

TIPPERARY energy AGENCY

Charting a path to a **Zero Carbon** future

EAR- Templemore College

Energy Audit Report-NR2212-EA01

Client Name:	Templemore College
Date:	20/11/2022
Prepared by:	Aaron Doherty-Building Services Engineer
Reviewed by:	John Hassett- Senior Building Services Engineer

93 Silver Street, Nenagh,
Co. Tipperary, E45 AD65.

Phone: 052 7443090
Email: info@tippenergy.ie
Website: tippenergy.ie

Table of Contents

1 EXECUTIVE SUMMARY 6

1.1 Annual Building Energy Consumption & Spend 2019 11

1.2 Predicted Savings 11

1.3 Savings that will Require Planning and Investment 12

2 GENERAL INFORMATION 17

3 INTRODUCTION 18

3.1 Context 18

3.2 Energy Consumption 18

3.2.1 Energy Cost Breakdown 18

3.3 Building Survey Information 21

3.4 Site Inspection Checklist 23

3.5 Typical Benchmarks 24

4 TECHNICAL REPORT DETAILS 26

4.1 Energy Audit 26

4.1.1 Description of the Site 29

4.1.2 Description, Thoroughness and Methodology 30

4.1.3 Preliminary Work 30

4.1.4 Desk Audit 31

4.1.5 Site Visit 31

4.1.6 Verbal Information Received 31

4.1.7 Analysis 31

4.1.8 Project Close Out 32

4.1.9 Data Collection 32

4.1.10 Utility Data 32

4.1.11 Estimates 33

4.2 Existing Building Services Review 34

4.2.1 Heating System Overview 34

4.2.2 DHW 34

4.2.3 Ventilation System Overview 35

4.2.4 Lighting System Overview 36

5 SUMMARY OF ENERGY CONSUMPTION 37

5.1 Electricity Bill Data Analysis 37

5.2 Electricity Costs & Consumption 37
5.3 Annual Electricity Consumption & Cost Breakdown 38
5.4 Thermal Bill Data Analysis 39
5.5 Thermal Costs & Consumption 39
5.6 Annual kWh Consumption & CO_2 Emissions 40

6 OPPORTUNITIES FOR IMPROVEMENTS IN ENERGY EFFICIENCY 41

6.1 Summary of Opportunities 41
6.2 LED Lighting Upgrade 42
6.2.1 NPV & IRR on LED Lighting Upgrade 43
6.3 Air Source Heat Pump (ASHP) Installation 46
6.3.1 NPV & IRR on ASHP 48
6.4 Heating Distribution Network Upgrade with New BMS 49
6.5 Installation of a 40.5kW$_p$ Solar PV (Photovoltaic) Array 50
6.5.1 NPV & IRR on Solar PV Array 53
6.6 Heat Recovery Ventilation System 55
6.7 Roof Upgrade 57
6.8 Replace the Windows and Doors with current Part-L Compliant Units 58
6.9 External Wall Insulation 59
6.10 Energy Awareness 60

7 ASSUMPTIONS 61

7.1.1 Economic Analysis 61

8 CONCLUSION 62

9 APPENDICES 64

9.1 Solar PV Design Report 64
9.2 Typical Solar Panel Specification 65
9.3 Typical Attic Insulation Specification 66
9.4 Typical External Wall Insulation Specification 67
9.5 Typical HRV Specification 68
9.6 Typical Air Source Heat Pump Specification 69
9.7 LED Lighting NPV & IPP 70
9.8 Solar PV NPV & IRR 71

Table of Figures

FIGURE 1: TEMPLEMORE COLLEGE THERMAL ENERGY CONSUMPTION TREND 2014 - 2021 7
FIGURE 2. PRICE PER KWH TREND 2017 - 2022 7
FIGURE 3. TOTAL THERMAL CARBON EMISSIONS 2014 – 2021, ... 9
FIGURE 4. ELECTRICITY EMISSIONS PER KWH TREND TOWARDS 2050 10
FIGURE 5. ENERGY COST BREAKDOWN 18
FIGURE 6. ELECTRICITY CONSUMPTION BREAKDOWN KWH/YR. 19
FIGURE 7. THERMAL ENERGY USE (KWH) BREAKDOWN 20
FIGURE 8. CIBSE TM46, BENCHMARK CATEGORIES 24
FIGURE 9. ANNUAL ELECTRICITY CONSUMPTION 38
FIGURE 10. ANNUAL ELECTRICITY COST BREAKDOWN. 38
FIGURE 11. ANNUAL ELECTRICITY AND GAS KWH CONSUMPTION BREAKDOWN 40
FIGURE 12. ANNUAL CO_2 EMISSIONS BREAKDOWN. 40
FIGURE 13. LED LIGHTING UPGRADE & EXISTING LIGHTING PERFORMANCE 42
FIGURE 14. LED LIGHTING RETROFIT PROJECT CASHFLOW 45
FIGURE 15. SOLAR PV INSTALLATION PROJECT CASHFLOW 54

Table of Tables

TABLE 1. SUMMARY OF ANNUAL ENERGY CONSUMPTION 2014 – 2021 9
TABLE 2. SUMMARY OF ANNUAL ENERGY CONSUMPTION & SPEND 11
TABLE 3. SUMMARY OF ESTIMATED ANNUAL SAVINGS 11
TABLE 4. REGISTER OF OPPORTUNITIES. 16
TABLE 5. SUMMARY OF DELIVERED ELECTRICAL ENERGY CONSUMPTION 19
TABLE 6. SUMMARY OF DELIVERED THERMAL (OIL) CONSUMPTION 2021 20
TABLE 7. BUILDING SURVEY INFORMATION 22
TABLE 8. SITE INSPECTION CHECKLIST 23
TABLE 9. ENERGY BENCHMARKS VS CISBE TM46 24

TABLE 10. ELECTRICITY SUPPLIER AND MPRN NO. 37

TABLE 11. ANNUAL ELECTRICITY CONSUMPTION & COSTS 37

TABLE 12. OIL SUPPLIER 39

TABLE 13. ANNUAL OIL CONSUMPTION & COSTS 39

TABLE 14. ENERGY CONSUMPTION & CO_2 EMISSIONS, EXISTING AND PROPOSED LIGHTING SYSTEM 43

TABLE 15. LIGHTING INPUT DATA 43

TABLE 16. NPV, IRR & PAYBACK ON THE BASE CASE SCENARIO FOR THE LED LIGHTING UPGRADE 44

TABLE 17. NPV, IRR & PAYBACK ON THE SENSITIVITY ANALYSIS SCENARIO FOR THE LED LIGHTING UPGRADE 44

TABLE 18. ASHP SAVINGS 47

TABLE 19. NPV, IRR & PAYBACK ON THE ASHP UPGRADE SCENARIO 48

TABLE 20. PREDICTED KWH SAVINGS SOLAR PV ARRAY 51

TABLE 21. SOLAR PV INPUT DATA 53

TABLE 22. NPV, IRR & PAYBACK ON THE BASE CASE SCENARIO FOR SOLAR PV INSTALLATION 53

TABLE 23. NPV, IRR & PAYBACK ON THE SENSITIVITY ANALYSIS SCENARIO FOR SOLAR PV INSTALLATION 53

TABLE 24. KWH SAVINGS ASSOCIATED WITH HRV INSTALLATION 56

TABLE 25. ENERGY AWARENESS OPPORTUNITIES 60

1 Executive Summary

Templemore College have requested this energy audit to gain an understanding on how to reduce the environmental impact of the school and to further the environmental education of its pupils. It is the objective of the Tipperary Educational Training Board (TETB) to operate their property portfolio as 'green' and environmentally friendly as possible. The mission of this management team in TETB is for their organisation to become a leading public sector body on building performance and building operation, in relation to both energy usage and carbon emissions. Public sector bodies are encouraged to lead by example for energy efficiency in Ireland. Every public service organisation was required to achieve a 33% energy efficiency improvement by the end of 2020. TETB, and in particular, Templemore College have delivered on this obligation. However, more ambitious, and demanding targets are now set for 2030 under the 2021 Climate Action Plan.

For ease of comparison, we have studied the historical billing data from 2014-2021. This provides us with an accurate overall energy consumption profile for the building. For the purposes of identifying energy savings and carbon emission savings, the 2021-2022 energy consumption data is used. This data gives a clearer use profile for the building when compared with the 2020 & 2021 calendar years due to COVID-19 restrictions. Only thermal bills are provided from the period 2014 -2021. Electricity bills for 2021 are provided. The school's electrical energy consumption is monitored on a 24-hour meter and is billed monthly.

Templemore College have seen thermal usage increase in this period. There has been a 21% increase in oil consumption from 2014 to 2021. It is assumed the 'end of life' boilers are becoming significantly inefficient, resulting in an increase in thermal consumption. Figure 1 illustrates these trends overleaf.

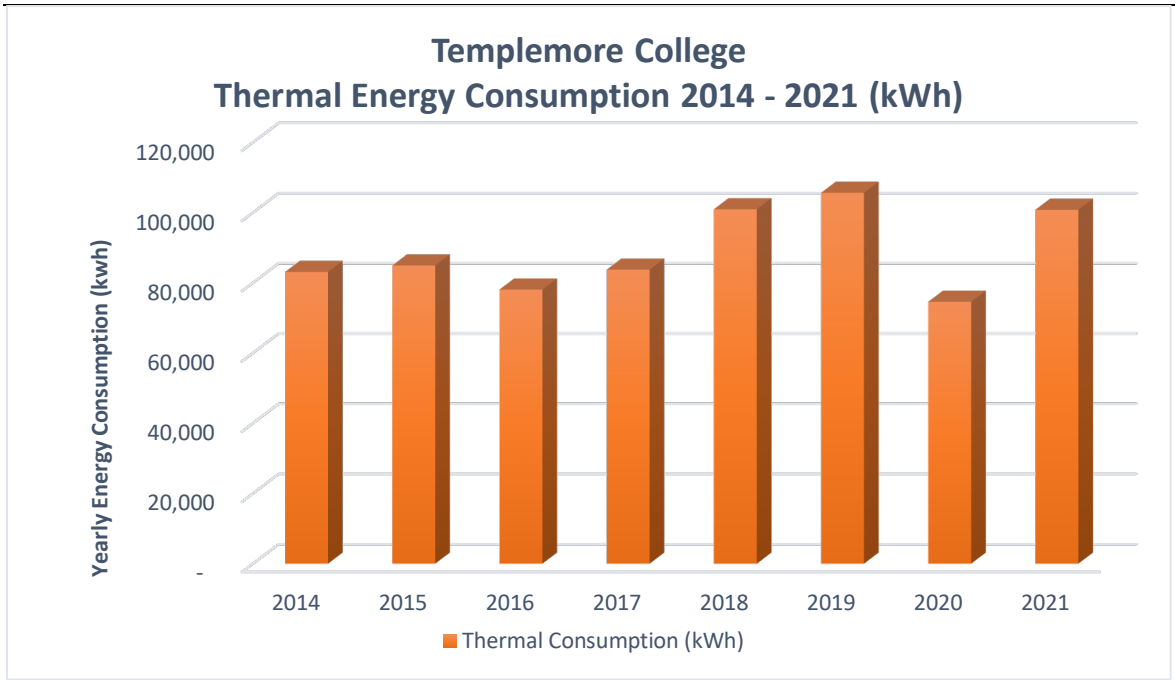


Figure 1: Templemore College Thermal Energy Consumption Trend 2014 - 2021

Throughout this period energy costs have continued to rise, leading to increased school running costs. This also has a knock on effect on carbon emissions, with the continuing rise in emissions from 2014. This cost is expected to continue to rise in the coming months as the energy crisis deepens. Figure 2 illustrates the cost per kWh for oil and electricity from 2017 to 2022. This data is taken from the Sustainable Energy Authority of Ireland (SEAI) website and is the market average price for the defined period. Figure 2 below clearly demonstrates this increase.

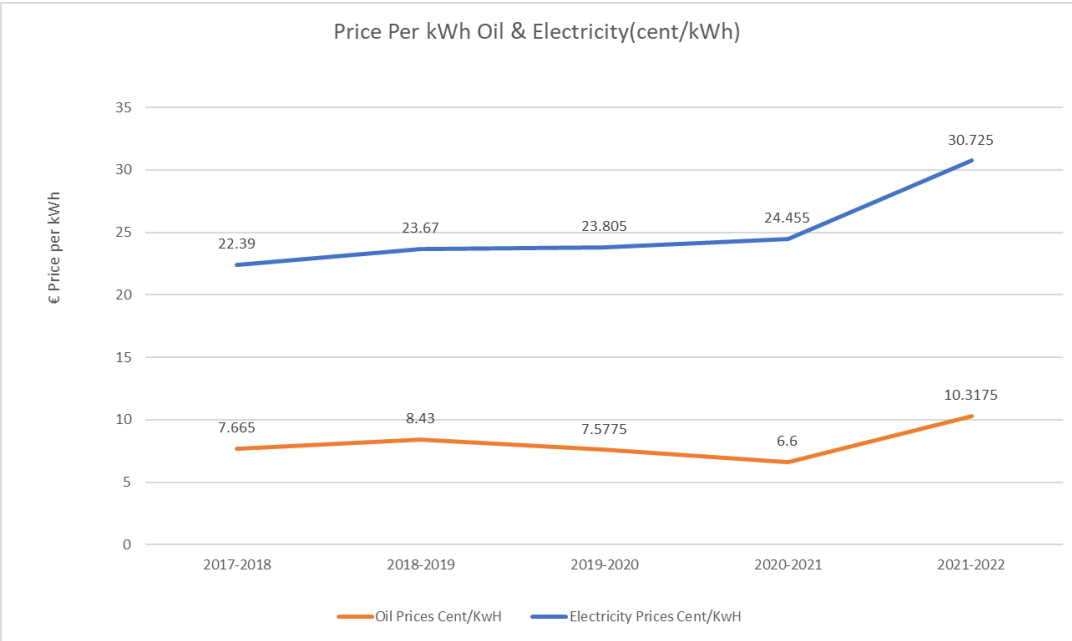


Figure 2. Price Per kWh Trend 2017 - 2022

Whilst energy reduction is the main driver, the school's management team are also very keen to ensure space conditions of the building are not jeopardised, but improved where possible, though remaining compliant with current building regulations for educational type buildings. COVID-19 highlighted the importance of meeting space requirements from a heating and ventilation perspective, but also from an energy consumption viewpoint. It is vital this type of building operates in an energy efficient and thermally effective manner.

With attention now turning to 2030 targets, Tipperary Energy Agency carried out a fully detailed site audit on the energy usage and building services performance of Templemore College on the 3rd of October 2022. The audit was requested on behalf of the management team in Templemore College. This team are eager to undertake ambitious retrofit projects to upgrade their building and go above where practicable to NZEB (Nearly Zero Energy Buildings) best in class energy efficient buildings. The 2021 Climate Action Plan sets out targets for all public buildings to meet the required level of emissions by 2030. The management team in Templemore College will aim to improve the energy efficiency of their building by 50%, and bring the college to a minimum Non-Domestic Building Energy Rating (NDBER) of B. Both measures are listed in the 2021 Climate Action Plan for public sector organisations, and Ireland's Long Term Renovation Strategy 2020. Quality and sustainability are the core drivers of this ambitious retrofit programme. Templemore College in partnership with TETB should be a leading example to other public sector/educational bodies when it comes to their buildings energy performance, operation, energy usage and greenhouse gas emissions, similar to the role they played in reaching their 2020 targets. The management team at Templemore College are keen to ensure that Templemore College of Further Education operates in an energy efficient and cost-effective manner.

