Residential Heating

ecodan
Renewable Heating Technology

MITSUBISHI ELECTRIC

An Introduction to Ecodan Air Source Heat Pump Design & Selection

Presented by | Craig Webb

Please note….

This is an introductory course covering the design and selection of Ecodan air source heat pumps and cylinders.

Whilst some of the principles, procedures and guidance covered herein can be utilised by unqualified person(s), there are aspects of this presentation which we recommend should always be undertaken by fully qualified and professional person(s) to ensure that the product(s) selected are optimised for the dwelling in question.

To help with this journey, our team of pre-sales engineers and support teams provide a premium service and are available to discuss your project and/or answer any questions you may have relating to design and selection.

We are here to help and are able to provide full design & selection courses at any of our 7 UK training centers

This course will cover…

- The importance of dwelling heat losses
- How to optimise comfort through design
- Core methods of product selection
- Which installation design factors are key
- How ME are able to support you

After this course you should have…

- Knowledge of how to estimate heat loads
- Means to guarantee customer satisfaction
- The ability to design & select products
- An appetite for further learning
- Confidence in how ME can support you

Poll Question

- What is your job role?
  - End-User/Purchaser
  - Installer/Contractor
  - Specifier/Developer
  - Facilities Manager/Service Engineer
  - Other

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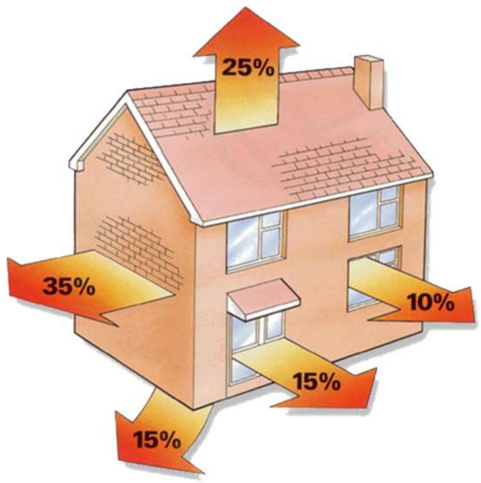
Overview of Heat & Ventilation Losses

Heat loss; what is it and why is it essential?

The estimated amount of heat energy escaping from your dwelling is the foundation of all design…

- **Ensures that the correct size products are selected**
- **Heat loads are [typically] measured in kW**
- **As ambient temperature drops, heat losses increase**
- **Use the lowest ambient temperature heat loss value**
- **Both over & under-sizing of system should be avoided**

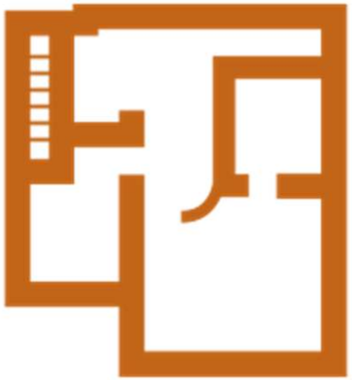


Heat loss methods

Commonly used methods with increasing degrees of accuracy used for ascertaining heat losses in dwellings…

Rule of Thumb

Whole House



Room by Room*

* Required to satisfy the standards of MCS & dRHI

Rule of Thumb method

The simplest and fastest method but with the lowest degree of accuracy

1930s – 40s	1950s – 60s	1970s – 80s	90s – 2000s	2010 onward	Passivhaus
90	80	70	60	50	10
W/m^2	W/m^2	W/m^2	W/m^2	W/m^2	W/m^2

Whole House method

The Ian Botham of heat loss calculations; an all-rounder that balances speed with accuracy…

- **Assesses the envelope of the dwelling**
- **Quality of information is important**
- **Not as accurate due to use of assumptions**
- **Does not account for varying fabric types**
- **Calculator included within the ME design tool***

*W: ecodanselectiontool.mitsubishielectric.co.uk

Room by Room method

The most time consuming but most accurate method

- **Required in order to claim the dRHI payments**
- **Assesses the heat loss of each individual room**
- **Accounts for both internal and external surfaces**
- **Should be used to select the correct size of emitter**
- **MCS approved calculator is available here***

*W: mcscertified.com/standards-tools-library/?subitem=Heat+Pumps

Heat loss

The measured rate of heat transfer through materials

- **Measured in W/m²K and are known as U-Values**
- **Not all materials have the same U-value**
- **A material U-value is the sum total of its parts**
- **U-values can vary across parts of a dwelling**
- **Used in whole house & room by room methods**

