QODA

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THE CHURCH OF ENGLAND

QODA

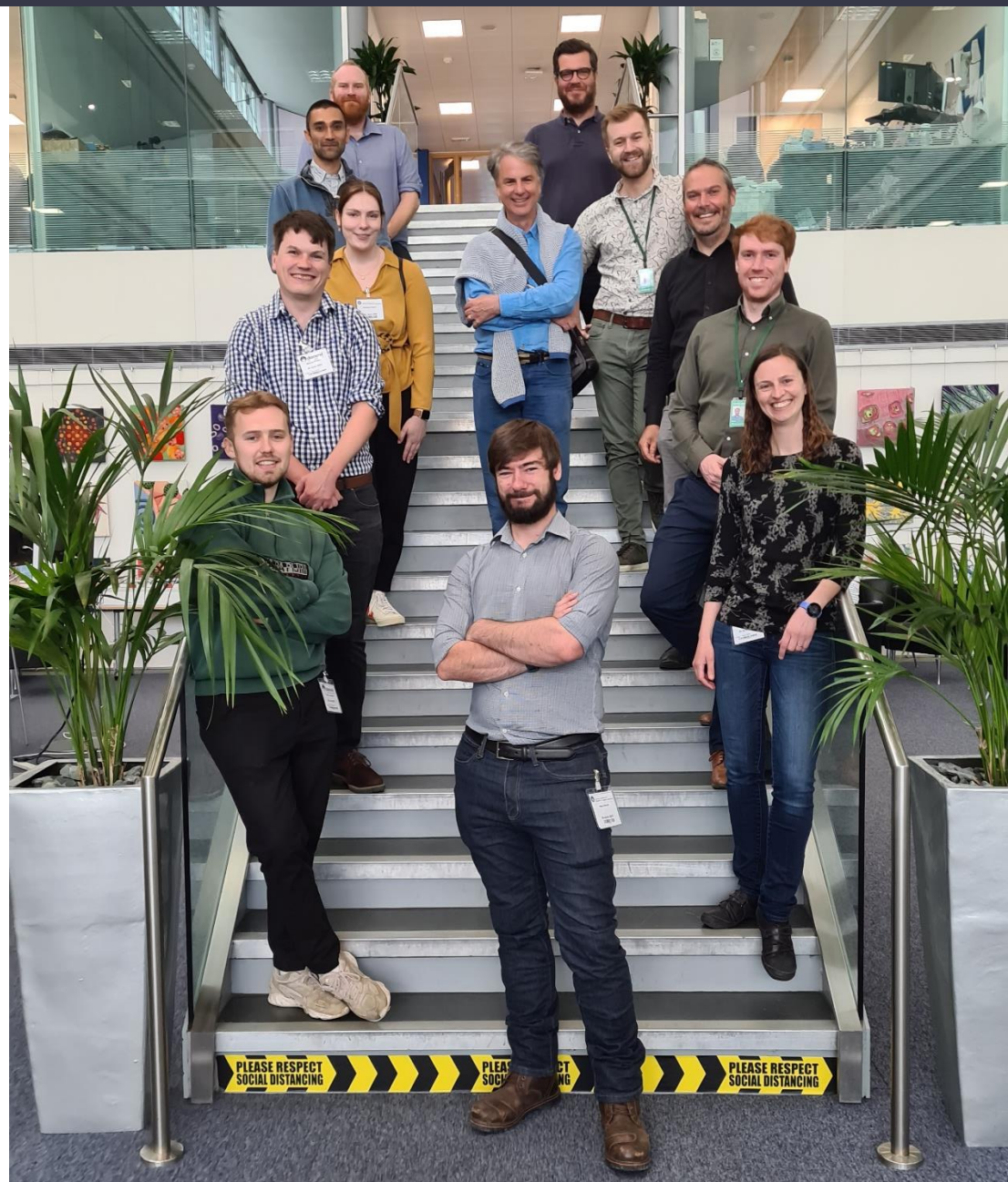
Who We Are

Set up in 2011, QODA has over 100 staff across our offices in Oxfordshire, London, Bristol, Norwich, Cambridge, and Peterborough.

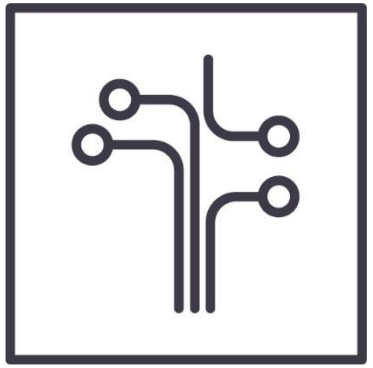
Everyone who works for QODA shares our vision for a more human approach to design and construction.

Our work covers everything from initial surveys and analysis, modelling, detailed design, and beyond.

Our team encompasses expertise in all the key areas of building services. We have a reputation for imaginative and innovative solutions utilising the most up to date technology and techniques to deliver robust, cost effective and appropriate solutions.



QODA Approach



We Are
Technological

We Are
Creative

We Are
Sustainable

We Are
Responsive and Engaging

We Are
Client Focussed

We Are
Fun to Work With

Core Services

- Building Services Design
- Planning Energy Statements
- Feasibility / Options Appraisal
- Infrastructure Master Planning
- Passivhaus Design
- Net Zero Studies
- Thermal Modelling including WUFI
- Daylighting Design
- Survey and Condition reports
- Heritage Environments
- Overheating Analysis

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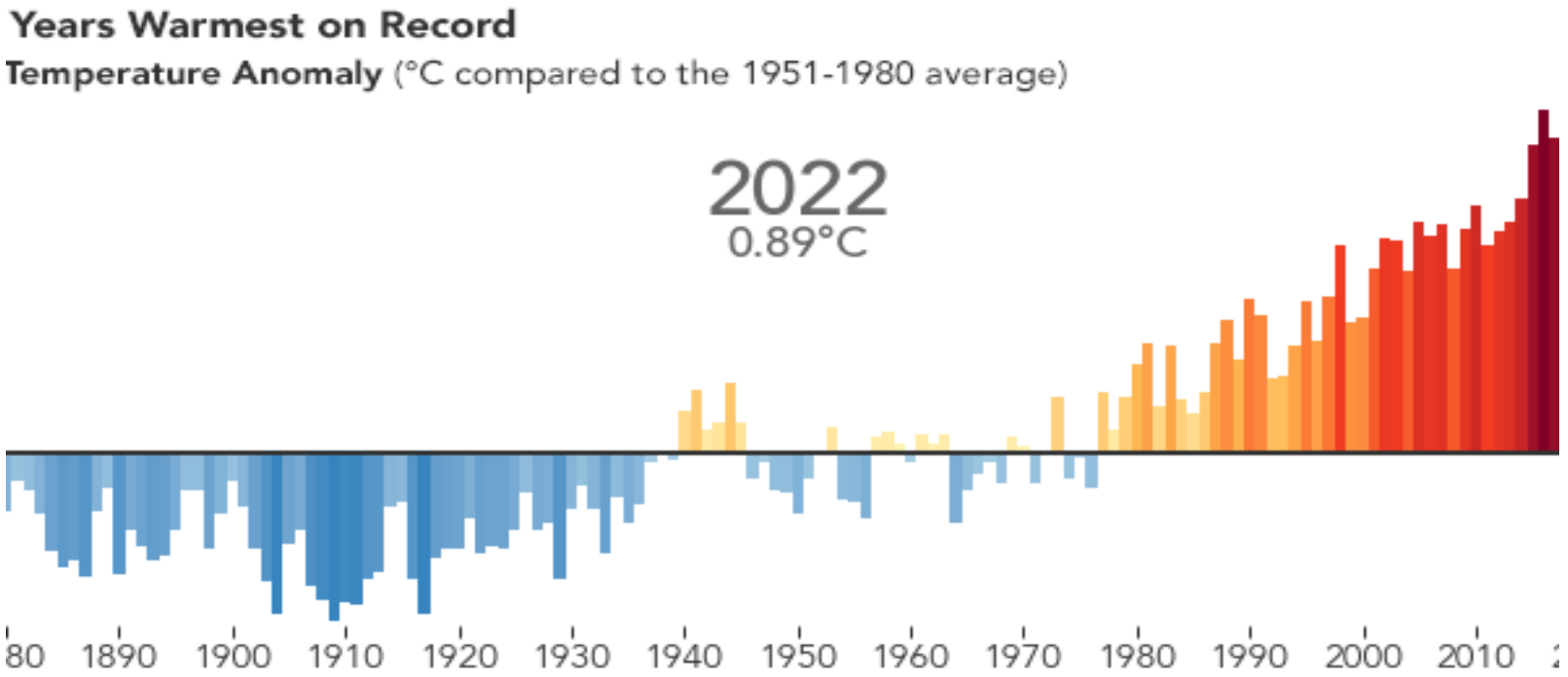
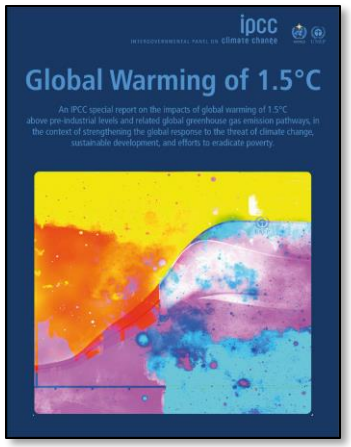
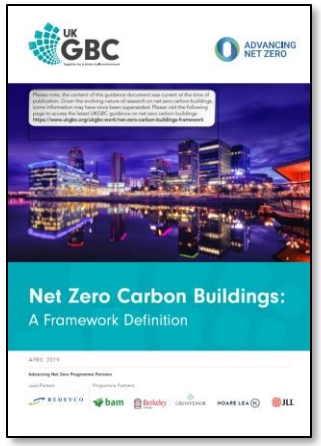
Our Home

