

# GeoAtlantic at Allenergy

A Scottish demonstrator project: feasibility and design of ground source or water source heat pump systems for use in buildings owned by Scottish Canals, many of which are situated adjacent to canal waterways



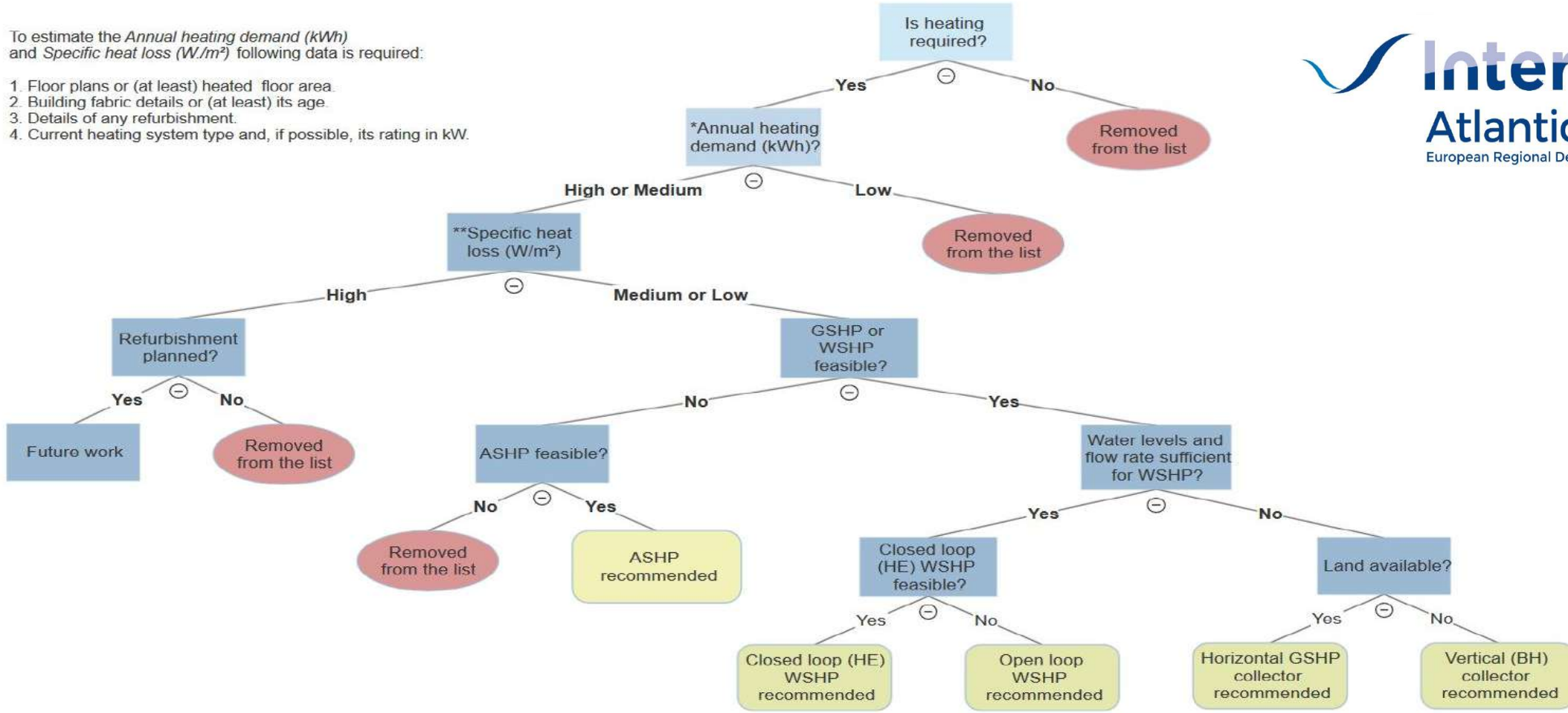
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# Decision process of the heat pump technology's feasibility for Scottish Canals

To estimate the *Annual heating demand (kWh)* and *Specific heat loss (W/m<sup>2</sup>)* following data is required:

1. Floor plans or (at least) heated floor area.
2. Building fabric details or (at least) its age.
3. Details of any refurbishment.
4. Current heating system type and, if possible, its rating in kW.





