Decarbonising heat supply to social housing

Housing Executive

Northern Ireland Housing Executive

NIHE: A UK social housing landlord with 84,000 homes.
30,000 of these are heated with fossil heating oil

The Regional Strategic Housing authority for 780,000 homes.
Northern Ireland Home Energy Conservation Authority role

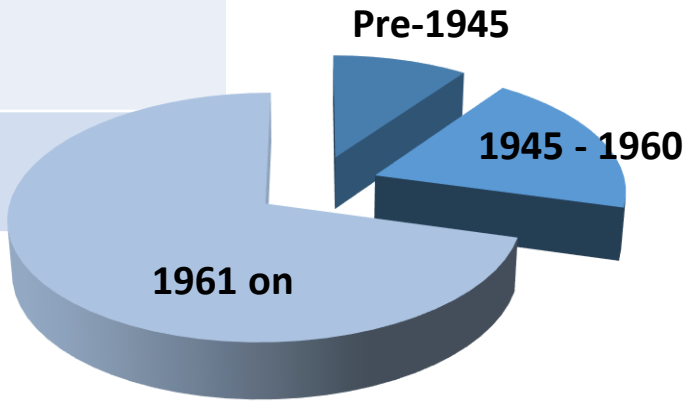
Approximately 500,000 of NI homes use heating oil.
Homes in rural areas are dependent on heating oil.
50% of private oil heated homes lack temperature controls.

Housing Executive

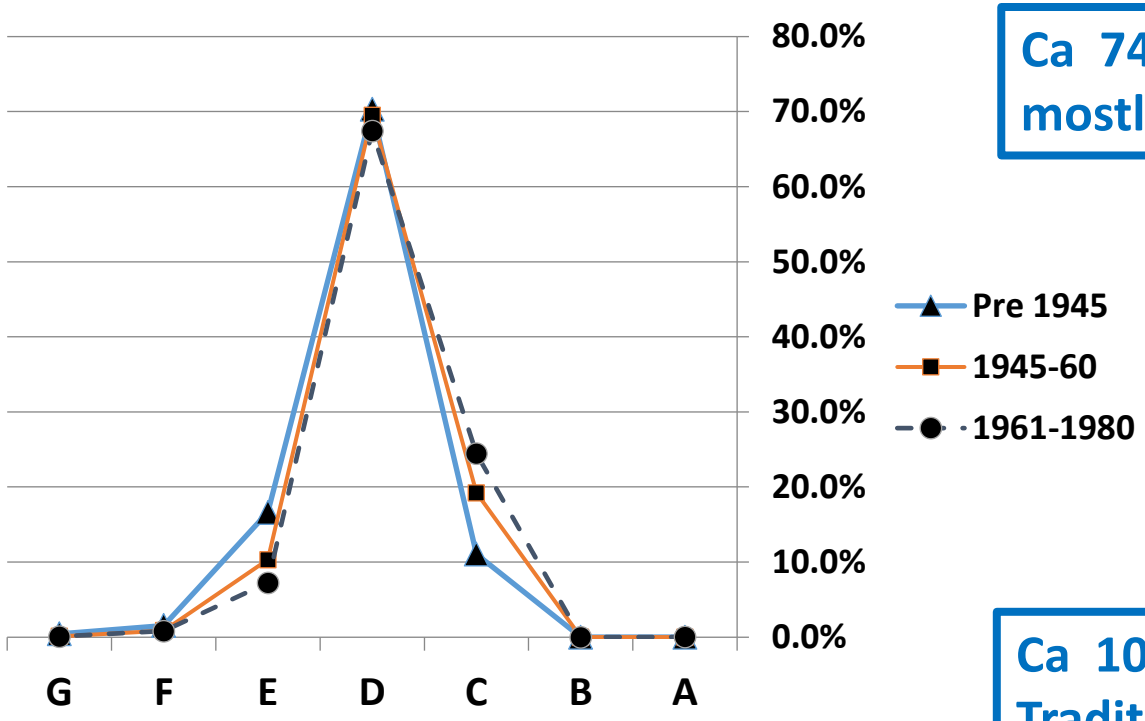
Where we are now

Main Fuel	%	number	on gas
Gas	56.0%	48,000	> 60%
Oil	36.9%	30,000	
Electricity	3.6%	3,100	
Coal/other	3.5%	2,900	
Total	ca	84,000	

+ “Gas to the West”



Where we are now



SAP 2012 scores

Ca 74k masonry, mostly cavity walls

Ca 10k Non-Traditional: No Fines, Timber Frame, Multi-storey flats, others.

