[CROATIA] Individual heat metering in multi-family buildings (2014 – 2016)

About the measure

Policy instrument	Sector	Starting date and status
Legislative / normative	**Residential (multi-family buildings)**	**[2014] – [2016]**

The Croatian legislature has embedded in 2014 Article 9(3) of the Energy Efficiency Directive (2012/27/EU) related to individual heat metering through the Heat Market Act (OG 80/13, 14/14) and Energy Efficiency Act (OG 127/14).

Before the implementation of these acts, heat from district and centralized heating systems was being paid based on the floor area of the dwelling. This payment scheme did not incentivize users to pay attention to regulating their energy consumption.

According to the Heat Market Act, all owners of dwellings or business spaces within apartment and commercial buildings connected to the central heating system, and with a joint heat meter, had an obligation to install individual heat meters or heat cost allocators[1] for each dwelling unit separately. The obligation was due in the end of 2015 for all buildings with more than 70 dwellings and end of 2016 for all other buildings. The goal was to give the end-users control over their own heat consumption and related costs, enabling a fairer distribution of heat costs among dwelling occupants.

Apartment buildings represent about 39% of the housing stock in Croatia. It is estimated that only 1% of these buildings are owned by public bodies (Ministry of Construction and Physical Planning, 2014b).

To facilitate the fulfillment of this legal obligation, a measure "Introduction of individual heat metering" was formulated in the 3rd NEEAP (2014) and incorporated in the Programme for energy renovation of multi-apartment buildings. In the period 2014-2016 grants were provided for installation of individual heat meters or heat cost allocators (installation of thermostatic radiator valves and hydraulic balancing after the installation was also covered by grants). For that purpose, the Environmental Protection and Energy Efficiency Fund announced a public call in 2014 based on which the building managers, on behalf of dwelling owners, could apply for co-financing up to 40% of eligible costs, for the purchase of individual heat meters or heat cost allocators.

[1] Individual heat meters refer to calorimeters. Heat cost allocators are based on temperature sensors that are used to count units then used to allocate the total heating bills of the buildings among the different dwellings proportionally to these units based on prescribed methodology/formula. The formula defines share of fixed and variable costs that are being allocated to the individual dwelling.

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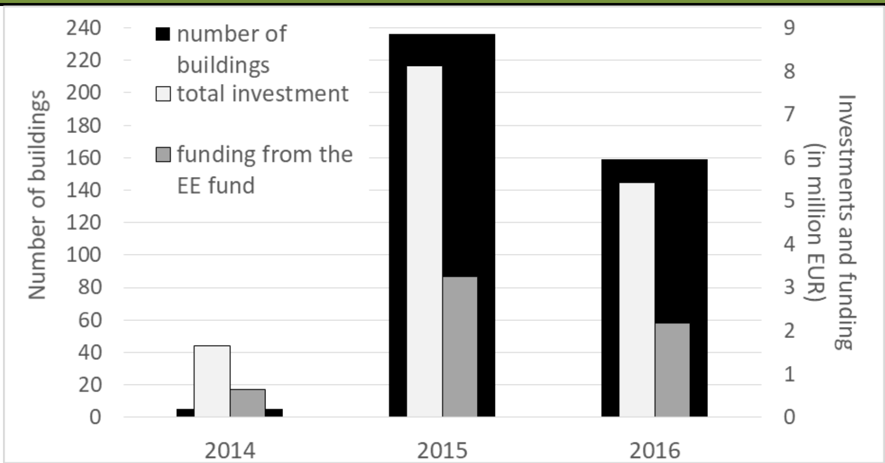
Expected energy savings in 2020	Benchmark
The objective specified in the Programme for energy renovation of multi-apartment buildings was to achieve new final annual energy savings of about 0.4 PJ/y (about 113 GWh/y) and reductions in emissions of 34 $ktCO_2/y$ each year over 2014-2016 (Ministry of Construction and Physical Planning, 2014a). Based on these estimates, the 3rd NEEAP (2014) thus assumed about 1.2 PJ/y (3 *0.4 PJ) of final annual energy savings in 2016. The targeted cumulative savings for the whole period 2014-2016 calculated using EED Art.7 methodology should be about 2.4 PJ, as the lifetime of these actions is set to only 2 years as per Ordinance on Monitoring, Measurement, and Verification of Energy Savings (NEEAP 2014, p.35). After 2016 no new annual savings were envisaged.	The assumption of the Programme for energy renovation of multi-apartment buildings was that in approximately half of the apartments (total number approx. 155,000, thus about 75,000) installation of individual heat meters or heat cost allocators will be subsidised, amounting to 25,000 apartments annually. Assumed cost of implementation of this action was, on average, 3,000 HRK (about 400 EUR) per dwelling.

