Long Term Renovation Strategy 2050

June 2021

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GLOSSARY

A/C	Air conditioning
ASHP	Air source heat pumps
AWHP	Air to Water Heat Pump
BCA	Building and construction authority
BEST	Benchmarking Energy Sustainability Targets
BICC	Building Industry Consultative Council
BRB	Building Regulation Board
BRO	Building Regulation Office
CHP	Combined heat and power
CISC	Construction Industry Skill Card
EE	Energy efficiency
EED	Energy Efficiency Directive
EEPI	Energy Efficiency Partnership Initiative
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificates
EPRDM	Energy performance rating of dwellings in Malta calculation tool
ERA	Environment and Resources Authority
ERDF	European Regional Development Fund
ESCO	Energy service company
EU	European Union
EWA	Energy & Water Agency
HFPs	Holiday Furnished Premises
HVAC	Heating, ventilation, and air conditioning
iSBEM	Simplified Building Energy Model for Malta
LED	Light-emitting diode
LTRS	Long Term Renovation Strategy
MECP	Ministry the Environment, Climate Change and Planning
MESD	Ministry for Energy and Sustainable Development
MHRA	Malta Hotels and Restaurants Association
MS	Member State
MTIP	Ministry for Transport, Infrastructure and Capital Projects
NECP	National energy and climate plan
NEEAP	National Energy Efficiency Action Plan
NSO	National Statistics Office
nZEB	Nearly zero energy building
PA	Planning Authority
PV	Photovoltaics
RES	Renewable energy sources
REWS	Regulator for Energy & Water Services
SME	Small and medium enterprises
SWH	Solar water heaters
UV	Ultra violet radiation

1 EXECUTIVE SUMMARY

The EU has identified the modernisation of its building stock as one of the key priorities of the European Green Deal, and is promoting a wide range of initiatives, such as those identified by the Renovation Wave, to ensure Member States invest sufficiently in their building stock. These initiatives, while supporting a variety of objectives, are primarily aimed at making the EU building stock more efficient and are a key driver in the transition to net zero by 2050. The Malta Long Term Renovation Strategy (LTRS) is a key planning document that sets out how the Maltese Government aims to tackle this challenge, and it presents an overview of the current situation and of the government new strategy.

Chapter 3 presents an assessment of the building stock, with a focus on energy efficiency and building characteristics. Using several sources, including data collected via building inspections, the analysis shows that the building stock is increasing, and is expected to do so for the next 15 years. The increase is driven by population changes and by economic growth, which are expected to drive an increase both in overall energy use and in average demand per building (energy consumption is expected to increase with income, in particular in households). While the average consumption in households is still relatively low compared with the rest of Europe, primarily because of the mild climate, the average Maltese home is still inefficient. Further, the current minimum standards set for non-residential buildings are not sufficiently ambitious and there is a clear opportunity to drive improvements via regulatory changes.

Chapter 4 analyses the key challenges to increasing the rate of renovation in Malta. While there are legal, technical and institutional elements that are currently hindering the deployment of energy efficiency measures (in particular, limited compliance with current standards), the key barrier is the limited economic returns that can be achieved by investing in energy efficiency. The mild climate of Malta requires heating in buildings for only few months per year, which means that better insulation would save only small amount of energy, far less energy than it does in most of Europe. Further, energy is priced relatively low for consumers, resulting in lower economic benefits for each unit of energy saved. These two factors lengthen the payback period of any investment, making it less attractive to building owners.

Chapter 5 provides an overview of existing strategies, legislation and government initiatives in support of buildings renovation. The analysis of historical data shows a good uptake of government's incentive schemes, and their success in collaboration with stakeholders. The Maltese government has also launched information campaigns, although their impact on renovation rates is less clear. However, the measures that have driven the majority of changes are building regulations for new built, also because of the high rate of redevelopments/new build experienced in the last 5 to 10 years.

Chapter 6 discusses the main cost-effective technical options to improve the energy efficiency of residential and non-residential buildings. These include measures targeting the building's fabric (insulation, glazing, shading, water collection, materials), technical systems (space heating and cooling, water heating, lighting), on-site generation (photovoltaic) and smart technologies (such as smart controls, preparedness for system integration).

Chapter 7 presents a list of actions that the government of Malta is considering to drive further renovation of the building stock, in particular to align energy use and carbon emissions from buildings with the new, more ambitious reduction trajectories being considered as part of the Green Deal. The proposed policy mix is underpinned by:

- stronger regulation, in cases where current minimum standards are substantially below recent technical developments and below what is economically efficient. Regulation will ensure that new build is future-proof and will affect mostly the non-residential sector, where more stringent minimum standards can substantially improve energy performance with a limited impact on construction cost;

- financial incentives, where the costs on installing energy efficiency measures would be uneconomical for the building owners. Incentives will instead support primarily renovation of the dwelling stock, including worst performing dwellings, and renewable generation.
- Exemplary role of government buildings, by investing at an increased rate in the public building stock.

Chapter 8 provides an overview of the expected impacts of the strategy. While it is not possible to be precise in respect to its long-term effects, the strategy is expected to halve energy use compared to the counterfactual and require substantial investments. Overall, the policies introduced could lead to cumulative savings of 60,000 GWh of primary energy in buildings by 2050, leading to emission reductions of 4.5 million tonnes CO_2. The strategy is expected to require investments of around €5.1 billion over 30 years (undiscounted), with the Maltese government covering around 33% and the private sector the remaining share. For the next 10 years, the government is planning over €800 million of investments in the residential, non-residential and publicly-owned stock.

2 INTRODUCTION

The revision of the EU Energy Performance of Buildings Directive (EPBD) (Directive (EU) 2018/844) was a key part of the Clean Energy for all Europeans policy package. The revised EPBD entered into force in July 2019 and provides Member States with clear direction on how to achieve the decarbonisation of the building stock by 2050. Every Member State has to detail this in their long term renovation strategy (LTRS), further updating the previous LTRS submitted in 2013 and 2017. Compared with previous strategies, the new directive strengthens the requirement for worst-performing buildings, split-incentive dilemmas and market failures. It also requires member states to:

- Provide an overview of the national building stock addressing key areas such as energy poverty and public buildings.
- Provide indicative milestones for 2030, 2040 and 2050.
- Review policies and actions implemented as part of previous LTRS, and propose new ones to stimulate cost-effective deep renovation of buildings
- Define initiatives to promote skills and education in the construction and energy efficiency sectors
- Provide an estimate of expected energy savings and wider benefits.

The analysis presented here builds upon the findings and the data provided in the 2017 LTRS, with appropriate updates from several sources where feasible. The main sources used to compile this report are the data on planning permits from the Planning Authority (PA), the electricity consumption data provided by Enemalta, the Maltese standards and regulations published in the *Technical Document F* and near Zero Energy Buildings (*nZEB)* plans, the data published in the eight *cost-optimality reports* (published by the BRO) and the 2015 report *Analysis for a Cost-Effective and Efficient Heating & Cooling* published by the Ministry for Energy and health. Official government forecasts and data produced for the National Energy and Climate Plan (NECP) (published in 2019) were also used to develop the analysis supporting the assessment of costs and impacts. The main source used throughout the report and in particular the analysis of the building stock and the impact assessment, is the database of Energy Performance Certificates (EPCs) owned by the Building Construction Authority (BCA), covering energy audits in dwellings and non-dwellings. Malta has invested substantially to ensure EPCs are carried out at key stages in the life of a building, and the data available (over 60,000 EPCs) offers a good coverage of the entire building stock (around 20-25% of buildings). Before being used, the data has been thoroughly checked and cleaned, so that only relevant records were maintained. This allowed to eliminate outliners and erroneous entries and to work only with reliable data. However, some limit to the result of EPCs assessments have emerged while analysing data in aggregate, which suggests that the methodology is not fully capable of capturing energy use in real world. This is an important limitation to some of the results and figures presented here.

This document presents Malta's plan for the renovation of the building stock, and its ambition in terms of number of properties renovated and energy saved. The strategy proposes a framework for the Maltese government to adopt when designing policies and schemes to support the uptake of energy efficiency measures, including deep renovations and on-site generation. The proposed policy mix and targets emerge from:

- the analysis of the current characteristics of the building stock and its likely evolution in the next 30 years;
- existing barriers to the uptake of energy efficiency measures;
- the lessons learned from implementing government schemes and campaigns to incentivise the uptake of energy efficiency measures;
- an analysis of the costs of and energy savings provided by the energy efficiency measures better suited to the Maltese climate, and the characteristics of its building stock.

Beside presenting the framework for long-term policies, the strategy provides more details about concrete actions that the Maltese government plans to put in place in the short to medium term. These actions will be aimed primarily at encouraging cost-effective measures and improving worst-performing buildings.

3 OVERVIEW OF NATIONAL BUILDING STOCK

3.1 *Analysis of dwellings*

The analysis of the residential sector in the 2017 LTRS relied largely on data from the National Statistics Office Census based on population and housing data from 2011[1]. The next Census is planned for 2021 and will again provide data in terms of dwelling use, their number and their characteristics. For this reason, this report will not attempt to duplicate the analysis already provided in the 2017 LTRS. Rather, this report looks at energy consumption in dwellings based on the EPC EPRDM[2] software methodology, the official system adopted in Malta to evaluate the energy performance of dwellings. The BCA owns a database with over 60,000 domestic EPCs, of which 28,500 were analysed for this report. Considering a total dwellings stock of about 180,000 units[3], the database provides a statistically good coverage and allows to tentatively draw conclusions for the entire building stock in Malta.

[1] NSO (2014) Census of Population and Housing 2011: Final Report.
[2] Energy Performance Certificates (EPC)- Energy Performance Rating of Dwellings in Malta (EPRDM)
[3] According to the Ministry of Finance, there are 180,744 households in 2020. Historically, the share of dwellings per households has been very close to 100% (99.9% in 2011).

3.1.1 Summary of LTRS 2017

Based on the National Statistics Office Census carried out on population and housing in 2011[4], the dwelling stock in Malta amounted to 223,850 units, ranging from single-family houses such as terraced houses/townhouses, to apartment blocks comprising units such as flats, maisonettes and penthouses. However, the total number of occupied dwellings was 152,770 units, equivalent to 68.2% of the total. A substantial portion of dwelling units was unoccupied property (71,080 dwellings, 31.8% of the total), that is either used as seasonal or secondary use, or else completely vacant. The remainder of the chapter will analyse the share of residential buildings that is occupied.

Of the occupied dwellings, the majority (58.3%) are part of multi-family houses (flats, maisonettes), while the remaining are detached, semidetached or terraced single-family houses.[5]

TABLE 3-1 – DISTRIBUTION BY TYPE OF RESIDENTIAL BUILDING

Type of dwelling	***Units***	***Percentage of total***
Terraced house/Townhouse	52,519	34.4
Semi-detached house	5,812	3.8
Fully detached house	1,306	2.2
Semi/Fully detached Farmhouse	3,383	0.9
Other	686	0.4
Single – Family houses	***63,706***	***41.7***
Maisonette Ground Floor Tenement	44,145	28.9
Flat/Apartment/Penthouse	44,919	29.4
Multi-Family Houses	***89,064***	***58.3***

SOURCE: LTRS 2017

The reported age distribution showed a relatively old stock. The figures also demonstrate a recent trend whereby single-family houses are either converted or demolished to make room for new multi-family houses, generally smaller in size.

TABLE 3-2 – DISTRIBUTION OF RESIDENTIAL BUILDINGS BY AGE BAND AND CATEGORY

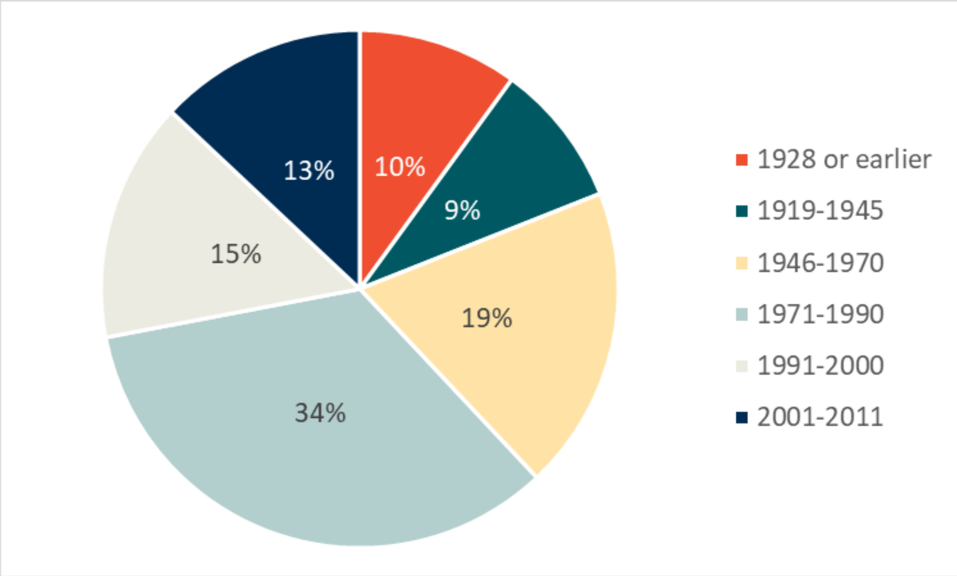
	Single-family	***Multi family***
1928 or earlier	10,872	4,883
1919-1945	7,001	6,329
1946-1970	11,052	18,453
1971-1990	25,249	26,122
1991-2000	7,263	16,123
2001-2011	2,269	17,154
Total	**63,706**	**89,064**

[4] NSO (2014) Census of Population and Housing 2011: Final Report.

[5] In this document, single-family dwellings are also referred as *Houses*, while multi-family dwellings are referred as *Flats*.

SOURCE: LTRS 2017

FIGURE 1- DISTRIBUTION OF RESIDENTIAL BUILDINGS BY AGE BAND (SOURCE: LTRS 2017)



About 76% of the occupied residential dwellings are owned by the household living in them, with or without ground rent. Investing in one's own property is a very common practice in Malta, also because this is often seen as a life-long investment. However, the share of dwellings that are rented has increased substantially recently, driven in part by the number of foreign workers moving to Malta to work.

TABLE 3-3 – DISTRIBUTION OF RESIDENTIAL BUILDINGS BY TYPE OF OWNERSHIP[6]

Tenure Status	***Units***	***Percentage of Total (%)***
Owned Freehold	92,281	60.4
Owned with ground rent	24,513	16.0
Rented unfurnished	22,351	14.6
Rented furnished	7,994	5.2
Held by emphyteusis	1,438	0.9
Used free-of charge	4,193	2.7
Total	***152,770***	

SOURCE: LTRS 2017

Traditionally, buildings in Malta were built with limestone, the most abundant natural resource available on the island. Buildings were characterised by thick stone walls, high ceilings and internal courtyards, which allowed the buildings to be naturally well insulated and ventilated, providing for a comfortable indoor temperature[7]. During the late 1800 and early 1900, new sanitary legislation and taxation generated an increase in terraced housing, which is still a relatively popular form of dwelling nowadays.

Post-second world war, reinforced concrete roofs became the norm. This, coupled with the opening of the first plant to produce prefabricated pre-stressed concrete roofing elements in 1956, changed the typical

[6]Contract that gives the holder the perpetual right to the enjoyment of a property on condition of proper care, payment of tax and rent

[7] This was changed when the new sanitary legislation was enacted/introduced in Malta in 1880/1934 (due to Cholera) whereby each dwelling had to have a backyard and owners had to pay a contribution according to street frontage – similar to British legislation.

method of building construction. More recently, most buildings started being built using thinner walls[8], usually with one leaf of hollow concrete blockwork rather than two leaves of masonry walls with cavity in between (without insulation) and lower concrete ceilings, in order to save construction costs.

The LTRS 2017 provides two further key insights:

- hollow concrete blocks have now become the norm in new buildings, with the use of limestone disappearing fast. While new blocks have a limited effectiveness in improving energy performance[9], a number of new products with improved insulation are becoming more frequent on the market (but not often used, typically due to a higher cost);
- most building related jobs (excluding the mason / builder who must possess a valid mason's license) were until recently being performed by persons who did not possess any form of certification, license or accreditation. Recently, the Building Industry Consultative Council (BICC), the local forum for building stakeholders, introduced the Construction Industry Skill Card (CISC), an accreditation scheme intended to improve and maintain higher standards in the construction industry[10].

3.1.2 Residential stock 2020[11]

The National Statistics Office (NSO) regularly collects data on households and ownership of the dwelling stock, including occupancy and other characteristics. Data from 2018 show that the number of dwellings has increased by 23% since 2011. Of these, the majority of dwellings are apartments in multi-family buildings, while fully detached houses are the less common type of dwelling. NSO data also show that a substantial share of single-family houses has a high number of rooms (seven or more), while apartments are more likely to have between 4 and 6 rooms.

TABLE 3-4 – DISTRIBUTION BY TYPE OF RESIDENTIAL BUILDING AND BY NUMBER OF ROOMS[12]

Dwelling type	***Number of rooms***						
	Less than 4	***4***	***5***	***6***	***7 or more***	***Total***	***%***
Detached house	--	--	1,221	2,259	4,024	8,790	4.7%
Semi-detached or terraced house	2,216	6,824	18,340	20,240	27,316	74,937	39.9%
Apartments and other dwellings (incl. maisonettes, garages, boathouses etc.)	5,601	24,648	41,525	21,012	11,236	104,022	55.4%
Total	***8,152***	***32,423***	***61,086***	***43,512***	***42,576***	***187,749***	***100%***

[8] Often such walls may end up having a higher U-Value than the minimum energy performance requirements (as set by Technical Document F)
[9] U-value for 230mm rendered concrete block in construction is 1.71 while for limestone is 2.31 – which is still very high – U values for concrete blocks in Western Europe are below 0.5 (http://www.schundler.com/rvalues.htm).
[10] The preliminary concept of the Skill Card was first introduced by the Government in the Budget 2015, whereby it was officially adopted as a government policy. BICC together with the Ministry of Education were entrusted to prepare a white paper for the eventual launch of this initiative; (Source: Building industry consultative council. Towards a socio-responsible construction industry-Skill cards in the construction industry in Malta
[11] NSO (2018) Statistics on Income and Living Conditions 2017: Main Dwellings
[12] A room is defined as a space of a housing unit enclosed by walls and with a ceiling, of a size large enough to hold a bed for an adult (four square metres at least) and whose height is at least two metres.

SOURCE: NSO, 2019

Ownership

The 2015 NSO Household Budgetary Survey[13] examined the share of dwelling by ownership and found that 71% of households are owned by those living in the building, a decrease compared to the 76% of 2011.

TABLE 3-5 – DISTRIBUTION OF RESIDENTIAL BUILDINGS BY TYPE OF OWNERSHIP

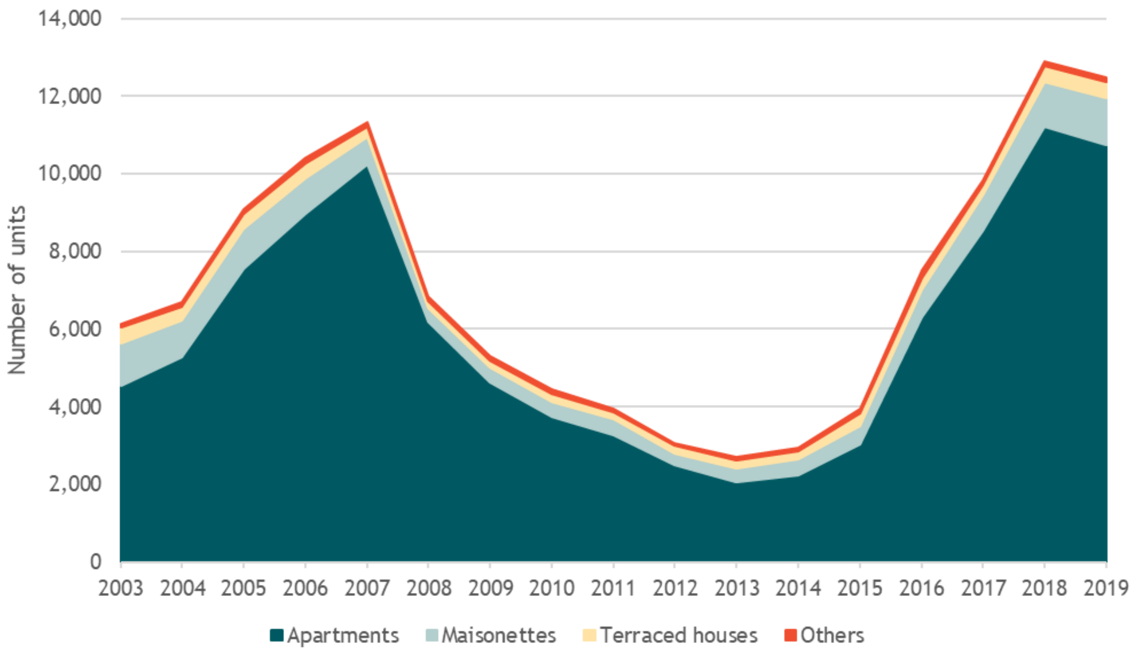
	NUMBER	SHARE
Owned	116,800	70.9
Of which:		
With mortgage	*30,586*	*18.6*
Without mortgage	*86,214*	*52.3*
Rented	27,147	16.5
Accommodation free of charge	7,429	4.5
Given for free	13,439	8.2
TOTAL	***164,815***	***100***

SOURCE: NSO HOUSEHOLD BUDGETARY SURVEY, 2015

Ownership of a secondary dwelling[14] is common in Malta: in 2015, the NSO found that around 14% of families owned a secondary dwelling. Data from the Planning Authority show that since 2014 the pace of dwelling construction has increased substantially, breaking the previous record from 2007. The data also further confirms the trend to build new apartments, rather than single-family homes. Figure 2 shows the number of permits awarded, which include both permits for a new construction or per minor work to an existing construction. The fact that a permit is required means that the work to be carried out will affect the fabric or the configuration of the building.

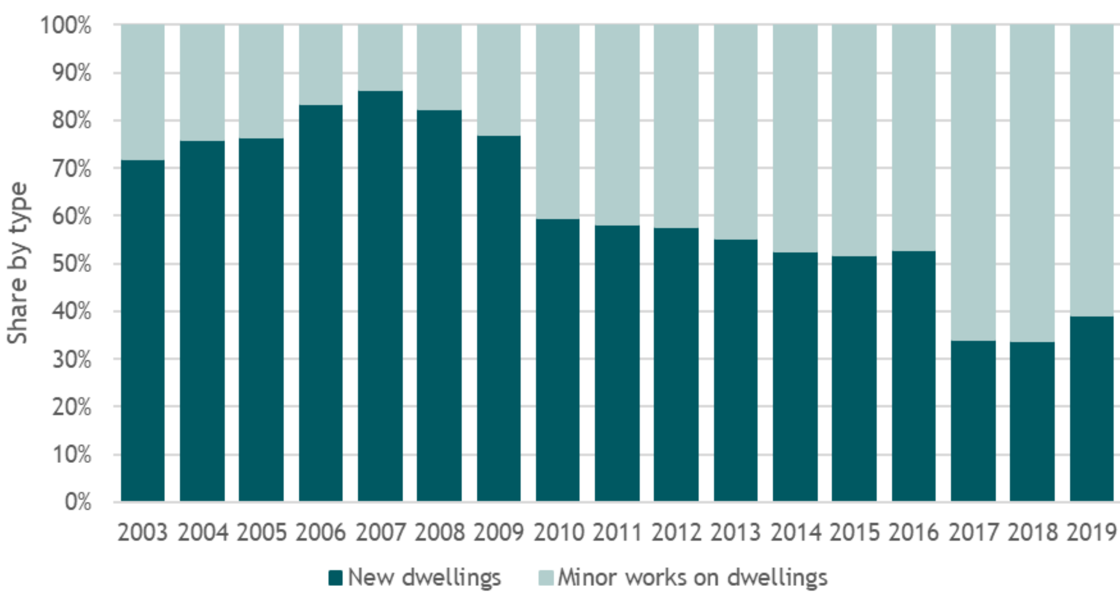
[13] NSO (2015) Household Budgetary Survey-Malta 2015
[14] NSO (2015) Household Budgetary Survey-Malta 2015

Figure 2 Number of permits by dwelling type and year (Source: Planning Authority)



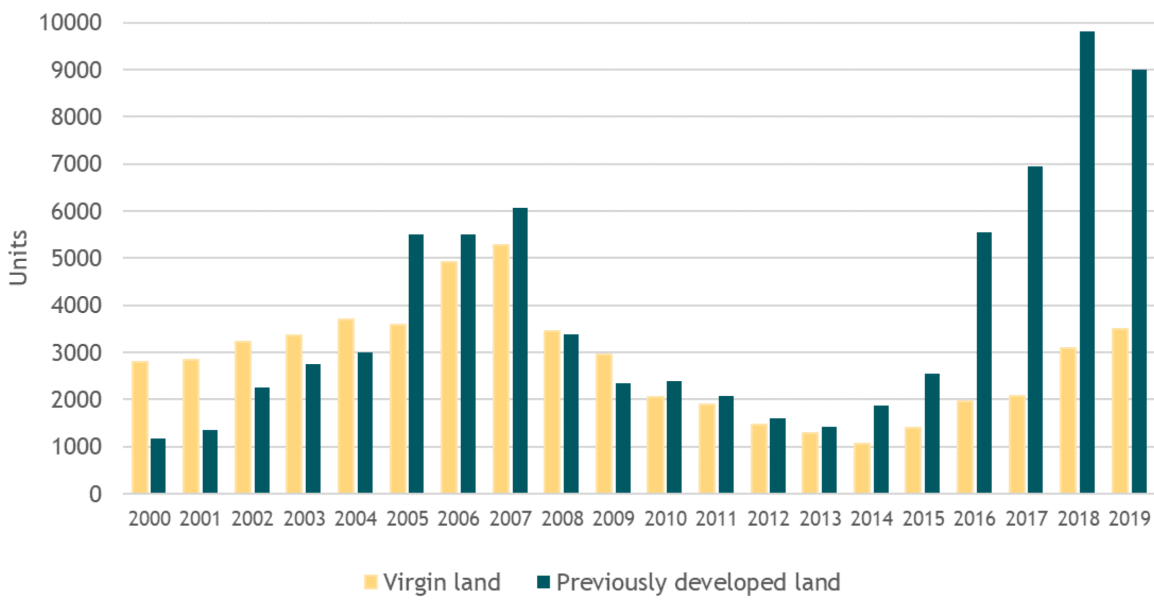
Data from the Planning Authority also demonstrate an important trend: the share of permits requested for minor works is now higher than the share of permits for new dwellings. However, this conclusion has to consider that new dwellings include also conversion of use, for example from a workshop to a house; and that a single permit may comprise work for a number of units.

Figure 3 Share of permits by type (Source: Planning Authority)



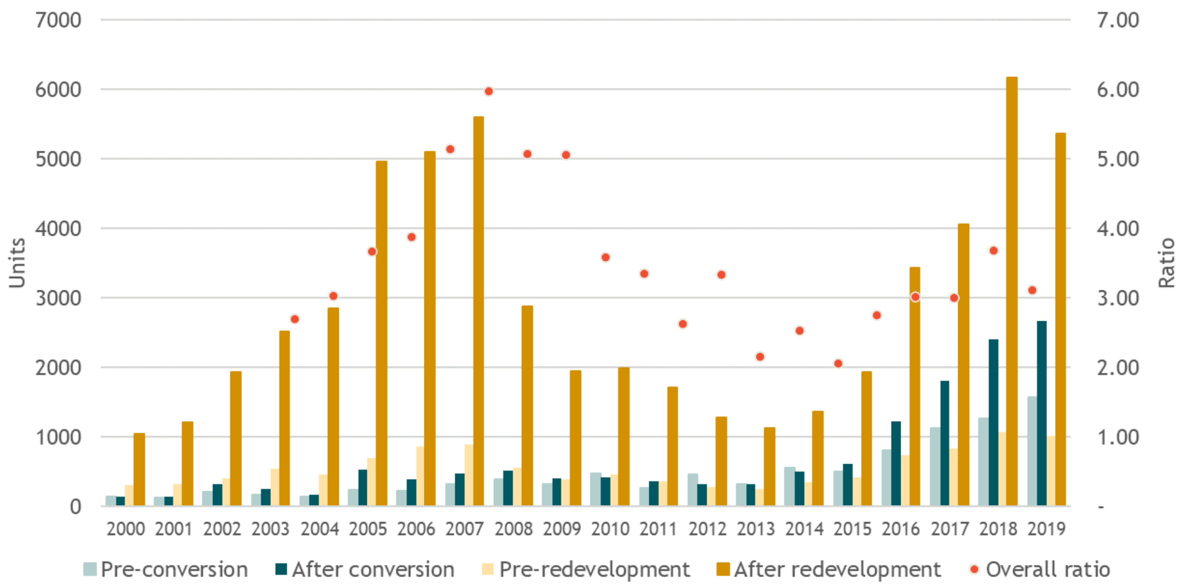
Planning Authority data also provides trends concerning developments on virgin land and conversions/redevelopments[15]. Since 2014, there has been a shift towards developments in previously developed land, which results from virgin land becoming more and more scarce in Malta. During peak periods, developers exploit available sites more than they do when demand for new housing is low (more new units for every old unit being redeveloped) as shown by the ratio in Figure 5. From the same figure, it is also possible to observe an overall preference for old buildings to be redeveloped, rather than converted, although recent trends are moving towards a more balanced distribution: in the last five years, developers have been converting many more dwellings compared to the previous 15 years (an average of 1,740 per year compared to 350 observed on average before 2015). On the other hand, the redevelopment ratio has remained stable at around 5, which means every old dwelling being demolished is replaced by 5 new dwellings. Generally, it is old houses that are demolished and replaced by medium-rise blocks of flats.

FIGURE 4 NUMBER OF UNITS BY LAND TYPE (SOURCE: PLANNING AUTHORITY)



[15] A redevelopment intervention means the existing structure is demolished and replaced by a new one, while a conversion will re-use all or part of the existing structure.

FIGURE 5 NUMBER OF UNITS BEFORE AND AFTER CONVERSIONS AND REDEVELOPMENT



It is important to note that not all building permits will convert into new buildings, as sometimes permissions are obtained years in advance or it may take several years before the property is completed and inhabited.[16]

Energy use

According to Eurostat, Malta's residential sector in 2019 was responsible for 14.5% of final energy consumption, which includes energy used for the building itself and appliances. This is below the EU average of 25%. Maltese households' final consumption in 2018 was 93 kToE (equivalent to 1084 GWh), an increase of 45% since 2009. For comparison, the EU equivalent figure has seen a decrease of 7% over the same period.[17] According to the Odyssee-Mure database[18], Maltese households are those with the lowest consumption (0.48 toe per year in 2018 or 5,6 MWh), around 37% of the European average. However, Malta is also the country where the average consumption has increased the most since 2000, while the majority of countries have seen their average decrease. This shows that, at EU level, policies on both energy performance of buildings and energy efficient appliances are having an impact, though this is partly offset by lifestyle changes such as an increasing number of electrical appliances and more homes.[19]

Using Eurostat figures, Maltese households' final electricity consumption in 2019 was 831 GWh (or 4.9 MWh per household[20]), an increase of 40% compared to 2010 (589 GWh).

[16] Steering Committee
[17] Eurostat (2020) Final energy consumption by sector
[18] Odyssee-Mure (2020) Average consumption per dwelling
[19] EEA (2019) Briefing on household energy consumption.
[20] Based on CEIC: 168.468 households in 2017 – assumption of 170.000 households has taken into account.

3.1.3 Energy performance of the dwelling stock

The BCA sample

The BCA database includes data covering several categories of dwellings and allows to discriminate between existing and new buildings. The sample analysed (based on info from the energy performance certificates) includes categories of dwellings, as presented in Table 3-6.

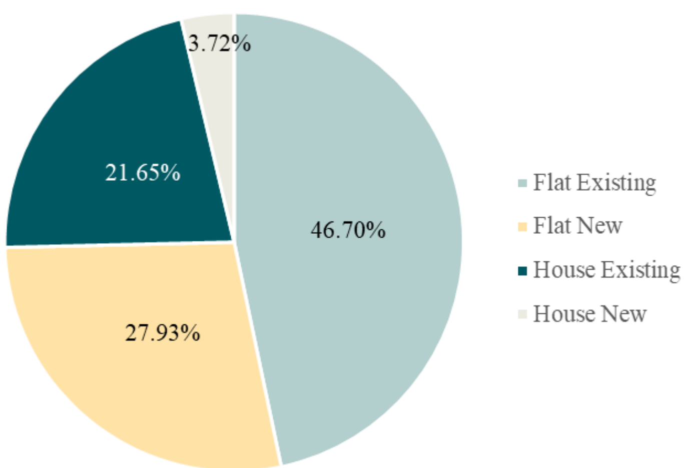
TABLE 3-6 DWELLINGS IN THE BCA SAMPLE

	Total	Existing dwellings (asset)	New dwellings (design)	Total share
House	**7,246**	**32%**	**12%**	**25%**
Terraced house	4,455	20%	6%	16%
Semi detached dwelling	498	2%	1%	2%
Fully detached dwelling	333	1%	1%	1%
Top floor maisonette	1,960	8%	4%	7%
Flat	**21,296**	**68%**	**88%**	**75%**
Apartment	18,880	59%	81%	66%
Ground floor maisonette	2,494	9%	8%	9%
Total	**28,655**	**100%**	**100%**	**100%**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA FROM BCA

Since 2011, the vast majority of new developments has been of new flats, often converting what was once a single-family home. However, a trend where a single-family dwelling is replaced by 3-4 dwellings in multi-family houses will change the balance between the two main categories rather quickly. Within our database, 31% of EPCs are for new dwellings[21], of which only 12% are for single family houses and 88% for flats.

FIGURE 6 DWELLINGS IN DATABASE AS SHARE OF TOTAL (SOURCE: BCA EPC DATABASE)



While the EPC building categories are not an exact match with the categories used in the 2011 census, the difference between the share of the two main categories is limited, which suggest the database offers a good snapshot of the Maltese dwelling stock. In total, the database covers 15% of dwellings.

[21] The EPC assessment is in this case based on project plans

Dwelling size

On the basis of our sample of 28,655 EPCs, the size of new dwellings is, on average, smaller than the size of existing dwellings. This is due to the fact that new dwellings are more likely to be flats than existing ones, and flats are usually smaller than houses. However, when looking at each category individually, dwellings are getting marginally bigger on average. When median values are considered, some trends are reversed: the median new house is smaller than the median existing one, while the median new flat is marginally bigger than the median existing flat.

TABLE 3-7 AVERAGE AND MEDIAN DWELLING SIZE BY CATEGORY IN SQUARE METERS[22]

	Existing		*New*		*All*	
	Average	***Median***	***Average***	***Median***	***Average***	***Median***
House	**161**	**147**	**181**	**160**	**164**	**148**
Terraced house	161	150	196	188	165	153
Semi-detached dwelling	229	214	256	228	235	217
Fully detached dwelling	254	233	273	229	257	231
Top floor maisonette	126	123	128	118	126	123
Flat	**102**	**98**	**105**	**100**	**103**	**99**
Apartment	102	97	103	99	102	97
Uppermost Floor	104	98	106	101	104	99
Ground floor maisonette	100	100	111	106	103	103
Total	**121**	**108**	**114**	**104**	**119**	**107**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA FROM BCA

TEXTBOX 1 CONSUMPTION DATA FROM EPCS

The Energy Performance Certificate (EPC) is released after an energy performance assessment, which evaluates the expected energy use of a dwelling based on building fabric, energy-using systems (heating, cooling, water heating, lighting) and on-site generation (generally PV systems). The consumption data calculated by the assessment software estimates how much energy the building will use if used throughout the year by the average user.

