020 has increased by 5.5 Mtoe/year of expected savings, totaling **9.73 Mtoe/year**.

Another long-term general target regarding energy efficiency in the transport sector is defined in the 2013 National Energy Strategy (SEN). The SEN sets that "primary energy consumption will have to fall in the range of **17-26%** by **2050** compared to 2010, by decoupling economic growth from energy consumption. In particular, efforts in building and transport will be critical".

Achievement of targets for the transport sector

Italy has several planning instruments related to the transport sector. The main national transport planning instruments are (see, for more details, Deliverable 1.2 of the HERON Project):

- Italy's National Plan for Logistics 2011/2020 (Piano Nazionale della Logistica 2011-2020) (Ministry of Transport note prot. 567/CGA 30 may 2012[15]);
- National Strategic Plan for Ports and Logistic (Piano Strategico Nazionale della Portualità e della Logistica[16]) (Ministry of Transport 2015);
- National infrastructure plan to set up electric vehicle charging points (Piano Nazionale Infrastrutturale per la ricarica dei veicoli alimentati ad energia elettrica, PNIRE) (L. 7 August 2012, n.134[17]);
- National Action Plan for Intelligent Transport System (Piano di Azione Nazionale sui Sistemi Intelligenti di Trasporto) (D.M. 12 February 2014, n.44[18]);
- Promotion of use of biomethane in transports. (Dlgs. 3 March 2011, N.28, Article 8[19]);
- Five years bus fleet renewal plan (Piano quinquennale per il rinnovo del parco mezzi del trasporto passeggeri su gomma) (L. 27 December 2014, N.147[20]);
- Contract for the development of the national rail infrastructures (Contratto di Programma 2012-2016. Parte Investimenti) (Report to Italian Senate 3 February 2015 n.21[21]);

[15] http://www.mit.gov.it/mit/mop_all.php?p_id=12968
[16] http://www.mit.gov.it/mit/mop_all.php?p_id=23291
[17] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2012;134
[18] http://www.mit.gov.it/mit/mop_all.php?p_id=17744
[19] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2011-03-03;28
[20] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2013-12-27;147

- Sustainable Urban Mobility Plans, SUMP (Piani Urbani per la Mobilità Sostenibile);
- National Green Procurement Plan (Piano d'Azione Nazionale per il GPP) (D.M. 11 April 2008, updated with D.M. 10 April 2013[22]);
- Sustainable Energy Action Plan, SEAPs (Piani d'Azione per l'Energia Sostenibile).

Among all these planning instruments, the "National infrastructure plan to set up electric vehicle charging points" (PNIRE) has been chosen for a deeper analysis as it is expected to have a big impact on the spread of electric vehicles in Italy.

Italy has several regulatory policy instruments related to the transport sector. The main national transport regulatory policy instruments are ((see, for more details, Deliverable 1.2 of the HERON Project):

- Vehicle Certification. Vehicle CO_2 emissions standards (several national laws compliant with European policies on theme);
- Renewable energy in transport sector. (Dlgs. 3 March 2011, N.28[23]);
- Urban Traffic Plans (Piano Urbano del Traffico) (Dlgs. 30 April 1992, N.285[24]);
- Obligation for national fuel producers to input into consumption 1% of biofuels of total traditional fuel. (L.11 March 2006, n. 81[25]);
- National quality standards for biofuels (AEEG Resolution 160/2012/R/GAS[26]);
- Minimum Environmental Criteria for the acquisition of vehicles for road transport (Criteri Minimi Ambientali per l'acquisizione dei veicoli adibiti al trasporto su strada) (D.M. 8 May 2012[27]);
- Limits to polluting vehicles (Regional legislations).

Finally, Italy has several financial policy instruments related to the transport sector. The main national transport financial policy instruments are (see, for more details, Deliverable 1.2 of the HERON Project):

- Government subsidies for the purchase of low-emission vehicles (D.L. 10 February 2009, n. 5, converted into law by L. 9 April 2009, n.33[28]; L. 7 August 2012, n.134[29]);
- Incentives for the promotion of biofuels in transport sector (Dlgs. 3 March 2011, n.28[30]);
- Ad-hoc fund of Ministry of Infrastructure and Transport on PNIRE implementation 2013-2015 (L. 7 August 2012, n.134);
- Ministry call in favour of the Regions to fund a network of electric vehicle charging points (L. 7 August 2012, n. 134);
- National electric car sharing project in cities (co-financed by the Ministry of Environment);

[21] http://serviziparlamentari.com/index.php?option=com_mtree&task=att_download&link_id=1166&cf_id=72
[22] http://www.sviluppoeconomico.gov.it/images/stories/normativa/decreto_ministeriale_10aprile2013.pdf
[23] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto-legislativo:2011-03-03;28
[24] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:1992-04-30;285
[25] https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/3457
[26] http://www.autorita.energia.it/allegati/docs/12/160-12.pdf
[27] http://www.minambiente.it/sites/default/files/archivio/allegati/GPP/gu_128_dm.pdf
[28] www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legge:2009-02-10;5!vig=2015-09-21
[29] www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2012-08-07;134!vig=2015-09-21
[30] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2011-03-03;28

- National funds for the development of underground railways (Defined in annual Italian Budget Laws);
- Funds related to the “Five years bus fleet renewal plan” (L. 27 December 2013, N.147[31]);
- Structural fund on thematic area “sustainable movement of people and goods” (EU 2014-2020 Structural Funds);
- Road tax (tax exemption for electric vehicles and discount on car assurance) and regional schemes for tax exemption for LPG and methane vehicles. (Regional legislations);
- National funds for local public transports (indirect effects for example in fleets renewal, etc.). (Defined in annual Italian Budget Laws);
- Funding for energy efficiency, renewable energy and bike-sharing (L. 24 December 2007, n.244[32]).

[31] www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2013-12-27;147!vig=
[32] http://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2007-12-24;244!vig=

CHAPTER 2: COMMON KEY ASSUMPTIONS FOR SCENARIO-BUILDING AND METHODOLOGICAL APPROACH TO SCENARIO ANALYSIS

2.1 POPULATION

The Eurostat projections for Italy[33] were used in the scenario-building. More specifically:

Table 2: Eurostat population projections for Italy (in people).

Years	2015	2020	2030
Expected population	60,944,960	61,961,266	64,115,332

Projections are based on the demography and migration data that Eurostat collects from EU Members States' National Statistical Institutes (NSIs) and also from almost all non-EU Member States in Europe (including EFTA countries and Candidate countries to the EU). Data are collected at national and at regional level[34].

Household size is derived from the same source.

Table 3: Eurostat household size projections (people per household).

Years	2015	2020	2030
Expected household size	2.44	2.40	2.20

2.2 GROSS DOMESTIC PRODUCT

Gross Domestic Product (GDP) assumptions are based on the long-term forecasts made by the International Monetary Fund’s World Economic Outlook [35].

Table 4: IMF GDP forecasts for Italy at current prices.

Forecasts for Italy	2015	2020	2030
GDP at current prices (€ billions)	1,636.37	1,809.86	2,169.11
GDP growth average (%, yoy)		1.15%	0.85%

[33] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=proj_13npms&lang=en
[34] http://ec.europa.eu/eurostat/web/population-demography-migration-projections/methodology
[35] http://www.imf.org/external/pubs/ft/weo/2016/01/weodata/index.aspx

2.3 NUMBER OF HOUSEHOLDS

The number of household is derived from the projections made by the Italian National Statistical Institute (2015).

Table 5: ISTAT forecasts for Italy.

Years	2015	2020	2030
Expected household size	2.50	2.40	2.20

2.4 BUILDING STOCK PROFILE

The total number of dwellings has been split between all the household types considered in this assignment. For this, historical data was taken from the Italian National Statistical Institute (2015). The dwellings were split to two main classes (multi-family and single-family) each of them to four classes:

Table 6: Stock profile.

Single-family dwellings	Multi-family dwellings
1. Existing single-family not to be renovated by 2030 2. Existing single-family to be renovated by 2030	1. Existing multi-family not to be renovated by 2030 2. Existing multi-family to be renovated by 2030
3. New single-family dwellings to be built between 2016-2020 according to the minimum energy performance requirements	3. New multi-family dwellings to be built between 2016-2020 according to the minimum energy performance requirements
4. New single-family dwellings to be built 2021-2030 according to the zero-energy standards	4. New multi-family dwellings to be built 2021-2030 according to the zero-energy standards

The assumptions of the new building stock have been made by following the building trend of 2000-2010. Assumptions made for the reconstruction have been described in the next Chapter.

Also, it is important to note that whilst by law, from 2021 onward, all new buildings must be nearly zero-energy buildings.

2.5 TRANSPORT PROFILE

Transport profile in the LEAP software has been structures as follows:

1. Passenger demand, total travel demand (passenger-km) split between motorized travel modes, fuel technologies and energy efficiency parameters (MJ/passenger-km of “Existing” and “Ideal” figures):

Table 7: Technologies and fuel for passenger transport.

Vehicle	Cars	Buses	Motorcycles	Rail	Water	Air
Fuel/Technology split	Petrol	Diesel	Petrol	Diesel	Fuel	Jet Kerosine
	Ethanol	Biodiesel	Electric	Electric	LNG	AV Gas
	Diesel	Hybrid		Biodiesel		
	Biodiesel	Electric				
	Hybrid Petrol	CNG				
	Plugin Hybrid Petrol	Biomethane				
	Electric					
	CNG					
	LPG					
	Biomethane					

2. Freight demand: total freight demand (ton-km) split between freight modes, fuel technologies and energy efficiency parameters (MJ/passenger-km of "Existing" and "Ideal" figures)

Table 8: Technologies and fuel for freight transport.

Transport method	Road	Rail	Water	Air
Fuel/Technology split	Diesel	Diesel	Diesel	Yet Kerosine
	Biodiesel	Electric	Biofuels	AV Gas
	Hybrid	Biodiesel		
	Electric			
	CNG			
	Biomethane			

2.6 CALIBRATION FACTORS APPLIED

Calculated as a last thing after the insertion of all the other data. The calculation factors have been calculated by dividing the last historical year fuel data with the first BAU year fuel data (Excel sheet from the Results window of LEAP).

In the buildings sector, in order to match the historical data with the projections data, calibration factors within the residential building sector were given to all fuels. The only major calibration was carried out for natural gas. The calibration factor was 0.69: this is because the demand is subject to considerable volatility according to the weather and data normalization is corrected several times.

To match the historical reported and first projection years of calculations a calibration factor of 0.82 for diesel and 0.95 for fuel oil was used in the transport sector as the LEAP calculated first projections were respectively higher than the last actual national accounts.

CHAPTER 3: FORWARD LOOKING SCENARIOS FOR BUILDINGS

3.1. HISTORIC DATA AND TRENDS

The available historical data for Italy were from year 1990 until year 2013. In the latest available year, the building sector (residential, tertiary and public sector) accounted for 26% of the final energy consumption (NEEAP, 2014).

Residential sector

Throughout these 23 years, energy consumption in the residential sector has been primarily driven by climatic conditions. Still, the penetration of electric appliances has brought about a slight increase in the first decade of the millennium. The economic crisis did not really affect household consumption. The fuel mix in the residential sector across these years changed (Figure 1). While the fuel (heating) oil has been constantly decreasing as more and more households have opted for pellets and other wood fuels. Still, almost two thirds of space heating needs is covered by natural gas. As for electricity, its consumption depends on appliances and electric water heating; electric space heating is almost non-existent. Finally, from 2010 onwards, it is worth noting that several local utilities have started deploying district heating (heat) in several Italian municipalities and its future importance will dramatically increase.

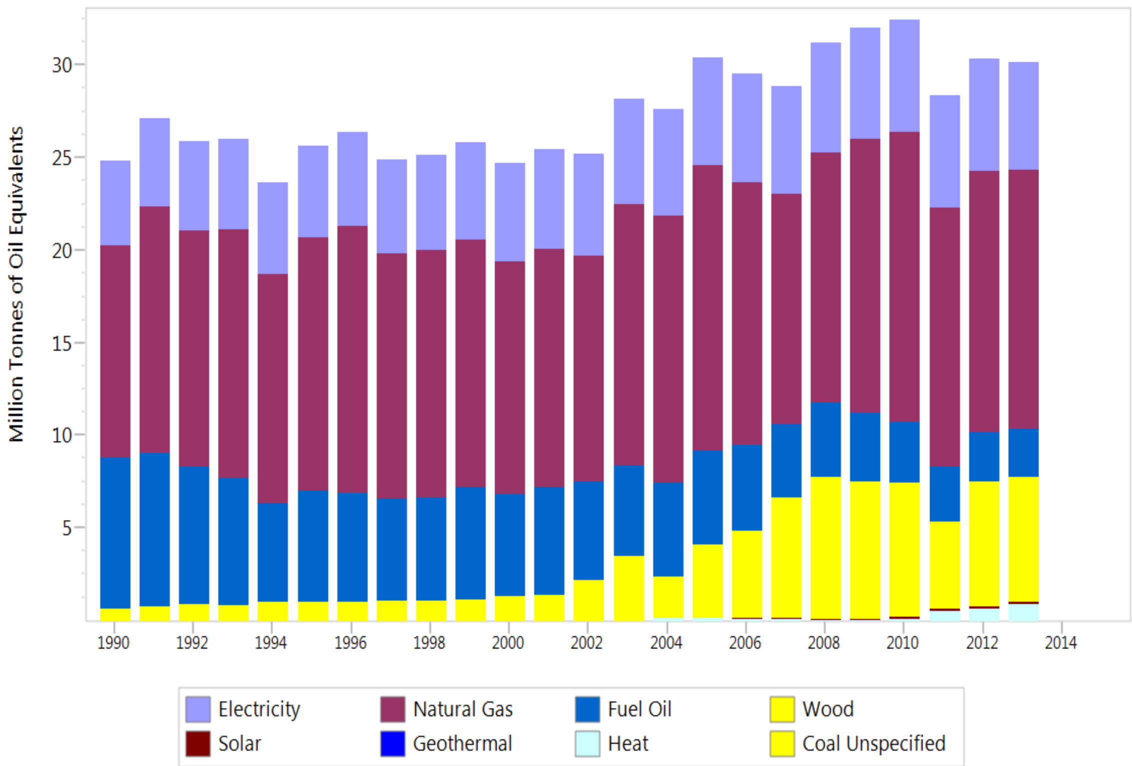

Figure 8: **Final energy consumption of the Italian residential sector by fuel (1990-2013) (data provided by Enerdata).**

Tertiary sector

In the tertiary sector, energy consumption almost trebled in these 23 years, increasing from 6 Mtoe in 1990 to more than 16 in 2013. As shown in the graph below, the energy sector experienced a little reduction in consumption only in 2011; hence, the economic downturn did not have a significant impact on service production.

Electricity accounts for almost half of the energy mix; natural gas follows shortly, as the main energy source for space heating. There is also a small share of renewables: biogas, biomass, geothermal, solar thermal.

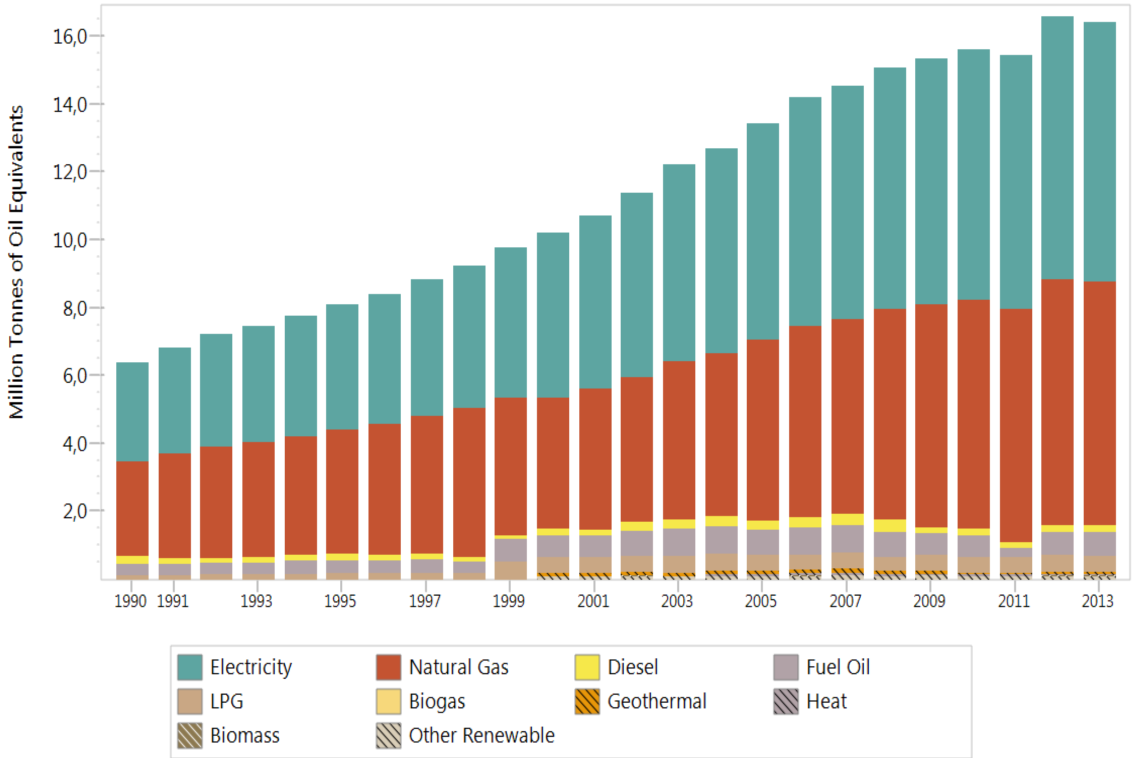

Figure 9: Final energy consumption of the Italian tertiary sector by fuel (1990-2013) (data provided by Enerdata).

3.2. BAU SCENARIO UP TO 2030

The Business-As-Usual scenario (BAU) looks into current possible trends until 2030 with policy measures/instruments already implemented.

3.2.1. Key assumptions and parameters

Residential sector

According to the 2011 census, dwellings occupied by residents are 24,141,324. From 2001 to 2011, there was an increase in the absolute value of 2,488,036 units (+11.5%). The highest increase was registered in the North (48% of all new units). The geographical distribution is shown in the table below.

Table 9: Geographical distribution of Italian dwellings occupied by residents.

Region	Number of dwellings occupied by residents	Percentage
North West	6,827,379	28.2
North East	4,777,305	19.8
Centre	4,793,525	19.8
South	5,185,891	21.4
Islands	2,611,318	10.8
TOTAL	24,141,324	100

The average square meters per resident are 40.7, a significant increase compared to 2001 (36.8), with the highest value in North East Italy of 44.3 sqm and a minimum in Southern Italy with 36.9 sqm.

72.1% of Italian families live in a home they own. This is one of the highest percentage in the World and it shows a very pulverized ownership of buildings, particularly in cities.

At the end of 2013, the overall residential housing stock is 33,806,919. Hence, in Italy there are almost 10 million non-permanently occupied homes, of which more than 4 million are holiday homes. All Italian dwellings are contained in 11.7 million buildings. Over 60% of the building stock is more than 45 years old, implying that it was built prior to Law 376 of 1976, the first Italian law on energy efficiency.

For the BAU, we take into account only dwellings occupied by residents and, therefore, we exclude from our analysis all non-occupied houses as well as holiday houses. On the one hand, consumption of holiday houses is certainly non-negligible; on the other, energy consumption in the holiday house generally implies an almost complete halt in consumption in the primary dwelling. Hence, in our analysis, we just fail to take into account energy performance differentials of dwellings and possible changes in energy consumption behaviour during holiday time. Moreover, holiday house occupation is shrinking to less than a month per year (ISTAT, 2015) and it is almost evenly distributed in summer and winter time, so there is no season bias.

The increase in occupied dwellings, which will reach more than 29 million in 2030, is therefore driven by the population increase and the reduction of household size. Moreover, we expect the average square meters per resident to increase of almost 17% by 2030, following the same trend experienced in these last 15 years.