Means and outputs



Source: data from Croatia's annual reports 2015, 2016 and 2017 for the EED

Figure 1. Number of apartment buildings and investments for the years 2014 to 2016.

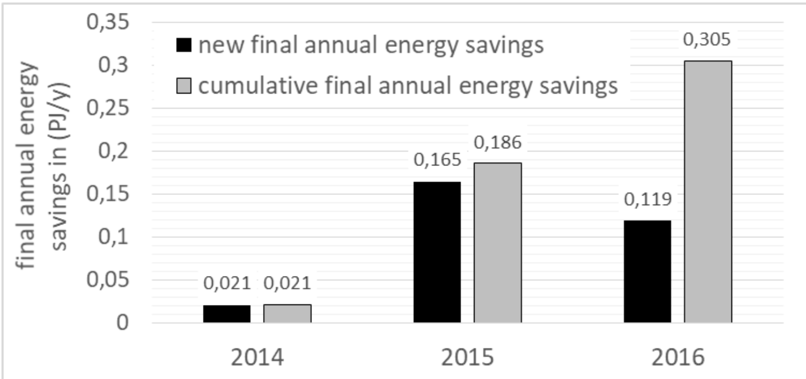
- **Total investments**: total investments made to install individual heat meters or heat cost allocators in apartment buildings. Total investments for the whole **2014 – 2016** period amounted to 117 million HRK (**15.8 million EUR**) (Ministry of Economy, 2017)
- **Funding from the EE fund**: grants awarded by the Energy Efficiency Fund. The grants for the whole **2014 – 2016** period amounted to 46 million HRK (**6.2 million EUR**) (Ministry of Economy, 2017).
- According to the System for Measuring and Verifying Energy Savings (SMiV), heat cost allocators have been installed in **almost 400 apartment buildings.** However, there are no data about the number of apartments in these buildings in SMiV, hence the comparison with the planned number of dwellings covered by the measure (75,000) could not be made using only publicly available data from SMiV.

Data about energy savings

Unit	Main source of data
Cumulative annual final energy savings (PJ/year)	Annual Report for the EED (based on data from SMiV)

According to the 4th Croatian National Energy Efficiency Action Plan (NEEAP 2017, draft version), the data from the System for Monitoring and Verifying Energy Savings (SMiV), and national annual report on progress in achieving energy saving targets, the following has been achieved:

- **New final annual energy savings in 2016: 0.119 PJ/y** (in comparison to the objective of 0.4 PJ/y) (Ministry of Economy, 2017)
- **EED art.7 cumulative energy savings for 2014-2016**: **0.513 PJ** (in comparison to objective 2.440 PJ) for actions installed over 2014-2016 (Ministry of Economy, 2017)



Source: data from Croatia's annual reports 2015, 2016 and 2017 for the EED

Figure 2. New and cumulative final annual energy savings (PJ/y) over 2014-2016.

