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SEPlaM-CC – Raising capacity of cross-border public institutions in sustainable energy planning and management and climate change mitigation

(HUHR/1901/3.1.1/0048)

Analysis of best practice examples in energy refurbishment, renewable energy sources usage and climate change mitigation

Prepared by: North-West Croatia Regional Energy Agency

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July, 2021

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1. Best practice examples in energy refurbishment, renewable energy sources usage and climate change mitigation at national level

1.1. Best practice examples in energy refurbishment

Num.	1	
Title of best practice	Energy refurbishment of high school in Velika Gorica	
Brief description	Buildings of City of Velika Gorica high schools with gymnasium (vocational, economy and grammar school) were fully retrofitted. The retrofit included new thermal insulation of the whole building envelope, with reconstruction of roof and all outdated installations. The project resulted with significant decrease in energy consumption and thus lower energy bills, and it also promotes utilisation of RES. The air-water heat pump was installed for heating and cooling of two gymnasium buildings, with full new ventilation systems. Remote metering was installed for all energy and water consumption thus enabling better management of consumption and promoting further energy and emission savings through energy planning optimisation. The overall result of the project, in addition to achieved energy and emission savings, was that the comfort of teaching and studying has been significantly improved. The project had thus directly benefited more than 1 300 students and school staff. The retrofit will also contribute to lower maintenance and operation costs and, due to improved comfort, to better quality of schooling.	
Detailed description	**Location**	City of Velika Gorica, Zagreb County, Croatia
	Concept and background	The school building was built in year 1985, using materials and design methods which do not meet today's energy efficiency standards. The project combined construction, mechanical and electrical engineering methods which resulted in energy efficiency improvements, energy savings and utilization or renewable energy sources. Financial savings resulting from energy savings and CO_2 emission reductions will enable quality improvements in conducting educational activities, while providing indoor comfort for students, teachers, and other school staff. The renovation project included thermal retrofitting of the building envelope – walls, windows and doors, reconstruction and insulation of the roof, installation of the air-water heat pump for heating and cooling of the gymnasium, and utilisation of RES. The project also contributed to boosting local business, particularly construction, thus contributing to overall economic development of the region.
	Timeframes	22/02/2019 – 22/05/2022

	Objectives and main activities	Aim of the project was to improve energy efficiency by implementing energy retrofit measures and by using RES. The project is demonstrating great potential and synergies of multiple benefits arising from energy retrofits of the buildings in the public sector, especially schools. In addition, besides energy and financial savings, the project is directly contributing to teaching next generations on benefits of energy efficiency and RES utilization. The project included the following main activities: - Reconstruction of the exterior walls - Replacement of the windows and doors - Reconstruction of the roof - Renovation of the heating system including new system for domestic hot water preparation and installation of the air-water heat pump for heating, cooling and ventilation in the gymnasium (2 separate buildings) - Reconstruction of indoor lighting replacing existing lighting with LED - Replacement of all outdated installations and installation of remote energy and water consumption metering
	Barriers and problems occurred	- Short implementation period – only 24 months for public procurement and construction works - Complex public procurement procedure - Performing construction works during teaching hours - Aligning additional user requirements with the project during construction works
	Main results and findings	- Improvement of energy class from D to A (heat transfer coefficient of the exterior walls U≤0,25W/m^{2}K, U≤0,20W/m^{2}K for ceiling towards the unheated area and U≤1,40W/m^{2}K for window frames with U≤1,10W/m^{2}K for glass); - Improvement of quality of working and learning conditions for teachers, other staff and students; - Boosting local business and economy; - Overall implementation of all measures results with 81.24% savings in heating, 75.72% savings in primary energy and 81.24% CO_2 emission savings
Contact details of the responsible investor	Zagreb County, Ulica grada Vukovara 72/V, 10 000 Zagreb, tel.: 00385 1 6009 461 Authorised for conducting the role of Head of the Administrative Department for Economy and EU funds, Damir Fašaić, dipl. oec., tel.: 00385 1 6009 461, e-mail: d.fasaic@zagrebacka-zupanija.hr	

Funding scheme	European Structural and Investment Fund, European Regional Development Fund, Operational Programme Competitiveness and Cohesion 2014-2020 Zagreb County [1] Total project net value: 30 817 443,78 HRK Total eligible costs: 30 340 441,28 HRK ERDF grant: 15 155 068,10 HRK Zagreb County own funding: 15 662 375,68 HRK
Photos	  

Num.	2	
Title of best practice	Energy refurbishment of kindergarten Buje and Italian kindergarten Mrvica	
Brief description	Project of energy refurbishment of the kindergarten in Buje with the net value of 7 million HRK (around 930k EUR) is the most valuable project implemented in City of Buje, supported by the EU funding. It is a remarkable example of how an older building can be fully retrofitted and turned into modern educational facility. The retrofit has resulted in switching the energy class of the building from E to a high A+ thus contributing to significant energy savings of more than 50%. The project included retrofit of the whole exterior building envelope (roof, walls, windows and doors) and instalment of the heat pump and photovoltaic panels. In addition to achieving significant energy and CO_2 savings, the project has contributed to boosting local economy, to increasing the production of RES powered electricity and to improvement in quality of schooling and working in the kindergarten. The overall functionality of the kindergarten was improved and better environment for children and staff was ensured.	
Detailed description	**Location**	City of Buje (Croatia)
	Concept and background	The building where the two main kindergartens of Buje are sited (Croatian speaking kindergarten and Italian speaking kindergarten Mrvica) was built in 1983 and it has an area of 1 637 m^2. Prior to renovation, the building (by its construction characteristics) did not meet the requirements of the functionality of the space for its purpose and energy efficiency. Therefore, the purpose of the project was to bring the building into architectural functionality and higher energy efficiency. At the end, after renovation was completed, this resulted with a better working environment both for users and for the employees. The project with a total value of 7 million HRK was mostly financed from EU funds and is a great example of how a very old building can get a new shine. After the renovation, the kindergarten building moved from E class to high A + class and thus brought energy savings of more than 50%.

