INVESTORS IN THE ENVIRONMENT

Cambridge Carbon Footprint

PECT
CREATING SUSTAINABLE PLACES

Cambridge Climate Change Charter

SETTING YOUR PATHWAY TO NET ZERO WITH LOW CARBON TECHNOLOGIES

INVESTORS IN THE ENVIRONMENT

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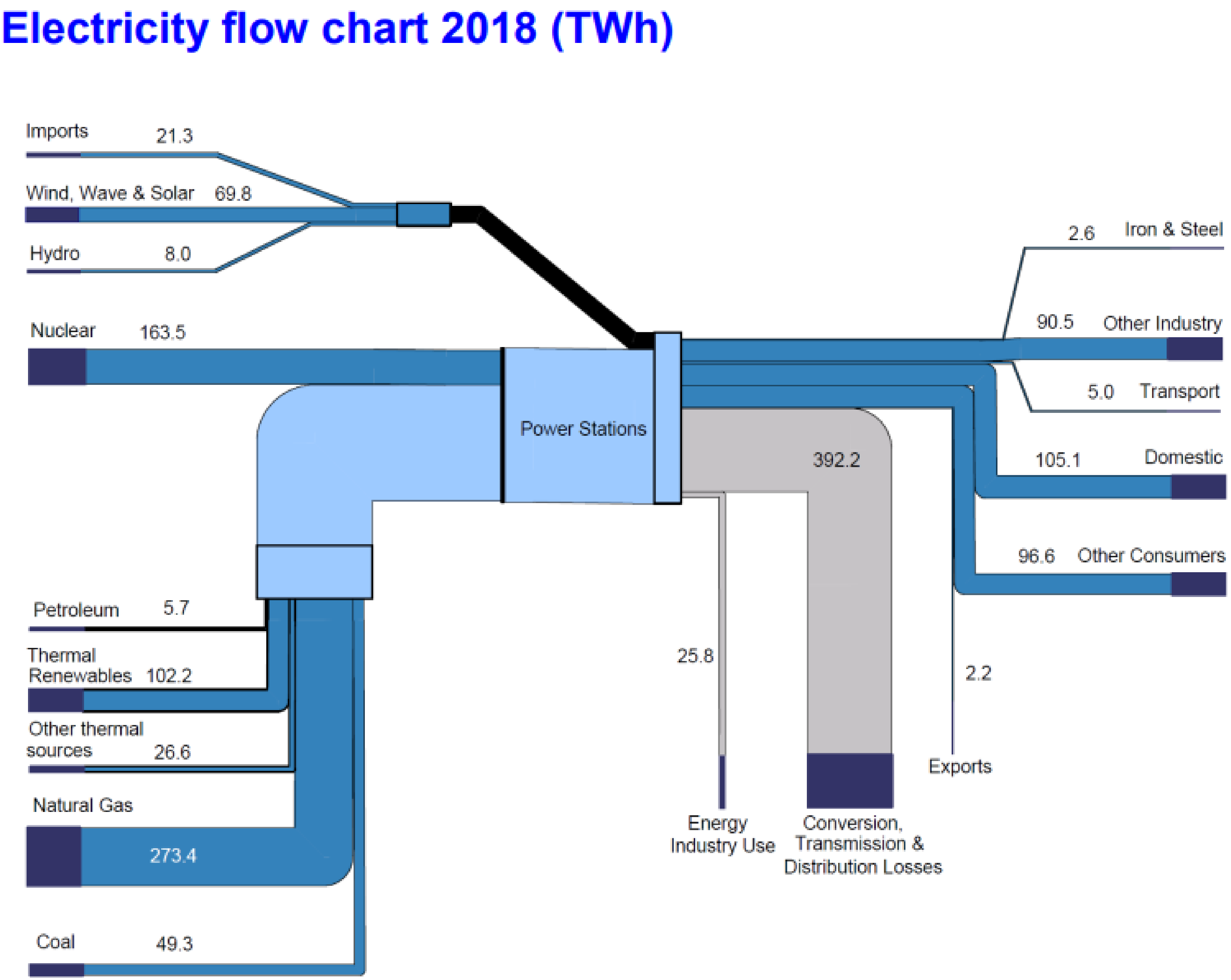
AGENDA

- The challenge
- Importance of energy management – behaviours first, technology second
- Fabric First approach, including building regulations
- Low carbon technologies
  - Lighting
  - Heating
    - Controls and additional considerations
    - Infrared
    - Heat pumps
  - Renewables
    - Solar PV
    - Solar thermal
    - Wind
    - Battery Storage
- Action plans