Sources of uncertainties about energy savings

- Differences between ex-ante calculation (deemed estimates) and actual energy savings (based on billing analysis).
- Use of default values instead of the project and/or object-specific ones.
- There is no systematic ex-post monitoring. Ex-post results are available from the sample investigated in the ex-post evaluations. These results were extrapolated to the whole set of apartment buildings where heat cost allocators were installed. This extrapolation contains statistical uncertainties.

Evaluation of the energy savings

Calculation method(s) and key methodological choices

- Calculation method used for reporting and used in official monitoring system (**SMiV**) is based on a **deemed** estimate of unitary energy savings (**method 3**). Bottom-up methodology and default values are defined in national legislation. Default (standardized) values can be used if there are no project specific parameters available. Standardized specific heat consumption (per m2 floor space), depending on the age (building period), is used. The specific energy use for hot water depends on the size of the building. Overall the energy savings from the individual metering action is assumed to be 10% of energy consumption before the action.
- The **first ex-post evaluation study** (Energetski institut Hrvoje Požar, 2016) used unitary energy savings established on the basis of **billing analysis** (**method 2**) for 56 buildings in 8 cities with district heating, totaling 3,842 households.

- The **second evaluation study** (Ekonomski institut Zagreb, 2017) used the same approach but with a larger sample set consisting of 276 buildings (22,475 dwellings), from the same 8 cities.
- For both evaluation studies, the **baseline** was the energy consumption before the installation of the heat cost allocators ("**actual before**") and to enable comparison all values were also normalized to control for climate conditions by using Heating Degree Days (proportional method).
- The evaluations done could not monitor the indoor temperature before and after the installation of heat cost allocators, so possible rebound effects could not be assessed. However, it should be noted that in most of the cases, the initial comfort issue was that the buildings were over-heated (which is confirmed in the interview). So, in these case, comfort improvements also mean a decrease in the heating consumption (unlike usual rebound effects).

Ex-post verifications and evaluations

The **monitoring and verification** of implemented actions was conducted through the (web-based) System for Monitoring and Verifying Energy Savings (**SMiV**), a tool defined by the legislature as obligatory for all grant providers (e.g. Environmental Protection and Energy Efficiency Funds), according to the Article 22 of the Croatian Energy Efficiency Act (OG 127/14). Therefore, this applies to the grants for individual heat metering.
Simple indicators, such as total energy and CO_2 savings, specific energy and CO_2 savings, the total amount of investments and grants provided, and cost of energy savings or CO_2 avoided can be seen with the SMiV application at any given moment for all types of measures or for different sectors. Actual energy consumption is not monitored. As mentioned above, the results in energy and CO_2 savings are based on deemed estimates, unless data specific to the energy savings projects are available.
First evaluation study (Energetski institut Hrvoje Požar, 2016) focused on the analysis of the applicability of individual heat cost allocators (HCA) to Croatian context and identifying common problems experienced after the implementation of HCA. Conclusions from the study, identifying these problems, are mentioned below. The study was commissioned by Ministry of Economy to evaluate the applicability of the technology used and methodology employed.
The second study (Ekonomski institut Zagreb, 2017) assessed the economic feasibility of implementation of heat allocators in multi-family buildings and used common criteria for cost-efficiency recommended by Concerted Action – Energy Efficiency Directive in 2014. For more details, see "*Focus on the ex-post impact evaluation*" and (Edelenbos and Martins, 2014). This study was commissioned by Ministry of Environmental Protection and Energy to explore the feasibility of individual heat cost allocators in Croatian case and to determine the conditions under which the HCA would be feasible.
The table below provides other indices that were used in evaluations while only indicators reported in SMiV are monitored regularly.

Other indicators monitored and/or evaluated

Indicator	Explanations
Annual avoided CO_2 emissions (in $ktCO_2/y$)	Calculated ex-ante in the System for Monitoring and Verifying Energy Savings (multiplying energy savings per fuel with CO_2 emission factor of the fuel, mostly based on standard emission factors for district heating) Cumulative annual CO_2 savings of **about 23.3 ktCO2/y** for actions implemented over 2014-2016 (source: data from the annual reports for the EED).
Costs	Total costs of individual heat cost allocators per building.

