# ISO 50001 Energy Management System – Case Study

2022 Ireland

# Tyndall National Institute

*From energy efficiency to carbon neutrality with ISO50001*

Tyndall National Institute

| Case Study Snapshot | |
|---|---|
| **Industry** | Research & Educational Institute |
| **Product/Service** | ICT Hardware & Systems Research |
| **Location** | Cork, Ireland |
| **Energy performance improvement percentage** (over the improvement period) | 5.8% over 3.5 years |
| **Total energy cost savings** (over the improvement period) | USD 152,373 |
| **Cost to implement Energy Management System (EnMS)** | USD 94,183 |
| **Total energy savings** (over the improvement period) | 7,591 GJ |
| **Total $CO_2$-e emission reduction** (over the improvement period) | 510 Metric Tons |

## Organization Profile / Business Case

Energy management and decarbonisation are engrained in all of Tyndall's activities due to both the research activities that are carried out onsite, and the means by which energy and carbon are managed within the facility. This commitment is visible through the development of centres within our facility such as The International Energy Research Centre (IERC). This centre delivers multidisciplinary energy systems research ranging across energy saving, production and storage technologies, to policy and regulation and business models.

Our buildings which date back as far as the early 1800's now house our research activities within the Tyndall complex. The renovation of these legacy buildings, and the construction of further lab and cleanroom spaces in the past 20 years have ensured that energy efficiency have been central to design decisions while also remaining sensitive to the historical nature of the site. Several of these design decisions were made during the early stages of this process which have assisted in the ability to achieve greater savings include:

- The design of HVAC systems for Low Pressure Warm Water which is at approximately 50°C. This allows us to now consider the installation of heat pumps to supply our largest energy users therefore fully decarbonizing our facility without any major infrastructural changes to our utilities distribution networks.
- The recovery of low grade heat from our cooling systems for reuse in our heating systems without the use of heat pumps.
- The design of spaces to ensure maximum light harvesting potential.
- The installation of heat pump technology to recovery heat from our data centre

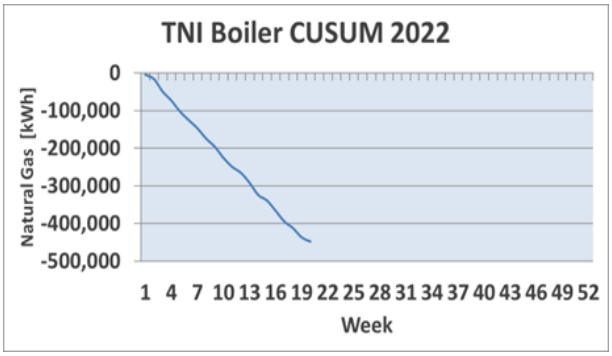
**"A core objective of Tyndall's research strategy is to develop innovative technologies to help address some of the most pressing sustainability challenges facing society today including climate, energy & clean water, through Tyndall deep tech research. To align our internal operations with this objective, a logical step was to implement an energy management system which is aligned to ISO50001. The benefits of this accredited management system extend far beyond the significant energy and carbon savings which have been achieved to date. The sustainability credentials which have been garnered through the standard have significantly raised the profile of our institute both nationally and internationally, enabling investment from organisations from both the public and private sectors."**