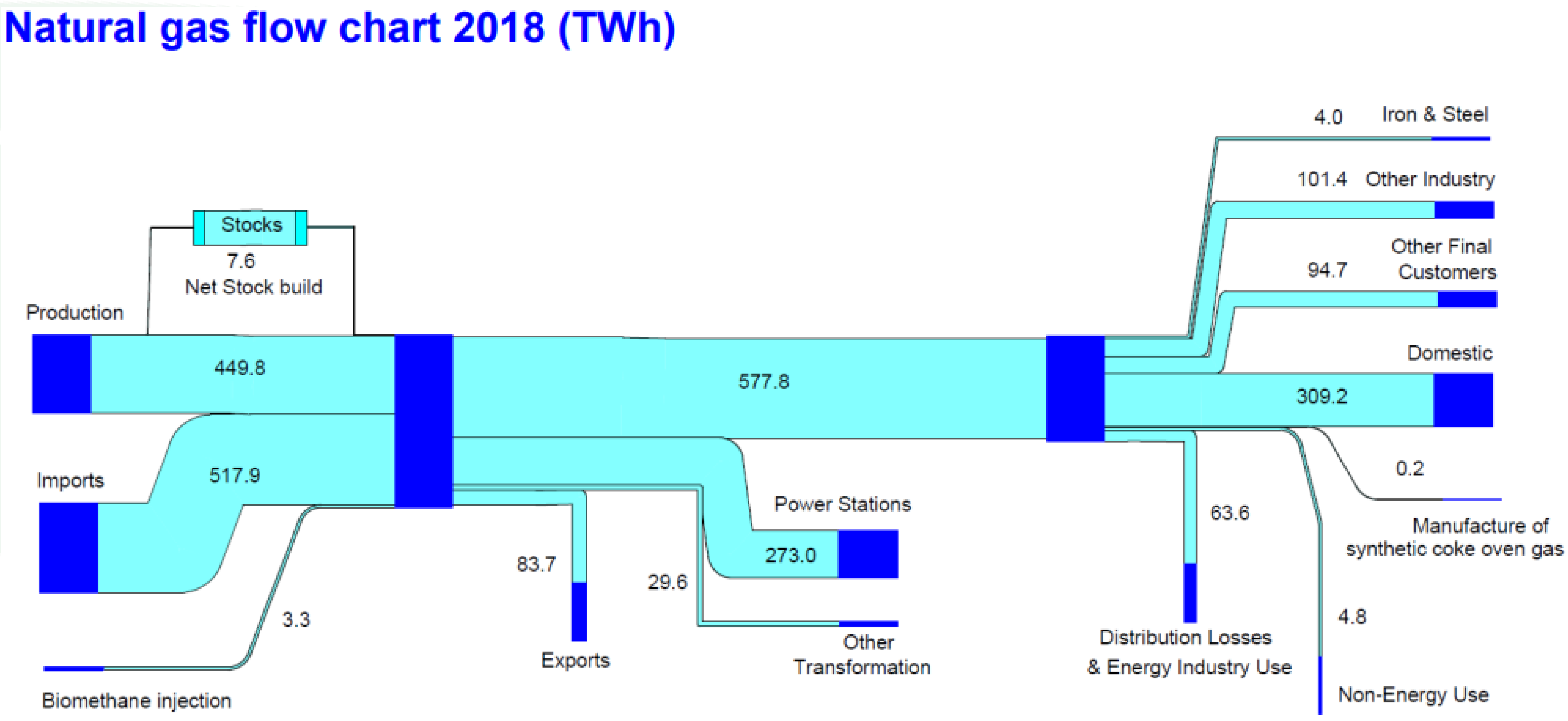


THE CHALLENGE

- Electricity use is set to rise
- Nearly all of energy is tied up in natural gas
- There is no silver bullet
- Solutions are still in the future

THE CHALLENGE

- Separate to electricity, natural gas alone provides over 800 TWh of energy
- It is not possible to convert all this energy to electricity
- Reducing energy demand is absolutely vital in tackling this problem



ENERGY MANAGEMENT – BEHAVIOURS FIRST

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- The energy need of the building must be understood first
- Technology needs to match what is possible, not what is needed
- Measuring your data is key, both to understand how energy is being used; but also for benchmarking
- Use baseline data to benchmark any changes – this measures how effective actions / installed technologies are
- Need to target occupancy and behaviour – technology should support, not replace

ENERGY MANAGEMENT TIPS

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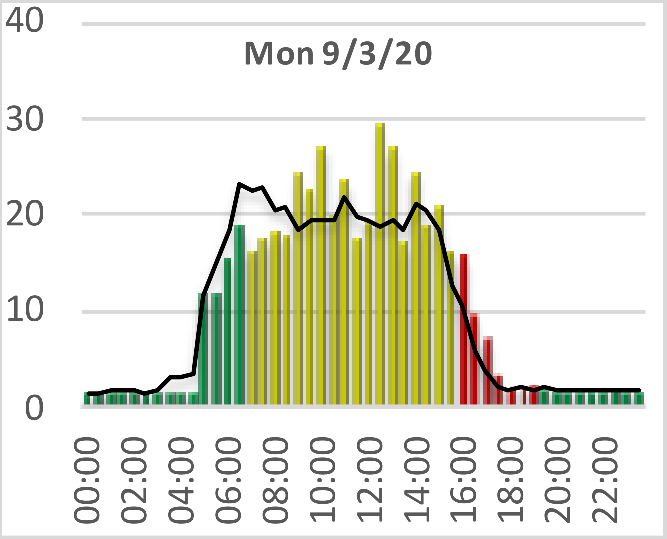
- Understand your energy bills:
  - Are they estimated or actual?
  - Do you have a smart meter or half-hourly meter?
  - Are you entitled to one?

- Useful resources:
  - https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills
  - https://www.moneysavingexpert.com/utilities/understanding-energy-bills

