Heat Pumps: Do they work?
some UK historical background

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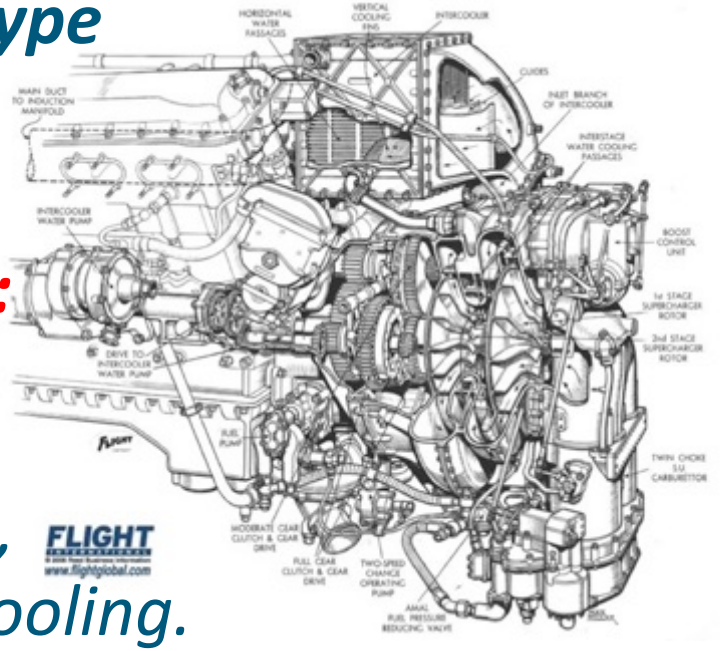
Festival of Britain 1951 – *Royal Festival Hall*

Heated and cooled from the Thames by water source centrifugal heat pumps
Capacity 7600 kW - powered by two Rolls-Royce Merlin engines run on coal gas

Intended prototype of UK export innovation.



REMOVED 1952: WHY?

- ***Oversized:*** *Too much heat, far too much cooling.*
- ***Politics****: The Tories razed the Festival site in 1952, apart from the RFH.*

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We all have efficient reliable heat pumps at home …

they're called refrigerators.

Why do they work so well?

- *Sealed*
- *Packaged*
- *Mass produced*
- *Single purpose*
- *Limited range of operational conditions.*

Why have systems for buildings been troublesome?

1980s: *Energy Efficiency Demonstration Scheme*

- **PUBS:** From cellar (beer) cooling to domestic hot water. *Simple systems,* ***Institutional problems:*** *crossed line between the brewery and the landlord.*
- **MOTORWAY SERVICES**: From kitchen extract to domestic hot water: ***Fouling, Lockout and Maintenance problems, Management responsibilities.***
- **DEHUMIDIFIED WAREHOUSES**: Worked well, *if buildings were* ***airtight****.*
- **HOTELS, SWIMMING POOLS:** Could work well, ***but maintenance*** *was often too* ***expensive****, so systems were often abandoned, particularly under 30kW.*

Oversizing common: energy requirements often overestimated – *poor data on "before". Potential for other energy saving measures not accounted for.*

Legionnaires Disease scare *caused many DHW systems to be abandoned.*

1987: *NMB Bank, Amsterdam*

- **Low-energy credentials depended on heat export from very large computer suite to adjacent housing and commercial buildings.**
- *In practice, the adjoining owners regarded such integration as too risky,* ***so the export never happened*** *as far as I know.*

1993: *Western Morning News, Plymouth*

- Packaged reversible air-to-water heat pump + thermosyphon “free cooling”.
- Integrated with gas-fired LTHW system. Also provided chilled water.

I suggested turning the heat pump off in winter; and …

- … **gas and electricity use and costs dropped significantly.**
- ***Why?*** *Problems with packaged unit design, control, system integration.*

1998: *Gothenburg District Heating visit*

Guidance from Göteborg

Scandinavian buildings are held to be paragons of energy efficiency. Certainly the rigours of its climate and the lack of indigenous fossil fuels have forced Sweden's hand, but are its buildings really that good? And how do UK buildings compare? New research provides some answers.