This building mostly falls into the educational building category from an operations viewpoint, but the facility also includes a canteen space, plant room, workshop, bathrooms, hair saloon, computer rooms and offices. Whilst energy reduction is the main driver, the building's management team are also very keen to ensure space conditions of the building are not jeopardised, but improved where possible, though remaining compliant with current building regulations for educational facility type buildings. The current heating system has been highlighted for remedial works. Space conditions in some rooms are often not met, with secondary heating sources noted on the day of the site audit, and the majority of main plant is end of life. Management is keen to rectify these problems and ensure space conditions are compliant with design recommendations, and health and safety standards are adhered to.

Table 1 below and Figure 3 below summarise the current state of play in relation to energy consumption and CO_2 emissions at Templemore College.

Templemore College of Further Education			
Year	**Oil Consumption (kWh)**	**Electrical Consumption (kWh)**	**Carbon Emissions Tonnes CO_2/kWh**
2014	83,084	No Data	21.35
2015	84,926	No Data	21.83
2016	78,059	No Data	20.06
2017	83,726	No Data	21.52
2018	100,940	No Data	25.94
2019	105,616	No Data	27.14
2020	74,582	No Data	19.17
2021	100,794	108,048	57.89
Total	**711,727**	**108,048**	**215**
2021 % Reduction	**-21%**	**N/A**	**-171%**

Table 1. Summary of Annual Energy Consumption 2014 – 2021

It is clear above that energy usage is increasing. There was a 21% increase in carbon emissions for the 2014 baseline year. The high 171% increase is down to the carbon emissions associated with electrical consumption. Previous years billing data was not provided for electricity usage and not included in Figure 3. The 2021 figures are a more appropriate representation of actual building use in relation to carbon footprint and energy consumption.

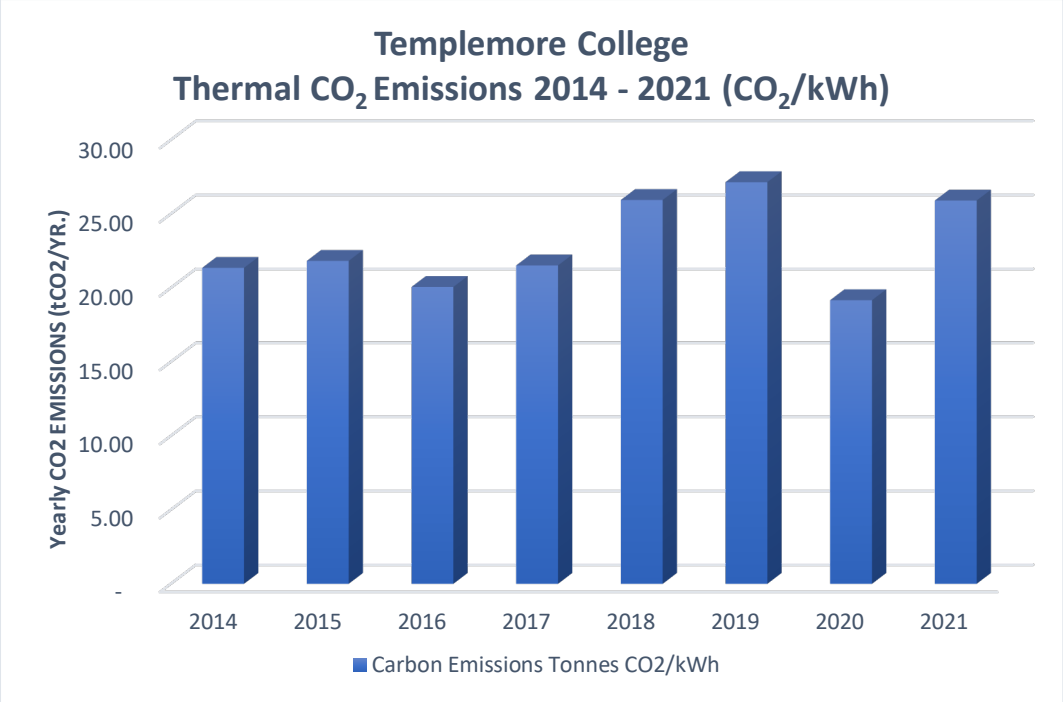


Figure 3. Total Thermal Carbon Emissions 2014 – 2021,

The emission factor associated with converting Kerosene heating oil to CO_2 is currently much lower than the emission factor associated with electricity, 257 gCO_2/kWh for kerosene vs 346 gCO_2/kWh for electricity. This however is predicted to change in the coming years as the grid becomes 'greener' in its production of electricity with more and more renewable energy being produced at source. The graphs in Figure 4 below demonstrate the levelling out of carbon intensity associated with electricity by 2025, with further reductions in intensity predicted as we head towards 2050.

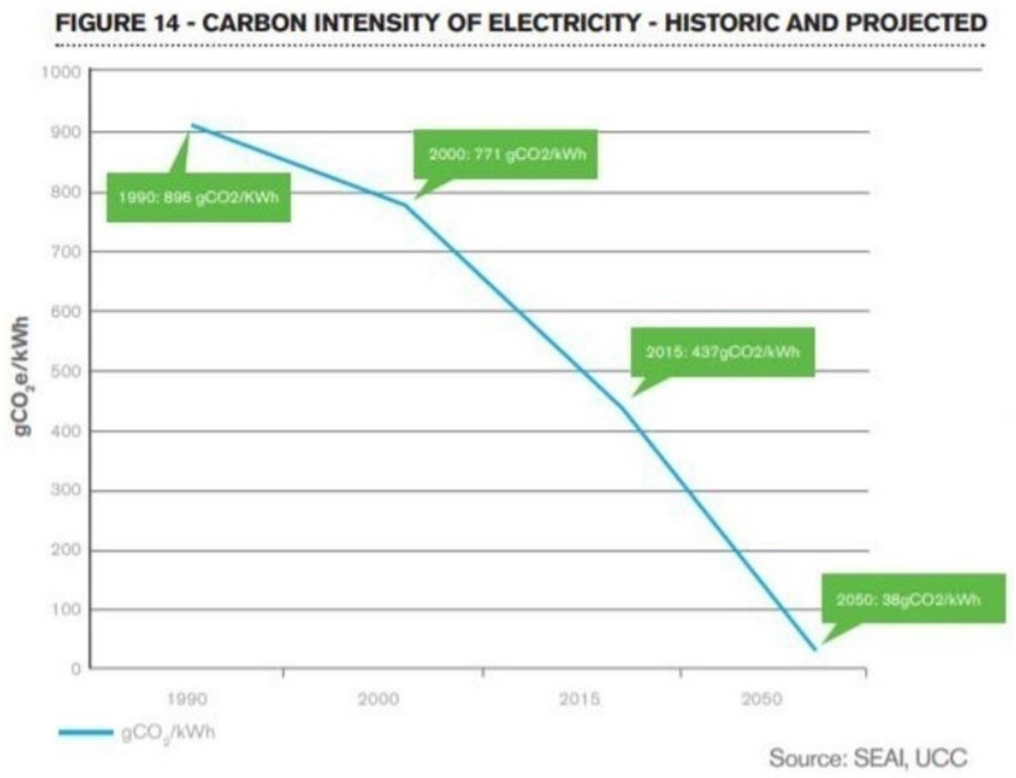


Figure 4. Electricity Emissions Per kWh Trend towards 2050

The ambition of the management team in TETB and Templemore College is to reduce this buildings energy consumption by over 50% and achieve a minimum NDBER Rating 'B' at minimum. This report will outline the steps and measures required to achieve this energy efficiency improvement and Climate Action Plan target

1.1 Annual Building Energy Consumption & Spend 2019

Utility	Energy Consumption		Cost		CO_2 Emissions	
	kWh/year	%	€/year	%	tCO_2	%
Electricity	108,048	52%	€16,907	74%	37	59%
Oil	100,794	48%	€6,067	26%	26	41%
Total	**208,842**		**€22,973**		**63**	

Table 2. Summary of Annual Energy Consumption & Spend

1.2 Predicted Savings

A range of energy saving opportunities were found at the premises, some will require significant investment but there is also a number of quick wins that will be easy to implement. Refer to sections 1.3 and 1.4 overleaf for a breakdown of opportunities.

Estimated Annual Savings		
€	(kWh)	CO_2 (tonnes)
€11,788	133,182	39
This is a cost saving of 51%	This is an energy saving of 64%	This is an emission saving of 62%

Table 3. Summary of Estimated Annual Savings

It should be noted that the above predicted savings assume the complete removal of fossil fuels from the site, all 100,794kWh thermal energy consumption associated with fossil fuels is removed. Depending on which measures are carried out, the sum of the savings can vary as one measure may depend on another or has a knock-on effect in terms of kWh savings and CO_2 emissions. If all measures are implemented, Templemore College will surpass the mandated 50% energy efficiency improvement, 51% absolute emissions reduction target, and a target B rating BER for Templemore College of Further Education, as set out in the Climate Action Plan 2021, 2030 public sector-built environment targets.

1.3 Savings that will Require Planning and Investment

Priority	Recommendations	Estimated annual savings			Estimated cost € (Ex. Vat)	Simple Payback (Years)	Comments
		(€)	(kWh)	CO_2 (tonnes)			
1	Upgrade all glazed elements to triple glazed units meeting NZEB standards and all doors to high thermal performing units. Total glazed area 188m², total door area 32m², total roof light area 3.6m²	€1,111	18,464	5	€143,690.70	<100 years	All windows require upgrading to triple glazed units. This upgrade will improve the overall air tightness of the structure, and reduce outside air infiltration, and lower heat loss through this building element. The windows were replaced in approx. 2011 and have a U-Value of 2.6W/m²K. The proposed replacement windows have a U-value of 0.74 W/m²K. Payback is normally high on building fabric upgrades; however, it is important to lower heat loss, improve indoor environmental conditions, and limit the ingress of outside air. The existing roof windows have a U-value of 2.6W/m²K. The proposed replacement windows have a U-value of 1.3 W/m²K. The existing doors have an assumed U-value of 2.6W/m²K. The proposed replacement doors have a U-value of 0.74 W/m²K. Savings associated with in-filtration through the walls, windows, doors and roof are included in this measure.
2	EWI (External Wall Insulation) to all external wall areas. U-Value 0.18 W/m²K & 0.13 W/m²K compliant with NZEB standards. Total external wall area 771m²	€767	12,741	3.4	€71,229	<75 years	The external wall is poorly insulated with an assumed U-Value of 1.0 W/m²K (pre 1994 build) and 0.27 W/m²K (2008/2015 constructions). It is proposed to externally insulate the building with 100mm Kingspan Kooltherm K5 external wall board to achieve a U-Value of 0.18 W/m²K (pre-1994) and 0.13 W/m²K (pre 2015). Substantial builders works involved with scaffold, access etc. Whilst payback is poor, it is vital heat loss is minimised through the building structure.

Priority	Recommendations	Estimated annual savings			Estimated cost € (Ex. Vat)	Simple Payback (Years)	Comments
		(€)	(kWh)	CO_2 (tonnes)			
3	Upgrade the current roof with new high thermal conductivity mineral wool insulation. Total roof area 1,386m². Roof insulation upgrade works to comply with NZEB standards and SEAI SR54 Code of Practice	€777	12,917	3.4	€19,407	24.9	The roofs of the pre 1994 & 2008-16 sections has an estimated U-Value of 0.61 W/m²K & 0.19 W/m²K respectively. The addition of 200mm insulation in the pre-1994 section and 200mm insulation with a thermal resistance of at 0.035 W/mK will decrease the U-value of the roof to 0.14 W/m²K & 0.12 W/m²K. Payback is normally high on building fabric upgrades; however, it is important to lower heat loss, improve indoor environmental conditions, and limit the ingress of outside air.
4	New Air Source Heat Pump System (ASHP) air to water 70kW capacity heating including new controls and 1 No. new dual coil 1000 litre DHW tank. It is proposed to install 2 No. 35kW air source heat pumps in cascade configuration. The existing oil boilers will be decommissioned and removed from site	€4,207	100,794 (Thermal Saving) 11,882 (Electrical Increase)	22.5	€69,313	16.5	The existing heating system is sized at 150kW. This equates to approximately 110W/m². Approx 5% of the boiler's heating capacity is used for DHW. it is proposed to retrofit with a ASHP that will provide space heating via retrofitted radiators. The system will also provide DHW to the facility, removing the requirement for under sink electric water heaters. Simple Payback is slightly higher than expected and is based on the current high electricity price of €0.21/kWh. ***Note: A detailed heat load analysis must be carried out for accurate system selection and sizing.***

Priority	Recommendations	Estimated annual savings			Estimated cost € (Ex. Vat)	Simple Payback (Years)	Comments
		(€)	(kWh)	CO_2 (tonnes)			
5	Upgrade heating distribution pipework, radiators, heating controls, (2 port valves, BMS), VSD pumps to all spaces on the ASHP system	€1,517	25,199	6.6	€122,000	<75 years	There are roughly 70 No. radiators installed with approximately 90% retrofit of radiators expected. The LPHW system appears to be in working order, but it is end of life and should be replaced. It is a one-pipe distribution network. Some of the existing radiators can be repurposed to smaller spaces, should their kW output at the lower delta t meet the space heat demand. New high output radiators will be required to most spaces, all installed with individual two port valve control (allowing for individual space temperature control). This measures also include a new BMS.
6	Install ventilation heat recovery (MVHR) to all teaching spaces within the building. Offices also should be included where void space is available.	€412	19,547 (Thermal Saving) 4,887 (Electrical Increase)	3.5	€75,000	<100 years	It is proposed to install a heat recovery ventilation system that will ventilate the teaching spaces and offices within the building, while also ensuring that heat losses through ventilation are kept to a minimum. Approximately 10 No. MVHR units to be installed including installation, ductwork, electrical attendances, controls, builders works, and fire alarm interface. Detailed design required prior to upgrade.