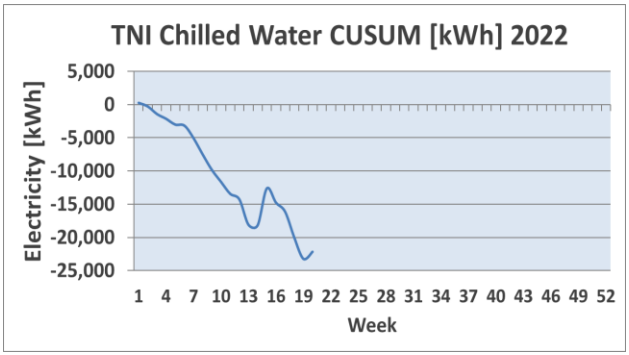
—Professor William Scanlon, CEO

## Business Benefits

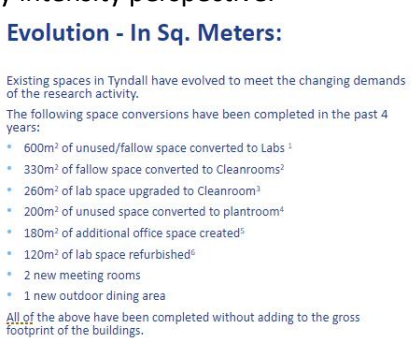
Tyndall implemented ISO50001 in 2012 as part of the institutes commitment to minimise energy consumption in line with Ireland's ambitions as a nation to achieve a 33% improvement in energy performance across it's public sector organisations by 2020. ISO50001 has been pivotal in assisting in the achievement in this target, and it is only through the structured approach to energy management that ISO50001 gives that this was possible. In 2018 we transitioned to the revised ISO50001:2018 version of the standard and have experienced many benefits as a result of the amendments which have been made. The timing of these amendments was optimal, as Ireland's ambitions have now increased, and all public bodies such as Tyndall are required to achieve a 50% improvement in energy efficiency, and a 51% reduction in energy related $CO_2$ emissions. ISO50001 will be central to ensuring that we can achieve these targets over the coming years. Our ability to monitor our significant energy users have even allowed us to determine how we can fully decarbonise our utilities over this period. The following points illustrate the key benefits which have been gained through the implementation of the management system:

- 7,591GJ of measurable savings in the last 3.5 years as a result of projects which have been carried out. This amounts to savings of $152,373 every year. It is evident below that there have been significant savings in 2022 as a result of our thermal system upgrade project in 2021. The savings in the graphs below are normalised against the previous years performance using regression analysis.



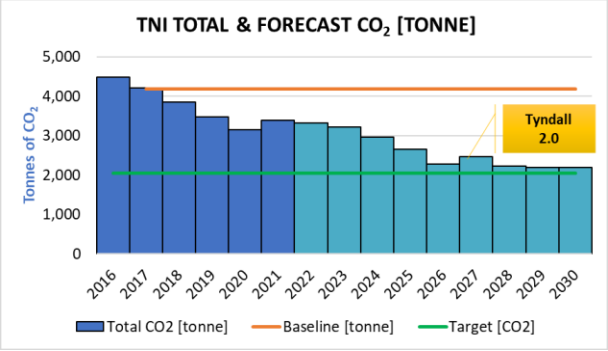

- The use of space within the institute is continuously in a state of flux as unused spaces or office spaces are transitioned to higher energy intensity lab and cleanroom space as our research activities expand. Recent space conversion activities are outlined in the figure below. Due to this, energy use at an institute level is increasing annually, however we are carrying out many efficiency projects which limit this increase. The tools of ISO50001 allow us to transparently and accurately measure and verify the savings from each projects, therefore it is possible to illustrate continuous energy performance improvement in buildings that are continuously expanding from an energy intensity perspective.




- Our design and procurement activities have been improved considerably due to the implementation of ISO50001. We have started to expand our energy efficient design processes to align with the energy efficient

design standard IS393 which is complimentary to ISO50001. This ensure excellence is energy efficient design and has yielded savings during our design and renovation projects.

- ISO50001 has assisted us in training our staff to consider energy during their day to day tasks. We collaborate with facilities, lab, cleanroom, and process personnel to ensure that energy efficiency is considered for all activities. This ensure that the use of energy is optimise alongside the plant and equipment that generates energy onsite.
- ISO50001 continuously challenges us to review out operational controls so that they can be optimised for energy efficiency. While the systems within the buildings were developed in a very efficient manner, we understand that opportunities continuously arise to improve performance. We are currently doing an in depth review of our BMS and HVAC systems to challenge their operation and determine where we can further optimise controls to improve energy performance.
- Overall, the key goal of our management system is to reduce absolute carbon. The structured approach to ISO50001 has allowed us to continuously reduce our absolute carbon emissions as can be seen below. While there was a minor increase in 2021 due to the opening up of a large amount of energy intensive research space, we have reacted to this and expect that carbon emissions will continue to reduce in 2022 and beyond. The yellow box indicates the opening of a new building in 2027. Due to low carbon design of this building, it is clear that it has little or no impact on our overall emissions.




