

CHP - but not as you know it

A new future for CHP in a low carbon world

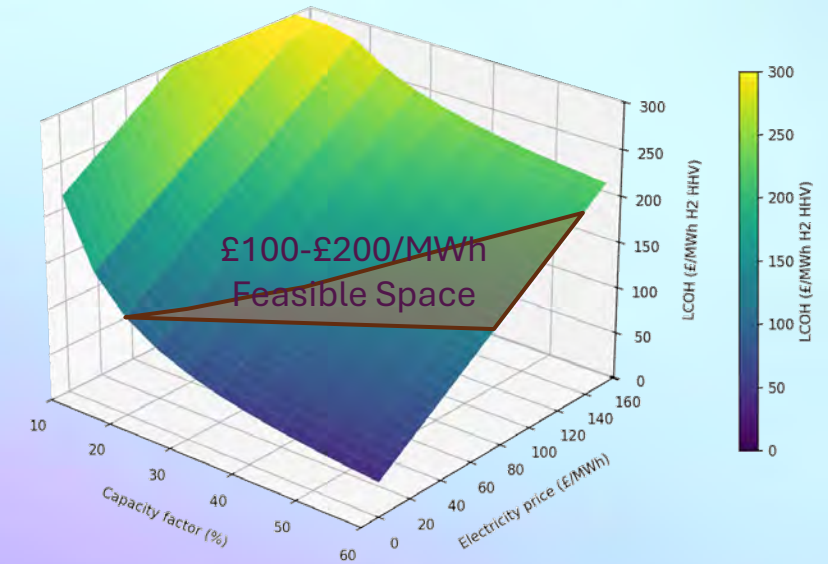
Rachel Lee



Moving towards 2050

- Achieving a low carbon economy will see a highly electrified economy
 - Suggestions of large-scale hydrogen use do not stand up to scrutiny, primarily because the cost is simply too high
 - Ultimately the same will be true for widespread biomethane use.
- This means high winter electricity demands that will sometimes meet with the dreaded '**Dunkelflaute**' periods of low wind and solar output

H2 Wholesale Cost
NESO 2040, Central Estimates

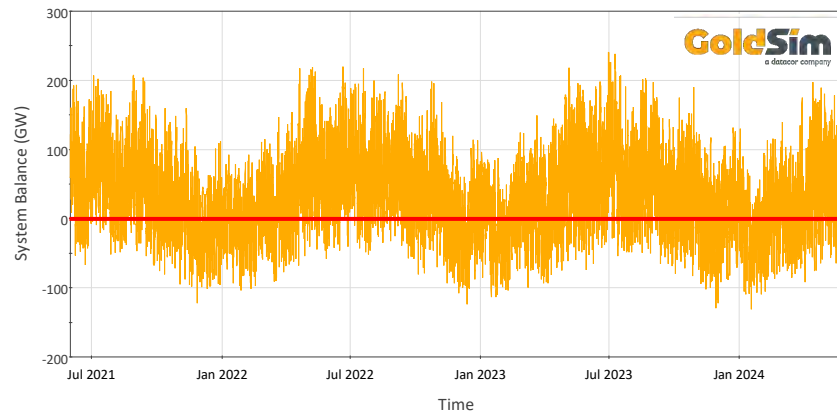


- It will be very hard for hydrogen to compete with direct electric heating let alone heat pumps.
- Large plants reduce cost, but there is a limit to how many you can build before electricity input, or feedstock prices, drive costs up.



How bad is Dunkelflaute?