Consumption data is provided both as delivered and as primary energy. The former will estimate how much energy will arrive into the building and is broadly equivalent to the amount for which households will be billed for. The primary energy is the amount of energy necessary to provide energy in the form used by the building. For example, a dwelling may use 1,000 kWh per year of electricity, but if that electricity was produced by a gas-fired power plant, this may require the equivalent of 2,500 kWh of gas. This is because some energy is lost into the conversion process and other is lost during the transport from the power plant to the site where it is used. In Malta, according to the EPRDM methodology, 3.45 kWh of primary energy is needed to produce 1 kWh of delivered electricity. This factor is due to be reviewed and EWA currently recommends a factor of 2.

[22] Simple average and median of all records considered (after data clean)

If not indicated otherwise, our analysis of buildings refers to delivered energy and conversion to delivered/primary are in accordance with current EPRDM methodology (using a 3.45 factor). However, when considering the overall impacts of the strategy, results are also presented as primary energy use.

Assumed Consumption

Our analysis of EPCs shows that the average assumed consumption[23] of a Maltese dwelling is 4,722 kWh per year, equivalent to 40 kWh per m^2 on average. This includes only the energy required by the dwellings (space heating and cooling, lighting and hot water) and excludes appliances such as televisions and refrigerators. In particular, this figure is based on energy needs of the heating, cooling, water heating and lighting system. New buildings (built from 2015 onwards) appear to consume on average 20% less energy than the existing ones. The median consumption is, as expected, slightly below the average value.

TABLE 3-8 TOTAL AND PER M^2 ANNUAL ASSUMED CONSUMPTION (KWH)[24]

		Existing		*New*		*All*	
		Average	***Median***	***Average***	***Median***	***Average***	***Median***
Total annual consumption kWh	Single-family houses	6,028	5 559	5,127	4 515	5,897	5406
	Multi-family houses	3,870	3 479	3,420	3 055	3,702	3299
	All	**4,553**	**3931**	**3,620**	**3133**	**4,258**	**3639**
Annual consumption kWh per m^2	Single-family houses	43	40	32	28	42	38
	Multi-family houses	42	38	35	32	39	35
	All	**42**	**38**	**35**	**32**	**40**	**36**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA FROM BCA

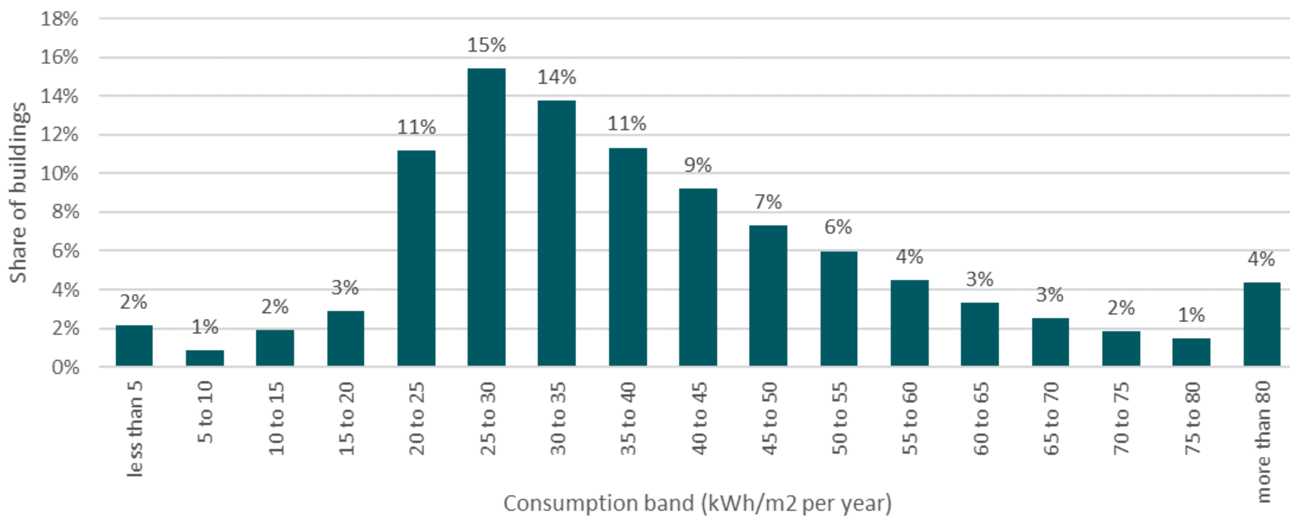
Assumed energy use – distribution

In terms of energy use, the distribution has a peak around an energy consumption of 25 to 30 kWh per m^2, with 70% of dwellings requiring between 20 and 50 kWh/m^2 per year.

[23] Data extracted from EPC database.

[24] Consumption estimated based on size and consumption per m^2 per category.

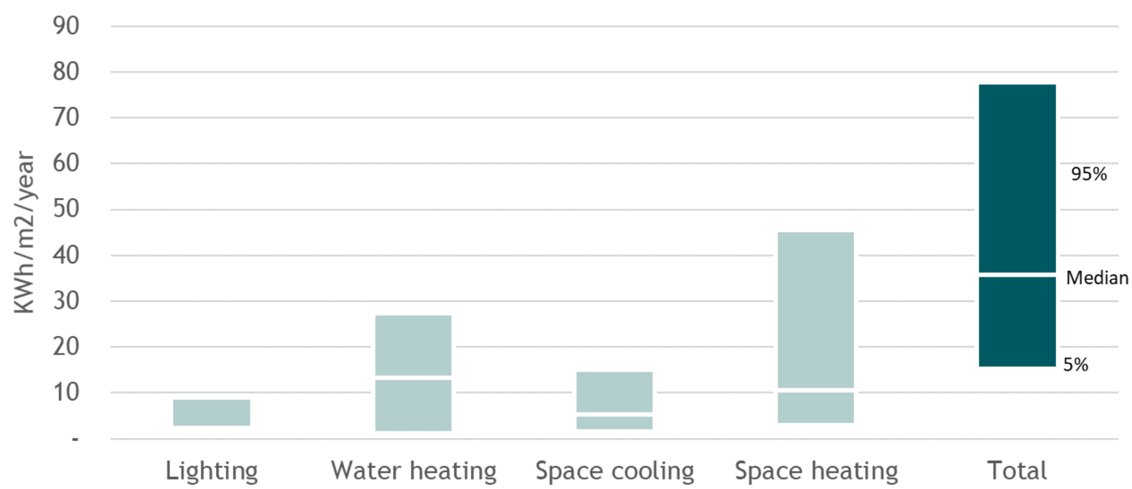
FIGURE 7 DISTRIBUTION OF DWELLINGS BY CONSUMPTION BANDS (SOURCE: EPC DATA)



Energy use – by end use

In 90% of the cases, energy use in dwellings ranges between 20 and 78 kWh/m^2 per year, with a median value of 36 kWh. Most energy consumption goes to power the heating system (between 3 and 46 kWh/m^2 per year), followed by water heating (1 to 27 kWh per year).

FIGURE 8 CONSUMPTION RANGES BY END USE (SOURCE: EPC DATA)



There is a substantial difference between the energy use estimated by EPCs and the energy actually used by households in Malta as projected by the NECP. This difference is more evident for heating. By combining data from EPCs and dwelling stock, it is possible to estimate the total energy required for heating, water heating and cooling, and compare with other statistics available for the residential sector. Table 3-9 shows the difference between EPC estimates and NECP projections: overall consumption in the real world appears to be 25% lower than estimated via EPRDM assessments. While estimated consumption for water heating is consistent, and the difference in cooling (11%) is important but not unexpected, there is a substantial discrepancy between the two values for heating demand.

TABLE 3-9 DIFFERENCE BETWEEN ESTIMATES BASED ON THE EPC SAMPLE AND NECP ESTIMATES (GWH PER YEAR)

GWh/ year	EPC sample	NECP projections Average 17-18-19	Difference
Delivered energy for heating	342	140	-59%
Delivered energy for water heating	274	269	-2%
Delivered energy for cooling	138	153	+11%
Total	***754***	***562***	***-25%***

SOURCE: OWN CALCULATIONS BASED ON EPC AND NECP DATA

The differences can be explained by two main factors:

- According to the EPC methodology, if a dwelling has no heating it will be included in the system as having an electric heating system with a coefficient of performance equal to 1. This system would require a high amount of electricity to bring the dwelling at the appropriate living temperature. In Malta, a substantial share of the population lives in dwellings with no heating, where heating is provided through heat pumps only to some rooms.
- Maltese are not used to heating their dwellings to levels more common in other EU countries. The EPRDM methodology assumes an indoor temperature of 23 °C in winter.

Onsite renewable generation

EPC data also provides an indication of onsite renewable generation. Our sample shows that 4% of dwellings have an onsite renewable generation system, the vast majority being PV. Three dwellings in our sample had a wind turbine installed. In terms of PV, our sample shows that, on average, systems have a capacity of 3 kW and produce 3.7 MWh per year each (below the 4.8MWh these systems are usually expected to generate).

Data from NSO[25] shows that in 2017 there were 21,500 domestic PV installations, 94% of the total PV installation in Malta. The combined output of the domestic, public and commercial PV amounted to 158 GWh.

Insulation

Insulation of the building fabric is measured through the U value, which estimates the resistance the walls offer to the outside temperature. The value is expressed in W/m^{2}K, which means that more efficient building would have a low U value.

3.1.3.1.1 Walls

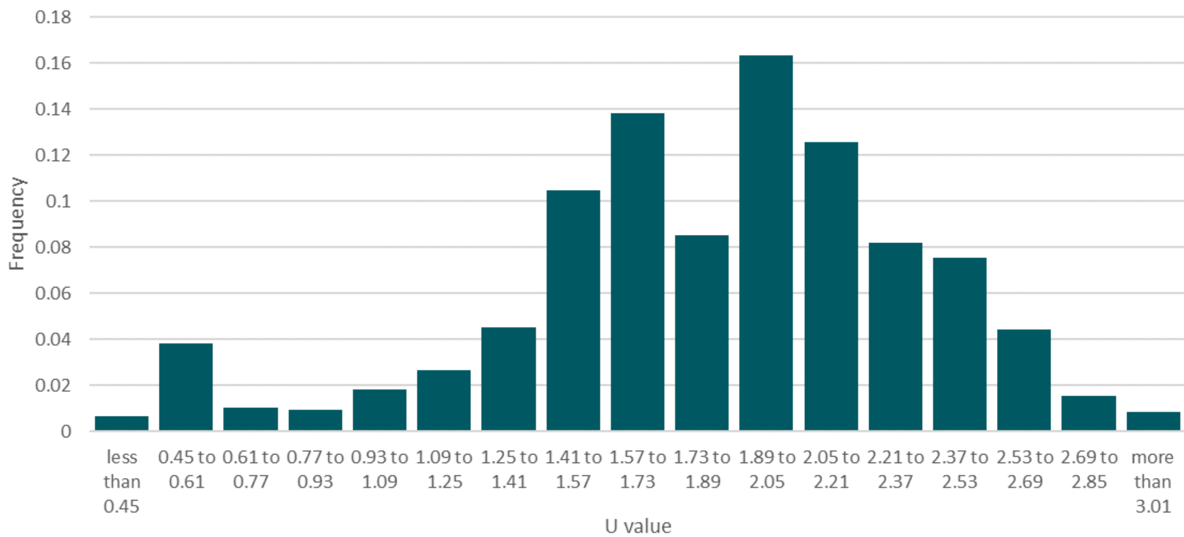
It is possible to calculate the weighted[26] average U value for the properties included in the database: the majority achieve a score between 1.4 and 2.45 W/m^{2}K. According to Maltese guidelines[27], the minimum requirement for new dwellings is to have a wall heat loss value of 1.57 W/m^{2}K.

[25] NSO (2020) Renewable Energy from Photovoltaic Panels (PVs): 2019.

[26] The analysis has been carried out by calculating an average U value per property weighted by wall area ((Σ(wall area * U value))/total wall area.

[27] According to Technical Document F

FIGURE 9 DISTRIBUTION OF U VALUES FOR WALLS (SOURCE: DOCUMENT F)



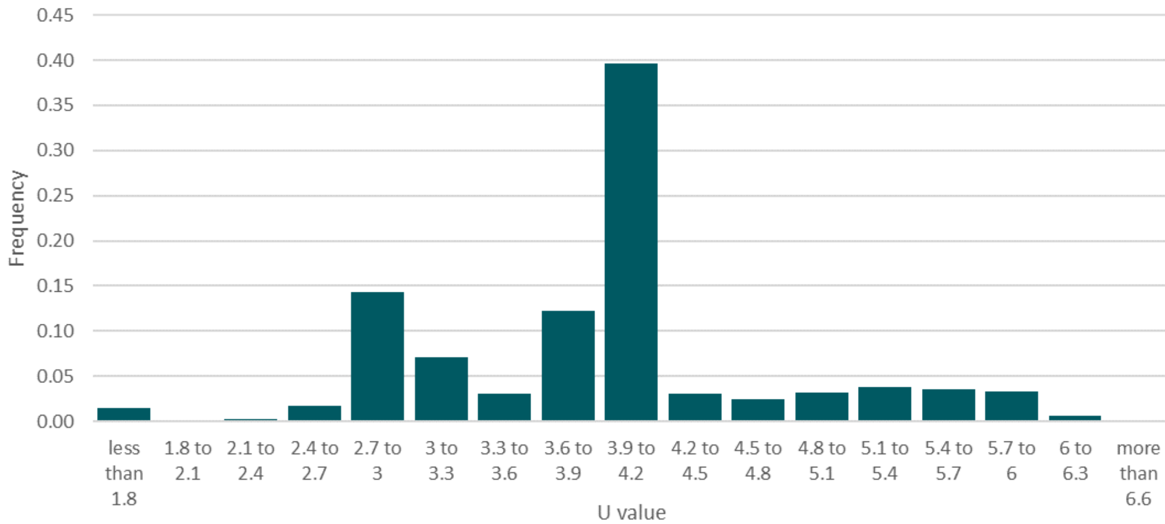
3.1.3.1.2 Windows

It is possible to calculate the weighted[28] average glazing U value for the properties included in the database: the majority achieve a score between 3.9 and 4.2 W/m^2K. For comparison, a modern double-glazed window in Western Europe has a U value lower than 1.5. According to Maltese guidelines[29], glazing for new dwellings is to have a maximum U value of 4.0 W/m^2K, which is also effective in keeping the heat out, by preference with 'coloured' glazing.

[28] The analysis has been carried out by calculating an average U value per property weighted by glazed area ((Σ(glazed area * U value))/total glazed area.

[29] According to Technical Document F

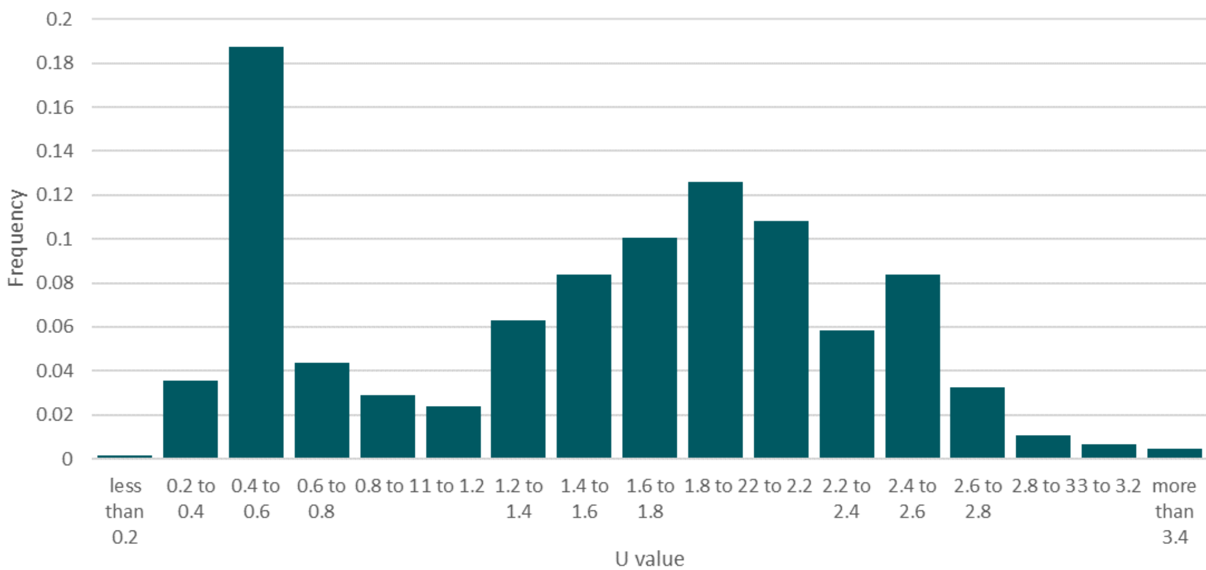
FIGURE 10 DISTRIBUTION OF U VALUES FOR WINDOWS (SOURCE: DOCUMENT F)



3.1.3.1.3 Roofs

We have extracted the simple average U value for the roof of the properties included in the database: the most populated band has values between 0.4 and 0.6 W/m^2K, but a high number of dwellings have U values comprised between 1.2 and 2.6. According to Maltese guidelines[30], roofs for new dwellings are to have a U value of 0.59 W/m^2K.

FIGURE 11 DISTRIBUTION OF U VALUES FOR ROOFS (SOURCE: DOCUMENT F)



Consumption by type of dwelling

Breaking down the average delivered and primary energy assumed consumption by dwelling type, revealed that single-family dwellings consume more electricity per year than dwellings in multi-family homes (on average 6,028 kWh/year compared to 3,870 kWh/year). This remains true when looking at sub-categories.

[30] Ibid.

Looking at consumption per square meter, flats are marginally more efficient (42 compared to 43 kwh/m^2/year), although when looking at some sub-categories the ranking is reversed. For example, fully and semi-detached dwellings consume less per m^2 than flats, including uppermost floor flats. Median consumption is generally 10% to 15% lower than the average consumption.

TABLE 3-10 AVERAGE DELIVERED AND PRIMARY ENERGY BY DWELLING CATEGORY (EXISTING BUILDINGS)[31]

	Delivered energy (kwh/year)		**Delivered energy (kwh/m^2/year)**		**Primary energy (kwh/year)**		**Primary energy (kwh/m^2/year) *including RES**		**Primary energy (kwh/m^2/year) *excluding RES[32]**	
	Average	***Median***	***Average***	***Median***	***Average***	***Median***	***Average***	***Median***	***Average***	***Median***
House	**6,028**	**5,563**	**43**	**40**	**19,750**	**18,461**	**142**	**132**	**149**	**135**
Terraced house	6,118	5,767	43	41	20,066	19,065	142	134	148	136
Semi detached dwelling	6,561	5,782	33	28	21,246	19,315	106	95	116	98
Fully detached dwelling	8,428	7,629	37	35	26,914	23,564	118	112	130	112
Top floor maisonette[33]	5,259	5,033	47	43	17,357	16,594	157	142	162	143
Flat	**3,870**	**3,479**	**42**	**38**	**12,975**	**11,726**	**140**	**127**	**142**	**127**
Apartment	3,664	3,257	39	36	12,319	11,013	132	121	133	120
Uppermost Floor	3,975	3,643	42	39	13,354	12,359	143	132	146	134
Ground floor maisonette	4,283	3,817	48	43	14,138	12,666	159	141	160	141
Total	**4,553**	**3,931**	**42**	**38**	**15,119**	**13,196**	**141**	**129**	**144**	**129**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

[31] Note that, while the relationship *area * consumption per m^2 = total consumption* is true at record (building) level, but once the average is taken the relationship is not true anymore: *avg. area * avg. consumption per m^2 ≠ avg. total consumption*

[32] According to EPRDM and SBEM methodology only PV and wind energy are considered renewable generation, while solar water heating is not. This is one of the elements that an updated methodology should rectify.

[33] A maisonette is defined as a two- (or sometimes three-) floor dwelling, where each unit has an independent Entrance and it is generally contained in a single floor. According to current practices, when it comes to building's characteristics, ground floor maisonettes are assimilated to a flat (as they are located under another dwelling, and sometimes also surrounded by adjacent buildings on both sides), while top floor maisonettes are more similar to a house, for example because owners have the right of extending upwards or installing rooftop solar panels.

TABLE 3-11 AVERAGE AND MEDIAN DELIVERED AND PRIMARY ENERGY BY DWELLING CATEGORY (NEW BUILDINGS) [34]

	Delivered energy (kwh/year)		Delivered energy (kwh/m²/year)		Primary energy (kwh/year)		Primary energy (kwh/m²/year) *including RES		Primary energy (kwh/m²/year) *excluding RES[35]	
	Average	***Median***	***Average***	***Median***	***Average***	***Median***	***Average***	***Median***	***Average***	***Median***
House	**5,127**	**4,529**	**32**	**28**	**16,967**	**15,253**	**108**	**95**	**117**	**99**
Terraced house	5,008	4,517	27	26	16,144	15,274	88	88	98	91
Semi detached dwelling	5,560	5,335	23	25	18,243	17,833	75	80	90	86
Fully detached dwelling	6,476	5,592	27	26	21,008	18,514	88	89	105	94
Top floor maisonette	4,968	4,171	43	35	17,124	14,389	147	121	150	121
Flat	**3,420**	**3,055**	**35**	**32**	**11,718**	**10,496**	**120**	**110**	**121**	**110**
Apartment	3,195	2,852	33	31	10,961	9,815	114	106	115	106
Uppermost Floor	3,599	3,216	37	33	12,314	11,030	125	115	127	115
Ground floor maisonette	3,717	3,299	35	32	12,747	11,270	120	111	121	111
Total	**3,620**	**3,133**	**35**	**32**	**12,334**	**10,755**	**118**	**108**	**121**	**109**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

For comparison, current minimum requirements expressed in the nZEB strategy are (primary energy), as included in Table 13.

TABLE 3-12 CURRENT MINIMUM REQUIREMENTS FROM NZEB PLAN

	Building according to current minimum requirements (Document F) (kwh/m²/yr)	Cost-optimal level without solar (kwh/m²/yr)	Requirements for nearly zero energy residential buildings (with res) (kwh/m²/yr)
Detached villa	94	68	55
Semi-detached villa	84	64	55
Terraced house	82	63	75
Top floor maisonette	97	102	N/A
Ground floor maisonette	127	115	N/A
Top floor flat	125	92	115
Mid floor flat	117	84	115

SOURCE: BASED ON BRO (2015) *NEARLY-ZERO ENERGY BUILDINGS PLAN FOR MALTA* AND BRO (2015) TECHNICAL DOCUMENT F

[34] Note that, while the relationship *area * consumption per m² = total consumption* is true at record (building) level, once the average is taken the relationship is not true anymore: *avg. area * avg. consumption per m² ≠ avg. total consumption*

[35] According to EPRDM and SBEM methodology only PV and wind are considered renewable generation, while solar water heating is not. This is one of the elements that an updated methodology should rectify.

While categories between the EPC dataset and minimum standards are not fully aligned, it is possible to conclude that:

- Average primary energy use for existing houses as estimated by the EPRDM software is much higher than the optimal level (142 kwh/m^2/year compared to 68-102). Many of these existing houses have been built before these standards were set;
- New houses, on average, have also an expected energy demand higher than the minimum standard and at least double than that of a near zero energy building, meaning there is room for savings;
- New and existing flats are much closer to optimal and near zero requirements.

3.1.4 Worst performing dwellings

The analysis of the BCA EPCs database allows the identification of the types of dwellings estimated to require substantially more energy than the average, and to understand the characteristics of these buildings. The top 5% consumers present in the BCA database (1,589 records) require more than 76 kWh/m^2 per year of delivered energy (262 kWh/m^2 of primary energy). Defining the worst performing in terms of energy consumption per m^2 penalises smaller dwellings, as they have generally higher per m^2 consumption than dwellings with a similar energy efficiency level. However, improving the efficiency level of smaller dwellings is also generally less expensive.

In our sample, 211 out of 1,589 (13%) records are of dwellings at design stage, showing that high consumption is not an issue that concerns only older buildings. Figure 12 shows the share of dwellings that use more than 76 kWh/m^2 per year across the entire building stock: 39% of worst performing dwellings are houses and 61% are flats, even though houses represent only 32% of the sample.

FIGURE 12 - SHARE OF WORST PERFORMING BUILDINGS

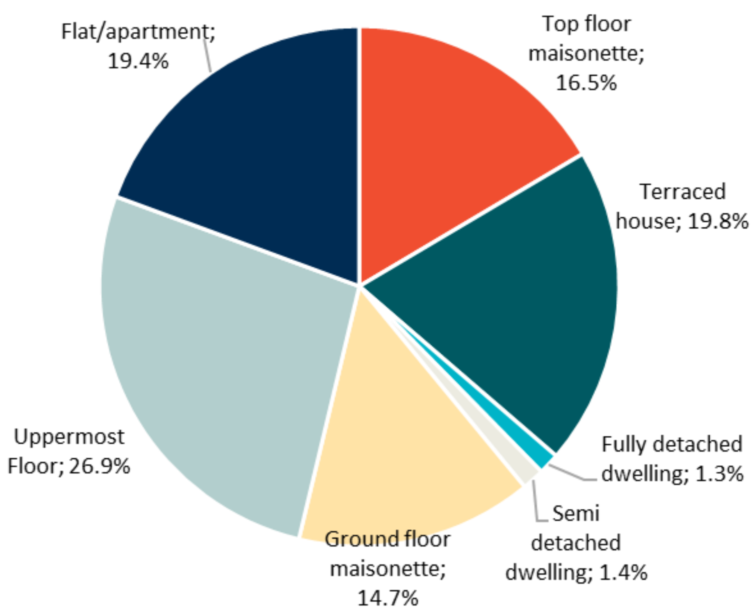


FIGURE 13 SHARE OF DWELLINGS IN CATEGORY ABOVE 95% CONSUMPTION

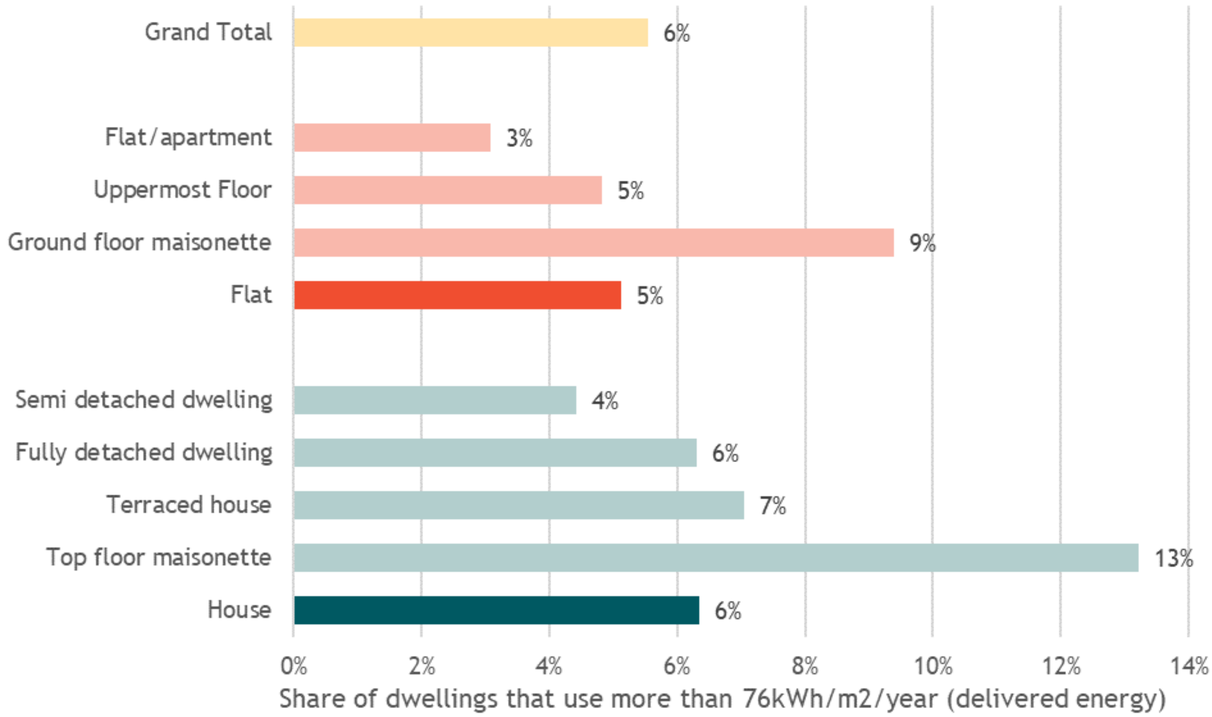


Figure 13 shows the share of dwellings that use more than 76 kWh/m^2 within each dwelling category. This shows that only 3% of apartments fall in the top 5% of energy users, while the figure is 6% for houses across the different typologies. The category that stands out is maisonettes, both ground and upper floor. Maisonettes are generally older buildings, where energy efficiency interventions are limited by a number of barriers (legal barriers, planning issues related to their location in conservation areas).

Including an additional 5% of worst performing dwellings (so extending the analysis to the top 10%) provides a similar distribution across categories. These dwellings use more than 65 kWh/m^3 per year (224 kWh/m^3 per year of primary energy) and are more likely to be houses, in particular top floor maisonettes. Ground floor maisonettes are the second-worst performer also in this case.

Characteristics of worst performing

Table 3-13 shows the share (within category) and characteristics of the top 5% of energy users, compared with average values found across the dataset. The analysis shows that, on average, worst performers have worse efficiency in their building fabric and in their efficiency of building's systems.

TABLE 3-13 ENERGY EFFICIENCY CHARACTERISTICS OF HIGHEST 5% ENERGY USERS

	Walls U value	Windows U value	Roof U value	Efficiency Cooling System	Efficiency Heating System	Water Heater Efficiency
	Higher values correspond to worse energy efficiency rating			Lower values correspond to worse energy efficiency rating		
House	**2.41**	**5.17**	**1.78**	**2.58**	**1.05**	**0.99**
Top floor maisonette	3.08	5.14	1.63	2.61	1.06	0.99

Terraced house	1.95	5.21	1.91	2.55	1.04	0.99
Fully detached dwelling	1.69	5.14	1.91	2.70	0.84	0.95
Semi detached dwelling	1.91	4.89	1.91	2.44	1.23	0.98
Flat	**2.11**	**5.03**	**1.89**	**2.62**	**1.13**	**1.19**
Flat/apartment	2.09	5.09		2.55	1.11	1.47
Uppermost Floor	2.12	4.98	1.89	2.65	1.14	1.11
Ground floor maisonette	2.14	5.05		2.67	1.13	0.98
Average across entire dataset	**1.88**	**4.38**	**1.52**	**2.96**	**2.47**	**1.00**

Houses: The thermal efficiency of walls windows and roofs found in houses are substantially below the average recorded across the dataset, although the analysis shows that houses generally do not perform poorly across the 3 main fabric elements considered. For example, worst performing fully detached houses have on average walls that are better than the average across the entire samples. Windows are however substantially worse than the average, which suggest glazing interventions are a priority for this category of dwelling. Concerning building's systems, worst performing houses are always worse than the average.

Flats: On average, flats that use more than 76 kWh/m^2 per year have better insulation and more efficient equipment than worst performing houses, but they are still less efficient than average. Due to their size, it is to be expected that flats may use more energy per m^2, but high U value for flats are an indication of very poor insulation levels, especially concerning roof insulation.

The data in Table can be compared with current minimum regulations , as defined in Document F (Table 3-14Table). It shows that on average, worst performing dwellings and the average value for the entire dataset have energy efficiency ratings for single items well above the current minimum standards.

TABLE 3-14 THRESHOLDS FOR EFFICIENT FABRICS AND ENERGY-USING SYSTEM

		Minimum U value (less than)	**Dataset average**	**Dataset median**	**Worst performing (simple average)**
Fabric (W/m2K)	Walls	1.57	1.88	1.93	2.17
	Windows	4.0	4.38	4.00	5.08
	Roof	0.59	1.52	1.10	1.85
		Minimum Efficiency (more than)			
Systems	Cooling[36]	2.6-4.7	2.96	3.00	2.60
	Heating[37]	2	2.47	3.20	1.08
	Water heating	1.0	1.00	1.00	1.07

[36] Excluding absorption cycle chillers and gas-engine driven flows
[37] Excluding heat pumps and gas engines

SOURCE: MINIMUM U-VALUES FROM BRO (2015) TECHNICAL DOCUMENT F; OTHER FIGURES FROM BCA'S EPC DATABASE

Retrofit interventions to worst-performing buildings should aim to go beyond minimum standards and achieve more substantial energy reductions. For example, a 100 m^2 dwelling with an average consumption of 76 kWh/m^2 per year would incur in an energy bill of €1,000 per year (assuming a cost of €0.13 per kWh). Over 25 years (average lifetime of energy efficiency measures) this is equivalent to an NPV of around €20,000 at a discount rate of 3% and €17,000 at a discount rate of 5%. This suggests that a deep retrofit able to halve consumption should not cost more than €8000 – €9,000 Euros, while a deep retrofit that is able to bring the dwelling to net 0 energy use (for example, through extensive use of PV generation) may cost up to €20,000. It is important to note that returns of 3%-5% are relatively low compared to the average return of, for example, a PV installation (10%-11%). In order to achieve a similar return, a retrofit intervention that is able to bring net consumption to 0 should not cost more than €12,000 to the households. While these are only indicative calculations, they offer a ballpark indication of what households can be expected to contribute towards the cost of a deep retrofit of a worst performing dwelling.

3.1.5 Conclusions

- Maltese flats and houses use, on average, less energy than dwellings in other EU countries. While Maltese buildings are not particularly well insulated, the climate and the habits of the local population are the main driving factors behind the low energy use.
- New flats are on average more efficient than existing ones, which suggests building regulations are having an effect.
- However, economic development is driving an increase in consumption, whereas the rest of Europe is decreasing average energy use. To counteract this trend, the share of population housed in flats rather than houses is increasing, and on average flats require less energy.

Other considerations:

- Maltese households rarely undertake extensive interventions in their dwellings, thereby limiting the opportunities of energy efficiency improvements.
- Water heating and space heating/cooling are the main energy users but it is expected that more people will install reversible heat pumps, These will increase energy used for cooling purposes but at the same time also produce heat much more efficiently than radiation heaters.
- Modern heat pumps are generally a very efficient way to provide heating and cooling (at low temperatures). If coupled with renewable electricity, they can provide thermal comfort at a low carbon intensity.

3.2 *Analysis of non-dwellings*

This section presents the analysis of non-residential buildings, according to a number of categories for which sufficient data was available. For non-residential buildings more prominence is given to the analysis of primary energy use (rather than delivered). This is because the share of building energy use derived from sources other than electricity of heat is much higher than in the residential sector, which means fuel change is an effective energy use reduction option. Further, fossil fuel use in the residential sector is generally limited to cooking, while in the non-residential sector the use of fossil fuel for heating or for on-site electricity generation is more widespread.

3.2.1 Summary of LTRS 2017

The 2017 LTRS covers the following non-dwelling building categories:

- Office buildings (main focus)
- Educational buildings;
- Hotels;
- Hospitals (incl. Retirement Homes); and
- Sports facilities.

Office buildings

In the past, office space consisted of converted and refurbished large residential units and only few buildings were specifically designed as offices. The increase in the services sector, along with the arrival of a number of international companies, generated an increased demand for dedicated office space. Some of these, such as Smart City Malta and Sky Parks Office Park, have voluntary eco certification such as LEEDS and BREEAM.

