



A Roadmap to Peer-to-Peer Energy Trading.

The challenge facing Wadebridge Renewable Energy Network

Climate change must be seen as the defining crisis of our time and it is unfolding far faster than we anticipated (UN, 2020). On 20 April 2021, the UK Government announced it will 'set the world's most ambitious climate change target'. This manifests in reducing total emissions 78% by 2035 in comparison to 1990 levels. Succeeding this the overarching target of 'Net Zero' by 2050 remains. In 2020, 24.2% of UK carbon dioxide emissions were from energy supply (Gov, 2021). Transitioning to low carbon electricity will accordingly be essential in a Net Zero shift, with the demand for carbon free generation expected to double as a consequence of electrification of transport and heat. Lowering these emissions will be possible through continued uptake of renewable energies and associated smart technologies. Renewables here must be seen as clean and inexhaustible resources (Bilgen et al, 2004). Power production from such sources provided record levels of generation in the UK last year, 43% of the nation's electricity demands were met by sources spanning solar, wind, hydro and biogas. This represents an increase from 37% in 2019 (Rayner, 2021). Renewable energy prominence is certainly on the rise.

Unfortunately, there's an inevitability that as we electrify everything; prices will subsequently rise. Electricity prices will inflate alongside demand, just as crude oil has spiked in previous decades. Thus, moving into this transition of electrification is concerning, it has the potential to push more people into fuel poverty and negatively impact those already assessed vulnerable. 12.6% of Cornwall's households currently face fuel poverty (Cornwall Council, 2020). As a community driven organisation therefore, WREN would like to ensure that nobody is left behind in the transition to clean power. WREN currently has 1130 members, and has supported the delivery of enough solar PV to power 1,120 homes throughout 104 privately owned installations spanning the Wadebridge and Padstow Network, as well as delivering a 100kW community owned solar array (WREN, 2021). Such high infiltration of renewables certainly represents a platform to help provide for those in need. It remains that becoming involved in community renewables is not solely financially driven, members really do want to help support those within local communities. Benefits of new schemes are immeasurable; bringing about additional public engagement benefits that are not witnessed in top-down initiatives (Sefyang et al, 2013). In fact WREN reported, when

looking at previous investment patterns, nearly all local investors were happy for proportions of dividends to be invested in supporting fuel poverty. Those engaged in community schemes would rather take lower rates of return, and ensure those in their community are being looked after. Community energy projects are notably powerful as local groups are very well placed to understand the workings, and issues immersed within their local areas. Currently WREN are investigating the feasibility of implementing a peer-to-peer (P2P) energy trading network as a solution to these issues, this roadmap highlights barriers they may face.

For the writing of this report substantial research has been undertaken. Initially this involved looking at policy and research papers. Following this 6 interviews with industry experts were undertaken. Of primary importance was an interview with Ofgem, the UK's energy regulator; this was able to highlight all regulations and offered particular direction.

Peer-to-Peer Explained

P2P is a new concept in electricity markets and is one that challenges the traditional model of a 'top-down' electricity system consisting of a generating plant flowing power to a transmission grid, to a distribution grid and then on to a relatively passive consumer (Figure, 1). Currently the system is directional with energy moving in one direction and payment the other.

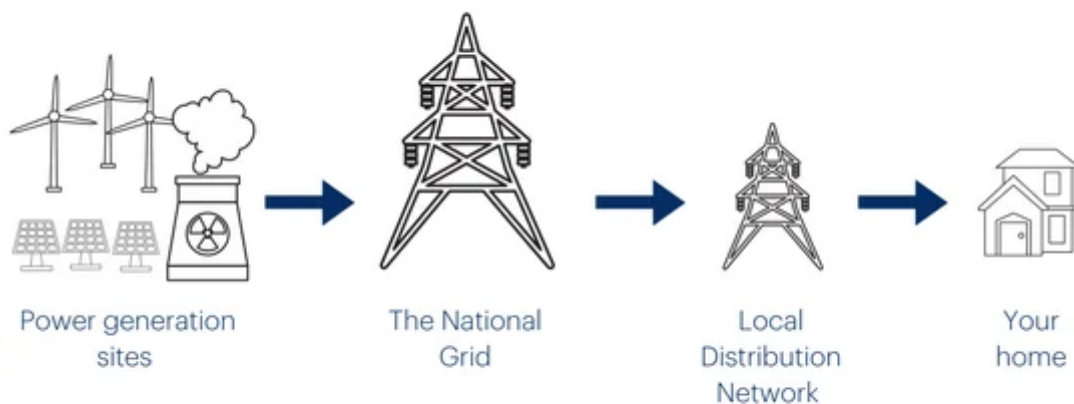


Figure 1: The 'Top-Down' or 'Supplier-Hub' model. 'Energy suppliers' purchase from the power generation sites and feed into the national grid. They purchase enough electricity to ensure that what they feed in covers what their customers take out at their homes (Bulb, 2017).

