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SONNET - SOCIAL INNOVATION IN ENERGY TRANSITIONS

Co-creating a rich understanding of the diversity, processes, contributions, success and future potentials of social innovation in the energy sector

D4.6 (D17): Report on the SIE City Lab in Warsaw

Project Coordinator: Fraunhofer ISI (Karoline Rogge)

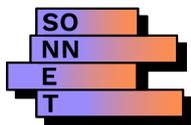
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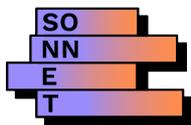
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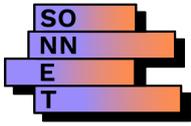


Preface

Increasing energy efficiency in households is one of the main ways to reduce greenhouse gas emissions and to improve air quality, health, and quality of citizens' lives. It also decreases energy costs, providing lower energy bills for households. A collaboration between a city administration and academics may help to achieve a sustainable energy system by re-adjusting energy efficiency measures and accelerating the direct use of renewable energy sources.

PROJECT PARTNERS

No	Participant name	Short Name	Country code	Partners' logos
1	Fraunhofer Society, with its Fraunhofer Institute of Systems and Innovation Research (Fraunhofer ISI)	ISI	DE	Fraunhofer ISI
2	Dutch Research Institute for Transitions	DRIFT	NL	drift for transition
3	University of Sussex, with its Science Policy Research Unit (SPRU)	UoS	UK	US UNIVERSITY OF SUSSEX
4	Grenoble Ecole de Management	GEM	FR	G GRENOBLE ECOLE DE MANAGEMENT
5	Akademia Leona Kozminkiego	ALK	PL	KOZMINSKI UNIVERSITY
6	Zuercher Hochschule for Applied Research	ZHAW	CH	zhaw
7	ICLEI European Secretariat	ICLEI	DE	ICLEI Local Governments for Sustainability
8	City of Mannheim	MANN	GER	STADT MANNHEIM
9	City of Antwerp	ANTW	BE	A City of Antwerp
10	City of Bristol	BRIS	UK	BRISTOL CITY COUNCIL
11	City of Grenoble	GREN	FR	VILLE DE GRENOBLE
12	City of Warsaw	WARS	PL	CITY OF WARSAW
13	City of Basel (Associated Partner)	BASE	CH	Kanton Basel-Stadt



Executive Summary

The report presents information about a city lab project conducted in Warsaw, focused on achieving energy savings by monitoring energy use in private apartments and providing personalised recommendations about everyday choices to affect energy consumption. The project was based on a small-scale socio-economic-technical experiment, involving a group of eleven apartments (inhabited by 37 people) located in different parts of Warsaw (6 districts). The experiment took place between March 2021 and July 2021 (however, this period included breaks due to COVID-19 pandemic restrictions).

The insights gained show that both households and the environment can benefit from analyses of, and advice on, energy efficiency in households. The city lab revealed a decrease in energy consumption, with estimated annual energy savings measured over the treated households at nearly 11 MWh, provided that this decrease continued over the year. The environmental benefits after the city lab's lifetime are to be over 2.5 tonnes of CO₂ avoided annually.

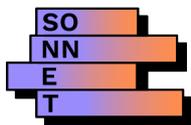
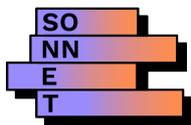


Table of Contents

1	INTRODUCTION.....	6
1.1	INFORMATION ABOUT CITY LAB-LIKE ACTIVITIES BEFORE SONNET	7
1.2	UNDERSTANDING OF SIE FOR SONNET	12
2	SONNET CITY LAB PROCESS	14
2.1	SETTING THE STAGE	14
2.2	AGENDA AND GOAL(S) SETTING, EX-ANTE ANALYSIS	18
2.3	EXPERIMENTING (INCL. NETWORK BUILDING):	19
3	EVALUATION.....	30
3.1	OVERVIEW OF THE EVALUATION PROCESS	30
3.2	ONGOING EVALUATION	32
3.2.1	ONGOING EVALUATION OF THE PROCESS	32
3.2.2	ONGOING EVALUATION OF THE EXPERIMENT	34
3.2.3	METHODS EVALUATION.....	35
3.3	OUTCOMES EVALUATION.....	36
3.4	ANALYTICAL REFLECTION OF EVALUATION AS A SUMMARY	44
4	CITY PARTNER ANALYTICAL REFLECTION AS A SUMMARY	45
	APPENDIX 1: EC SUMMARY REQUIREMENTS.....	47

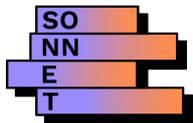


Figures

Figure 1: A view over Warsaw	6
Figure 2: Promoting the elimination of fossil fuels and subsidies for renewable energy	7
Figure 3: Cyclists, Vistula Boulevards.....	9
Figure 4: Panoramic view from POLiN	10
Figure 5: Panoramic view of Warsaw from Gdański Bridge	11
Figure 6: City lab schedule	15
Figure 7: Map of Warsaw’s districts.....	16
Figure 8: Goals of the city lab	20
Figure 9: Organisation of the city lab.....	20
Figure 10: devices measuring electricity consumption installed in one of the apartments participating in the city lab.....	21
Figure 11: Devices installed in one of the flats participating in the city lab	21
Figure 12: Socio-economic survey	26
Figure 13: Survey about energy efficiency conducted among the participants.....	27

Tables

Table 1: Recommendations on energy use for households from 27 May 2021 to 10 June 2021	22
Table 2: Recommendations on energy use for households from 10 June 2021 to 28 June 2021	24
Table 3: socio-economic survey	25
Table 4: Survey about energy efficiency conducted among the participants.....	28
Table 5: Energy consumption in households.....	45



1 INTRODUCTION

This section will serve as a reference point for the SONNET city lab analysis. It presents the main characteristics of the city and consist of a description of the city's experiences with city lab methodology, lessons learnt from the previous experiences with transition-oriented and participatory activities. In the following parts of this report, we explain the understanding of social innovation in energy in the Warsaw City Lab and describe the process and outcome of the City Lab. The report is supplemented by the evaluation report prepared by partners from the Kozminski University.

Located in the east-central part of the country, in Mazovia (Mazovian Province), Warsaw is the capital of Poland. Warsaw is the largest city in Poland with a population of about 1,800,000 and an area of 517.24 sq. km. It consists of 18 districts and lies on the Vistula River.

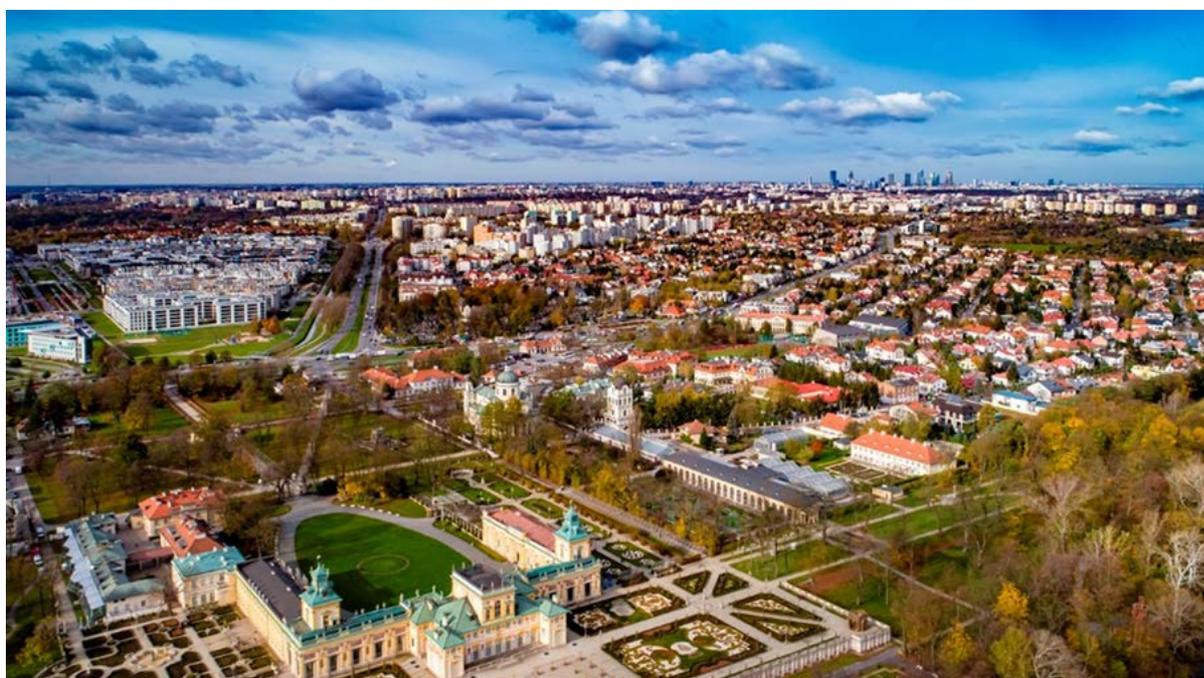


Figure 1: A view over Warsaw

(source: City of Warsaw)

Due to the fact that district heating (covering 80% of households) and electricity supplied in Warsaw rely on energy produced in four plants, i.e. two heating plants (Kawęczyn, Wola) and two combined heat and power plants (Siekierki, Żerań), which are mainly based on fossil fuels, and considering that nearly 2 million cars are registered in Warsaw, air quality in Warsaw is average, according to EEA Report No 9/2020. Moreover, there are still many individual solid fuel stoves that generate pollution from private and public housing stock. To counter this, Warsaw has been involved in multiple climate and air quality efforts, such as the programme to replace solid fuel stoves with environmentally friendly heat sources (starting from 2023, there will be a ban on the use of classless stoves within the Mazovia Province, including Warsaw) and subsidies for

renewable energy sources to increase their share in the energy mix. The entity responsible for such activities within the City of Warsaw, including for urban climate policies and purchasing green energy, is the Air Protection and Climate Policy Department. In 2020, a total of 580 subsidies were granted for the replacement of stoves and 908 for RES. For 2021, the plan is to liquidate over 2,100 stoves and grant subsidies for 1,200 new RES installations.



Figure 2: Promoting the elimination of fossil fuels and subsidies for renewable energy

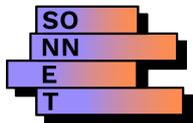
(source: City of Warsaw)

Furthermore, in June 2021, old coal-fired boilers were phased out at the Kawęczyn Heat Plant and replaced by a gas and steam unit, which reduces the share of coal in the energy mix from 95% to 55%, while also increasing electricity production by 50%.

The City of Warsaw joined the SONNET (Social Innovation in Energy Transitions) project to develop solutions and strengthen bottom-up activities in the field of energy efficiency. The housing sector is considered to be responsible for over 40% of greenhouse gas emissions in Warsaw. The aim of the Warsaw City Lab was to involve citizens in creating innovations in the field of energy efficiency, and to develop solutions to reduce energy consumption, which can be further used in the city's housing sector or public buildings (e.g. kindergartens) to reduce energy demand and thereby improve the air quality in Warsaw. Therefore, we are looking for solutions that have not yet been used. The SONNET project gives us an opportunity to test them before they are implemented.