Priority	Recommendations	Estimated annual savings			Estimated cost € (Ex. Vat)	Simple Payback (Years)	Comments
		(€)	(kWh)	CO_2 (tonnes)			
7	LED Smart Lighting Upgrade with occupancy detection and daylight sensing, internal & external. Approx 122 No fittings to be upgraded	€1,907	12,190	4.2	€30,500	15.9	It is proposed to install a new LED lighting system throughout the building. A new LED lighting system will reduce energy consumption. The existing lighting system comprising of fluorescent fittings are high energy users and the control strategy is simple on/off switching. There is a total of 122 No. fittings to be retrofitted. Smart scan fittings are daylight sensing and occupancy detection incorporated into each fitting. Built in energy monitoring of each fitting allows measuring and optimisation of the building lighting system. ***Note: payback is normally lower but calculated on the Oct electricity cost at €0.16/kWh***
8	Installation of a 40.5 kWp Solar PV Array system on the building roof top. Proposed arrays are south facing. System can avail of the Clean Export Guarantee (CEG) tariff for any exported electricity. System size selected to incentivise self-consumption with the CEG tariff capped at 80% of generation capacity	€5,673	32,080 4,842 (Grid Feed In)	12.8	€50,625	8.9	System size selected to incentivise self-consumption with the CEG tariff capped at 80% of generation capacity. Total PV array area 196m² approximately 90 No. PV modules/panels. Planning per-mission not required. ***Note: Approx. 4,842kWh exported back to the grid at an estimated price of €0.135 per kWh. This Clean Export Premium is guaranteed for 15 years. Refer to Appendix 9.1 PV Sol Report for further details. *Structural survey of the existing roof will be required to deter-mine if the roof structure can support the addition-al load of the PV array system.***

Priority	Recommendations	Estimated annual savings			Estimated cost € (Ex. Vat)	Simple Payback (Years)	Comments
		(€)	(kWh)	CO_2 (tonnes)			
TOTAL		**€11,788**	**166,763**	**39.5**	**€581,764**	**49.3**	It should be noted that depending on which measures are carried out, the sum of the savings can vary as one measure may depend on another or has a knock-on effect in terms of kWh savings and CO_2 emissions

Table 4. Register of Opportunities.

All proposed upgrade works must be developed and designed to comply with the current Building Regulations Technical Guidance Documents best practice guidance. Table 4 provides a breakdown of the possible energy saving upgrades which could be carried out on the building. Energy savings are estimated based on the analysis of existing annual energy consumption. Costs are estimated for complete upgrades, and a simple payback on investment excluding grant funding is calculated. Evidently, the majority of complete upgrades do not have a sufficient payback on investment, particularly building fabric upgrades, and the switch to electrification of heat. However, a fabric first approach is always the recommended approach when trying to reduce the built environment carbon footprint. Also, carbon emissions and the mandated 2021 climate action plan public sector targets should be considered when targeting the built environment carbon footprint of this building. Estimated costs can be used as a basis for future decisions as to whether to proceed with an upgrade with the aim of improving the space condition of the space and increasing the use of the building in future years

2 General Information

Building Name:	Templemore College
Site Address:	Richmond, Templemore, Co. Tipperary
Site Eircode:	E41 FF98
Client ID:	TEANR-202212
Date(s) of Site Visit:	3rd of October 2022
Duration of Site Visit(s):	3 hours
Energy Auditor:	John Hassett- john@tippenergy.ie Aaron Doherty- aaron@tippenergy.ie Billy Donnellan- billy@tippenergy.ie
Visit Hosted By:	Mr. David Young, Youthreach Coordinator, Templemore College of Further Education

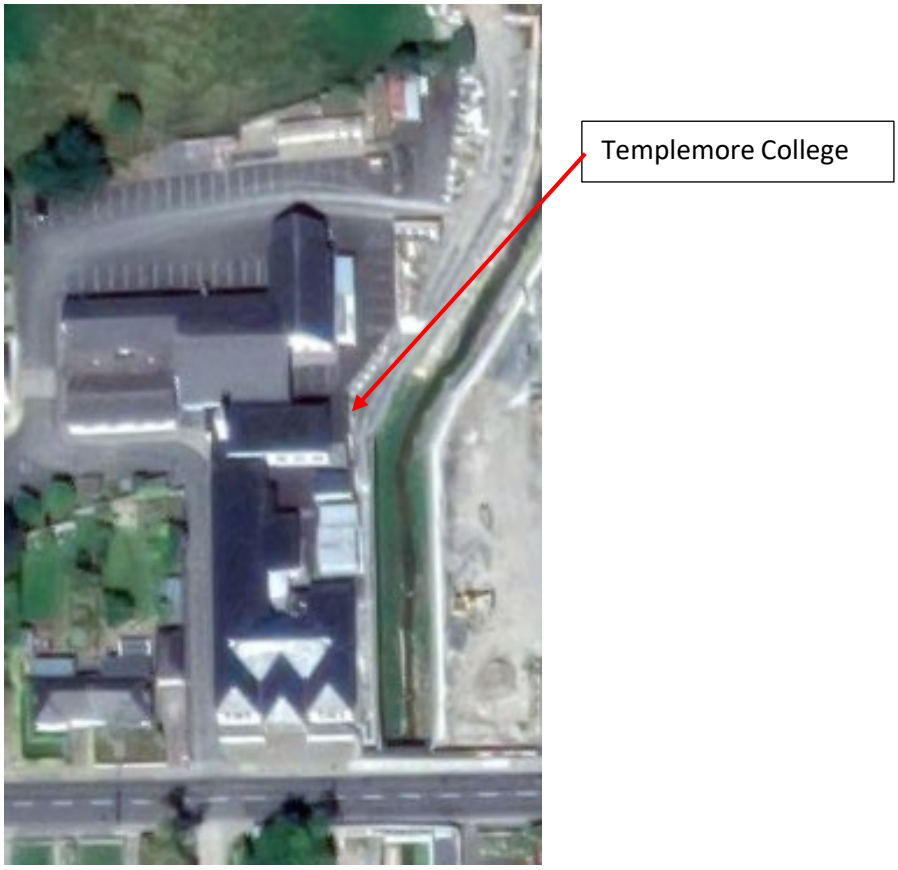


Image 1: Templemore College – Site Image

3 Introduction

This section of the report outlines the site energy costs and consumption breakdown and a high-level survey of the building from a visual inspection only in relation to energy and building performance. It also compares this buildings energy performance against CIBSE TM46 Energy Benchmarks 2008 for educational buildings. For this report, energy consumption data from 2021 is used.

3.1 Context

The building includes a canteen space, plant room, workshop, bathrooms, hair saloon, computer rooms and offices. The building's current energy use is slightly above typical benchmarks for electrical and thermal consumption. The building's management are eager to improve the space conditions of the building but in doing so reduce energy consumption also. Management and staff are keen to ensure the building operates in an energy efficient and cost-effective manner.

3.2 Energy Consumption

3.2.1 Energy Cost Breakdown

The annual energy bill for bill is €22,973 including VAT. The following table summarises the fuel types that are used at the site.

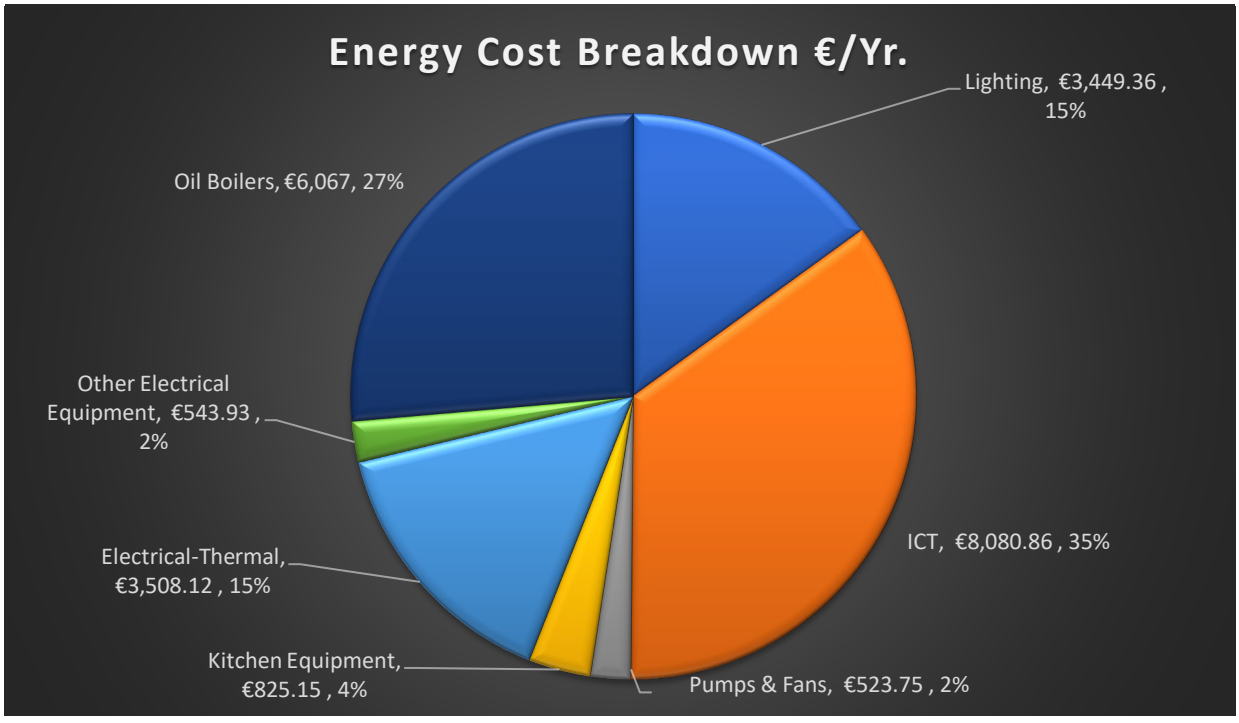


Figure 5. Energy Cost Breakdown

As is expected with this building type, the thermal load, i.e., space heating, is the largest consumer of energy in the premises. Heating accounts for approximately 48% of the total energy costs for the year with electricity at 52%. Other noticeable electrical energy costs consumers are ICT, secondary space heating, and lighting. Table 5 & Figure 6 below outline the delivered electrical energy consumption breakdown.

Electricity				
Significant Electricity User	Consumption [kWh]	[% of Billed Consumption]	Cost [€]	[% of Billed Cost]
Lighting	22,013	20%	€ 3,449.36	20%
Information & Communication Technology (ICT)	51,569	48%	€ 8,080.86	48%
Pumps & Fans	3,342	3%	€ 523.75	3%
Kitchen Equipment	5,266	5%	€ 825.15	5%
Electrical-Thermal	22,388	21%	€ 3,508.12	21%
Other Electrical Equipment	3,471	3%	€ 543.93	3%
Total (Significant Energy Users)	**108,048**	**100%**	**€16,931**	**100%**
Unaccounted for Shortfall (Excess)	0	0%	€0	0%
Total Billed Amount in Year	**108,048**	-	**€16,931**	-

Table 5. Summary of Delivered Electrical Energy Consumption

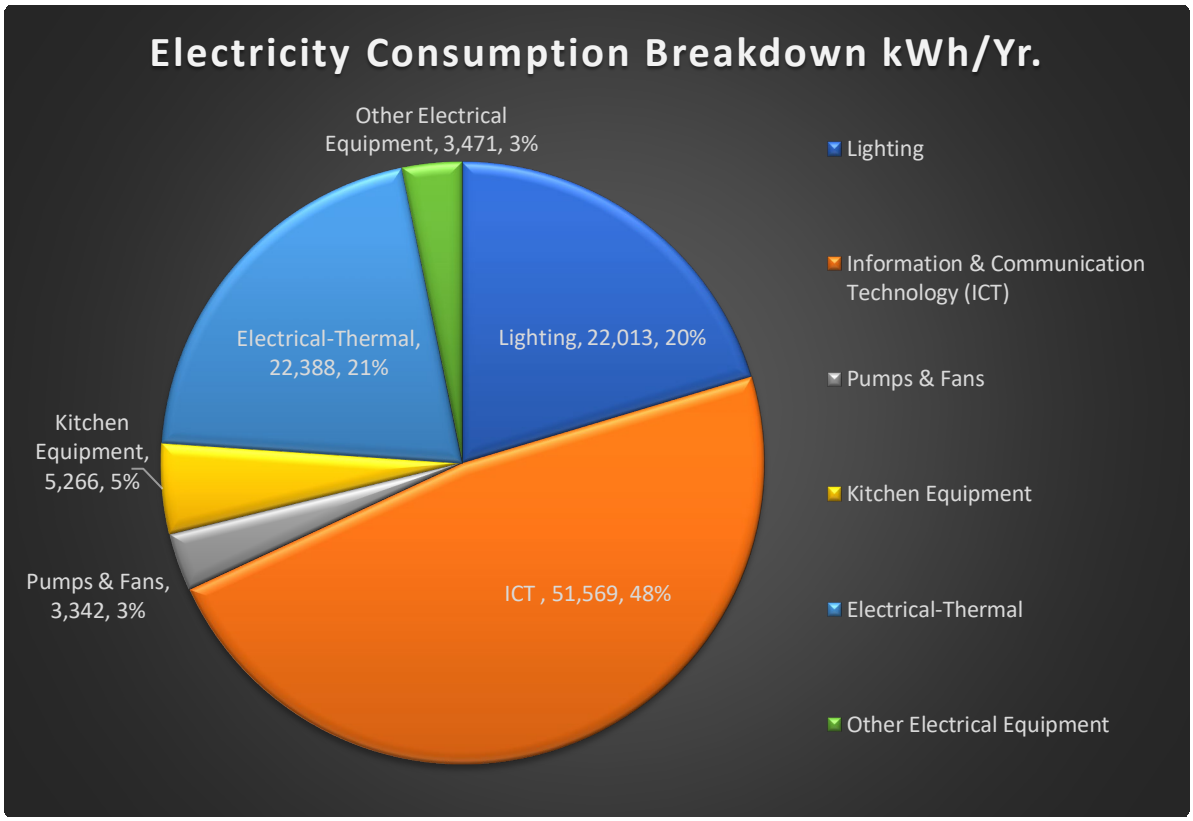


Figure 6. Electricity Consumption Breakdown kWh/Yr.

Thermal energy consumption related to fossil fuel use is below typical benchmarks for this type of building. TM46 educational building benchmark for thermal consumption is 150 kWh/m^2, the actual building usage is at 72.7 kWh/m^2, approximately 52% difference. Templemore College are keen to decarbonise heat by changing to electrification of heat. This strategy will pay dividends in the future as the national electricity grid becomes greener with more and more renewable energy production coming onstream. Table 6 and Figure 7 below outline the delivered thermal energy consumption breakdown.