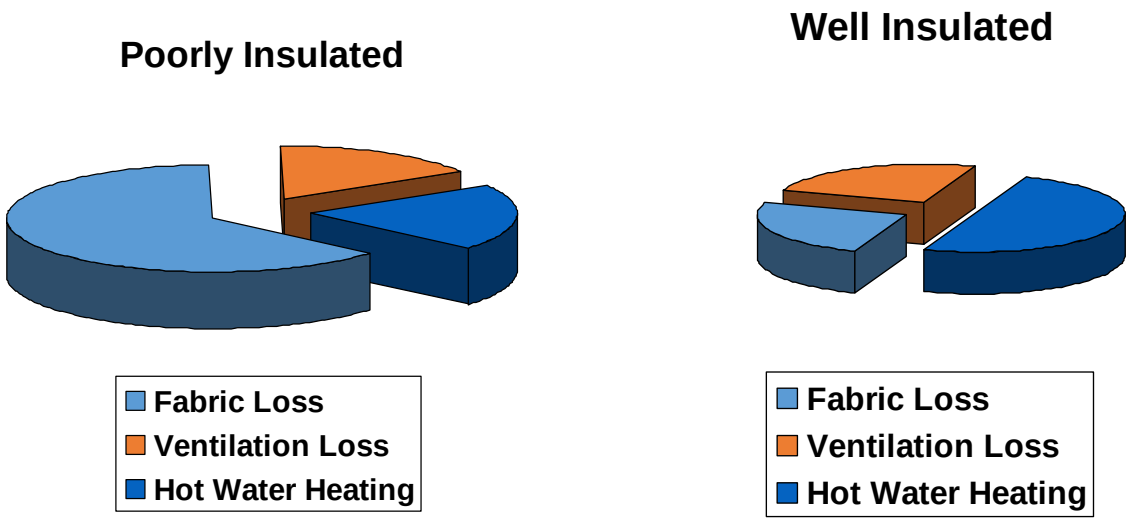
“Fabric First”

- Loanda Crescent Newry
- External Wall Insulation EWI outside cavity walls
- Shortened heating season
- Constant ventilation systems
- Smart controls, Gas boilers

Project Architect Caroline Best NIHE

EWI: Enhanced heat storage capacity compatible with heat pumps.

Heated ventilation air carries away moisture, pollutants: ventilation measures have been shown to improve health



After insulation, heat is still required to heat hot water & ventilation air> Decarbonise heat supply.

NIHE Heating Issues 1 Rural

Issue	Status	Risks	Benefit
Oil boilers 	Soon: No new boilers. 2028? **Pay As You Go service unavailable.**	**Extra CO2, soil spill remediation, oil theft, arson, air Q. Future fuel costs.**	Robust and reliable, high peak output.
Heat Pumps 	Required soon for homes on 'thin' rural power grid. **Insulation needed**.	**Unbalanced flows** Wrong type? Tariffs? Grid connections? **Planning & Noise**	**Pay As You Go. Good local air quality. Future proof.**

NIHE Heating Issues 2 Towns

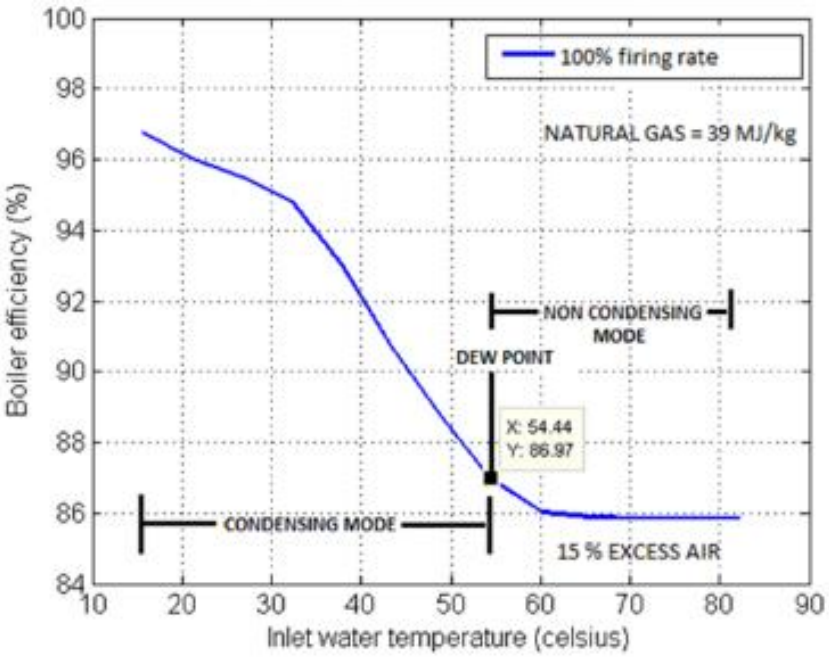
Issue	Status	Risks	Benefit
Community 	Is now reliable, has ultra low carbon potential. Hot + ambient Temp. versions	Likely to be promoted, grant funded	Avoided insulation? V. low carbon & low maintenance.
Gas Boilers 	In general use. Annual check needed. ErP% upgrades possible.	Gas future costs, Hydrogen safety	Most homes Pay As You Go Compact, proven & powerful.