	Timeframes	From November 2019 to April 2021
	Objectives and main activities	Reduction of CO_2 emissions and increase of energy efficiency is sought to be achieved through European legislation, cross-sectoral cooperation, connecting international, national and regional stakeholders and EU projects. In Croatia, as in the entire European Union, almost 50% of final energy consumption is used for heating and cooling, of which 80% in buildings. The City of Buje is among the first local authorities in the Region of Istria to be involved in reducing harmful gas emissions and slowing down climate change, all through the key energy sector. Implementation of energy renovation measures included increasing the thermal protection of the roof above the heated space, increasing the thermal protection of the external wall, replacing the external carpentry, installing a new highly efficient heating system (heat pump), replacing the existing DHW system with RES using production of electricity from RES for the needs of ETC.
	Barriers and problems occurred	The age of the building (40 years), the location (steep and slippery terrain and the old reinforced concrete prefabricated structure) were a challenge in terms of works to be done very carefully to avoid damages to the building itself and to its stability.
	Main results and findings	The achieved energy savings Qh, and is 69 647.69 [kWh/a] (or 55.89%), and the reduction of CO_2 emissions is 20.52 [t/year, and the facility has switched to energy class A
Contact details of the responsible investor	City of Buje-Buie, local authority, Istarska n. 2; 52460 Buje (Croatia), Tel: + 385 52 772 122, Fax: + 385 52 772 158, e-mail: info@buje.hr, www.buje.hr, Mayor: Fabrizio Vižintin	
Funding scheme	1. External financing: 1.1. EU funds: total Euro 1 390 691,22 HRK = 185 425,50 EUR 1.2. Croatian Ministry for regional development and EU funds: 2 588 602,13 HRK = 345 146,95 EUR 2. Internal auto financing by the City of Buje: total Euro 2 958 019,51 HRK = 394 402,60 EUR	

Photos	  


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EUROPSKI STRUKTURNI I INVESTICIJSKI FONDOVI
EUROPSKA UNIJA ZAJEDNO DO FONDOVA EU
Energetska obnova zgrade Dječji vrtić Buje i talijanski vrtić „Mrvica“ na adresi Matije Gupca 13, Buje
Projekt je sufinancirala Europska unija iz Europskog fonda za regionalni razvoj.

1.2. Best practice examples in renewable energy sources usage

Num.	3	
Title of best practice	Construction of the solar power plant through the on-site power purchase agreement (PPA) project at the Zabok General Hospital	
Brief description	Zabok General Hospital is a significant electricity user, and as it is suitably located for installation of photovoltaic power plant it was decided to consider possibility of renewable energy production for own purposes. As the initial investment is significant and posed a barrier to implementation if the hospital was to fund the entire investment, the public- private model was chosen. The power purchase agreement (PPA) was defined and signed between the hospital and private investor enabling hospital to save on initial investment costs, and after expiration of the PPA to have lower electricity bills and thus to redirect savings into better healthcare.	
Detailed description	**Location**	Zabok General Hospital, Bračak 8, 49210, Bračak (Croatia)
	Concept and background	Hospitals are recognized in all countries of the world as critical places in terms of the importance of uninterrupted supply of electricity and other energy sources. The goal of each hospital is to provide primary health care to its users and most of the institution's budget is used for this purpose. The idea of the solar power plant construction project was to reduce the cost of electricity in the long run and to free up a part of the institution's budget that can be redirected to items directly related to primary health care.
	Timeframes	2018-2019
	Objectives and main activities	Main objective was to provide hospital with solar electricity through installation of photovoltaic panels, without requiring significant investment from the hospital. After defining the technical solution in accordance with all existing restrictions (available roof area available, connection power etc.)- the objective was to close the financial structure without the need for Hospital's participation. The PPA was chosen as optimal financing mechanism and main activities included: - Designing an implementation model, presentation to stakeholders and consulting with authorities - Development of the PPA contract (electricity supply/works contract, along with roof lease contract) and adoption by stakeholders - Preparation of project technical details and consulting with the local DSO - Public procurement - Selection of PPA provider - Execution of works - Trial operation and commissioning

	Barriers and problems occurred	When implementing the project of any kind in public buildings - the implementation depends either on the availability of grants or on the possibilities of using alternative implementation mechanisms. Most of the barriers are related to the financial nature. Technical problems in solar power plant projects are mostly regulated on national level and although it sometimes takes time- there is a solution to every technical problem if specifically communicated with a local DSO.
	Main results and findings	Main result of the project is a 420 kW solar power plant installed at the rooftop of Zabok General Hospital. After the contract with PPA provider is finished - a plant becomes the ownership of the Hospital and more visible cost savings are occurring.
Contact details of the responsible investor	Key stakeholder: Zabok General Hospital, Bračak 8, 49210, Bračak (Croatia) Secretary: +385 (0)49/204-000 Technical, financial and legal assistance (outsourced): North-West Croatia Regional Energy Agency Project leader: Marko Vlainic, mvlainic@regea.org, +385 91/3885-341	
Funding scheme	The project was funded through an on-site Power Purchase Agreement (PPA) scheme. Power Purchase Agreement (PPA) often refers to a long-term electricity supply agreement between two parties, usually between a power producer and a customer (an electricity consumer or trader). An on-site PPA (one of the PPA variations) is a direct physical supply of electricity, necessitating physical proximity of plant and consumer. An on-site PPA means that the generation plant is located behind the metering point of the consumer and consumption profile of the consumer usually dictates the specific installation and also the parameters of the PPA contract. The investment amounted to 300 000 EUR and was 100% financed by PPA provider. Duration of PPA contract is set to 10 years.	
Photos		

Num.	4	
Title of best practice	Municipality of Pokupsko Biomass District Heating Power Plant	
Brief description	In 2015 in Municipality of Pokupsko first communal biomass district heating system has started its operation. The constriction of the system was fully financed by the IPARD Pre-accession program, and subsequently additionally financed by Croatian Environmental Protection and Energy Efficiency Fund. Pokupsko is situated in the southern part of Zagreb County, and it is a home to 2 224 inhabitants (2011 census). Almost 70% of the area is covered with forests and this is one of the main reasons why the biomass heating plant has been established right here. The installed power of the district heating system is 1MW and it is providing heat to about 30 end users (including all public buildings) which have been connected free of charge. The management of the system is done by the newly founded utility. Total value of the investment was about 7 milion HRK, and the project has contributed to energy savings through provision of a more efficient heating source, reduction of the local pollution and cost savings. The final result is that currently more than 75% of energy needs in Pokupsko are satisfied through local resources, with the plans to reach 100% within next five years.	
Detailed description	**Location**	Municipality of Pokupsko, Zagreb County, Croatia
	Concept and background	Municipality of Pokupsko, like most rural areas in Croatia, has faced many problems. Despite its hurdles of facing degrowth and development issues, today Pokupsko is a shining example of sustainable development and proudly stands side by side with the best in Europe. By continuously investing in various projects, municipality has used different available sources of funding in Croatia and EU to increase the quality of life for those who have decided to stay and live in this area. It should be noted that the biomass heating plant in Pokupsko is the only one that managed to obtain funding through the IPARD pre-accession program, although the IPARD Operational Program provides for the financing of a total of 12 such heating plants in Croatia. The heating plant is intended for heating all public buildings and households in the municipal centre. The video about the biomass district heating plant in the municipality of Pokupsko is available at: https://www.youtube.com/watch?v=kd7TYl5XaHI.
	Timeframes	06/2008: Start of concept development 01/2011: Application to IPARD 27/11/2015: Official opening
	Objectives and main activities	The main objective was to provide municipality area with more sustainable and more affordable heating. Main project activities included a lengthy preparation phase where all terms and conditions were agreed upon with the local