Thermal Energy				
Significant Fuel User	Consumption		Cost	
	[kWh]	[% of Billed Consumption]	[€]	[% of Billed Cost]
Oil Boiler-Extension	100,794	100%	€6,067	100%
Total (Significant Energy Users)	**100,794**	100%	**€6,067**	100%
Unaccounted for Shortfall (Excess)	0	0%	€0	0%
Total Billed Amount in Year	**100,794**	-	**€6,067**	-

Table 6. Summary of Delivered Thermal (Oil) Consumption 2021

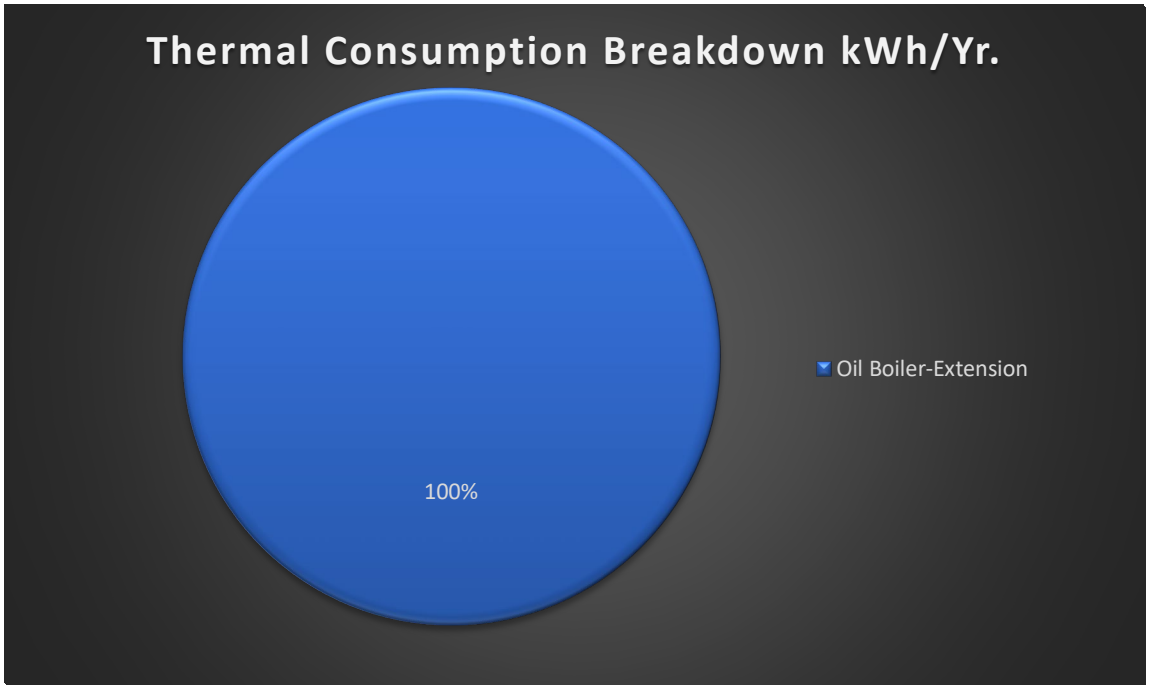


Figure 7. Thermal Energy Use (kWh) Breakdown

3.3 Building Survey Information

Building Details	Description
Building Age	1933, with extensions added in 1989, 2012, & 2015
Building Area	Approx. 1,386m^2 TUFA
Building Fabric	The building fabric is in good condition but has poor thermal properties when compared to the current thermal performance of building fabric and building regulations minimum requirements. The original roof has an assumed U-value of 0.61 W/m²K. The windows in the building are 12mm double glazed with a U-Value of 2.60 W/m²K. The external wall of the 2015 construction is cavity wall construction. There is a solid wall in the 1930's section. The walls have an assumed U-Value of 0.27 W/m²K and 1.00 W/m²K. The external doors are recorded as having a U-Value of 2.6 W/m²K.
Building Services	The heating system is supplied to the building via an oil boiler system. There is 1 No. Hogfors 20 Nova oil boiler installed, rated at 150kW capacity, assumed 80% efficient. This supplies LPHW to a radiator circuit. The boiler is switched locally and have an estimated run hours of 600 hours per year.
Ventilation	Ventilation is a natural ventilation strategy achieved by opening windows and passive vents.
Domestic Hot Water Controls	DHW is provided by 8 No. electric under sink heaters situated locally around the building. There is 1 No. Joule Cyclone 300l tank serving the hair salon. This tank is heated by 2 No. 6kW immersions which are set on timer.
Lighting	Lighting is controlled via local switching throughout. The lighting is a mix of fluorescents and LEDs. The building is compliant with Emergency lighting having received upgrades in the past number of years.
Lighting Controls	Existing lighting switched on/off control throughout.
External Lighting and Control	External lighting is building mounted and has a mixture of On/Off switched and sensor control.

Building Details	Description
Small Power Equipment	Servers, Electric heaters, printers, hand dryer, burco boiler and PC's, construction room equipment, hair salon equipment

Table 7. Building Survey Information

3.4 Site Inspection Checklist

Item	Score Poor Excellent 1 2 3 4 5 N/A	Observations / Comments
Physical Condition of Buildings	☐ ☐ ☐ ■ ☐ ☐	The building is in good condition. It is noted that although the levels of insulation were compliant at the time of construction, they are not sufficient when compared to current building regulations. The existing external walls requires investment due to the low levels of insulation. The roof appears to be insulated to an average level but should be investigated further.
Insulation of Walls, Roofs	☐ ■ ☐ ☐ ☐ ☐	The walls are a mix of solid and cavity wall construction, poor insulation levels
Windows	☐ ☐ ■ ☐ ☐ ☐	The windows are all double-glazed units and are original to the construction of 1989, 2012, & 2015. They are in average condition and should be upgraded to current high efficiency best practice units.
Adequacy of Daylighting	☐ ☐ ☐ ■ ☐ ☐	Natural daylight is adequate in all other areas.
Adequacy of Natural Ventilation in the building.	☐ ■ ☐ ☐ ☐ ☐	Background ventilation (windows) evident in the building.
External Doors	☐ ■ ☐ ☐ ☐ ☐	External doors are in very poor condition and require upgrading to current Part L standards.
Space Heating Plant	☐ ☐ ■ ☐ ☐ ☐	There is 1 No. Hogfors 20 Nova boiler installed, rated at 50 kW capacity each. It is in fair working order.
Interior Lighting	☐ ☐ ■ ☐ ☐ ☐	Halogen T8, fluorescents and LED's fittings throughout. Several have failed and have been replaced with LED equivalents.
Interior Lighting Controls	☐ ■ ☐ ☐ ☐ ☐	On/Off Switches.
Exterior Lighting	■ ☐ ☐ ☐ ☐ ☐	The external lights are wall mounted and in poor condition.

Table 8. Site Inspection Checklist

3.5 Typical Benchmarks

Templemore College is categorised as a combination of community building and educational facility in terms of usage. CIBSE Technical Memorandum TM46, Energy Benchmarks, offers a comprehensive outline of building energy benchmarks. Figure 8 below is an image from Table 1 of the TM46 guide outlining benchmark categories and values. For the purpose of this report, Templemore College falls into Category 17, Schools and Seasonal Public Buildings.

Table 1 Benchmark categories and values; (*b*) benchmarks and building size metrics

[A]	[B]	[C]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]
Name and description			Energy benchmarks		Illustrative CO_2 benchmarks calculated from the energy benchmarks (see Table 3)			Building size metric for use by assessors		
Category	Name	Brief description	Electricity typical benchmark (kW·h/m^2)	Fossil-thermal typical benchmark (kW·h/m^2)	Illustrative electricity typical benchmark (kgCO_2/m^2)	Illustrative fossil-thermal typical benchmark (kgCO_2/m^2)	Illustrative total typical benchmark (kgCO_2/m^2)	Primary metric (as in energy benchmarks)	Approved alternate metric	Default multiplier (applied to alternate metric to obtain primary metric)
17	Schools and seasonal public buildings	Public buildings nominally used for part of the year	40	150	22.0	28.5	50.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	

Figure 8. CIBSE TM46, Benchmark Categories

It should be noted that TM46 is dated 2008 and benchmark figures from that time have changed. Templemore College is currently 95% higher for electricity consumption (kWh/m^2) than the energy benchmark and 52% lower for thermal consumption (kWh/m^2). In relation to CO_2, Templemore College is 17% lower for emission per m^2 (kgCO_2/m^2) than the benchmark figure. The table below summarises the typical benchmarks for both electricity and fossil fuels.

Energy Benchmarks		
Description	**Quantity**	**Unit**
Floor Area	1,386	m^2
Electricity Consumption	108,048	kWh/Yr.
Fossil-Thermal Consumption	100,794	kWh/Yr.
TM46 Benchmark Electricity	40	kWh/m^2
TM46 Benchmark Thermal	150	kWh/m^2
Actual Electricity Benchmark	***77.9***	***kWh/m^2***
Actual Thermal Benchmark	***72.7***	***kWh/m^2***
Actual Total Energy Benchmark	150.7	kWh/m^2
TM 46 CO_2 Benchmark	50.5	kgCO_2/m^2
Actual CO_2 Emissions	41.8	kgCO_2/Yr.
% Difference Total Energy	**21%**	**%**
% Difference Total CO_2	**17%**	**%**

Table 9. Energy Benchmarks Vs CISBE TM46

Any text highlighted in red indicates a percentage increase from the TM46 recommendations, and the text highlighted in green highlights a percentage improvement/decrease on the TM46 recommendations. The above benchmark value attributed to electricity is potentially down to the electrical usage associated with the hair salon training studios.

4 Technical Report Details

This section of the report outlines the main aspects of the energy audit and the methodology and works undertaken. It gives a high-level summation of the existing plant and its operation.

4.1 Energy Audit

This report has been prepared with all reasonable skill, care and diligence and summarises the findings from the Energy Audit. All values quoted for energy savings are estimates derived in accordance with energy auditing standards.

Tipperary Energy Agency undertook an Energy Audit of Templemore College of Further Education. Authority to undertake this report was provided by Mr. David Young, Youthreach Coordinator, Templemore College of Further Education.

This report is based on a detailed survey and detailed energy calculations of the complete site. The site audit took place on the 3rd of October 2022 and involved a detailed review and inspection of the complete premises. Each space was surveyed with particular attention paid to building services, building performance and high energy use items, i.e., lighting, space heating, DHW (Domestic hot water heating), ICT and electrical equipment.

The building is a single-story building. The heating is supplied to the building via an oil boiler system. There is 1 No. Hogfors Nova 20 boiler installed, rated at 150 kW capacity with an assumed efficiency of 80%. This supplies LPHW to a one pipe radiator circuit. The boiler is switched locally and has an estimated run hours of 600 hours per year. The boiler was installed in 1990 and is practically end of life. The heating distribution network requires significant investment. It is a highly inefficient one pipe distribution system that is end of life also. Ventilation is predominately a natural ventilation strategy throughout, with mechanical ventilation installed to the construction room.

Lighting is controlled via local switching throughout. The lighting is a mix of fluorescents and LEDs. The building is compliant with Emergency lighting having received upgrades in the past number of years. The emergency lighting is operational and is compliant with 'I.S.3217:2013 Emergency Lighting'. Regular maintenance and

testing of the emergency lighting system was identified on site. The external lighting is switched with some sensor lights in less used areas.

The buildings fabric was noted during the audit, and on visual inspection it appeared to be in poor condition. U-Values are way below current Part L guidelines for ground floor, walls, windows, doors, and roofs. Therefore, various fabric upgrades will be recommended for this building.

Should the client wish to improve the external wall U-Value to at least Part L 2021 requirements, they would trigger Part L compliance. Ideally, all fabric upgrades to a non-domestic building should be to current best practice U-Values as outlined in the current Technical Guidance Document Part L 2021 – Buildings other than Dwellings. The upgrade measures identified in this report will trigger the major renovations category and therefore must comply with the current TGD Part L. This document states the following:

' buildings in which a material alteration or change of use or major renovation takes place, where the work, material alteration or the change of use commences or takes place, as the case may be, on or after 27th July 2021''.

Therefore, any major renovation works undertaken must comply with the new technical guidance document, Part L. Major Renovation is defined as where more than 25% of the surface of the building envelope undergoes renovation and therefore according to the current Building Regulations the energy performance of the whole building should be improved to Cost Optimal level.
The following improvements are considered to be cost optimal and will typically be economically feasible when more than 25% of the surface area of a building is being upgraded:

- Upgrading oil, gas or biomass heating systems more than 15 years old
- Upgrading controls for direct electric space heating systems to achieve the level of controls.
- Upgrading cooling and ventilation systems more than 15 years old and a cooling unit seasonal energy efficiency ratio less than that in the Eco-design Regulations
- Upgrading general lighting systems that are more than 15 years old or have an average lamp efficacy of less than 40 lamp-lumens per circuit-watt as defined in NEAP and that serves greater than 100m².

The buildings management spends approximately €22,973 including VAT, standing charges etc. on energy each year using 108,048 kWh of electricity and 100,794 kWh of thermal energy.

It is suggested the following energy efficient upgrade works are undertaken:

- Upgrade all external windows to triple glazed units complying with NZEB standards. Proposed U-Value 0.74 W/m^2K. Approx. 188m^2 area. Upgrade all external doors, approx. 32m^2 area to high efficiency, airtight units. Upgrade existing roof lights to high thermal performing units, approx. area 3.6m^2.
- Insulation Upgrade to External Walls- addition of 100mm external insulation with a thermal conductivity of 0.021 W/mK.
- Insulation Upgrade to Roof- addition of 200mm insulation with a thermal conductivity of 0.035 W/mK.
- New Air Source Heat Pump (ASHP) air to water system with DHW top up. Approx. 70kW capacity Including heat pumps, buffer tank, controls, etc.
- New BMS & Heating Distribution Network from ASHP, serving new radiators, two pipe distribution network, and controls.
- Heat Recovery Ventilation to all teaching spaces and offices.
- LED Smart Lighting Upgrade with occupancy detection and daylight sensing
- Installation of a 40.5Wp Solar Photovoltaic Array on the roof of the building, south orientation.

4.1.1 Description of the Site

The building is located in Templemore and is the property of TETB. The building consists of the following main areas:

Description	Area (m^2)	Days	Working Hours
Classrooms	885.5	Monday to Friday	1,500 hr/yr.
Canteen	148	Monday to Sunday	1,500 hr/yr.
Offices	52.5	Monday to Sunday	1,500 hr/yr.
Circulation	195	Monday to Sunday	1,500 hr/yr.
Stores	95	Monday to Sunday	1,500 hr/yr.
Plantroom	8	Monday to Sunday	1,500 hr/yr.

Note: Some spaces are not in continuous operation, and this is accounted for in energy consumption calculations.



Image 2: Aerial View of Building

4.1.2 Description, Thoroughness and Methodology

The energy audit was carried out, where practical, in accordance with I.E. EN 16247 Parts 1 and 2 or ISO:50002. The thoroughness is enough to be considered an investment grade energy audit. This audit meets the SEAI minimum criteria for energy audits as per European Union (Energy Efficiency) Regulations 2014 (SI 426 of 2014), as amended by SI 646 of 2016 and SI 599 of 2019. This audit meets the minimum criteria for energy audits based on the four high-level principles: listed below;

1. The audit is based on up to date, measured, traceable operational data on energy consumption and (for electricity) load profiles.
2. The audit comprises a detailed review of the energy consumption profile of the building.
3. The audit includes, where feasible, life cycle cost analysis (LCCA) instead of simple payback periods (SPP) in order to take account of long-term savings, residual values of long-term investments and discount rates.
4. The audit is proportionate and sufficiently representative to permit the drawing of a reliable picture of overall energy performance and the reliable identification of the most significant opportunities for improvement.

The audit comprises:

- Study of historical records of energy
- Inspection of available drawings and manuals
- Survey of energy consuming processes
- Discussions with occupants and staff to establish an understanding of the building operations.
- Measurement, calculations and estimations of energy consumption patterns based on experience and industry norms.
- Reporting on energy usage profiles and providing recommendations to reduce site energy consumption, green-house gas emissions and operating costs.

4.1.3 Preliminary Work

Tipperary Energy Agency have complied this report based on the following activities:

- Walk through inspection of the services of all areas.
- Discussions with David Young- Templemore College.
- Perusal of various site plans and documentation listed below.

Apart from where noted in the specific sections of this report, we have not verified the written and verbal information provided. In addition, the following work has not been undertaken:

- Verification of design
- Inspection of equipment not readily accessible (e.g., roof top, some ceilings, storage tanks)
- Measurement of actual equipment performance
- Assessment of compliance with original or current codes.

