Managing Energy Efficiency in Glasshouses:

The challenges and opportunities in heating and renewables

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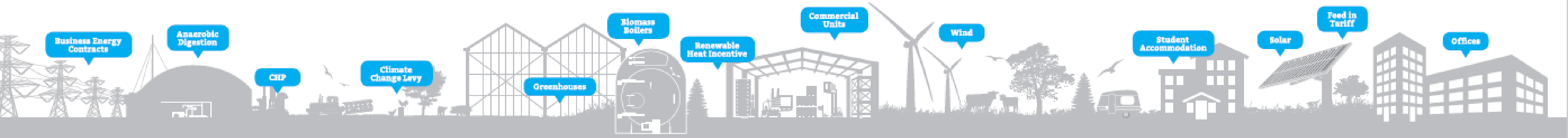


What is Energy Efficiency?

Output Work/Energy
(Work / Energy generated by the system)

$$Efficiency = \frac{W_{out}}{W_{in}}$$

Input Work/Energy
(Work / Energy supplied to the system)

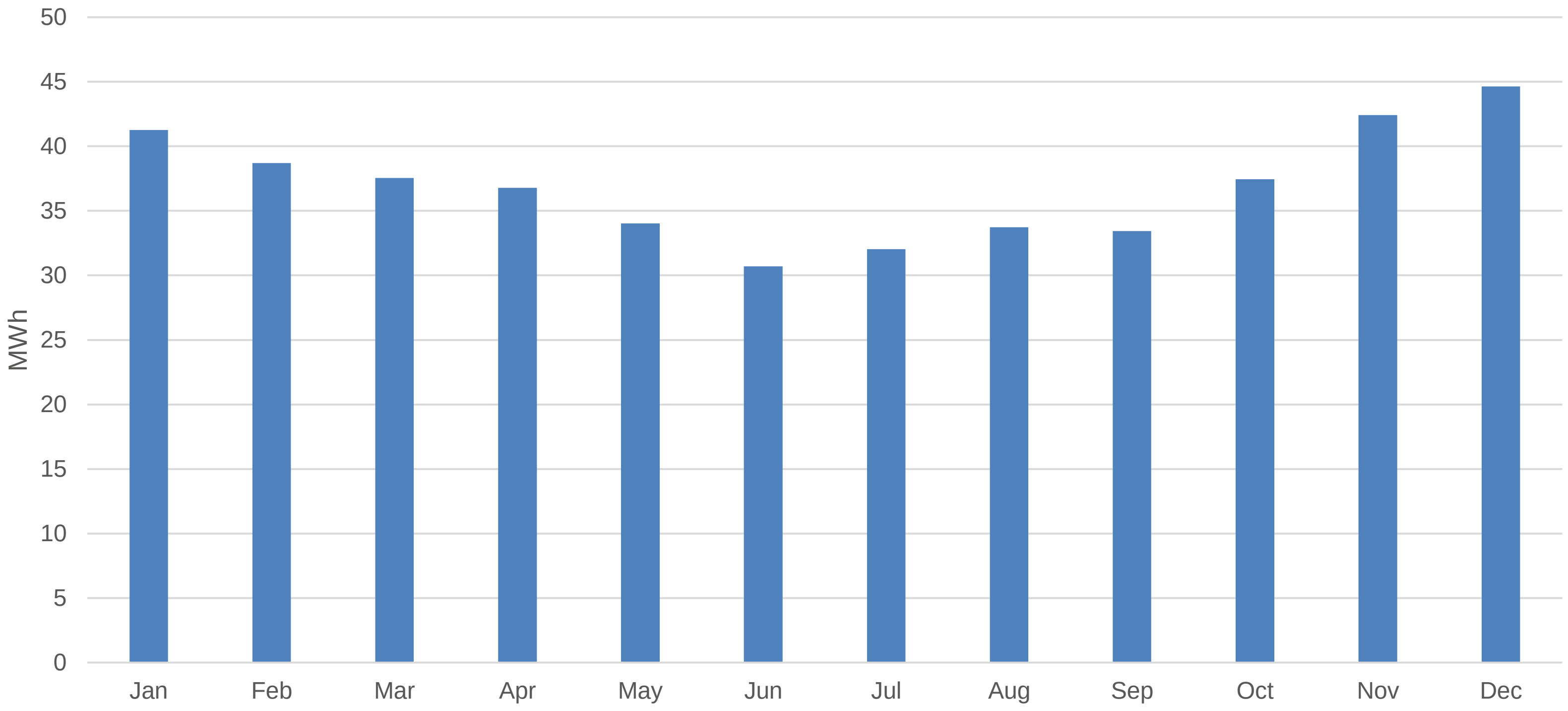
Improving Efficiency

- To save energy, you must first understand how it’s used

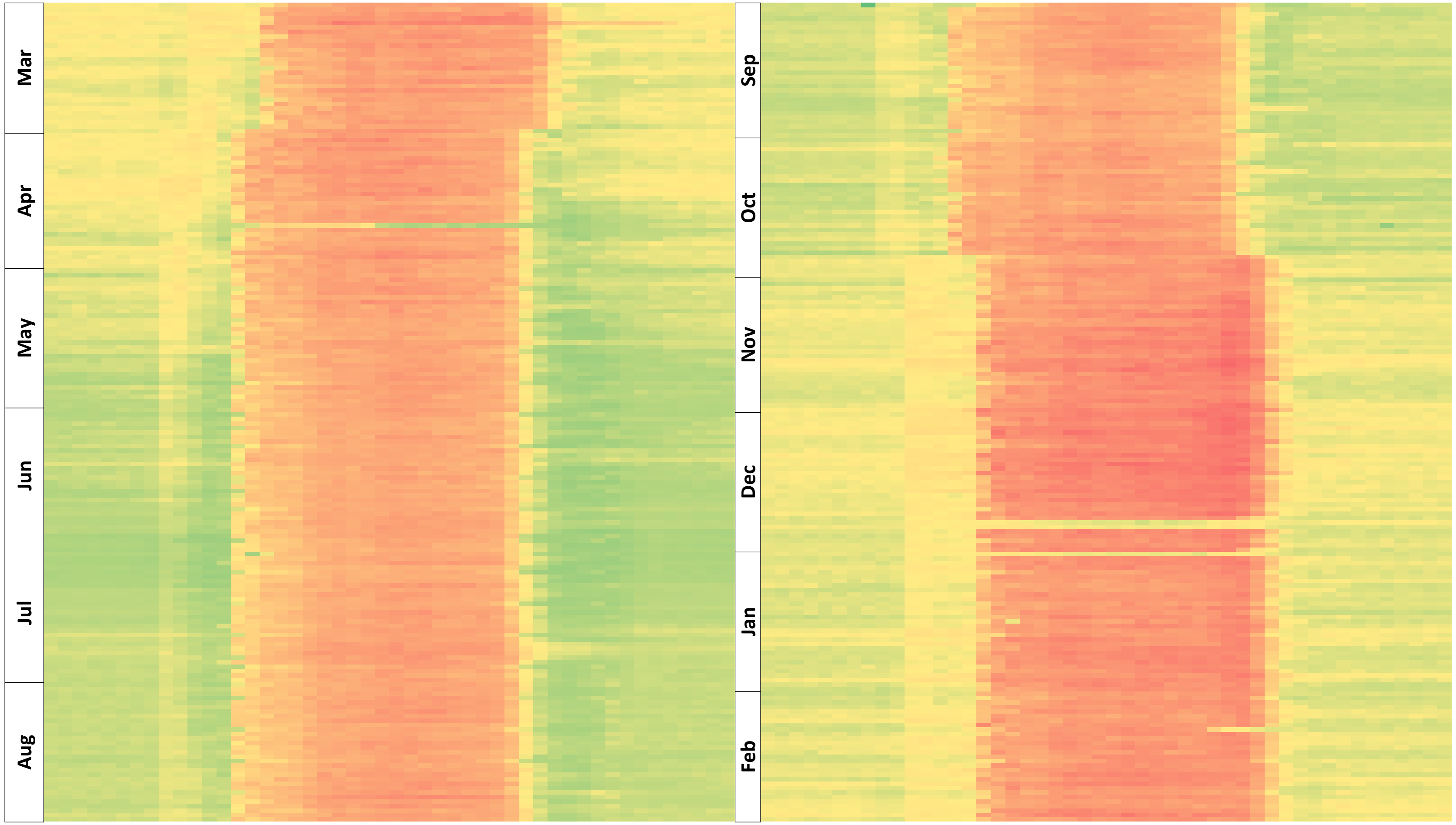
- The following questions need to be answered about how you use energy:

- What?
- Where?
- When?
- Why?

The Importance of Data



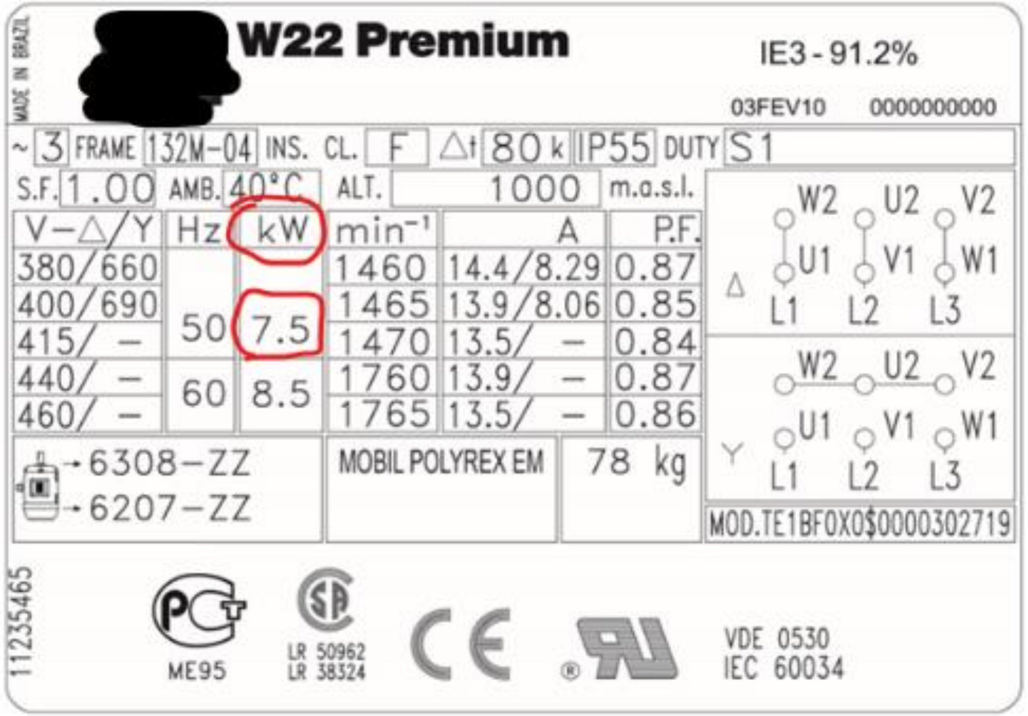
The Importance of Data



How Do You Use Energy?