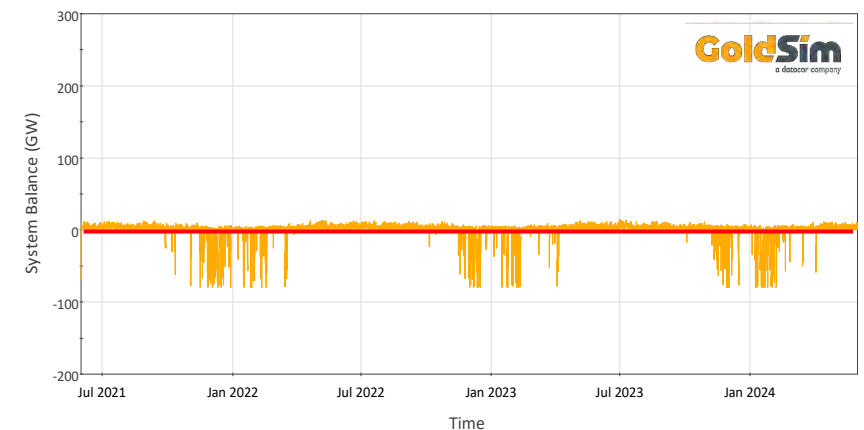
System Balance Before Batteries and Flex



- Events are real, but volume is low
 - A well optimised, flexible, highly electrified energy system dominated by wind and solar might only require Dunkelflaute cover for 3-5% of annual electricity needs.
 - This is only about 30TWh of electricity in a 2050, highly electrified, world

- How long can batteries and smart charging plus some over-capacity see us through?
 - Probably around 2-3 days
 - Depends on shortfall and baseload capacity

System Balance With Batteries and Flex

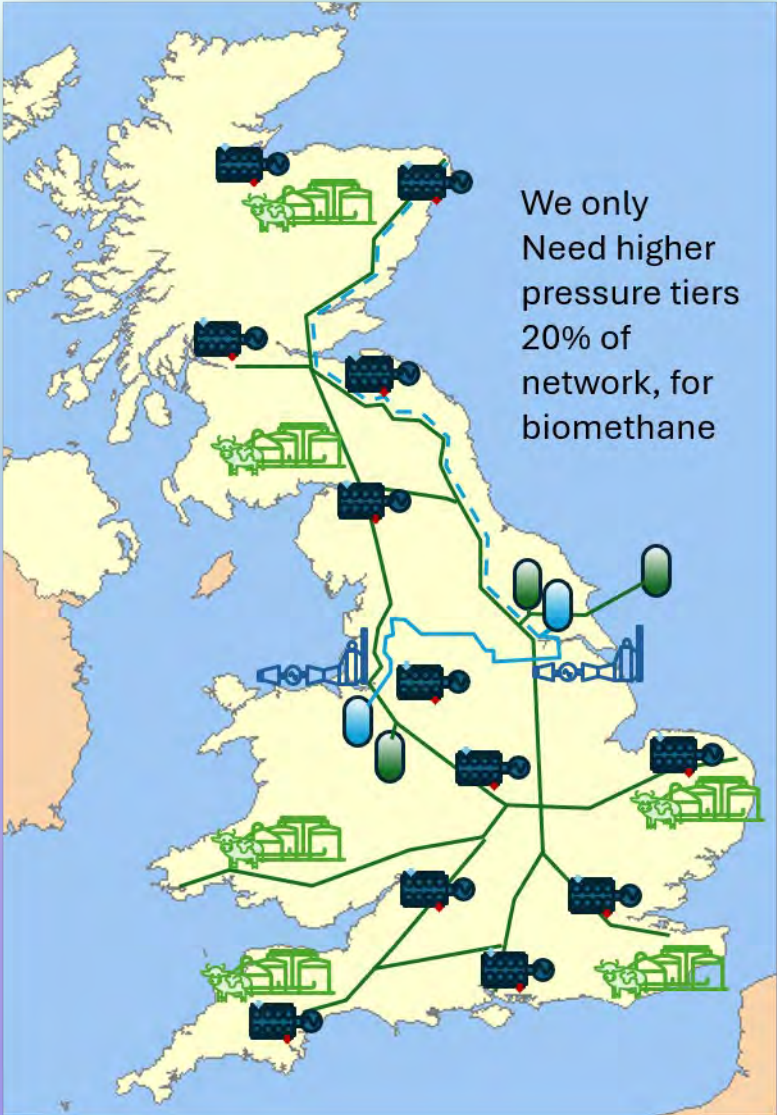


What are practical solutions?