1.1 Information about city lab-like activities before SONNET

Warsaw implements many projects towards energy transition whose aim is to reduce climate change and its effects. By implementing the “Green City Action Plan” (GCAP) project, Warsaw is



creating a long-term sustainable development plan, assessing and prioritising environmental challenges, including water, air, soil and climate change issues. The GCAP is based on specific indicators and an action plan to tackle the challenges through policy intervention and sustainable infrastructure investments, which will contribute to reducing greenhouse gas emissions.¹ By joining C40, Warsaw pledged to achieve climate neutrality by 2050 at the latest, and to implement tools to mitigate the effects of climate change. Through C40 networks, cities advise and learn from one another about the successes and challenges of implementing climate action.²

City of Warsaw is a Covenant of Mayors signatory, which aims to bring together representatives of local authorities who voluntarily commit to the EU's climate and energy goals. Signatories support accelerating decarbonisation in their territories, strengthening their ability to adapt to unavoidable climate change and giving citizens access to secure, sustainable, and economic energy. Signatory cities have pledged to act to support the implementation of the EU's goal of reducing greenhouse gas emissions.³

Under the Paris Agreement, which was adopted during the Paris Climate Conference (COP21) in December 2015, its signatories, including Poland, defined a global action plan which aims to protect us from the effects of far-reaching climate change by limiting global warming to well below 2°C and preferably to 1.5°C. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by the second half of the 21st century. The implementation of the Paris Agreement requires an economic and social transformation, based on the best-available science, and brings nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.⁴

Warsaw is a member of ICLEI - Local Governments for Sustainability, which is a global network of more than 2500 local and regional governments committed to sustainable urban development. ICLEI helps to drive sustainability policy and drive local actions for low emission, nature-based, equitable, resilient, and circular development. Its members and team of experts work together through peer exchange, partnerships, and capacity building to create systemic change for urban sustainability.⁵

In 2019, Warsaw has also developed the Climate Change Adaptation Strategy for the city of Warsaw by 2030, with a perspective 2050 setting directions for Warsaw's spatial development and budget. It is the result of the joint work of residents, entrepreneurs, representatives of various types of organisations and the City of Warsaw. The project was co-funded by the European

¹ Warsaw. [online] EBRD Green Cities. Available at: <https://www.ebrdgreencities.com/our-cities/warsaw/>

² About C40. [online] C40. Available at: <https://www.c40.org/about>

³ Covenant initiative. [online] Covenant of Mayors. Available at: <https://www.covenantofmayors.eu/about/covenant-initiative/origins-and-development.html>

⁴ The Paris Agreement. [online] UNFCCC. Available at: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

⁵ ICLEI - Local Governments for Sustainability. [online] ICLEI. Available at: <https://www.iclei.org/>

Commission's LIFE+ financial instrument and the National Fund for Environmental Protection and Water Management in Poland.

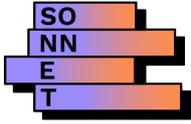
In addition to these plans and strategies, Warsaw is also implementing various initiatives towards environmental protection and sustainable development, such as developing a system of bicycle paths that ensures fast, efficient, and safe travel across the city. The system of bicycle routes serves both transport and recreational functions. It is assumed that the bicycle paths will be prioritised and adjusted to serve their purpose within the transport system. Currently, there are over 700 km of such paths.



Figure 3: Cyclists, Vistula Boulevards

(source: City of Warsaw)

Warsaw engages its citizens in co-creation of urban policies and decision-making. The Warsaw Climate Panel, which took place on November 28th in 2020, was attended by 80 randomly selected Warsaw residents, who voted on 49 recommendations that will be implemented by the city. The selected recommendations include the following actions: implementing an energy management system in all municipal public buildings (based on the PN-EN ISO 50001 standard), establishing the Warsaw green building standard, launching a municipal energy advisory system for individual and institutional investors, investing in ventilation system upgrades in schools (including recuperation) to ensure better air quality for the students, installing solar panels on the roofs of all city-owned buildings belonging by 2030 (including public car parks and city bus depots), preparing a draft resolution on real property tax exemptions for buildings or their parts connected to installations and systems using renewable energy sources.



The city's administration has been consistently greening Warsaw and taking care of its existing greenery. It is working on a Tree Rights Charter – a set of rules for greenery care and maintenance in which trees are treated as subjects rather than objects. It has also created a Tree Crown Map to facilitate the effective management of high vegetation.



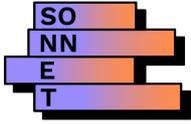
Figure 4: Panoramic view from POLiN

(source: City of Warsaw)

For several years now, Warsaw has been supporting its residents in implementation of investments that protect the environment. The municipality offers attractive grants for reservoirs and retention facilities, the installation of renewable energy sources, as well as the liquidation of obsolete stoves.

Warsaw is implementing a project called “Warsaw Green Energy Group” to provide entirely green energy for all public buildings. The city's total electricity consumption in 2020 was 7,500 GWh, with public units accounting for 616.5 GWh annually (8.22% of the city's total consumption), of which 51 GWh is renewable energy. The project involves purchasing green electricity from renewable energy sources (guarantees of origin) and the production of electricity from photovoltaic systems.

Warsaw is also preparing energy upgrades of 50 buildings as part of a public-private partnership (PPP) project. The consumption of heat and electricity from suppliers' networks will be reduced, causing a decrease in greenhouse gas emissions. The estimated annual savings related to heat



consumption and electricity will amount to approx. 17.63 GWh and 2.43 GWh, respectively. The assumed environmental effect in the form of emission reduction will be 8,068 MgCO₂ per year.

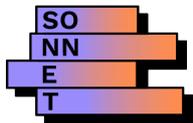
The Warsaw Climate Panel's recommendations are being prepared for implementation. Work is underway on the development of the GCAP in cooperation with ARUP.

The project involving upgrades of 50 public schools is at the stage of preparing the public procurement procedure for comprehensive consulting (economic, financial, technical and legal) services. Initially, we assumed the investment could be implemented in the ESCO model. However, having analysed the different aspects of this model, we are now considering investment also in a PPP. Advisory services will be used to compare various models of conducting the project and formulate a recommendation on the optimum one.



Figure 5: Panoramic view of Warsaw from Gdański Bridge

(source: City of Warsaw)



1.2 Understanding of SIE for SONNET

The city lab's approach to social innovation is in line with the *Warsaw2030 Strategy*⁶, the main document defining the directions of development for Warsaw. According to operational objective 4.2. – “We generate innovations” – the emergence of new ideas requires a flexible approach and mechanisms that facilitate the exchange of thoughts, experimenting and testing new solutions in various socio-economic areas. Achieving this goal is based on the development of interdisciplinary cooperation networks comprising actors from scientific, academic and research and development areas, as well as from the private and public sphere, including local communities.

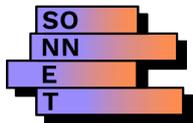
We consider SIE in our city lab as the result of a search process, which could speed up energy efficiency improvements in private households. On the one hand, it provides an opportunity for testing innovative solutions in the energy sector, and on the other, it creates room for cooperation between various social groups such as the city's administration, academics, technological innovators and, last but not least, citizens. Thus, Warsaw's case also promotes the understanding of the new role of the city's administration by engaging with diverse SIE actors.

Our perception of SIE is also based on the view that the boundaries between administration and society are blurring and that the inhabitants should be more involved in creating urban policies and governance.

Initially, we planned to conduct our city lab in eight care and education centres located in single-family detached buildings. Warsaw owns and manages these spaces, with an area of approx. 250 m² each. In every building, there are seven bedrooms, a room for the staff, a combined kitchen, a dining room, and a living area. The city lab was to rely on monitoring energy consumption in these homes, and also on youth training and gamification to increase awareness of energy use. It was defined by the Welfare and Social Projects Department, which conducted the project at the time, since it closely aligned with the Department's remit.

When the project was reassigned to the Air Protection and Climate Policy Department in January 2020, we met with Akademia Leona Koźmińskiego to discuss whether to continue with the city lab or define a new one. Since the Air Climate and Policy Department is involved in activities related to energy efficiency, as well as in engaging citizens in the co-decision making process (e.g. Warsaw Climate Panel), we decided to adjust the scope such that it aligns with these activities. At that time, we were preparing the energy transition of Jazdów (26 wooden Finnish houses, built in the summer of 1945 as the first housing estate in post-war Warsaw to provide accommodation for the engineers rebuilding Warsaw). This process was conducted with the participation of non-profit and community organisations that used these houses. This subject was also discussed during one of the meetings of the "Partnership for Climate" (organised by the Air Protection and Climate Policy Department – a knowledge and practice exchange platform which includes representatives of non-profit organisations, businesses, science, academia, and administration). Initially, the concept assumed that the city lab team would participate in defining the project, conducting interviews with participants, setting progress indicators, and checking their

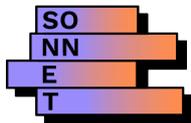
⁶ Strategia Warszawa2030, [online]. Available at: <https://um.warszawa.pl/waw/strategia/dokument-dopobrania>, accessed 05.09.21.



achievement (during the process). The guiding theme of the city lab was to co-create energy transition with the participation of various social groups, taking into account enabling factors (e.g. the involvement of various groups) and impeding factors (e.g. the need of acquiring substantial investment funds). However, despite the fact that the project could provide an interesting collaboration platform, we recognised it had too little modification value to be a city lab.

Another idea was to study energy saving methods within a community in a multi-family building in Muranów (in the north of the Śródmieście district). This community was chosen for distinguishing itself through a series of pro-ecological and social activities (e.g. a roof-installed photovoltaic system supplying energy to the common parts of the building, a meeting room for residents in the basement). We concluded a contract with the foundation that managed this building, held several meetings, and developed an action plan. However, when we agreed on the organisation of an opening event, the foundation withdrew. It turned out that the residents of the building who did not take part in the city lab were concerned about monitoring energy consumption in the apartments. According to the explanation we received from the representative of the foundation, they were afraid of the risk that their payment method for heat energy in their flats would change – they used to pay a fixed rate for energy from the district heating network, which is based on the apartment's surface area, not the actual consumption.

Due to the termination of the contract, we decided to redefine the city lab and announce a new tender for a subcontractor. Instead of conducting energy-consumption monitoring in a single multi-family building, we decided to perform data analysis in separate locations. This decision was made mainly for two reasons. First, we were mindful of the lessons learned from the previous version of the experiment. Although not all apartments in the building were to be monitored, a protest was lodged by those who lived there but were not to participate in the city lab. This revealed the risk that the consent (resolution) of the community may not be gained, with the vote of those who do not participate leading the project to failure. Second, the location of the experiment in various buildings in different districts made it possible to diversify the study group of people. This allowed us to present and review recommendations without the participants being influenced by the results obtained from their neighbours (e.g. during conversations or meetings), potentially compromising the reliability of feedback data.



2 SONNET CITY LAB PROCESS

2.1 Setting the stage

The issue addressed by the city lab related to the technological and behavioural aspects of energy efficiency in private homes. Energy efficiency is a cost-effective way to reduce greenhouse gas emissions and save money. The fact that people spend about 90% of their time indoors has a significant impact on energy consumption.⁷ Based on certain consumption trends, we can determine which behaviours can be changed in order to achieve energy savings.

The process of identifying the issue to be addressed involved representatives of Akademia Leona Koźmińskiego (Agata Dembek, Alicja Dańkowska, Agata Stasik) the Welfare and Social Projects Department (Paulina Szczęsna, Kamila Parnicka), the Air Protection and Climate Policy Department (Jacek Kisiel - Deputy Director, Marcin Grądzki – Head of Division, Dominik Kołodziejczyk – Member of the Sustainable Energy Team), as well as a private innovative entrepreneur, including Bartłomiej Steczowicz –President of the Board at NAATU Operator sp. z o. o., the company which provided technological solutions through market testing and consultations. The city lab team was involved in every task because of the established organisation of work from the very beginning. This was also necessitated by the experimental nature of the city lab, which did not have predetermined target results and focused more on reacting (by iteration) than on implementing a rigid plan. During the city lab, a communication plan was developed that involved meetings. The Air Protection and Climate Policy Department and Akademia Leona Koźmińskiego were responsible for defining the city lab and designing its schedule, as well as for its implementation, modifications, and optimisation. The energy consumption monitoring systems tested during the city lab were installed in eleven different locations in six districts of Warsaw. The system was originally developed by NAATU Operator Sp. z o. o.