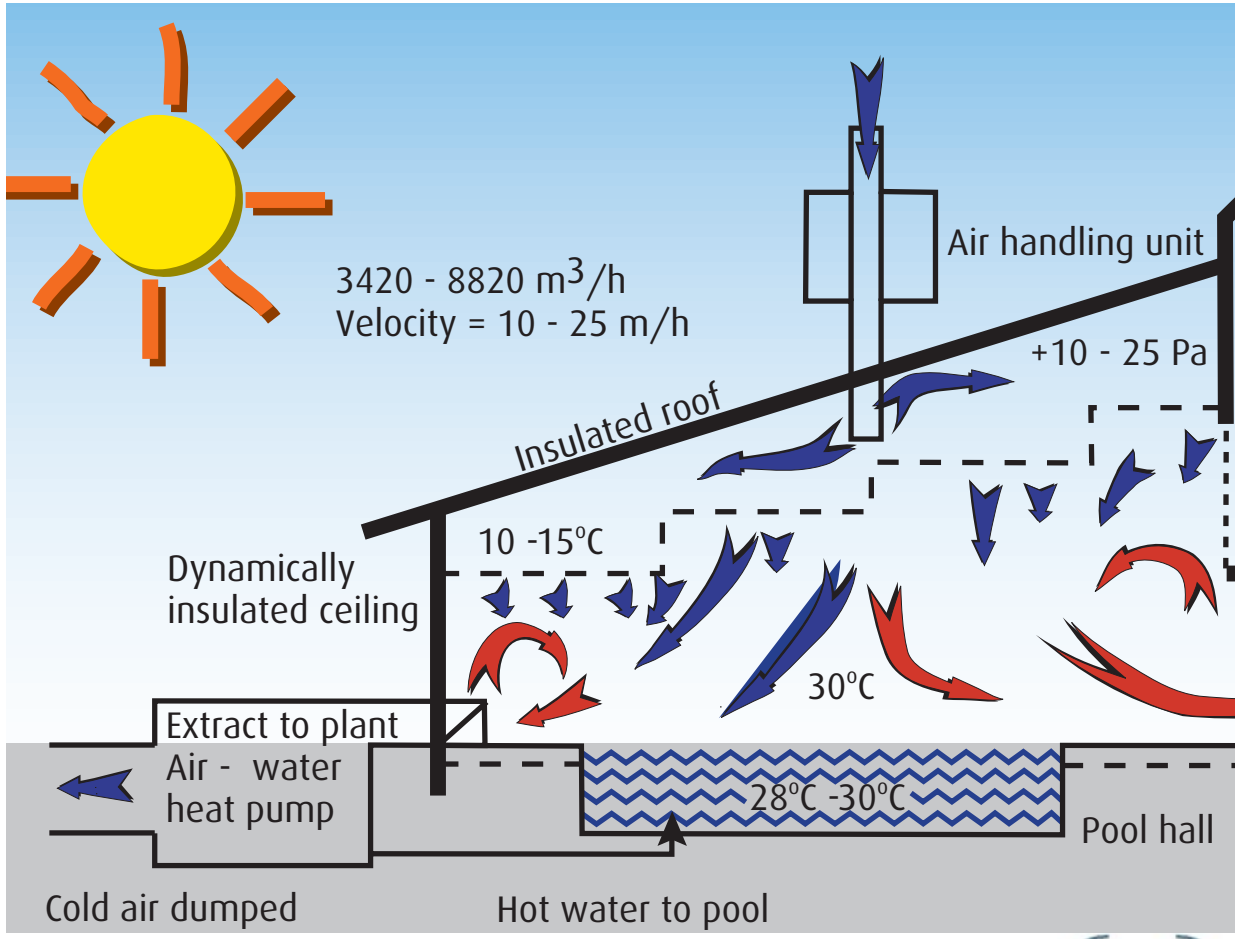
CIBSE Journal April 1998 BY BILL BORDASS AND LENNART JAGEMAR