Other benefits include:

- The ability to attract companies to rent space within our institute due to the sustainability credentials of the business.
- The ability to attract high quality staff given that Tyndall is a sustainability conscious business.
- The ability to obtain grant funding for both the upgrading of our facilities and for the research activities that are being carried out within the institute.
- The ability to easily find faults with our systems due to the advanced operational controls that are in place on the system. This both helps with efficiency and reduced downtime in our cleanroom spaces.
- The ability to review our service providers in depth through the requirement for energy efficient procurement processes. This ensures that service providers such as refrigeration, boiler and BMS maintenance personnel are highly skilled.

## Plan

### Top Management

The senior leadership team are committed to ensuring that the energy management system is maintained in Tyndall as can be seen from the continued investment in energy performance improvement activities. This is largely due to the fact that energy efficiency and carbon reduction are an essential part of the institutes core activities. There is very little persuasion required to obtain commitment from the top decision makers for the implementation of ISO50001 and for the continued support of the system. This is evident given the ongoing investment in energy performance improvement

projects such as the recent refurbishment of a 100 year old Kiln building as can be seen in the images below. This building achieved a building energy performance rating of A3 on a scale of A1 to G3 once the renovation was complete. More details on this project can be found here: https://www.tyndall.ie/news/revamp-of-tyndalls-100-year-old-kiln-building-scoops-seai-award/

In addition the senior team are involved in the ongoing review of the management system and are pivotal to ensuring collaboration on energy issues across the multiple stakeholders within the institute. Our Chief Operations Officer, Cormac Harrington takes a very active role in ensuring that effective objectives, targets and action plans are put in place and followed through to completion. This is largely done through periodic meetings and an in depth annual management review which is required by the standard.

**Financial Commitments**

We use a data based approach to obtaining financial resources. This includes the development of lifecycle cost assessments for projects, including the implementation of ISO50001. It was illustrated to the senior management team that the implementation and maintenance of ISO50001 was a financially positive exercise due to the continued control that the system ensures on energy costs. Long term energy and carbon costs are also taken into consideration during the development of the business case for energy and carbon reduction projects. This ensure that project ambitions are not impacted by simple payback metrics. It also assists during the process of applying for grant aid for projects which is essential for the improvement in the overall lifecycle cost of large scale projects.

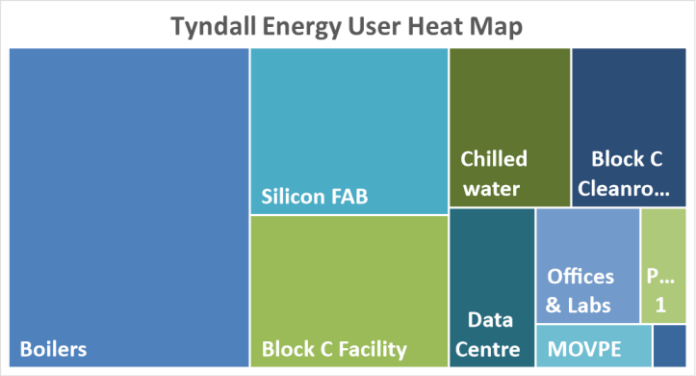
**Strategy & Targets**

Energy planning has now been incorporated into our strategic plans. We are currently on a journey to becoming a carbon neutral site with the hope of achieving a circular economy within our thermal system through the installation of heat pumps. We establish objectives, targets and action plans on an annual basis such as those illustrated in the table below. These plans are discussed annually with the senior leadership team to ensure that they remain ambitions and in line with the institute's overall strategy. If adjustments are required, then they are incorporated into the EnMS.

| Objectives | Targets | EnMP Actions | Target Closeout Date |
|---|---|---|---|
| Achieve measured and verified savings of 2% of previous year final consumption.<br><br>51% absolute carbon reduction by 2030 against a 2016-2018 baseline | Achieve measured and verified savings of 2% of 2021 total final consumption<br><br>Develop the projects required to achieve decarbonisation objectives in 2022. | Projects identified with total annual savings if implemented successfully of 2.6% for 2022 | Dec-22 |

### Energy Review

We continually update and review our energy balance such as the one illustrated on the right to determine our significant energy users so that they can be incorporated into the management system. We assign any user which consumes over 5% of total energy consumption as significant, and then ensure that each of these users is controlled as per the requirements of the standard.




