Increasing energy efficiency in accordance to energy efficiency 2012/27/eu directive to decrease energy consumption for a final energy end user

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INCREASING ENERGY EFFICIENCY IN ACCORDANCE TO ENERGY EFFICIENCY 2012/27/EU DIRECTIVE TO DECREASE ENERGY CONSUMPTION FOR A FINAL ENERGY END USER

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ABSTRACT

As the energy consumption increases, the energy efficiency measures must be found and implemented. 2012/27/EU Energy efficiency Directive aims the targets to decrease energy consumption for a final energy consumer by 1,5 % annually, but do not defines how these targets can be achieved by member state. Article presents the analysis how these targets can be reached by the means of individual heat metering for every flat decreasing energy consumption for a final consumer. Statistical analysis of identical buildings with heat cost allocators and without them is presented. Heat cost allocator do not decrease energy consumption by itself, so this article presents a technical solution and a set of additional equipment as thermostatic valves, balance valves, hot water meters and remote system must be installed. The final results shows that the targets of 2012/27/EU Energy efficiency Directive can be reached as the buildings with individual heat cost allocators consumes about 20-30 % less of heat energy.

Keywords: energy efficiency, heat meters, heat cost allocators, 2012/27/EU Energy Efficiency Directive, buildings

1. The final customer and energy efficiency

While world fuel prices takes the high places and global warming still increasing, the attention is paid not to how extract ever greater amounts of energy, but how to use in more efficient way extracted primary energy. The European Union is not indifferent for this problem and to increase the efficiency of primary energy use, the European Parliament and of the Council on 25 October 2012 has approved the 2012/27/EU energy efficiency Directive which replaces Directives 2009/125/EC and 2010/30/EU and repealing Directive 2004/8/EC and 2006/32/EC. It aims to oblige Member States to introduce the energy sector to improve energy efficiency measures to help ensure the most effective use of produced energy.

In Lithuania energy efficiency problem is more acute. It shows that for heat energy a statistical Lithuanian resident spends a considerably higher part of income than in other European countries, so it can be concluded that the group of heat energy consumers is financially the most sensitive group of all consumers. This group of users shares into two large segments - living in private houses and multi-apartment residential buildings. As a private house has the possibility to select free the type of fuel and do not have a necessity to heat by expensive gas, can keep the desired temperature comfort level according to their income level, decrease temperature for the night, weekend or other desired time period of day, the multi-apartment residential buildings do not have such flexible options. In order to optimize the expenses for heat energy in residential buildings, in particular, reduction is possible in two main dimensions: the price of heat and amount of consumed heat. As practice shows, the heat price can be reduced by changing the structure of the balance of used fuel, i.e. reducing the use of expensive gas and increasing the use of local biofuel. In this case we have two main benefits: a) reduction of expenses for heating; b) instead of buying expensive imported fuel buying much cheaper local fuel, the expended money for these fuels remains within the country limits and does not goes out of the of Lithuania borders, that positively contributes to the economic welfare of the whole Lithuania. Municipalities which use the potential of local biofuel in most intensive way, have a heat price range of 5-7 € cents/kWh and the municipalities for heating using natural gas has from 7 to 10 cents/kWh ranging price. Comparing the lowest 5 cents/kWh local biofuel and the highest 10 cents/kWh natural gas price, the difference is almost double.

Reduction of the amount for heat energy is much more complex task. This task is more complex not from the point of view of technical or engineering solutions, but taking a look from our country's legal framework, which precisely and unequivocally does not names the entities responsible for the heat consumption in buildings. However, this legal framework was made by the European Parliament by Efficiency Directive, which aims energy distributors and

retail energy sales companies to a goal to get for end-consumers annual new energy savings equivalent to 1,5%. That must be done from 1 January 2014 to 31 December 2020 [2].

2. Introducing the main targets of energy efficiency directive 2012/27/EU for a centralised heat supply sector

European Union is facing increased volume of imported energy resources, limited energy resources, climate change and the economic crisis. This leads to draw extra attention to energy efficiency, because the reduction of primary energy consumption directly reduces dependence on imported energy resources and increases energy security. Development of energy-efficient economics is conducive to innovative technological solutions and enhances the European Union's industrial competitiveness, promotes economic growth and creation of a skilled workforce.