Getting more from oil and gas (esp Combi) boilers now:

5C reduction in flow Temp saves ca 2% (more from heat pumps later)

Balancing radiator flows and adding ErP Class V room thermostats/ controls reduce the radiator output temperature according to the actual room temperature:

- Radiant radiator temperatures are boosted when the room is cold.
- Boiler output is then ‘modulated’, limited to maximize more efficient condensing boiler operation.
- Installing bigger radiators now heats rooms OK with lower water temperatures, and prepares the way for savings with heat pumps.



Getting more from oil boilers now:

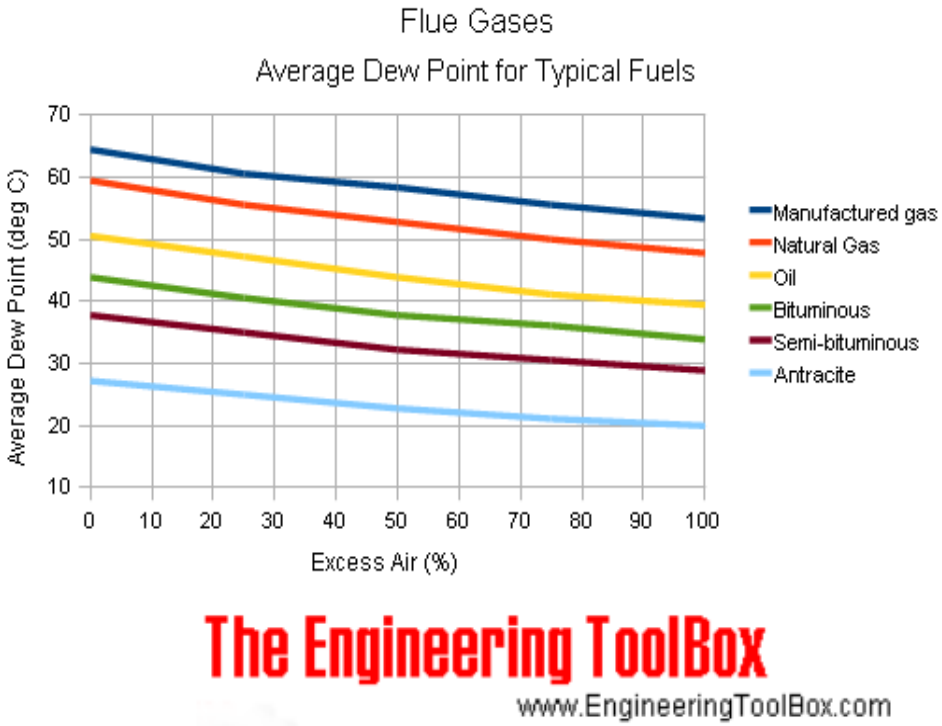
(and from heat pumps later)

Oil boilers' condensation temperature is lower than 50C, e.g. With larger radiators sized for later installation of a heat pump. 5C lower saves ca 2% Oil. ErP controls save another 3-4%; TPI ca 2%

- ErP Class VII controls start& stop the boiler to reach the target room temperature.
- TPI Time Proportional Integral controls also provide savings

- The larger mass of water in bigger radiators can reduce boiler cycling losses.

- Priority Domestic Hot Water [PDHW] controls can ensure Hi. Temp. legionella protection