Global Warming







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Decision by General Synod

‘Work to achieve year-on-year reductions in emissions and urgently examine what would be required to reach net zero emissions by 2030’

- *February 2020. Motion approved by the General Synod*

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Cathedrals

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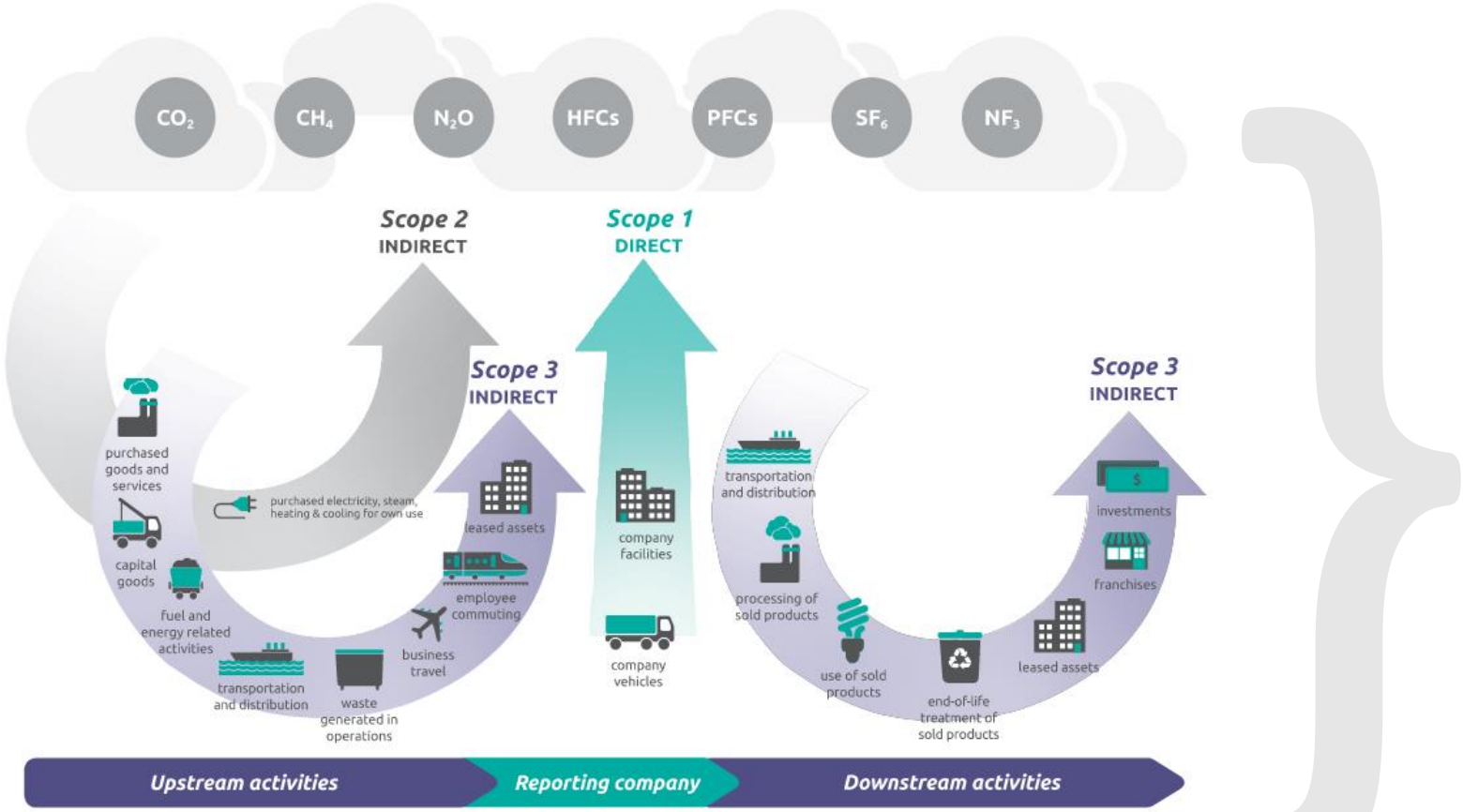
8,300tonnes CO_2 per year

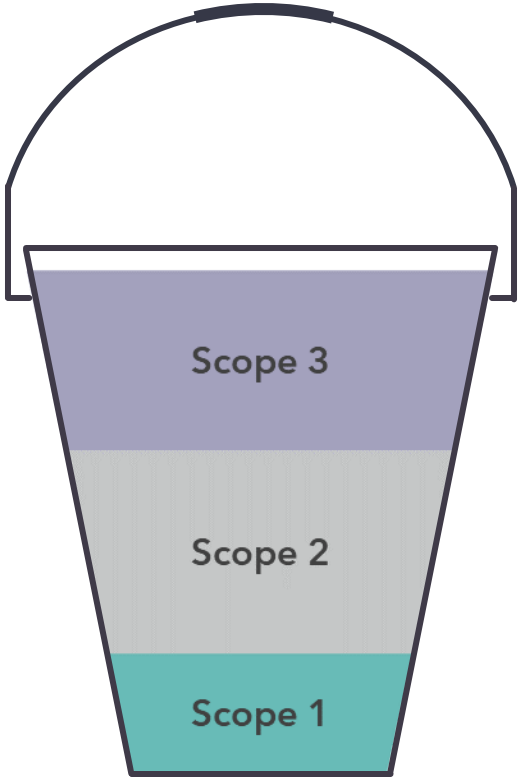
Measuring Carbon Emissions

GREENHOUSE GAS PROTOCOL

Emission Scopes



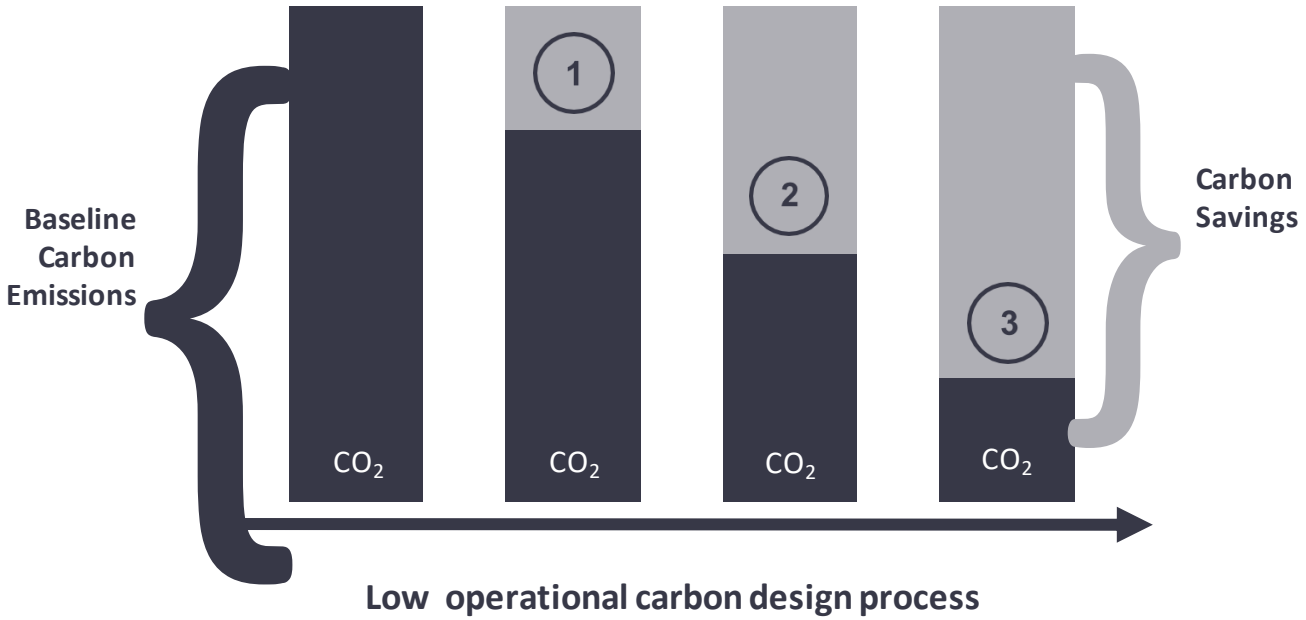
The Carbon Bucket



Source: GHG Protocol, Scope 3 Standard

Our Net Zero Carbon

Principles of Low Carbon Building Design



Approach

- ✓ Understanding
- ✓ Baseline data
- ✓ Create options
- ✓ Review and implement

1 **Passive Design:** use less energy

- Efficient form and orientation
- Insulation
- Efficient fenestration and solar shading
- Thermal bridge free construction
- Natural ventilation and passive cooling
- Airtightness