Great attention is paid to improve energy efficiency in the public sector. Even higher targets and obligations are provided for in order to enable the end user itself regulate his energy consumption, as buildings are responsible for 40% of total EU final energy consumption [2].

Section 7 of Energy efficiency directive 2012/27/EU states that until 31 December 2020 must be reached a final energy consumption savings target to save annually 1,5 % of end-user energy [2]. The aim is to ensure that all energy distributors and/or retail energy sales companies, as designated by obligated parties, from 1 January of 2014 until 31 December 2020 each year must save the new amount of energy equivalent to 1,5 % of end user energy [2].

Section 9 of Energy efficiency directive 2012/27/EU states that in multi-apartment and multi-purpose buildings supplied from a district heating network individual consumption meters shall be installed by 31 December 2016 to measure the consumption of heat or hot water for each unit where technically feasible and is cost-efficient [2]. Where the use of individual meters is not technically feasible or not cost-efficient, to measure heating, individual heat cost allocators shall be used for measuring heat consumption at each radiator.

Section 10 obligates that invoicing must be based on actual consumption. The final customer must be able to make a comparison of energy consumption during the current period and the same period of the last year. Preferably it has to be done in graphic form. For a final customer provided information must be accurate and based on actual consumption. This obligation can be met by regular self-reading system that allows communicate readings from consumer meter to the energy supplier. Final customer must be able easily to obtain additional information on the previous consumption, which would allow for the same end-user to make a detailed self-control.

Information on historical consumption must include cumulative data for at least the three previous years. The data shall include detailed data according to the time of use for any day, week, month and year and shall be made available to the final customer via the internet or the meter interface for the period of at least the previous 24 months. For a final customer must be offered the option of electronic billing information, a clear and understandable explanation of how their bill was derived.

3. Methodology for an actual energy consumption evaluation

In order to assess not theoretical but actual energy consumption of each building for space heating, hot water preparation and hot water circulation, actual energy consumption class was used (AECC) [1]. AECC is used to evaluate real/actual energy for premises heating. According to the energy consumption for space heating buildings are divided into 15 classes: the smallest and energetically most effective class is 1, the largest and energetically least effective buildings have 15 class. Numeric value of an Actual Energy Consumption Class is the energy consumption amount for premises heating, from which by calculation procedure are eliminated various influencing factors - eliminated the factor of different heating season duration, eliminated the influence of different heating season outside air temperature, influence of different buildings heated area. Results lets to compare the energy consumption of the same two buildings or energy consumption of different types buildings during different heating seasons, can be compared AECC of the same building during different years, months, together can be compared several buildings of different heating areas, different heating seasons and so on. For AECC calculation is used energy balance of total consumed energy $Q_{\sum}$, MWh in building:

$$\sum Q = Q_h + Q_{hwp} + Q_{hwc} \tag{1}$$

where:

$\sum Q$ – total heat consumption in building, MWh;

Q_h – heat energy for space heating, MWh;

Q_{hwp} – heat energy for hot water preparation, MWh;

Q_{hwc} – heat energy for hot water circulation, MWh;

For AECC calculation is eliminated actual hot water amount (not according to defined norms for all buildings):

$$Q_h = \sum Q - Q_{hwp} - Q_{hwc} \quad (2)$$

Heat energy for hot water Q_{hwp}, MWh preparation is evaluated according to:

$$Q_{hwp} = G \times 0.051 \quad (3)$$

where:

G – hot water consumption before hot water exchanger (this consumption is not the sum of declared hot water amount of all final customers/flats in building), m^3;

0.051 – heat energy to rise hot water temperature by 44°C, kWh. If an actual rised temperature is known, it should be used instead of 44°C;

After elimination of outside air temperature, heating season duration and heated area, the factor q_m, Wh/DD/m^2 is obtained:

$$q_m = \frac{Q_h}{DD \times S} \quad (4)$$

where:

q_m – heat amount to rise 1 m^2 of premises heated area by 1 ºC during 1 day (24 h), Wh/DD/m^2;

DD – Degree days (base temperature is 18°C), DD;

S – heated area of premises, m^2;

Evaluated heat amount q_m is individual for every building. According to q_m, the Actual Energy Consumption Class is prescribed:

Table 1. Actual Energy Consumption Class and heat energy amount for premises heating q_m.