The city lab started with the opening meeting and was followed by a socio-economic survey to determine the habits and daily-life routines of the participants. At the second stage, email reports were provided every week, and feedback surveys were conducted. Before the third phase, old bulbs for low energy lighting were replaced in each apartment with LED bulbs that use about 90% less energy than incandescent bulbs. The goals of the closing event were to summarise the city lab, present achievements and obtain feedback from the participants, share team reflections on the completed project, and to discuss the possible ways by which the solutions could be disseminated in the future. The event was scheduled to take place at the end of July, but due to the holiday period and the absence of most participants, it was moved to October 7th., 2021. The closing event was not very well attended and only 2 participants joined. During the discussion, the residents asked about the possibility of continuing the city lab (providing an analysis of energy consumption) and other city activities towards energy efficiency. The city wants to support

⁷ Our Time Indoors. [online] building green. Available at: <https://www.buildinggreen.com/blog/we-spend-90-our-time-indoors-says-who>

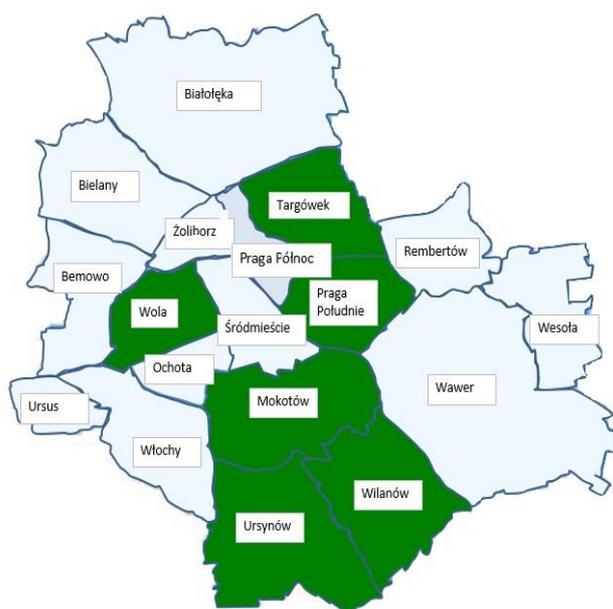
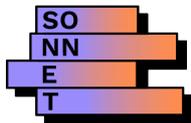


Figure 7: Map of Warsaw's districts

(source: City of Warsaw)

The issue had been addressed by the city earlier but in different ways. The Infrastructure Department of the City of Warsaw participated in the StepByStep, ICE-WISH and E3 SOHO ICT (Horizon2020) projects. The StepByStep project was based on an online platform that was created with the use of a behavioural strategy – the energy-saving actions proposed to the residents were personalised, and the proposals to take new actions were based on previous actions and responses from the survey. The residents could choose the means of contact – by phone or e-mail. The project called ICE-WISH – Demonstrating through Intelligent Control (smart metering, wireless technology, cloud computing and user-oriented display information), Energy and Water Wastage Reduction in European Social Housing was implemented from 01 April 2011 to 31 March 2014. As part of the project, residents of social housing buildings gained access to communication devices which, through an interactive system of monitoring energy consumption, were to help residents reduce electricity, water and heating bills by up to 15%. The main objective of the project was to demonstrate an integrated and repeatable ICT-based solution in 10 pilot social housing buildings across Europe. This system was intended to achieve a significant reduction in energy consumption in European social housing. The objectives were mainly to be achieved by providing feedback to residents on energy consumption and offering personalised advice on improving energy efficiency. As part of the project, an ICT system was designed and installed in social housing.

The E3SoHo – ICT Services for Energy Efficiency in European Social Housing project aimed to create a comprehensive, integrated system of controlling and managing energy consumption in social housing buildings. The system included both the monitoring and controlling of energy consumption, as well as educating residents on energy saving. The project consisted of demonstrating an integrated and repeatable ICT-based solution in three pilot social housing buildings. In Warsaw, a building at 5 Szancera Street was selected for demonstration purposes.



This system was designed to help achieve a significant (at least 25%) reduction in energy consumption. The primary means of achieving the objectives included providing feedback to residents on energy consumption and offering personalised advice on improving energy efficiency. As part of the project, an ICT-based information system was designed and installed in social housing to substantially reduce energy consumption.

The issue addressed by the SONNET City Lab is in line with the core strategic document – Warsaw 2030 – setting out a vision for the city's development to be pursued in the coming years. It is the most important document for local authorities, drafted to help them make crucial decisions.

The city lab team was composed to meet requirements specific to the project. The process of team formation started with consultations with the Welfare and Social Projects Department, which previously conducted the project. After several meetings, we decided that a new team would be formed to consist of members with different specialty areas.

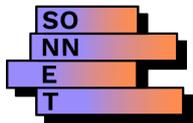
Marcin Grądzki, the Head of the Climate Policy Division (at the Air Protection and Climate Policy Department) supervised the work of the team. Dominik Kołodziejczyk, a member of the Sustainable Energy Team (the Air Protection and Climate Policy Department) led the city lab team. Agata Dembek PhD from Akademia Leona Koźmińskiego was a co-leader, and Agata Stasik PhD from Akademia Leona Koźmińskiego was a member of the city lab team. Alicja Dańkowska was a member of the team in the first phase of the experiment. The subcontractor was represented by Bartłomiej Steczowicz – the President of the Board at NAATU Operator Sp. z o. o.

It should be mentioned here that the participation of all stakeholders in the city lab was voluntary from the very beginning. However, the composition of our team changed depending on the specific requirements of the city lab as the project unfolded.

To ensure that all the stakeholders were included we conducted meetings with representatives of the academic partner, the subcontractor, and the Welfare and Social Projects Department. Every member of the team was treated equally. Members of the city lab team had equal access to information, with all perspectives and ideas being given voice, and decisions regarding both the definition of the city lab and the aspects related to its implementation being made collectively. During the city lab, the team met once a week to discuss the city lab's progress, including what has been done, what needs to be done and what hinders progress.

When starting the analysis, we faced two challenges: the need to find a reference point and define the target results. Although Warsaw had previously implemented projects on energy efficiency, such as StepByStep, ICE-WISH and E3 SOHO ICT, they had a different format. At the stage of defining our city lab, we consulted these projects with representatives of the Infrastructure Department, who implemented them, to identify potential similarities. However, discussing these projects in relation to our city lab was somewhat like comparing apples to oranges. The main differences were that those projects were of major proportions, long-term, technologically advanced and covered a large group of participants. Our project was small-scale by design.

The needs analysis was based on the purpose of our city lab, i.e. to develop collaborative governance arrangements to make energy more visible. The needs analysis method comprised



several steps. First of all, we identified groups of potential stakeholders – citizens wishing to participate voluntarily. We took into account the residents of local-authority housing buildings, but since previous experiments had already been carried out in this type of buildings, we decided not to replicate it. Subsequently, we described the service environment and the desired performance outcomes. Finally, we produced and prioritised solutions. Our city lab objective was to explore various forms of communication, raise environmental awareness, test the energy monitoring system in private apartments, compare the expenditures and profits involved in the implementation of such a system, obtain residents' feedback about the nuisance of the system (including the need to install certain devices in the apartment, collection of data on the current energy consumption, which, for example, can indicate whether someone is at home or not, and therefore raise privacy concerns). In summary, we decided that the city lab would be based on several techniques, including direct observation, questionnaires, consultation, focus group interviews, surveys (outcomes).

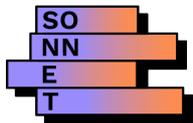
Our needs analysis took longer than originally assumed, mostly because of the Covid-19 pandemic, and due to the city lab's scope being changed. The change in the city lab scope was related to the fact that it was originally implemented by another Department of the City of Warsaw. Since the needs changed, the analysis had to be performed again. It was finished in December 2020. Later, we needed to make further adjustments following the first subcontractor's withdrawal (instead of one building, the project was to involve 11 separate locations). Nevertheless, the main assumptions, such as implementing an energy measurement system and collecting feedback from residents, remained the same.

2.2 Agenda and goal(s) setting, ex-ante analysis

The selected goals were based on project assumptions on the one hand, and in alignment with the Department's remit on the other. From the beginning, we recognised that social involvement was a key condition. Since the project was started by the Welfare and Social Projects Department, the original scope was adjusted to align with its remit, focusing on vulnerable groups. When the project was reassigned to the Air Protection and Climate Policy Department, the objectives were redefined to be more in line with its scope (the improvement of air quality, energy efficiency, social engagement) and in accordance with the strategic documents of Warsaw.

We used the SMART method when setting goals and defined them clearly. The specific issue addressed by our city lab pertained to saving energy in private homes. The project was based on measuring consumption (Measurable), possible to achieve – we performed market testing to determine if there was an innovative entrepreneur which could implement such a system (Achievable) – in line with the remit of the Air Protection and Climate Policy Department (Relevant), and had a schedule, set to end in June 2021 (Time-bound).

This process involved representatives of Akademia Leona Koźmińskiego and the Air Protection and Climate Policy Department.



Because the process could involve people with lower qualifications and exclude certain members of the community (e.g. due to the lack of internet access), we provided alternative forms of communication, such as phone calls instead of e-mails, and printed reports instead of digital ones. In addition, due to the COVID-19 pandemic and people's concerns about face-to-face contacts, we provided virtual meetings.

2.3 Experimenting (incl. network building):

The goals of the opening meeting were to present the assumptions for the city lab, its relationship with the city's politics, the schedule and procedures, and to discuss challenges and opportunities. It was attended by various stakeholders, such as the residents involved in the experiment and the contractor. All participants agreed for the outcomes of the experiment to be used for research purposes and published on SONNET websites, research blogs and academic journals, and gave permission that research data (e.g. notes taken during experiment discussions) be kept anonymous and confidential.

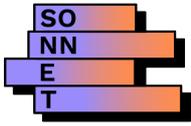
Information about the start of the city lab was posted on the city's websites and also a video promoting the start of the experiment was recorded and made available to the public. As a result, information about the start of the experiment was disseminated and reached a larger number of residents.

The opening meeting was conducted by: Bartłomiej Steczowicz – (NAATU Operator sp. z o. o.), Agata Stasik, Agada Dembek (Akademia Leona Koźmińskiego), Jacek Kisiel (Deputy Director, Air Protection and Climate Policy Department), Dominik Kołodziejczyk. Eleven residents took part in the meeting (the event was addressed only to the participants of the experiment).

Below is the agenda of the meeting that took place on 15 April 2021:

- 18:00-18:05 - Welcome speech – Jacek Kisiel
- 18:05-18:15 - Organisation of the city lab - Dominik Kołodziejczyk
- 18:10-18:20 - Presentation of city lab assumptions – Agata Stasik
- 18:20-18:30 - Innovative aspects of the city lab - Bartłomiej Steczowicz
- 18:30-19:00 - Questions and answers

The experiment started after the installation of devices measuring energy consumption. For almost six weeks that followed, participants received advice on lower energy use. In the first phase of the city lab, the contractor installed smart meters in 11 households in various locations of Warsaw to measure electricity consumption and factors affecting indoor conditions, like carbon dioxide concentration, humidity, and temperature. In the next step, participants maintained ongoing contacts with the contractor and the project partner, who investigated changes in their habits and behaviours relevant to the more efficient use of energy. Various research methods were used at this stage, such as telephone calls, regular energy efficiency reports sent by e-mail, surveys to determine the socio-economic profile of participants and their energy consumption. The last phase of the project consisted of analytical work and presenting the conclusions and solutions that could be further used in order to reduce energy consumption in everyday life –



even small energy savings in apartments, when properly propagated, can exert a strong impact on a city scale.

City Lab Goals



Creating social innovations in the energy efficiency sector by looking for ways to reduce energy consumption in everyday life



Benefits for residents (premium lighting, lower consumption, lower bills, consumption awareness)



Scaling the developed solutions by applying them in the city's housing stock

Figure 8: Goals of the city lab

(source: City of Warsaw)

The city lab's goals are presented above. The primary goal of the project is in line with Warsaw's core strategic document – Warsaw 2030 Strategy (Goal 4.2 We generate innovations). The emergence and development of ideas requires the flexible support mechanisms that facilitate the exchange of thoughts, experimenting and testing new solutions in various socio-economic areas. Once the innovations are tested and proven to work, the next step is to deploy and scale them. The city lab was an opportunity to test various solutions for implementing an energy efficiency monitoring system for private homes before these solutions were scaled.

Organization of the city lab

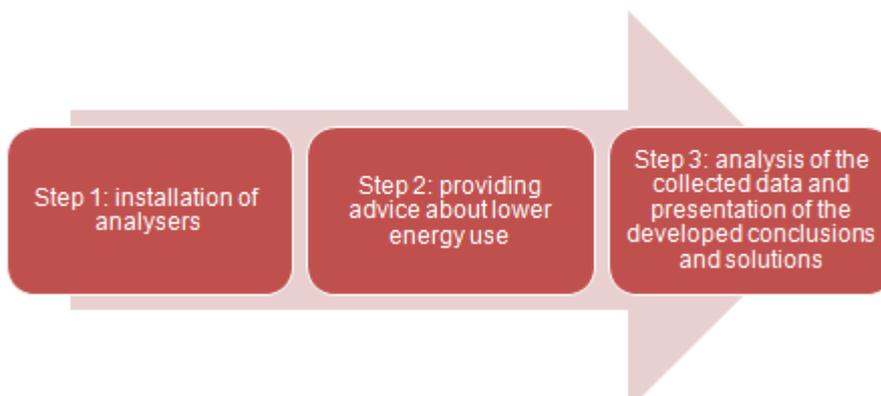
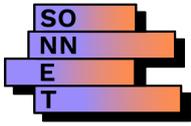


Figure 9: Organisation of the city lab



(source: Air and Climate Policy Department)

The city lab consisted of 3 cascading stages, which are presented in the diagram above. Before part one, the opening meeting with residents was organised to inform them about the roadmap of the experiment and its goals. The second stage was the main part of the city lab, consisting of data collection, aggregation, and validation – all steps needed to analyse the results. During this, phase control and telemetry stations communicated with the central system via a separate secure APN (*Access Point Name*) / GSM (*Global System for Mobile Communications*), and an IoT Sigfox network was implemented. The central system was a set of tools for the optimisation of electricity consumption and production as well as for investigating the indoor climate (CO₂, humidity, temperature).

