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Gas Networks Ireland

Natural gas solutions for the commercial building sector

Case study

New, state-of-the-art, seven-storey office development achieves Nearly Zero Energy Building (NZEB) standards and LEED Platinum Grade A using natural gas

Combined Heat & Power (CHP), gas-fired boilers and Photovoltaic (PV) panels combine to provide a sustainable, future-proofed solution to meet building energy performance requirements.

Energy system benefits

- The energy system designed integrates multiple different technologies to meet the NZEB standards in an extremely efficient way
- Meets renewable energy production requirements with CHP and solar
- Meets energy performance requirements
- Existing gas network fully compatible with renewable gasses such as biomethane and hydrogen
- Maximises use of office space, increasing rental income potential and catering for setback terraces on upper levels

Earlsfort Terrace in Dublin exceeds NZEB requirements with natural gas

Building energy system requirements

Located on the corner of Earlsfort Terrace and Adelaide Road the office development has a gross floor area of 14,000m^2 and car park basement of 2000m^2.

Based in Dublin's Central Business District, this development provides a sustainable solution to the every day demands of best-in-class office facilities and services which commercial tenants have come to expect. The building has been designed around ceiling-mounted fan coil units. In addition to their high outputs, these units are well suited to easy reconfiguration, which is essential in flexible modern office environments.

Low specific fan power (SFP) air handling units with high efficiency thermal wheel heat recovery provide tempered fresh air throughout the year with minimal energy requirements.

Commercial spaces are provided with low pressure hot water (LPHW) and chilled water (CHW) capped connections for onward distribution to fan coil units. Communal areas are heated by a range of technologies, each the most appropriate for the space served.

Low level trench heating, underfloor heating, radiators and tempered air supply ensure a comfortable environment even in the most severe winter conditions. LPHW is generated centrally by a high-efficiency CHP unit complemented by condensing gas-fired boilers to meet peak loads and provide added resilience.

Typical technical specifications

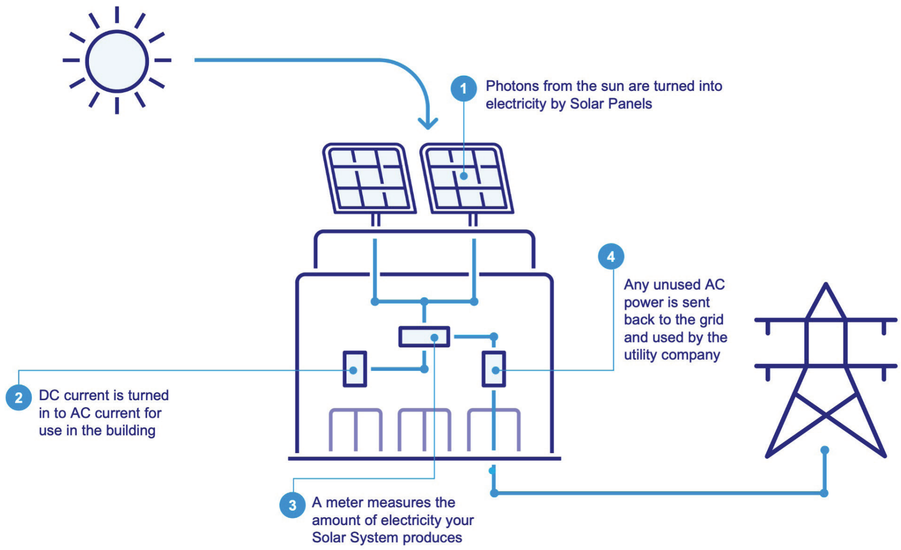
PV output	23KWp
PV surface	112.4m²
Number of modules	56
Number inverters	1
CO² emissions avoided	8147 Kg/ Annum

Did you know that there are 319 operational CHP units across Ireland with 93.2% using natural gas as their primary fuel choice? This operational capacity equates to 300 MWe*.

Why CHP and solar?

Modern city centre office developments pose a number of specific and often competing objectives for design teams. Plentiful natural daylight or low solar gains? Large column-free flexible floorplates or efficient structures with low embodied carbon? External green areas or terraces and courtyards for occupants to enjoy? The energy solution proposed for this particular development - using CHP and solar PV - yielded a number of benefits.