The public sector, including a considerable amount of central government bodies, mostly use government owned (often scheduled) buildings. Renovation usually takes place to satisfy a change of use rather than to improve energy performance. In some cases, especially when EU funds were available, buildings have been refurbished extensively and some energy savings registered.

Construction & renovation trends: A number of mixed-use buildings specifically catering for dedicated high-end office space have been earmarked for construction and have been given planning permission or are in the process of obtaining permission. Main changes in terms of renovation are related to PV installation, change of old split-unit air-conditioners to modern energy-efficiency ones and change to energy-efficient lighting. Architectural changes have been more difficult to come by, mainly due to long payback periods.

Educational buildings

Malta's educational system is divided in two parts: compulsory schooling and higher education.

The **compulsory educational** system is structured in three stages: pre-primary, primary and secondary. Traditionally, education was provided by the State or Church, but independent privately run schools have become available over the last decades. Buildings serving compulsory education are diverse, and their age and footprint varies. Some date to around the second world war period while others have been built recently. Commonly their size is between 100 m^2 and 1000 m^2.

TABLE 3-15 DISTRIBUTION OF EDUCATIONAL BUILDINGS BY LEVEL AND TYPE

Educational level	*State*	*Church*	*Independent*	*Total*
Pre-Primary	61	32	24	117
Primary	72	25	16	113
Secondary	33	23	8	64
Total	**166**	**80**	**48**	294

SOURCE: LTRS 2017

Higher Education (voluntary schooling) mainly comprises Post-Secondary and Tertiary Education and is offered by the State, Church or private institutions. There are 138 licensed institutions; however, the number and size of buildings used does not reflect the number of licences. Buildings used are very diverse: mostly small entities offering tuition in privately owned or rented buildings catering for 1 or 2 classrooms; others, though these are unique cases, - like the University of Malta or the Malta College for Arts, Science and Technology – are proper campuses, with different locations across Malta and Gozo.

TABLE 3-16 HIGHER EDUCATION

Offered by	*Institutions*
State	• Giovanni Curmi Higher Secondary School (Post-Secondary) • Sir Michelangelo Refalo Sixth Form (Post-Secondary) • Junior College (Post-Secondary) • Malta College for Arts, Science and Technology (Post-Secondary & Tertiary) • University of Malta (Tertiary)
Church	• Sixth Form (post-secondary) education through a number of Colleges manned by the Roman Catholic Congregations/Orders.
Independent	• Institutions offering Post-Secondary Education • Institutions offering Tertiary Education through Foreign Qualifications • Institutions offering Vocational Qualifications • Institutions offering English as a Foreign Language

SOURCE: LTRS 2017

Construction & renovation trends: A number of government schools have been extended (while others are planned) to cater for the increased number of student population in specific areas of the country. Schools built or renovated in the last decade considered energy efficiency improvements where possible and cost-effective. Renovation trends are similar to offices (PV, A/C, lighting). An example of this is the Siggiewi Primary School, which underwent a holistic retrofitting.

Hotels

Since Malta's Independence in 1964, the sector has developed into a pillar of the Maltese economy. Besides hotel buildings, Malta also has guest houses, hostels and one dedicated tourist village. A recent trend is for new hotels to refurbish and renovate old buildings in urban conservation or historical areas to be used as boutique hotels.

TABLE 3-17 DISTRIBUTION OF TOTAL NUMBER OF ACCOMMODATION UNITS BY TYPOLOGY[38]

	Units	*Beds*
5 star hotel	15	7,210
4 star hotel	44	16,253
3 star hotel	52	10,433
2 star hotel	21	1,460
Total Hotels	**132**	**35,356**
Tourist Village	**1**	**612**
Guest Houses/Hostels	**70**	**3,236**
Total Serviced Accommodation	***203***	***39,204***

SOURCE: LTRS 2017

Construction & renovation trends: A number of hotels have increased the number of beds available, driven by a relaxation in height restrictions in certain tourist areas. Some hotels have included architectural changes such as double glazing and roof insulation, usually implemented as part of a renovation process.

Healthcare

This category covers hospitals and homes for the elderly (retirement homes). In Malta, 95.5% of the **hospital** beds are publicly owned and managed (see Table 3-18).

[38] The data shown includes only serviced accommodation. Self-catering units are excluded from the analysis.

Retirement homes are on huge demand due to the increase in the number of elderly people. St. Vincent de Paul hospital residence (1,100 residents) is the main government presence in the sector. Its footprint is over 1 km^2 and provides work for 2,500 employees. The private sector and the Church run 28 other homes between Malta and Gozo.

TABLE 3-18 DISTRIBUTION OF HOSPITAL BEDS BY OWNERSHIP, YEAR OPENED AND TYPOLOGY

Ownership	*Name*	*Number of beds*	*% of Total*	*Type of Hospital*	*Year Opened*
Public Sector	Mater Dei Hospital	825	43.3	Acute General Hospital	2007
	Gozo General Hospital	158	8.3	Acute General Hospital	-
	Mount Carmel Hospital	512	26.9	Mental Health and Substance Abuse Hospital	-
	Sir Anthony Mamo Oncology Centre	113	5.9	Other Specialty Hospitals	2015
	Rehabilitation Hospital/Karen Grech Hospital	212	11.1	Other Specialty Hospitals	1979
Public Sector Sub-Total		***1,820***	***95.5***		
Private Sector	St. James Capua Hospital, Sliema	79	4.1	Acute General Hospital	1996
	St. James Hospital, Zabbar	6	0.3	Acute General Hospital	1984
Private Sector Sub-Total		***85***	***4.5***		
Total		***1,905***			

SOURCE: LTRS 2017

Construction trends: A specialised hospital, the Sir Anthony Mamo Oncology Centre was built in 2015. A study for 'Deep' Energy and Resource retrofitting was conducted for the St. Vincent de Paul complex with the aim of assessing not only the energy efficiency potential but also the cost benefit analysis of these retrofits.

Sports facilities

Malta has a number of sports facilities including one or more of the following facilities: multi-purpose hall, a full-size football pitch or a swimming pool.[39] Most are government owned, but rented out to national associations and, or private sports clubs. The LTRS 2017 considered only the two main 'national/regional' (indoor) sport complexes:

- **Cottonera Sports Complex**: Located in Cospicua and built in 2003, it is the main sports complex in the south of Malta and the largest indoor sports facility in Malta (footprint of circa 5,250m^2).
- **Gozo Regional Sports Complex**: Built in 1993 and recently refurbished, it is the main sports complex in Gozo (footprint of circa 2,100m^2).

Renovation trends: A number of smaller sports facilities have been undergoing renovation, including installation of PV and/or the use of combined heat and power to heat outdoor swimming pools.

[39] Football stadia are excluded, as these are outdoor facilities, with only the basic showering and changing facilities in small annexed buildings (except for the National Stadium in Ta'Qali).

3.2.2 Non-residential stock 2020

The sections below provide a preliminary overview of the 2020 non-dwelling building stock. Information on offices and healthcare will be included at a later stage.

Educational buildings

Table 3-19 provides an overview of the education buildings in Malta. In total there are 255 institutions in the country, while the majority of them are pre-primary schools, holding 58% of the total share. The area of the schools differs among the educational levels, with the secondary schools occupying the largest area, (on average 11,310 m^2).

TABLE 3-19 OVERVIEW OF EDUCATION BUILDINGS[40]

	Number of institutions	***Average students***	***Average total area (m^2)***
Pre-primary	147	42	251
Primary	69	234	4287
Secondary	23	506	11 310
Other	16	NA	4 059

Hotels

Table 3-20 provides an overview of the types of tourist accommodation and the respective building stock in Malta. The BCA data indicate that hotels (2 to 5 stars) account for only 3% of the accommodation sector, while the Holiday Furnished Premises (HFPs) in Malta and Gozo account for 84% of the total accommodation stock.

TABLE 3-20 OVERVIEW OF ACCOMMODATION PER TYPE[41].

Type of accommodation	**Number of buildings**
Hotels	132
Hostels	31
Guest houses	102
HFPs Malta	2,774
HFPs Gozo	1,224
Host families	469
Total	***4,732***

Catering establishments

An overview of the catering establishments in Malta is provided in Table 3-21. Data from the BCA demonstrate that bars represent the majority of the building stock in the catering sector, accounting for 61% of the total stock, following by restaurants which hold a 16% share.

TABLE 3-21 OVERVIEW OF CATERING ESTABLISHMENTS PER TYPE[42].

Type of catering establishment	***Number of buildings***
Restaurants	624
Take-aways	150
Coffee shops	9

[40] Data provided in personal communications from Perit Joel Fenech (State Schools) and Dr. Van Hear (Independent Schools)
[41] Malta Tourism Authority, Establishments registration
[42] Ibid.

Bars	2,273
Snack bars	598
Kiosks	57
Total	**3,711**

Sports facilities

Table 3-22Table provides an overview of the sports facilities under SportMalta responsibility along with their size and their lighting changes[43]. Cottonera is the main sport complex in Malta with a floor area of 7,301 m^2, where the lighting system is expected to be replaced in 2021. Kirkop and Marsa sports complexes come next in terms of floor area accounting for 3,406 and 4,611 m^2, respectively. The national pool complex, shooting range and snooker academy complete the list of sport facilities, and these facilities have already implemented some changes in their lighting systems.

TABLE 3-22 OVERVIEW OF SPORTS FACILITIES WITHIN RESPONSIBILITY OF SPORTMALTA[44].

Name	Floor area (m^2)	Lighting
Cottonera Sports Complex	7301	To be changed in 2021. Main hall/corridor lighting to commence 2020.
Kirkop Sports Complex	3406	Hall and grounds changed in 2020
National Pool Complex	542	Floodlights changed in 2019
Marsa Sports Complex	4611	Commenced 2020
Shooting Range	1500	Changed in 2018
Snooker academy	200	Changed in 2019

According to communications with SportMalta, renovation trends in these sports facilities include improvements both to the buildings (such as insulation, shading, double glazing, and LED lighting) as well as renewable energy (solar panels). From 2019, floodlights have started to be replaced by LEDs as shown above.

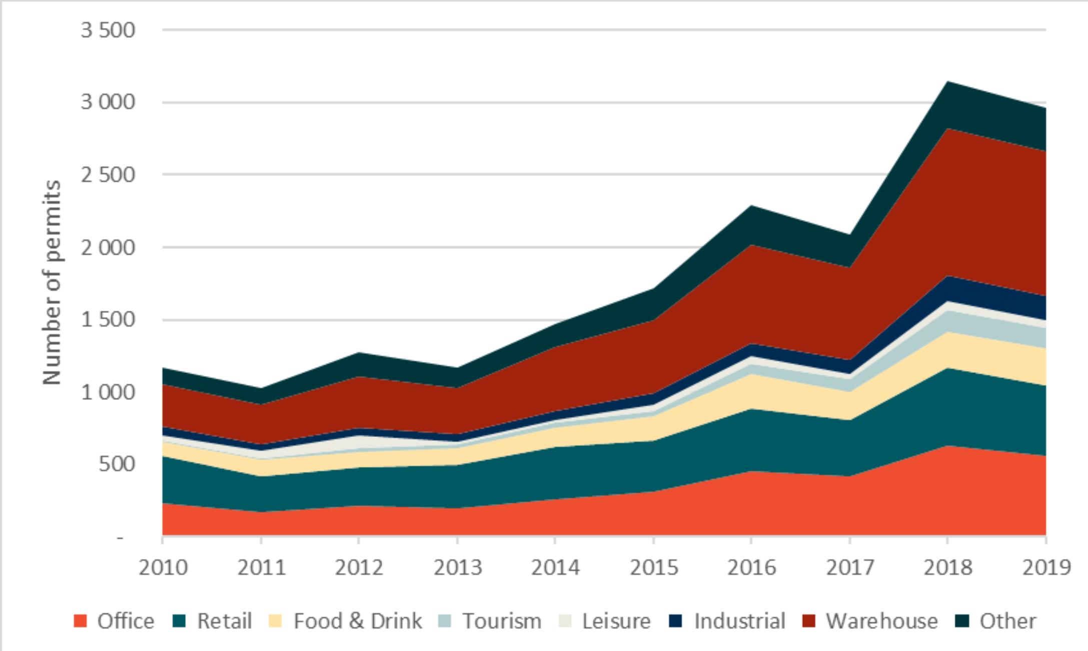
Cottonera's latest renovations include the latest in energy efficiency. Additionally, there is UV protection filming for all windows, A/C units with energy saver grade A, and rainwater reservoir. For Kirkop, latest developments include solar systems and energy saving A/C. Future projects[45] all account for energy efficiency considerations.

Permits

Data from the Planning Authority shows that, as for dwellings, since 2013 the pace of non-dwelling construction has increased substantially. The data also further confirms the trend to build new office space, as well as buildings related to tourism, food and drink. The figure below shows the number of permits awarded. The fact that a permit is required means that the work to be carried out still affects the fabric or the configuration of the building.

[43] Lighting is often the most significant energy use in a sport facility.
[44] Data provided in personal communications from Sinclair Cassar (SportMalta)
[45] Indoor pool, White Building, Netball Complex, Handball complex, Table Football complex, all planned for 2023

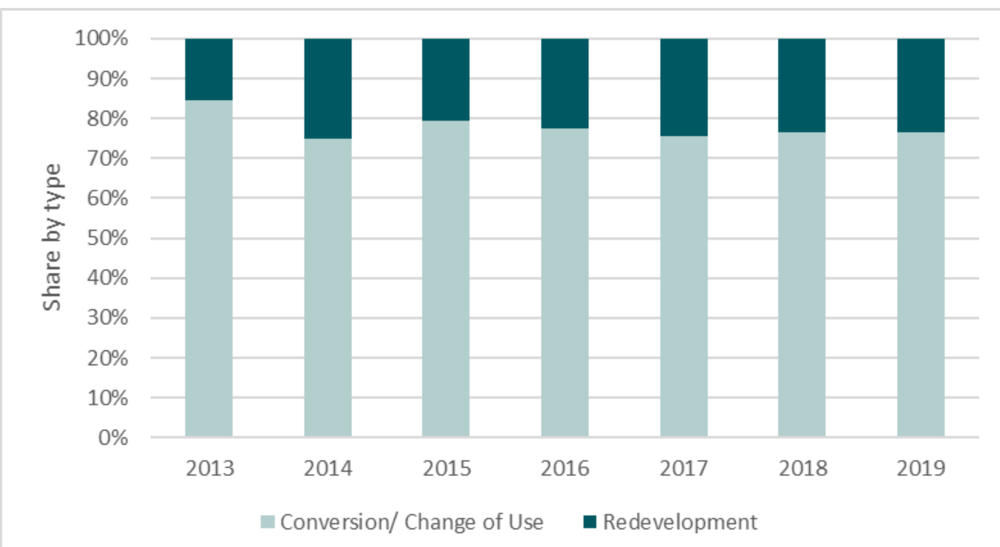
FIGURE 14 NUMBER OF PERMITS AWARDED BY BUILDING TYPE AND YEAR (SOURCE: PLANNING AUTHORITY)



Note: If a permit includes different use types, it is included in more than one category.

Data from the Planning Authority also shows that the share of permits requested for conversion or change of use has consistently been much higher than the number of permits for redevelopment.

FIGURE 15 SHARE OF PERMITS BY TYPE (SOURCE: PLANNING AUTHORITY)

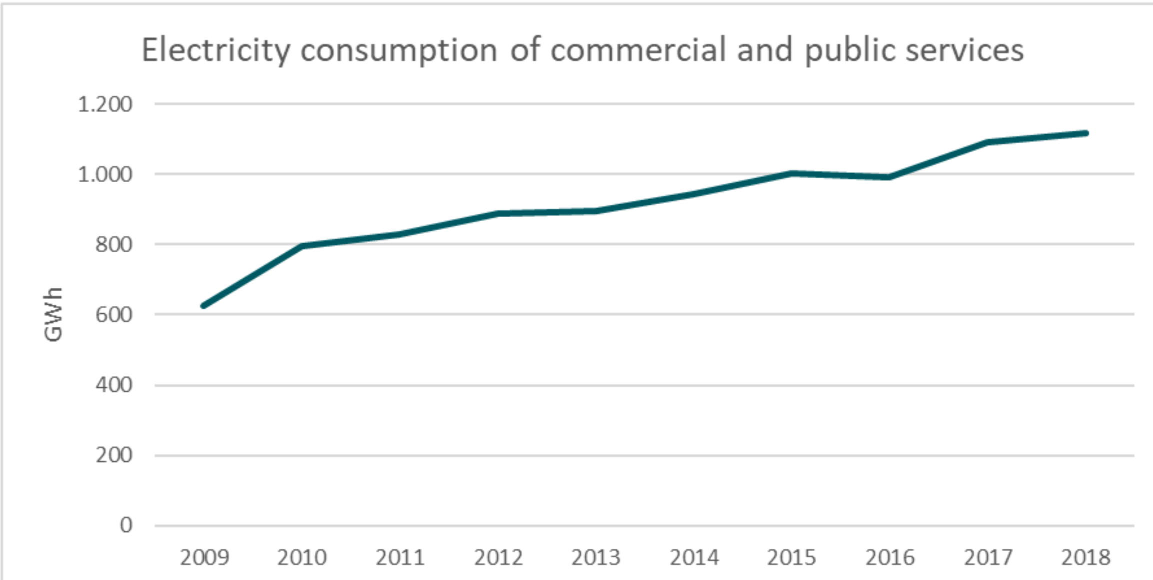


It is important to note that not all buildings' permits will be followed up by actual work.

Energy use in the non-residential sectors

According to Eurostat, Malta's commercial and public services sector is responsible for 19% of final energy consumption (versus an EU average of 13%). Maltese final consumption in 2018 for commercial and public services sector was 1,460 GWh, an increase of 77% since 2009. For comparison, the EU equivalent figure has remained stable over the same period.[46] According to Odyssee-Mure database[47], Malta's service sector has one of the lowest energy intensities in the EU (second only to Ireland), around 67% of the European average.

FIGURE 16 ELECTRICITY CONSUMPTION OF COMMERCIAL AND PUBLIC SERVICES IN MALTA OVER TIME (SOURCE: EUROSTAT)



Further, Malta's NECP highlights that Hospitality, manufacturing and offices and schools are the sectors with the highest energy use in 2018 both in terms of total energy and electricity.

3.2.3 Energy performance of the non-residential building stock

The following findings are based on the analysis of EPC certificates available in the BCA database. These include data covering the following categories of buildings, in the following proportion. Some EPCs were excluded as they may have skewed the data, and 4,923 were used in this analysis.

TABLE 3-23 BUILDINGS IN OUR SAMPLE

Type of building	Units	Percentage of total
Shops	2677	54.4%
Offices	1200	24.4%
Restaurants	503	10.2%
Schools	400	8.1%
Hotels	70	1.4%
Other accommodation	39	0.8%
Hospitals	24	0.5%
Homes for the elderly	6	0.1%
Sports complex	4	0.1%
Total	***4923***	***100***

[46] Eurostat (2020) Data on simplified energy balances
[47] Odyssee-Mure (2020) Energy consumption and value added growth

SOURCE: OWN CALCULATIONS BASED ON EPC DATA FROM BCA DATABASE

New vs existing buildings

Within our database, 81% of the EPCs are carried out on existing buildings (labelled 'as built') and only 19% are carried out for new buildings (labelled 'as designed').[48] These percentages remain similar across most of the building types, with EPCs for existing buildings ranging from 70% to 92% and for new ones from 8% to 30%. The only exception regards the *Sport complex* category, for which the dataset includes only existing buildings.

TABLE 3-24 BUILDINGS IN OUR SAMPLE

Type of building	Existing	New
Shops	73%	27%
Offices	75%	25%
Restaurants	81%	19%
Schools	76%	24%
Hotels	70%	30%
Other accommodation	77%	23%
Hospitals	92%	8%
Homes for the elderly	83%	17%
Sports complex	100%	0%
Total	**81%**	**19%**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

Building size

Building sizes vary depending on the type of building. Table 3-25Table provides an overview of average sizes, as well as the median size of the buildings to eliminate any outliers still in the sample (note that the sample was already originally cleaned from extreme and incomplete records). Hospitals are the biggest buildings in our sample, but the size of new hospitals is significantly smaller. Next in line in terms of size are homes for the elderly, schools and hotels; while restaurants, offices as well as shops tend to be the smallest.

TABLE 3-25 AVERAGE AND MEDIAN NON-DWELLING SIZE BY CATEGORY IN SQUARE METERS IN OUR SAMPLE

Type of building	Size of buildings (m^2)					
	Existing		New		All	
	Average	Median	Average	Median	Average	Median
Shops	375	61	307	66	356	63
Offices	698	170	678	174	693	170
Restaurants	112	72	93	74	108	72
Schools	2,321	1,439	3,381	1,675	2,576	1,663
Hotels	3,257	963	1,616	878	2,764	963

[48] In cases where the same building was assessed at both stages, it is counted twice.

Other accommodation	629	379	2,047	829	956	414
Homes for the elderly	3,865	4,052	4,599	4,599	3,987	4,113
Hospitals	8,005	6,338	1,544	1,544	7,467	5,701
Sports complex[49]	3,965	4,009	3,965	4,009	3,965	4,009
Total	**673**	**104**	**649**	**88**	**667**	**99**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

Energy use by type of building

In terms of energy consumption per m^2, schools, offices and homes for the elderly buildings have the lowest primary energy consumption per square meter (Table 3-26); while restaurants, hospitals and hotels have the highest. This is partially linked to the size of the buildings, where smaller buildings have a higher consumption per square meter, and vice versa. Table 3-26 also presents data from Gatt et al.[50], extracted from an analysis of cost-optimal energy efficiency refurbishments published in 2019, based on a sample set of buildings for each category (ranges represent the extreme values of the buildings analysed). It shows that, often, primary energy needs estimated for buildings included in the EPC dataset is lower than energy efficiency estimated after a cost-optimal refurbishment.

TABLE 3-26 AVERAGE AND MEDIAN NON-DWELLING PRIMARY ENERGY CONSUMPTION PER M^2

Type of building	Primary energy (kWh/m²/yr)				
	Existing		***New***		***Cost-optimal refurbished***[51]
	Average	**Median**	**Average**	**Median**	***Range (central value)***
Shops	719	540	797	590	781 – 908 (887)
Offices	510	391	445	397	--
Restaurants	1015	976	1140	1093	1552 – 1960 (1595)
Schools	338	257	242	187	327 – 417 (375)
Hotels	848	890	892	853	901 – 977 (901)
Other accommodation	788	815	607	485	--

[49] The data provided from the EPC for buildings size and primary energy consider only existing buildings, therefore the same values are assumed for new buildings as well.
[50] Gatt, D., Yousif, C., Barbara, C., Caruana, T. F., & Degiorgio, M. (2019). EPBD cost-optimal analysis for non-residential buildings in Malta.
[51] Ibid.

Homes for the elderly	594	631	591	591	735 – 898 (747)
Hospitals	920	821	1017	1017	--
Sports complex	505	544 666	505	544	715 – 730 (638)
Total	**675**	**485**	**668**	**516**	**-**

SOURCE: OWN CALCULATIONS BASED ON EPC AND GATT ET AL. (2019)[52]

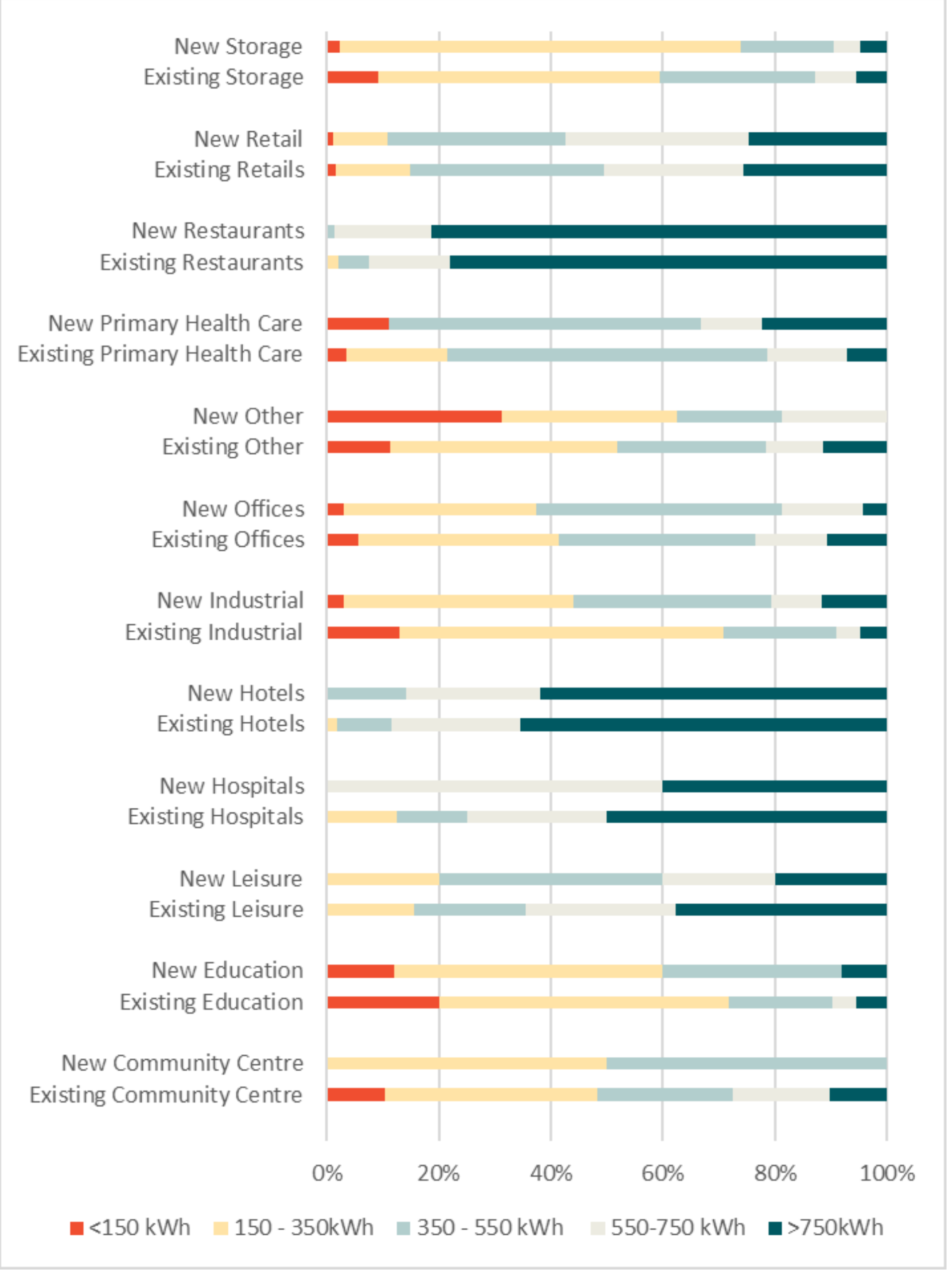
TABLE 3-27 AVERAGE AND MEDIAN NON-DWELLING DELIVERED ENERGY CONSUMPTION PER M²

Type of building	**Average energy use (kWh/m²/yr)**			
	Existing		***New***	
	Average	**Median**	**Average**	**Median**
Shops	208	157	231	171
Offices	148	113	129	115
Restaurants	294	283	330	317
Schools	98	75	70	54
Hotels	246	258	258	247
Other accommodation	228	236	176	140
Homes for the elderly	172	183	171	171
Hospitals	267	238	295	295
Sports complex	146	158	146	158
Total	**196**	**140**	**194**	**150**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

[52] Gatt, D., Yousif, C., Barbara, C., Caruana, T. F., & Degiorgio, M. (2019). EPBD cost-optimal analysis for non-residential buildings in Malta.

FIGURE 17 DISTRIBUTION OF BUILDINGS BY PRIMARY ENERGY CONSUMPTION BANDS (SOURCE: OWN CALCULATIONS BASED ON EPC DATA)



Energy use by end-use

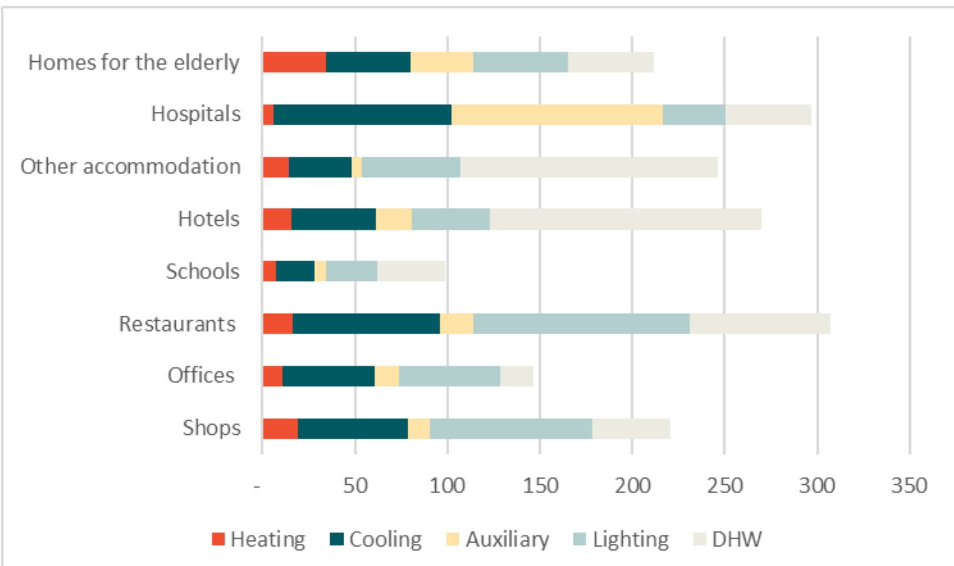
Energy by end/use also varies depending on the building type. However, on average, heating and cooling represent 51% of the total energy use. Domestic water heating also forms a large share of energy use for hotels and other accommodation, sport complex and education buildings (ranging from 60% to 40% of total energy use respectively).

TABLE 3-28 AVERAGE NON-DWELLING ENERGY USE (KWH/M² PER END-USE, DELIVERED ENERGY)

Type of building	Heating	Cooling	Auxiliary	Lighting	Water heating
Shops	19	60	12	88	42
Offices	11	50	13	55	18
Restaurants	16	80	18	117	76
Schools	8	20	6	27	37
Hotels	15	46	20	43	147
Other accommodation	15	34	5	54	139
Hospitals	6	96	115	34	46
Homes for the elderly	34	45	34	51	47
Sports complex	Not available				
Overall average	**16**	**56**	**13**	**77**	**42**

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

FIGURE 18 DISTRIBUTION OF ENERGY USE PER BUILDING TYPE BY END-USE (SOURCE: OWN CALCULATIONS BASED ON EPC DATA, DELIVERED ENERGY)



Onsite renewable generation

EPC data also provides an indication of onsite renewable generation. Less than 6% of the buildings in our sample had a PV system, and in average, these PV systems provide 2 kWh/m². This is due to lack of available roof space (compared to floor area) given that such space typically houses services such as HVAC systems.

TABLE 3-29 AVERAGE ONSITE PV GENERATION PER SQUARE METER BY CATEGORY IN OUR SAMPLE

Type of building	Average PV generation (kWh/m²)	Number of buildings with PV	Share of buildings with PV
Shops	1.2	86	3.2%
Offices	2.5	95	7.9%

Restaurants	0	-	0.0%
Schools	2.8	75	18.8%
Hotels	1.2	9	12.9%
Other accommodation	0.9	3	7.7%
Hospitals	0.3	1	4.2%
Homes for the elderly	0	-	0.0%
Sports complex	0	-	0.0%
	Average: 1	***Total: 269***	***5.5% of total buildings***

SOURCE: OWN CALCULATIONS BASED ON EPC DATA

Recommendations for improvement

As part of the EPC reports, recommendations are provided per building in order to increase energy savings and reduce CO_2 emissions. These are split according to the payback period into short term, medium term and long term, and categorised according to their impact on energy savings and CO_2 emission reduction. The tables below highlight the measures recommend with a high energy impact. The most recommended measures were all long-term payback measures:

- Consider installing a ground source heat pump (n=193[53]).
- Consider installing an air source heat pump (n=180).
- Some walls have uninsulated cavities – introduce cavity wall insulation (n=149).
- Some glazing is poorly insulated. Replace/improve glazing and/or frames (n=148).
- Some windows have high U-values – consider installing secondary glazing (n=143).

Figure 19 to Figure 21 show what type of building element (fabric, technical system) was targeted by the recommendations for different building types. Recommendations with short payback periods generally concern lighting and water heating, as the capital investment require to implement these measures is relatively low. On the other hand, measures that affect the building fabric have long payback periods; in the sample analysed, these recommendation targeted mostly glazing or cavity wall insulation.

[53] *n* is the number of times the recommendation was included in the sample of EPC analysed (4,923 EPCs). Not all EPCs included a recommendations report.