Energy consumption of Italian households is provided for and constantly updated by ISTAT and ENEA. We have used the data for the construction of the LEAP dataset. The mean final energy consumption of an Italian household is 1.2 tep. For all scenarios we have modelled all end-uses: space heating, air-conditioning, cooking, lighting, water heating and appliances.

Table 10: Percentage distribution of total energy consumption by end-use.

Percentage distribution of total energy consumption by end-use	
Space heating and cooling	76%
Cooking	5%
Water heating	7%
Appliances, illumination and other electric uses	12%

Table 11: Electricity end-use

Type of end-use	Percentage
Entertainment	18.6
Refrigerator/freezer	18.4
Illumination	11.4
Washing machine	10.3
Electric water heating	9.8
Air conditioning	6
Dish washer	5.4
Electric cooking	4.7
Other	15.4
TOTAL	100

For the BAU, we presume that policy measures and instruments already implemented will not change.

For the space heating, existing buildings are divided into two categories: single-family and multi-family dwellings and we use the average consumption per square meter, equal to 150 kWh per sqm for single-family dwellings and 120 kWh per sqm for multi-family dwellings, as our starting point for our projections.

We are aware that Italian buildings vary greatly both in terms of energy performance as well as for climatic zones. For instance, Italy has six climatic zones (A, B, C, D, E, F) and there is a consistent share of buildings that consumes more than 220 kWh per sqm. In order to have comparable results with those elaborated by ENEA, we elaborate our projections just taking into account the average consumption per square meter.

Of course, the raw efficiency of existing dwellings is not expected to change. In the BAU we just model the evolution of the different energy fuels used for heating. The change in the energy mix is based on historical trends and it slightly improves the final useful energy intensity as more efficient energy sources are adopted (for instance, geothermal and district heating). By 2030, energy consumption equals 120 kWh for single-family dwellings and 100 kWh per sqm for multi-family dwellings.

The new single-family and multi-family buildings were divided in two types: those that comply with the Energy Efficiency Regulation for Buildings and those that are Nearly Zero Energy Buildings (NZEB). For each housing type, the useful energy intensity for space heating was determined using provided by CRESME (2012). In particular, we model that new buildings have a performance of 50 kWh per sqm; moreover, we model that from 2021 onwards, only NZEB buildings are built, with an overall energy performance of 20 to 30 kWh per sqm.

We project a 1% yoy renovation rate and a 0.05% demolition rate of existing buildings, following historic trends (CRESME, 2012). Also new additions are projected according to historic trends corrected for slower GDP growth.

As for air-conditioning, we model an increase in its use. Currently, only 31% of households have an air conditioning system. According to RSE’s projections, a 1% yoy increase is expected. Moreover, overall energy consumption per dwelling is expected to grow from 330 KWh per dwelling to 578 kWh per dwelling.

As for cooking, we project an increase in induction and with no further penetration as cooking appliances are present in all dwellings.

As for lighting, we project a 100% penetration of efficient technology due to increased standards and phase out of incandescent light bulbs.

As for water heating, we project a growth of more efficient technologies following historical trends.

Finally, for all other appliances we use the results of the MATISSE model elaborated by RSE to project electric consumption to 2030.

Below, we show the projected evolution of space heating consumption for existing single and multi-family, both for those who are renovated as well as for those who are not. Those which are not subject to renovation might improve their efficiency as well, as there can be a change in the space heating system.

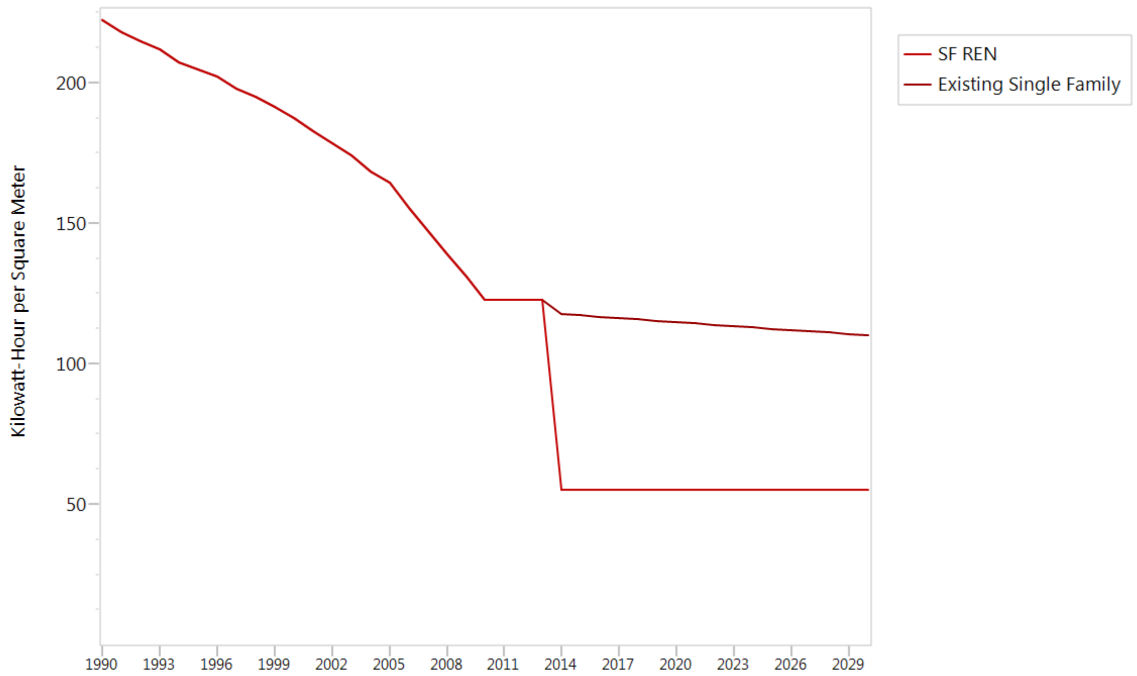

Figure 10: Existing Single Family, Useful Energy Intensity for Space Heating (Kilowatt-Hour per Square Meter).

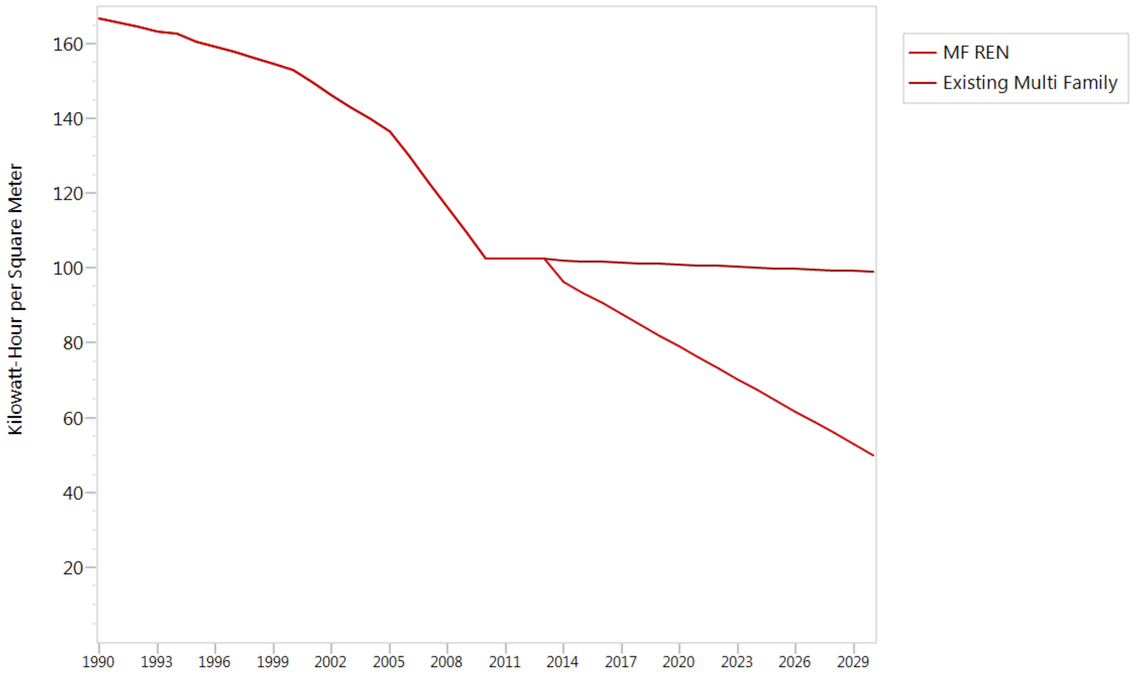

Figure 11: Existing Multi Family, Useful Energy Intensity for Space Heating (Kilowatt-Hour per Square Meter).

As for air-conditioning, we project a major increase in energy intensity, due to expected increase in adverse and hot summers as well as an increase in the penetration of this technology.

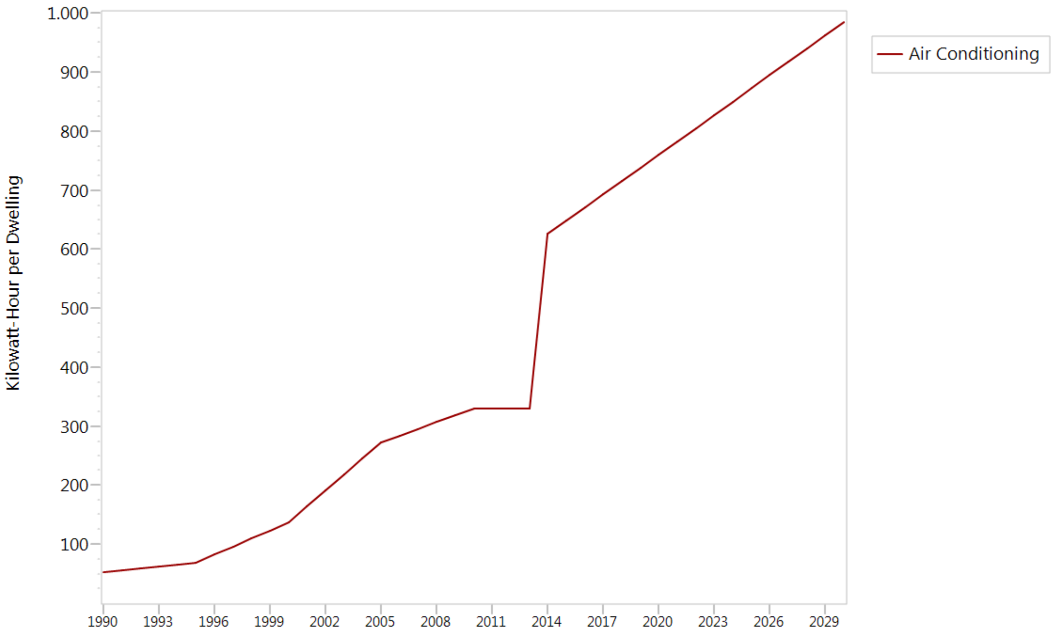

Figure 12: Air Conditioning: Useful Energy Intensity (Kilowatt-Hour per Dwelling).

Tertiary sector

According to the latest available data (OMI 2016), the tertiary buildings in Italy are 3,497,486. The latest available data on the buildings owned by the Public Administrations (MEF, 2014) reveals that in Italy we have more than 700,000 public buildings, of which more than 50,000 are schools.

Table 12: Type of tertiary buildings.

Category	Number of buildings	Percentage
Offices	644,311	18
Shops	2,550,998	73
Banks	20,117	1
Commercial buildings	223,681	6
Hotels	58,379	2
TOTAL	3,497,486	100

For our BAU, the existing buildings in the tertiary sector were divided into shops & Other Commercial Buildings, Offices, Hotels, Hospitals, Schools and all other public administration buildings. There are no available detailed data concerning different building types for each category, as in residential sector. Therefore, our projections are based on average final energy intensity, derived by the studies of ENEL FOUNDATION (2013) and ENEA (2009). As energy intensity data are provided in square meters, we have used the amount of square meters per single category as an input data, totalling to almost 800 million square meters.

In these last four years (OMI, 2016), stock additions have been limited: the compounded average growth rate has been 0.16% and it has come mainly from Hotels, Offices and Shops. In the BAU, we project stock additions only for these three categories. All other categories are projected to stay as they are (demolitions and additions are expected to equal). Following CRESME (2012), we project a renovation rate of 1%, similar to that of the residential sector.

We do not project any variation in energy intensity for existing buildings, while we project significant reduction in energy intensity for renovated buildings. Energy intensity targets are defined by ENEA (2009, 2011, 2014) for all building categories.

Below, we show the evolution of the useful energy intensity in all sectors for existing buildings, which will not be subject to renovation. The reduction is generated by a change of the fuel for space heating. Historic data refer to the average consumption of the existing stock.

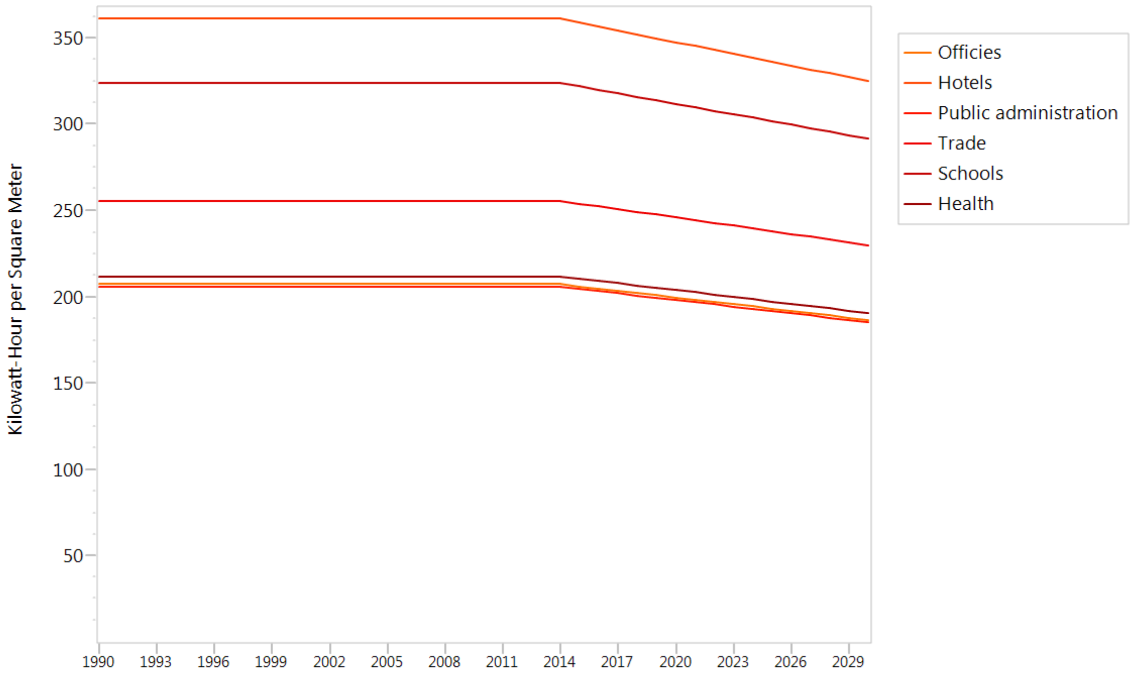

Figure 13: Existing, Useful Energy Intensity (Kilowatt-Hour per Square Meter).

Below, we show the evolution of the useful energy intensity in all sectors for renovated buildings. Historic data refer to the average consumption of the existing stock.

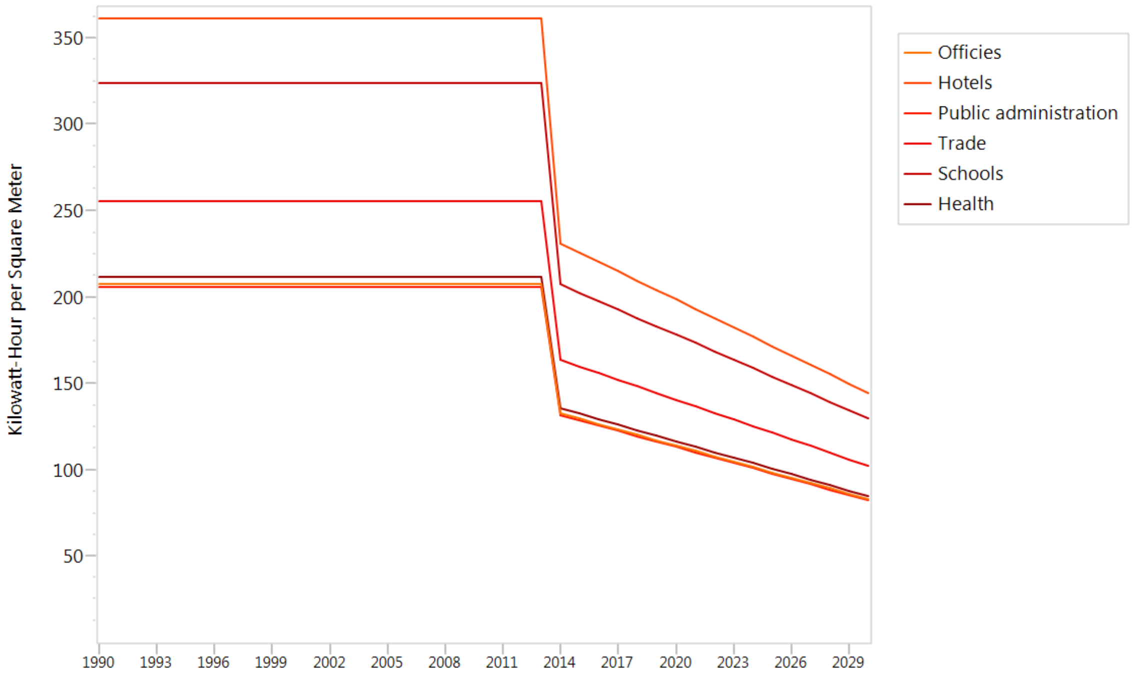

Figure 14: Renovated, Useful Energy Intensity (Kilowatt-Hour per Square Meter).

3.2.2. Analysis and results of BAU scenario

The results for BAU scenario are shown separately for residential and tertiary sectors.

Residential sector

In order to meet the targets presented before (that is the 24% reduction by 2020), residential consumption should be equal to 29.48 Mtoe in 2020; in 2030, with a 30% reduction compared to the reference scenario, consumption should equal 27.85 Mtoe.

In the BAU, the total final energy consumption in Mtoe – LEAP outcomes - is presented in the table below:

Table 13: Projected final energy consumption for residential sector.

Year	Final energy consumption (in Mtoe)
2016	31.20
2020	32.92
2030	32.48

As it is possible to see from the table, the measures already implemented are not enough to meet both targets; hence, there is more to do.

The GHG target for Italy for 2020 is 13% reduction of GHG emissions compared to 2005 levels for non-ETS sectors and 18% at National level. The SEN (2013) has introduced higher targets at National level by 2020, with a 21% reduction compared to 2005 levels. The amount of total GHG emissions in 2005 was approximately 575 $MtCO_{2eq}$ (European Environmental Agency, 2016).

The amount of residential GHG emissions for the year 2005 was 57.79 $MtCO_{2eq}$; they decreased to 53.1 in 2010 and in 2014 they equaled 45 $MtCO_{2eq}$ (ISPRA, 2015). The GHG emissions in BAU scenario for the residential sector reach the amount of 39.74 $MtCO_{2eq}$ for 2020 (-31%, compared to 2005 levels) and 30.06 $MtCO_{2eq}$ for 2030 (-48%).

