Ministry of Regional Development and Public Administration

Ministry of Energy

Report on the assessment of the national potential to implement high-efficiency cogeneration and efficient district heating and cooling

- December 2015 -

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Abbreviations

ANRE	Autoritatea Națională de Reglementare în Domeniul Energiei (National Energy Regulatory Authority)
ANRM	Agenția Națională pentru Resurse Minerale (National Mineral Resources Agency)
ANRSC	Autoritatea Națională de Reglementare pentru Serviciile Comunitare de Utilități Publice (National Regulatory Authority for Municipal Services)
TEPP	Thermoelectric Power Plant
LLF	Light liquid fuel
CT	Boiler station
GC	Green certificate
PES	Primary energy savings
EIA	Energy Information Administration (US)
EUR	European currency, Euro
Gcal	Giga Calorie
GJ	Giga Joule
GWh	Gigawatt-hour
INS	Institutul Naţional de Statistică (National Institute of Statistics)
Kcal	Kilo-calorie
kg	Kilogramme
km	Kilometre
m	Metre
MWh	Megawatt-hour
LCV	Lower calorific value
PJ	Peta Joule
PNAEE	National Action Plan for Energy Efficiency
PNAER	National Renewable Energy Action Plan
SACET	District heating system
SCADA	Computer system for data monitoring, command and collection
NES	National Energy System
NEES	National Electronic Energy System
RES	Renewable Energy Sources
TJ	Tera Joule
ST	Steam turbine
toe	Tonne oil equivalent
GT	Gas turbine

EU	European Union

Measurement units

Measurement unit	MWh	GJ	Gcal
MWh	1	3.6	0.86
GJ	0.28	1	0.24
Gcal	1.16	4.19	1

Definitions

District heating - the technical process of heat supply of a large number of buildings (residential consumers, public and private) characterised by high density; heat is generated from distinct sources and transported and/or distributed through pipe networks (heating networks).

District heating system (SACET) - ensemble of technological facilities, equipment and buildings, placed in a precisely identified area, linked through a joint technological and functional process, intended for heat generation, transport and distribution through heating networks for at least two users.

Boiler station (CT) - ensemble of facilities, buildings and equipment necessary for converting primary energy into thermal energy. Boiler stations only generate heat used for heating and for preparing domestic hot water.

Thermoelectric (cogeneration) Power Plant (TEPP) - ensemble of facilities, buildings and equipment necessary for the combined generation of electricity and heat.

Cogeneration - simultaneous generation in one process of thermal energy and electrical and/or mechanical energy.

High-efficiency cogeneration - implies that the production of cogeneration units should provide primary energy savings of at least 10 % compared with the baseline values for separate generation of heat and electricity.

Cogeneration power plant (CPP) - may be defined as the ensemble of facilities within the same layout and generating useful energy types such as electricity and heat.

Transport networks - ensemble of pipes intended for continuous transport of heat from generation facilities to distribution plants or consumers' equipment.

Distribution networks - ensemble of pipes intended for continuous transport of heat from distribution plants or transport network to users.

Thermal point / Thermal station - ensemble of facilities within a SACET, through which the parameters of the thermal agent are transformed and/or adapted to the consumption needs of one or several users.

Thermal connections - physical link between a heating network and the own equipment of the user.

Heat consumer - natural or legal person using heat for itself through its own facilities.

Energy balance - the analysis representing in a coherent framework all quantities of energy generated, transformed, transported and consumed in a certain geographical area and in a certain time frame; these energy quantities are expressed in the same measurement unit, so that they could be compared and summed up.

Energy efficiency - the ratio of output of performance, service, goods or energy, to input of energy.

Efficiency in energy use, increased energy efficiency - obtaining one unit of product, good or service without decrease in its quality or performance, concomitantly with a decrease in the quantity of energy required for obtaining that product, good or service.

Energy saving - an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of an energy efficiency improvement measure, whilst ensuring normalisation for external conditions that affect energy consumption.

Primary energy consumption - gross inland consumption, excluding non-energy uses.

Final energy consumption - all energy supplied to industry, transport, households, service provision sectors and agriculture, excluding energy intended for the generation of electricity and heat and for covering own technological consumption in plants and equipment related to the energy sector.

1. Introduction

Article 14(1) of Directive 2012/27/EU, transposed in the national legislation by Law No 121/2014 on energy efficiency, provides for the carrying out of a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling in the whole country.

In the area of buildings, heat generation and its distribution and supply through the district heating system are public services of general interest. The purpose of the assessment is to identify, based on the forecast evolution of the demand in thermal energy for heating and domestic hot water and of the demand in energy for cooling, the relevant influence factors and the areas with potential in applying high-efficiency cogeneration and efficient district heating and cooling.

This assessment is based on data and information concerning the current status of the district heating system (generation, transport, distribution, consumption) in localities, and on data obtained from the annual reports of statistics institutes and/or from the annual reports of national regulatory public institutions in the area of energy, as follows:

- National Regulatory Authority for Municipal Services (ANRSC);
- National Energy Regulatory Authority (ANRE);
- National Institute of Statistics (INS);
- Statistical Office of the European Union (EUROSTAT).

The methodology used to carry out the assessment follows the recommendations of Directive 2012/27/EU on energy efficiency and complies with the national legislation in force with regard to the focus on relevant aspects concerning the assessment of the potential of efficient district heating and cooling, taking into account the cost-benefit analysis.

2. Description of heating and cooling demand

Two models currently exist in Romania for the value chain of thermal energy, from generation to final consumption of thermal energy, as follows:

a) The **district heating system** (SACET), consisting of the district heating systems ensuring heat generation, transport and distribution, as well as supply to end users in a centralised manner. The public service of district heating in administrative units is under the management, coordination and responsibility of operators delegated by local public administration authorities, and is directly monitored and controlled by the National Regulatory Authority for Municipal Services (ANRSC), which has a regulatory role in this sector. The purpose of the service is to provide thermal energy necessary for heating and for preparing domestic hot water for the population, public institutions, social and cultural facilities as well as economic operators;

b) **Decentralised system** for thermal energy generation and supply, including two consumer categories:

1. Consumers *without access* to the district heating system, consisting in a large part of the population of Romania mainly living in rural areas, in isolated localities or localities remote from urban centres, where district heating systems have not been developed; these consumers mainly use firewood in order to generate heat;
2. Consumers *having opted out* from the district heating system and the consumers from towns and localities where district heating systems were removed; these consumers use various individual heating systems.

Pollution decrease in urban areas is a global priority that occupies the public agenda more and more intensely in terms of decrease in carbon dioxide emissions and other greenhouse gas emissions. In this context, district heating has become again a topic of interest, as solutions are sought for more and more crowded cities, where district heating may be the more sustainable and efficient method for district heating and cooling of housings, in terms of both costs and possibility to integrate different energy sources.

Concerning the demand for district cooling, no infrastructure for a district cooling system was in place at the time of this assessment.

Taking into account the climate conditions in Romania, the cooling demand could only refer to approximately 3 months per year. In residential buildings, almost all cooling energy needed is ensured through split-type air conditioning devices, powered by electricity, mounted individually by each consumer. This is also generally the case for non-residential buildings but, in this case, new buildings are equipped with district chiller-type cooling facilities.

The increase in electricity consumption for cooling by residential and non-residential consumers has been spectacular, in particular due to the development of air conditioning systems for housings, and in a context where cooling systems in buildings were almost completely absent before 1990 while they currently cover 50 % of the housing stock.

2.1. Existing infrastructure in localities (points of heat demand)

The number of localities connected to district heating in Romania decreased by approximately 78 % during the period 1989 ÷ 2014, namely from 315 to 70 localities.

Figure 2.1.1 shows the evolution in the number of localities in Romania provided with a district heating service during the period 1989 ÷ 2014 [1], [2].

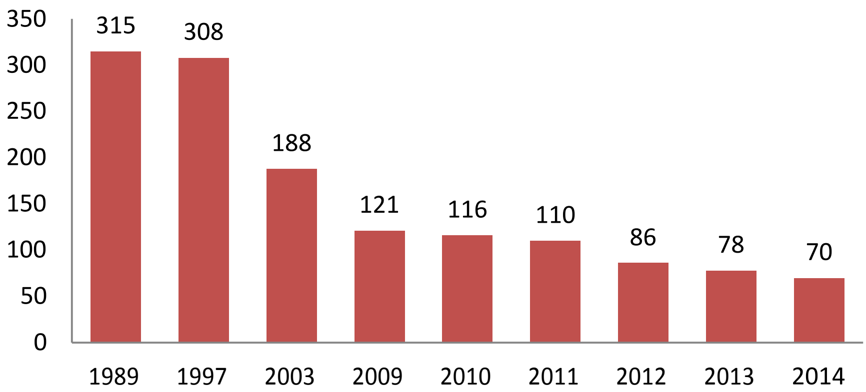


Figure 2.1.1 Evolution in the number of localities connected to the SACET in Romania

Based on the data shown above and on the annual reports of the public institutions, the following were found:

- Continuous trend of decrease in the number of localities connected to district heating in Romania;
- During the period 1997 ÷ 2003, approximately 40 % of urban localities saw their public services of district heating fully removed;
- Annual decrease, by an average percentage of 10 %, in the number of localities connected to district heating;
- Among the localities still connected to SACET in 2014, 64.3 % (45 localities) refer to localities having at least 20 000 inhabitants;
- Concerning the localities having less than 5 000 inhabitants, only 2 are found to benefit of district heating.

Approximately 22 % of all cities and towns in Romania (320 cities and towns) use a district heating system.

Taking into account the total number of cities, towns, municipalities and villages (2 861 municipalities and 12 957 villages), it can be noticed that only 0.43 % of them have an operational district heating service (see Figure 2.1.2).

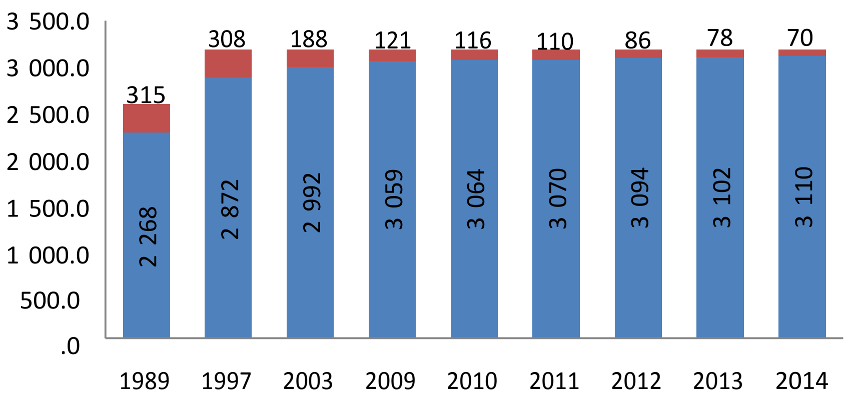
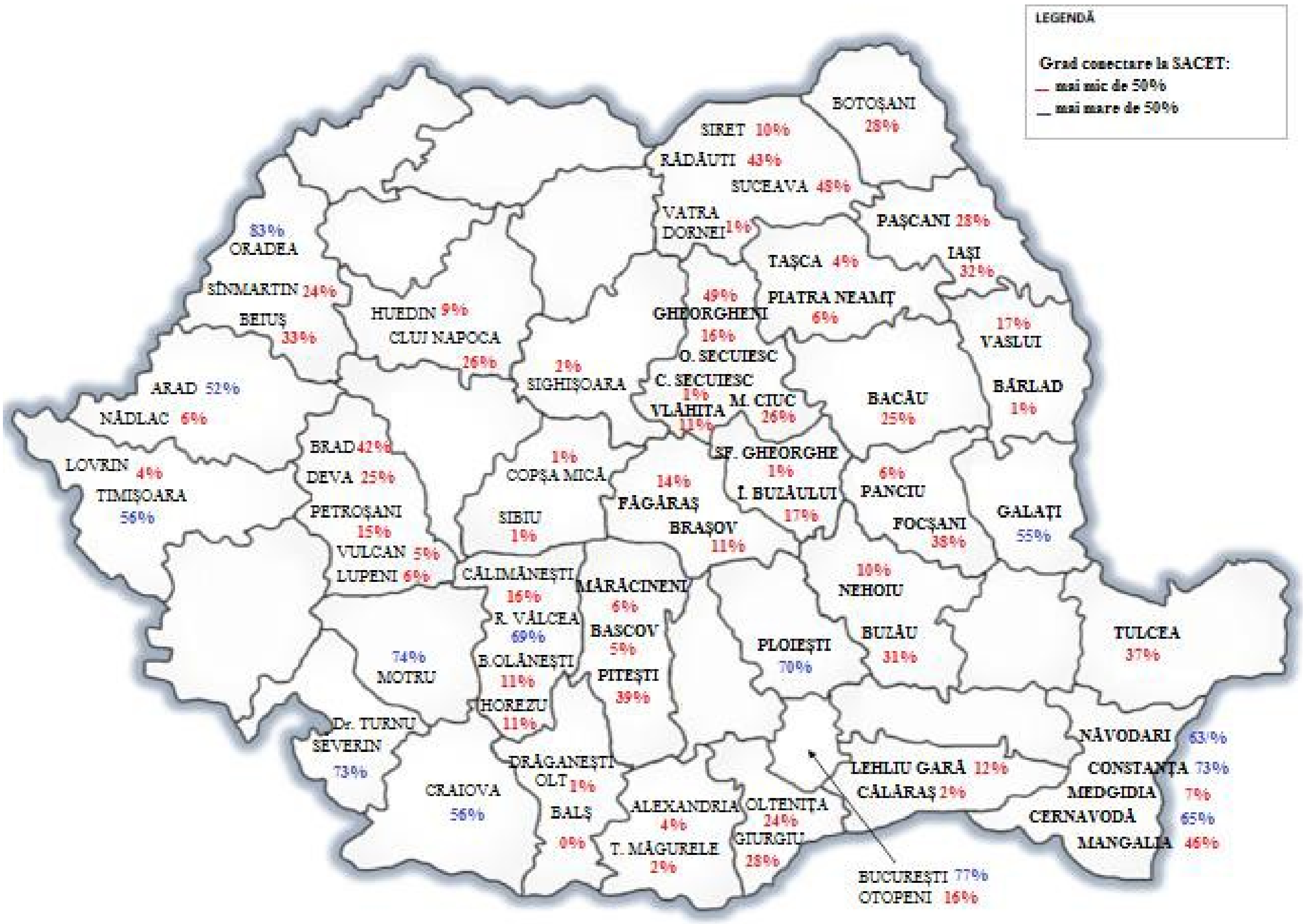


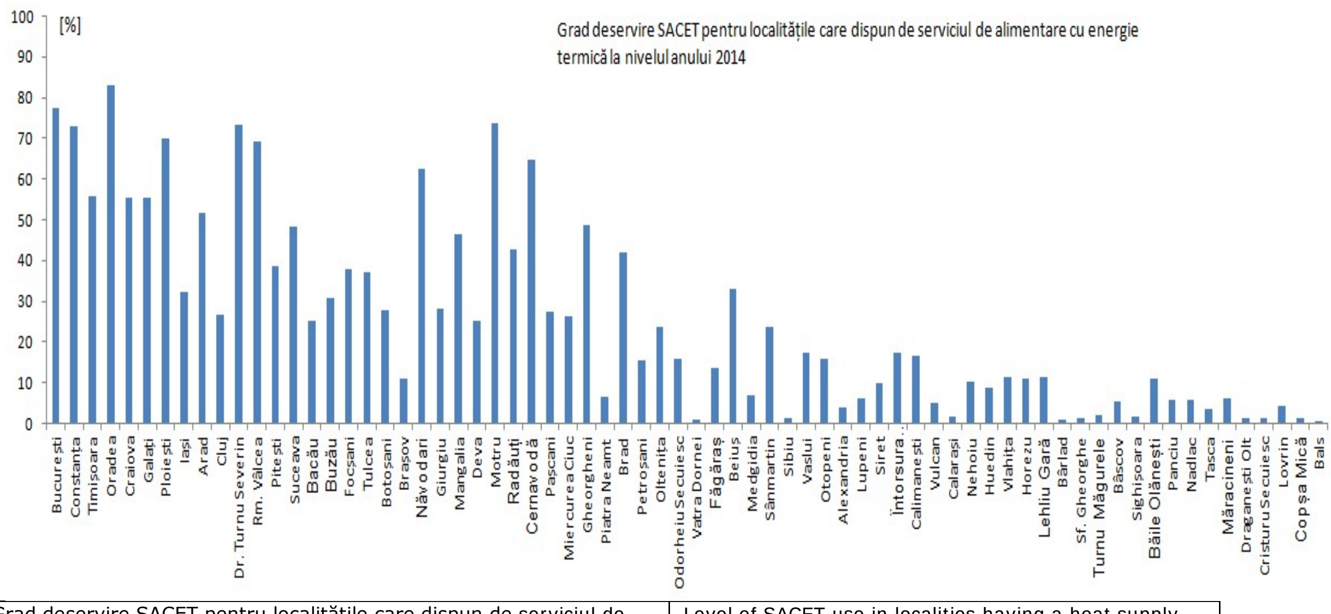
Figure 2.1.2 Evolution in the number of localities connected to the SACET in Romania out of the total number of cities, towns and municipalities of Romania

Figure 2.1.3 and Figure 2.1.4 show the main localities provided with a district heating service in 2014 and the level of connection to the SACET therein [1].



RO	EN
Legendă	Legend
Grad conectare la SACET	SACET connection level
mai mic de 50%	below 50 %
mai mare de 50%	above 50 %

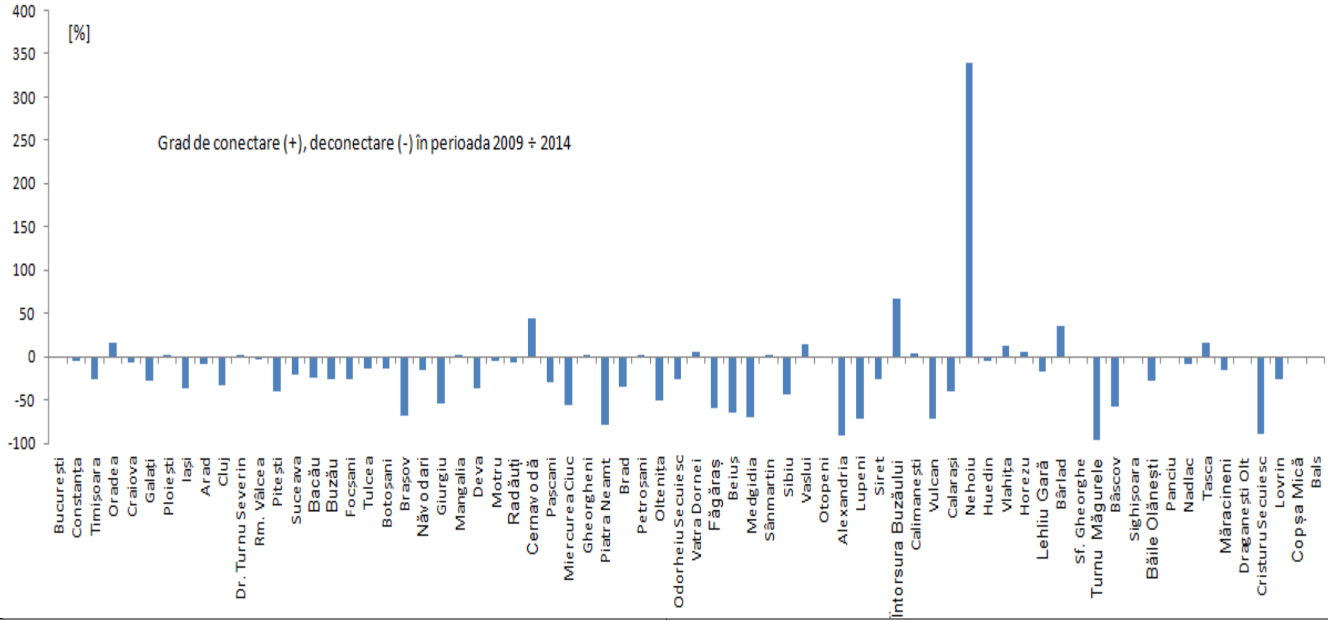
Figure 2.1.3 Localities provided with a district heating service in 2014 and the level of consumer connection to the SACET



Grad deservire SACET pentru localitățile care dispun de serviciul de alimentare cu energie termică la nivelul anului 2014	Level of SACET use in localities having a heat supply service in 2014

Figure 2.1.4 Level of SACET use in localities having a heat supply service in 2014

Figure 2.1.5 shows the existing status in the main localities in Romania that are connected to the SACET, the level of connection and disconnection of consumers from the district heating system, during the period 2009 ÷ 2014 [1].



RO	EN
Grad de conectare (+), deconectare (-) în perioada 2009 ÷ 2014	Level of connection (+), deconnection (-) during the period 2009 ÷ 2014

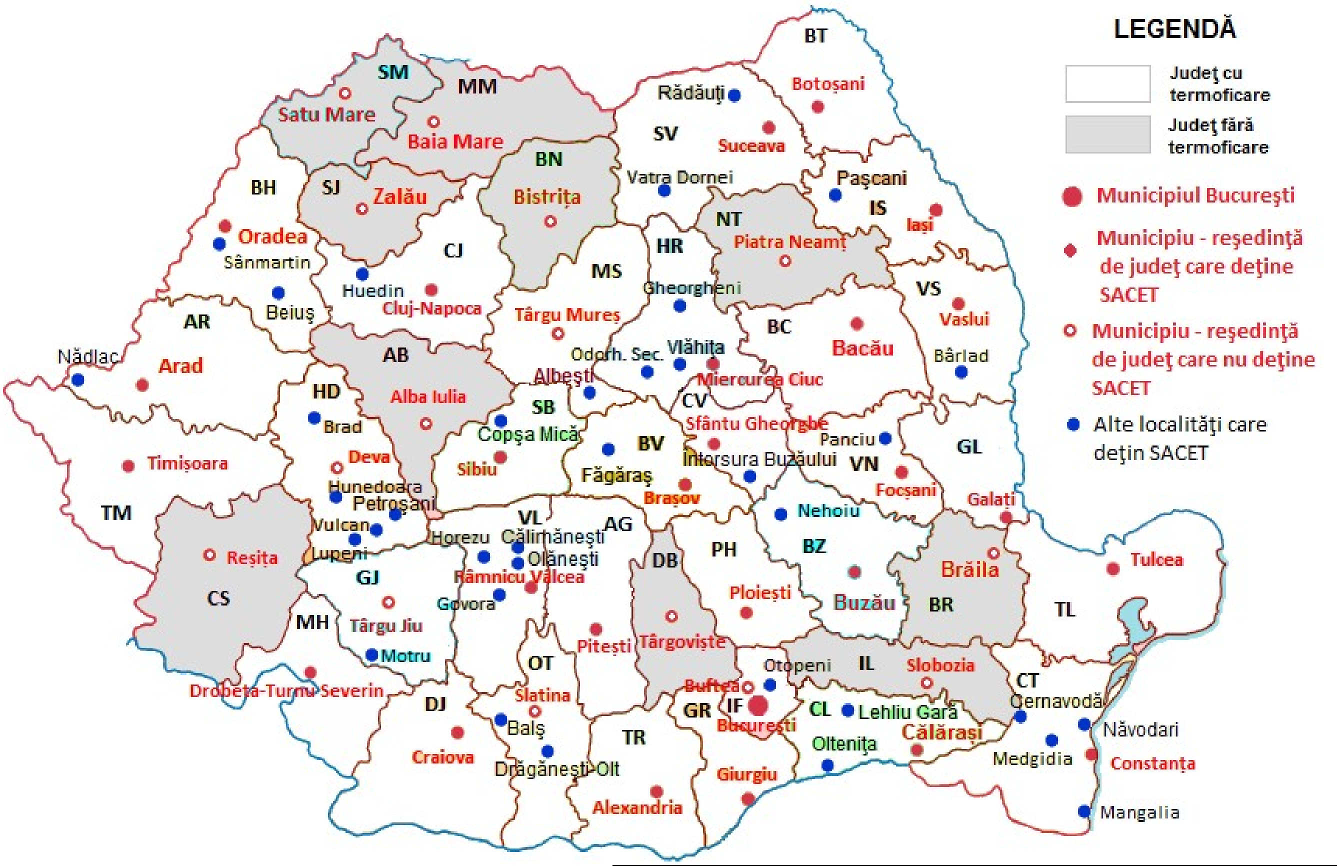
Figure 2.1.5 Level of connection and disconnection of consumers from the district heating system, during the period 2009 ÷ 2014

Remark: The data shown in the figures above are also detailed and shown as a table in Annex 1.

In addition to and based on the data shown in the figures above (Figure 2.1.3 ÷ 2.1.4), for the period 2009 ÷ 2014, the following aspects may be pointed out:

- An increase in the number of consumers connected to SACET is found in approximately 24 % of the total number of localities that are still connected to SACET;
- In 6 localities, the level of connection/reconnection found is 15 % higher in 2014 as compared to 2009;
- A SACET disconnection level of more than 50 % is found in approximately 21 % of the total number of localities that are still connected to SACET;

A summarised nation-wide analysis of the localities having a heat supply service, made on the basis of the data sent by district heating operators, updated for 2015, shows the following (see Figure 2.1.6) [3]:



RO	EN
Legendă	Legend
Judeţ cu termoficare	County with district heating
Judeţ fără termoficare	County without district heating
Municipiul Bucureşti	Bucharest City
Municipiu - reşedinţă de judeţ care deţine SACET	City – county seat with SACET
Municipiu - reşedinţă de judeţ care nu deţine SACET	City – county seat without SACET
Alte localităţi care deţine SACET	Other municipalities with SACET

Figure 2.1.6 Localities in Romania connected to SACET in 2015

Remark: The data shown in figure 2.1.6 are also detailed and shown as a table in Annex 1. Moreover, Annex 1 shows the full list of district heating operators, in alphabetical order of the counties.

A number of 62 localities have operational district heating systems (SACET), as follows:

- Municipality of Bucharest and 26 county seats: Alexandria, Arad, Bacău, Botoşani, Braşov, Buzău, Călăraşi, Cluj-Napoca, Constanţa, Craiova, Drobeta Turnu Severin, Focşani, Galaţi, Giurgiu, Iaşi, Miercurea Ciuc, Oradea, Piteşti, Ploieşti, Râmnicu Vâlcea, Sfântu Gheorghe, Sibiu, Suceava, Timişoara, Tulcea, Vaslui;
- 12 localities having more than 20 000 inhabitants: Bârlad, Făgăraş, Hunedoara, Lupeni, Mangalia, Medgidia, Năvodari, Odorheiu Secuiesc, Olteniţa, Paşcani, Petroşani, Rădăuţi;
- 10 localities having between 10 000 and 20 000 inhabitants: Balş, Beiuş, Brad, Cernavodă, Drăgăneşti Olt, Gheorgheni, Motru, Nehoiu, Otopeni, Vatra Dornei;
- 13 localities having less than 10 000 inhabitants: Albeşti, Băile Olăneşti, Călimăneşti, Copşa Mică, Horezu, Huedin, Întorsura Buzăului, Lehliu Gară, Nădlac, Panciu, Sânmartin, Vlăhiţa, Vulcan.

A number of 15 county seats (36.6 % of the total of 41 counties) have no SACET system, as follows: Alba Iulia, Baia Mare, Bistriţa, Brăila, Buftea, Deva, Piatra Neamţ, Reşiţa, Satu Mare, Slatina, Slobozia, Târgovişte, Târgu Jiu, Târgu Mureş, Zalău.

Taking into account the relatively high level of consumer disconnection from the SACET, it may be stated that the disconnection process is on-going, pushing the energy balance from a relative process of individual savings to uneconomic use of primary energy resources and thus to higher costs on a medium and long term.

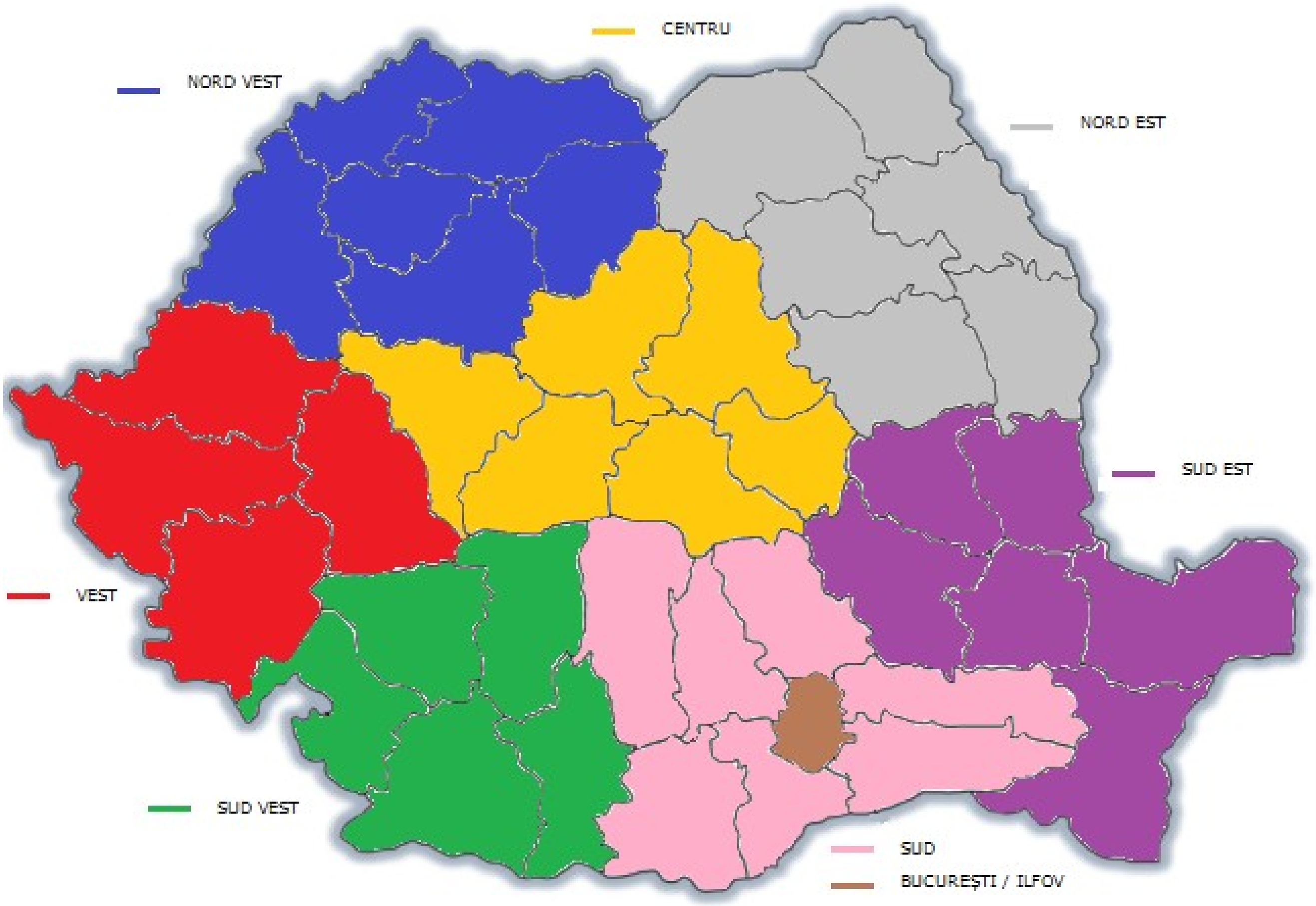
Municipalities and conurbations in Romania with an area ratio of at least 0.3

The starting point in the analysis of heating and cooling demand is the fact that approximately 90 % of the localities, municipalities and conurbations in Romania have an area ratio, defined as the ratio between the total area of the buildings and the area of the land within a given administrative division, above 0.3. This is generally not the case in residential rural areas, where no district heating and cooling demand was recorded.