- Heating and domestic hot water provided by same space-efficient central plant (located at basement level).
- Accommodated the use of high-efficiency water cooled chillers (with adiabatic dry coolers) - superior to what would be possible with alternative technologies.
- Peak electrical load minimised, resulting in reduced costs and demands on building electrical infrastructure.
- Gas supply will meet the future office catering needs of larger tenants, if required.
- NZEB compliant, BER A3, LEED V3 Platinum grade A office.

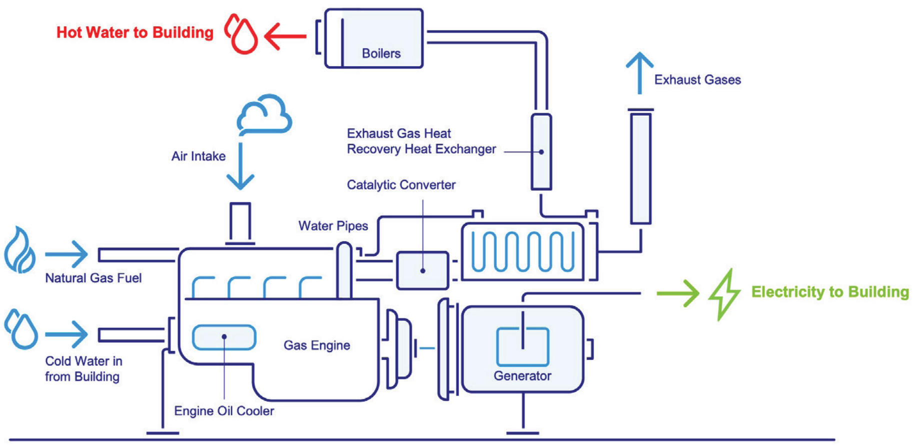


How does PV work?

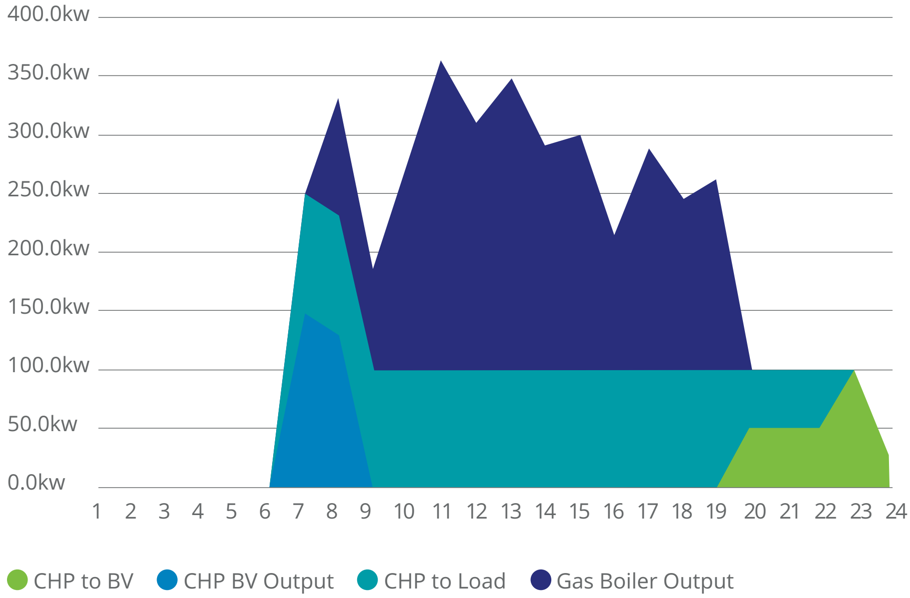
A 23kWp PV system was specified for Earlsfort Terrace and supplied by Resolute Engineering Group. Based on the PV modelling software, it is calculated that this will provide 17,334kWh annually. With a panel efficiency of 81.1% the total PV array would equate to 112.4 m^2, orientated 180 degrees.

How does CHP work?

CHP also known as co-generation, is the simultaneous production of electricity and heat usually in the form of hot water or steam from a primary fuel such as natural gas. Electricity is generated on site by using natural gas to drive an alternator connected to the engine. The heat from the exhaust fumes generated by the engine is harvested to provide heating and hot water for the building, while some of the energy within the hot water can also be used to provide cooling and air conditioning by using absorption chillers.