- Multi-use building cluster, currently heated with combination of electric storage and oil. Estimated Heat Demand: 50,664 kWh/year / £7,599
- Water and ground source heat pumps are options. Water, open loop taking water from the canal upstream of the lock, and ground source using boreholes. Both are doable, but more costly than an air source system
- Reducing heat loss of the building would be important prior to installing any low temperature heating system

Recommended System Type **WSHP**:  
CO<sub>2</sub> Emission Reduction 8,370 (kg/year)  
Running Cost Reduction 5,458 (£/year)  
Potential RHI Income 3,962 (£/year)  
System Payback Time with RHI/without **4.1/7.0** (years)  
Estimated Cost of Installation **38,228** (£)  
Cost per kg of CO<sub>2</sub> Reduced 0.30 (£/kg)

Recommended System Type **ASHP**:  
CO<sub>2</sub> Emission Reduction 8,078 (kg/year)  
Running Cost Reduction 5,268 (£/year)  
Potential RHI Income 1,413 (£/year)  
System Payback Time with RHI/without **4.4/5.5** (years)  
Estimated Cost of Installation **29,187** (£)  
Cost per kg of CO<sub>2</sub> Reduced 0.24 (£/kg)



Recommended System Type: **WSHP** open loop  
CO<sub>2</sub> Emission Reduction 11,027 (kg/year)  
Running Cost Reduction 7,191 (£/year)  
Potential RHI Income 4,427 (£/year)  
System Payback Time with RHI/without **3.3/5.4** (years)  
Estimated Cost of Installation **38,559** (£)  
Cost per kg of CO<sub>2</sub> Reduced 0.23 (£/kg)

Recommended System Type: **ASHP**  
CO<sub>2</sub> Emission Reduction 10,642 (kg/year)  
Running Cost Reduction 6,940 (£/year)  
Potential RHI Income 1,862 (£/year)  
System Payback Time with RHI/without **3.4/4.3** (years)  
Estimated Cost of Installation **29,518** (£)  
Cost per kg of CO<sub>2</sub> Reduced 0.18 (£/kg)

- Offices, customer facilities, store and plant
- Electric storage or panel heating
- Estimated Heat Demand 66,744 kWh/year / £10,012
- 268m<sup>2</sup> area and high energy costs
- A water source heat pump is an option with either an open loop or closed loop system



- General maintenance workshop, storage and trade work, drying area, welfare and office facilities.
- Steel framed brick with part metal cladding, refurbished in 2005, with double glazing; electric heating and hot water.
- Est. Heat Demand 52,567 kWh/year/ £7,885
- A water source heat pump is an option, with either an open loop or closed loop system. A ground source heat pump would avoid the need to cross the road with pipework, drilling boreholes instead in the yard. Equally, an ASHP system could be installed.

Recommended System Type **WSHP** open loop  
 CO<sub>2</sub> Emission Reduction 8,925 (kg/year)  
 Running Cost Reduction 5,820 (£/year)  
 Potential RHI Income 2,946 (£/year)  
 System Payback Time with RHI/without **3.9/5.9** (years)  
 Estimated Cost of Installation **34,488** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.26 (£/kg)

Recommended System Type **GSHP** with boreholes  
 CO<sub>2</sub> Emission Reduction 8,925 (kg/year)  
 Running Cost Reduction 5,820 (£/year)  
 Potential RHI Income 2,946 (£/year)  
 System Payback Time with RHI/without **5.2/7.8** (years)  
 Estimated Cost of Installation **45,626** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.34 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 8,382 (kg/year)  
 Running Cost Reduction 5,466 (£/year)  
 Potential RHI Income 1,466 (£/year)  
 System Payback Time with RHI/without **2.5/3.1** (years)  
 Estimated Cost of Installation **17,125** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.14 (£/kg)



- Tourist destination: café/take away, commercial kitchen, office space, rented commercial retail outlet. En-suite rooms and housekeeping storage. Major refurbishment in 2018. Heating is all electric via panel heaters and hot water is provided by an LPG boiler. Estimated Heat Demand 104,612 kWh/year/ £15,691
- The site is very tight with a road between the building and the canal. There is a lock at this point of the canal which would add a level of complexity that would unfortunately make a water source option challenging and expensive. The tight nature of the site would also make it a challenge for ground source.

Recommended System Type **GSHP** with boreholes  
 CO<sub>2</sub> Emission Reduction 17,340 (kg/year)  
 Running Cost Reduction 11,308 (£/year)  
 Potential RHI Income 6,146 (£/year)  
 System Payback Time with RHI/without **4.9/7.5** years  
 Estimated Cost of Installation **84,668** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.33 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 17,225 (kg/year)  
 Running Cost Reduction 11,234 (£/year)  
 Potential RHI Income 2,918 (£/year)  
 System Payback Time with RHI/without **2.8/3.5** years  
 Estimated Cost of Installation **39,346** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.15 (£/kg)



