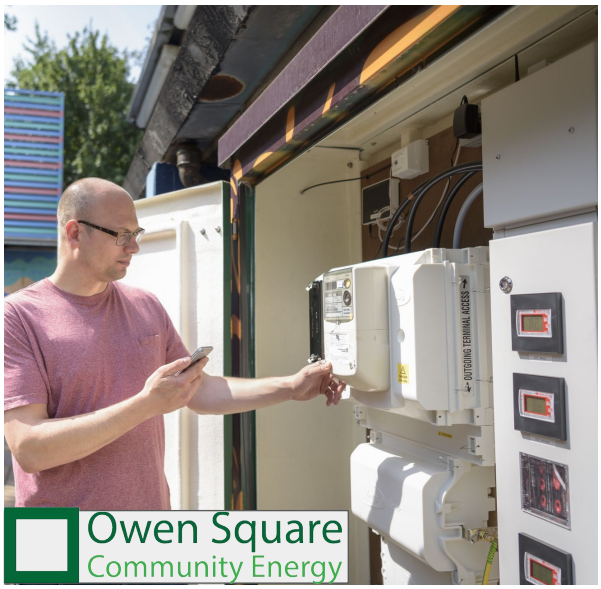
- Damon Rand from CEPRO (Clean Energy Prospector)
- We are developing community ESCo that integrate (microgrid approach) solar, central batteries and heat pumps on new build developments
- We also work with communities in the south-west seeking to develop new renewable generation assets and new community energy business models

Interacting with the Codes - connecting generation

We interact with the network codes on a regular basis in order to get our generators on the network -- the technical engineering codes G59/G99 being the main relevant rules.

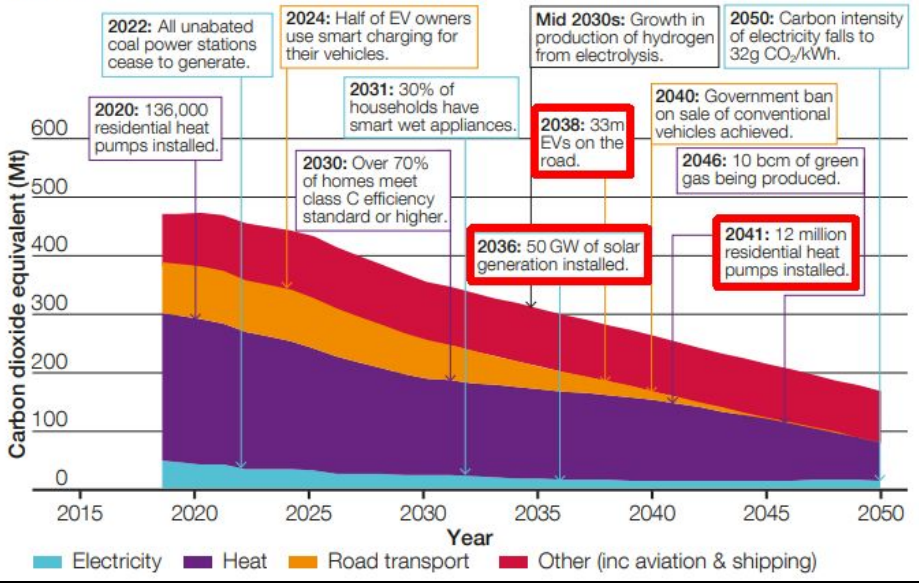
Interacting with the Codes - supply metering



We also interact with the energy codes through metering rules. At the moment we mainly supply electricity under license exemptions (2.5MW limit). The licence exemption legislation is an excellent way to support innovation in our sector, allowing for lighter regulation for small companies to test and trial new concepts. But there is limited “route to market” for doing things differently once 2.5MW scale is reached and innovations are back in the rigid license/codes frramework.

Our business plan (secret, don't tell anyone!)

Figure 3.1
Decarbonisation in ***Community Renewables***



Future Energy Scenarios

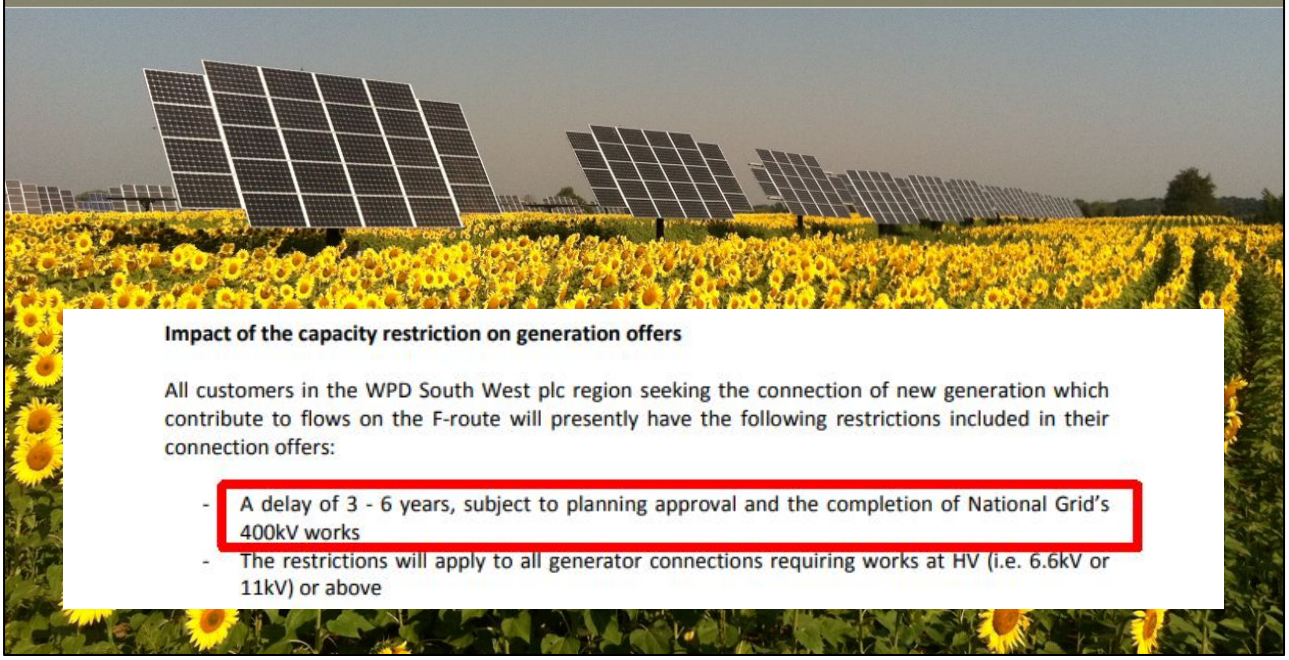
System Operator

A huge wealth creation opportunity exists for community energy businesses to claim a large share of the market over the next 10 years with 50GW of solar, 12million residential heat pumps and 33m vehicles supporting by EV charging.

