

2019 Energy Review



National University of Ireland Galway

Prepared by

The NUI Galway Energy Team

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1 Energy Review Summary

This energy review is being carried out to comply with the ISO5001: 2011 Energy Management System (EnMS) standard. The relevant clause is 4.4.3 and its main purpose is to determine NUI Galway's energy performance based on data and other information leading to identification of opportunities for improvement. It is defined as the process of identification and evaluation of energy use leading to the definition of areas of significant energy usage and the identification of opportunities for improving energy performance.

Buildings that are included within the scope of the NUI Galway ISO50001 EnMS are documented and included in a thorough review and updated on the NUI Galway Energy Dashboard. There are 58 buildings included that have a total internal floor area of 155,090 m².

Internal audits of the ISO50001 EnMS have been carried out during 2019 and a number of observations were noted. Those observations coupled with resulting actions taken, compliment the continuous improvement statement as outlined in the NUI Galway Energy Policy.

Section 2, Energy Review ~ Analysis outlines the current (2018) energy sources; including the type, quantity, cost and environmental emissions associated with that energy usage. Additionally, an evaluation of the past and present energy usage is also outlined. Section 3, Energy Review ~ Significant Energy Users, outlines NUI Galway's energy baselines, energy performance indicators, significant energy users, other relevant variables, current energy performance and the estimated future energy usage and consumption. Section 4, Energy Review ~ Opportunities for Improvement, documents recent and ongoing energy management system's related improvements, energy management actions and current legal and other requirements pertaining to its operations as a large Irish Public Body.

The management team measure electrical and thermal energy performance using key performance indicators; kWh (e)¹ and kWh (th)² per metre squared of treated floor area per annum. These are termed Energy Performance Indicators, or EnPIs, and are being used to set targets for enhanced energy performance improvement plans.

NUI Galway operate a formal EnMS which is compliant with the requirements of ISO50001; Energy Management Systems Standard. The Energy Review is carried out once a year. If there is a major change; such as the addition, or decommissioning, of a building, that effects the scope of NUI Galway's ISO50001 Energy Management System, then the energy review, and accompanying document, is updated accordingly. The Energy Review is normally carried out during September, and compiled, reviewed and reported during October, each year.

¹ kWh (e) relates to electricity related usage – the average unit price per kWh(e) used is €0.132c

² kWh (th) relates to gas usage – the average unit price per kWh(gas) used is €0.068c

2 Energy Review ~ Analysis

2.1 Current Energy Sources

The current energy sources being utilised at NUI Galway to sustain its activities are outlined on table 1. In the main, the campus uses imported electrical and gas related energy to sustain its operations. It also uses a considerable amount of renewable energies such as combined heat and power plant, biomass boiler, solar thermal and solar photovoltaic systems. The campus building's energy consumption during 2018 is set out in Table 1 and summarised in figures 1, 2 and 3.

Table 1: Annual Energy Consumption, Energy Costs & CO2 Emissions (t)

Fuel	2018	
	Quantity [kWh]	CO2 Emissions [t]
Net Electricity Imports	17,424,502	7,607.5
Net Electricity Generated on-site- Est.	160,000	-69.9
Gas Imports	15,689,313	3,211.6
LPG	698,010	160.1
Gasoil	1,371,595	362.0
Wood pellets	459,082	-121.2
Solar Thermal	75,000	-19.8
Road Diesel	80,250	21.2
Biodiesel Litres/% biodiesel	1,325,120	265.0
Total	37,282,872	11,416.5

<https://www.seai.ie/publications/Commercial-Fuel-Cost-Comparison.pdf>

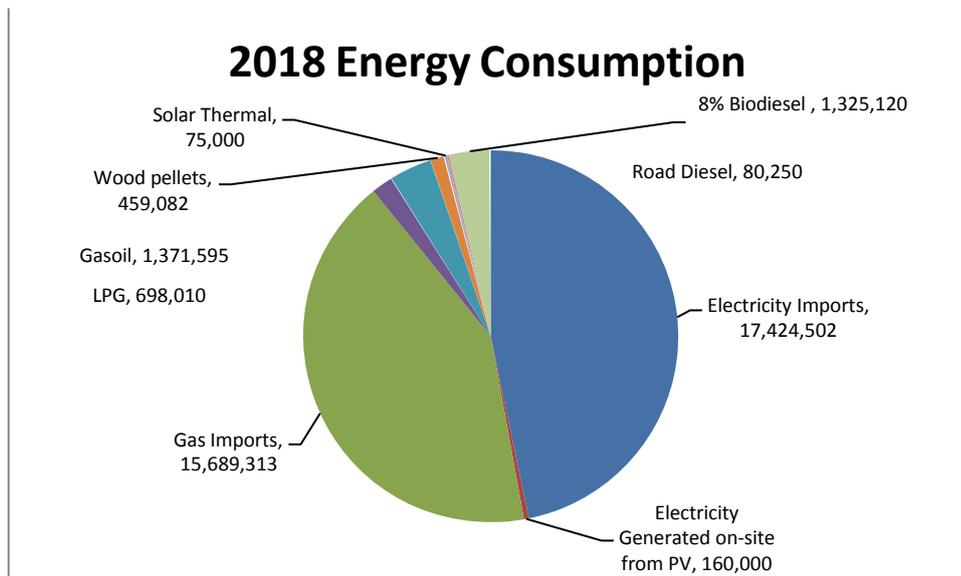


Figure 1: 2018 Breakdown of Energy Consumption (kWh)