2 **Efficient Building Services:** use energy efficiently

- Mechanical vent with heat recovery
- Heat pumps
- Efficient lighting
- Low carbon district heating
- Efficient water use and heat recovery
- Electric heating and hot water

3 **Renewable Energy:** use low and zero carbon technologies

- Solar PV and solar thermal
- Wind power

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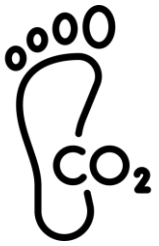
- Methodology and Current Performance
- Building Fabric and Operation
- Unique and Common Approaches
- Grid Electricity Carbon Emissions Factor
- QODA Decarbonisation Decision Tree
- ‘Best Case’ Performance
- Significance of Other CoE Buildings

Methodology

- Understand the Building - Survey



- Quantify the Current Carbon Footprint

- Identify the Decarbonisation Options Available

- Compare these Options to the Baseline

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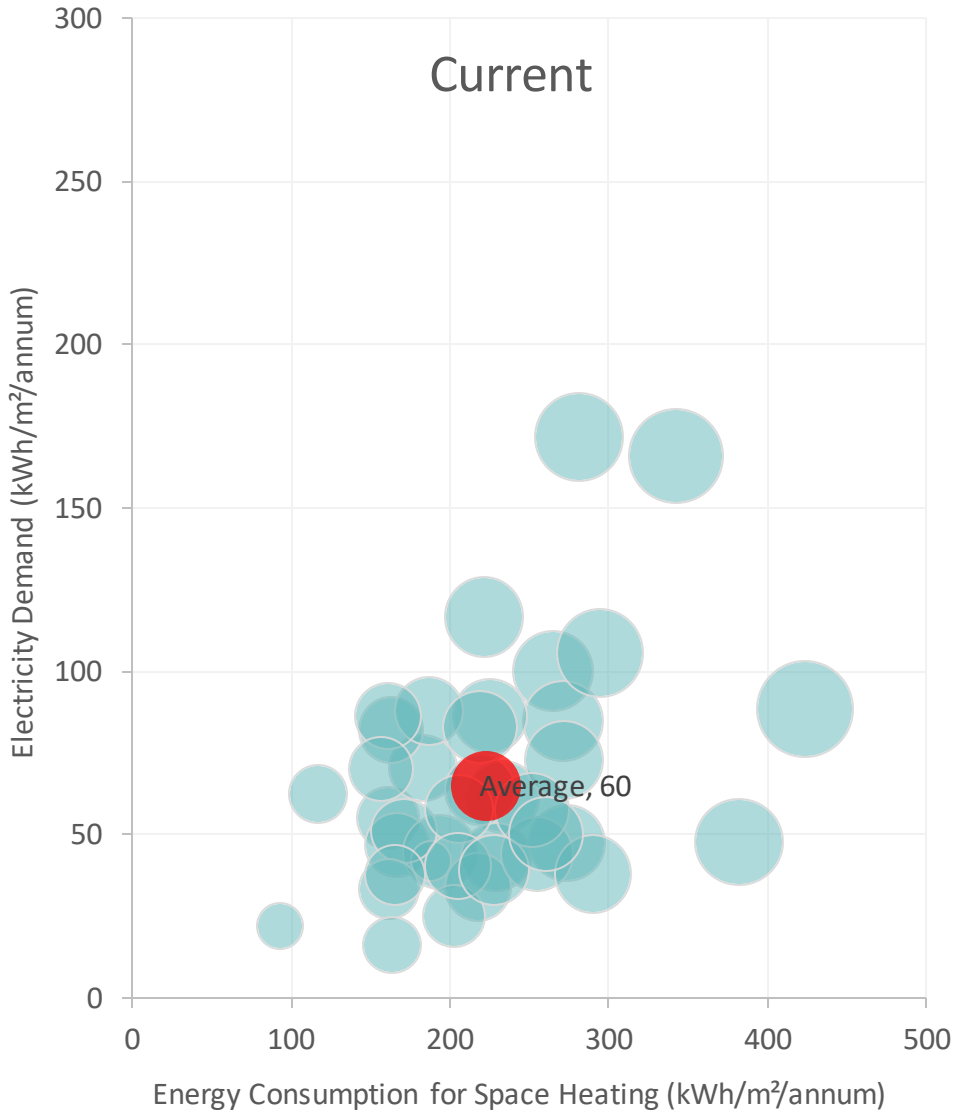
Operational Carbon Footprint