To store the volumes of energy needed we are likely to need molecules – Fossil Gas, Biomethane, Hydrogen, Ammonia, Methanol... (though Iron-Air batteries and geo-thermal stores are potentially interesting)

	Carbon Emissions	Network & Storage Compatibility	End User Equipment Compatibility	Cost (Green)	Volume Available
Fossil Gas	High	Excellent	Excellent	2025: £34/MWh 2050: Who knows	Plenty
Hydrogen	Blue vs Green	Poor (convertible in places)	Poor	2025: £240/MWh 2050: £120/MWh	Plenty at high cost or carbon
Biomethane	Negative to Mildly Positive	Excellent	Excellent	2025: £70-100/MWh 2050: £60-120/MWh	May be limited
Ammonia	Blue vs Green			2025: £200/MWh 2050: £100-150/MWh*	Plenty at high cost or carbon
Methanol	Blue vs Green			2025: £180/MWh 2050: £50-100/MWh*	Plenty at high cost or carbon

% of Dunkelflaute need
 DESNZ: 42%
 FES 25: 90%
 GGTF: 165%
 Assuming all to power

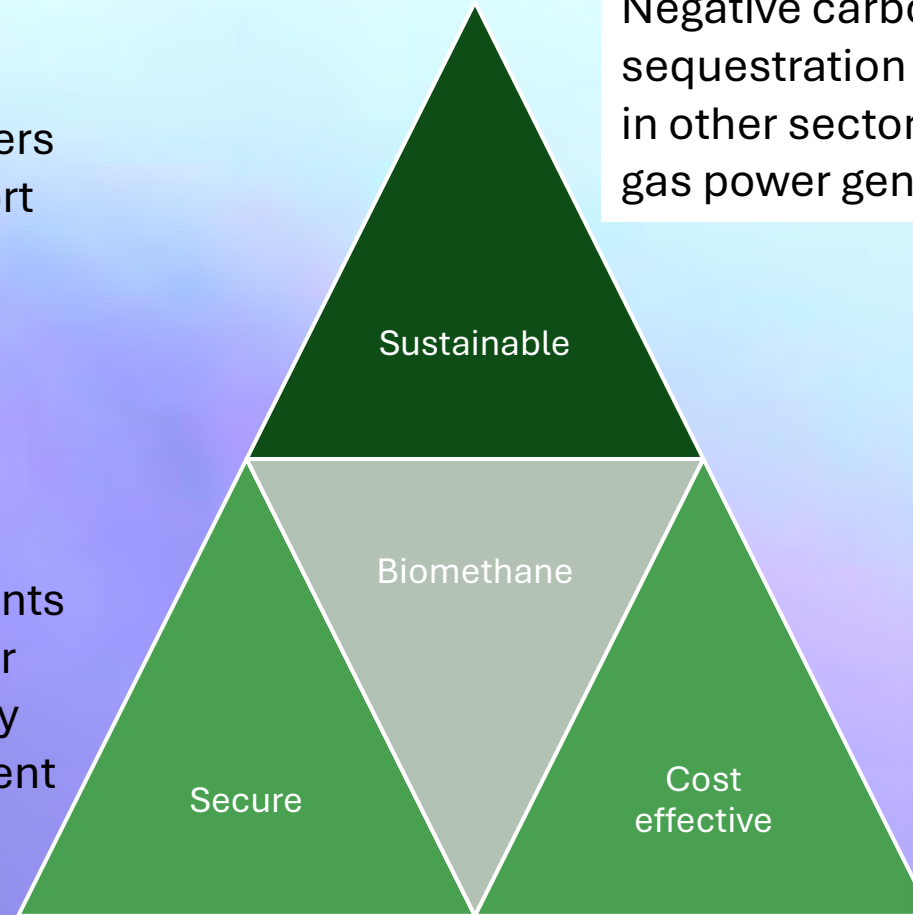


Biomethane & the energy trilemma

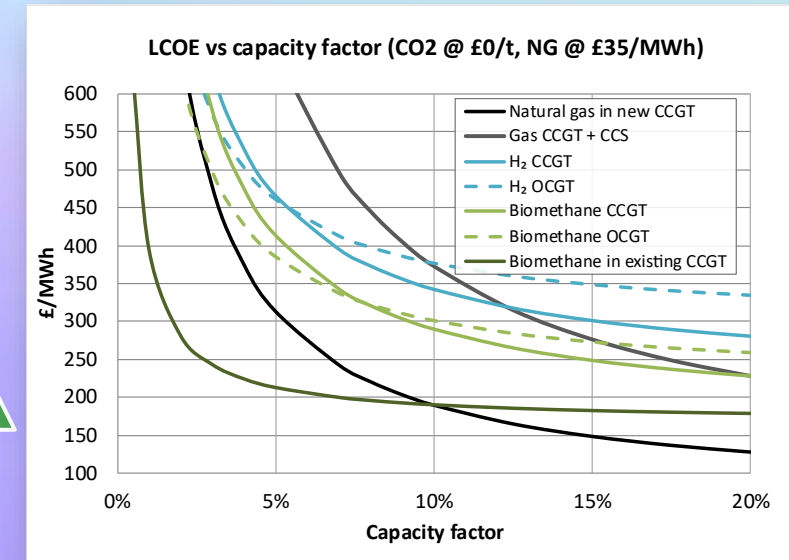
Security of Supply

- ✓ Geopolitically Secure
- ✓ Improves resilience for fertilisers
- ✓ Nationally secure fuel transport
- ✓ Fully dispatchable
- ✓ Can provide ancillary services
- ✓ Enables local smart grid resilience
- ✓ Can provide heat resilience..

In Combined Heat and Power Plants (CHP) - could theoretically deliver over 80% of dunkelflaute capacity requirement if we meet government heat network targets



Negative carbon from CO2 sequestration can offset emissions in other sectors or allow some fossil gas power generation to continue



CHP past and future?