4.1.4 Desk Audit

Documentation Sighted:

The following documentation has been sighted:

- Architectural Drawing (Procad Engineering)
- 2014-21 Energy Use Data

Documentation Not Sighted:

The following documentation was not sighted or not available on site:

- Electrical As-Built Drawings
- Mechanical As-Built Drawings
- Mechanical & Electrical Services Equipment Schedules
- M&E Service Records
- Building Fabric Thermal Specification
- BMS Manual

4.1.5 Site Visit

Every space/room was surveyed during the site energy audit. All building services systems were reviewed.

4.1.6 Verbal Information Received

Some of the following information included in this report was provided verbally by persons as indicated hereunder:

- Mr. David Young, Templemore College of Further Education

4.1.7 Analysis

EN 16247, ISO50002 and SI426 require that the interaction between energy consuming systems must be considered. For example, additional heating energy may be required if more efficient lighting is installed. Tipperary Energy Agency used a combination of the following methods as appropriate:

- Analysis of electrical consumption data
- Significant Energy Users Tool (SEAI)
- CIBSE Guides, in particular CIBSE Guide A, Environmental Design, CIBSE Guide B, Ventilation and Air Conditioning, CIBSE Guide F, Energy Efficiency in Buildings, CIBSE LG7 Lighting Guide and CIBSE SSL Lighting Handbook, CIBSE TM46, Energy Benchmarks 2008
- Life cycle cost analysis using Internal Rate of Return

The Significant Energy Users Tool is a spreadsheet tool in which the results of the site survey are entered, and estimates made of kWh consumed per year for each item using:

- operating hours per year (estimated in some instances)
- lamp watts for lighting (surveyed)
- Plant peak consumption kW (nameplates, product catalogues etc.)
- "ballast" factors for lighting to cover control gear.
- Load factors for HVAC equipment and motors etc. (estimated where not accessible or available)
- Seasonal efficiency of heating plant (estimated using SEAI guidance figures)

The analysis was used to provide:

- A breakdown of major energy consuming systems.
- Energy flows and energy balances.
- Patterns of energy use over time.
- Relationship between energy use and influencing factors such as weather.
- Energy performance indicators.
- A list of energy efficiency measures.
- Financial, delivered energy and carbon savings associated with the savings.
- Required capital investment budgetary estimates and life cycle costs.
- Other non-energy gains such as reduced maintenance.
- Technical interactions between investments.
- Savings are ranked by Internal Rate of Return.

4.1.8 Project Close Out

A representative of the Tipperary Energy Agency can attend a final meeting with the management to go through the findings, present and explain the results, and take part in discussion of any further work which may be required.

4.1.9 Data Collection

Building Survey Information and Site Inspection Checklist – See Section 3.3 & 3.4 of this report.

4.1.10 Utility Data

Summary of Energy Consumption – See Section 5 of this report.

4.1.11 Estimates

Where data was not available, estimates have been made. Estimates can be based on simple calculations, the auditors experience, published energy performance indicators to specific uses etc. Examples are:

- Laptop power consumption, Watts.
- Other IT equipment power consumption, Watts
- Lab equipment power consumption, Watts
- Hours of usage of each item of energy consuming equipment
- Load factors and seasonal efficiencies of HVAC plant items
- Fabric details

Estimates have a significant impact on analysis.

4.2 Existing Building Services Review

4.2.1 Heating System Overview

The building is heated with a Hogfors Nova 20 Boiler, rated at 150 kW capacity output. It supplies low pressure hot water to 2 No. radiator circuits via a one pipe distribution network. The system reticulates out to serve multiple different radiator types. This boiler was manufactured in 1990 and is approaching end of life. The plantroom pipework is insulated with some pipework showing levels of rust and corrosion. The radiator system in the old section of the building is single pipe system with many cast iron radiators. The newer section of the building has a 2-pipe circuit with flow, return and re-circ.

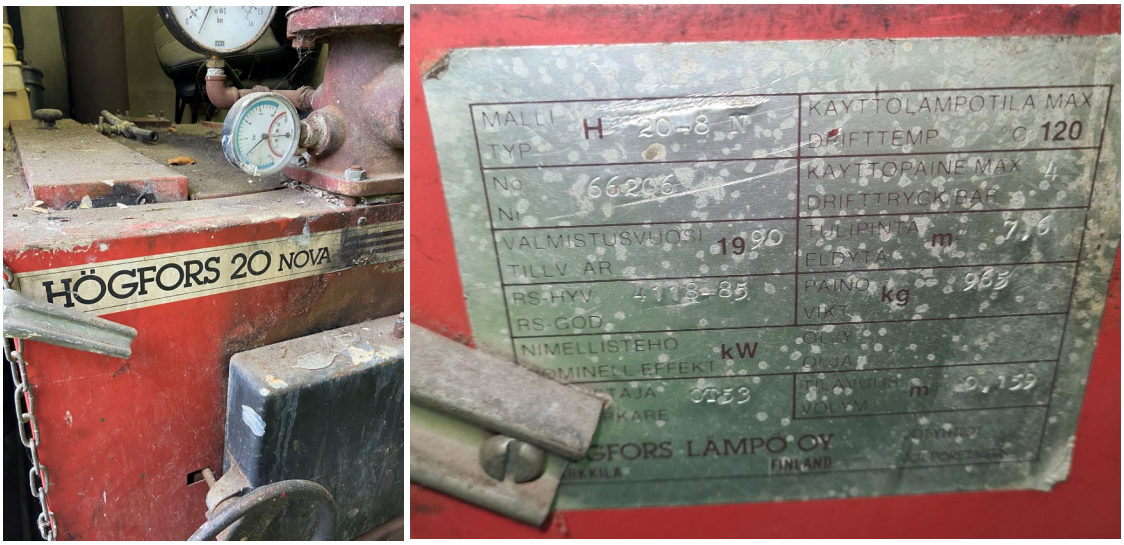


Image 3: Hogfors Nova 20 Boiler

4.2.2 DHW

The DHW is supplied to the building via direct electric under sink heaters. There are 8 No. throughout the toilets, canteens and practical classrooms. There are several different models of under sink heaters and all have an approximate input power of 2kW.There is also a hot water tank in the attic above the hair salon which is a 300-liter factory insulated copper tank. The tank is a Joule Cyclone 300l with 2 No. 6kW immersions installed to heat the tank.



Image 4: DHW Tank and Undersink Heater

4.2.3 Ventilation System Overview

Ventilation is a natural ventilation strategy achieved by opening windows and passive vents in the toilet areas.

On days with heavy usage the external fire doors maybe opened to provide ventilation in some classrooms.



Image 5: Natural Ventilation Strategy

4.2.4 Lighting System Overview

The lighting is fluorescent throughout the school. The classrooms of the 1930's section of the school is lit by new LED fittings. The other areas of the original section of the school are lite by 2 X 49W Fluorescents fittings. Lighting is controlled via local switching throughout.

The building is compliant with Emergency lighting having received upgrades in the past number of years. The emergency lighting should be reviewed if lighting upgrade works are undertaken. It is recommended a detailed lighting design is carried out should any lighting upgrade works be undertaken. External lighting is building mounted and has a mixture of On/Off switched and sensor control.









Image 6: Lighting in the building

5 Summary of Energy Consumption

This section of the report analyses the billing data provided for both gas and electricity at Templemore College. Costs and consumption are broken down to demonstrate or highlight any unusual trends in the building's overall energy consumption.

5.1 Electricity Bill Data Analysis

Current Supplier: Electric Ireland **MPRN:** 10009770228	**Electricity Bill Name:** Tipperary ETB

Table 10. Electricity Supplier and MPRN No.

5.2 Electricity Costs & Consumption

The table located below summarises the annual electricity consumption and associated costs for the period.

Period	Consumption (kWh)	Total Cost (Excl. VAT)	Total Cost (Incl. VAT,)	Overall Cost per kWh (Incl. VAT)
October 2021 to September 2022	108,048	€16,966	€18,897	€0.1743

Table 11. Annual Electricity Consumption & Costs

For the above stated period, electricity costs amounted to €18,897 resulting in an overall VAT inclusive cost per kWh of electricity consumed of €0.1743/kWh.

5.3 Annual Electricity Consumption & Cost Breakdown

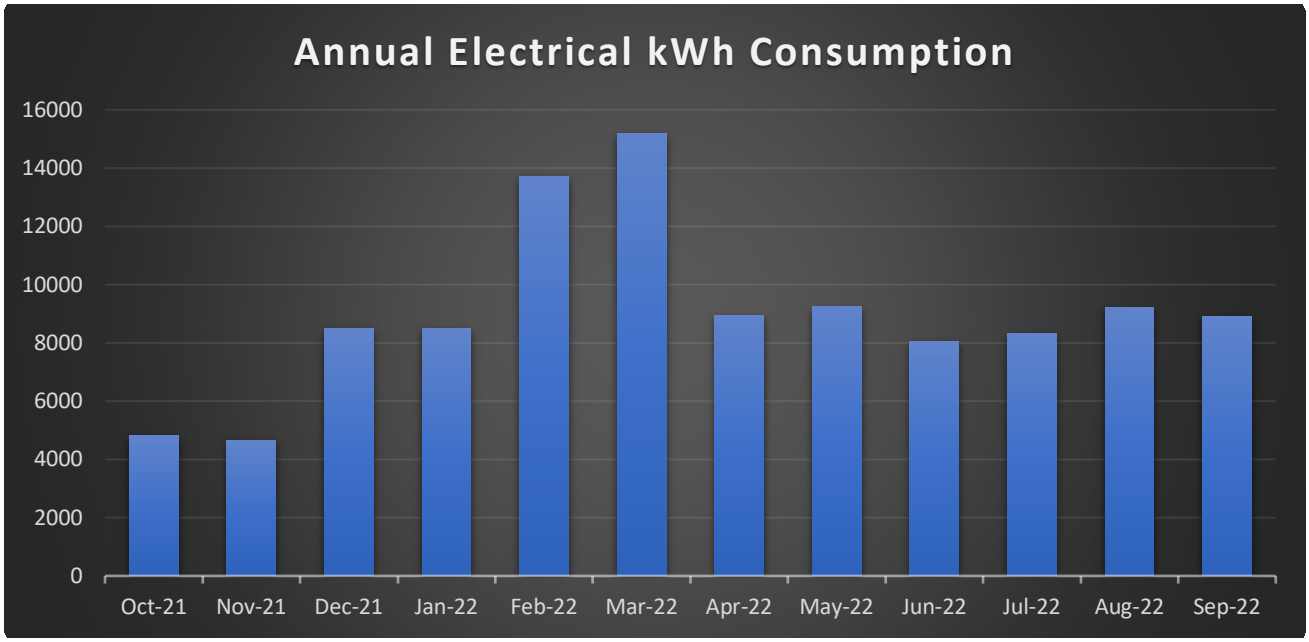


Figure 9. Annual Electricity Consumption

Electricity demand is normally distributed throughout the year with an average consumption of 9,004 kWh per month. The consumption profile follows the heating season with the peak demand in February and March. Further analysis and meter logging is required to identify any spikes in consumption, and the key energy consumers of electricity onsite.

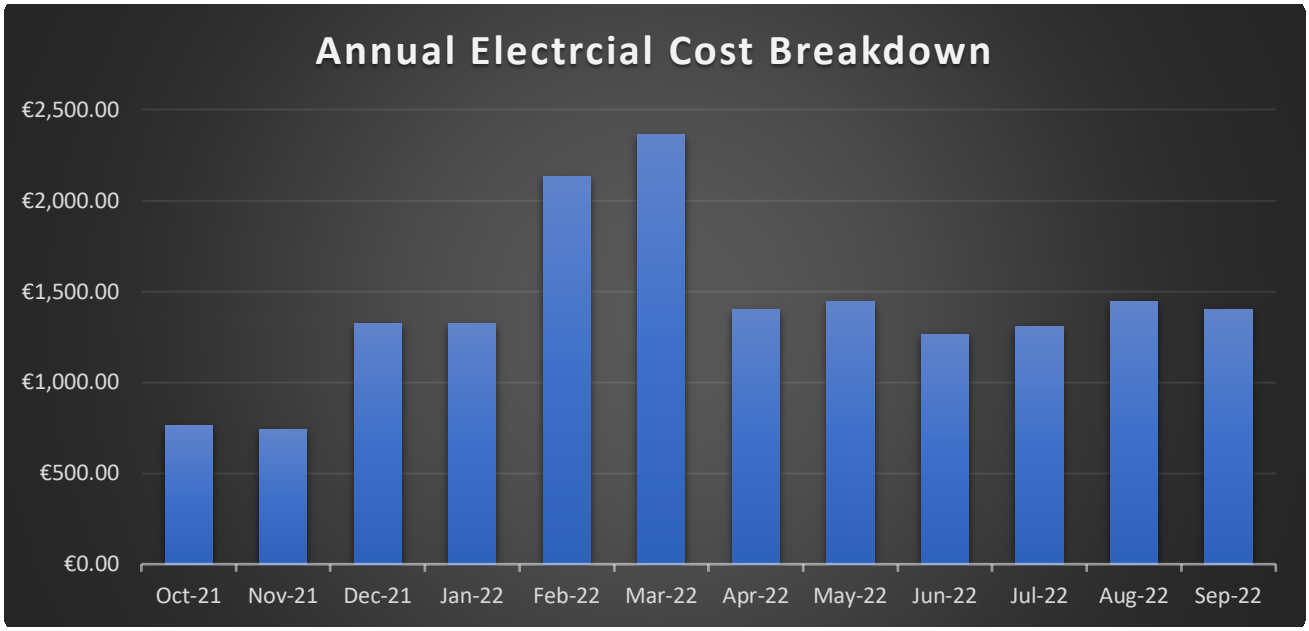


Figure 10. Annual Electricity Cost Breakdown

5.4 Thermal Bill Data Analysis

Current Supplier: Circle K	**Bill Name:** Templemore College TETB

Table 12. Oil Supplier

5.5 Thermal Costs & Consumption

Table 13 summarises the annual oil consumption and associated costs for the period.

Period	Consumption (kWh)	Total Cost (Excl. VAT)	Total Cost (Incl. VAT)	Overall Cost per kWh (Incl. VAT)
January 2021 to December 2021	100,794	€6,066	€6,885	€0.068

Table 13. Annual Oil Consumption & Costs

For the above stated period, oil costs amounted to €6,885 resulting in an overall VAT inclusive cost per kWh of oil consumed of €0.068/kWh.