Critical to ensuring this control is the establishment of energy performance indicators [EnPI's] for these large users. We utilise effective EnPI's to determine deviations in performance. If a deviation in performance is determined then a non-conformance is raised and the deviation is investigated. The table below illustrates a high level dashboard for reviewing deviations. When the performance boxes are green there is no action required. When they are red there is a requirement to take action and review performance.

**"ISO50001 has not only put a structure on our management of energy, but has assisted us in putting a better structure on our asset management as a whole. This not only reduces energy cost but also improves equipment reliability and assists us in achieving our carbon reduction targets."**
—Derry Kelleher, Facilities Manager

| SEU | Weekly Baseline [kWh] | Weekly Actual [kWh] | Weekly Performance % | YTD Baseline [kWh] | YTD Actual [kWh] | YTD Performance % | YTD Performance Trend |
|---|---|---|---|---|---|---|---|
| Boilers | 54,852 | 43,719 | -20% | 1,706,038 | 1,257,487 | -26% | |
| Silicon FAB | 31,064 | 34,847 | 12% | 621,278 | 643,878 | 4% | |
| Block C Facility | 28,996 | 26,280 | -9% | 579,920 | 540,883 | -7% | |
| Chilled Water | 22,789 | 23,858 | 5% | 272,574 | 250,379 | -8% | |
| Block C Cleanroom | 17,525 | 18,108 | 3% | 350,503 | 341,995 | -2% | |
| Data Centre | 13,339 | 12,590 | -6% | 266,781 | 264,202 | -1% | |
| Offices & Labs | 15,332 | 12,590 | -18% | 306,631 | 241,813 | -21% | |

**Tyndall Energy Performance Dashboard**

## Do, Check, and Act

Our energy programme is updated on an ongoing basis in a structured manner. Core steps that are followed to ensure this include:

- Setting of Objectives, targets & action plans on an annual basis which are aligned to our overall strategy and legal & other requirements. Action plans for 2022 can be seen below. These plans will both generate energy savings, and assist in improving the energy management system.

| Project ID | Description | Total kWh Savings | Total Cost Savings | Responsibilities & Resources Required | Target Closeout Date |
|---|---|---|---|---|---|
| EMP-2022-1 | Carry out a Challenge & Analyse on the institutes thermal systems with a goal of decarbonisation and alignment of energy and carbon performance with public sector targets. | 248,719 | € 24,531 | GB to project manage. Cleanroom owner time to review opportunities. | Dec-22 |
| EMP-2022-2 | Strobic fan replacement Block C | 60,000 | € 7,200 | DK to project manage. CD to review potential financial resource through BEC funding. | Dec-22 |
| EMP-2022-3 | EED of new TNI 2.0 - New build | - | € - | DK to ensure whole building energy is reviewed in detailed design. | Dec-22 |
| EMP-2022-4 | Review chilled water metering to determine what is included in the chilled water electricity meter. Determine any additional metering that is required to manage this SEU. | - | € - | GB to project manage. Additional resourced to be determined once EFT are engaged. | Q2-2022 |
| EMP-2022-5 | Coordinate energy management activities with the TNI Green Team ensuring a holistic approach to sustainability | - | € - | DK to project manage. Green team personnel time requirement to be reviewed. | Dec-22 |
| EMP-2022-6 | Develop a functional design spec for boilers, chillers and BMS | - | € - | GB to project manage. Automation contractor time required to assist. | Dec-22 |
| EMP-2022-7 | Sign an agreement with an obligated party so that energy credits can be obtained for projects that are complete. | - | € - | DK to manage. Input from UCC required to ensure no crossover and streamline tendering process. | Q2-2022 |
| EMP-2022-8 | Carry out a BER B review of buildings to determine what upgrades are required so that we can be project ready when grant supports are made available. | - | € - | DK to manage. BER assessor fee required. CD to obtain details. | Dec-22 |
| EMP-2022-9 | Develop a training plan for onsite personnel to improve the management of energy onsite. | - | € - | CD time to develop training options. DK to manage training time. | Q2-2022 |
| | **Potential Savings Total** | **308,719** | **€ 31,731** | | |

