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INTERREG EUROPE ZEROCO2 PROJECT - ACTION PLAN FOR MALTA TO PROMOTE NEAR ZERO CO2 EMISSION BUILDINGS

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ABSTRACT: Buildings are responsible for 36 % of CO_2 emissions in the EU. The Interreg Europe project entitled ZEROCO2 ''*Promotion of Near Zero CO_2 emission buildings due to energy use*" aims at addressing policies, actions and investments to facilitate the transition of buildings to nearly Zero CO_2 emission buildings due to energy use (NZCO2EB). The project is made up of eight partners from eight different regions and has a duration of 4 years. Project phase 1 (2016-2018), dedicated to interregional learning, has been completed. This paper summarises the deliverables of project phase 1, with a special emphasis on Malta's market needs and policy action plans required to ease its transition to NZCO2EB. It is envisaged that in project phase 2 (2018-2020), the priority policy action plans identified in this paper will be implemented. This will enable Malta to reduce its operating CO_2 emissions from buildings, while assisting the country to reach its 2020 energy efficiency (EE), renewable energy (RE) and nearly zero energy in building (NZEB) targets.

Keywords: buildings, ZEROCO2, Interreg Europe, NZCO2EB, Malta, energy policy

1 INTRODUCTION

Buildings are responsible for 36 % of CO_2 emissions in the EU [1]. The ZEROCO2 project [2] entitled ''*Promotion of Near Zero CO2 emission buildings due to energy use*" is an Interreg Europe project that falls under Interreg Europe priority axis 3: '*Low-carbon economy*'. The project's aim is to address policies, support actions and investments to increase the levels of energy efficiency in public buildings and the housing sector, as well as to raise the share of energy from renewable sources in the overall energy mix. By addressing such policies and support actions, the transition of buildings to nearly Zero CO_2 emission buildings due to energy use (NZCO2EB) is facilitated.

The project's focus is on new and existing public buildings, including the housing sector. Public buildings are buildings frequented by the public such as hotels, cinemas, restaurants, health centres, shops, and sports complexes. To satisfy these aims, the ZEROCO2 project follows an interregional approach, which links different policy makers and stakeholders to understand common challenges and share good policy practices among the project partner regions.

Partners from eight different EU regions make up this project as follows:

- The Local Energy Agency Spodnje Podravje (LEASP) (Ptuj, Slovenia) – being the lead partner;
- The European Institute for Innovation (Germany) – being the advisory partner;
- The Mediterranean Agronomic Institute of Chania (MAICH) (Crete, Greece);
- Molise Region (Molise, Italy);
- The Municipality of Kaunas District (KD) (Kaunas, Lithuania),
- Thermopolis Ltd. (Lapua, Finland);
- The Agency for Sustainable Mediterranean Cities and Territories (AVITEM) (Marseille, France) and the
- University of Malta (UM) (Malta).

The ZEROCO2 project started in April 2016 and has a duration of four years in total. The project is designed in two phases:

- '**Phase 1'** (April 2016 – March 2018): is dedicated to interregional learning and to preparing the exploitation of the lessons learnt from the cooperation through the development of a policy

action plan by each project partner. The aim of the policy action plan is to provide insight to policy makers and assist them in improving existing policies and considering new ones within the regional policy instrument addressed.

- '**Phase 2'** (April 2018 – March 2020): is dedicated to monitoring the implementation of the proposed policy action plan.

Phase 1 of the project has been completed. This paper gives a summary of phase 1 project deliverables. Focus is on Malta's market needs to enable its transition NZCO2EB and on the proposed policy action plan to tackle the identified needs.

2 PHASE 1 PROJECT DELIVERABLES

2.1 Description of deliverables

Figure 1 depicts the deliverables produced in each semester during project phase 1. For deliverables denoting "*partnership*", the partnership produced one common deliverable, while for deliverables denoting "*all partners*", implies that each partner region produced a separate deliverable. This section gives a brief overview of the main project deliverables. The lessons learnt from each deliverable, enabled each project partner to draft the action plan.