- Walk around to key energy uses and investigate:

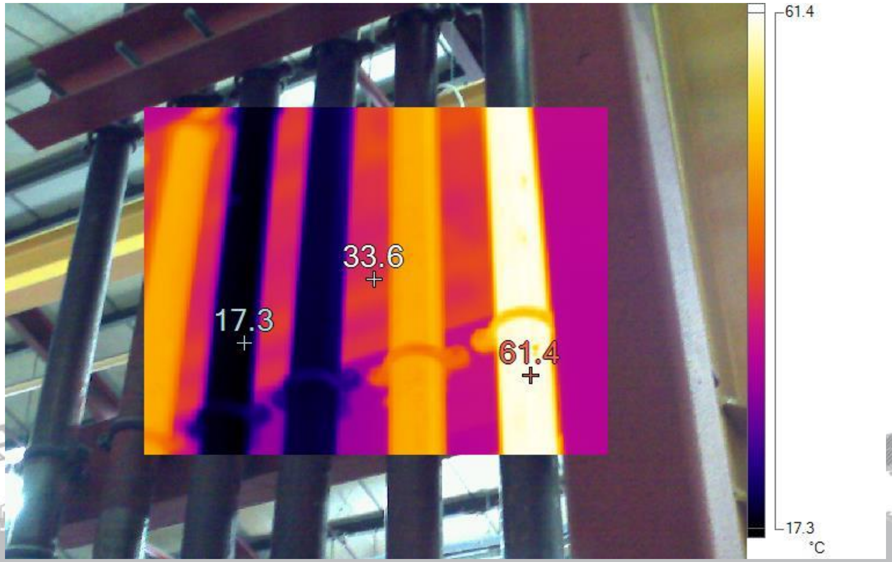
- What? - kW rating
- Where?
- When? - Run hours
- Why?



Improving Efficiency

- Reduce Load:

- Adjust heating/cooling setpoints
- Improve insulation
- Replace broken panes
- Install/replace screens
- Upgrade old/inefficient equipment
- New installations



Improving Efficiency

- Reduce Time:

- Switch off
- Improve metering/sensors
- Adjust heating/cooling setpoints
- Install timers
- Training & behaviour changes

E.g. Adjusting Setpoints

- Degree-Day Analysis

- Measure of the difference between, and number of days, that the 'base temp' is:

- Below the ambient – heating degree days
- Above the ambient – cooling degree days

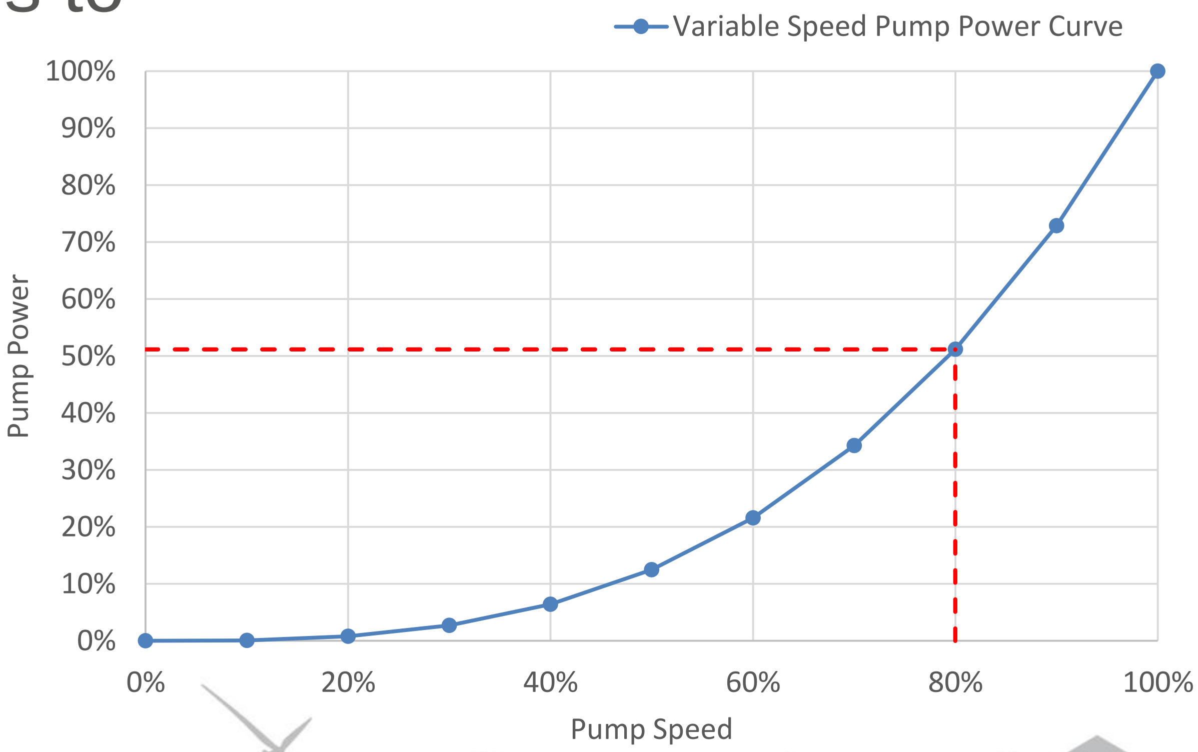
Base Temp	HDD	Reduction
12°C	1,199	-
10°C	787	44%

E.g. Insulation Improvement

- Wet or degraded insulation loses most of its savings
- Not only pipe lagging, but pump and valve jackets
- 2-5% savings on heating fuel typical

E.g. Variable Speed Drives

- Adjusts the frequency of motors to match demand
- Cubic relationship
- 20-45% savings typical



E.g. Upgrade Equipment: Lights

- LED lights use up to 60% less energy to deliver the same lighting levels, compared to conventional bulbs

- Additional benefits:

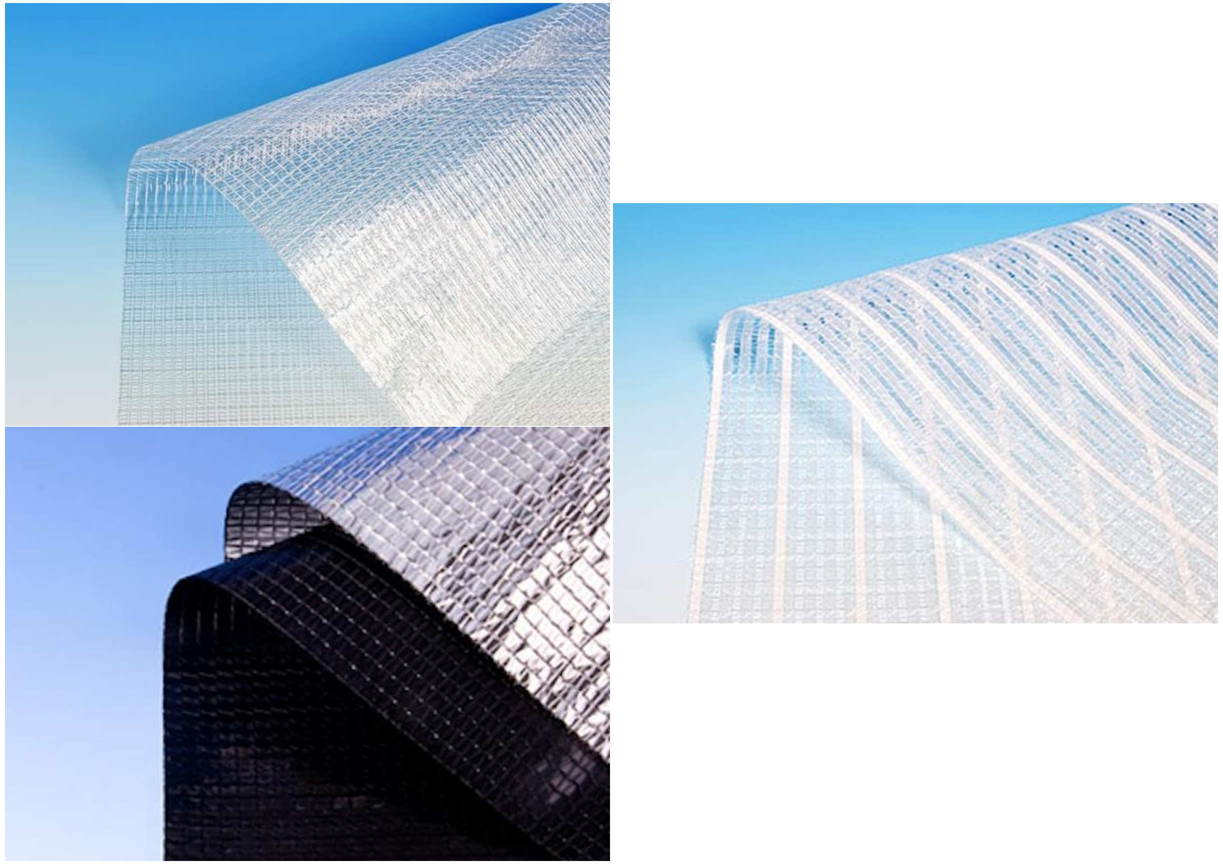
- Faster response to timing/controls
- Adjustable spectrum
- Produce less heat

Lighting	Hours	MWh/year	Saving	
500kW HPS	1,500	750	-	-
350kW LED	1,500	525	30%	£56,250

E.g. Screening Improvement

- ‘Set and forget’ mentality
- Aged/broken/soiled screens are common
- Can be as low as ~5-year lifespan
- This reduces energy saving ability

E.g. Screening Improvement



- Material improvements – light, breathable, etc.
- 15-75% energy savings with single screens
- 17-23% minimum shading
- Versatile – different types for different purposes
- Can be retrofit

E.g. Screening Improvement

- Wageningen University, shade screen over rose: 5% increased yield
- Wageningen & Svensson, diffuse screens over anthurium and bromeliad: 25% increase in plant weight
- Svensson, several screen scenarios over pepper crop:

	No Screen	Energy Screen	Energy + Diffuse + Vertical	Energy + Blackout + Vertical
Heat savings	-	26%	37%	41%

Heating Systems

- Key considerations:

- Temperature
- Seasonality
- Delivery
- Cost!