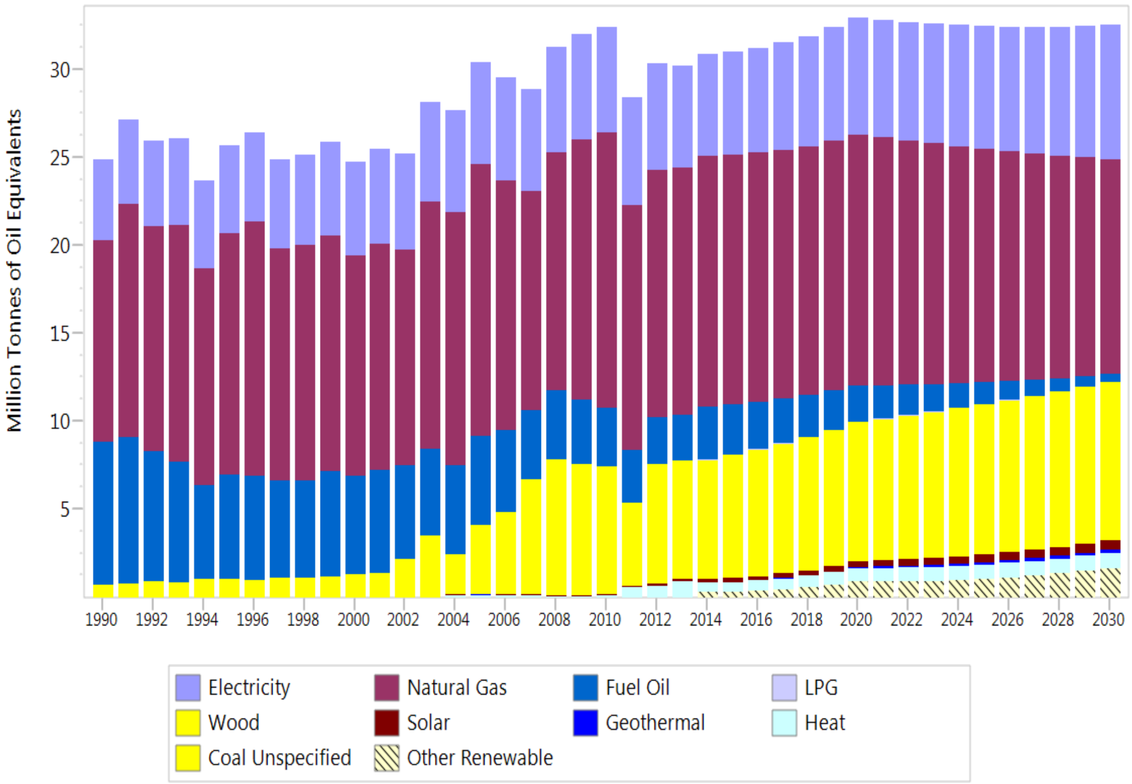

Figure 15: Evolution of final energy consumption of residential sector till 2030 in BAU scenario.

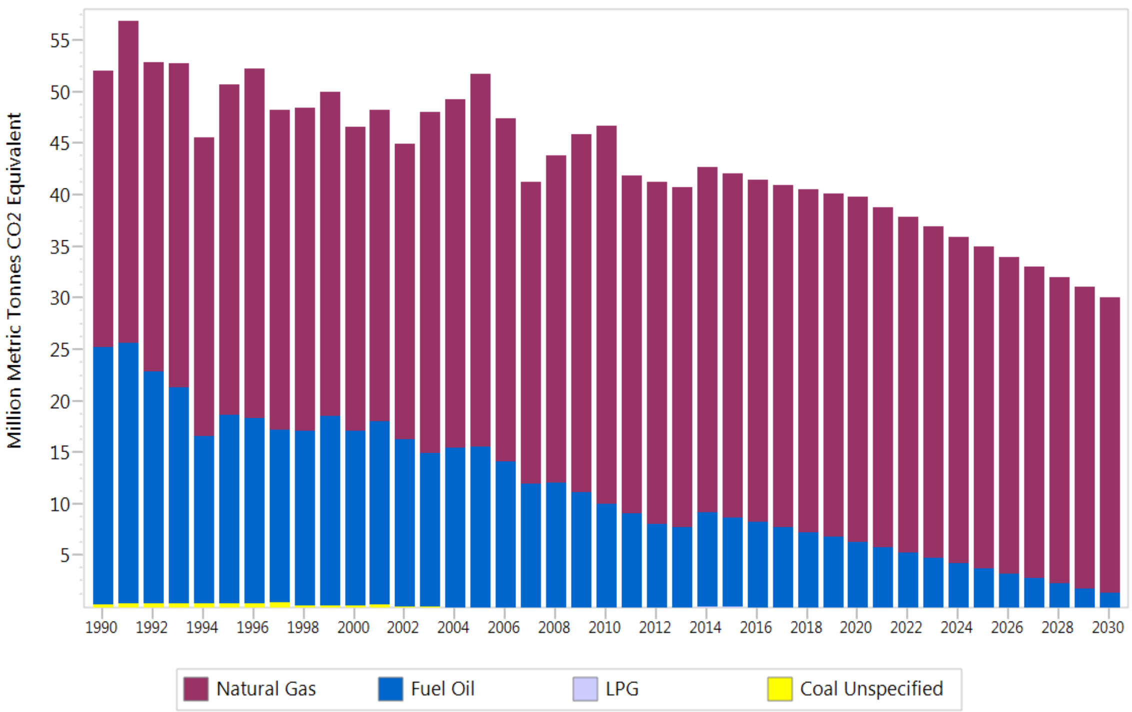

Figure 16: Evolution of GHG emissions of the residential sector in BAU scenario.

Tertiary sector

As for the tertiary sector, in order to meet the targets presented before (that is the 24% reduction by 2020), tertiary consumption should be equal to 18.57 Mtoe in 2020; in 2030, with a 30% reduction compared to the reference scenario, consumption should equal 18.08 Mtoe. **It is important to highlight that our LEAP projections take into account just the energy consumption of buildings and not all other forms of energy consumption; therefore, immediate comparisons are not possible.** Still, consumption from buildings and related appliances represents more than two thirds of total consumption, implying that measures already implemented are driving the tertiary sector towards its targets.

In BAU, the total final energy consumption in Mtoe is presented in Table 7:

Table 14: Projected final energy consumption for the Italian tertiary sector.

Year	Final energy consumption (in Mtoe)
2016	16.9
2020	16.6
2030	15.8

The amount of tertiary GHG emissions for the year 2005 was 26.2 $MtCO_{2eq}$; they increased to 30.7 in 2010 and in 2014 they equaled 27.1 $MtCO_{2eq}$ (European environmental Agency, 2016; European Commission, 2015). The GHG emissions in BAU scenario for the tertiary sector reach the amount of 20.28 $MtCO_{2eq}$ for 2020 and 19.09 $MtCO_{2eq}$ for 2030 (again, we recall that our projections take into account only the energy consumption from buildings).

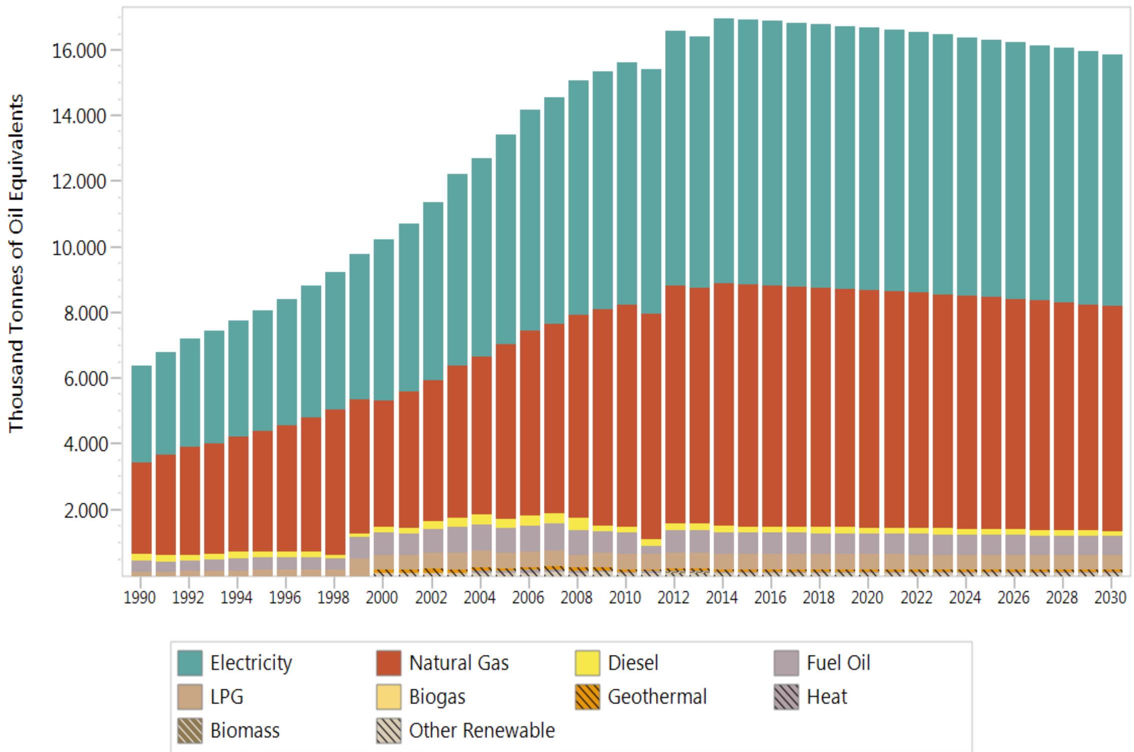

Figure 17: Evolution of final energy consumption of tertiary sector until 2030 in BAU scenario.

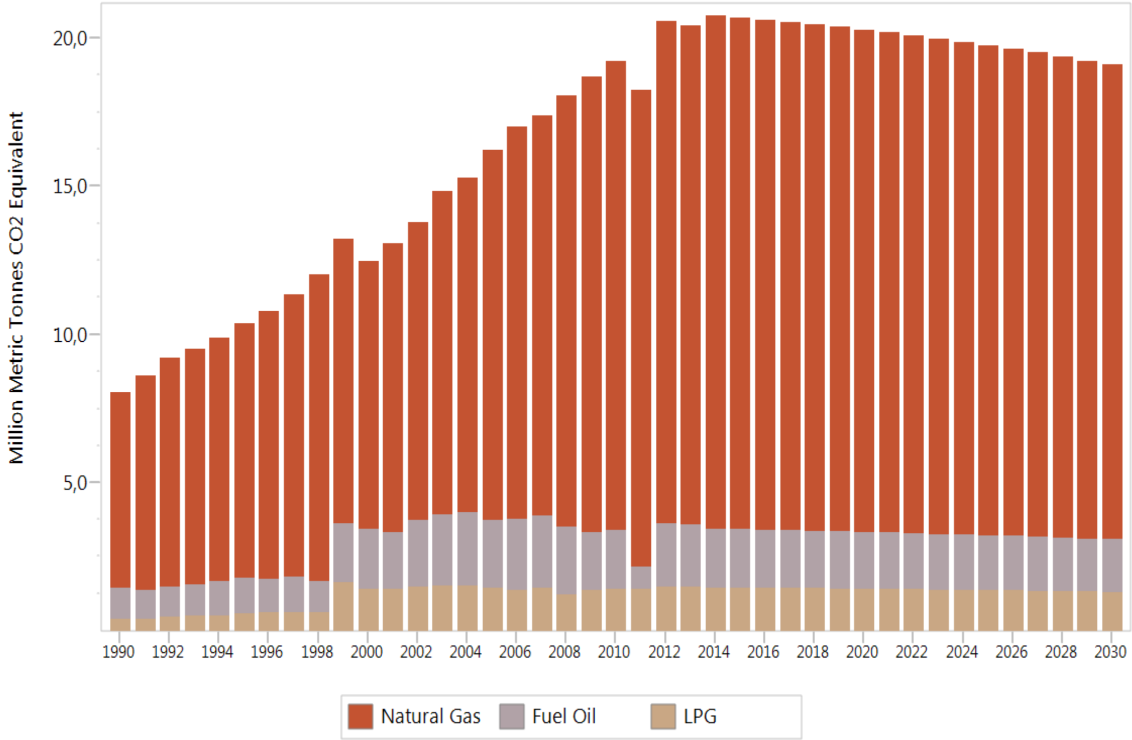

Figure 18: Evolution of GHG emissions of the tertiary sector in BAU scenario.

3.3. ENERGY EFFICIENCY SCENARIOS UP TO 2030

Particular policies and penetration of technologies, the adoption of measures and the implementation of the respective policy instruments that support the exploitation of technologies and the achievement of measures characterize the scenarios both in the residential and tertiary sectors. The choice of these measures and technologies for the HERON scenarios is based on the HERON questionnaire survey. All - developed for HERON - EE scenarios reach the horizon of 2030 and all types of assumed targets (concerning shares of specific technologies or general targets (overall reductions of energy consumption, energy savings etc…) are aligned with EU 2030 targets for energy savings and CO_2 emissions.

It is important to highlight that the first energy efficiency scenario EE-BR0 is a scenario driven only by two specific additional policies: awareness campaigns and specific advertisement to show the economic rationale of EE technologies. Most of the energy efficient technologies already have economic rationale, therefore, people should adopt them in the first place. For the purpose of this report, these technologies are cost-effective either because they cost less than non-efficient technologies, either because the current policies are enough to make them cost less. Hence, with perfect information on technologies (i.e. no information costs), with perfect allocation of funds in financial markets (i.e. no transaction costs) and with perfect cooperation among agents (i.e. no coordination costs), rational agents would opt for these technologies.

All sub-sequent scenarios (EE-1 to EE-4) internalize the effect of barriers and the effect of policies aimed at minimizing those barriers. The idea of all scenarios is that there are educational, social as well as economic barriers that create costs that alter the adoption of these technologies. Hence, there is the need to introduce policies to minimize those barriers in order to let the market work properly.

Residential sector hypothesis

Five sub-scenarios for residential buildings are developed, each of which assuming a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems in existing buildings (single-family, multi-family, tertiary).
2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space-heating for all housing types of the existing building stock.
3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family).
4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family) including cooking devices and water heaters.
5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).

The developed scenarios are the following:

1. EE - BR0: the combination of all developed sub-scenarios into one (1) EE scenario that should lead to the achievement of EE targets with the use of all cost-effective technologies;
2. EE - BR1: the combination of all developed sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST;
3. EE - BR2 to EE – BR4: the best combinations of technologies/measures (i.e. of the sub-scenarios) with the higher penetration levels after the minimization of barriers.

3.3.1. Energy efficiency scenarios for the Residential sector: assumptions

Below we present the assumptions and the results of all the energy efficiency scenarios elaborated for the residential sector.

Based on work under Deliverable 1.4, we recall the theoretical and expected energy savings related to different technologies (HERON Deliverable 1.4).

Table 15: 'Theoretical' and 'expected' potential savings in 2020 (TWh) of each technology within the buildings sector

Technologies	'Theoretical' potential savings			'Expected' potential savings		
	Residential sector	Services	Total	Residential sector	Services	Total
Lighting	8.57	6.13	14.7	4.47	3.68	8.15
Building Automation	11.6	2	13.6	1.2	0.62	1.82
Fixtures with high efficiency	20.2	2.2	22.4	4.94	0.36	5.3

Opaque building surfaces	70.35	3.95	74.4	29.6	1.4	31
Heat pump	101	10	111	36.73	4.37	41.1
Condensing boilers	55.2	6.6	61.8	11.12	2.58	13.7
Solar thermal	17.5	4.4	21.8	5.39	0.65	6.34

As shown in the table above, according to the calculations by ENEA, the most energy efficient interventions, in terms of primary energy savings (kWh/year) per year, are insulation works of horizontal and vertical structures, among which: flooring and homes roofing. In addition, thermal technologies like Geothermal Heat Pumps and Biomass Boilers are quite efficient in energy saving, being able to save up to 17 thousand kWh per year per intervention. Instead, windows figure as the least energy efficient product covered by the policy.

However, this was the most incentivized product in terms of number of interventions sent by ENEA in 2007-2013.This is why replacement of windows has been the incentive responsible for the second highest amount of overall energy savings in 2007-2012, becoming the first one in 2013, exceeding the energy savings accrued to the installation of energy efficient thermal systems.

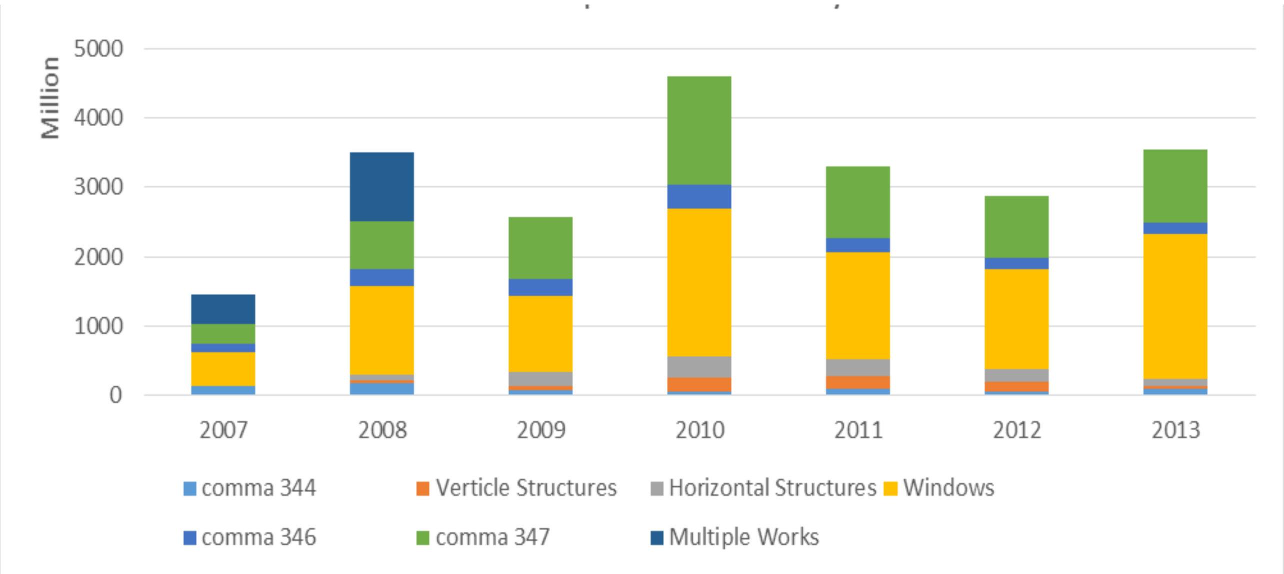

Figure 19: investments in energy efficiency 2007-2013.

The figure above summarizes the amount of investments in energy efficiency implementation, partially subsidized by the government between 2007 and 2013. It immediately stands out that most of the investments have been directed to replacement of windows and thermal technologies (yellow and green area above). Indeed, from 2007 to 2013 only the replacement of windows amounted to more than 10 billion of investments that corresponds to more than 45% of the overall expenditures (21.865 million) (ENEA).

Sub-Scenario 1: Building shell improvement (BSI)

This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space-heating for all housing types of the existing building stock.

The measures that are included in this scenario:

- External insulation of opaque structural elements according to the specifications set out in the Regulation on the efficiency of buildings, to prevent loss in the first place that has savings potential 33-60%.
- Replacement of single glazing with other glazing complying with high thermal insulation specifications and with low thermal emissivity that has savings potential 14-20%.
- Replacement of window and door frames with energy-efficient ones, fitted with a thermal break system, that has savings potential 14-20%.

Sub-Scenario 2: Efficient heating (EHeating)

The basic assumptions for the construction of our efficient heating scenario are:

- Two end-uses: water heating and space heating;
- Technologies: high-efficiency co-generation, heat pumps and district heating.

This scenario focuses on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on district heating systems in existing buildings (single-family and multi-family).

As for district heating, it is important to highlight that recently, GSE has published an official document to support efficient district heating, particularly in Mountain areas where households still burn fuel oil.

The potential of high efficiency district heating depends on the retail price of heath. With an estimated retail price of € 94.8 / MWh, the economic potential of high efficiency district heating is 2.2 TWh of annual thermal energy supplied to end users. To this, it is possible to add an additional 1.3 TWh of high efficiency district heating with heating plants burning biomass.

Sub-Scenario 3: Efficient cooling (ECool)

This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary). Assumptions for the penetration of efficient air-conditioning systems are based on the results of RSE Matisse simulation software.