Figure 1:Project phase 1 deliverables and intelinkage of activities

2.2 Regional studies

Table 1 depicts the renewable energy (RE) contribution as a percentage of total energy consumption for each partner region, as well as the main renewable energy sources (RES) each region uses. From Table 1, the challenging situation for Malta to generate and consume energy sustainably can be clearly identified given both our high population density and our lack of resources for biomass and/or hydro power, which partner regions primarily rely on, to reduce their CO_2 emissions from energy generation.

Another interesting point from Table 1 is that in Crete, which has a similar Mediterranean climate to Malta, there is a higher percentage contribution of solar thermal energy as opposed to PVs. In contrast, in Malta the trend has shifted towards PVs instead of solar thermal, primarily due to the more favourable feed-in tariff and capital grant available for PVs. Greece has a legal requirement that all new (or redeveloped) buildings must cover at least 60% of their hot water requirements using solar energy [3]. There are also incentives for renewable energy heating systems that include favourable grants and a tax deduction scheme covering 20 % (up to € 700) of the installation cost.

A policy framework like Crete can be adopted for Malta, given that solar water heating, having a much higher efficiency than PVs, should remain a very important RES. In addition, the solar thermal storage potential is the main cost-effective RE storage system that can alleviate generation peaks at the power station because electricity powers over 90% of hot water boilers in Malta.

The second regional studies deliverable was for each partner to identify a typical commercial building in the region under study to find optimal combinations of energy efficiency and renewable energy systems for transforming the chosen building to NZCO2EB. This deliverable is summarised in Table 2 for all partners. For most regions under analysis, choosing a careful combination of energy efficiency (EE) measures and renewable energy sources (RES), reduces the operating CO_2 emissions by 75% or more over a base scenario, with a reasonable payback period of between nine and twelve years. This shows that NZCO2EB is not a futuristic concept, but is achievable using current technology.

Table 2 also identifies the climate classification for each building under study. It is interesting to note that most regions considered PVs to reduce the operating CO_2 emissions irrespective of the climate. This despite the temperate Mediterranean dry and hot summer (Csa climate according to Köppen Code), climate having a more favourable solar resource for this technology.

Another point of interest is that for the regions having an oceanic climate (Cfb), cold continental climate (Dfb) and subarctic climate (Dfc), more importance is given to high performance insulation of the envelope, as a measure to reduce the operating CO_2 emissions, as opposed to regions having a Mediterranean (Csa) climate. The very low winter temperatures in the cold climates result in large temperature gradients between the building envelope's exterior and interior surfaces making very low U-values for the envelope (i.e. high insulation levels) technically and economically attractive.

Table 1:The contribution of RE from the total energy consumption and the utilised RES for each partner region

Partner	Data Provided for Country/Region	Region Population density (Inhabitants /km^2)	Country 2020 RE targets	% RE production	RES (% of total RE production)
LASP (Slovenia)	Slovenia	101.8	25%	23 % (2015)	Wood Biomass - 61.4 % Hydro - 24.2 % Geothermal - 7.8 %
MAICH (Greece)	Crete	74.7	18%	16.28 % (2013)	Wood Biomass - 52.3 % Wind Power- 18.6 % Solar thermal - 18.5 % Solar PV - 10.3 %
Molise Region (Italy)	Molise	70.31	17%	34.53 % (2013)	Wood Biomass - 54.3 % Wind Power -26.5 % Hydro - 10.5 % Solar energy - 8.7 %
KD (Lithuania)	Lithuania	60	23%	23.9 % (2014)	Wood Biomass - 84.8 % Wind power - 4.9 % Hydro Power - 2.1 % Solar energy - 0.5 %
Thermopolis Ltd. (Finland)	South Ostrobothnia	18.1	38%	23.3 % self-generated excl. 12 % peat (2014)	Wood fuels - 77 % Hydro Power - 17 % Heat Pumps - 4%
AVITEM (France)	Provence + Alpes+ Côte d'Azur	159	23%	10% (2014)	Hydro - 53.8 % wood - 33.33 %
UM (Malta)	Malta	1,329	10%	4.68 % (2014)	PV - 26.1 % Heat pump - 24.4 % RES transport - 19.4 % Solar thermal - 18.8%