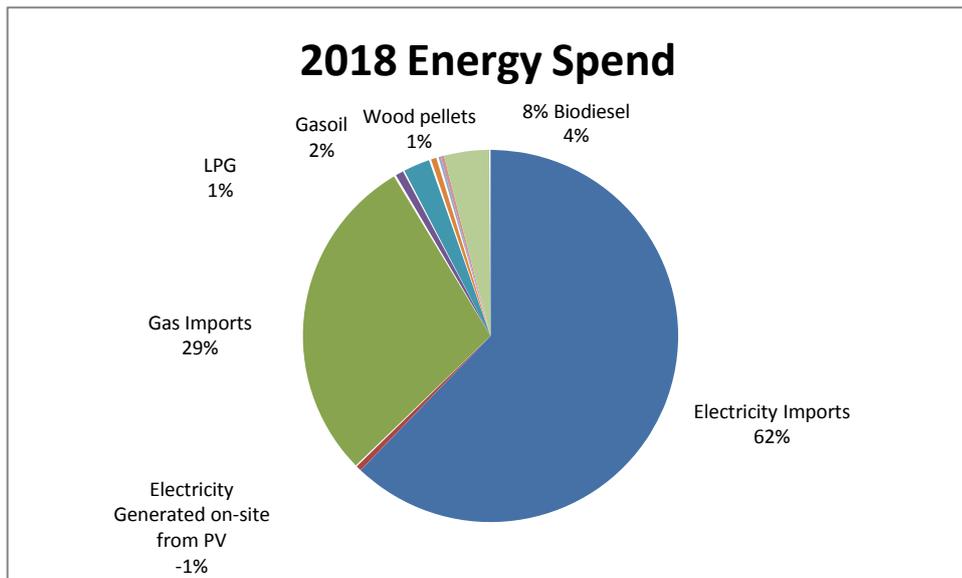


Figure 2: 2018 Breakdown of Energy Spend

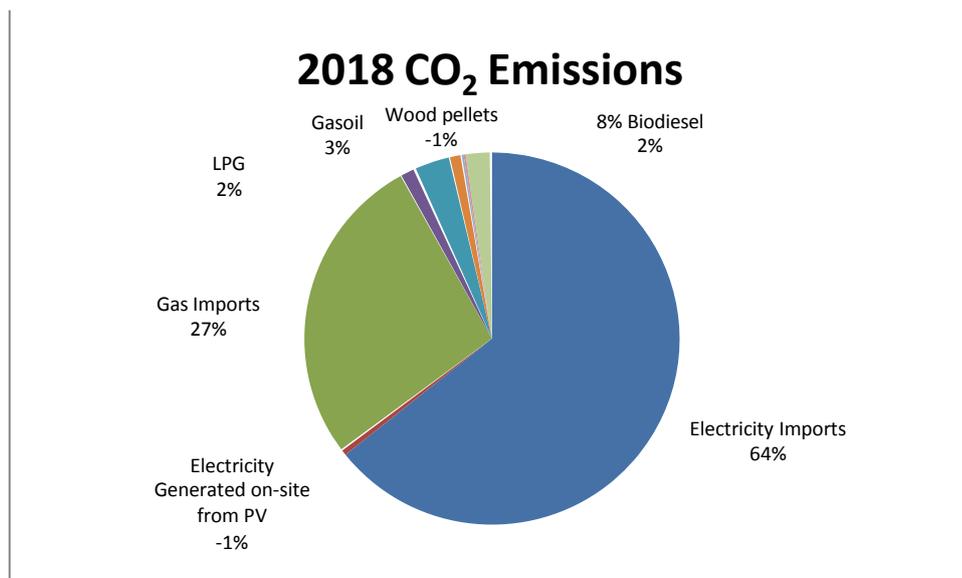


Figure 3: 2018 Breakdown of Energy Related CO₂ Emissions

2.2 An evaluation of the past & present energy use and consumption

An evaluation of the past and present energy use and consumption was carried out using the SEAI's M&R System. This is the national database of all public sector organisations' independently assessed energy profile. This is being used as it demonstrates that we are being independent in our assessment criteria. However, this data includes energy used to sustain science and research activities carried out at the SRB Building and that building is not included in NUI Galway's ISO50001 scope. This is discussed in more detail in section 1.5.

Since Baseline to 2018



Energy Performance Indicators - 2018

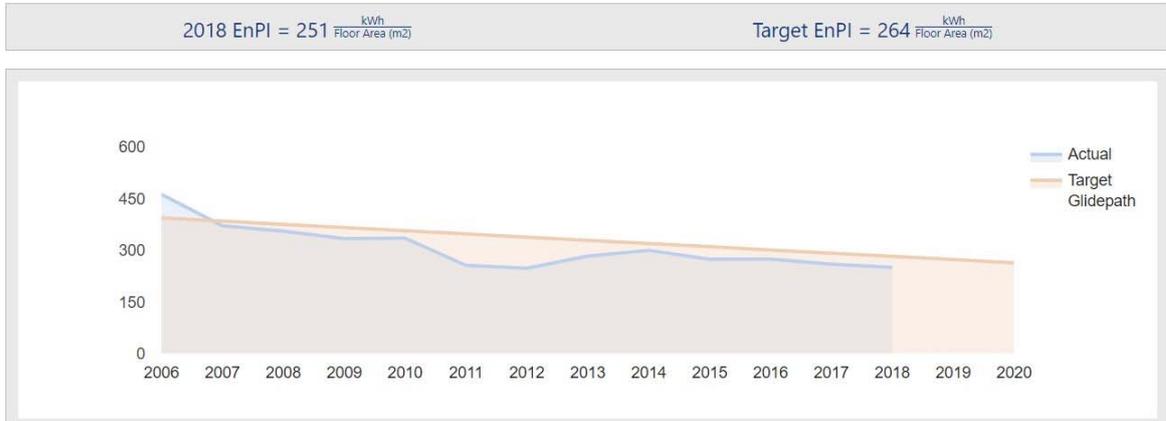


Figure 4: NUI Galway’s actual energy performance Source SEAI’s M&R System

3 Energy Review ~ Significant Energy Users

3.1 Energy baseline

The energy baseline used is the kWh (e) and kWh (th) per m² of treated floor area. The baseline year is 2006 and NUI Galway’s progress since then is plotted on Figure 4. Our energy performance during 2006 was 462.64 kWh per M² of treated floor area. During 2018 that figure fell to 251.36 kWh per m². The target for 2018 was 282.90 kWh per m². The target for 2019 is 273.60 and for 2020 is 264.30. It is worth noting that during 2011 and 2012, our performance was 256.78 and 248.77 respectively.

NUI Galway’s target for 2019 is 273.60 kWh/m², which is above the 2018 performance level (251.36 kWh per m²). It is expected that our performance will decrease during 2019, as the new Human Biology Building, becomes fully operational. That building is fully treated with exact heating, cooling & humidity controls and comprises of 8,000 m².

During 2019 and 2020 the target performance drops to 273.6 kWh/m² and 264.3 kWh/m², respectively, and we have already reached our 33%, 2020 target. That said, the team has decided to introduce a 40% target by 2020; and we are well on the way to achieving that target as our performance during 2018 is 36.3% better than our baseline year. This equates to an overall target of 3.7% during 2019 and 2020.

It is expected that SEAI’s 2030 targets will be incorporated into next year’s National M&R System, and the target for all public sector organisations will be a 40% improvement in their energy efficiency compared to the baseline year; which in our case is 2006.



3.2 Energy performance indicators

The management team measure its electrical and thermal energy performances using key performance indicators; kWh (e) and kWh (th) per metre squared of treated floor area per annum. These are termed Energy Performance Indicators, or EnPIs, and are being used to set targets for enhanced energy performance improvement plans. Electrical and thermal energy related energy performance indicators (EnPIs) are also used to demonstrate compliance with and achievement of Public Sector 2020 targets, the use of EnPIs may be developed further to include performance monitoring of each of its significant energy users such as the chiller, IT equipment, catering, lighting, boilers, and CHP plant.

Table 2: 2009-18 Energy performance indicators

Year	Energy Performance Indicator (EnPI)	
2018	kWh (e & th) /m ²	251.36
2017	kWh (e & th) /m ²	260.43
2016	kWh (e & th) /m ²	275.34
2015	kWh (e & th) /m ²	274.66
2014	kWh (e & th) /m ²	300.29
2013	kWh (e & th) /m ²	283.71
2012	kWh (e & th) /m ²	248.77
2011	kWh (e & th) /m ²	256.77
2010	kWh (e & th) /m ²	336.32
2009	kWh (e & th) /m ²	334.55
2008	kWh (e & th) /m ²	356.04
2007	kWh (e & th) /m ²	371.86
2006	kWh (e & th) /m ²	462.64

Additionally, EnPIs (kWh (e)/m² of treated floor area) are being used to monitor the energy performance of each building and those are reported and discussed during monthly energy review meetings. In the case where buildings are under performing by 10%, or overperforming by 20%, the reasons why the performance has improved or worsened are noted and follow on actions are agreed. Those are then documented and followed up on during the course of the next few days, and reviewed again during the next scheduled energy review meeting. In this manner, the EnPI data is being used as a springboard for enhanced energy efficiency. NUI Galway are using EnPIs as an essential tool for developing

an effective EnMS and are also using those as a method to demonstrate that it is achieving its targets for improvement.

Finally, we also use Display Energy Certificates (DECs) to report each publicly used building, to report the operational performance, in kilograms of CO₂ per m² of treated floor area. The DECs are a performance rating and also demonstrate that we are compliant with the requirements of the European Union (Energy Efficiency) Regulations and the Irish Statutory Instrument; S.I. 426 of 2014. Examples of 2 DECs carried out at The Martin Ryan Institute Annex and The Arts Millennium Building are outlined on Appendix A.

3.3 Significant Energy Users

The main energy consumers are summarised in Table 3 below. This table is based on the electrical energy using data obtained using the Building Energy Management System (BMS). A table for primary thermal energy users is being developed to include information from the new thermal energy meters.