Challenges to our plan

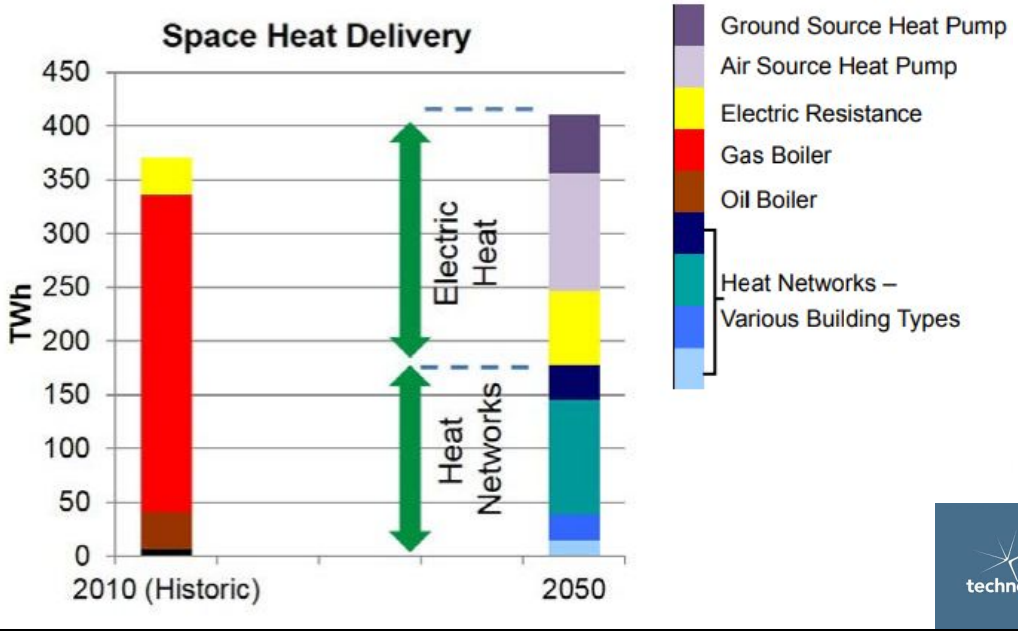
1. The ‘Summer’ problem
2. The ‘Winter’ problem

Decarbonisation - The ‘Summer’ problem



The Summer problem. How do we reach 50GW solar without huge network reinforcement costs? These delays and reinforcement costs have arisen because DNO’s have allowed renewable generation to be connected distribution systems on “must take” connection agreements. Now DNOs are blocking access to new generation rather than sufficiently developing controllable solar and wind.

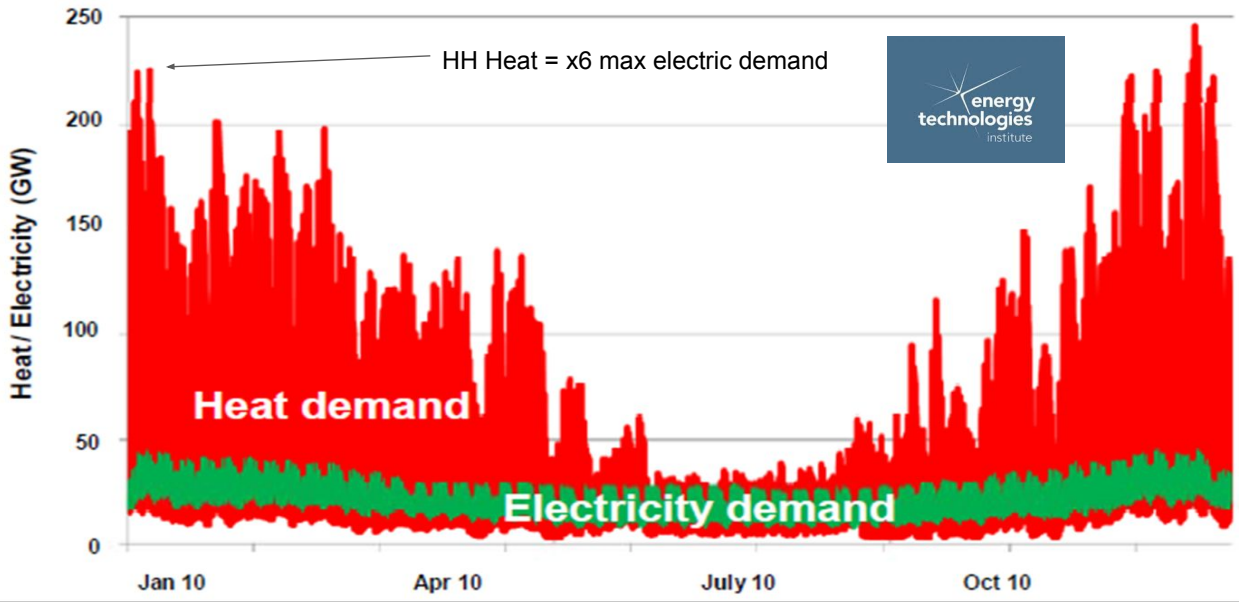
Decarbonisation - The ‘Winter’ problem



energy technologies institute

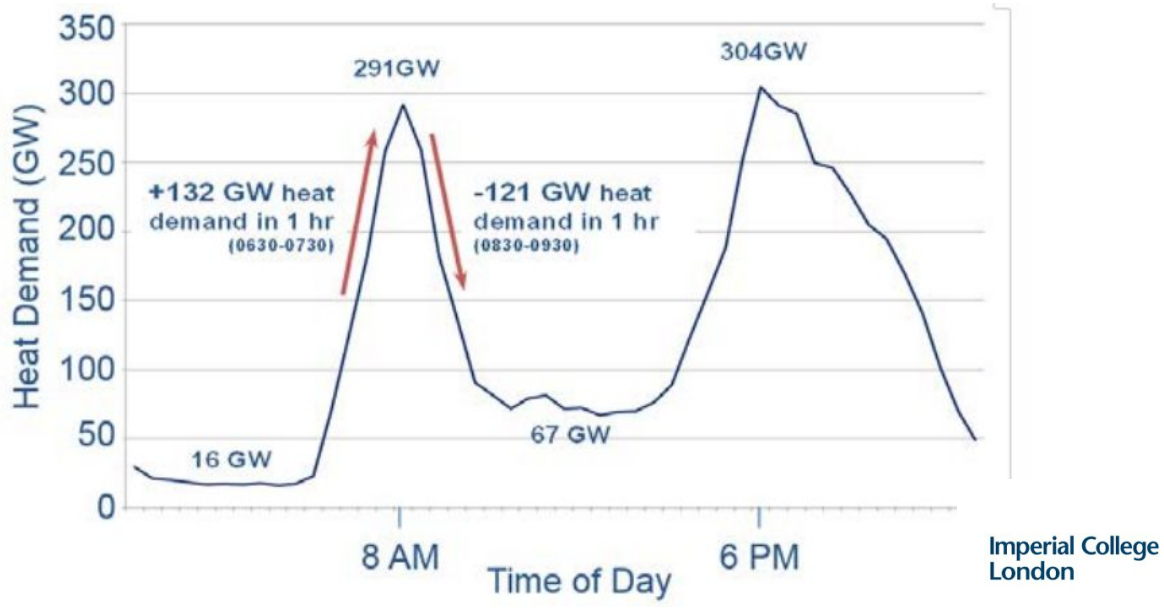
The Winter problem. How do we reach 12million residential heat pumps in homes without requiring expensive network reinforcement?