Table 2: Case studies to tranform buildings to NZCO2EB as depicted by the partner regions

Partner	Case study	Climate classification	Base scenario	Measure variant 1	Measure variant 2	Measure variant 3	Measure variant 4	% CO_2 emissions reduction	Simple Pay back (Years)
LASP (Slovenia)	Kindergarten 365 m^2 usable area	Cfb	Well insulated building, natural gas boilers	Biomass boiler + Photovoltaics	Geothermal Heat pump + PVs			100% (both variants)	Variant 1 17.3 yrs Variant 2 10.7 yrs
MAICH (Greece)	Public school 2,190 m^2	Csa	Reinforced concrete building, Heating oil boiler	DHW Solar thermal + PVs + biomass heating	DHW Solar thermal + PVs + Geothermal heating			100% (both variants)	Variant 1 11.0 yrs Variant 2 11.5 yrs
Molise Region (Italy)	Matrice Municipality building	Cfb	Not stated	Gas boiler + solar thermal + windows	Envelope insulation	Variant 1 + variant 2 + HRV + PVs		Variant 1 21.9 % Variant 2 26.4 % Variant 3 72.5 %	Not stated
KD (Lithuania)	Gymnasium building 4,329 m^2	Dfb	Poorly insulated building & DHW, district space heating	Envelope insulation + automatic space heating + PVs				Variant 1 48.2 %	Not stated
Thermopolis Ltd. (Finland)	Day care 446 m^2 heated area	Dfc	Well insulated envelope, Oil boiler + wall mounted radiators + HRV	GSHP + 55 kWp PV	Wood boiler + 55 kWp PV	GSHP + 12 kWp PV	Wood boiler + 12 kWp PV	Variant 1 88.4 % Variant 2 100 % Variant 3,4 76 %	55 kWp PV: 29 yrs 12 kWp PV: 21 yrs GSHP:12 yrs Boiler: 11 yrs
AVITEM (France)	Social housing block 2,326 m^2	Csa	Poorly insulated building, oil boilers heating	Envelopw insulation+ ext. shading + windows + GSHP	Variant 1 measures + solar heating system			Variant 1 95.7 % Variant 2 96.8 %	Variant 1 36 yrs Variant 2 49 yrs
UM (Malta)	3-star hotel 397 m^2 conditioned floor area	Csa	Minimum compliant envelope, electrical DHW, ASHP, electrical catering equip.	BIPV + PVs + DHW heat pump + LPG catering equipment	Refer to [9]	Refer to [9]	Refer to [9]	Variant 1 75%	Variant 1 9.2 yrs

In contrast, for Mediterranean countries, it has been shown in various studies for Malta including [4], [5] that using very high insulation levels to go well beyond the minimum energy requirements of Technical Document F, is generally not cost-optimal and should not be prioritised to reduce the operating CO_2 emissions.

Heat pumps including ground source heat pumps (GSHPs) to reduce the NZCO2EB emissions also prove to be an important technology for all climates to reduce their CO_2 emissions. Air source heat pump water heaters (ASHPs) have also been shown to be a suitable alternative to solar water heaters in Malta , especially for buildings with no access to a rooftop [6]. Thanks to this project, the University of Malta has emphasised the importance of domestic hot water heat pumps to the main stakeholders being the Energy and Water Agency [7] and the Building Regulation Office [8] to meet Malta's RE, energy efficiency and NZEB targets. As a result, a DHW heat pump grant has recently (October 2017) been introduced in Malta and has been included as a good practice in the Interreg Europe website [6].

2.2 Good practices

Each project partner submitted various good practice examples, which can be found on the Interreg Europe website policy learning platform [6]. Good practices included both case studies of NZCO2EB buildings and good practice policies aiding in the transition to NZCO2EB.