FIGURE 19 RECOMMENDATIONS WITH SHORT PAYBACK AND HIGH ENERGY IMPACTS (SOURCE: OWN ELABORATION)

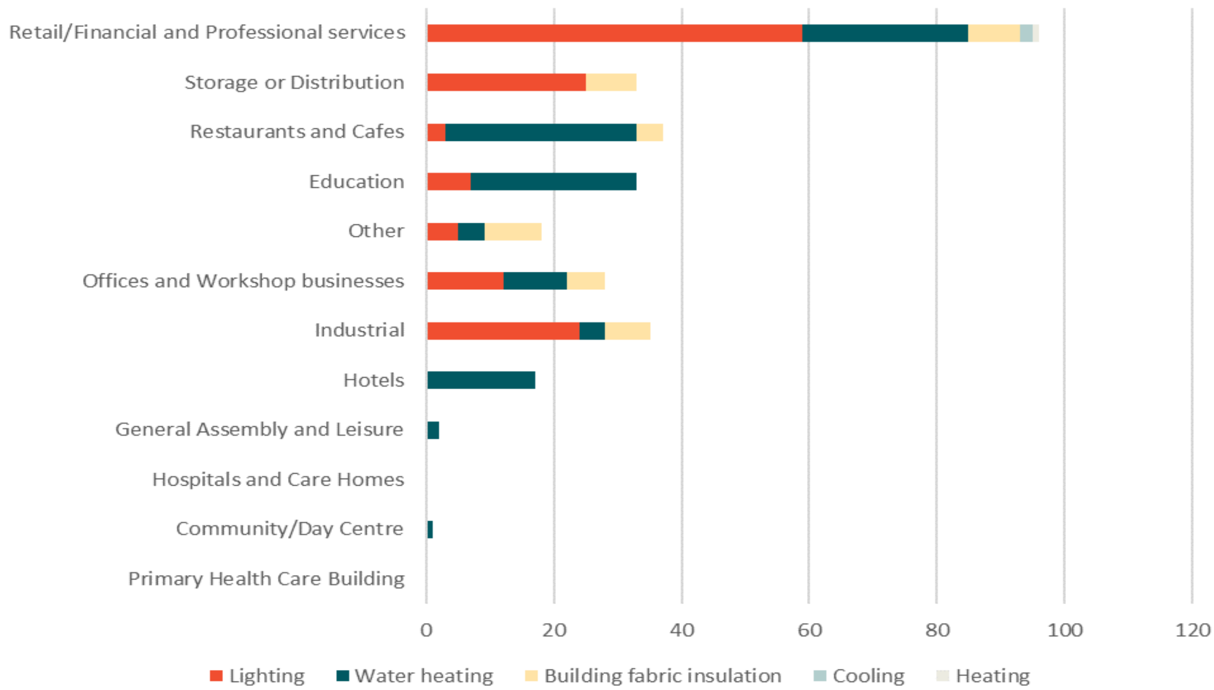


FIGURE 20 RECOMMENDATIONS WITH MEDIUM PAYBACK AND HIGH ENERGY IMPACTS (SOURCE: OWN ELABORATION)

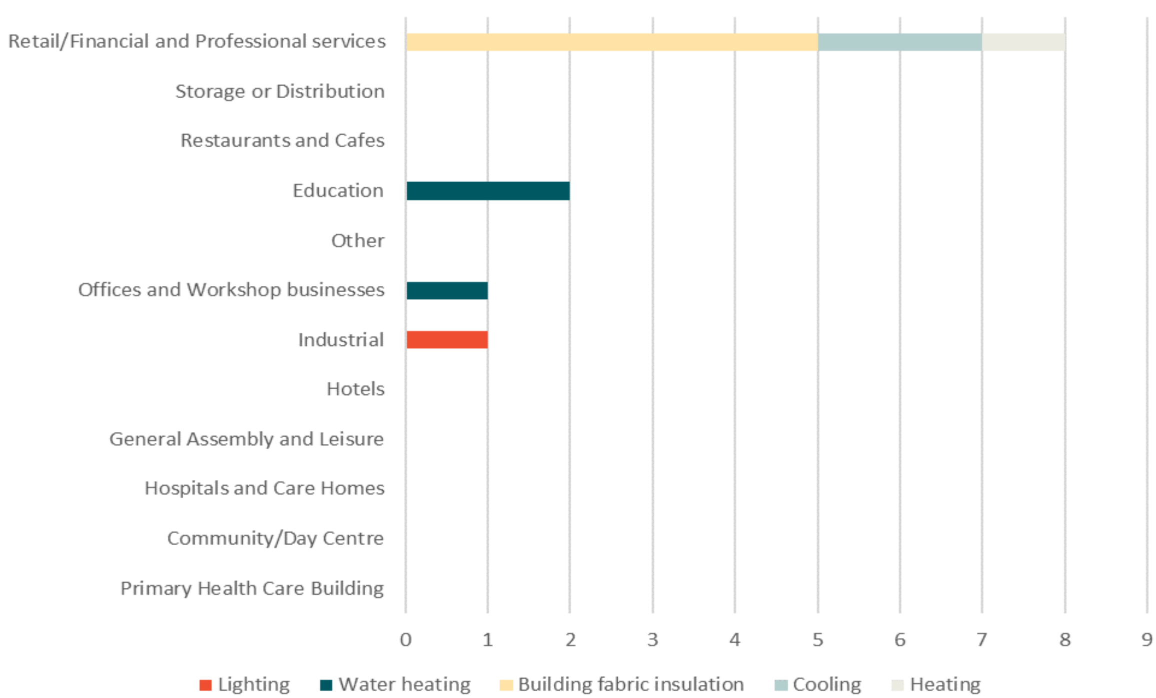
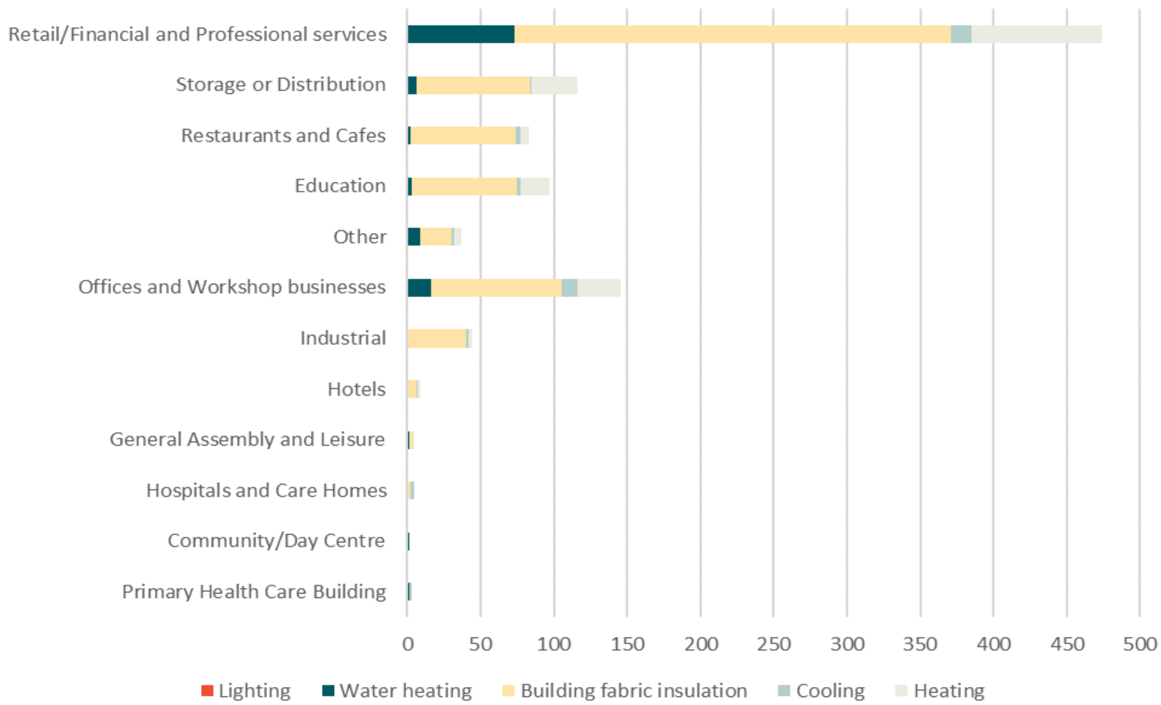


FIGURE 21 RECOMMENDATIONS WITH LONG PAYBACK AND HIGH ENERGY IMPACTS (SOURCE: OWN ELABORATION)



3.2.4 Public buildings

The role of Government and public bodies in promoting energy efficiency is emphasised in Directive 2012/27/EU amended by Directive 2018/2002/EC. The directive specifies that central government buildings are to "*gradually refurbish […] energy performance standards of buildings, or otherwise reach equivalent savings. Buildings of other public bodies should also be good examples of energy efficiency of buildings.*"[54] Further, Article 5 of the EED sets a target of 3% renovation rate for Central Government buildings.

Public buildings in Malta vary in size, building characteristics and age as well as energy use. As a part of central government efforts to play an exemplary role in energy efficiency and renovation, a detailed inventory of all central government buildings was compiled by the Maltese Energy Agency and the BRB. As part of the 2017 LTRS, their energy use was assessed in detail to identify those buildings with the best improvement potential. Efforts to renovate a number of these public buildings and reduce their energy use are underway.[55]

TABLE 3-30 SUMMARY OF PUBLIC BUILDING AVERAGE CHARACTERISTICS. SOURCE: INVENTORY COMPILED BY THE ENERGY AGENCY AND BRB

Characteristic	Value	Unit
Area	1,920	m^2
Energy consumption	331,178	kWh/year
	204.5	kWh/m^2
Number of buildings in inventory	84	Buildings

The values above are in line with those presented for offices, hospitals, homes for the elderly and sports complexes based on EPC data available, which range from 147-297 $kWh/m^2/yr$.

Challenges

The main challenges for public building renovation consist of:

- Low-energy consumption of public buildings and slow pay-back of the energy saving measures (except for investment in renewable energy, the payback time exceeded the expected lifetime of the measure itself or the building)[56]
- Lack of a clear indication regarding which renovation route may be most appropriate (not necessarily due only to energy savings but possibly also as part of a process of creating a better indoor environment or as part of a larger architectural or structural renovation) for different building categories[57]
- Historical buildings pose a particular challenge for the public sector, where these are used as offices, hospitals and schools. A large share of public buildings are located in conservation areas or are **listed historical buildings.** Legal requirements do not allow any alterations to the building appearance and historic element, thus limiting the use of certain technologies such as external wall insulation, PV, HVAC and heat pumps. (For more details see section 4.1.1).

[54] Ministry for the environment, sustainable development and climate change (2018) Green public procurement- National Action Plan 2019-2025
[55] BRO (2016) Implementation of the EPBD in Malta.
[56] Malta's National Energy Efficiency Action Plan (NEEAP) (2017) & Malta's 2030 National Energy and Climate Plan (NECP) (2019)
[57] Malta's Long-Term Strategy (LTRS) for Mobilising Investment in the Renovation of the National Stock of Residential and Commercial Buildings (2017)

Measures taken for government building renovation

Measures taken for central government buildings with a floor area above 250 m^2, to achieve the requirement under **EED Article 5**, included:

- New energy efficient lighting systems and replacing fluorescent tubes to LEDS;
- Smart meter installations & Energy Management systems: control of ACs and lighting, dimmers, etc;
- Replacement of ACs to inverter integrated ACs;
- Sustainable procurement of appliances and equipment, including PVs installation for own consumption and SWH installation;
- Behavioural changes;
- Roof and wall insulation/double glazing or glass tinting, etc.

The implementation of Article 5 of the EED by the Building Regulations Board is an ongoing process and Malta has already taken several measures to implement energy savings in public buildings. According to Malta's NEEAP 2017, these measures are usually very expensive in the sense that the actions deliver a small amount of savings compared to the costs. Some of these measures are also listed in the 2017 NEEAP as contributing to the EED Article 7 target. Under the measures taken to fulfil the 1.5% yearly energy savings (**Article 7 EED obligation**), Malta composed a policy mix of which one component is "Public Sector leading by Example" which goes beyond building renovation[58] and is expected to contribute 7% of the projected cumulative energy savings of 935 GWh.

TEXTBOX 2 ESTIMATED POTENTIAL ENERGY SAVINGS FOR AUDITED BUILDINGS

According to the LTRS 2017, the **estimated potential final energy savings** per year for the 50 audited public buildings amount to a cumulative 2.6 GWh/year or 1.1 GWh/year if the renovations exclude the use of renewable sources of energy. Renovations would be mainly related to installation of energy efficient lighting and better systems control, installation of photovoltaics and/or solar water heaters, the installation of new energy-efficient air conditioners replacing older less efficient systems, motion sensors for rooms with low occupancy and solar films on glazing. These savings could lead to **emission reductions**[59] of around 1,278 t CO_2 per year or 541 t CO_2 if renewable energy sources are not included.

A number of public buildings have been refurbished extensively, such as buildings which fall under the Ministry for Gozo, where a staggered renovation approach was taken and is still undergoing. In terms of educational buildings (which are mostly public), several public school renovation projects have been carried out, which included photovoltaic installations, energy efficient lighting and in some cases, replacement of apertures with double glazing and the addition of efficient inverter-controller air-conditioning systems. In terms of offices, in the case of the public sector, many offices are government-owned scheduled buildings, and thus few interventions to the building envelope are allowed.

A best practice example in the public healthcare sector is the renovation of St Vincent De Paul Residence, which also includes a hospital building. This complex is currently undergoing a deep renovation and extension process. While the Gozo general hospital is expected to undergo a deep renovation in the coming years as part of a PPP agreement between the Maltese Government and an international private healthcare group, the Maltese general hospital is around 20 years old and therefore no renovation is expected in the

[58] Measures related to building renovation include energy efficiency measures in ICT, retrofitting at St. Vincent De Paul – Rehabilitation Centre & Old People's Home as well as at Malta Police Force Buildings, Tal-Oroqq national pool complex energy efficiency project, lighting for reduced carbon footprint and energy efficiency at MFSA offices. (Source: Annex I of NEEAP 2017.)

[59] Assuming an end-use emission factor for the electricity network of 0.4914 kgCO2/kWh

near future. Although sports facilities are mostly government owned, these are usually rented on a long-term basis to national associations or private sport clubs. Financial incentives for energy renovation of such facilities were introduced in 2019.

The Office of the President, as with the rest of the Palace, is expected to undergo major renovation works.[60] Nonetheless, the Office of the President is sited within a Grade 1 scheduled building, and according to LN 47 of 2018 Article 5.5(a) such buildings are exempt from the minimum energy performance requirements as established by Document F, as well as exemption for the provision of an Energy Performance Certificate. Nevertheless, OPR/Heritage Malta will take every measure possible to extensively improve the Grandmaster's Palace's (including the Office of the President areas) energy performance, within the limitations of a Grade 1 scheduled building.

3.3 *Renovation trends*

3.3.1 Renovation levels

Energy renovation activities incorporate a wide range of actions aiming at improving the energy performance of the existing buildings. Across EU legislation there are several definitions regarding the depth of renovations. According to BPIE[61] and European Commission[62], there are 5 main renovation levels which depend on the primary energy savings and on the number of measures applied.

1. **Below threshold:** the type of renovation where primary energy is reduced by less that 3% compared to the primary energy demand prior to the renovation.
2. **Minor renovation:** this level of renovation includes the implementation of one to three low-cost measures (e.g. insulation of the roof) and the expected primary energy savings are up to 30%.
3. **Moderate renovations:** this level of renovation includes 3 to 5 energy improvement measures which can result to 30%-60% primary energy savings.
4. **Deep renovation:** in deep renovation level, a package of measures is implemented, working simultaneously, aiming at 60%-90% of primary energy savings.
5. **Zero Energy Building (nZEB):** this level of renovation includes a wholesale implementation of measures, which aim at energy use reduction as well as at installation of renewable energy technologies that will contribute to reach almost zero energy consumption and carbon emission levels.

The EPBD defines major renovation as:

> *The renovation of a building where:*
>
> > *(a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or*
> >
> > *(b) more than 25 % of the surface of the building envelope undergoes renovation;*
>
> *Member States may choose to apply option (a) or (b).*

[60] Email exchange

[61] BPIE (2011) Europe's buildings under the microscope: A country-by-country review of the energy performance of buildings. Buildings Performance Institute Europe, EU. Retrieved from http://bpie.eu/wp-content/uploads/2015/10/HR_EU_B_under_microscope_study.pdf

[62] Esser, A., Dunne, A., Meeusen, T., Quaschning, S., Wegge, D., Hermelink, A., ... & Reiser, M. (2019). Comprehensive Study of Building Energy Renovation Activities and the Uptake of Nearly Zero-Energy Buildings in the EU. Final Report.

The intervention measures that can be applied to achieve energy savings can be classified into 5 categories.

TABLE 3-31 ENERGY RENOVATION TYPES OF MEASURES (SOURCE: JRC 2020[63])

Category	Measures
Building envelope	• Insulation of external walls, roofs, lofts, floors • Replacement of windows, doors • Draught proofing • Installation of solar shading systems • Employment of natural ventilation techniques, passive solar heating or cooling techniques
Building technical systems	• Replacement of inefficient boilers with condensing gas boilers • Improvement of mechanical ventilation, air-conditioning, lighting, auxiliary systems • Installation of heat recovery system • Improvement of emission/distribution systems of technical systems (e.g. pipework insulation) • Installation of building controls • Installation of micro cogeneration systems
Renewable heat generation systems	• Biomass boilers •
Renewable electricity generation systems	• Photovoltaic systems, micro wind generation systems, micro-hydro systems
Other energy-related measures	• Energy efficient and smart appliances • Thermal solar systems • Ground, water, air source heat pumps • BMS

As part of improving the energy efficiency of the buildings in Malta, some of those measures are expected to be implemented, according to LTRS 2017[64]. More specifically, in the residential sector, improved insulation, glazing replacement, reversible heat pumps, energy efficiency lightings (e.g. LEDs) and energy efficient materials with low U-values are some measures that could contribute to achieve the minimum energy requirements. In the non-residential sector, some past renovation projects show that some of the measures that effectively improve the energy performance are insulation of external walls, double glazing, heat pumps and photovoltaic installation.

3.3.2 Renovation rates

The rate of renovation can be calculated by taking into account the building floor area of all the buildings that were subjected to energy renovation or by taking into account the number of affected building stock.[65] In Malta the annual refurbishment rate is low; considering the second approach, it is estimated in the 2017

[63] Joint Research Centre (2020) Energy renovation

[64] Malta's Long-Term Strategy (LTRS) for Mobilising Investment in the Renovation of the National Stock of Residential and Commercial Buildings (2017)

[65] Esser, A., Dunne, A., Meeusen, T., Quaschning, S., Wegge, D., Hermelink, A., ... & Reiser, M. (2019). Comprehensive Study of Building Energy Renovation Activities and the Uptake of Nearly Zero-Energy Buildings in the EU. Final Report.

LTRS at 0.3%, increasing to 0.5% in 2020 and then to 0.7% in 2025[66]. It is important to note that it is more common to demolish and re-build old buildings than to renovate them. This is however not possible for listed buildings, which are buildings of historical value where refurbishment interventions are limited by strict regulations. Renovations are also typically carried out either just before or soon after a change of ownership. This has relevant implication for renovation policies:

- there are limited opportunities to engage with homeowners about improving energy efficiency;
- building standards have a large impact, as it is unlikely that new buildings will have any major intervention undertaken for several years after construction.
- if the party in charge of defining the building's specifications is a private developer, they will be interested in building at the lowest cost within the limit imposed by Document F[67], irrespective of the operating costs of the buildings. This acts as a disincentive to investments in energy efficiency beyond what is required by current regulations.

[66] Ministry for Energy and Health (2015) Analysis for a Cost-Effective and Efficient Heating & Cooling. Report drawn up in line with the requirements of Article 14(1) and 14(3) of Directive 2012/27/EU on Energy Efficiency.

[67] It is important to note not all new buildings will be compliant with Document F once completed.

4 KEY CHALLENGES TO RENOVATE THE BUILDING STOCK

This chapter focuses on a review of key challenges to renovate the building stock and improve energy use in buildings. Focus is on the barriers that can affect building renovation in Malta as well as aspects such as energy poverty. Covering these challenges will allow to tailor the LTRS such that it addresses the different barriers and challenges.

4.1 *Barriers related to improving building energy performance*

Barriers, which have an impact on the improvement of the building energy performance cover institutional, financial, information and other barriers. This chapter provides an overview of the existing barriers in Malta with regards to:

- **Technical aspects**, including challenges related to interventions carried out on the building fabric and the introduction of certain technologies in different types of buildings;
- **Legal and regulatory aspects**, which cover the relevant legislation, as well as the regulations that are in place to support the operationalization and enforcement of the legislation;
- **Commercial and financial aspects**, which cover the financing tools and mechanisms for implementing energy efficiency improvement measures;
- **Institutional aspects**, which cover factors such as consistency of policies and measures, transparency and accountability, good governance, and the capability of institutions to execute the policies and measures to improve energy efficiency in buildings;
- **Other aspects**, including for example awareness & expertise, such as the skills and knowledge to design and implement good policies and measures.

The following sections provide more detail on the barriers identified.

4.1.1 Technical barriers

There are a number of technical barriers in place preventing the improvement of energy performance of buildings in Malta. These range from floor-area restrictions to constraints with regards to historical buildings, to technical limitations of solar technologies.

In Malta, priority is given to a reduction in the construction costs and **maximising floor area**, particularly in the case of buildings being developed by contractors for resale purposes. Due to these aspects, most buildings are built using thinner walls made of local porous limestone or dry cast concrete bricks, and in the majority of cases without any insulation. This has led to a low uptake of innovative technologies available in the market (such as building blocks with integrated insulation) due to their higher price and the fact that the use of these results in thicker walls and therefore less internal floor area.

The lack of enforcement on the minimum requirements for building renovation and new developments makes the use of more efficient building materials or technologies – which are generally more expensive – challenging. There are also technical difficulties in relation to the replacement of older systems with new efficient technologies that involve major changes to the present infrastructure while the building is in use.

In addition, the existing legal requirements related to a substantial number of buildings located in conservation areas or **listed buildings** allow very limited changes to the building fabric and glazing and do not allow any alterations to the building appearance and historic element. This makes the use of certain technologies (e.g. PV panels) as well as the use of energy efficient equipment such as heat pumps difficult, since all changes made to the fabric, even internally, must be reversible (depending on the grade of scheduling). For office space located in historical buildings, it may also be more complicated to install the more advanced HVAC systems, for example including thermal controls in different areas. Traditional buildings are also often limited in the type of glazing available, selection of uPVC needs to be made to avoid clashing with the building style and the use of good quality and high efficiency wood double glazed windows can be more expensive. Another issue is related to properties located in the "buffer zone" of certain buildings which are protected, which would also be very limited in terms of interventions affecting the aesthetics of the buildings. However, it is important to note that improving the energy performance is generally possible even in listed buildings, if the appropriate measures are selected. Concerning the measures with major impacts on building's appearances (wall insulation, windows replacement), listed buildings have generally limited need for these. This is because their walls are ticker (providing already sufficient insulation), and because they often have small windows on external facades – using the internal courtyard as the main source of light and air.

TEXTBOX 3 LISTED AND HISTORICAL BUILDINGS IN MALTA

Traditional buildings are relatively common in Malta (in 2011, 19% of dwellings were built before 1945[68]), but it is often costly to bring such buildings up to a modern standard of comfort and space without substantially altering their character. The addition of energy efficiency considerations increases the required investment, sometimes substantially. The necessity to deal with stringent regulations, and associated costs, ends up diverting investment in new buildings, and in some cases has lead to the abandonment of older buildings. However, there is still a strong interest in traditional buildings in Urban Conservation Areas (UCAs), as these offer more character compared to new suburbs. Further, historical buildings are an attractive option for commercial and institutional spaces. For example, in 2017, the Planning Authority received 98 applications for hotels, guesthouses and other forms of tourism accommodation[69]. This is part of a recent trend that has seen an increase in the number of buildings in urban conservation areas or historical areas refurbished and renovated to enable their use as boutique hotels[70]. Historical buildings are also widely used by the public sector, generally as offices, hospitals and schools. Given the interests in the use of historical buildings, and the challenges associated with ensuring that recovery interventions improve energy efficiency, is important to identify solutions and mechanisms to support households, the hospitality sector, and other stakeholders that want to invest in listed buildings.

Conflicting roof space[71] is one of the main barriers to the uptake of solar technologies such as PV panels and solar water heaters since rooftops in Malta need to accommodate a number of services (water tanks,

[68] NSO (2014) Census of Population and Housing 2011: Final Report
[69] Times of Malta (2017) 98 applications for boutique hotels and guesthouses in 2017
[70] Malta's Long-Term Strategy (LTRS) for Mobilising Investment in the Renovation of the National Stock of Residential and Commercial Buildings (2017), p9.
[71] Rooftops in Malta need to accommodate a number of services (water tanks, antennae and other building services, area for clothes drying, leisure space).

antennae and other building services, area for clothes drying, leisure space). This is particularly challenging in densely populated areas where there is an increase of multi-storey apartment blocks. In multi-apartment buildings, roofs are usually owned by the upper floor tenant, that usually do not allow other tenants to use the roof except for restricted service access – generally consisting of maintenance to water tanks and maybe an antenna

Finally, there are **technical limitations** concerning the use of solar technologies such as:

- Shadowing from neighbouring buildings lowers the yield of PV systems. This is due to planning policies which encourage redevelopment of two or three-storey buildings into multi-storey apartment blocks which then cast shadows on neighbouring buildings. Because of planning height restrictions, buildings located in UCAs do not suffer from this issue, and PVs are therefore a strong option to lower net energy use in listed buildings, if installed with appropriate considerations for planning rules.
- Hard water present in the Maltese Islands has led to concerns regarding the useful life and potential payback of installing a solar water heater, especially for small households.
- The hot water provided by solar water heaters might not be sufficiently hot on cloudy or rainy days and the use of an electric heating element might be required.

4.1.2 Legal barriers

There are also legal barriers to the improvement of energy performance of buildings. A key aspect is related to the increase of rentals and apartment buildings. Even though ownership of residential dwellings is very common in Malta (around 76% of occupied residential dwellings are owned by households), the number of **rented units** – especially in other buildings categories such as offices, retail outlets, restaurants – is on the increase and this can pose a challenge to renovation due to **split incentives**[72].

Based on the current trend, it is expected that 70% of Malta's building stock will be constituted by apartments by 2040. New apartment blocks are primarily being built by developers with the intention of **re-selling** the single units, and thus they are interested in building a block which conforms with building regulations and not necessarily interested in investing further in the quality of the building. Once units have been sold, **multiple ownership** makes it all the more difficult to reach agreements to implement energy efficiency measures. Additionally, it is only in recent years that having a condominium administrator has become a legally mandatory requirement (including registration with the local authority), thereby ensuring that regulations are followed, and decisions taken by the building occupants.

The increase in the number of apartment blocks / multi-family buildings (often replacing terraced houses) also leads to challenges related to **limited roof** space which is shared by the different homeowners as well as limitation to visible interventions that can be carried out on the building envelope. In the case of office buildings, where roof space is not generally available due to **right of access and ownership of roof space,** the introduction of PV panels becomes more complicated**.** Most office buildings in Malta either consist of large office blocks that make the cost-optimal target of 30% of roof area covered with PV not achievable or else offices are part of a larger establishment and roof access is not available for the installation of PV panels.

[72] See section 4.2

There are also limitations when it comes to the spatial planning policy, which currently does not fully considers how renewable energy installations and passive design should be integrated in the design of new or renovated properties.

There is room for improvement in terms of minimum energy performance requirements for buildings and lack of compliance mechanisms to ensure that the standards are reached, including related to regulations in Document F. . BCA took over the role from BRO and is now the entity responsible for confirming compliance with the regulations within Document F.

4.1.3 Financial barriers

Financial challenges remain an important barrier to improving the energy performance of the building stock in Malta. Energy performance improvement can very often require **high up-front capital (**especially when targeting deep renovation) and owners may be reluctant to borrow funds for energy renovation purposes, even though green loans are available. This is particularly relevant in the case of new technologies such as concrete blocks with integrated insulation (locally produced, various insulation boards and energy efficient building systems can also be used) and building integrated PV. The consumer tends to choose the most financially convenient option when given a price list, regardless of any environmental benefits because these will not result in a direct financial benefit. In addition, **non-energy costs** associated with a deep retrofit may be substantial, such as the problem of disturbance during works which might result in the need of relocation for the owners/users and loss of business in the case of commercial premises such as retail outlets.

Lower electricity tariffs and mild climate conditions also discourage investment in energy efficient technologies. In Malta, dwellings already have a final energy consumption which is much lower than other Member States, rendering most traditional energy efficiency measures (such as improving the building fabric), effective in terms of reducing energy demand but cumulatively **not cost-effective**. The reason for this is the climatic conditions in Malta which results in **long pay-back periods** for retrofitting, in particular for interventions related to the building fabric and glazing as well as new technologies. Most commercial entities invest if payback periods are short (under 4 or 5 years), longer pay-back periods make most energy renovation solutions unattractive. Additionally, energy renovation solutions are often in direct competition with other investments required, both for the residential and commercial sector, and many a time are not a seen as a priority.

TEXTBOX 4 ADDRESSING THE LONG PAYBACK PERIOD FOR PV

In some cases, for PV projects which tend to have payback periods above 7 years, there is a budding local trend where PV systems are built by technical investors, who offer part of the energy or financial benefits to the building owners who would not have been able to invest the capital due to lack of funds or payback period policies. This approach usually involves a rental agreement of the space (typically roof), whereby the technical investor designs, finds and implements the project, maintains such project for a period of 20 years, and in turn pays the space owner a fixed annual fee or a lump sum fee equivalent to the discounted cashflow of the 20 year rent. Main entry barriers for such an approach have been increased requests by the space owners (being that land is highly sought after in Malta), connection costs from Enemalta, and fees due to tenants when the building is not specifically owned by the building user.

Further to this, there is **insufficient funding** for more certain measures whereby low-income homeowners may find it difficult to bridge the gap between the assistance provided through grants and the investment required; and a **lack of attractive financing** for homeowners with low to medium incomes who may not be eligible for bank loans (poor credit eligibility). In parallel, the **ESCO (Energy Service Companies) market for energy efficiency is currently non-existent in Malta**, also due to the rather low energy consumption levels for most dwellings. ESCOs differ from the traditional energy consultants or equipment suppliers since they finance or arrange financing through third parties for the operation and their remuneration is directly tied to the energy savings achieved[73] through an Energy Performance Contract (EPC). In 2017, the Energy and Water Agency (EWA) launched a public consultation on Energy Performance Contracting bringing together academics in the engineering sector, the energy Regulator, the buildings industry Regulator, energy service companies, the Distribution System Operator, an Energy NGO and the Malta Business Bureau. The conclusion was that while the EPC model can be suitable for Malta, the take up is limited due to limited savings and very long payback periods. A challenge highlighted during the consultation was that it would be very difficult for a contractor to guarantee savings unless regular maintenance was carried out and thus a maintenance agreement needs to be in place.

Split incentives, where there is a separation of expenditure and benefits between the landlord and tenant respectively, whereby the cost of the renovation would not be incurred by the persons taking advantage of it, also remains a barrier. With a prevalent trend of purchasing home properties (rather than renting) there is often a separation between the entity performing the expenditure (the seller) and the people benefitting from this (the buyer).

In the case of government-owned buildings, any refurbishment carried out needs to follow public **procurement regulations** which in the majority of cases favours the lowest price. It is therefore difficult for suppliers to compete in public tenders with more innovative and cost-effective products under a tender. The Green Public Procurement National Action Plan was launched in September 2018. However, this plan is broadly relating to procurement in general including construction and therefore does not address directly minimum requirements for products or materials required for retrofitting or new developments.

4.1.4 Institutional barriers

Fragmentation of competences between the different ministries and government entities. The competencies were assigned amongst different ministries and government entities according to legislature portfolios. Currently, work is being carried out to fully establish a centralized institution, the Buildings and Construction Authority, to be responsible for regulation in relation to energy in buildings.

The fact that there are multiple administrations dealing with buildings in Malta makes it challenging to implement policy measures to address the long-term renovation process. The ministries are working to reach an overall cohesion of policies as well as coherent implementation of energy efficiency measures.

TEXTBOX 5 FRAGMENTATION OF COMPETENCES

A number of different competences are split across different ministries. The responsibilities are as follows:

- and The Parliamentary Secretary for Construction under MECP: Building regulations and the EPBD directive.
- Ministry for Energy, Enterprise and Sustainable Development (MESD): Energy and EED, excluding Article 4 and Article 5.

[73] Joint Research Centre (JRC)-European Energy Efficiency Platform (E3P) (2020) Energy Service Companies (ESCOs)

- REWS is the entity directly responsible for the incentives which are related to the energy performance improvement in residential buildings, such as grants for renewable technologies and interventions to the building envelope.
- The Ministry of the Environment, Climate Change and Planning (MECP): The Planning Authority (PA) which is responsible for the approval of all building permits.

Work is being carried out to ensure that there is more streamlining of the existing systems so as to facilitate the process for the general public especially when these apply for grants and incentives.

There are a number of subsidies and grants to aid building energy renovation. The process and documentation required can be complex for homeowners and small building companies, and this may also discourage the use of such incentives. In the case of public buildings, procurement processes can be very long and complex. For large PV systems, it is often necessary to deal with different entities/ministries to carry out projects which can discourage the uptake of certain projects due to long and bureaucratic procedures. In order to solve this, a number of Ministries are working together to have established a one stop shop to facilitate the whole process and experience.

Presently no permit is required to carry out refurbishment or renovation. In fact, permits from PA are only required in the case of new developments or structural changes. It is therefore not possible to know of interventions such as upgrading of apertures or installation of roof insulation unless such interventions received a grant through REWS. This makes it challenging to take stock of the present energy state of all the buildings in Malta.

The government of Malta recognised the need to streamline how it deals with energy in buildings. For this reason, in 2019 the government established the Buildings Construction Agency to be responsible for policies related to buildings. This Agency was setup as a transition towards establishing a Regulator. Indeed in 2021, the Buildings and Construction Authority Act was set up under MECP, and given responsibility for the regulation, improvement and sustainable management of the building and construction industry in Malta.

4.1.5 Other barriers

In addition to the technical, legal, financial and institutional barriers listed above, there are other barriers worth considering in Malta.

Consumer acceptance of new technologies is one of the main barriers from a social perspective. The Maltese population tend to have a lack of trust in new technologies, which may also be due to the fact these are not built for the Maltese climate, and therefore underperform. It is also common for people to be unwilling to replace equipment which is still functioning well with a more efficient system.

Due to the **mild climate**, many households do not see the value of replacing windows. In many newer buildings double glazed windows and doors are usually installed; however, the use of coated argon-filled double-glazing is not enforced, and thus even though double glazing is generally used in newly built units it is usually not the most efficient type. In contrast, even though the climate conditions and electricity tariffs in Malta make the use of renewable energy one of the most financially attractive options to improve the energy performance of buildings, the integration of PV systems within the built environment is still perceived as having a **negative visual impact**, especially when deployed in large numbers, or in sensitive areas such as village cores. The installation of PV systems is currently regulated by Development Control Design Policy, Guidance and Standards 2015 (DC15) which presents a barrier to the installation of small PV systems.

Disturbance during site works or the need for relocation is also a main barrier for deep renovation projects, both in the case of residential buildings where an alternative residence needs to be available or rented as well as in the case of public / commercial buildings where operations need to be temporarily relocated, resulting in additional expenses. For example, the integration of wall insulation inside furnished buildings can present a number of challenges due to the extensive works required and high expenditures involved, and thus the building would probably need to be unoccupied for the period of renovation. In fact, current renovation trends show that most people are reluctant about making physical alterations to the building fabric, particularly in the residential sector.

The construction industry in Malta is based on small and micro-enterprises, most of which are engaged in new construction projects often resulting in a **shortage of skilled workforce** available to carry out deep renovations, as new builds are generally larger and less diverse projects. There are also concerns over the competence of skilled workers and equipment installers, especially when non-conventional systems need to be installed. This issue is currently being addressed by the BICC, through the introduction of Construction Industry Skill Card (CISC) in 2017, which is intended to improve quality standards, health and safety practices and employment conditions.

Finally, any proposed policies related to enforcement of minimum requirements for buildings need to take into consideration the impact on **vulnerable consumers**.

4.2 *Split incentives*

As mentioned above, one of the barriers hindering energy performance improvements in buildings are split incentives, often found in the owner/user dilemma. A split incentive occurs when the party paying for the improvement (energy renovation in this case) does not obtain the full benefits deriving from it. For example, in the case of rented properties, landlords invest in energy saving improvements, but it is the tenants who benefit from the reduced energy costs. On the other hand, tenants have little incentive to invest – so neither party is motivated to upgrade the building. This dilemma often results in poorer energy efficiency outcomes in both the rented residential and commercial sectors. In order to increase the number of energy renovations in these market segments, it is necessary to develop models that allow both owners and tenants to profit equally from the financial benefits of the renovations.

4.2.1 Status quo – split incentives in Malta

Split incentives in Malta are present in the following forms:

- **Landlord-tenant split incentives.** In this case, landlords with tenants who pay the utility bill tend to underinvest in energy efficiency measures. While homeowners make up the bulk of households in Malta (over two-thirds of the occupied residential dwellings are owned by the household living in them), almost 24% households live in rented accommodation. Owning a property is seen as a long-life investment, thus buying an own house is a very common practice in Malta. However, the share of dwellings that are rented has increased substantially recently, driven in part by the number of foreigners moving to Malta to work. A way to address this dilemma is through minimum energy performance certificates and regulations.
- **Developer-buyer split incentives**. The new owner is not involved in the decision making process and the selection of energy-related features, while the property developer’s main concern is to reduce the construction costs. This is generally addressed through stronger minimum energy performance regulation for new buildings.
- **Multi-tenant, multi-owner split incentives**. The multi-tenant or multi-owner situation brings the additional challenge associated with collective decisions making, where energy efficiency projects can only be realised if multi-occupancy consent is reached. In this case, often, the benefits and costs of an energy performance upgrade may vary from one apartment to another.

- **Split incentives related to listed and historic buildings**. Owners are required to spend more in order to properly insulate their properties[74] (or may be unable to do it due to stringent regulations), while the benefit of conservation is accrued to Malta as a whole, by allowing the preservation of historical sites.