Heat loss - continued

The measured rate of heat transfer through materials

- **Common material U-value tables available online**
- **Material U-value = 1 ÷ cumulative R-Value(s)**
- **R-value is a materials resistivity to heat transfer**
- **Material R-value = 1 ÷ thermal conductivity**
- **Thermal conductivity values are available online**

Heat loss - summary

A set of values that are to be used during the product selection process…

- Both R & U-values are measured in W/m²K (Watts per sq. meter Kelvin)
- U-values are the measured rate of heat transfer through a material
- R-values are the resistance to heat flow through a thickness of material
- The U-value of a material = 1 ÷ cumulative R-Value(s)
- Accurate U-values result in accurate heat loss estimates

Ventilation loss; what is it & why it should be considered?

Heat losses that occur due to the ingress of air into a dwelling

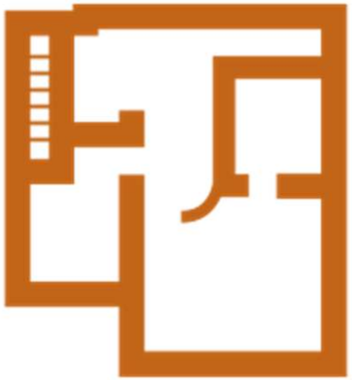
- **Due to open windows, trickle vents, air gaps, etc.**
- **Essential to ensure a healthy living environment**
- **Ingress of cold ambient air results in thermal loss**
- **These losses can be substantial and considered**
- **Room volumes are required for calculations**

Ventilation loss methods

The same type of methods can be used to assess the ventilation losses in dwellings…

Rule of Thumb

Whole House



Room by Room*

* Required to satisfy the standards of MCS & dRHI

Ventilation loss - summary

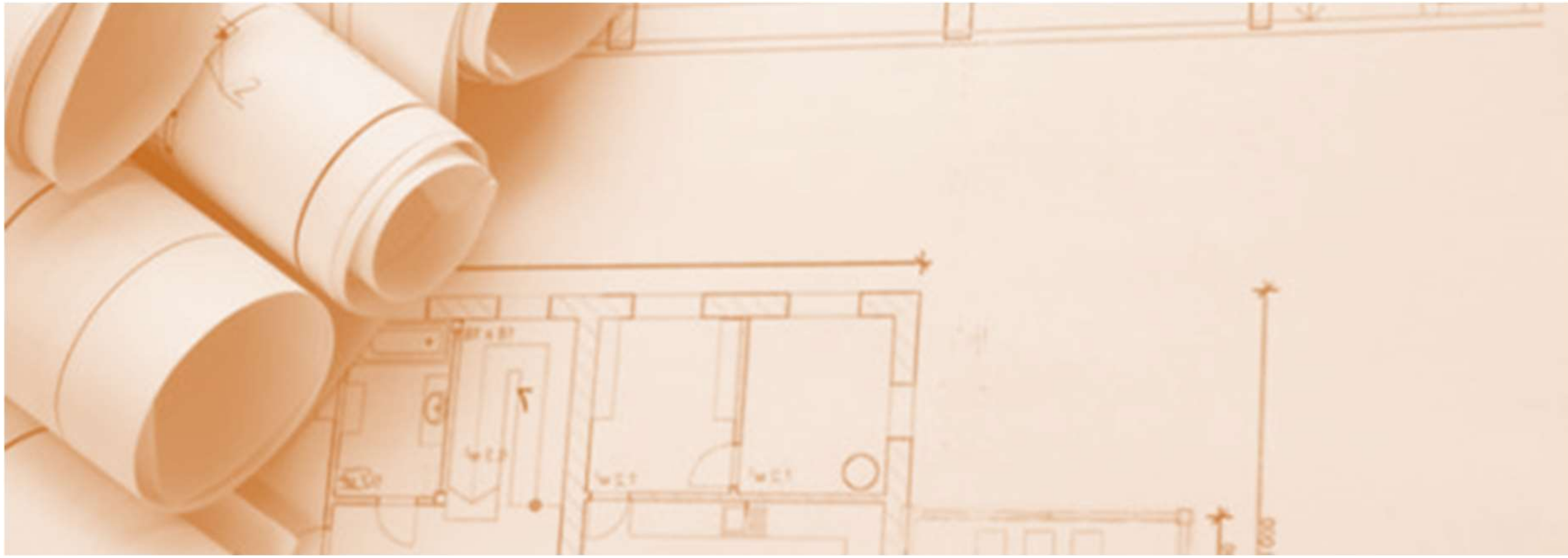
As building quality improves and air tightness increases, the limitations of natural ventilation must be considered