		community, followed by the development of project application to the EU funding and finalised with the implementation phase. The project also included setting up a new communal service provider (utility) who would be in charge of power plant and its operation.
	Barriers and problems occurred	The preparation process for this project was lengthy – it took 6 years to prepare all the paperwork, and only 6 months to build the production facility and district heating infrastructure.
	Main results and findings	The project was successfully implemented after 7 years due to lengthy preparation phase. The installed power of the power plant is 1MW and as a district heating plant it is providing heat to about 30 end users which have been connected free of charge and it was built to enable future expansion. The management of the system is done by the newly founded utility. The project was awarded with the prestigious EUSEW (EU Sustainable Energy Week) award in the public sector category.
Contact details of the responsible investor	North-West Croatia Regional Energy Agency, Andrije Žaje 10, 10000 Zagreb, Croatia Velimir Segon, Deputy Managing Director, vsegon@regea.org www.regea.org	
Funding scheme	The construction of the heating plant was financed by grants provided by the Municipality of Pokupsko through the pre-accession program IPARD Measure 301, to which the Republic of Croatia was entitled before full membership in the European Union, as well as funds from the Environmental Protection and Energy Efficiency Fund. The total construction costs for the part financed through the IPARD program were around 6.2 million HRK (excluding VAT, because the projects from the IPARD program are exempt from VAT), which a company that performs works selected through public procurement. In addition to these costs, there were additional costs for the installation of thermal substations in the amount of about 2.6 HRK (including VAT) for which co-financing of the Environmental Protection and Energy Efficiency Fund was provided.	

Photos	 Photo source: [2]  Photo source: [3]

1.3. Best practice examples in climate change mitigation

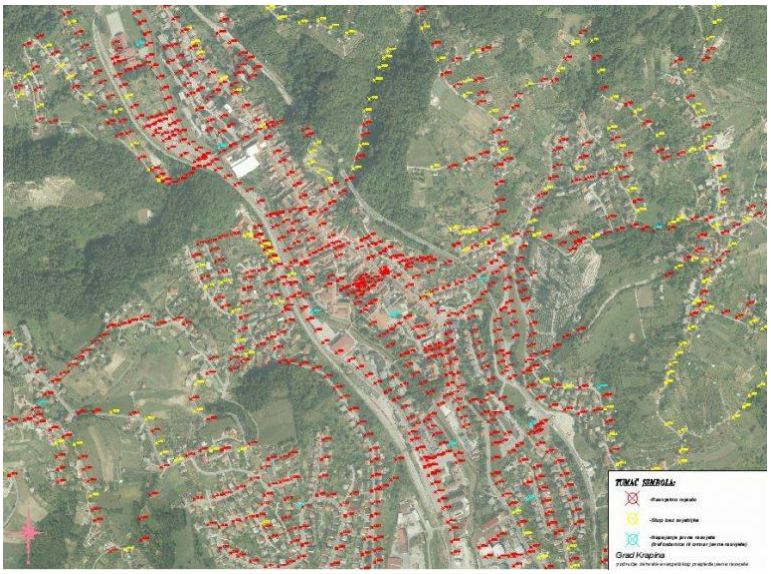
Num.	5
Title of best practice	On the Sunny Side (hrv. na sunčanoj strani)
Brief description	A matchmaking platform "On the Sunny Side", connecting citizens interested to invest in their own roof-top PV system with solar entrepreneurs – namely project designers and solar installers – has been launched in October 2020. "On the Sunny Side" is a digital tool for citizens interested to invest in their own rooftop PV system, where they can: (1) become part of the first joint/cooperative procurement of PV systems in Croatia, making procurement and installation of quality equipment more affordable, and (2) get full support of ZEZ team and trusted entrepreneurs at every step of implementation of PV system. The project was developed and is being implemented by the Green Energy Cooperative (ZEZ) and it has aim to contribute to about 10% of the installed capacity needed for achieving national target for 2030.

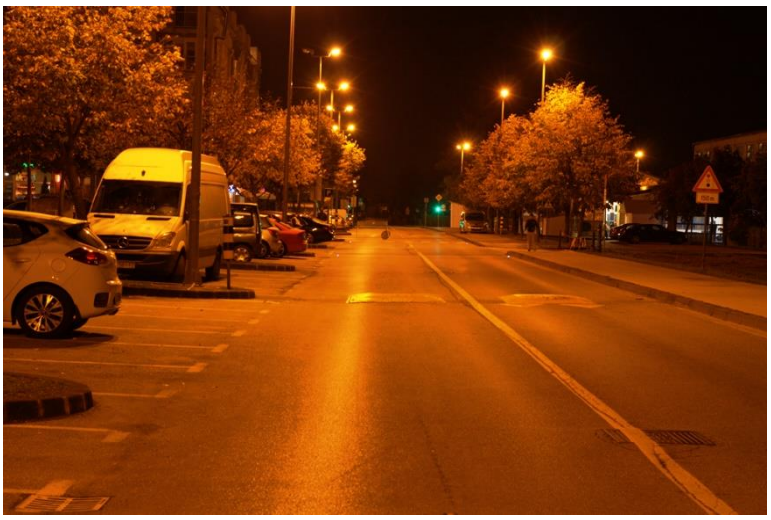
	In January this year, Google launched Google.org Impact Challenge for Central and Eastern European countries to help organizations work to reduce the digital divide and promote inclusive economic growth. Google recognised the potential „On the Sunny Side" to contribute to their goals and bring innovation to the sector of small-scale solar.	
Detailed description	**Location**	Croatia, nationwide
	Concept and background	There is huge untapped potential for solar PV in Croatia. Green Energy Cooperative (ZEZ) wants to encourage citizens to become actively involved in the energy transition, as prosumers and investors, and not only be passive bystanders (which is often the case with big RES projects such as wind farms). In order to achieve their mission, ZEZ is focusing on strong partnerships, collaborating with local solar companies and local authorities and digital tools, community activation and matchmaking platform for roof-top solar.
	Timeframes	July 2020 – ongoing
	Objectives and main activities	The platform is at the core of the commercialisation strategy to setup a pathway for achieving a systemic change and enabling around 10 MW of installed capacity annually. In Croatia it could contribute to around 10% of the national target set for 2030, which would entail an investment in the range of 10-15 million EUR each year and open a market pathway for 3 000 – 8 000 jobs annually in solar rooftop energy. The main objective in development of the platform was to create and offer citizens a one-stop solution for roof-top solar PV systems for self-consumption, with incorporated cooperative approach and values in the business model behind. The main service is the provision of services surrounding rooftop solar systems. Communication activities that took place during the project have provided a wide outreach. Some of the communication activities, such as the Good Energy Tour, will be replicated to expand the outreach.
	Barriers and problems occurred	There is still low awareness among Croatian citizens on benefits of utilizing RES, such as PVs. Thus ZEZ focused their effort on educational activities, for both citizens and solar entrepreneurs, to become solar ambassadors in their local communities. At this point platform is fully manual and consists of individualized case-specific offers. The current set-up of relies on openly available tools and elements, while a future iteration could include custom-build rooftop configurators.