4.2.2 Policy measures and other initiatives addressing split incentive dilemmas

The JRC[75] lists the following good practices to address split incentives:

- **Splitting costs and benefits in a balanced way**. A share of energy cost savings should be allowed to be used for investment repayments and landlords should take part of the investment cost in view of the property's value increase.
- **Integrating energy performance in the rent ceiling evaluation** to help reduce disincentives.
- **Total housing cost guarantee** ensuring that social tenants are protected in case of an energy renovation.
- **On-bill finance programme creating incentives for all stakeholders**: tenants (savings), landlords (savings/investment), utilities (protection/decoupling) and by extension banks.
- **Forbidding landlords to let properties of very low energy efficiency levels**.
- **Allowing tenants to demand energy efficiency upgrades** on their properties.
- **Distinguishing between building- and user-related energy consumption**, where the responsibility of the first lies with the landlord and the second with the tenant.
- **Individual metering**, where this is cost-effective and technically possible.
- **Shifting towards inclusive rent** can support cost-recovery models based on a rent increase or fee on utility bill.
- **Introducing green leases in the commercial sector,** splitting costs and benefits between the parties in such a way that both parties can benefit from an energy retrofit.
- **Include a "performance buffer" in green leases** in order to protect the tenant against any risk of underperformance compared to the expected savings from the renovation.

4.3 *Energy poverty*

Although the Maltese climate is mild and low winter temperatures are rare, energy poverty is still present and a challenge that fall within the context of the long-term renovation strategy. The following sections provide a brief overview of the status quo, existing policies and recommendations.

4.3.1 Status quo – energy poverty in Malta

Reducing general poverty is **part of Malta's National Strategic Policy for Poverty Reduction and for Social Inclusion 2014-2024, whi**ch acknowledges the multidimensional forms of poverty. It is respectively measured by absolute and relative poverty[76]. In 2016, 85,000 individuals (20% of the population) were at risk of poverty or social exclusion, but this datum improved to 16.7% in 2017[77]. Malta performs above average compared to the EU, where on average 23% of individuals are energy poor. Of Malta's population

[74] It is important to note that wall insulation in older properties is almost never a required option, as these have already thicker walls. However, measures affecting roof and windows (including sharing) would be affected.

[75] JRC (2014) Overcoming the split incentive barrier in the building sector.

[76] Relative poverty can be measured through the material deprivation rate (MDR) which is defined as "the number of persons living in households who are not able to afford at least three out of nine deprivation items. These include "mortgage or rent, utility bills, hire purchase instalments or other loans" and "keeping their home adequately warm in winter". Such are also primary indicators for energy poverty defined by the EU Energy Poverty Observatory.

[77] NSO (2019) Regional Statistics MALTA 2019- Salient points of the publication

being at risk of poverty or social exclusion, 50,000 suffered from monetary poverty, 8,000 from severe material deprivation, and 6,000 from low work intensity. Meanwhile, 21,000 persons experienced a combination of two or more forms of poverty.[78]

An assessment of the number of households in energy poverty was carried out in the NECP in line with the Governance Regulation. In the NECP, the indicator '*inability to keep a household adequately warm (in winter)*'[79] was used, as agreed with MSFC. This indicator is one of the primary indicators used by the European Energy Poverty Observatory (EPOV). In the NECP, Malta concluded that it does not have a significant number of households in energy poverty and therefore no quantifiable national objective to reduce energy poverty was set.

TEXTBOX 6 PROFILING THE ENERGY POOR IN MALTA

Officially, there is no definition of "energy poverty" in Malta. When transposing Directive 2009/72/EC and 2009/73/EU into the law, the term "vulnerable customer" has been defined which leans on the eligibility criteria of receiving the Energy Benefit, which are beneficiaries of social security assistance, unemployed assistance or pensioner, children allowance or qualifying on humanitarian grounds[80].
The energy poor/vulnerable can be profiled as follows[81]:

- Weak in income (student, unemployed, retired, single or single parent);
- Migrant background (non-EU citizenship);
- Not owning the home – renting;
- Problems in affording energy (paying the bills and keeping it comfortably warm/cool), due to:
    - Low income;
    - Low energy efficiency of the building envelope which increases the energy bill;
    - Old and inefficient appliances (e.g. fridge and microwave) which increase consumption.

According to the EU Energy Poverty Observatory, in 2017 only 6.6% of the Maltese population was not able to sufficiently heat their home in colder months. This represents an almost four-fold improvement compared to the results in 2013 (23.4%) and it also outperforms the EU average which lays at 8% in 2017[82]. However, within the last two years, this result changed slightly: whereas Malta's share increased to 7.6% in 2018, the EU's average decreased slightly. The Energy Poverty Observatory also includes a secondary indicator on whether the dwelling is comfortably cool during summer time. In this ranking, Malta performs below the EU average.[83]

These indicators, and the overall performance in all primary and secondary EU Energy Poverty Observatory indicators[84], suggest that Malta still performs worse than the EU, on average, when it comes to energy poverty. This is surprising given that Malta has one of the lowest electricity prices in the EU and has Mediterranean climate. This supports the data analysis outcomes that Malta's households are negatively affected by poor energy efficiency.[85]

[78] Central Bank of Malta (2018) Poverty, social exclusion and living conditions in Malta: an analysis using SILC
[79] Insight_E (2015) Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures
[80] SMART-UP (2018) Analyse and evaluate the project results-WP6-task 6.3
[81] Central Bank of Malta (2018) Poverty, social exclusion and living conditions in Malta: an analysis using SILC
[82] Bouzarovski S, Thomson H, Cornelis M, Varo A and Guyet R, Towards an inclusive energy transition in the European Union: Confronting energy poverty amidst a global crisis, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19635-8, doi: 10.2833/103649, EU Energy Poverty Observatory.
[83] OpenExp (2019) European Energy Poverty Index (EEPI)
[84] See Annex for the complete list, including results.
[85] EU Energy Poverty Observatory (2020) Member State Report Malta

However, EWA and the Maltese Government have already expressed a number of reservations concerning the methodology and the scope of the indicators used in in the Energy Poverty Observatory: the concept of energy poverty is highly dependent on local climate and conditions, and comparisons across Member States with different climates and subjective experiences have limited validity. Further, a number of the indicators monitored and reported by EPOV are about subjective experiences, based on self-assessment and carried out over the phone. These elements limit the robustness of the analysis, and require careful considerations and treatment of biases (for example, interviews carried out after a heat wave or a cold spell).

A concrete example in the dataset is the indicator used to estimate the level of comfort during summer. The only data point used to evaluate this aspect is based on the SILC study carried out in 2012, and therefore it does not capture recent trends (such as the significant increase in the deployment of air-to-air heat pumps in households) which significantly improved the thermal comfort in the summer period. The decision was therefore not to use this indicator in the NECP assessment.

4.3.2 Policy measures and other initiatives addressing energy poverty in Malta

The **National Reform Program** (NRP), which outlines the government's country policies and measures and its efforts to sustain growth and jobs and to reach the Europe 2020 targets, confirms that the issue of poverty and social inclusion is a growing and prime challenge within the changing political, cultural, social and economic development of Malta. However, as the share of households being subject to energy poverty has overall reduced within the last years, **no current national objectives or targets** have been set. Within the last couple of years, EU policies and national polices and measures implemented by the Maltese Government and complimenting substantial reduction in energy bills resulting from significant investments in energy infrastructure, have had a positive impact on the level of energy poverty.

The following measures have been specifically designed in Malta to address households vulnerable to energy poverty:

The energy benefit scheme is the main and longest standing instrument to tackle energy poverty in Malta. It aims to decrease the energy cost burden of low-income and vulnerable households. Approximately €4-5 million are budgeted by the Maltese government (Ministry of Social Policy)[86]. In 2017, 20,488 consumers received the energy benefit.[87]

The Energy Incentives Advice Scheme for Vulnerable Households was set up by EWA in 2018 aiming at reducing the energy and water consumption through the replacement of old and inefficient appliances, specifically targeting vulnerable households[88]. This scheme is executed in collaboration with LEAP and funded with €200,000 annually. Based on 470 home visits, EWA identified 277 households that needed a replacement of a fridge-freezer, washing machine and AC unit as these are considered high energy consumers[89].

The Energy Efficiency in Low Income Households in the Mediterranean (ELIH MED) project works towards the identification of cost-effective solutions and innovative public and private financing mechanisms to foster energy efficiency investment in low income households. Initiated and co-funded by the EU, this project has a total budget of €250,000 to be used for 35 households in Malta between 2014-2020[90].

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[86] SMART-UP (2018) Analyse and evaluate the project results-WP6-task 6.3, p.4
[87] Malta's 2030 National Energy and Climate Plan (NECP) (2019)
[88] The Energy and Water Agency Targeting Energy Poverty through the Replacement of Old and Inefficient Appliances
[89] Ibid.
[90] Malta Intelligent Energy Management Agency Energy Efficiency in Low-Income Housing in the Mediterranean (ELIH MED)

The Consumer empowerments in a smart meter world (SMART-UP) is a European Horizon 2020 project partnering with local organisations and national ministries to fight energy poverty in 5 EU Member States, i.e. Spain, Italy, France, the UK and Malta.[91] The project focused on increasing the awareness of vulnerable households to their energy consumption and to help them adopt new energy efficient consumption patterns by providing educational and practical means [92]. The project has been delivered by the Maltese partner Project in Motion (PiM) in collaboration with the Ministry for the Family, Children's Rights and Social Solidarity and LEAP.

The Eco-reduction scheme under which households that consume either: (i) less than 2,000 kWh per year in a single household; or (ii) less than 1,750 kWh per person in a two or more-person household, receive a direct rebate on 15-25% of their electricity bills. This policy incentivises efficiency and lower consumption, while also having a positive effect on the bills of low-income households who fall within the consumption limit.

The provision of professional advice, free-of-charge, by the Energy and Water Agency to vulnerable and low-income households on energy efficient appliances and behaviour.

4.3.3 Concluding remarks

National policies and measures, implemented by the Maltese Government and complementing substantial reduction in energy bills resulting from significant investments in energy infrastructure, have had a positive impact on the level of energy poverty. The effectiveness of the schemes and measures could be increased by increasing public and private investments in energy efficiency and tailoring the measures better to the target group, even if this can be administratively more expensive[93].

Fuel price support, energy efficiency schemes in dwellings and income support are the three main levels that government uses to address energy poverty. However, there are several supporting measures likely to be beneficial in supporting the effective reduction of energy poverty, such as training, behavioural change or capacity building measures with legal and fiscal instruments.

The type of measures formulated to tackle energy poverty and their implementation are a key function of policy frameworks and are explicitly targeted at supporting vulnerable consumers and/or addressing energy poverty. This strongly determines the type of interventions that are put in place. The social policy-led approach primarily focuses on tackling energy poverty through social security provision, while the energy policy-led approach focuses more explicitly on energy poverty through specific measures[94]. However, both social and energy policy mechanisms are needed, especially as energy poverty does not overlap fully with income poverty and has a number of infrastructural causes[95].

[91] AISFOR. Vulnerable consumer empowerment in a smart meter world (SMART-UP)
[92] Ibid.
[93] Thomson and Bouzarovski (2018) Addressing Energy Poverty in the European Union: State of Play and Action
[94] Pye et al. (2015) Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures
[95] Thomson and Bouzarovski (2018) Addressing Energy Poverty in the European Union: State of Play and Action

5 OVERVIEW OF POLICY AND LEGISLATION RELATED TO THE ENERGY PERFORMANCE OF BUILDINGS

5.1 *Key institutions involved in the buildings' energy performance in Malta*

Policies related to the energy performance of buildings falls primarily under the remit of the **Building and Construction Authority (BCA)** which falls under the **Ministry of the Environment, Climate Change and Planning** (**MECP)**. The BCA aims to design, implement and disseminate policies as well as consolidate and review laws and regulations in relation to the building and construction industry. The authority is responsible for the administration of building regulations and endorsement of certificates of compliance, including Energy Performance Certificates. One of the aims of the authority is to eventually consolidate the various entities involved in the sector, including the **Building Regulation Board (BRB)**, a statutory, regulatory and judiciary Board, which was established following the enactment of the Building Regulation Act (Chapter 513 of the Laws of Malta) in 2011. The Board is presently responsible for formulating regulations and policies in line with EU legislation and directives and monitors the operations of the BCA. Another important entity under the remit of the Parliamentary Secretary for Construction (MECP) is the **Building Industry Consultative Council (BICC)** which is responsible for advising Government and the private sector on ways of upgrading and monitoring the building and construction industry.

The EPBD falls under the responsibility of MECP, while the EED, excluding Article 4 and Article 5, falls under the responsibility of the **Ministry for Energy, Enterprise and Sustainable Development (MESD,** previously Ministry for Energy and Water). The two ministries collaborate via the BCA and the BRB in the implementation of Article 4 of the EED. MESD, through the **Energy and Water Agency (EWA)**, is responsible for the National Energy Efficiency Action Plan (NEEAP), last updated in 2017 and the National Energy and Climate Plan, last updated in December 2019. The **Regulator for Energy and Water Services (REWS),** is an independent entity operating directly under the Permanent Secretary of MESD. The regulator is responsible for the regulation of practices, operations and activities in the energy and water sectors.

The **Ministry of the Environment, Climate Change and Planning (MECP)** is another key institution in relation to the building sector in Malta, particularly through the **Planning Authority (PA)** which is responsible for the vetting and approval of all building-related permits and the **Environment and Resources Authority (ERA)** which is the national regulator on the environment. MECP is the ministry responsible for the climate change policies, including the National Climate Change Adaptation Strategy. Since November 2020, the BCA, PA and ERA are part of the same portfolio, with the aim of enhancing the synergies between their policies and programmes in relation to buildings.

As mentioned above, MECP, through BCA, is responsible for issuing regulations and policies in relation to the building and construction industry. On the other hand, incentives in relation to energy in buildings such as grants for renewable energy and energy efficiency interventions for the residential sector and the feed-in tariff are presently issued and regulated by REWS, which falls under the responsibility of MESD. The PA, under MECP is then responsible for the approval of all building permits (i.e. all planning permit and not the conformity of a building with building regulations). However, a permit is not required for energy renovation in buildings, unless structural changes are required.

5.2 *Key targets*

As part of various EU directives, Malta has set a number of energy and climate targets. The renovation of the building stock plays an important role in achieving them[96]:

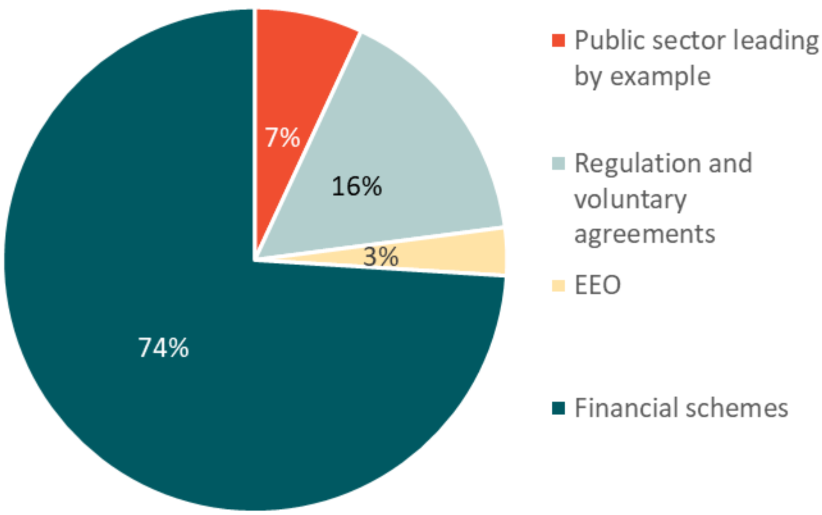
- A maximum increase of greenhouse gas emissions not falling within the scope of the European Union Emissions Trading Scheme of 5% by 2020 (compared to 2005 levels particularly emissions from transport, mainly road transport, waste, agriculture and fuel combustion in industry and commercial and residential buildings).
- A commitment to achieve by 2020 a share of energy from renewable sources in gross final energy consumption of 10%.
- A commitment to achieve an energy end use efficiency target of 9% or 378 GWh/year by 2016, which has been achieved.
- An indicative target to reduce its primary energy consumption to 822,903 toe / 9,570.36 GWh in 2020[97].
- A target of 19% reduction in GHGs emissions by 2030 , currently being reviewed as part of the Green Deal package.
- 3% annual renovation rate for public authority buildings[98].

Under **Article 7 of the EED**, Malta is required to achieve energy savings of 1.5% annually between 2014-2020. Considering the provision under Article 7 (2)(a), (2)(b) and (3), allowing a 25% reduction, Malta's cumulative energy savings to be achieved in 2020 is 774 GWh. The projected cumulative energy saving resulting from measures listed in Annex I of the NEEAP 2017, predicts to exceed this target with a total of 935 GWh[99].

In order to reach national energy targets, Malta has designed a policy mix composed of public sector leading by example, regulation and voluntary agreements, Energy Efficiency Obligation (EEO) and financial schemes. According to Malta's Annual Report pursuant to Article 24(1) of Directive 2012/27/EU on Energy Efficiency, these policy categories have contributed as shown in the pie diagram below to the cumulative energy savings of 935 GWh over the time period of 2014-2020.

[96] Concerted Action- Energy Efficiency Directive (2014) D9: EED implementation in Malta
[97] Malta's National Energy Efficiency Action Plan (NEEAP) (2017)
[98] Energy Efficiency Directive, Article 5.
[99] Malta's National Energy Efficiency Action Plan (NEEAP) (2017)

FIGURE 22 CONTRIBUTIONS TO CUMULATIVE END USE ENERGY SAVINGS 2014-2020 (SOURCE: OWN CALCULATIONS BASED ON ANNEX I, NEEAP 2017)



From January 2021 onwards, Article 7(1)(b) of the revised EED, requires Malta to achieve new savings each year equivalent to 0.24% of annual final energy consumption averaged over the most recent three-year period prior to 1 January 2019 (or 1.5 ktoe / 17.45 GWh of new savings required each year reaching 82.2 ktoe / 955.99 GWh of cumulative energy savings by end 2030).[100]

5.3 *Overview of current strategies*

In the context of the EU regulations and Directives, Malta has prepared the following strategies:

- **National nearly Zero-Energy Building (nZEB) Plan, 2015.** In accordance with the EPBD, every Member State (MS) had to draw up and submit nZEB plans. Malta's nZEB Plan addresses both new and renovated buildings. It includes the strategy and actions necessary for achieving nearly zero-energy buildings after the end of 2018 for buildings occupied by public authorities and by the end of 2020 for all buildings respectively.

TABLE 5-1 NZEB ENERGY REQUIREMENTS FOR RESIDENTIAL BUILDINGS.

Building category	nZEB overall energy demand requirement (kWh/m^2-year)	RES contribution requirement
Flatted dwellings	115	Yes
Terraced houses	75	Yes
Semi-detached housing	55	Yes
Fully-detached housing	55	Yes
Mean energy requirement	***75***	-

SOURCE: NEEAP 2017

As shown in the right column in the above table, the amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site. The definitions of nZEB have been developed with two components: a

[100] Malta's 2030 National Energy and Climate Plan (NECP) (2019)

basic mandatory contribution from the building fabric and efficient building services and the application of solar-based RES whenever possible. Together they would reach a mean figure of 75kWhr/m^2/yr for dwellings and 220kWh/m^2/yr for other buildings. However, the nZEB Plan acknowledges that Malta has only a limited range of renewables which may be of use. The most obvious, especially for buildings, is solar-based renewables (mostly photovoltaic and thermal). Unfortunately, due to space and use restrictions on the roofs these installations cannot be applied in a large scale. Another point of conflict is that the scarcity of land competes against communal photovoltaic farms,[101] and it is also necessary to further develop infrastructure to support these installations. A solar farm policy is currently being developed and aims to ensure further infrastructure will be developed in line with the actions and needs of the LTRS.

Long-Term Strategy for Mobilising Investment in the Renovation of the National Stock of Residential and Commercial Buildings 2014 and 2017. As set out in the Energy Performance of Buildings Directive (EPBD) (2010/31/EU) and according to Article 4 of Directive 2012/27/EU, every EU MS is required to develop and submit a LTRS every three years since 2014. Malta's LTRS presents a strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. It includes an overview of the national building stock, policies and actions and initiatives to drive energy efficiency and renovation in the building sector as well as a roadmap with concrete milestones, measures, expected energy savings, wider benefits and the contribution of the renovation of buildings to the Union's energy efficiency target.

National Energy Efficiency Action Plan (NEEAP) 2017. As a requirement of the EED Article 3, Malta should submit from 2014 and every three years thereafter its National Energy Efficiency Action Plan. It includes the indicative target demanded under Article 3(1) of the EED (822,903 toe primary energy consumption in 2020) and measures related to energy efficiency including energy supply and distribution, buildings and transport, as well as expected and/or achieved energy savings and energy end-use. More specifically, it highlights following measures and actions:

- Electricity tariffs designed to promote energy efficiency among consumers;
- Large enterprises are to perform high quality energy audits every four years;
- Non-SMEs encouraged to sign voluntary agreements with the Agency to pursue energy efficiency measures;
- Smart metering of electricity to continue also with the aim to empower consumers to manage their energy consumption intelligently;
- The inclusion of renewable energy in households in the drafting of the 'Minimum Energy Requirements for Building Guidance' and the 'Nearly Zero Energy Building Plan';
- Residential schemes continuation till 2020, i.e. grants for the installation of photovoltaic systems, solar water heaters, roof insulation, double glazing, and water-to-water heat pumps;
- Actions undertaken by Transport Malta to improve the efficiency in transport and highlights the importance of the ongoing 'scrappage' scheme deemed critical for the rejuvenation of the Maltese car fleet;
- Upgrading of the national electricity distribution network[102].

[101] Ministry for Transport and Infrastructure (2015) Nearly Zero Energy Buildings (NZEB) plan for Malta
[102] Energy and Water Agency (2017) National Energy Efficiency Action Plan

National Energy and Climate Plan (NECP) 2019. To meet the EU's energy and climate targets for 2030, the Regulation on the governance of the energy union and climate action (EU)2018/1999 demands each MS to establish a 10-year integrated NECP. Malta's NCEP follows the scope of the Energy Union and covers its five dimensions: decarbonisation, energy efficiency, energy security, internal energy market, and research, innovation and competitiveness. It serves as a strategic planning framework and policy document that will guide Malta's contribution to achieving the Energy Union's 2030 objectives and targets, whilst identifying those measures necessary for their achievement during the period until 2030, with an outlook until 2040.

The policies set up by the Maltese government are aimed at reaching its targets and ensuring compliance with the requirements of the EPBD (recast), both in terms of the cost-optimal and nZEB energy performance requirements for new buildings and for buildings undergoing major renovation[103].

5.4 *Overview of existing policies*

In order to achieve the nationally set energy-related targets, thus complying with European legislation, Malta follows a two-fold approach which is composed of:

- **enforcing minimum standards through legal obligations**, like the technical guidance captured in the minimum requirements for building services (Technical Guide F), which every new building or any building undergoing major renovations has to comply with; and
- **providing financial incentives** to new buildings going above minimum requirements and to existing buildings to improve their energy performance. These means are complemented by education and information campaigns and trainings.

Malta has adopted measures to promote renovation and energy efficiency in buildings as part of its obligations in terms of the Energy Performance of Buildings Directive (EPBD 2010/31/UE) and Energy Efficiency Directive (EED 2012/27/EU). The most important resulting **national policies** are included in this section.

TABLE 5-2 NATIONAL REGULATION TO PROMOTE RENOVATIONS AND ENERGY EFFICIENCY IN BUILDINGS

Policy	Year	Coverage	Objective
Legal Notice 376, 2012 – EPBD	2012	Responsibilities of the different authorities in relation to energy performance of buildings	Promote the improvement of the energy performance of buildings for both new and existing buildings
Sustainable Development Act, Chapter 521	2012	Responsibility of government entities with respect policies, plans, programmes and projects in relation to sustainable development	To mainstream sustainable development across the workings of government, to raise awareness of sustainable development issues and practices across society and to promote their adoption
Regulation 10 of LN 196	2014	Non-SMEs	Mandatory energy audits for non-SMEs doing business in Malta every 4 years

[103] Gatt & Yousif (2018) Promotion of near Zero CO2 emission buildings due to energy use

Minimum requirements for building services (Technical Guide F)	2006, 2015 (updated)	New buildings and existing buildings undergoing major renovations	The Building Regulation Board updated the minimum energy performance requirements (requirements of primary energy demand) based on cost-optimal studies by building category.
Legal Notice 47 of 2018 & Legal Note 261:2008	2018	Transposing Directive 2010/31/EU on the energy performance of buildings (recast)	Obligations with regards to EPC when advertising/selling/renting

Resulting from these national regulations, Malta developed various policy measures to support the transition towards higher energy efficiency in the building sector, as introduced below.

5.4.1 Financial Incentives

The following table gives an overview of the main financial incentives, grouped by sector covered.

TABLE 5-3 FINANCIAL INCENTIVES

Sector	Authority	Details	Year active
Domestic	REWS, Ministry of Finance, ERDF	Grants for specific measures (Glazing, roof, PV, solar water heater, heat pumps)	2011-2020
	PA	Irrestawra Darek – Grants for renovation of grade 1 and 2 buildings	2017-2019
Non-domestic (Commercial)	Malta Enterprise	Grants for high-Efficiency Cogeneration	2017
	Malta Enterprise, EWA	Investment aid for energy efficiency projects (cash grants of tax credit)	2007-2013; 2018-2020 2020-2022
	MHRA, Malta Enterprise	Loans and grants for EE measures/projects coupled to benchmark ranking in hospitality sector	2011-2016 2018-2020
	REWS, National Government	Free PV systems for voluntary organisations	2019 2020
	EWA, Sport Malta, National Government	Grants for EE measures for sport clubs	2019

Financial incentives schemes have contributed the largest part to energy savings in Malta (74% of cumulative end use energy savings in the period 2014 to 2020) which confirms their effectiveness. For the domestic sector the main grant schemes funded by the Maltese Government, in particular REWS, are provided for double glazing, roof insulation, PV, solar water heater and heat pumps. The grant usually covers a relevant share (40-50%) of the investment cost. Most of the schemes have been in place for several years (starting from 2006), while the support for heat pumps was started for the first time in 2017. Financial incentive schemes have proven to be generally very successful, and they have been relaunched frequently once funds were exhausted, annually in the case of PVs. To specifically target the renovation of historical buildings in the grade class 1 and 2, the PA funded the grant scheme Irrestawra Darek in 2017.

Financial support for non-domestic buildings comprises of grants for energy efficiency measures related to the building envelope and electrical appliances. Malta Enterprise is often involved in delivering and supporting these schemes, although financial resources come from the Maltese Government. Schemes aimed at non-residential buildings provide financing in the form of cash grants and/or tax credits such as the Investment Aid for Energy Efficiency Project which was re-launched in 2020. On the other hand, the scheme for high efficiency co-generation has had a very low uptake (this was due to legal and technical barriers rather than lack of interest). Financial incentives for the installation of PV schemes (and associated feed-in tariffs) have had substantially more success. Two incentive schemes have specifically been tailored to the hospitality and sport sectors, providing grants and loans for energy efficiency measures.

There is no financial scheme or incentive in place for the public sector buildings. However, relevant ministries and public bodies have committed additional funds when full refurbishments programmes have been implemented, for example in schools and hospitals.

5.4.1.1 Grants for specific measures (Double-glazing and roof insulation, PV, Solar water heater, Heat pumps)

Grant schemes funded by REWS target investments in the domestic sector for double-glazing and roof insulation, PV systems, solar water heaters and, until recently, also heat pumps. The government launched the first scheme to support the installation of solar water heaters in 2006, and then re-launched it in 2011. Afterwards, the government launched schemes to support double-glazing and roof insulation (2012), PV (2013), and heat pumps (2017). They were either scheduled for a certain time period, like the scheme for double-glazing and roof insulation for 2012-2018, or they have been re-launched annually after a successful uptake in the previous year.

The **coverage** of each grant scheme is set as listed below:

- *Double-glazing and roof insulation scheme*: 50% of the eligible costs up to €1,000 for both retrofitted roof insulation and double glazing and 50% of the eligible cost up to €350 for newly constructed residential units that go over and above the minimum requirements[104]
- *PV scheme*: up to 50% of eligible costs up to a maximum of €3,000 per system and €1,000/kWp and (kWp times €3800) minus eligible cost[105]
- Solar water heater scheme: 50% of the eligible costs up €700[106]
- *Heat pump scheme*: 50% of the eligible cost up to €700 [107]

All the schemes were highly successful and often there were more applicants than grants or funds allocated. This justified a relaunch and/or an increase of the budgets, for instance, a 30% budget increase for the PV grant scheme in 2020.

Between 2018-2020, the installed windows under the Double-glazing scheme had an average U-value of 2.227 W/m^{2}K (which is better than the maximum allowed U-value defined in Document F which is 4 W/m^{2}K. The most common windows used a 5mm outer glass pane and 30% had a simple or double laminate. The renovated and retrofitted roofs had an average U-value of 0.402 W/m^{2}K which complies well with the given maximum U-value of 0.59 W/m^{2}K (cf. Document F). The most common insulation material was Polystyrene foam with a strength of 50mm. Between 2018-2020, the most common heat pumps purchased under the Heat Pump grant scheme, had a module wattage of 685 W. In the years 2016, 2019 and 2020, the most common PV system installed, supported by the PV grant scheme, were 10 modules with one inverter with up to 390 W per module and 12 modules with one inverter with up to 400 W per module.

Overall, the Maltese government spent a total of €19 million in insulation measures and the installation of PV panels, since 2016 (see Table 34). On average, the government has awarded €3.8m per year in grants

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[104] Regulator for Energy and Water Services (2018) ROOF THERMAL INSULATION AND DOUBLE GLAZING Scheme – 2018/RIDG

[105] Regulator for Energy and Water Services (2020) 2020 PV Grant Scheme

[106] Regulator for Energy and Water Services (2018) solar water heaters and collectors scheme – 2018/swh

Various sources. See for example Rod Janssen and Dan Staniaszek: *How Many Jobs? A Survey of the Employment effects of Investment in Energy Efficiency of Buildings*, 2012

[107] Regulator for Energy and Water Services (2018) HEAT PUMP WATER HEATER SCHEME – 2018/HP

thereby contributing to 1,900 interventions per year. 94% of the funding was used for PV installations and only 6% for insulation measures leading to 8,168 buildings with new PV installations and to 1,382 buildings with better insulation. Comparing the sum of the grant awarded with the total investment, a leverage factor of nearly 2 was reached (each €1 spent by the government resulted in an additional €2 of private investment).

TABLE 5-4: GOVERNMENT FUNDED FINANCIAL INCENTIVES GRANT DETAILS

	Total govt payment amount	Nr. Grants awarded	Average grant	Total investment (if grant awarded)	Average quote	Leverage (€ invested /€ incentive)
2016 PV	€13,951,430	6,306	€2,212	€39,820,825	€6,315	2.9
2019 PV	€1,687,854	755	€2,236	€4,786,170	€6,339	2.8
2020 PV*	€1,973,276	688	€2,868	€5,174,589	€7,521	2.6
2018 SWH	€286,741	419	€684	€709,256	€1,693	2.5
Double glazing	€999,563	1073	€932	€4,616,350	€4,302	4.6
Roof insulation	€61,328	177	€346	€309,950	€1,751	5.1
Retrofit roof	€48,779	58	€841	€117,868	€2,032	2.4
2018 HPWH	€51,765	74	€700	€141,914	€1,918	2.7
TOTAL	**€19,060,736**	**9,550**	**€1,996**	**€55,676,922**	**€5,830**	**2.9**

** Provisional, allocated data rather than paid out*

5.4.1.2 Irrestawra Darek – Grants for renovation of grade 1 and 2 buildings

This grant scheme, funded by the PA, the Office of the Prime Minister and the Minister of Finance was launched in 2017. It specifically targets the sustainable renovation and restoration of historical, privately-owned buildings located in urban conservation areas and/or scheduled as grade 1 or grade 2. While the focus of this scheme is to preserve the aesthetic and historical value of such buildings, the fund also covers retrofitted green initiatives enhancing energy efficiency.

The eligible renovation and restoration works include energy efficiency measures, like the installation of double glazing on existing original façade timber fixtures or of roof insulation[108]. The scheme is divided into the following two groups:

- *Buildings of grade 1 or 2:* rebate on 70% of eligible costs of restoration and conservation works and interior up to a maximum of €100,000;
- *Urban Conservation Areas*: rebate of up to a maximum of €10,000.

[108] Planning Authority (2019) Irrestawra Darek- Restoration grant scheme for Grade 1 and Grade 2 scheduled residential buildings, or heritage buildings (residential) and streetscapes within urban conservation areas

By the end of 2017, the scheme was fully subscribed and subsequently relaunched each year. Since 2019, the scheme also allows commercial entities to apply within a streetscape application with other residents.

For the years 2017-2019, a total of €23m was available for the PA Regulation Scheme: €8m in 2017, €10m in 2018 and €5m in 2019. This scheme provides the grants on a first come first serve basis. According to the PA website, it is currently closed as the funds have been exhausted again[109].

5.4.1.3 Investment Aid for high-Efficiency Cogeneration

Launched in 2016 by Malta Enterprise, this scheme was developed aiming to promote the investment in or upgrade of high-efficiency cogeneration equipment in the commercial and industrial sector. Generated energy from this equipment must be used by the business for their direct operation activities and will automatically reduce their energy bill.

The scheme provided a tax credit depending on the type of undertaking. For small undertakings, the cap was 65% of eligible costs, for medium ones it was 55% and for large ones, 45%. The scheme was suitable for undertakings operating hotels, hospitals, commercial buildings and specific industrial processes where there is a steady demand for heat and power throughout most of the year.

The available fund for the High-efficiency Cogeneration Scheme amounted to €5m. Aid was distributed on a first come first serve basis, and once funds were exhausted, the scheme was closed.

The uptake of this scheme was not successful. Main reasons for this were technical and legal barriers related to gas-fired technologies. In Malta, there is no gas grid and it is forbidden to have gas-fired equipment located underground within a building. Such installations are only allowed to be located outside a building. The high density and the restricted space available, have presented a practical barrier to this measure.

For the small-scale and micro installations, it is rather difficult to apply as a result of the market competition of heat pumps or condensing boilers[110]. A comprehensive assessment examining the Maltese heating and cooling demand shows that CHPs only have a marginal potential in Malta. Early analysis showed that for some higher consumption sectors, such as hospitals it could be cost-effective to switch from LPG to CHP, but more recent recommendations following projects carried out by at the Mater Dei hospital suggest heat pumps to be more efficient in ensuring adequate heating and cooling. The recommendation on the use of heat pumps has also been extended to the rest of the hospitality sub-sector which includes old peoples' homes and hotels.

5.4.1.4 Grants for building renovation

There are two financial schemes that target energy efficient renovation measures: the ERDF Energy Grants Scheme for energy saving measures and alternative energy sources and the Investment Aid for Energy Efficiency Projects. Both projects are supported and administered by Malta Enterprise while they differ in their funding sources.

[109] Ibid.

[110] Malta's National Energy Efficiency Action Plan (NEEAP) (2017)

The ERDF grant scheme was first launched in 2007 and lasted until 2013 before it got relaunched due to its successful uptake for the period of 2016-2020. It was developed to financially support businesses in their investments into energy saving measures as well as to utilise alternative energy sources.