- Half-hourly data is king. If you have a half-hourly meter, use the data provided regularly. If you can get one, get one installed ASAP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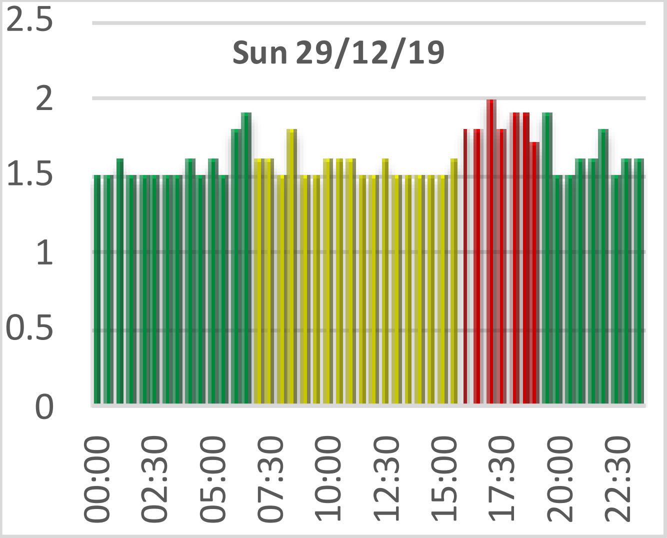
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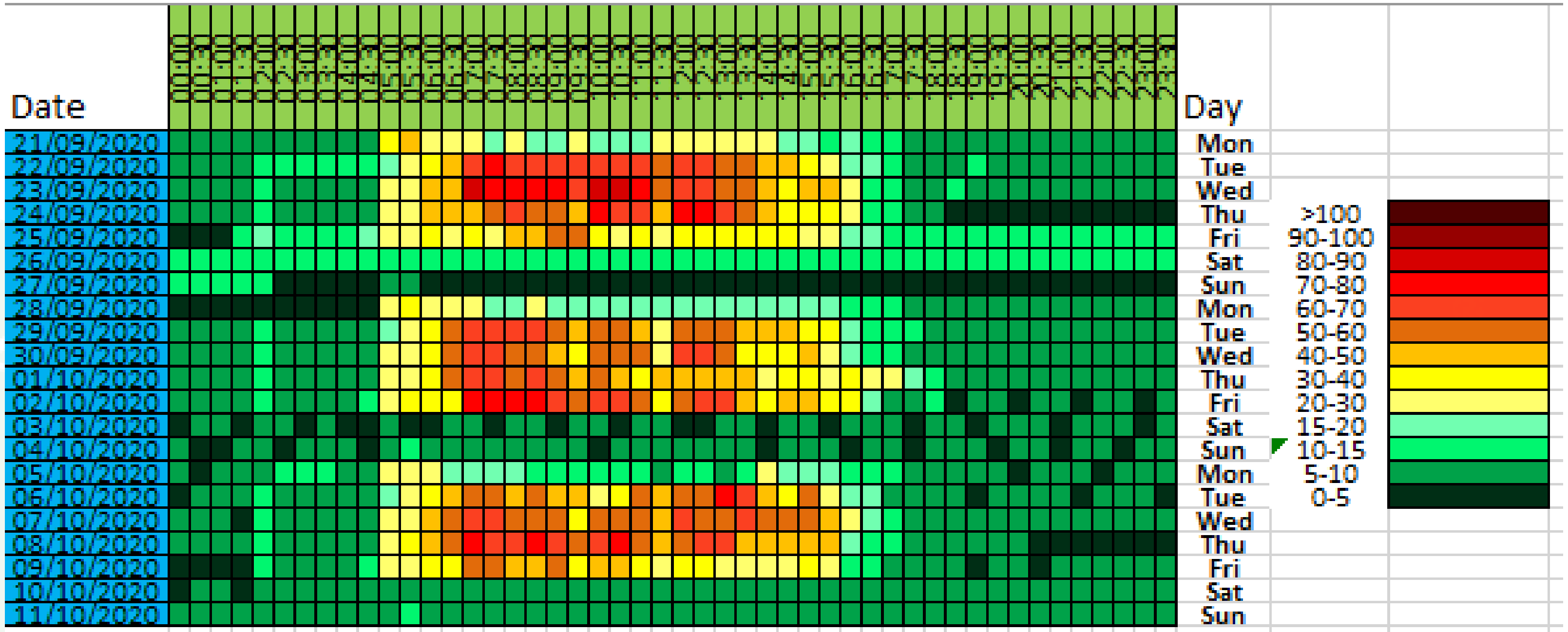
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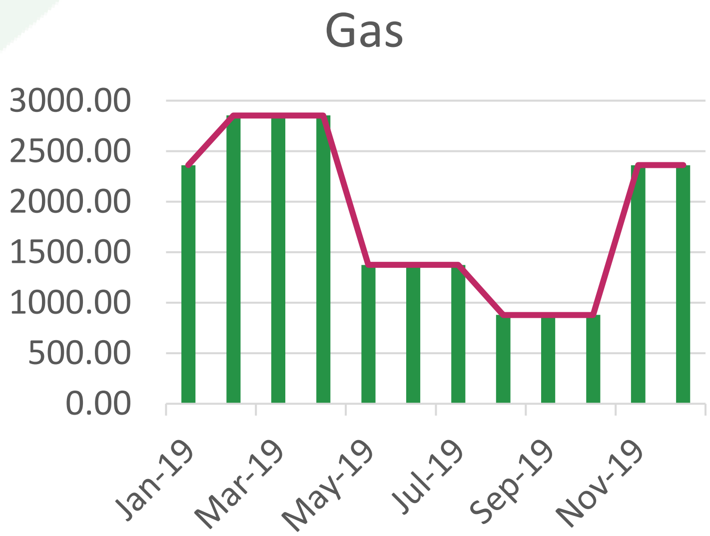
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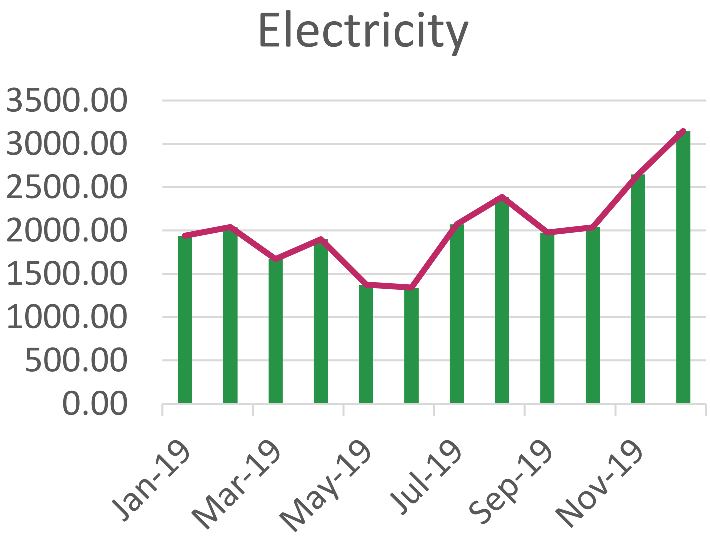
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ENERGY MANAGEMENT TIPS

Vampire Loads

- Out of hours electrical use – can range from good (18%) to average (28%) to bad (35%+)
- Economy 7 (day and night rate) meters are great at identifying night usage, as are half hourly meters; otherwise, manual reading at end of day and beginning of next day will provide information as well
- Shut down checklists and procedures help to reduce use
- Computers, printers, vending machines, extractor fans, compressors, air conditioning
- This is wasted energy you are paying for
- Identify what can and cannot be switched off, by plug where possible
- Introduce actions to encourage staff to switch off at end of the day
- Fit 7 day timers (~£3 - £10) on hard to access plugs or wherever possible

ENERGY MANAGEMENT TIPS

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Timers and temperatures

- Regular management of heating schedule ensures wasted running times are minimised
- Where thermostats are installed – ensure they are not in unrealistic places (under equipment, next to windows, etc.; in the same room)
- Where thermostats are not installed – set up thermometers (or equivalent) to measure temperature in rooms and compare to set temperature; adjust TRVs to balance the heating system better
- Reduce the temperature to the lowest possible – accept that not everyone will be happy, so compromises are required

Building / Sector	Room Type / Area	Temperature (°C) – Based on winter operation, and assumed normal clothing levels
Office / Service provision	Banks, Post Offices	19-21
	Computer Rooms	19-21
	Conference / Board Rooms	22-23
	General Office / Open Plan	21-23
General Areas	Corridors, Reception Areas, Lobbies / Entrance, Toilets, Waiting Areas	19-21
	Kitchens (Commercial)	15-18
Retail / Food Provision	Bars / Lounges, Restaurants / Dining Rooms	21-23
	Small Shops / Supermarkets	19-21
Factories / Warehouse	Heavy Work	11-14
	Light Work	16-19
	Sedentary Work	19-21
Hotels	Bathrooms	20-22
	Bedrooms	19-21