Decarbonisation - The ‘Winter’ problem

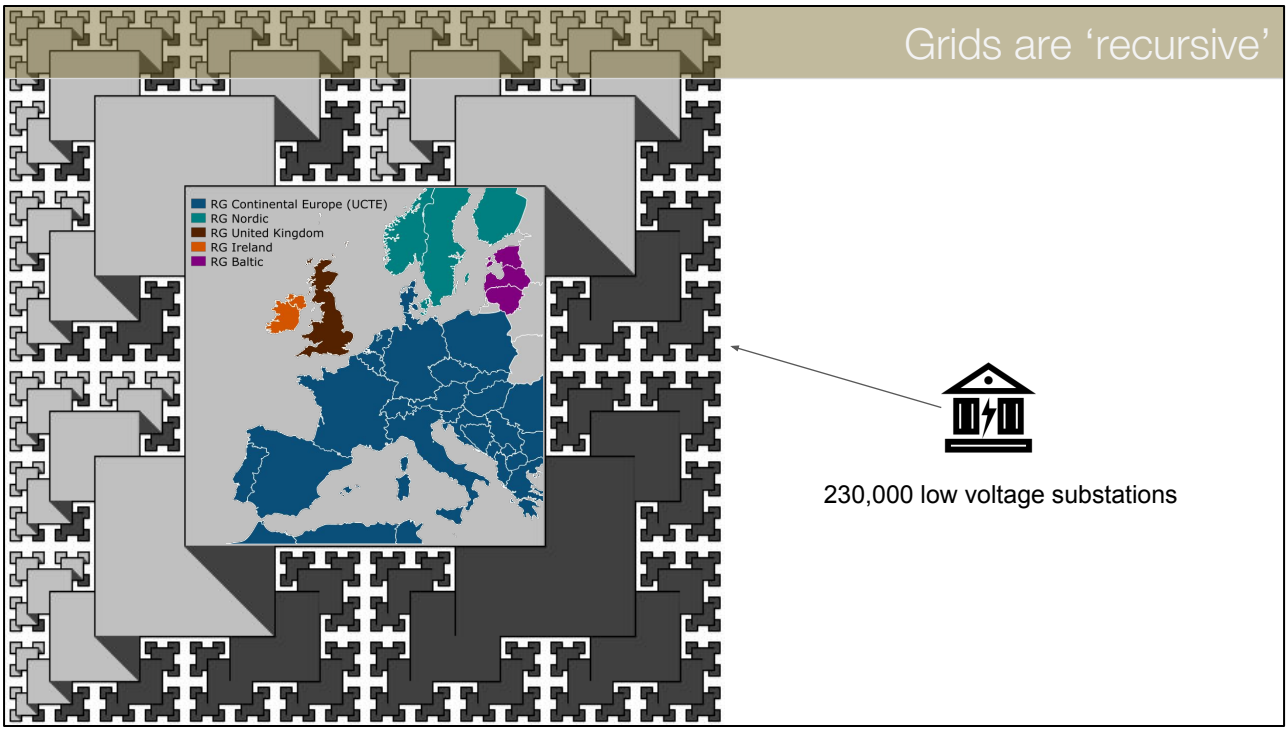


In theory if all heating was electric we would have x6 current power flow levels across the distribution networks during occasional winter heat peaks.

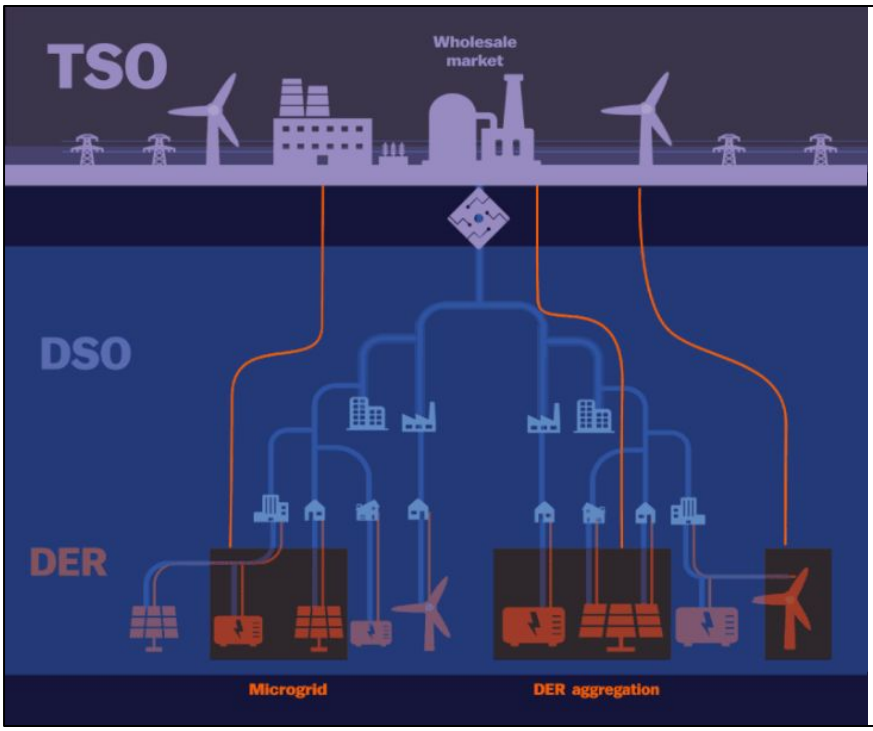
Decarbonisation - The ‘Winter’ problem



Also the ramping rates would be very steep due to strong concidence with heating systems that switch on/off across common morning and evening peaks.



Our grids are already recursive in nature, each level look similar in nature to the levels above and below and the mechanisms for operating the top tiers can also work for operating the lower tiers.



The “National Aggregator” model for integrating distributed energy resources **bypasses** the DSO Tier.

We already see a shift to distribution system operators where the distribution system starts to take on some balancing functions. But still we are mostly connected new distributed energy resources into national TSO markets in most cases. DSO delegation is not comprehensive or complete enough to be fit for purpose. The idea remains that TSO systems built to operate hundreds of assets can be expanded to optimise millions of DERs in the future. This is unlikely to be the best way to optimise the system.

https://www.vox.com/energy-and-environment/2018/11/30/17868620/renewable-energy-power-grid-architecture

The alternative is a “layered” grid architecture that fully delegates authority to the layers below

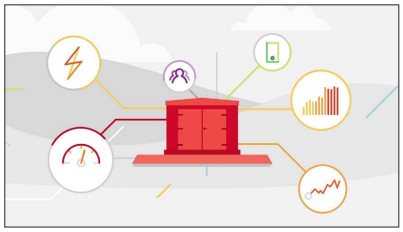
Instead we should more fully delegate balancing and economic dispatch of assets to downwards. Each main level in the hierarchy can be operated with self awareness of it’s own present/future balancing requirements, grid constraints, voltage control, etc. This approach ensures that each grid tier has the maximum set of assets available to that tier to economic optimise.

https://www.vox.com/energy-and-environment/2018/11/30/17868620/renewable-energy-power-grid-architecture

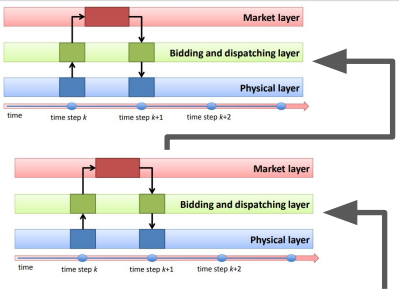
Energy Transition needs a layered architecture