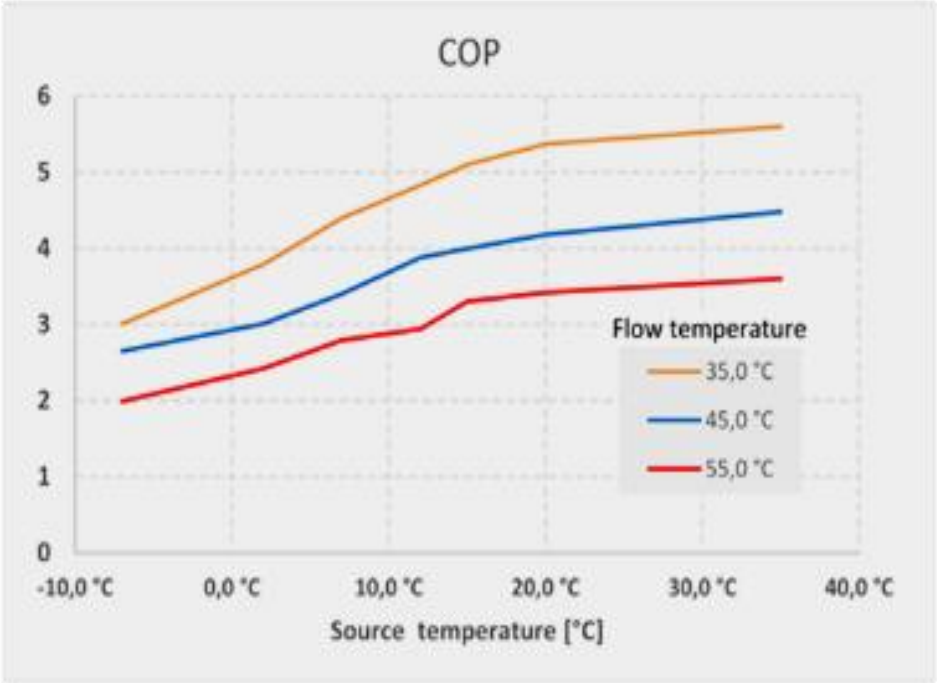


Preparing for heat pump installations:

Bigger radiators, flow balancing, save even more than with condensing boilers: Allowing a decrease in flow temperatures from 55 to say 50 could save much more. E.g. improving the COP from 2.5 to 2.75 could save over 10%, £130+ PA

Paul Kenny 'Superhomes' heat pumps + retrofitting expert:

- "Good heating circuit plus ordinary heat pump = OK"
- "Bad heating circuit plus good heat pump: Not OK"



Specify by low average flow temperatures and Temp. difference. e.g. 50C/10C, but also flow rates. Pipework has to have a bigger flow capacity.

“Ambient” heat loops for individual heat pumps:

- **Electric “Pay As You Go” system. Flats etc.**
- Boreholes, sea, may also provide some cooling
- By raising solar thermal/ geothermal heat source temperatures, can meet high winter loads or use existing radiators:
  - Electric heat pump load is reduced
- Eligible for GB commercial RHI payments?
- **No ‘fan box’ outside, QUIET (PlanningOK).**
- Private network& borehole finance?
- Solar thermal borehole re-heating?