- Average Operational Carbon Dioxide: 209 Tonnes

x 354

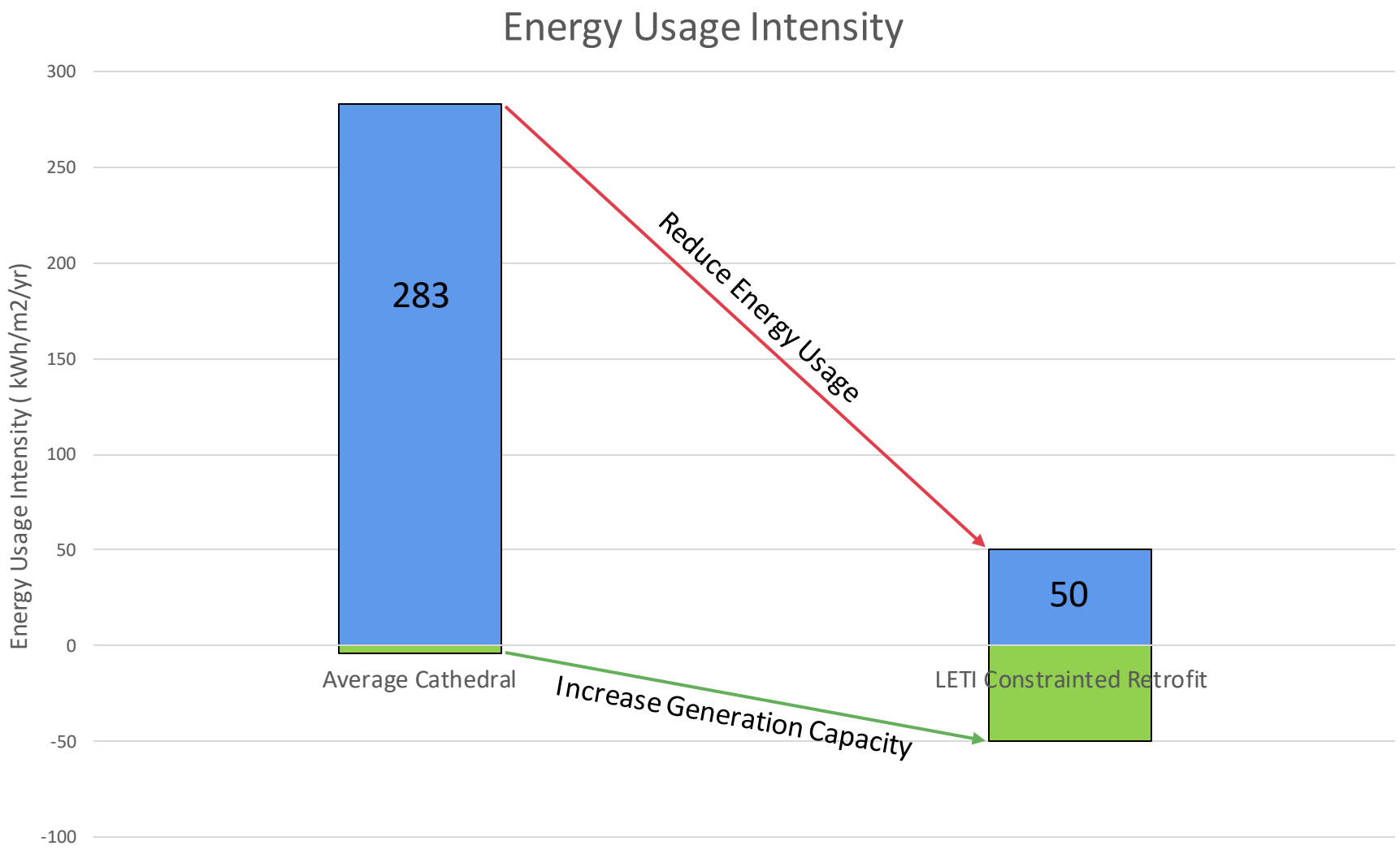
- Average Heating Consumption: 802 MWh

x 67

- Average Electrical Consumption: 233 MWh

x 80

Targeting Net Zero Carbon



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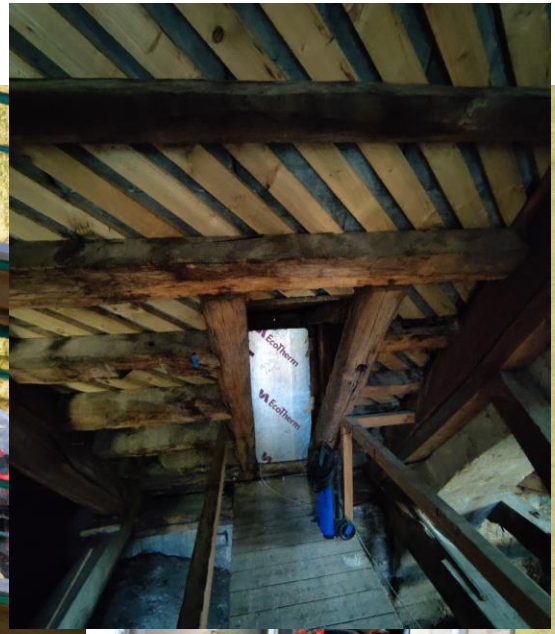
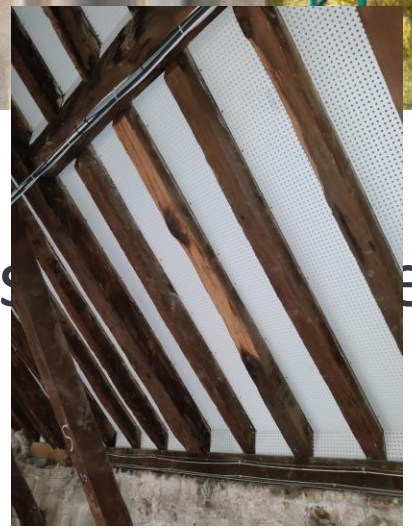
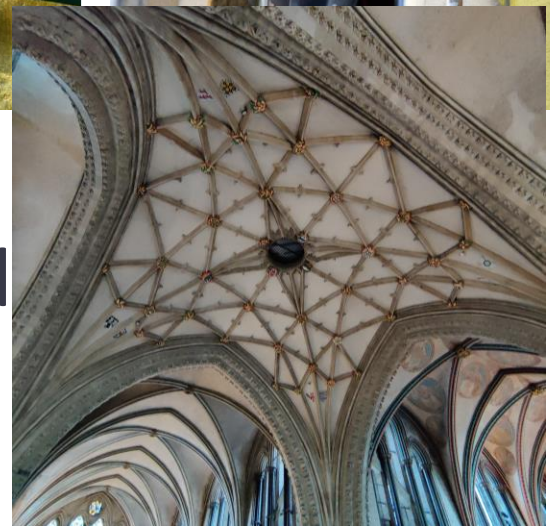
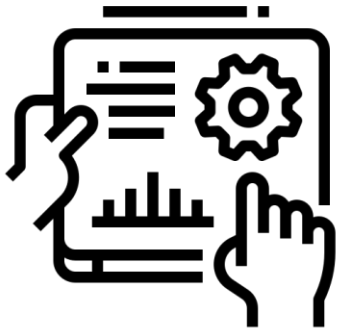
Fabric Opportunities





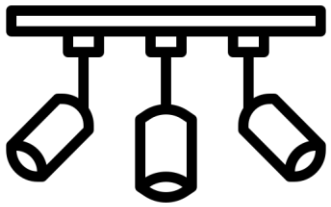


Energy Efficiency



- Better Controls and Monitoring.

- Target Heat Efficiently to Specific Zones



- Efficient Lighting and Modern Controls

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Unusual and Interesting Approaches

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Common Approach

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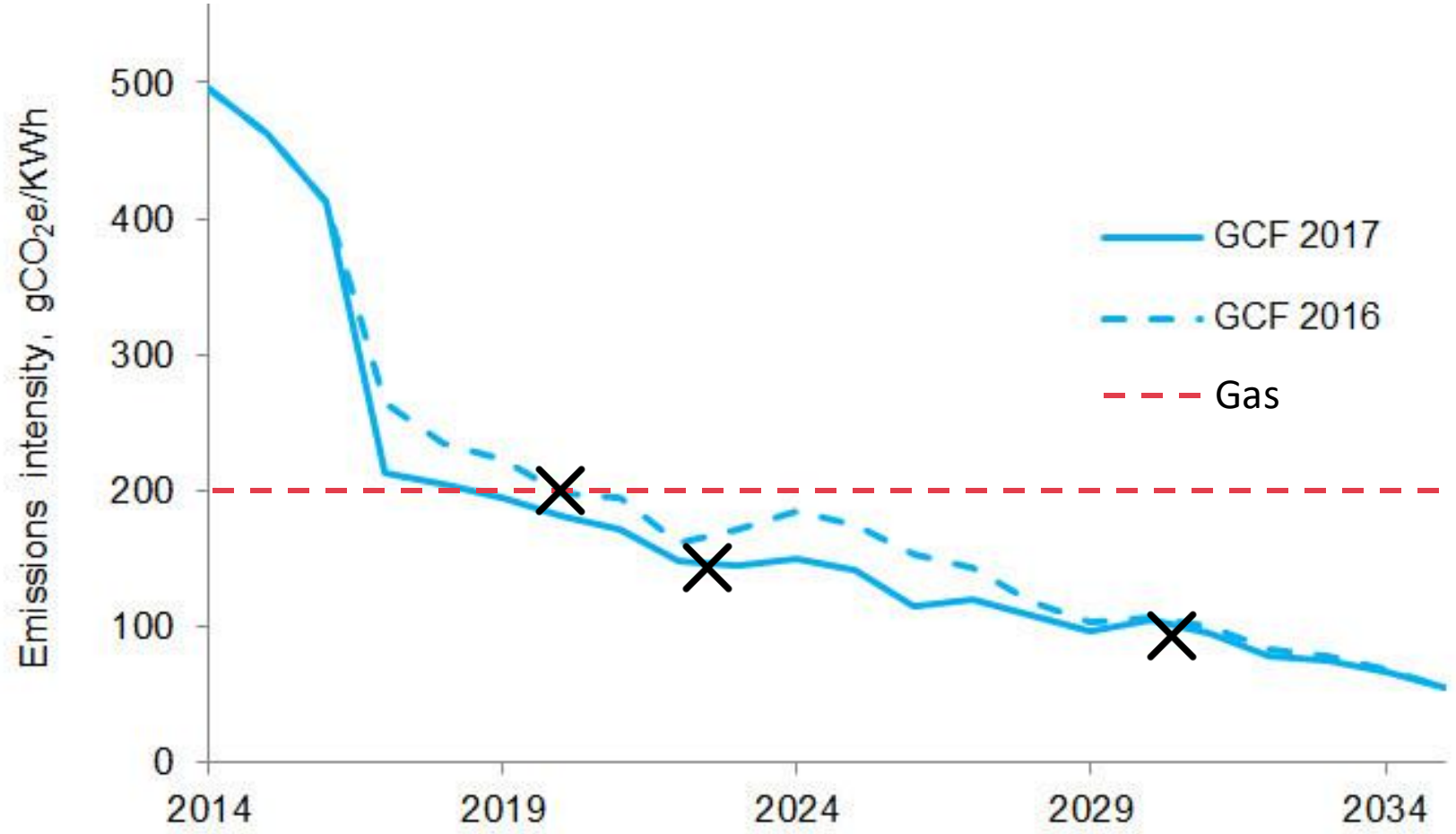
Grid Carbon Emissions Factor