System Type **WSHP** open loop  
 CO<sub>2</sub> Emission Reduction 2,841 (kg/year)  
 Running Cost Reduction 1,852 (£/year)  
 Potential RHI Income 999 (£/year)  
 System Payback Time with RHI/without **10.0/15.4** years  
 Estimated Cost of Installation **28,613** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.67 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 2,745 (kg/year)  
 Running Cost Reduction 1,789 (£/year)  
 Potential RHI Income 447 (£/year)  
 System Payback Time with RHI/without **5.1/6.4** years  
 Estimated Cost of Installation **11,492** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.28 (£/kg)

- Constructed in 2007, customer facility with toilets and showers, store, laundry and plant room. Electric heating. Estimated Heat Demand 16,048 kWh/year / £2,407
- An IDM Terra Heat WSHP was installed but was decommissioned because it didn't meet the showers and laundry requirement.
- it is worth investigating whether the heat pump could be replaced with a more modern and therefore efficient model that would achieve the temperature and hot water demands. This would require a site visit to try and ascertain whether the water source collector system is useable and sized such that it would service a new heat pump. Meanwhile, calculation is based on full system replacement.





- The Crinan Canal HQ has now moved, leaving this building currently unoccupied and due for renovation with a view to letting it out as tourist accommodation.
- The ground floor is heated by a 5 year old oil boiler. Upstairs there are electric storage heaters. Estimated Heat Demand 39,991 kWh/year / £1,919
- Good opportunity to incorporate renewable heat. Improved insulation and air tightness will create a building suitable for a low temperature heating system. Over-sized radiators can be specified to maximise system efficiency. Allowance can also be made for a plant room to house a heat pump and hot water tank.
- Ground source is an option for this building. There is limited available land for a ground collector system but plenty of space for drilling boreholes at the back.

Recommended System Type **GSHP** with boreholes  
 CO<sub>2</sub> Emission Reduction 9,657 (kg/year)  
 Running Cost Reduction 890 (£/year)  
 Potential RHI Income 2,583 (£/year)  
 System Payback Time with RHI/without **16.0/62.5** (years)  
 Estimated Cost of Installation **55,690** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.38 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 9,524 (kg/year)  
 Running Cost Reduction 803 (£/year)  
 Potential RHI Income 1115 (£/year)  
 System Payback Time with RHI/without **13.0/31.0** (years)  
 Estimated Cost of Installation **24,895** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.17 (£/kg)



- Existing dysfunctional WSHP has been decommissioned and a gas boiler installed. Estimated Heat Demand 116,650 kWh/year / £4,899
- Recommendation is to replace the heat pump system with a new water source heat pump for the following reasons: the cost of system fault-finding, repair and possible re-commissioning could be significant with no guarantee of reinstating a resilient system that remains operational; the installed system is around 15 years old and heat pump technology has improved significantly during this time; installing a new system with guarantees, within the RHI qualifying timescale, means that it could qualify for RHI payments for the next 20 years.
- Existing wet heating system with radiators seems to be in good order and already sized for a low temperature heating system. Existing gas boiler can be retained as a back-up.
- A GSHP with boreholes is also an option at this site.

Recommended System Type **WSHP** open loop  
 CO<sub>2</sub> Emission Reduction 16,176 (kg/year)  
 Running Cost Reduction 738 (£/year)  
 Potential RHI Income 6,493 (£/year)  
 System Payback Time with RHI/without **5.6/55.0** (years)  
 Estimated Cost of Installation **40,597** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.17 (£/kg)

Recommended System Type **GSHP** with boreholes  
 CO<sub>2</sub> Emission Reduction 16,176 (kg/year)  
 Running Cost Reduction 738 (£/year)  
 Potential RHI Income 6,493 (£/year)  
 System Payback Time with RHI/without **9.4/92.0** (years)  
 Estimated Cost of Installation **68,272** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.28 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 16,213 (kg/year)  
 Running Cost Reduction 763 (£/year)  
 Potential RHI Income 3,254 (£/year)  
 System Payback Time with RHI/without **8.1/42.0** (years)  
 Estimated Cost of Installation **32,400** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.13 (£/kg)



- 1000m<sup>2</sup> including adjacent and connected extension. Currently heated by a gas boiler (15+ years old) and wet radiator system. Additional heating and cooling is delivered via multiple air to air heat pumps and convector fan units. Estimated Heat Demand 165,055 kWh/year / £6,932
- recommendation is for open loop WSHP. The existing gas boiler would be retained as back-up. Included our calculations is the upsizing of radiators to ensure best system efficiency associated with a low temperature heat pump system.