Images: Kensa Heat Pumps

NIHE Heating Issues 3

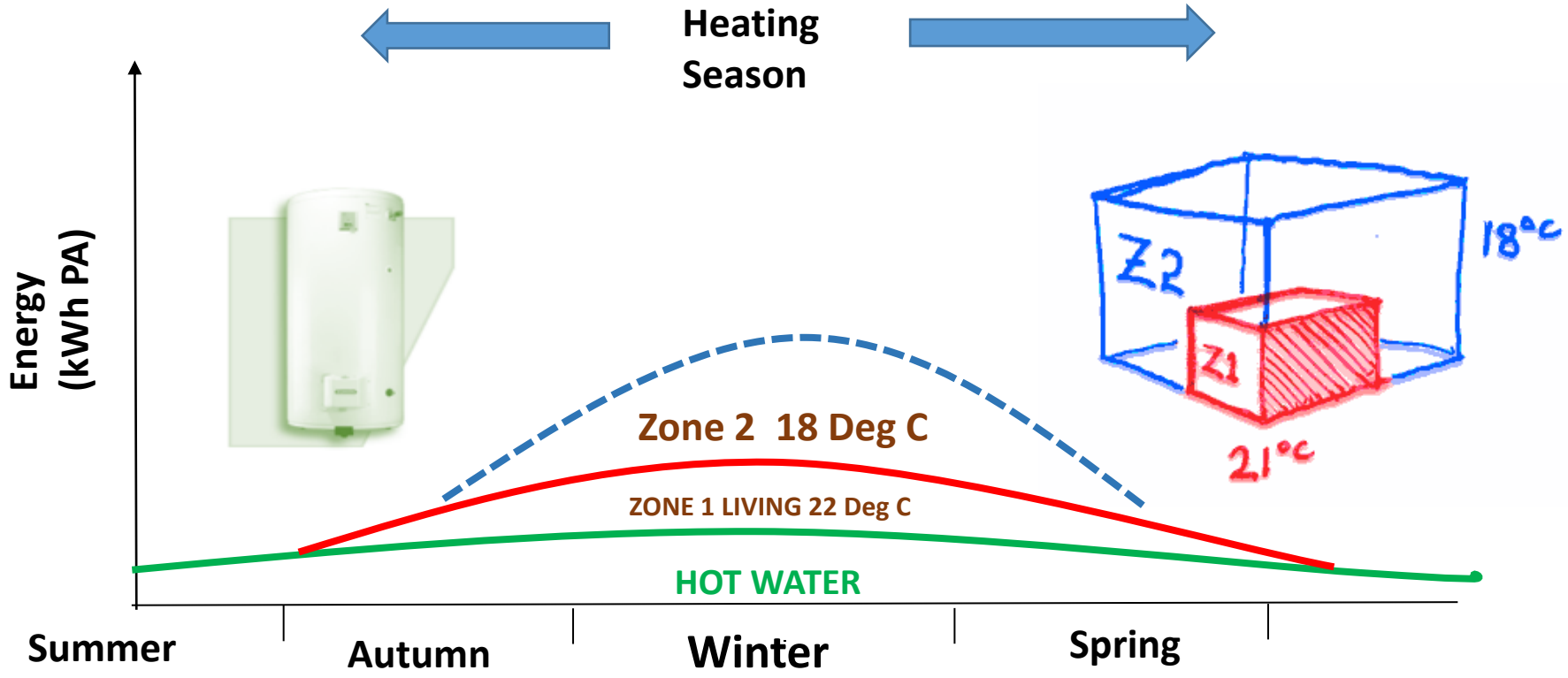
Issue	Status	Risks	Benefit
Electric Storage Heaters 	Often overheated at night or underused.	**High power prices in future**	**PAYGO, can be made Smarter.** **Add Air to Air Heat Pump with summer cooling?**
Photovoltaic Panels 	Effective. Interaction with H.Pumps, DHW?	Asbestos in roofs Falling costs	**Widely applicable and effective.**

Solar Orientation - Time Of Use pm/am ?

	Orientation from North						
	W			S			E
Tilt	270°	240°	210°	180°	150°	120°	90°
0°	84	84	84	84	84	84	84
10°	84	87	90	91	90	87	84
20°	82	89	94	96	94	89	82
30°	81	90	97	100	97	90	81
40°	78	89	97	100	97	89	78
50°	74	87	95	98	95	87	74
60°	69	82	92	95	92	82	69
70°	64	77	86	89	86	77	64
80°	57	69	78	81	78	69	57
90°	50	61	68	71	68	61	50

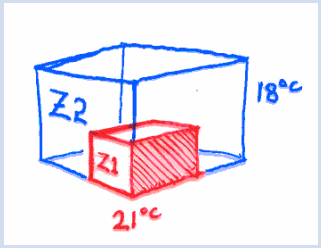
East and West orientations can match actual power demands.
Diversion of solar PV to water & heating is now cost-effective

Annual Fuel Demands: Living & Bed Zones



NIHE monitoring: Upstairs heating zone on ca 20% of time. Saves between 6-24%. Safer for moderately insulated homes.

NIHE Heating Issues 4

Issue	Status	Risks	Benefit
Heating Controls 	Often: Single setpoint electro-mechanical thermostats No temperature display. Now: Digital ErP versions	Now: inaccurate, do not prepare for Heat pumps & 'warm' (not V.hot) Radiators, or for home pre-heating or background heat.	ErP Prepares for heat pumps. New 'Smart' types can interact with electricity system & **Boiler/ASHP hybrids**
Ventilation 	**Now: Intermittent extract fans only**	**Damp, mould**	**Healthier homes with upgraded ventilation, demand control?**