The Past

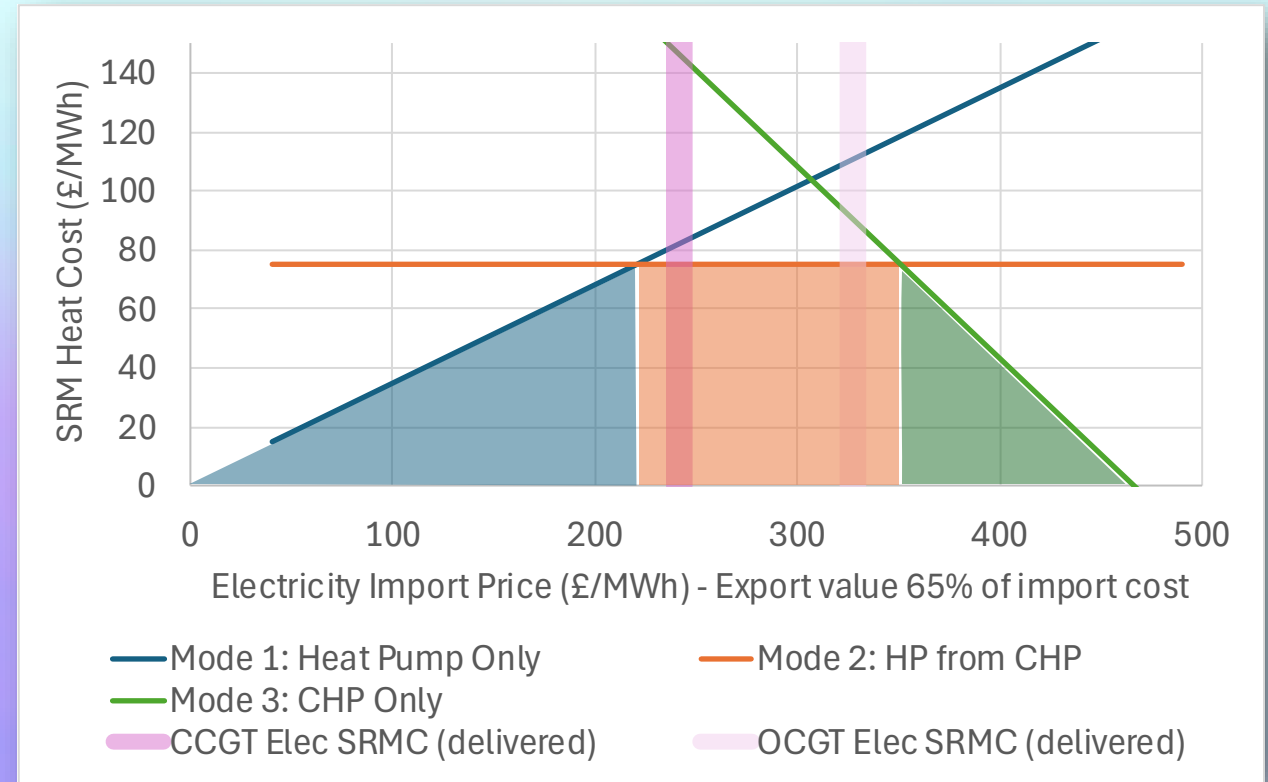
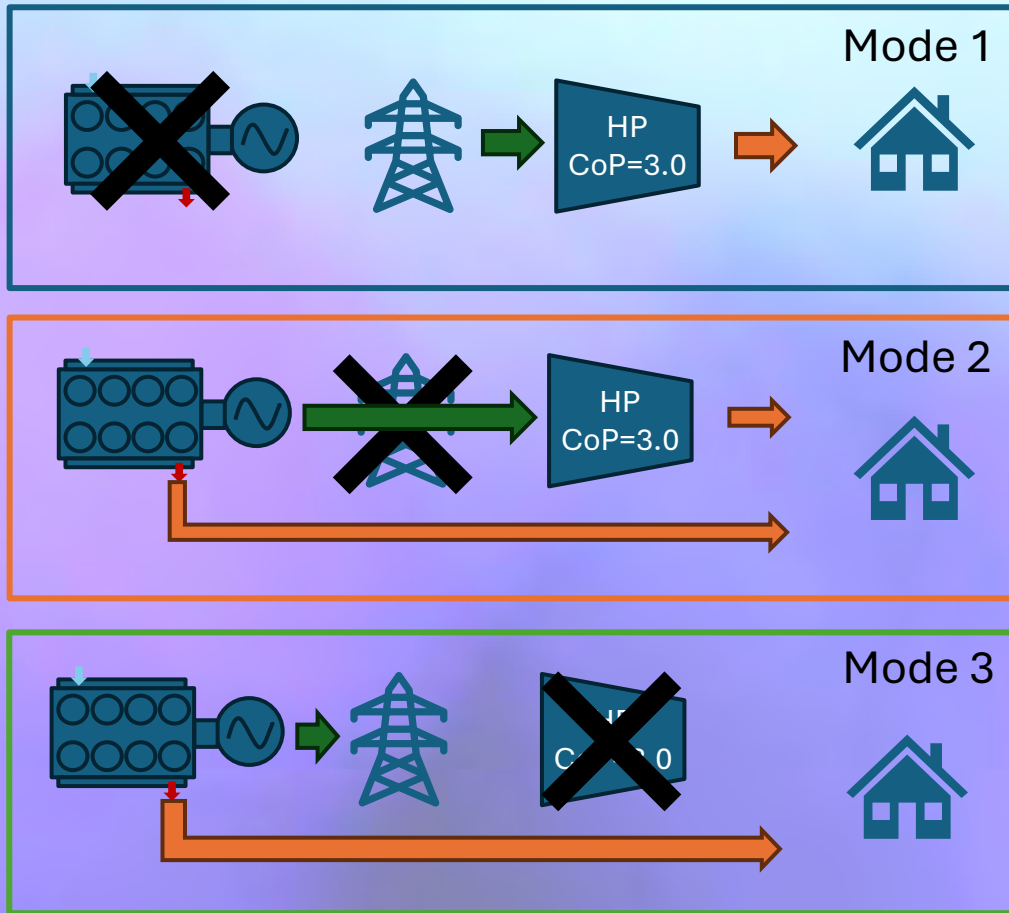
- Historically the rule of thumb was that CHP had to operate for 5000+ hours per year to be economic
- Why? To deliver a payback against relatively stable electricity prices
- Very sensitive to spark-spread and heat demand
- Competing with baseload, low-cost, fossil fuel generation and low-cost gas boilers.