- Typically older buildings with lower levels of air tightness have higher losses
- Reducing gaps between materials via improved practices reduces losses
- In modern air-tight dwellings, artificial ventilation needs to be considered
- Artificial solutions range from trickle vents to mechanical ventilation
- Mechanical Ventilation & Heat Recovery (MVHR) systems reduce total losses

Poll Question

- Which heat loss method do you need to use to comply with MCS standards?
  - No methodology is required
  - Rule of Thumb
  - Whole House
  - Room by Room
  - All mentioned methods comply
- Answer: Room by Room: The most accurate method

System Design



Design ambient temperature

The founding design characteristic needed to select a heat pump

- **Essential to ensure that a heat pump can deliver the required heating capacity**
- **Different geographical locations have differing design temperatures**
- **A comprehensive list of average ambient temperatures are available online***
- **If a high temperature is used, the system may not be able to satisfy demand**
- **Heat pump should be selected to cover 100% of heat loss at design temp.**

*W: mcscertified.com/standards-tools-library/?subitem=Heat+Pumps

Flow temperature

Key reference point to establish design temperature and heat load requirements

- This is the water output temperature that the heat pump will produce
- Heat pumps are designed to operate at lower temperatures (vs. boilers)
- Different operating temperatures can have an effect on emitter outputs
- Efficiency of a system is also affected by the flow rate (high °C = lower eff.)
- It is therefore essential to ensure that enough heat energy is being delivered

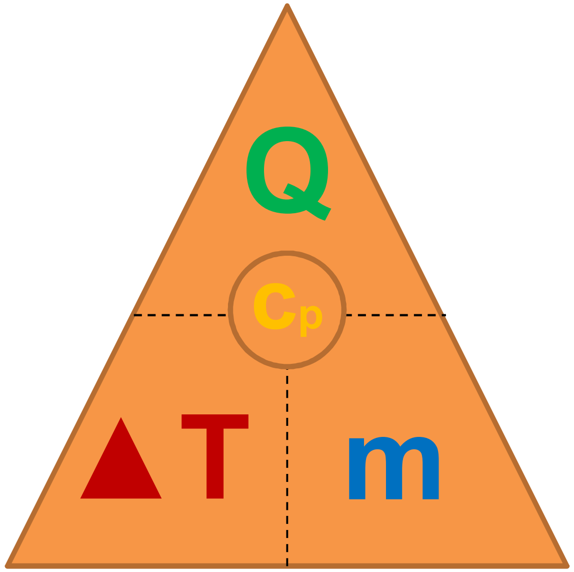
Flow Rates

Essential to ensure enough heat load is being delivered and the system efficiency is optimised

- **This is the rate at which water passes through the hydraulic system**
- **Heat pump flow rates differ from traditional boiler systems**
- **Calculating the heat energy (Q: Power) delivered is required:**
    - **$Q = mc_p \blacktriangle T$**
        - **m = mass flow rate**
        - **c_p = specific heat capacity**
        - **▲T = difference between flow and return temperatures**

Flow Rates – continued

Where; Q = Energy (Power), m = mass flow rate, c_p = specific heat capacity and ▲T = temperature difference