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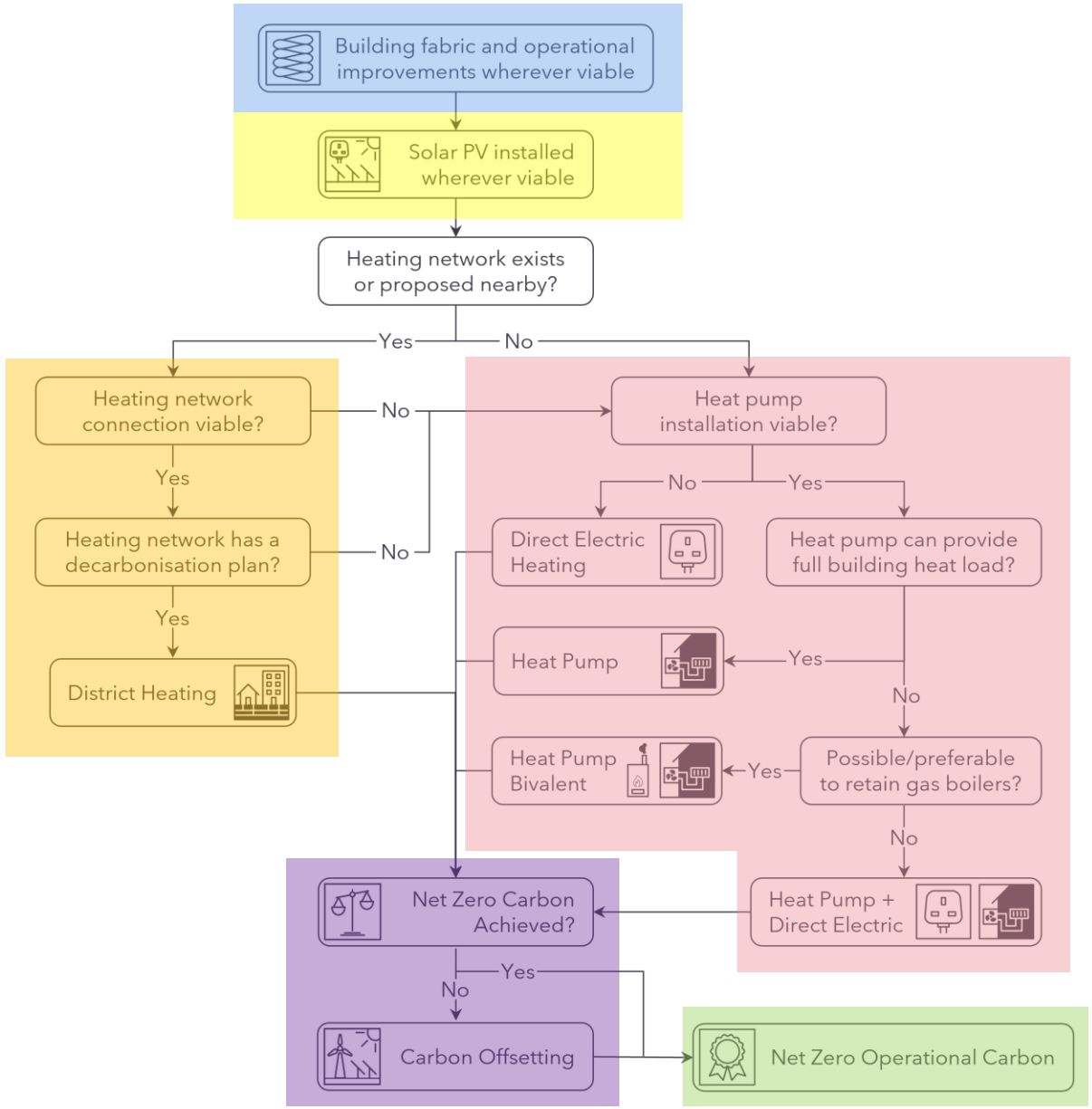
Decision Flow Chart

Install PV

District Heating

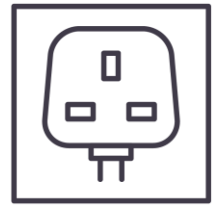
Carbon Offsetting

Net Zero Carbon



Make Energy Savings

Heat Pumps



Direct Electric

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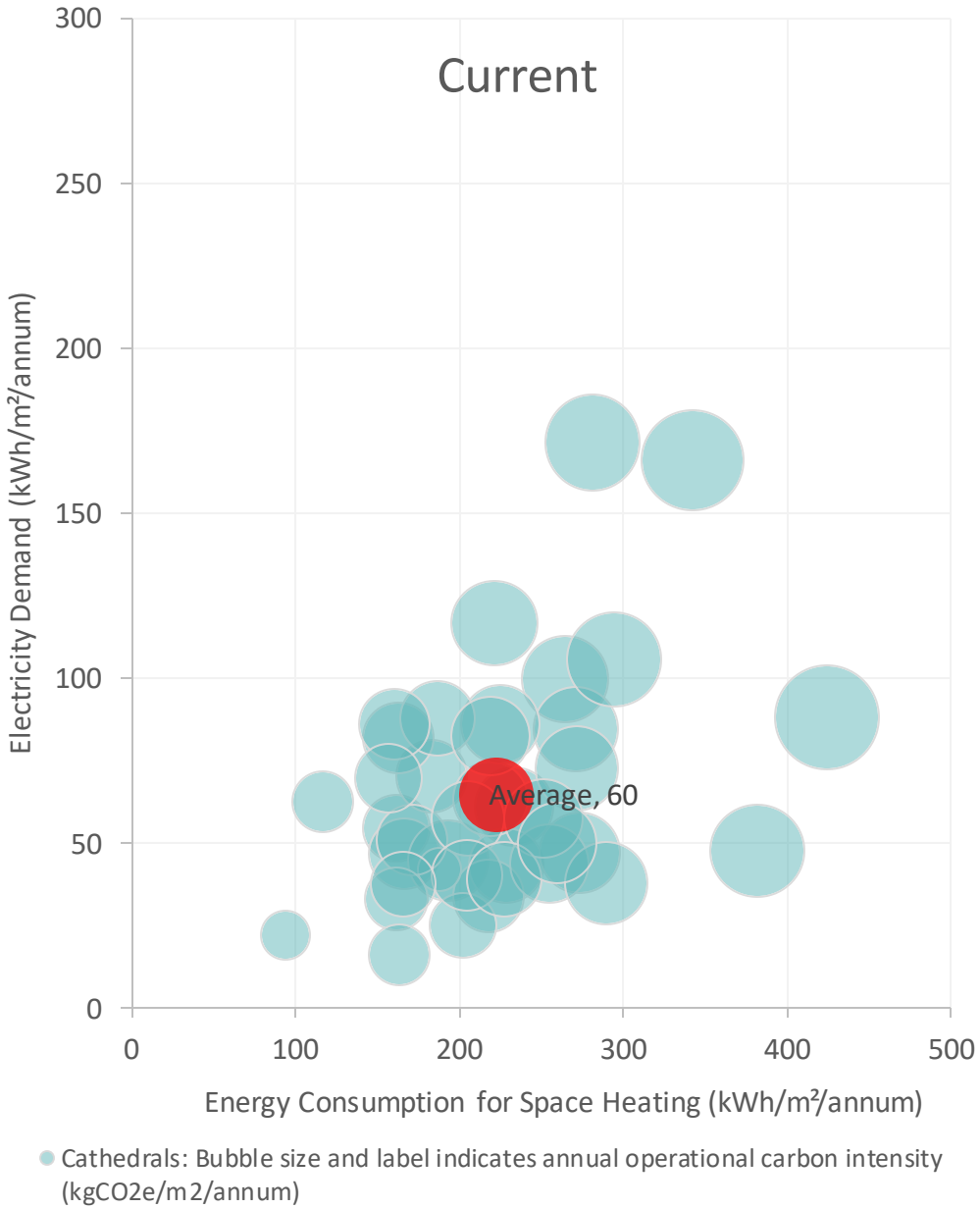
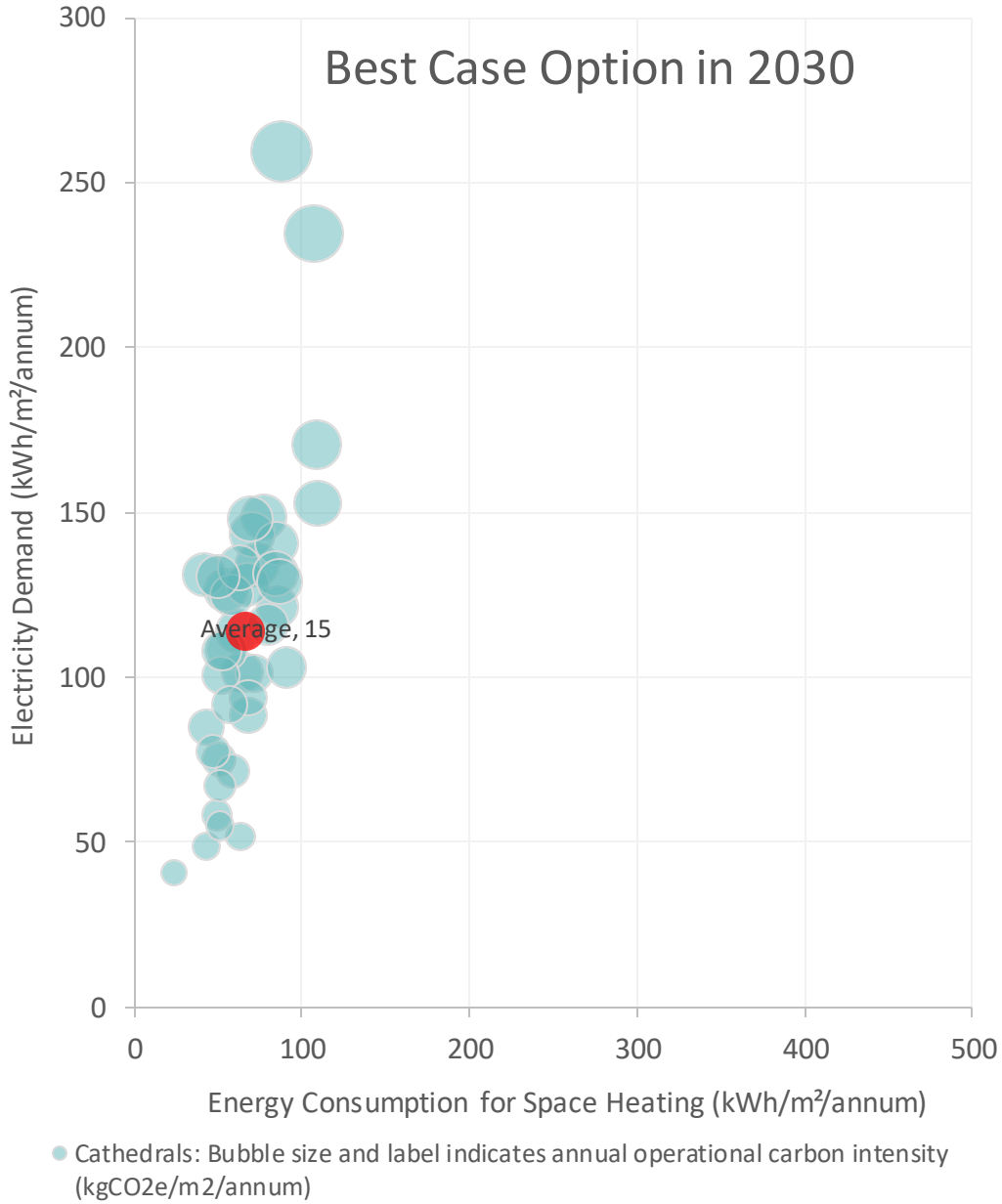
Current vs Best Case