No.	*q_m, Wh/(DD×m^2)*	*AECC*
1	$q_m < 5$	1
2	$5 \le q_m < 10$	2
3	$10 \le q_m < 15$	3
4	$15 \le q_m < 20$	4
5	$20 \le q_m < 25$	5
6	$25 \le q_m < 30$	6
7	$30 \le q_m < 35$	7
8	$35 \le q_m < 40$	8
9	$40 \le q_m < 45$	9
10	$45 \le q_m < 50$	10
11	$50 \le q_m < 55$	11
12	$55 \le q_m < 60$	12
13	$60 \le q_m < 65$	13
14	$65 \le q_m < 70$	14
15	$q_m \le 70$	15

4. RESULTS AND DISCUSSION ON IMPLEMENTATION OF ENERGY EFFICIENCY MEANS

The targets of 2012/27 / EU directive on the energy efficiency in district heating sector can be implemented by application of technical energy efficiency means. Complete combination package allows to access it in the most energy efficient way. It is important to distinguish the minimal measures that enable to achieve energy efficiency at the minimum level. Performed analysis shows that the reconstruction of internal heating and hot water systems in multi-apartments buildings under 1992 and installing individual heat and hot water consumption meters for each final customer has a potential to decrease energy consumption for a final customer by about 25% [1].

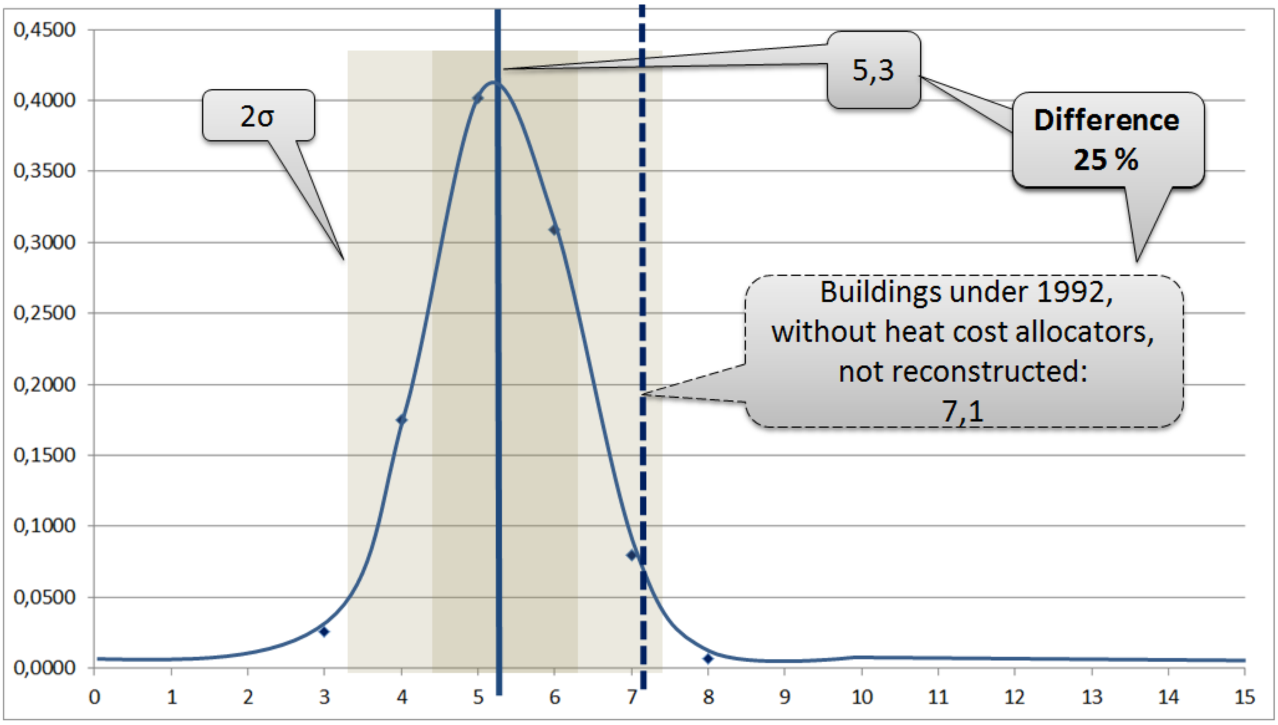

Fig. 1. Energy consumption in not reconstructed multi-apartment buildings under 1992 with individual heat metering and without [1].