Regions with high ratios of built area to total area within a given administrative division are generally due to urban development in the 1970s ÷ 1980s, which occurred around large industrial areas and was based on district heating systems.

2.2. Existing district heating infrastructure at consumers

The assessment of the existing infrastructure at consumers who use district heating is based on the map of development regions in Romania shown in Figure 2.2.1 [3].



RO	EN
Bucureşti/Ilfov	Bucharest/Ilfov
Centru	Centre
Nord Vest	North West
Vest	West
Sud Vest	South West
Sud	South
Sud Est	South East
Nord est	North East

Figure 2.2.1 Map of development regions in Romania

Figure 2.2.2 shows the statistical change in the number of flats and in the number of persons using the district heating system in Romania during the period 1992 ÷ 2014 [2].

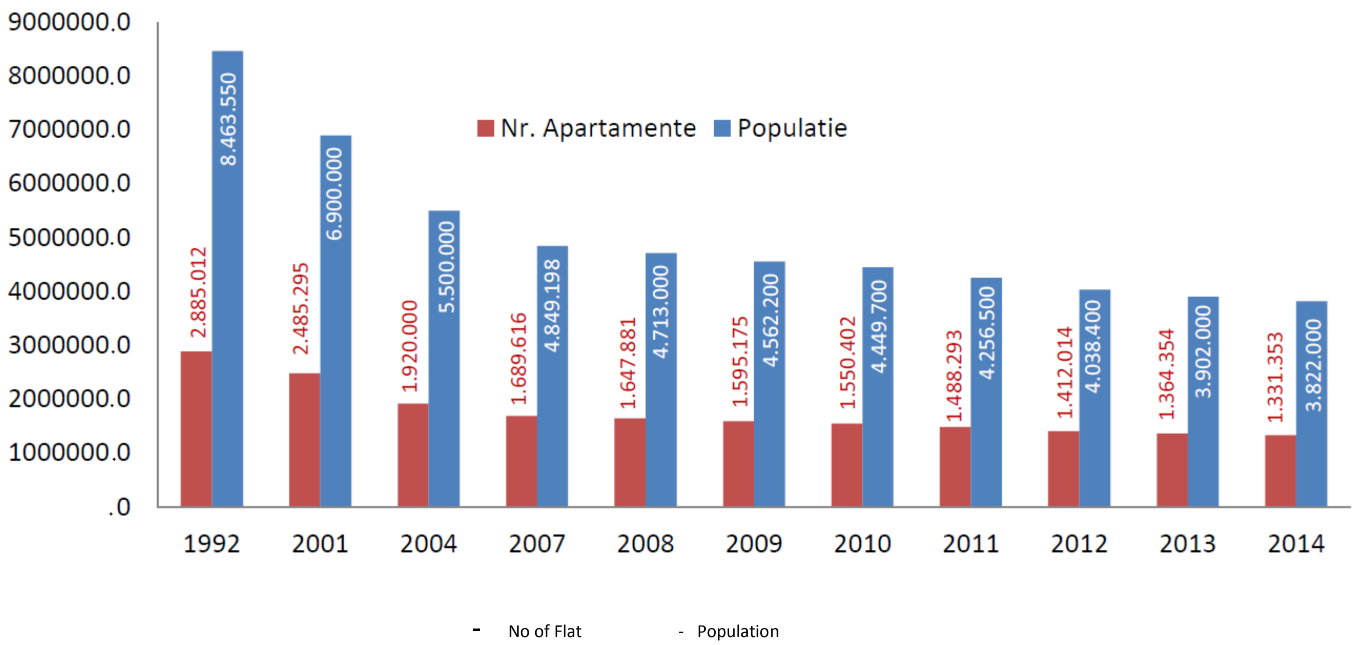


Figure 2.2.2 Statistical change in the number of flats and persons using the district heating system in Romania during the period 1992 ÷ 2014

The data in Figure 2.2.2 reveal a continuous downward trend, year-on-year, in the number of flats supplied with district heating. Figure 2.2.3 shows the percentage of flats disconnected from the district heating system (SACET) compared to the previous year, for the period 2009 ÷ 2014.

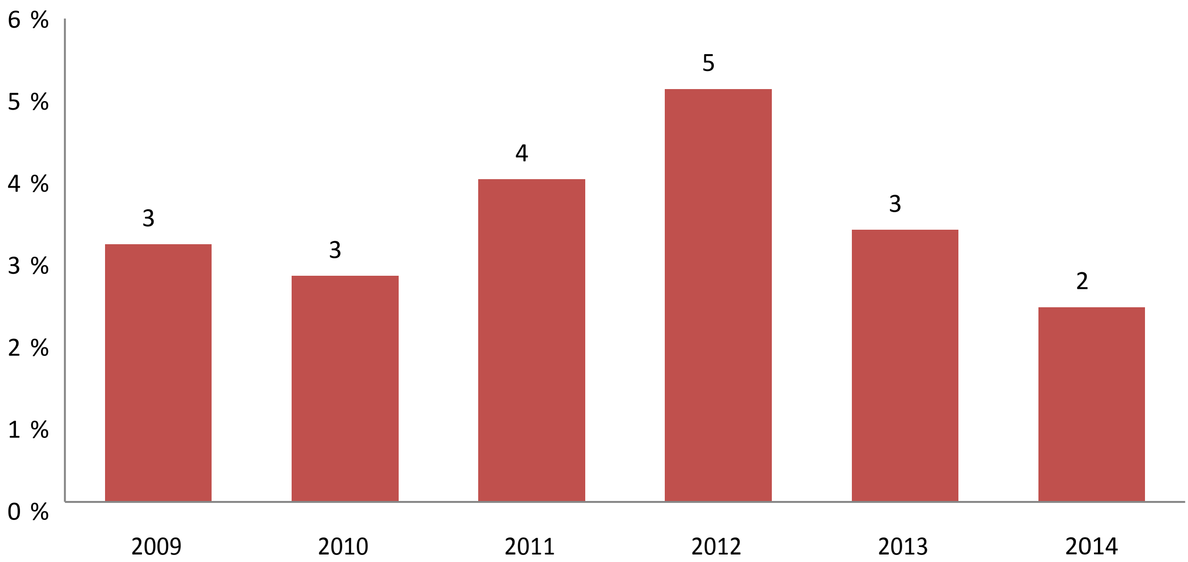
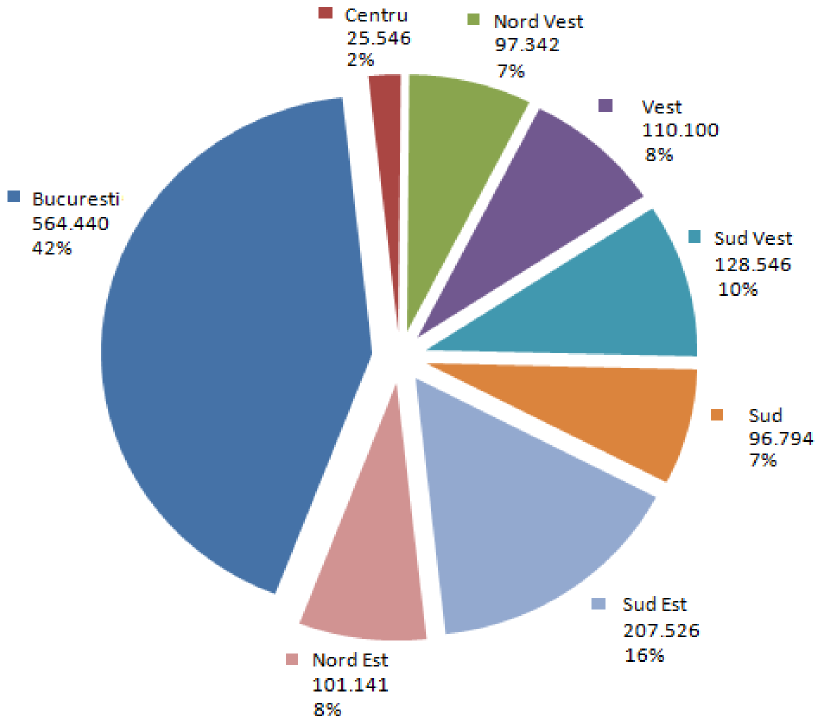


Figure 2.2.3 Rate of disconnection (compared to the previous year) of flats from the district heating system in Romania, during the period 2009 ÷ 2014

Figure 2.2.4 shows a breakdown by number and percentage of flats connected to the district heating system in Romania in 2014, by main areas, micro-regions in Romania (The map of macro-regions in Romania is shown in Figure 2.2.1) [2].



RO	EN
Bucureşti	Bucharest
Centru	Centre
Nord Vest	North West
Vest	West
Sud Vest	South West
Sud	South
Sud Est	South East
Nord Est	North East

Figure 2.2.4 Breakdown by number and percentage of flats connected to the district heating system in Romania in 2014

In addition to and based on the data shown in Figure 2.2.4, the following may be pointed out:

- Of the total permanent population of Romania of 19 043 767 inhabitants, according to the 2011 census, approximately 3 822 000 inhabitants were connected to the district heating system in 2014, which represents 20 %;
- Of the total population receiving district heating, an average percentage of approximately 45 % are connected to and supplied through the district heating network;
- Taking into account the breakdown by percentage of the number of flats connected to the district heating system in Romania, it can be noticed that approximately 42 % are in Bucharest, approximately 33 % in southern Romania, 15 % in northern Romania, 8 % in western Romania and 2 % in central Romania;
- Considering the period 2009 ÷ 2014, it may be noted that 275 379 flats were disconnected from the district heating system and that 11 917 flats were connected to the district heating system. It may thus be noted for the period 2009 ÷ 2014 that, for a total number of flats connected to SACET in 2009 of 1 595 517, between 2009 and 2014 the disconnection rate was 17.29 % and the reconnection rate was 0.75 %;

In 2014, approximately 1 331 353 flats were being supplied with heat via the SACET, of which approximately 93 % were in the urban area and approximately 7 % were in the rural area.

Figure 2.2.5 shows change in the number of thermal connections, which are defined as the physical connection between a heating network and a user's own facilities.

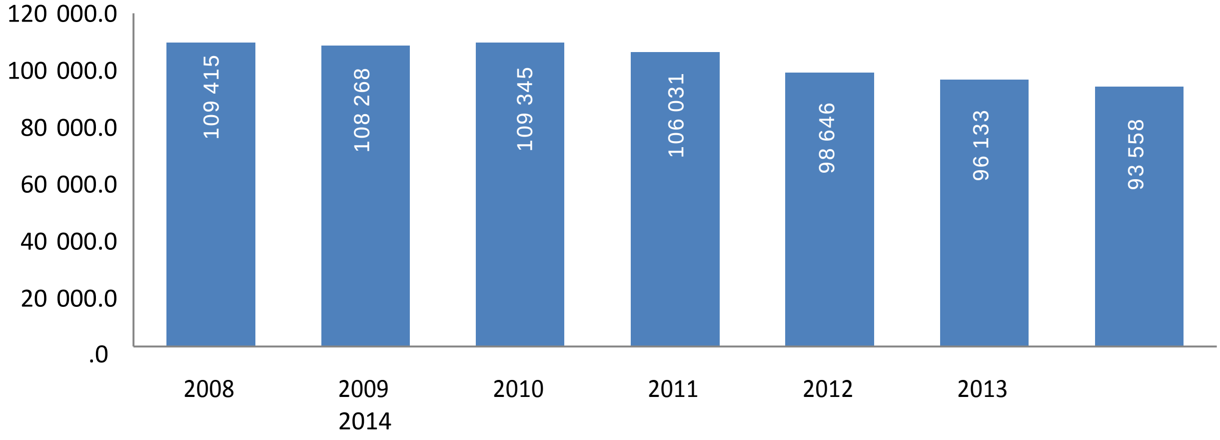
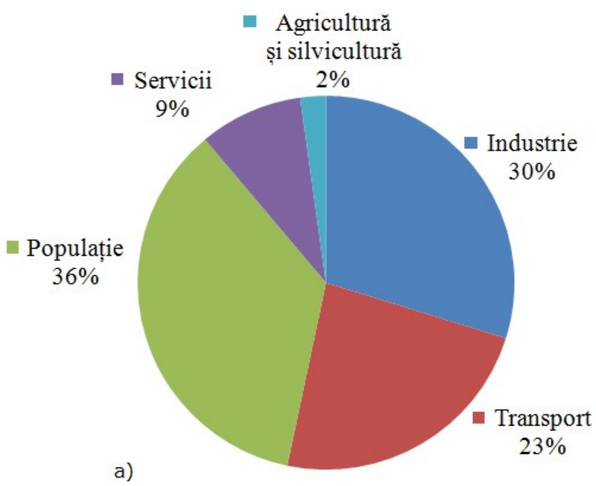
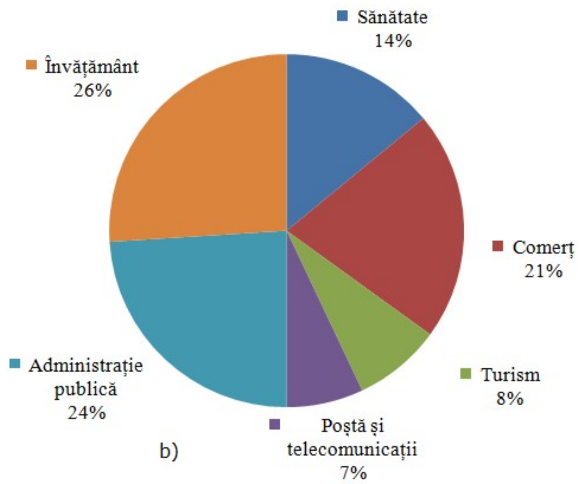


Figure 2.2.5 Change in the number of thermal connections during the period 2008 ÷ 2014

The connection is the point at the limit of the property or the place where the ownership of the facilities in a SACET system changes. It is an extremely important element in establishing the relationship between distribution system operators and beneficiaries. As compared to 2008, when there were 109 415 connections nationally, in December 2014, 93 558 connections were recorded, which means a decrease by 15 857 connections (14.5 %).

Taking into account the data shown above, it may be stated that the useful heat demand in Romania is concentrated in the big cities. The estimates show that the residential area consumes approximately 80 % of the total heat supplied via the district heating system. Moreover, at national level, the consumption of energy in the residential area and in the tertiary sector (offices, commercial areas and other non-residential buildings) stand together for 45 % of total energy consumption (see Figures 2.2.6 and 2.2.7).





RO	EN
Populaţie	Households
Servicii	Services
Agricultură şi silvicultură	Agriculture and forestry
Industrie	Industry
Transport	Transport
Învăţământ	Education
Sănătate	Healthcare
Comerţ	Trade
Turism	Tourism
Poştă şi telecomunicaţii	Post and telecommunications
Administraţie publică	Public administration

Figure 2.2.6 Distribution of final energy consumption: a) at national level and b) in non-residential buildings

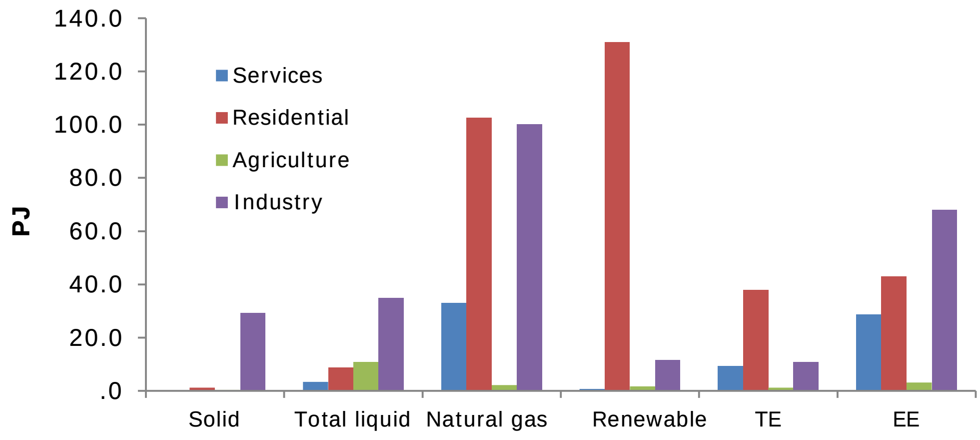
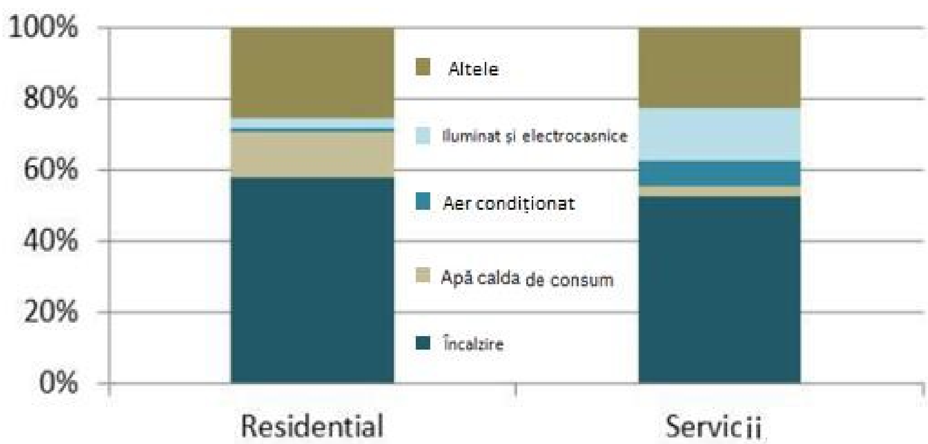


Figure 2.2.7 Final energy consumption in 2013, broken down by consumer type

The residential sector is one of the most important consumers of heat, which is due to the structure of the average energy consumption of a home, as shown in Figure 2.2.8, revealing that the consumption of thermal energy for heating and domestic hot water in a home stands for approximately 70 % of total consumption of energy resources.



RO	EN
Încălzire	Heating
Apă caldă de consum	Domestic hot water
Aer condiţionat	Air conditioning
Iluminat şi electrocasnice	Lighting and home appliances
Altele	Other
Rezidenţial	Residential
Servicii	Services

Figure 2.2.8 Structure of average energy consumption in the residential and non-residential sectors

The existing building stock in Romania has a total built area of 493 000 000 m², and 86 % thereof consists of residential buildings. Of the 8.8 million of housing units (in 2014), single-family homes are in higher number, accounting for 61 % of the total.

Concerning the residential sector, the following may be stated [5]:

- Approximately 88.5 % of dwellings are permanently inhabited;
- Almost half of the total number of all homes (47.5 %) are located in rural areas, which means that the proportion of rural population in Romania is above the European average;
- In rural areas, 95 % of dwellings are individual family houses;
- In urban areas, 72 % of dwellings are located in multi-family houses (which comprise an average of 40 apartments per block of flats);
- More than 60 % of the blocks of flats consist of GF+4 storeys, and 16 % consist of GF+10 storeys;
- Private property is the main form of property, standing for 84 % of the total stock of residential buildings, approximately 1 % of the buildings are under public property, and the remaining 15 % are buildings under some form of mixed property;
- Multi-family dwellings have an average heated area of 48 m², as compared to 73 m² for single family dwellings.

Figure 2.2.9 shows the total built area by building type in Romania in 2013.

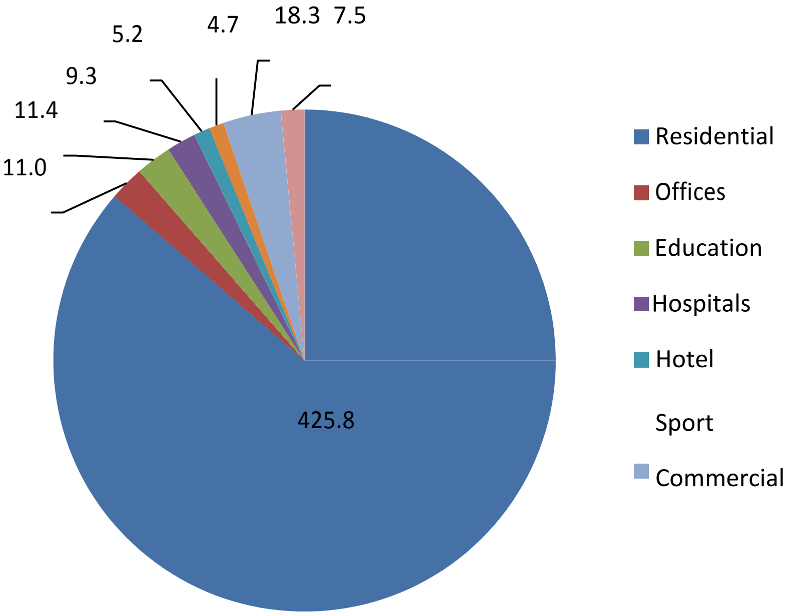


Figure 2.2.9 Total built area by building type in Romania [km^2]

As far as the age profile is concerned, the majority of residential buildings were built in the second half of the 20th century, especially during the period 1961–1980, as shown in Figure 2.2.10.

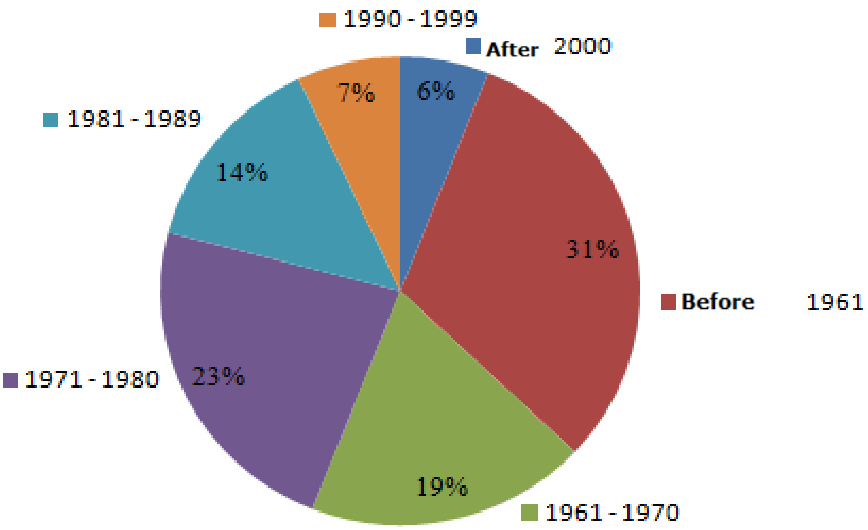
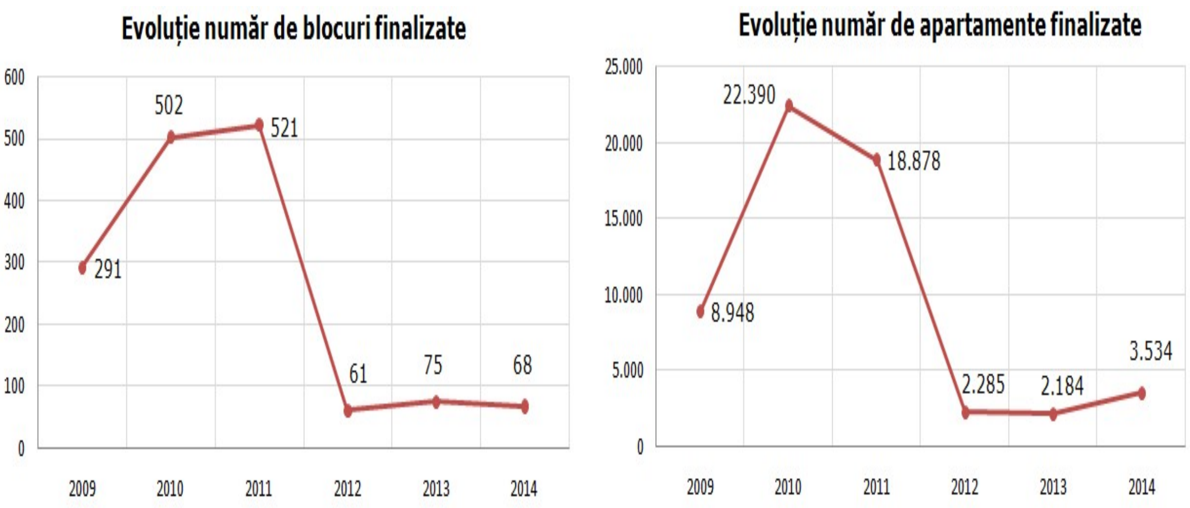


Figure 2.2.10 Age profile of residential buildings by year of construction

Romania has an important heritage of buildings mainly achieved during the period 1960-1990. During that period, most of the buildings were made of envelope elements that did not have to meet any specific heat-related requirements. Dwelling in Romania thus record big heat losses, which translates into an increase in the urban energy consumption of up to 25 % as compared to normal consumption. Moreover, the existing real estate stock still has a significant potential of being brought to high energy efficiency standards, which points out the importance of residential building restoration programmes on-going in Romania.

Due to the state of the buildings, mainly as a result of the neglect of repairs, in particular, in the case of multi-family houses in urban areas, and partially, in the case of single-family houses in rural areas, approximately 58 % of the existing multi-family houses (about 2.4 million apartments) built before 1985 require restoration and thermal modernisation. The current evolution of buildings and flats having been subject to thermal restoration works is shown in Figure 2.2.11.



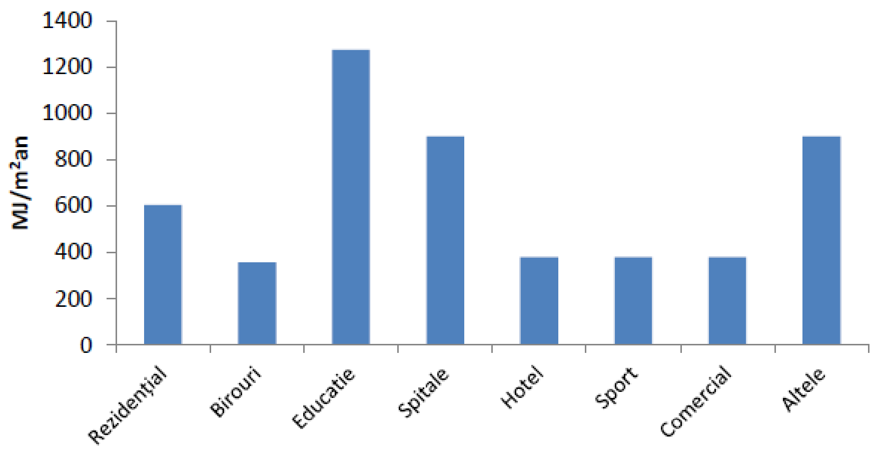
RO	EN
Evoluţie număr de blocuri finalizate	Evolution in the number of completed blocks of flats
Evoluţie număr de apartamente finalizate	Evolution in the number of completed flats

Figure 2.2.11 Evolution in the number of buildings and flats thermally restored

Non-residential buildings represent 18 % of total floor area. This includes most of Romania's public buildings, amounting to some 5 % of the total building stock. Premises occupied by public administration institutions, educational and commercial buildings jointly represent about 75 % of the non-residential energy consumption, each one of them representing 20÷25 % of the overall value.

Considering that approximately 75 % of the buildings were built 45 ÷ 50 years ago and because building thermal restoration is slow, it may be stated that heat loss in buildings is relatively high. In particular, the average heat consumption of buildings in Romania is 250 ÷ 300 kWh/m$^{2/year}$, which is two times higher than the EU average.

Figure 2.2.12 shows the specific average energy consumption in residential and non-residential buildings.

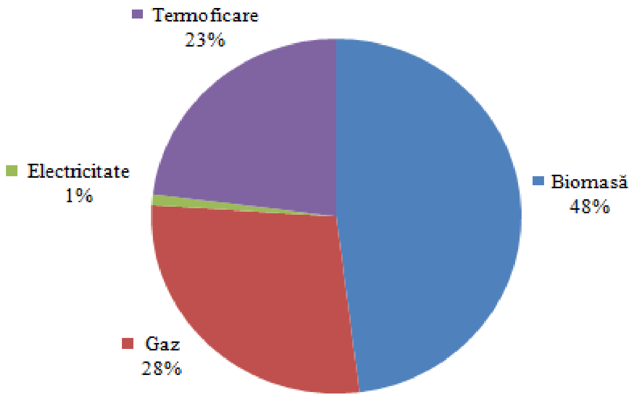


RO	EN
Rezidenţial	Residential
Birouri	Offices
Educaţie	Education
Spitale	Hospitals
Hotel	Hotel
Sport	Sports
Comercial	Trade
Altele	Other

Figure 2.2.12 Specific average energy consumption in residential and non-residential buildings.

There are three main heating sources in the residential and non-residential sector in Romania, as follows:

a) biomass (mainly wood),
b) natural gas and
c) district heating system (see Figure 2.2.13).



RO	EN
Gaz	Gas
Electricitate	Electricity
Termoficare	District heating
Biomasă	Biomass

Figure 2.2.13 Heating sources in the residential and non-residential sector in Romania

Metering of users' heat consumption currently amounts to approximately 50 %. The individual metering system for heat consumption in apartments, in blocks of flats connected to the district system with vertical distribution, consists in mounting thermostatic radiator valves and cost allocators in apartments. However, individual metering is still low and unmetered blocks of flats consume 45 % more than metered blocks.

Moreover, metering percentage of connections to heating in Romania is 97.1 % and to hot water is 96 %.

2.3. Existing infrastructure at heat generation sources and at supply networks

The heat supply service is provided through the specific planned technical infrastructure belonging to the public or private property of the local public administrative authority or to the community development association.

The district heating system (SACET) is made up of a unitary technological and functional ensemble intended for the generation, transport, distribution and supply of thermal energy in localities, which contains:

- **a)** sources of heat generation, such as boiler stations or thermoelectric power plants;
- **b)** transport and distribution networks, thermal points/stations;
- **c)** ancillary facilities and plants;
- **d)** connections, until the limit/separation points of the plants;
- **e)** measure, control and automation systems.

a) Heat generation sources

a.1 Heating thermal or electrical power plants

The heat distributed via SACET is mainly generated in boiler stations (CT), using hot water (with temperature above 115 °C) or average parameter steam (pressure of 6 ÷ 16 bars) as thermal agent, and in conventional and high efficiency cogeneration power plants (TEPP). The statistical data concerning the status of the capacities of heat generation for the population reveal that the structure by plant categories is dominated with a percentage of 94 % by boiler stations, while thermoelectric power plants (TEPPs) only account for 6 % [1].

Heat generation capacities decreased in number during the period 2009 - 2014, from 684 in 2009 to 601 in 2014, which is a decrease by 12.13 %, or, in other words, 83 plants ceased to generate heat, of which 58 boiler stations and 25 thermoelectric power plants. Table 2.3.1 shows the evolution of the generation sources belonging to the SACET during the period 2009 ÷ 2014.