Malta provided three good practice examples. One example is the deep energy renovation of St. Nicholas College Siggiewi Primary School [5], [6], [10], for which a number of passive and active measures shown in Figure 2 were implemented, to achieve NZCO2EB.

Measures included:

- Wall and roof-mounted PV systems;
- A programmable active external shading system;
- A solar pool heating system;
- An automated pool cover;
- Carbon-dioxide demand controlled mechanical ventilation system to satisfy air quality requirements;
- Ventilation system to bring in fresh warmer air from the surrounding corridors to the classrooms in winter to enhance thermal comfort;
- Summer night purging to bring fresh air into the school's building;
- High efficiency ceiling infra-red heaters;
- LED dimmable luminaires;
- Instantaneous water heaters instead of electric boilers, and
- A BMS control and data collection system.

Figure 2: From top left to bottom right : Roof mounted photovoltaics, wall mounted photovoltaics also acting as overhangs, BMS controlled, automated lovers, pool solar water heating, automated pool cover, CO_2 controlled mechanical ventilation system, Intelligent lighting using photocells + soffit mounted infra-red panel heaters and the fully fledged BMS

The University of Malta has also submitted two good practice policy examples, being the heat pump water heater grant [6] and the solar photovoltaic communal farm scheme [8]. These two policies are well oriented for households that do not have the potential to install solar RES, which sector is very important for Malta given that almost 60 % of all dwellings are flatted dwellings as per 2011 National Census data.

The DHW heat pump grant is open to the residential sector. Heat pumps provide the advantage over solar water heaters of not requiring a roof space for installation. This technology also counts towards the 10 % RE target for Malta. Given that the grant is open for all the residential sector, it helps to solve the issue of households that also have shaded roofs or have no space on the roof. This is because a heat pump water heater can be installed anywhere as long as there is ample supply of air.

The communal solar farm scheme ran between October 2016 and June 2017 and allocated a PV capacity of 999 kW_p, exclusively targeting the residential sector whose main residence has no right of use of own rooftop for installing PVs. The scheme therefore gave the opportunity for households without a rooftop to reach NZCO2EB.

Interesting good practice NZCO2EB case studies from other regions included the creation of a zero

CO_2 emissions off-grid building due to energy use in Crete [11], the energy renovation of a primary school Makole [12] and the energy renovation of seven buildings of Kindergarten Ptuj in Slovenia [13]. A select of good policy practices from other regions are identified in the market needs report for Malta [14] and discussed briefly in this paper. Gaps in Malta's policy instruments are identified in line with the knowledge transfer aspect of the project, showing how successful policy instruments from partner regions can be adapted to other regions to ease the transition to NZCO2EB.

3 MARKET NEEDS REPORT

The main project deliverables are the **market needs report** and the **policy action plan**. Prior to establishing the required actions, the market needs required for Malta to ease the transition to NZCO2EB were identified, so that the required action plans tackle directly the needs of the market.

3.1 Development of the Market needs for Malta

The market needs were established from the:

1. University of Malta project deliverables carried out in consultation with the project stakeholders,
2. Lessons learned from the good policy practices from partner regions, as identified in the project website [15] and in the Regional Policies and Best Practices common study [16].

The most important project deliverables for Malta are the:

1. Regional study discussed in section 2.2,
2. Regional policy report for Malta [17], [18] presents a PESTEL analysis of the current policy mechanisms for renewable energy and energy efficiency (EE).
3. Presentation on the overview of policy measures towards near zero CO2 buildings [19], [20] provides a detailed literature review of guidelines and state of the art policies from various sources around Europe, including Building Performance Institute Europe (BPIE) [21] and ENTRANZE [21].
4. Technology options towards NZCO2EB for Malta presentation [22], [23] shows different passive and active technology options to reduce CO_2 emission from buildings, including quick win measures and other measures, which have longer payback periods.
5. Presentation on technology options for achieving Near Zero CO2 Buildings: Real Operational Results [24] depicts performance studies of various energy efficiency options for the building envelope, as well as performance of energy efficient technology options when tested in Malta. Technologies include PVs, solar water heating, infra-red heaters, air to water heat pumps and solar-assisted thermodynamic heat pump water heating, as well as studies on the effect of thermal insulation, shading and double-glazing in dwellings, offices and hotels.