Source: Taken from CIBSE Guide A – Environmental Design

BUILDING FABRIC

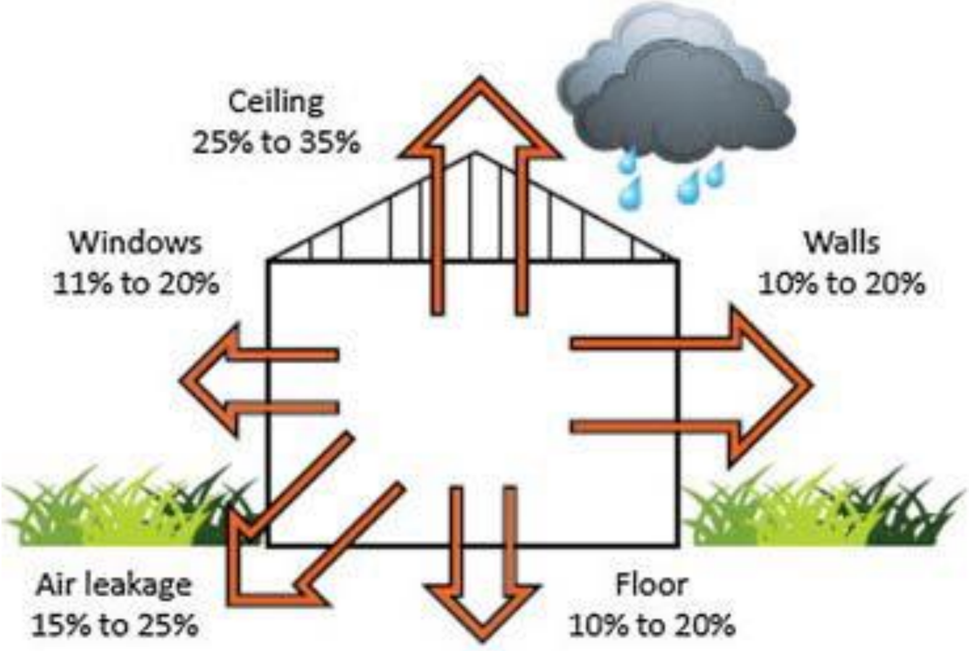
Fabric First Approach

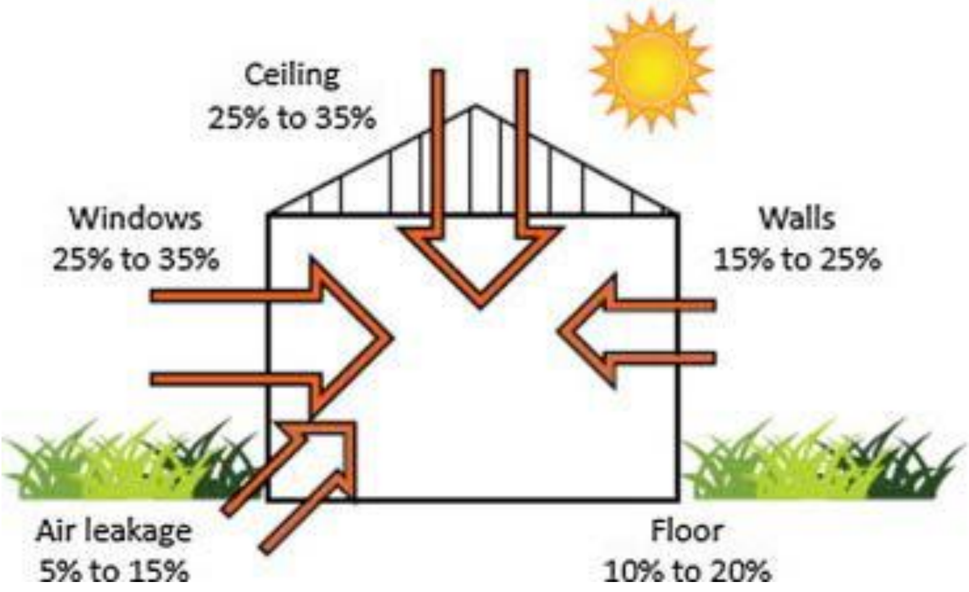
- Improving the thermal performance of a building will significantly reduce the energy needed to thermally manage a building, both heating and cooling
- It is now considered best to look at the fabric of the building first before you consider the systems that operate within

However:

- This works well for newbuilds but very difficult for existing buildings
- Retrofitting is necessary – but comes with significant complications:
  - Overheating, poor ventilation, thermal bridging, condensation, etc.

- It is also carries significant cost, with high payback periods making it difficult to justify financially
- There are also a lot of organisations who do not own their buildings, making this approach more problematic
- MEES regulations are being tightened to help push landlords towards making improvements





BUILDING FABRIC

- U-Value = W/m2.k
- Measure of how much energy (Watts) passes through a sq.m. of building fabric for every degree difference between the internal and external temperature
- The lower the number, the better the material for insulation
- Understanding the U-Values helps measure how thermally efficient a building is
- Understanding building regulations helps to suggest proposed requirements when retrofitting any element of building fabric

Table 5 Upgrading retained thermal elements

Element[1]	U-value W/(m².K)	
	(a) Threshold	(b) Improved
Wall – cavity insulation	0.70	0.55[2]
Wall – external or internal insulation	0.70	0.30[3]
Floors[4,5]	0.70	0.25
Pitched roof – insulation at ceiling level	0.35	0.16
Pitched roof – insulation at rafter level[6]	0.35	0.18
Flat roof or roof with integral insulation[7]	0.35	0.18