This table is being used to prioritise opportunities and to support cost accounting exercises. The Arts Science Building include the Main concourse, Chemistry/bio-chemistry and Physics. Also note that the Science Research Building (SRB) is outside the scope of the ISO50001 Energy Management System, and is being managed and operated by Apleona.

Additionally, Sankey diagrams are being used to display the energy usage of the significant energy users within buildings. An example of the Arts Millennium Building Sankey Diagram is outlined in Appendix E.

Table 3: Summary of top 10 electrical energy consuming buildings – Oct'17 to Sept'18 and Oct '18 to Sept 19

Name	Year	GIA ³	2018 kWh (e)	2019 kWh (e)	Diff.
Arts Science Building – All Departments	1970, 1973	31,312	4,839,060	4,545,941	-293,119
Science Research Building	2012	8,212	2,543,815	2,616,242	72,427
Human Biology Building	2017	8,000	1,422,039	1,545,019	122,980
James Hardiman Library	1980	9,415	1,412,322	1,333,950	-78,372
Orbsen Building	2003	6,491	1,372,751	1,350,307	-22,444
Engineering Building	2011	14,145	1,193,122	1,135,424	-57,698
Arts, Humanities, Social Sciences Research Building (AHSSRB)	2013	5,436	843,520	791,001	-52,519
Arts Millennium Building (incl. AMBE extension)	2000, 2012	8,054	575,260	603,848	28,588
Áras de Brun, Anatomy & Terrapin	1960	2,426	601,259	548,698	-52,561
Áras Na Mac Léinn / Cultural centre	1995	4,307	591,808	555,411	-36,397
Overall			<u>97,798</u>		<u>-369,115</u>

³ GIA – Gross Internal Floor Area

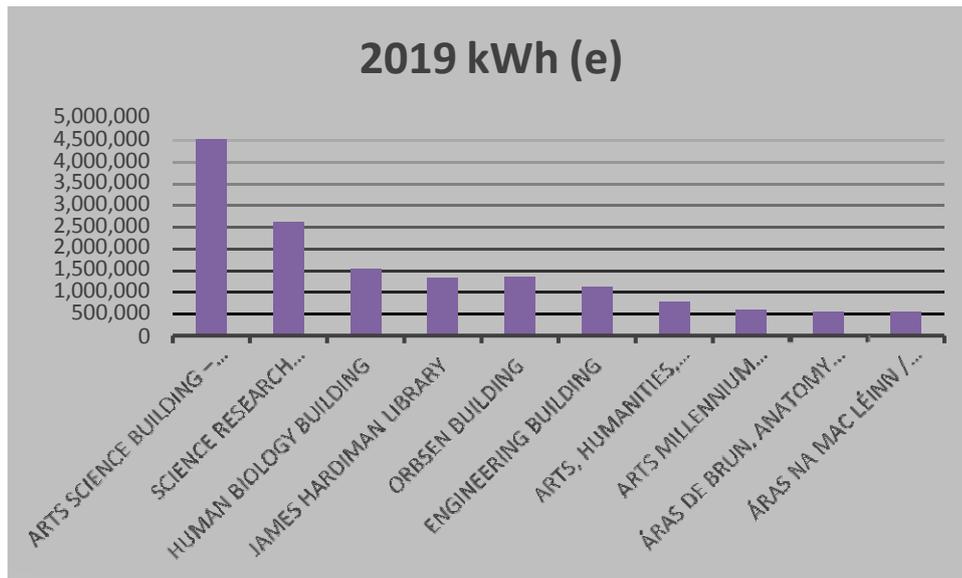


Figure 5: Summary of top 10 electrical energy consuming buildings – Oct'18 to Sept'19

3.4 Other Relevant Variables

There are a number of other relevant variables such as number of students and staff (and researchers), number of conferences, number of projects completed (including new or renovated buildings) and degree days⁴. Degree days and regression analysis exercises have been carried out on a number of buildings using a base temperature of 15.5 deg C. Those buildings are the Science Research, Engineering (Alice Perry Building), Arts Science and the Orbsen Buildings.

Building works on new buildings will have a negative impact on the energy performance of the campus; as construction related energy usage (generally electricity) will be supplied using the campus' main incomers and the overall performance of the campus is measured in kWhs per unit of treated floor area (which will not include buildings being constructed).

As part of last year's Green Flag initiative, it was decided to develop a carbon and energy per student related key performance metric and this has proved to be a successful tool in engaging with students to enable them to become conscious of their impact on energy and carbon usage at our university. The number of students and the attributable energy and carbon emissions continue to be reported and graphed. The use of carbon performance metrics will be more prevalent in future as this method compliments the move towards a more sustainable campus.

⁴ Degree days are essentially a simplified representation of outside air-temperature data. "Heating degree days", or "HDD", are a measure of how much (in degrees), and for how long (in days), outside air temperature is lower than a specific "base temperature" (or "balance point"). Source www.degreedays.net

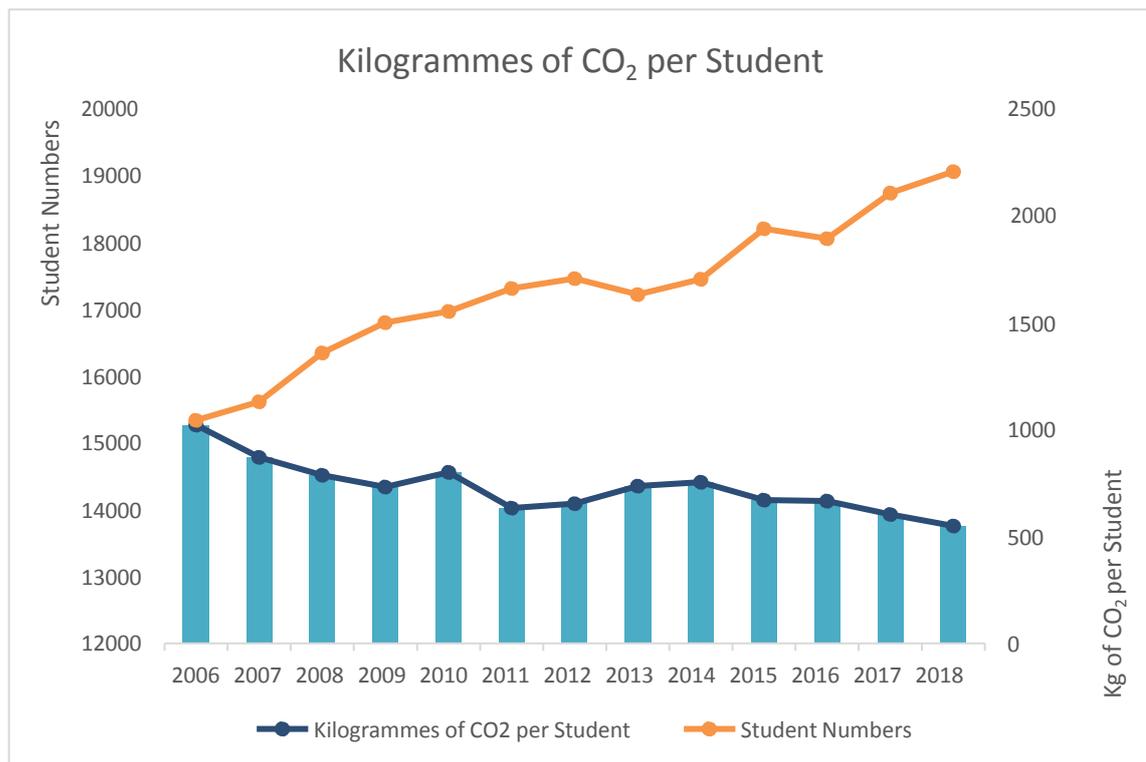


Figure 6: Kilogrammes of CO₂ per Student (2006-2018)

3.5 Current Energy Performance

As discussed previously, the current energy performance of buildings is being monitored daily and being reported on a monthly basis. The energy team reviews the performance of each of the significant energy using buildings; using monthly cumulative electrical energy usage data, and compares that to the cumulative electrical energy usage for the equivalent month, from the previous year. Additionally, the annual SEAI M&R Report is being used to review the college's current energy performance. NUI Galway's progress on the M&R systems is being monitored on an ongoing basis. Top management receive a copy of the M&R Annual Report and their comments and any direction given are incorporated into the work undertaken by the Energy Team.