3.2 Current funding opportunities for EE and RE for Malta

In order to identify the market needs, one has to look at the main funding opportunities promoting RE and EE, which are:

1. National funds, and
2. ERDF (2014- 2020) funds

The different funding opportunities to finance national schemes are compiled from various entities including the Regulator for Energy and Water Services (REWS) [8], Malta Hotels and Restaurants Association [8], Malta Enterprise [25], Planning and Priorities Coordination Division (PPCD) [8] and the Energy and Water Agency [8], as shown in Figure 3. In addition, Figure 4 depicts the private funding opportunities, which most commonly consist of green loans and energy performance contracting.

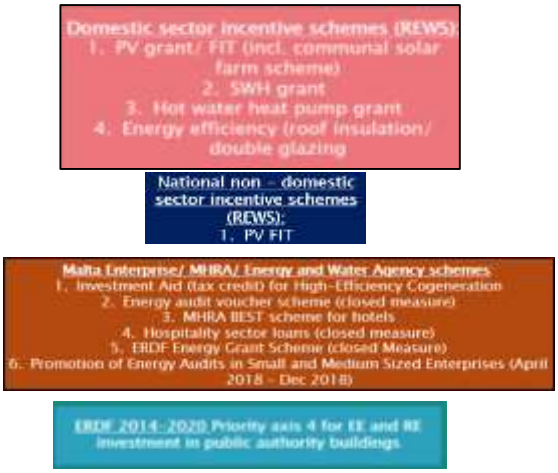

Figure 3: Current funding opportunities for EE and RES for Malta based on national schemes (national and ERDF funding)

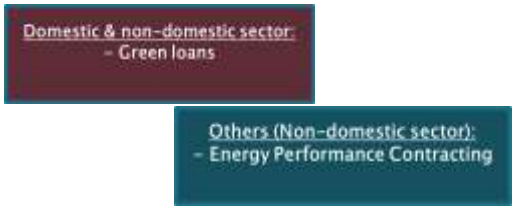

Figure 4: Private funding opportunities for EE and RES for Malta

A detailed description of these funding opportunities, including their success, the funds used and the foreseen funding for each measure is detailed

in the Regional Policy Report for Malta [17], [18] and in the Market Needs Report for Malta [14].

3.3 The Market needs

The market needs to enable the transition of public buildings to NZCO2EB are explained in detail in [14] and summarised below:

1. Reduced bureaucracy;
2. Targeted support schemes towards specific sectors;
3. Upgrade of unsuccessful grants and schemes and target them towards the most effective energy efficiency measures;
4. Increased public acceptance and good use of Energy Performance Certificates (EPCs) and their accompanying recommendation reports;
5. Provide incentives/schemes to allow public building/housing sector with no or shaded roof top to achieve low operational CO_2 levels;
6. Reduced barriers and uncertainties when undertaking Energy Performance Contracting;
7. Provide support schemes targeted towards the public housing sector;
8. Public authority buildings to serve as exemplary buildings;
9. Minimum RE targets for new constructions and for buildings undergoing deep renovation;
10. Promote measures achieving deep energy renovation / low CO_2 emissions, as opposed to shallow renovation;
11. Increased awareness and improved technical expertise;

There are currently no schemes specifically targeted for the housing sector despite this sector being unlikely to have the necessary capital to invest in technologies to reduce CO_2 emissions. The importance of energy efficiency renovation of the housing sector is identified in the Regional Policies and Best Practices Common Study [16]. The project partners of Slovenia, Finland, and France all have policies related to the energy renovation of the housing sector.

The integrated design process required to achieve or renovate buildings to NZEB requires expertise which many engineers, architects and project managers' lack.

4 THE POLICY ACTION PLAN FOR MALTA

The policy action plan [14] proposals are divided into two categories. The first category deals with soft measures i.e. measures not requiring ERDF or national funding sources, while the second category concerns policy proposals requiring ERDF/national funding sources.