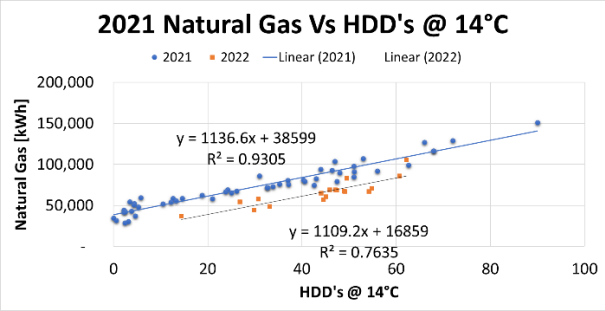
- Presentation of objectives, targets and action plans to the senior leadership team to ensure strategy alignment and to obtain financial and other resources that are required to achieve them.
- Continuous review of the performance of significant energy users, energy performance indicators, status of action plans and projects, progress on closing out non-conformances and other energy and carbon related issues during monthly energy team meetings. This meeting includes personnel from the facilities department, process personnel and subject matter experts when required.
- We carry out annual internal audits on all our significant energy users and the management system annually. This is carried out by our energy consultant to ensure independence from the day to day processes. Audits are carried out with significant energy user owners which includes both facilities and research area personnel.
- At the end of each year the savings that have been achieved during the year are reviewed against the baseline. The table below illustrates the 2021 measured and verified savings versus the 2020 annual consumption. All savings are annualised and it can be seen that a 9.28% improvement was seen in 2021 due to the energy projects that were carried out.

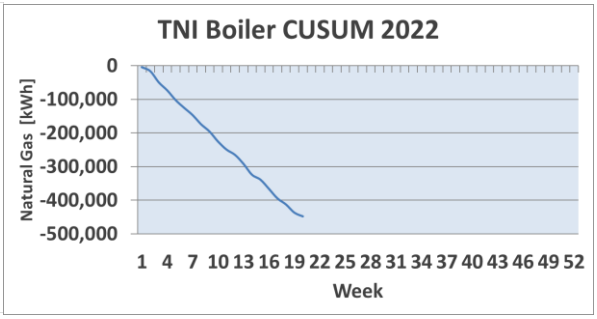
| | Electricity (kWh) | Gas (kWh) | Site Energy (kWh) |
|---|---|---|---|
| 2020 Total Baseline Actual | 7,895,337 | 3,747,280 | 11,642,617 |
| 2021 Verified Project Savings | 315,958 | 764,198 | 1,080,156 |
| Increase/Decrease on Baseline | -4.00% | -20.39% | -9.28% |

- Year on year measured and verified savings are summed to determine the total energy savings over an extended period. The table below illustrates the savings which have been determined from 2019 to Week 18 of 2022. This table is presented to the senior leadership team so that continual improvement can be demonstrated in line with the organisation's objectives & targets. It is clear that targets are being achieved here.

| Year | Expected Energy [kWh] | Electricity [kWh] | Natural Gas [kWh] | Net Energy Savings [kWh] | Cost Saving [€] | $CO_2$ Reduction [$tCO_2$] | % of Previous Years Consumption | Target [%] |
|---|---|---|---|---|---|---|---|---|
| 2019 | 11,950,396 | 0 | 358,230 | 358,230 | 17,912 | 73 | -1.1% | 2% |
| 2020 | 11,815,097 | 29,365 | 291,083 | 320,449 | 18,078 | 68 | -2.7% | 2% |
| 2021 | 11,598,923 | 315,958 | 764,198 | 1,080,156 | 76,125 | 250 | -9.3% | 2% |
| 2022 | 4,304,756 | 114,608 | 412,915 | 527,523 | 34,399 | 118 | -4.2% | 2% |