Crop heating

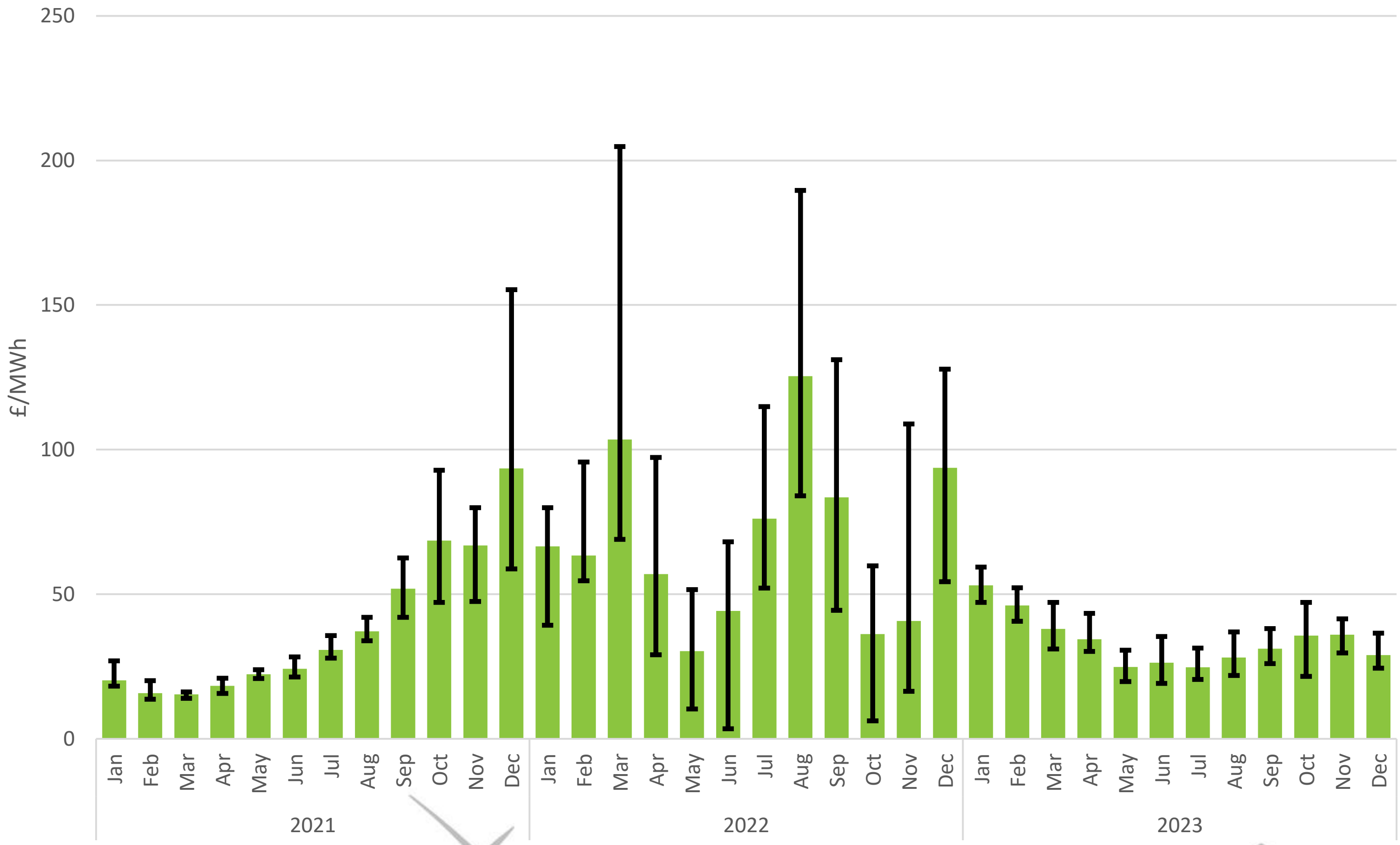
Frost protection

Tray wash

Occupancy

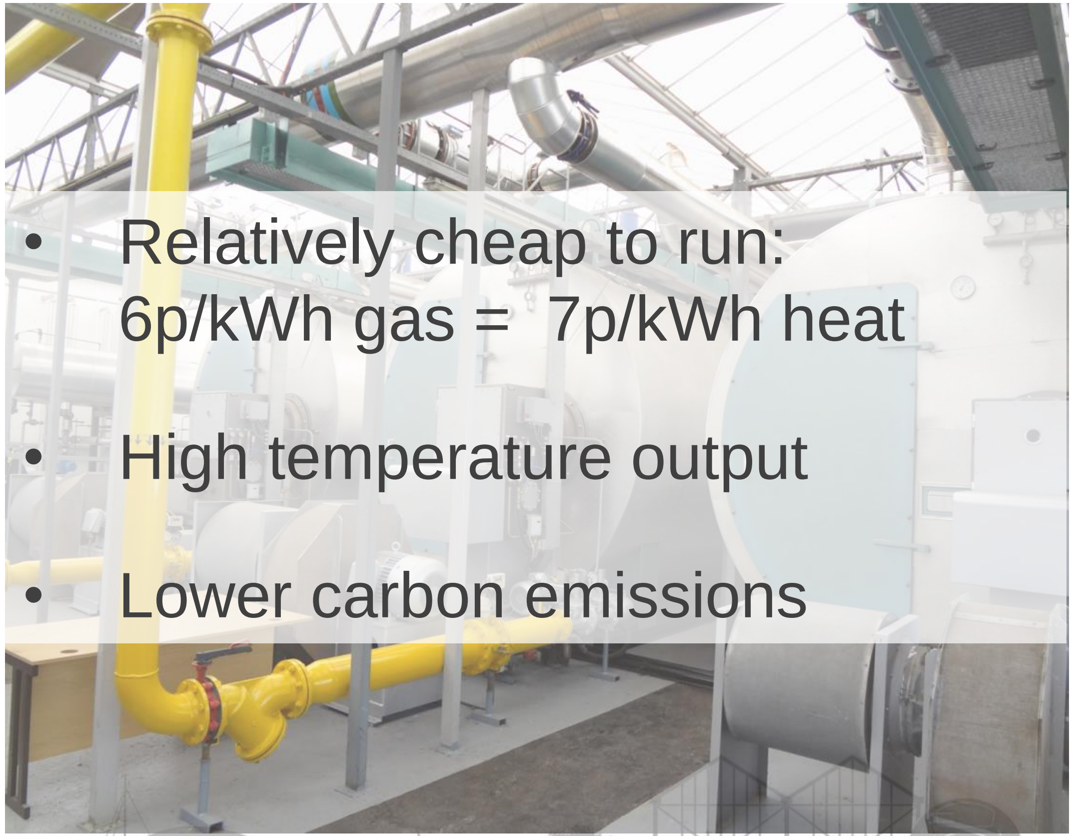
Natural Gas

- High Price Volatility:
- Peaking around £200/MWh, or 20p per unit!
- Averaging less than £50/MWh in 2023
- Range is less than last year, still higher than most of 2021