For both categories, the policy measures are listed in terms of priority. It is envisaged, that at least two measures from each category will be implemented within the next two years, until March 2020.

4.1 Soft measures

1. Provide training and continuous professional development to architects, engineers and project managers on aspects of design, technologies, life cycle costings and energy performance certification to facilitate the transition to NZCO2EB.
   - Players involved: University of Malta
   - This measure addresses Market Need point 11.
2. Introduce a mandatory minimum RE share in new and renovated buildings.
   - Players involved: Building Regulation Office
   - This measures addresses Market Needs points 9 and 10.
3. Provide a guide on best-practice methods to renovate public buildings according to their specific sector, such as schools, offices, health centres and housing blocks to facilitate their transition to NZCO2EB status.
   - Market Needs 6 and 11 are addressed by this measure.
4. Provide non-biased information campaigns using social media on the most effective measures including energy management practices that can be applied for buildings in Malta to reduce CO_2 emissions. The campaign should also focus on the role of EPCs to improve the public perception on the certification and enhance their utilisation.
   - Market needs 4 and 11 are addressed by this measure.
5. Provide a one-stop shop for all financial incentive measures and to provide technical advice to the general public who would like to achieve NZCO2EB.
   - Market Need 1 is addressed.
6. Improve the public perception of EPCs by encouraging banks to calculate maximum loan limits for potential property buyers based on the energy performance rating of the property.
   -Market Needs 4, 10 and 11 are addressed.
7. Provide statistical analysis results of the EPC database for different categories of buildings to serve as benchmarks for comparing the EPC of different buildings within the same category. Such studies are already available for other EU Member States.
   -Market Needs 4, 10 and 11 are addressed.

4.2 Fiscal Measures requiring National/ ERDF funds

1. Revise SWH grant to regenerate interest in solar water heating.
   - Players involved: The Energy and Water Agency

- Market Need 3 is addressed.

2. Pilot project to renovate a public housing sector block to reduce its CO_2 emissions by 30 % or more by end of 2020.
   - Players involved: Housing Authority
   - Market need 7 is addressed.
3. Provide fiscal incentives or tax rebates for contractors, who opt to build new buildings of high efficiency rating beyond the minimum energy requirements of Technical Document F [26], [27].
   - Market Needs 3, 4 and 10 are addressed.
4. Devise projects to improve the energy, performance rating of public authority buildings, such as Ministries, public offices, health centres and public schools and sports complexes.
   - Market Needs 8 and 11 are addressed.
5. Provide grants to install SWHs and/or heat pumps for DHW for the hospitality sector (hotels/ restaurants), residential homes for the elderly and sports complexes.
   - Market Needs 2, 3 and 10 are addressed.
6. Provide bundled incentives combining two technological options such as PVs/SWH, PVs/Heat pump for existing buildings and incentives that combine envelope improvement with RES such as roof insulation/PVs or roof insulation/SWH or roof insulation and shading/heat pump for existing buildings to be renovated.
   - Market Needs 3 and 10 are addressed.
7. Provide incentives for solar shading and/or spectrally selective coatings and films for the commercial building sector.
   - Market Needs 3 and 10 are addressed.
8. Extend government communal solar farm projects to households, who despite having a roof cannot install PVs due to solar shading. Another possibility can be to extend communal farms to commercial buildings (such as restaurants) that do not own a roof top.
   - Market Needs 5 and 9 are addressed.