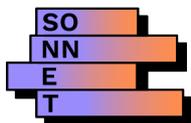


Figure 10: devices measuring electricity consumption installed in one of the apartments participating in the city lab

(source: NAATU Operator Sp. z o. o.)



Figure 11: Devices installed in one of the flats participating in the city lab



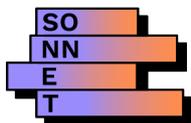
(source: NAATU Operator Sp. z o. o.)

The figures above show components of electricity consumption and indoor climate monitoring systems installed in 11 apartments. The system has been developed by NAATU Operator Sp. z o. o. Initially, the plan was to install it in March of 2021, but due to the severity of the coronavirus pandemic and residents' concerns about direct contact with the specialist installing the device (risk of infection), it was postponed. The system was set up in early May when the Covid situation seemed better. This caused the city lab to take longer than originally assumed – until 28 June 2021 (originally 20 May 2021).

The table below presents the recommendations sent to residents during the second part of the city lab. In the first week, no anomalies were found in four apartments, in the second week, this number rose to five. In one of the apartments, the consumption of energy (due to kettle use) decreased by 30%. Only one out of eleven households did not follow the recommendations given. This shows a positive trend in energy consumption following the received reports.

Table 1: Recommendations on energy use for households from 27 May 2021 to 10 June 2021

Household No.	Number of household members	27/05/2021 – 3/06/2021	3/06/2021 – 10/06/2021
1	4	Despite our suggestions in the previous report, we did not notice any change in kettle use. We reminded the household members of this issue. Additionally, significant power consumption levels at night were identified. We suggested checking the number of power supplies and home electronics in standby mode.	Household members reduced electricity consumption by an electric kettle by 30%. There is no change in the high consumption profile at night. We have not detected another anomaly.
2	4	Despite the suggestions in the previous report, we did not notice any changes in the use of air conditioning. We reminded household members of this issue. In addition, the high power consumption of the refrigerator was indicated. We suggested checking for frost and damages to the refrigerator door seal.	The householders did not respond to previous suggestions. We have not detected another anomaly.
3	4	We did not identify any anomalies. The household members went on vacation.	We did not identify any anomalies. The household members went on vacation.
4	3	The resistive device we identified proved to be a space heater used by the daughter on a regular basis to dry her sportswear. We suggested the purchase of a laundry dryer.	We did not detect other anomalies. The space heater is no longer used.



Household No.	Number of household members	27/05/2021 – 3/06/2021	3/06/2021 – 10/06/2021
5	2	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.
6	4	We identified that the energy consumption was consistently very high, 24 hours a day, at 250W. We suggested checking all the devices to see if anything is buzzing or heating up.	Household members did a check and detected a non-luminous and very warm energy-saving bulb. After replacing it, the power consumption was no longer excessively high.
7	5	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.
8	3	We learned that the lady of the house bakes pies for sale. We suggested buying a commercial oven, which has better thermal insulation and can hold several pies at a time.	The household members consider renting a small place and moving the production of pies there.
9	4	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.	We did not identify any anomalies. We identified high humidity and CO2 levels in the bedroom.
10	3	The household members started to open the window at night. CO2 levels in the bedroom at night dropped from 1,800 ppm to 700 ppm.	We did not identify any anomalies. We showed the household members a comparison of consumption with other households.
11	1	Despite the suggestions in the previous report, we did not notice any change in air quality.	Household members are considering the installation of an air handling unit with a recuperator.

(source: NAATU Operator Sp. z o. o.)

The table below presents recommendations provided to participants from the next two reports. As can be seen, in the week from 10 June to 17 June, no anomalies were detected in nine out of eleven the apartments.

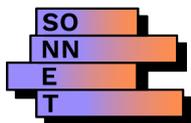
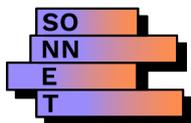


Table 2: Recommendations on energy use for households from 10 June 2021 to 28 June 2021

House hold No.	Number of household members	10/06/2021 – 17/06/2021	17/06/2021 – 28/06/2021
1	4	Night consumption fell by 50% after turning off the electronic organ, which was on all the time. We have not detected other anomalies.	The participant asks if he can keep the terminals for free permanently. He was informed that he can participate in the development of the platform for free as a Tester.
2	4	The energy consumption of the refrigerator decreased three-fold. Household members will buy a new refrigerator. We have not detected any further anomalies.	Householders are very pleased with the new refrigerator. They received the bulbs and asked if some of them could be given to their mother-in-law. We agreed.
3	4	We did not identify any anomalies. Household members were very keen to replace their light bulbs.	The participant called and asked for an offer to implement the system in his company. He asked if innogy would attach such reports to the bills in the future.
4	3	We did not identify any anomalies.	The participant received the bulbs and handed them over to our technician with a request for disposal because he did not know where to discard them.
5	2	We did not identify any anomalies. We have shown a comparison of consumption with other houses.	The participant asked if he could compare his consumption with another apartment with higher bills.
6	4	We did not identify any anomalies. We showed the household members a comparison of consumption with other houses.	Delivery of bulbs. Participant on vacation. He asked to be contacted upon his return regarding the choice of the washer / dryer.
7	5	We did not identify any anomalies. We showed the household members a comparison of consumption with other houses.	The participant said the reports should be done less frequently so that people do not grow tired of them. The information provided in these reports is valuable and it would be a pity if people lost interest.
8	3	We did not identify any anomalies. We showed the household members a comparison of consumption with other houses.	The participant asked for help in choosing a confectionery oven and calculating the cost of electricity per one baked pie.
9	4	We did not identify any anomalies. Moisture and CO2 levels are still high.	A longer telephone conversation (50 minutes) with the participant about the impact of CO2 levels on health and well-being. He lives on the top floor and is considering a private air handling unit.



House hold No.	Number of household members	10/06/2021 – 17/06/2021	17/06/2021 – 28/06/2021
10	3	We did not identify any anomalies. We showed the household members a comparison of consumption with other houses.	The question is whether you can buy bulbs from NAATU with the replacement service and whether it will be cheaper than at the store. Conversation about heavy smog in Warsaw.
11	1	We did not identify any anomalies. We showed the household members a comparison of consumption with other houses.	The question is whether Warsaw will pay for ventilation systems and chargers for electric cars.

(source: NAATU Operator Sp. z o. o.)

Below are the results of a socio-economic survey conducted in the first phase of the city lab, to which 8 out of 11 representatives of households replied (3 participants did not complete the questionnaires). 1 means: definitely no (useless, incomprehensible etc.), 5 - definitely yes (useful, understandable etc.).

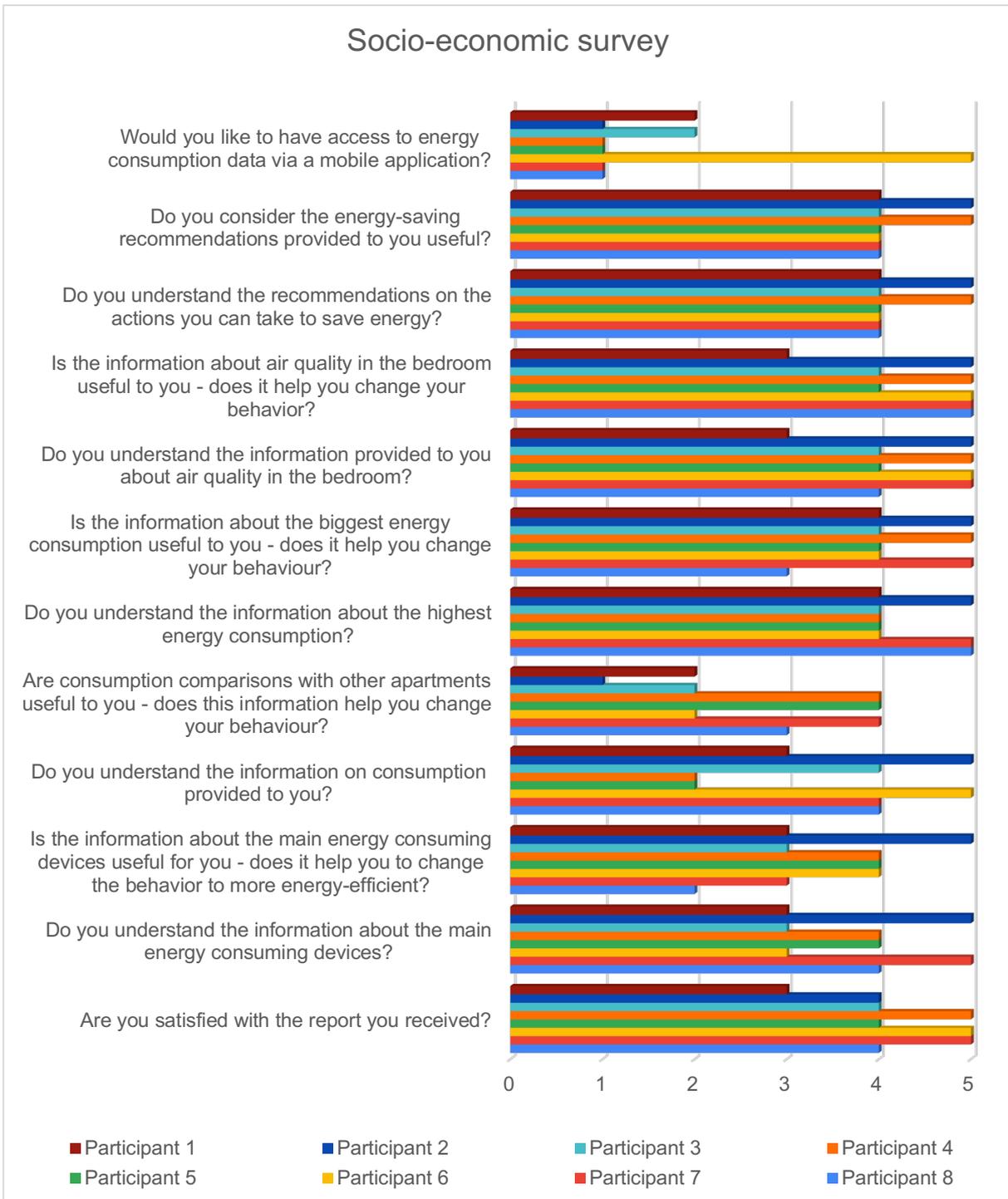


Figure 12: Socio-economic survey

(source: City of Warsaw)

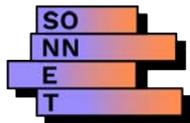
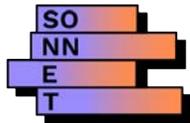


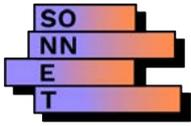
Table 3: socio-economic survey

No.	Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8
1	How would you rate the frequency of contact with the City Lab contractor (Naatu Energy)?	Sufficient	Too frequent	Too frequent	Too frequent	Too frequent	Too frequent	Too frequent	Too frequent
2	Comments and suggestions, regarding contact with the contractor (e.g. form and scope of information received).	It is a pity that the project overlaps with the end of the school year and the beginning of summer holidays.	I would like to receive such reports once a month, but on a long term basis, not only for 3 months.	Great report, could be once a month, with a text message if something is wrong with energy consumption.	Such support is valuable, but there is no time to deal with power consumption matters so often	It has to be an e-mail every 2 months and a phone call / message if there are any irregularities.	A lot of information! A report once a month would be good.	E-mail report and a telephone number at which you can call to ask questions.	It's ok.
3	If you discussed the report with other household members, what was the topic of the conversation (e.g. which information, recommendations)?	This report should be attached to your energy bill.	We didn't discuss it, but I am very interested in the air quality in our apartment and we want to have this sensor permanently .	You have to open bedroom windows at night but there is noise outside and that energy is becoming more and more expensive and you need to start saving.	Such a report should be issued to every home in Poland, it's great that Polish companies do such things.	Power monitoring should be a standard service provided by the utility company.	We talked about how technology today provides so many possibilities for energy monitoring and savings, and why the utility companies that earn so much do not provide such things.	We didn't discuss the report, but consider it valuable.	:)