These potential savings for minimal energy efficiency can be achieved by in the table No.1 specified minimal technical means. Measures for larger energy efficiency can be described also, but they have a potential only of small saving percentage.

The minimal investment level to install minimal technical means for such individual heat metering is about 15 EUR/m^2 or about 900 EUR for a typical apartment of 60 m^2. The reconstruction of one pipe heating system, installation of thermostatic valves and heat cost allocators for separate individual apartment can be made in 1 day. The total reconstruction to have a potential of 25% energy savings also includes installation of automated balancing valves for heat and hot water systems, smart intelligent wireless monitoring and data collection system, hot water metering for each final customer.

These measures are applied and a potential of about 25% of energy savings is for buildings with independent heat substations with separate heat exchangers for heating and hot water. If the building does not have an independent type heat substation, the reconstruction of heat substation and installation of individual heat metering for every final customer in addition, gives savings much higher than 25 %.

Table 2. The minimal technical means for potential energy savings.

No.	*Measure*	*Measures for minimal efficiency*	*Measures for larger efficiency*
1.	Independent heat substation for heat and hot water preparation (the analysed buildings almost have reconstructed heat substations, so if heat substation is not reconstructed, the potential energy savings will be much more higher)	+	+
2.	Balancing of the heating system	+	+
3.	Hot water system balancing	+	+
4.	Thermostatic valves on the building heating system heating appliances	+	+
5.	Individual heat metering for each final customer of the building (heat meters or heat cost allocators)	+	+
6.	Hot water metering for each final customer of the building	+	+
7.	Smart intelligent wireless monitoring and data collection system	+	+
8.	Energy efficient heating and hot water pumps	-	+
9.	Replacement of heating appliances with more efficient	-	+
10.	Reflecting screens under heating devices	-	+

11.	Etc.	-	+

This heating system reconstruction does not preclude further renovation of the building envelope, as after additional building thermal insulation would be applied, the internal heating and domestic hot water systems still needs to be reconstructed according to a new heat demand. Once this is done before building envelope renovation, the savings due to heating system reconstruction can be obtained and get already before partitions insulation.

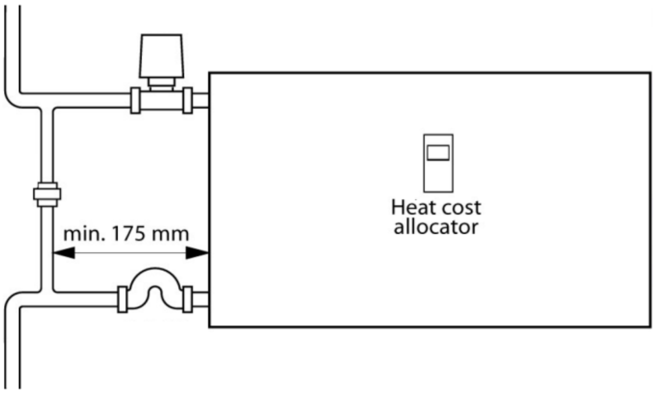

Fig. 2. The reconstruction of one pipe heating system for multi-apartment buildings.

5. FINDING THE SCENARIOUS FOR THE IMPLEMENTATION OF 2012/27/EU ENERGY EFFICIENCY DIRECTIVE

In order to implement the 2012/27/EU energy efficiency directive for centralized heat supply sector with the lowest costs, the potential to achieve the targets by different implementation scenarios must be evaluated for the Member State.

According to preliminary estimation, obligations for Lithuanian electricity, heat and gas sectors are provided in the table below. Lithuania by the year 2012 has consumed 646,8 ktoe of final energy. The total final energy consumption goal of all the electricity, heat and gas sectors by 2020 is 2'639 GWh . Heat sector provides 33% or 870 GWh of final energy consumption. The annual savings during 2014-2020 years is 145 GWh.

Table 3. Economic evaluation of 2012/27/EU energy efficiency directive in the district heating sector.