Scenario 4: Efficient appliances (EApp)

This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices.

Scenario 5: Efficient lighting (ELight)

This scenario focuses only on the penetration of LED both in existing and new buildings (single-family, multi-family, tertiary).

For the penetration of LED in the residential sector, we used the global trends (McKinsey, 2012).

EE-BR0 scenario

The five sub-scenarios are combined in to all the subsequent scenarios. The first one is the cost-effective scenario, named EE-BR0 scenario. This scenario for the residential sector is presented in Table 12. The policy assumptions of this scenario will be used as inputs for the DST.

Table 16: Assumptions of EE-R0 scenario (only residential sector)

Sub-scenarios	**Policy assumptions**	**Policy instrument**
Building Shell improvement	Renovation rate of 3% Target consumption for renovated houses: • 50 kWh per square meter for single family • 40 kWh per square meter for multi family houses	Awareness campaign and specific advertisement to show the economic rationale of EE technologies
Efficient heating and heat pumps	15% penetration of heat-pumps and high efficiency cogeneration by 2030 7.6% penetration of district heat by 2030 for single family 29% penetration of district heat by 2030 for multifamily -1% Natural Gas consumption for single family houses -1.5% Natural Gas consumption for multifamily houses 0% of fuel oil consumption by 2030	Awareness campaign and specific advertisement to show the economic rationale of EE technologies
Efficient cooling	50% penetration of air-conditioning technologies 20% penetration of high efficiency technologies (A+++ only)	Awareness campaign and specific advertisement to show the economic rationale of EE technologies
Efficient appliances	31% of electricity induction for cooking 27% of electricity conduction for cooking -2% household consumption for higher efficiency appliances -1.5% of Natural gas for water heating -4% of LPG for water heating	Awareness campaign and specific advertisement to show the economic rationale of EE technologies
Efficient lighting	100% penetration of efficient lighting technologies.	By 2020, LED lighting to become technological standard, with complete phase-out of less efficient technologies, which will be no more avaialble on the market.

EE-BR1 – EE-BR4 scenarios for buildings

We now present the results of all the scenarios elaborated with the DST. The first one (EE-BR1) represents the negative effect of the barriers on the assumptions and targets of the EE-BR0 scenario. The second, third and fourth scenarios, EE-BR2, EE-BR3 and EE-BR4 quantifies the effect of the introduction of specific policies aimed at minimizing the effect of the barriers. For each scenario, we describe the barriers that have been minimized as well as the policies introduced to minimize the barriers.

Table 17: EE-BR1 scenario assumptions.

Sub-scenarios	Assumptions for EE-BR0	EE-BR1: DST outcome (after considering impact of barriers)
Building Shell improvement	Renovation rate of 3% Target consumption for renovated houses: • 50 kWh per square meter for single family • 40 kWh per square meter for multi family houses	Renovation rate of 1.37%
Efficient heating and heat pumps	15% penetration of heat-pumps and high efficiency cogeneration by 2030 7.6% penetration of district heat by 2030 for single family 29% penetration of district heat by 2030 for multifamily -1% Natural Gas consumption for single family houses -1.5% Natural Gas consumption for multifamily houses 0% of fuel oil consumption by 2030	8.38% penetration of heat-pumps and high efficiency cogeneration by 2030 5.5% penetration of district heat by 2030 21.6% penetration of district heat by 2030 -0.37% Natural Gas consumption for single family houses -1.21% Natural Gas consumption for multifamily houses 2% of fuel oil consumption by 2030
Efficient cooling	50% penetration of efficient air-conditioning technologies 20% penetration of high efficiency technologies (A+++ only)	47% penetration of efficient air-conditioning technologies 20% penetration of high efficiency technologies (A+++ only)
Efficient appliances	31% of electricity induction for cooking 27% of electricity conduction for cooking -2% household consumption for higher efficiency appliances. -1.5% of Natural gas for water heating -4% of LPG for water heating	31% of electricity induction for cooking 27% of electricity conduction for cooking -1.25% household consumption for higher efficiency appliances. -1.5% of Natural gas for water heating -4% of LPG for water heating
Efficient lighting	100% penetration of efficient lighting technologies, with a 120 kWh target per household.	100% penetration of efficient lighting technologies, with a 130 kWh target per household.

Table 18: EE-BR2 scenario assumptions.

Sub-scenarios	Policy instrument for EE-BR0	EE-BR2: DST outcome (after considering impact of minimized barriers)	Minimized barriers	Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target
Building Shell	Awareness	Renovation rate	BSI was the main focus	Better conceived financial

improvement	campaign and specific advertisement to show the economic rationale of EE technologies	of 1.72%	of this scenario along with heat pumps and efficient heating. This technology has a large number of barriers compared to the others, some of which are common with the other two. The barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Lack of experienced professionals, trusted information (Educational); 2. Lack of awareness (Educational) 3. Lack of any type of financial support (Economic) 4. High costs and risks (Economic)	incentives than those already in place: 65% tax deduction payback on a shorter period of time (5 years instead of 10 years[36]); specific incentives for multi-family buildings with public guarantees for ESCO. Regulatory standards: NZEB not just for new buildingsbut also for “deep renovation” Awareness campaigns about the potential of energy savings Specific tax deductions for supporting professionals in acquiring additional skills and knowledge on energy efficient technologies and practices this will improve the situation
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	8.38% penetration of heat-pumps and high efficiency cogeneration by 2030 5.9% penetration of district heat by 2030 26% penetration of district heat by 2030 -0.43% Natural Gas consumption for single family	The common barriers with the “Building shell improvement” affected positively this technology.	No specific additional policy to the ones already in place (BAU). Policies for BSI will foster the adoption for efficient heating technologies.

[36] Berton and Cavallari (2013) demonstrates empirically that shorter tax deductions payback periods have higher positive impacts on investment decisions than higher deduction rates on longer periods.

		houses -1.27% Natural Gas consumption for multifamily houses 2% of fuel oil consumption by 2030		
Efficient cooling	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	47% penetration of efficient air-conditioning technologies 20% penetration of high efficiency technologies (A+++ only)	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).
Efficient appliances	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	31% of electricity induction for cooking 27% of electricity conduction for cooking -1,25% household consumption for higher efficiency appliances. -1.5% of Natural gas for water heating -4% of LPG for water heating	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).
Efficient lighting	By 2020, LED lighting to become technological standard, with complete phase-out of less efficient technologies, which will be no more avaialble on the market.	100% penetration of efficient lighting technologies, with a 130 kWh target per household.	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).

Table 19: EE-BR3 scenario assumptions.

Sub-scenarios	**Policy instrument for EE-BR0**	**EE-BR3: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Building Shell improvement	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Renovation rate of 1.83%	The common barriers with the "efficient heating" affected positively this technology.	Better conceived financial incentives than those already in place: 65% tax deduction payback on a shorter period of time (5 years instead of 10 years); specific incentives for multi-family buildings with public guarantees for ESCO. Regulatory standards: NZEB not just for new buildingsbut also for "deep renovation" Awareness campaigns about the potential of energy savings Specific tax deductions for supporting professionals in acquiring additional skills and knowledge on energy efficient technologies and practices this will improve the situation
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	8.38% penetration of heat-pumps and high efficiency cogeneration by 2030 6.7% penetration of district heat by 2030 23.5% penetration of district heat by 2030 -0.45% Natural Gas consumption for single family houses -0.899% Natural Gas consumption for multifamily	Efficient heating was the main focus of this scenario along with BSI and efficient cooling. This technology has a large number of barriers compared to the others, some of which are common with the other two. The barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Lack of awareness of saving potential (Educational); 2. Lack of any type of financial support (Economic) 3. High costs and	Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the "Conto Termico" but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs and lower VAT) Awareness campaigns

		houses 2% of fuel oil consumption by 2030	risks (Economic)	
Efficient cooling	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	48.8% penetration of efficient air-conditioning technologies 18.8% penetration of high efficiency technologies (A+++ only)	The common barriers with the “efficient heating” affected positively this technology.	No specific additional policy to the ones already in place (BAU).
Efficient appliances	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	31% of electricity induction for cooking 27% of electricity conduction for cooking -1,25% household consumption for higher efficiency appliances. -1.5% of Natural gas for water heating -4% of LPG for water heating	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).
Efficient lighting	By 2020, LED lighting to become technological standard, with complete phase-out of less efficient technologies, which will be no more available on the market.	100% penetration of efficient lighting technologies, with a 130 kWh target per household.	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).

Table 20: EE-BR4 scenario assumptions.

Sub-scenarios	**Policy instrument for EE-BR0**	**EE-BR4: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Building Shell improvement	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Renovation rate of 1.37%	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	Better conceived financial incentives than those already in place: 65% tax deduction payback on a shorter period of time (5 years instead of 10 years); specific incentives for multi-family buildings with public guarantees for ESCO. Regulatory standards: NZEB not just for new buildingsbut also for "deep renovation" Awareness campaigns about the potential of energy savings Specific tax deductions for supporting professionals in acquiring additional skills and knowledge on energy efficient technologies and practices this will improve the situation
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	9.2% penetration of heat-pumps and high efficiency cogeneration by 2030 6.3% penetration of district heat by 2030 27% penetration of district heat by 2030 -0.41% Natural Gas consumption for single family	Heat pumps was the main focus of this scenario along with efficient heating and efficient cooling. This technology has a large number of barriers compared to the others, some of which are common with the other two. The barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Lack of any type of financial support	Financial incentives to citizens (capital subsidy; low interest loans and specific tariffs) such as the "Conto Termico" but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs and lower VAT) Awareness campaigns

		houses -1.25% Natural Gas consumption for multifamily houses 2% of fuel oil consumption by 2030	(Economic) 2. High costs and risks (Economic)	
Efficient cooling	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	49% penetration of efficient air-conditioning technologies 19% penetration of high efficiency technologies (A+++ only)	The common barriers with the "efficient heating" affected positively this technology.	No specific additional policy to the ones already in place (BAU).
Efficient appliances	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	31% of electricity induction for cooking 27% of electricity conduction for cooking -1,25% household consumption for higher efficiency appliances. -1.5% of Natural gas for water heating -4% of LPG for water heating	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).
Efficient lighting	By 2020, LED lighting to become technological standard, with complete phase-out of less efficient technologies, which will be no more avaialble on the market.	100% penetration of efficient lighting technologies, with a 130 kWh target per household.	This technology was not one of the targeting ones. The impact of the barriers linked with this technology remain as they are.	No specific additional policy to the ones already in place (BAU).

3.3.2. Analysis and results of EE scenarios for the residential sector compared with BAU and policy targets

Preliminary results: sub-scenarios and EE-BR0

The results of all five sub-scenarios are presented below. In the subsequent graphs, we isolate the effect of each single measure: hence, EE-BR0 scenario is equal to the sum of BSI+EH+ECool+Eapp+Elight. As shown in the two figures, improving building shells and improving the efficiency of heating systems achieve higher effects for both emission reduction and energy savings.

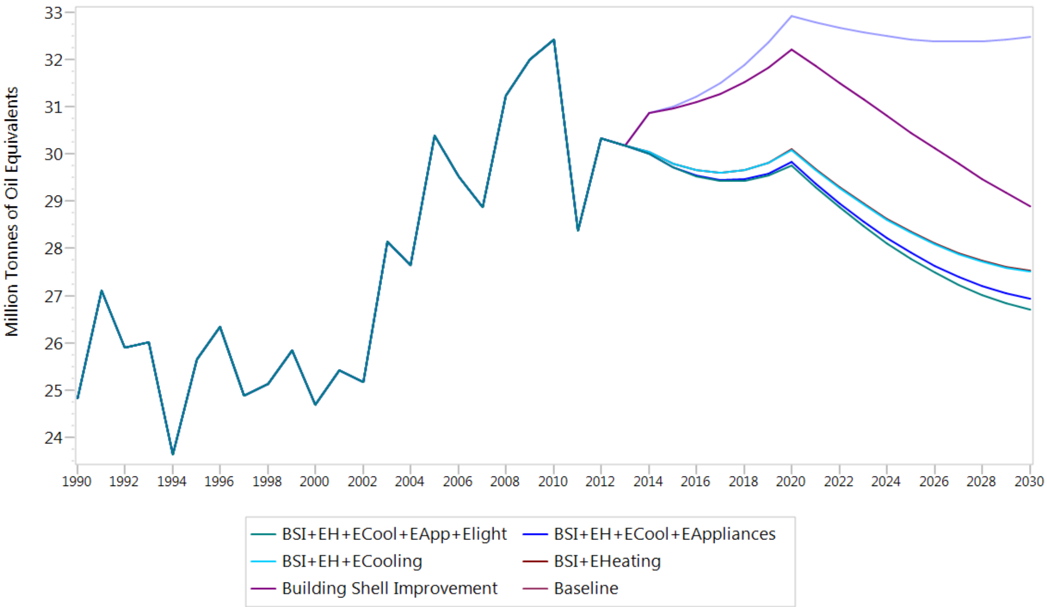

Figure 20: Final energy consumption of the residential sector in the five sub-scenarios and BAU

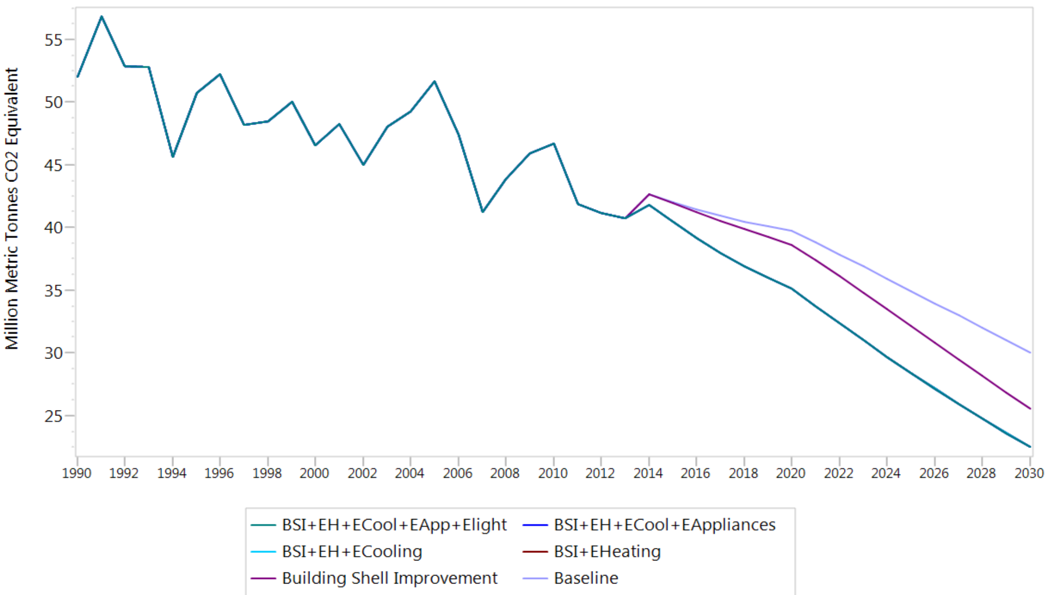

Figure 21: Emission of the residential sector in the five sub-scenarios and BAU.

Comparing all scenarios

Below we show the results have all scenarios compared to National Target for the residential sector.

Table 21: Comparisons among scenarios for final energy consumption in building sector in Mtoe.

	Target for final energy consumption by 2020	***Final energy consumption in year 2020***	***%Change in 2020 compared to 2020 national target***	***Final energy consumption in year 2030***	***%Change in 2030 compared to HERON BAU scenario***
BAU	29.41	32.92	+11.66%	32.48	
EE-BR0 (without running DST)		29.41	0.00%	26.77	-17.59%
EE-BR1		31.07	5.63%	29.64	-8.76%
EE-BR2 (1st combination)		30.77	4.61%	28.94	-10.90%
EE-BR3 (2st combination)		30.81	4.75%	28.98	-10.79%
EE-BR4 (3st combination)		30.98	5.34%	29.50	-9.19%

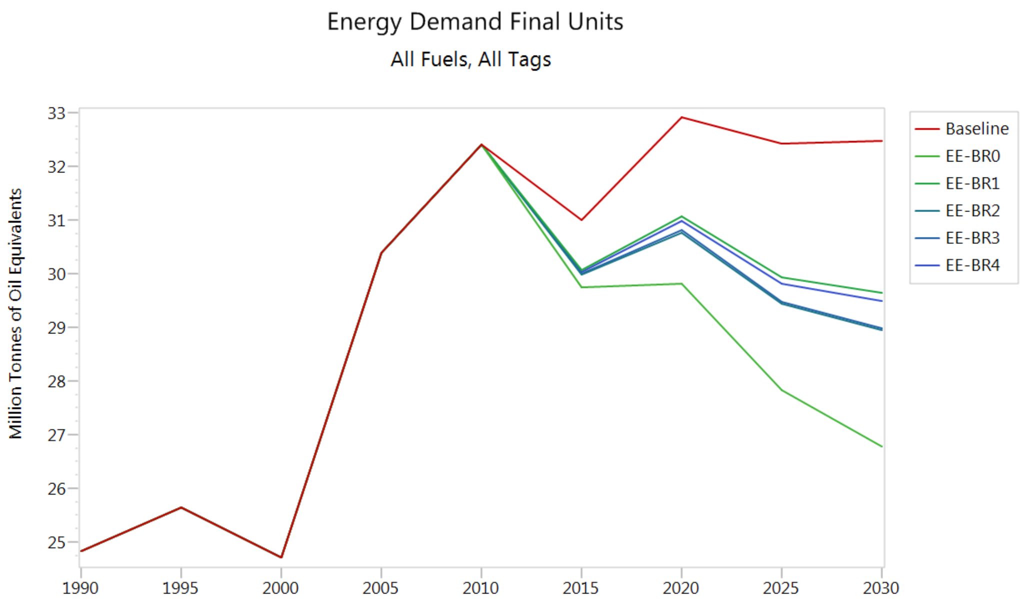

Figure 22: Final energy consumption of the residential sector in the BAU and in the five EE scenarios.

Below. we present the outcome of all scenarios on GHG emissions.

Table 22: Direct GHG emissions in $MtCO_2$.

	1990	2005	2020	2030
EU Policy target and national target if applicable	52.02	57.79	43.92	40.45
HERON BAU scenario			39.74	30.06
% change compared to target			-9.50%	-25.69%
HERON EE-BR0 scenario			35.63	23.28
% change compared to target			-18.87%	-42.45%
HERON EE-BR1 scenario			37.59	27.01
% change compared to target			-14.42%	-33.22%
HERON EE-BR2scenario			37.05	25.93
% change compared to target			-15.64%	-35.90%
HERON EE-BR3 scenario			37.20	26.15
% change compared to target			-15.31%	-35.36%
HERON EE-BR4 scenario			37.49	26.90
% change compared to target			-14.64%	-33.50%

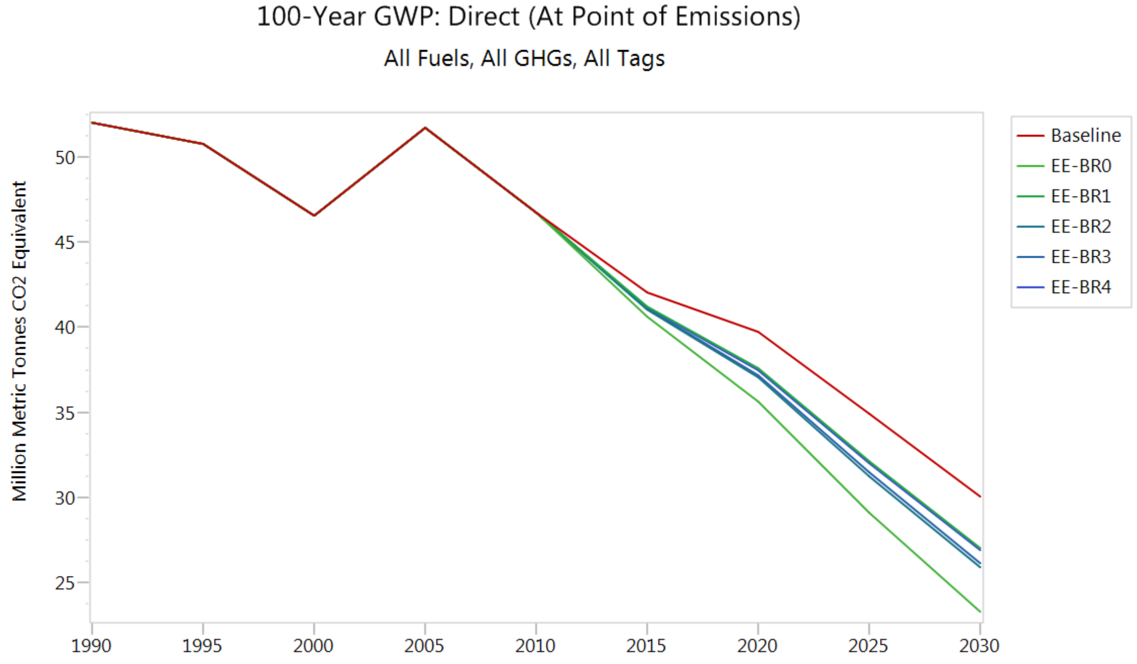

Figure 23: CO2 emissions of the residential sector in the BAU and in the five EE scenarios.