NPV	Net present value of investment and energy savings, assuming lifetime of equipment 10 years, and a discount rate of 4%
Payback period	Payback period or return period for the investment into HCA.

Other aspects evaluated

According to an analysis reported by EIHP (Energetski institut Hrvoje Požar, 2016), 70 consumer objections, selected by heating companies as representative of most frequent complaints, were divulged on individual heat meters by end-users whose buildings have implemented heat meters, where three groups of complaints were brought to the forefront:

1. Dissatisfaction with the methodology for heat energy calculation when individual heat metering is used,
2. High bills for both heat energy and hot water, compared to the users' expectations,
3. Demand for more information and transparency.

The first group of issues was associated with the calculation of cost distribution. In some cases, heat suppliers, responsible for sending the energy bills, tended to disassociate themselves from the potentially incorrect information on the bills, namely the number of calculated impulses. There were also reports on the discrepancies in the data for hot water consumption between the heat supplier and water utility company.

The total cost of heating energy for some users increased by 70% and the reasons behind this vary from case to case. In general, the poor understanding of the purpose of HCA was noted (i.e. consumers often expect energy savings just from the introduction of HCA without any changes in their behaviors). Furthermore, there is also a lack of understanding of the method for calculation of costs and billing. Namely, part of the total cost was allocated based on the dwelling area and partly based on the number of impulses on HCA, hence even if a number of impulses were zero, there was still certain amount on the bill that had to be paid. There were also experiences noted of the incorrect estimation of impulses in rooms where there was no heating due to the false assumption that heat meters were broken.

Users also demanded a higher level of transparency of the distribution of costs and more elaborated calculation, especially elaboration on fixed costs irrespective of heat consumption.

Focus on the ex-post impact evaluation

The goal of the analysis conducted by the Zagreb Economic Institute (Ekonomski institut Zagreb, 2017) was to determine the cost-effectiveness of heat cost allocators (HCA). It included separate analysis for each of the 8 cities with 2 types of costs (with or without hydraulic balancing of the heating system) and under 8 scenarios of savings. This analysis had to evaluate under which conditions implementation of HCA would be economically feasible. Therefore, the analysis extrapolated the results from the available sample of buildings to the whole building stock (that uses district heating) by accounting for various possibilities through scenario analysis. The 8 scenarios differed as to assumed energy savings after the HCA implementation. Four scenarios were based on actual energy savings (without and with heating degree days correction, extrapolated from smaller and larger sample), and four based on assumed energy saving rates ranging from 15 % to 30 %, to evaluate the energy savings threshold for implementation of the HCA to be economically viable. In addition to the scenario analysis, the study provides economic sensitivity analysis comparing results in case price of heat increases 2.5 % faster than annual consumer price index, and with the lower discount rate of 3 %. The authors also compared the NPV for different combinations of initial energy consumption and reduction in consumption.

The average reduction in energy consumption, based on metered energy consumption without climate normalization, after HCA implementation in analyzed cities, was -21,9 %, ranging in values between -19,8 % and -33,0 %. After accounting for differences in weather conditions in analyzed heating seasons, i.e. after heating degree days normalization, the effect of HCA implementation was -16,5 %, and ranging in values between -7,5 % and -26,7 %. In comparison to the other EU Member States, those values are somewhat higher. For example, in Germany reported decrease is between 13 and 25 %, in Austria between 10 and 30 %, in France 20 % (Calenza (2016), Felsman (2015)).