5 CONCLUSION

This paper has summarised the main project phase 1 deliverables of the Interreg Europe ZeroCo2 project, which aims to devise actions and policy measures to facilitate the transition of new and public buildings to NZCO2EB. Focus has been placed on the University of Malta deliverables, most importantly the NZCO2EB market needs for Malta and the required policy action plans to tackle these market needs. All project deliverables were carried out in close collaboration with the project's stakeholders. It is envisaged that implementation of the priorityy actions in project phase 2 will facilitate Malta's transition of NZCO2EB, while aiding the country reach its 2020 RE, EE and NZEB targets as defined in [28]–[30]

It is with satisfaction that one notes that only after a few weeks from communicating the proposed policy action plan for Malta to the policy makers, the Ministry for Energy and Water Management has announced important upgrades to the solar heating systems, double glazing and roof insulation grant schemes [31]. This clearly shows the results of the positive collaboration that was initiated in the ZEROCO2 project between the University of Malta and the main policy advisors' stakeholders, the Energy and Water Agency and the Building Regulation Office, which was strengthened by the signing of a Memorandum of Understanding, at the beginning of the project.

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7 REFERENCES

[1] European Parliament, "Directive 2010/31/EU of the European Parliament and of the council of 19 May 2010 on the energy performance of buildings (recast)," 2010.

[2] I. Europe, "ZeroCO2 - Promotion of near zero CO2 emission buildings due to energy use," 2016. [Online]. Available: http://www.interregeurope.eu/zeroco2/.

[3] J. G. Fantidis, D. V Bandekas, C. Potolias, N. Vordos, and K. Karakoulidis, "Financial Analysis of Solar Water Heating Systems during the Depression: Case Study of Greece," *Inz. Ekon. Econ.*, vol. 23, no. 1, pp. 33–40, 2012.

[4] T. Caruana and C. Yousif, “The Effect of Different Glazing Apertures on the Thermal Performance of Maltese Buildings,” in *International Sustainable Built Environment Conference, Europe and the Mediterrnean towards a Sustainable Built Environment, 16-18 March*, 2016, pp. 435–442.

[5] Damien Gatt and Charles Yousif et al., “Intelligent Retrofitting of a Primary School Building in Malta,” in *Engineering Today August 2016 Issue 54, Chamber of Engineers, Malta*, pp. 18–27.

[6] S. M. Gutiérrez, C. Yousif, and R. N. Farrugia, “Testing of an Air Source Heat Pump Water Heater in Malta,” no. September, pp. 508–513, 2010.

[7] “The Energy and Water Agency.” [Online]. Available: https://www.energywateragency.gov.mt/. [Accessed: 01-May-2018].

[8] “The Regulator for Energy and Water Services (REWS),” *REWS*, 2017. [Online]. Available: https://www.rews.org.mt/#/en/home. [Accessed: 01-May-2018].

[9] Damien Gatt and Charles Yousif, “ZeroCO2 Building - How low can we go: A Case Study of a Small Hotel in Gozo - Malta,” 2016. [Online]. Available: https://www.youtube.com/watch?v=GtV-QUtoVxc&t=362s. [Accessed: 08-Feb-2018].

[10] D. Gatt, “Renovating primary school buildings in Malta to achieve cost-optimal energy performance and comfort levels,” University of Malta, 2015.

[11] G. Angelakis, “Good practice: Creation of a zero CO2 emissions small off-grid commercial building,” *Interreg Europe*, 2018. [Online]. Available: https://www.interregeurope.eu/policylearning/good-practices/item/40/creation-of-a-zero-co2-emissions-small-off-grid-commercial-building/. [Accessed: 01-May-2018].

[12] T. Potocknik, “Good practice: Energy renovation of Primary school Anica Černejeva Makole,” *Interreg Europe*, 2018. [Online]. Available: https://www.interregeurope.eu/policylearning/good-practices/item/144/energy-renovation-of-primary-school-anica-cernejeva-makole/. [Accessed: 01-May-2018].

[13] T. Potocknik, “Good practice: Energy renovation of buildings of Kindergarten Ptuj,” *Interreg Europe*, 2018. [Online]. Available: https://www.interregeurope.eu/policylearning/good-practices/item/135/energy-renovation-of-buildings-of-kindergarten-ptuj/. [Accessed: 01-May-2018].

[14] D. Gatt and C. Yousif, “Malta Policy Action Plan Report,” *University of Malta*, 2018. [Online]. Available: https://www.um.edu.mt/__data/assets/pdf_file/0009/350010/PolicyActionPlan_Malta28March2018.pdf. [Accessed: 01-May-2018].

