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Gas Networks Ireland

Natural gas solutions for the commercial buildings sector

Case study

New 50-bedroom nursing home meets Nearly Zero Energy Building (NZEB) standards with Gas Absorption Heat Pump (GAHP)

Nursing home meets NZEB requirements with natural gas.

The nursing home with a floor area of approx 4,290m² is designed to leverage natural gas as a versatile, low carbon and responsive energy source to meet its energy demands.

Results

- Meets Part L Building Regulation standards (NZEB)
- Meets renewable energy ratio requirements
- Meets energy performance requirements
- Existing gas network fully compatible with renewable gases such as biomethane and hydrogen
- Constant heating supply at a low running cost

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	27.5kgCO_2 /m² per annum
Calculated CO_2 emission rate from actual building	25.2kgCO_2 /m² per annum
Carbon Performance Coefficient (CPC)	0.92
Maximum Permitted Carbon Performance Coefficient (MPCPC)	1.15
Calculated primary energy consumption rate from reference building	148.1 kWh/m² per annum
Calculated primary energy consumption rate from actual building	133.4 kWh/m² per 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

Heating system requirements

During the early stages in the design process it was agreed that the Gas Absorption Heat Pump (GAHP), in combination with standard system boilers, provided the right balance between cost, reliability, performance and the ability to meet the specified environmental requirements.

The system was designed to provide 100% of the heating and hot water demand of the nursing home. Therefore, it was essential that building comfort, response time and reliability were taken into consideration, while ensuring compliance with NZEB Part L 2017 building regulations.

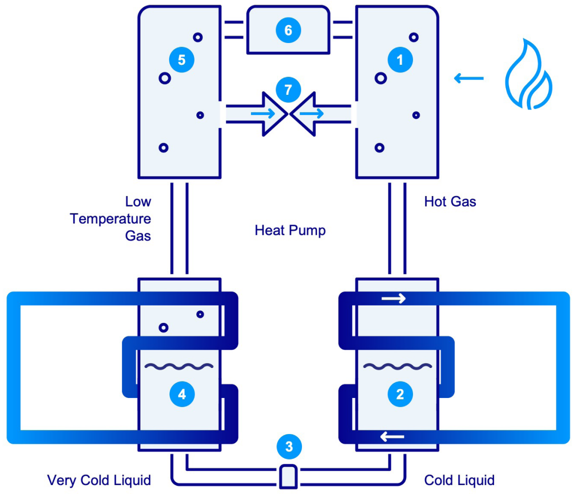
Building system requirements

The IES modelling and Building Energy Rating (BER) software calculates an overall energy requirement of 133.4kWh/m² per annum for the nursing home. With a total building size of 4,290m² this gives an overall estimated energy usage of 572, 286kWh per annum.

It is expected that 33% of the building's energy will be used for heating and 31% for hot water. The heating system is designed to meet 80% of this demand using the GAHP with the remaining 20% being met by standard system boilers.

Gas Absorption Heat Pumps

- **Are up to 164% efficient.**
- **Reduce electrical load requiring only single phase power supply.**
- **Provide heating and hot water with continuous hot water supply through the defrost cycle.**
- **Are fully F-gas exempt.**



Gas Absorption Cycle

What is a Gas Absorbtion Heat Pump (GAHP)?

A GAHP uses a gas burner to drive the refrigeration cycle, the output of which can be used to supply hot water for space heating and/or for the production of domestic hot water via an indirect cylinder, similar to a traditional boiler.

How does a GAHP work?

1. Generator

Within the generator (1) the burner heats the ammonia/water solution via a heat exchanger, increasing the temperature and pressure. The ammonia vapour travels to the condenser (2) whilst the ammonia solution is circulated to the absorber.

2. Condenser

The high temperature, high pressure ammonia vapour releases its heat into the heating system in the condenser. The vapour becomes a liquid and travels to the expansion valve (3) on its way to the evaporator (4).

3. Expansion valve

The high pressure ammonia passes through the expansion valve where the pressure falls. The ammonia now has a reduced boiling point and the liquid changes back to a vapour. This vapour passes on to the evaporator (4).