	Main results and findings	- Good Energy Tour in 11 cities - 30 000 platform visitors and more than 700 expressions of interest from citizens. - A community Solar Club (FB page) of more than 3 000 citizens/members interested to invest in solar PVs - 103 PV System Electrical Design Projects have been developed in the demo site Varaždin out of which, 53 have been developed and submitted to the national fund for subsidies, and 21 projects (total capacity of 98 kW) have been installed in 2020.
Contact details of the responsible investor	Green Energy Cooperative (hrv. Zelena energetska zadruga, ZEZ), is a RES cooperative and social enterprise based in Zagreb, Croatia. Contact: Melani Furlan, project manager melani.furlan@zez.coop	
Funding scheme	The SOL4ALL project has been initiated with the support of the EIT Climate KIC (for period of July 2020 to December 2020), amounting to 80 000 EUR. ZEZ has attracted additional investment for the project activities through sponsorship agreements with Raiffeisen bank (amounting to 50 000 EUR).	
Photos	 	

Num.	6	
Title of best practice	NEWLIGHT	
Brief description	The NEWLIGHT project was initiated as a follow-up to the project Masterplan of public lighting, with the aim of reconstruction and construction of energy sustainable and environmentally friendly public lighting in the Zagreb and Krapina-Zagorje counties (a total of 57 local governments participated with 48.000 inhabitants benefiting). The total capital investment triggered by the project was about 14 million Euros. The project development services supported the preparation and implementation of EE measures in public lighting. The North-West Croatia Regional Energy Agency prepared all tender documentation and launched public procurement for streetlight energy audits in 57 local authorities. The investments foreseen were implemented mainly through Energy Performance Contracting (EPC) with some local authorities opting for the Design and Build (D&B) – traditional contract model. The project has also achieved significant energy and CO_2 emission savings– 21.38 GWh (saved/year) and CO_2 reductions – 7050 CO_2 eq t. The project was awarded with the prestigious European Energy Services Award (EESA).	
Detailed description	**Location**	Zagreb County, Krapina-Zagorje County, Croatia
	Concept and background	Improving energy efficiency of the public lighting offers one of the quickest payback periods out of all energy efficiency measures. At the same time, Croatia was still faced with low energy efficiency and poor quality of public lighting in many areas. Local authorities were not capacitated to undertake all

		steps needed to change needed to their public lighting systems, and there was poor availability of potential sources for co-financing or utilisation of ESCO models. REGEA thus, with support of ELENA funding, supported the refurbishment of luminaires in the two counties to increase the energy performance of public lighting. The implemented EE measures included mainly replacing the luminaires with more efficient technologies such as LED. Public lighting energy audits (inventory) details of existing systems from around 72 200 lighting points have been collected and analysed. This resulted in a unique database, which has been used for technical and financial investment assessment.
	Timeframes	October 2015 – October 2018
	Objectives and main activities	Main objective was to improve energy efficiency of the public lighting system, thus reducing energy costs and saving CO_2 emissions while at the same time providing better quality of public lighting for the inhabitants. Main activities were: - Preparation of tender documentation for the implementation of public procurement for the provision of detailed energy audits of public lighting systems; - Implementation of detailed energy audits of the existing public lighting system; - Development of action plans for the implementation of modernization and reconstruction of the public lighting system; - Preparation of tender documentation for the selection of contractors, with emphasis on ESCO sources of funding; - Preparation of the main project for the construction of new lighting; - Application to European and national sources of financing for the execution of works on the modernization and reconstruction of the public lighting system; - Project management.
	Barriers and problems occurred	- Incomplete database of the existing situation - Underdeveloped ESCO market - the need to inform and educate all stakeholders - Technical barriers included low price of electricity - Low availability of traditional co-financing and knowledge and access to the alternative financing (EPC/PPP)
	Main results and findings	- 57 energy audits completed - GIS based database with more than 2 million attributes from 57 local authorities prepared - 57 Action plans - Detailed analysis of market conditions

		- Out of 72 200 existing luminaires, more than 54 000 (approx. 75%) were reconstructed in 26 municipalities using four financial models. - 26 public authorities engaged in tendering process - 13 EPC procurement processes - 8 traditional procurement processes - 1 D&B procurement process - 4 Leasing procurement processes
Contact details of the responsible investor	Project beneficiary: North-West Croatia Regional Energy Agency, www.rega.org, newlight@regea.org	
Funding scheme	Total investment in implementation phase: 14.36 MEUR - 13 EPC procurement processes - 8 traditional procurement processes - 1 D&B procurement process - 4 Leasing procurement processes Total PDS costs: EUR 704 469 - 90% (634 022 EUR) provided through ELENA, the remaining 19% provided by Zagreb and Krapina-Zagorje County	
Photos	 Photo source: [4]	



Old lighting

New lighting- image source: [5]

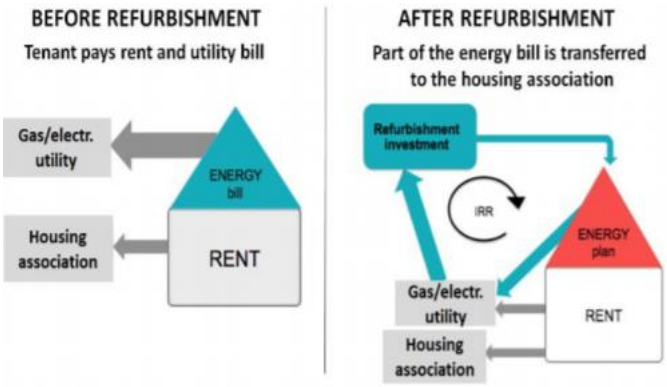
Award ceremony - image source: [6]

2. Best practice examples in energy refurbishment, renewable energy sources usage and climate change mitigation at international level