Table 2.3.1 Evolution of the heat generation capacities belonging to the SACET

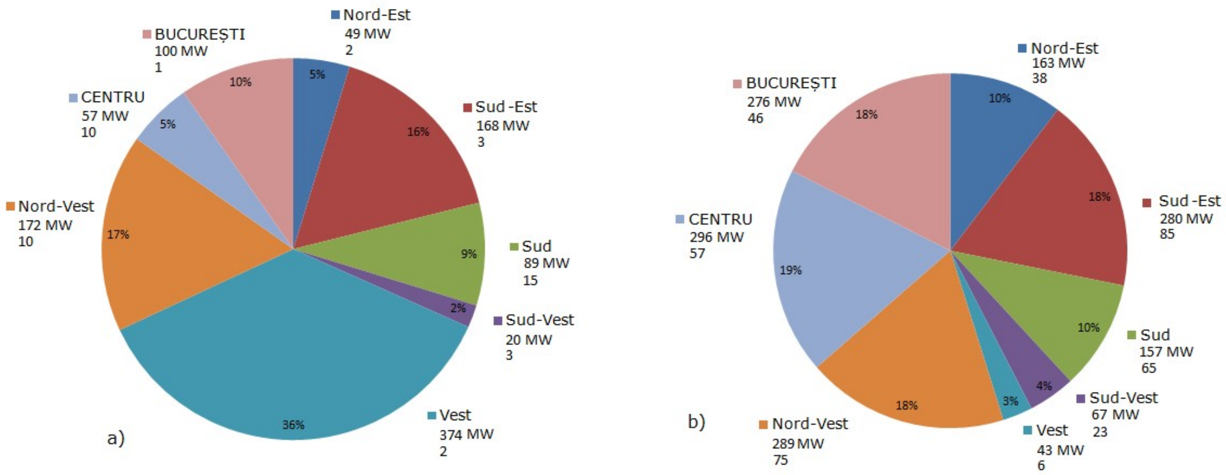
Source type	2009	2010	2011	2012	2013	2014
Boiler stations	643	638	621	577	584	585
Thermoelectric Power Plants	41	41	36	36	23	16
Total	684	679	657	613	607	601

Table 2.3.2 shows the boiler stations, except for cogeneration plants, existing in each administrative unit in 2015 [3].

Table 2.3.2 Heat generation capacities, except for cogeneration plants, belonging to the SACET, in 2015

Boiler stations	Number of stations	Rated thermal input [MW]	Operational thermal input [MW]
Area stations	46	1 029	969
District stations	394	1 570	1 164

Figure 2.3.1 shows the rated thermal input in the main development microregions in Romania (see Figure 2.2.1), as well as the number of boiler stations existing in each administrative unit, except for the cogeneration plants, in 2015 [3].



RO	EN
Bucureşti	Bucharest
Centru	Centre
Nord Vest	North West
Vest	West
Sud Vest	South West
Sud	South
Sud Est	South East
Nord Est	North East

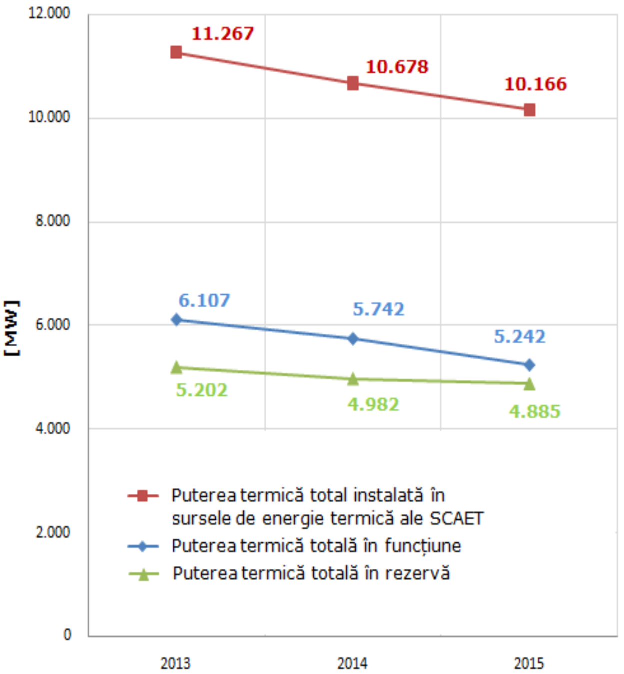
Figure 2.3.1 Rated thermal input and number of boiler stations existing in each administrative unit, except for the cogeneration plants, in 2015

a) Area stations and b) District stations

The thermal input within the SACET decreased during the period 2013 - 2015, as follows:

- decrease by 9.8 % of the total rated thermal input in SACET heat sources, namely from 11 267 MW to 10 166 MW;
- decrease by 14.2 % of the total operational thermal input, namely from 6 107 MW to 5 242 MW;
- decrease by 6.1% of the total back-up thermal input, namely from 5 202 MW to 4 885 MW;

A graph showing the evolution of the thermal power in the SACET can be found in Figure 2.3.2.



RO	EN
Puterea termică total instalată în sursele de energie termică ale SACET	Total rated thermal input in SACET heat sources
Puterea termică totală în funcţiune	Total operational thermal input
Puterea termică totală în rezervă	Total back-up thermal input

Figure 2.3.2 Evolution of the thermal power in the SACET

In addition to the heat generation sources belonging to SACET, there are sources of the heat producers supplying heat to the district system.

a.2 Existing cogeneration facilities

According to ANRE Decision 2362 of 22 October 2014, there were 59 cogeneration plants supplying electricity in the National Energy System (SEN) in 2013, whose installed electric capacity is 17 772.94 MW_e.

Table 2.3.3 shows the cogeneration plants by installed electric power.

Table 2.3.3 Number of cogeneration plants by installed electric power

Number of cogeneration plants	Rated electric input
	MWe
12	> 1
17	1 ÷ 10
23	10 ÷ 100
7	> 100

Of the total cogeneration capacity existing in Romania, approximately 85 % is used for the supply of heat to consumers connected to the district heating system.

Table 2.3.4 shows the high efficiency cogeneration capacity (approximately 34 cogeneration producers) in Romania in 2013 [7].

Table 2.3.4 Installed high efficiency cogeneration capacities in Romania, in 2013

Ref. No	Cogeneration technology	Maximum capacity	
		Electric (Gross)	Thermal (Net)
		MW	MW
1	Combined cycle gas turbine with heat recovery	186	188
2	GT with heat recovery	142	223
3	Internal combustion engines	151	136
4	Steam back pressure turbines	816	3 387
5	Condensing steam turbine with cogeneration valves	3 137	6 107
6	Other cogeneration technologies	1	5
-	**TOTAL**	**4 433**	**10 046**

Approximately 80 % of the thermal energy groups in Romania were mainly installed during the period 1970 ÷ 1980 and are more than 30 year old, and thus have practically exceeded their standard life cycle. The stock of groups in boiler stations have poor efficiency, with an output of approximately 30 %, because of the technology of the 70s and of wear, except for certain coal groups restored that reach approximately 33 %. These outputs represent 65 ÷ 70 % of the output of modern groups, which currently operate in most of the developed European countries.

Most of the thermal energy capacities have not been equipped yet with efficient plants intended to reduce pollution, and therefore SO2 and NOX emissions are above the maximum values accepted by the EU. A number of heat and electricity plants accounting for 10 % of the rated power were refurbished in the last 10 years.

Taking into account the legal provisions in force concerning the environment requirements, refurbishment works are currently under progress in most thermal power plants equipped with cogeneration energy generation systems.

Moreover, approximately 200 MWe were installed in cogeneration in the last four years. Approximately 80 % of these new capacities installed supply thermal energy to the SACET and approximately 20 % are intended for the industrial sector.

a.3 Waste incineration facilities

There are currently no applications concerning the energy recovery of municipal waste in waste incineration facilities generating heat with a view to its supply to consumers connected to a district heating system.

b) Heat transport and distribution networks, heating points / stations

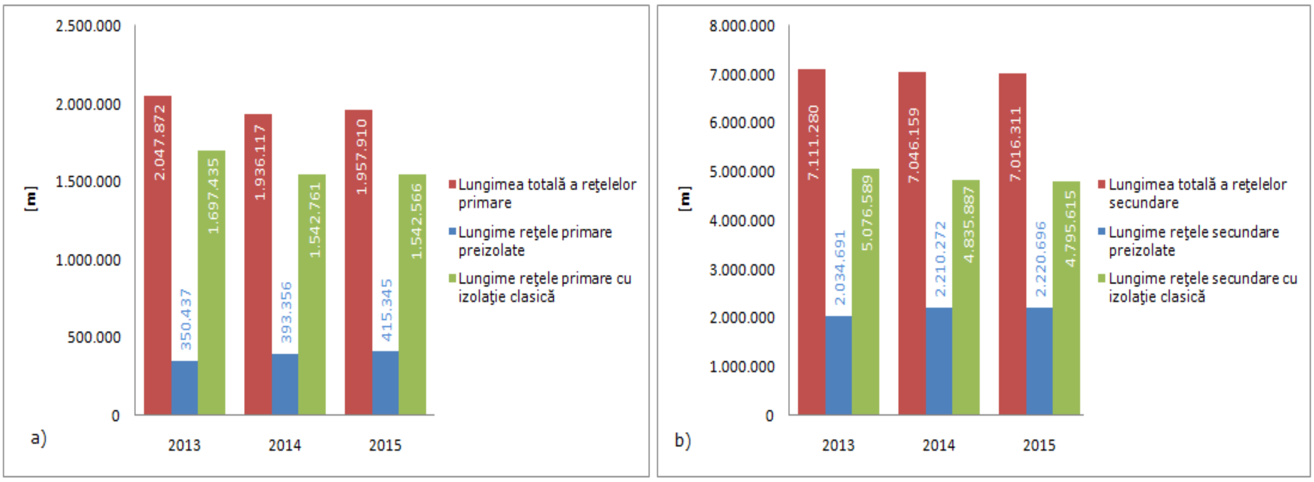
According to the reports of the heating operators, the length of transport networks at national level is approximately 1 957 km, and the length of the distribution networks is approximately 7 016 km. Table 2.3.5 shows the lengths of the primary and secondary heating networks and the number of heating points in operation [3].

Table 2.3.5 Number of thermal points, lengths of the heating networks

Thermal points / Thermal networks	Length of primary networks [m]		
	Year 2013	Year 2014	Year 2015
Total length of primary, transport networks (Percentage as compared to 2013) of which:	2 047 872 (100 %)	1 936 117 (94.5 %)	1 957 910 (95.6 %)
- pre-insulated networks	350 437	393 356	415 345
- networks with classical insulation, of which:	1 697 435	1 542 761	1 542 566
- total length of segments in operation for less than 10 years	153 721	141 156	113 964
- total length of segments in operation for 10÷25 years	165 844	179 877	190 325
- total length of segments in operation for more than 25 years	1 377 870	1 221 728	1 238 277
Number of thermal points (Percentage as compared to 2013), of which:	215 928 (100 %)	218 986 (101.4%)	222 057 (102.8%)
- belonging to local and regional authorities	41 827	41 849	41 901
- belonging to users	174 101	177 137	180 156
Total length of secondary, distribution networks (Percentage as compared to 2013) of which:	7 111 280 (100 %)	7 046 159 (99.1%)	7 016 311 (98.7%)
- pre-insulated networks	2 034 691	2 210 272	2 220 696
- networks with classical insulation, of which:	5 076 589	4 835 887	4 795 615
- total length of segments in operation for less than 10 years	907 215	903 346	868 018
- total length of segments in operation for 10÷25 years	949 699	850 630	857 842
- total length of segments in operation for more than 25 years	3 219 675	3 081 911	3 069 755
Total length of underground pipe tracks for primary networks	1 671 266	1 582 121	1 602 463
Total length of above-ground pipe tracks for primary networks	376 606	353 996	355 448
Total length of underground pipe tracks for secondary networks	6 318 002	6 265 230	6 235 762
Total length of above-ground pipe tracks for secondary networks	793 278	780 929	780 549

According to the data in Table 2.3.5, decreases in the total length of the primary and secondary networks are noticed, which may only be explained by the dismantling of parts of the district heating system.

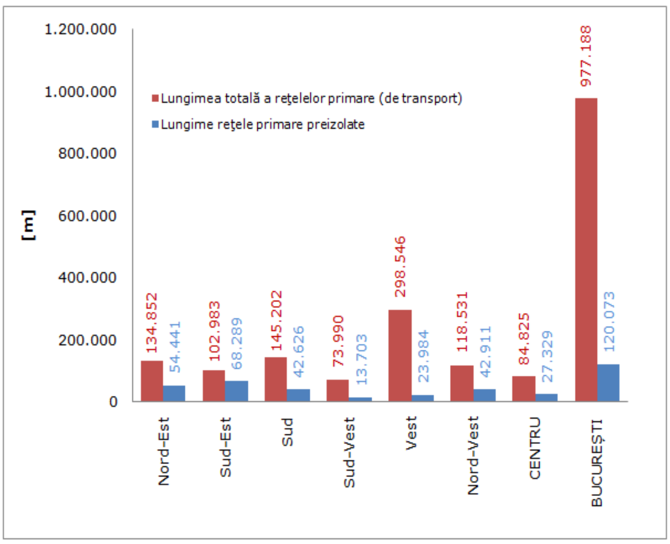
Figure 2.3.3 illustrates the evolution of the heating networks and of the pre-insulated pipe networks refurbished during the period 2013 ÷ 2015.

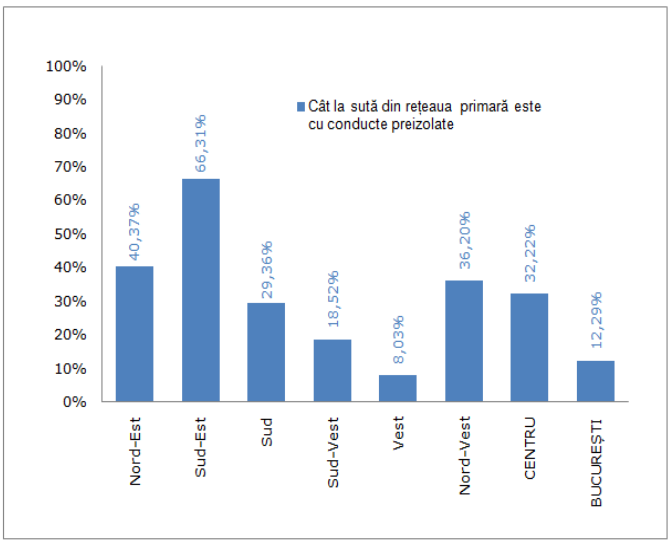


RO	EN
Lungimea totală a reţelelor primare	Total length of primary networks
Lungimea reţelele primare preizolate	Length of preinsulated primary networks
Lungimea reţelele primare cu izolaţie clasică	Length of primary networks with classical insulation
Lungimea totală a reţelelor secundare	Total length of secondary networks
Lungimea reţelele secundare preizolate	Length of preinsulated secondary networks
Lungimea reţelele secundare cu izolaţie clasică	Length of secondary networks with classical insulation

Figure 2.3.3 Evolution of the heating networks and of the pipe networks pre-insulated during the period 2013 ÷ 2015: a) Primary networks and b) Secondary networks

Figures 2.3.4 and 2.3.5 show the length of primary and secondary heating networks, as well as the length of primary and secondary heating networks with pipes pre-insulated in 2014, by development macroregions (see Figure 2.2.1).

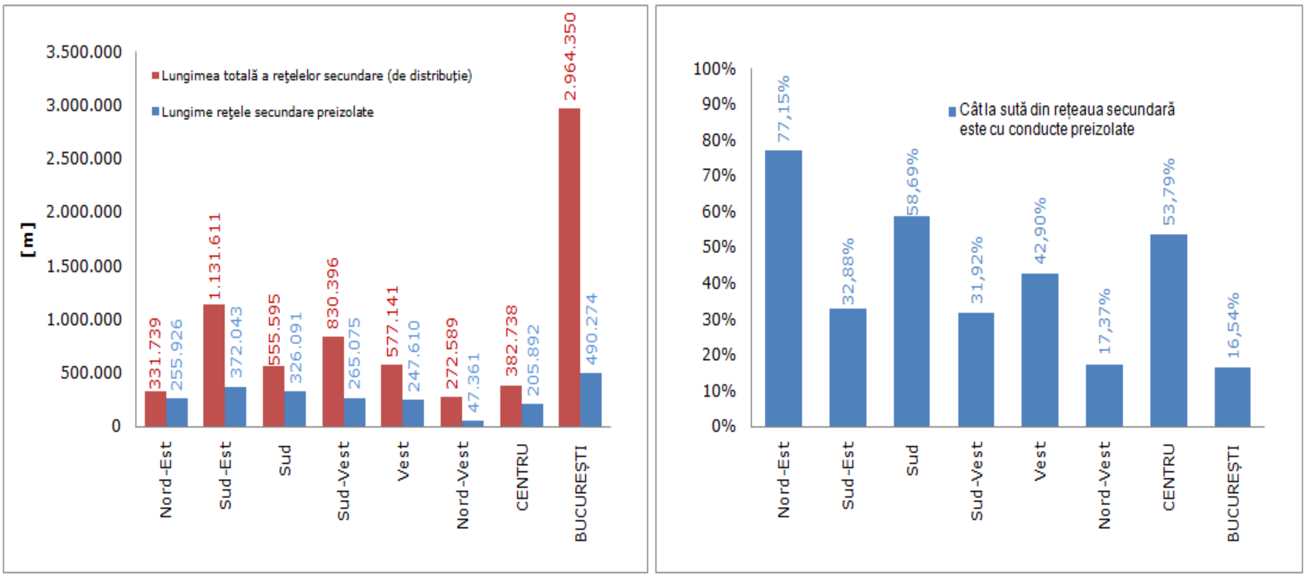




RO	EN
Nord Est	North East
Sud Est	South East
Sud	South

Sud Vest	South West
Vest	West
Nord Vest	North West
Centru	Centre
Bucureşti	Bucharest
Lungimea totală a reţelelor primare de transport	Total length of primary transport networks
Lungimea reţele primare preizolate	Length of primary pre-insulated networks
Cât la sută din reţeaua primară este cu conducte preizolate	Share of pre-insulated pipes in the primary network

Figure 2.3.4 Length of primary heating networks and length of primary heating networks with pre-insulated pipes



RO	EN
Nord Est	North East
Sud Est	South East
Sud	South
Sud Vest	South West
Vest	West
Nord Vest	North West
Centru	Centre
Bucureşti	Bucharest
Lungimea totală a reţelelor secundare de transport	Total length of secondary transport networks
Lungimea reţele secundare preizolate	Length of secondary pre-insulated networks
Cât la sută din reţeaua secundară este cu conducte preizolate	Share of pre-insulated pipes in the secondary network

Figure 2.3.5 Length of secondary heating networks and length of secondary heating networks with pre-insulated pipes

The analysis of the data presented above reveals that more than 70 % of the transport and distribution networks more than 20 ÷ 45 years old have an inappropriate thermal insulation level or have leaks leading to high thermal energy and agent loss.

In terms of condition of the heat transport and distribution networks, an increased restoration level may be noted lately. The restoration of the heating networks consists in replacing existing old pipes with pre-insulated pipes for both transport and distribution, in replacing existing compensators with expansion joints, in mounting ball-valves, in installing leak monitoring and detection systems. Approximately 20 % of the heat supply primary network and 31 % of the heat supply secondary network is currently refurbished, and the national target for 2020 is to refurbish, restore (replace and extend) approximately 30 % of the total heat supply primary network and approximately 40 % of the total heat supply secondary network.

d) Efficiency and loss in heat sources and heat transport networks

Because of the condition of the system and of the characteristics of the generation, transport, distribution infrastructure, of the quality and characteristics of the radiators, etc., the energy quantity in the district heating systems reaching the user is lower than the energy at the source, while the difference consists of losses all along the chain from source to beneficiary.

The ratio of thermal energy loss in the district heating system is represented in this presentation by the following relation: (quantity of heat generated and bought for distribution in a centralised manner by year minus the quantity of heat invoiced, sold in a centralised manner by year)/(quantity of heat generated in a centralised manner by year), which reveals operators' capacity and quality of supply, in terms of efficiency.

The national average loss recorded in 2005 was 23 % and the one recorded in 2007 was 27 %. After taking over the apartment records from the operators subject to ANRE regulation, the average national loss in district heating was found to be lower (in relation now to a *larger number of apartments)*.

This value in 2008 is 24.59 %. However, this value increased each year as the number of apartments connected to the system decreased. The average national loss in district heating was approximately 27.91 % in 2010, 26.54 % in 2011, 27.23 % in 2012, and 26.98 % in 2013, while it reached 28.32 % in 2014 (see Figure 2.3.6) [1].

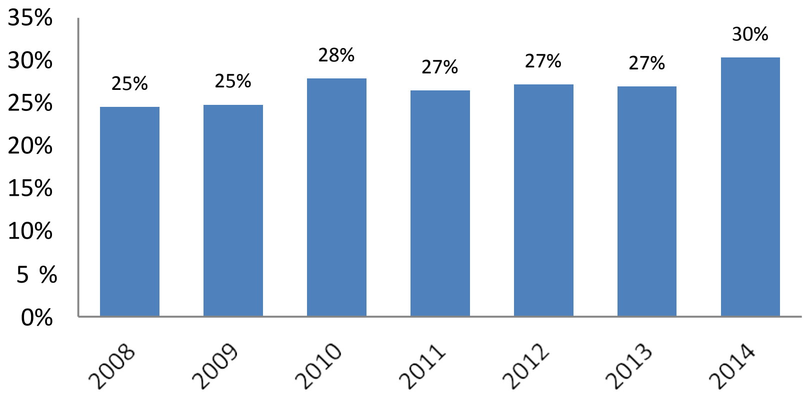
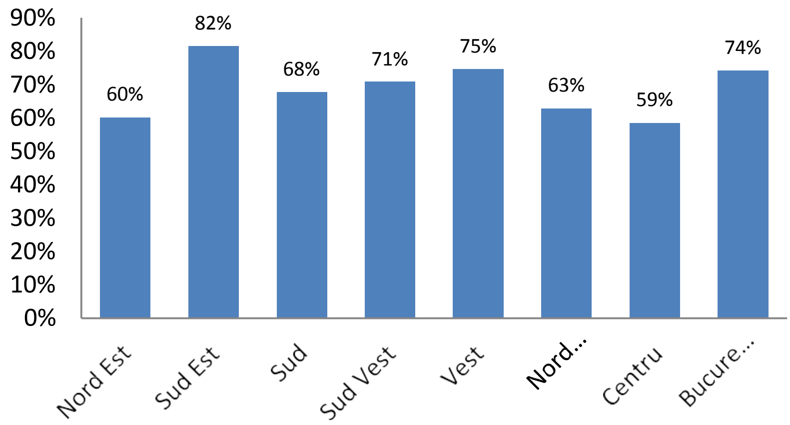


Figure 2.3.6 Average heat loss

Figure 2.3.7 shows SACET efficiency in relation with heat generation in 2014, defined as the ratio between the quantity of heat sold cumulatively since the beginning of the year and the quantity of heat generated cumulatively since the beginning of the year by main area/ microregion in Romania (see Figure 2.2.1).



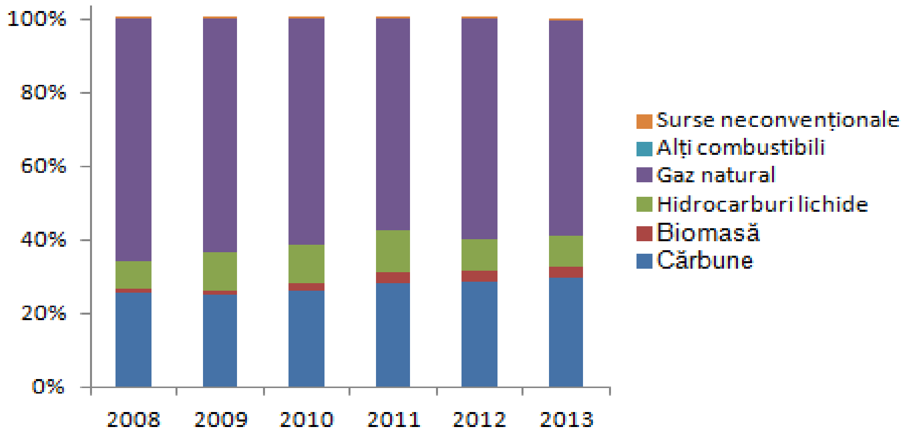
RO	EN
Nord Est	North East
Sud Est	South East
Sud	South
Sud Vest	South West
Vest	West
Nord ...	North ...
Centru	Centre
Bucureşti...	Bucharest...

Figure 2.3.7 SACET efficiency in 2014 (ratio between the heat sold and the heat generated)

2.4. Main resources used for heat generation

As to the type of fuel used for heat generation, hydrocarbons account for the highest percentage, namely more than 60 % of the fuel used, and coal accounts in average for more than 25 %. Unconventional energy sources account for less than 1 % in heat generation. The types of sources used for heat generation during the period 2008 ÷ 2013 are shown in Figure

2.4.1 [2].



RO	EN
Surse neconvenţionale	Unconventional sources
Alţi combustibili	Other fuels
Gaz natural	Natural gas
Hidracarburi lichide	Liquid hydrocarbons
Biomasă	Biomass
Cărbune	Coal

Figure 2.4.1 Evolution in the consumption of different types of energy sources used for the generation of heat

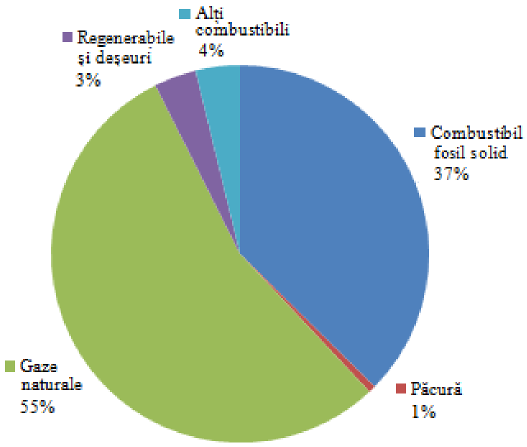
The shares of the different types of energy resources used in the SACET in 2015 are:

- Natural gas 80.18 %;
- Coal 17.67 %;
- Other resources (combustible waste, etc.) 1.06 %;
- Renewable energy sources (plant and wood biomass, geothermal energy, sun energy) 0.64 %;
- Black oil 0.45 %.

The following may be pointed out with regard to the consumption of energy resources used in the 59 cogeneration plants with electricity input in the National Electronic Energy System:

- 45 cogeneration plants, with a total installed electric capacity of 1 067 $MW_{e,}$ use natural gas;
- 12 cogeneration plants, with a total installed electric capacity of 678 $MW_{e,}$ use coal;
- 2 cogeneration plants, with a total installed electric capacity of 28 $MW_{e,}$ use other fuels.

Figure 2.4.2 shows the share of each type of energy source used in 2013 in the cogeneration facilities in Romania [8].



RO	EN
Gaze naturale	Natural gas
Regenerabile şi deşeuri	Renewable and waste
Alţi combustibili	Other fuels
Combustibil fosil solid	Solid fossil fuel
Păcură	Black oil

Figure 2.4.2 Breakdown of energy source consumption in high efficiency cogeneration plants

2.5. Statistical change, description of heat demand (heat and domestic hot water)

To cover the heating needs of consumers connected to the SACET, in 2014 the district heating system operators bought part of the heat from various producers other than producers in the district heating systems (ELCEN, CHPPs, etc.), accounting for 64.17 % of the total heat generated and bought for distribution in district heating and domestic hot water systems. The other part is generated by operators from natural gas (22.10 %) or coal (approximately 12.17 %), and the remaining approximately 1.56 % of heat from the total thermal energy generated and bought is generated from fuel oil, LLF, diesel, biomass, geothermal water, sawdust (see Figure 2.5.1) [1].

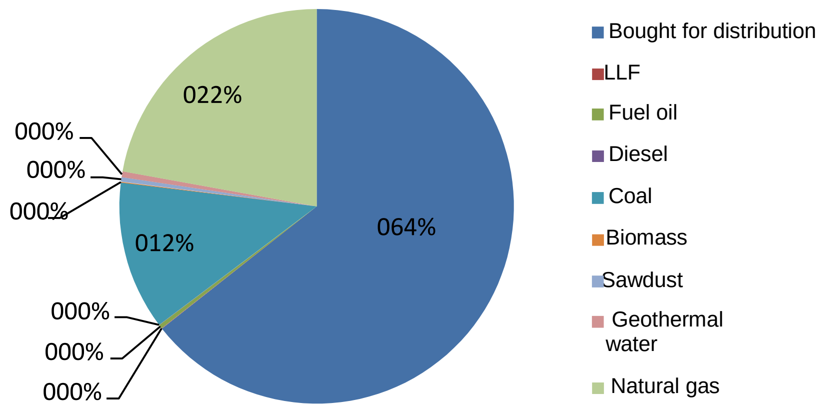
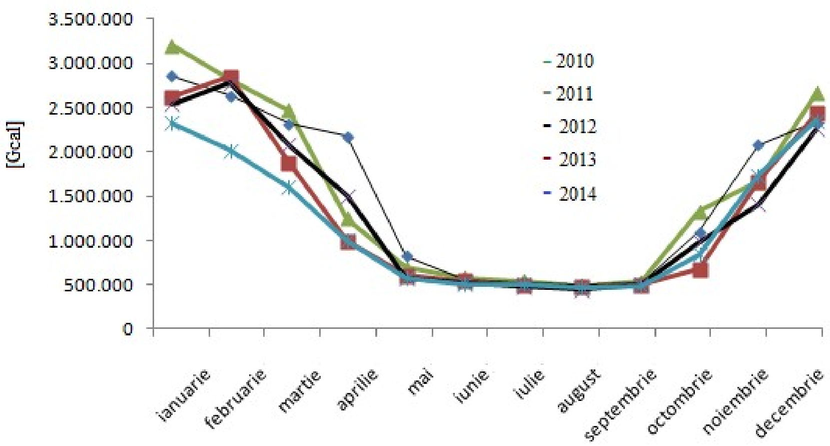


Figure 2.5.1 Covering the heating needs of consumers connected to the SACET in 2014

Heat is generated in power plants as steam, hot water or warm water and is intended to ensure heating and domestic hot water for households, public institutions and economic agents. Figure 2.5.2 shows the curve of the monthly variation in the monthly quantity of heat generated during the period 2010 ÷ 2014.



RO	EN
Ianuarie	January
Februarie	February
Martie	March
Aprilie	April
Mai	May
Iunie	June
Iulie	July

August	August
Septembrie	September
Octombrie	October
Noiembrie	November
Decembrie	December

Figure 2.5.2 Annual curves of heat generated

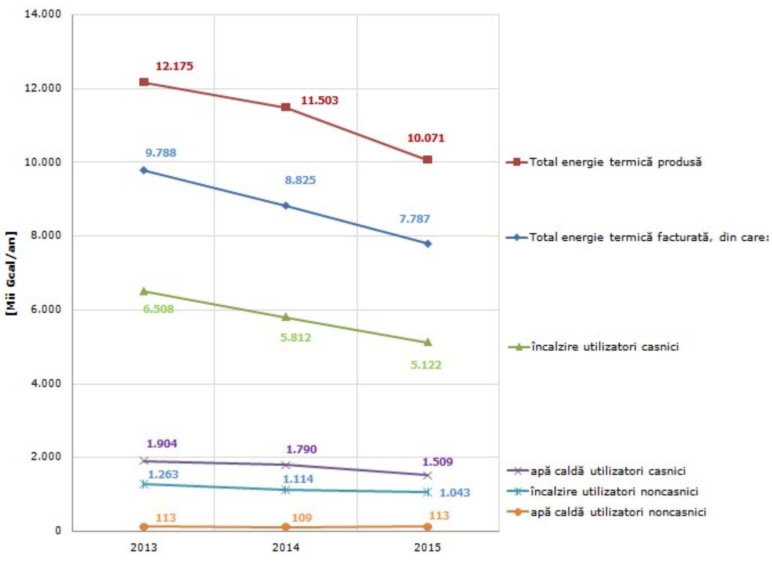
The total quantities of heat generated and invoiced can be found in Table 2.5.1, which includes the values of the gross output of the energy transformation chain from generation to distribution.