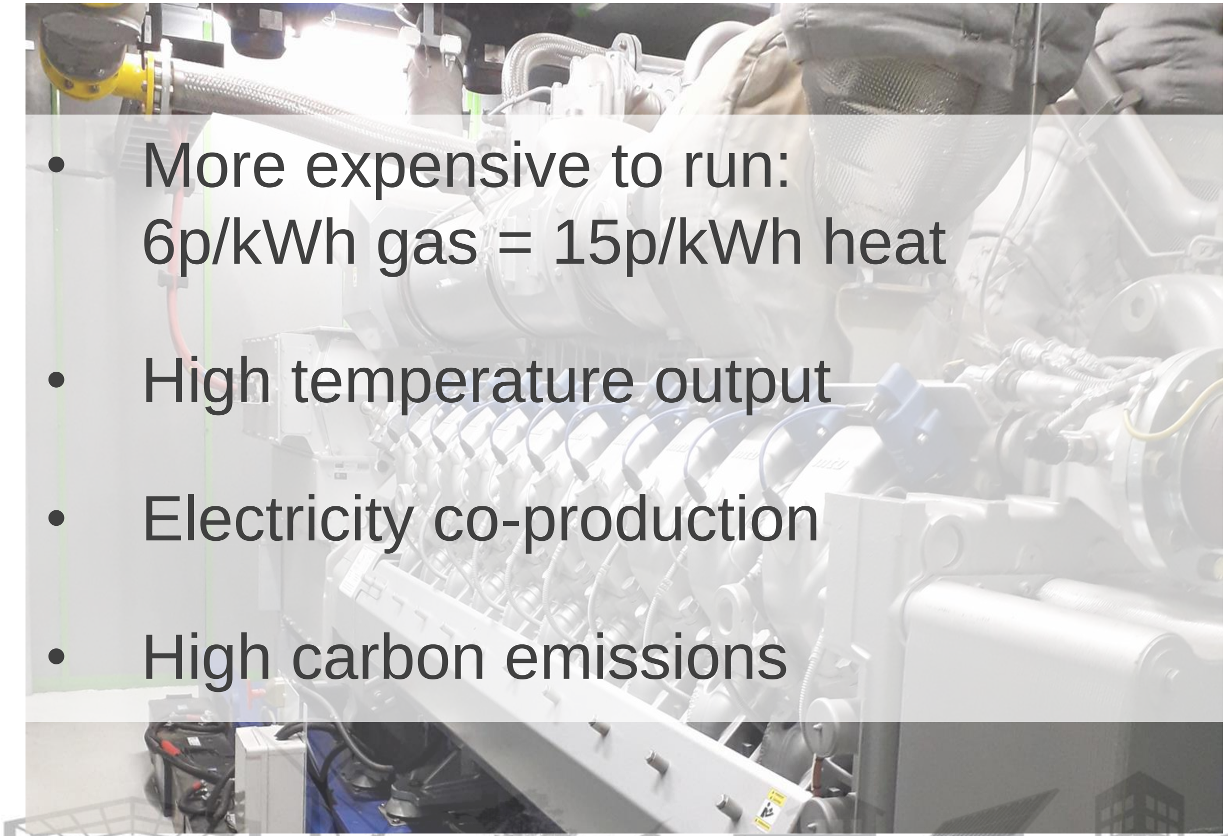
Natural Gas

Boiler



- Relatively cheap to run:
  6p/kWh gas = 7p/kWh heat
- High temperature output
- Lower carbon emissions

CHP



- More expensive to run:
  6p/kWh gas = 15p/kWh heat
- High temperature output
- Electricity co-production
- High carbon emissions

Oil/LPG

- Can modulate with heat demand
- Requires physical fuel delivery
- 78 p/l = 8-12 p/kWh

Biomass

- £120/t = 3.2 p/kWh
- Fuel cost & availability can be an issue
- New installations are relatively expensive & not incentivised
- Physically large

Biomass

- Secondhand boilers
- Low carbon emissions
- More sustainable fuel
- Difficult to capture carbon

Heat Pumps

- Very expensive
- 25p/kWh elec = 5-8.5p/kWh
- Heat source is important
- Not incentivised
- Low temperature

Heat Pumps

- Runs on electricity
- Potential for carbon neutrality
- With electricity costing 25p/kWh and gas 6p/kWh, CoP must be >3.5