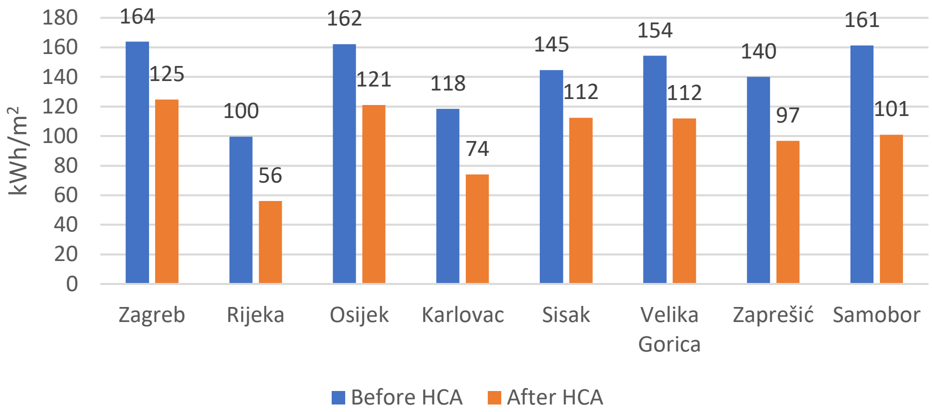


Figure 3. Specific heat consumption (HDD normalized) before and after HCA implementation.

Since the available data included only 20 %[2] of all apartment buildings and households that implemented HCA, the study also provides an econometric, i.e. statistical, model of the energy savings. Using bootstrapping method, the density distribution function of energy savings is estimated for the entire population of buildings.

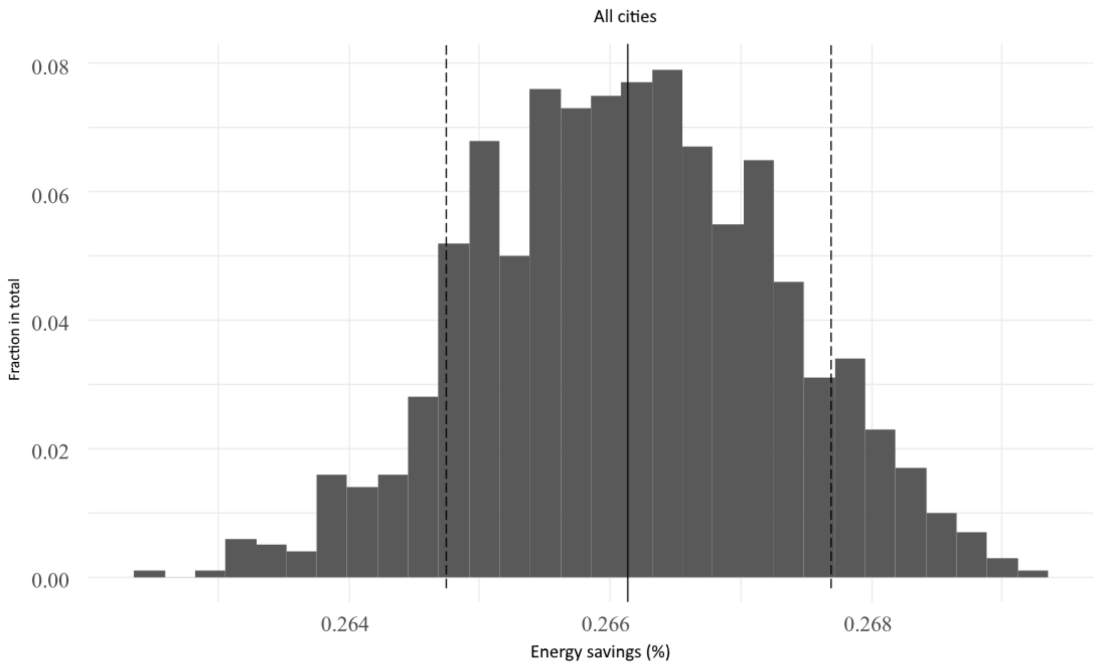


Figure 4. Bootstrap distribution of energy savings

Source: Ekonomski institut Zagreb (2017)

[2] Data can be obtained from the Fund as well as from the suppliers, but it is not available in SMiV.