No.	Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8
4	We want the report to be simple and short. Select two pieces of information that you think are the most interesting and should be included in the report.	Recommendations, CO2 levels	Appliances that consume the most energy.	Energy consumption compared to other households, CO2 levels.	Recommendations, CO2 levels	The most energy consuming devices, CO2 levels	The most energy consuming devices, CO2 levels.	Recommendations, the most energy consuming devices.	Recommendations, the most energy consuming devices.
5	Is there any other information on energy consumption that you would like to see in the next report? Submit your suggestions.	Green energy purchase proposal.	The price of energy from a cheaper supplier.	How to change the energy supplier to a cheaper one.	I do not know yet.	Planned increase in electricity prices.	Offer for electric cars.	Seasonal analysis of energy costs.	I don't know yet.
6	Is there any data you don't want to see in the report?	The amount of charges for coal and CO2 emissions on the energy bill.	Question about data security, data should be encrypted.	No	The report should be on one page.	No	No	It's all right as it is.	No
7	Other comments and suggestions	I have seen such a systemic approach in the Netherlands, it is interesting to see when such solutions will be implemented by cities and energy companies.	Warsaw has a lot of money and can subsidise such a system.	Is it a research project or something like that that will be for Warsaw residents? e.g. cheaper energy	How much will such a service cost commercially?	A nice project.	Thanks for the bulbs.	No comments.	-

(source: City of Warsaw)



Below are the results of the second survey conducted among participants in the first phase of the city lab. 8 out of 11 representatives of households replied (3 participants did not complete the questionnaires).

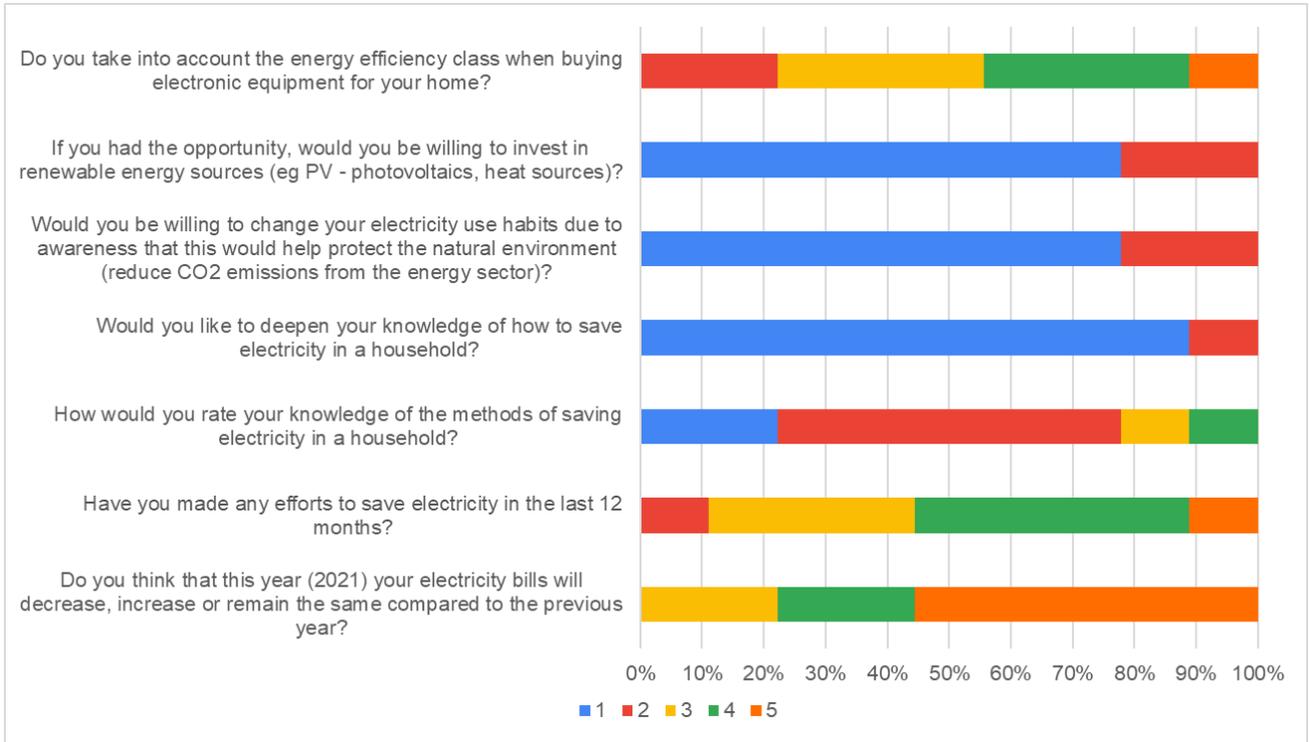


Figure 13: Survey about energy efficiency conducted among the participants

(source: City of Warsaw)

1 – definitely yes (strongly agree useful, understandable etc.).

5 – definitely no (strongly disagree, useless, incomprehensible etc.)

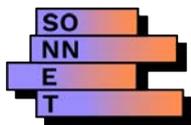
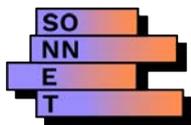


Table 4: Survey about energy efficiency conducted among the participants

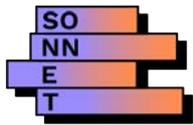
Participant	What is the name of your energy supplier?	Do you remember your (annual) average monthly electricity bill?	Would you be willing to change some of your electricity use habits if this resulted in reduced electricity bills?	On what basis do you occupy the dwelling unit?	Are there renewable energy sources installed in the building?	How long have you lived in this place? Please enter the number of years.	Which of the following expressions best describe how you manage financially in terms of the costs of running your household?
Participant 1	innogy	PLN 151-200	Yes, with savings of at least 10%	I am the owner	No	12	We're doing well - we have enough money without saving much on household costs
Participant 2	innogy	PLN 151-200	Yes, with savings of at least 5%	I am the owner	No	14	We're doing well - we have enough money without saving much on household costs
Participant 3	Alpiq	PLN 101-150	Possible savings do not motivate me to change my habits	I am the owner	No	8	We're doing very well - I (we) can afford a certain luxury
Participant 4	PKP Energetyka	PLN 201-250	Yes, with savings of at least 10%	I am the owner	No	15	We're doing averagely well - we have enough money for everyday needs, but for more expensive purchases, we need to save on household costs
Participant 5	innogy	PLN 201-250	Yes, with savings of at least 10%	I am the owner	Nie	3	We're doing well - we have enough money without saving much on household costs
Participant 6	Handen	More than PLN 250	Yes, with savings of at least 10%	I am the owner	No	18	I don't want to answer this question.



Participant	What is the name of your energy supplier?	Do you remember your (annual) average monthly electricity bill?	Would you be willing to change some of your electricity use habits if this resulted in reduced electricity bills?	On what basis do you occupy the dwelling unit?	Are there renewable energy sources installed in the building?	How long have you lived in this place? Please enter the number of years.	Which of the following expressions best describe how you manage financially in terms of the costs of running your household?
Participant 7	innogy	PLN 151-200	Yes, with savings of at least 5%	I am the owner	No	7	We're doing very well - I (we) can afford a certain luxury
Participant 8	PGE	More than 250 zł	Yes, with savings of at least 10%	I am the owner	No		We live modestly - we have to be very economical on a daily basis
Participant 9	innogy	PLN 201-250	Yes, with savings of at least 20%	I am the owner	No	14	We're doing very well - I (we) can afford a certain luxury

(source: City of Warsaw)

The overwhelming majority of respondents took energy saving measures to reduce their bills. For five out of nine, their bills should be reduced by at least 10%, for two by at least 5%, and for one by 20%. Only one of the nine respondents replied that this did not affect his choice. All respondents believed that electricity bills would grow.



3 EVALUATION

3.1 Overview of the evaluation process

The evaluation of the Warsaw SONNET City Lab aimed at supporting the City officers and other engaged parties in using the full learning potential of this experiment.

Our main goal was to understand how the method of a city lab works in the institutional context of the City of Warsaw, and how it can be adapted in the future to support the development of the City's policies for sustainable transitions in urban energy policy and beyond. For that reason, we also aimed at identifying of the most important enabling and impeding factors that shaped the process of Warsaw City Lab.

Our second goal was to understand how the concept of social innovation in energy (SIE), central to the SONNET project, was understood and shaped in the city experiment, and whether the engaged parties found the concept useful and inspiring in their work of moving towards a sustainable urban energy transition, or rather unclear and difficult to put to work.

Finally, we were interested in understanding how the direct results of the City Lab - that is, data on impact of the users behaviours on the energy use patterns - can be used to support the development of the relevant urban policies.

WP-lead suggested the following evaluation criteria, common for all SONNET City Lab:

Criteria for an ongoing evaluation:

- relevance (whether actions undertaken to address the goals set),
- inclusiveness (communication, team building).

Criteria for outcomes evaluation:

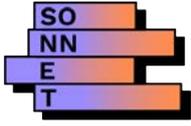
- relevance (whether actions undertaken met the goals set),
- inclusiveness (whether the results address /involve all the relevant parties),
- outreach (scope of the results and chances for scaling up).

Taking these suggestions as the point of departure, we developed the following specific questions connected to the criteria of the ongoing and outcome evaluation:

Questions for ongoing evaluation for the specific criteria:

relevance:

- How have the goals of the City Lab evolved?
- What were the obstacles to effective conduction of the City Labs?
- What lessons learnt has the city lab provided for the city administration?



inclusiveness

- Who (what categories of participants) took part in the process and what were their roles?
- Who was able to learn in the process?
- How was the process perceived by experiment participants?

Questions for outcomes evaluation for the specific criteria:

relevance:

- to what extent did the results of City Lab support the development of the urban policy for energy efficiency
- to what extent did the concept of social innovation in energy (SIE) support the City officers' broaden understanding of the challenges and possible solutions for the urban energy transition

inclusiveness:

- To what extent did the City Lab allow the new voices to the discussion of the direction of the urban energy policy, especially the voices of the previously excluded groups?
- To what extent did the City Lab strengthen the networks between urban actors interested in energy innovations and/or energy efficiency?

outreach:

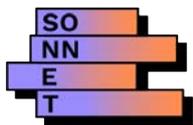
- To what extent did the City Lab allow for better preparation for further similar experiments involving monitoring of energy consumption to develop behavioural interventions to improve efficiency?
- To what extent did the City Lab contribute to a better understanding of social innovations in energy among the involved parties?
- To what extent did City Lab allow learning, testing, and evaluation of the usefulness of city lab as a method in the Warsaw context?

Due to the nature of the questions and the explorative and open character of the City Lab process, the quantitative indicators were not applied. Instead, a qualitative and reflexive approach was applied.

Following the WP4 design, the evaluation was conducted by the representatives of the Kozminski University, who were engaged in the whole process of designing, conducting, and analysing data from the City Lab.

The following evaluation methods were applied:

- Regular meetings between the Kozminski University team and the Warsaw City Lab team, documented by short memos.
- 3 interviews, conducted after the CityLab was completed, focused on the perspective of the main actors engaged in City Lab
- Surveys filled in by the participants of the experiment.



3.2 Ongoing evaluation

3.2.1 Ongoing evaluation of the process

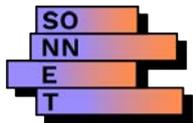
The ongoing evaluation of the City Lab process aimed at monitoring and understanding of how the process unfolded and how it was adapted to the changing circumstances. Evaluation criteria linked to the relevance and inclusiveness of the city lab drew our attention to the content of the process (goals, activities, response to conditions, and lessons learnt) and to the actors of the process.