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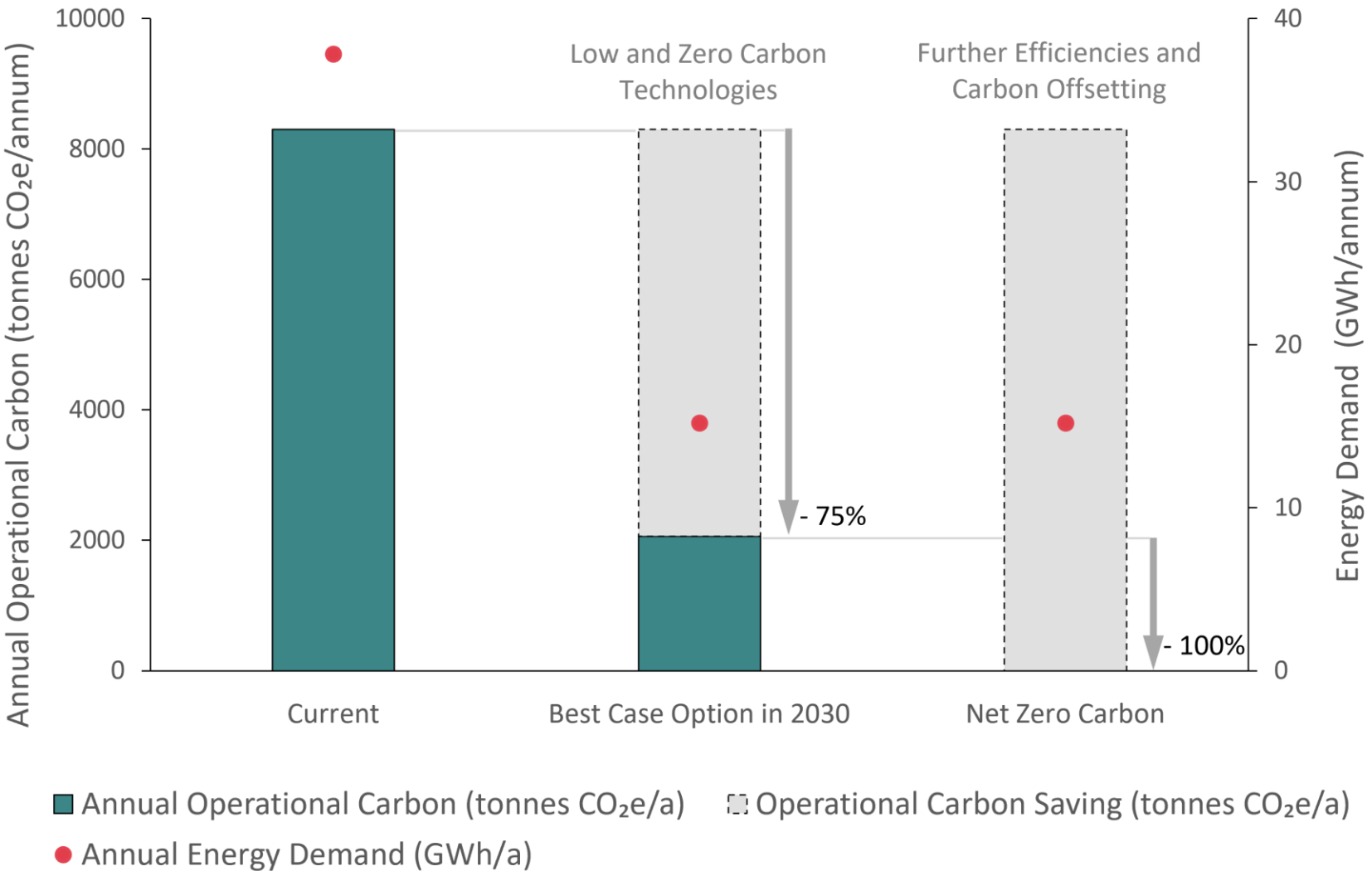
Cumulative Carbon Emissions



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Other CoE Buildings

- Roof Insulation

- Air Tightness

- Floor Insulation

- Wall Insulation

- Window Improvements

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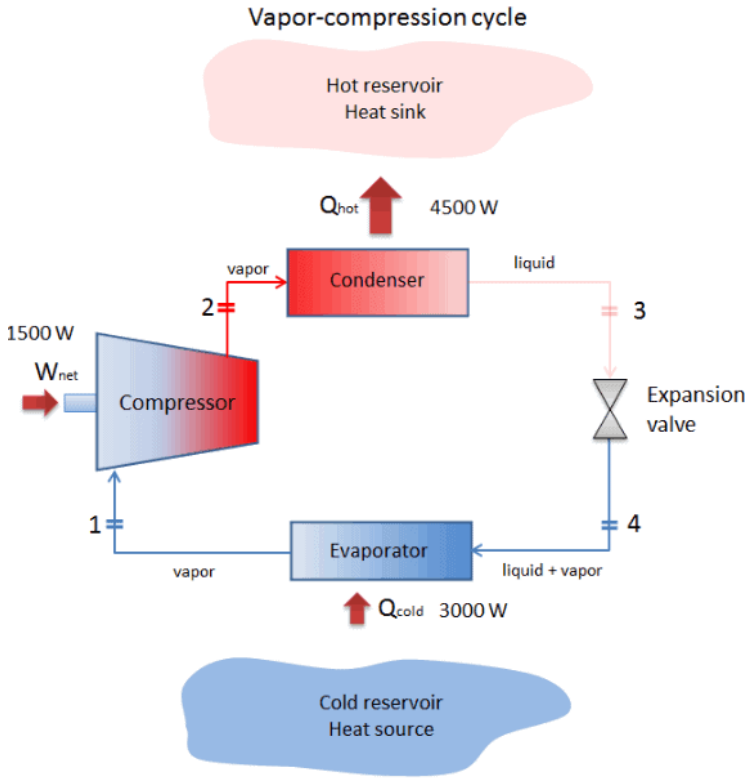
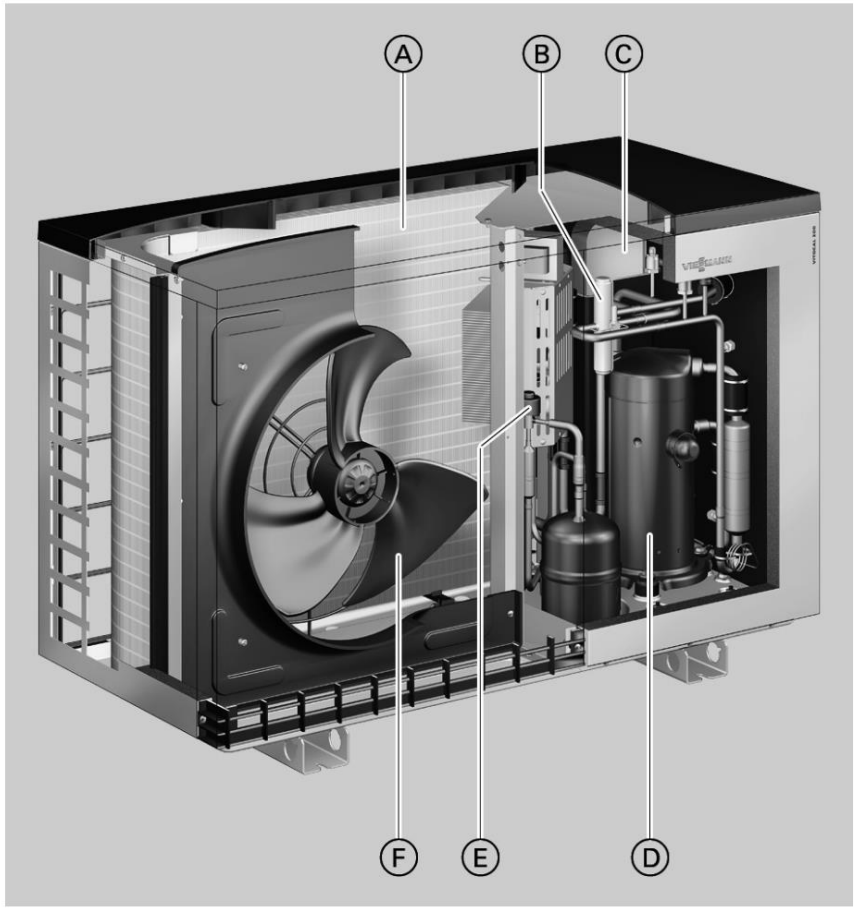
- Heat Pumps
- Key Terminology
- Heating Principles and Case Study
- Challenges
- Direction of Technology