5.6 Annual kWh Consumption & CO_2 Emissions

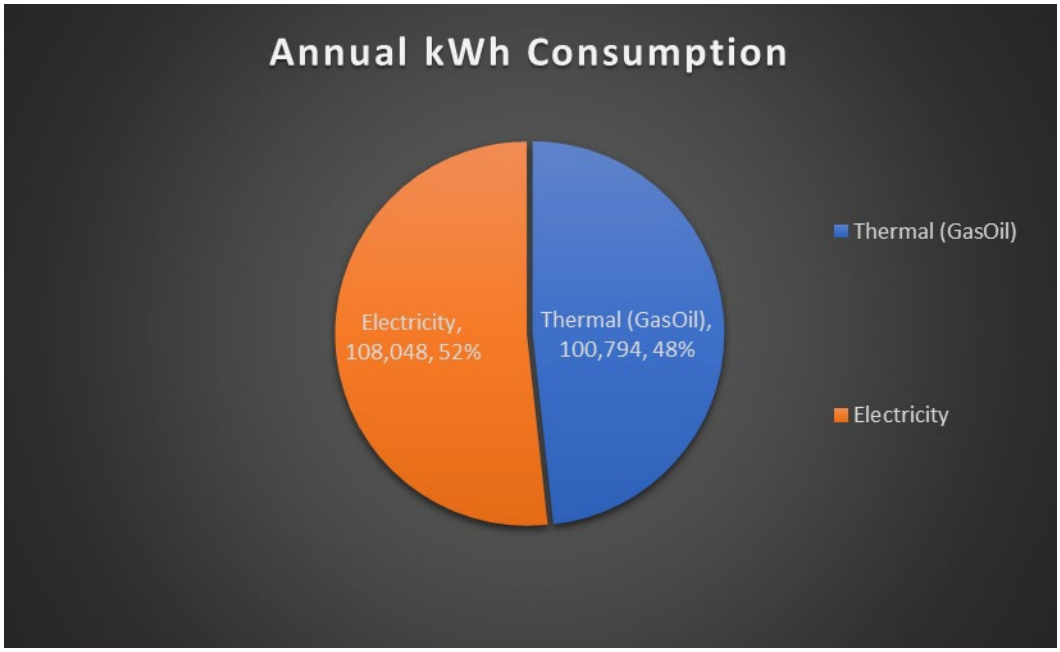


Figure 11. Annual Electricity and Gas kWh Consumption Breakdown

Figure 11 illustrates the annual kWh consumption at the building. Electricity accounts for 108,048 kWh and oil accounts for 100,794 kWh, approximately 52% and 48% respectively. In relation to CO_2 emissions, electricity accounts for 59%, or 37 tonnes of CO_2/yr. and 26 tonnes CO_2/yr. or 41% is associated with oil consumption. Refer to Figure 12 for breakdown.

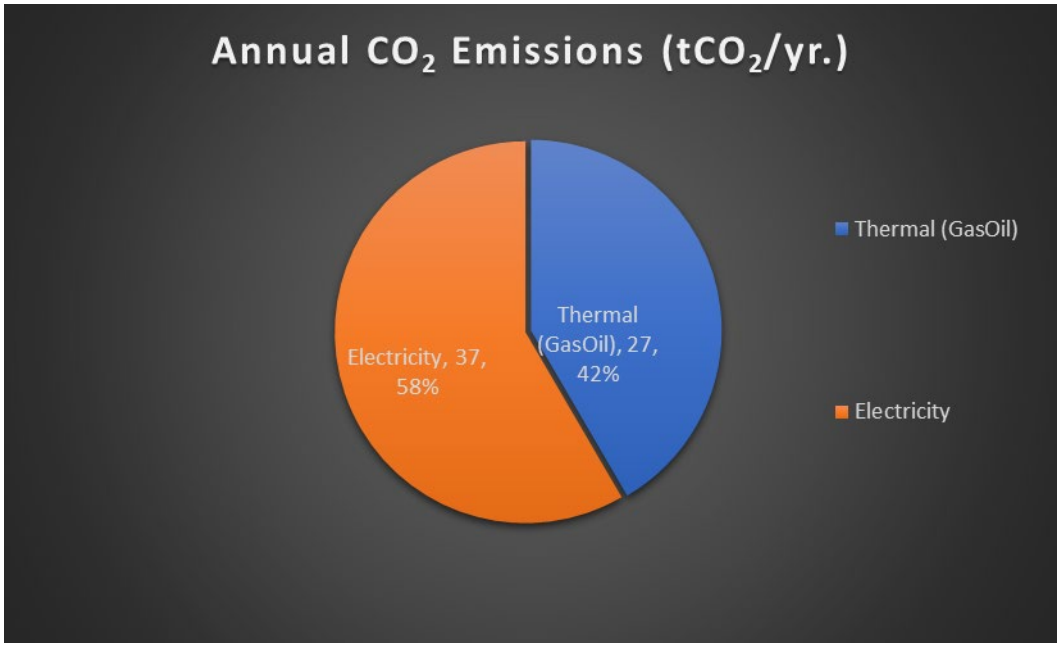


Figure 12. Annual CO_2 Emissions Breakdown

6 Opportunities for Improvements in Energy Efficiency

This section of the report goes into further detail on the Register of Opportunities recommended in Section 1.3 of this report.

6.1 Summary of Opportunities

See Section 1.3 of this report for a breakdown of energy efficient opportunities that will require planning and investment.

- Upgrade all glazed elements to triple glazed units meeting NZEB standards and all doors to high thermal performing units. Total glazed area 188m^2, total door area 32m^2, total roof light area 3.6m^2.
- EWI (External Wall Insulation) to all external wall areas. U-Value 0.18 W/m^{2}K (old section), and 0.13 W/m^{2}K (new section), compliant with NZEB standards. Total external wall area 771m^2
- Upgrade the current roof with new high thermal conductivity mineral wool insulation. Total roof area 1,386m^2. Roof insulation upgrade works to comply with NZEB standards and SEAI SR54 Code of Practice.
- New Air Source Heat Pump System (ASHP) air to water 70kW capacity heating including new controls and 1 No. new dual coil 1000 litre DHW tank. It is proposed to install 2 No. 35kW air source heat pumps in cascade configuration. The existing oil boilers will be decommissioned and removed from site.
- Upgrade heating distribution pipework, radiators, heating controls, (2 port valves, BMS), VSD pumps to all spaces on the ASHP system.
- Install ventilation heat recovery (MVHR) to all teaching spaces within the building. Offices also should be included where void space is available.
- LED Smart Lighting Upgrade with occupancy detection and daylight sensing, internal & external. Approx 122 No. fittings to be upgraded.
- Installation of a 40.5 kWp Solar PV Array system on the building roof top. Proposed arrays are south facing. System can avail of the Clean Export Guarantee (CEG) tariff for any exported electricity. System size selected to incentivise self-consumption with the CEG tariff capped at 80% of generation capacity.

6.2 LED Lighting Upgrade

It is proposed to install a new LED lighting system with occupancy detection and daylight sensing throughout the building. A new LED lighting system will reduce energy consumption. The existing lighting system comprising of fluorescent fittings are high energy users and the control strategy is simple on/off switching. There is a total of 122 No. fittings to be retrofitted. The upgrade must comply with the current lighting standards (CIBSE Lighting Guides, LG5, and LG7) and Emergency Lighting Standard (I.S.3217-2013+A1-2017). It is recommended that a lighting survey is carried out prior to any lighting retrofit. Lighting lux levels must be compliant with current building regulations and CIBSE Lighting Design Guides. It was noted on site that some areas were over lit as there was good natural daylight present in some rooms. However, it is important to note that some spaces may be under lit and non-compliant with health and safety standards and CIBSE Lighting Design Guides. A detailed lighting design must be carried out on the building to ensure compliance with current standards. This may have a knock-on effect on predicted savings if additional fittings are required.

The proposed LED lighting upgrade could potentially see an 55% reduction in the lighting electrical load, and a 11% reduction in the overall electrical consumption of Templemore College. There is the opportunity to save 4 tonnes of CO_2/yr. with a smart LED lighting system.

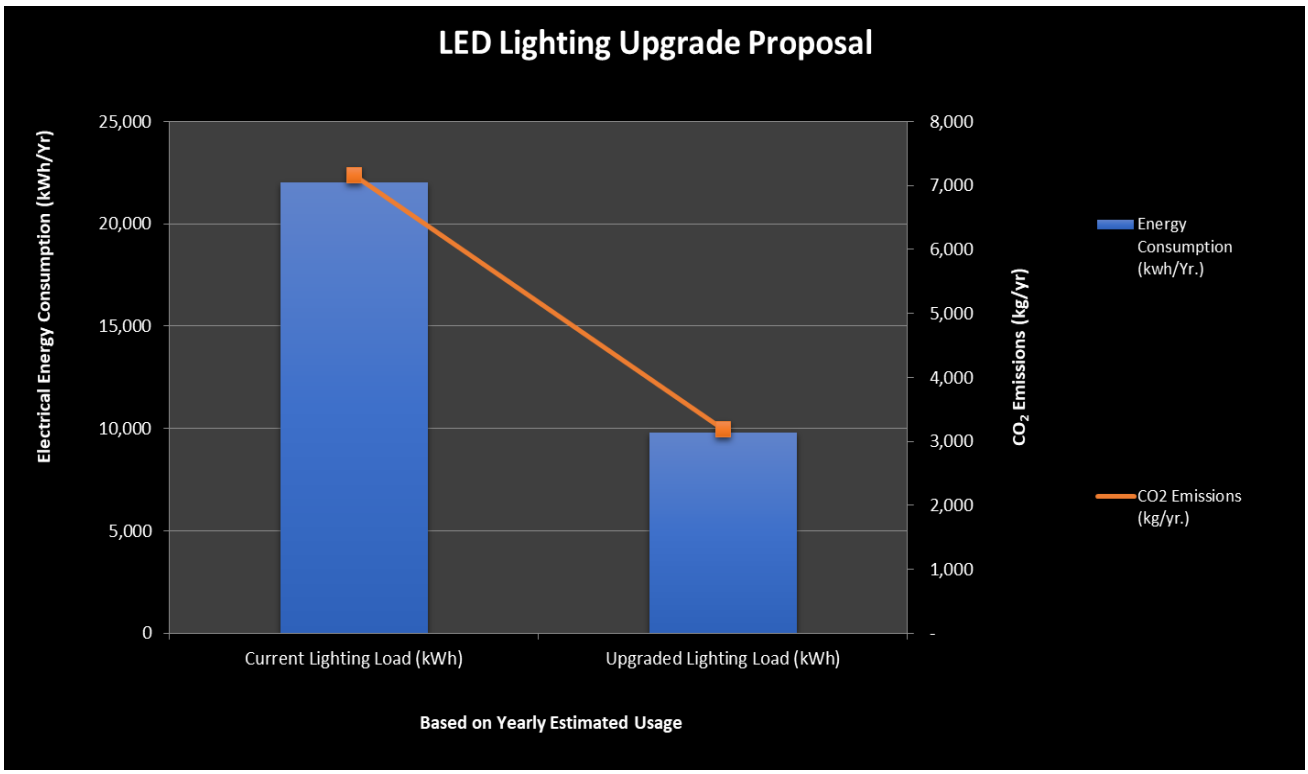


Figure 13. LED Lighting Upgrade & Existing Lighting Performance

Templemore College of Further Education		
Unit	Current External Lighting System	Upgraded Lighting System
Energy Consumption (kWh)	22,013	9,822
CO_2 Emissions $kgCO_2/yr.$	7,154	3,192

Table 14. Energy Consumption & CO_2 Emissions, Existing and Proposed Lighting System

Any upgrade works to the lighting system must include for any modification to the emergency lighting system if required. It is highly recommended that all emergency lighting is compliant or made compliant with 'I.S.3217-2013+A1-2017Emergency Lighting', and lighting levels meet the recommended levels outlined in the CIBSE Lighting Hand-book Guide.

Cost Breakdown of LED Lighting System

Supply of 122 No. Smart LED Fittings	€ 15,500
Electrical Wiring	€ 9,000
Builders Works	€ 4,500
Testing & Commissioning	€ 1,500
Total	**€ 30,500**

6.2.1 NPV & IRR on LED Lighting Upgrade

This financial model tool for lighting retrofit projects allows the estimation of the cashflows, payback, IRR and NPV of lighting retrofit projects over 20 years. A cashflow analysis for two scenarios is put forward as follows.

- The Base Case. This scenario considers that the costs and savings are accurate.
- The Sensitivity Analysis. This scenario considers a 10% increase in capital cost, a 5% decrease in energy savings, and a 75% saving in maintenance versus 95% saving.

Method of Cost Calculation	Budget or Tendered Costs
Retrofit Type	High spec LED retrofit, full controls
Floor Area (If Floor Are Cost Selected) - m^2	1,380
System Cost (If Budget or Tendered Cost Selected) - €	€30,500
Pre-Retrofit Lighting Energy Consumption (kWh)	22,013
Method of Energy Savings Calculation	Calculated based on Survey
Post Retrofit Consumption (kWh - Elec) if Calculated Selected	9,822
Electricity Price (€/kWh)	€0.16

Table 15. Lighting Input Data

Lighting Retrofit (Base Case)	
Capital Outlay	€ 33,500
Total 20 Year Savings	€ 83,709
Payback years	9
Project IRR	12.6%
Net Present Value (NPV)	€33,066

Table 16. NPV, IRR & Payback on the Base Case Scenario for the LED lighting Upgrade

Lighting Retrofit (Sensitivity Analysis)	
Capital Outlay	€ 33,550
Total 20 Year Savings	€ 83,709
Payback years	9.05
Project IRR	9.2%
Net Present Value (NPV)	€20,510

Table 17. NPV, IRR & Payback on the Sensitivity Analysis Scenario for the LED lighting Upgrade

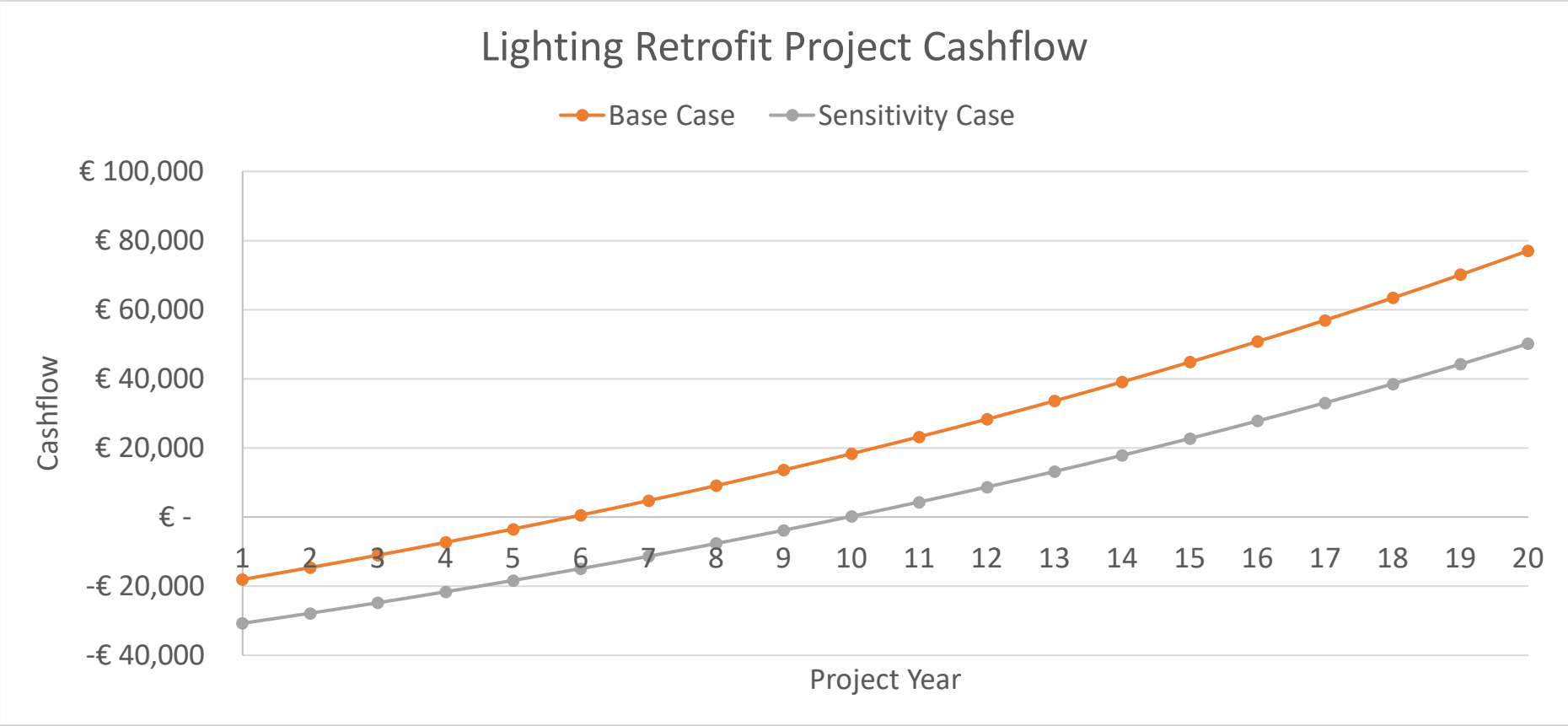


Figure 14. LED Lighting Retrofit Project Cashflow

Refer to Appendix 9.7 for detailed calculation of NPV & IRR for both scenarios.