No.	*Name*	*Electricity*	*Heat*	*Gas*
1.	Final consumption, ktne (2012)	767,2	646,8	548,1
2.	Final consumption, %	39,1%	33,0%	27,9%
3.	Total 2020 target without buildings envelope reconstruction, GWh	2‘639		
4.	2020 targets for obligated countries 2020, GWh	1032	870	737
5.	Annual targets for obligated countries, GWh	172	145	123
6.	Investments for a measure, mln. Eur/GWh	0,579		
7.	Annual investment, mln. Eur	100	84	71
8.	Annual support for investment, mln. Eur (20 %)	20	17	14

Investments and cumulated savings for implementation of 2012/27/ES Energy efficiency directive are presented in Fig. 3.

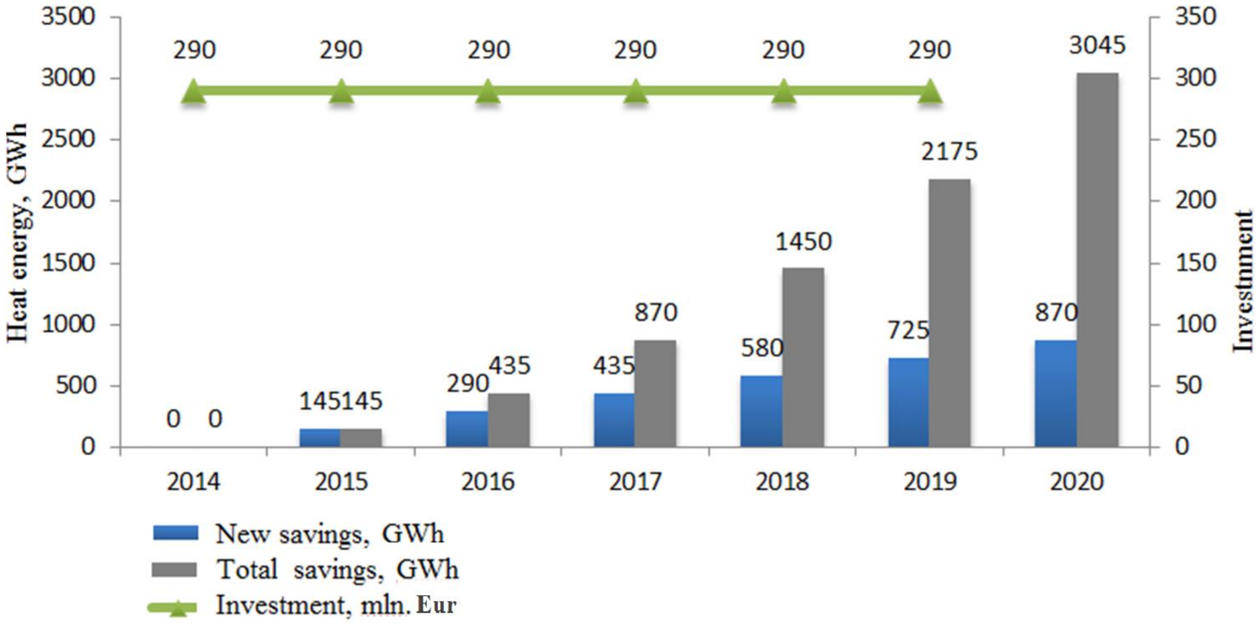

Fig. 3. Investments and savings for implementation of 2012/27/ES Energy efficiency directive.

Different scenarios of 2012/27/ES Energy efficiency implementation is possible and directly depends on the investment lay down schedule and percentage of buildings will be selected. Table 4 shows implementation of technical means for 100% of the buildings then investments are instant on 2017, Table 5 shows implementation of technical means for 50% of the buildings then investments are instant on 2017, Table 6 shows implementation of technical means for 50% of the buildings then investments are set during thirst three years (2017-2019).

Table 4. Implementation for 100% of the buildings, investments – instant on 2017.

No.	*Name*	*2'017*	*2018*	*2'019*	*2020*	*2'021*	*2'022*	*Sum*
1.	Target, GWh	145	145	145	145	145	145	**870**
2.	Target, ktne	12	12	12	12	12	12	75
3.	Target, Eur:	37'932	37'932	37'932	37'932	37'932	37'932	227'592
4.	Heated area, m^2:	30'000'000						30'000'000
5.	Potential buildings, %:	100						
6.	Area of potential buildings, m^2:	30'000'000						30'000'000
7.	Reconstructed buildings, m^2:	30'000'000						30'000'000
8.	New annual savings, GWh:	0	858	0	0	0	0	858
9.	New annual savings, ktne:	0	74	0	0	0	0	74
10.	Savings, GWh:	0	858	858	858	858	858	**4'292**
11.	Savings, ktne:	0	74	74	74	74	74	369
12.	Savings, Eur:	0	224'583	224'583	224'583	224'583	224'583	1'122'914
13.	Investment, mln. Eur:	1'500	0	0	0	0	0	1'500

Table 5. Implementation for 50% of the buildings, investments – instant on 2017.