There are no national targets for Nox emissions. The results of Nox emissions for each scenario will be compared to BAU respective results.

Table 23: Comparisons among scenarios for Nox emissions in MtCO2eq.

	2020	*%Change in 2020 compared to BAU*	*2030*	*%Change in 2030 compared to BAU*
BAU	0.038	0	0.027	0
EE-BR0 (without running DST)	0.035	-10.42%	0.021	-23.79%
EE-BR1	0.036	-5.58%	0.024	-11.45%
EE-BR2 (1st combination)	0.036	-6.89%	0.023	-15.02%
EE-BR3 (2st combination)	0.036	-6.57%	0.024	-14.33%
EE-BR4 (3st combination)	0.036	-5.77%	0.024	-11.77%

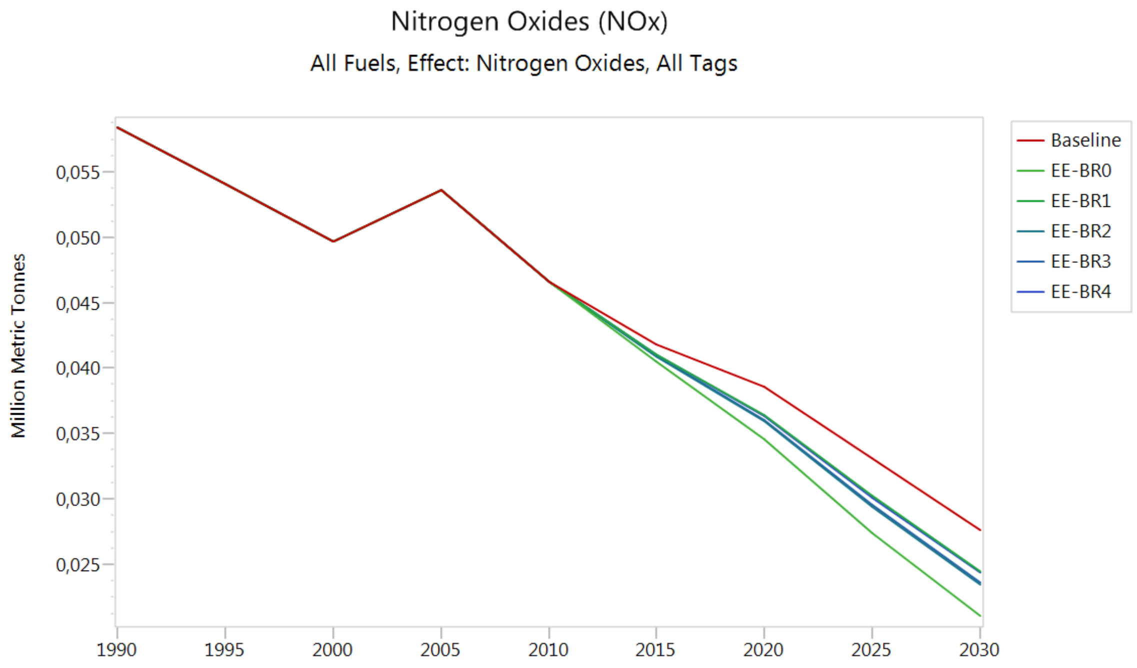

Figure 24: NOx emissions of the residential sector in the BAU and in the five EE scenarios.

3.3.3. Energy efficiency scenarios for the Tertiary sector: assumptions

Below we present the assumptions and the results of all the energy efficiency scenarios elaborated for the tertiary sector.

It is important to highlight that the first energy efficiency scenario EE-BR0 is a scenario driven only by two specific additional policies: awareness campaigns and specific advertisement to show the economic rationale of EE technologies. Most of the energy efficient technologies already have economic rationale, therefore, people should adopt them in the first place. For the purpose of this report, these technologies are cost-effective either because they cost less than non-efficient technologies, either because the current policies are enough to make them cost less. Hence, with perfect information on technologies (i.e. no information costs), with perfect allocation of funds in financial markets (i.e. no transaction costs) and with perfect cooperation among agents (i.e. no coordination costs), rational agents would opt for these technologies.

Three sub-scenarios for the tertiary sector are developed. Each of which assuming a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:

1. Efficient heating: This scenario focuses the penetration of highly energy efficient heating systems in existing tertiary buildings.
2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings.
3. Heat pumps: This scenario focuses the penetration of heat pumps (such as air-to-air. water source. and geothermal).

The developed scenarios are the following:

- EE-BT0: the combination of all developed sub-scenarios into one (1) EE scenario that should lead to at least 30% energy savings compared to BAU scenario. without using DST.
- EE-BT1: the combination of all developed sub-scenarios into one (1) EE scenario using the actually expected levels of penetration. derived from DST.
- EE-BT2 – EEBT4: the three best combinations of technologies/measures (ie of the sub-scenarios) with the higher penetration levels after the minimization of barriers. According to the results presented below.

Sub-Scenario 1: Building shell improvement (BSI)

This scenario focuses on the improvement of insulation in existing buildings in all sectors. This scenario decreases the energy intensity of the space-heating for all building types of the existing stock.

The measure included in this scenario is a comprehensive deep renovation in order to achieve a 60% improvement in energy efficiency (CRESME. 2014).

Sub-Scenario 2: Efficient heating (Eheating)

The basic assumptions for the construction of our efficient heating scenario are:

- Two end-uses: water heating and space heating;
- Technologies: high-efficiency co-generation.

For security reasons, we let in all scenarios hospitals to have their reserves of diesel and fuel oil.

Sub-Scenario 2: Heat Pumps (EPumps)

The basic assumptions for the construction of our heat pump scenario are:

- Two end-uses: water heating and space heating;
- Technology: heat pumps.

EE-BT0 scenario

The two sub-scenarios are combined in one: the EE-BT0 scenario. This scenario for the tertiary sub-sector is presented in the Table below. The policy assumptions of this scenario will be used as inputs for the DST.

Table 24: Assumptions of EE-BT0 scenario

Sub-scenarios	Policy assumptions	Policy instrument for EE-BT0
Building Shell improvement	Renovation rate of 3% for all types of tertiary buildings Target consumption: • Schools 134 kWh per square meter • Hospitals 88 kWh per square meter • Shops 106 kWh per square meter • Public Administration 85 kWh per square meter	Awareness campaign and specific advertisement to show the economic rationale of EE technologies

	• Hotels 149 kWh per square meter • Offices 86 kWh per square meter	
Efficient heating and heat pumps	Schools • 8% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 9% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Public administration • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Hotels • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Offices • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030	Awareness campaign and specific advertisement to show the economic rationale of EE technologies

EE-BT1 – EE-BT4 scenarios for buildings

We now present the results of the four scenarios elaborated with the DST. The first one (EE-BT1) represents the negative effect of the barriers on the assumptions and targets of the EE-BT0 scenario. All other scenarios quantifies the effect of the introduction of specific policies aimed at minimizing the effect of the barriers.

Table 25: Assumptions of EE-BT1 scenario

Sub-scenarios	**Policy assumptions**	**EE-BT1: DST outcome (after considering impact of barriers)**
Building Shell improvement	Renovation rate of 3% for all types of tertiary buildings Target consumption: • Schools 134 kWh per square meter • Hospitals 88 kWh per square meter	Renovation rate of 1.37% for all types of tertiary buildings

	• Shops 106 kWh per square meter • Public Administration 85 kWh per square meter • Hotels 149 kWh per square meter • Offices 86 kWh per square meter	
Efficient heating and heat pumps	Schools • 8% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 9% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Public administration • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Hotels • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030 Offices • 7% of heat pumps • Phase out of fuel oil, LPG and diesel by 2030	Schools • 6% of heat pumps • 2% of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 6.6% of heat pumps • 2.2% of fuel oil, LPG and diesel by 2030 Public administration • 5.5% of heat pumps • 1.5% of fuel oil, LPG and diesel by 2030 Hotels • 4.9% of heat pumps • 2.1% of fuel oil, LPG and diesel by 2030 Offices • 4.6% of heat pumps • 2.4% of fuel oil, LPG and diesel by 2030

Table 26: Assumptions of EE-BT2 scenario.

Sub-scenarios	**Policy instrument for EE-BR0**	**EE-BT2: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Building Shell improvement	Awareness campaign and specific advertisement to show the economic	Renovation rate of 2% for all types of tertiary buildings	BSI was the main focus of this scenario along with efficient heating. This technology has a large	Financial incentives for private operators: in particular, tax credits and special amortization rules

	rationale of EE technologies		number of barriers compared to the other, some of which are common. The barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Lack of experienced professionals, trusted information (Educational); 2. Lack of awareness (Educational) 3. Lack of any type of financial support (Economic) 4. High costs and risks (Economic)	for investments; Policy incentives for Local Administration (assistance in borrowing and in PPP); Educational programmes for technical staff of municipalities
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Schools • 6% of heat pumps • 2% of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 6.6% of heat pumps • 2.4% of fuel oil, LPG and diesel by 2030 Public administration • 5.5% of heat pumps • 1.5% of fuel oil, LPG and diesel by 2030 Hotels • 4.9% of heat pumps • 2.1% of fuel oil, LPG and	The common barriers with the “BSI” had basically the same effect. Hence, values are the same with values of EE-BT2.	Financial incentives to private operators (capital subsidy; low interest loans and specific tariffs) such as the “Conto Termico” but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs and lower VAT)

		diesel by 2030 Offices • 4.6% of heat pumps • 2.4% of fuel oil, LPG and diesel by 2030		

Table 27: Assumptions of EE-BT3 scenario.

Sub-scenarios	**Policy instrument for EE-BR0**	**EE-BT3: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Building Shell improvement	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Renovation rate of 1.83% for all types of tertiary buildings	The common barriers with the “efficient heating” affected positively this technology.	Financial incentives for private operators: in particular, tax credits and special amortization rules for investments; Policy incentives for Local Administration (assistance in borrowing and in PPP); Educational programmes for technical staff of municipalities
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Schools • 7.2% of heat pumps • 0.8% of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 7.9% of heat pumps • 1.1% of fuel oil, LPG and diesel by 2030 Public administration • 6% of heat pumps • 1% of fuel oil, LPG and diesel by 2030	1. Lack of awareness of saving potential (Educational) ; Efficient heating was the main focus of this scenario along with BSI. The common barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 2. Lack of any type of financial support	Financial incentives to private operators (capital subsidy; low interest loans and specific tariffs) such as the “Conto Termico” but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs and lower VAT)

		Hotels • 6.4% of heat pumps • 0.6% of fuel oil, LPG and diesel by 2030 Offices • 5.5% of heat pumps • 1.5% of fuel oil, LPG and diesel by 2030	(Economic) 3. High costs and risks (Economic)	

Table 28: Assumptions of EE-BT4 scenario

Sub-scenarios	**Policy instrument for EE-BR0**	**EE-BT4: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Building Shell improvement	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Renovation rate of 1.37% for all types of tertiary buildings		Financial incentives for private operators: in particular, tax credits and special amortization rules for investments; Policy incentives for Local Administration (assistance in borrowing and in PPP); Educational programmes for technical staff of municipalities
Efficient heating and heat pumps	Awareness campaign and specific advertisement to show the economic rationale of EE technologies	Schools • 5.6% of heat pumps • 2.4% of fuel oil, LPG and diesel by 2030 Hospital • No fuel mix change Shops • 7% of heat	Efficient heating was the only focus of this scenario. The barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Lack of any type of financial	Financial incentives to private operators (capital subsidy; low interest loans and specific tariffs) such as the “Conto Termico” but with more favourable terms (HERON Deliverable 1.1) Financial incentives for switching to district heating (specific tariffs

		pumps • 2% of fuel oil, LPG and diesel by 2030 Public administration • 5.3% of heat pumps • 1.7% of fuel oil, LPG and diesel by 2030 Hotels • 4.9% of heat pumps • 2.1% of fuel oil, LPG and diesel by 2030 Offices • 5% of heat pumps • 2% of fuel oil, LPG and diesel by 2030	support (Economic) 2. High costs and risks (Economic)	and lower VAT)

3.3.4. Analysis and results of EE scenarios for the tertiary sector compared with BAU and policy targets

4. Preliminary results: sub-scenarios and EE-BT0

The results of the two sub-scenarios are presented below and they show their contribution to the overall EE-BT0 scenario (which is represented by the curve BSI+EE heating). We see that, compared to the BAU, most of the efficiency gains will come from the building shell improvement.

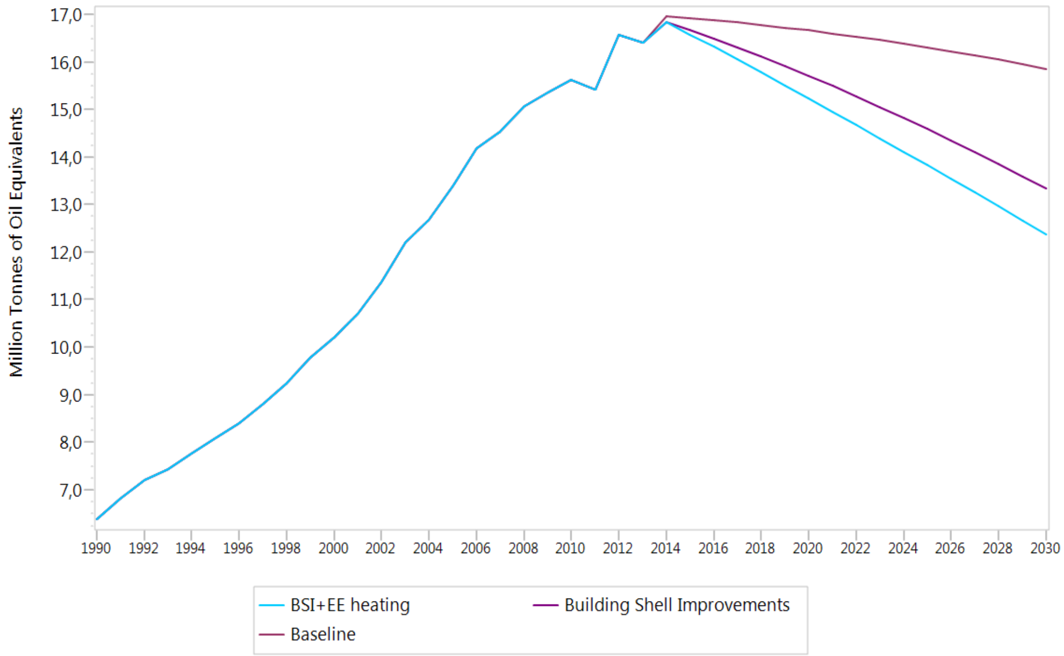

Figure 25: Final energy consumption of the tertiary sector in the two sub-scenarios and in the BAU.

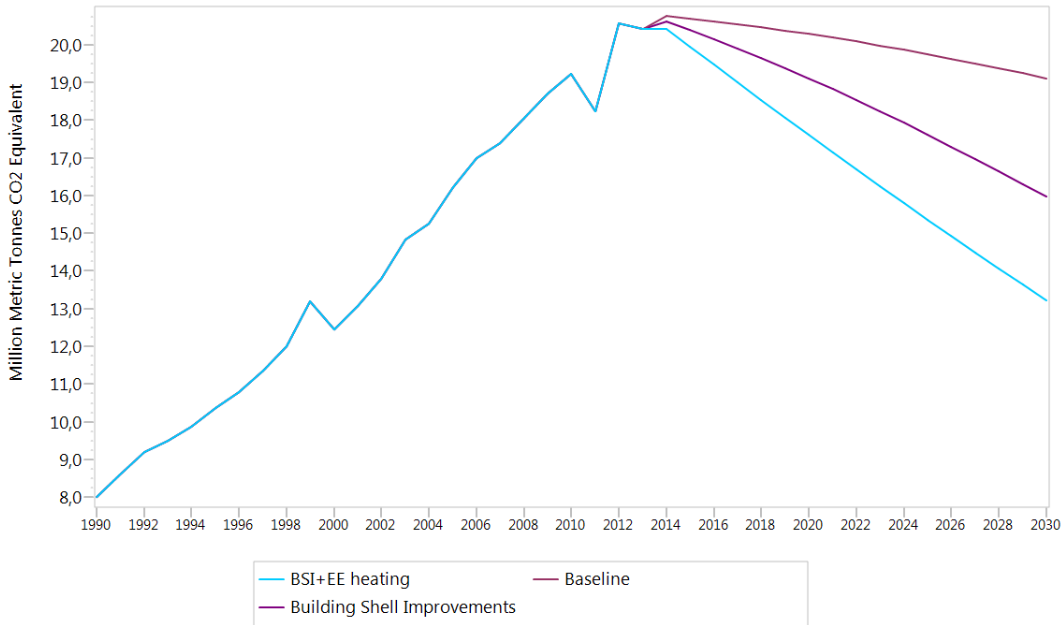

Figure 26: Emission of the tertiary sector in the two sub-scenarios and in the BAU.

Comparing all scenarios

Below we show the results of all scenarios compared to National Target for the residential sector.

Table 29: Comparisons among scenarios for final energy consumption in building sector in Mtoe.

	Target for final energy consumption by 2020	*Final energy consumption in year 2020*	*%Change in 2020 compared to 2020 national target*	*Final energy consumption in year 2030*	*%Change in 2030 compared to HERON BAU scenario*
BAU	18.57	16.66	-10.28%	15.85	
EE-BT0 (without running DST)		15.23	-17.98%	12.39	21.87%
EE-BT1		15.92	-14.24%	14.03	-11.48%
EE-BT2 (1st combination)		15.65	-15.31%	13.34	-14.62%
EE-BT3 (2st combination)		15.73	-15.75%	13.54	-15.86%
EE-BT4 (3st combination)		15.93	-14.24%	14.04	-11.46%

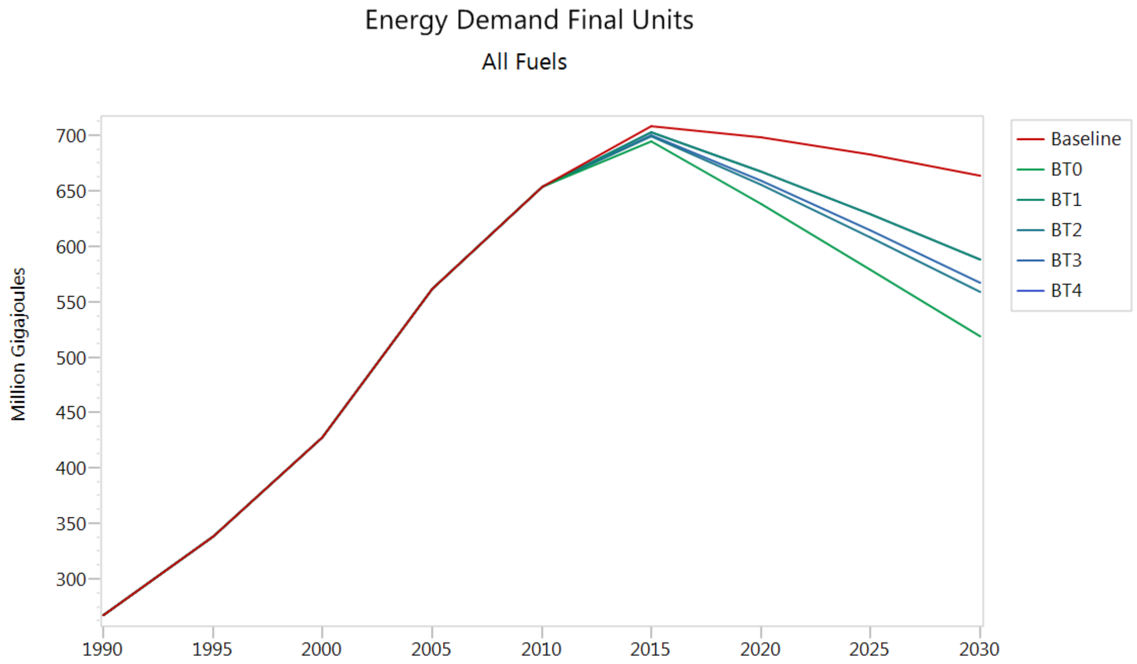

Figure 27: Final energy consumption of the tertiary sector in the five EE scenarios.