Normalisation is carried out where appropriate to determine these savings. An example of this includes the regression model below for natural gas consumption and heating degree days at 14°C. The blue dots represent the 52 weeks in 2021 while the orange dots represent the first 18 weeks of 2022. There has been a dramatic shift in performance over these periods. This is as a result of a large scale HVAC project which was carried out to reduce thermal energy demand. This regression model is used annually to calculated expected consumption. The expected consumption is then subtracted from actual consumption to determine if there has been a saving or loss on a weekly basis. The weekly calculated values are then summed to determine the year to date performance. The graph on the right illustrates the saving for 2022 based on this baseline. The year to date performance improvement in natural gas is 412,915kWh. This is where the last value in the 4$^{th}$ column of the table above was obtained. This form of analysis is essential for determining the true performance of our systems as it takes any ambiguity out of the results. It allows us to chase real deviations in performance as opposed to needing to spend time analysing in depth hour by hour data to determine where issues may have occurred based on specific energy metrics or metrics which are not normalised. The equation of the line is essential for this as it takes the baseload operating consumption into consideration, separate from the variable element of consumption. In the regression graph on the left the equation is y = mx +c where y =the expected energy, m = the slope of the line, x = the variable factor and c = the constant or baseload energy. In this graph the equation for 2021 is y = (1136.6 x Weekly Heating Degree Days) + 38,599kWh. In 2022 we use this equation every week to determine how much energy we should use based on the Heating Degree Day [HDD] value for each week. E.g. there were 62.2 HDD's in Week 1 2022 so we should have consumed (1136.6+62.2)+38,599 or 109,295kWh of gas. We actually used 105,194kWh giving us a saving of 4,101kWh in that week or 4%. We also use this type of equation to forecast our energy consumption using a waterfall type diagram which illustrates our expected consumption annually.



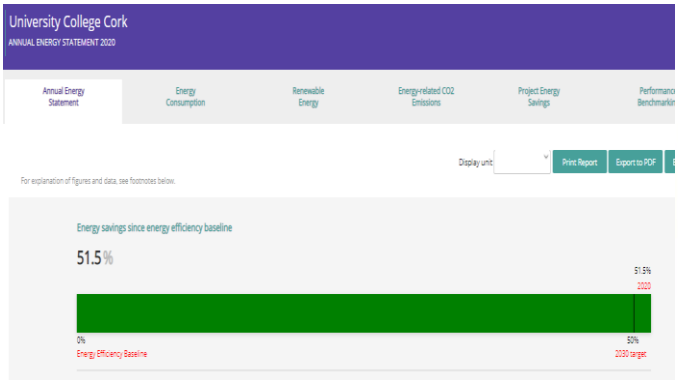

Normalisation is not always possible for all of our SEU's as we have very varied operations across the institute because of the research nature of the organisation which requires space conditioning 24 hours a day, 7 days per week. We do however challenge this annually to determine if we can now start to normalise our performance in a better way. An example of this is the new capability to log process equipment hours in our cleanroom spaces. We are starting to compile process equipment run time data so that we can determine if our cleanroom space energy consumption can be normalised against run hours or booking time hours. This is currently a work in progress.