2.1. Best practice examples in energy refurbishment

Num.	7	
Title of best practice	Energy jump (Energiesprong)	
Brief description	Energiesprong ("Energy jump") innovative and award-winning approach, is probably the most successful European nZEB retrofit project. It has contributed to refurbishing over 6 000 homes across Europe, with over 20 000 more in the pipeline. Energiesprong works with Market Development Teams who are located in the UK, Netherlands, Germany, France and Italy. The State of New York and California work with Energiesprong inspired teams. A Net-Zero Energy house, developed by Energiesprong (Energy Jump), generates sufficient energy to heat the house, provide hot water and power its household appliances. Money normally spent on energy bills and maintenance work pays for the upgrade. Tenants no longer receive energy bills and the buildings have a 30-year performance warranty on both the indoor climate and the energy performance. The Energiesprong model is a radical transformation – both practically and conceptually – as it focuses on creating a volume market for solutions that satisfy five key criteria: - Guaranteed performance for 30 years - Hassle-free, one-week implementation - Affordability - Attractiveness - From tendering to purchasing	
Detailed description	**Location**	UK, Netherlands, Germany, France and Italy
	Concept and background	Energiesprong was commissioned by the Dutch Ministry of Interior Kingdom Relations and run from 2010 till 2016 under the experiments program of Platform31. Energiesprong resulted from this as the most successful innovative approach for net-zero energy retrofits. Since 2017 the Energiesprong approach has spread over Europe. Because the approach works with off-site manufacturing, the nuisance for residents can be kept to a minimum. As is the time that is needed to complete a retrofit. Because volume is the key to a viable path to scale, Housing Organisations are first organisations of interest. The bigger the volume, the more costs can go down and the more interesting the Energiesprong approach will get. To both Housing Organisations (home owners) and industry. As the volume goes up, the more promising the market will be to the construction companies [7]

	Timeframes	2010 - now
	Objectives and main activities	Energiesprong (Energy Leap) is an innovative market development programme that was launched in 2010 with a 50 million EUR government funded budget to develop attractive and viable net-zero energy retrofit solutions for the mass market by 2020 [8]. It was commissioned by the Dutch Ministry of the Interior and Kingdom Relations (BZK) and implemented by Platform31, which is a knowledge-sharing network of organisations committed to urban and regional development. It is designed to implement the Energy Innovation Agenda for the Built Environment (IAGO, 2009)4 and its primary goal is to create the market conditions for energy neutral buildings in the Netherlands. It aimed to deliver energy saving solutions to 5 000 building objects, including 2 500 new buildings and 2 500 renovated buildings . It aims to achieve a target of 45% to 80% energy savings in the built environment and energy-neutral new buildings by 2020. Longer-term, it targets a 50% overall reduction.
	Barriers and problems occurred	- Regulatory and planning barriers - Creating the necessary funding conditions - Generating demand for (not yet existing) NZEB refurbishments - Mobilising the construction sector to move towards a completely new system of working
	Main results and findings	- Over 6 000 net-zero energy houses are in use and thousands of retrofits in the pipeline - 2018, Energiesprong won the World Green Building Council award and Nottingham's Energiesprong homes won the UK Housing Award and Shift Award - 2019, Energiesprong's E=0 and Transition Zero projects won the EU Sustainable Energy Award, Energiesprong UK won the prestigious Ashden Award, solution provider Melius Homes won a Construction News Awards for its Energiesprong retrofits in Nottingham
Contact details of the responsible investor	Energiesprong Foundation info@energiesprong.org The Netherlands All contact info available here: https://energiesprong.org/contact/	
Funding scheme	Energiesprong attracts funding through several European projects supporting this international expansion: Transition Zero (H2020), E=0 (InterregNWE) and Mustbe0 (InterregNWE). Furthermore, teams in countries have acquired funding from national funds. (https://energiesprong.org/about/). Initiall fudning: 50 million (Govt funding: 2010-2016) 6 billion (WSW Social Bank funding for Stroomversnelling (Rapids) deal) Additional European project funding	

	awarded: 3.6 million (Transition Zero / H2020) 5.4 million (E=O / Interreg NW Europe).  *Source: Energiesprong*[14] Energiesprong business/revenue model source [8]
Photos	  The Nottingham homes before and after their Energiesprong refurbishment (some in the picture chose not to participate) [9]

Photos source [10]

Video's about Energiesprong projects: https://vimeo.com/energiesprong

Num.	8	
Title of best practice	Social Housing energy renovation in Porto - Portugal – 2013-2020 period	
Brief description	The Porto City Council, through Domus Social, E.M., the municipal company in charge of Social Housing management, carried out a set of rehabilitation interventions, to improve the habitability of the building stock and increase the energy efficiency of its constituent units, thus contributing to social promotion and the quality of life of municipal tenants, mitigating potential and actual situations of energy poverty in a population in more frail economic conditions. With these interventions, it was sought to increase the thermal comfort and salubrious conditions of the occupants of the houses and the rational use of energy with the consequent reduction of energy bills, also increasing the sustainability of this building stock.	
	Location	Porto, Portugal

Detailed description	**Concept and background**	Municipality managed Social Housing in Porto accounts for around 13 000 dwellings and almost 30 000 inhabitants[1], or 13% of the total population. Energy audit and certification studies were developed for ten housing clusters in a total of 2 158 dwellings. These studies included the assessment of opportunities to improve energy performance and resulted in projects for energy efficiency interventions contemplating a total of 2 540 dwellings. Based on the impacts obtained and with the estimates of reduction in energy use and CO_2 emissions resulting from the studies, it was possible to extrapolate and estimate the impact of the interventions for all the dwellings subject to intervention between 2013 and 2020. The implementation was carried out in a mix of own and ERDF funds (Norte2020).
	Timeframes	2013 - 2020
	Objectives and main activities	The main objectives were to improve the habitability and increase energy efficiency, while improving thermal comfort, reducing energy bills and fighting energy poverty. The energy efficiency measures applied to the dwellings in the social housing clusters were essentially thermal insulation of the external walls, thermal insulation of the roofs, installation of more efficient glazing and, whenever possible and feasible, installation of solar thermal collectors for the preparation of domestic hot water.
	Barriers and problems occurred	- Need to comply with the norms to meet new energy requirements, which increased complexity - Need for financing the necessary renovation works - Carrying out the needed for renovation works while reducing the impact in the tenant's day-to-day life.
	Main results and findings	- 11 groups of social housing intervened - 125 buildings/blocks - 2 540 dwellings - 130 400 m^2 of total useful area - 7 year period (2013-2020) - 56 M EUR investment - Mix of own and ERDF funds (Norte2020) - 47% reduction in final energy use (9,4 GWh)[2] - 50% reduction in CO_2 emissions (3 584 tCO_2) - Increased production of renewable energy

[1] http://www.domussocial.pt/noticias/aposta-na-promocao-da-eficiencia-energetica-na-habitacao-social , visited on 22/07/2021

[2] The results expressed in terms of final energy and CO_2 emissions are based on the calculation method associated with the Portuguese Energy Certification System for Buildings (SCE, Decree-Law 118/2013), by transposition of the European EPBD - Energy Performance of Buildings Directive, constituting a benchmark for comparing this type of intervention in buildings

Contact details of the responsible investor	José Ferreira – Domus Social, EM e-mail: jferreira@domussocial.pt
Funding scheme	The project was financed by City of Porto, complemented with ERDF funds (Norte2020).
Photos	  Photos source: [12] Other sources: https://www.youtube.com/watch?v=-fRuQvs8w_A

2.2. Best practice examples in renewable energy sources usage

Num.	9
Title of best practice	Shallow Geothermal Heating and Cooling at the Parliament of Andalusia
Brief description	The Andalusian Parliament is the legislature of the Spanish Autonomous Community of Andalusia. The seat of the Parliament is located in Seville, the capital city of Andalusia. Its building is the former historic Hospital of the Cinco Llagas (Five Wounds Hospital). Built in 1546, used as hospital until 1972, and renovated in 1992, when this large building was retrofitted to be the seat of the Andalusian Parliament [13] [14]. Sevilla has a Mediterranean-oceanic climate and is probably the hottest spots in Europe. Cooling needs are essential but heating is very necessary also [13].