3.6 Estimate future energy usage and consumption

An estimate of the college's future energy usage and consumption was carried out. Historical data was collected over the past 10 years and used to carry out these estimates. The energy usage and consumption may increase during 2019 mainly due to the projected growth in student numbers and research intensity. The expected energy usage and performance is used to budget for energy usage, consumption and costs over the next period. That increase is factored into the predicted energy use as outlined on the figures included in Table 4 as below. Additionally, the predicted energy consumption is itemised and that factors in energy increases due to factors outlined above and also our energy reduction target; which as stated previously, is 40% up to 2020 or 3.7% between now and the end of 2020.

Table 4: Estimate of Future Energy Usage and Consumption

MWh -Usage	2019	2020	2021
Electricity	19,170	18,595	18,037
Gas	17,144	16,630	16,131
Heating Oils	783	759	737
Wood Fuels	449	436	423
Solar Thermal	67	65	63
Bio Diesels	1,563	1,516	1,470
Total	39,175	38,000	36,860
EnPI -Consumption			
KWh per Meter Squared (Floor Areas)	183.06	177.57	172.24
Total Primary Energy Equivalent (which will change every year)	245.48	230.55	215.62

4 Energy Review ~ Opportunities for Improvement

4.1 Recent/Existing Energy Saving Initiatives

Noel O'Connor, Lorraine Rushe, Michael Curran and the energy team at NUI Galway are doing great work in implementing and using their ISO 50001 compliant energy management system, to achieve targets and objectives, and to demonstrate compliance with its legal obligations. Lorraine is the acting Energy Manager and she manages the entire ISO50001 System. The energy team comprises of Noel O'Connor (Assistant Director, Estates Operations), Michael Curran (Head of Building Services, Energy & Utilities), Seán Farrell, Anthony Nevin (Mechanical Supervisor), Kenneth O'Toole (Electrical Supervisor), Karl Byrne (Building Management Systems' Consultant) and John Harrington (Energy Management Systems' Consultant). Occasionally, other interested parties are invited to attend and to present to the EnMS Team. In general, the team meet once a month to undertake a review of the EnMS and in particular to review each of the significant energy using building's monthly energy performances. Actions are taken to address any deviations that are found to be + 10%, and -20%, from the norm; see also Section 3.2.

Noel O'Connor has continued to lead the ISO50001 Energy Management System and represents top management. Noel has continually demonstrated his commitment to supporting the EnMS and is focused on delivering an effective system; by defining, implementing and maintaining the NUI Galway Energy Policy. He has appointed Lorraine Rushe as the Energy Manager and has provided the resources⁵ needed to maintain and improve the EnMS and resulting energy performance.

In addition to managing the NUI Galway ISO50001 EnMS, Lorraine has been pivotal in securing the An Taisce Green Flag for outstanding environmental leadership within the college. This flag is a testament to the campus wide environmental awareness programmes that have been put in place. This was awarded in April 2019 and some more details are outlined on Appendix C. Furthermore, Lorraine has developed the legal and other requirements aspect of the EnMS. The external legal registrar is Antaris Consulting, trading

⁵ Resources include human resources, specialised skills, technology and financial resources.

as Pegasus. That registrar updates and advises NUI Galway on their energy, environmental and health and safety legal obligations. Lorraine and her team have received training in the use of the Pegasus System. The work carried out by Lorraine has ensured that NUI Galway is fully compliant with the Legal and other requirements (4.4.2) and Evaluation of legal requirements and other requirements (4.5.7) clauses of the standard.

Michael Curran has managed the over-haul of the energy management dashboard. That entailed the re-design and re-development of the interfaces and the addition of a number of sheets such as Procedures, Electrical & Thermal Logic Diagrams and Legal Requirements. The 'new' dashboard is a fantastic document and will copper fasten it as one of the key EnMS collection and dissemination communications tools. Seán Farrell has joined the energy team in the past year and has been given responsibility for supporting Michael in the development and maintenance of the NUIG Energy Dashboard.

Karl Byrne has developed and managed the Monthly Building Performance Reporting System. He presents the results to the energy team once a month. He follows up on any metering related action(s) and updates the reports and corrective actions accordingly.

John Harrington has carried out and completed Internal Audits of the EnMS system during 2018. A number of observations were found and, in each case, Lorraine Rushe was informed using the Internal Audit Report Feedback Forms. John also supported Lorraine in following through, and closing out, actions required arising from those observations.

NUIG's main objective is to reduce electricity and thermal related energy consumption and to improve the overall energy performance of its buildings. The energy performance improvement results during 2018; taken from the Sustainable Energy Authority of Ireland's M&R System proves that NUI Galway's EnMS is being implemented effectively.

Furthermore, the energy team has been recently awarded the national SEAI award for best performing Energy Manager and Energy Team. Figure 6 outlines a photo taken at the ceremony held on 16th October 2019. This is a recognition and award for demonstrating continued excellence in energy management practices.



Figure 6: Michael Curran receiving the Energy manager and Energy team of year award at this year's national SEAI Energy Awards

Additionally, the Buildings & Estates Team are doing great work on developing energy efficiency projects such as deep energy efficiency upgrades, Boiler-house upgrades, LED lighting replacement projects, implementing set back HVAC opportunities and replacing older generation pumps with modern energy efficient equivalents and continuing to roll out renewable energy projects such as the installation of large scale photovoltaic and solar hot water systems and biomass boiler and combined heat and power plant upgrades. A list of completed projects are outlined in the next section, 4.2 ~Energy Management Action Plan.

By taking an energy management system's approach to reducing energy costs and usage, NUI Galway continually improve its energy performance and, in so doing, reduces its environmental burden

4.2 Energy Management Action Plan

A number of opportunities for further energy savings have been carried out over the past year. The most significant projects include Boiler-house upgrades; moving from oil to condensing gas/heat pump technology, the continued roll out of energy efficient space heating pumps and the ongoing replacement of florescent light fittings with LED equivalents e.g. The Library, Dunican Theatre, Human Rights Building, Dangan Hurling Pitches etc. Furthermore, the energy measurement and metering systems have been comprehensively upgraded and the graphical user interfaces improved significantly. See also Appendix B.

Additionally, #9 Distillery Road has been significantly upgraded and has been designed to achieve an A2 rating. This include a small PV installation, Heat pump, and comprehensive zoning. Furthermore, the fabric has been upgraded with 100mm wrap around insulation, attic insulation and triple glazed windows and passive house standard doors.

Similarly, an ongoing list of opportunities for improvement and potential projects; for the current period, 2019-20, are outlined in the Register of Opportunities (ROO). The values quoted for energy savings are reasonable estimates and calculations, and any assumptions made, are carried out on the right-hand side of the ROO sheet.

One of the highlight action plans relates to the 2030 Zero Carbon Action Plan. NUI Galway is formulating a fully costed action plan to transition to a zero-carbon campus in the next decade. It includes the installation of 2 district heating networks with a biomass energy centres which is estimated to cost in the region of €3.4 mio. Other key actions relate to the numerous fume cupboards; and retrofitting new energy efficient motors and new screens to same, carrying out behavioural change campaigns to improve the energy efficiency of ICT equipment and reviewing the building fabrics with the view to improving U-values and thermal mass of buildings and reducing unwanted draughts and noise.