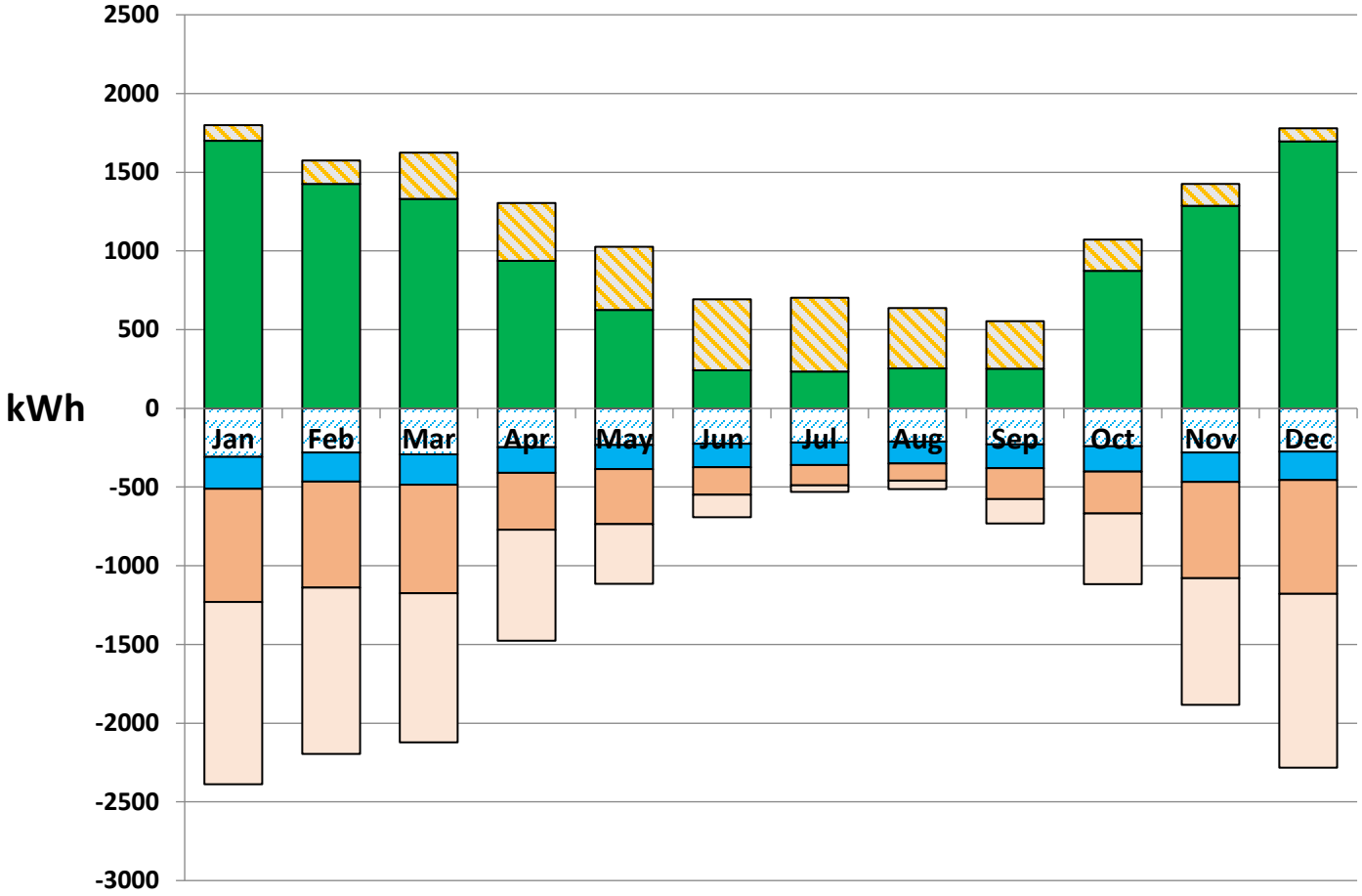
Electricity will be decarbonised over time:

Draft Carbon Factors x SAP10 (draft TBC)	kg CO2	approximate	Kg CO2	CO2
BRE	per kWh	efficiency	Per kWh of heat	% of gas
Mains gas	0.210	85%	0.247	100%
Electric direct	0.136	105%	0.130	52%
Electric heat pump ASHP	0.136	250%	0.054	22%
Heat pump Ground Source	0.136	350%	0.039	16%
Oil boilers kerosene	0.298	85%	0.351	142%
75% Oil kerosene 25% wind	0.220	85%	0.259	105%
30% Oil kerosene 70% ASHP	0.122	85%	0.144	58%
Community Heat: Heat Pump & Wind, Seasonal Storage	*0.01*	*100%*	*0.010*	*4%*

Community heating systems with insulated pipes can be very low carbon. Heating hot water with electricity is already more carbon efficient than oil

Renewable Electricity & Monthly Heat Demands

For total home energy demands, wind is more abundant than solar.
The living room radiator/ zone/ downstairs needs heat more often.
Hot water tanks can accept heat inputs at most times and in summer.



Monthly Renewable Energy availability and Home Energy Demands

- PV Output
- Wind O/P
- Upstairs Heat
- Living Heat
- Hot Water
- *Electricity*

Making use of variable wind energy for heat, while it is available/ cheap:

Overnight hot water heating? '**Energycloud**'

Boiler Heat Pump 'Hybrids' and wind

Boiler can replace 'missing' wind energy, or avoid high power prices.