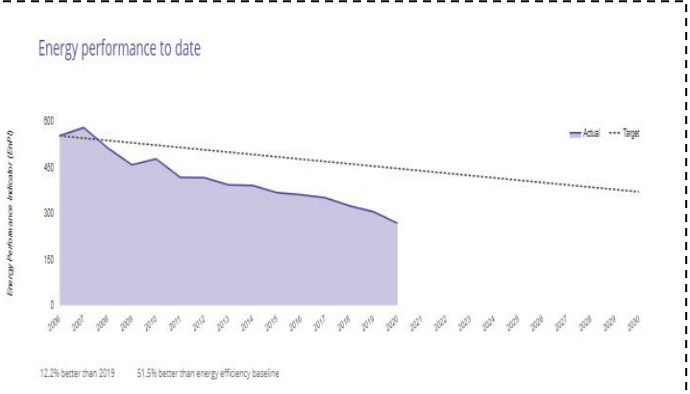
**Operational Control**

Operational control is monitored through our BMS and maintenance activities. We have established parameters based on user requirements and these have been implemented on our BMS system. We are currently reviewing all operational controls across the institute to challenge these parameters for energy saving given that they would have been put in place during the commissioning of the buildings. This includes the review of energy services i.e. the requirements for energy use, such as temperatures, pressures, and relative humidity requirements. Once we have determined the exact requirements, we will challenge how we deliver these requirements. The process that we are following is aligned with the Energy Efficient Design Standard IS399 which is pivotal for all our upgrade and new design activities. Information on this can be found here https://www.seai.ie/business-and-public-sector/standards/is-399-energy-efficient-design-management/

**Procurement & Design**

We have standardised design and procurement procedures as a result of our energy management system. This include requirements to carry out lifecycle costing, and the requirement to follow set design stages. In addition, there is a requirement in our contracts to ensure that that performance of systems have been achieved as originally specified. This could include the energy rating of a building, a refrigeration system COP, or the control strategy of a system. Our design process requires energy analysis to be carried our for projects in a phased manner including Stage 1: Concept Design, Stage 2a: Detailed Design a, Stage 2b: Detailed Design & Implementation Plan, Stage 3: Tendering & Construction. All of our projects which effect our SEU's must also be measured and verified after installation to ensure that savings have been achieved. This is carried out using the concepts in the International Measurement & Verification Protocol [IPMVP]. Suppliers and contractors are informed of this through our internal policies.



## Transparency

Tyndall reports its energy performance to the Sustainable Energy Authority of Ireland under the institutes parent company University College Cork [UCC]. This information is publicly available and can be accessed here: https://psmr.seai.ie/Reports/PublicAnnualReportForPublic?customerId=374&query=undefined

An extract from this system can be seen above whereby a 51.5% improvement in energy performance has been seen to date based on a baseline of the average consumption for the years 2006-2009. While there was a significant dip in 2020 due to Covid 19, the institute is well on the way to achieving its energy efficiency target based on this data.

We also publish our ISO50001 certificate on the institute's website. This can be seen here: https://www.tyndall.ie/contentfiles/Tyndall_National_Institute_ISO50001_CertA5_ED2023.pdf

Communication of the achievement of ISO50001 certification can also be seen at the following links:

https://www.certificationeurope.com/iso-blog/iso-50001-awarded-to-tyndall-national-institute/
https://www.ucc.ie/en/news/archive/2014andbeyond/2012/energy-management-award-for-tyndall.html
https://redfm.ie/post/uccs-tyndall-institute-wins-seai-energy-awards/

## What We Can Do Differently

Our system is not perfect, but we are continually trying to improve it. Essential to this is the defining of "lessons learned" during the whole process. Some of the main things that we would do differently based on learnings from this process include:

- We would ensure ongoing engagement with the wider team within the institute. As the system historically operated within the facilities department we focused heavily on the optimisation of facilities. We forgot however that the control of energy is managed largely by the building and process users. We would ensure ongoing and open communication with all people within the organisation ensuring they are aware of performance issues, improvements made, and planned changes to systems which may affect them.
- We would implement stronger control processes on our BMS & data collection systems at an earlier stage. We found that operational controls and energy metering data integrity disimproved over time due to the number of people that were engaging with these systems. While we have now got these systems under control again due to changes that we made within our system, it took considerably effort to get them back to a stable state.
- We would carry out energy efficient design and procurement training with our personnel at an earlier stage in the process. As we are an expanding business, it is essential that we have these topics engrained in our systems and procedures. We understand now that all new projects must either be carbon neutral or carbon neutral ready. If we realised this at an earlier stage we would be closer to decarbonisation than we are. It is essential for businesses to get this thought process into their daily activities.

Our sights are now solely fixed on decarbonisation but we realise that decarbonisation without energy efficiency will result in the use of excess materials to construct renewable energy technologies. For this reason we are engraining an energy efficient and carbon neutral design process within our business. This will expand outside Scope 1 & 2 emissions but will also tackle our Scope 3 emissions in both our operations and the built environment. ISO50001 will remain the backbone for this scope expansion given that it has allowed us to development strong structures for energy management.