The cost-effectiveness, and therefore attractiveness for the consumers, was shown to be highly dependent on the price of heat, which varies among cities, with the lowest price being in Zagreb. All cost-effectiveness calculations were performed using assumed average representative household in the building, but as was stressed in both studies, and more thoroughly analyzed in the EIHP study (Energetski institut Hrvoje Požar, 2016), distribution of costs among users was a common issue and reason of public outcry.

Both evaluations provided a set of recommendations to remedy identified problems. Analysis by Ekonomski institut (2017) found three groups of apartment buildings regarding the feasibility of HCA implementation. HCA is a viable option in the first group, the one with high specific energy consumption. For the second group of buildings, with moderate specific energy consumption, an energy audit should be executed before deciding. The third group, with lower specific energy consumption, wouldn't pay back the cost of implementation in the lifetime of an HCA. Authors suggest that each group of buildings should have different subsidy scheme, especially the third one.

The analysis by Energetski institut Hrvoje Požar (2016) provided a list of (1) technical, (2) billing related, (3) legal, and (4) financial recommendations. Technical recommendations relate to technical correctness and optimization of buildings, billing related recommendations to suggest the change in the formula for heat cost allocation, legal recommendations suggested improvement of the legal framework and increased customer protection, and financing recommendations suggested the re-evaluate subsidy and financing scheme for HCA implementation.

Experience feedback from stakeholders

Interview with Krešimir Ižaković (representative of tenants at the Sjenjak 101 building in Osijek, Croatia)

1. **Your case is stated as a positive example of implementing heat cost allocators and building energy renovation by the Croatian Ministry of Construction and Physical Planning. How did the project come about and what were its effects?**

Individual heat meters were implemented in my high-storey apartment building in Osijek, Croatia in mid-2015. The building was built in 1980. The main motivator for introducing heat cost allocators was the improvement of thermal comfort in our dwellings, while the reduction of costs was only a secondary motive. We were experiencing high temperatures in our dwelling and had no other possibilities for regulation than opening the windows. The building has 133 dwellings (with 260 tenants) and in all except one, heat allocators were installed.

It should be emphasized that we also performed a thorough balancing of the system and we installed a new heating substation in the building. The energy consumption has significantly decreased, while the only negative effect was the appearance of mold due to cold thermal bridges and reduced air exchange/ventilation [*due to fewer windows opening*].

However, this problem is eliminated with the thermal insulation of outer walls of our buildings. The building started with insulation work in August 2017 and was completely insulated by the end of 2017. Insulation will, therefore, prevent the appearance of cold thermal bridges and resulting mold, with additional savings in thermal energy.

2. **What were the results as far as heat consumption go?**

It is important to note that, apart from implementing individual heat cost allocators in 2015, the building had switched from a direct to indirect heat system with the construction of a heat substation. The result was a 25 percent reduction in thermal power that we need to contract with the supplier, which caused a decrease in overall heating bills in the building. As for heat consumption, it was reduced from 1,284,000 kWh/y in 2014 to 875,000 kWh/y in 2017, i.e. a reduction of 32% and annual energy savings are 409,000 kWh/y.

As for heat cost reduction, it has to be emphasised that we have decided to choose the cost allocation calculation method that assumes that 50% of total energy delivered to the building (as per common metering point in the building heating substation) is billed according to shares of impulses registered in an individual dwelling in total number of impulses registered for the whole building. Croatian regulation allows this share to be set between 50% and 90%. We have chosen 50% as we did not want to cause huge differences in bills between dwellings, especially we did not want to have a situation in which some dwelling owners would have to pay more because other dwellings are empty and potentially not heated at all. Due to this choice, the cost reduction for the whole building was approximately 25%.