No.	*Name*	*2'017*	*2018*	*2'019*	*2020*	*2'021*	*2'022*	*Sum*
1.	Target, GWh	145	145	145	145	145	145	**870**

2.	Target, ktne	12	12	12	12	12	12	75
3.	Target, Eur:	37’932	37’932	37’932	37’932	37’932	37’932	227’592
4.	Heated area, m^2:	30’000’000						30’000’000
5.	Potential buildings, %:	50						
6.	Area of potential buildings, m^2:	15’000’000						15’000’000
7.	Reconstructed buildings, m^2:	15’000’000						15’000’000
8.	New annual savings, GWh:	0	429	0	0	0	0	429
9.	New annual savings, ktne:	0	37	0	0	0	0	
10.	Savings, GWh:	0	429	429	429	429	429	**2’146**
11.	Savings, ktne:	0	37	37	37	37	37	185
12.	Savings, Eur:	0	112’291	112’291	112’291	112’291	112’291	561’457
13.	Investment, mln. Eur:	750	0	0	0	0	0	750

Table 6. Implementation for 50% of the buildings, investments – 2017-2019.

No.	*Name*	*2’017*	*2018*	*2’019*	*2020*	*2’021*	*2’022*	*Sum*
1.	Target, GWh	145	145	145	145	145	145	**870**
2.	Target, ktne	12	12	12	12	12	12	75
3.	Target, Eur:	37’932	37’932	37’932	37’932	37’932	37’932	227’592
4.	Heated area, m^2:	30’000’000						30’000’000
5.	Potential buildings, %:	50						
6.	Area of potential buildings, m^2:	15’000’000						15’000’000
7.	Reconstructed buildings, m^2:	5’000’000	5’000’000	5’000’000	0	0	0	15’000’000
8.	New annual savings, GWh:	0	143	143	143	0	0	429
9.	New annual savings, ktne:	0	12	12	12	0	0	37
10.	Savings, GWh:	0	143	286	429	429	429	**1’717**
11.	Savings, ktne:	0	12	25	37	37	37	148
12.	Savings, Eur:	0	37’430	74’861	112’291	112’291	112’291	449’166
13.	Investment, mln. Eur:	250	250	250	0	0	0	750

Table 4 shows, that implementation of technical means for 100% of the buildings then investments are instant on 2017 would lead to 4292 GWh savings then the obligation in heat sector is only 870 GWh. The obligation for all heat, gas and electricity sectors is just 2639 GWh, so the total savings for all sectors can be get only by heat sector. As it is difficult to implement all technical means during one year, the third scenarios (table 6) is practicable and the savings of 1717 GWh is possible.

6. CONCLUSIONS

Energy efficiency 2012/27/EU directive obligates Member States to reach energy savings target by 2020 year. Section 7 defines 1,5% annual savings for a final customer, section 9 and 10 defines the installation of individual heat metering for every final customer (flat) and requirements for invoices. Performed analysis shows that:

1. Obligations of Energy efficiency 2012/27/EU directive for 1,5% annual savings for a final customer can be reached by implementing technical means installing individual heat metering for every final customer.
2. Performed analysis shows that the reconstruction of internal heating and hot water systems in multi-apartments buildings under 1992 and installing individual heat and hot water consumption meters for each final customer has a potential to decrease energy consumption for a final customer by about 25%.
3. The targets of Energy efficiency 2012/27/EU directive for Lithuanian Gas, Electricity and Heat sectors can be reached applying a technical measures only in heat energy sector. Implementation of technical means for 100% of the buildings then investments are instant on 2017 would lead to 4292 GWh savings then the obligation in heat sector is only 870 GWh. The obligation for all heat, gas and electricity sectors is just 2639 GWh, so the total savings for all sectors can be get only by heat sector. As it is difficult to implement all technical means during one year, the third scenarios (table 6) is practicable and the savings of 1717 GWh is possible.

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