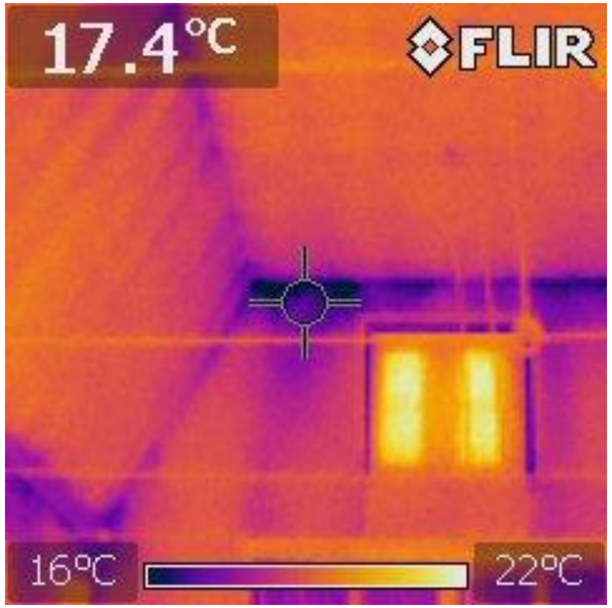
Historic U-values for non-domestic buildings (W/m²/K)

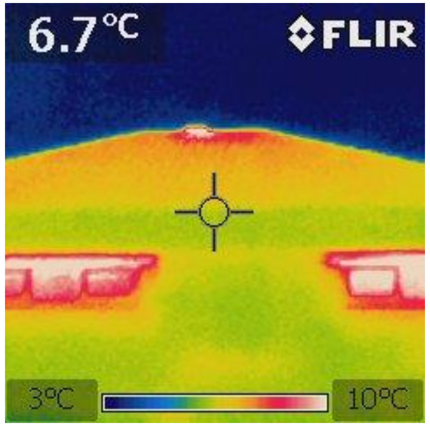
	1958	1965	1974	1981	1990	1995	2002	2006*	2010*	2013*
Roof	n/a	1.42	0.60	0.35	0.25	0.25	0.16	0.25	0.25	0.18
External wall	1.7	1.7	1.0	0.6	0.45	0.45	0.35	0.35	0.35	0.26
Floor	n/a	n/a	n/a	n/a	0.45	0.45	0.25	0.25	0.25	0.25
Windows	n/a	5.7	5.7	5.7	5.7	3.3	2.0	2.2	2.2	1.6

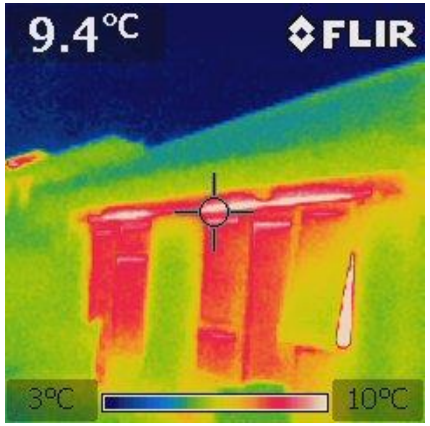
*Since 2006, new buildings have had to meet a CO_2 target. This generally necessitates lower U-values.
Source: *Building Regulations 2010, Approved Document L2A, 2013 edition and older equivalents*
www.planningportal.gov.uk

BUILDING FABRIC

- **Thermal bridging** – significant barrier to retrofit; retrofit material needs to be constant with no breaks between the internal and the external fabric
- Need to consider **natural ventilation** or **nighttime cooling** to avoid overheating
- Best approach is to consider **increasing thermal mass** – but this is long term approach (for example, green walls/roofs)
- **Glazing** is an important element – windows and doors are the weakest point of building fabric
- **Triple glazing** is very effective – but carries significant cost vs improvement; i.e. single to triple, yes, double to triple, no.
- **Roof insulation** is cheapest and easiest option; as heat rises it is usually first area for heat loss
- **Walls** offer the next best option but come with compromise; cavity insulation adds complication and potentially leads to thermal bridging and condensation
- **Solid wall insulation** is more expensive but offers a better solution; external most expensive – will move the external dimension of the building; internal insulation cheaper – will reduce the internal dimension of rooms
- **Ventilation** can be a large contributor to heat loss – most passivehaus buildings used mechanical ventilation with heat recovery to reduce heat loss
- **Insulating floors** is complex, ceiling/floor option is easiest; ground floor cost will vary depending on the material







LIGHTING

LED Lighting

- Proven technology to save money instantly
- Significant difference in lighting too – better light for better running price
- Average saving on lighting costs is around 50%, and paybacks can vary from under 2 years to under 5 years depending on lighting profile and changes

PIR and Light sensors

- To further improve on savings, PIR (movement) and LUX (light) sensors will reduce or turn off lights when there is no movement or adequate natural lighting
- This reduces the time lights are on even further and reduces risks of behavioural error
- Average savings of 30% on existing/installed lighting running costs

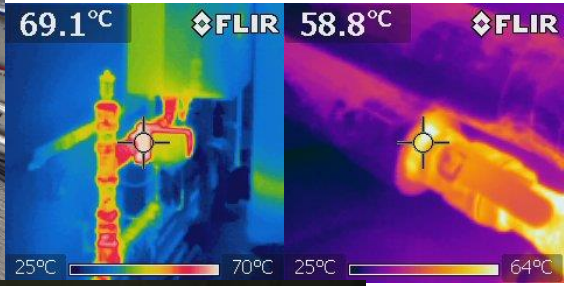
Illuminance / lux	Characteristics of activity/interior	Representative activities/interiors
50	Very infrequent use Visual tasks without perception of detail	Cable tunnels, indoor storage tanks, walkways
100	Infrequent use Visual tasks need only limited perception of detail	Corridors, changing rooms, bulk stores, auditoria
150	Occasional use Visual tasks requiring some perception of detail	Loading bays, medical stores, switch rooms, plant rooms
200	Continuously occupied Visual tasks not requiring perception of detail	Foyers and entrances, monitoring automatic processes, casting concrete, turbine halls, dining rooms
300	Continuously occupied Visual tasks moderately easy	Libraries, sports and assembly halls, teaching spaces, lecture theatres, packing
500	Visual tasks moderately difficult	General offices, engine assembly, painting and spraying, kitchens, laboratories, retail shops
750	Visual tasks difficult	Drawing offices, ceramic decoration, meat inspection, chain stores
1000	Visual tasks very difficult	General inspection, electronic assembly, gauge and tool rooms, retouching paintwork, cabinet making, supermarkets
1500	Visual tasks extremely difficult	Fine work and inspection, hand tailoring, precision assembly
2000	Visual tasks exceptionally difficult	Assembly of minute mechanisms, finished fabric inspection