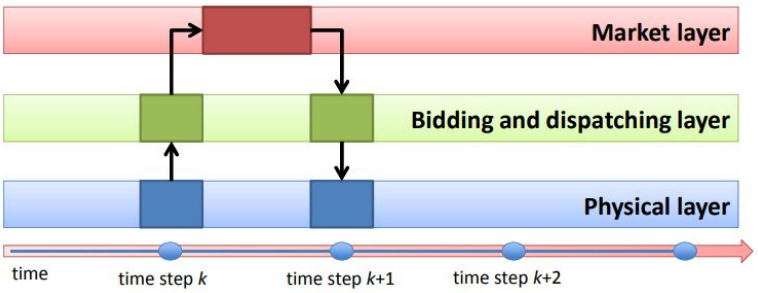
1 National System Operator
(+4 EU Interconnectors)

Distribution System Operator
14 license areas (380 GSPs)



OpenLV or Microgrid SO
230,000 distribution substations

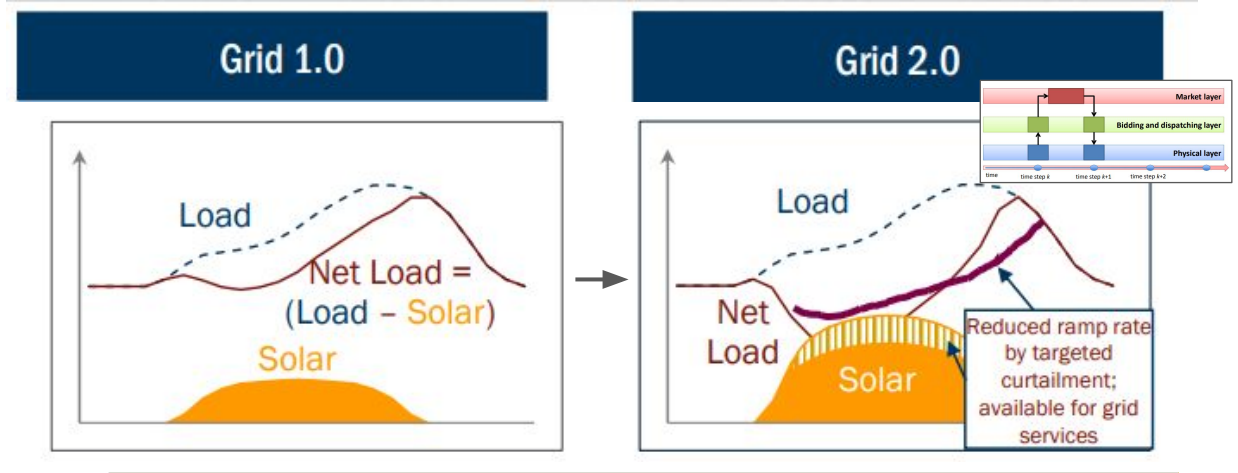




Most likely the 14 DSo license areas are too big to be most efficient as well. It is worth exploring and may be optimal to introduce a third tier under the DSO levels where a sinle system operator in each local area optimises all assets connected to that grid. Already this is happening for private microgrids which operate as system operator for a smart grid connected under a DSO. We could also take this concept and apply it to either Primary or Secondary public distribution substations. Perhaps a single town/city becomes an local area at this third tier.

All the distributed energy resources within an area would participate in their local markets, the local system operator would act as a single market participant to the tier above. “Economic dispatch” would be undertaken at each level, this is the process of selecting the least cost resource for dispatch (activation) based on all the constraints relevant to that tier.

Decarbonisation - The ‘Summer’ solution



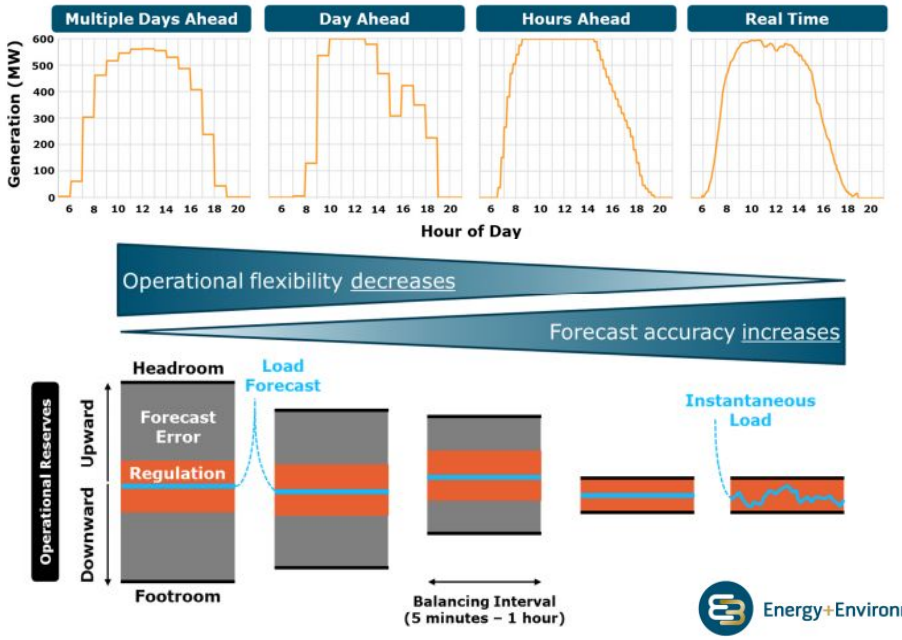
Full economic dispatch of solar power plants by the tier System Operator

First Solar

Energy+Environmental Economics

Now we can see the solution to the ‘summer problem’. We can allow much more solar (utility scale and rooftop) onto our distribution grids if this solar bids its forecasted generation into markets and is dispatched by a system that is optimising for least cost AND thermal constraints on certain lines. Here we see a First Solar project from the USA where solar farms were controlled to reduce output during the day and instead provide frequency response and balancing services to the market rather than energy. The assets sell energy into morning/evening peaks, they sell invertor driven regulation services when their energy is not required.

Decarbonisation - The ‘Summer’ solution



First Solar

Energy+Environmental Economics

Here we see how forecasts are bid into the market ahead of time and get more and more accurate for the closer timesteps.