[15] “Good practices from Interreg projects and beyond,” *Interreg Europe*. [Online]. Available: https://www.interregeurope.eu/policylearning/good-practices/. [Accessed: 30-Apr-2018].

[16] “Regional Policy Reports: Regional Policies and Best Practices common study,” 2017. [Online]. Available: https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1499847144.pdf.

[17] D. Gatt and C. Yousif, “Interreg Europe ZEROCO2 regional policies report promoting energy efficiency & renewable energy Malta,” 2017. [Online]. Available: https://www.researchgate.net/publication/315114295_Interreg_Europe_ZEROCO2_regional_policies_report_promoting_energy_efficiency_renewable_energy_Malta.

[18] D. Gatt and C. Yousif, “ZeroCO2 Interreg Europe - Policies Promoting Energy Efficiency and Use of Renewable Energy Resource,” 2017. [Online]. Available: https://www.youtube.com/watch?v=z2nTZy1JluQ&t=496s.

[19] D. Gatt and C. Yousif, “Drivers, barriers and policy requirements to retrofit public buildings in Malta to NZCO2EB,” 2017. [Online]. Available: https://www.researchgate.net/publication/316188681_Drivers_barriers_and_policy_requirements_to_retrofit_public_buildings_in_Malta_to_NZCO2EB.

[20] D. Gatt and C. Yousif, “ZeroCO2 Interreg Europe Presentation - Retrofit public buildings in Malta to NZCO2EB,” 2017. [Online]. Available: https://www.youtube.com/watch?v=xOukEpP9UoA&t=170s.

[21] “BPIE,” 2018. [Online]. Available: http://bpie.eu/. [Accessed: 02-May-2018].

[22] D. Gatt and C. Yousif, “Interreg Europe ZEROCO2 technology options towards NZEB (NZCO2EB) for Malta,” 2017. [Online]. Available: https://www.researchgate.net/publication/315114455_Interreg_Europe_ZEROCO2_technology_options_towards_NZEB_NZCO2EB_for_Malta.

[23] D. Gatt and C. Yousif, “Interreg Europe ZEROCO2 - Technology options towards NZEB (NZCO2EB) for Malta,” 2017. [Online]. Available: https://www.youtube.com/watch?v=EZveDHyM1vM&t=249s.

[24] “University of Malta Youtube videos.” [Online]. Available: https://www.youtube.com/user/universityofma

lta/videos.
[25] "Malta Enterprise," *MALTA ENTERPRISE CORPORATION*, 2018. [Online]. Available: https://www.maltaenterprise.com/. [Accessed: 01-May-2018].
[26] Building Regulation Office, "Technical Document F Part 1, Minimum Energy Performance Requirements for buildings in Malta," Malta, 2015. [Online]. Available: https://secure2.gov.mt/epc/legislation?l=1.
[27] Building Regulations Office, "Technical Document F part 2 : Minimum Energy Performance Requirements for Building Services in Malta," Malta, 2015 [Online]. Available: https://secure2.gov.mt/epc/legislation?l=1.
[28] "National Renewable Energy Action Plan 2015-2020," *Energy and Water Agency*, 2017. [Online]. Available: https://energywateragency.gov.mt/en/Documents/National_Renewable_Energy_Action_Plan(2017).pdf. [Accessed: 10-Jan-2018].
[29] "Malta's National Energy Efficiency Action Plan (NEEAP)," 2014. [Online]. Available: https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_malta.pdf.
[30] Building Regulation Office, "Nearly-zero energy buildings plan for Malta," 2015. [Online]. Available: https://secure2.gov.mt/epc/file.aspx?f=131.
[31] Philip Leone Ganado, New Grants for Solar Panels, Double Glazing and Roof Insulation, [Online]. Available: https://www.timesofmalta.com/articles/view/20180502/local/new-grants-for-solar-panels-double-glazing-and-roof-insulation.678017, The Times of Malta, 2nd May 2018.