The story of the SONNET Warsaw City Lab turned out to be quite vivid and complicated. The host of the city lab within the city administration structure, as well as the topic and scheme of the lab, were changing throughout the process. Although those changes created difficulties for conduction of the city lab and resulted in a relatively short timeframe to be able to conduct the final experiment, it was possible to draw significant insights about the process itself.

Initially, the Warsaw City Lab was hosted at the Welfare and Social Projects Department and the energy efficiency interventions were meant to be performed in municipal care and education buildings. The Kozminski University team met with the Department's representatives several times, discussing possibilities and plans for the lab. However, a significant discrepancy between the Department's key activities and priorities of the SONNET city lab's objectives emerged. Hence, the City of Warsaw decided to "move" the city lab project from the Welfare and Social Projects Department to the Air Protection and Climate Policy Department. The objectives of the city lab were more aligned with the Air Protection and Climate Policy Department's agenda and responsibilities. In addition, the Department had better access to past lessons learnt from the energy efficiency related projects conducted by the City (outlined earlier in this report), the decision on changing the lab operator within the city structure was well justified. Nevertheless, it should be noted that this process delayed the start of the city lab for several months.

It is worth mentioning that the process of choosing the most adequate operator for the lab within the city administration created an opportunity to review the departments' skills and capacities related to participatory methods and energy practices. An analysis of previously conducted projects in the field allowed tailoring the final city lab's scope and objectives. People conducting these projects shared their experiences and insights with the Air Protection and Climate Policy Department's officers responsible for the SONNET City Lab. Those insights were recognised as valuable and helpful by the officers we interviewed for this report.

Decisions on the city lab goals and objectives (i.e. achieving energy savings by monitoring energy use in private apartments and providing recommendations about everyday choices to affect energy consumption) were made by the city representatives, together with the representative of the community in which the experiment was to take place at the first attempt (multi-family building in Muranów), and supported by the Kozminski University team. The community representative approached the Air Protection and Climate Policy Department with an idea for



actions aimed at energy efficiency monitoring, and the city decided to support this bottom-up initiative through a city lab methodology.

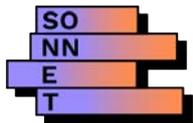
From the beginning of April 2020, an intense exchange (online meetings) between the Air Protection and Climate Policy Department's officer, the Muranów community representative and the KU team was taking place. Various options of measurement methods and communications channels were discussed. Since those developments coincided with the outbreak of the Covid-19 pandemic and the first national lockdown, it was impossible to address the community members directly at the time. Nevertheless, the community representative remained in contact with the building inhabitants, informing them about the progress of the process. In the hope of a possible loosening of lockdown restrictions, the planned opening event was postponed until fall 2020. In the context of worsening epidemic conditions, it was finally decided to organise an event online and not to meet with community members in person. Soon after that, the community partner withdrew from the project.

In an evaluation interview conducted with the community representative, the reasons for the withdrawal were discussed. The interviewee explained that some of the community members had not been sufficiently informed about the planned activities (installation of the devices measuring energy consumption in the apartments), and as a consequence "misunderstood their impacts", which led those members to not being willing to participate in the city lab. "Their refusal to participate was unexpected and shocking to me" - he declares. The community representative regrets this outcome and plans to search for other opportunities to introduce energy saving oriented interventions in the building. Reflecting on the SONNET City Lab experience, he stresses the importance of participants' involvement from the very beginning to gain their support and to explain the expected benefits. He admits he might not have paid enough attention to those initial aspects of work.

The community partner's withdrawal from the project was identified to be the most difficult and unexpected obstacle in the city lab process by the City of Warsaw representative, Dominik Kołodziejczyk (i.e. the main author of this Deliverable). By the end of 2020, the City Lab team was operating under the time pressure to find a new partner willing to perform the experiment. NAATU Operator was chosen as a subcontractor.

At this point of the process the further efforts towards the city lab realisation were led in a small team, with no outreach to involve other potential stakeholders and participants. That was due to time pressure, severe pandemic-related restrictions, but also lack of existing network of organisations and firms specialised in social aspects of energy (where the City might have looked for support) and the declared lack of experience with the lab methodology in the Air Protection and Climate Policy Department. The design of the activities and the ongoing decisions surrounding necessary corrections (e.g. linked to the scheme of weekly reports for the participants and content of the survey for participants) were made within the team composed of the Air Protection and Climate Policy Department officers, NAATU representative and the Kozminski University team. Only NAATU maintained direct contact with the experiment participants.

Reflecting on the process, the Air Protection and Climate Policy Department's officer underlined the importance of regular and frequent meetings within the core city lab team that allowed for



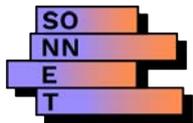
ongoing updates and necessary adjustments while the experiment was conducted. He also observed a certain ambivalence between the need for setting concrete tasks and responsibilities for a subcontractor, and the need for flexibility necessary in developing social innovation. Considering the intensity of work linked to the conduction of the experiment (e.g. weekly reporting) and the time constraints (resulting from the challenges outlined above), the dialogical potential of the city lab method was not exercised to its fullest. Nevertheless, acknowledging these obstacles, the city lab team managed to deliver valuable results.

Based on Warsaw city lab's process experience, the interviewees from the City of Warsaw drew several insights for the future. First, all of them recognised that more time and effort must be put in the early stages of the process, when the goals of the lab are defined, and stakeholders are getting involved. The work invested in these stages would increase chances for participants' buy-in and commitment, which proved to be necessary for the lab's overall success. Second, city representatives found that they might be more directly involved with the participants of the experiment, rather than “delegate” this contact to a contractor. This would be even more relevant if the lab was performed in city-owned buildings. The importance of building direct, personal relationships with the parties involved was stressed by all the interviewees. Third, they recognised that cooperation with social partners, such as relevant NGOs, and involving them from the early stages of the process, would be supportive and beneficial for an endeavour. When talking about future plans on the use of lab-like methods by the city, and about the potential for scaling up the SONNET City Lab results, city representatives acknowledged the need to involve directly (not only in a consulting role) colleagues experienced in use of participatory methods exercised in other projects conducted by the city administration (cross-departmental exchange of skills and knowledge).

3.2.2 Ongoing evaluation of the experiment

The final version of the city lab, conducted in cooperation with NATUU Operator from the beginning of 2021, was focused on achieving energy savings by monitoring energy use in private apartments and providing personalised recommendations about everyday choices to affect energy consumption. The 11 households that took part in the experiment were recruited by the contractor via LinkedIn and Facebook, as well as through a snowball method. Hence, the recruitment process cannot be evaluated as particularly open and inclusive, however given the time constraints, pandemic-related restrictions, and challenges outlined in previous parts of the report (especially a withdrawal of the community partner in the last months of 2020), it was accepted by the City Lab team. The objectives were built on the previous version of the city lab, developed with the Muranów community partner, and adjusted and enriched by NATUU Operator's expertise and technical capacities.

The final version of the city lab faced some obstacles that shall be acknowledged. The process took place at the time of Covid-19 pandemic, which significantly impacted the process. Delays and lack of possibility to meet with experiment's participants in person undermined their commitment. Due to restrictions, people were also reluctant to invite NATUU installers to their homes, so the measuring devices' installation also took more time than initially planned.



Nevertheless, key elements of the experiment, including measurements, data monitoring and ongoing feedback through reporting and surveys, were performed despite the listed barriers.

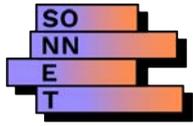
After the measuring devices were installed in the apartments, the contractor provided participants with the weekly reports on their energy usage, with personalised recommendations on behavioural changes that could improve their results. Then, the participants were asked to share their opinions on the reports in short online surveys. Those surveys served also as a communication channel between the participants and the city lab team. During the weekly meetings within the city lab team, both the content and scheme of the reports were discussed and adjusted. For example, some participants expressed concerns regarding the usage of the collected data and the operator's capacity to anonymise the results. The city lab team managed to develop a reporting scheme that allowed for capturing changes in energy usage in particular apartments (to identify interventions' impact) without disclosing participants' personal data.

It is worth mentioning that although the communication between participants and the city lab team only took place via online tools, the participants evaluated contacts with the contractor as too frequent (weekly). Possible explanations of such sentiment may be: 1) little commitment to the process due to insufficient involvement at the planning stages of the project (lack of "sense of ownership"), 2) online fatigue due to long lasting Covid-19 related restrictions, and 3) non-optimal recruitment of participants. Regardless of the answer, it should be stated that the dialogical character of the city lab method was not sufficiently explored. Participants' reluctance to get involved in communication with the city lab team was surprising for the Air Protection and Climate Policy Department's officers, as they explicitly stated in the interviews.

3.2.3 Methods evaluation

The most important method in the City Lab relied on the measurement of energy-related behaviours by the dedicated sensors and the weekly analysis of the results on the level of the household. Based on the analysis, the subcontractor presented personalised recommendations to the experiment's participants. This method served its purposes and led to the reduction of energy use, as well as the raising the awareness of the energy-saving behaviours. More so, it allowed organisers to generate insights useful for possible future experiments with energy data monitoring and for the urban energy and climate policies. However, it should be noted that due to the recruitment strategy, only highly motivated and highly aware residents joined the project. That means that one should be very cautious while generalize the results to the whole population of Warsaw residents.

Online survey was another method used during the City Lab. Throughout the duration of the experiment, by filling out two online surveys prepared with the support of the KU team, the participants could express their attitude, experience, and opinions about the experiment. Surveys were also intended to identify potential changes in participants' awareness and commitment to energy-saving behavioural patterns.



Direct contact with participants was carried out by the subcontractor. Considering participants' attitude, that is, the feeling expressed in the surveys that participation in the experiment was already quite burdening in terms of demanded time and attention, it would be difficult to perform additional activities such as interviews with them. This probably resulted from the strategy of recruiting participants to the experiment, where the expectations to engage in communication activities was not stressed enough.

3.3 Outcomes evaluation

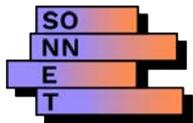
The most important method used to evaluate the outcome of the City Lab was interviews that were conducted with the key actors after the CityLab was completed. The interviews focused on the perspective of the main participants and their understanding of the process and results. Additionally, we analysed the final report submitted by the contractor and the results of the surveys filled out by the participants of the experiments. This data was scrutinised against the questions connected to the three main evaluation criteria: relevance, inclusiveness, and outreach, and discussed in detail below.

The direct result of the City Lab was the reduction of the energy consumption in the households participating in the experiments. As many as 9 out of 11 households experienced a decrease in electricity consumption. The average decrease in consumption in the whole group was about 20%. This shows a great potential of the energy efficiency and energy saving connected to the behavioural change and minor investments (change of light bulb to LED). If the whole residential sector in Warsaw decreased its energy usage by 20%, its contribution to the national and urban energy targets would be significant. Additionally, this may help to shield the residents, especially vulnerable groups, from the consequences of foreseen rises of energy prices, deriving both from climate policy and other megatrends. However, it is important to stress that due to the limited timespan of the experiment and the small sample, it is not methodologically correct to extrapolate the results to the whole population of Warsaw. The results should be rather read as an encouragement for more thorough and comprehensive research on the issue.

In our opinion, the results of this small-scale experiment show that the City can try to influence the behaviour of its residents to reduce the City's total greenhouse emissions and mitigate the consequences of rising energy prices. The approach based on regular feedback to the energy user, possible due to the real-time data analysis of the specific user, proved to be more effective than general education activities linked energy efficiency and energy saving issues. The full potential of this approach may be harnessed if the number of users will be much bigger, which allows e.g. for householders to compare their energy savings and elements of gamification.

The report submitted by the contractor allowed for the preliminary analysis of the actions, which brought the biggest changes in energy use patterns. It showed that data on energy usage inspires participants to consider the purchase of more energy-efficient home appliances. They were also ready to change some of their daily habits, such as the multiple boiling of water in the morning.

The process also allowed for the identification of potential challenges connected to the development of the system of energy usage monitoring. First, some of the participants raised



concerns related to privacy. The high-resolution real-time data on energy usage allows reconstructing the daily habits of inhabitants in detail, which bothered experiments' participants. We discuss the potential approaches to solve this issue for future similar actions in upcoming parts of this report.