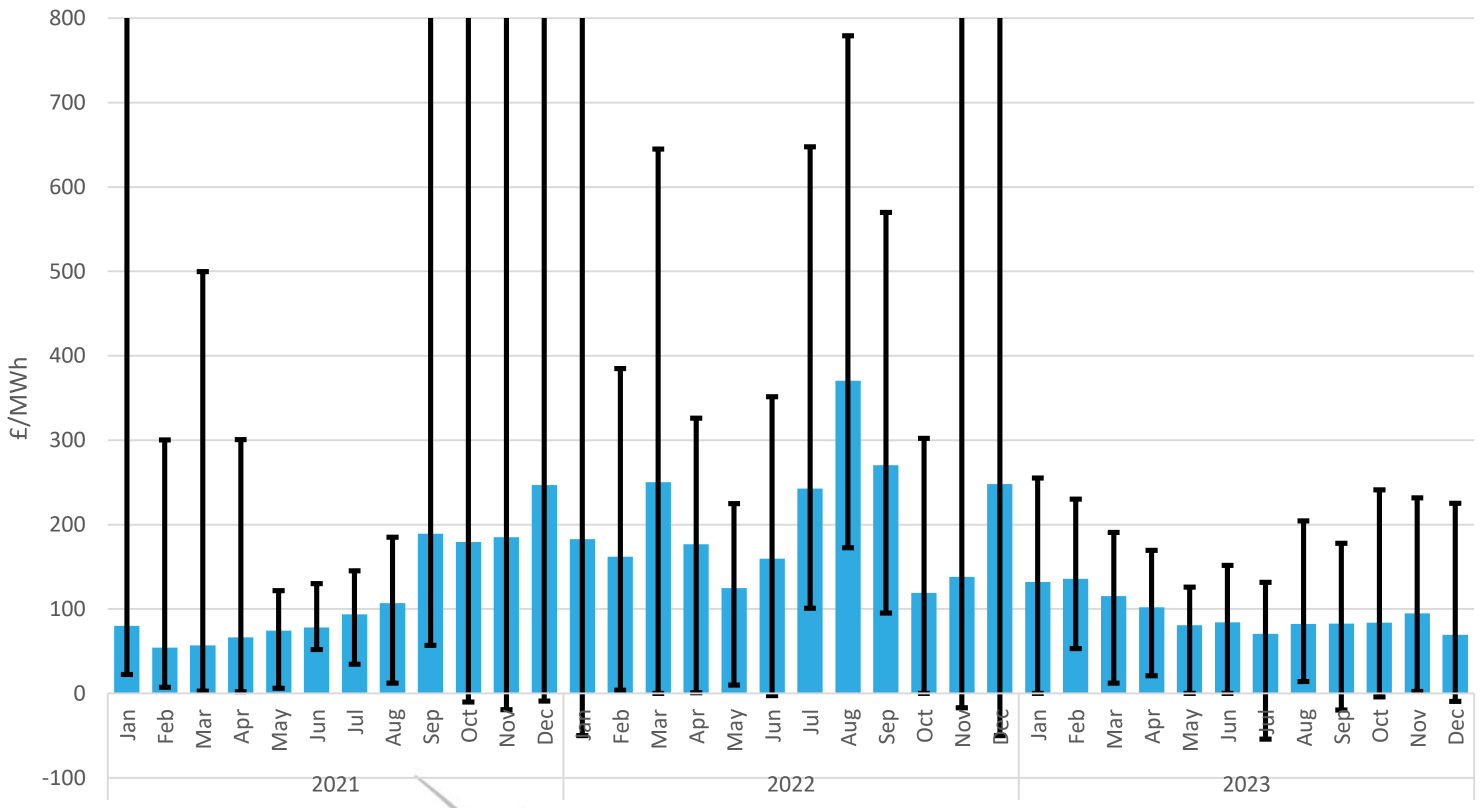
Electricity

- High Price Volatility:

- Peaking around £2,500/MWh, or 250p per unit!

- Averaging around £100/MWh in 2023

- Range is less than last year, still high



Electricity

- Key considerations:

- Seasonality
- Time of use
- Grid connection
- Contract - Cost!