HEATING

- Space heating and hot water is typically a businesses’ largest consumption of energy
- Consider the need for heating and how your heating is supplied
- What type of boiler, how old, how is it managed? – timers, do they work correctly?
- What additional controls are present – is it zoned heating? Does it measure external temperatures? What internal thermostats are present and are they working?
- Consider what water provision is made and how that water is heated?
- Often, district hot water (DHW) systems are installed in buildings, which over time building use changes, and DHW systems are no longer needed
- Heating and storing water unnecessarily is a waste of energy; consider point of use systems where appropriate
- High ceilings, high traffic entrance areas, large glazing facades – are examples of areas where the heating will be problematic

HEATING

- Destratification fans
  - Useful for buildings with high ceilings, sports centres, warehouses, etc.
  - Pushes accumulated warm air from the ceiling towards ground level
  - Can reduce heating consumption by around 26% on average
  - Very cheap and cost-effective option
- Air barriers
  - Keeps up to 90% of the hot air from escaping through open doors
  - Useful for businesses that use heated air for thermal comfort in delivery areas, also useful for reception areas or any location that has high movement
  - Can also be used in large chillers to keep hot air out when opening or moving through doors
  - Good for pubs that have external access for barrel delivery
- Value Wrap Insulation / Jackets
  - All pipes should be lagged, but it is often that plant rooms do not have valves or fittings lagged due to the shape
  - Costs of jackets range £20 - £60 and can payback in under 5 years



HEATING AND HOT WATER

- Weather compensation / Load compensation
  - Weather compensation tracks the external temperature and adjusts heat of water accordingly – can save up to 20% on energy
  - Load compensation tracks the internal temperatures and adjusts the heat of the water accordingly
  - Both adjust the flow temperature leaving the boiler to minimize energy

- Hot water can be provided through point of use heaters, these are more efficient than managing large water tanks where a lot of water is not needed
- If heating is switched to an electric system, hot water will also need to be considered and possibly heated electrically
- Instant hot water taps are ideal for spaces that use only a small amount of hot water in the kitchen and can replace kettles, increasing the savings made

INFRARED HEATING

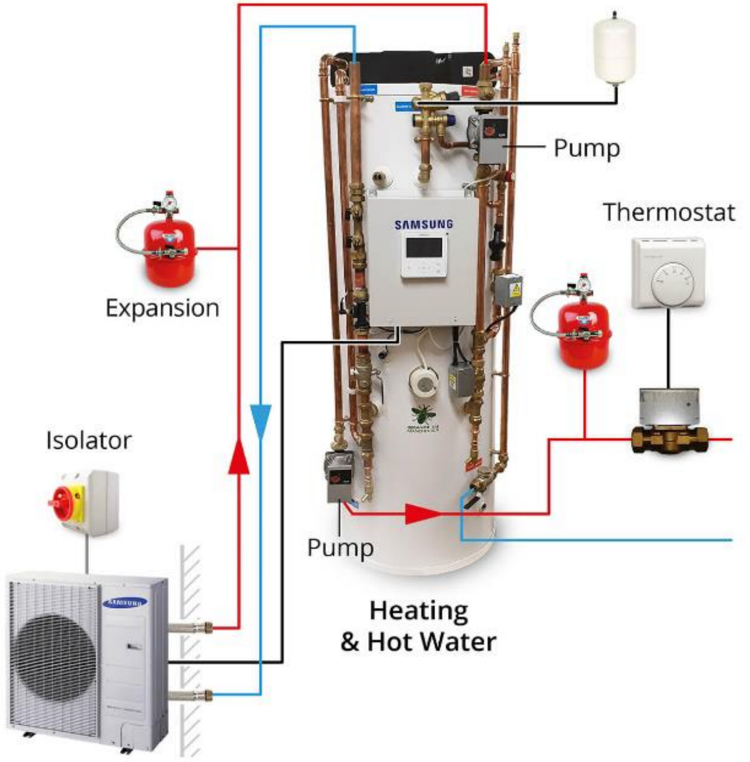
- Traditionally, heating is supplied via convection – either an electric radiator, or a 'wet' radiator connected to a boiler system
- Air is a poor conductor of heat, and porous buildings mean air changes quickly
- Not all rooms require full room heating, some spaces only need zones heated
- Secondary heat sources may be required in problematic rooms or areas of high external traffic

Infrared Heating Panels

- Works the same as sunlight, heats thermal mass and not the air
- Is not heavily impacted by air movement or open doors
- Ideal for receptions, open plan offices, factories or warehouses
- More efficient as a secondary heat source than convection heaters
- Three panel types, short wave (outdoor), medium wave (high ceiling / warehouse), and long wave (domestic / office)
- Works well for dynamic heat where heat is only needed for short periods

HEAT PUMPS

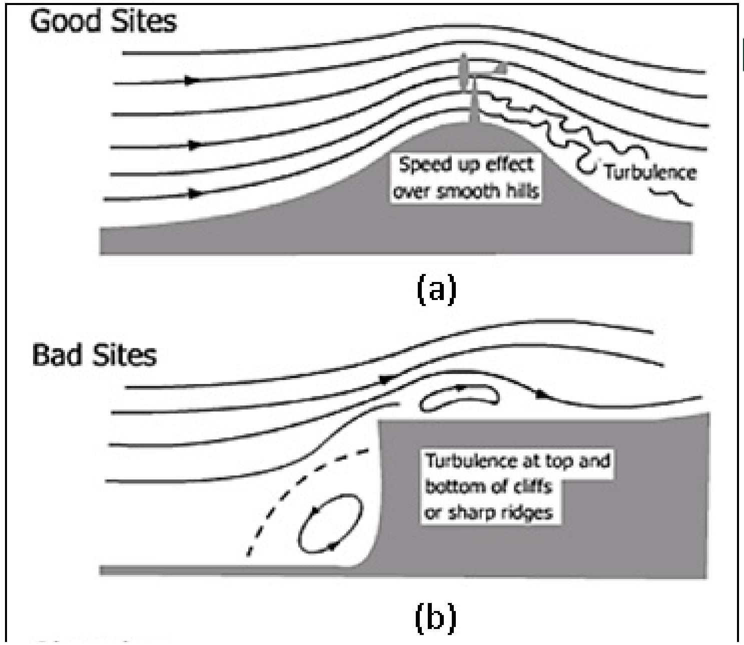
- Heat pumps use latent heat from an external source through a heat exchanger to provide low carbon heating to a building
- Ground source (GSHP) – sources heat from ground / water
- Air source (ASHP) – sources heat from air (even when cold, latent heat from traffic, thermal drafts, etc.)
- Very expensive – GSHP ~£20k-£40k ; ASHP ~£10k-£30k
- Co-efficiency of performance (COP) – term that describes efficiency of system. Due to heat exchange process, uses less electrical energy to provide higher thermal energy
- ASHP COP ~3 ; GSHP COP ~4 – every 1kW electrical energy provides 3-4kW thermal energy
- Low temperature heating system (LTHS) – most efficient at around 40°C, or lower
- Means does not work in 'porous' building ; air tightness must be high to be efficient
- Best targeted to provide baseload of heat ~60-80% of heat load
- More efficient houses often do not need additional energy to make up difference, poorer houses will need secondary system
- Hot water systems are problematic requiring 60°C water – often needs separate water system to be most efficient
- GSHP requires a significant amount of space ; ASHP less so, but all systems need a large buffer vessel
- Work best through underfloor heating
- Radiator heating requires low temperature radiators – around 40% larger than traditional radiators
- Can be adapted to provide heat through air (AC systems)