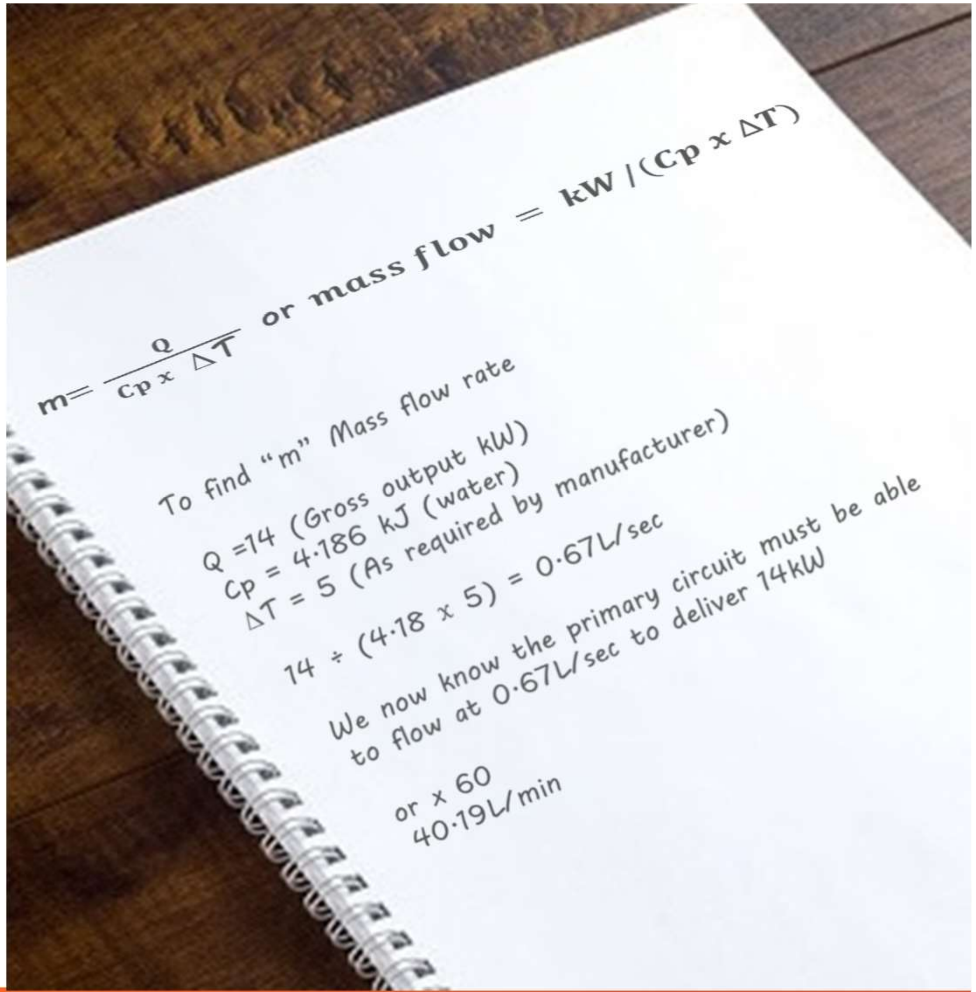


1. $Q = mc_p \Delta T$ (kW)
2. $\Delta T = Q \div mc_p$ (K)
3. $m = Q \div c_p \Delta T$ (l/s)

Flow Rates – continued

Calculating the mass flow rate

- **Using the flow rate to determine the volume of water required to deliver enough energy to overcome the heat loss of the room being designed**
- **Resultantly, pipe sizes need to be considered to ensure this energy is delivered effectively**



Flow temperature & emitters

Considerations to make when designing your heat pump system

- Emitters are typically oversized (not always by enough)
- Lower flow temperatures are more efficient
- Unit capacities affected by flow temperatures
- Ambient outdoor temperatures also affect unit capacity
- Adjustment factors ensure radiators are sized correctly

Radiator Size Adjustment	
ΔT	Factor (Divide by)
20	0.25
25	0.37
30	0.50
35	0.62
40	0.75
45	0.87
50	1.00
55	1.13
60	1.37
65	1.41
70	1.55

Flow temperature & emitters

Considerations to make when designing your heat pump system

- Lower flow temperatures = larger radiators
- Divide the 1.1kW heat loss by 0.37 = 2.9kW
- Resultant radiator size doubles as a result
- Other types of radiator can be considered
- Double panel or fan assisted are common

Height	Length	Sections	Heat output	
mm	mm		Watts	BTU/hr
300	500	15	506	1727
300	1000	30	1012	3454
300	1500	45	1518	5181
300	2000	60	2024	6908
300	2500	75	2530	8635
300	3000	90	3036	10362

Poll Question

- What factors affect design ambient temperatures?
    - Geographical location
    - Flow rates
    - Specific heat capacity of a fluid
    - Heat pump capacity
    - None of the above
- Answer: **Geographical location:** Note that altitude is also a factor

W: https://www.gov.uk/guidance/f-gas-in-refrigeration-air-conditioning-and-fire-protection-systems

System Selection

Core Heat Pump Range

Residential Air Source Heat Pump Monobloc Range (4kW to 84kW*)