Relevance:

- *to what extent did the results of the City Lab support the development of the urban policy for energy efficiency?*

According to the interviewed city officers, the results of the City Lab provided convincing evidence that the interventions based on nudging the behavioural changes can result in significantly lower energy usage. As the targets related to energy efficiency are among the most important in both urban, national, and European strategies in the climate and energy area, this result is highly relevant.

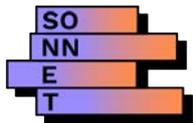
The specific way of making use of the results is still being discussed. The following options are considered:

-- using the results of the City Lab to create anonymised profiles of the energy consumers, whose changes in energy use led to lower energy usage and consequently in lower energy bills. The profiles, based on real-life data, are to be used in communication and education activities via different city channels.

-- the continuation of the research on the changes of the behavioural factors determining energy efficiency in the city context, conducted on a bigger scale would allow the creation of a more specific and detailed segmentation of the inhabitants and a better understanding of the determinants of their readiness to change their behaviours. The SONNET City Lab could serve as a "pilot study", providing useful lessons on the methodology and operational details on how to conduct this type of study. More detailed data would be very useful to understand how households from different socio-economic groups react to the information on their energy use patterns.

The option to build a large-scale system based on direct feedback on their energy use, like the one created for the City Lab participants, is not considered by the city officers now. It is perceived as too costly and operationally complicated. The officers attempt currently to make use of a number of other actions that are less expensive and may bring significant results. However, it is worth noticing that such a system may be created as a commercial service available for the Warsaw inhabitants as part of new services connected to the management of the demand side of the energy market. In such a case, the City of Warsaw may consider whether and how to support such attempts to create a new business model, which can generate a "positive externality" of lower energy use and contribute to the city's strategy.

- *to what extent did the concept of social innovation in energy (SIE) support the City officers' broaden understanding of the challenges and possible solutions for the urban energy transition?*



The notion of social innovation in energy (SIE) is understood by the city officers as a bottom-up, small-scale solution to the problems related to energy use. As SIEs emerge to answer specific problems, they often are more creative and agile than solutions proposed by the city or other established institutions. Officers from the City of Warsaw understand the importance of being able to identify and support ideas that may generate social innovations connected to energy challenges. They stress that it has already happened through different forms of public consultation and participation, such as the Warsaw Climate Panel or consultation of the new strategy “Green Warsaw Vision”.

Inclusiveness:

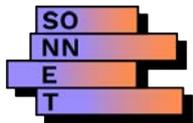
- *to what extent did the City Lab allow new voices to the discussion linked to the direction of urban energy policy, especially the voices of the previously excluded groups?*

The design of the Warsaw City Lab did allow for the entrance of the new, previously unheard voices to the debate about urban energy policy but based on a limited scope, seeing that the actions were conducted as part of a group that consisted of the City representatives, the KU representatives, the contractor, and the members of 11 households (34 people). Thus, the inclusiveness was limited to this group.

The experiment’s participants shared their opinion mainly through the surveys. This allowed us to understand their perspectives on different aspects of the experiment, energy use, and broader issues related to energy policy. Among the interesting results, surveys allowed establishing that most of the participants are convinced that energy prices are going to rise. Interestingly, 80% assess their own knowledge on energy-saving as high or rather high, but all of them wanted to deepen the knowledge. 80% were ready to change their habits if energy bills were to be lowered by 10% or less, and for all the participants, environmental motivation (potential to curb CO2 emissions) was also important. Finally, all the participants express their interest in investing in renewable energy sources, if the opportunity emerges. These answers allow us to see that the City Lab participants are very advanced in terms of their awareness of changes in the energy sector and their impact on the climate and environment. Their answers and attitudes should not be generalised for the whole population of the City of Warsaw. However, it shows that in the City of Warsaw there is a group of inhabitants, who are ready to take an active role in the coming energy transition.

Inclusiveness and communication between the city representatives and participants were limited due to the following reasons, which should be taken into account in the follow-up research:

-- the recruitment of the participants, conducted by the contractor, was focused on ensuring the participation of the households ready for the installation of the sensors. Seeing it as a main part of the activities undertaken in City Lab, participants did not secure the time to take part in other activities and were rather annoyed by frequent contact by the City Lab organizers. Almost 90% of the participants evaluated the contact with a contractor as “too frequent”, signalling that they experienced it as a burden. This reflects a common dilemma linked to these types of actions where the inhabitants’ participation is desired but the active and time-consuming participation is “luxury” many people cannot afford.



-- communication with participants was conducted by the contractor and not the city representatives. This could have led to the loss of some information and feedback conveyed to the contractor.

- *to what extent did the City Lab strengthen the networks between urban actors interested in energy innovations and/or energy efficiency?*

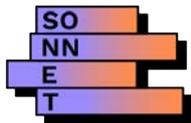
As the City Lab was conducted in cooperation between the representatives of the City of Warsaw, Kozminski University, and the contractor (NAATU energy), the relations between involved parties were mainly strengthened.

The City Lab could be more inclusive if other social partners would have been involved, especially at the early stage (when the final shape of City Lab was decided) and at the stage of sharing results and generating ideas on how they might be used. This second activity can still be conducted beyond the scope of SONNET City Lab.

Most important method used to evaluate the outcome of the City Lab was interviews conducted with the key actors after the CityLab was completed. Interviews were focused on the perspective of the main participants and their understanding of the process and results. Additionally, we analysed the final report submitted by the contractor and the results of the surveys filled by the participants of the experiments. These data were scrutinized against the questions connected to the three main evaluation criteria: relevance, inclusiveness, and outreach, and discussed in detail below.

The direct result of the City Lab was the reduction of the energy consumption in the households participating in the experiments. As many as 9 out of 11 households experienced a decrease in electricity consumption. The average decrease in consumption in the whole group was about 20%. That shows a great potential of the energy efficiency and energy saving connected to the behavioural change and minor investments (change of light bulb to LED). If the whole residential sector in Warsaw decreased its energy usage by 20%, its contribution to the national and urban energy targets would be significant. Additionally, that may help to shield the residents, especially from vulnerable groups, from the consequences of the foreseen rise of energy prices, deriving both from climate policy and other megatrends, such as high prices of natural gas on global markets. However, it is important to stress that due to the limited timespan of the experiment and the small sample, it is not methodologically correct to extrapolate the results to the whole population of Warsaw households, or even be sure that observed change would be stable and did not result from random factors. Rather, the promising results should be read as encouragement for more thorough and comprehensive research on the issue.

In our opinion, the results of this small-scale experiment show that the City can try to influence the behaviour of its residents to reduce the City's total greenhouse emissions and mitigate the consequences of rising energy prices. The system based on the regular feedback to the energy user, possible due to the real-time data analysis of the specific user, proved to be more effective than general education on energy efficiency and energy saving. The full potential of this system may be harnessed if the number of users will be much bigger, which allows e.g. for the comparison between similar households and elements of gamification.



The report submitted by the contractor allowed for the preliminary analysis of the actions which brought the biggest changes in energy use patterns. It showed, i.e., that data on energy usage inspires participants to consider the purchase of more energy-efficient home appliances. They were also ready to change some of their daily habits, such as the multiple boiling of water in the morning.

The process also allowed for the identification of potential challenges connected to the development of the system of energy usage monitoring. First, some of the participants raised concerns related to privacy. The high-resolution real-time data on energy usage allows reconstructing the daily habits of inhabitants in detail, which bothered experiments' participants. We discuss the potential approaches to solve this issue for future similar actions in further parts of this report.

Relevance:

- *to what extent did the results of City Lab support the development of the urban policy for energy efficiency?*

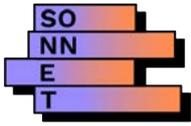
According to the interviewed city officers, the results of the City Lab provided convincing evidence that the interventions based on nudging the behavioural changes can result in significantly lower energy usage. As the targets related to energy efficiency are among the most important in both urban, national, and European strategies on the climate and energy area, this result is highly relevant.

The specific way of making use of the results is still being discussed. The following options are considered:

-- using the results of the City Lab to create the anonymized profiles of the energy consumers, whose changes in energy use led to lower energy usage and in consequence - lower energy bills. The profiles, based on real-life data, are to be used in communication and education via different city channels.

-- the continuation of the research on the changes of the behavioural factors determining energy efficiency in the city context, conducted on the bigger scale, which would allow the creation of the more specific and detailed segmentation of the inhabitants and better understanding of the determinants of their readiness to change their behaviours. For that, SONNET City Lab would serve as a "pilot study", providing useful lessons on the methodology and the operational details on how to conduct the study of this type. More detailed data would be very useful to understand how households from different socio-economic groups react to the information on their energy use patterns.

The option to build a large-scale system based on the direct feedback on the energy use, like the one created for the City Lab participants, is not considered by the city officers now. It is perceived as too costly and operationally complicated. At this stage of the efforts to raise energy efficiency on the city level, the officers see the number of other actions that are less expensive and still may bring significant results. However, it is worth noticing that such a system may be created as a commercial service available for the Warsaw inhabitants as a part of the new services connected



to the management of the demand side of the energy market. In such a case, the City of Warsaw may consider whether and how to support such attempts to create a new business model, which can generate a “positive externality” of lower energy use and contribute to the city’s strategy.

- *to what extent did the concept of social innovation in energy (SIE) support the City officers’ broaden understanding of the challenges and possible solutions for the urban energy transition?*

The notion of social innovation in energy (SIE) is understood by the city officers as a bottom-up, small-scale solution to the problems related to energy usage. As SIEs emerge to answer specific problems, they often are more creative and agile than solutions proposed by the city or other established institutions. Officers from the City of Warsaw understand the importance of being able to identify and support ideas that may generate social innovations connected to energy challenges. They stress that it already happens through different forms of public consultation and participation, such as the Warsaw Climate Panel or consultation of the new strategy “Green Warsaw Vision”.

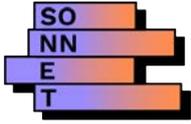
Inclusiveness:

- *to what extent did the City Lab allow the new voices to the discussion of the direction of the urban energy policy, especially the voices of the previously excluded groups?*

The design of the Warsaw City Lab did allow for the entrance of the new, previously unheard voices to the debate on the urban energy policy for the limited scope, as the actions were conducted in the group consisted of the City representatives, KU representatives, the contractor, and the members of 11 households (34 people). Thus, the inclusiveness was limited to these groups.

The experiment’s participants shared their opinion mainly through the surveys. That allowed us to understand their perspectives on different aspects of the experiment, energy usage, and broader issues related to the energy policy. Among the interesting results, surveys allowed establishing that most of the participants are convinced that energy prices are going to rise. Interestingly, 80% assess their own knowledge on energy-saving as high or rather high, but all of them wanted to deepen the knowledge. 80% were ready to change their habits if energy bills were to be lower 10% or less, and for all the participants, environmental motivation (potential to curb CO2 emissions) was also important. Finally, all the participants express their interest in investing in renewable energy sources, if the opportunity emerges. These answers allow us to see the City Lab participants as very advanced in terms of awareness of the changes in the energy sector and their impact on the climate and environment. Their answers and attitudes should not be generalized for the whole population of the City of Warsaw. However, it shows that in the City of Warsaw there is a group of inhabitants who are ready to take an active role in the coming energy transition.

Inclusiveness and communication between the city representatives and participants were limited due to the following reasons, which should be taken into account in the follow-up research:



-- the recruitment of the participants, conducted by the contractor, was focused on ensuring the participation of the households ready for the installation of the sensors, and they were not very open to taking part in other activities due to limited time. Almost 90% of participants evaluated the contact with a contractor as “too frequent”, signalling that they experience it as a burden. That reflects a common dilemma of the actions where the inhabitants’ participation is desired: active and time-consuming participation is “luxury” many people cannot afford.

-- communication with participants was conducted by the contractor and not the city representatives. That could have led to the loss of some information and feedback conveyed to the contractor.

- *to what extent did the City Lab strengthen the networks between urban actors interested in energy innovations and/or energy efficiency?*

As the City Lab was conducted in cooperation between the representatives of the City of Warsaw, Kozminski University, and the contractor (NAATU energy), mainly the relations between involved parties were strengthened.

The City Lab could be more inclusive if other social partners were involved, especially at the early stage (when the final shape of City Lab was decided) and at the stage of sharing results and generating ideas on how they may be used. This second activity can still be conducted beyond the scope of SONNET City Lab.