	Heating and cooling needs are served by very low enthalpy geothermal energy (heat pump) by exchanging energy water-to-water with an underground shallow waters reservoir lying 10-20 meters above the ground at a very constant temperature of 18-22ºC along the year. There is no water consumption (close circuit). This temperature stability is critical for a high performance. This way, the water reservoir acts as a "seasonal heat reservoir" in a much more much more efficient way than standard air-to-air model. [14] This project is an excellent example of integrating RES into historic and cultural buildings.	
Detailed description	**Location**	Seville, Andalusia, Spain
	Concept and background	Heating and cooling needs of the Parliament are assisted with a geothermal shallow energy installation (very low enthalpy geothermal energy) by exchanging heat with underground shallow waters. The project used is a safe and eco-friendly method of extracting heat from underground water (or bedrock), in order to heat or cool buildings. The water reservoir lies 10-20m bellow the ground, and separated by 150m from the re-injection zone, at a very constant temperature of 18-22ºC along the year. This temperature stability is critical for a high performance. This way, the water reservoir acts as a "seasonal heat reservoir", giving back away in winter the heat injected in summer. Heat is extracted from underground waters in winter (18ºC underground water temperature, +5ºC typically outdoors) and re-injected in summer (22ºC underground water temperature, +40ºC typically outdoors). Most of these features can be directly implemented in existing European historic buildings. [13]
	Timeframes	2016 - 2017
	Objectives and main activities	The main objective was to design and integrate a modern, eco friendly and efficient heating and cooling system into a building which has significant historic and cultural heritage. The system needed to accommodate needs of Mediterranean-oceanic climate, and to be integrated in a way it utilises potential of locally available RES. Shallow geothermal cooling and heating was chosen as a solution, using water for heat transfer and utilising potential of reservoir's temperature stability when placed some 10-20m bellow the ground. This approach is easily replicated on similar sites and locations offering solution for heating and cooling while meeting the requirements of protection of historic buildings. This solution assures high comfort and energy savings compared to standard HVAC alternatives.

	Barriers and problems occurred	- There is significant potential for replication, however, depending on the availability of an underground water reservoir - Large initial investment - Heritage restrictions and conservation requirements - Environmental regulation on drilling works and underground water bodies
	Main results and findings	- The geothermal facility saves energy both in winter and summer due to the energy demand reduction, but also because in medium seasons there is simultaneous production of both heating and cooling. The thermal devices can produce 7ºC and 45ºC water at the same time at the same machine, avoiding the use of chillers and boilers. - External extreme temperatures do not affect the coefficient of performance of the heat pumps because the water reservoir keeps a stable temperature. [13]
Contact details of the responsible investor	Andalusian Energy Agency, Joaquín Villar, joaquin.villar@juntadeandalucia.es, www.agenciaandaluzadelaenergia.es/knowthe-agency	
Funding scheme	For a total power of approximately 5 MW of refrigerating production equipment, the cost of the wells was approximately 345 000 EUR. The budget includes water extraction and reinjection wells, as well as a network of buried pipelines. The project was financed by Parliament´s own funds.	
Photos		

Num.	10
Title of best practice	Solar Pecka
Brief description	“Solar Pecka” initiative enabled implementation of the first photovoltaic (PV) system in a rural area in Bosnia and Herzegovina (BiH) has been installed on the roof of the Visitor Center Pecka near the city of Mrkonjić Grad thanks to

	an online crowdfunding campaign that attracted donors from the country, the region, and all over the world. As part of this initiative, an online fundraising campaign was launched to raise funds needed to install a system of solar panels and collectors on the roof of the Visitor Center Pecka. The campaign had a wide outreach, reaching also neighbouring countries and has gathered a total of 6.687 USD. The funds gathered were used to install 300l solar thermal collector and photovoltaic panels, making it the first of a kind project in Bosnia and Herzegovina, and proving that it is possible to find alternative solutions to implement such needed projects even with the lack of funding.	
Detailed description	**Location**	Mrkonjić Grad, Bosnia and Herzegovina
	Concept and background	The initiative "Solar Pecka" was initiated by the Visitor Center Pecka from Mrkonjić Grad and the Center for the Environment from Banja Luka in May 2019. The 'Coalition for Sana' was also involved, which has been working for a long time to protect this area. The building targeted with this project was an old school building which, with the support of the Municipality, was given to a group of enthusiasts in 2014, and which was then reconstructed in the Center for Sustainable Tourism in the Rural Community. The Center has quickly become an unavoidable destination for many tourists, and for many school excursions. The initiators wanted to encourage and promote use of RES and show that energy can be obtained in this way. In addition, a new socio-educational dimension was added to the Visitor Center: the example of using the sun to produce energy through the direct participation of citizens and private individuals, through this unique model of joint investment.
	Timeframes	May 2019 – June 2021
	Objectives and main activities	A total of ca. 13 000 USD was needed to install the complete system (5.4 kW) on the roof of the Visitor Center and realize the idea. The aim was to provide the Center with solar energy for both electricity and domestic hot water production and to set an example for rural Bosnia and Herzegovina, as well as for all other communities on how RES can be accessible. "Solar Pecka" ensured the educational component – by showing in practice the benefits of solar energy. "Solar Pecka" is a pioneering project which demonstrates that sustainable citizen energy projects in BiH are feasible despite numerous financial, technical, and regulatory challenges", says Nestor Ruiz, coordinator for the Solar Pecka initiative at the CZŽS. The main activities were the fundraising campaign which was focused mostly on crowdfunding as the main mechanism, installation of the photovoltaic and solar thermal panels, and promotional campaign.