Recommended System Type **WSHP** open loop  
 CO<sub>2</sub> Emission Reduction 22,806 (kg/year)  
 Running Cost Reduction 992 (£/year)  
 Potential RHI Income 12,978 (£/year)  
 System Payback Time with RHI/without **6.5/91.0** (years)  
 Estimated Cost of Installation **90,167** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.26 (£/kg)

Recommended System Type **ASHP**  
 CO<sub>2</sub> Emission Reduction 21,148 (kg/year)  
 Running Cost Reduction -89 (£/year)  
 Potential RHI Income 4,605 (£/year)  
 System Payback Time with RHI/without **21.8/-** (years)  
 Estimated Cost of Installation **98,368** (£)  
 Cost per kg of CO<sub>2</sub> Reduced 0.31 (£/kg)

## Payback with RHI

Ranking of top 10 buildings (1 = First/Top)			
	CO <sub>2</sub> Emission Reduction		System Payback Time with RHI
1	Scotland SC HO	1	Dochgarroch Maint. Depot
2	Caledonian Canal Centre	2	Caledonian Canal Centre
3	The Boathouse	3	Seaport Marina
4	Seaport Marina	4	Clachnaharry Sea Lock Office
5	Crinan Canal HQ	5	Gairloch Customer Facility
6	Dochgarroch Maint. Depot	6	Lowland Office / Workshop
7	Clachnaharry Sea Lock Office	7	The Boathouse
8	Old Basin House	8	Scotland SC HO
9	Gairloch Customer Facility	9	Crinan Canal HQ
10	Lowland Office / Workshop	10	Old Basin House

Ranking average CO <sub>2</sub> reduction & payback (with RHI) - top 10 buildings (1 = First/Top)					
Combined Ranking Average	Building	Ranking	Preferred System	Est. current heating cost £/m <sup>2</sup>	Est. cost of installation £
2.0	Caledonian Canal Centre	1	ASHP	28	39,346
3.5	Seaport Marina	2=	ASHP	37	29,518
3.5	Dochgarroch Maint. Depot	2=	ASHP	41	17,125
4.5	Scotland SC HO	4	WSHP open	7	90,167
5.0	The Boathouse	5	WSHP open	5	40,597
5.5	Clachnaharry Sea Lock Office	6	ASHP	50	29,187
7.0	Crinan Canal HQ	7=	ASHP	7	24,895
7.0	Gairloch Customer Facility	7=	ASHP	49	11,492
8.0	Lowland Office / Workshop	9	ASHP	32	11,737
9.0	Old Basin House	10	ASHP	6	15,380

## Payback with NO RHI

Ranking of top 10 buildings (1 = First/Top)			
	CO <sub>2</sub> Emission Reduction		System Payback Time- NO RHI
1	Scotland SC HO	1	Dochgarroch Maint. Depot
2	Caledonian Canal Centre	2	Caledonian Canal Centre
3	The Boathouse	3	Seaport Marina
4	Seaport Marina	4	Clachnaharry Sea Lock Office
5	Crinan Canal HQ	5	Gairloch Customer Facility
6	Dochgarroch Maint. Depot	6	Lowland Office / Workshop
7	Clachnaharry Sea Lock Office	7	Crinan Canal HQ
8	Old Basin House	8	The Boathouse
9	Gairloch Customer Facility	9	Old Basin House
10	Lowland Office / Workshop	10	Scotland SC HO

Ranking average CO <sub>2</sub> reduction & payback (NO RHI) - top 10 buildings (1 = First/Top)					
Combined Ranking Average	Building	Ranking	Preferred System	Est. current heating cost /m <sup>2</sup>	Est. cost of installation
2.0	Caledonian Canal Centre	1	ASHP	28	39,346
3.5	Seaport Marina	2=	ASHP	37	29,518
3.5	Dochgarroch Maint. Depot	2=	ASHP	41	17,125
5.5	Scotland SC HO	4=	WSHP open	7	90,167
5.5	The Boathouse	4=	WSHP open	5	40,597
5.5	Clachnaharry Sea Lock Office	4=	ASHP	50	29,187
6.0	Crinan Canal HQ	7	ASHP	7	24,895
7.0	Gairloch Customer Facility	8	ASHP	49	11,492
8.0	Lowland Office / Workshop	9	ASHP	32	11,737
8.5	Old Basin House	10	ASHP	6	15,380

- The total annual carbon emission reduction if all the buildings in the top 10 had heat pumps installed would amount to 102 tonnes CO<sub>2</sub>, over 10% of Scottish Canals total emissions.
- The project has shown the potential for water and ground source heat pumps and other renewable energy alternatives across the Scottish Canals estate and also highlighted the importance of a 'fabric first' approach to energy efficiency and carbon footprint reductions.

## Thank you

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