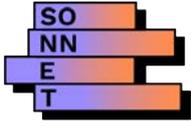
Outreach:

- *to what extent did the City Lab allow for a better preparation for further similar experiments involving monitoring of energy consumption to develop behavioural interventions to improve efficiency?*

The experience gathered in the City Lab allowed the city representatives to gain a better understanding of the challenges linked to the activities involving the gathering and processing of the real-time data on energy use.

First, it showed the importance of communicating about the issues related to privacy and data protection. This is a sensitive topic for the participants and even though digital “tracking” is a common experience, the situation where energy data enabled the detailed observation of everyday actions caused some unease among participants.

Second, the communication with experiment participants allowed for a better understanding of the people’s expectations connected to the type of information feedback needed and resources they are ready to devote to monitor their energy usage and energy-related behaviour. As mentioned above, the frequency of the reports - sent once a week during the City Lab - was experienced as too high. Participants suggested that they would like to receive the reports monthly or bi-monthly. Apart from the regular reporting, they were also open to the possibility to receive an alert (via SMS or e-mail) if some irregularity is detected.



Third, the experiment allowed us to gain insights on how to present the information on energy use - e.g. which graphs are found to be most understandable and useful to modify energy-related behaviours. Participants especially appreciated data on home appliances, which are responsible for the largest amount energy consumed (“energy eaters”) and specific recommendations. The presentation of the household’s energy consumption against the background of similar households was less attractive and understandable.

Fourth, the experiment shows that participants found the data on the CO₂ indoor concentration interesting and relevant; adding this information may make the participation in similar project in future more attractive.

- *to what extent did the City Lab contribute to a better understanding of social innovations in energy among the involved parties?*

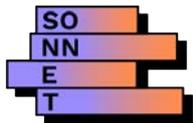
The City Lab was focused on the technology-mediated change of energy-related behaviour, which is one of the types of social innovation in energy. However, it did not create the space to consider other types of SIE, or a variety of SIEs. Especially when communicating with the City Lab participants, aspects of awareness-raising or education on SIE was not explored - communication was focused on the technical issues and related behaviours.

- *to what extent did the City Lab allow learning, testing, and evaluation of the usefulness of the CityLab as a method in the Warsaw urban context?*

The SONNET City Lab allowed the representatives of the City of Warsaw to test the specific organisational setting – city lab – to conduct the small-scale experiment. It encouraged a cooperation between the City, Kozminski University, and the contractor, with the involvement of the experiment’s participants. As the City Lab allowed the city to gather useful data, it proved its value.

At the same time, the difficulty to find a city department interested in conducting the City Lab shows that this organisational form is somehow difficult to align to the existing structures and routines that make up the Warsaw City Hall.

We believe that future city labs - if the City of Warsaw decides to continue experimenting with this form of information gathering and solution testing - should be more closely connected to other ongoing projects and programs conducted by the City of Warsaw, to offer additional insights for the activity that is seen as a priority in the City Hall. What is more, to harness the full potential of the city lab, its future formula should be more inclusive both towards social organisations interested in the issue at stake (e.g. social innovations in energy transition) and towards the inhabitants. Thanks to such modifications, the city lab could be a more efficient tool to harness diverse perspectives and ideas on how to shape urban energy transitions with the participation of the residents.

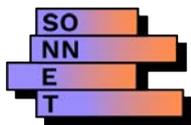


3.4 Analytical reflection of evaluation as a summary

The Warsaw SONNET City Lab provided a space that allowed us to collect promising data on the impact of providing personalised energy behaviour feedback on people's energy saving. As discussed above, the results can inspire further actions conducted by the Warsaw City Hall to ground the evidence in more comprehensive research projects and communicate the results to its stakeholders, including residents.

The design of the Warsaw SONNET City Lab assumed the close cooperation between the officers from the Air Protection and Climate Policy Department, Kozminski University, and the subcontractor experienced in energy monitoring and analysis. Through regular meetings, it allowed the exchange of knowledge and know-how between the parties and due to this collaboration, we can frame it as social innovation in energy in the context of Warsaw City Hall practices (especially in terms of "thinking and organising energy"). However, its design did not allow for the involvement of other stakeholders, such as NGOs, non-formal groups, or housing cooperatives. More attention to issues of inclusiveness would strengthen the social innovativeness of the Warsaw City Lab. Admittedly, building more inclusive experiments demands more resources, especially time, necessary to create a community around the issue at stake, build common understandings, and collectively decide on the course of action. The process of the Warsaw City Lab that was influenced by having to change contractors and executive departments, left limited time to develop a more inclusive endeavour. Under the pressure of time, the actions towards broader engagement of different stakeholders were not initialised. COVID-19 pandemic made it even more difficult, as the face-to-face meetings were virtually impossible.

It is worth stressing that the City of Warsaw supports the turn towards more inclusive decision-making in the area of the environmental and climate challenges, e.g. through the Warsaw Climate Panel. However, it is still not easy to include this rule in everyday actions. The City Lab, if accepted as one of the methods to foster broader engagement, experimentation, and as a consequence better decision-making, could be a vehicle that strengthens the City's capacity to reach out for ideas and other resources from its social environment. We believe that each consecutive city lab on social innovation in energy would build on the experience of the former, to find a mode of collaboration which is both efficient and inclusive. However, as in other cities, it is not easy to secure the funding for such lab-like activities from the departments' regular budget. Rather, city labs are funded by tailored projects such as SONNET, which makes it harder to build know-how and networks within a city administration.



4 CITY PARTNER ANALYTICAL REFLECTION AS A SUMMARY

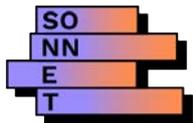
Raising climate awareness among the residents was one of the goals of the project (opinions were collected by a contractor). The participants learned about the map of climate threats in Warsaw. Seven out of eleven participants confirmed that they were afraid of rising temperatures in Warsaw. Four out of eleven participants confirmed that they were afraid of floods in Warsaw. Eight out of eleven participants confirmed that they were concerned about the increase in the frequency and intensity of heavy precipitation (heavy rainfall and hail) in Warsaw.

Project participants expressed their interest in permanent cooperation with the City of Warsaw to create an urban ecosystem that would promote the reduction of the carbon footprint and climate threats in Warsaw. This insight should inspire efforts to build a systemic solution for cooperation between the City of Warsaw and the residents.

Table 5: Energy consumption in households

Household no	Number of household members	Type of dwelling unit	Electric energy consumption 27.05 - 03.06 [kWh]	Electric energy consumption 03.06 - 10.06 [kWh]	Increase / decrease in energy consumption week to week [kWh]	Electric energy consumption 10.06 - 17.06 [kWh]	Increase / decrease in energy consumption week to week	Electric energy consumption 17.06 - 24.06 [kWh]	Increase / decrease in energy consumption week to week	TOTAL ENERGY CONSUMPTION [kWh]	TOTAL ENERGY CONSUMPTION [kWh]
1	4	apartment	53.00	56.00	6%	46.00	-18%	45.00	-2%	200	-15%
2	4	apartment	68.00	66.00	-3%	67.00	2%	49.00	-27%	250	-28%
3	4	apartment	94.00	83.00	-12%	79.00	-5%	85.00	8%	341	-10%
4	3	apartment	45.00	38.00	-16%	36.00	-5%	23.00	-36%	142	-49%
5	2	apartment	67.00	54.00	-19%	55.00	2%	49.00	-11%	225	-27%
6	4	semi-detached house	211.00	164.00	-22%	158.00	-4%	99.00	-37%	632	-53%
7	5	apartment	89.00	86.00	-3%	89.00	3%	93.00	4%	357	4%
8	3	apartment	52.00	42.00	-19%	43.00	2%	37.00	-14%	174	-29%
9	4	apartment	77.00	87.00	13%	65.00	-25%	46.00	-29%	275	-40%
10	3	apartment	40.00	32.00	-20%	29.00	-9%	24.00	-17%	125	-40%
11	1	apartment	21.00	32.00	52%	29.00	-9%	35.00	21%	117	67%

(source: Naatu Operator Sp. z o.o.)



The table above shows a summary of the analysis based on data obtained from electricity consumption analysers during the city lab (second stage from 20 May 2021 to 28 June 2021), figured on a weekly basis [in kWh] and indicating the week-to-week differences (%) in energy consumption (per household). Nine out of eleven households decreased their electricity consumption following the experiment. The average decrease in consumption was about 19.9%.

This proves that the recommendations provided in reports were effective. The participants of the SONNET project expressed their interest in long-term participation in such projects, suggesting that they must be multi-annual, since 2-3 months was too short.

The participants liked the design of the reports, submitting various interesting ideas and comments to them.

The participants expressed their wish to receive monthly reports containing:

- comparisons of energy consumption with similar households (benchmarking reports),
- alerts to indicate which devices are consuming too much energy,
- alerts about device failures, including alerts about fire hazards of photovoltaic systems and energy storage,
- alerts for excessive/insufficient air humidity and CO2 levels.

Residents indicated the nuisance of the heat in Warsaw. Most of them would like to have air conditioning if it was available at a very affordable price and if the energy was green.

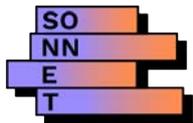
Project participants said their children and grandchildren would have to deal with the effects of climate change. Before the project, participants were convinced that they were unable to cope with these challenges. To many of them, it seemed that there was nothing they could do as individuals to change the situation.

In the opinion of the city lab team, the greatest achievement of the lab was awakening the awareness that everyone is able to do at least a little, and that great changes could be achieved collectively: we can manage our energy more efficiently. Reducing the amount of energy consumed by using energy-efficient devices and services, and ensuring that we do not waste energy, can make a significant difference to future generations.

Participants believed it was possible to reduce the actual energy consumption of their households by 20-30% without compromising their quality of life.

The city lab had too short of a timeframe to provide detailed recommendations for the replacement of home appliances. However, the participants understood that a new refrigerator could provide them with energy savings and that, for example, a damaged seal in a refrigerator leads to a 20% increase in energy consumption by the appliance.

The implementation of the city lab showed a positive trend in energy consumption and growing environmental awareness among the citizens who took part in it. The project's cost-benefit analysis seems favourable. Therefore, we are interested in scaling up the developed solutions or applying a similar model in public buildings.



Appendix 1: EC summary requirements

Changes with respect to the DoA

The city lab was completed but faced several challenges during implementation which led to some minor delays. First, the process of defining the city lab took longer than originally planned, mostly because of covid-19 pandemic impacts. In addition, the city lab was moved to the Air Protection and Climate Policy Department within the city of Warsaw due to better alignment, but this implied the need for some replanning. Second, the city lab team had to make adjustments following the first subcontractor's withdrawal. In doing so, the team ensured that the main assumptions of the experiment, such as implementing an energy measurement system (data monitoring) and ongoing feedback through reporting and surveys, remained unchanged. Third, due to the severity of the coronavirus pandemic and residents' concerns about direct contact with the specialists installing the devices, the installation was postponed. The system was thus set up in early May 2021 when the covid-19 situation seemed better (initially, the plan was to install it in March of 2021). Dealing with these challenges caused the city lab to take longer than originally assumed – until 28 June 2021 (originally 20 May 2021). Finally, because of the holiday period the closing event was moved to October 7th, 2021.

Dissemination and uptake

This deliverable will be made publicly available on the SONNET website (<https://sonnet-energy.eu>) as well as via Zenodo.

Short Summary of results (<250 words)

The purpose of the Warsaw city lab was to develop collaborative governance arrangements to make energy more visible. On the one hand, it provided an opportunity for testing innovative solutions in the energy sector, and on the other, it created room for cooperation between various social groups such as citizens, the city's administration, academics, technological innovators. The direct result of the City Lab was the reduction of the energy consumption in the households participating in the city-lab (the average in the whole group was about 20%). The conducted city lab also allowed for the identification of potential challenges with the development of the system of energy usage monitoring. First, some of the participants raised concerns related to data privacy and data security. Collection of data on the live energy consumption allows reconstructing the daily habits of experiments' participants. It showed the importance of communicating about the issues related to privacy and data protection but also an importance of the transparency of the process. Second, the frequency of the reports - sent once a week during the City Lab - was experienced as too high. Participants suggested that they would like to receive the reports once or twice a month. They were also open to the possibility to receive an alert (via SMS or e-mail) if some irregularity is detected.

Evidence of accomplishment

This document.