Typical heating profile



Under the 2017 building regulations (Part L), CHP systems can contribute to a building's Renewable Energy Ratio (RER). The amount of renewable primary energy from the CHP unit depends on the heat demand from the CHP unit and its thermal and electrical efficiency.

Best practice design suggests that CHP units are sized to run as baseload units to maximise running hours, minimising plant cycling. Whilst undertaking the design for Earlsfort Terrace, Arup performed a dynamic energy analysis *(see graph above)* throughout the entire year to optimise the output of the CHP system and associated buffer vessel. This wss particularly important given the real estate value of city centre plant space.

The results indicate that a 95kWt CHP paired with an 8,000L buffer vessel will provide 56% of the total heating and hot water load for the building, allowing the CHP unit to run at full load for 71% of its running hours, ensuring maximum efficiency. Coupled with the fact that modern, well insulated office buildings require very limited heating, this is particularly impressive.

Typical technical specifications

Electrical power	63kW
Thermal power	95kW
Energy input	177kW
Electrical efficiency	35.6%
Thermal power	53.7%
Thermal efficiency	**89.3%**

Did you know 6.6% of electricity in Ireland is generated from CHP*?

Did you know that 499kt of CO_2 emissions are avoided in co-generation when compared to the separate production of heat and power*?

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"At no point has sustainability been in sharper focus for our clients. There is a clear aspiration and determination to not just meet, but exceed, the requirements of the building regulations and push toward a radical change of approach in our society. Multi-disciplinary engineering consultancies will be central in advising, analysing and designing the built environment of tomorrow. At Arup, we strongly believe in an analytical approach to selecting the appropriate technologies and systems, such as, PV and CHP for each project to achieve these objectives and deliver excellent buildings for owners and occupiers alike."

Mark McMullan, Arup

Building global parameters	Actual	Reference
Area (m^2)	16,169	16,169
External area (m^2)	20,596	20,596
Weather	DUB	DUB
Infiltration (m^3/hm^2 @50Pa)	3	3
Average conductance (W/K)	10,182.6	6,120.93
Average U-value (W/m2K)	0.49	0.3
Alpha value* (%)	14.12	12.28

*Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Air permeability	Upper limit	Actual building value
(m^3/hm^2 @50Pa)	5	2.5

Heat transmission through building fabric

Element	Ua-Limit	Ua-Calc	Ui-Limit	Ui-Calc
Walls**	0.21	0.57	0.6	1.69
Floors (ground and exposed)	0.21	0.20	0.6	0.20
Pitched roofs	0.16	N/A	0.3	N/A
Flat roofs	0.2	0.16	0.3	2.28
Windows, roof windows and rooflights	1.6	1.36	3	1.40
Personnel doors***	1.6	1.60	3	1.60
Vehicle access & similar large doors	1.5	N/A	3	N/A
High usage entrance doors	3	N/A	3	N/A

Ua-Limit= Limiting area-weighted average U-values [W/(m2K)] Ua-Calc= Calculated area-weighted average U-Values [W/(m2K)]
Ui-Limit= Limiting individual element U-values [W/(m2K)] Ui-Calc= Calculated individual element U-values [W/(m2K)]
**There might be more than one surface with the maximum U-value. **Automatic U-value check by the tool does not apply to curtain walls whose area-weighted average and individual limiting standards are 1.8 and 3 W/m2K, respectively.*
**** A type of commercial door, designed specifically for use by employees (or personnel). They are usually installed internally – where there is a constant flow of foot traffic.*

Primary energy consumption, CO_2 emissions and renewable energy ratio

The compliance criteria in the TGD-L have been met	
Calculated CO_2 emission rate from reference building	16.4kgCO_2 /m^2 annum
Calculated CO_2 emission rate from actual building	14.7kgCO_2 /m^2 annum
Carbon Performance Coefficient (CPC)	0.89
Maximum Permitted Carbon Performance Coefficient (MPCPC)	1.15
Calculated primary energy consumption rate from reference building	85.6 kWh/m^2 annum
Calculated primary energy consumption rate from actual building	77.4 kWh/m^2 annum
Energy Performance Coefficient (EPC)	0.9
Maximum Permitted Energy Performance Coefficient (MPECPC)	1
Renewable Energy Ratio (RER)	0.1
Minimum renewable energy ratio	0.1

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CL5014/07/2022