4.0kW	5.0kW	8.5kW	11.2kW	14.0kW
				
QUHZ-W40VA R744 (CO2) Compact	PUHZ-W50VHA R410a Compact	PUHZ-W85VAA R410a Ultra Quiet	PUHZ-W112VAA R410a Ultra Quiet	PUHZ-HW140VHA R410a Zubadan

* Achieved by cascading 6 outdoor units

Outdoor unit selection

Selecting the correct outdoor is essential to ensuring dwellings are heated optimally

- **Selection should be undertaken once the design process is completed**
- **Heat losses & flow temperatures are used to select the correct capacity unit**
- **Corresponding capacity selection tables are provided in the ME databook***
- **Alternatively, the ME Ecodan Selection Tool can be used for this process**
- **Consider the minimum operational capacity as well as maximum requirement**

* https://library.mitsubishielectric.co.uk/pdf/directory/heating/technical_documents/current/databook

Compatible Indoor Cylinder Range

Residential Packaged (Cased) & Pre-Plumbed Slimline, Standard & Solar Cylinders (150 to 300 litres)

Thermal Store	Packaged	Slimline	Standard	Solar
				
QUHZ only 200L 1 model	PUHZ only 200L 1 model	PUHZ only 150 & 170L 2 models	PUHZ only 150L to 300L 5 models	PUHZ only 210L to 300L 3 models

Indoor unit selection

Selecting the correct Domestic Hot Water (DHW) cylinder is dependent upon dwelling use

- **Each dwelling type will have its own usage pattern based upon its occupancy***
- **Heat pump capacity is not a limiting factor when selecting the DHW size**
- **However, consider how heat pump capacity will affect DHW heat up duration**
- **Ecodan cylinders are equipped with immersion heaters as standard**
- **A programmed legionella cycle (60°C for 1hr every week) is also required**

* Typical demand is estimated to be 50L per person, per day

Poll Question

- Which is the correct legionella cycle requirement for a DHW when set to 60°C?
  - 35 mins per week
  - 45 mins per week
  - 55 mins per week
  - 65 mins per week
  - None of the above
- Answer: None of the above: 60 mins at 60 degrees, once a week

Installation design considerations

Basic installation considerations

For heat pump systems

- **Install in locations that can guarantee a plentiful supply of renewable energy**
- **Ensure that the water volume for defrost & sustained operation is adequate**
- **Design your primary side to deliver good water circulation – complex routes**
- **Consider the requirements for connecting the flow and return pipework**
- **Make provisions to ensure that any electrical connections are catered for**

Installation location

Focusing on air source heat pump systems

- Locate the outdoor unit in a place that can ensure a quality supply of air
- Consider the drainage & control of condensate water
- Position the unit so that it can be easily accessed for maintenance & service
- Guarantee that permitted development guidelines (noise & size) are followed
- Install suitable external insulation to minimise heat losses from the pipework

Airflow

Always important for an air source heat pump

- **Good airflow = good heating capacity**
- **Poor airflow = poor efficiency**
- **Low airflow = higher running costs**
- **Lack of airflow can lead to coil freezing**
- **Clearances described in ME technical manuals***

* https://library.mitsubishielectric.co.uk/pdf/directory/heating/technical_documents/current/installation_manual

Drainage & condensate

Consider health and safety when locating a heat pump

- **Up to 8 L/hr can be generated**
- **Pure water so not acidic**
- **Plumbed directly to drain, downpipe, soak-away…**
- **Should not be allowed to run pathways**
- **Consider freezing conditions**

Maintenance

Practical application of guidance is recommended

- **System performance is optimised when maintained well**
- **Access for outdoor units is required on all four sides**
- **Access for cylinders is typically limited to the front**
- **Note that maintenance and design guidelines can differ**
- **Failure to maintain a system could void its warranty**

Sound

Seek to minimise potential disruption to neighbours and comply with guidelines

- **Heat pumps are machines and can generate noise**
- **ME products are designed to minimise noise output**
- **MCS020 details a calculation method for assessment**
- **Permitted development limits noise to 42dBA @ 1m***
- **Calculations for multiple units should be considered**