Decarbonisation - The ‘Winter’ solution

WaterLilies, Bristol
33 homes, 115kWp microgrid

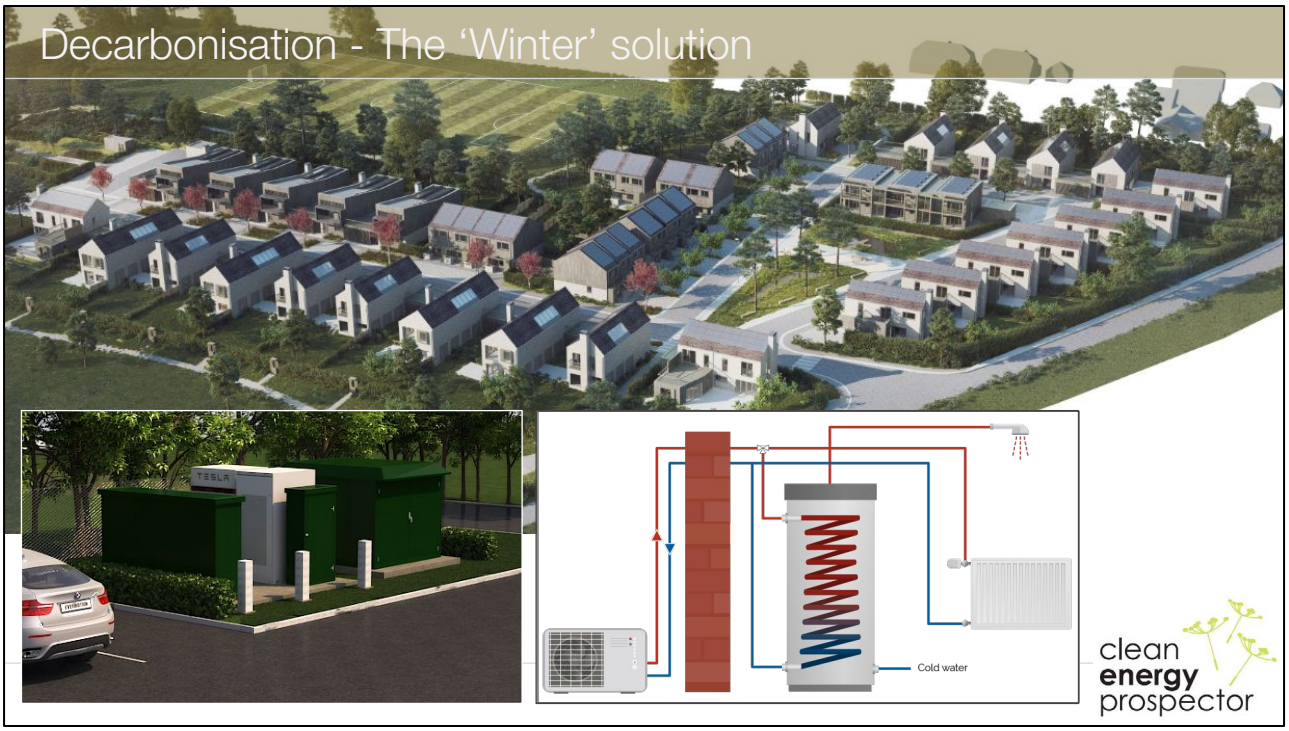
Hazelmead, Bridport
54 homes, 210kWp microgrid

<undisclosed>
104 homes + retail space,
300kWp microgrid

Full economic dispatch of electric heat demand+thermalstore in microgrids

Microgrid Foundry

We believe the same approach works for heat pump technology in winter. We are developing innovative microgrid projects (under a 2.5MW license exemption) to develop a testbed to understand the economics better.

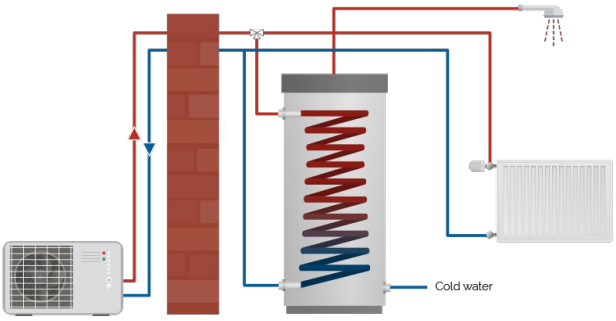


Each microgrid home generates heat with electric Heat Pumps but also has thermal storage. The local microgrid runs an economic dispatch algorithm that decides whether to supply heat directly from the heat pump, to over supply and charge the thermal store, or under supply and discharge the thermal store. This approach smooth peaks enabling more electric heating on smaller grids.

Decarbonisation - The ‘Winter’ solution

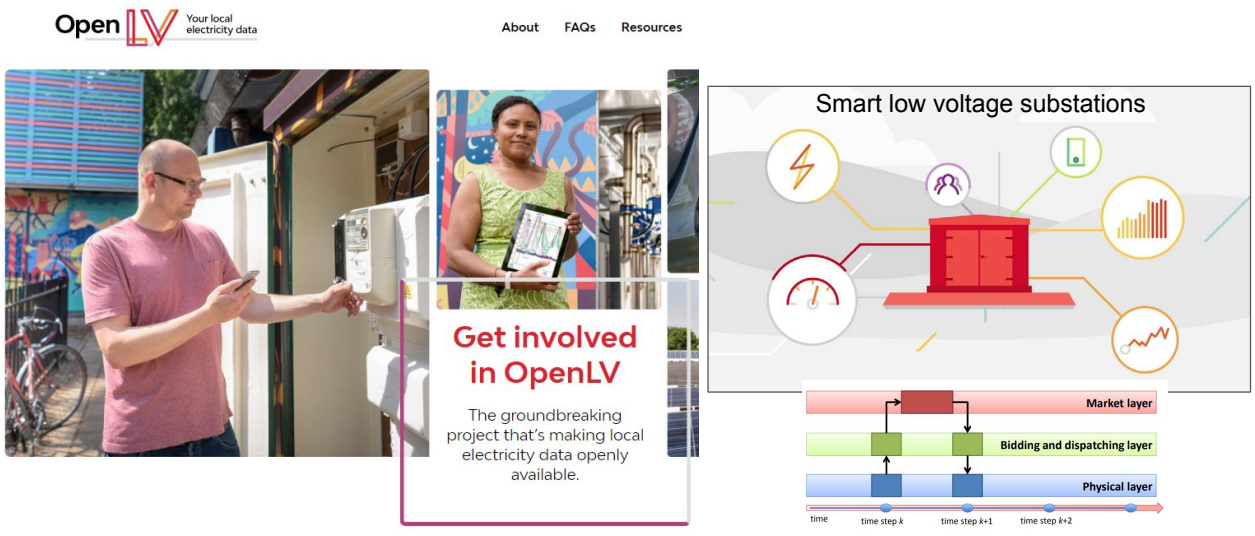
Technology Stack:

+ Solar (LV connected)
+ ASHP (High Temp)
+ Storage (hot water + PCM)
+ Energy Efficiency (Aerogels)
+ OpenLV Smart Grids



The same approach can be applied on retrofit projects. In this case we must also add an energy efficiency (insulation) component to the project.

Decarbonisation - The ‘Winter’ solution



Full economic dispatch of electric heat demand+thermalstore at the LV level

We are developing this concept on retrofit through the Owen Square Community Energy project (www.owensquare.coop). In this case we see a smart OpenLV instrumented substation could become a system operator for assets connected under that substation.