Table 2.5.1 Evolution in the heat quantity generated and bought by SACET

Heat generated and bought by SACET	Heat values [Gcal/year]		
	Year 2013	Year 2014	Year 2015
Total heat generated and bought (percentage as compared to 2013)	12 174 661 (100 %)	11 502 821 (94.48%)	10 071 002 (82.72%)
Total heat invoiced (percentage as compared to 2013) of which:	9 788 214 (100 %)	8 824 318 (90.15)	7 786 790 (79.55)
- hot water for households (Percentage as compared to 2013)	1 903 935 (100 %)	1 789 733 (94.00)	1 508 543 (79.23)
- heating for households (Percentage as compared to 2013)	6 508 391 (100 %)	5 811 771 (89.30)	5 122 279 (78.70)
- hot water for non-household users (Percentage as compared to 2013)	113 193 (100 %)	108 900 (96.21)	113 389 (100 17)
- heating for non-household users (Percentage as compared	1 262 695 (100 %)	1 113 914 (88.22)	1 042 580 (82.57)
Transformation chain output	Output values [%]		
Gross output of the generation-distribution transformation chain	80.40	76.71	77.32

Taking into account the data shown in the table above, it may be stated that the decrease in heat generation and distribution was accompanied by a significant decrease in the values of the gross output.

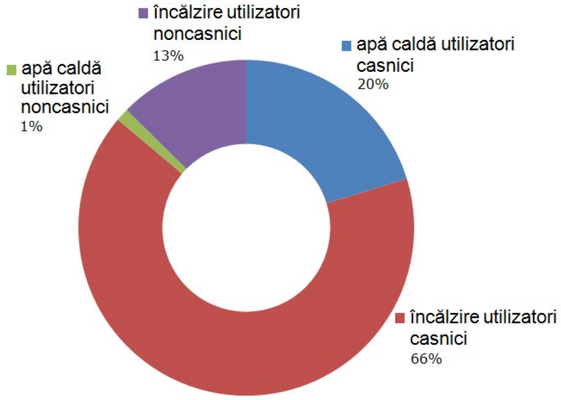
Figure 2.5.3 shows change in the values of heat generated and invoiced to consumers.



RO	EN
Total energie termică produsă	Total heat produced
Total energie termică facturată, din care	Total heat invoiced, of which
încălzire utilizatori casnici	heating for households
apă caldă utilizatori casnici	hot water for households
încălzire utilizatori non-casnici	heating for non-household users
apă caldă utilizatori non-casnici	hot water for non-household users

Figure 2.5.3 Change in the heat generated and the heat invoiced

Figure 2.5.4 shows the share of each type of consumer in heat invoiced annually, for 2014.



RO	EN
apă caldă utilizatori non-casnici	hot water for non-household users
încălzire utilizatori non-casnici	heating for non-household users
apă caldă utilizatori casnici	hot water for households
încălzire utilizatori casnici	heating for households

Figure 2.5.4 Share of each type of consumer in heat invoiced annually, for 2014

The charts provided in Figures 2.5.5 and 2.5.6 show the quantity of heat generated and sold, respectively, by region. It is thus shown that, in 2014, 41 % of the whole quantity of heat generated nationally was supplied in Bucharest, and the next region in terms of heat supplied was the South-East, with approximately 12 % of the heat generated nationally supplied. Annex 2 includes in a table the heat production and the quantity of heat sold to the main localities connected to the SACET in 2013, 2014 and 2015 [2].

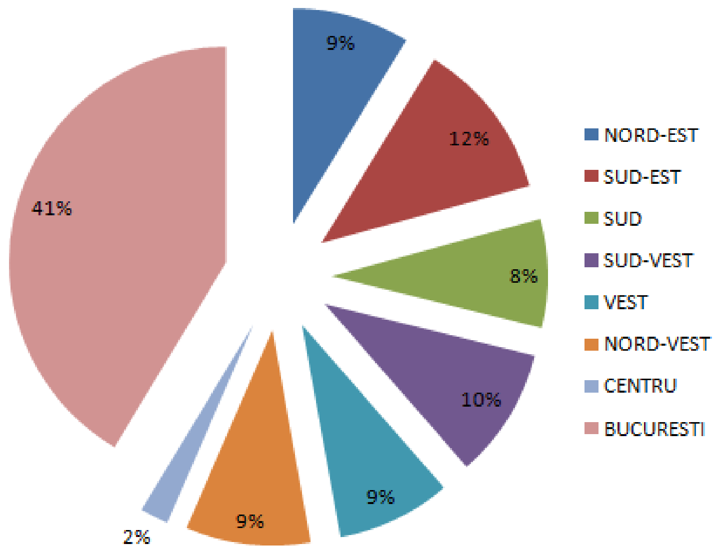


Figure 2.5.5 Aggregate percentages of heat generated/bought in 2014, broken down by region

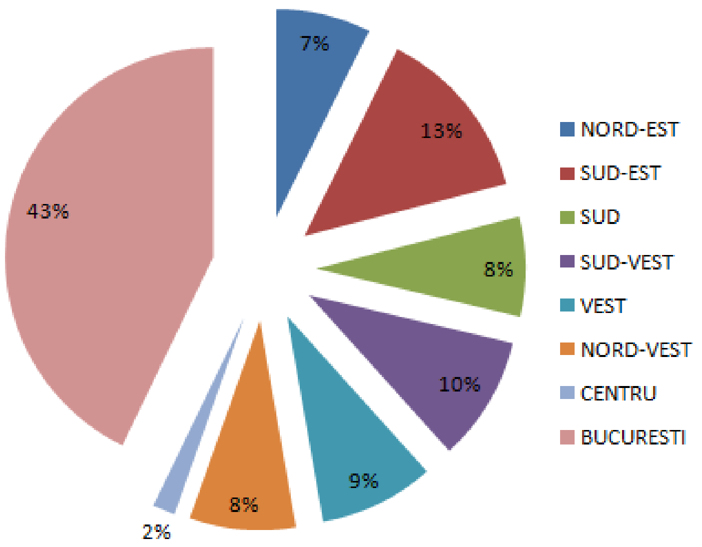


Figure 2.5.6 Percentages of heat sold, invoiced in 2014, broken down by region

The chart in Figure 2.5.7 shows the main areas in Romania based on the following criteria:

- current status of the district heating and cooling system;
- current level of heating and cooling demand in residential and non-residential urban consumers;
- level of heat demand at industrial consumers;
- increase potential in heating and cooling demand both at urban and at industrial consumers;
- potential to use renewable resources for the production of heating and cooling.

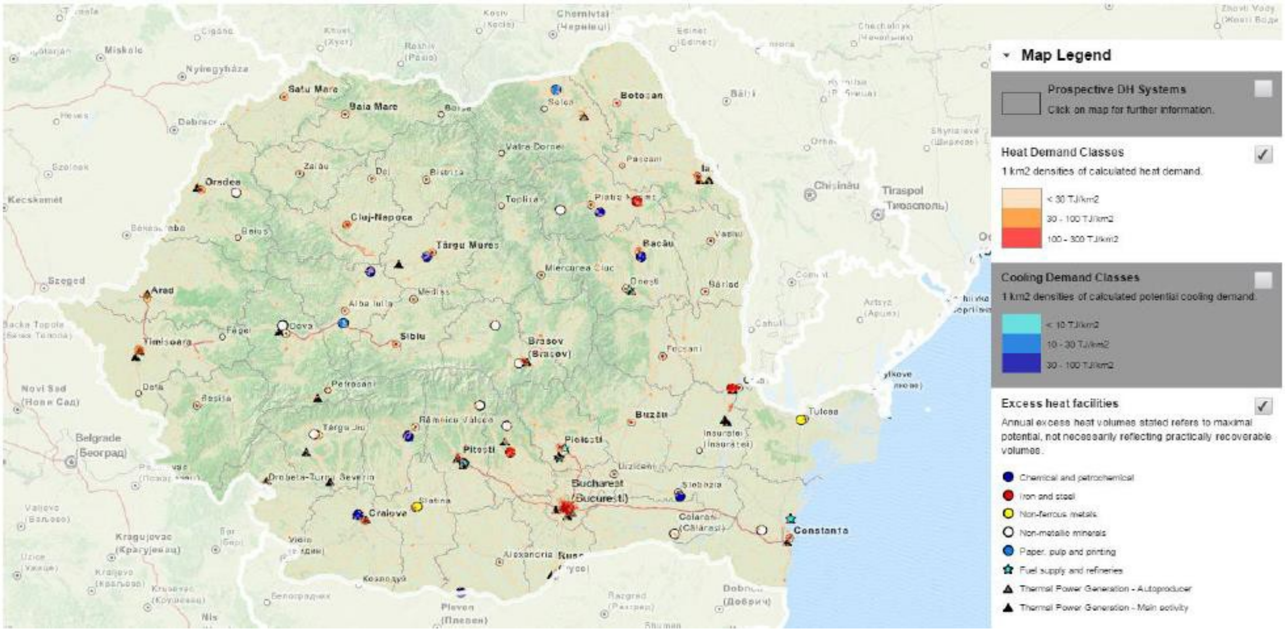


Figure 2.5.7 Areas in Romania by significance of thermal energy demand (http://maps.heatroadmap.eu/)

2.6. Statistical evolution of heat price / tariff

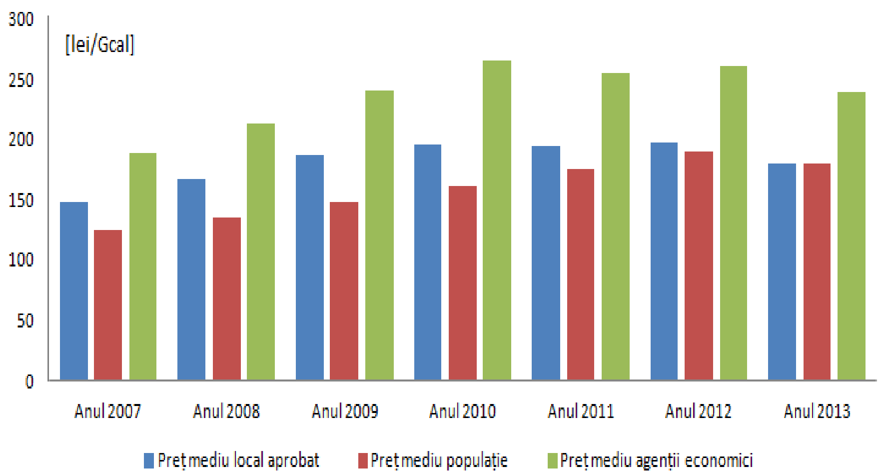
According to the provisions of Order No 66/2007 of the President of ANRSC approving the Methodology for fixing, adjusting or changing local prices and tariffs for the public services of district heating supply, excluding cogeneration heat, ANRSC approves the local prices and tariffs for the operators supplying/providing public services of heat supply, excluding cogeneration heat, as well as the local prices and tariffs for the public institutions and economic operators who do not operate a SACET, but who provide heat supply services.

The local prices of heat invoiced to the population are approved by the local authorities of the public administration concerned. The local authorities of the public administration may approve local prices for the heat invoiced to the population that are lower than the price of generation, transport, distribution and supply of heat delivered to the population. Where the local authorities of the public administration approve local prices for the heat invoiced to the population that are lower than the price of generation, transport, distribution and supply of heat delivered to the population, they shall cover the difference between the price of generation, transport, distribution and supply of heat delivered to the population and the local price of the heat invoiced to the population from the local budgets. The local price invoiced to the population is the price for the heat invoiced and supplied to the population through the district systems, approved by decision of the local authorities of the public administration or of the community development association.

Table 2.6.1 and Figure 2.6.2 show the values of the average annual prices for the giga calorie, the value approved by the public authority and the value of the heat supplied to the population and to the companies operating locally [8].

Table 2.6.1 Average annual values of the heat generation price (lei/Gcal)

Year	2007	2008	2009	2010	2011	2012	2013
Local average price approved by the public authority for heat (lei/Gcal)	147.34	166.58	186.84	195.81	194.70	197.59	179.44
Average price for heat supply to the population (lei/Gcal)	124.69	134.59	148.63	161.52	174.93	189.88	179.38
Average price for heat supply to economic agents (lei/Gcal)	188.20	213.02	240.06	264.87	254.75	261.28	239.72



RO	EN
Preţ mediu local aprobat	Local approved average price
Preţ mediu populaţie	Population average price
Preţ mediu agenţi economici	Economic agent average price

Figure 2.6.1 Evolution of the average heat generation price, 2007-2013

The analysis of the data sent to ANRSC has revealed that the lowest price for heat in 2013 was paid by residential consumers in Cernavodă, Arad, Vaslui, Tulcea and Bacău, who paid amounts between 86 lei and 154 lei per giga calorie.

The same year, the highest price for heat was applied in Constanța, Reșita, Brăila, Miercurea Ciuc and Târgu Mureș, where inhabitants paid between 311 lei and 387 lei per giga calorie.

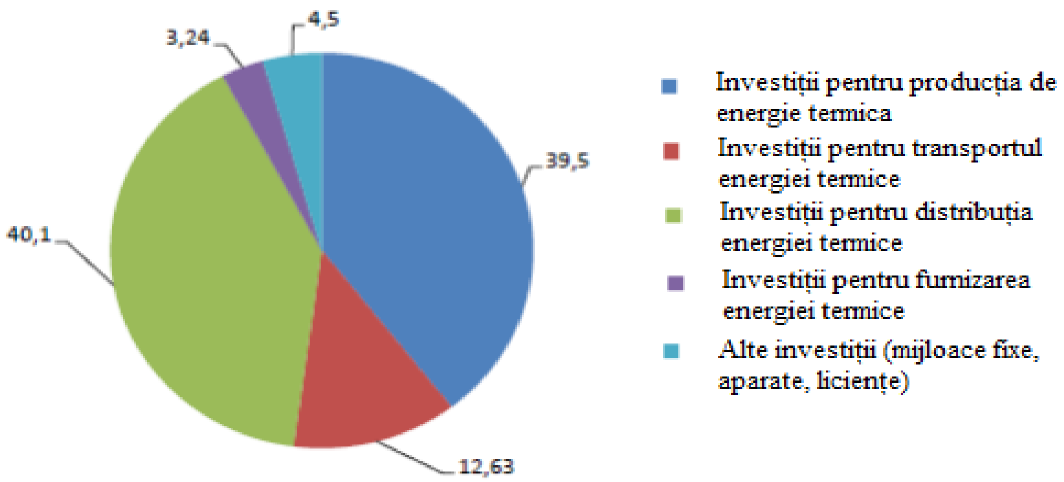
Annex 2 shows, for 2014, the values of the supply prices approved by type of fuel for the population and of the invoice price for the population by main operator supplying heat in localities connected to the SACET [3].

2.7. Investment records

The investment effort for district heating supply public services is high, because of the system condition.

The investments in the district heating system were *low*, between 175 161.97 thousand lei in 2011 and 243 800 thousand lei in 2009; *the highest investment value*, i.e. 2 024 513 thousand lei, was recorded in 2012, which includes the implementation of the project concerning the district heating system in Beiuş town in the North – West Region, financed under SOP Environment. The investment achievement level during the period 2009 – 2011, analysed globally, was only half of the planned level (52.79 % - 2009, 51.69 % - 2010, 53.62 % - 2011).

Figure 2.7.1 shows the structure of the investment costs by technological stages of the heat generation and supply activity.



RO	EN
Investiţii pentru producţia de energie termică	Investment for heat production
Investiţii pentru transportul energiei termice	Investment for heat transport
Investiţii pentru distribuţia energiei termice	Investment for heat distribution
Investiţii pentru furnizarea energiei termice	Investment for heat supply
Alte investiţii (mijloace fixe, aparate, licenţe)	Other investment (fixed assets, apparatus, licences)

Figure 2.7.1 Structure of the investment costs

2.8. Identification of the heating and cooling demand that may be met through the district heating and cooling network

The analysis for determining the evolution in the heating and cooling demand starts from and is mainly focused on determining and forecasting the demand in thermal energy that may be generated using high-efficiency facilities, in particular cogeneration plants (trigeneration).

Figure 2.8.1 shows the forecast for the total demand in thermal energy that may be produced by cogeneration, and its current coverage percentage.

RO	EN
Legendă	Legend
Botoşani – nume judeţ	Botoşani – county name
EPCT – potential de consum energie termică din cogenerate	EPCT – cogeneration heat potential consumption
PR – procent realizat din EPCT	PR – EPCT achievement level

Figure 2.8.1 Potential of cogeneration thermal energy and current coverage percentage of this demand

Moreover, another element considered for assessing the evolution in heat and cold demand was the forecast of the structure of energy consumption for ensuring the necessary thermal energy. Figure 2.8.2 shows the forecast evolution and the structure of thermal energy consumption.

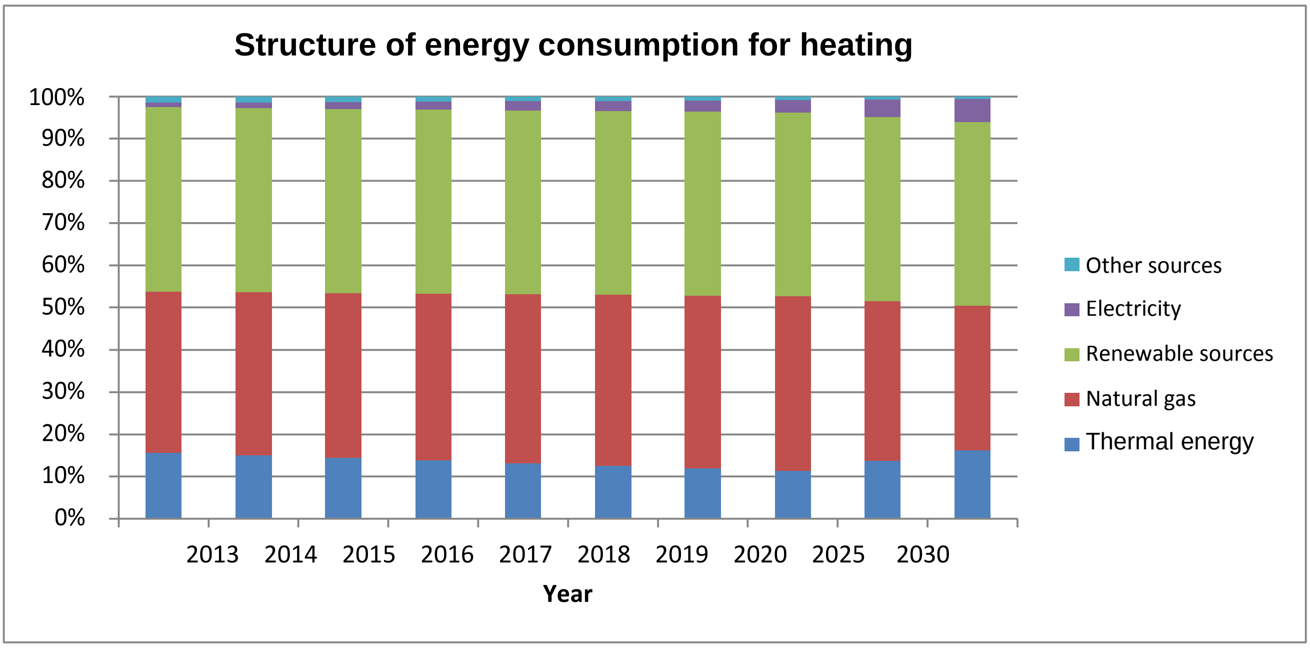


Figure 2.8.2 Structure of energy consumption for heating

Moreover, in order to determine the evolution in the heating and cooling demand, the specific consumption of thermal energy was established by building type (residential and non-residential). Figure 2.8.3 shows the evolution in the specific consumption of heat by building type.

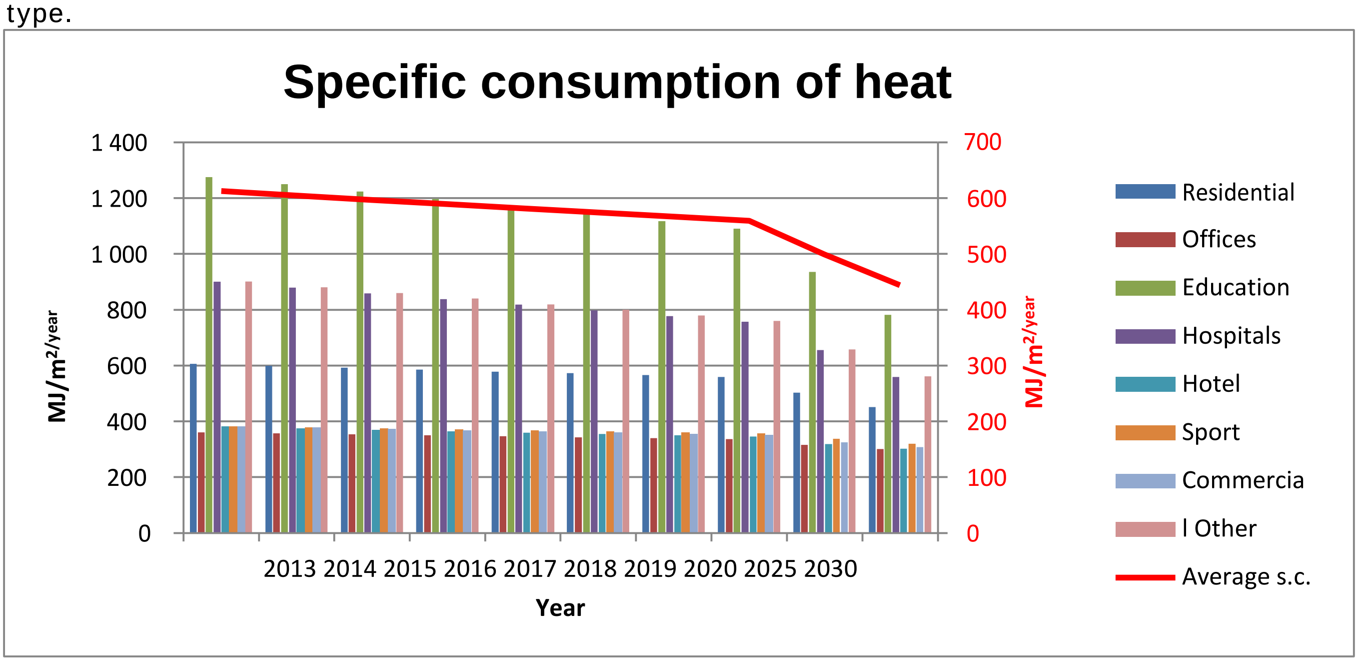


Figure 2.8.3 Specific consumption of heat

Taking into account the aspects listed above, Figure 2.8.4 shows the forecast evolution in the demand of heat broken down by consumer type. This structure of the evolution in heat demand is considered to be a reference for the analysis in the next chapters of this paper.

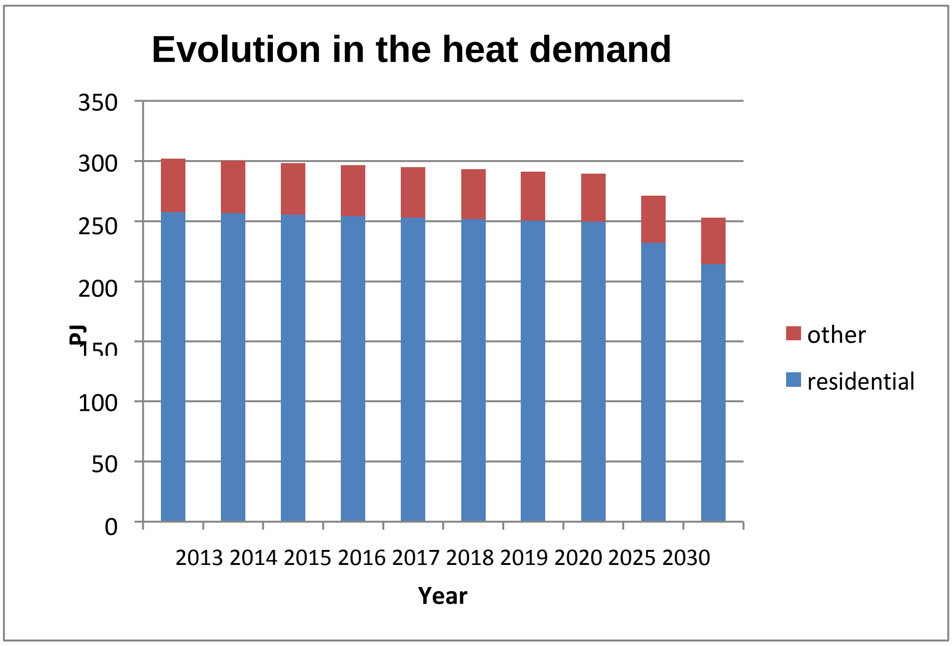


Figure 2.8.4 Evolution in the heat demand

Based on the evolution in the heat demand, the potential of cogeneration heat was established (see Figure 2.8.5). Moreover, the evolution in the potential of cogeneration heat has taken into account the achievement of new buildings and the reconnection to SACET.

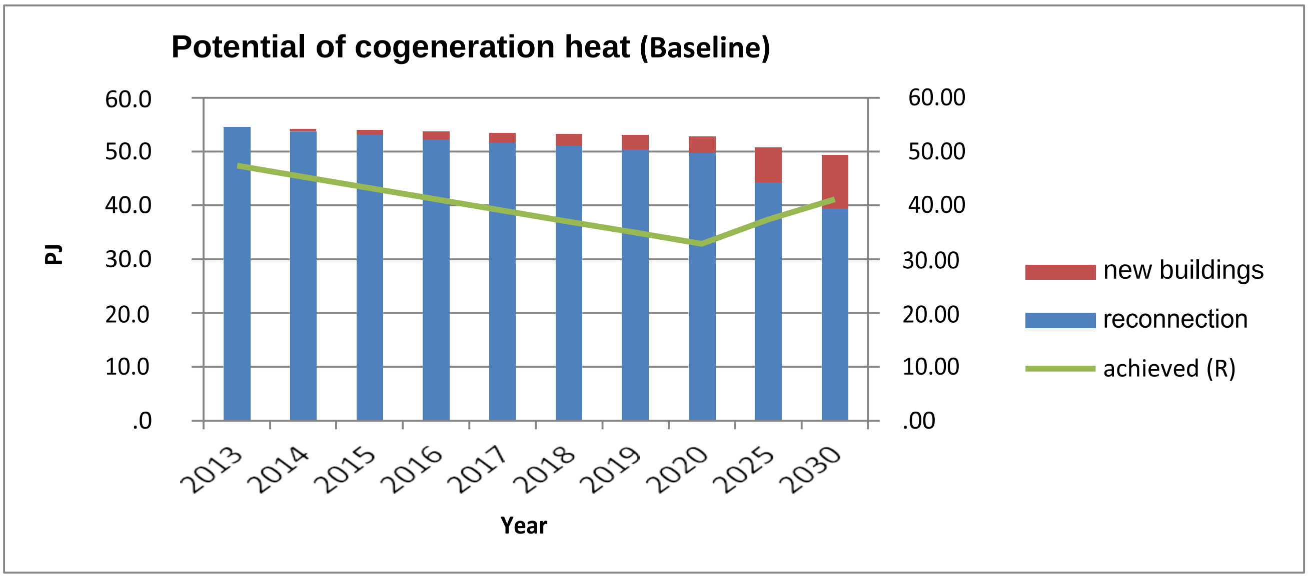


Figure 2.8.5 Potential of cogeneration heat

3. Identification of energy efficiency potentials of district heating and cooling infrastructure

Taking into account the current condition of the whole heat supply system, from source to consumer, its improvement potential is estimated at 30 % at the least. The energy efficiency improvement potential in the next period refers to:

- Energy refurbishment of residential and non-residential buildings, in particular owned by the central administration (3 % per year);
- Refurbishment/extension of primary and secondary heat networks in the thermal energy supply systems, including thermal points. As mentioned above, the national target includes refurbishment, restoration (replacement + extension) by 2020 of approximately 30 % of the whole primary network for heat supply and of approximately 40 % of the whole secondary network of heat supply;
- Improvement of metering and of the monitoring and control systems in district heating systems. While metering and monitoring of generation and consumption of energy sources is satisfactory in the area of thermal energy generation sources, as far as consumers are concerned, individual metering is relatively low (metering of heat consumption is currently approximately 50 %);
- Promotion of efficient cogeneration, of district heating and of energy from renewable sources. The potential of energy efficiency in the area of thermal energy generation sources is high and mainly refers to replacing sources using coal as primary energy source with new energy efficient plants (cogeneration / trigeneration plants) using natural gas or renewable energy sources.

In addition, the areas, localities that currently no longer have access to SACET may be important elements in improving the efficiency and/or extension of the national thermal energy supply system. Making the district systems more efficient et more developed would bring about an increase margin of at least 40 % on the market of district heating consumption in Romania.

Concerning the potential of district cooling, taking into account the significant increase in electricity consumption in the summer and the safe operation conditions for the National Energy System, solutions have been submitted for analysis referring to the generation of energy for cooling using thermal energy from district heating or waste thermal energy from the industry, using an absorption cooling device.

Moreover, taking into account the advantages of trigeneration, it is more and more seen as the solution for making the cogeneration groups from the district system efficient in the summer too, when the need of heat is low.

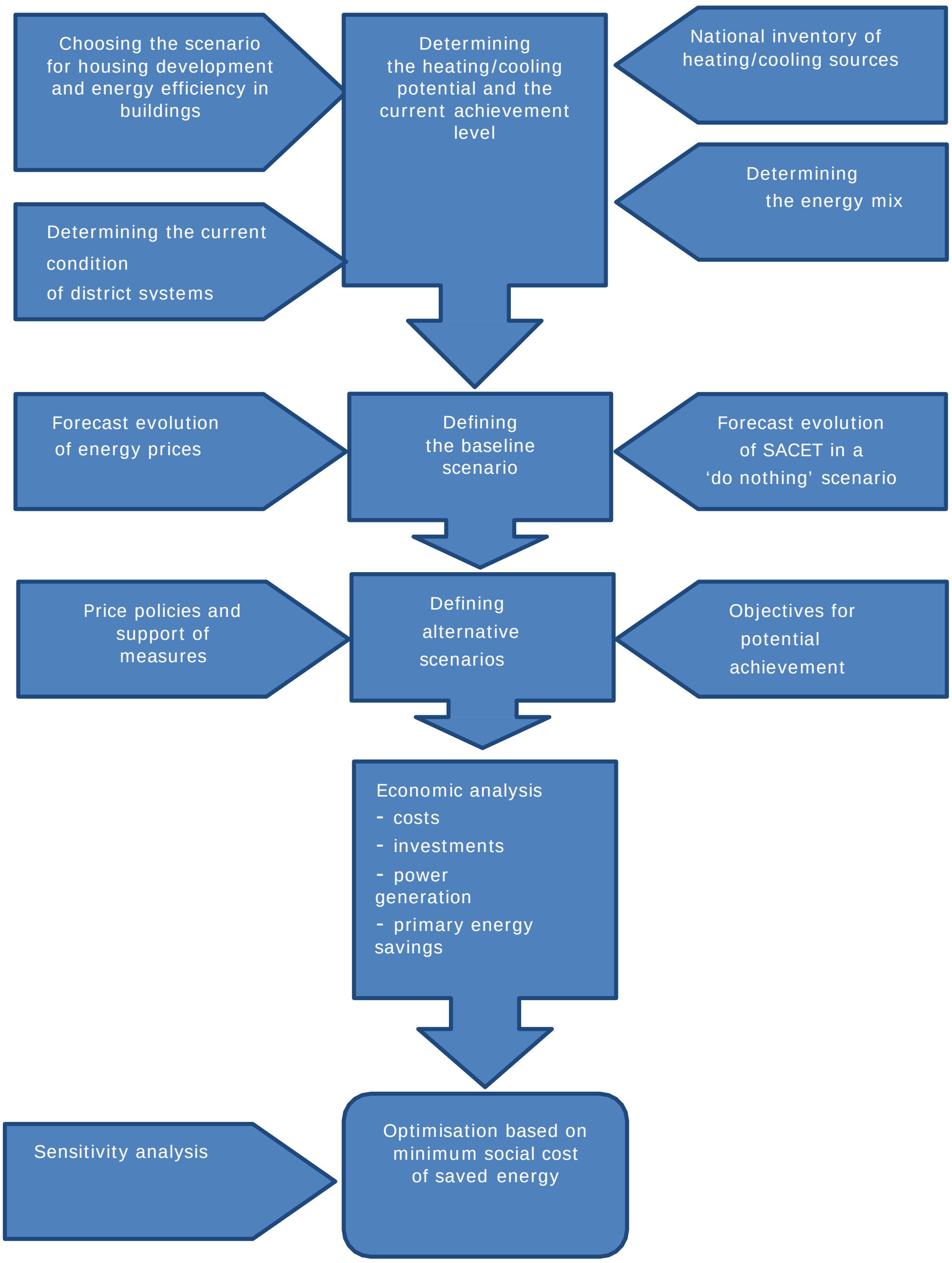
The production of cold agent using heat is not a novelty. The solution mainly refers to a connection, inside the building, of the networks, underground pipes with a common air treatment unit or with a fan-coil unit ensuring cooling of the air passing through cooled water. Consequently, it will no longer be necessary to have chillers positioned locally in buildings. Water will return into the district plant for cooling and recirculation, after use, through a closed loop pipe system. This means that an external cooling equipment may provide the necessary energy for several buildings. This cooling system is more flexible and thus more efficient than traditional chillers, no matter the load conditions.