4 & 5. Evaporator and Absorber

A fan draws ambient air through the evaporator. The ambient air captured by the ammonia vapour, contains a high amount of free, renewable energy. The now heated, low pressure vapour passes on to the absorber (5).

6. Second expansion valve

This second valve controls the flow of weak ammonia between the generator (1) and the absorber (5).

7. Heat pump

The pump moves the ammonia solution from the absorber (5) back to the generator (1) where the process starts again.

Why choose a GAHP?

- Lower emissions and network losses as it uses the primary source of fuel at the point of consumption.
- Minimal moving components - reduces maintenance and increases reliability.
- Minimal requirement for “defrost”- EN12309.
- Continuous heating output during defrost cycle.
- Exhaust flue uses gas and water vapour, minimising energy loss in exhaust gas.
- No harmful F-gases used as a refrigerant, ensuring zero potential for greenhouse gas release during maintenance or decomissioning.

Benefits of Gas Absorption Heat Pumps

GAHPs have a number of benefits when compared to other systems, including cost, reliability and performance.

- There are no electricity supply capacity upgrades needed to the network.
- The GAHP operates off a single phase power supply less than 0.9kW, which ensures that there is no significant requirement for an electrical capacity increase.

Exceeds renewable energy production requirements

- The heat pump technology in this system operates with a gas utilisation efficiency (GUE) of up to 164%. This provides the specified renewable energy requirements to meet NZEB Part L 2017 building regulations.

Running cost

With an efficency of up to 164%, this unit will be significantly cheaper than a boiler only system and can be cheaper than an equivalent electric heat pump.

Maintenance

This system has a sealed refrigeration circuit with a natural refrigerant (water/ammonia) and a gas burner, which means that an F-gas installer is not required and a Registered Gas Installer can take care of the maintenance.

Gas Utilisation Efficiency (GUE) performance

GAHP- A HT (High Temperature)