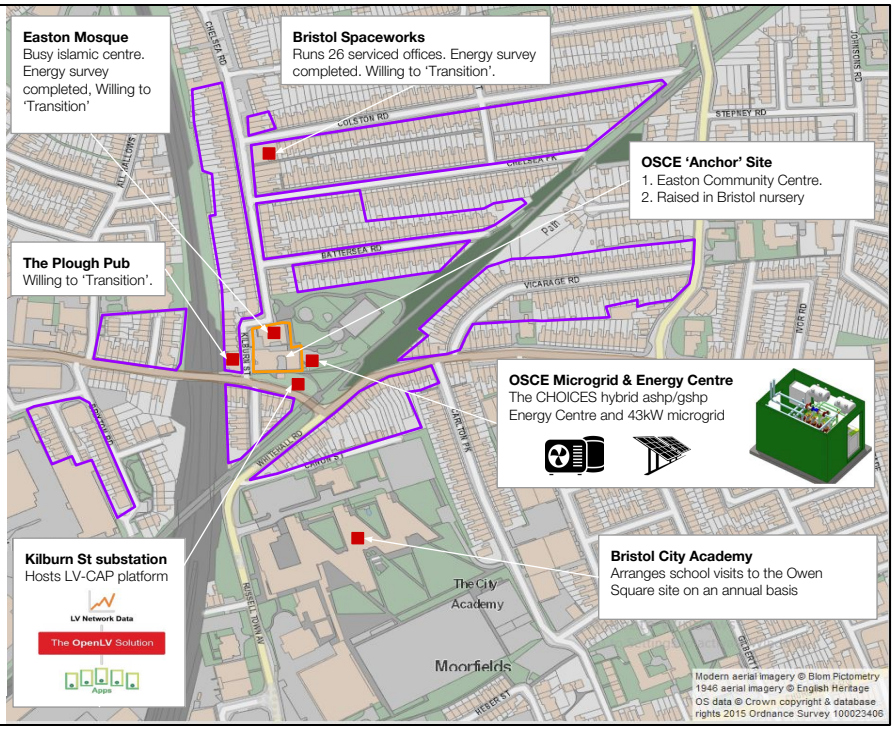
Owen Square
Community Energy

Homes connected to the Kilburn Street substation:

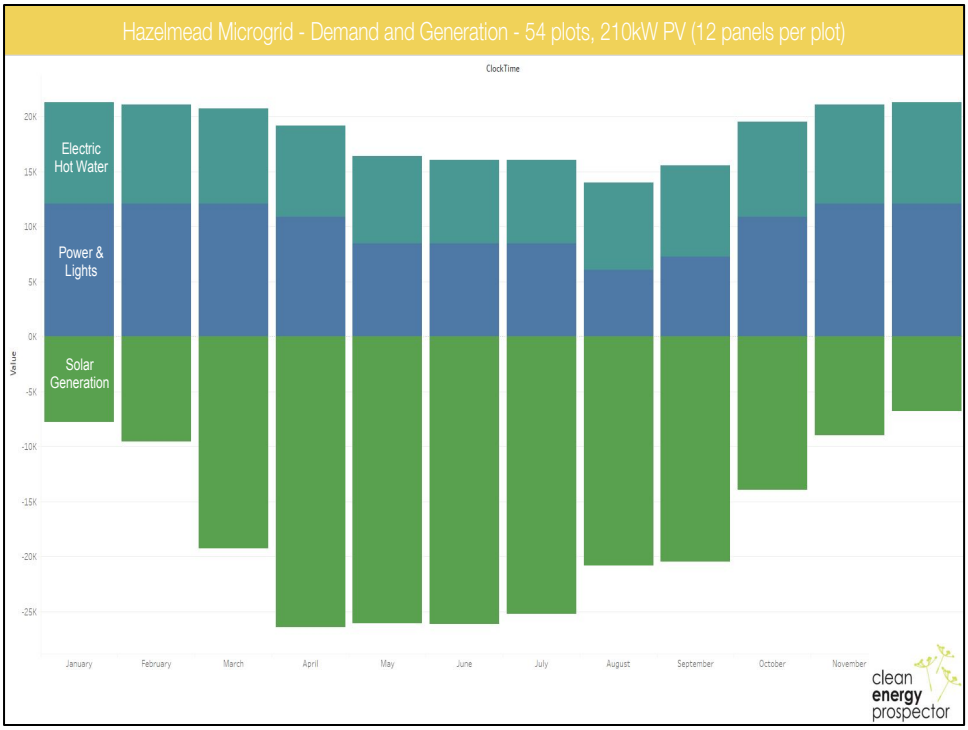
Substation retrofit

Physical Microgrid & Energy Centre

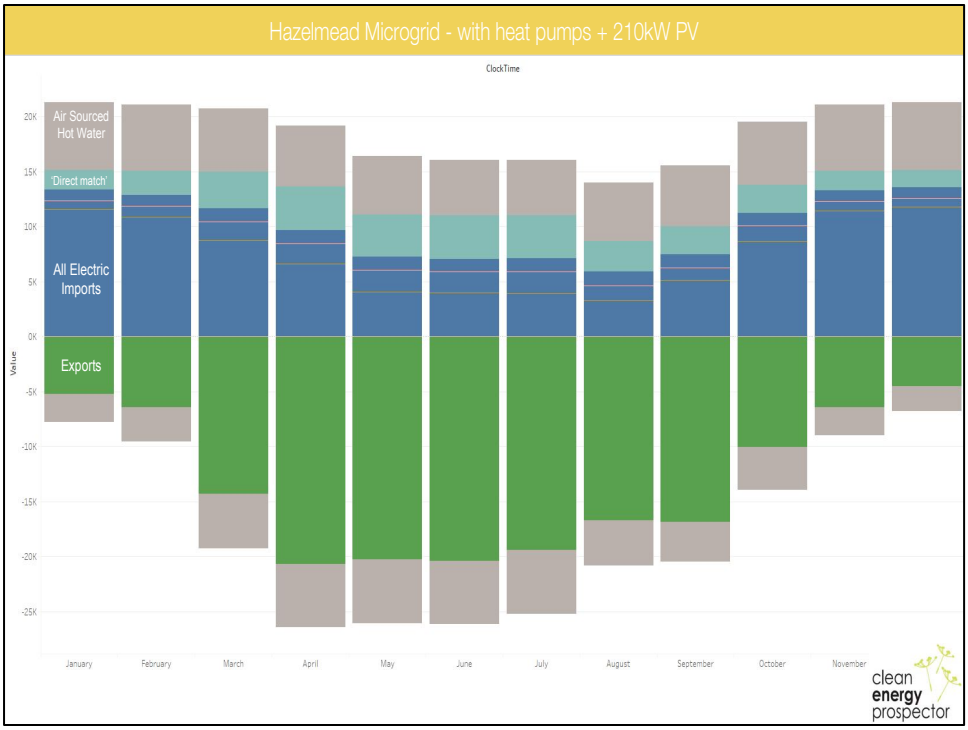
https://www.owensquare.coop/



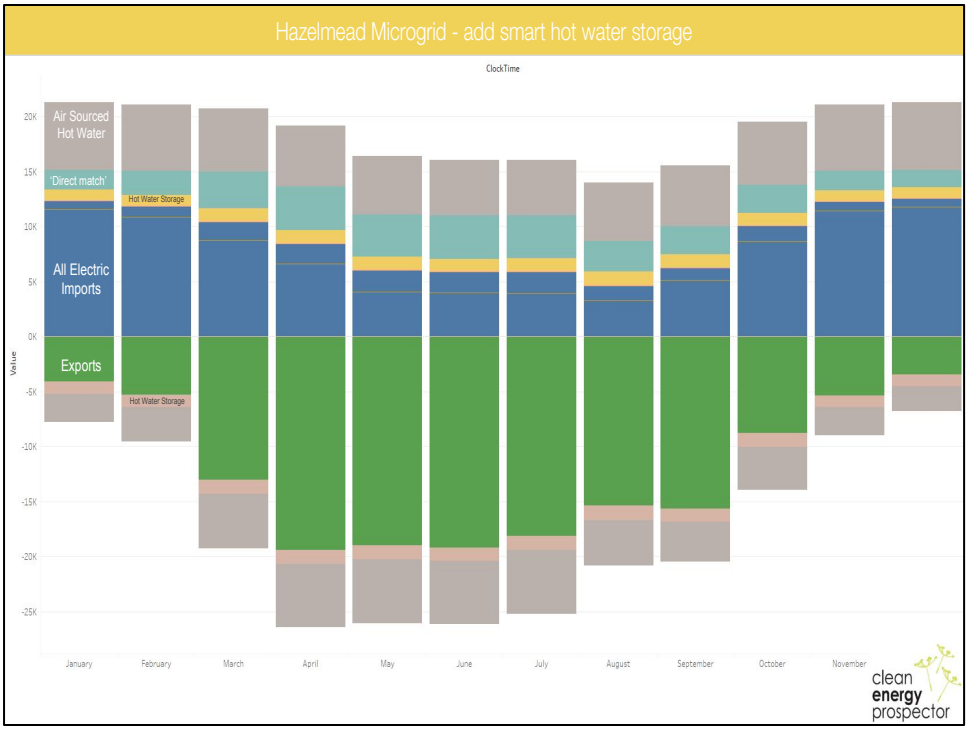
Each local community would engage with properties around their substation (which could be a Primary substation of ~10000 homes) to engage existing assets and install new assets.