What are heat pumps and why do we like them?

The technology is mature, reliable and scalable. Gothenburg City has been heated by 160MW heat pumps since 1985.





A – Evaporator with corrugated fins

B – 4 way divert valve

C – Condenser

D – Scroll Compressor

E – Expansion valve

F – Variable speed fan

Key terminology and performance

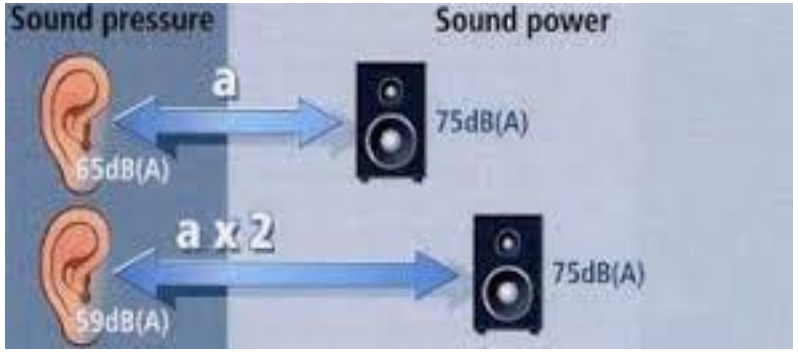
- Coefficient of Performance
  - Useful energy out vs energy in [Boiler – 0.85, HP – 3]

Type	Refrigerant	GWP	Toxicity and flammability classification
HFO	R1234yf	<1	A2L
HFO	R1234ze	1	A2L
HC (natural)	R290 (propane)	3	A3
HFC	R32	675	A2L
HFC	R410A	2,088	A1
HFC	R454A	238	A2L

Toxicity and flammability classification: A= lower toxicity, B= higher toxicity; 1 = no flame propagation; 2L = lower flammability; 3 = higher flammability (See BS ISO 817[7] for full definitions). Grey shading indicates those refrigerants with GWP<150
Table 2: Refrigerants commonly employed in building services systems

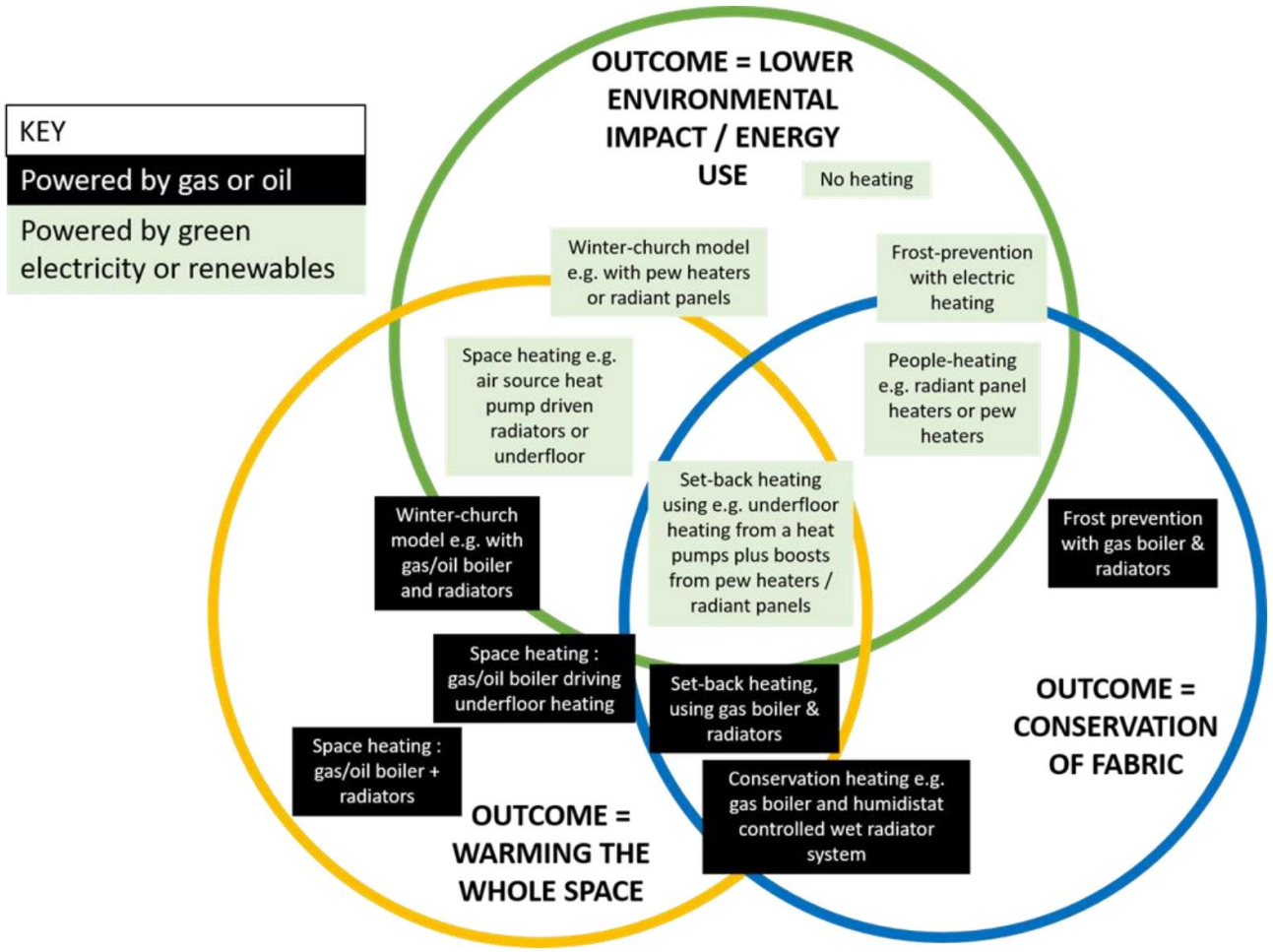
- Refrigerants
  - Fluids chosen for their phase change properties and labelled along with their global warming potential (GWP – 100-year potential of 1kg gas relative to CO2)

- Acoustic Impact
  - Sound Power and Pressure Level (dB(A))
  - Power = acoustic energy emitted
  - Pressure = sound energy transferred within specific acoustical constraints



Sound Source	Sound Pressure	Sound Pressure Level at 1m, L_p re 20 µPa
Rifle	200 Pa	140 dB
Threshold of pain	20 Pa	120 dB
Pneumatic hammer	2 Pa	100 dB
Street traffic	0.2 Pa	80 dB
Talking	0.02 Pa	60 dB
Library	0.002 Pa	40 dB
Quiet rural location at night	0.0002 Pa	20 dB
Threshold of hearing	20×10^{-6} Pa	0 dB