The ROO is an active document with 42 opportunities in the seeking funding category, 22 opportunities that have been approved ,11 that have been completed recently and a further 3 that are ongoing. There are also 6 opportunities that have not garnished approval and these are on hold. The ROO is a colour coded document for ease of use. Table 5, below contains a summary of the potential projects and their expected savings. This table forms the basis for achieving energy efficient targets; that are set at the annual management review meetings.

Table 5: Summary of the 2019-20 energy efficient projects; either seeking approval, approved or completed, and their respective kWh (t), kWh (e), Kilogrammes of CO2 and Cost Savings and the average payback periods

	Status	kWh (t)	kWh (e)	KgCO2	Capital Cost (€)	Saving (€)	Payback
2019-20	Seeking	6,248,925	2,197,656	7,903,086	5,130,795	1,670,076	3.07
	Approved	752,945	566,506	422,813	472,160	154,491	3.06
	Completed ~						
	Approved-Ongoing	99,212	346,136	1,028,869	383,000	250,160	1.53
	Total		7,101,082	3,110,298	9,354,768	€5,985,955	€2,074,728

Table 6, gives an outline of the opportunities for energy efficiency improvements and are categorised as Seeking Funding/Approval, Approved, completed ~ Approved/Ongoing or Not Approved. These are colour coded in light brown, light green, dark green and red, respectively. The following tables should be read in conjunction with the master ROO; which is presently at Revision 4.

Table 6: Opportunities for Energy Savings and Action Plan (2019-20)

NUI Galway National University of Ireland, Galway		ISO 50001		Register of Opportunities 2019/2020											
NUI GALWAY		Michael Curran / Lorraine Rushe / John Harrington		Noel O'Connor		Estimated Annual Savings									
Building	Opportunity/Objective	Energy	Reason Included	Comment	Business Unit	Project Approval	Fuel Type	KWh (t)	KWh (e)	KgCO2	Capital Cost (€)	Saving (€)	Payback	Comment	
NUI Galway	2030 Carbon Zero Planning, Strategy document for January 2020 costed for the complete campus.	Therm/Elec	NUI Galway must meet the challenges set out by the Government Climate Action Plan	MC to attend briefing with Department of Climate, this shall include a complete review of all the existing mechanical and electrical equipment and check inefficiencies	Buildings and Estates										
ISS	Review of all IT software and the use of PCs, Printers, electronic equipment, AV etc	Elec	NUI Galway must look at the behavioural requirements of all its staff in the use of IT equipment and also the cost running of all equipment during the week ends and evenings. Green Procurement of all new equipment	Strategic alliance with ISS on the computer equipment	Buildings and Estates/ISS										
Fume Cupboards	Review the upgrade of older stock of Fume Cupboards with new energy efficient motors and use of new screens etc	Elec	Review the existing 180+ plus Fume Cupboards and introduce new VSD on fans and replace aging stock.	Review with Science based units	Buildings and Estates										
FABRIC	The energy team need to review energy projects in the replacement of Fabric in buildings windows etc	Therm	Strategic review of the buildings to look at costs associated with Fabric upgrades to buildings	Building Engineer and Energy team	Buildings and Estates										
Anatomy	Upgrade boiler house from oil to natural gas, new boiler and burner	Therm	Removal of oil off site, install new natural gas supply and boiler house	Energy efficient installation, new controls etc.	Anatomy	SEEKING	Thermal	28,000		5,768	135,000	13,797	9.2	Additionality, Replacing oil use on campus - Health, Safety & Environmental risk mitigation	
AMB	Upgrade controls to the boiler house serving the arts millennium building	Therm/Elec	The existing control panel has had modification carried out and is installed a number of years, replace the panel and update controllers	Existing control panel needs to be changed out and new modern controls to be installed. Recommendation from controls specialist.	Arts Millennium Building	SEEKING	Elec/ Thermal	259,661	0	53,153	138,000	17,865	2.1	Thermal savings are estimated. There will be additional electrical savings accrued, but these are difficult to estimate	
Áras na Mac Léinn	Upgrade the heating system considering heat pump technology	Therm/Elec	Boiler is inefficient and does require attention	Upgrade the existing thermal heating system to consider Heat Pump	Áras na Mac Léinn	SEEKING	Elec/ Thermal	602,784	-172,224	123,390	178,000	141,472	1.9		

Arts Science Building (Microbiology)	Window Upgrade	Elec	Single glazed units are not fit for purpose	Qty 50 * Metal framed, Single glazed units to uPVC double with an expected improvement of from 5 watts per m ² . K to 2.8 watts per m ² . K.	Arts Science	SEEKING	Thermal	55,642		11,390	1100,000	13,828	26.1	Payback is quiet high
CHP Project 01	Supply and Installation of CHP to the Biomedical Research Building	Therm/Elec	New 140 kW units	Provision for CHP has been left for a unit in HBB	Biomedical Research Building	SEEKING	Elec/ Thermal	686,040	686,040	356,054	1267,750	1124,026	2.2	E-Tender requirement (140 kW E & 187 kW T)
BOI Theatre	Upgrade the lighting to the BOI Theatre	Elec	The existing lighting is highbay light fittings and switch control.	Install new LED lighting to serve the BOI Theatre	BOI Theatre	SEEKING	Electrical	3,585	3,585	1,861	13,500	1478	7.3	
Cairnes	Upgrade boiler house from Oil to LPG, new boiler and burner	Therm	Removal of oil off site, install new natural gas supply and boiler house	Energy efficient installation, new controls etc.	Cairnes	SEEKING	Thermal	179,379		36,719	138,000	112,341	3.1	
Campus Wide	Develop district heating networks for the North & South Campus	Therm	Installation of 2 comprehensive district heating networks linked to 2 energy centres.	Application made to the carbon fund and submitted in October 2018	Campus Wide	SEEKING	Thermal	2,493,600		5,676,970	13,552,090	11,117,095	3.2	Link to the Application Document, Calculations sheets and application details
Cultural Space	Replace two direct gas fired air handling units feeding student centre	Therm	Existing Direct gas fired units are not efficient and need to be replaced	Installation of new energy efficient Air Handling units	Cultural Space	SEEKING	Thermal				170,000			Additionality; is is also a Health and Safety related Project
No. 14 University Road	Deep Retrofit project - Installation of new electric heat pump and associated works, new radiators and controls. Installation of insulation in cavities.	Therm	Existing heating installation not efficient and heating in house is very poor	Installation of Electric Heat Pump and radiators/insulation	No. 14 University Road	SEEKING	Elec/ Thermal	33,755	-9,644	6,910	130,000	12,322	12.9	SEAI Better Energy Grant, insulation etc - Need to carry out a BER and establish the EE measures and resulting improvements
No. 12 Distillers Road	Deep Retrofit project - Installation of new electric heat pump and associated works, new radiators and controls. Installation of insulation in cavities.	Therm	Existing heating installation not efficient and heating in house is very poor	Installation of Electric Heat Pump and radiators/insulation	No. 12 Distillers Road	SEEKING	Elec/ Thermal	33,755	-9,644	6,910	130,000	12,322	12.9	SEAI Better Energy Grant, insulation etc - Need to carry out a BER and establish the EE measures and resulting improvements
Engineering	Installation of 100sqm Solar PV to the roof of Engineering	Elec	Installation of 100sqm of Solar PV to the roof Engineering Building	Panels installed to reduce electrical load of the engineering	Engineering	SEEKING	Electrical		11,169	5,392		11,360		
CHP Project 02	Supply and Installation of CHP unit to the Human Biology Building	Therm/Elec	new 140 kw units	Provision for CHP need to find space in SRB	Human Biologs Building	SEEKING	Elec/ Thermal	686,040	686,040	356,054	1267,750	1124,026	2.2	E-Tender requirement (140 kW E & 187 kW T)
Kingfisher	Upgrade of 2no existing natural sectional boilers to gas condensing boilers and controls	Therm	Installation of new wall hung gas condensing boilers and controls	New gas condensing cascading boilers and controls	Kingfisher	SEEKING	Thermal	720,000	720,000	148,320	152,000	18,657	6.0	
O'Donoghue Theatre	Installation of 20sqm Solar PV to the roof of O'Donoghue Theatre	Elec	Installation of 20 SQ M of Solar Photovoltaic Panels to the roof of O'Donoghue Theatre	Panels installed to reduce electrical load of the O'Donoghue	O'Donoghue Theatre	SEEKING	Electrical		2,234	1,078		1272		
Orbsen Building	Refurbishment of 12 no air handling units to the Biomedical section of the Orbsen building	Therm/Elec	Installation of new Energy efficient fans, controllers, filters and heater/cooling coils, resealing the air handling units	Master air air handling units installed 16 years need to be upgraded.	Orbsen Building	SEEKING								
Physics	Upgrade of 4no fume cupboards to the Physics department, central fan and ducting.	Elec	Installation of 4no fume cupboards and 4 separate fans and VSDs	VSDs on fans etc.	Physics	SEEKING	Electrical	20,000	20,000		165,000			Health and Safety project
Shannon	Replacement Air Handling unit project in Shannon Catering Colleges	Therm/Elec	Existing Air Handling units installed around 1997, Masterair systems, controls not working and not efficient	Recommendations to replace air handling units with new packaged energy efficient units	Shannon	SEEKING	Elec/ Thermal			8,956	145,000	12,259	19.9	Existing system to is redundant and needs to be replaced urgently. No works were done previously and there is a legacy issue.
Tower 1 & 2	Upgrade existing lighting in both Towers to LED lighting inline with other buildings	Elec	Installation of LED panels, recessed lights and control sensors	LED Lighting and controls	Tower 1 & 2	SEEKING	Electrical	57,158	57,158	29,655	123,950	17,622	3.1	surface fittings requirements
Carna	Upgrade the existing oil fired water heater and the oil fired boiler in the Research building	Therm	Existing ACV water heater and oil fired sectional boiler	Install new LPG Gas to the site and replace burners only	Carna	SEEKING	Thermal							