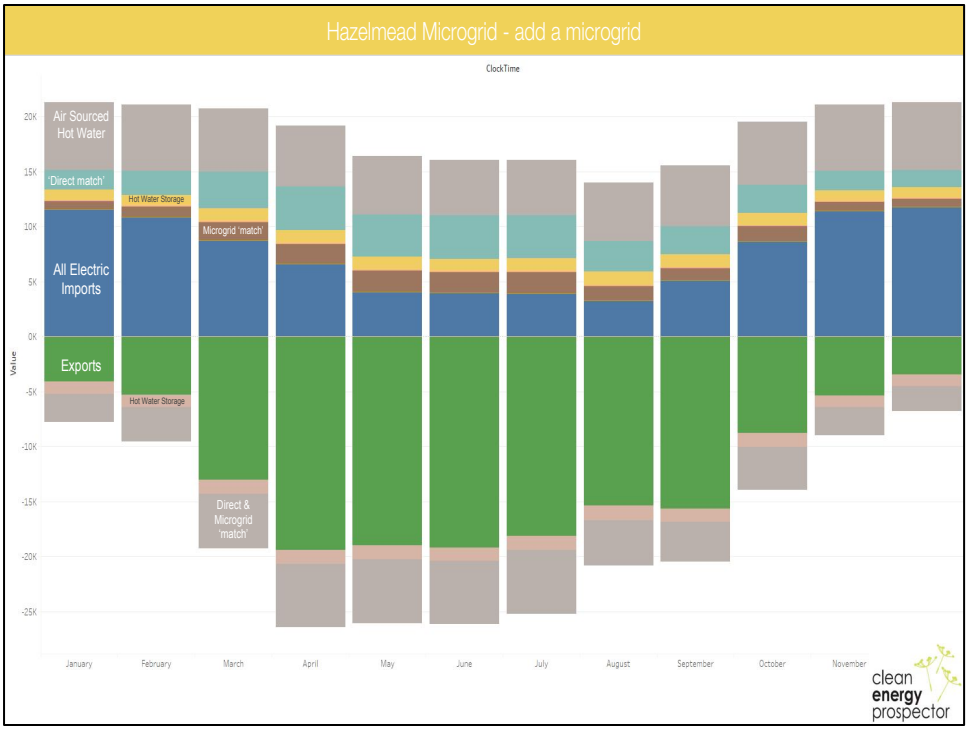
Simulation data for annual DHW Load, Power & Lights Load and PV in the CEPRO Hazelmead microgrid.



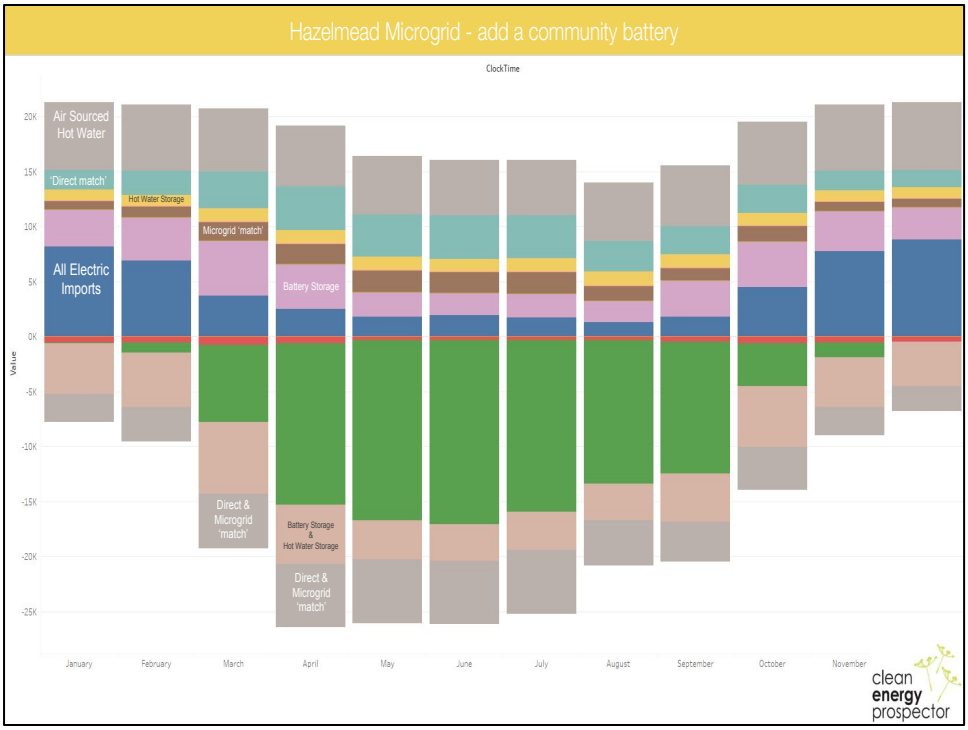
Simulation data for annual DHW Load, Power & Lights Load and PV in the CEPRO Hazelmead microgrid.



Simulation data for annual DHW Load, Power & Lights Load and PV in the CEPRO Hazelmead microgrid.