Heating principles



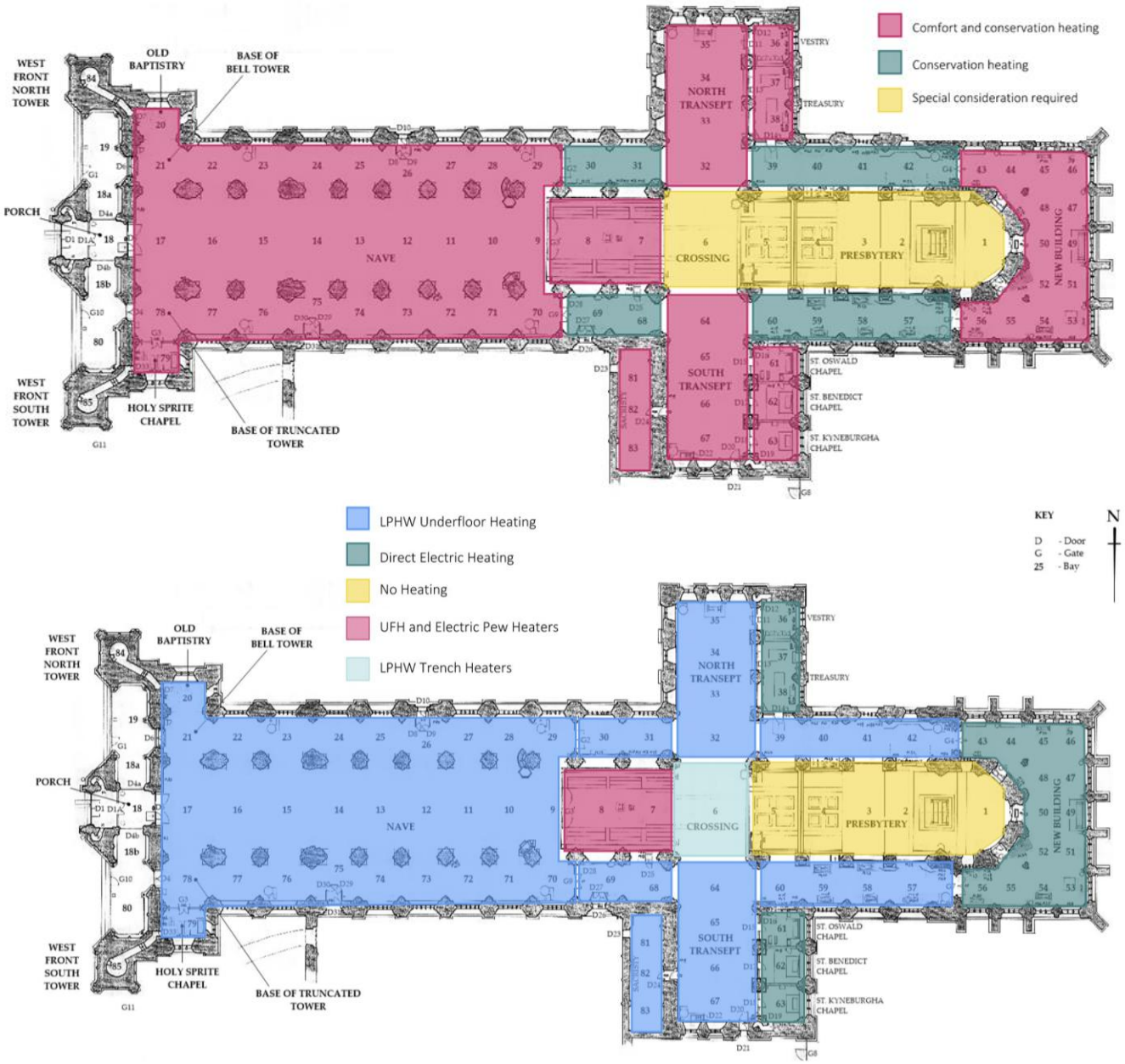
1. Find the right balance, for each church, of:
   a) Church users being comfortable, so the church is welcoming and usable
   b) Preservation of historic building fabric
   c) Affordability to install, operate and maintain
   d) Feasibility for change, and
   e) Reducing greenhouse gas emissions

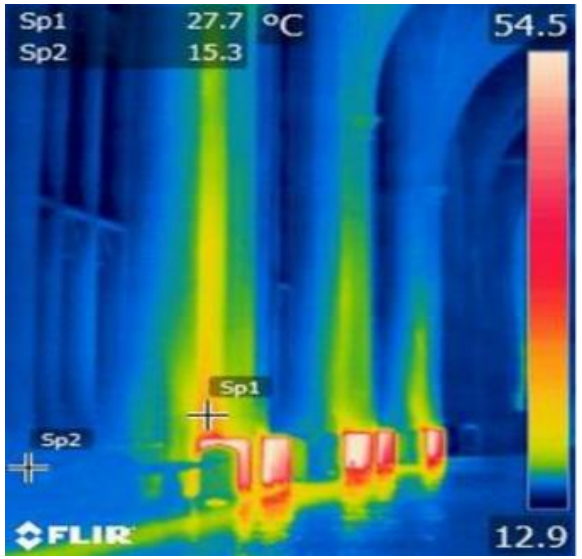
1. Define and agree how each space is used throughout the week, and throughout the year. Who are the users? How do they use the space?

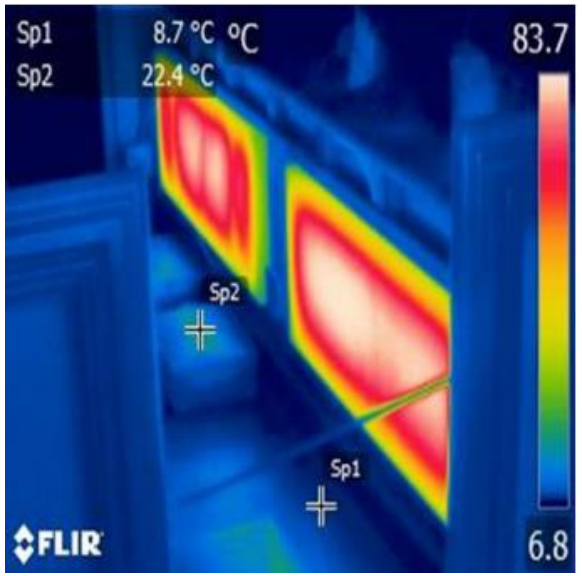
2. If comfort is needed, focus on the people not on the space.

3. The cheapest/greenest kilowatt hour is the kilowatt hour never used!

Heating principles



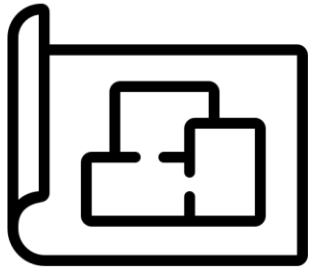


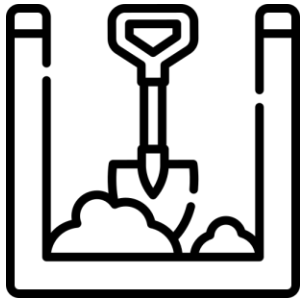


- Move to radiant heating, which promotes:
  - Fabric preservation
  - Comfort in the occupied zone
- Underfloor heating suited to building with regular use
- Electric heating in zones that need faster response
- No heating proposed in rarely occupied zone with unique tiled floor

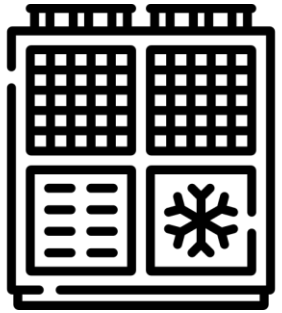
Challenges to adoption and preparation

- Noise and visual impact of air source heat pump
  - Recent study by Historic England found few adopters had visual or noise issues
- Archaeology and locating external services
- Incoming electrical supply
- Very few early adopters at scale
- Record information and extent of existing heat emitters and pipework
- Defining coverage of cathedral estate

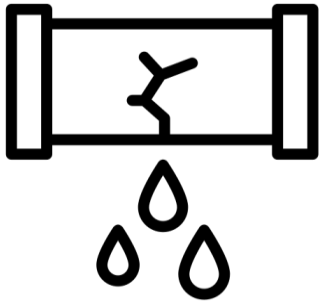




Where is the technology going?

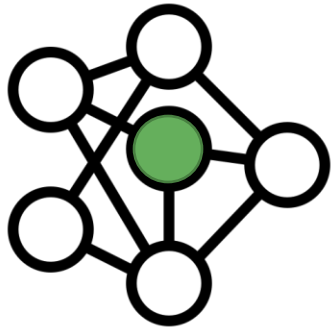


- Emerging refrigerant regulations around global warming potential
  - Whole life carbon



- Fan technology and noise

- Available flow temperatures to suit low performance buildings



- Where heat networks are planned, early indications are that cathedrals are considered good potential customers.

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