	Barriers and problems occurred	- Lack of funding - Administrative barriers - Longevity of the project since initiation until realisation - Low awareness amongst general population
	Main results and findings	- 226 individuals and organisations took part in the crowdfunding gathering a total of 6 687 USD, thus surpassing the goal set to 6 000 USD - 300l solar thermal collector installed - 4.5 kW photovoltaics installed - High visibility and access to general public
Contact details of the responsible investor	Center for Environment, https://czzs.org/?lang=en Miše Stupara 5, 78 000 Banja Luka info@czzs.org +387 51 433 140, +387 51 433 142	
Funding scheme	Deploying the entire planned PV system, with a capacity of 5.4 kW, requires a total of 13 000 USD, and the second phase of the project should be implemented with the support of associations and businesses. A total of 6 687 USD was gathered through the fundraising campaign.	
Photos	 	

	Opening of the solar instalations, photo source [15]  Photo source: [16] Solarna Pecka video: https://www.youtube.com/watch?v=i_Fk8zsvL-4

2.3. Best practice examples in climate change mitigation

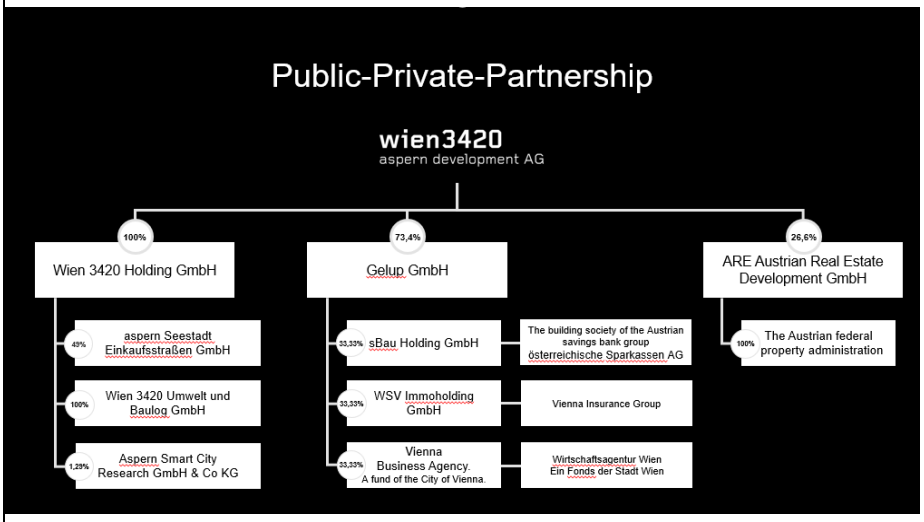
Num.	11	
Title of best practice	Energy access SMEs development project	
Brief description	Recognising the significant struggles rural populations in Central Asia face in terms of accessibility of reliable and affordable energy services, project was developed and implemented in Tajikistan and Kyrgyzstan. Aim of the project was to provide affordable and accessible sustainable energy solutions such as DIY solar thermal collectors, installing mini electricity RES powered grids, providing public institutions such as hospitals with hot water, and developing and testing innovative business models for local SMEs. The project was focused on using locally available and intermediate technologies and empowering local population, to take part in the process. The focus was on wide typology of interventions including setting a basis for reforms in the energy sector, awareness rising through demonstrating the economic benefits of the green energy solutions and building capacity of technical experts for installation and repair of the green energy equipment, etc. Project has been formally launched in January 2018, building upon previous experiences from the United Nations Development Programme (UNDP) Green Villages Initiative implemented in Kyrgyz Republic and Tajikistan.	
Detailed description	**Location**	Tajikistan and Kyrgyzstan
	Concept and background	Rural population in Central Asia is facing many struggles with severe energy poverty. They often lack access to sufficient amounts and quality of all energy services. Other big problem is poverty and lack of employment opportunities. Thus, the project was developed, piloting innovative sustainable solutions for villages in Kyrgyzstan and Tajikistan providing affordable and accessible energy solutions, empower local population to take part in the process and strengthening and promoting local SMSs. The project also aimed to utilise innovative financing mechanisms such as crowdfunding and using locally available materials and intermediate technologies. The project's goal was to offer a comprehensive strategy to scale-up private sector engagement in energy access by improving the risk-return profile of private investment in energy access products and services.
	Timeframes	2 years, starting in 2018
	Objectives and main activities	The key objective was to expand energy access and provide reliable, affordable, and sustainable energy products and services for the rural population of the Kyrgyzstan Tajikistan facing energy poverty, through promoting scalable, private sector-led business models and de-risking their investment. The project activities focused on introducing and testing new technologies and energy services in selected villages.

		12 policy recommendations were developed for green energy development, working closely with national stakeholders. The project cooperated with the most suitable microfinance institutions for stimulating investments in green energy project.
	Barriers and problems occurred	- Lack of access to finance and limited market demand for renewable technologies - Immature renewable energy market with limited number of high-quality products and equipment suppliers; and - Low technical capacity of local enterprises.
	Main results and findings	- More than 16 000 households benefited from the RE - 31 public buildings equipped with PV and sustainable water heating Kyrgystan: - 5.2 kW photovoltaics - 3 650 litres of installed solar water heating systems - 8.8 kW cooling and 8.9 kW heating - air-to-air heat pumps - Solar driers with 101 m^2 of drying area and 21.9 kW backup electric capacity. Tajikistan: - 83 kW photovoltaics, including 25 kW installed within 7 mini-grids (off grid) pilots - - 8 300 litres of installed solar water heating systems
Contact details of the responsible investor	The project is funded by Organization for Petroleum Export Countries (OPEC) Fund for International Development.	
Funding scheme	In total, 10 micro-finance institutions (MFIs) and banks have been featured on the Energy Access Platform. In parallel, the project tested crowdfunding products, leveraging impact in establishing micro-financing incentives for investors and users of the RE technologies. The project also tested four new business models for SMEs under various agreement modalities such as concession, energy cooperative, rental, and as pay-as-you-go model. Although, COVID-19 has brought unexpected challenges in fully supporting these business models, the pilot activities have proven to be impactful for further scaling up in future projects, improving access to modern, affordable, and sustainable energy services. Total Budget: 406 000 USD 800 000 USD (OPEC Fund) 1 050 000 USD (UNDP parallel funding) 180 000 USD (Government parallel) 376 000 USD (Other donors parallel)	

Photos	   

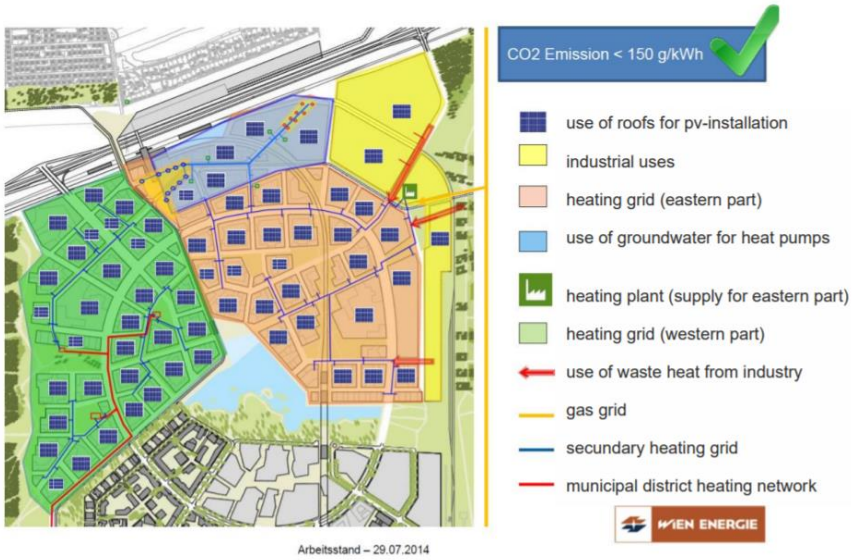
Num.	12
Title of best practice	Aspern Seestadt Vienna
Brief description	Aspern Seestadt is one of Europe's largest urban development projects. The fast-growing 22nd district in the north-east of the Vienna, a new urban centre is taking shape – a smart city with a heart, designed to accommodate the whole spectrum of life. A multi-phase development foresees the creation of high-quality housing for over 25 000 people and, eventually, thousands of workplaces. Aspern Seesstadt Vienna has the potential for 20 000 workpaces with total investment volume of 5bn EUR. The City of Vienna and a network of strong partners from business and the public sector are the organisations