In terms of energy and savings, the district cooling system may reduce the quantity of electricity used by more than 65 % as compared with traditional air-conditioning systems. Concerning the district cooling system, it is thus important to promote the solution and to adapt the inside facilities so that they could take up and use the cold agent, as the technological solutions are well-known. To start with, the large commercial areas, the modern office buildings and the new buildings in residential areas should be connected to the SACETs.

4. Energy efficiency strategies, policies and measures under horizon 2020 - 2030

The EU Integrated Energy and Climate Change Strategy proposes the following objectives for each EU country:

- Cutting greenhouse gas emissions by 20 % by 2020 as compared to 2005;
- Increasing the share of renewable energy in the overall energy mix to 20 % by 2020;
- Decreasing the final energy consumption through 20 % increase in energy efficiency by 2020.



4.1. Energy efficiency measures

The main policies and measures for making the district heating system more efficient should consider the following:

- Increase the share of cogeneration in heating and cooling systems and in electricity generation;
- Develop efficient district heating and cooling infrastructure to accommodate the development of high-efficiency cogeneration and the use of heating and cooling from waste heat and renewable energy sources;
- Encourage new thermal electricity generation installations and industrial plants generating waste heat to be located in sites where a maximum amount of the available waste heat will be recovered to meet existing or forecast heat and cooling demand;
- Encourage new residential zones or new industrial plants which consume heat in their production processes to be located where available waste heat, as identified in the comprehensive assessment, can contribute to meeting their heat and cooling demands. This could include proposals that support the clustering of a number of individual installations in the same location with a view to ensuring an optimal matching between demand and supply for heat and cooling;
- Encourage thermal electricity generating installations, industrial plants producing waste heat, waste incineration plants and other waste-to-energy plants to be connected to the local district heating or cooling network;
- Encourage residential zones and industrial plants which consume heat in their production processes to be connected to the local district heating or cooling network;

Table 4.1.1 shows specific energy efficiency measures recommended for analysis, as well as the time horizon for the implementation of these measures.

Table 4.1.1 Energy efficiency measures intended for the district heating system

Ref. No	Energy efficiency measures	Time horizon for measure implementation
1	Energy refurbishment of residential and non-residential buildings, in particular owned by the central and local public administration.	2016 ÷ 2030
2	Replacement of pipe networks for primary thermal agent transport and of worn and oversized thermal energy distribution networks, as well as reduction of technological leaks in networks to less than 15 %.	2016 ÷ 2025
3	Retooling the thermal stations and sub-stations adding high-efficiency heat exchangers, varying speed pumps, full automation and remote control.	2016 ÷ 2020
4	Implementation of measure and control systems all along the energy chain, source-network-consumer, in order to reveal as precisely as possible the leaks related to various energy sub-ensembles and to draw up accurate energy balances.	2016 ÷ 2018
5	Reduction or full removal of certain secondary distribution networks by installing sub-stations or building thermal modules.	2018 ÷ 2025
6	Full replacement of heat distribution networks inside the buildings and adaptation of their layout to the need of individual metering of heat consumption by apartment.	2018 ÷ 2025
7	Metering of all individual consumers of thermal energy in both condominiums and individual houses, and concomitant mounting of thermostatic radiator valves on each heating device, as well as of meters for domestic hot water. This will create the possibility of concluding individual contracts for each household consumer, with direct invoicing, as well as the possibility for the consumer to adjust its thermal comfort depending on its needs and payment capacity, while the operator of the heat supply service will be able to restrict the thermal agent supply exclusively to consumers who do not comply with the contract terms and conditions, without effecting the quality of the service supplied to the other consumers in the condominium.	2018 ÷ 2025
8	Information and guidance (education) of the population concerning the need to save energy resources, to protect the environment and to extend the use of renewable energy sources.	Continuously
9	Extension and implementation of the programmes for the use of renewable sources and of the production of cogeneration electricity and heat, including in the rural environment.	2019 ÷ 2030

In addition, other solutions may be envisaged combined with the National Energy System (NES). The National Energy System includes critical components that may be used for generating thermal energy using electricity.

These are closely linked to the electricity market and to the operation mode of the National Energy System. The 'green' sources for electricity generation have inserted a significant quantity of energy into the system in excess (through unbalance), which is generated when there is no consumption.

This energy may be found in 2 components: The Balancing Market and the System Technological Services Market Electricity in excess has a relatively low price, as it is considered to be in addition to the forecast energy, which is 40 lei/MWh (2013 average). For the System Technological Services Market, there is a special bonus for granting availability. This electricity may be transformed into heat using electric boilers. The main advantages of this type of equipment is high efficiency (99 %) and very low response time (less than 3 minutes from warm reserve to rated power). District heating systems provided with such equipment can be found in the European Union, and their electric part is used to balance the energy system or to operate low cost energy on the market (night hours, negative price hours, etc.).

4.2. Measures of public support for heating and cooling services

In order to develop the district heating system and make it more efficient, a series of public support measures and policies should be set up. In particular, the following directions should be considered in order to support the district heating solution:

- Drawing up a plan pointing out the main advantages provided by the district heating system, and showing the main directions for development, refurbishment, retooling, extension of the district heating system at national level and its promotion to the local and national administration and to heat consumers;
- Considering the local authorities' lack of experience in the field, levers need to be put up in order to establish public-private partnerships and to develop projects intended at restructuring the existing district heating systems by leasing them to specialised private companies;
- Setting up a stable and predictable climate in terms of legal and regulatory framework in the field, which is investment-friendly (few, non-discriminatory rules ensuring attraction of investments in the field);
- Intensification and diversification of governmental programmes for investments in retooling;
- Development of policies for the promotion of renewable sources for heat generation by cogeneration or from separate sources, and preservation and development of energy capacities using autochthonous fuel and sources (lignite, biomass, geothermal energy) in order to increase energy independence;
- Development of policies favouring energy recovery of urban waste. The Romanian strategy for urban waste management only provides for ecological landfill construction and not for energy recovery of waste;
- Drawing up a legislative framework compelling the new heat consumers (new buildings, neighbourhoods) to mainly use the district heating system solution, and favouring this solution (based on technical and economic studies);
- Drawing up a legal framework favouring the consumers who get connected to the district heating system (new or re-connected consumers) by offering them grants covering the investment in the local equipment for heat distribution and metering. In particular, in order to encourage the population to come back to the district heating system, the local administration authorities will have to provide free of charge reconnection, subject to

compliance with the legislation in force and provided that the specific technical conditions are met.

4.3. Investments planned for developing the existing district heating infrastructure

4.3.1 Investments planned for cogeneration facilities and facilities using renewable resources

Table 4.3.1 shows the planned investments in new thermal energy sources, which will be implemented in the period 2016-2021.

Table 4.3.1 Planned investments in new thermal energy sources in the period 2016-2021

Total thermal input, newly installed/refurbished in SACET heat sources	Thermal input [MW]	Investm ent value [
Total of which:	267.2	90 784 075
- new high-efficiency cogeneration capacities	258.7	82 632 047
- new capacities using renewable energy sources	8.5	8 152 028

4.3.2 Investments planned in heating networks

Table 4.3.2 shows the planned investments in heating networks, which will be commissioned in the period 2016-2025.

Table 4.3.2 Planned investments in heating networks in the period 2016-2025

Heating networks	Length [m]	Investment value [Euro]
Transport networks, of	205 164	268 345 443
- newly installed	27 045	13 374 726
- replaced	178 119	254 970 717
Distribution networks, of	556 960	305 250 646
- newly installed	58 270	19 434 127
- replaced	498 690	285 816 519

4.4 The promotion of high-efficiency cogeneration

Pursuant to GD No 1215/2009 setting up the criteria and conditions necessary for implementing the aid scheme for the promotion of high-efficiency cogeneration based on the demand of useful heat, as subsequently amended, the bonus-type scheme applicable to the producers having units with installed electric capacity above 1 MW was implemented, and promotion was made through regulated prices and the obligation for default suppliers to buy energy in the case of producers and household consumers holding low power cogeneration units or micro-cogeneration units.

The bonus-type scheme is State aid (no 437/2009), approved by the European Commission as compatible with the Common Market pursuant to Article 87(3)(c) of the EC Treaty by Decision C(2009) 7085 also establishing the conditions for being granted the aid, including the obligation of annual reporting on how the aid is implemented.

The bonus-type scheme became operational on 1 April 2011.

Description of the aid scheme

The bonus-type scheme is intended to promote cogeneration electricity and heat generation systems, to encourage new investments in the cogeneration technology, as well as works for the replacement/restoration of existing facilities.

This scheme may be accessed only for cogeneration plants complying with the requirement of primary energy saving as compared to separate generation, as laid down in GD No 219/2007, and the aid is thus accessible only to high-efficiency cogeneration electricity. The criteria for the promotion of high-efficiency cogeneration electricity are laid down in Electricity and Natural Gas Law No 123/2012, as subsequently amended and supplemented.

In order to receive the bonus, the producers have to sell the electricity on the competition market; electricity which has not been sold on the competition market, may be sold at regulated price, set up at 90 % of the average price on the day-ahead market of the previous year, through regulated contracts, according to the electricity demand related to the regulated contracts.

The reference price and the regulated prices for electricity in 2014 were approved by Order No 77/2013 of the President of ANRE:

- reference price 152.91 lei/MWh, without VAT;

- regulated price:

- 177.00 lei/MWh, without VAT, for electricity sold during day hours;

- 104.73 lei/MWh, without VAT, for electricity sold during night hours.

Based on the data provided by ANRE, a total number of 42 plants with cogeneration units, belonging to 36 producers as legal persons, received a bonus in 2014. A total quantity of 5 102 GW high-efficiency cogeneration electricity benefited of bonus during the period January – December 2014.

The total quantity of high-efficiency cogeneration electricity having benefited of bonus during the period January – December 2014 for the producers concerned was 4.998 TWh, before the balancing performed in March 2015, and 5.102 TWh after the balancing performed in March 2015.

There are 25 cogeneration plants with capacity below 20 MWe, 19 with capacity below 10 MWe and 9 with capacity below 5 MWe. Approximately three quarters of the heat is delivered to the SACET, and a quarter is supplied to industrial consumers.

Table 4.4.1 National production of cogeneration electricity and heat

Year	Electricity produced in cogeneration units	Cogeneration electricity (Annex I – D2012/27/EU)		Cogeneration electricity in the total national production	Useful heat produced in cogeneration units (Annex I – D2012/27/EU)	
		Total	of which self-producers		Total	of which self-producers
	TWh	TWh	%	%	PJ	%
2007	14.23	6.62	14.65	10.7	73.2	15.85
2008	14.06	6.21	15.62	9.6	71.5	18.04
2009	12.33	6.26	13.74	10.8	66.3	17.05
2010	11.93	6.54	17.74	10.8	69.0	22.46
2011	13.47	7.28	17.45	11.9	71.9	23.5
2012	12.54	6.72	16.07	11.4	66.1	22.37
2013	11.1	6.6	18.78	11.3	57.9	21.99

The energy saving achieved under the high-efficiency cogeneration processes having received a bonus pursuant to the provisions in the Qualification Rules can be found in Table 4.4.2.

Table 4.4.2 Energy saving achieved under the high-efficiency cogeneration processes having received a bonus

MU	**Q I 2013**	**Q II 2013**	**Q III 2013**	**Q IV 2013**	**Q I 2014**	**Q II 2014**	**Q III 2014**	**Q IV 2014**	**Total 2013**	**Total 201**
GWh	1 550	1 394	522	511	323	298	1 095	848	3 490	3 051
toe	133 300	119 884	44 892	43 946	27 778	25 628	94 170	72 928	303 140	262 386

In order to support the high-efficiency cogeneration programme, European funds amounting to EUR 67 584 480 were engaged under LIOP-SO 6.4 Improving energy efficiency in industry by promoting consumption of energy produced in high-efficiency cogeneration systems.

Beside industry, the district heating systems are an important market for cogeneration. However, the market is limited by the number and size of district heating systems, on the one hand, and by the economic factors on the other hand. The best solution in terms of environment and efficiency would be that all heat should be produced by high-efficiency cogeneration. However, the best economic and financial size of a cogeneration plant is much smaller and usually represents 20-50 % of the total peak thermal load of a district heating system. If this potential is used, the heat sales may be reasonably increased only for new or restore district heating systems.

5. Evaluation of the current energy potential of renewable energy sources in Romania

The implementation of an energy strategy intended to use the potential of renewable energy sources (RES) is in line with Romania's coordinates for energy development on the medium and long term and provides the appropriate framework for adopting decisions concerning energy alternatives a compliance with the relevant Community acquis.

The main renewable energy sources that may be successfully used for the production of district heating and cooling are:

a) Biomass;
b) Geothermal sources;

Figures 5.1.1 and 5.1.2 show relevant areas in Romania and the potential of using renewable energy sources such as biomass (wood and plant-based) and geothermal sources.

RO	EN
Legendă	Legend
Botoşani – nume judeţ	Botoşani – county name
PEBL – potential energetic din biomasă lemnoasă	PEBL – wood biomass energy potential
PEBV – potential energetic din biomasă vegetală	PEBV – plant biomass energy potential

Figure 5.1.1 Wood and plant-based biomass potential

RO	EN
Legendă	Legend
Botoşani – nume judeţ	Botoşani – county name
30% - Procent din suprafaţă cu potential geotermal	30% - Area percentage with geothermal potential

Figure 5.1.2 Geothermal source potential

The following aspects can be pointed out with regard to the absolute values of the potential of using renewable sources such as biomass and geothermal energy:

- According to the data in the specialised analyses, Romania has a biomass potential of approximately 318 PJ. The largest share is obtained from the use of agricultural biomass;

- A number of 66 geothermal water sources have been found in Romania, having an annual potential of 10 106 Gj and approximately 30 % of this potential is currently used.

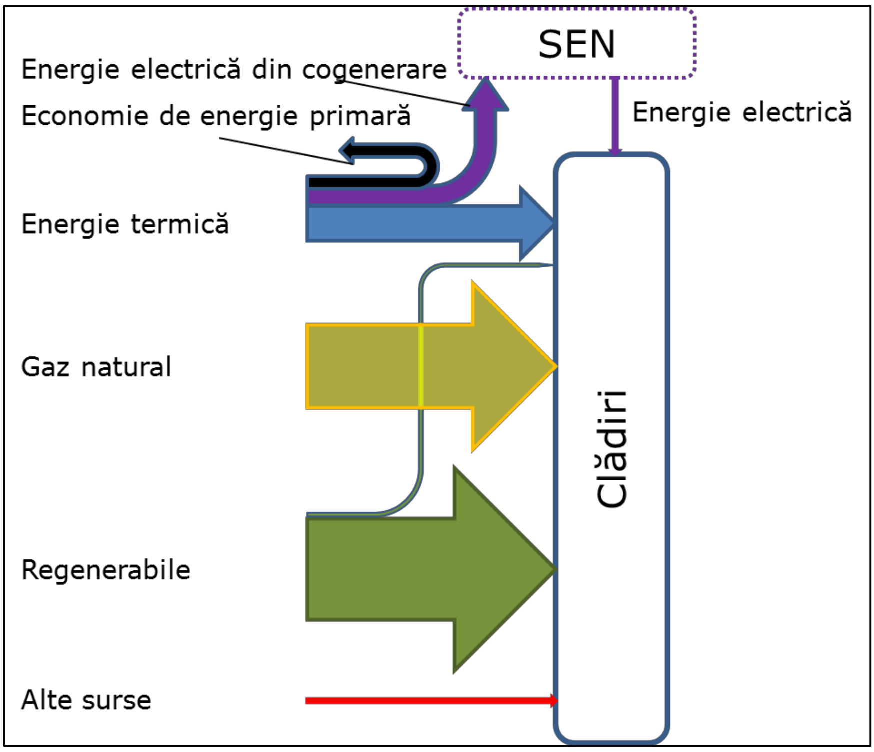
6. Cost-benefit analysis

The cost-benefit analysis refers to the final energy consumption for building heating in Romania. Consequently, prices contain VAT and include transformation costs.

Subsidies, bonuses and aids are not taken into account, as they are only redistribution tools. Based on the information in the cost-benefit analysis, price policies for heating can be developed.

6.1 System boundary and geographical boundary

The system subject to analysis is limited to the heated or cooled volume of the buildings in Romania (see Figure 6.1.1).



RO	EN
SEN	NES
Energie electrică din cogenerare	Cogeneration electricity
Economie de energie primară	Primary energy saving
Energie termică	Heat
Gaz natural	Natural gas
Regenerabile	Renewable
Alte surse	Other sources
Energie electrică	Electricity
Clădiri	Buildings

Figure 6.1.1 Boundaries of the analysed system and energy flows

The system includes the heating networks and the sub-stations distributing the thermal agent. The participation of the networks at the final energy consumption is similar to the participation of the buildings, mainly influenced by the thermal resistance of the walls (pipes).

The analogue energy behaviour of networks and buildings is reflected in energy demands that depend on the thermal insulation level. The heat leaks in the public networks can be found in the tariffs. Consequently, the decrease in leaks leads to a decrease in the heat price, which has been taken into account when establishing the price evolution.

6.2 Integrated approach - inventory of energy sources

The final energy consumption in Romania (reference year 2013, source *Eurostat Energy Balances 2013*) was 905.6 PJ, broken down as in Figure 6.2.1.

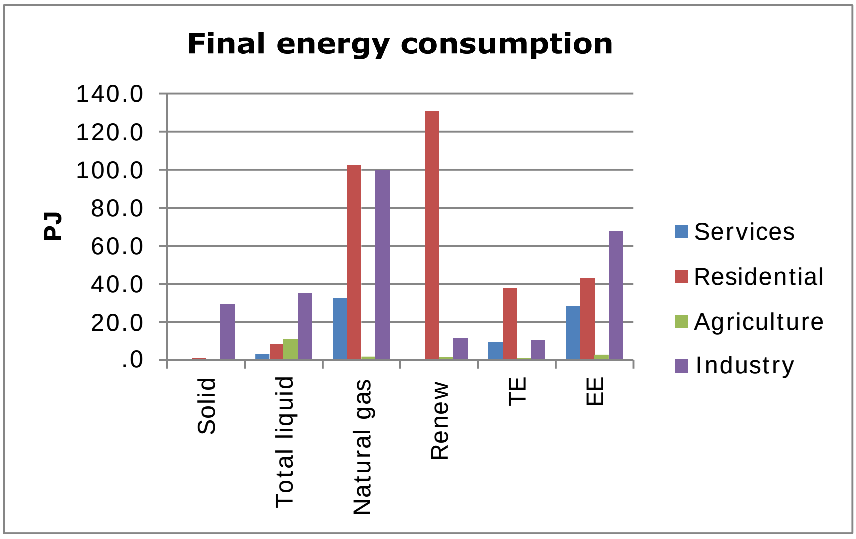


Figure 6.2.1 Final energy consumption by sector and energy source

A significant share of the residential sector in the total energy consumption can be noticed, as well as a significant consumption (8.6 PJ) of liquid fuel (which does not refer to transport). Statistics show that this consumption results from LPG, which is widely used in households and which contributes, sometimes indirectly, to covering the heat demand.

The structure of the final energy consumption for heating in reference year 2013 is shown in Figure 6.2.2.

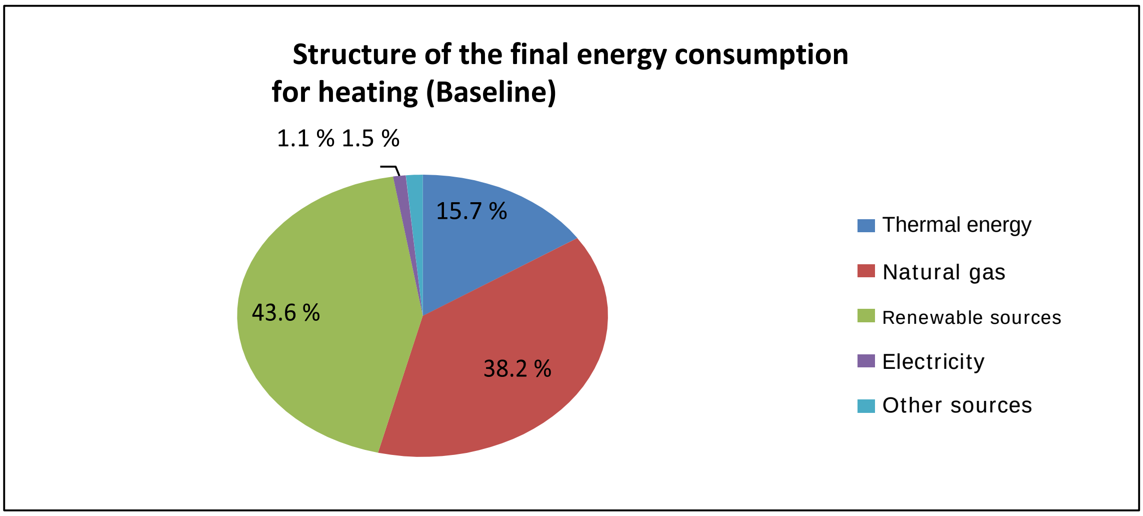


Figure 6.2.2 Consumption structure

Beside the energy sources mentioned above, the following aspects have been considered when developing the scenarios:

a) cogeneration from municipal waste incineration – potential 4.9 PJ in municipalities where the technology may be implemented (Bucharest, Brașov, Constanța, Timișoara);
b) thermal energy from excess electricity – potential 1.3 PJ (system services).

6.3 Baseline scenario

The baseline scenario is based on the following assumptions:

a) the heat demand evolves depending on the development of the built area and of the programmes on energy-efficiency in buildings according to scenario PS2 MDRAP, which is in line with the energy-efficiency targets in the National Action Plan for Energy Efficiency (PNAEE);
b) energy efficiency in the distribution networks leads to limiting leaks to 15 % of the annual heat input;
c) the investment programme from EU funds has already been set up until 2020 for 7 municipalities and Bucharest (LIOP), which covers approximately 65 % of the operational networks;
d) investments in networks will also be supported in the period 2020-2030, but not so as to fully cover new and existing networks, and thus the leaks in 2030 will be 18 % of the quantity of the annual heat input. *The energy efficiency of the networks is directly reflected in the heat price.*

6.3.1. Energy demand and consumption structure

Energy demand and consumption structure are shown in Figure 6.3.1.

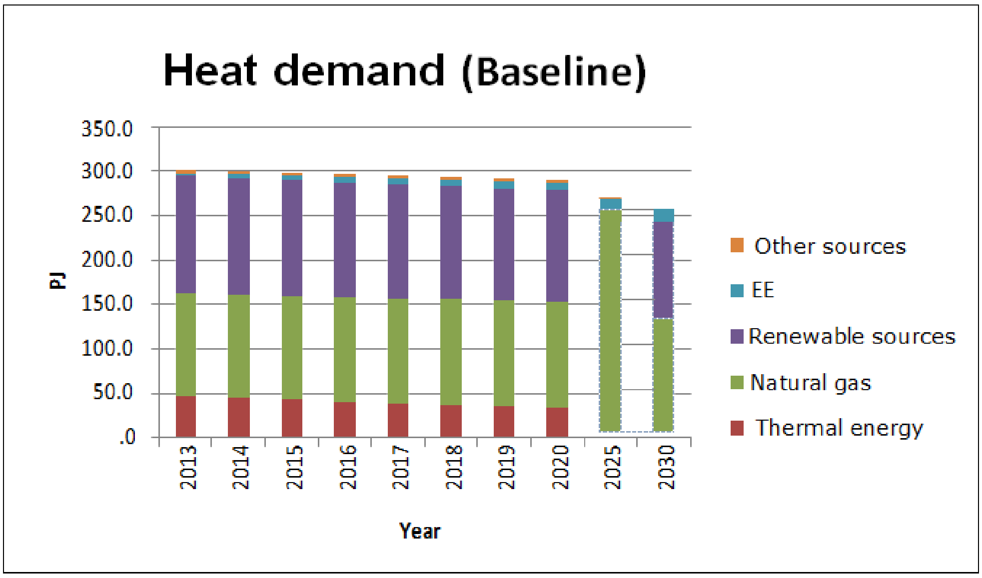


Figure 6.3.1 Energy demand for heating and contribution of the sources

6.3.2. Evolution of energy prices

The evolution of energy prices considers a restrained growth scenario (source: EIA Annual Energy Outlook 2015).

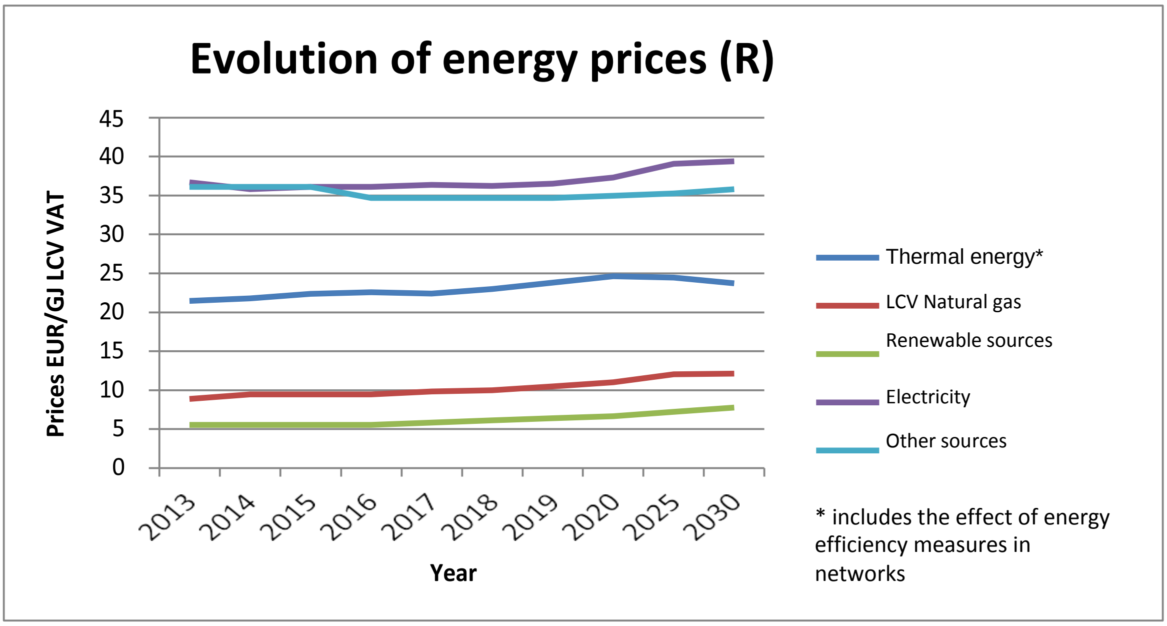


Figure 6.3.2 Price evolution

As pointed out in Chapter 6.1, the price of thermal energy includes the effect of the energy efficiency measures in the networks. This effect will fade out by 2020 due to the decrease in heat demand, and the further trend will be of decrease as investments in active networks will be carried on.

The measures for energy efficiency in networks mainly refer to investments in the replacement of pipes and of distribution stations that are technically inappropriate for use, as well as to investment-type repairs (critical), which may be depreciated (for example, replacement of valves, metering, special insulation, etc.).

The efficiency measures generate a residual value at the end of the analysed period, which shall be subtracted from the 2030 costs.

The scenario includes the price of the services for the operation of apartment boilers and of other individual sources of energy transformation. They refer to expenses for the maintenance, verification and repairing of individual units and for the electricity they use, as appropriate.

The baseline scenario starts from the cogeneration potential already achieved in 2013 and it is a ‘do nothing’ type scenario: unless significant investments are made in new cogeneration capacities, the energy mix for ensuring heating will evolve towards increase in the share of natural gas use in the distribution network, which, at least in the urban area, replaces the inefficient district heating networks.

Table 6.3.1 Baseline scenario

Baseline	**2013**	**2015**	**2020**	**2025**	**2030**	**TOTAL**
Heat demand PJ						
Thermal energy	47.4	43.2	32.9	37.4	41.1	698
Natural gas	115.3	116.6	119.8	102.6	86.5	1 952
Renewable sources	131.6	129.9	125.8	117.8	109.8	2 200
EE	3.3	4.9	8.5	11.3	13.7	162
Other sources	4.4	3.8	2.5	2.0	1.5	47
TOTAL	302.0	298.4	289.5	271.1	252.6	5 058
Network efficiency	24.3%	25.2%	24.9%	20.9%	17.7%	
Prices EUR / GJ LCV VAT incl.						
Thermal energy*	21.5	22.3	24.6	24.5	23.7	
Natural gas LCV	8.9	9.5	11.0	12.1	12.1	
Renewable sources	5.6	5.6	6.7	7.2	7.8	
Electrical	36.7	36.1	37.3	39.1	39.4	
Other sources	36.1	36.1	35.0	35.3	35.8	
OPEX NG	4.2	4.2	4.2	4.2	4.2	
OPEX other sources	1.4	1.4	1.4	1.4	1.4	
Electricity in the NES	11.1	11.1	11.1	11.1	11.1	
Primary energy saving NG	5.6	5.6	5.6	5.6	5.6	
Production value MEUR						
Distributed heat	1 017	966	809	914	975	16 418
Natural gas	1 022	1 104	1 317	1 237	1 049	21 292
Renewable sources	731	722	839	851	854	14 635
Electrical	121	176	318	440	538	6 210
Other sources	159	139	87	71	55	1 665
OPEX NG	480	486	499	428	360	8 133
OPEX other sources	6	5	3	3	2	65
CAPEX networks	24	31	141	86	86	1 300
Residual value					-847	
Financial total	*3 561*	*3 629*	*4 015*	*4 029*	*3 073*	*68 871*
Electricity in the NES	749	711	617	658	692	12 071
Primary energy saving NG	37	37	37	37	37	673
Economic total	*2 775*	*2 880*	*3 360*	*3 334*	*2 344*	*56 127*
Network investment						
Repairs MEUR	12	11	11	11	11	205
Networks MEUR	12.5	20	130	75	75	1 095
Achievement cogeneration potential	54%	50%	39%	45%	51%	

6.4 Alternative scenarios

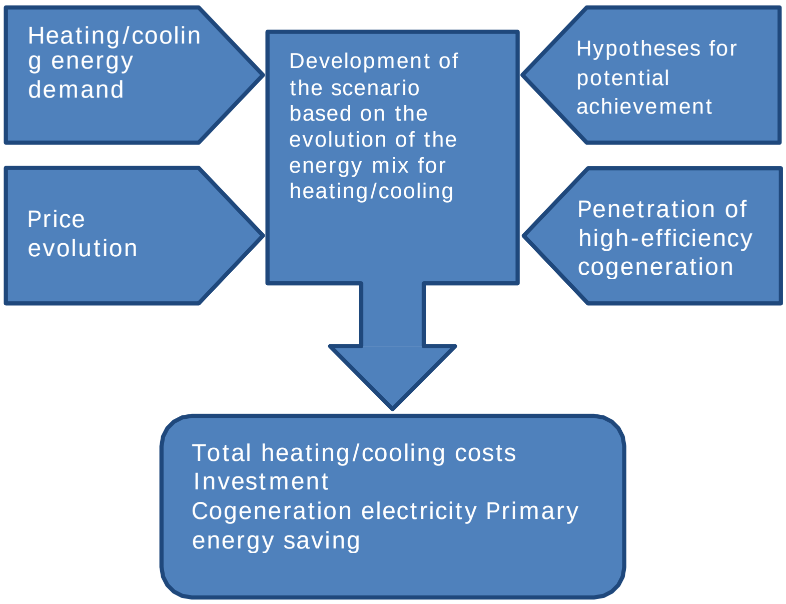
Alternative scenarios consider first of all the investment effort in cogeneration units and the extension/refurbishment of district heating networks.