Contrary to the normal application process (filling out an application form on the website of the institution in charge), this scheme is distributed based on competitive calls that interested businesses have to apply for. Based on those, the applications are ranked; the highest-ranked qualify for the grant. Once allowed for this grant scheme, businesses are offered a minimum grant value of €12,500, provided the total project value lays between €25,000-200,000.

Its main funding source is the European Regional Development Fund (ERDF). In the programming period of 2007-2013, the total amount awarded totalled €14.9m. For the three calls announced between 2007-2013, only half of the 443 applicants have received a grant. The most common measures financed from this scheme, were PV systems and power factor corrections, rooftop insulations and solar water heaters[111].

The grant scheme for energy efficient projects was launched in 2020 and is planned to last until 2022. It aims to support undertakings in carrying out investments leading to improved energy-efficiency through technological solutions that provide higher energy efficiency and contribute directly to a reduction in the energy requirements of the beneficiaries.

The financial support applies to those projects of over €25,000. For a project to be eligible, the project must result in at least 10% energy savings. Depending on the size of the company, 30-50% of the eligible project costs can be granted. Where the energy savings exceed 30% of eligible costs divided by a rate per unit of 0,07 €/kWh times a lifetime of 7 years, the award support can be in the form of a cash grant. If the energy savings do not exceed this value, a tax credit is applied.

This scheme is funded by Malta Enterprise and the EWA.

5.4.1.5 Loans and grants for EE measures/projects coupled to benchmark ranking in hospitality sector

Since 2011, the hospitality sector is the first sector among the commercial (non-dwellings) sector that received special attention and industry-targeted support. Until 2016, Malta Enterprise offered loans for investments in energy saving solutions and renewable energy sources made by undertakings active in the hospitality sector[112].

For this scheme, Malta Enterprise approved loans of up to €400,000, covering up to 80% of the project costs from following properties: hotels, guesthouses, hostels, farmhouses, snack bars and restaurants. The aid intensity was calculated as 13% of the soft loan amount. The loan period was limited to five years and the applicable interest rate was 1.5% over the discount rate charged by

[111] Gatt & Yousif (2018) Promotion of near Zero CO2 emission buildings due to energy use
[112] Malta Enterprise (2011) Energy Efficiency Measures for the Hospitality Sector

local commercial banks. Approved projects were also granted a moratorium covering the initial 12 months from the first withdrawal[113].

In the meantime, this scheme has been closed. Similar ones are only being offered by Maltese banks, like HSBC or the Malta Development Bank.

In 2018, the Malta Hotels and Restaurants Association (MHRA) initiated, in collaboration with the Ministry for Tourism, a benchmarking scheme called Benchmarking Energy Sustainability Targets (BEST). It aims to establish the local hotel sector as leader in energy efficiency. The programme ranks hotels according to energy efficiency based on key performance indicators as well as energy efficiency projects undertaken.

Those hotels ranking above an established threshold within their category are qualified to receive a credit, which can be used to finance eligible future energy efficiency related projects. A cap of €30,000 is applicable per hotel per year. The fund for each hotel can be used to cover between 30-50 % of the cost of any approved energy efficiency project depending on the category of the hotel size, as defined by the EU parameters for SMEs. In 2018, the foreseen funds allocated to this scheme were estimated at €800,000 per year[114].

Depending on how this scheme will develop and which to traceable benefits it will lead, it could be applied to other (hospitality) businesses or sectors.

5.4.1.6 Free PV systems for voluntary organisations

In 2019, REWS launched a scheme to promote the application of renewable energy sources, i.e. PV systems. The scheme was administered by the Ministry for Energy and Water Management (MEW, now MESD) and managed by REWS.

Within a very short application period of 10 days in October last year, MEW (now MESD) granted free PV systems with capacities of 3.6 kWp and 7.2 kWp to voluntary organisations. The electricity generated is to be consumed by the client and any extra electricity generated, and not consumed, is sold to the grid at the proxy for the market price[115].

The funds have been generated from national funds. In total, 45 PV systems have been granted of which 25 were at a capacity of 7.2 kWh and 20 at 3.6 kWh[116]. A second call for this scheme was launched in July 2020[117].

113 Gatt & Yousif (2018) Promotion of near Zero CO2 emission buildings due to energy use
114 Ibid.
115 Environment, energy, agriculture and fisheries (2020) 2019 Scheme for the Promotion of Renewal Energy Sources for Voluntary Organisations
116 Ministry for Energy and Water Management Scheme for the Promotion of Renewable Energy Sources for Voluntary Organisations
117 Regulator for Energy and Water Services (2020) 2020/PV/VO Scheme (2nd call).

5.4.1.7 Grants for Energy Efficiency measures for sport clubs

The Energy Efficiency Scheme for Sport Organisations provides financial assistance to Maltese sport clubs for investments aimed at improving the overall energy performance of their buildings and increasing their energy efficiency.

This scheme has been launched by the EWA together with Sport Malta in 2019. As usual, typical interventions that are considered as eligible include improvements in equipment efficiency, energy related building envelope improvement, reduction of energy consumption for heating and cooling systems, improvement of lighting efficiency and any other action which is expected to result in energy savings of at least 20%[118]. The eligible cost range between €250-50,000. The grant shall cover 100% of the eligible cost in the case of investments up to €20,000 and 90% of the eligible cost in the case of investments greater than €20,000.

While the implementation of the projects is still on-going, the uptake of the grant has been extremely good with the budget having to be doubled and a number of applicants not accepted, due the extensive number of applications.

5.4.2 Information and education

TABLE 5-5 INFORMATION AND EDUCATION

Sector	Authority	Details
Domestic	ARMS ltd.	My consumption – online portal for consumption overview, bill calculation and information
	EWA	– Online tool to explore energy saving tips for the household: https://energyefficiencymalta.com/
Non-domestic	Malta Business Bureau, EWA, National Government, Malta Chamber of Commerce and Industry	Energy audit scheme, staff training workshops, and a mentoring programme 'Investing in Energy 'pairing interested Medium-Sized Enterprises with best practice enterprises amongst many other activities. Active in 2016-2018. 119
	MHRA	Joint Committee – promotion of EE
	National Government	In-service courses for teachers addressing climate change and EE
Domestic and non-domestic	National Government, BRO	Content distribution and publications of information related to EE, EPCS, EPBD
	Local councils	Lectures about EPBD and EE
	Enemalta, MRA	Websites to inform about energy consumption and use of RES and to bring all relevant legal and relevant information to one place

In order to increase awareness, the Government has initiated multiple **information campaigns**. These include:

- the spreading of information related to energy efficiency or the use of RES in newspapers, radio, television and on websites;
- publication of documents relevant to energy efficiency in the building sector, like the EPBD or the nZEB Plan;
- interactive sessions with BRO experts on the radio;
- special lectures held at local events, organised by the local councils;

[118] Energy efficiency scheme for Sport Organisations
[119] Malta Business Bureau (2020) Introduction to 'Investing in Energy' Project

- website hosted by Enemalta, assisting in clarifying concerns related to energy consumption and the use of RES, including a tool, called Eco-calculator, with which users can estimate how much energy they have used and how much emissions they produced, based on their appliances. Another website,hosted by MRA,lists authorisations, regulated tariffs, permits, relevant publications, impact and adaptation matters, licenses and notifications covering electricity and RES, registrations of training courses or other relevant activities[120].

For the domestic sector specifically, the local utility provider ARMS developed an online tool which enables residential consumers to check their consumption, to get information on energy efficient consumption patterns and to calculate their energy bills[121]. Another online tool, developed by the EWA, is available at energyefficiencymalta.com The online platform enables domestic consumers to explore energy efficiency tips for their homes in a simple and playful way[122].

The non-domestic sector mainly received help through capacity building measures:

- The partnership 'Investing in energy project' performed outreach to SMEs in the manufacturing, wholesale and retail sectors and aims to bring forward energy efficiency improvements. It included an energy audit scheme, staff training workshops, and a mentoring programme pairing interested Medium-Sized Enterprises with best practice enterprises. This project organised a conference and carried out a socio-economic study on the impact of increased energy efficiency on Malta's industry. It was set up in 2016 as a public-private-partnership led by the Malta Business Bureau together with the EWA and the Malta Chamber of Commerce, Enterprise and Industry. Co-financing was received from the REWS and the Ministry for the Economy Investment and Business.
- The MHRA has two complementary initiatives going on, including the Environment Committee, which is a joint initiative to promote sustainability, including energy efficiency, in the hospitality sector.
- In-service courses are provided by the National Government which train teachers in topics, such as climate change and energy efficiency, who may then impart knowledge to students.

For future endeavours, the NECP 2019 reports that information campaigns will continue to incentivise the uptake of new technologies and fostering behavioural change related to energy efficiency where necessary. These will be coupled by the free service offered by the EWA whereby technical personnel visit households, hold discussions in order to understand energy usage and, as a result, provide tailored energy conservation tips. An annual budget of €10,000 will be required to support this action.

The Energy and Water Agency will also be undertaking initiatives to help raise awareness among the public on behavioural changes which can help save energy. These include studies as well as educational and social media campaigns in order to increase energy efficiency in households.

5.4.3 Other policies and measures

TABLE 5-6: OTHER POLICIES AND MEASURES

Sector	Authority	Details	Year active
Domestic	Enemalta	EEO (progressive rising block system and eco-reduction scheme)	2018-2020

[120] Rivas et al. (2016) Information measures to promote energy use reduction across EU Member States; EUR 27997 EN; doi:10.2790/581788
[121] Automated revenue management services limited, Bill calculator
[122] Energy and Water Agency, Energy and water saving tips

	EWA, LEAP Ministry for Social Policy, MEMA, Ministry for Energy and Health, EU	Various policies to support vulnerable households and against energy poverty (advice, audits, grants, information campaigns and discount on energy bills)	2011-2018
	Specialised Housing Program	Creation of housing and integrated service provision, offering solutions based on the needs of primarily vulnerable groups	2020
Non-domestic	EWA, Malta Enterprise, National Government, ERDF	Energy audits grants, vouchers, tax credits on EE investment resulting from audit	2017-2020
		Energy Efficiency Partner Initiative (Voluntary agreement)	
Public	Central government	Public sector leading by example (EE in ICT, Retrofitting measures in public schools, retirement homes, police office, pool complex, MFSA offices)	
		EE standards in Green Public Procurement	
		Audits and EPCs	
Domestic and non-domestic	HSBC, Bank of Valletta, APS Bank	Green loans	

Other policy measures are those that are not categorised as financial incentives nor information/sensitisation campaigns. For the residential sector these include:

- Obligations as part of Article 7 of the Energy Efficiency Directive, such as the Energy Efficiency Obligation, the rollout of smart meters (completed in 2016). These also contain the application of progressive rising block tariffs, which penalise households with higher consumption by progressively increasing the unit rate after set thresholds.
- Schemes to support energy poverty. While energy poverty in Malta is not a central issue, due mainly to the mild climate, the government has put in place a number of schemes to support vulnerable households. The Ministry of Social Accommodation recently launched the Sustainable Communities, Housing for Tomorrow policy[123], a scheme that aims at building affordable housing by developing solutions at neighbourhood level, which are developed following sustainability and energy efficiency principles[124]. These schemes targeting energy poverty are discussed in chapter 4. A number of measures are also available for non-domestic buildings.

Measures for the commercial sector include:

- Three schemes (one voucher and two grant schemes) to lower the costs of energy audits as well as tax credits on EE measures installed following advice received in an audit, funded by EWA, Malta Enterprise and the Maltese Government. All of these schemes had a relatively low uptake.
  - The energy audit voucher scheme, launched by Malta Enterprise in 2017 and co-funded by the Maltese Government, provided €250 for buildings consuming between 10,000 kWh-25,000 kWh and €380 for buildings consuming 25,001-

[123] Sustainable Communities; housing for tomorrow (2019) Towards sustainable housing and neighbourhoods.
[124] Housingauthority.org.mt, Specialised Housing Programmes

  - 75,000 kWh. This scheme had a very low uptake, expectedly due to its relatively low grant amount, and it was closed in the same year.
  - The energy audit in SMEs, launched by the EWA in 2017 and relaunched in 2020, provides grants between €1,000-5,000, depending on the NACE code and the yearly consumption of the SMEs (10,000-75,000 kWh/a). It has also been co-funded by the Maltese Government, the Ministry for Energy, Enterprise and Sustainable Development.
- The Energy Efficiency Partnership Initiative (EEPI)[125] encourages non-SMEs to sign voluntary agreements committing to implement measures that increase their energy efficiency on an annual basis[126]. The partnership also aims to foster the relationship between the Government and enterprises. The EEPI partners are required to report on energy efficient measures and achieved savings. This is shared with the Government to identify trends and facilitate policymaking. This initiative has potential to be more tailored to the building sector.

After being originally considered for only the domestic sector, within the last years, green loans have become a means to also support businesses and investors for large scale solar projects. Over the last 10 years, commercial banks, like HBSC[127], Bank of Valletta[128] and APS Bank[129], offer green loans or 'eco loans' with the aim of providing financial assistance in relation to purchases having a positive impact on the environment. Such loans may be used to assist in the capital investment of purchases of renewable energy systems, energy efficient equipment, interventions to the buildings envelope and green mobility, depending on the particular product offered and subject to approval by the bank. They are offered at a more favourable rate (3.75-4.85%) compared to other personal loans with an interest rate of 8% and may include other benefits, such as waiving of the bank processing fee.

These green loans can provide financing for quite a large number of technologies that improve the energy performance of buildings. Such loans may be used to bridge the gap between grants offered by the government and the capital investment required for energy efficiency measures and renewable energy. However, it is important to note that a number of actions for which no government incentive is currently available (such as external shading and residential energy management systems) are also eligible for a loan. All loans identified can provide 100% financing, thus the client is not required to make any upfront payment which makes the use of such financial products more accessible. In addition to this, certain measures such as renewable energy for which a feed-in tariff is available and replacement of old inefficient equipment with a much more efficient model can cover the interest paid for the loan through energy generated /savings achieved.

Analysing the conditions of each loan, it stands out that, although these loans have been originally developed for the domestic sector, they might not be accessible to households with a lower income whereby such clients would not be financially eligible to apply for the loan. The same applies for a number of

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[125] Malta-Voluntary National Review of the implementation of the 2030 Agenda (2018)
[126] Energy and Water Agency (2017) National Energy Efficiency Action Plan
[127] HSBC (2020) What is a HSBC Green Loan?
[128] Bank of Valletta BOV ECO Personal Loan
[129] APS Bank (2017) Benefits of The Loan

homeowners due to their financial position resulting from other financial commitments, such as a house loan and the repayment of another loan might be difficult to manage.

The main initiative for the **public sector** is underpinned by the leading by example strategy: the government is active by mandating ministries to follow energy efficiency purchases guidelines, carrying out audits of the majority of the buildings it uses, and by carrying out a substantial number of energy efficient renovations. This initiative will be further elaborated in chapter 7.

6 COST-EFFECTIVE APPROACHES TO RENOVATION

6.1 *Analysis of energy efficiency measures*

This chapter examines the solutions available to reduce energy use in new and existing buildings, considering the characteristics of the Maltese building stock. This chapter does not aim to set statutory performance levels, but it aims to present the opportunities currently available to improve the performance of buildings.

6.1.1 Measures affecting the building's fabric

Roof insulation

The roofs of Maltese buildings are predominantly flat in nature and contrary to buildings in Northern Europe, roofs (and particularly the roofs of dwelling), are an integral part of the usable outdoor space. The availability of usable roof areas increases the amenity and hence value to the property. Besides being practical areas for the placing of building services, roof areas were, and up to a certain extent still are, useable spaces for uses ranging from the traditional practice of hanging out the washing to the more contemporary practice of outdoor living, sometimes further upgraded by the availability of roof top bathing spas or splash pools, the latter becoming increasingly popular in residential and commercial buildings.

Research has shown that the roof of any building is the most critical element in terms of energy performance as it is the primary source of heat gains and losses into and out of the building. It has also been demonstrated that the roof insulation is a most cost-effective investment to any building, coupled by the fact that it is relatively easy to install especially in new builds as it requires no special skill for the appropriate placing of thermal insulating material within the roof build-up.

There are various materials which are currently being used in roof insulation these include:

- **Thermal insulation boards.** These have consistent insulating properties across all board thicknesses. Board thicknesses may range from 20mm to 240mm and their U-Value may vary from 0.5W/m²K up to 0.14W/m²K. This current technology has been used in Malta with less frequency and the thicknesses used were 50mm and 80mm which had U Values of 0.39 and 0.32 respectively.[130]
- **Expandable Polystyrene (EPS)**. Expandable polystyrene foam is manufactured by adding steam to polystyrene beads. This creates a product which contains a lot of air, having a low thermal conductivity and is resistant to natural breakdown. In Malta this technology is used quite frequently and the most preferred options are 15Kg/cu.M and 20Kg/cu.M having a U value in the range of 0.4W/m²K[131]
- **Polyisocyanurate (Polyiso PIR)**. This thermoset plastic product is produced as a foam and used as a rigid thermal insulation panel, it is most affective at temperatures above 15°C and may cause moisture damage due to its lack of permeability. The thickness of this material can vary from 12mm to 200mm and its respective U value can vary from 1.81W/m²K to 0.11W/m²K, [132,133]
- **Extruded Polystyrene (XPS)**. XPS is a synthetic thermoplastic polymer, it is composed of monomer styrene which is made from benxene and ethylene. It has closed cell structure and it is

[130] Styrodur (2019) Technical Data; Application Recommendations Dimensioning Aids.
[131] Insulfoam (2020) What is expandable polystyrene?
[132] Ecohome (2020) Rigid Insulation panels: which ones to use for different applications.
[133] insulationshop.co (2020) PIR (polyisocyanurate) Boards

often stronger with a higher mechanical performance. Its production process is slightly different from EPS. This material has been used in Malta and the typical thickness used is 50mm or 80 mm having a U value of around 0.4W/m²K. [134]

Polyurethane Foam. Polyurethane foam is a closed cell thermoset polymer. It is one of the most ideal materials since it has properties that guarantee air tightness, impermeability, absence of joints and a low thermal conductivity. Thermal conductivity of this material varies between 0.022W/mK and 0.035W/mK.[135]

The energy efficiency gains of roof insulation depends on a number of factors. In general, the less efficient are the other characteristics of the building, the higher the savings delivered by insulating the roof. Real world examples show that:

- when upgrading the roof insulation from a U-Value of 1.35W/m^{2}K to a U-Value of 0.59W/m^{2}K, the average energy use reduction amounted to 4.58 kWh/m^2 per year of delivered energy (7.56 kWh/m^2 per year primary energy) for a typical residential building.
- when upgrading the roof insulation from a U-Value of 1.35 to a U-Value of 0.4, the average energy use reduction amounted to 5.12kWh/ m^2 per year of delivered energy (9.44 kWh/m^2 per year primary energy) for a typical residential building.

According to data collected as part of the government scheme to finance roof insulation, the average cost of retrofitting roof insulation is in the range of €16.40/m^2 to €27.00/m^2, while installing insulation in new buildings cost / in the range of €14.75/m^2 to €18.03/m^2.

TEXT BOX 1 REAL WORLD EXAMPLES

Roof insulation is in general a non-intrusive and cost-effective measure, **which allows** to save between **15**% and **3**0% of **space heating and cooling** energy use**; installing the measure** costs **in general** between €700 (a small flat roof) and €4,000 (large tilted roof). For example, considering a roof upgrade from a value of 2W/m^{2}K to 0.42 W/m^{2}K and residential energy cost of €0.1298/kWh:

- A 83m^2 uppermost apartment requires 29kWh/m^2 per year in heating and cooling energy, which result in an energy bill of €316. Insulating its roof would save 28% of its space energy use (680kWh per year, or €88), with substantial savings especially in energy required for cooling. Considering an installation cost of €2,200 (€17 per m^2 of roof), the payback period of such a measure is higher than 25 years at any discount rate. In order for the measure to pay back in 15 years at 8% return, the installation cost of the measure should decrease by 65%.
- A 69 m^2 terraced house requires 41 kWh/m^2 per year of heating and cooling energy, equivalent to an energy bill of €365 per year. The house is on two floors, and it has 24 m^2 of roof, with an estimated insulation cost of €700. Such measure would save 12% of the dwelling's energy use for heating and cooling, and would pay back in 23 years at a 3% discount rate. In order to pay back in 15 years at 8%, the installation cost of the measure should decrease by 50%.
- If roof insulation is installed at building stage, the payback period will be much shorter: for the 83 m^2 uppermost apartment, the installation cost will be €1,300 and the payback period (at 8%)

[134] Connor N. (2019) What is extruded polystyrene
[135] Synthesia Technology (2019) Sprayed polyurethane foam: an optimal insulating material

would be 24 years with a 30% discount on the installation cost. For the 69 m^2 terraced house, installing roof insulation would cost €400 and the payback period would be 17 years at 8%.

Financial grants issued by Government have had a very good turnout and further investment in financial aid to homeowners and building developers would be strongly recommended. In addition and to further strengthen the importance of having roof insulation installed as standard, Government ought to strictly enforce the inclusion of roof insulation in new builds and to embark on a regeneration programme to have insulation retrofitted on all building stock within a predetermined timeframe.

Wall insulation

Walls within the local building stock can be classified according to both material and typology. In terms of material, walls can either comprise of the traditional *locally quarried globigerina limestone*, predominantly in use up to the 1980s and the *hollow concrete blockwork* (locally referred to as "bricks"). Block thicknesses of both materials being either 150mm, 178mm and 230mm. In addition, walls differ according to typology as follows:

a) Walls fronting the public road, hence legally referred to as the "façade" of the building: considered fully as exposed walls in terms of environmental performance.
b) Common party walls, adjacent and/or immediately contiguous to neighbouring property: walls that can range from being fully protected to fully exposed in terms of environmental performance.
c) Walls overlooking back and internal yards: considered fully as exposed walls in terms of environmental performance, and which however may be subjected to different shading factors by virtue of the size and depth of the internal/back yards of which they form part.

Due to the natural composition of local globigerina limestone and its susceptibility to moisture absorption, walls fronting the public road were, and still are required by sanitary law to be erected in two leaves (the external wet wall and the internal dry wall). In the case of hollow concrete blockwork, intended to receive a watertight cement rendering on its external face, could and still is being employed mostly in single leaf walls. Walls built out of single leaf hollow concrete blockwork are proven to behave dismally in terms of environmental performance, whereas all walls built out of *globigerina* limestone and which do not form part of the "façade" of the building, can still be legally built[136] in single leaf notwithstanding scientific proof that local limestone would lead to the formation of dampness and mould growth on the internal surfaces of spaces if not externally treated against water ingress and absorption.

Unlike roof insulation, wall insulation is not very popular in Malta.[137] The main barrier for applying wall insulation is the high capital investment requirement, and therefore longer payback period. A recent analysis of the cost effectiveness of different energy efficiency measures to education buildings[138] compared costs and benefits of insulating walls to two different U values across a number of schools: the reference case had a value of at 1.57W/m^2K, and the upgrades considered were 1.2 W/m^2K and 0.85 W/m^2K. The analysis concluded that the best mix of energy efficiency features is not highly sensitive to the wall U-value measure.

[136] legally built to sanitary law, however may fall short of the u-value regulated in Document F
[137] Most facades in Malta are constructed with 2 masonry leaves with a cavity in between. A cost-effective system should be to construct two masonry leaves with insulation in between.
[138] Cost optimality study - schools

Even considering a U value of 2W/m^{2}K (worse than the reference case) wall insulation did not provide sufficient benefit to justify the intervention. Similar conclusions were reached for hotels and elderly homes.

Further, residential buildings more likely to benefit from this measure are single-family houses built in the post-war period. However, these buildings are often the primary candidate to be demolished and converted to flats.

Additional barriers to the installation of wall insulation include:

a) Externally applied wall insulation, although more thermally effective, leads to airspace ownership issues with adjacent property owners. By affixing external insulating material onto exposed common party walls for instance, property owners would be effectively encroaching onto third party airspace making this practice legally prohibited. In addition, similar practices onto walls overlooking internal and back yards would constitute the reduction of internal clear dimension of such yards, thus making them not compliant with the minimum sizes of yards as specified in Legal Notice 227 of 2016 and subsequent amendments.
b) Internally applied insulation would avoid ownership issues altogether but tend to be unpopular due to the take-up of valuable indoor space and the general overall lack of acceptance of having walls which do not sound solid to permit the straightforward installation of any hanging furniture or fixture.

When applying this measure to an apartment which is at the uppermost level having a total floor area of 83 m^2 and a wall area of 42 m^2, the cost of installing wall insulation with a U-Value of 0.85 W/m^{2}K can start from €3,209. The average reduction in energy estimated for such a measure is 15.58 kWh/m^2 per year for primary energy. This would add up to 1,293 kWh per year for the whole premises. Assuming a discount rate of 3% the payback period would be higher than 30 years. If an incentive is applied covering 50% of the costs the payback period would be reduced 14 years.

Any government intervention that may be targeted at incentivising wall insulation would need not only to focus on exposed walls of any typology, but needs to be backed up by appropriate legislation to permit compliance with sanitary legislation and without infringing on third party civil rights.

Windows

Windows are a key element of the building fabric and play a substantial role in reducing heat transfer between the inside and outside of a building. Traditionally, buildings were built with small apertures to avoid sun and heat during summer. However, modern houses often have large panoramic windows, including glazed doors to balconies, which increase the importance of having appropriate glazing. The issue of windows and apertures in general is further exacerbated in most contemporary commercial buildings and nowadays, high-rise developments. In the case of the former, wall to glazing ratios are continuously on the increase with the latest design trends inappropriately following those of mainland Europe without any consideration of the specific cooling-dominated climate in which Malta is located. Although the importance of transparency in a building is well documented and the ever-so-important visual connection between indoors and outdoors being so beneficial to occupant well-being, any architectural concept intended to achieve a “glass-box” is not appropriate to Malta’s climate. Hence the importance of treating apertures with care for the avoidance of overheating and glare.

Any aperture consists of a framing system, the aperture’s fixing and hence its method of opening, and of course, the glass. Traditional window frames were predominantly made up of timber, with steel becoming increasingly available from the 60s onwards. Aluminium as a framing material was introduced in the 70s and is still considered as the preferred type of aperture framing material. The availability of thermal-break aluminium framing systems together with PVC and composite material frames have increased the choice of framing types to the Maltese market.

The chosen method of opening of apertures is predominantly dictated by spatial constraints, accessibility issues, furniture, and personal preference, with decisions sometimes being taken by the aperture manufacturer himself. Environmental issues such as light distribution and natural ventilation principles rarely feature as design decisions and competent professional in the fields such as architects and engineers seldom get consulted on the actual design of apertures with most decisions being left either to chance or to the cost-centred approach of the manufacturers themselves.

Windows are available with a range of thermic performance, which depends on the number of glass layers (up to triple glazed), on the width of the intra-glass cavity and on whether the cavity is filled with gases to reduce the rate of heat transfer. In addition, the availability of numerous solar control coatings further improves thermal and optical performance of glass. Modern windows offer also improved noise insulation, and can greatly reducing noise pollution, for example from roads.

There are two main types of coatings these are the low emissivity coatings and the spectrally selective coatings. Low emissivity coatings have control over the heat transfer. They are 10% to 15% more expensive than regular windows however they reduce energy loss by 30% to 50%. Low emissivity coatings have a very thin metal or metallic oxide layers deposited directly on the window panes. This coating lowers the U and g-values of the window and can be modified to allow the amount of solar gains which the user needs. Spectrally selective coatings filter out 40% to 70% of the heat that can be transmitted. This type of coating is optically designed to reflect particular wavelengths but remains transparent to others. Usually they are used to reflect infrared portion of the solar spectrum while admitting visible light. They create a low U-value and g-value but a high VT (visible transmittance).[139]

A window that has double glazing with a 10 mm argon filled cavity without coating has a U-Value of 2.8 W/m^{2}K however when adding coating the U-Value can be lowered down to 1.4 W/m^{2}K and sometimes even less.

Research carried out locally in the field of glazing with static control coatings confirm that in our Mediterranean climate, the use of spectrally selective and low emissivity coatings is essential to ensure an improved solar performance. Contrary to popular belief, uncoated double-glazed units generally perform worse than single glazed units as the improved U-value of the unit counteracts the design intent by preventing solar heat gain from being lost from within the space.

The relevance of this study towards the current industry practice in Malta is worth noting. Although mandatory EU legislation in terms of the energy performance of buildings may have been the driving force behind an attempt of Government to instil the industry to shift from energy-guzzling design to a more sustainable manner of construction, in the case of fenestration, the omission from the 2016 version of the national Guide F document of what is scientifically proven to improve the thermal performance of glass, is unfortunate. The current industry trend to install uncoated double glazing on all orientations, irrespective of whether the unit is shaded or otherwise is clearly misinformed. Similarly, Government schemes intended

[139] Energysaver, Window types and technologies

to offer financial incentives for the blanket installation of "double glazing" with the good intention of providing for "better energy efficiency" may indeed by counterproductive in increasing energy demands.[140]

Glazed apertures do not only affect thermal issues within a space. The aspect of visual comfort primarily related to the availability or otherwise of visual light transmission is worth noting. Large, glazed apertures within buildings often lead to over lighting and discomfort glare – an environmental factor that is often under rated and poorly controlled by the retrofit installation of an indoor blind.[141] Besides weathering poorly and being the perfect breeding ground for allergens, indoor shades not only are largely ineffective at protecting the building thermally, but completely obliterate outlook from within a building creating a consequential negative effect on occupant well-being and productivity.

Dynamic/switchable glazing may shortly become a mainstream approach of altering the optical properties of glass to suit the seasonal and diurnal transient requirements of an indoor space. Technologies based on the application of dynamic coatings at nanoscale to the interlayers between sandwiched glass panels can effectively transform a plain sheet of float glass into a digitally-connected device that can have its optical properties altered by the occupant at will, or through automated controls. Suspended particle devices, liquid crystal devices and electrochromic devices all permit for instance, the gradual tinting of the glass through the use of electric currents within the interlayer of the glass, allowing for the control of the amount of daylight that enters an indoor space.

Although dynamic glazing may still yet be a product affordable solely on high-end properties, substantial energy improvements can be attained by retrofitting existing building with solar control glass through financial grants. Besides the need for improved legislation in relation to the g-value of the glass, regulations related to the use of appropriate solar control glass in all new builds and limitations to the maximum window to wall ratio unless it can be proven that additional measures can counteract any negative effects brought about by increasing the glazing ratio above the maximum allowable limit.

TEXT BOX 2 REAL WORLD EXAMPLES

Wall and roof insulation are measures carried out with the sole aim to improve thermal comfort and generally last as long as the buildings. Other interventions on building fabric, such as replacing windows instead can have a significant impact on the experience of buildings users. Replacing windows will also improve the aesthetic value of a property, while roof and wall insulation are measures that do not significantly alter the exterior, unless wall insulation is applied on an exposed brick wall. Compared to wall and roof insulation that are done once during the life of a building, windows have a shorter lifespan (generally 25 years). The cost of high efficiency glazing varies more than other measures, are windows can have a lot of additional features and come in a range of materials. Considering a glazing upgrade from a value of 5.7 W/m^{2}K to 1.4 (high efficiency windows) and residential energy cost of €0.1298/kWh:

- An 83 m^2 uppermost apartment requires 26 kWh/m^2 per year in heating and cooling energy, which result in an energy bill of €281. Replacing its windows with high efficiency glazing would save 30% of its space energy use (648 kWh per year, or €84). There is large variation in

[140] Magri, E., Buhagiar, V., & Borg, S. P. (2017) An assessment of glazing systems suitable for the Mediterranean climate. PLEA2017 – Passive & Low Energy Architecture, Edinburgh.

[141] Magri, E., Buhagiar, V., and Overend, M. (2019) ``The Potential of Smart Glazing for Occupant Well-Being and Reduced Energy Load in a Central-Mediterranean Climate" in 2019 XJTLU International Conference: Architecture across Boundaries, KnE Social Sciences, pages 534--545. DOI 10.18502/kss.v3i27.5555

the cost for high efficiency windows. Assuming the difference between a window at minimum standard (4 W/m^2K) and a high efficiency one (1.4 W/m^2K) is €200 per m^2 and that the apartment requires 14 m^2 of windows, the payback period of such a measure is higher than 25 years at any discount rate. In order for the measure to pay back in 15 years at 8% return, the installation cost of the measure should decrease by 75%.

- A 27 m^2 uppermost apartment requires 14 kWh/m^2 per year in heating and cooling energy, which result in an energy bill of €48. Replacing its windows with high efficiency glazing would save 30% of its space energy use (112 kWh per year, or €15). There is large variation in the cost for high efficiency windows. Assuming the difference between a window at minimum standard (4 W/m^2K) and a high efficiency one (1.4 W/m^2K) is €200 per m^2 and that the apartment requires 3 m^2 of windows, the payback period of such a measure is higher than 25 years at any discount rate. In order for the measure to pay back in 15 years at 8% return, the installation cost of the measure should decrease by 80%.

Shading Devices

Shading devices, predominantly those externally installed, have always been the vernacular approach of protecting buildings, mainly these consist of protection against substantial incident solar radiation impinging on the glass. The ever-so-effective *loggia* on the southern aspects of buildings, the timber louvered window and the modest reed cane curtain (*ħasira*) have all given their contribution to environmental control to our pre-war buildings. Development of buildings from the 60s to date, have sadly done away with the basics of environmental control measures and no attempt has ever been made to develop basic concepts using modern materials. Today’s complete reliance on active, energy-consuming measures for the attainment of comfortable indoor environments is indeed having its toll on the overall energy consumption of a building. Moreover, most form of external shades such as canopies, awnings and blinds often get installed onto building facades as an afterthought following the first experiences of occupant discomfort, and rarely feature as an integral designed element on local building facades.

The mandatory inclusion of appropriate shading devices on new build properties, designed according to orientation can be a cost-effective measure by Government to firstly re-instil the importance of passive solar control measures and secondly to help reduce energy demand and increase occupant comfort. Financial grants can additionally be considered for retrofit installations that help improve on energetic performance, keeping in check the overall aesthetic of buildings. The development of high-end, PV-integrated solar shades may additionally provide a source of power generation.

Lighting

Lighting is a relatively small share of energy use in domestic buildings, but it is a much more important ones in commercial and industrial ones. While local legislation does not impose the use of LED lighting within buildings, the Technical Guide F strongly recommends the use of “reasonably efficient” artificial lighting including controls (Building Regulations Office, 2006).

An important player in lighting today is LED technology which dramatically reduce the electricity use. Because of the very nature of how light is generated through LED, the technology can be as much as 90% more efficient in generating the same amount of light (lumens), when compared to conventional lighting technologies such as incandescent light bulbs (Energy Star, 2020[142]). Additionally, LED lighting typically has much longer lifetimes than conventional lighting, with LED chips today lasting for over 50,000 hours. In recent years, there has also been an increase in lighting control technologies, including dimming, colour and orientation. Such controls, especially systems which incorporate with presence detection, natural light monitoring and building management systems, can achieve even higher levels of overall energy savings.

As highlighted by studies performed by the National Statistics Office, lighting accounts for a significant portion of the energy footprint within the existing residential building stock, with as much as 30% of the total energy footprint (National Statistics Office Malta, 2011). Knowledge of the benefits of the technology, availability of cost-effective lighting options, and a matured local market, has led to most of the residential and office buildings to opt for LED lighting when retrofitting or changing home lighting. Similarly, this has also been the case very recently in commercial and architectural lighting, albeit slower, driven mostly by the ability to control the photometrics more accurately with LED technology. The slower uptake is mainly due to the higher capital cost of architectural LED lighting. On the other hand, uptake locally has lagged behind for other lighting applications such as sports lighting and other higher power lighting applications. This is mainly due to the lack of availability of good quality high power LED lighting, leading to high investment costs.