		Heating						Domestic Hot Water
Water Delivery Temp (°C)		**40 °C**	**45 °C**	**50 °C**	**55 °C**	**60 °C**	**65 °C**	**70 °C**
	Gas Input (Kw)	25.2	25.2	25.2	25.2	25.2	25.2	12.6
OUTDOOR TEMPERATURE								
-20 °C	Output (kW)	31.5	29.6	27.7	25.7	23.7	22.7	9.3
	Effic. (GUE)	1.250	1.175	1.100	1.020	0.940	0.900	0.740
-15 °C	"	32.8	30.9	29.0	27.0	24.9	23.9	10.0
	"	1.300	1.225	1.150	1.070	0.990	0.950	0.790
-12 °C	"	33.5	31.6	29.7	27.7	25.7	24.7	10.3
	"	1.330	1.255	1.180	1.100	1.020	0.980	0.820
-10 °C	"	34.0	32.1	30.2	28.2	26.2	25.2	10.6
	"	1.350	1.275	1.200	1.120	1.040	1.000	0.840
-8 °C	"	36.0	33.7	31.4	29.2	27.0	25.5	10.8
	"	1.430	1.338	1.247	1.160	1.073	1.013	0.860
-7 °C	"	37.0	34.5	32.0	29.7	27.5	25.7	11.0
	"	1.470	1.370	1.270	1.180	1.090	1.020	0.870
-6 °C	"	37.4	34.9	32.4	30.2	28.0	26.1	11.0
	"	1.484	1.384	1.284	1.197	1.110	1.034	0.874
-5 °C	"	37.7	35.2	32.7	30.6	28.5	26.4	11.1
	"	1.498	1.398	1.298	1.214	1.130	1.048	0.878
-4 °C	"	38.1	35.6	33.1	31.0	29.0	26.8	11.1
	"	1.512	1.412	1.312	1.231	1.150	1.062	0.882
-3 °C	"	38.5	35.9	33.4	31.4	29.5	27.1	11.2
	"	1.526	1.426	1.326	1.248	1.170	1.076	0.886
-2 °C	"	38.8	36.3	33.8	31.9	30.0	27.5	11.2
	"	1.540	1.440	1.340	1.265	1.190	1.090	0.890
-1 °C	"	39.0	36.7	34.4	32.3	30.1	27.8	11.3
	"	1.547	1.457	1.366	1.281	1.195	1.105	0.895
0 °C	Output (kW)	39.2	37.1	35.1	32.7	30.3	28.2	11.3
	Effic. (GUE)	1.555	1.474	1.393	1.297	1.201	1.120	0.900
1 °C	"	39.4	37.6	35.8	33.1	30.4	28.6	11.4
	"	1.562	1.491	1.420	1.314	1.206	1.135	0.905
2 °C	"	39.6	38.0	36.5	33.5	30.5	29.0	11.5
	"	1.570	1.509	1.448	1.330	1.212	1.150	0.910
3 °C	"	39.7	38.3	36.8	33.9	31.0	29.4	11.6
	"	1.575	1.519	1.462	1.347	1.231	1.166	0.918
4 °C	"	39.8	38.5	37.2	34.4	31.5	29.8	11.7
	"	1.581	1.528	1.476	1.363	1.251	1.183	0.926
5 °C	"	40.0	38.8	37.5	34.8	32.0	30.2	11.8
	"	1.586	1.538	1.490	1.380	1.270	1.200	0.934
6 °C	"	40.1	39.0	37.9	35.2	32.5	30.7	11.9
	"	1.591	1.548	1.504	1.397	1.291	1.218	0.942
7 °C	"	40.2	39.3	38.3	35.7	33.0	31.1	12.0
	"	1.597	1.558	1.519	1.415	1.311	1.236	0.950
8 °C	"	40.4	39.4	38.5	36.0	33.5	31.6	12.1
	"	1.602	1.565	1.527	1.428	1.329	1.254	0.961
10 °C	"	40.6	39.8	38.9	36.6	34.4	32.5	12.4
	"	1.613	1.578	1.542	1.454	1.367	1.290	0.984
12 °C	"	40.9	40.1	39.2	37.3	35.4	33.4	12.7
	"	1.624	1.590	1.557	1.480	1.404	1.326	1.006
15 °C	"	41.3	40.6	39.8	38.3	36.8	34.8	13.1
	"	1.640	1.610	1.580	1.520	1.460	1.380	1.040

Typical technical specifications

Available in 38kW modules

Dimensions 1,230 x 1,280 x 1,540mm

Weight 400kg

Typical noise 45dB(A)

Can be installed on skid

40% air source renewable energy

This highly efficient and low CO_2 emission application of natural Gas Absorption Heat Pumps further highlights the continued success of natural gas in providing developers and customers with a reliable, low-carbon, competitive source of fuel which meets the most stringent building regulations. As Gas Networks Ireland moves forward with plans to decarbonise the gas network, customers will benefit from further reductions in their carbon emissions.

Building design

50-bed nursing home of 4,290m² net area building specifications

Building global parameters	Actual	Reference
Area (m²)	4,290	4,290
External area (m²)	7,824	7,824
Weather	DUB	DUB
Infiltration (m3/(h. m²)@50Pa)	3	3
Average conductance (W/K)	1,821.23	2,582.55
Average U-value (W/m2K)	0.49	0.33
Alpha value* (%)	17.35	19.18

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

Air permeability	Upper limit	Actual building value
m3/(h. m²)@50Pa	5	3

Heat transmission through building fabric

Element	Ua-Limit	Ua-Calc	Ui-Limit	Ui-Calc
Walls**	0.21	0.18	0.6	0.18
Floors (ground and exposed)	0.21	0.15	0.6	0.15
Pitched roofs	0.16	N/A	0.3	N/A
Flat roofs	0.2	0.15	0.3	0.15
Windows, roof windows and rooflights	1.6	1.37	3	1.41
Personnel doors***	1.6	1.44	3	1.44
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.

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The gas absorption heat pump referenced in this case study is a Robur heat pump www.robur.com

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