ASHP Hybrids need 'Smart' Control for oil, kWh prices, weather etc.

Oil: seasonal heat battery ?

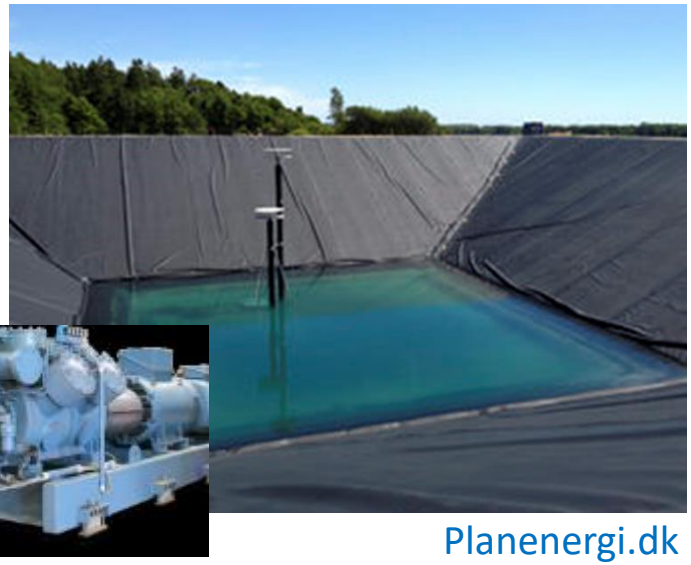
Boiler reduces peak grid demands

Making use of variable wind energy for heat, while it is available/ cheap:

Low Carbon Street Heat Networks

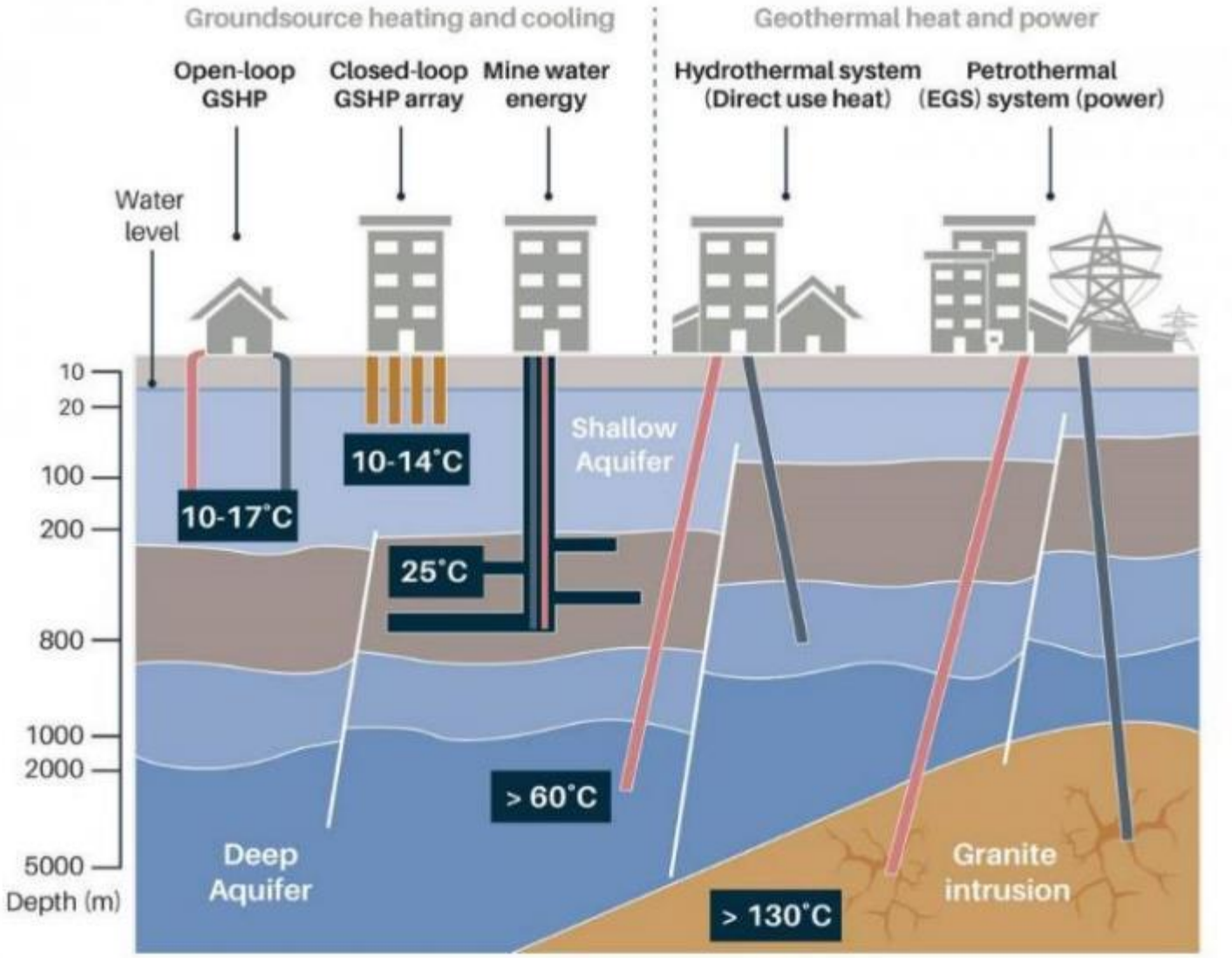
Very large community heating systems with large heat pumps can use large heat storage tanks as heat reservoirs for many weeks to ensure that heat is always available.