As far as investment is concerned, there was no additional investment from the tenants outside of regular building fees. The Environmental Protection and Energy Efficiency Fund was co-financing the project (approximately 30% of the total investment excluding VAT), which included heat meters and the thermal substation.

As we have now renovated our building completely by thermally insulating the envelope, we are expecting additional energy and cost savings. As the representative of dwelling owners, I am monitoring these effects through data about the heat consumption and related bills. All tenants are informed about the effects through our building Facebook profile. This way, the awareness on energy consumption and consequences of our investment activities, but also our behavior as energy consumers, is raised.

3. **Were there any special administrative demands from the Energy Efficiency Fund after co-financing?**

No. The project documentation was submitted, the financing was received with the very little hassle and the project moved on with no particular obstacles on the administrative side. There were no additional requests for reporting on actually achieved energy savings, which would not be a problem as these data are easily obtained.

Author's note: Annual energy savings in SMiV for this particular building amount to 291,835.60 kWh, which is approx. 30% lower than actually achieved based on metered data. Energy savings in SMiV are calculated based on pre-defined referent values for specific heat demand of a typical building from that construction period, the pre-defined efficiency of the heating system and assumed savings of 10% of final energy consumption (these assumed savings include installation of HCA, thermostatic radiator valves and balancing of heating system).

To go further

About the measure

- Ministry of Construction and Physical Planning. (2014a). Program energetske obnove višestambenih zgrada za razdoblje od 2014. do 2020. godine. [*Programme for energy renovation of multi-apartment buildings for the period 2014-2020*] Ministarstvo graditeljstva i prostornoga uređenja, May 2014 (in Croatian)

http://www.mgipu.hr/doc/Propisi/Program_EO_VS_ZGRADE.pdf

- NEAAP (2014). Third Croatian National Energy Efficiency Action Plan, Ministry of Economy, Republic of Croatia.

https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans

References of the evaluation(s)

- Ministry of Economy. (2017). Annual Report on the progress made towards achieving the national energy efficiency targets under Article 25(1), in accordance with Part 1 of Annex XIV to Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency.

https://ec.europa.eu/energy/sites/ener/files/documents/hr_annual_report_2017_en.pdf

- Ekonomski institut Zagreb. (2017). Ekonomska isplativost korištenja razdjelnika topline u višestambenim zgradama u Republici Hrvastkoj. [*Economic viability of using heat cost allocators in apartment buildings in the Republic of Croatia*] April 2017. (in Croatian)

http://www.mzoip.hr/doc/ekonomska_isplativost_koristenja_razdjelnika_topline_u_visestambenim_zgradama_u_republici_hrvatskoj.pdf

- Energetski institut Hrvoje Požar. (2016). Analiza implementacije Direktive o energetskoj učinkovitosti u dijelu mjerenja u sustavima daljinskog grijanja. [*Analysis of the implementation of the EED about heat metering in buildings connected to district heating*] (in Croatian)

Other useful references

- Ministry of Construction and Physical Planning. (2014b). Proposal of the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia. April 2014.

https://ec.europa.eu/energy/en/topics/energy-efficiency-directive/buildings-under-eed

- Edelenbos, E., Martins, F., Cost effectiveness of individual metering/billing, Concerted Action – Energy Efficiency Directive

https://www.ca-eed.eu/content/download/4500/file/WG3.3%20Exec%20Summary%20FINAL.pdf

- Felsmann, C., Schmidt, J., Mroz, T., Effects of Consumption-based Billing Depending on the Energy Qualities of Building in the EU, December 2015

https://www.ista.com/fileadmin/twt_customer/countries/content/Hungary/Documents/EED/Summary_LiteraturrechercheEinsparungHKV_final_20151218.pdf

- Calenza, L., et al., Economic and Technical Feasibility of Metering and Sub-metering System for Heat Accounting, International Journal of Energy Economics and Policy, 2016

http://www.econjournals.com/index.php/ijeep/article/view/2457

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