6.4.1. Methodology

The graph below shows the logics of alternative scenario implementation.

The main heat sources are biomass and natural gas, both relatively abundant in Romania. They will remain preponderant at the evaluation time horizon.

Biomass provides heating for almost 50 % of households, almost most of them in the rural area. No major changes in rural area heating technology are foreseen in the next 15 years, and no investments in district systems, since the communities are under the pressure of investments for water and sewage systems.



The difficulties in supplying industrial quantities of biomass, the environment issues and the public acceptance of biomass cogeneration plants, as well as the specific investment cost, which is 3 to 4 times higher than for natural gas boilers are barriers to a significant development of biomass district heating in the next 15 years.

Consequently, the scenarios mainly analyse the potential of replacing natural gas with cogeneration heat. Without giving technical details, the scenarios assess the costs of this replacement, taking into account two quantifiable advantages of high-efficiency cogeneration:

a) electricity generation from distributed sources, which increase NES stability and capacity of response to load variations, in particular if the plants can decouple heat generation from electricity generation by using heat accumulators;
b) primary energy savings, which may reach values much higher than the value of 10 % required for the 'high-efficiency' qualification.

6.4.2. Scenario S0: moderate increase / moderate penetration of efficient cogeneration

The scenario proposes gradual penetration of high-efficiency cogeneration by 2030, maintaining existing cogeneration as far as the heating demand allows it.

The efficient heating/cooling potential shall be achieved up to 45 % in 2020 and up to 65 % in 2030.

Table 6.4.1: Alternative scenario S0

S0	2013	2015	2020	2025	2030	TOTAL
Heat demand PJ						
Thermal energy	47.4	43.2	38.2	45.3	52.2	796
Natural gas	115.3	116.6	114.5	94.7	75.4	1 853
Renewable sources	131.6	129.9	125.8	117.8	109.8	2 200
EE	3.3	4.9	8.5	11.3	13.7	162
Other sources	4.4	3.8	2.5	2.0	1.5	47
TOTAL	302.0	298.4	289.5	271.1	252.6	5 058
Network efficiency	24.3%	25.2%	23.6%	19.9%	17.1%	
Prices EUR / GJ LCV VAT incl.						
Thermal energy	21.5	22.3	24.4	24.3	23.6	
Natural gas LCV	8.9	9.5	11.0	12.1	12.1	
Renewable sources	5.6	5.6	6.7	7.2	7.8	
Electrical	36.7	36.1	37.3	39.1	39.4	
Other sources	36.1	36.1	35.0	35.3	35.8	
OPEX NG	4.2	4.2	4.2	4.2	4.2	
OPEX other sources	1.4	1.4	1.4	1.4	1.4	
Network electricity	11.1	11.1	11.1	11.1	11.1	
Primary energy saving NG	5.6	5.6	5.6	5.6	5.6	
Production value MEUR						
Distributed heat	1 017	966	926	1 093	1 229	18 600
Natural gas	1 022	1 104	1 259	1 142	914	20 134
Renewable sources	731	722	839	851	854	14 635
Electrical	121	176	318	440	538	6 210
Other sources	159	139	87	71	55	1 665
OPEX NG	480	486	477	395	314	7 721
OPEX other sources	6	5	3	3	2	65
CAPEX	24	31	277	202	187	2 615
Residual value					-1 884	
Financial total	*3 561*	*3 629*	*4 186*	*4 196*	*2 210*	*69 761*
Network electricity	749	711	678	929	1 111	15 013
Primary energy saving NG	37	37	37	58	81	908
Economic total	*2 775*	*2 880*	*3 471*	*3 208*	*1 018*	*53 841*
Investments MEUR						
Repair	12	11	11	11	11	205
Networks	12.5	20	130	75	75	1 095
Network extension	0	0	107	105	0	1 052
High-efficiency plants			102	94	0	1 202
Global cogeneration index	*40%*	*41%*	*44%*	*49%*	*54%*	
Potential achievement	*54%*	*50%*	*45%*	*55%*	*65%*	

6.4.3. Scenario S1: moderate increase / efficient cogeneration in 2020

The scenario proposes a cogeneration potential achievement level of 45 % in 2020 and of 65 % in 2030, implying an investment effort of EUR 2.55 billion, of which EUR 952 million (EUR 729 million in 2019) in high-efficiency cogeneration plants, with a view to removing less efficient plants.
The latter shall be closed down in 2020. For reasons related to investment efficiency, the global cogeneration index reaches 64 % in 2020, which puts additional pressure on electricity price.

Table 6.4.2: Alternative scenario S1

S1	2013	2015	2020	2025	2030	TOTAL
Heat demand PJ						
Thermal energy	47.4	43.2	38.2	45.3	52.2	796
Natural gas	115.3	116.6	114.5	94.7	75.4	1 853
Renewable sources	131.6	129.9	125.8	117.8	109.8	2 200
EE	3.3	4.9	8.5	11.3	13.7	162
Other sources	4.4	3.8	2.5	2.0	1.5	47
TOTAL	302.0	298.4	289.5	271.1	252.6	5 058
Network efficiency	24.3%	25.2%	23.6%	19.9%	17.1%	
Prices EUR / GJ LCV VAT incl.						
Thermal energy	21.5	22.3	24.2	24.2	23.5	
Natural gas LCV	8.9	9.5	11.0	12.1	12.1	
Renewable sources	5.6	5.6	6.7	7.2	7.8	
Electrical	36.7	36.1	37.3	39.1	39.4	
Other sources	36.1	36.1	35.0	35.3	35.8	
OPEX NG	4.2	4.2	4.2	4.2	4.2	
OPEX other sources	1.4	1.4	1.4	1.4	1.4	
Network electricity	11.1	11.1	11.1	11.1	11.1	
Primary energy saving NG	5.6	5.6	5.6	5.6	5.6	
Production value MEUR						
Distributed heat	1 017	966	926	1 093	1 229	18 600
Natural gas	1 022	1 104	1 259	1 142	914	20 134
Renewable sources	731	722	839	851	854	14 635
Electrical	121	176	318	440	538	6 210
Other sources	159	139	87	71	55	1 665
OPEX NG	480	486	477	395	314	7 721
OPEX other sources	6	5	3	3	2	65
CAPEX	24	31	191	128	122	2 550
Residual value					-1 661	
Financial total	*3 561*	*3 629*	*4 100*	*4 122*	*2 369*	*69 920*
Electricity in the NES	749	711	1 002	1 070	1 111	16 654
Primary energy saving NG	37	37	64	69	73	1 016
Economic total	*2 775*	*2 880*	*3 034*	*2 983*	*1 184*	*52249*
Investments MEUR						
Repair	12	11	11	11	11	205
Networks	12.5	20	130	75	75	1 095
Network extension	0	0	28	27	27	298
High-efficiency cogen plants			22	14	9	952
Global cogeneration index	*40%*	*41%*	*64%*	*59%*	*54%*	
Potential achievement	*54%*	*50%*	*45%*	*55%*	*65%*	

6.4.4. Scenario S2: accelerated increase / efficient cogeneration in 2020

The scenario proposes a cogeneration achievement level of 55 % in 2020 and of 85 % in 2030, where the investment effort amounts to EUR 3.14 billion (EUR 1.06 billion in 2019 for closing down inefficient plants) and the global cogeneration index in 2020 is 64 %.

Table 6.4.3 Alternative scenario S2

S2	2013	2015	2020	2025	2030	TOTAL
Heat demand PJ						
Thermal energy	47.4	43.2	46.7	57.6	68.3	949
Natural gas	115.3	116.6	106.0	82.4	59.4	1 700
Renewable sources	131.6	129.9	125.8	117.8	109.8	2 200
EE	3.3	4.9	8.5	11.3	13.7	162
Other sources	4.4	3.8	2.5	2.0	1.5	47
TOTAL	302.0	298.4	289.5	271.1	252.6	5 058
Network efficiency	24.3%	25.2%	22.1%	18.8%	16.6%	
Prices EUR / GJ LCV VAT incl.						
Thermal energy	21.5	22.3	23.8	23.8	23.4	
Natural gas LCV	8.9	9.5	11.0	12.1	12.1	
Renewable sources	5.6	5.6	6.7	7.2	7.8	
Electrical	36.7	36.1	37.3	39.1	39.4	
Other sources	36.1	36.1	35.0	35.3	35.8	
OPEX NG	4.2	4.2	4.2	4.2	4.2	
OPEX other sources	1.4	1.4	1.4	1.4	1.4	
Network electricity	11.1	11.1	11.1	11.1	11.1	
Primary energy saving NG	5.6	5.6	5.6	5.6	5.6	
Production value MEUR						
Distributed heat	1 017	966	1 110	1 372	1 596	22 009
Natural gas	1 022	1 104	1 166	993	720	18 347
Renewable sources	731	722	839	851	854	14 635
Electrical	121	176	318	440	538	6 210
Other sources	159	139	87	71	55	1 665
OPEX NG	480	486	442	343	247	7 085
OPEX other sources	6	5	3	3	2	65
CAPEX	24	31	226	157	146	3 135
Residual value					-2 074	
Financial total	*3 561*	*3 629*	*4 191*	*4 230*	*2 084*	*71 077*
Electricity in the NES	749	711	1 192	1 325	1 415	19 578
Primary energy saving NG	37	37	73	82	90	1 161
Economic total	*2 775*	*2 880*	*2 925*	*2 824*	*579*	*50 338*
Investments MEUR						
Repair	12	11	11	11	9	195
Networks	12.5	20	130	75	75	1 096
Network extension	0	0	43	42	41	459
High-efficiency cogen plants			42	29	21	1 386
Global cogeneration index	*40%*	*41%*	*64%*	*59%*	*54%*	
Potential achievement	*54%*	*50%*	*55%*	*70%*	*85%*	

6.4.5. Scenario S3: increase supported by the natural gas pricing policy

The scenario implies a pricing policy for residential consumption natural gas that should differentiate the retail sales (in the urban distribution network) from industrial consumers, including heat producers. The prices for households and similar consumers in 2020 will reach the level of the current EU average.

The scenario proposes a cogeneration achievement level of 55 % in 2020 and of 95 % in 2030, where the investment effort amounts to EUR 6.35 billion and the repair expenses to EUR 195 million.

This is a ‘break-even’ scenario, where the increase in natural gas price is compensated in society by the benefits of high-efficiency cogeneration. However, the impact of electricity generation needs to be analysed separately.

Table 6.4.4 Alternative scenario S4

S3	2013	2015	2020	2025	2030	TOTAL
Heat demand PJ						
Thermal energy	47.4	43.2	42.5	57.6	72.3	940
Natural gas	115.3	116.6	110.2	82.4	55.4	1 710
Renewable sources	131.6	129.9	125.8	117.8	109.8	2 200
EE	3.3	4.9	8.5	11.3	13.7	162
Other sources	4.4	3.8	2.5	2.0	1.5	47
TOTAL	302.0	298.4	289.5	271.1	252.6	5 058
Network efficiency	24.3%	25.2%	22.8%	18.8%	16.5%	
Prices EUR/GJ LCV VAT incl.						
Thermal energy	21.5	22.3	24.0	23.8	23.3	
Natural gas LCV	8.9	9.5	19.4	21.1	21.7	
Renewable sources	5.6	5.6	6.7	7.2	7.8	
Electrical	36.7	36.1	37.3	39.1	39.4	
Other sources	36.1	36.1	35.0	35.3	35.8	
OPEX NG	4.2	4.2	4.2	4.2	4.2	
OPEX other sources	1.4	1.4	1.4	1.4	1.4	
Network electricity	11.1	11.1	11.1	11.1	11.1	
Primary energy saving NG	5.6	5.6	5.6	5.6	5.6	
Production value MEUR						
Distributed heat	1 017	966	1 018	1 372	1 687	21 840
Natural gas	1 022	1 104	2 143	1 739	1 199	27 901
Renewable sources	731	722	839	851	854	14 635
Electrical	121	176	318	440	538	6 210
Other sources	159	139	87	71	55	1 665
OPEX NG	480	486	459	343	231	7 123
OPEX other sources	6	5	3	3	2	65
CAPEX	24	31	379	361	389	5 322
Residual value					-3 881	
Financial total	*3 561*	*3 629*	*5 247*	*5 180*	*1 075*	*80 880*
Electricity in the NES	749	711	1 166	1 861	2 699	25 680
Primary energy saving NG	37	37	72	102	147	1 420
Economic total	*2 775*	*2 880*	*4 009*	*3 216*	*-1 771*	*53 779*
Investments MEUR						
Repair	12	11	11	11	9	195
Networks	12.5	20	130	75	75	1 096
Network extension	0	0	60	57	56	634
High-efficiency cogen plants			178	217	249	3 398
Global cogeneration index	*40%*	*41%*	*68%*	*83%*	*98%*	
Potential achievement	*54%*	*50%*	*50%*	*70%*	*90%*	

6.5 Time horizon

The time horizon of the evaluation is 2030 with benchmarks in 2020 and 2025.

In general, the data for 2013 (baseline) and for 2014 are known, and 2015 can thus be characterised in relatively accurate terms.

In order to evaluate the residual values at the end of the analysed period, depreciation periods were considered as follows: 25 years for high-efficiency cogeneration plants and 30 years for networks.

6.6 Primary energy savings

The strategy adopted in the alternative scenarios implies replacement of a significant quantity of natural gas currently used in individual heating facilities (most of them in areas with district heating potential) with high-efficiency cogeneration heat produced in plants mainly using natural gas as fuel. Primary energy saving is proportional with the gas quantity replaced.

As an analogy, no matter the fuels or technologies used to replace natural gas consumption and leading to primary energy savings, they may be translated into natural gas savings. Consequently, primary energy savings are quantified at the price of natural gas in the transport network.

The primary energy savings during the period evaluated are shown in the table below by scenario.

Table 6.6.1 Primary energy savings

Primary energy savings	Baseline	S0	S1	S2	S3
Energy PJ	121	163	183	209	256
NG equivalent price MEUR	673	908	1 016	1 161	1 420

Primary energy savings increase with the penetration of high-efficiency cogeneration. However, as shown further on, the trend is not a sufficient argument for choosing the scenario revealing the highest primary energy savings. The most important optimization factor is the cost for obtaining these savings.

6.7 Economic analysis

6.7.1. Methodology

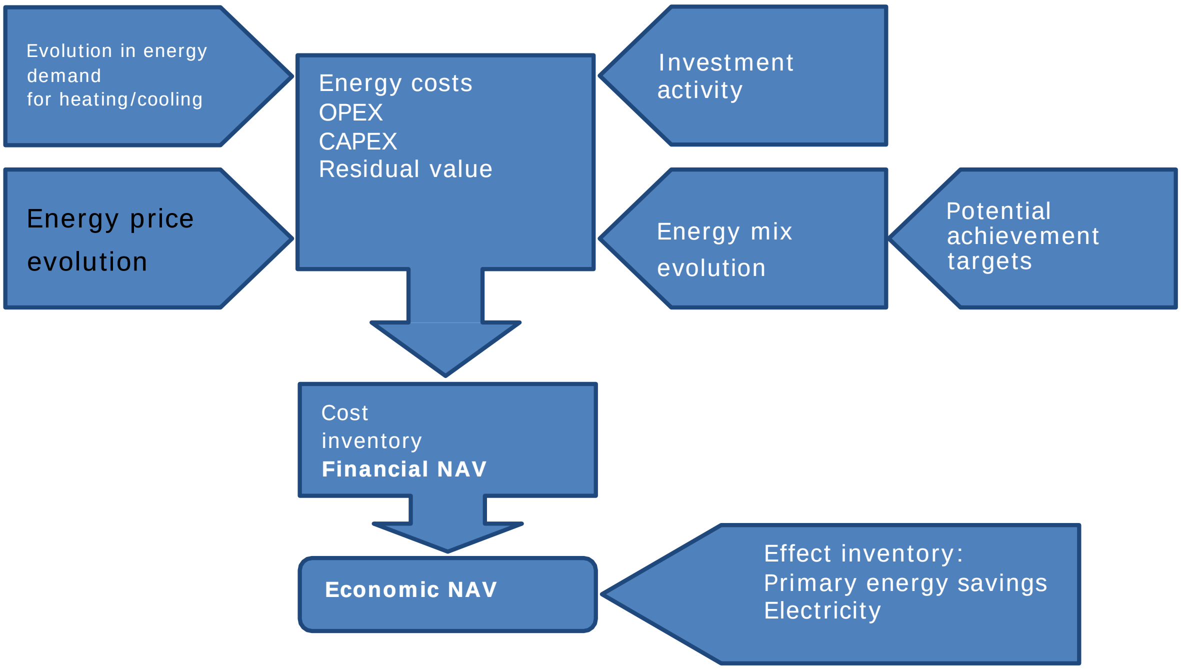
The economic analysis makes a comparative evaluation of the effects in case of implementation of one or the other scenario proposed as compared to the baseline scenario.

Since heating/cooling is considered to be final energy consumption, namely without possibility of recovery or transformation, it is a real cost (for example, import energy) or an opportunity (for example, energy from national sources). Consequently, the comparisons between scenarios are made based on costs.

The use of a certain technology or energy source may generate benefits such as savings of primary energy (fossil – with impact on the carbon emissions) or of a useful product (electricity).

Without favouring any specific technology, we state that the influence of cogeneration plant efficiency is appreciated for its global cogeneration index. It is likely that the technicians, the market mechanisms (in particular the electricity market) and the financial constraints co-work in order to achieve the heating/cooling potential in line with the targets approved politically.

The graph below shows the logics of the cost and benefit evaluation method.



6.7.2. Results

The economic analysis used a 3 % **discount rate** according to Romania's reports in the Eurostat.

The impact of high-efficiency cogeneration on the electricity market was approached conservatively in all scenarios with moderate energy prices, taking into account a decrease in the global cogeneration index from the maximum value recorded in 2020. The guidance towards efficient and preponderant use of heat implies the use of relatively low-cost technologies, such as low-power gas turbines, stream turbines, etc.

An exception is scenario S3 (forced increase in natural gas price), which implies a cogeneration index of 0.98 in 2030, namely an industry dominated by thermal machines with high electric efficiency raging between 10 and 50 MW.

The results of the economic analysis are shown in the table below.

Table 6.7.1: Economic analysis

Scenario (MEUR)	Baseline	S0	S1	S2	S3
Total heating costs	68 871	69 761	69 920	71 077	80 880
of which CAPEX	1 300	2 615	2 550	3 135	5 322
Cogen electric power	12 071	15 013	16 654	19 578	25 680
Primary energy saving NG	673	908	1 016	1 161	1 420
Financial NAV	54 032	54 771	54 956	55 856	63 171
Economic NAV	43 973	42 551	41 421	40 163	43 346
Cogeneration index annual variation		-1%	-1%	-1%	3%
NG price evaluation from PES EUR/MWh LCV		76	61	90	322

The analysis points out the advantages of widely introducing high-efficiency cogeneration. The economic NAV decreases as cogeneration share and potential achievement level increase.

However, considering *the marginal cost of primary energy savings*, interpreted on the basis of the apparent price of natural gas savings, where the natural gas is a primary source, we find it to be minimum in a scenario of moderate increase and of removal of cogeneration that does not qualify as ‘high-efficiency’ in 2020 (S1).

6.8 Sensitivity analysis

The main factors influencing the value of the total costs for heating/cooling are the following:

- *technology*, represented in scenarios by the global cogeneration index and which the investment effort depends on
- *price* of natural gas in the retail distribution network (at small consumers).

An investment effort of 400 EUR/kW for networks and of 1 000 EUR/kW$_e$ for natural gas cogeneration plants was considered when developing the scenarios. Achieving a share of 75 % of high-efficiency cogeneration heat is possible by using heat accumulators and by decreasing the supply temperature of the thermal agent, which are both energy and economic efficiency measures intended to increase cogeneration use capacities.

In order to evaluate sensitivity to the cogeneration technology used, two cases are analysed starting from the global cogeneration index in 2020:

a) orientation towards generation of *heat*, through annual reduction of the cogeneration index by one percent (-1 %) as compared to the trend considered in the scenarios

b) orientation towards generation of *electricity*, through an increase in the global cogeneration index by 1 % above the trend in the scenarios.

The results are shown in the table below.

Table 6.8.1: Sensitivity to technology variations

Scenario	S0	S1	S2	S3
Cogeneration index annual variation	*-2%*	*-2%*	*-2%*	*2%*
Total heating costs	-0.1%	-0.1%	-0.1%	-0.1%
of which CAPEX	-13.8%	-13.6%	-14.2%	-8.9%
Cogen electric power	-7.0%	-7.5%	-7.9%	-6.2%
Primary energy saving NG	-4.6%	-3.4%	-4.0%	-4.8%
Financial NAV	-0.1%	-0.1%	-0.2%	-0.2%
Economic NAV	1.5%	1.9%	2.4%	2.3%
Cogeneration index annual variation	*0%*	*0%*	*0%*	*4%*
Total heating costs	0.1%	0.1%	0.1%	0.1%
of which CAPEX	13.8%	13.6%	14.2%	8.9%
Cogen electric power	7.0%	7.5%	7.9%	6.2%
Primary energy saving NG	5.0%	3.8%	4.5%	5.0%
Financial NAV	0.1%	0.1%	0.2%	0.2%
Economic NAV	-1.6%	-1.9%	-2.4%	-2.3%

A direct and very significant impact on the investment effort (13-14 %) can be noticed, which is however minimum for scenario S1, and reversed on the economic NAV. The minimum influence on the total costs underlines again the importance of the policies on energy and optimization of the technological mix for maximum economic effects.

The sensitivity to the price variations of the natural gas in the retail distribution network, which price is a critical element of the policy promoting efficient heating/cooling, is proportional to the share of natural gas in the energy mix. The variations of this price do not impact energy generation in cogeneration plants (plausibly assuming that a distinction will be made between 'wholesale' and 'retail' consumers).

Table 6.8.2: Sensitivity to price variations

Scenario	S0	S1	S2	S3
NG price variation	+1%	+1%	+1%	+1%
Total heating costs	0.3%	0.3%	0.3%	0.3%
Financial NAV	0.3%	0.3%	0.3%	0.3%
Economic NAV	0.4%	0.4%	0.4%	0.5%
NG price variation	-1%	-1%	-1%	-1%
Total heating costs	-0.3%	-0.3%	-0.3%	-0.3%
Financial NAV	-0.3%	-0.3%	-0.3%	-0.3%
Economic NAV	-0.4%	-0.4%	-0.4%	-0.5%

Even if the impact of price variations seems low, the experience suggests that the demand elasticity is high: leaving aside the quality of the service, a quick migration from the district systems to individual heating occurred based on the hope of a relatively low decrease in expenses. The issue of the price of natural gas for the population has a high emotional load, with political implications, and it can decisively influence the acceptance of energy policies.

7. Conclusions

Below we summarise the trends, objectives and targets described in this evaluation as decisive for the achievement of the potential to implement high-efficiency cogeneration and efficient heating/cooling. The reference year is 2013. However, for comparisons for 2020-2030, we will use 2015, which is relatively well known at the moment and includes the rather significant changes that occurred in SACET in the last 2 years.

The district heating supply public service is delivered through the specific technical urban infrastructure belonging to the public or private domain of the local public administration authority or of the community development association, which constitutes the district heating system of the locality or of the community development association.

Trends in specific energy consumption in buildings: continuous decrease in average consumption is foreseen, from 600 MJ/m^2year in 2015 to 440 MJ/m^2year in 2030, which is still above the EU average. The most spectacular decrease will occur in buildings used by the education system, which are currently the most inefficient (1 200 MJ/m^2year), but which will reach an average consumption of 800 MJ/m^2year.

Trends in housing stock: the built area will increase from 500 km^2 in 2015 to 569 km^2 in 2030. Residential buildings will record 10 % increase, and non-residential buildings 35 % increase, among which office and commercial buildings will record the highest increases (50 %).

Effect of energy efficiency policy on buildings: The increase in built area, combined with a decrease in average energy consumption, brings about a downward trend in heat demand, from 300 PJ in 2015 to 250 PJ in 2030.

State of SACET systems: Out of 315 localities with a SACET in 1990, only 62 still exist in 2015, which cover the heating needs for 20 % of the permanent population of Romania. The heat consumption in the SACET only represents 14.5 % of total demand in 2015. In the baseline scenario, heat will only cover 11.4 % of total demand in 2020, and will increase to 16.3 % in 2030 as a result of the reconnection trend following the energy efficiency measures for buildings and networks taken by the mayor's offices where there still is a SACET.

Coverage of the heat demand by thermal energy	2015	2020	2025	2030
Baseline	0.145	0.114	0.138	0.163
S0	0.145	0.132	0.167	0.207
S1	0.145	0.132	0.167	0.207
S2	0.145	0.161	0.213	0.270
S3	0.145	0.147	0.213	0.286

Technical condition of the networks: Only 20 % of the transmission network and only 31 % of the distribution network have been refurbished. Network losses represent up to 25 % of the generated thermal energy, far from the 15 % target. Even so, none of the scenarios implies reaching this target in 2030 because of insufficient financial resources and time.

Network losses	2015	2020	2025	2030	Total investment
Baseline	25.2%	24.9%	20.9%	17.7%	1 300
S0	25.2%	23.6%	19.9%	17.1%	1 598
S1	25.2%	23.6%	19.9%	17.1%	1 598
S2	25.2%	22.1%	18.8%	16.6%	1 749
S3	25.2%	22.8%	18.8%	16.5%	1 924

Technical condition of the sources: 80 % of the thermal energy groups were installed during the period 1970-1980 and their efficiency levels only partially qualify them for high-efficiency cogeneration. The global cogeneration index is 41 % in 2015 and it varies from one scenario to the other, but it reaches significantly higher levels in 2030, revealing a mixed structure of the cogeneration plants, except for scenario S3, oriented towards heat generation.

Global cogeneration index	**2015**	**2020**	**2025**	**2030**	**Total investment**
Baseline	41%	45%	43%	42%	-
S0	41%	44%	49%	54%	1 017
S1	41%	64%	59%	54%	952
S2	41%	64%	59%	54%	1 386
S3	40%	68%	83%	98%	3 398

Potential of efficient heating / cooling: It is evaluated for the urban area, and it is almost fully characterised by a 0.3 ratio between the built area and the land, and it is increasing as the living area per housing unit increases. The potential is made up of two main components: *reconnection* to the SACET and *extension* of the SACET to new buildings. The total potential in 2015 is evaluated at 86.4 PJ of which 70.8 PJ from reconnection. Out of this value, 43.2 PJ (50 %) has already been achieved.

Efficient heating potential	**2015**	**2020**	**2025**	**2030**
reconnection	70.8	66.3	59.2	52.7
new buildings	15.7	18.6	23.1	27.7
Total	**86.4**	**84.9**	**82.3**	**80.3**
Achieved				
Baseline	50%	39%	45%	51%
S0	50%	45%	55%	65%
S1	50%	45%	55%	65%
S2	50%	55%	70%	85%
S3	50%	50%	70%	90%

Up to 10 % of the potential may be achieved from renewable energies (4 %), waste incineration (5 %) and electricity in excess (1 %). The rest may be covered from cogeneration plants using 60 % of natural gas. The share of the natural gas will increase during the analysed period as a result of the closing down of coal plants.

Scenario characterisation: the *baseline* scenario is of ‘do nothing’ type and consists in keeping the current status of heat sources and in making the planned investments in the networks.

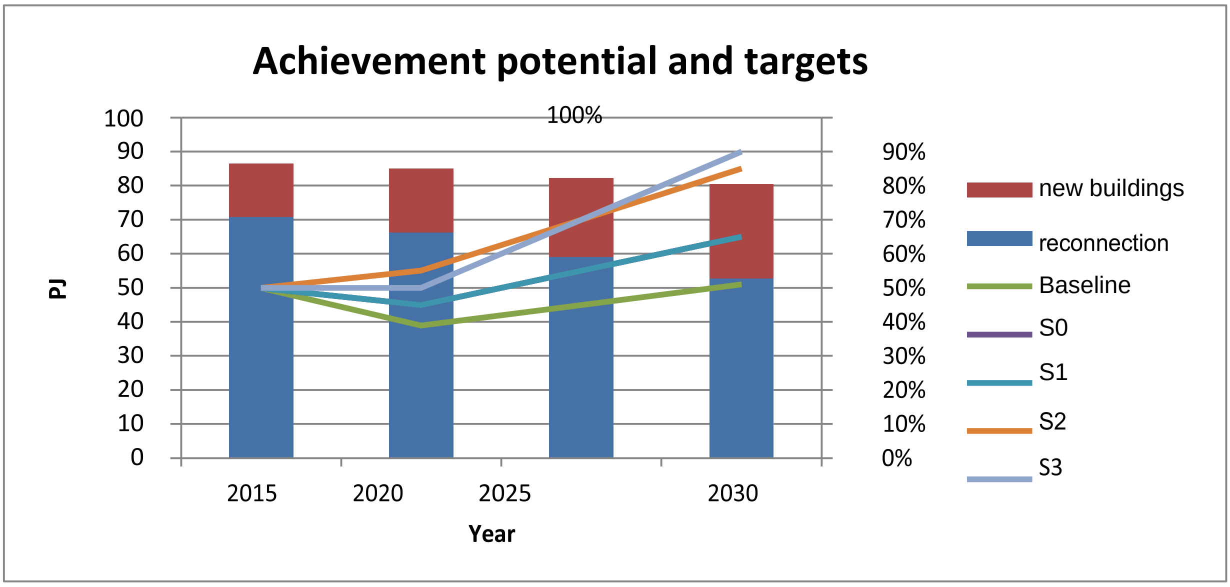
The alternative scenarios consist in achieving the potential at different degrees and with different orientations concerning the electricity/heat relation:

S0 – progressive removal of inefficient cogeneration plants by 2030 and moderate achievement of the potential

S1 – removal of inefficient cogeneration plants by 2020 and moderate achievement of the potential (S0)

S2 – removal of inefficient cogeneration plants by 2020 and advanced achievement of the potential

S3 - removal of inefficient cogeneration plants until 2020 and accelerated achievement of the potential in a context of increase in the price of natural gas for small consumers at the average European level by 2020



Best scenario: the results of the economic analysis suggest that the best scenario is S1. It ensures primary energy savings with lowest costs for the society. In addition, a moderate approach of the potential achievement level, in a context where the source inefficiency will be dealt with as a priority by 2020, has the advantage of sound planning of SACET refurbishment and extension projects, and of adjustment of the measures for enhancing investments in cogeneration units so that the potential energy market disturbances could be controlled.