6.3 Air Source Heat Pump (ASHP) Installation

It is advised that a heat pump is installed to supply all heating and DHW requirements to the building. This opportunity outlines the predicted savings associated with an ASHP system and should be investigated and analysed in relation to the current fossil fuel heat source. A detailed heat load of the building is required to size the system correctly.

It is important to get optimum COP's with this system so energy costs and CO_2 emissions are reduced. TETB are keen to move away from their reliance on fossil fuel as an energy source. With energy costs continuing to rise, this is the perfect opportunity to investigate a renewable heating system alternative. Ground source heat pumps have become very popular for larger buildings in recent times, particularly educational facilities. This type of heating system works best in well insulated buildings with huge potential for reduced running costs and energy consumption. The heat loss at Templemore College is currently high, and it highly recommended to improve the buildings fabric prior to the installation of a heat pump system, as this will greatly reduce the load on the heating system. It is vital heat loss is minimised for optimal performance of a heat pump system. Heat pumps operate by absorbing heat from the outside air (operating with external temperatures as low as -15°C), and using the refrigeration cycle, transforming this to a liquid. This liquid will pass through a compressor, where the temperature of this liquid increases. From here it transfers its higher heat temperature to the heating and hot water circuits through the building via the wet central heating system. Heat pumps operate much more efficiently at lower temperatures than the current boiler thus reducing energy costs and consumption. For every unit of electricity needed to power the system, 3-4 units of heat are supplied into the room. This performance is recorded via the system coefficient of performance (COP). With a well-insulated and controlled heating system, COP's of 3 & 4 are achievable. It must be noted for the heat pump to work efficiently, building fabric should be sufficiently insulated to ensure that the heat loss is minimal. Outside air infiltration should be minimised as is practicably possible. The low temperature supply from the ASHP system ($35/40^0$C) can maintain space conditions while operating at high COPs. The requirement for fabric and ventilation upgrades is for space heating purposes, and to keep the ASHP system operating at high COP's. Reduced energy consumption and running costs are the main advantage of this system, however, carbon emissions are also greatly reduced and will reduce further as the grid becomes greener in its production of electricity.

kWh Saving with ASHP Upgrade	
Heat Pump Savings kWh Thermal	100,794
Heat Pump Capacity (kW)	**70***
COP	3.5
ASHP Electrical Input kWh	11,882
Cost Savings €	€4,207
tCO_2 Saving	22.5
Simple Payback (Yrs)	16.5

Table 18. ASHP Savings

*A detailed design model and heat load is required prior to any heat pump selection.

The following is the cost breakdown of the proposed ASHP system:

Air Source Heat Pumps 2x35kW, including	
Buffer tank, DHW cylinders, valves, expansion modules	€36,938
Controls & Electrical Attendances	€5,500
Builders Works, Making Good	€2,000
Installation & Commissioning	€24,875
Total	**€69,313**

Note: This capital cost excludes the distribution network upgrade. Radiators would require replacement to operate from the lower supply temperature from the heat pumps.

6.3.1 NPV & IRR on ASHP

This financial model tool for the ASHP installation allows the estimation of the cashflows, payback, IRR and NPV of an ASHP installation over 20 years. The 20-year period has been selected to detail the savings and costs up to the breakeven point of this exercise. A cashflow analysis for two scenarios is put forward as follows.

The Base Case.
Do nothing, retain existing boilers and live with existing levels of energy usage, maintenance and expected service life span, replacing the equipment as and when it reaches end of life. The existing boilers use 100,794 kWhrs thermal. A direct oil/gas boiler replacement has been selected as this will allow for the quickest solution to a boiler failure, allowing for the existing distribution network to be retained/unchanged. The calculation also factors in the yearly carbon tax increase for the use of fossil fuel. A budget of €15,0000 has been allowed for the replacement of boilers in year 3.

Upgrade Solution
Replace the existing boilers with an ASHP. The new ASHP will use 11,882 kWhrs electricity. The cost to supply and install a new ASHP and associated distribution network is estimated at €191,312.

ASHP Upgrade Option	
Capital Outlay	€ 191,313
Total 20 Year Savings	€ 433,406
Payback years	14.96
Project IRR	6.79%
Net Present Value (NPV)	€41,723

Table 19. NPV, IRR & Payback on the ASHP upgrade Scenario

The ASHP upgrade will have a positive cash flow at year 13. The air source solution capital costs have less risk of fluctuations as they are not dependant on carbon tax increases.

6.4 Heating Distribution Network Upgrade with New BMS

Should the client decide to retrofit to heat pump, the distribution network will need to be upgraded. The pipework and controls are in poor condition, and modifications will be required to the overall heating distribution network as radiators will need to be replaced, and a new two pipe distribution network installed. The current radiator capacities range from 500W to 3.5kW. There is scope to relocate some of the larger radiators to smaller rooms with low heat demand. There may be sufficient capacity in these larger units to meet the heat load from the lower delta t associated with heat pumps. The larger spaces will require new radiators to meet their space heat demand from the low temperature supply flowrate from heat pumps. Prior to any upgrade works, it is recommended a detailed heat load analysis is undertaken to determine the heat load of the building and each heated space. It is vital radiators are capable of meeting space heating conditions at lower flow rates from a heat pump system.

Savings associated with this measure are estimated at 25,199 kWh. There are currently 70 No. radiators installed with approximately 90% retrofit of radiators expected. Carbon reduction of 6.6 tCO_2 /yr. predicted.



Image 7: Typical radiator installed in the school

Cost Breakdown Heating Distribution System

Decommissioning of existing heating system and disposal from site	€2,500
Wall/ground penetrations/trenching and making good	€5,500
Installation of low temp. radiators	€42,000
Installation of centralised and individual controllers	€13,000
Installation of new LPHW Pipework	€56,800
Builders Works	€2,200
Total	**€122,000**

6.5 Installation of a 40.5kW$_p$ Solar PV (Photovoltaic) Array

It was noted at the time of the site visit that a solar PV system may be an economic way of lowering energy demand on site, especially if a retrofitted heat pump system is pursued. It would also have a huge bearing on a NDBER for the building, with the potential to go to an A rated certificate, surpassing the minimum B rating requirement as outlined in Ireland's Long Term Renovation Strategy 2020. There is a steady electrical demand throughout the year at the premises, and ample roof space upon which a PV system could be installed. When a PV system is producing more power than required by the building, the excess power is exported to the grid at no credit to the building owner. This has now changed under the governments Micro-generation Support Scheme (MSS). Non domestic clients such as Templemore College can avail of the Clean Export Guarantee (CEG) tariff, for any exported electricity, at a competitive market rate from their electricity supplier. Projects between 6kW and 50kW will receive a Clean Export Premium (CEP) tariff per kWh exported for a period of 15 years. The CEP rate varies from €0.135/kWh to €0.19/kWh depending on supplier. Exported volumes of electricity eligible for the CEP tariff are capped at 80% of generation capacity. This is to incentivise self-consumption.

The proposed array at Templemore College will use approximately 86.9% of its generated capacity, with the remaining 13.1% exported to the grid under the CEP tariff. The size array is proposed to future proof the building in terms of the electrification of heat and move towards heat pumps.

Refer to Image 8 overleaf for summary details on the proposed array, and Appendix 9.1 for the Solar PV Report.

Project Overview

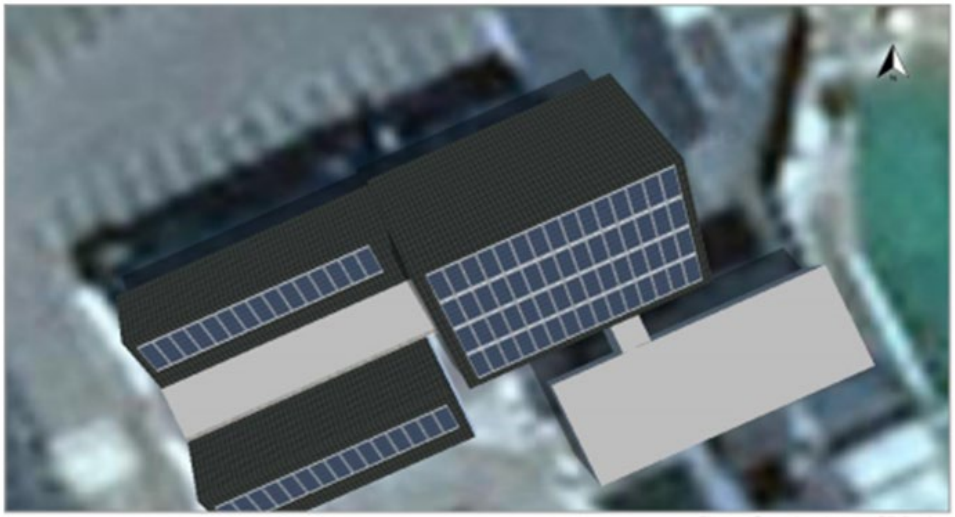


Figure: Overview Image, 3D Design

PV System

3D, Grid-connected PV System with Electrical Appliances

Climate Data	Templemore, IRL (1991 - 2010)
PV Generator Output	40.5 kWp
PV Generator Surface	196.0 m²
Number of PV Modules	90
Number of Inverters	5

Image 8: PV Sol Proposed Array at Templemore College

kWh Saving with 8kW$_p$ Solar PV Array	
PV Generator Output kW$_p$	40.5
kWh Saving	32,080
Grid Feed In (kWh) (*Potential Microgeneration)	4,842
Feed in Tariff (€) Estimated	€0.135
Cost Savings €	€5,020
Cost Savings € (*Feed in Tariff Microgeneration)	€654
Carbon Saving (tCO$_2$/yr.)	12.8
Capital Costs €	€50,625
Life Cycle (Years)	25
Simple Payback with Feed in Tariff (25 years)	8.9
Potential Grid connection costs and application (estimated) €	€5,000

Table 20. Predicted kWh savings Solar PV Array

**For the purpose of this report the costings and expenditure associated with the microgeneration scheme are included.*

PV Sol and Homer Pro software were used to model prospective solar PV systems for the building. It is proposed that a 40.5kWp system be installed on the roof of the building, mounted in a south orientation. It should be noted that this is a high-level feasibility study and sections of the roof will require surveying for roof penetrations associated with services. This may alter the predicted output of the solar array. A structural survey of the existing roof will be required to determine if the roof structure can support the additional load of the solar PV array system.

The proposed PV system is sized conservatively. The proposed PV system will export approximately 13.1% of its generated energy. The design predicts that the system will generate 36,922kWh per year, resulting in a carbon emission reduction of 12.8 tonnes. Of the generated energy, 4,842kWh is expected to be exported, and the remaining 32,080kWh will be consumed on site. The system is expected to cost €50,625 and will pay for itself in 8.9 years.

Cost Breakdown of Solar PV Array

Preliminaries	€2,500
Scaffold/access hire	€8,000
Supply of modules, inverters, ancillary equipment	€22,435
Installation of modules	€12,590
Electrical Attendances	€5,100
Commissioning & Certification	€incl.
Total	***€50,625***

6.5.1 NPV & IRR on Solar PV Array

This financial model tool for the solar PV projects allows the estimation of the cashflows, payback, IRR and NPV of a PV installation over 20 years. A cashflow analysis for two scenarios is put forward as follows.

- The Base Case. This scenario considers that the costs and savings are accurate.
- The Sensitivity Analysis. This scenario considers a 20% increase in capital cost, a 50% decrease in energy exports.

Method of Cost Calculation	Budget or Tendered Costs
Retrofit Type	High spec Solar PV Array Tier 1
Array Area (If Area Cost Selected) - m^2	196
System Cost (If Budget or Tendered Cost Selected) - €	€50,625
Energy Consumption Pre-Installation (kWh)	108,048
Method of Energy Savings Calculation	Calculated based on Survey
Post Retrofit Consumption (kWh - Elec) if Calculated Selected	75,968
Electricity Price (€/kWh)	€0.16

Table 21. Solar PV Input Data

Solar PV Array Installation (Base Case)	
Capital Outlay	€ 50,625
Total 20 Year Savings	€ 140,593
Payback years	8.97
Project IRR	11.6%
Net Present Value (NPV)	€34,489

Table 22. NPV, IRR & Payback on the Base Case Scenario for Solar PV Installation

Solar PV Array Installation (Sensitivity Analysis)	
Capital Outlay	€ 60,750
Total 20 Year Savings	€ 143,680
Payback years	9.62
Project IRR	9.3%
Net Present Value (NPV)	€26,100

Table 23. NPV, IRR & Payback on the Sensitivity Analysis Scenario for Solar PV Installation