- **Large sewage heat pumps: 2 x 30 MW, 2 x 40 MW, *part of much larger system*.**
- **Users pay for water, not heat,** *assuming they return it at 30 C:* ***Incentive!***
- **Standard heat transfer stations *cascade five levels of ΔT.***

2000: *McLaren Sports Centre, Callander, Trossachs*

- **Heat pump from exhaust air to swimming pool and hot water.**
- Backup from gas boiler.
- *Nearest accredited maintenance contractor in Liverpool.*
- ***Heat pump abandoned** owing to maintenance difficulty and costs.*
- ***Electricity quite expensive** here too – little economic incentive to use HP.*

DESIGN FOR USABILITY AND MANAGEABILITY. CHECK TARIFFS.



2010s: *System integration often trips things up*

The late David McKay, then **Chief Scientist at DECC, *advocated all-electric economy with heat pumps for their theoretical benefits,*** *but this ignored practical difficulties.*

Energy Saving Trust field trials Part 1 found *performance of domestic heat pumps disappoints.* But recent studies by EST and UCL find improvements, *though still with some old problems, e.g. integration, control, sizing, lack of fine tuning.* **Maturing?**

Initial findings report from the Technology Strategy Board **/ Innovate UK's *Building Performance Evaluation programme in non-domestic buildings:***

- **Bluebell Health Centre:** *ASHP struggled in winter so gas took over.* HP not linked to BMS, not even mentioned in the Log Book! ***Integration problems.***
- **Loxford School:** *Leaky building shifted more load onto the gas boilers.* GSHP not metered, so impossible to tell its contribution. ***Integration problems.***
- **Stockport Academy:** *GSHP intended to lead, but installed to follow the gas* boiler, so only half the anticipated annual contribution. ***Integration problems.***

Conclusions 1 : *It's the context, stupid …*

- **POLICY: Why do policymakers see heat pumps as renewable,** rather than efficient electricity users? ***Were their effects on electricity network properly understood?***
- **BRIEFING:** ***Will a heat pump suit the building****, its location & management?*
- **SYSTEM**: ***Is it the right size and type?*** Is the ΔT kept low? Are parasitic losses minimised? Will the controls be intelligible? ***Will it cross management divides?***
- **PROCUREMENT:** *Will there be sufficient attention to detail?* ***Will it be properly tuned-up?*** *Will your experiences be shared?*
- **CONTROL** and **OPERATION:** ***Will people understand it?*** *Is the design intent clear?*
- **SUPPORT:** ***Will the system be reliable,*** *with low need for vigilance and maintenance?*
- **KISS**: **Simple and standard is best.** ***Integration can be highly problematic.***

Conclusions 2 : *Scale of heat pump installations*

SCALE	EXAMPLE	Seasonal Performance Factor SPF	COMMENTS
Sub-system	*Exhaust air To Domestic Hot Water*	3 to 5	Simple, packaged, standardised. Potentially reliable, *if filters and heat recovery coils are kept clean. Need to alert management to lockouts, or system failures can persist for long periods unless service is mission-critical.*
Building	*ASHP, GSHP or Heat recovery*	2 to 4	*Integration can be problematic, even adding immersion heaters!* Keep systems separated where possible (e.g. top-up woodstove).
Group of buildings	*Group heating/ cooling/trigen*	2 to 5	Larger systems perhaps easier to manage effectively. Keep flow and return temperatures low. *Beware institutional problems, high standing charges.*
City scale	*District heating and cooling*	3 to 5	Major opportunities if return temperatures are kept low. Work best as local monopolies, *but EU competition law no longer allows this.*
Centralised	*Thermal power station*	6 at 100°C 12 at 70°C	CHP can be regarded as a **Virtual Heat Pump** with a high CoP. *[R Lowe, CHP … as a virtual heat pump, Energy Policy, 9 May 2011].*

Thank you

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