	behind Aspern Seestadt. The development agency Wien 3420 AG is in overall charge of the project. Around 50% of the Seestadt are reserved for parks and green spaces. These smartly planned and designed public spaces enable a balanced life and work in the country and yet in the middle of the pulsating city with all its urban amenities. 40% cycling and walking, 40% public transport and only 20% car traffic - this is the targeted distribution of local traffic in Seestadt. Numerous measures contribute to this goal and make a valuable contribution to climate protection.	
Detailed description	**Location**	Aspern Seestadt, 1220 Wien
	Concept and background	With the aim to redesign the old airfield the project was initiated in 2003. The goal of the project was to design a smart and sustainable city which had all the needed services easily accessible by foot or by bike and with good connection to the city centre. The innovative mobility concept Aspern mobil is all about sustainability. The target is that 40% of trips at Seestadt will be made by public transport, 40% by bike or on foot, and only 20% by car, moped or motorbike. The innovative mobility concept Aspern mobil is all about sustainability. The aim: a mobility mix that conserves resources and contributes to a superlative quality of life. And, with the diverse range of mobility options available, you're always one step ahead.
	Timeframes	2003 - 2028
	Objectives and main activities	The aim: a mobility mix that conserves resources and contributes to a superlative quality of life. Step by step, milestone by milestone - until 2028 Aspern is growing urban lakeside of Vienna in area of 2.4 million m². Living space is created for over 20 000 people and with similar number of job openings. In 2003 the project team was formed and the planning initiated. In 2004 public consultations and appointment of “on-site experts” took place together with the launch of master plan competition for the former airfield redesign and reuse. The masterplan was approved in 2007, and in 2008 the competition for public space planning concept was initiated. 2009 was the start of dismantling of old roadways, and in 2011 the first construction started. Underground stations were opened already in 2013 followed by the first wave of residents in 2014. By 2017 already more than 6000 people lived in Seestadt. The process continues with focus on sustainability and smart city design.
	Barriers and problems occurred	- Removing transportation barriers between green and transport areas - Setting up official quantifiable targets for such a large project

		- Making decisions with unknown framework conditions
	Main results and findings	- More than 120 businesses already located in Seestadt - By 2028, Aspern Seestadt will boast homes for over 20 000 people, plus almost as many workplaces - 2 900 already completed flats - 1 500 people already work there - 2 900 balconies and terraces - 56 bikes and e-bikes to rent and share - 7 communal underground garages for cars - 25 minutes to the city centre by metro - Car sharing system - Work sharing system - Short distances and design for commuting on foot or by bike - Focus of green spaces
Contact details of the responsible investor	Wien 3420 Aspern development AG and the City of Vienna's Aspern Seestadt Project Management unit are the two essential points of contact for all stakeholders at Seestadt.	
Funding scheme	The financing is built on Public-Private-Partnership model, built on the following pillars of the funding model: - Start-up funding from equity capital - Acquisition of property depends on intended use - Purchase price of properties fixed from the outset - 50% co-funding of infrastructure by the City of Vienna - Phase-by-phase construction of infrastructure - Income and expenditure are index-linked - Expansion phases pre-funded through down payments received or advance sales - No funding from banks 	

Photos

Illustration 10: Heat supply concept for aspern Seestadt North – minimum scenario



Source: Wien Energie, 2014

Photo source: [17]

Photo source: [18]

Photo source: [18]

Photo source: [18]

Documentary about Seestadt Aspern:
https://www.youtube.com/watch?v=xSqw7xDVW0U

3. Problems occurred during the best practice research and development of the analysis

During the analysis three main methods were used: literature research based on key words focused then on literature available in English, followed up by searching more information available on local languages which was then translated using online translation tools, and using personal contact to highlight best case examples and share needed information.

The individual success stories are often available only in the language of the country of origin of the success story and thus they may be hard to be identified unless they are mentioned in some other publication available in English. Using the modern technologies and online translation service, once identified, it is possible to translate key information about the given success story, however, this has proven to offer only partial information needed for this analysis in most cases.

The other method of searching already existing brochures and awards for the best practice examples, offers a good insight into those projects which have already been recognized internationally. This approach usually offers solid quality of the information needed, however, it brings another issue of repeating already shared information, while leaving some other, maybe even better cases unrecognized.

Third method used was based on personal contact and networks through which information was shared and best practices identified. This method has proven to provide the most thorough access to information and originality.

One of barriers which occurred in the research was slow responsiveness of the key stakeholders due to their lack of capacities and/or interest to take part in the study. Some originally identified best practice examples, although they can be seen as pioneering and shining examples of energy refurbishment, RES utilization and climate change mitigation, had to be replaced with alternative examples due to lack of information available to the consultants.

4. Conclusions

There is a significant number of best practice examples in energy refurbishment, renewable energy sources usage and climate change mitigation available. The information is however dispersed, provided in different languages and format. Formats available seldomly include comprehensive up-to date best-practice data bases and they are often in form of individual, and hard to identify stories, and brochures.

Best practice examples can serve as excellent tool for motivating change in new locations implemented by new actors. Availability of such information can ensure that there is greater uptake of RES and EE technologies and quicker achievement of climate change mitigation goals. Greater availability of extensive and thorough information on best practice examples is likely to contribute to transferring the know-how and avoiding the repetition of same mistakes and easier overcoming of the typical barriers.

Sharing knowledge and lessons learned can help speed up energy transition process and enable quicker and better uptake of technologies and mechanisms needed for achieving climate neutrality. Local champions often struggle with similar barriers and problems, such as lack of financing, low awareness, and administrative struggles. Lack of financing, as shown through this analysis, can be overcome with financing mechanisms alternative to conventional public funding such as public private partnerships, crowdfunding, EU funding, loans, and energy communities. With careful planning and strategic approach low awareness can be bypassed in the beginning phase of project initiation, while overcoming administrative barriers requires evidence-based advocacy and lobbying.

There is a great potential in further development of similar analyses to offer comprehensive and easy to access database for all interested stakeholders, enabling quicker and smarter transition towards carbon neutral society.

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