- Can use power when rural heat pumps are not running.
- **Also compatible with CHP.**



Planenergi.dk

Heat supply can be decarbonised 90%+ using wind energy, PV, & heat pumps.



Belfast &
Co Antrim
B.Castle
Larne
Ref. GSNI

Pic: British Geological Survey/UKRI

NI. Geothermal Energy/LongTerm Heat Storage

Small Business Research Initiative: Smart Systems R&D

Sensor data	*Tenant Benefit*	*NIHE Benefit*
Oil boiler firing times	*Predicting oil costs, or Pay As You Go PAYGO system*	*Damp reduction*
Room temperatures	*+ Feedback: Avoiding overheating, waste*	*Informed investments*
External weather	*Automatic lower running costs. E.g. with Oil boiler/ Air Source Heat Pump Hybrids*	*Arrears reduced*
Hot water tank temperatures.	*Lower cost hot water using solar or wind energy*	*Lower carbon emissions*

Renewable electricity is getting even cheaper

Insulated housing allows more renewable electricity to be used as it is produced, reduces the cost of new energy infrastructure.

But to achieve Nett Zero emissions at least cost over a region, balancing a constantly changing renewable energy supply, heat supply must be changed:

Individual systems using a percentage of renewable electricity for heat and hot water can save carbon affordably. E.g. Hybrids

Urban community heating systems with thermal storage can use electricity at different times from the heat pumps in rural areas.

Thank You

END

References 1:

https://www.gov.uk/government/publications/evidence-gathering-high-temperature-heat-pumps-hybrid-heat-pumps-and-gas-driven-heat-pumps

https://www.gov.uk/government/collections/heat-pump-research

QUB Geothermal Report:
https://nora.nerc.ac.uk/id/eprint/531393/33/GSNI-%20NI%20Geothermal%20Energy%20Summary%20for%20GAC%202021_report.pdf

https://www.escubed.org/articles/10.3389/esss.2022.10047/full “Heat Battery”

http://www.sdewes.org/jsdewes/pid8.0340 National power system synergies

"decarbonisation of the example district’s power and heating energy can be reached even without the availability of biomass, if sufficient Power to Heat (XXL Hpumps) and Power to Gas capacity is integrated to the District Heating grid, and sufficiently more wind- and solar power is installed“ e.g. Using existing power connections.

References 2:

Drakes landing solar community _____https://www.dlsc.ca/

https://www.imperial.ac.uk/people/c.markides
Thermo-mechanical energy storage systems can be very durable.
Can use salt cavern storage, the sea as a heat sink, underground strata.

Cambridge Econometrics study:
https://europeanclimate.org/resources/renovating-and-and-electrifying-buildings-strengthens-europes-economy-and-energy-security/

Consultant shared interesting 'SEEMS' paper on meshed heat networks, using solar thermal in France, (but wind powered ASHPs could be better here): interseasonal BTES storage. "We are still far away from this, due to our prevalent and (not optimal) techno-economic systems. I have recently written a paper on this topic":
https://drive.google.com/open?id=10KEFutLzlX5uo4M3BYwxXir18KNI7LKk&authuser=davidbourguignon.net%40gmail.com&usp=drive_fs

References 3:

- https://www.seai.ie/data-and-insights/national-heat-study/

Lots of documentation

- Geothermal Heat Storage potential: (NI also has above average heat at depth, potential in sandstone aquifer under Belfast)

- https://www.heatstore.eu/documents/HEATSTORE_UTES%20State%20of%20the%20Art_WP1_D1.1_Final_2019.04.26.pdf

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Send details of your interests, also anything I should see please.