Below we present the results for GHG.

Table 30: Direct GHG emissions in $MtCO_2$.

	1990	2005	2020	2030
EU Policy target and national target if applicable		26.2	26.4	21.1
HERON BAU scenario			20.28	19.10
% change compared to target			-23.17%	9.50%
HERON EE-BT0 scenario			17.51	12.88
% change compared to target			-33.67%	-38.97%
HERON EE-BT1 scenario			18.57	15.25
% change compared to target			-29.66%	-27.70%
HERON EE-BT2scenario			18.24	14.46
% change compared to target			-31.08%	-31.90%
HERON EE-BT3 scenario			18.19	14.37
% change compared to target			-30.93%	-31.46%
HERON EE-BT4 scenario			18.53	15.16
% change compared to target			-29.81%	-28.15%

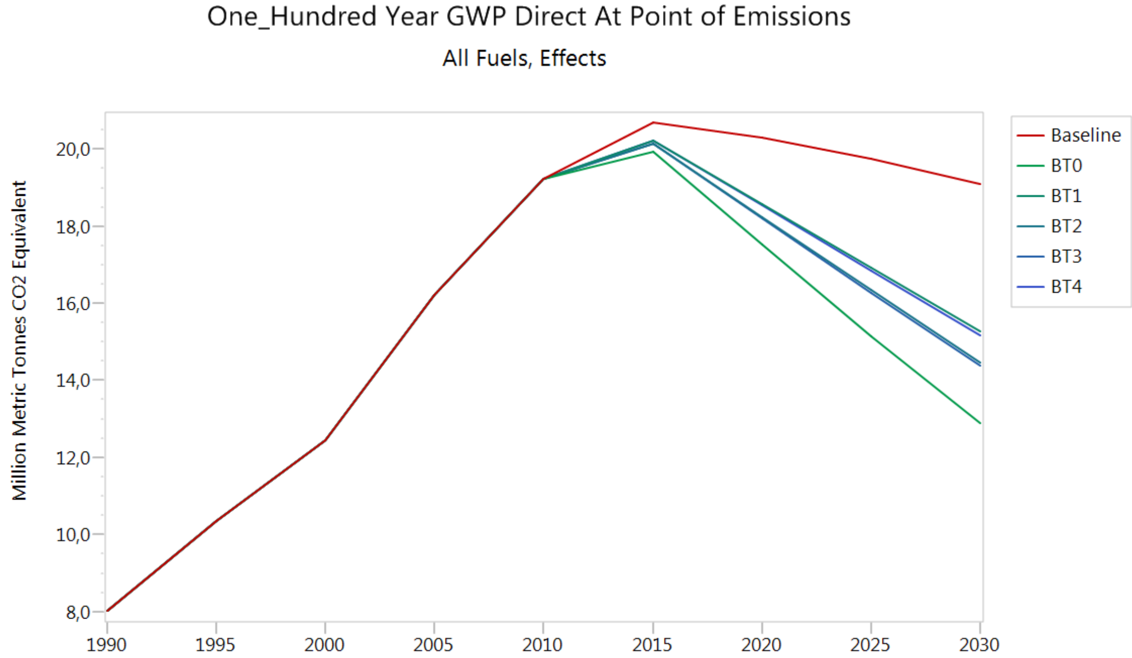

Figure 28: CO2 emissions of the tertiary sector in the five EE scenarios.

There are no national targets for NOx emissions. The results of NOx emissions for each scenario will be compared to BAU respective results.

Table 31: Comparisons among scenarios for NOx emissions in MtCO2eq.

	2020	***%Change in 2020 compared to BAU***	***2030***	***%Change in 2030 compared to BAU***
BAU	0.0197	0	0.0185	0
EE-BT0 (without running DST)	0.0166	-15.63%	0.0117	-36.65%
EE-BT1	0.0177	-10.00%	0.0142	-23.44%
EE-BT2 (1st combination)	0.0174	-12.11%	0.0135	-28.65%
EE-BT3 (2st combination)	0.0173	-11.64%	0.0132	-27.47%
EE-BT4 (3st combination)	0.0177	-10.28%	0.0141	-24.13%

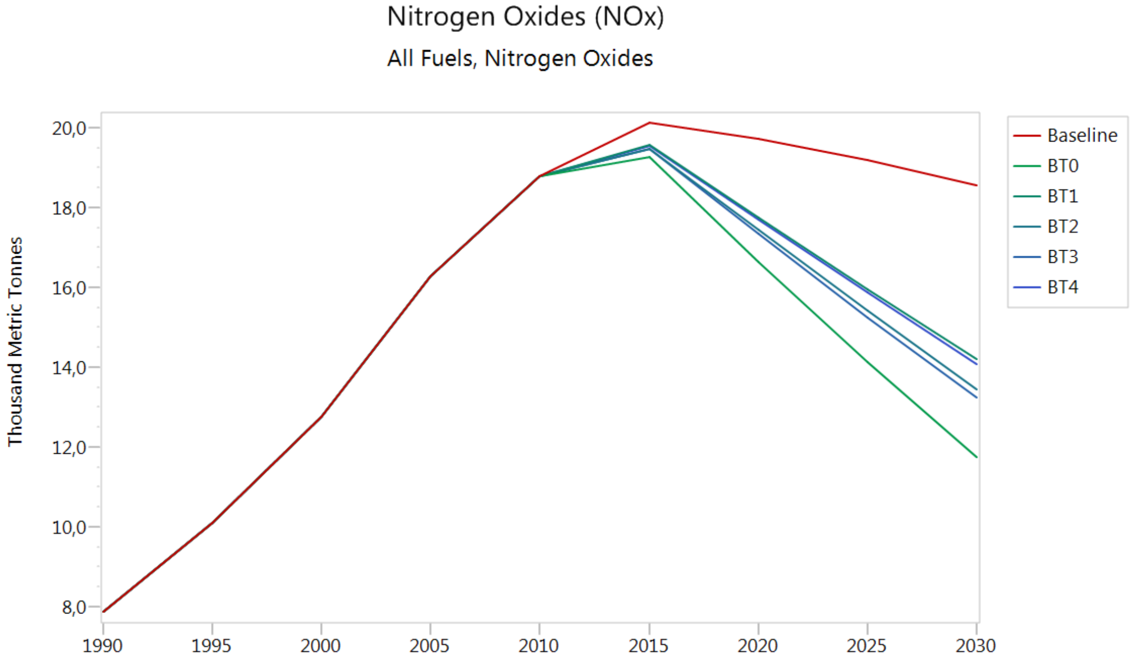

Figure 29: NOx emissions of the tertiary sector in the five EE scenarios.

3.4 Summing up all the results from the building sector

Below we present the main tables summing up energy consumption, emissions and savings for both the residential and the tertiary sector. Combined, they represent the building sector.

Table 32: Sum of both residential (BR) and tertiary (BT) scenarios for final energy consumption in building sector in Mtoe.

	Target for final energy consumption by 2020	*Final energy consumption in year 2020*	*%Change in 2020 compared to 2020 national target*	*Final energy consumption in year 2030*	*%Change in 2030 compared to HERON BAU scenario*
BAU	47.98	49.58	3.3%	48.33	
EE-B0 (without running DST)		44.64	-7.0%	39.16	-18.97%
EE-B1		46.99	-2.1%	43.67	-9.64%

EE-B2 (1st combination)		46.42	-3.3%	42.28	-12.52%
EE-B3 (2st combination)		46.54	-3.0%	42.52	-12.02%
EE-B4 (3st combination)		46.91	-2.2%	43.54	-9.91%

Table 33: Sum of both residential (BR) and tertiary (BT) scenarios for GHG emissions in Mton.

	1990	**2005**	**2020**	**2030**
EU Policy target and national target if applicable		83.99	70.32	61.55
HERON BAU scenario			60.02	49.16
% change compared to target			-14.65%	-20.13%
HERON EE-BT0 scenario			53.14	36.16
% change compared to target			-24.43%	-41.25%
HERON EE-BT1 scenario			56.16	42.26

% change compared to target			-20.14%	-31.34%
HERON EE-BT2scenario			55.29	40.39
% change compared to target			-21.37%	-34.38%
HERON EE-BT3 scenario			55.39	40.52
% change compared to target			-21.23%	-34.17%
HERON EE-BT4 scenario			56.02	42.06
% change compared to target			-20.34%	-31.67%

Table 34: Sum of both residential (BR) and tertiary (BT) scenarios for NOx emissions in Mton.

	2020	***%Change in 2020 compared to BAU***	***2030***	***%Change in 2030 compared to BAU***
BAU	0.058		0.046	
EE-BT0 (without running DST)	0.052	-10.57%	0.033	-28.13%

EE-BT1	0.054	-6.93%	0.038	-16.04%
EE-BT2 (1st combination)	0.053	-7.45%	0.037	-19.78%
EE-BT3 (2st combination)	0.053	-7.63%	0.037	-18.24%
EE-BT4 (3st combination)	0.054	-6.93%	0.038	-16.26%

Table 35: Sum of both residential (BR) and tertiary (BT) scenarios for energy savings per capita and GHG emissions per capita.

Scenarios	***Energy savings/capita in toe***		***GHG emissions per capita in tCO_{2eq}***	
	2020	**2030**	**2020**	**2030**
BAU	0.000	0.000	0.970	0.767
EE-B0	0.080	0.143	0.858	0.564
EE-B1	0.042	0.073	0.907	0.659
EE-B2	0.051	0.094	0.893	0.630
EE-B3	0.049	0.091	0.895	0.632
EE-B4	0.043	0.075	0.905	0.656

3.5 key findings

In the building sector, the adoption of cost-effective technologies, even without further supporting policies should be enough to meet EE targets. As the DST shows, though, barriers impede the penetration of these technologies. People perceive adoption costs, which “artificially” increase the cost of these EE technologies. Hence, there is the need to introduce specific policies aimed at reducing those “transaction costs”.

In particular, barriers increase by more than 5% energy consumption in the residential sector and by more than 7% in the tertiary sector. Hence, barriers do not allow the residential sector to achieve its target by 2020. On the other hand, they still allow the tertiary sector to achieve its targets as it is performing much better than the forecasts that were used when targets were set.

All minimization scenarios are effective in smoothing the effect of the barriers. Not surprisingly, the scenario that focuses on minimizing the barriers for the “building shell improvement” technologies is the most effective in terms of EE results. BSI technologies are responsible for more than 50% of the expected savings and together with efficient heating technologies and heat pumps they are expected to contribute more than 90% to the overall targets.

Therefore, additional policies aimed at minimizing barriers should focus on BSI and efficient heating. In particular, there is the need to introduce policies promoting "community energy" solutions for multifamily buildings. These policies need not be financial policies, but rather policies that allow people to invest collectively in deep renovation and in energy production. For instance, a good policy would be to allow multifamily building to sell electricity to all households within the building, using the electricity generated by a CHP technology.

In terms of emissions, instead, irrespective of the barriers, Italy will meet its targets. This is given by the energy mix change that has happened in this last decade, which has dramatically reduced CO2 and NOx emissions.

CHAPTER 4: FORWARD LOOKING SCENARIOS FOR TRANSPORT

4.1. HISTORIC DATA AND TRENDS

In the transport sector. until 2007. there was mainly a growing energy demand that reached 45.5 Mtoe. After 2009. due to economic recession and energy efficiency measures. the final energy consumption has been decreasing. reaching 38.1 Mtoe in 2013. accounting for 32% of total final energy consumption. During the last years. following EU directives. biodiesel was introduced in the fuel mix. Nevertheless. petroleum products are the dominant fuel in the mix. The fuel mix remains almost stable across the years.

Road transport accounts for the highest share (90%) of the total final energy consumption of the sector (CRES. 2015).

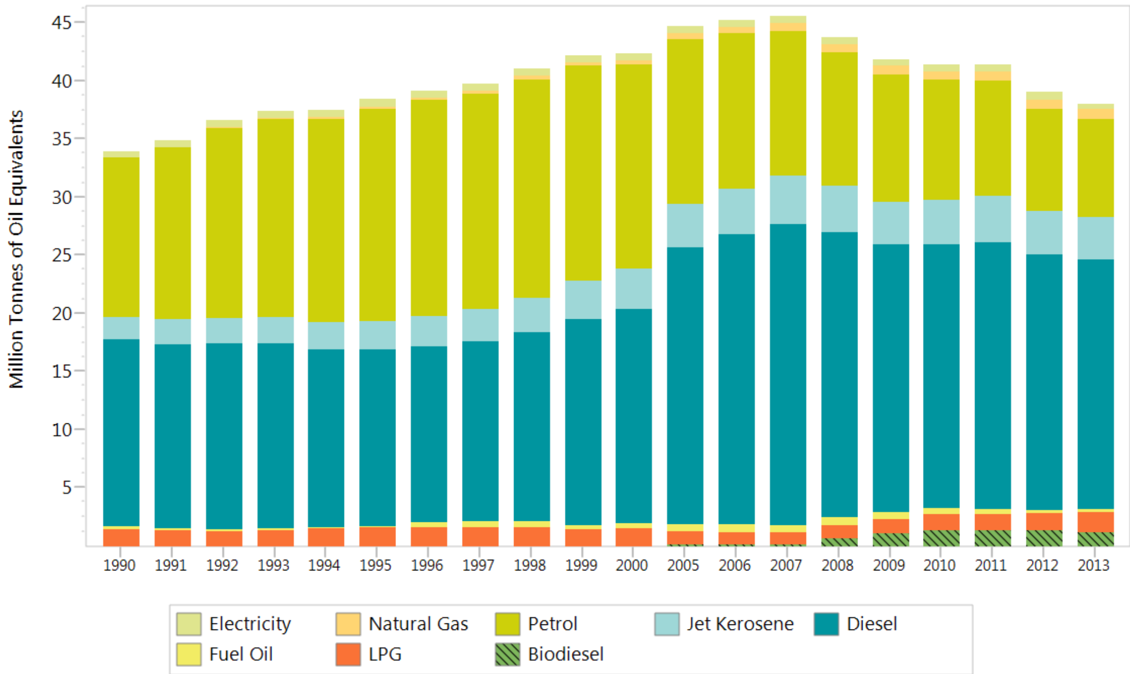

Figure 30: Final energy consumption of the Italian transport sector by fuel (1990-2013).

4.2. BAU SCENARIO UP TO 2030

BAU looks into current possible trends until 2030 with policy measures already decided or in place.

4.2.1. Key assumptions

Both passenger and freight transport are modelled in the Italian LEAP dataset. Road. rail. aviation and navigation are included in both categories. All data were obtained from EUROSTAT statistical pocketbooks. database and ODYSEE-MURE[37]. Due to the slight increase in population. as well as the slight increase in GDP. both passenger-kms and freight-kms are assumed to increase by a CAGR of 1.1% and 1.7% respectively. Moreover. given that only air transport has gained shares in these last thirteen years. the modal shares project a constant increase in air transport penetration. reaching almost 7% to its current 5%.

The passenger road transport is divided to private cars. motorcycles and buses. According to ISTAT and EUROSTAT (2010). the distribution of total road vehicle-km is the following: 78% private vehicles (cars. trucks. taxis and 2 wheel vehicles) and 10.9% buses. The fuel mix for this sub-sector is assumed to follow the historical trends and we expect a faster penetration of natural gas.

In the passenger and freight rail transport. the fuel mix is also assumed to follow the historical trends - increase of biodiesel and electricity. Concerning aviation and navigation. the fuel mix was assumed to remain stable.

4.2.2. Analysis and results of BAU scenario

The total final energy consumption for the reference period 2001-2005 is 42 Mtoe. This is the reference period for the 2020 target. The transport sector accounts for 32% of the total energy according to 2013 data (MISE. ENEA. 2015).

In order to meet the targets presented before (that is 9.7 Mtoe reduction by 2020). transport consumption should be equal to 42.87 Mtoe in 2020; in 2030. with a 30% reduction compared to the reference scenario. consumption should equal 39.22 Mtoe.

In BAU. the total final energy consumption in Mtoe is presented below:

Year	Energy consumption (in Mtoe)
2016	39.7
2020	41.3
2030	44.8

As shown above. in BAU scenario. the targets are achieved in 2020 while for 2030 there is a deviation from the target by 14.2%.

The GHG target for Italy for 2020 is 13% reduction of GHG emissions compared to 2005 levels. The amount of transport GHG emissions in 2005 is 127.1 $MtCO_{2eq}$ (ISPRA). The GHG emissions in BAU scenario for the transport sector reach 114.6 $MtCO_{2eq}$ for 2020 and 118.3 $MtCO_{2eq}$ for 2030 (LEAP calculations). In 2020. the percentage difference from the reference year is -6.9%.

The total GHG emissions per capita for the transport sector are 1.85 tCO_{2eq}/capita for 2020 and 1.84 tCO_{2eq}/capita for 2030.

[37] http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html

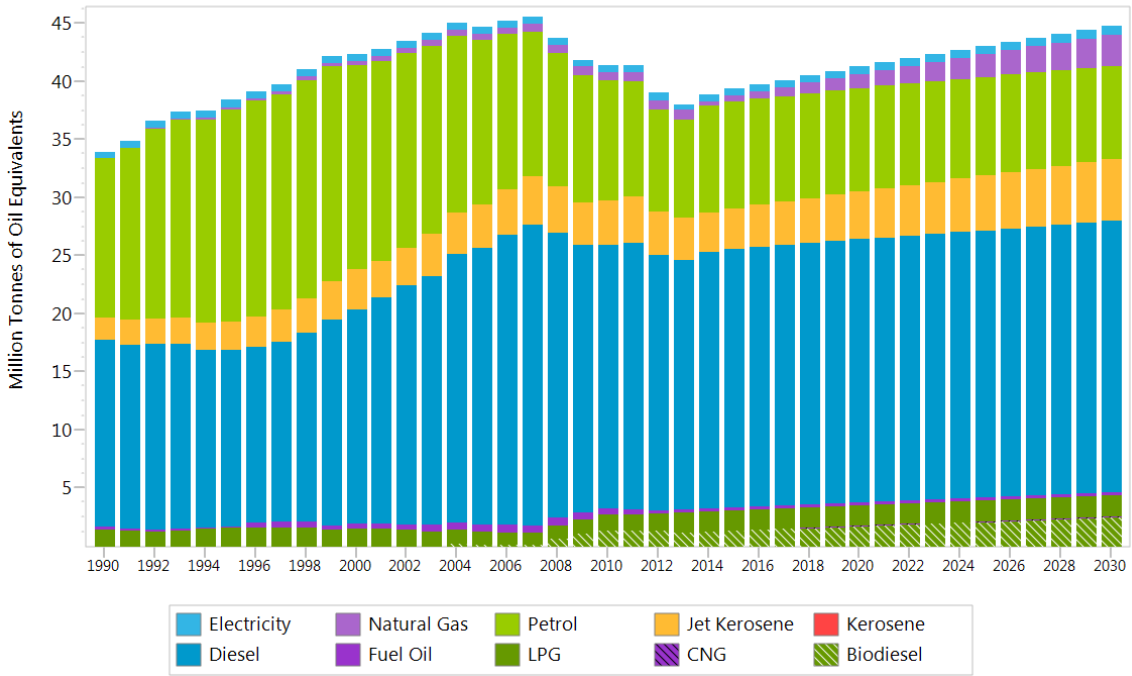

Figure 31: Evolution of final energy consumption of transport sector until 2030 in BAU scenario.