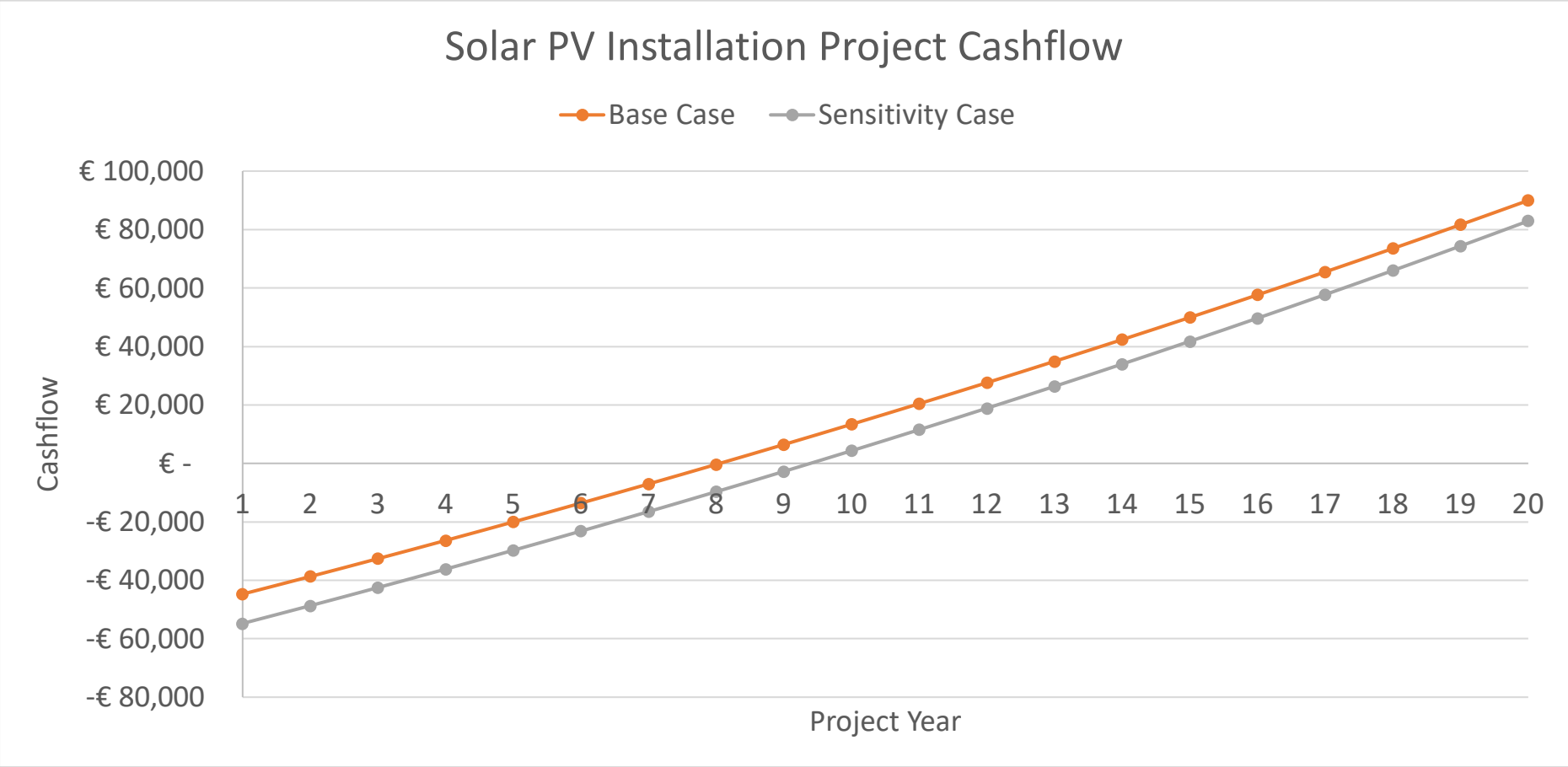


Figure 15. Solar PV Installation Project Cashflow

Refer to Appendix 9.8 for detailed calculation of NPV & IRR for both scenarios.

6.6 Heat Recovery Ventilation System

The current fresh air strategy within the building is achieved by mostly natural ventilation, with some mechanical ventilation in the construction rooms. The natural ventilation strategy is achieved in the office and teaching areas by opening and closing windows. To assist the operation of the heating system, drive efficiency of the heating system, and to minimise the fresh air load exerted on the system, it is recommended to install a heat recovery ventilation (HRV) system in the offices and all teaching spaces within the building. These spaces are heated via the radiator circuit, and it makes sense to recover this heat via a MVHR system.

The HRV system operates as a ventilation unit that recovers waste energy from the building's extract air. This heat is normally dumped to the atmosphere. No extra heat or energy source needs to be generated to run the system. The supply fresh air is tempered by the return extracted warm air leaving the space. Heat recovery is made possible by an ultra-thin paper core technology which is constructed in a corrugated form and layered in alternative directions as this specific design allows a cross airflow to maximise heat recovery without the supply and exhaust air mixing, therefore ensuring that fresh air only is supplied into the building. The units transfer between 79%-86%, (depending on the fan speed the unit is running at) of the energy from the warm extracted air to the cold fresh incoming air.

kWh Savings Associated with HRV Installation	
Existing Fresh Air Strategy	Natural Ventilation
Proposed Ventilation Strategy	Heat Recovery Ventilation
Area (m^2)	1,386
Occupancy Load Factor	7
Occupancy	198
Occupancy Diversity	90%
Occupancy	178
Fresh Air (l/s/person)	10
Fresh Air Requirement (l/s)	1,782
Fresh Air Requirement (m^3/s)	1.78
Mass - Convert form m^3/s to kg/s	2.14
Specific Heat Capacity of Air (kJ/kg.K)	1.02
Mean External Temperature (^0C)	9.8
Room Internal Temperature (^0C)	21
DT	11.2

Q (kW)	24.4
Run Hours	1,000
kWh Thermal Consumption	24,433
Heat Recovery Ventilation Efficiency	80%
kWh Thermal Saving with HRV	19,547
Load on Heat Pumps with HRV (kWh)	4,887
Capital Costings (€)	€75,000
tCO_2	3.5
Savings €	€412

Table 24. kWh Savings Associated with HRV Installation

Note: Electrical consumption of the HRV units if factored into the overall energy saving calculation.

Occupancy load factor and mean temperature are taken from the Technical Guidance Document Part B Fire Safety.

Cost Breakdown of Heat Recovery Ventilation

HRV unit supply	€45,000
Installation (Including ductwork, diffusers, grilles)	€19,000
Mains Power and controls	€6,000
Builders Works	€5,000
Total	**€75,000**

Table 1.1 **Occupancy load factor**

	Accommodation (1)	Occupancy load factor
1.	Standing area in assembly and recreation building	0.3
2.	Bar, lounge bar	0.5
3.	Restaurant, dining room, meeting room, committee room, staff room	1.0(2)
4.	Factory production area, open plan offices	5.0
5.	Bedroom or study bedroom	8.0(3)
6.	Offices, kitchen	7.0
7.	Storage building, car park	30.0(4)

Image 9: TGD B Fire Safety Table 1.1 Occupancy Load Factor

6.7 Roof Upgrade

The existing roof has an assumed U-Value of 0.61W/m²K in the pre-1994 construction section of the building, and 0.19 W/m²K in the 2008/2015 section of the building. It is proposed to upgrade / top up the insulation levels in all sections of the roof with mineral wool insulation. This measure will reduce the roof U-Value to 0.14, and 0.12 W/m²K respectively. Payback is normally high on building fabric upgrades; however, it is important to lower heat loss, improve indoor environmental conditions, and limit the ingress of outside air. This upgrade would also improve the comfort of occupants within the space. Total roof area 1,386m². Roof to comply with NZEB standards from a thermal performance perspective.



Image 10: 100mm Attic Insulation with 0.035 W/mK

Cost Breakdown of attic insulation

Supply of new roof insulation	€11,000
Installation of new roof insulation	€8,408
Ventilation as per SR54	€incl.
Total	**€19,408**

6.8 Replace the Windows and Doors with current Part-L Compliant Units

As mentioned previously in this report the windows in the building are in average condition from a thermal performance perspective. There is high outside air infiltration through the existing units. All the windows require upgrading to triple glazed units. The existing windows, roof lights and doors installed have a U-values of 1.6W/m²K, 2.6 W/m²K, and 2.6W/m²K respectively. The proposed replacement windows and doors have a U-value of 0.74 W/m²K and 1.3 W/m²K.

Savings associated with infiltration through the walls, windows, doors and roof are included in this measure, although a percentage of this should be spread across the fabric upgrade measures as air tightness works will form part of the scope in all fabric upgrades. Actual fabric savings associated with the window and door upgrade are 5,373 kWh. Total window area is 188m², total roof light area is 3.6m², and the total door area is 32m².



Image 11: Existing Doors & Wndows

Cost Breakdown of Window Upgrade

Preliminaries	€4,600
Supply of triple glazed windows, roof lights and upgraded doors	€105,050
Installation of windows and doors	€34,041
Total	**€143,691**

6.9 External Wall Insulation

Building insulation and building airtightness are extremely important when it comes to reducing energy consumption and improving thermal comfort for the occupants. The external wall is poorly insulated with an assumed U-Value of 1.0 W/m²K in the solid wall section of the college, and 0.27 W/m²K in the cavity wall section of the college. It is proposed to externally insulate the building with 100mm Kingspan Kooltherm K5 insulated board to achieve a U-Value of 0.18 W/m²K and 0.13 W/m²K. This goes above the requirements of 0.21 W/m²K at minimum for Part L compliance. Refer to Image 12 below from the typical external wall board specification. Payback is normally high on building fabric upgrades; however, it is important to lower heat loss, improve indoor environmental conditions, and limit the ingress of outside air. This upgrade would also improve the comfort of occupants within the space.



Image 12: Kooltherm K5 External Wall Insulation

Cost Breakdown of External Wall Insulation

Preliminaries	€4,850
Supply of insulation	€36,900
Installation of insulation	€29,549
Total	**€71,229**

6.10 Energy Awareness

By implementing an effective energy awareness campaign any unnecessary energy consumption in the building can be reduced. Measures in the energy awareness campaign will be low-cost measures and shall not require any professional trades or labour. It is recommended that they are carried out immediately. Further details on how to implement an energy awareness campaign can be found on the SEAI website at http://www.seai.ie/EnergyMAP/Energy_Awareness/

Ref	Opportunity	Cost Range	Additional Information / Comments
001	Ensure lights are not on when there is excessive natural daylight	No / Low	Opening of blinds in rooms should improve natural daylight level in rooms
002	Ensure PC monitors are switched to "Power Saving Mode"	No / Low	Power saving mode operates at 20% less energy than normal setting
003	Ensure PC monitors/photocopiers/scanners/lights are not left on overnight	No / Low	Turning off computers/photocopiers/scanners/printers/lights at night instead of leaving it on will reduce the overall energy consumption in the building
004	Ensure Dishwasher is full each time it is used to reduce no. of washes per year	No / Low	The dishwasher in the staff room is 1.96 kW. If it was used twice per week, it would consume approximately 196kWh or €65. Reducing the run hours will decrease the cost.
005	Install TRV's to radiators in the old section of the building	Approx. €100 per Rad	Most radiators are left turned on max all the time. TRV's allow for each radiator to be turned up or down by the teacher in the room. Allows for quicker temperature control and will reduce running costs of the boilers.

Table 25. Energy Awareness Opportunities

7 Assumptions

We have assumed:

- Energy inflation rate of 2% per annum

Assumptions have been made concerning.

- Operating hours per year (estimated)
- Lamp watts for lighting (surveyed/estimated) where lamp wattage could not be observed.
- Plant peak consumption kW (where not available from nameplates, product catalogues etc.)
- "ballast" factors for lighting to cover control gear.
- Load factors for HVAC equipment and motors etc. (estimated)
- Seasonal efficiency of heating plant (estimated using SEAI guidance figures based on age of boilers)
- Assumptions are documented in calculation spreadsheets of excel significant energy users.

7.1.1 Economic Analysis

In each case, simple payback period was calculated for The Register of Opportunities listed in Section 1.4 of this report. However, more detailed analysis in Section 6 of this report for item of plant that life cycle costings can be performed, namely.

- Solar PV Array
- Air Source Heat Pump (ASHP)
- LED Lighting Upgrade

Time of day utility rates are used as appropriate. Demand charges, capacity charges, etc. are ignored

8 Conclusion

The building has a variety of energy upgrade opportunities available including, solar PV, ASHP heating system upgrade, building fabric, LED lighting, and a distribution network upgrade. These opportunities are based on the current building layout and services that were identified at the time of the site visit. If the above measures are implemented there is potential for savings in energy costs and CO_2 emissions.

Not all thermal energy savings may be made as the building may currently be under heated in some spaces. From a health and safety viewpoint it is very important that space conditions meet current health and safety standards and Technical Guidance Document recommendations.

The proposed upgrades will increase sustainability and thermal comfort for the occupants and improve overall building services system performance and internal space conditions. A significant reduction of approximately 51% in total energy costs and 62% in carbon emissions could also be achieved.

It should be noted that depending on which measures are carried out, the sum of the savings can vary as one measure may depend on another or has a knock-on effect in terms of kWh savings and CO_2 emissions. The costs per measure are based on best estimates from Tipperary Energy Agency's previous projects and current product costs. Further engagement with industry is required to ascertain definite costs and how measures should be implemented. Predicted energy savings given above are from an energy calculation package and may be used as a close if not exact indication of the savings possible.

The 2021 Climate Action Plan sets out targets for all public buildings to meet the required level of emissions by 2030. The management team in both TETB and Templemore College will aim to improve the energy efficiency of all their buildings by 50%, and bring all their buildings to a minimum Non-Domestic Building Energy Rating (NDBER) of B. A range of energy saving opportunities were identified in this report that will require significant investment and planning. The table below summarises the potential savings that can be achieved, and also the reduction in carbon emissions.

Estimated Annual Savings		
€	**(kWh)**	**CO_2 (tonnes)**
€11,788	133,182	39
This is a cost saving of 51%	This is an energy saving of 64%	This is an emission saving of 62%

If all measures highlighted in this report are implemented, Templemore College will surpass the mandated 50% energy efficiency improvement, 51% absolute emissions reduction target, and a target B rating BER for Templemore College, as set out in the Climate Action Plan 2021, 2030 public sector-built environment targets, and Ireland's Long Term Renovation Strategy 2020.

TETB can deliver on the mandated criteria and targets for public sector bodies set out in The Climate Action Plan 2021 if the recommended measures are carried out in Templemore College. The main aim of the Public Sector Decarbonisation Strategy is to deliver 51% emissions reduction by 2030 and to develop a roadmap to carbon neutrality by 2050. Below is a list from the climate action mandate for public bodies that Templemore College will comply with should the recommended measures in this report become a reality.

- CO_2 reduction of 51% - ***62% potential reduction highlighted in this report.***
- 50% improvement in energy efficiency – ***64% potential improvement highlighted in this report.***
- Building to reach BER 'B' Rating – ***Potential to go to BER 'A' rating with recommended measures implemented.***
- Carbon neutrality by 2050 – ***Roadmap identified with improving measurement over time.***
- Adoption of measures which yield carbon abatement at no cost where lifetime costs are considered – ***Solar PV, LED Lighting, and ASHP.***
- Reporting of greenhouse gas emissions and sustainability activities in annual reports – ***Plan in process to actively market and promote sustainability activities to staff.***
- Establishing a green team to engage staff in being part of the solution – ***Climate Change Team to be put in place***
- Display up-to-date DEC (Display Energy Certificate – ***Already actioned by the team in TETB***.
- Facilitating employees in adopting lower carbon lifestyles – ***Plan to be identified by the team.***
- Implementing all measures which reduce carbon emissions, which have a positive NPV (Net present value), using the trajectory for carbon price issued by the Department of Public Expenditure and Reform – ***Measures identified in this report with positive NPV.***
- A proportion of energy to come from certified renewable sources and/or onsite renewables – Proposed - ***Solar PV array identified in this report demonstrating onsite renewable energy generation.***

9 Appendices

9.1 Solar PV Design Report

9.2 Typical Solar Panel Specification

9.3 Typical Attic Insulation Specification

9.4 Typical External Wall Insulation Specification

9.5 Typical HRV Specification

9.6 Typical Air Source Heat Pump Specification

9.7 LED Lighting NPV & IPP

9.8 Solar PV NPV & IRR