In 2009, the Maltese government launched a scheme for residents to receive a number of high efficient bulbs for free. This was done both to introduce the technology within the household, but also to educate the public on efficient lighting in light of EU directives in place. Additionally, through the EU Ecodesign Directive 2005/32/EC, inefficient bulbs such as incandescent bulbs have been phased out of the EU over the past decade. This has also been the case in Malta, leading to a larger market share for LED lighting. An LED bulb which in 2010 would have cost over 10 Euro, is now less than a third of the price, making it accessible to a wider group of consumers.

While no incentives have been launched specifically for the implementation of LED lighting, schemes aimed at enhancing the energy efficiency of buildings have led to the conversion of conventional lighting to LED technology. One such scheme is the "ERDF Energy Grant Scheme" launched by Malta Enterprise in 2016[143], which supports enterprises to implement energy saving measures, including lighting, with a 50% grant value (Malta Enterprise, 2020). Another recent scheme is the "Leading Sport Organizations to Higher Efficiency Scheme" launched by the Energy and Water Agency (EWA) and Sport Malta in 2019, which covers up between 90 to 100% of the capital cost required to enhance the efficiency of the sports premises, including lighting (Energy and Water Agency, 2020).

Below is an analysis of the costs of typical tube LED lighting system and the respective savings achieved when compared to conventional fluorescent lighting.

TABLE 6-1: COSTS AND SAVINGS FROM TYPICAL LED LIGHTING SYSTEM

Technology	LED	T8 Fluorescent
Tube power (W)	10	18
Total system power (W)	200	360
Capital Cost (Euro)	120	90

[142] Energy Star. (2020) Learn About LED Lighting
[143] Maltaenterprise (2016) ERDF Energy grant scheme (closed measure)

Annual use (h)	2,400
Annual Energy Savings (kWh)	384
NPV (Euro)	109
Payback period (years)	4

SOURCE: ENERGY AND WATER AGENCY, 2020

While the LED lighting market in Malta is now an established one, there are a number of challenges which may hinder technological adoption. Below is a brief list.

- Cost of product – LED lighting, especially architecture and higher power variants, remain more expensive than conventional technology lighting product, reducing uptake of the technology in specific sectors
- Quality of products – the growth in market has also led to an availability of lower quality LED lighting units available, which in turn have led to a decrease in the consumer's confidence in the product
- Utility prices – with some of the lowest electricity utility prices in Europe, the financial benefit achieved through energy savings has decreased
- Grid stability – electronics within LED light units and their power supplies may suffer from voltage and harmonics instability within the grid, which can be apparent in "small" grids such as Malta's
- Lighting Control – it is not customary that lighting control is present within residential buildings, and thus, the dimming and consequently energy saving potentials of LED lighting are often not benefitted from

The Guidelines for the Reduction of Light Pollution in the Maltese Islands' (ERA & PA, 2020) feature how to design and plan lighting in different types of buildings such as residential houses, urban areas, sports and recreational facilities. These guidelines should be used in order to manage lighting in a sustainable manner and reduce any light pollution to surrounding areas and natural ecosystems.

Green Roofing and Green Walls

A green roof is a roof that is covered in vegetation and it is obtained by covering the roof with a waterproofing membrane and a specially designed growing medium. In order to avoid damage to the roofs, other layers such as root barriers and drainage systems are included. Apart from offering a more aesthetically pleasing environment, green roofs have other benefits such as rainwater absorption, insulation, carbon dioxide offsetting and stress reduction potential to occupants at large. A research project undertaken at the Faculty for the Built Environment at the University of Malta served as a prototype of this building element and intended to increase public awareness in the field.[144]

In Malta, the green roofing option is as yet not adopted frequently primarily due to roof spaces being so restricted and valuable, especially in domestic buildings. More people opt to use precious roof space for a PV or a solar water heating (SWH) system due to the lower payback period. In addition, and as highlighted earlier in this section, roof spaces are increasingly being used for outdoor living and entertaining, despite the added requirement of having to contain water tanks. To further exacerbate matters, second class water systems that are separately outlined further on in this section, would invariably double the requirement for space to contain additional water tanks.

[144] Life Med - Green Roof Project (2020) Constructing two demonstration green roofs to illustrate the potential of meeting environmental and energy targets

Roof spaces of commercial and industrial establishments may have a greater potential of having green roofs installed due to the availability of additional roof areas. This potential however would need to be considered carefully versus the other potential of having the same area utilised for PV installations. Green roofs require continuous maintenance which industrial and commercial establishments may not be in a position to provide efficiently due to the relatively low occupancy of this type of building typology. The maintenance of such plants can be reduced when using native plants and plants which are adapted to the Maltese climate. The potential of green roofs over commercial building may be more beneficial in the case of office buildings, requiring chill out areas for their employees, which can be very effectively provided for by a green roof installation.

The INDIS MALTA LTD and Infrastructure Malta have initiated projects where green walls will be installed within their premises and alongside major traffic throughfares. This option can be another effective way to increase building insulation through shading, thus reducing energy consumption and improving thermal comfort. As part of this initiative, the possibility to combine green roofs and PVs is being explored. A combination of green roofs and PV system enhances the effectiveness of both systems through the cooling and shading effects created thus an increase in energy efficiency can be obtained.[145]

Apart from Government incentives to promote the installation of green roofs on new builds and within the existing building stock, planning policy may be amended to include a minimum amount of soft landscaping at roof level in those cases where the roof area of buildings would exceed a recommended area required for installation of plant and for outdoor amenity. Such a measure would ensure that any additional roof area not utilised for plant and outdoor living could be converted into localised green lungs.

Government may additionally consider the promotion of green roof and green wall installations within local schools. Apart from the availability of unutilised roof and wall areas that educational establishments may already have, green wall and roof installations can provide school children with an educational potential and the much needed contact with nature which is so lacking in modern generations who are increasingly spending most of their time indoors, within an urban setting and so far from nature.

Water Collection & Reuse

Malta is one of the top 10 water-scarce countries in the world, with nature providing only half of the water the population needs. Malta 'produces' clean water and tries to make sure that not one drop is wasted. The energy and water agency claims that the energy needed to produce one cubic metre of freshwater from seawater is expected to be reduced to 2.8 kilowatt hours from the 6-kilowatt mark in 2008.[146]

Current legislation requires any development to make a provision for rainwater storage equivalent in volume to 60% of the roof area in square metres. Additionally, Guide F requires that at least one residential unit in a multi-unit development to have a second-class water system installed. Besides the complete lack of enforcement of these two requirements, real-life practice in the field demonstrates that both of these requirements need to be immediately revised.

Considering the limited sizes of our plots, contiguity to adjacent third party properties, the legal requirement to maintain mandatory distances from adjoining properties when excavating, the increased cost of excavation due to transportation and dumping fees, practise demonstrates that a reservoir with a size to

[145] DRAFT Maltese Standard SM3700:2017– National Standard for Green Roof - MCCAA
[146] European environment agency (2018) Malta water scarcity is a fact of life

contain an entire year of rainfall can never be practical on any site and this physical limitation invariably leads to failing to comply with current regulations.

Policy needs to be immediately revised to cater for practical, real-life problems with the minimum size of the water storage drastically reduced. This however would need to be coupled with an increased mandatory requirement for the obligation to use second-class water for irrigation and for flushing requirements. The long-term target is for all new build residential and commercial units to be fitted with second class water systems. Government financial incentives to retrofit the existing building stock with second class water systems need to be considered, this considered as an effective, cost-effective measure to reduce water consumption. Since second class water systems often entail the requirement to install additional water tanks at roof level, the increased pressure for precious roof space for the placing of additional services would need to be taken into consideration.

Legislation needs to also address the current lacuna of reservoir ownership issues within a multi-unit block of residential units. Presently, there is confusion as to whether a reservoir is to be owned by the ground floor owner beneath whose floor the reservoir lies and who would have direct access to it, as opposed to whose roof, rainwater would be feeding the reservoir from. Whereas the quality of the water fed into the reservoir is directly attributed to the owner of the roof, the access to the reservoir is often contained within third party property. Legislation requires revision to specifically consider a reservoir as mandatorily being common property in the same way the façade of a building is considered such.

Reconstituted Stone Blocks

The University of Malta has been investigating new ways to reuse limestone blocks. They have invented a new process to reconstitute waste from limestone building blocks or excavated waste. The waste is processed to create a better building material with respect to strength, water resistance and weathering. [147]

A project with INDIS MALTA LTD has been initiated to use this this process to recover and re-use material from an existing landfill.

6.1.2 Measures affecting technical systems

Water Heating, Space heating and Space Cooling

Water heating is one of the primary consumers of electricity in any household since it needs to be available all year round. In terms of national energy consumption, the services sector (which includes hotels, hospitals, offices, restaurants, schools, shops and warehousing) uses around 44% of the total energy consumed[148] to satisfy the heating and cooling demands, including those for domestic water heating. The different technologies considered which offer higher efficiency than the electric storage tank water heaters are:

- **Instant gas water heaters –** This technology offers the advantage of heating only the amount of water that is required rather than continuously heating a full tank, this system reduces losses due to storage and standby.
- **Heat pumps -** Heat pumps use a different technology altogether to achieve heated water. A vapour compression cycle is implemented to extract energy from a low temperature source and transport it to a high temperature reservoir. The current technology has a COP ranging from 2.5 to 4.5 for air source heat pumps.

[147] University of Malta, Reconstituted stone
[148] Eurostat Energy Balances

- **Solar Water Heaters -** There are four main types of solar water heaters which are the batch collectors, flat-plate collectors and the evacuated tube collectors. To determine the efficiency, the solar energy factor (SEF) and solar fraction (SF) can be used together with the solar fraction. Systems having a SEF of 2 or 3 are the most common however the range can vary from 1 to 11. The solar fraction can vary from 0 to 1.0 however typical solar factors are 0.5–0.75. [149] Practical experience on the use of solar water heaters shows that in the case of the local climate, flat plate solar water collectors are generally sufficient at providing for most of the hot water requirements of a typical household. Evacuated tube collectors, although more efficient in collecting incident solar radiation in climates with much less hours of sunshine, are more fragile and require higher maintenance costs.
- **Boilers -** Boilers are usually the preferred option for hotels which would require both underfloor heating and domestic hot water heating. Heat pumps are also being used by some larger residential premises that have a higher heating load.

The technology which is mostly used for residential premises is the electric storage water heaters, but a recent trend is showing an increase in instant gas water heaters. Heat pumps are also being used by some larger residential premises that have a higher heating load.

In the cost optimality studies for schools, various options were considered for domestic hot water including having an electric boiler with storage, having an air to water heat pump and having a solar water heater with an auxiliary electric resistance heater. From this cost optimality study 5 schools were investigated, and it was noted that heat pumps dominate the cost optimal range. From the cost optimality studies carried out for the elderly homes and for the hotels the heat pump and the heat pump combined with the solar water heater dominated the cost optimal range.

For residential buildings an incentive was given to financially aid the public to opt for new technologies in this case solar water heaters and heat pumps. Since 2018, 419 households have benefited from incentives on solar water heaters while 74 households have benefited from heat pumps; 28% of them opted for a heat pump having 685W.

In a typical residential building, an electric water heater of around 100 litres has a power rating of 1.5kW and a COP of 1. The yearly consumption, assuming it is used for 3 hours daily, is 1,642kWh. Currently available heat pumps (with a COP of 3) consume 60% less than an electric water heater and their price, including installation, is around €1400. Assuming an electricity rate of €0.13/kWh the payback period of such a system is between 12-15 years at a discount rate of 3%.

Space cooling is another factor which needs to be considered. Due to the high temperatures in the summer period Malta spends a considerable amount of energy to maintain an acceptable thermal comfort level. Inverter type air conditioners having a COP of 3.8 are the most opted option for residential premises. Several old buildings which had the old non-inverter type system are being refurbished with the newer models. This technology allows the motor speed of the unit to be adjusted according to the required temperatures without having the need to switch the motor on and off continuously thus having less power losses while saving more energy.

In residential premises the most commonly used system is a split type air conditioner system where one outdoor and an indoor unit form the system. The outdoor unit houses a compressor, a condenser coil and an expansion coil while the indoor unit contains the cooling coil, a long blower and a filter. The reason why such systems are most commonly used in residential premises is that they do not require large ductwork,

[149] Energystar, How it works- Solar Water heaters

thus making the system less expensive, while reducing the need of space above soffits. Without ductwork there is a very small opportunity of energy losses.

Larger premises such as offices or hotels usually opt for a more centralised system having better control over temperature and relative humidity such as a VRV. This system works with an inverter technology based compressor and it is ideal for large spaces since it allows individual zone controls. These systems also have a variable refrigerant flow control thus having the ability to adjust the refrigerant amount flowing through the branch piping. Another advantage of such systems is that they have the ability to heat or cool specific spaces continuously based on the temperatures required.

When installing new cooling systems, more premises are opting for a heat recovery unit which reduces the energy required to heat or cool the outside air for ventilation purposes. Using an air to air heat exchanger, heat which normally wasted is recovered. Another system which is mostly used for commercial premises is the chiller system. The system uses air handling units to control the airflow through the building. Chiller systems can operate on alternative energy sources and are usually used when constant climate control such as in manufacturing plants is required. Such systems are optimal when a readily available source of chilled water is available for cooling.

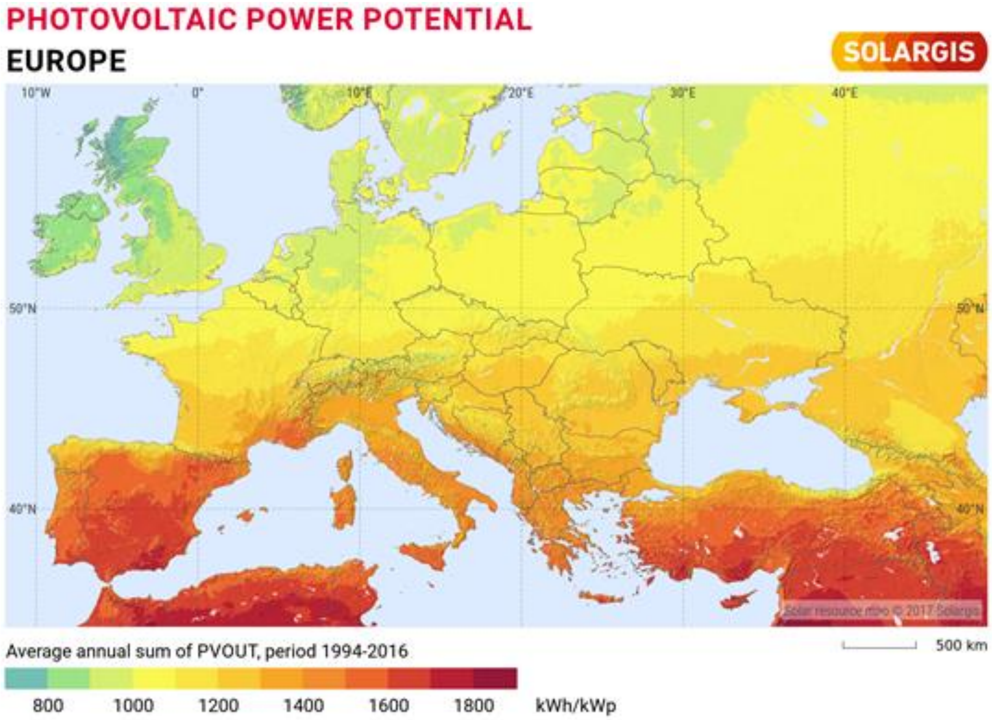
6.1.3 Renewable Energy Sources

Both the Renewables Energy Directive, 2018/2001/EU, and Energy Efficiency Directive, 2018/2002/EU, have been transposed in the Maltese legislation. The original Maltese National Renewable Energy Action Plan, focuses mostly on onshore and offshore wind energy, solar photovoltaic and solar thermal energy, as well as waste to energy. The technologies considered in the update NREAP (2017) are solar, heat pumps, energy from waste, and biomass until 2020.

Photovoltaic Panels

Malta has one of the highest annual solar irradiation in Europe (Figure 23), and with temperature levels that are not as high as the equatorial countries, the Malta region makes it ideal for PV Power generation, as shown in the figure. Photovoltaics are often of one the cheapest ways to reduce net energy use from buildings of most categories, as confirmed by the result of the cost-optimal studies, both for renovation and new buildings.

FIGURE 23 - CONTRIBUTIONS GLOBAL HORIZONTAL IRRADIATION IN EUROPE[150]

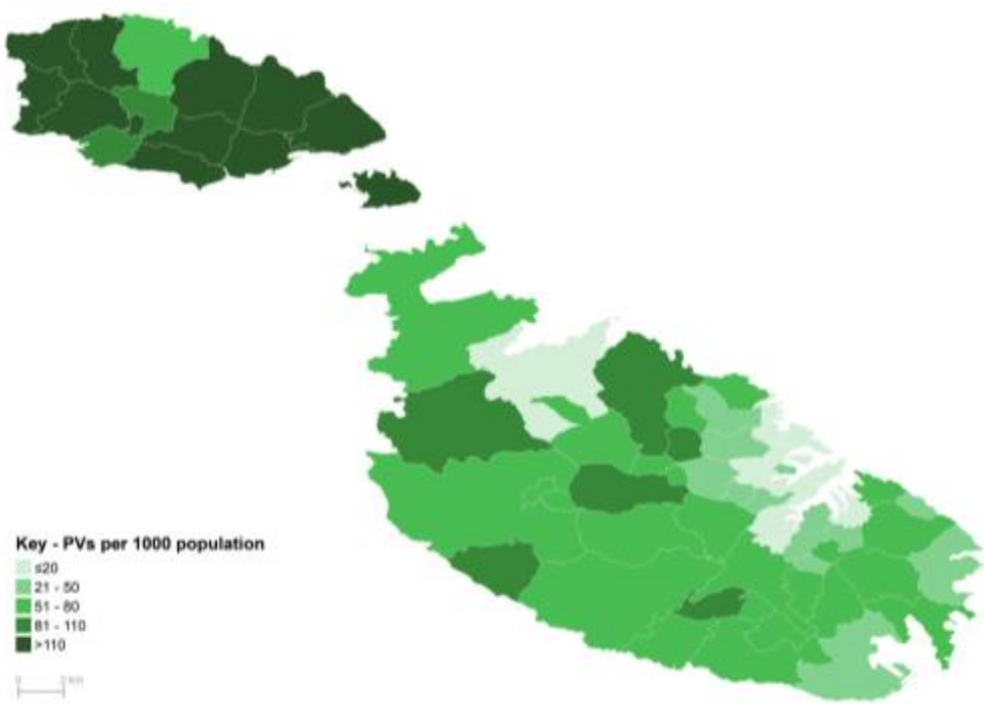


While Malta contributes marginally to the total PV installed capacity in Europe, positive environmental conditions and attractive incentives have placed Malta amongst the top 5 EU countries with the highest PV capacity per inhabitant[151.] In 2019 alone, Malta experienced a 14.6% increase in energy production from PV from the previous year, with a total of 217.3 GWh. The total PV installation stock amounted to 27,454 installations of which 84.8% were installed in the island of Malta and 15.2% in the island of Gozo. In 2019, the domestic sector accounted for 93.7% of the PV installations, with the rest being in the commercial and public sector, yet when considering PV energy production, the domestic sector accounts for around 51.4%, the commercial for 45% and the public for 3.6%. This is mainly due to PV system sizes, with the average peak power rating of a domestic system being 3.0 kW, while the commercial and public sector having system average peak power rating at 47.0kW and 20.6 kW, respectively[152].

The eastern regions of Malta are the areas most densely populated, these are also the areas with the lowest total PVs installed per 1,000 population. This is because dwellings in that area are mostly apartment blocks, where small roofs in common use, have prevented the technology from spreading more widely.

[150] Solargis. (2020) Solar resource maps of Europe
[151] EurObserv'ER. (2020) Photovoltaic barometer 2020
[152] NSO. (2020) Renewable Energy from Photovoltaic Panels (PVs): 2019.

FIGURE 24 - TOTAL PVS INSTALLED IN THE DOMESTIC SECTOR PER 1,000 POPULATION (SOURCE: NSO, 2020)



While Maltese legislation does not impose mandatory installation of PV technologies on new or existing buildings, incentives and Feed-in Tariff schemes have driven the installation of PVs for a number of years. In 2020 and 2021, new schemes based on new EU legislation requirements were launched. Table 6-2 below summarizes the details of the incentive scheme. The new incentives are managed by the Regulator for Energy and Water Services (REWS), except for the scheme aimed at systems above 400 kWp, which is managed by the Ministry of Energy directly.

TABLE 6-2:SUMMARY OF THE LATEST PV INCENTIVE SCHEMES

Scheme	Sector and requirements	Grant	Feed in tariff
2021 PV SUPPORT - "Standard" PV installation – no battery	Households and Small Scale PV; >=1kWp and < 40 kWp	Grant capped at €625/kWp / €2500 max (capped at 50% of Capex)	10.5c /kWh for 20 years
2021 PV SUPPORT - battery-ready PV system	Households and Small Scale PV; >=1kWp and < 40 kWp	Grant capped at €750/kWp / €3000 max (capped at 50% of Capex)	10.5c /kWh for 20 years
2021 PV SUPPORT – battery storage – upgrade to existing PV system	Households and Small Scale PV; >=1kWp and < 40 kWp	Grant given at €600/kWh or ~80% of cost for Battery (max) – capped at €3600. €450/kWp for New Hybrid Inverter (~80% cost of inverter) – capped at €1800	
2020 PV Grant (finances the installation of the measure)	Residential	50% of eligible costs up to a maximum of Euro 3,000 per system and Euro 1000/kWp and (kWp times €3800) minus eligible cost	Feed-in Tariff: 10.5c /kWh for 20 years
Feed in Tariff	Residential and non-residential for systems >=1kWp and < 40 kWp		Feed-in Tariff: 15.5c/kWh for 20 years

Feed in Tariff	Residential and non-residential for systems >=40kWp and < 400 kWp		Feed-in Tariff: 14c/kWh for 20 years
Feed in Tariff	Residential and non-residential for systems >=400kWp and < 1000 kWp		Feed-in Tariff: Value for 20 years allocated through a competitive bidding process
Feed in Tariff Scheme	Residential and non-residential for systems >=1000 kWp		Feed-in Tariff: Value for 20 years allocated through a competitive bidding process

In recent years, the industry has seen a number of Government policies and guidelines being launched to ensure regularization of the newly created market. In 2015 the then Malta Environment and Planning Authority (MEPA), today the Planning Authority (PA), launched the "Development Control Design Policy, Guidance and Standard 2015" or "DC15", which stipulated guidelines on how PV systems are to be installed on roofs and structures, and visual abatement measures required (Malta Environment and Planning Authority, 2015). In 2017 the Maltese Government launched the "Solar Farm Policy", which regularized the implementation of large-scale PV systems and ground mounted PV systems (Planning Authority, 2017).

PV incentives in Malta over the last decade, have led to an increase in the local renewable energy market, with over 50 registered PV suppliers. The sector has seen an increase in access to financing, both through bank financing, with most of the major local banks offering preferential incentives on loans for PV investment, and through private financing, with local and international companies setting up platforms to invest in medium to large scale PV systems. Such access to financing has given the possibility to individuals and companies who may not have the risk appetite, liquidity, or space to implement PV projects to participate in such renewable energy projects.

In the past years, the Maltese Government also launched a number of other schemes to increase PV uptake. One scheme launched successfully in 2019 and again in 2020 has been the "Photovoltaic Scheme for Voluntary Organization" which gave the possibility to registered voluntary organizations to apply for a domestic scale PV system at zero capital investment (Regulator for Energy and Water Services, 2020). A second scheme provided the opportunity to apartment owners without access to roofs to invest in a Government solar park , thereby generating their renewable energy portion remotely from their respective homes. Table 39 presents an analysis of Capital Investment and Payback period of a typical PV systems in Malta, showing that returns on average are in the range of 7.7% to 11.8%.

TABLE 6-3: CAPITAL INVESTMENT AND PAYBACK ANALYSIS FOR PV SYSTEMS IN MALTA

	Domestic	Industrial	Investment
System Size (kWp)	3	100	1000
Investment Size (Euro)	6,000	130,000	1,200,000
Feed in Tariff (Euro/kWh)	0.105	0.14	0.12
Grant (Euro)	3,000	0	0
Project lifetime (years)	20	20	20
NPV (Euro)	6,000	250,000	1,800,000
IRR (%)	11.8	10.8	7.5
Simple Payback (Years)	8	8	10

Combined heat and power systems

The level of CHP development in a country depends on the characteristics of the heating and cooling demand in the industrial, commercial and residential sectors. This demand is used as the basis for the approach to analyse CHP potentials: to estimate, taking into account different national circumstances, the proportions of current and future heating and cooling demand in each of the areas that could be reasonably served by CHP.

Historically, Malta does not have an active CHP market, mainly because of its climatic conditions that limit the demand of heat for space heating. In addition, infrastructural and market barriers such as the absence of a national gas grid, lack of interconnection to the European electric grid (until a few years ago), and spatial restrictions have stalled the nationwide introduction of CHP technology. Until recent years, awareness and knowhow with regards to alternative heating technologies such as CHP systems has also been lacking, and the fact that other alternative technologies such as solar water heating and PV are in general more attractive. Further, as concluded in a recent report on the potential for efficient heating and cooling in Malta: "*The recommendation for potential use of CHPs outlined in the 2015 Comprehensive Assessment report, was met with significant challenges during its implementation. In an effort to overcome these challenges and incentivize the uptake of highly efficient CHP units, in 2016 the Government released a scheme whereby enterprises were eligible for aid through tax credits. To date, the uptake was nil, mainly due to spatial requirements for on-site fuel storage (mainly LPG) and applicable international standards. Such challenges brought about by spatial constraints, along with Malta's ambition to contribute to the EU wide commitment of decarbonizing by 2050, led to the prioritization of more relevant technologies to Malta's heating and cooling specificities".*[153]

In Malta, at present there are very few CHP plants in operation. One of these is a system which was licensed in 2011 to Wasteserv Malta Ltd, consisting of two engines, the first with a peak power of 1MWe and a second of 716kWe, which run on biogas. The plant on average generated 2,73GWh electricity and 2,52GWh of heat and was in use until end of 2013, with a reduction in CO_2 emissions of 10.000 ton/year[154]. At the ECOHIVE complex Maghtab landfill there is a CHP system which was licensed in October 2012 and consists of a reciprocating engine of 190kWe. In 2020, this CHP generated 1,104.5 MWh of electricity. Another CHP system was licensed in February 2017 and it is operating at the ECOHIVE complex in the Mechanical and Biological Treatment Plant (MBT). The system consists of a reciprocating engine for a total of 1.523MWe and in 2020, it generated 264.94 MWh of heat and 1,423.09 MWh of electricity.

Rules and guidelines for connection and feed-in mechanisms of electrical energy generated by CHPs came into force in 2011 through the "Electricity Market Regulations", with subsequent changes through the years (Government of Malta, 2011)[155]. The Table below summarizes the current available mechanisms for the feed-in of electrical energy generated by CHPs.

TABLE 6-4: CHP ELECTRICAL ENERGY FEED-IN MECHANISMS

System sizes	Application Mechanism	Electrical Energy Mechanism
CHP with a rating <=16	Notification in writing to REWS	Two options available:

[153] Ministry for Energy, Enterprise and Sustainable Development (2020): Comprehensive Assessment of the potential for efficient heating and cooling, including the overall final and useful energy used for heating and cooling purposes, in the Maltese Islands
[154] Federazione delle associazioni scientifiche e tecniche. (2014) Final Cogeneration Roadmap non pilot Member State: Malta
[155] Government of Malta. (2011) ELECTRICITY MARKET REGULATIONS S.L.545.13

Amps/phase 230/400V		1. Generate electricity primarily for own consumption and be paid the proxy of the market price for any electricity exported to the grid; or 2. Sell the electricity generated according to a power purchase agreement with the distribution system operator (DSO)
CHP with a rating >400kW	Bidding process mechanism followed by an application with REWS for an Authorization and License	Two options available: 1. Generate electricity primarily for own consumption and be paid the proxy of the market price for any electricity exported to the grid; or 2. Sell the electricity generated according to a power purchase agreement based on a bidding process

SOURCE: REGULATOR FOR ENERGY AND WATER SERVICES, 2020

In addition to the set-up of feed-in tariff structures, in 2016 Malta Enterprise and the then Sustainable Energy and Water Conservation Unit (today Energy and Water Agency) launched a scheme to support investment in high efficiency cogeneration in the business sector, with a tax credit equivalent to a percentage of the capital investment based on the undertaking size. The incentives were 65%, 55%, and 45% for Small, Medium and Large companies respectively[156]. It is to be noted that CHP systems may also require planning permission and gas storage licenses, with larger system requiring broader studies including environmental impact assessments (EIA).

6.2 *Smart technologies*

Article 2a, section 1, letter f) of the EPBD requires that long-term renovation strategies encompass 'an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors'.

The promotion of smart technologies and well-connected buildings and communities will play a very important role to achieve and maintain energy efficiency targets in the longer term. Smart systems can communicate and exchange information in a digital environment to optimise building performance and energy use. The implementation of smart systems in both individual buildings and the interconnection between different buildings in energy communities is very important also to provide the necessary flexibility. Modern technologies, digitisation of the construction process and building management are key measures to be considered when addressing the renovation of the building stock. New technologies and smart systems to help improve energy efficiency should be recognised and promoted in Malta.

6.2.1 Existing measures and initiatives promoting smart technologies

There are a few initiatives in Malta which encourage the use of smart technologies. These have been presented in previous sections and are briefly summarised here:

- **Smart metering** of electricity to empower consumers to manage their energy consumption intelligently as one of the NEEAP 2017 actions. Similarly, smart meter installations and energy management systems for central Government buildings to comply with Article 5 of the EED.
- The **Building Industry Consultative Council**[157] (BICC), which continuously monitors the building industry and advises policy makers on ways to enhance it as a strong social and economic

[156] Malta Enterprise. (2016) Investment Aid for High-Efficiency Cogeneration.
[157] Website https://bicc.gov.mt/

contributor to improve sustainable development. It has 5 dedicated working groups, including one on research & innovation, and another one on education & training. BICC also maintain an information website,[158] that provides a information regarding eco-friendly products, including for home renovations

- The **Construction Industry Skill Card (CISC)** is intended to improve and maintain the highest standards in the construction industry. This is provided by BICC since 2017.[159]
- **Ecobuild project[160]**, an initiative from the BICC using ERDF funding, aiming to provide information about different types of building interventions, increasing product visibility and therefore competition, and providing building industry professionals with a wider range of information and tools to implement better performing buildings.
- **SMART-UP project**, which focused on increasing the awareness of vulnerable households to their energy consumption and help increase their energy efficiency by providing educational and practical means.
- **SmartCity Malta** is an example of a highly energy and resource efficient construction area in Malta, which combines a range of innovative and smart technologies. This can be used as a benchmark for new developments.[161]

6.2.2 EPC recommendations

The database on non-residential EPCs provides an overview of the recommendations made to improve the energy performance of the buildings (for details see Figure 19 to Figure 21 above). The analysis of recommendations shows that there are several smart technologies which are recommended regularly, as they offer short payback periods:

- Add (local) time control to heating/cooling system.
- Add local temperature control to the heating/cooling system.
- Add optimum start/stop to the heating/cooling system.
- Add weather compensation controls to heating system.
- Add time control to HWS secondary circulation.

6.3 Staged versus one-step renovations

According to our definitions (see section 3.3.1), deep renovations consist of a package of measures which, working simultaneously, aim at 60%-90% of primary energy savings compared to pre-renovation levels.

Staged deep renovations consist of several renovation steps spread over several years. In **one-step renovations,** on the other hand, all energy saving measures are taken at the same time. So far, in the EU, the renovation market mostly consists of staged renovation, as one-step renovation costs are often prohibitive (Saheb, 2018).

When comparing the two, one-step renovations benefit from integral planning while staged renovations may have issues regarding component connections during construction work and lock-in dilemmas. However, staged renovations mostly "*allow for less disruptive and more cost-efficient renovation measures*

[158] ecobuild.gov.mt. The site also allows to compare similar products and companies which the additional benefit of increasing competitivity within this sector.
[159] BICC General Information
[160] Ecobuild (2013) An informative online tool & helpline for green building technology
[161] LinkedIn (2016) SmartCity Malta: Commitment to Sustainability and Society

by aligning them with given trigger points (see next section)."[162] There is no consensus on this, as others expect staged renovations to increase the overall cost of the renovation (Saheb, 2018).

According to Fritz et al (2019), both approaches are suitable solutions, and the approach should be defined based on the specific situation. However, it is important that the renovation strategies ensure that staged renovations are deep. Others[163] are less optimistic regarding the success of staged deep renovation, as the disruptions that these renovations entail discourage consumers from implementing the additional measures needed to reach nZEB status.

6.4 *Trigger points*

Trigger points are favourable moments during the lifetime of a building when the implementation of energy renovation measures would be less disruptive and more financially advantageous[164]. For example, rental decision, change of use, maintenance work. Those "windows of opportunities" can significantly affect the decision-making process of building owners.

Case studies in several Member States show that significant maintenance and major improvement works (such as work on external facades and roofs), but also the building of extensions and conversion of use (for instance from a residence to a commercial building), offer a clear opportunity to simultaneously implement energy improvement measures. This is because the building owner or occupant is already engaged in many of the step necessary to plan energy efficiency measures, and they are already in the mindset of carrying out work. Also, disruption for the occupants is minimized compared to a case where the works are done in two separate moments. Doing two interventions at the same time also provides opportunities to minimise the overall costs[165]. Even the improvement of one energy efficiency aspect could trigger the application of other energy retrofit activities, if the right motives are provided. For example, the change of a heating boiler could be accompanied with heating insulation to improve the overall thermal comfort of the building. However, the main barrier is often financial, especially when dealing with households, where often one intervention on the house requires a substantial disbursement. For this reason, encouraging combined interventions required either legislative provisions (e.g. extensions are allowed only if combined with energy efficiency measures) or financial support which would make the implementation of the additional measures more attractive[166].

A trigger point could even be the introduction of renovation obligations or the introduction of minimum energy performance criteria for the buildings, in order to be rented or sold. In this case building owners may be interested in going beyond the minimum required by law and implementing more extensive renovations. This has happened in France, which has obliged residential building owners to renovate before a specific year, depending on the energy class that the building is subject to[167]. Flanders region of Belgium has set minimum requirements for roof insulation for residential buildings since 2015, while from 2020, minimum requirements would be applied for floor insulation as well[168].
On a wider sense, trigger point is also a decision to purchase a certain energy using equipment, for example installing a new air conditioning unit. In this respect, price signals are an important tool to steer consumers towards energy efficiency appliances.

In Malta, a few trends could help identify useful trigger points trigger points:

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[162] Fritz, et al (2019) Planned staged deep renovations as the main driver for a decarbonised European building stock
[163] E.g. Saheb, Y. (2018) Energy-efficient buildings: Why MEPs should ban the staged renovation approach
[164] BPIE (2015) Trigger points as a "must" in national renovation strategies- Policy factsheet
[165] Ibid.
[166] Ibid.
[167] Ibid.
[168] Ibid.

- High rate of redevelopments and new build offers the opportunity to act on the energy efficiency of the new stock;
- The growing demand for air conditioning units and water heater offers the opportunity to steer the purchase towards more efficient appliances;
- Higher share of rented accommodations compared to historical trends suggest introducing obligations associated with rental agreements could capture a substantial number of buildings, often worst performing;
- Seasonal variation in utilisations of holiday apartments and some businesses provides windows of several months to carry out extensive work with minimal disruptions for occupants.