Áras na Gaeilge	Boiler Upgrade	Elec	Boiler is inefficient and does require attention	Upgrade the existing therm heating system to Condensing Gas Boiler & Cascade Control technology - Apportioned the capital cost as follows: (23k to space heating upgrade and 15k to DHW Upgrade)	Áras na Gaeilge	Approved	Elec/ Thermal	241,114	4,140	51,355	123,000	117,093	1.3	Reviewed on 30th Oct and this project is almost complete. Pumps have been upgraded. Boilers are in place, Being commissioned.
Áras na Gaeilge	DHW Upgrade - Included in the boiler house upgrade project, as above	Elec	The capital cost includes boilers, pumps, calorifier & associated controls	See over & above	Áras na Gaeilge	Approved	Elec/ Thermal	-48,223	60,480	13,411	15,000	14,049	1.2	Reviewed on 30th Oct. Calorifier has been delivered and will be installed over the next few days.
Áras de Bruin	Install new LED Lighting to the upper floors	Elec	Existing lighting is fluorescent lighting and should be replaced with LED Lighting	Existing lighting can be changed out with new LED panels and also install new Emergency Lighting	Áras de Bruin	Approved	Electrical	0	55,276	26,687	17,000	16,733	1.0	Successful project which has complimented the PV Project
Arts Science Building	Service and carry out works to CHP Unit	Therm/Elec	Annual service to the CHP unit	Manufacturer contract	Arts Science	Approved	Elec/ Thermal	54,320	27,160	24,232	165,000	17,045	9.2	Completed by PSE
AMB	Update the insulation in the boiler house	Therm	Changes to pipework and pumps new insulation to be installed to reduce losses	Internal works to be carried out.	Arts Millennium Building	Approved	Thermal	37,094	0	7,593	15,000	12,552	2.0	Existing insulation to be removed and replaced with new insulation and valve jackets.
Arts Science	Upgrade the remaining Fluorescent lighting in the Arts Science building with new LED lighting	Elec	A number of areas require the upgrade of fluorescent lighting with new LED	Works to be carried out by Engineering Services in house, survey to be carried out.	Arts Science	Approved	Electrical		26,527	12,807	110,000	13,231	3.1	Project Completed
Biochemistry	Installation of VSD on the existing Fume Cupboard fan	Elec	The existing fan is a fixed speed fan and needs to be controlled better	Adjoining extract fan fitted with VSD and reduced energy costs	Biochemistry	Approved	Electrical	0	23,126	11,165	15,000	12,817	1.8	1 large motor serving multiple fume cupboards
Block D & E	Replace existing oil fired boilers with new Gas fired boilers and reduce oil risk - multiple benefits include reducing/eliminating the risk of oil leaks	Therm	Existing 4 No. oil fired boilers to be replaced and install new wall hung gas condensing boilers and controls	Disconnection and removal of the existing oil tank install new Natural gas network points.	Block D and E	Approved	Thermal	103,864	0	21,261	110,000	17,146	1.4	Approximate
Arts Science Boiler-house	Replace the existing two burner existing natural gas burners and controllers	Therm	The existing burners and controllers are causing problems and installed a number of gears, invertors overheating	Install new control panel for optimisation of the boilers, install new high efficiency burners and controls package to the two 11Mv boilers.	Boiler-House	Approved	Thermal	74,189		15,186		15,104		One burner and VSD has been replaced, second tender this summer to replace No 2 Burner and VSD
Cairnes	Upgrade pump sets in the boilerhouse, replace current fixed speed pumps	Therm/Elec	Replace pumps	In-house project which has been a great success already registered	Cairnes	Approved	Electrical		17,511	11,979	120,000	13,022	6.6	Project Completed
Engineering	Install water savings devices on the Urinals	Water	Existing water usage on 16 urinals is high and needs to be reduced	Existing urinals to be reviewed	Engineering	Approved	Water	0	0	0	13,720	122,008	2.9	Tender review with specialist
Engineering	Service and carry out works to CHP Unit	Therm/Elec	Annual service to the CHP unit	Manufacturer contract	Engineering	Approved	Elec/ Thermal	59,656	29,828	26,613	145,000	17,737	5.8	Completed - Schmitt-Enertec CHP by PSE 255 kW; PF
Library	Complete the upgrade of the heating installation in the Ground and First floor of the library area to match Summer 2016 project	Therm	Replace the existing radiant heaters with new panel radiators and TRVs	Works to be carried out to the existing installation.	Library	Approved	Thermal	55,642		11,390	130,000	13,828	7.8	
Library	Upgrade pump sets in the boiler-house, replace current fixed speed pumps	Therm/Elec	Replace pumps	In-house project, great success already registered	Library	Approved	Electrical		49,622	23,958	145,000	16,044	7.4	Project Completed
Library	Service and carry out works to CHP Unit	Therm/Elec	Annual service to the CHP unit	Manufacturer contract	Library	Approved	Elec/ Thermal	50,532	25,266	22,542	15,000	16,554	0.8	Completed by PSE
Miscellaneous	Install new LED lighting to replace the existing fluorescent/ Metal halides	Elec	Existing lighting is fluorescent lighting and should be replaced with LED Lighting	This project is in relation to LED upgrade (x20 fittings) to offices and Replacement of external lamps with LED Equivalents	Miscellaneous	Approved	Electrical	0	86,982	41,995	1,000	110,594	0.1	At approximately 160 per fitting
Mogola	Upgrade pump sets in the boiler-house, replace current fixed speed pumps	Therm/Elec	Replace pumps	In-house project, great success already registered	Mogola	Approved	Electrical		29,109	14,263	140,000	13,598	11.1	Project Completed