Measures for enhancing the potential achievement:

1. Adapting the SACET and the sources to the new heat consumption types and ensuring efficient operation and compliance with environment protection rules;

2. Increase in energy efficiency all along the chain: sources, generation, transport, distribution, consumption;

3. Due to its advantages and to its highly developed mature technology, cogeneration is promoted as fundamental vector for the restoration of the heat generation and production system;

4. Accelerating the refurbishment process for the infrastructure related to the local interest energy services, with public and/or private financial support;

5. Increasing the involvement of the local public administration authorities strictly in line with their duties and powers laid down in the law;

6. Promoting the use of renewable energy sources in order to reduce the heat price and to comply with the environment requirements.

According to the current legal framework, namely: Government Decision No 246/2006 approving the National strategy for accelerated development of municipal services, Government Decision No 882/2004 approving the National strategy for heat supply in localities through district generation and distribution systems, Government Decision No 1661/2008 approving the National 2009 - 2010 programme for increased energy efficiency and use of renewable energy sources in the public sector. SACET development is a strategic option, considering that its replacement with other natural gas-based individual systems leads to unreasonable use of primary energy sources and implies investments in new infrastructure for their distribution.

The main issues for the local interest energy services:

- the existing district heat generation systems need to be adapted to the new heat consumption patterns, in particular to be refurbished and developed so as to ensure efficient operation and compliance with the environment protection rules,

- all the studies made on highly and densely populated urban areas concluded that district heating systems are more advantageous in terms of energy efficiency and environment protection, and that cogeneration should be one of the main criteria in the restoration of the heat generation and distribution system,

- a major objective for the district heating public service should be an increase in energy efficiency all along the chain: sources, generation, transport, distribution, consumption,

- the use of renewable energy sources in order to decrease the heat price and to comply with the environment requirements.

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Annex 1 – District heating status in localities (2015 estimation)

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-residential users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Total number of inhabitants benefiting of domestic hot water from the SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
COUNTRY TOTAL			5 565 501	942 202	69 901	12 742	1 240 950	-	3 156 215	2 664 609	2 845 733
NORTH-EAST DEVELOPMENT REGION (1)											
NE AGENCY TOTAL			396 971	173 239	6 362	570	68 364	-	580 908	162 414	168 272
1	THERMOENERGY GROUP S.A. Bacau	Bacau	99 690	45 135	2 032	80	15 700	9	144 300	32 970	32 970
2	MODERN CALOR S.A. Botoşani	Botoșani	70 394	18 614	1 257	87	11 756	3	101 000	21 535	25 600
3	VEOLIA ENERGIE S.A. Iaşi	Iași	173 795	95 642	2 572	225	29 700	0	260 000	89 100	89 100
4	R.A.G.C.L. Paşcani	Iași	29	6	226	66	3 304	12	34 700	6 300	6 600
5	Servicii Comunale S.A. Rădăuţi	Suceava	43 650	4 600	-	45	4 740	35	22 950	8 134	8 441
6	Vatra Dornei Town Hall - D.A.D.P.	Suceava	7 560	9 240	167	66	2 188	6	17 292	3 409	2 795
7	TERMICA S.A. Suceava	Suceava	-	-	-	-	-	-	-	-	-
8	C.U.P. S.A. Bârlad	Vaslui	1 853	2	12	1	276	0	666	466	666
9	TERMPROD S.R.L. Vaslui	Vaslui	-	-	96	-	700	11		500	2 100
SOUTH-EAST DEVELOPMENT REGION (2)											

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-resident ial users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Number Total number of inhabitants benefiting of domestic hot water from SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
SE AGENCY TOTAL			886 668	108 304	14 303	1 209	172 940	-	598 277	331 658	414 755
1	R.A.M. Buzău	Buzău	111 200	30 300	1 306	55	14 900	6	115 500	46 000	45 000
2	WWE NEHOIU S.R.L. Nehoiu	Buzău	-	-	475	38	475	4	1 338	-	808
3	R.A.D.E.T. Constanţa	Constanța	603 972	65 916	4 680	440	69 029	8	297 000	182 569	182 569
4	UTILITĂŢI PUBLICE S.R.L. Cernavodă	Constanța	-	-	1 226	-	4 198	-	-	8 465	8 101
5	UZINA TERMOELECTRICĂ MIDIA S.A. Năvodari	Constanța	-	-	-	-	-	-	-	-	-
6	Năvodari Town Hall	Constanța	62 509	3 118	340	90	5 595	15	41 298	16 540	11 273
7	APOLLO ECOTERM S.A. Medgidia	Constanța	-	-	1 148	15	1 143	45	36 000	2 200	2 870
8	GOLDTERM S.A. Mangalia	Constanța	-	-	286	94	7 005	-	33 434	11 100	21 015
9	CALORGAL S.A. Galaţi	Galați	20	2	2 654	280	45 000	29	-	48 426	100 888
10	ENERGOTERM S.A. Tulcea	Tulcea	108 865	8 952	985	128	11 972	9	73 707	2 137	25 141
11	DUSPI SERV S.R.L. Panciu	Vrancea	2	2	3	5	218	0	-	30	468
12	ENET S.A. Focşani	Vrancea	100	13	1 200	64	13 405	0	-	14 191	16 622
SOUTH DEVELOPMENT REGION (3)											
S AGENCY TOTAL			530 751	108 521	6 644	434	87 231	-	357 064	185 005	201 759
1	TERMO CALOR CONFORT S.A. Pitești	Argeș	-	-	3 143	45	23 440	10	155 383	60 940	60 940

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-residential users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Number Total number of inhabitants benefiting of domestic hot water from the SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
2	Lehliu Gară Town hall - D.G.C.L.	Călăraşi	1 124	1 756	276	20	276	-	834	-	834
3	Călăraşi Town hall S.P. C.T. - A.F.L.	Călăraşi	2 746	235	34	1	414	8	64 000	790	698
4	TERMOURBAN S.R.L. Olteniţa	Călăraşi	8 624		180	-	1 200	63	23 000	2 132	2 556
5	GLOBAL ENERGY PRODUCTION S.A. Giurgiu	Giurgiu	40 000	17 500	712	145	5 363	36	47 479	237	12 710
6	VEOLIA ENERGIE PRAHOVA S.A. Ploieşti	Prahova	478 257	89 030	2 094	207	55 300	4	-	120 780	120 780
7	TERMIC CALOR SERV S.R.L. Alexandria	Teleorman	-	-	46	2	510	36	52 507	-	1 785
8	VEOLIA ENERGIE PRAHOVA S.A. - Otopeni	Ilfov	-	-	159	14	728	1	13 861	126	1 456

SOUTH-WEST DEVELOPMENT REGION (4)											
SW AGENCY TOTAL			474 195	109 721	8 505	1 264	126 921	-	560 941	285 849	287 639
1	TERMO CRAIOVA S.R.L. Craiova	Dolj	249	23	3 579	175	62 111	3	306 440	123 950	124 530
2	U.A.T.A.A. S.A. Motru	Gorj	56 271	7 017	42	388	6 084	2	22 848	12 599	12 599
3	Drobeta Turnu Severin City Hall - S.P.A.E.T.	Mehedinți	179 273	43 404	2 801	401	29 347	0	62 353	62 053	62 353
4	APĂ CANAL OLTEŢUL S.R.L. Balş	Olt	-	290	-	1	-	0	19 658	-	-
5	Olt	Town Hall	420	-	60	-	60	-	11 900	130	130

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-residential users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Number Total number of inhabitants benefiting of domestic hot water from the SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
	Drăgăneşti-Olt - D.G.C.L										
6	SACOMET S.A. Horezu	Vâlcea	1 400	800	15	15	280	7	6 750	-	910
7	C.E.T. Govora S.A. Râmnicu Vâlcea	Vâlcea	230 000	54 884	1 898	240	28 366	1	119 184	85 098	85 098
	C.E.T. Govora S.A. Râmnicu Vâlcea - Călimăneşti	Vâlcea	5 895	2 593	83	24	499	1	7 622	1 497	1 497
	C.E.T. Govora S.A. Râmnicu Vâlcea - Olăneşti	Vâlcea	686	710	27	20	174	9	4 186	522	522

WEST DEVELOPMENT REGION (5)											
W AGENCY TOTAL			331 191	109 893	11 074	1 699	106 780	-	630 238	196 551	266 173
1	C.E.T. HIDROCARBURI S.A. Arad	Arad	265 100	70 470	4 180	806	31 993	8	173 000	28 064	84 266
2	APOTERM S.A. Nădlac	Arad	-	-	28	33	78	0	7 300	-	-
3	COLTERM S.A. Timişoara	Timiș	325	77	4 094	440	62 500	10	319 279	150 000	150 000
4	COMPLEXUL ENERGETIC S.A. Hunedoara	Hunedoara	50 700	37 700	1 567	205	6 547	2	56 647	16 367	16 367
5	TERMOFICARE S.A. Petroşani	Hunedoara	-	-	491	193	2 470	0	33 650	2 120	6 274
6	UNIVERSAL EDIL S.A. Lupeni	Hunedoara	2 112	100	61	3	270	70	-	-	-
7	TERMOFICARE S.A. Vulcan	Hunedoara	-	-	478	11	500	9	24 160	-	2 000
8	TERMICA S.A. Brad	Hunedoara	12 954	1 546	175	8	2 422	2	16 202	-	7 266

NORTH-WEST DEVELOPMENT REGION (6)

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-residential users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Number Total number of inhabitants benefiting of domestic hot water from the SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
NW AGENCY TOTAL			17 500	1 000	8 942	2 071	92 738	-	20 300	221 501	221 281
1	R.A. TERMOFICARE Cluj-Napoca	Cluj	-	-	3 854	190	29 387	7	-	70 441	70 441
2	PAULOWNIA GREENE INT. S.R.L. Cluj-Napoca - Huedin	Cluj	-	-	-	-	352	-	9 800	860	860
3	TERMOFICARE S.A. Oradea	Bihor	-	-	5 088	1 858	60 820	0	-	146 300	146 300
4	TRANSGEX S.A. ORADEA - Oradea	Bihor	-	-	-	-	-	-	-	-	-
	TRANSGEX S.A. ORADEA - Beius	Bihor	17 500	1 000	-	23	2 179	0	10 500	3 900	3 680

CENTRE DEVELOPMENT REGION (7)											
CENTRE AGENCY TOTAL			111 001	30 704	3 344	463	22 650	-	408 487	51 631	55 854
1	ECOTERM S.A. Făgăraş	Brașov	6 535	6 363	122	19	1 884	20	30 000	1 296	4 710
2	TETKRON S.R.L. Brașov	Brașov	57 717	18 291	892	357	10 710	5	280 000	25 900	25 900
3	GOSCOM S.A. Miercurea Ciuc	Harghita	22 351	5 351	319	21	3 450	35	38 966	8 650	8 625
4	E-STAR CENTRUL DE DEZV. REG. S.R.L. Gheorgheni	Harghita	20	6	247	47	3 617	1	18 377	7 116	7 116
5	Vlăhiţa Town Hall	Harghita	-	-	45	-	312	0	744	-	744
6	URBANA S.A. Odorheiu Secuiesc	Harghita	14 000	500	280	5	2 087	8	35 000	6 500	6 500
7	APA TERMI	Mureș	-	-	-	-	-	-	-	-	-

Item No	Name of the operator	County	Contracted thermal input residential users	Contracted thermal input non-residential users	Number of thermal connections residential users	Number of thermal connections non-residential users	Number of flats connected to SACET	Flat disconnection from the SACET, as compared to 2013	Total number of inhabitants in the administrative unit	Number Total number of inhabitants benefiting of domestic hot water from the SACET	Total number of inhabitants benefiting of heating from the SACET
			MW/year	MW/year	-	-	-	%	-	-	-
	TRANSPORT S.A. Albeşti										
8	Copşa Mică Town hall - S.P.	Sibiu	882	-	30	-	-	0	5 400		90
9	URBANA S.A. Sibiu	Sibiu	3 696	193	769	14	-	0	-	769	769
10	URBAN-LOCATO S.R.L. Sfântu Gheorghe	Covasna	-	-	-	-	-	-	-	-	-
11	TERMO-ÎNTORSURA S.R.L. Întorsura Buzăului	Covasna	5 800	-	640	-	590	7	l0000	1 400	1 400

BUCHAREST											
1	R.A.D.E.T. Bucharest	Bucharest	2 817 224	300 820	10 727	5 032	563 326	0	0	1 230 000	1 230 000

Main district heating operators

The full list of the district heating operators in the alphabetical order of the counties is given in the table below.

Item No	County	District heating operators
1	Alba	No operators at present.
2	Arad	1. C.E.T. HIDROCARBURI S.A. Arad 2. APOTERM S.A. Nădlac
3	Argeș	3. TERMO CALOR CONFORT S.A. Pitești
4	Bacău	4. THERMOENERGY GROUP S.A. Bacău
5	Bihor	5. TERMOFICARE S.A. Oradea 6. TRANSGEX S.A. ORADEA for Oradea City and Beiuş Municipality
6	Bistrița-Năsăud	No operators at present.
7	Botoșani	7. MODERN CALOR S.A. Botoşani
8	Brașov	8. TETKRON S.R.L. Brașov 9. ECOTERM S.A. Făgăraş
9	Brăila	No operators at present.
10	Buzău	10. R.A.M. Buzău 11. WWE NEHOIU S.R.L.
11	Caraș-Severin	No operators at present.
12	Călărași	12. Călăraşi City Hall - S.P. C.T. - A.F.L. 13. TERMOURBAN S.R.L. Olteniţa 14. Lehliu Gară Town Hall - D.G.C.L.
13	Cluj	15. R.A. TERMOFICARE Cluj-Napoca 16. PAULOWNIA GREENE INTERNATIONAL S.R.L. Cluj-Napoca for Huedin Town
14	Constanța	17. R.A.D.E.T. Constanţa 18. UTILITĂŢI PUBLICE CERNAVODĂ S.R.L. 19. GOLDTERM MANGALIA S.A. 20. APOLLO ECOTERM S.A. Medgidia 21. Năvodari Town Hall 22. UZINA TERMOELECTRICĂ MIDIA S.A. Năvodari
15	Covasna	23. URBAN-LOCATO S.R.L. Sfântu Gheorghe 24. TERMO-ÎNTORSURA S.R.L. Întorsura Buzăului

Item No	County	District heating operators
16	Dâmbovița	No operators at present.
17	Dolj	25. TERMO CRAIOVA S.R.L.
18	Galați	26. CALORGAL S.A. Galaţi
19	Giurgiu	27. GLOBAL ENERGY PRODUCTION S.A. Giurgiu
20	Gorj	28. U.A.T.A.A. S.A. Motru
21	Harghita	29. GOSCOM S.A. Miercurea Ciuc 30. E-STAR CENTRUL DE DEZVOLTARE REGIONALA S.R.L. Gheorgheni 31. URBANA S.A. Odorheiu Secuiesc 32. Vlăhiţa Town Hall
22	Hunedoara	33. COMPLEXUL ENERGETIC HUNEDOARA S.A. 34. TERMICA BRAD S.A. 35. UNIVERSAL EDIL S.A. Lupeni 36. TERMOFICARE S.A. Petroşani 37. TERMOFICARE VULCAN S.A.
23	Ialomița	No operators at present.
24	Iași	38. VEOLIA ENERGIE S.A. Iaşi 39. R.A.G.C.L. Paşcani
25	Ilfov	40. VEOLIA ENERGIE PRAHOVA S.A. for Otopeni Municipality
26	Maramureș	No operators at present.
27	Mehedinți	41. Drobeta Turnu Severin City Hall - S.P.A.E.T.
28	Mureș	42. APA TERMIC TRANSPORT S.A. Albeşti
29	Neamț	No operators at present.
30	Olt	43. AQUA TRANS S.A. Balş 44. Drăgăneşti-Olt Town Hall - D.G.C.L.
31	Prahova	45. VEOLIA ENERGIE PRAHOVA S.A. Ploieşti
32	Satu Mare	No operators at present.
33	Sălaj	No operators at present.
34	Sibiu	46. URBANA S.A. Sibiu 47. Copşa Mică Town Hall - S.P.
35	Suceava	48. TERMICA S.A. Suceava 49. Servicii Comunale S.A. Rădăuţi 50. Vatra Dornei Town Hall - D.A.D.P.

Item No	County	District heating operators
36	Teleorman	51. TERMIC CALOR SERV S.R.L. Alexandria
37	Timiș	52. COMPANIA DE TERMOFICARE LOCALĂ "COLTERM" S.A. Timişoara
38	Tulcea	53. ENERGOTERM S.A. Tulcea
39	Vaslui	54. TERMPROD S.R.L. Vaslui 55. C.U.P. S.A. Bârlad
40	Vâlcea	56. C.E.T. Govora S.A. Râmnicu Vâlcea + Călimăneşti + Olăneşti 57. SACOMET S.A. Horezu
41	Vrancea	58. ENET S.A. Focşani 59. DUSPI SERV PANCIU S.R.L.
42	Bucharest City	60. R.A.D.E.T. Bucharest

District heating status in localities (2014)

Table 1 shows the existing district heating connection status in the main municipalities in Romania [1].

Table 1 Data on the district heating system in Romanian municipalities

Item No	Municipality	Apartments connected to the SACET		Connection (+), disconnection (-) in the period 2009 ÷ 2014	Population (census 2011)	Population served by the SACET 2014	SACET share in 2014
		2014	2009	%			%
1	**Bucharest**	564 440	569 768	-1	1 919 352	1 484 477	77
2	**Constanța**	83 184	86 822	-4	299 824	218 774	73
3	**Timișoara**	65 131	88 269	-26	307 561	171 295	56
4	**Oradea**	64 359	55 567	16	204 358	169 264	83
5	**Craiova**	62 792	67 531	-7	297 510	165 143	56
6	**Galați**	60 312	82 758	-27	287 046	158 621	55
7	**Ploiești**	60 063	59 985	0	225 636	157 966	70
8	**Iași**	37 082	57 906	-36	302 971	97 526	32
9	**Arad**	32 257	35 041	-8	164 208	84 836	52
10	**Cluj**	30 407	45 963	-34	301 913	79 970	26
11	**Dr. Turnu Severin**	29 364	28 899	2	105 232	77 227	73
12	**Rm. Vâlcea**	29 120	29 902	-3	110 697	76 586	69
13	**Pitești**	24 428	40 965	-40	165 733	64 246	39
14	**Suceava**	19 564	24 680	-21	106 682	51 453	48
15	**Bacău**	16 594	21 707	-24	174 182	43 642	25
16	**Buzău**	15 327	20 672	-26	130 320	40 310	31
17	**Focşani**	14 023	19 000	-26	97 714	36 880	38
18	**Tulcea**	12 744	14 790	-14	89 993	33 517	37
19	**Botoșani**	12 063	13 855	-13	114 799	31 726	28
20	**Brașov**	11 462	36 863	-69	275 901	30 145	11
21	**Năvodari**	8 690	10 285	-16	36 497	22 855	63
22	**Giurgiu**	7 151	15 540	-54	66 949	18 807	28
23	**Mangalia**	6 975	6 781	3	39 598	18 344	46
24	**Deva**	6 339	10 086	-37	65 998	16 672	25
25	**Motru**	6 194	6 516	-5	22 134	16 290	74
26	**Rădăuţi**	4 795	5 176	-7	29 523	12 611	43
27	**Cernavodă**	4 507	3 115	45	18 319	11 853	65
28	**Paşcani**	4 413	6 336	-30	42 072	11 606	28
29	**Miercurea Ciuc**	4 100	9 337	-56	41 166	10 783	26
30	**Gheorgheni**	3 617	3 572	1	19 601	9 513	49

Item No	Municipality	Apartments connected to the SACET		Connection (+), disconnection (-) in the period 2009 ÷ 2014	Population (census 2011)	Population served by the SACET 2014	SACET share in 2014
		2014	2009	%			%
31	**Piatra Neamţ**	2 580	12 149	-79	106 892	6 785	6
32	**Brad**	2 473	3 760	-34	15 506	6 504	42
33	**Petroşani**	2 453	2 430	1	41 947	6 451	15
34	**Olteniţa**	2 429	4 844	-50	26 923	6 388	24
35	**Odorheiu Secuiesc**	2 200	2 957	-26	36 277	5 786	16
36	**Vatra Dornei**	2 188	2 086	5	685 585	5 754	1
37	**Făgăraş**	1 940	4 705	-59	37 360	5 102	14
38	**Beiuş**	1 387	3 837	-64	11 096	3 648	33
39	**Medgidia**	1 140	3 746	-70	43 727	2 998	7
40	**Sânmartin**	861	859	0	9 572	2 264	24
41	**Sibiu**	784	1 389	-44	154 224	2 062	1
42	**Vaslui**	744	649	15	11 201	1 957	17
43	**Otopeni**	738	0	-	12 248	1 941	16
44	**Alexandria**	710	8 708	-92	48 754	1 867	4
45	**Lupeni**	676	2 384	-72	28 401	1 778	6
46	**Siret**	612	830	-26	16 353	1 610	10
47	**Întorsura Buzăului**	589	352	67	8 993	1 549	17
48	**Călimănești**	546	529	3	8 704	1 436	16
49	**Vulcan**	538	1 937	-72	27 998	1 415	5
50	**Călărași**	440	744	-41	72 754	1 157	2
51	**Nehoiu**	439	100	339	11 201	1 155	10
52	**Huedin**	325	344	-6	9 734	855	9
53	**Vlahița**	304	272	12	7 138	800	11
54	**Horezu**	282	267	6	6 661	742	11
55	**Lehliu Gară**	278	338	-18	6 347	731	12
56	**Bârlad**	276	204	35	68 585	726	1
57	**Sf. Gheorghe**	260	-	-	61 074	684	1
58	**Turnu Măgurele**	229	5 118	-96	27 872	602	2
59	**Bâscov**	206	490	-58	10 218	542	5
60	**Sighișoara**	204	204	0	31 803	537	2
61	**Băile Olănești**	188	261	-28	4 553	494	11
62	**Panciu**	185	-	-	8 582	487	6
63	**Nadlac**	179	194	-8	7 990	471	6
64	**Tasca**	126	109	16	9 216	331	4
65	**Măracineni**	122	145	-16	5 193	321	6
66	**Drăgănești Olt**	60	60	0	12 027	158	1

Item No	Municipality	Apartments connected to the SACET		Connection (+), disconnection (-) in the period 2009 ÷ 2014	Population (census 2011)	Population served by the SACET 2014	SACET share in 2014
		2014	2009	%			%
67	**Cristuru Secuiesc**	56	518	-89	10 223	147	1
68	**Lovrin**	54	73	-26	3 223	142	4
69	**Copșa Mică**	30	30	0	5 606	79	1
70	**Bals**	25	25	0	20 632	66	0

Annex 2 – Heat generation, prices

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-residential users	Heating non-residential users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
COUNTRY TOTAL			12 174 661	9 788 214	1 903 935	6 508 391	113 193	1 262 695	3 616	620
NORTH-EAST DEVELOPMENT REGION (1)										
NE AGENCY TOTAL			906 641	569 200	88 255	314 628	16 870	149 447	289.35	47.26
1	THERMOENERGY GROUP S.A. Bacău	Bacău	232 504	130 568	16 088	77 828	3 212	33 440	37.00	3.05
2	MODERN CALOR S.A. Botoşani	Botoșani	112 817	76 640	10 529	51 731	1 419	12 961	38.00	9.00
3	VEOLIA ENERGIE S.A. Iași	Iași	455 142	268 106	42 612	128 365	9 258	87 871	165.40	24.70
4	R.A.G.C.L. Paşcani	Iași	30 056	27 954	3 779	19 508	124	4 543	10.15	0.59
5	Servicii Comunale S.A. Rădăuţi	Suceava	49 388	45 438	12 782	28 561	260	3 835	24.00	6.00
6	Vatra Dornei Town Hall - D.A.D.P.	Suceava	25 551	17 956	2 041	6 526	2 597	6 792	12.00	2.80
7	TERMICA S.A. Suceava	Suceava	-	-	-	-	-	-	-	-
8	C.U.P. S.A. Bârlad	Vaslui	-	1 674	387	1 284	-	3	1.29	1.12
9	TERMPROD S.R.L. Vaslui	Vaslui	1 183	864	38	825	0	1	1.51	0.00
SOUTH-EAST DEVELOPMENT REGION (2)										

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-residential users	Heating non-residential users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
SE AGENCY TOTAL			469 787	1 263 498	167 829	955 629	7 204	132 836	444.47	84.12
1	R.A.M. Buzău	Buzău	185 200	117 003	8 775	83 189	234	24 805	45	6
2	WWE NEHOIU S.R.L. Nehoiu	Buzău	3 940	3 397		1 923		1 473	1.58	0.00
3	R.A.D.E.T. Constanţa	Constanța	18 018	521 041	87 495	384 698	2 909	45 939	-	-
4	UTILITĂŢI PUBLICE S.R.L. Cernavodă	Constanța	64 864	58 967	10 736	37 641	1 002	9 588	-	-
5	UZINA TERMOELECTRICĂ MIDIA S.A. Năvodari	Constanța	-	-	-	-	-	-	-	-
6	Năvodari Town Hall	Constanța	66 866	66 866	1 611	62 288	196	2 771	15.20	3.37
7	APOLLO ECOTERM S.A. Medgidia	Constanța	14 748	12 510	689	10 792	25	1 004	29.35	12.90
8	GOLDTERM S.A. Mangalia	Constanța	38 545	34 415	829	32 058	101	1 426	14.00	0.20
9	CALORGAL S.A. Galaţi	Galați	-	252 410	41 739	187 767	2 220	20 684	307.21	60.10
10	ENERGOTERM S.A. Tulcea	Tulcea	112 633	101 651	7 394	86 992	157	7 108	30.30	0.76
11	DUSPI SERV S.R.L. Panciu	Vrancea	1 140	1 140	30	556	0	554	0.79	0.00
12	ENET S.A. Focşani	Vrancea	149 033	94 098	8 531	67 724	360	17 483	46.04	6.79

SOUTH DEVELOPMENT REGION (3)										
S AGENCY TOTAL			1 033 342	756 857	136 530	504 031	4 734	111 563	336.63	46.76
1	TERMO CALOR CONFORT S.A. Pitești	Argeș	286 398	180 780	36 872	116 219	3 178	24 511	56.08	5.57
2	Călărași	Town Hall	2 121	2 119	-	1 011	-	1 108	4.50	-

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-residential users	Heating non-residential users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
	Lehliu Gară - D.G.C.L.									
3	Călăraşi City Hall - S.P. C.T. - A.F.L.	Călărași	7 284	3 617	562	2 838	7	210	0.70	0.20
4	TERMOURBAN S.R.L. Olteniţa	Călărași	21 335	18 954	3 300	15 654	-	-	15.65	7.99
5	GLOBAL ENERGY PRODUCTION S.A. Giurgiu	Giurgiu	45 610	59 077	102	42 698	-	16 277	45.00	-
6	VEOLIA ENERGIE PRAHOVA S.A. Ploiești	Prahova	657 721	483 981	95 694	318 076	1 549	68 662	213.00	33.00
7	TERMIC CALOR SERV S.R.L. Alexandria	Teleorman	376	260	-	251	-	8	1.70	-
8	VEOLIA ENERGIE PRAHOVA S.A. - Otopeni	Ilfov	12 497	8 070	-	7 283	-	787	-	-
SOUTH-WEST DEVELOPMENT REGION (4)										
SW AGENCY TOTAL			1 412 283	989 500	157 695	698 643	10 949	122 213	435.77	69.48
1	TERMO CRAIOVA S.R.L. Craiova	Dolj	548 966	423 151	75 159	320 413	5 240	22 339	255.05	39.06
2	U.A.T.A.A. S.A. Motru	Gorj	93 562	63 632	6 372	46 694	1 811	8 755	14.75	2.45
3	Drobeta Turnu Severin City Hall - S.P.A.E.T.	Mehedinți	355 070	226 982	34 328	148 912	1 506	42 236	52.16	7.72
4	APĂ CANAL OLTEŢUL S.R.L. Balş	Olt	242	223	-	-	-	223	2.50	-
5	Drăgăneşti-Olt Town Hall	Olt	353	353	63	290	-		0.21	0.01

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-resident ial users	Heating non-resident ial users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
	- D.G.C.L.									
6	SACOMET S.A. Horezu	Vâlcea	2 287	2 015	-	1 701	-	314	4.00	-
7	C.E.T. Govora S.A. Râmnicu Vâlcea	Vâlcea	410 202	264 188	40 790	175 518	2 039	45 841	101.00	18.00
	C.E.T. Govora S.A. Râmnicu Vâlcea - Călimăneşti	Vâlcea	-	7 400	796	4 262	305	2 037	4.70	1.54
	C.E.T. Govora S.A. Râmnicu Vâlcea - Olăneşti	Vâlcea	1 601	1 557	188	852	48	469	1.40	0.70

WEST DEVELOPMENT REGION (5)										
W AGENCY TOTAL			1 387 180	952 138	145 983	601 369	17 989	186 797	450.25	67.80
1	C.E.T. HIDROCARBURI S.A. Arad	Arad	390 028	259 879	44 997	159 982	4 779	50 121	107.00	29.00
2	APOTERM S.A. Nădlac	Arad	2 150	1 947	177	769	10	991	1.00	0.02
3	COLTERM S.A. Timişoara	Timiș	845 738	587 097	91 832	386 533	11 050	97 682	260.00	36.00
4	COMPLEXUL ENERGETIC S.A. Hunedoara	Hunedoara	130 406	58 375	8 157	25 387	951	23 879	18.57	2.40
5	TERMOFICARE S.A. Petroşani	Hunedoara	-	29 306	819	14 354	1 199	12 934	9.30	0.38
6	UNIVERSAL EDIL S.A. Lupeni	Hunedoara	-	6 033	-	5 856	-	177	44.38	-
7	TERMOFICARE S.A. Vulcan	Hunedoara	-	-	-	-	-	-	-	-
8	TERMICA S.A. Brad	Hunedoara	18 859	9 502	-	8 489	-	1 013	10.00	0.00

NORTH-WEST DEVELOPMENT REGION (6)										
AGENCY TOTAL			1 340 37	848 036	153 869	554 810	17 544	121 813	145.82	54.88

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-residential users	Heating non-residential users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
NW			5							
1	R.A. TERMOFICARE Cluj-Napoca	Cluj	369 799	223 336	49 472	164 245	593	9 026	119.00	49.00
2	PAULOWNIA GREENE INT. S.R.L. Cluj-Napoca - Huedin	Cluj	-	-	-	-	-	-	-	-
3	TERMOFICARE S.A. Oradea	Bihor	914 353	568 477	87 696	352 875	16 888	111 018	297.5	54.2
4	TRANSGEX S.A. Oradea - Oradea	Bihor	41 141	41 141	14 219	25 852	0	1 070	17.50	5.20
	TRANSGEX S.A. ORADEA - Beiuş	Bihor	15 082	15 082	2 482	11 838	63	699	9.32	0.68

CENTRE DEVELOPMENT REGION (7)										
CENTRE AGENCY TOTAL			165 219	175 391	30 763	110 331	2 427	31 869	117.66	15.10
1	ECOTERM S.A. Făgăraş	Brașov	18 219	15 801	1 051	6 898	1 039	6 813	14.48	1.40
2	TETKRON S.R.L. Brașov	Brașov	24 669	65 350	11 822	40 099	762	12 667	22.00	2.00
3	GOSCOM S.A. Miercurea Ciuc	Harghita	46 210	37 336	7 502	24 334	436	5 064	37.00	6.80
4	E-STAR CENTRUL DE DEZV. REG. S.R.L. Gheorgheni	Harghita	38 885	30 375	6 226	19 471	105	4 573	26.00	3.00
5	Vlăhiţa Town Hall	Harghita	6 179	4 293	-	4 293	-	-	1.90	0.70
6	URBANA S.A. Odorheiu Secuiesc	Harghita	20 481	13 121	1 855	10 810	76	380	11.20	0.70
7	APA TERMIC TRANSPORT S.A. Albeşti	Mureș	1 908	1 908	503	743	-	662	1.83	-