7 POLICIES AND ACTIONS TO DRIVE THE COST-EFFECTIVE TRANSFORMATION OF THE MALTESE BUILDING STOCK

Malta's long term strategy is made of a policy mix that uses different levers to ensure public spending and regulation incentivise private investment in energy efficiency. While each lever has its own specific objectives, these are complementary and work together to ensure building owners' decisions are shifted towards improving the energy efficiency of their buildings (Table).

TABLE 7-1 – SPECIFIC OBJECTIVES OF THE DIFFERENT ELEMENTS OF THE STRATEGY

Lever	New building	Existing building (retrofit)
Stakeholders	Help developers, owners and prospective owners to overcome financial and technical barriers. For example, financial institutions supporting with long-term finance at convenient terms.	
Information	Shift design, build and purchasing choices towards more efficient buildings	Stimulate the demand for retrofit and the frequency of replacement of fixtures and appliances, shifting purchasing choices towards more efficient products
Regulation	Increase the energy efficiency of new buildings towards the cost-optimal level. This is achieved when the additional requirements set by the regulation may increase the investment cost but will decrease running costs or increase comfort during use (measures with low payback period)	• Increase the energy efficiency of existing buildings through minimum requirements for retrofit products when the owner decides to invest on them (cost-optimal level). • Address split incentives in the rental market, ensuring landlords invest in energy efficiency and protect vulnerable households from living in poor conditions
Enforcement	Ensure standards are applied consistently	
Incentives	• Increase the energy efficiency of new buildings closer to near zero net energy (beyond minimum standards). This includes supporting the installation of measures with longer payback periods that owners may not be able to finance themselves. • Leverage the maximum amount of private investment	• Increase the energy efficiency of existing buildings (including worst performing buildings) towards near zero net energy. This includes supporting the installation of measures or replacement of fixtures with longer payback periods that owners may not be able to finance themselves. • Leverage the maximum amount of private investment

It is important to clarify that these levers are not presented in a hierarchical order: they are expected to work together and to contribute jointly to achieve the objectives of the strategy. Each lever is made up of a number of parallel initiatives, which are described in the following section.

7.1 *Implementation pathway*

An indicative pathway of how the different levers are put into practices is presented in the following sections, by distinguishing short- and long-term actions.

7.1.1 Short and medium-term actions

Cross cutting initiatives

This review identified two actions that will support the implementation of various informational, regulatory and financial support measures:

- **Addressing actions that trigger renovation:** Between 2021 and 2025 the government will target buildings that are most likely to undergo refurbishment by making use of 'natural' times when renovation or improvements are already planned, such as transferring to a new owner, carrying out structural upgrades and applications for a change of use or extensions. This includes specific incentives to provide assistance, including financial incentives, for the engagement of energy experts to prepare an energy renovation plan which includes estimated cost savings and grants available for upgrades to the building envelope and technical systems. Incentives shall be accompanied with a minimum energy performance requirement to be achieved by the buildings undergoing renovation. In the case of scheduled buildings, the energy upgrading to that minimum level might not be technically feasible and therefore different energy performance criteria need to be defined.
- **Revision of the methodology for calculating the energy performance of a building:** The software and tools used to issue Energy Performance Certificates will be revised by 2022 to address problems and gaps observed in the existing methodology, as well as strengthen the value of recommendations. The current software was adapted over a decade ago from a methodology developed for a different country, which means it carries assumptions on climate, energy use habits and technologies. Discrepancies between energy use predicted by the software and observed via other sources confirmed the need for such a review. As part of this review, other changes to the application rules would be considered, such as the frequency or triggering point for assessments. The revision of the software will be accompanied by training sessions for energy performance assessors for both dwellings and non-dwellings as well as a campaign and information sessions to explain the information provided via the energy performance certificate to potential buyers or tenants of buildings. The aim of the information sessions will be to translate the data shown on the energy performance certificate into building operating costs for the owner/user.
- **Overview of the building stock owned by the public sector:** it is estimated that the government of Malta owns over 3,500 buildings, of which 84 are directly used by the central government and fall under article 5 of the EED (see section 3.2.4). There is currently substantial uncertainty concerning the state and use of the remaining buildings, but they should also be considered for renovation. For this reason, the BCA will launch a review of the public building stock, aimed at evaluating its energy saving potential and a list of priority actions, including whether projects could be grouped, staged or outsourced (via energy performance contracting) to save on the cost of renovation.

Information and voluntary schemes.

Continuing and extending past initiatives, the Maltese government will launch a number of campaigns to increase awareness of the benefit of more energy efficient buildings, and the requirements of updated regulations. These campaigns will be aimed at the general public, but some initiatives will target specifically building owners, trade associations and the workforce employed in the sector. Actions promoting nZEBs in public buildings, including social housing, and increased public awareness on the benefits and impacts of deep renovation as well as cost effective approaches towards deep renovation are included under this heading. These measures are key in the short term. The following actions are planned:

- **Information campaigns.** Between 2021 and 2030 the government will have set up a number of initiatives aimed at supporting developers and building owners with their choices for energy improvements. These initiatives will include support for accessing incentives, understanding regulation and disseminate the outcome of pilot schemes and innovative buildings (for example, evaluate the implementation of deep renovation in public buildings).
- **Schemes for domestic energy advisory services.** Energy advisory service schemes will be extended to the residential sector by 2023, aiming to reinforce energy consumers' own ability to make decisions and help to choose the most effective investments. Such a scheme will aim to increase the number of studies available for different building typologies (to complement data obtained through energy performance certification), use cases and enable the design of future incentives to address identified barriers and promote the most effective energy efficient solutions.
- **Schemes for energy consultancy services for NGOs and voluntary organisations.** While non-SMEs are required to carry out energy audits according to LN196/2014 and schemes for the financing of energy audits in SMEs have been launched, there are presently no support measures to assist other organisations such as NGOs to engage energy consultants. Carrying out an energy assessment often triggers more ambitious efficiency measures, thus contributing significantly to achieving energy savings. The government will therefore address other organisations by 2022 through the introduction of financing schemes or grants to carry out energy auditing.
- **Appointment of energy officers for public buildings.** Officers responsible for energy management shall be appointed in each public building by 2023. Adequate training will be provided, and the officers will be responsible for monitoring energy consumption and promoting energy efficiency among their colleagues through information measures.
- **Implementation of energy management systems in public buildings.** By 2025, the government will introduce the use of an energy management methodology in public buildings, following the models adopted in approved standards. The energy officers (assisted by an "energy team" in larger buildings) will be responsible for the implementation of the system in the respective buildings, including energy planning, performance indicators, energy monitoring and reporting to MESD.
- **Building institutional capability.** Managing complex multi-department programmes (energy, environment, climate, finance) will pose a challenge for the Maltese government, its key arm-length bodies and key institutional stakeholders. Actions will be put in place to increase coordination and responsiveness to transversal targets and long-term programmes.
- **Skills building.** By 2025, the government will develop a scheme to train and certify professionals and tradesmen of various levels in order to obtain a mandatory skill card which would need to be presented to work in the respective sectors. Certification will be extended to installers of several technologies and a life-long-learning approach will be adopted through regular training sessions addressed to skill card holders. Finally, in order to ensure adequate implementation of the regulation (see section below), it is important to support the skilling of architects, engineers and contractors, particularly in the short term.
- **Research into smart building design in Malta, including smart technologies.** Further studies and research will investigate the best options for future-proofing the design of physical infrastructure, including focus on innovative and smart measures and system integration. This includes research to explore the applicability of traditional construction and design techniques and how these can be exploited to promote energy efficiency in modern buildings.

Working with stakeholders

The government will work with a range of stakeholders to identify ways to support households and business in improving the energy efficiency of buildings. A key element of this will be a programme of work with banks and financial institutions, with the aim of developing financial instruments to stimulate investment in the renovation of buildings.

- **Voluntary schemes:** Between 2021 and 2030, on the model of the BEST scheme, the government will work with trade associations to develop schemes aimed at rewarding those establishments that showcase best practices in terms of energy management. These schemes may be complemented by associated incentives schemes
- The government will setup a platform to engage with academia and industry to ensure the skills and professional accreditations required to deliver the LTRS are available. This may include initiative such as the development of a training framework for professionals.

Regulation and enforcement

The approach to regulation includes a number of principles and measures:

- Maltese technical regulations , including the nZEB Plan, will continue providing the benchmarks for new and converted buildings. These regulations will be reviewed at regular intervals and should become more stringent over time. Regulations will keep the current distinction as minimum standards (currently Document F) and more ambitious regulations for nZEBs and take into account the new cost-optimality studies. Over time, minimum standards will "catch up" with the limits set in the nZEBs, while nZEBs will become more and more ambitious.
- Minimum standards and guidelines will focus on measures that offer a good return (short payback period) to building owners, such as:
    - **Non-residential**: LEDs and light sensors; roof insulation, double glazing, shading elements, grey/rain water storage, air source heat pumps (ASHP), solar water heating.
    - **Residential**: LEDs, roof insulation, ASHP, double glazing.

While minimum standards apply to all new buildings, a parallel minimum standards concerning overall energy use will also apply to existing buildings that are rented (landlords will have to reach a minimum efficiency level before being allowed to rent out the building). Other minimum standards will also apply to existing buildings, at such time when owner decides to replace appliances or elements of the building fabric. For example, minimum standards concerning thermal rating of windows, HVAC systems or water heater will be progressively introduced. The aim is to avoid the installation of the most inefficient fixtures and equipment available on the market.

The focus on regulation will be accompanied by a renewed focus on enforcement, through more frequent inspections and checks, an update of the software tools and focus on skills certification and training. Together, the regulation and enforcement aspects aim to achieve a more energy efficient design of buildings becoming an inherent process in planning.

The following actions are envisaged:

- **Regulation**: the review and update of minimum standards will happen at regular 5-year intervals. This is to ensure these reflect the newest available technologies, and that they become more ambitious as the market evolves. The programme has the following milestones:
    - 2015 nZEB Plan;
    - 2016 Maltese Technical Regulation Document F;
    - 2022 updated Document F;

    - 2023 updated nZEB Plan.
- **Guidelines.** Guidance for practitioners will be released together with the regular reviews and updates of minimum standards and include an update/review of the supporting tools EPRDM and iSBEM. It is important that these tools reflect reality and the most recent technical guidelines and minimum standards. Benchmarks for different types of buildings (for both new and rentals) can be incorporated in these updates and communicated via the EPCs.
- **Benchmarking** indicators will be established for both dwellings and non-dwellings, with specific milestones for implementation in the different building sectors to be in place by 2030. Rating with benchmarking for rental purposes shall also be included after the revision of the certification tools used to issue energy performance certificates. Due consideration will be given to efficiency levels realistically reachable by different building types (such as listed buildings).
- **Certification and enforcement**: measures to increase the number of inspections and their nature (focus on energy efficiency) will be in place by 2025. Compliance certificates which presently only include planning considerations shall include building energy performance compliance which shall be under the remit of the BCA. Energy performance compliance for new built shall be implemented by 2034 and for refurbishment or extensions to existing buildings shall be in place by 2040. To ensure regulations are applied, an additional step will be introduced in the approval process: currently, new buildings undergo an inspection once built to ensure they comply with the planning regulation (planning inspection). A new step in the process and compliance certificate will introduce a building inspection to ensure they comply with approved building design submitted and that fixtures meet minimum standards as stated in document F both for new buildings, and refurbishments/extensions which require a building permit. Additional resources and capacity in this regard will be crucial.

Financial incentives

Financial incentives are expected to continue playing a significant role in supporting efforts towards better energy efficiency for households and businesses. The aim of incentives is to reach energy efficiency standards which are significantly more ambitious than the minimum set by regulation. Incentives will support a broad range of measures so to allow energy efficiency improvements in a range of building types, and new schemes will be introduced to support new measures, such as green rooftops. However, while in the past incentives supported mostly on-site generation (rooftop PV installations), the new schemes will support an increasing amount of efficiency measures, such as improved insulation (roof, windows, walls), more efficient appliances (space heating and cooling, water heating), and innovative solutions (shading elements, natural ventilation, green roofs and walls, energy recovery, and other elements of building design). Incentives will be targeted primarily at existing buildings (retrofit) but will also support new buildings that aim to go beyond minimum requirements.
Financial incentives may include:

- Fiscal incentives for developers
- Preferential bank rates and financial instruments through national banks to leverage investment in the renovation of buildings;
- Grants for domestic sector;
- Incentives for commercial sector;
- Funding grants for public buildings (including EU funding).

The following schemes are envisaged:

- **Energy efficiency package for dwellings**. Incentives will continue to be deployed according to funds availability, but their individual amount (the share of the cost of the measure supported by public funds) will progressively decrease as technology costs come down and the technology becomes more established. It is possible to envisage that this scheme will have facilities dedicated to specific instruments, for example targeting water heating (Solar Water Heaters and Heat Pumps). Measures supported will include those measures which, while cost effective, have long payback period: roof insulation in single-family dwellings, ASHPs and AWHPs, solar water heaters; higher-efficiency glazing, walls (including pre-insulated blocks), sustainable materials. While the details of the scheme are not yet defined (for example, to what extent each technology will be supported), the aim is to support the most effective solution according to the characteristics of the dwelling, exploit natural trigger points, and incentivise the installation of multiple measures at the same time, to reduce inconvenience for households and take advantage of possible cost reductions.
- **Energy efficiency package for industry**. The scheme targets industrial and commercial spaces, providing support for various actions aimed at improving the efficiency of non-residential dwellings owned by the private sector. The scheme is expected to work alongside stricter minimum standards, which will be the real drivers of improvements in the energy efficiency of commercial buildings. Measures supported will include those measures which, while cost effective, have long payback period: ASHP, AWHP, solar water heaters, higher-efficiency glazing, wall insulation (such as pre-insulated blocks), shading elements, green roofs, sustainable materials. Investments in reducing the energy use of industrial and commercial equipment are excluded.
- **Deep renovation scheme**. The scheme will target less efficient buildings with potential for achieving good energy efficiency rating and historic buildings that require extensive interventions to achieve substantial energy performance improvements. The scheme may sit alongside Irrestawra Darek, to identify and deliver savings opportunities and reduce overall cost of maintaining Malta's historical heritage. For example, where Irrestawra Darek provides support for maintaining façades in historical areas, the deep renovation scheme may provide additional funding to ensure that the renovation of the façade considers measures such as wall insulation and energy efficient glazing. However, differently from Irrestawra Darek, the scheme will also support measures such as space heating and cooling, water heating and lighting. One of the key benefits of such approach is the fact that it will enhance the positive energy characteristics of older buildings (designed to favour temperature stability) with the addition of modern technologies, and as a consequence make older dwellings more attractive.
- **Incentives to promote energy generation in buildings.** Existing schemes supporting the installation of PV systems cater for the option of self-consumption of renewable electricity in both the residential and non-residential sector. Under existing legislation, the applicant may opt to sell all electricity generated to the DSO (full export) or export only the surplus electricity (partial export). As the support period for several PV systems come to an end, it is expected that most of these will switch to a "self-consumption" billing option. In such cases, schemes to maximise the use of energy self-consumption through the use of energy storage systems become very important. In 2021 the Ministry for Energy, in collaboration with the Energy and Water Agency (EWA) has launched a flexible PV support scheme for households and small-scale PV installations. The scheme is aimed at increasing the number of standard PV installations and encouraging the use of battery storage systems (the scheme supports integrated battery storage systems and upgrading existent PV installation with the addition of hybrid inverters and storage batteries. The support consists of grants covering the investments costs as well as a FiT for the next 20 years. Installations

which are not benefiting from a grant are allocated a higher level of FiT per kWh for the next 20 years. The main aim of this scheme is to enable households to self-consume more solar-generated electricity.

- **Renovation of public buildings:** the government of Malta will continue to invest on its building stock, with the aim to go beyond the requirement of the energy Efficiency Directive (which requires the renovation of 3% of central government buildings). As a large share of public buildings and listed or historical, the cost of these interventions will be substantial and will continue for a number of years. The cost estimates presented in paragraph 7.1.3 provide a rough estimate of the scale of the challenge, but the government aims to lay down a more detailed plan of this measure, which includes the identification of EU funds. As part of the work to renovate the public building stock, due attention will be given to the Green Public Procurement processes and criteria,[169] to ensure that the renovation programme in public buildings promotes sustainable use of resources and improve government's sustainable consumption.

7.1.2 Long-term actions

- **Energy communities**. Article 2a, section 1, letter (f) of the EPBD specific that long-term renovation strategies must encompass 'an overview of national initiatives to promote smart technologies and well-connected buildings and communities". In view of the structure of Malta's electricity system, the NECP does not foresee that renewable energy communities will develop by 2030. Malta obtained a derogation from the European Commission from the obligation to permit electricity consumers to choose their electricity supplier or for third party operators to access the electricity grid, as is the practice in all EU countries (Directive (EU) 2019/944 due to the small size of the country countries (Directive (EU) 2019/944). Malta is obliged to monitor the evolution of the energy sector and report to the Commission accordingly. The derogation presently does not allow the establishment of energy communities. However, given the present scenario in term of de-centralized renewable energy generation through PV systems and expiring feed-in tariffs contracts, an enabling framework for renewable energy communities in line with Article 22 of Directive (EU) 2018/2001 shall be defined.
- **Promotion of smart technologies**: The promotion of smart technologies and well-connected buildings and communities will play a very important role to achieve and maintain energy efficiency targets in the longer term. Smart systems can communicate and exchange information in a digital environment to optimise building performance and energy use. The implementation of smart systems in both individual buildings and the interconnection between different buildings in energy communities is very important also to provide the necessary flexibility. An action plan for the deployment of smart technologies, including possible incentives will be elaborated post-2030. The plan will be based on data collected between 2021 and 2030, in relation to renewable energy production, use of energy storage systems, as well as the increase in electro-mobility which is expected to increase the overall energy demand of buildings. The action plan will aim to capitalise on Malta's National Electromobility Action Plan (MNEAP) which is currently undergoing review and being updated to reflect the National Transport Strategy and National Operational Transport Master Plan, including a new action plan up to 2025 and a strategy leading to 2050.

[169] See page on government website: https://environment.gov.mt/en/decc/Pages/environment/gpp/gpp.aspx

7.1.3 Costs

The policies and actions identified by the long-term strategy are expected to stimulate a substantial amount of investment: €5.1 billion over 30 years (undiscounted). The main costs, over the next 30 years, would be distributed among the key sectors of the economy:

- Households are expected to contribute with €1.3 billion, in part through voluntary initiatives and in part because of regulation;
- Businesses are expected to contribute €2 billion, also in part through voluntary initiatives and in part because of regulation;
- The government is expected to incentivise households and businesses by providing financial support, in various forms, amounting to €1.7 billion million (€748 million to household, €155 million to business). Government is also expected to invest €440 million to renovate its own building stock.

The investment is expected to take place mostly in the next 10-15 years, to support the achievement of the 2030 targets. Further, it is expected that most of the new buildings will be built before 2035, which will affect compliance cost with new energy efficiency standards. The total government cost in the next decade should average €70 million per year, of which an average of €32 million per year will be for its own stock, and the remaining half to support businesses and households.

Financial incentives and other government costs

In the short term, the main financial commitment of the government concerns the following incentives schemes:

TABLE 7-2 BUDGET FORECAST AND EXPECTED NUMBER OF RESIDENTIAL BUILDINGS AFFECTED[170]

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
PV schemes for residential buildings											
Cost (€million)	5	5	5	4	3	2	2	1	1	-	**28**
Buildings affected	2,200	2,200	2,200	1,800	1,300	800	800	400	400		**12,100**
Deep Renovations											
Cost (€million)	7.0	7.9	7.9	7.9	21.1	21.1	21.1	21.1	21.1	21.1	**158**
Buildings affected	400	450	450	450	1,200	1,200	1,200	1,200	1,200	1,200	**8,950**
Energy efficiency package											
Cost (€million)	5.0	5.1	5.1	15.0	15.1	15.2	15.2	15.2	15.3	15.3	**121**
Buildings affected	1,700	1,800	1,800	5,200	5,300	5,300	5,300	5,400	5,400	5,400	42,600
Total (€million)	**17**	**18**	**18**	**27**	**39**	**38**	**38**	**37**	**37**	**37**	**308**

TABLE 7-3 BUDGET FORECAST AND EXPECTED NUMBER OF NON-RESIDENTIAL BUILDINGS AFFECTED

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Energy efficiency package in industry											
Cost (€million)	5	5	5	5	6	5	5	5	5	5	**54**
Buildings affected	238	241	244	246	249	251	253	254	256	258	**2,489**
Area affected (thousand m^2)	134	135	137	139	140	142	143	144	145	146	**1,404**

[170] The number of buildings affected is indicative. In practice, it will depend by the average grant awarded to each applicants, given that the size of individual grants may vary with the characteristics of the supported measure.

Renovations of public buildings										
Cost (€million)	-	14	14	59	59	59	59	59	59	59	**440**
Buildings affected	-	38	39	127	124	130	139	138	139	138	**1,011**
Area affected (thousand m^2)	-	34	34	112	110	115	123	122	123	122	**895**
PV schemes for non residential buildings										
Cost (€million)	2	2	2	2	2	2	2	2	1	1	**18**
PV generation (GWh)	16	15	14	13	12	11	11	10	9	9	**121**

Further cost may be incurred via feed-in tariffs, especially in the commercial/industrial sector, but these costs will be offset by the resale of electricity generated. In fact, a large share of net energy savings in non-residential buildings are expected to come from the installation of PV panels.

7.2 *Monitoring strategy*

Accompanying the implementation of the LTRS, a monitoring strategy will be put in place to ensure that the objectives are met. This includes:

- **measurable progress indicators** to assess progress towards ensuring a highly energy-efficient and decarbonised national building stock.
- **indicative milestones** for 2030, 2040 and 2050.

The following sections introduce our selection of key indicators and milestones to monitor this strategy. Both the indicators and milestones can and should be revised as necessary, especially in the case of an increased climate ambition of the EU.

Progress should be monitored continuously to ensure resources are being utilised effectively. In case the progress is not aligned with the indicative milestones, corrective actions (such as further implementation efforts or more stringent measures) should be taken.

7.2.1 Indicators

The LTRS will be monitored by recalculating, according to established methodologies, a number of indicators at regular intervals. These indicators that aim to capture the key objectives of the strategy:

1. energy use reduction;
2. emissions reductions; and
3. zero energy buildings.

As such, the indicators have been defined, respectively as:

1. **Residential sector: Average delivered energy demand kWh/m^2/year by dwellings**

The indicator uses the standard approach to measure energy efficiency in buildings, by tracking how the consumption per m^2 changes over time. According to EPCs, the average energy use per m^2 is broadly similar for houses and flats, which means that a different split houses/flats in the future (as more flats are built to replace houses) will not affect the overall result. For transparency and better traceability however, the indicator may track the trends in houses, flats and both combined. The methodology used to calculate the average use is based on the EPRDM methodology but adjusted to account for the discrepancy in space heating use according to the methodology and recorded use in Malta. Reviewing the methodology is one of the key actions identified in this strategy, which means that the baseline may have to be recalculated. The indicator is suggested to cover space heating and cooling, hot water and lighting net of on-site renewables, rather than the entire consumption of the residential sector. This allows to focus on the consumption of the dwellings, rather than on energy-using products (covered by product policy).

2. **All sectors: CO_2 emissions from residential and non-residential buildings**

This indicator will reflect the combined progress both in reducing energy use and in decarbonising energy sources used in buildings. As the majority of energy used in buildings is electricity, it will show how the reduced carbon intensity of the electricity grid will reduce emissions associated with every unit of energy used in buildings. However, it will also reflect decarbonisation efforts in other fuels and fuel switch, for example increasing use of biogas, and the increasing amount of self-generation.

3. **NZEB standards**

The aim of this indicator is to evaluate how many buildings achieve the higher standards required to reach nZEB status. According to the strategy, the government will review the nZEB criteria at regular intervals, in order to account for technical progress and updated costs: as technologies become more established, their prices tend to drop, which means some technologies would become a technically and financially viable solution in more cases than in the past. For example, the price of rooftop photovoltaic has more than halved since they were first installed, while their yield has increased. Therefore, this indicator will track both previous and most up-to-date nZEB standards. There are a number of options considered for the setup of this indicator:

- % of new built and redevelopments that meet nZEB standards each year. It will be measured for dwellings and for non-dwellings;
- Share of the building stock built or refurbished after 2020 that meet nZEB standard.

This indicator will be fully defined in the next nZEB strategy.

7.2.2 Indicative milestones

For each target, an indicative evolution trajectory, showing changes compared to 2018 and compared to the baseline is presented. The baseline has been estimated based on the EPC data, the NECP baseline trajectory[171] and NSO population trends projection. NECP and NSO series have been extrapolated to 2050 according to the trends estimated for the years 2030 to 2040. Further, the baseline includes a more detailed breakdown that describes how the building stock will evolve in absence of any policy (the business as usual scenario). The key assumptions built into the baseline concerns the growth of the building stock (to accommodate a growing population); the different consumption levels of new stock compared to the existing stock; limited to the residential sector, a certain amount of comfort taking, driven particularly by a growing use of heat pumps for heating and cooling. The combination of these trends, both for residential and non-residential buildings, suggests that average consumption may increase slightly in the absence of any new policy, but the larger stock will determine a higher total energy consumption in both the residential and non-residential sector.

1. **Residential sector: Average delivered energy demand kWh/m^2/year by dwellings (all dwellings).**

[171] The data considered from NECP projections concern only use for lighting, hot water, colling and heating.

The following table presents the expected progression for the dwelling consumption per m^2 over time, split by building type. Progress can be monitored every 2 years using data from the EPCs. This process can be carried out every two years, and the outputs can be used to validate and fine-tune the residential sector's energy consumption as presented in the NECP progress monitoring reports every 2 years.

TABLE 7-4 - AVERAGE NET USE (KWH/M^2/YEAR) – INDICATIVE EXPECTED PROGRESSION[172]

	2018	2030			2040			2050		
	Average use	Average use	Change from baseline	Change from 2018	Average use	Change from baseline	Change from 2018	Average use	Change from baseline	Change from 2018
house	23	17	-34%	-26%	17	-46%	-27%	15	-51%	-34%
flat	29	25	-20%	-13%	25	-29%	-15%	25	-31%	-15%
Total	27	22	-26%	-18%	21	-37%	-20%	20	-42%	-25%

2. All sectors: CO_2 emissions from residential and non-residential buildings

The following table presents the expected progression for the average emissions per year for residential and non-residential buildings. These values could be monitored and presented along with the NECP progress monitoring reports every 2 years.

TABLE 7-5 - TOTAL EMISSIONS PER YEAR (THOUSANDS TONNES CO_2) – INDICATIVE EXPECTED PROGRESSION

	2018	2030			2040			2050		
	Total emissions	Total emissions	Change from baseline	Change from 2018	Total emissions	Change from baseline	Change from 2018	Total emissions	Change from baseline	Change from 2018
Residential buildings	194	118	25%	-39%	78	36%	-60%	50	40%	-74%
Non-residential buildings	513	318	-26%	-38%	196	-40%	-62%	120	-52%	-77%

3. NZEB standards related indicator

The milestones will be developed in line with Malta's nZEB plan.

[172] Space heating and cooling, hot water and lighting, net of on-site renewable generation. The values used to model long-term trends differ from the average reported in chapter 3. This is because expected energy use produced by the EPRDM methodology appears to be overestimated compared to fuel usage statistics.

8 ESTIMATED ENERGY SAVINGS AND WIDER BENEFITS DERIVING FROM THE PROPOSED ACTIONS.

The analysis presented in this section has been carried out as part of the impact assessment, through a combination of modelling and qualitative analysis. For a description of the methodology and the assumptions used to arrive at these figures, please refer to the impact assessment document. Key limitations of the analysis presented are:

- The results are to be considered provisional and subject to uncertainty margins.
- Policy costs and benefits provided are cumulative figures up to 2050 and undiscounted;
- The costs assumptions used to arrive at the combined cost of a policy are based on indicative installation prices of energy efficiency measures and packages as applicable to different building types. The modelling for the residential sector specifies only the number of deep retrofits and PV installations, while other measures are considered in aggregate. The modelling of non-residential buildings instead considers the additional cost of retrofits and build at higher standard per m^2, based on data from the cost-optimal studies and assumptions in terms of further measures included in the packages of measures considered.
- The uptake of different types of measures is based on the number of buildings per category, both residential and non-residential.
- The energy savings provided are indicative and are expressed in delivered energy, rather than primary, for dwellings. This is because the majority of building's energy use is electricity, and the primary factor[173], which is expected to change substantially between 2020 and 2050, is an exogenous element to the LTRS. It was not possible to calculate with precision delivered energy for non-residential buildings. For this reason, aggregate results are provided as primary energy and based on the current standard conversion factor of 3.45.

The policy measures proposed in Chapter 7 would work together to:

- **Increase the renovation rate**: for residential buildings, energy efficiency improvements will affect a total of 5% to 6% of the stock per year, including all types of interventions. Of these, the rate of deep renovation will be 0.6% per year from 2025 onwards. This approach to renovation (focus on more cost effective measures across the entire stock rather than on deep renovation on few buildings) is driven by the fact that energy consumption is rather limited even in the less efficient dwellings, while there are more cost-efficient opportunities to save energy in most existing and new dwellings. For non-residential buildings owned by private, it is expected that the schemes proposed will be able to drive an increase in renovation by 1.1 percentage points above the baseline rate up to 2030. In order to reach the targeted savings, the renovation rate will have to increase by 2.5 percentage points above the baseline up to 2050. For public sector buildings, the indicative amounts indicated in Table 7-3 will boost renovation in public buildings by 5.4 percentage points up to 2030. The renovation rate for non-residential buildings is calculated based on area rather than building numbers.
- **Increase the quality of renovations, improving the energy performance of refurbished building stock.** Renovations would affect building fabric, appliances and energy generation, and allow to achieve around 45% reduction in energy use in non-residential buildings, including on-

site generation. This would be achieved by updated minimum standards for existing buildings (regulation & enforcement) and policies to stimulate the uptake of additional energy efficiency measures in existing buildings (information & incentives).

- **Increase the energy performance of new building stock** by updating minimum standards for new buildings (regulation & enforcement) and by policies to stimulate the uptake of additional energy efficiency measures in new buildings (information & incentives).

Overall, the policies introduced in the previous chapter could lead to savings of over 60,000 GWh of primary energy in buildings by 2050 (25,000 GWh in the residential sector, equivalent to 7,500 GWh of delivered energy, and 36,000 GWh in the services sector), leading to emission reductions of 4.4 million tonnes CO_2 (a reduction of 150,000 tonnes per year in 2030). Overall, the strategy involves a cost of €5.1 billion over 30 years (undiscounted). Based on current assumption, this could be achieved with the Maltese government stimulating investments by providing around 33% of funds, and the private sector the remaining 66%. Government costs cover both the costs for policy measures to incentivise high quality refurbishments and new built, as well as the cost for renovating and building new publicly owned buildings. We expect this investment to have a strong impact especially on the construction sector and to lead to the generation of between 1,300 and 4,300 jobs per year. Overall, the strategy provides a stimulus to the economy, which is particularly important during the post-COVID 19 economic recovery.

Energy savings for the residential sector

The result of the modelling exercise for the residential sector (Table 8-1) shows that by combining the three levers, it is possible to achieve an average reduction of 40% compared to the baseline. This is achieved by combining mandated interventions and voluntary actions, including those supported by financial incentives.

TABLE 8-1 – RESIDENTIAL SECTOR - CUMULATIVE COST AND ENERGY SAVINGS TO 2050 (UNDISCOUNTED)

	Number of measures stimulated/ dwellings affected[174]	**Government cost (€ million)**	**Private investment stimulated (€ million)**	**Energy saved (GWh delivered)**	**Energy saved (GWh primary)[175]**	**Change in average consumption vs BAU**
Regulation & information	Not available	-	646	2,198	7,585	14%
Energy efficiency package	152,030	427	242	1,333	4,598	9%
PVs	16,100	37	121	2,301	7,937	10%
Deep renovations	16,150	284	284	1,623	5,598	8%
Total	**184,280**	**748**	**1,293**	**7,455**	**25,718**	**40%**

[174] It is not possible to determine reliably how many buildings may be affected by tighter regulation as it depends on several unknown factors. The estimate private investment required an energy saved via regulatory interventions is also highly uncertain. The total includes double counting some buildings – i.e. some buildings will be captured by more than one of the policies presented in Table 8-1. For example, a building may require investment to comply with new minimum standard regulation; the building may then receive measures with the support of the energy efficiency package and finally a PV system.

[175] At current standard conversion factor of 3.45

Energy savings for the non-residential sector

For the non-residential stock, the cumulative costs are based on additional full-building renovations stimulated by the new policies (additional to baseline renovations). It is estimated that these may deliver an average reduction of 45% compared to the baseline in 2050. Government costs cover both the costs for policy measures to incentivise high quality refurbishments and new built for the privately owned buildings, as well as the cost for renovating publicly owned buildings (covering government offices, as well as a share of education and hospital buildings).

TABLE 8-2 – NON-RESIDENTIAL SECTOR - CUMULATIVE COST AND ENERGY SAVINGS TO 2050 (UNDISCOUNTED)

	Additional buildings affected[176] (number)	Government cost (€ million)	Private investment stimulated (€ million)	Energy saved (GWh primary)	Energy savings compared to the baseline in 2050 (GWh)
Shops	2,655	43	240	7,261	-47%
Offices	9,076	284	1,198	10,725	-46%
Governmental Offices	1,308	366	-	3,176	-39%
Restaurants and Cafes	2,709	13	90	3,234	-47%
Education	166	172	47	1,504	-41%
Hotels	110	18	100	2,908	-47%
Other accommodations	2,845	46	324	5,408	-47%
Homes for the elderly	40	13	95	1,073	-46%
Hospitals	15	33	17	904	-37%
Sport facilities	3	6	1	82	-41%
TOTAL	**18,927**	**995**	**2,113**	**36,274**	**-45%**

Wider benefits

The total expected energy savings from dwellings and non-dwellings (cumulatively) is expected to amount to over 60,500 GWh of primary energy up to 2050. These, combined with an increasing share of renewables in the generation mix, are equivalent to a reduction of 4.4 million tonnes in CO_2 by 2050.

Further benefits associated with the savings and with the actions promoted by the strategy are:

- Substantial savings on the energy bill (and positive impact on energy poverty). Household bills will be less burdensome for vulnerable families, and reduce health consequences associated with underheated or undercooled dwellings;
- Substantial savings associated with ETS carbon permits (lower energy demand will reduce fossil fuel generation), which will further lower the energy bill;

[176] This includes renovated buildings for public and private sector as well as high efficiency new build for private buildings.

- Studies show that for each €1 million invested in energy efficiency, 8 to 27 jobs are created per year.[177] Given the estimated costs associated with the strategy, this is equivalent to between 1,200 and 4,300 jobs per year created in the construction and energy services sectors;
- Increase in skills and innovation in the construction and energy services sectors;
- Increased quality and comfort in dwellings and in the working environment which may lead to health and wellbeing impacts such as reduced illness;
- Reduced amount of land and sea space dedicated to renewable generation;
- Reduced harmful emissions from fossil fuel electricity generation and domestic gas-powered appliances leading to environmental benefits and improved air quality (and related health benefits);
- Improved national energy security and reduced operational and capital cost for the electricity grid. Growing shares of renewables pose particular challenges to island nations, as the import/export of electricity with neighbouring countries is limited by interconnectors capacity. A lower overall electricity demand will help manage peak periods more easily and reduce the need for additional backup capacity.

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