RENEWABLES

Wind Turbines

- The UK has a lot of wind, so great potential to reduce energy from grid all year round (winter generally better than summer)
- Not all UK experiences same wind – requires full survey to determine performance
- Better suited for larger application (wind farms)
- Can be done at business level, but very costly and requires a lot of planning
- Rooftop systems are poor, too much turbulence, impacts on efficiency of system – generally not recommended
- Best suited for high poles, however, higher you go, more you pay



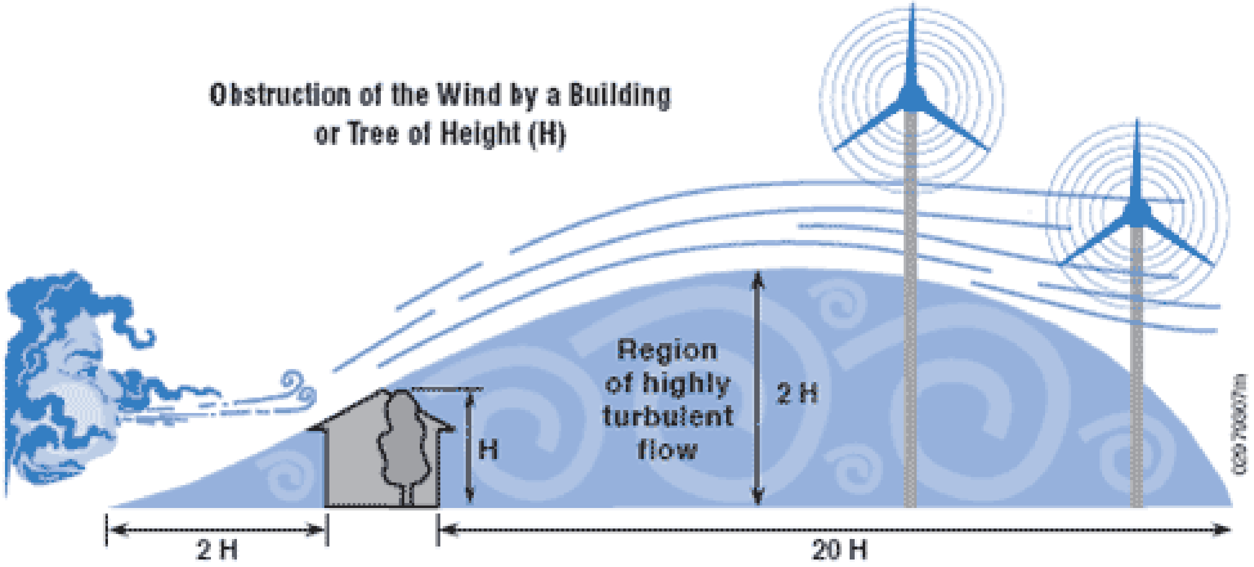
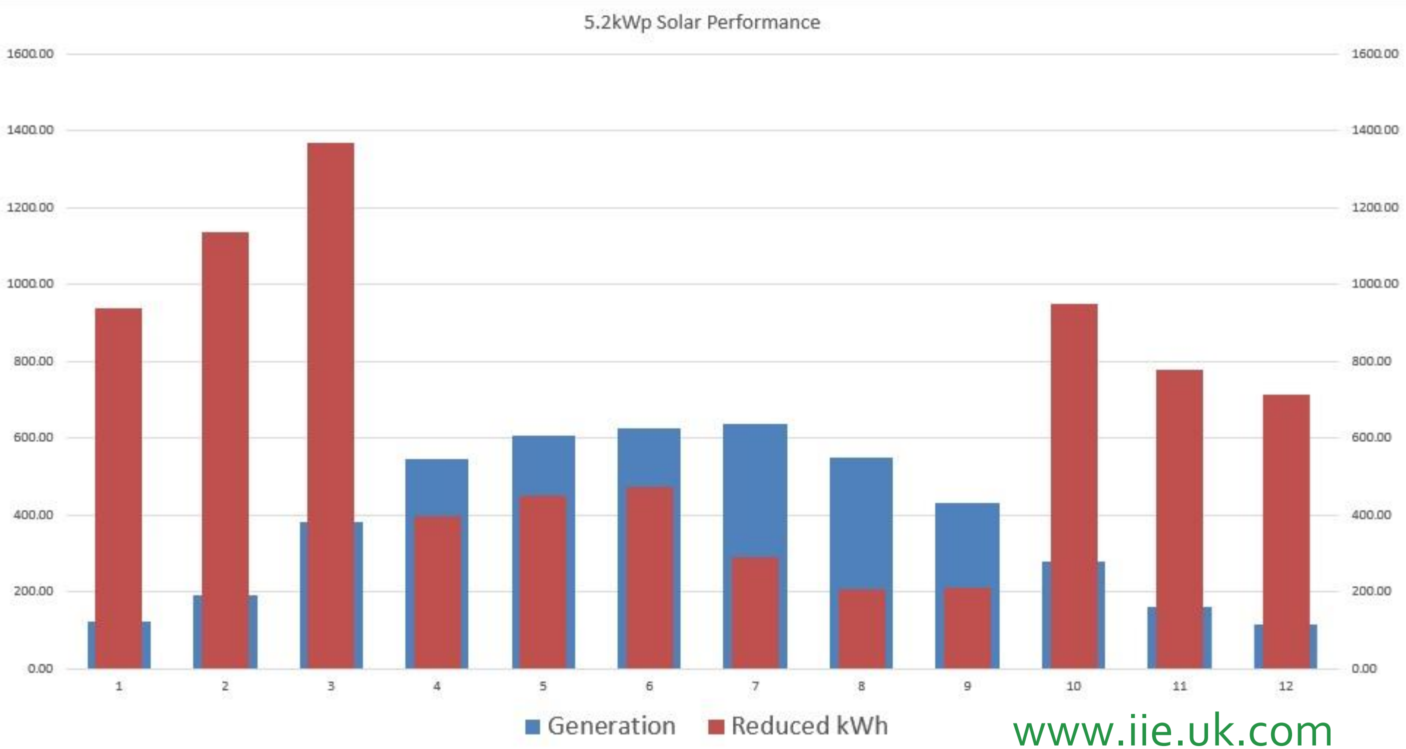