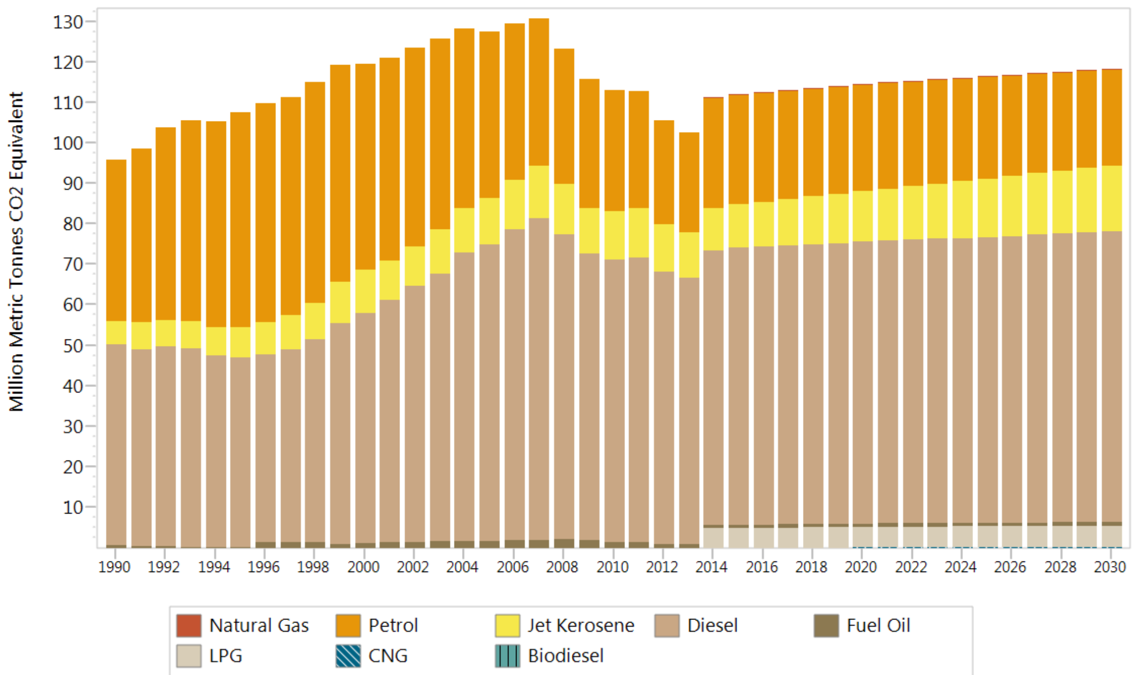

Figure 32: Evolution of GHG emissions of transport sector until 2030 in BAU scenario.

4.3. ENERGY EFFICIENCY SCENARIOS UP TO 2030

The energy efficiency scenarios are built on specific sub-scenarios and are based on the DST outcomes. The scenarios both for buildings and transport sectors are characterized by penetration of technologies/measures and the respective policy instruments that support the penetration. The choice of these policies and technologies are based on the HERON questionnaire survey and the DST. These scenarios reach the horizon of 2030 and all targets (either concerning specific technologies or overall reductions of energy consumption) are aligned with EU 2030 targets for energy savings and CO_2 emissions.

Contrary to what we have done in the building sector, the first energy efficiency scenario, EE-T0 is driven by additional policies. This was necessary, as there are no cost-effective technologies allowing the achievement of EE targets. All the technologies taken into account, in particular, electric and hybrid vehicles, need specific support policies. Hence, in the EE-T0 we introduce policies simply aimed at making cost-effective the technologies that we want to promote. Of course, we do not take into account the effect of all barriers, which increase the cost of adopting a technology, in terms of transaction costs, information costs, and behavioral resistance. These barriers require additional policies that are discussed in the EE-T1 to EE-T4 scenarios.

Each EE scenario is composed of three sub-scenarios, each assuming a specific level of penetration for one technology/measure that was included in the WP2 survey. The sub-scenarios in transport are the following:

1. Modal shift in passenger transport;
2. Modal shift in freight transport;
3. Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable).

The developed Energy Efficiency (EE) scenarios for transport are:

1. EE-T0: the combination of the three sub-scenarios into one (1) EE scenario that lead to at least 27% energy savings compared to BAU, without using DST.
2. EE-T1: the combination of the three (3) sub-scenarios into one (1) EE scenario using the actually expected levels of penetration, derived from DST.
3. EE-T2 up to EE-T4: the best combinations of sub-scenarios with the updated levels of penetration after the minimization of barriers.

4.3.1. Key assumptions and policy measures

The sub-scenarios for the transport sector are the following:

- Passenger transport: Use of more sustainable and efficient modes;
- Freight transport: Use of more sustainable and efficient modes;
- Penetration of electric and hybrid vehicles in passenger and freight transport.

Sub-Scenario 1: Modal shift

Passenger transport: Use of more sustainable and efficient modes

The measures in this scenario include:

- modal shift from private cars to public transportation for city users;
- modal shift from road to rail for long distances.

In the EE-T0 scenario, we project a 1.5% yoy reduction in the use of private car in favour of public transportation in urban areas. At present, this is the modal split in major Italian cities:

Table 36: Mobility within major Italian cities (EUROSTAT).

City	Walking	Cycling	Public Transport	Cars
Milan	17%	6%	41%	36%
Naples	13%	2%	26%	58%
Rome	7%	5%	24%	64%
Florence	8%	6%	22%	66%
Bologna	8%	4%	21%	67%
Bari	13%	1%	14%	72%
Palermo	12%	1%	9%	78%
Turin	12%	3%	5%	79%

Within our scenario, we project that all cities converge to the benchmark, which is represented by Milan. By 2030, the average use of private cars should be close to no more than 50%. Public transportation will be promoted by new investments, but also with the introduction of new restricted traffic areas (ZTL in Italian) as well as new car free zones (aree pedondali in Italian).

As shown in the figure below, they have grown in Italy at a very rapid pace, averaging a 45% to 60% growth.

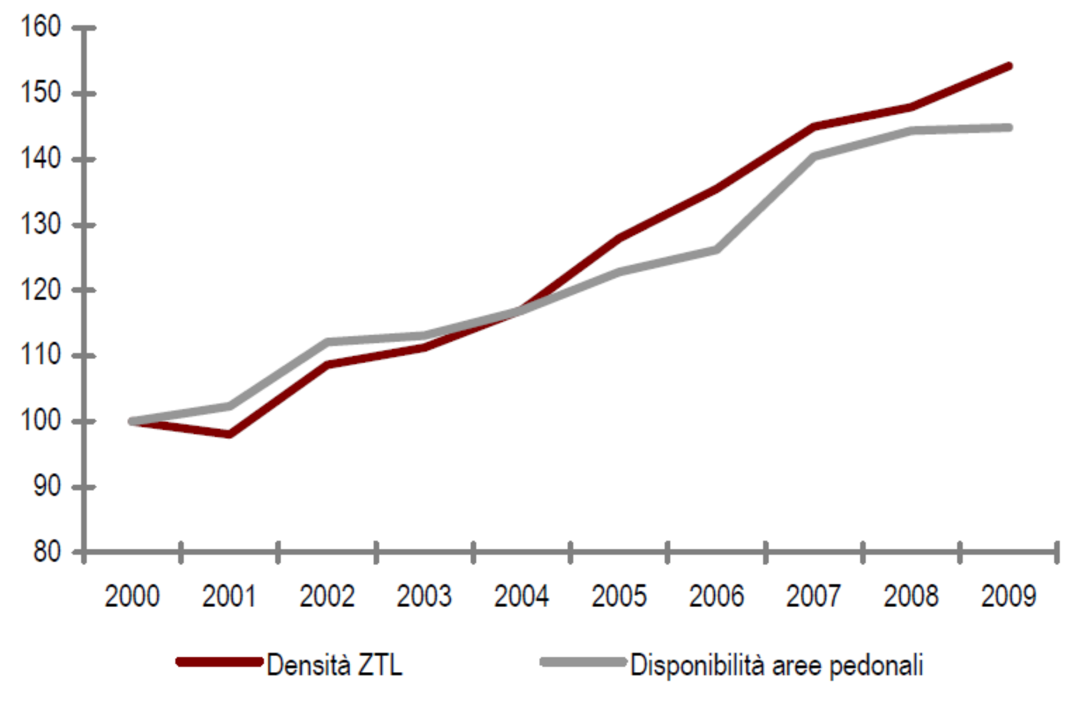

Figure 33: **Evolution index of restricted traffic zones (ZTL) and car free zones (aree pedonali). 2000=100.**

As for the modal shift on long distances, in the EE-T0 scenario, we project a 4% yoy growth of the rail. This is more than the recent growth and it will be driven by the new investments in high-speed train and the full development of this sector.

Freight transport: Use of more sustainable and efficient modes

The measures include:

- modal shift from road to rail for freight transportation.

As for the modal shift on long distances, we project a reduction of -1% yoy of road-based freight transport, to reach an overall contribution of the rail for freight transport of 24% (from the current 6%). close to the Austrian case (30%), which represents a benchmark (EUROSTAT). In particular, the scenario takes into account:

- Extension of the tracks within the rail terminal to allow the transit of trains up to 700 meters in length;
- Reclassification of railway lines to allow the transit of trains with 22 tonnes per axle;
- Reactivation of the transport support contributions by rail;
- Establishment of a guarantee fund for the railway companies for the purchase of rolling stock.

Sub-Scenario 2: Penetration of electric and hybrid vehicles in passenger transport

The scenario is based on the comprehensive study carried out by RSE on the penetration of electric cars in Italy (it is an optimistic scenario, if some policy instruments are put in place). The study provides a scenario for the spreading of electrically powered transportation means, with 2020 and 2030 as landmarks. This scenario allows for an assessment of the impact on the national electric power/energy systems and environmental consequences with a view to both curb emission and concentration levels and to provide an overall estimate.

The scenario elaborated by RSE considers fully electric cars (BEV – Battery Electric Vehicles) and hybrid vehicles (PHEV - Plug-in Hybrid Electric Vehicles), where the battery can be recharged by both the network (such as the BEV) and by internal combustion engine on board.
It is assumed the development of two generations of electric cars: the first (and BEV1 PHEV1), sold until 2020 and characterized by a relatively low penetration, and the second (BEV2 PHEV2) characterized by better performance, with higher penetration rate. In total, the Scenario elaborated by RSE foresees electric cars as being the 3% of the fleet in 2020, reaching 25% of the car stock by 2030.

In terms of use, the BEVs are suitable for a typical urban use, as they have less than 150 km of autonomy. On the other hand, instead, PHEVs are much more versatile, being able to travel on extra-urban routes. The scenarios thus assumes a penetration of PHEV cars significantly superior to BEVs, in a proportion of 80% PHEV1 – 20% BEV1, for first-generation, and 70% PHEV2 – 30% BEV2 for the second generation.
RSE further assumes that all BEV1 are small cars, belonging to segments A and B, while all hybrid (both PHEV1 both PHEV2) are larger cars belonging to segments C and D. As for BEV2. RSE assumes that 50% are belongs to segments A and B. and 50% to segments C and D. In order to define the circulating fleet and the overall stock, population projections and current trend in passengers and car per inhabitant are used. In particular, RSE relies on the same population projections developed by ISTAT that we have used for the other scenarios and it uses the same data for the other variables. This returns an overall stock of 40 million cars by 2030, of which almost 10 electric.

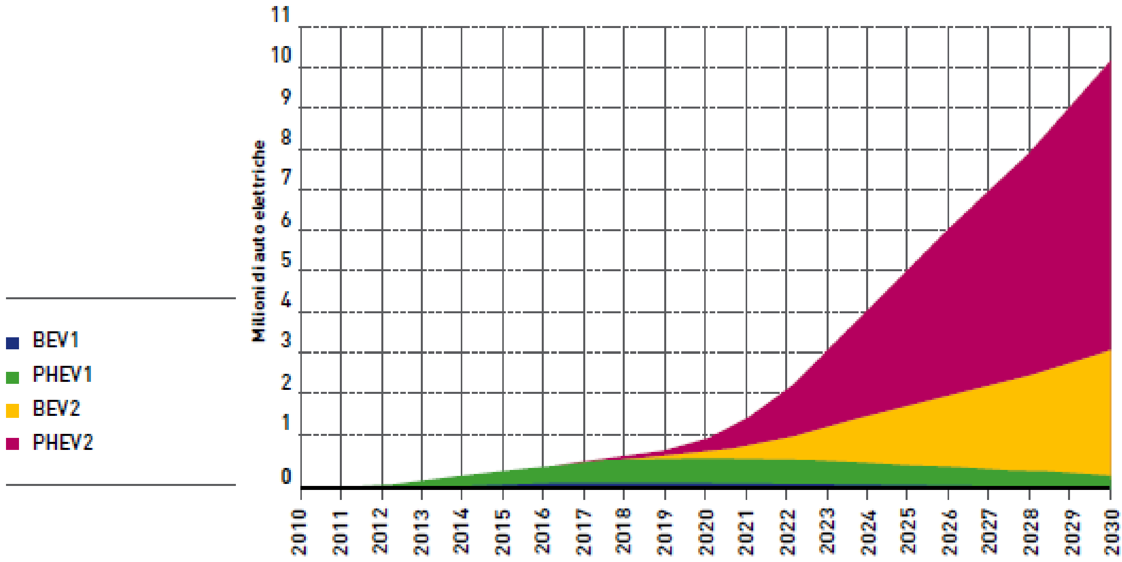

Figure 34: **Penetration of electric cars in our scenario (based on RSE scenario).**

Sub-scenario 3: Biodiesel

Write something.

Table 37: Assumptions of EE-T0 scenario

Sub-scenarios	**Penetration assumptions for cost-efficient solutions**	**Policy instrument(s)**
Modal shift	-1.5% yoy of car use 2% yoy of bus increase 16% penetration of rail by 2030 -1% of road freight transportation	Introduction of greater restricted traffic zones and car free zones; Higher costs of public parking.
Penetration of electric and hybrid vehicles	7% penetration of plug-in hybrid by 2030 18% penetration of electric cars by 2030	Grants for the purchase of electric cars Facilitating circulation for electric cars only
Biodiesel	7% penetration of biodiesel by 2030	Lower tariffs on biodiesel

EE-T1 – EE-T4 scenarios for transport

Below, we present the assumptions for all the EE scenarios after taking into account the effect of the barriers.

Table 38: EE-T1 scenario assumption.

Sub-scenarios	**Penetration assumptions for cost-efficient solutions**	**EE-T1: DST outcome (after considering impact of barriers)**
Modal shift	-1.5% yoy of car use 2% yoy of bus increase 16% penetration of rail by 2030 -1% of road freight transportation	-1.2% yoy of car use 1.6% yoy of bus increase 14.4% penetration of rail by 2030 -0.8% of road freight transportation
Penetration of electric and hybrid vehicles	7% penetration of plug-in hybrid by 2030 18% penetration of electric cars by 2030	5.8% penetration of plug-in hybrid by 2030 13.5% penetration of electric cars by 2030
Biodiesel	7% penetration of biodiesel by 2030	6.4% penetration of biodiesel by 2030

Table 39: EE-T2 scenario assumption.

Sub-scenarios	**EE-T2: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Modal shift	-1.25% yoy of car use 1.7% yoy of bus increase 14.7% penetration of rail by 2030 -0.82% of road freight transportation	The common barriers with biodiesel affected positively this technology.	Introduction of greater restricted traffic zones and car free zones; Higher costs of public parking; Contribution and fiscal incentives for modal shift for freight transport.
Penetration of electric and hybrid vehicles	6.6% penetration of plug-in hybrid by 2030 14.3% penetration of electric cars by 2030	The common barriers with biodiesel affected positively this technology.	Facilitating circulation for electric cars only; Campaigns for raising awareness towards electric vehicles; Extension of the grid of e-mobility (charger points, etc.).
Biodiesel	6.6% penetration of biodiesel by 2030	Biodiesel was the main focus of this scenario along with modal shift and penetration of hybrid and electric vehicles. The common barriers	Lower tariffs on biodiesel; **Increased tax deductions for producers of biodiesel.**

		that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Concerns on reliability / Hesitation to trust new technologies 2. Socio - economic status of users 3. Problems with infrastructure / public transport services	

Table 40: EE-T3 scenario assumption.

Sub-scenarios	**EE-T3: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Modal shift	-1.3% yoy of car use 1.6% yoy of bus increase 15.3% penetration of rail by 2030 -0.86% of road freight transportation	Modal shift was the main focus of this scenario along with penetration of hybrid and electric vehicles and biodiesel. The common barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Problems with infrastructure / public transport services 2. Low satisfaction/ lack of trust for public transport	Introduction of greater restricted traffic zones and car free zones; Higher costs of public parking; Contribution and fiscal incentives for modal shift for freight transport; **PPP investments in transportation.**
Penetration of electric and hybrid vehicles	6.4% penetration of plug-in hybrid by 2030 13.6% penetration of electric cars by 2030	The common barriers with modal shift affected positively this technology.	Facilitating circulation for electric cars only Campaigns for raising awareness towards electric vehicles

			Extension of the grid of e-mobility (charger points, etc.)
Biodiesel	6.4% penetration of biodiesel by 2030	The common barriers with modal shift affected positively this technology.	Lower tariffs on biodiesel

Table 41: EE-T4 scenario assumption.

Sub-scenarios	**EE-T4: DST outcome (after considering impact of minimized barriers)**	**Minimized barriers**	**Policy instrument(s) that focus on addressing barriers so as to be minimized and allow the achievement of the policy target**
Modal shift	-1.3% yoy of car use 1.6% yoy of bus increase 15.3% penetration of rail by 2030 -0.83% of road freight transportation	The common barriers with penetration of hybrid and electric vehicles affected positively this technology.	Introduction of greater restricted traffic zones and car free zones; Higher costs of public parking; Contribution and fiscal incentives for modal shift for freight transport.
Penetration of electric and hybrid vehicles	6.1% penetration of plug-in hybrid by 2030 14.3% penetration of electric cars by 2030	Penetration of hybrid and electric vehicles was the main focus of this scenario along with modal shift and biodiesel. The common barriers that were assumed to have a reduced impact within the time interval 2015-2030 are the following: 1. Problems with infrastructure / public transport services 2. Low satisfaction/ lack of trust for public transport	Facilitating circulation for electric cars only; Campaigns for raising awareness towards electric vehicles; Extension of the grid of e-mobility (charger points, etc.); **Higher Grants for the purchase of electric cars**.
Biodiesel	6.4% penetration of biodiesel by 2030	The common barriers with penetration of hybrid and electric vehicles affected positively this	Lower tariffs on biodiesel.

		technology.	

4.3.2. Analysis and results of EE scenario compared to BAU scenario and policy targets

Comparing all scenarios

Below, we compare the results with the PRIMES reference scenario and with the LEAP baseline.

Table 42: Comparisons among scenarios for final energy consumption in transport sector. Mtoe.