* From the face of the nearest point of potential ingress; e.g. window or door

Poll Question

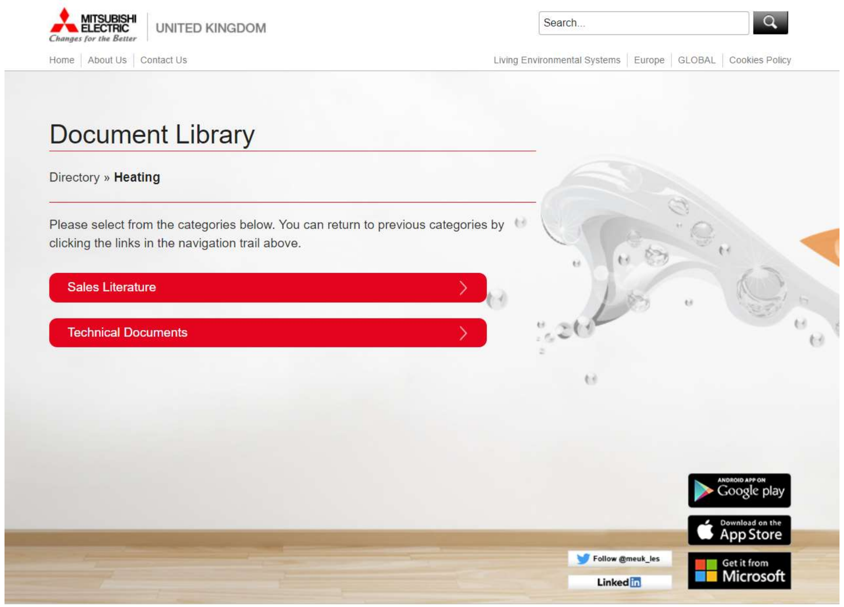
- What word best describes the state of condensate generated by a heat pump?
  - Discolored
  - Smelly
  - Acidic
  - Non-acidic
  - None of the above
- Answer: Non-acidic: This differs from a conventional boiler

How Mitsubishi Electric are able to support you

Helpful sources of information

Web based document library & app

- **Full library of technical information**
- **Free accompanying smartphone app**
- **Ability to use app offline**
- **Key documents can be downloaded**
- **Both sales and technical info**



W: https://library.mitsubishielectric.co.uk/pdf/directory/heating

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Ecodan Selection Tool design software

With different user access levels, both homeowners and installers alike can select their heat pump system

- **Web based free to use ME software***
- **2 user access levels; homeowner & installer**
- **Step-by-step homeowner selection process**
- **Installer heat loss calculation selection process**
- **MIS3005 compliant & includes an RHI calculator**

*W: ecodanselectiontool.mitsubishielectric.co.uk

Mitsubishi Electric pre-sales support team

Staffed every working day from 9am-5pm, Mitsubishi Electric are here to help when needed

- **UK call center (T: 01707 278666 – option 3)**
- **Able to assist with all Ecodan design questions**
- **Whole House design and selection as standard**
- **Specialist Room by Room design service***
- **Priority order quotation service**

* Supplied by a 3rd party company and is subject to availability – terms and conditions apply

Our full Ecodan design and application course

Available at all of our 7 national training centers – reservations can be made by calling 0161 866 6089, option 6

- **Overview of heat pump technology and Ecodan product range**
- **Theoretical training on whole system design and selection methods**
- **Hands on practical training session using our Ecodan selection tool**
- **Introduction to maintenance requirements and advanced product features**
- **Further information and more courses available via our website**

W: https://les.mitsubishielectric.co.uk/installers/installer-training

Poll Question

- What support services & tools are provided by the pre-sales technical team?
    - Whole house heat loss calculations
    - MCS compliant design software
    - Sound calculations
    - Specialist Room by Room design service
    - All of the above
- Answer: All of the above: We are here to help!

Residential Heating

ecodan® Renewable Heating Technology

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Q&A Session

Presented by

Craig Webb & Marc Overson

Final thoughts

Some key takeaways from our session today

- **Accurate heat loss calculations are the foundation of any HP design process**
- **HP's typically operate on lower flow temperatures & higher flow rates**
- **Consider both the theoretical and practical aspects of design & selection**
- **We are here to help and recommend the use of our phone, web & app services**
- **We invite all engineers to attend our full Design & Application course**

Poll Question

- On a scale of 1 (low) to 5 (high), how useful have you found this webinar?
  - 1
  - 2
  - 3
  - 4
  - 5

Residential Heating

Thank You

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Presented by Craig Webb