Nursing	Install new installation to the Nursing Library adjoining the Hardmann library, install new pumps	Therm	Replace fno pumps	In-house project	Nursing	Approved	Electrical	2,509	1,211	16,500	1306	21.3	Project Completed	
Orbsen	Upgrade pump sets in the boiler-house, replace current fixed speed pumps	Therm/Elec	Replace pumps	In-house project, great success already registered	Orbsen	Approved	Electrical	41,544	20,057	128,000	15,060	5.5	Project Completed	
Orbsen	Service and carry out works to CHP Unit	Therm/Elec	Annual service to the CHP unit	Manufacturer contract	Orbsen	Approved	Elec Thermal	109,721	54,860	48,346	165,000	114,231	4.6	Completed - Schmitt-Enertec CHP by PSE, 189 kV (e) output
Shannon	Install new LED lighting throughout to replace the existing fluorescent	Elec	Existing lighting is fluorescent lighting and should be replaced with LED Lighting	Existing lighting can be changed out with new LED panels and also install new Emergency Lighting	Shannon	Approved	Electrical	15,036	15,036	8,661	133,940	113,604	2.3	To be completed by YERDE, funding secured through energy savings on other projects.
Sports Pavilion	Upgrade pump sets in the boiler-house, replace current fixed speed pumps	Therm/Elec	Replace pumps	In-house project, great success already registered	Sports Pavilion	Approved	Electrical	17,529	7,500	119,000	12,135	8.9	Project Completed	
Áras na Gaeilge	Installation of Solar PV to Áras na Gaeilge roof	Elec	Installation on flat roof	Assist reduction in electrical loading	Áras na Gaeilge	Completed	Electrical	12,500	55,000	138,000	11,905	3	ACA /SEAI Grant	
Áras Uí Éimhígh	Replace the existing electric heating in the building with new heat pump, low temperature radiators & controls	Therm	Installation of and steel panel radiators	Heat Pump, Radiators & Controls	Áras Ní Éimhígh	Completed	Thermal	15,483	7,475	122,000	11,886	11.7	Dalín Atherma Monobloc EDL007CAV3 used. New low temperature radiators installed. Heating control system upgraded.	
Arts Millennium Building	Upgrade lighting and lighting control to 3no lecture theatres	Elec	Installation of new LED lighting and controls for the 3 no lecture theatres	LED Lighting and controls	Arts Millennium Building	Completed	Electrical	22,105	36,390	130,000	19,332	3.2		
AHSSRB	Upgrade existing fixed speed pumps with new energy efficient pumps	Elec	Installation of new energy efficient pumps	Replace 10 No. pumps in plantroom	AHS SRB	Completed	Electrical			125,000			Grundfos Engineer to review in January	
Block Q	Upgrade existing lighting and storage heating installations	Elec/Therm	Installation of new LED lighting and replace heaters with new energy efficient heaters	Installation of LED Lighting	Block Q	Completed	Electrical	57,158	57,158	29,655	126,000		3	Replace old fittings and heaters
Campus Wide	Develop EV Charging Point System	Elec	Develop and support a sustainable energy campus	Orbsen Bld - 2*2 Charging Points, Cairns Bld - 2*2 Charging Points, Áras na Cathal T2 Charging Point, Quad (Upgrade of existing Charging Point System, Park & Ride T1)	Campus Wide	Completed	Electrical							Link to Green Campus and NUI Galway's Sustainable Campus Strategy. This project also demonstrates that NUG is committed to reducing carbon emissions by promoting and facilitating Electric Vehicles (EV's)
Campus Wide	New EV Post Van - Renault Kangoo, located at the HEB Building	Elec	Develop and support a sustainable energy campus	EV Post Van - Quiet, Clean Delivery!	Campus Wide	Completed	Electrical							Linked to Green Campus and NUI Galway's Sustainable Campus Strategy
Campus Wide	Provision of Campus wide Energy Campaign to the students, staff and contractors	Therm/Elec	Energy awareness campaign and program of events	Provide energy awareness literature, campaigns, switch off days, green week etc.	Campus Wide	Completed - ongoing	Elec Thermal		360,099	150,000	103,724		0.5	Awareness Campaign - See also Energy Review Document 2018/Link to the Green Campus Application
Campus Wide	Installation of additional metering to remaining buildings not connected to the BMS	Therm/Elec	Recording of energy usage and performance data and information. This provides the information which is reviewed daily, weekly and during our monthly energy review meetings.	Provides Up-To-Date records of systems etc.	Campus Wide	Completed - ongoing	Elec Thermal		360,099	150,000	103,724		0.5	E-Tender requirement - Ongoing and active monitoring is helping us to reduce energy usage by 3%
Campus Wide	Maximum Import Capacity (MIC) Project	Elec	Review of existing bills to reduce the import capacity charges	Review and collate	CAMPUS WIDE	Completed	Elec			115,000				Summer of 2018. Ongoing monitoring
Engineering	Carry out a complete energy efficiency design review of the heating, cooling, ventilation and electrical supply strategies employed at the Engineering Building.	Therm/Elec	Review the existing heating and cooling strategies, review times, air handling units and air balancing	Specialist engineering review	Engineering	Completed - ongoing	Elec Thermal			125,000	10		N/A	Review by Energy Specialist - Ongoing - carry this out during the heating season of 2018-19
Human Biology Building	Installation of Solar PV to the Human Biology Building	Elec	Installation to the roof of the new Human Biology Building for creating electrical energy	High electrical loading to the building	Human Biology Building	Completed	Electrical	15,500	70,002	145,000	12,381	3	ACA /SEAI Grant was awarded to this project that reduced the payback to 3 years	
Library	Upgrade the existing Lighting installation in parts of the Hardmann Library	Elec	Installation of new LED lighting and controls to the library on Ground, first and second floor levels	Existing 418 fluorescent light fittings (with choke start ballasts) factor of 12 replaced with new LED	Hardman Library	Completed	Electrical	181,336	87,549	122,000	122,087	1.0	Good data available - discussed at September 2018 Monthly Energy Meeting	
Mogola	Installation of LED Lighting to Block A, replace the existing fluorescent	Elec	Installation of new LED Lighting	LED Lighting and controls	Mogola	Completed	Elec	42,054	42,054	22,000	135,000	15,122	5	