Crop lighting

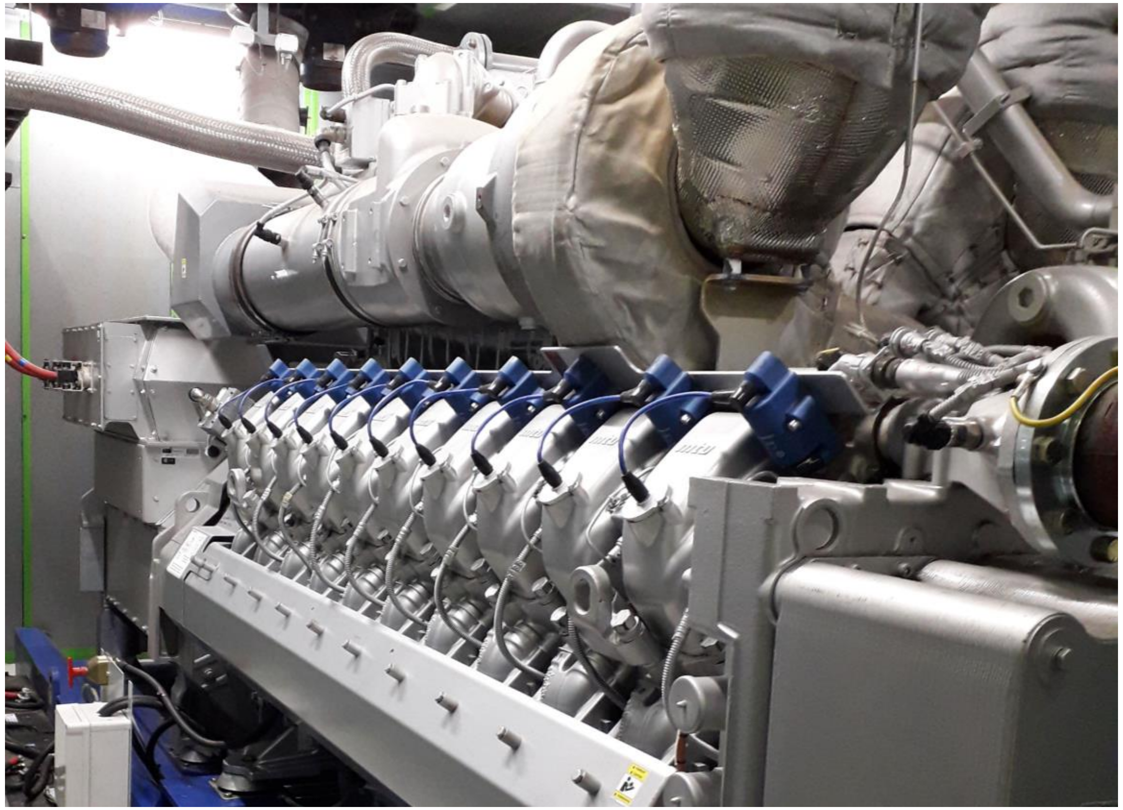
Irrigation

Air movement

Cold storage

Occupancy

Natural Gas CHP



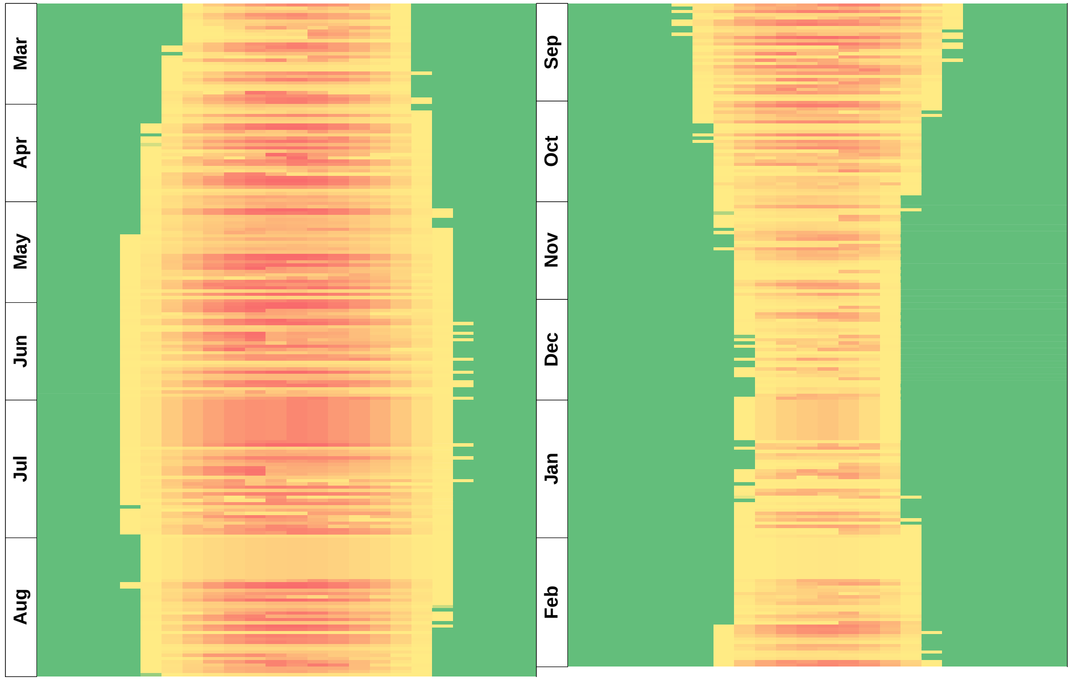
- With gas costing 6p/kWh, CHP-generated power costs 14p/kWh
- Co-generation
- Can bolster income by exporting power

Solar PV

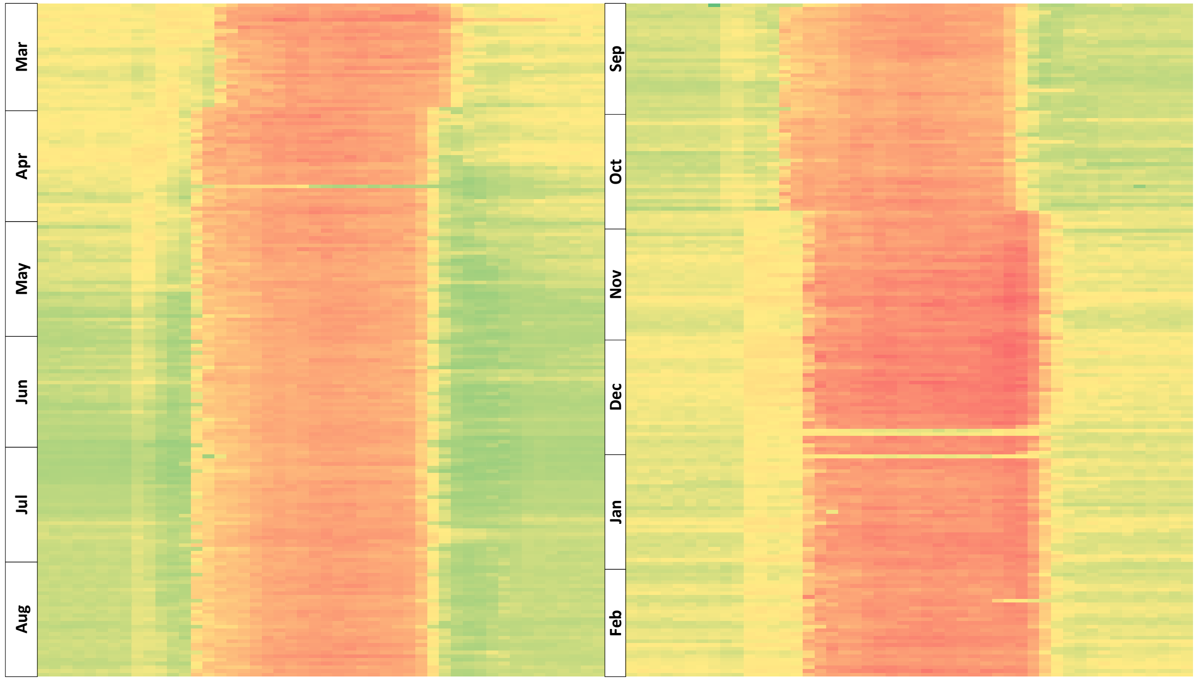
- Agrivoltaics
- Panels available with 33% light transmission
- Most suitable over non-growing areas

Solar PV

PV Generation



Site Demand



Thanks for Listening

Questions?

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