Item. No	Operator Name	County	Total heat generated	Total heat invoiced, of which:	Hot water residential users	Heating residential users	Hot water non-residential users	Heating non-residential users	Maximum hourly heat load required in the cold season	Maximum hourly heat load required outside the cold season
			Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/year	Gcal/h	Gcal/h
8	Copşa Mică Town Hall - S.P.	Sibiu	389	389		389	-	-	0.15	-
9	URBANA S.A. Sibiu	Sibiu	5 238	3 776	1 412	2 060	9	295	2.20	0.50
10	URBAN-LOCATO S.R.L. Sfântu Gheorghe	Covasna	3 041	3 041	393	1 234	-	1 415	-	-
11	TERMO-ÎNTORSURA S.R.L. Întorsura Buzăului	Covasna	-	-	-	-	-	-	0.90	-

BUCHAREST										
1	R.A.D.E.T. Bucharest	Bucharest	5 459 834	4 233 594	1 023 011	2 768 950	35 477	406 157	1 396	235

Data on the prices of the heat supplied through the SACET

Year 2014

Item No	Operator Name	County	Local price for heat supply	Local price of heat for the population
			lei / Gcal	lei / Gcal
COUNTRY TOTAL			-	-
NORTH-EAST DEVELOPMENT REGION (1)				
NE AGENCY TOTAL			-	-
1	THERMOENERGY GROUP S.A. Bacău	Bacău	315.4	124.87
2	MODERN CALOR S.A. Botoşani	Botoșani	379.18	170
3	VEOLIA ENERGIE S.A. Iaşi	Iași	328.41	265
4	R.A.G.C.L. Paşcani	Iași	322.26	265
5	Servicii Comunale S.A. Rădăuţi	Suceava	263.78	180
6	Vatra Dornei Town Hall - D.A.D.P.	Suceava	272.8	272.8
7	TERMICA S.A. Suceava	Suceava	-	-
8	C.U.P. S.A. Bârlad	Vaslui	315.63	198.72
9	TERMPROD S.R.L. Vaslui	Vaslui	451	180

SOUTH-EAST DEVELOPMENT REGION (2)				
SE AGENCY TOTAL			-	-
1	R.A.M. Buzău	Buzău	317.68	149.39
2	WWE NEHOIU S.R.L. Nehoiu	Buzău	207.27	207.27
3	R.A.D.E.T. Constanţa	Constanța	363.37	310
4	UTILITĂŢI PUBLICE S.R.L. Cernavodă	Constanța	97.31	91.11
5	UZINA TERMOELECTRICĂ MIDIA S.A. Năvodari	Constanța	-	-
6	Năvodari Town Hall	Constanța	276.13	186
7	APOLLO ECOTERM S.A. Medgidia	Constanța	370.31	234
8	GOLDTERM S.A. Mangalia	Constanța	426.04	200
9	CALORGAL S.A. Galaţi	Galați	327.42	200
10	ENERGOTERM S.A. Tulcea	Tulcea	349.9	172.23

Item No	Operator Name	County	Local price for heat supply	Local price of heat for the population
			lei/Gcal	lei/Gcal
11	DUSPI SERV S.R.L. Panciu	Vrancea	263	263
12	ENET S.A. Focşani	Vrancea	395.81	240

SOUTH DEVELOPMENT REGION (3)				
S AGENCY TOTAL			-	-
1	TERMO CALOR CONFORT S.A. Pitești	Argeș	394.96	397.59
2	Lehliu Gară Town Hall - D.G.C.L.	Călărași	338.33	304.5
3	Călăraşi City Hall - S.P. C.T. - A.F.L.	Călărași	354.62	212.77
4	TERMOURBAN S.R.L. Olteniţa	Călărași	332.83	299.55
5	GLOBAL ENERGY PRODUCTION S.A. Giurgiu	Giurgiu	399.23	299.23
6	VEOLIA ENERGIE PRAHOVA S.A. Ploieşti	Prahova	222.1	186.97
7	TERMIC CALOR SERV S.R.L. Alexandria	Teleorman	356.88	356.88
8	VEOLIA ENERGIE PRAHOVA S.A. - Otopeni	Ilfov	400.8	90.32

SOUTH-WEST DEVELOPMENT REGION (4)				
SW AGENCY TOTAL			-	-
1	TERMO CRAIOVA S.R.L. Craiova	Dolj	253.72	220.5
2	U.A.T.A.A. S.A. Motru	Gorj	189.1	160
3	Drobeta Turnu Severin City Hall - S.P.A.E.T.	Mehedinți	227.2	199.65
4	APĂ CANAL OLTEŢUL S.R.L. Balş	Olt	357.88	-
5	Drăgăneşti-Olt Town Hall - D.G.C.L.	Olt	236.7	236.7
6	SACOMET S.A. Horezu	Vâlcea	353.4	285
7	C.E.T. Govora S.A. Râmnicu Vâlcea	Vâlcea	272.48	201.62
	C.E.T. Govora S.A. Râmnicu Vâlcea - Călimăneşti	Vilcea	184.72	132.86
	C.E.T. Govora S.A. Râmnicu Vâlcea - Olăneşti	Vâlcea	353.46	276.89

WEST DEVELOPMENT REGION (5)				
W AGENCY TOTAL			-	-
1	C.E.T. HIDROCARBURI S.A. Arad	Arad	307.42	290
2	APOTERM S.A. Nădlac	Arad	275	275

Item No	Operator Name	County	Local price for heat supply	Local price of heat for the population
			lei/Gcal	lei/Gcal
3	COLTERM S.A. Timişoara	Timiș	377.88	252.17
4	COMPLEXUL ENERGETIC S.A. Hunedoara	Hunedoara	243.16	178.17
5	TERMOFICARE S.A. Petroşani	Hunedoara	240.8	172.72
6	UNIVERSAL EDIL S.A. Lupeni	Hunedoara	226.15	226.15
7	TERMOFICARE S.A. Vulcan	Hunedoara	234.91	192.68
8	TERMICA S.A. Brad	Hunedoara	896.84	295

NORTH-WEST DEVELOPMENT REGION (6)				
NW AGENCY TOTAL			-	-
1	R.A. TERMOFICARE Cluj-Napoca	Cluj	351	165
2	PAULOWNIA GREENE INT. S.R.L. Cluj-Napoca - Huedin	Cluj	-	-
3	TERMOFICARE S.A. Oradea	Bihor	263.76	240
4	TRANSGEX S.A. ORADEA - Oradea	Bihor	82.04	-
	TRANSGEX S.A. ORADEA - Beiuş	Bihor	80.81	80.81

CENTRE DEVELOPMENT REGION (7)				
CENTRE AGENCY TOTAL			-	-
1	ECOTERM S.A. Făgăraş	Brașov	302.66	252.73
2	TETKRON S.R.L. Brașov	Brașov	515.68	200
3	GOSCOM S.A. Miercurea Ciuc	Harghita	386.32	304.54
4	E-STAR CENTRUL DE DEZV. REG. S.R.L. Gheorgheni	Harghita	305.28	354.66
5	Vlăhiţa Town Hall	Harghita	135.46	135.46
6	URBANA S.A. Odorheiu Secuiesc	Harghita	485.57	240
7	APA TERMIC TRANSPORT S.A. Albeşti	Mureș	357.15	357.15
8	Copşa Mică Town Hall - S.P.	Sibiu	204.79	130
9	URBANA S.A. Sibiu	Sibiu	388.85	265.34
10	URBAN-LOCATO S.R.L. Sfântu Gheorghe	Covasna	308.41	308.41
11	TERMO-ÎNTORSURA S.R.L. Întorsura Buzăului	Covasna	79.56	-

BUCHAREST				
1	R.A.D.E.T. Bucharest	Bucharest	408.33	169.88

Annex 3 – Heat demand

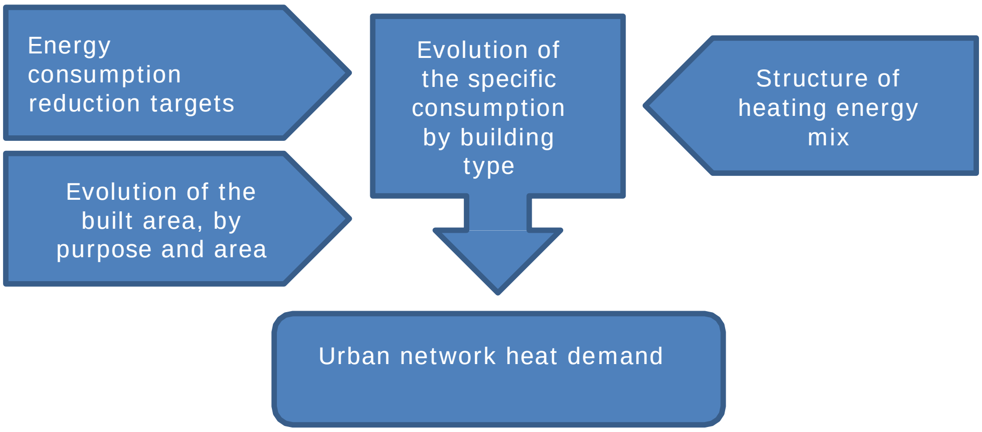
The heat demand is the basis for drawing up the scenarios.

The measures for energy efficiency in buildings practically develop irrespectively of the heating source, under the pressure of energy prices, of the wish for comfort (for example, reduction in air currents, in temperature spatial variation, increase in heated area, etc.) and of the decarbonisation targets.

Consequently, the evolution of the heat demand is assessed by building type and heating source, and it is considered to be the same in all scenarios. Actually, the following data result from processing information from the recent strategic documents dealing with energy efficiency in buildings. The purpose of the processing is to determine the district heating (SACET) consumption trends, which is the main variable in assessing the efficient heating/cooling potential.

1. Methodology

According to the graph below, choosing an evolution scenario for energy efficiency in buildings and for the energy mix used for heat supply helps to evaluate the district heating demand.



2. Assumptions and sources

The scenario chosen for the evolution of building energy efficiency is MDRAP PS2. The scenario refers to energy consumption reduction targets as in PNAEE 2014, except for the non-residential sector where PNAEE 2014 values are extremely conservatively, although this sector is more likely to improve its energy efficiency due to the concern of commercial building owners of cutting their service charges.

TJ	2014	2015	2016	2017	2018	2019	2020
Residential							
Savings PS2	1 160	2 320	3 481	4 641	5 801	6 961	8 121
Savings PNAEE	1 800	3 642	4 898	6 112	6 572	7 074	7 577
Non-residential							
Savings PS2	619	1 238	1 857	2 475	3 094	3 713	4 332
Savings PNAEE	126	167	167	167	167	167	167

According to the scenario, the energy demand for heating is reduced by 5.1 % in 2020 and by 17.2 % in 2030 as compared to reference year 2008. The decrease in energy consumption in 2013 is 1 %.

Benchmark 2008	305 096 TJ		
% / TJ	**2013**	**2020**	**2030**
PS2	-1.0%	-5.1%	-17.2%
Heat demand	301 990	289 536	252 620

The structure of the heat energy mix in 2013 corresponds to the statistical data for the final consumption, and it is the following for 2020 and 2030:

Consumption structure	**2013**	**2020**	**2030**
Residential			
Thermal energy	14.7%	8.3%	11.9%
Natural gas	33.9%	40.0%	35.0%
Renewable sources	50.8%	50.0%	50.0%
Electricity	0.2%	1.5%	3.0%
Other sources	0.4%	0.2%	0.1%
Non-residential			
Thermal energy	21.2%	30.5%	41.0%
Natural gas	63.4%	50.0%	30.0%
Renewable sources	1.3%	2.5%	6.5%
Electricity	6.5%	12.0%	19.0%
Other sources	7.6%	5.0%	3.5%
Total			
Thermal energy	15.7%	11.4%	16.3%
Natural gas	38.2%	41.4%	34.2%
Renewable sources	43.6%	43.5%	43.4%
Electricity	1.1%	2.9%	5.4%
Other sources	1.5%	0.9%	0.6%

Source: 2013 – Energy balance, INS; 2020, 2030 – MDRAP PS2

The variation between the values of the residential/non-residential mix in 2013, 2020 and 2030 is linear. The total mix results after determination of consume as absolute value.

The area built in the residential sector increases by a constant value of 0.7 % of the built area existing in 2013. It is a conservative value justified by the demographic evolution, the comfort level and the housing occupancy rate (MDRAP).

The area built in the non-residential sector is evaluated at horizon 2020 and 2030 based on the specialised forecast of real estate developers and of the real estate companies.

km^2	**2013**	**2020**	**2030**

Built area	493	517.8	569.0
Residential	**425.8**	**446.7**	**476.5**
Non-residential	**67.2**	**71.1**	**92.5**
Offices	11.0	12	18
Education	11.4	11	11
Hospitals	9.3	9.5	10
Hotel	5.2	6.2	10
Sports	4.7	4.8	5.5
Commercial	18.3	20	30
Other	7.5	7.6	8

The variation of the built area in the non-residential sector is linear between the time benchmarks in the table above.

The scenario implies a decrease in the *specific consumption for heating* by aligning old residential buildings to efficiency standards imposing a restoration rate of 1.5 % per year by 2020 and of 2.7 % per year from 2021 until 2030.

The restoration rate of non-residential buildings is 3 % per year. The

consumption standards are:

- residential buildings 289 MJ/m$^{2/year}$ until 2020 and 204.7 MJ/m$^{2/year}$ after 2020
- non-residential buildings 275 MJ/m$^{2/year}$

The evolution of specific consumers is shown in the table below:

MJ/m$^{2/year}$	**2013**	**2020**	**2030**
Residential	**605**	**559**	**450**
Non-residential	**658**	**561**	**411**
Offices	360	336	300
Education	1 274	1 090	781
Hospitals	900	757	559
Hotel	381	345	302
Sports	381	357	320
Commercial	381	352	307
Other	900	760	561
Average specific consumption	*613*	*559*	*444*
Average specific consumption in new		*287*	*240*

3. Evolution in energy demand for heating

The data above reveal the following values of energy consumed for heating, by building type and energy source:

TJ	**2013**	**2020**	**2030**
Residential			
Total consumption for heating	*257 774*	*249 653*	*214 572*
Thermal energy	38 010	20 721	25 534
Natural gas	87 287	99 861	75 100
Renewable sources	130 998	124 826	107 286
Electricity	430	3 745	6 437

Other sources	1 050	499	215
Non-residential			
Total consumption for heating	*44 216*	*39 884*	*38 048*
Thermal energy	9 366	12 164	15 600
Natural gas	28 025	19 942	11 414
Renewable sources	588	997	2 473
Electricity	2 877	4 786	7 229
Other sources	3 360	1 994	1 332

Annex 4 – Renewable sources

1. Energy potential of biomass in Romania

1.1. Methodology

Further to detailed analysis on various relevant documents concerning the energy potential of biomass in Romania, a selection of documents has been made. The documents are public and have been selected from various specialised websites. They have been selected based on relevance and topicality.

1.2. Sources

The basic document is the Action plan for bioenergy/biomass for the Centre Region for 2014-2020, drawn up by PROMO BIO in cooperation with Intelligent Energy Europe 1 January 2014.

http://www.adrcentru.ro/Document_Files/ADDocumentePlanificare/00001655/4ufi7_Plan_bioenergie_Regiunea%20Centru_2014.pdf

2. Potential of heat generation from geothermal sources in Romania

2.1. Methodology

Further to detailed analysis on various relevant documents concerning the energy potential of biomass in Romania, a selection of documents has been made. The documents are public and have been selected from various specialised websites. They have been selected based on relevance and topicality.

2.2. Sources

The basic document is 'STRATEGO Enhanced heating&cooling plans- Creating National Energy Models for 2010 and 2050', drawn up by David Connolly, Kenneth Hansen, David Drysdale of Aalborg University Denmark. This is a project supported by the European Union – Intelligent Energy Europe Programme.

STRATEGO Website: http://stratego-project.eu

Heat Roadmap Europe Website: http://www.heatroadmap.eu

Online Maps: http://maps.heatroadmap.eu

Annex 5 – Cogeneration potential

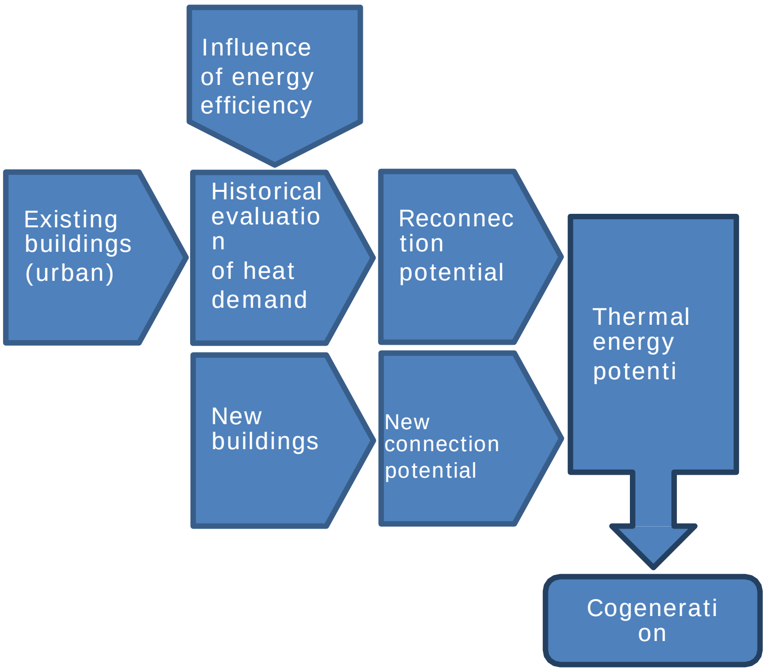
Only the buildings from the urban area were taken into account in order to determine the cogeneration heating potential.

District heating in the rural area might become relevant after horizon 2030 and only if the migration towards the urban areas is reversed. A potential increase in the cogeneration capacity in the rural areas may be connected in particular with agriculture industrialisation processes and with electricity production from biomass, which makes area heating appear a secondary, limited and incidental issue.

1. Methodology

The district heating potential is seen as made up of two components:

- potential from reconnection
- potential from new connection



Taking into account the major contribution of natural gas to ensuring urban heating, efficient heating is considered to mean, at least at horizon 2030, the replacement of natural gas with high-efficiency cogeneration heat. In other words, cogeneration share as defined in Law No 121/2014 should be 75 %.

2. Assumptions and sources

INS TEMPO data series are the historical data source on heat consumption.

3. Potential from reconnection

The data on several important cities where the district heating system has survived without significant disconnection and has even developed (Bucharest, Constanța, Oradea, Ploiești, Râmnicu Vâlcea) suggest that heat demand represents 50 % as compared to the demand in the period 1993-1995, probably as a result of energy efficiency measures (in terms of investments and behaviour) adopted by the subscribers. The demand includes the new buildings built until 2000, when disconnection frequency increased.

Starting from this finding, we consider that *the district heating potential* from reconnection is 50 % from the average consumption in the period 1993-1995.

The commercial building stock was expected to be more dynamic than the residential stock. However, heating consumption in the non-residential sector has been maintained at a constant share of 20 % from total. This reveals a potential certain inertia in relation with changing the heating source in minimally or not at all refurbished buildings. The fact that very few new commercial buildings have been connected to the district heating system has however a more significant consequence.

The building stock that may be reconnected is considered to be constant, but the consumption potential changes during the analysed period in order to take account of the evolution of the specific energy consumption resulting from refurbishments.

4. Potential from new connection

According to the TEMPO data series, the number of urban housings increased by 16 % in the period 1995-2013, while the living area increased by 60 %, which means an average increase in the living area of 39 %. This is mainly due to the restoration of already existing single-family housings and to the development of suburban single-family housing districts. Subject to potential reconfigurations of existing blocks of flats, for which there are no statistical data, the increase in living area occurred elsewhere, and it thus represents new connection potential. It is useful to point out that urban developments after 2000 are relatively compact, with building ratios above 0.3, and thus appropriate for district heating.

Urban living area increased by 68.4 km^2 in the period 2001-2013, with specific consumption of at least 289 MJ/m^2/year, namely a heat demand of 19 768 TJ. A quantity of 4 237 TJ of this is covered by operational district heating systems (according to improper ratios of potential achievement in several towns).

Although the area of commercial buildings has increased significantly, the potential of connection to district heating of the areas built in the last 15 years is limited by the technologies used for air treatment. They are not adapted to the operation on the thermal agent used in the district heating network, are very efficient in case of combined gas/electricity operation and are relatively inexpensive. Consequently, the cogeneration potential may only be considered in case of replacement of the facilities (at the end of their life cycle), somewhere at the end of the analysed period or beyond it.

The heat supply potential for the newly built commercial buildings may be evaluated in a context of generalisation of absorption chillers or of trigeneration. This is a real potential, whose chance of achievement is higher as the increase in the price of natural gas in the distribution network is quicker.

Besides, there is the potential generated by the new residential buildings built during the forecast period.

5. Potential of district heating, total and from reconnection

Macroregion, development regions and counties	consumption	Reconnection potential all consumers		consumption	Reconnection potential residential		Reconnection potential all consumers				Potential all new	
Year	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2015**	**2020**	**2025**	**2030**	**2013**	**2**
MU	**TJ**	**TJ**	**%**	**TJ**	**TJ**	**%**	**TJ**	**TJ**	**TJ**	**TJ**	**TJ**	
TOTAL	**44 805**	**72 655**	**62%**	**35 543**	**58 696**	**61%**	**70 785**	**66 328**	**59 178**	**52 666**	**88 395**	**86**
MACROREG. I	**4 926**	**17 889**	**28%**	**3 297**	**15 489**	**21%**	**17 428**	**16 332**	**14 571**	**12 966**	**22 953**	**22**
NORTH-WEST	*3 508*	*8 962*	*39%*	*2 688*	*7 589*	*35%*	*8 732*	*8 182*	*7 300*	*6 496*	*11 610*	*11*
Bihor	2 473	2 272	109%	1 784	1 764	101%	2 214	2 074	1 851	1 647	2 564	2
Bistrița-Năsăud	0	1 047	0%	0	793	0%	1 020	956	853	759	1 269	1
Cluj	943	3 331	28%	899	3 157	28%	3 245	3 041	2 713	2 414	4 358	4
Maramureș	15	1 394	1%	2	1 088	0%	1 358	1 272	1 135	1 010	1 959	1
Satu Mare	0	454	0%	0	408	0%	442	414	369	329	847	
Sălaj	77	465	16%	4	379	1%	453	425	379	337	613	
CENTER	*1 418*	*8 927*	*16%*	*609*	*7 900*	*8%*	*8 696*	*8 150*	*7 271*	*6 470*	*11 343*	*11*
Alba	0	907	0%	0	731	0%	884	828	739	657	1 269	1
Brașov	929	2 746	34%	251	2 493	10%	2 675	2 507	2 237	1 990	3 513	3
Covasna	24	886	3%	14	693	2%	864	809	722	643	1 036	1
Harghita	363	841	43%	308	753	41%	819	768	685	610	1 010	
Mureș	33	2 018	2%	20	1 812	1%	1 966	1 843	1 644	1 463	2 488	2
Sibiu County	68	1 528	4%	16	1 420	1%	1 488	1 395	1 244	1 107	2 026	2
MACROREG. II	**8 489**	**16 837**	**50%**	**7 051**	**14 151**	**50%**	**16 404**	**15 370**	**13 714**	**12 206**	**21 090**	**20**
NORTH-EAST	*3 165*	*9 142*	*35%*	*2 318*	*7 498*	*31%*	*8 907*	*8 345*	*7 446*	*6 628*	*11 627*	*11*
Bacău	564	2 159	26%	409	1 853	22%	2 103	1 971	1 758	1 565	2 489	2
Botoșani	321	871	37%	261	648	40%	849	795	710	632	1 207	1
Iași	1 257	2 616	48%	831	2 356	35%	2 549	2 388	2 131	1 896	3 201	3
Neamț	57	1 190	5%	44	790	6%	1 159	1 086	969	863	1 538	1
Suceava	933	1 708	55%	741	1 350	55%	1 664	1 559	1 391	1 238	2 436	2
Vaslui	33	598	6%	33	499	7%	583	546	487	434	756	
SOUTH-EAST	*5 323*	*7 695*	*69%*	*4 733*	*6 653*	*71%*	*7 497*	*7 025*	*6 268*	*5 578*	*9 463*	*9*
Brăila	40	1 461	3%	24	1 184	2%	1 424	1 334	1 190	1 059	1 545	1
Buzău	512	772	66%	416	680	61%	752	705	629	560	1 075	1
Constanța	2 884	2 562	113%	2 610	2 293	114%	2 496	2 339	2 087	1 857	3 401	3
Galați	1 063	1 718	62%	965	1 521	63%	1 673	1 568	1 399	1 245	2 082	2
Tulcea	426	377	113%	396	307	129%	367	344	307	273	373	
Vrancea	398	805	49%	321	666	48%	785	735	656	584	987	
MACROREG. III	**23 128**	**23 978**	**96%**	**18 432**	**18 026**	**102%**	**23 362**	**21 890**	**19 530**	**17 381**	**27 602**	**26**
SOUTH-MUNTENIA	*5 388*	*6 481*	*83%*	*2 536*	*5 594*	*45%*	*6 315*	*5 916*	*5 279*	*4 698*	*6 168*	*6*
Argeș	773	1 809	43%	654	1 575	42%	1 763	1 652	1 474	1 312	2 368	2
Călărași	103	554	19%	94	469	20%	540	506	451	401	674	
Dâmbovița	54	551	10%	22	472	5%	537	503	449	399	777	
Giurgiu	127	385	33%	91	351	26%	375	352	314	279	482	
Ialomița	0	541	0%	0	449	0%	527	493	440	392	825	
Prahova	4 324	1 987	218%	1 670	1 820	92%	1 936	1 814	1 619	1 441	231	
Teleorman	6	653	1%	5	458	1%	637	596	532	474	811	
Bucharest - Ilfov	*17 740*	*17 498*	*101%*	*15 896*	*12 431*	*128%*	*17 047*	*15 974*	*14 251*	*12 683*	*21 433*	*20*
MACROREG. IV	**8 263**	**13 951**	**59%**	**6 763**	**11 031**	**61%**	**13 591**	**12 736**	**11 363**	**10 113**	**16 750**	**16**

Macroregion, development regions and counties	consumption	Reconnection potential all consumers		consumption	Reconnection potential residential		Reconnection potential all consumers				Potential all new	
Year	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2015**	**2020**	**2025**	**2030**	**2013**	**2**
MU	**TJ**	**TJ**	**%**	**TJ**	**TJ**	**%**	**TJ**	**TJ**	**TJ**	**TJ**	**TJ**	
SOUTH-WEST	*4 201*	*4 609*	*91%*	*3 557*	*3 844*	*93%*	*4 489*	*4 207*	*3 754*	*3 341*	*5 383*	*5*
Dolj	1 771	1 824	97%	1 656	1 651	100%	1 777	1 665	1 486	1 322	2 456	2
Gorj	246	807	30%	197	559	35%	786	736	657	585	1 112	1
Mehedinți	949	335	283%	767	292	262%	326	306	273	243	-199	-
Olt	2	673	0%	0	517	0%	655	614	548	488	1 007	
Vâlcea	1 233	970	127%	937	825	114%	945	886	790	703	1 007	1
WEST	*4 062*	*9 342*	*43%*	*3 206*	*7 187*	*45%*	*9 102*	*8 529*	*7 609*	*6 772*	*11 367*	*11*
Arad	1 036	1 586	65%	871	1 215	72%	1 545	1 448	1 292	1 150	2 144	2
Caraș-Severin	95	1 219	8%	29	1 041	3%	1 188	1 113	993	884	1 472	1
Hunedoara	459	2 569	18%	292	2 029	14%	2 503	2 345	2 092	1 862	2 891	2
Timis	2 472	3 968	62%	2 014	2 903	69%	3 866	3 623	3 232	2 876	4 859	4

6. Cogeneration potential

Cogeneration coverage of 75 % of the total district heating potential means a net cogeneration potential (evaluated at consumer level) having the values in the table below.

Macroregions, development regions and counties	2013	2015	2020	2025	2030
MU	**TJ**	**TJ**	**TJ**	**TJ**	**TJ**
TOTAL	**65 360**	**64 833**	**63 679**	**61 722**	**60 248**
MACROREGION I	**17 215**	**17 136**	**16 982**	**16 700**	**16 536**
NORTH-WEST Region	*8 708*	*8 671*	*8 599*	*8 468*	*8 397*
Bihor	1 923	1 898	1 841	1 748	1 669
Bistrița-Năsăud	952	950	947	939	939
Cluj	3 269	3 258	3 240	3 204	3 189
Maramureș	1 469	1 468	1 467	1 463	1 469
Satu Mare	636	640	650	666	685
Sălaj	459	458	454	448	444
CENTRE Region	*8 507*	*8 465*	*8 383*	*8 231*	*8 139*
Alba	952	953	957	960	969
Brașov	2 635	2 643	2 669	2 703	2 754
Covasna	777	765	736	690	649
Harghita	757	748	727	693	664
Mureș	1 866	1 842	1 788	1 699	1 623
Sibiu	1 519	1 514	1 505	1 487	1 478
MACROREGION II	**15 817**	**15 678**	**15 362**	**14 836**	**14 424**
NORTH-EAST Region	*8 720*	*8 641*	*8 460*	*8 160*	*7 923*
Bacău	1 867	1 836	1 764	1 645	1 542
Botoșani	905	898	881	853	831
Iași	2 401	2 371	2 302	2 191	2 096
Neamț	1 153	1 137	1 099	1 038	986
Suceava	1 827	1 835	1 856	1 887	1 929
Vaslui	567	564	557	545	538
SOUTH-EAST Region	*7 097*	*7 037*	*6 902*	*6 676*	*6 501*
Brăila	1 159	1 139	1 091	1 014	947
Buzău	806	796	773	735	703
Constanța	2 551	2 562	2 596	2 644	2 707
Galați	1 561	1 535	1 474	1 375	1 287
Tulcea	280	275	262	243	225
Vrancea	740	730	705	666	631
MACROREGION III	19 765	19 596	19 228	18 601	18 134
SOUTH-MUNTENIA Region	*4 626*	*4 567*	*4 434*	*4 213*	*4 035*
Argeș	1 776	1 762	1 730	1 675	1 632
Călărași	505	498	478	448	421
Dâmbovița	583	580	574	564	556
Giurgiu	361	357	351	338	327
Ialomița	618	620	626	634	646
Prahova	174	151	98	13	-59
Teleorman	608	599	577	542	511
Bucharest - Ilfov Region	*15 139*	*15 029*	*14 794*	*14 388*	*14 100*

Macroregions, development regions and counties	2013	2015	2020	2025	2030
MACROREGION IV	12 563	12 423	12 107	11 585	11 154
SOUTH-WEST OLTENIA Region	*4 037*	*3 999*	*3 915*	*3 776*	*3 666*
Dolj	1 842	1 822	1 775	1 700	1 636
Gorj	834	828	816	794	778
Mehedinți	-149	-148	-144	-138	-129
Olt	755	745	720	681	646
Vâlcea	755	752	749	739	736
WEST REGION	*8 525*	*8 425*	*8 192*	*7 809*	*7 487*
Arad	1 608	1 604	1 596	1 580	1 575
Caraș-Severin	1 104	1 086	1 043	973	911
Hunedoara	2 169	2 134	2 052	1 919	1 803
Timiș	3 644	3 601	3 501	3 337	3 198

The net cogeneration heat production (after subtraction of network leaks) in 2013 was approximately 35.5 PJ, which implies a potential achievement level of 54 %.