	2020 national target	*2020*	*%Change in 2020 compared to reference year of national target*	*2030*	*%Change in 2030 compared to HERON BAU scenario*
BAU	42.9	41.3	-3.78%	44.8	
EE-T0		36.5	-14.91%	33.5	-25.27%
EE-T1		37.0	-13.86%	34.6	-22.67%
EE-T2 (1st combination)		36.9	-13.99%	34.5	-22.96%
EE-T3 (2st combination)		36.9	-14.10%	34.4	-23.28%
EE-T4 (3st combination)		36.9	-14.10%	34.4	-23.28%

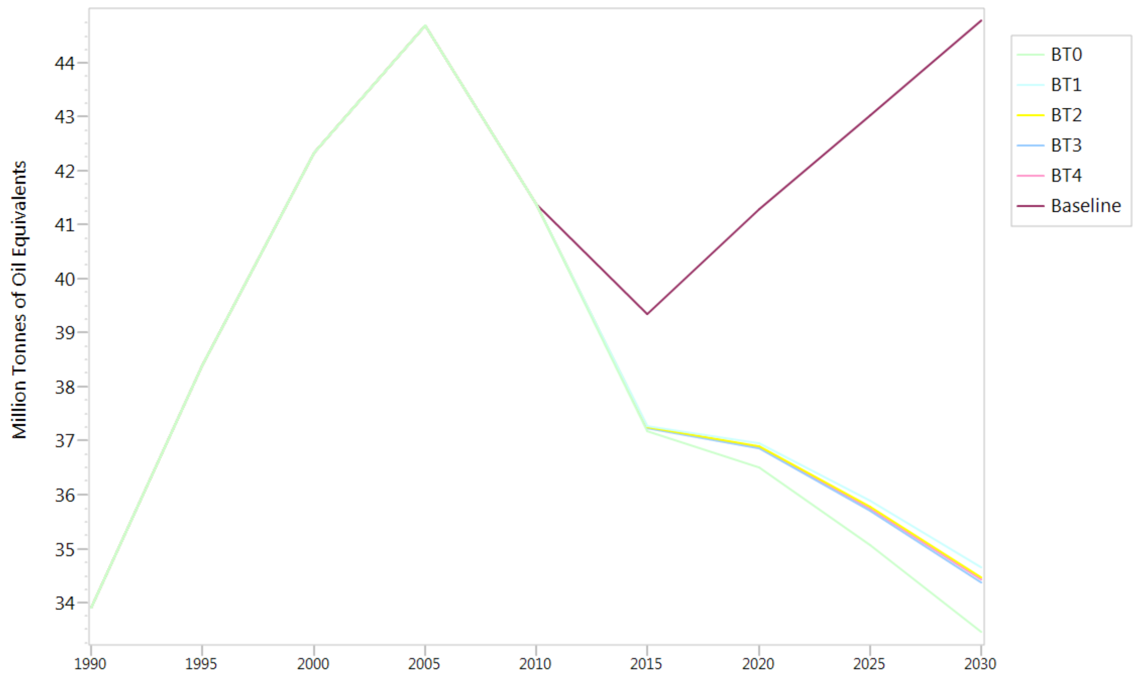

Figure 35: Energy consumption of the transport sector in the five scenarios compared to the baseline.

Table 43: Direct GHG emissions in $MtCO_2$.

	1990	2005	2020	2030
EU Policy target and national target if applicable		127.1	127.1	118.3
HERON BAU scenario			114.6	118.3
% change compared to target			-9.87%	0.00%
HERON EE-T0 scenario			95.1	74.7
% change compared to target			-25.15%	-36.85%
HERON EE-T1 scenario			97.7	80.6
% change compared to target			-23.14%	-31.90%
HERON EE-T2scenario			97.2	79.5
% change compared to target			-23.52%	-32.79%
HERON EE-T3 scenario			97.2	79.3
% change compared to target			-23.52%	-32.96%
HERON EE-T4 scenario			97.3	79.7
% change compared to target			-23.45%	-32.63%

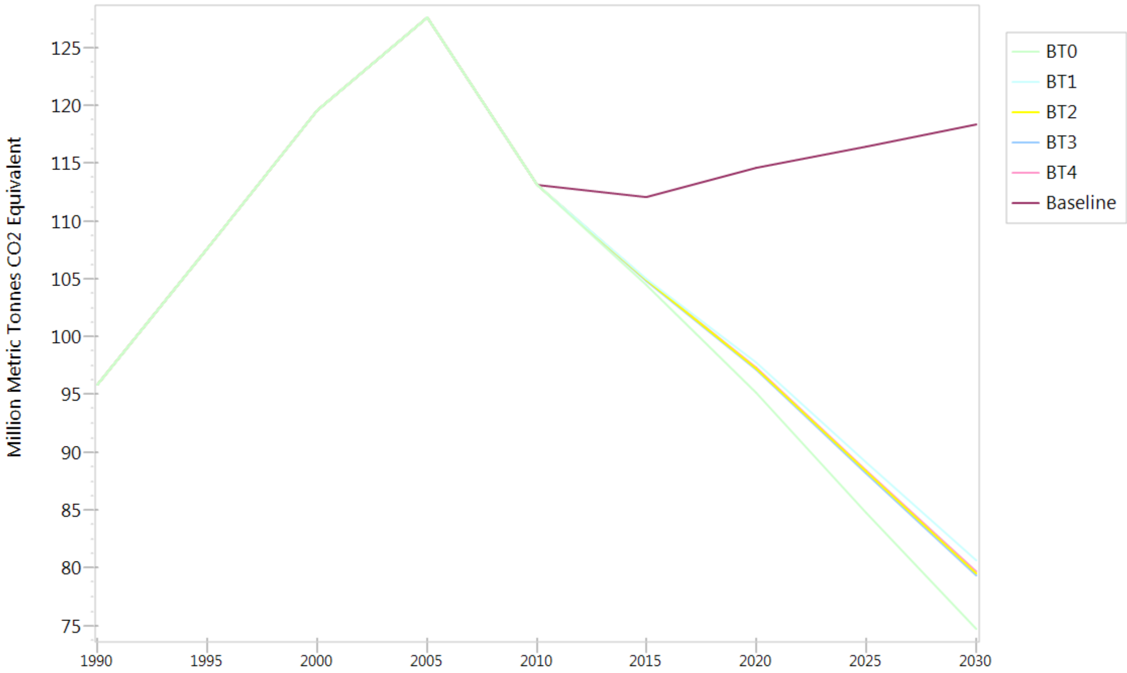

Figure 36: CO2 emissions of the transport sector in the five scenarios compared to the baseline.

There are no national targets for NOx emissions. The results of NOx emissions for each scenario will be compared to BAU respective results.

Table 44: Comparisons among scenarios for NOx emissions in MtCO2eq.

	2020	***%Change in 2020 compared to BAU***	***2030***	***%Change in 2030 compared to BAU***
BAU	1.29	*0*	1.35	*0*
EE-T0	1.08	-16.04%	0.86	-35.93%
EE-T1	1.11	-14.10%	0.92	-31.40%
EE-T2 (1st combination)	1.10	-14.36%	0.92	-32.00%
EE-T3 (2st combination)	1.10	-14.50%	0.91	-32.43%
EE-T4 (3st combination)	1.10	-14.59%	0.91	-32.59%

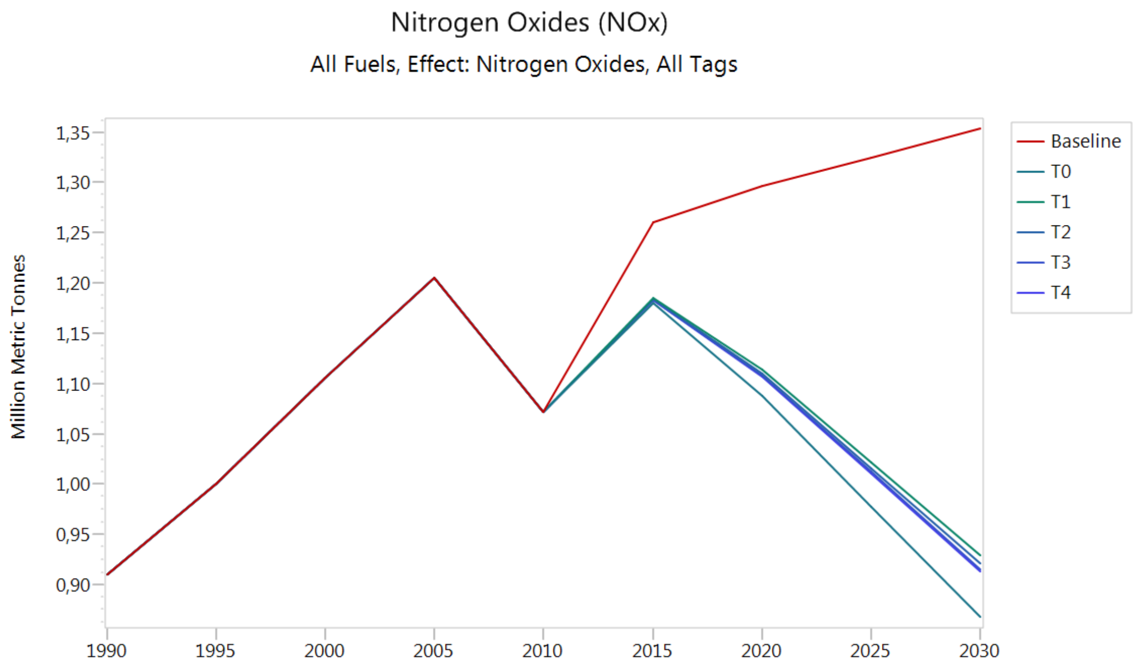

Figure 37: NOx emissions of the transport sector in the five scenarios compared to the baseline.

Table 45: Energy savings/cap and GHG emissions/cap for transport for 2020 and 2030 per scenario.

Scenarios	***Energy savings/capita in toe***		***GHG emissions per capita in*** tCO_{2eq}	
	2020	**2030**	**2020**	**2030**
BAU	0.000	0.000	1.851	1.846
EE-T0	0.078	0.176	1.536	1.165
EE-T1	0.069	0.159	1.578	1.257
EE-T2	0.071	0.161	1.570	1.240
EE-T3	0.071	0.162	1.570	1.237
EE-T4	0.071	0.162	1.572	1.243

4.4. KEY FINDINGS

As the results show, Italy is expected to achieve its 2020 and 2030 targets in the transportation sector even in the BAU scenario. Compared to 2005, Italy now has a very efficient car fleet and it is the second EU countries in terms of natural gas cars: moreover, several forecasting exercise foresee a significant improvement in the years to come. In particular, gasoline and diesel consumption have been constantly reducing and will continue to follow this trend, also because people tend to drive less.

Of course, targets that are more ambitious are difficult to achieve without proper policies. As already stated above, contrary to the building sector, at present there are no cost-effective green technologies in the transportation sector, which remains a captive market for oil products. Hence, any EE policy has to financially support electric and hybrid solutions. To this respect, we show that a 15% penetration of electric cars would reduce by 15% the energy consumption and by 25% the emissions with respect to the target. On the other hand, DST shows that there are important barriers that need to be overcome: one is the lack of infrastructure and the second one is the lack of trust on alternative means of private and public transportation. The first barrier requires a significant amount of financial effort to be overcome. Hence, there is the need for proper cost benefit analyses before implementing major supporting policies for electric cars. As for the second barrier, instead, it is important to lead by examples: Milan can be considered a best practice in Italy in terms of new and sustainable means of transportation and its effectiveness in promoting public transportation. The correct promotion of such an example could easily help other major Italian cities in developing more successful local transport policies. As shown by EE-T2 to EE-T4 scenarios, effective policies can basically overcome all barriers and attain results similar to the benchmark EE-T0 scenario.

CONCLUSIONS

The aim of this report is to quantify the effect of the barriers on the penetration of energy efficiency technologies and their effectiveness in limiting the possibility of Italy to meet its 2020 and 2030 targets.

Moreover, we test the effect of different policies aimed at minimizing the effect of the barriers and hence, to allow EE technologies to achieve their full potential. In order to do so, we have developed several forward-looking scenarios on energy efficiency for two sectors: building and transportation. For both sectors, we elaborated a first scenario aimed at forecasting the evolution of consumption and emissions without the implementation of any additional policy measure and taking into account current penetration rates of different EE technologies.

Then we have elaborated **a cost-effective scenario to meet the 2030 targets. It is important to highlight that the first energy efficiency scenario is a scenario not driven by additional policies**. For the purpose of this report, cost-effective scenario means that all the adopted efficient technologies have an economic rationale, either because they cost less than non-efficient technologies, either because the current policies are enough to make them cost less. Hence, with perfect information on technologies (i.e. no information costs), with perfect allocation of funds in financial markets (i.e. no transaction costs) and with perfect cooperation among agents (i.e. no coordination costs), rational agents would opt for these technologies.

A partial deviation to this approach was introduced for two specific technologies considered in the transportation sector: electric and hybrid plug-in cars. For this specific case, we considered the introduction of a specific policy measure aimed at making cost-effective the technologies that we want to promote.

All sub-sequent scenarios, instead, internalize the effect of barriers and the effect of policies aimed at minimizing those barriers. The idea of all scenarios is that there are educational, social as well as economic barriers that create costs that alter the adoption of these technologies. Hence, there is the need to introduce additional policies specifically aimed at targeting and removing those barriers in order to let the market work properly.

As for the results obtained with all the scenarios elaborated, we can say that, in the building sector, the adoption of cost-effective technologies, even without further supporting policies, should be enough to meet EE targets.

At the same time, our simulations show that barriers impede the penetration of these technologies. In particular, there are some barriers, which severely affect the penetration of some technologies. People perceive adoption costs that "artificially" increase the cost of these EE technologies. Hence, there is the need to introduce specific policies aimed at reducing those "transaction costs".

In particular, barriers increase by more than 5% energy consumption in the residential sector and by more than 7% in the tertiary sector, with respect to the best scenario. Hence, barriers do not allow the residential sector to achieve its target by 2020. On the other hand, they still allow the tertiary sector to achieve its targets as it is performing much better than the forecasts that were used when targets were set.

All minimization scenarios are effective in smoothing the effect of the barriers. Not surprisingly, the scenario that focuses on minimizing the barriers for the "building shell improvement" technologies is the most effective in terms of EE results. BSI technologies are responsible for more than 50% of the expected savings and together with efficient heating technologies and heat pumps they are expected to contribute more than 90% to the overall targets.

Therefore, additional policies aimed at minimizing barriers should focus on BSI and efficient heating. In particular, there is the need to introduce policies promoting "community energy" solutions for multifamily buildings. These policies need not be financial policies, but rather policies that allow people to invest collectively in deep renovation and in energy production. For instance, a good policy would be to allow multifamily building to sell electricity to all households within the building, using the electricity generated by a CHP technology.

In terms of emissions, instead, irrespective of the barriers, the Italian building sector will meet its targets. This major achievement is guaranteed by the energy mix change that has happened in this last decade, which has dramatically reduced CO2 and NOx emissions.

In the transportation sector, Italy is expected to achieve its 2020 and 2030 even in the BAU scenario. Italy already has a very efficient car fleet and it is the second EU country in terms of natural gas cars. Gasoline and diesel consumption have been constantly reducing also because people drive less.

Of course, targets that are more ambitious are difficult to achieve without proper policies. As already stated above, contrary to the building sector, at present there are no cost-effective green technologies in the transportation sector, which remains a captive market for oil products. Hence, any EE policy has to support electric and hybrid solutions. To this respect, we show that a 15% penetration of electric cars would reduce by 15% the energy consumption and by 25% the emissions with respect to the target. On the other hand, DST shows that there are important barriers that need to be overcome: one is the lack of infrastructure and the second one is the lack of trust on alternative means of private and public transportation. The first barrier requires a significant amount of financial effort to be overcome. Hence, there is the need for proper cost benefit analyses before implementing major supporting policies for electric cars.

As for the second barrier, instead, it is important to lead by examples: Milan can be considered a best practice in Italy in terms of new and sustainable means of transportation and its effectiveness in promoting public transportation. The correct promotion of such an example could easily help other major Italian cities in developing more successful local transport policies. As shown by EE-T2 to EE-T4 scenarios, effective policies can basically overcome all barriers and attain results similar to the benchmark EE-T0 scenario.

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ANNEX

3.1 Weight Coefficient for barriers in the building sector

Building Sector

subsector Building Sector

Type	Name of barrier	Weight coefficient
Social	S1. Social group interactions and status considerations	0,065
Social	S2. Socio - economic status of building users	0,144
Social	S3. Strong dependency on neighbors (multi - family housing)	0,049
Social	S4. Inertia	0,033
Social	S5. Lack of Commitment - motivation of public social support	0,033
Social	S6. Rebound effect	0,033

Type	Name of barrier	Weight coefficient
Economic	Ec1. Lack of any type of financial support	0,086
Economic	Ec2. High costs and risks	0,030
Economic	Ec3. Payback expectations / investment horizons	0,041
Economic	Ec4. Misleading prices (energy / fuel / tariffs)	0,033

Economic	Ec5. Unexpected costs	0,014
Economic	Ec6. Financial crisis / Economic stagnation	0,013
Economic	Ec7. Embryonic or poorly developed markets	0,012

Type	Name of barrier	Weight coefficient
Institutional	I1. Split Incentive(s)	0,033
Institutional	I2. Legislation issues	0,039
Institutional	I3. Building stock characteristics and special issues	0,017
Institutional	I4. Poor compliance - Performance gap / mismatch	0,007
Institutional	I5. Lack of data / information - diversion of management	0,007
Institutional	I6. Problematic implementation network / governance framework	0,007
Institutional	I7. Disruption / Hassie factor	0,007
Institutional	I8. Security of fuel supply	0,007

Type	Name of barrier	Weight coefficient
Educational	Ed1. Lack of experienced professionals, trusted information	0,045
Educational	Ed2. Lack of awareness on savings potential, technologies, EE	0,091

Type	Name of barrier	Weight coefficient
Cultural	C1. Lack of interest / low priority / Undervaluing EE	0,049
Cultural	C2. Customs - habits - relevant behavioural aspects	0,082
Cultural	C3. Bounded rationality / Visibility of EE	0,013
Cultural	C4. Missing credibility - mistrust in technologies / contractors	0,013

3.2 Weight Coefficient for barriers in the transport sector

Transport Sector

subsector Transport Sector

Type	Name of barrier	Weight coefficient
Social	S1. Low satisfaction / lack of trust for public transport	0,156
Social	S2. Concerns on reliability / Hesitation to trust new technologies	0,081
Social	S3. Socio - economic status of users	0,014
Social	S4. Suburbanisation trends / Low density	0,038
Social	S5. Mobility problems	0,051
Social	S6. Inertia	0,016

Type	Name of barrier	Weight coefficient

Economic	Ec1. Lack or limited finance / incentives	0,094
Economic	Ec2. Limited infrastructure investment for public transport	0,028
Economic	Ec3. Low purchasing power of citizens / Financial crisis	0,047
Economic	Ec4. High costs	0,033
Economic	Ec5. Payback period / low economic viability	0,015
Economic	Ec6. Negative role of Investment schemes / employee benefits	0,012

Type	Name of barrier	Weight coefficient
Institutional	I1. Lack of integrated governance / entities - fragmentation / bureaucracy	0,031
Institutional	I2. Lack of EE in Government Agenda / priorities / coordination	0,021
Institutional	I3. Problems with infrastructure / public transport services	0,040
Institutional	I4. Lack or limited policies on EE transport issues	0,009
Institutional	I5. Limited / complex funding procedures	0,006
Institutional	I6. Lack of policy support (technological issues / research needs)	0,006
Institutional	I7. Contradicting policy goals	0,009

Type	Name of barrier	Weight coefficient
Educational	Ed1. Lack of knowledge / information on EE transport	0,039

Educational	Ed2. Low / Limited awareness – environmental sensitivity on EE	0,071
Educational	Ed3. Confusion on car - fuel costs – Negative perception	0,010
Educational	Ed4. Lack of certified and experience staff	0,017

Type	Name of barrier	Weight coefficient
Cultural	C1. Car - symbol status & group influence	0,036
Cultural	C2. Habit / social norm of driving - car ownership & use	0,079
Cultural	C3. Cycling is marginalized	0,030
Cultural	C4. Buyer attitude / Bounded rationality	0,011