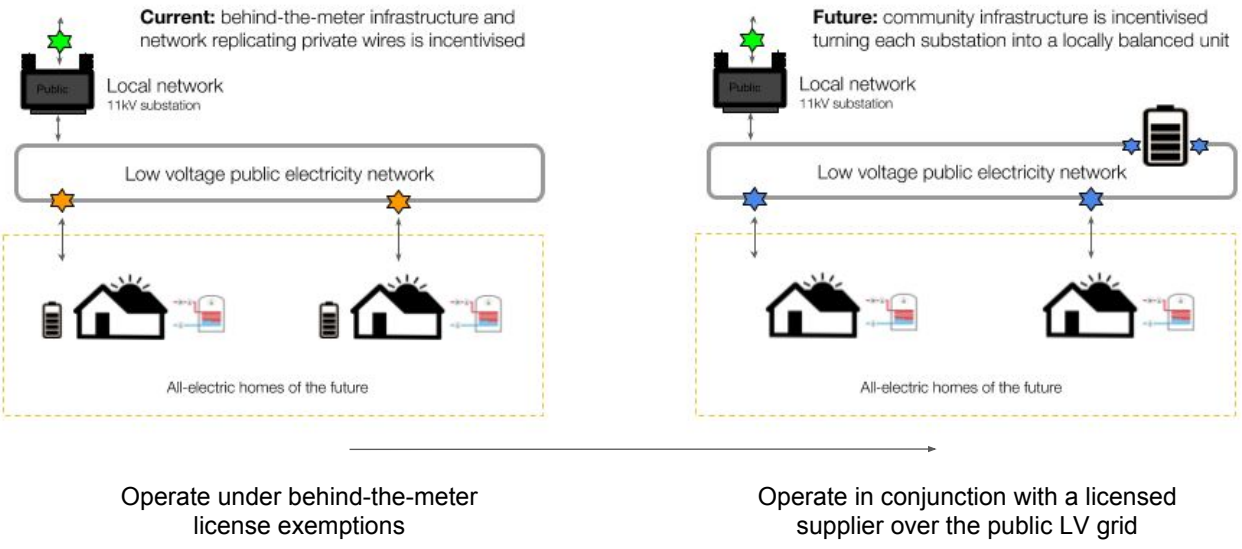
Simulation data for annual DHW Load, Power & Lights Load and PV in the CEPRO Hazelmead microgrid.



Simulation data for annual DHW Load, Power & Lights Load and PV in the CEPRO Hazelmead microgrid.

Ofgem Sandbox derogation

Overview of proposed Owen Square community battery derogation & trial



Operate under behind-the-meter license exemptions

Operate in conjunction with a licensed supplier over the public LV grid

Currently our work is only possible under the legislative License Exemptions which are capped at 2.5MW. We are seeking to prove these local optimisation models are beneficial in this ‘sandbox’ and then later seek to make a case for testing these ideas in public grids.

Summary and final thoughts

1. TSO should delegate full authority to DSOs
2. DSOs should also somehow (OpenLV?) delegate down to communities
3. Bid energy resources into the appropriate grid tier
4. Full Market Participation for distribution connected assets

5. Simple electricity-only licenses will become more important!
6. Why are gas boilers even still allowed in new build?

7. Why do I have to pay for legal advice & consultancy to interpret the Codes?
8. Why do 'Sandbox' processes end up picking multinational incumbents?
9. Innovation will need an opt-out from SMETS2 for many years to come

When we design or redesign markets and rules we first have to remember that our grids are machines that operate within the laws of physics. We can use these underlying laws to help us shape markets and rules that play well with these rules. A layered architecture with delegation of system operations and market participation for assets at the appropriate layer is a good place to start.

The consequence of this is that we end up with a world that is more electrified and has more participants who each control less assets. It isn't appropriate to imagine that all market participants will become or even want to become national or large. We should design market entry the supports purposefully small, local and electric only utilities to enter and develop.

The existing codes and licenses work against this. They support market entry only for organisations with an ambition to become large and national.

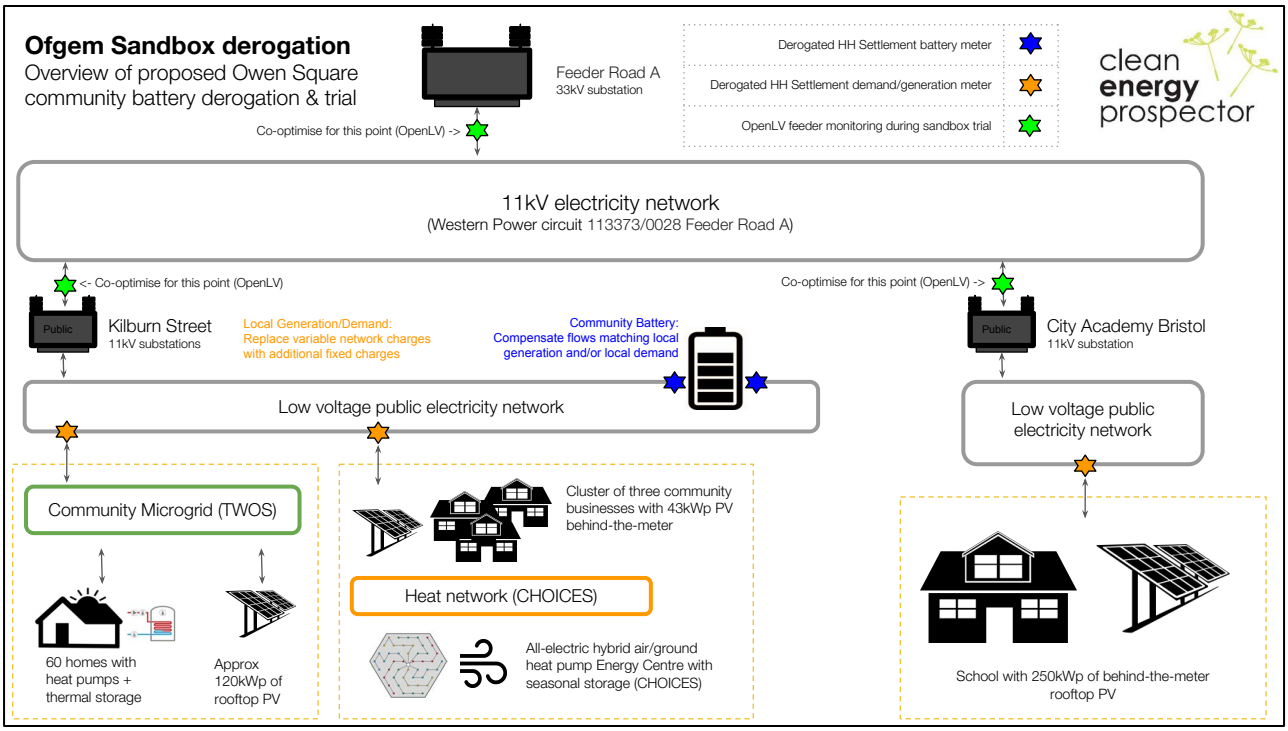
"Looks like you're on top of the new regulations."

- Damon Rand, Cofounder
- E: damon@cepro.co.uk
- T: 07887 682995

Investing in low carbon renewable energy schemes alongside UK housebuilders

clean energy prospector

http://www.cepro.co.uk


Ofgem Sandbox derogation
Overview of proposed Owen Square community battery derogation & trial
Feeder Road A
33kV substation
Co-optimise for this point (OpenLV) ->
Derogated HH Settlement battery meter
Derogated HH Settlement demand/generation meter
OpenLV feeder monitoring during sandbox trial
clean energy prospector
11kV electricity network
(Western Power circuit 113373/0028 Feeder Road A)
<- Co-optimise for this point (OpenLV)
Co-optimise for this point (OpenLV) ->
Public
Kilburn Street
11kV substations
Local Generation/Demand:
Replace variable network charges with additional fixed charges
Community Battery:
Compensate flows matching local generation and/or local demand
Public
City Academy Bristol
11kV substation
Low voltage public electricity network
Low voltage public electricity network
Community Microgrid (TWOS)
60 homes with heat pumps + thermal storage
Approx 120kWp of rooftop PV
Cluster of three community businesses with 43kWp PV behind-the-meter
Heat network (CHOICES)
All-electric hybrid air/ground heat pump Energy Centre with seasonal storage (CHOICES)
School with 250kWp of behind-the-meter rooftop PV