4.3 Legal & Other Requirements

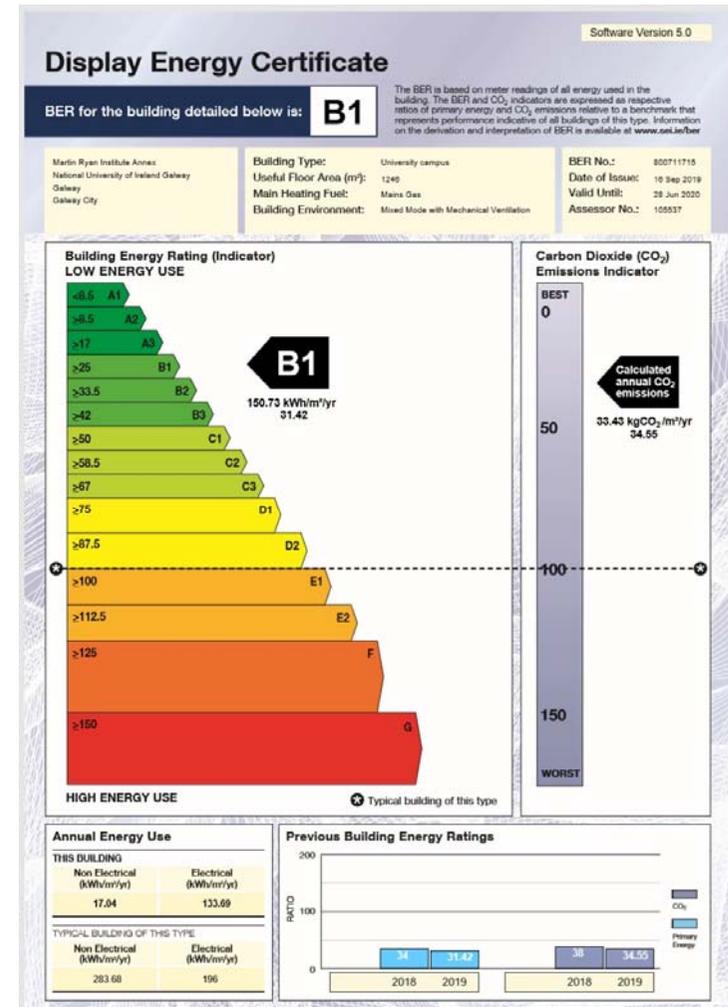
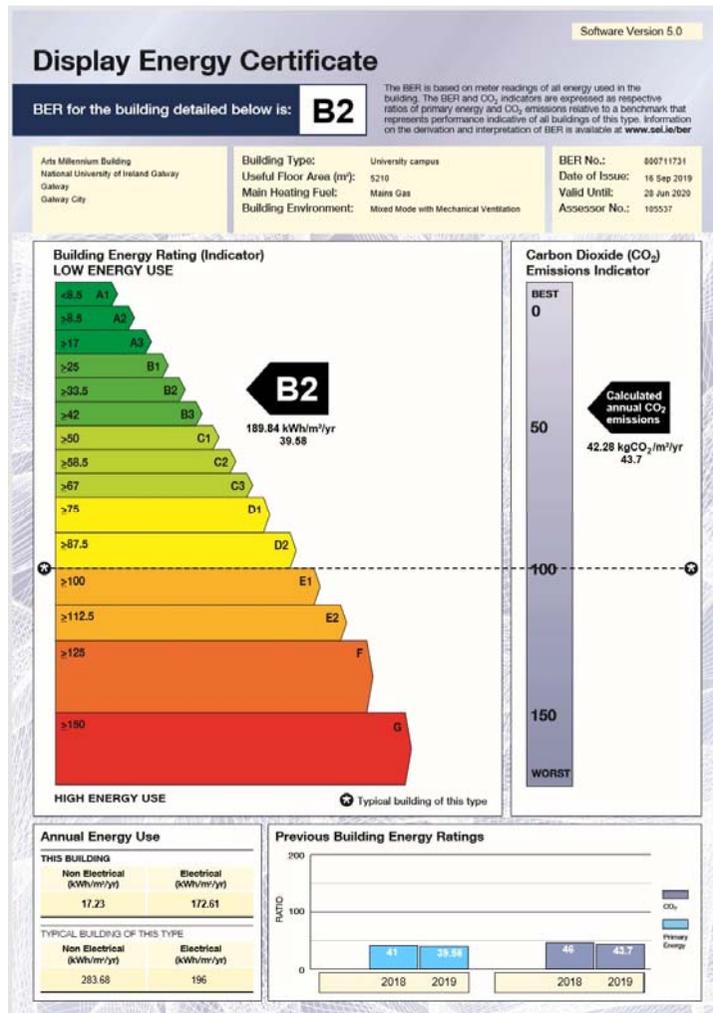
Legal and other requirements are being evaluated on an ongoing basis. Since Q1 of 2017, NUI Galway has subscribed to an external register of energy legislation and staff has undergone training in its use, and the requirements of ISO50001: 2011 Clause 4.4.2. Furthermore, both Lorraine and Michael have undergone ISO50001:2018 training in the past year, in preparation for NUIG transitioning over to the 2018 version of the standard.

The main pieces of legislation and other requirements that apply to NUI Galway on an ongoing basis are: -

- S.I. 426 of 2014 – European Union (Energy Efficiency) Regulations – that place responsibilities on public sector organisations to take an exemplar role in relation to energy efficiency and energy management.
- NEEAP 3, NEEAP 2, NEEAP 1 – National Energy Efficiency Action Plans.
- Public Sector Energy Efficiency Strategy – January 2017 – to drive the extra effort needed to realise the energy efficiency potential of the public sector and gain a 33% improvement compared to 2009 levels, by 2020.
- Technical Guidance Document Part L – Conservation of Fuel and Energy – Buildings other than Dwellings. The current edition is operative up to 31st December, 2018. The new/future Edition TGD Part L – Conservation of Fuel and Energy (2017) is effective from 1st January 2019.

Finally, the Buildings and Estates team operate a comprehensive 'Statement of fundamentals' that is integrated into the college's purchasing procedure. This document obliges all interested parties to undertake life cycle assessments so that all new and refurbished plant, equipment and projects undertaken include energy efficiency measures during the design, procurement, installation and commissioning phases.

Appendix A: Display Energy Certificates.



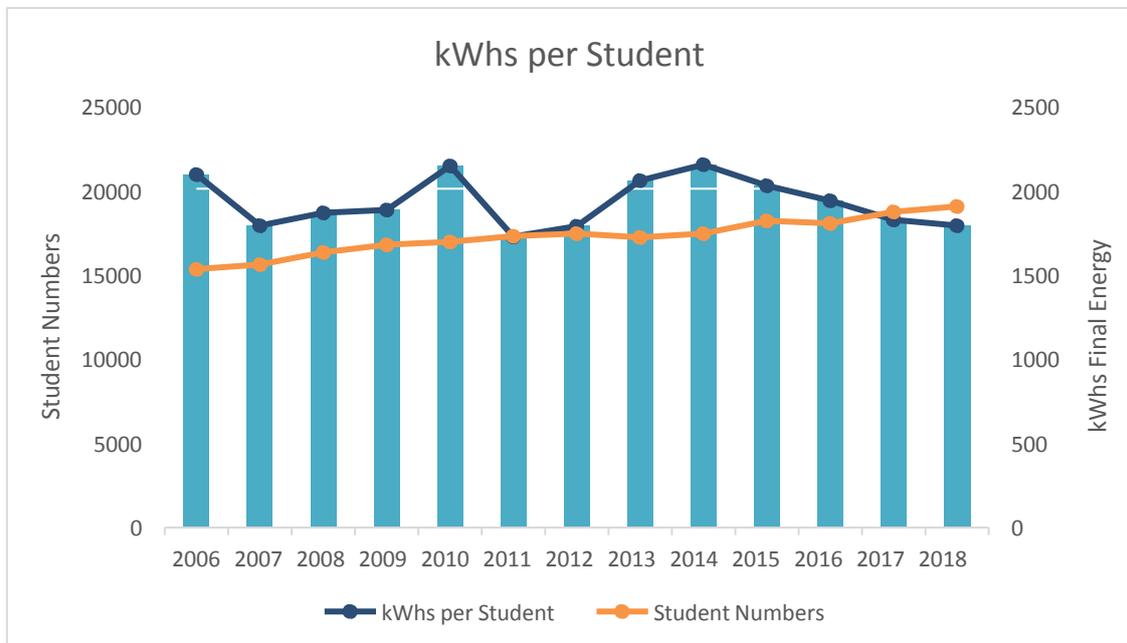
Appendix B: Images of the new Building Energy Management System



Appendix C: Photograph of Lorraine Rushe, and the College's Green Team, receiving the An Taisce Green Flag, on 23rd April 2019.



Appendix D: Graph depicting kWh usage per Student; from 2006 to 2018



Appendix E: Sankey Diagram of energy use in the Arts Science Building, during 2018