The future?

- Operates as “Dunkelflaute” generation
- Only operates when electricity prices are very high - spark spread is no longer relevant
- Waste heat replaces heat pump output, driving down demand and increasing effective electricity output
 - A 40% electrical/40% heat efficient CHP engine is effectively 53% electrically efficient assuming a heat pump CoP of 3.0
- Competing with high-cost renewable molecule ‘peaking’ type generation



How would it behave if exposed to real-time market prices?



Biomethane price fixed at £120/MWh, CHP $\eta_e = \eta_h = 40\%$

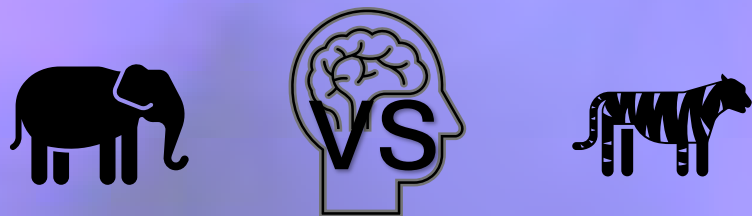


How do we make it happen?

The mindset challenge and policy needs

What heat networks developers want	What 'peaking' plant operators want
Long tenor low-cost debt financing	Quick win equity financing
Stable cash flow	Volatile cash flow
Long term price stability	Price volatility
Steady operation	Flexible and responsive

- Economic and policy blockers:
 - Heat networks are not cost effective without support at current electricity prices
 - Fossil gas CHP could be a useful stepping stone but..
 - Government is actively preventing the deployment of fossil-gas CHP in heat networks since it does not deliver carbon savings vs heat pumps.
 - High capex of CHP is problematic without accepting risk exposure to market prices.
 - Need to access other revenue streams including ETS benefits, local flex markets and ancillary services

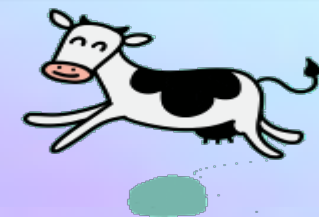


Could a heat cap contract be the answer?



Summary

- Dunkelflaute events mean we will probably need molecule-based generation
- Biomethane provides the cheapest green molecules and is compatible with all our existing infrastructure
- Biomethane is expensive compared to natural gas and there is limited availability
- CHP is the most cost effective and frugal way to use it
- It can do most of the heavy lifting required for dunkelflaute
- It can provide increasingly important system resilience, buffering against geopolitical shocks and protecting energy supplies against malign actors
- To make it work we need to combine different mindsets and influence government policy



**Biomethane to the
rescue?**