Image courtesy of the U.S. Department of Energy

RENEWABLES

Solar panels

- Most known technology
- Large arrays require a lot of space
- Space must be free from shading and ideally, Southerly – but East and West orientations will work
- Only usable when the sun is up; better summer performance than winter
- Does generate energy where there is light (overcast), but is heavily impacted
- Best suited for an organisation that operates all day, everyday
- Costs have reduced significantly making it an attractable option with paybacks ~7-8 years
- Installations are available through PPA, Power Purchase Agreements
- Does require permission from DNO (District Network Operator) to install if system above 4kW
- If a connection is allowed, excess energy can be sent back into Grid but at significantly reduced cost (5p/kWh vs 16p/kWh)
- Minimal maintenance, but does need cleaning, regular checks (inverters, cables, etc.), tree cover, etc.
- Roof type and structure can affect installation, also access to the roof needs to be considered
- Location of the system to distribution board needs to be considered



RENEWABLES

- Generates electricity by absorbing sunlight
- 2 types of panels
  - Evacuated tube ~78% efficient
  - Flat panel ~83% efficient
- Offers ~30-40% of annual hot water load
- Only suited for buildings that require high amounts of hot water, all year round
- Sizing defined by space available for installation, amount of hot water needed, and storage requirements
- System requires a buffer tank – must be replaced, cannot be connected to existing system
- Also consider existing pipes as these may need to be changed
- Similar to solar PV, roof structure needs to be able to support installation
- Tank should be as close to collectors as possible
- Maintenance similar, regular checks, cleaning, shading, etc.
- Important that glycol levels are consistency checked – ideal that these are flushed every three years where necessary

RENEWABLES

Battery Storage

- Electricity cannot be stored in its raw form and has to be transformed in order to allow storage
- Battery storage is the conversion of electrical to chemical energy through various chemical combinations
- Most common battery types is Li-ion; Average lifespan (3-10k cycles), can be 100% discharged but usually limited to 80%, round trip efficiency 83%, more expensive to manufacture but cheap lifecycle cost
- Batteries can either be charged during cheap tariff times, through renewables or any other type of generation, to be discharged at times that suit the user – i.e. higher tariff rates, high energy loads, etc.
- Can also be used as a stand-alone emergency system (UPS) for either part or all of a building
- Batteries have a potential major role in Grid balancing
- Battery life can be impacted by a number of different conditions
- High temperatures
- How often they are cycled (discharged and recharged)
- Charging too much or for long periods
- Discharging the battery fully
- Batteries best designed for short, partial cycles – system design, therefore, need to oversize the battery to minimise this

RENEWABLES

Battery Storage

- Battery sizing depends both on capacity (how much energy is required) but discharge as well
- Individual battery is rated at 100Amp hours (Ahr) which can be discharged at 100Amps over 1 hour or 1Amp over 100 hours
- Need to plan both charging (input capacity) and output
- Ideal to match most of the load to ensure consistent discharge over a consistent time
- Manufacturers should take this into account when discussing your project or plan

ACTION PLANS

- Use your carbon assessment to build your plan – consider the business case for each action
- Focus on your significant areas of impact
  - Buildings
  - Fuels
  - Gases, etc.
- Consider both short term 'quick wins' and long-term ambitions and build actions accordingly
- Consider both 'control / managing' actions, and 'minimising' actions
- Do not rule anything out; larger actions (for example, renewables) may not yet be feasible but could become a suitable option over time

FREQUENTLY INTRODUCED ACTIONS

- LED lighting
- Sensors (PIR / LUX)
- Switch off campaigns
- Timed plugs for equipment
- Asset list
- Travel needs (surveys)
- Vehicle trackers

- Renewable generation (solar, etc)
- Heat pumps
- Infrared heating
- EV charging

- Heating needs
  - Heating timers
  - Thermostats
  - Weather compensation
  - Zonal control
  - Insulated pipes (lagging)
  - Building insulation levels
  - Age of plant

- Hot water
  - Is DHW needed?
  - Kettles vs instant taps
  - Leak checks

GRANT FUNDING OVERVIEW

- Funding is available to help catalyse capital investments in energy efficiency and renewable energy initiatives

- Different schemes covering different geographical areas

- Eligible technology list varies between schemes

- Common requirement is that projects seeking a grant must have a beneficial impact in terms of reduced energy use, improved energy efficiency and/or renewable energy generation

WHO IS ELIGIBLE

Eligibility criteria will vary between different projects. Many are still EU funded through the European Regional Development Fund (ERDF). To qualify for support the following criteria will apply;

- Geography: Varies (but must in England)
- Size: Must have less than 250 employees
- Finances: Annual turnover less than €50M/ annual balance sheet below €43M
- State Aid: Have received less than €200,000 within last 3 years
- Sectors: Some sectors not eligible (i.e. agriculture)

GRANT FUNDING IN THE EAST OF ENGLAND

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- Eastern New Energy https://www.uel.ac.uk/sri/eastern-new-energy
- Up to 25% intervention rate, with minimum grant £1,000
- Grant fund is due to complete this year (2022)
- However, speak with your local Growth Hubs or local authorities for information
- Some funds are also available close to landfill sites or large energy installations (wind farms, etc.) where companies have set up funds to help local businesses or communities within the area

Eastern NewEnergy
European Union European Regional Development Fund
HM Government

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QUESTIONS AND ANSWERS

THANK YOU!

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