While ‘peer’ typically invokes the notion of equals, it is also used in the electricity system to describe a situation where one party specifies the other party they want to trade with. A consumer specifying who they want to buy from or sell to. The most commonly cited peer-to-peer model is where consumers with their own generation assets (‘prosumers’) such as rooftop solar want to trade their surplus power to other local consumers (Figure 2). Such a platform enables people in the local community who generate their own energy to trade surplus generation with those in the community without similar methods of generation.

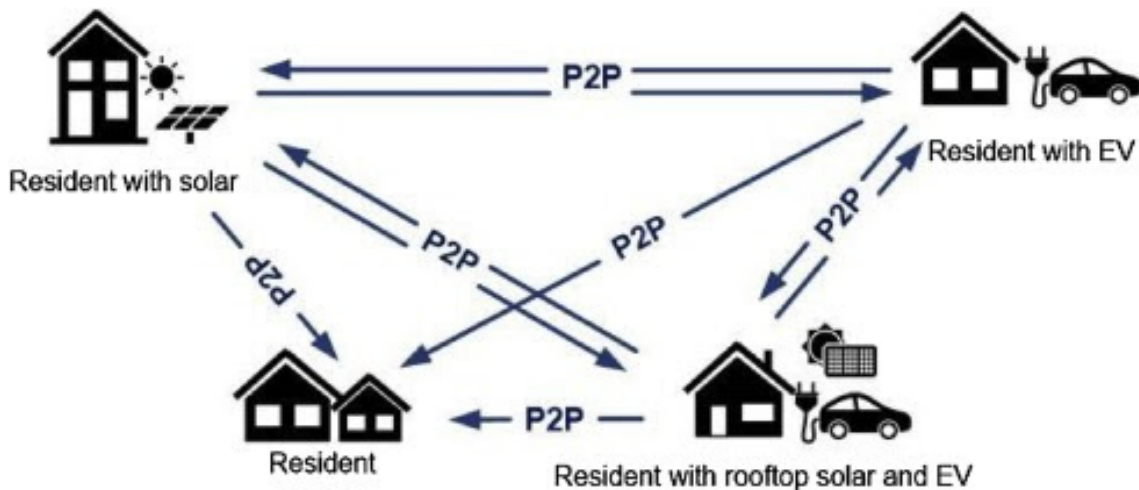


Figure 2: Peer-to-peer flows, may involve both ‘prosumers’ and local consumers as indicated ‘Resident’.

Thus, the community therefore, is able to have reliable consistent energy supplies by both selling and purchasing excess energies. This process may unfold via one neighbour's excess solar panel generation being sold on a sunny day, while possessing the ability to buy energy from another neighbour's wind generation on a windy day. As energy is sold directly between peers, 'decentralisation' is enabled. True P2P suggests direct trades reduce the requirement for an energy supplier as the prosumer fulfills this role. Therefore, this de-monopolises the energy market as money no longer flows to suppliers connected to the electricity network, instead it flows to local people. Hence, prosumers looking to sell may receive a better price than they would via a commercial outlet, and those looking to purchase may pay less for electricity than they would to a supplier. Mutually beneficial energy agreements may be formulated. Something often overlooked within the energy sector is giving citizens a voice in business operations. It remains a very centrally controlled industry; a community driven P2P network offers a ‘fairness’ not currently witnessed in energy supply. P2P is not currently legal in the UK, there exist regulatory barriers to it’s implementation.

Feed-In-Tariff removal

In April 2010 the 'Feed-In-Tariff' (FIT) scheme was introduced by the government. This allowed community renewable projects to thrive, the perfect way to generate renewable penetration nationwide (Burdett, 2016). The FIT represented two payments. The first was a 'Generation Tariff', a payment for green energy produced on site; this was regardless of whether it was utilised or not, essentially a green 'pat on the back'. Secondly, existed an 'Export Tariff', a payment for energy not utilised and sold back to the energy supplier. In 2015 generators were able to make back 5.24p per unit of excess electricity (GOV, 2015). These payments made prospects of community renewables financially feasible undertakings. However, a high FIT was not a sustainable option for the government to maintain (Denktas et al, 2018). Therefore, in March 2019 the government removed the FIT for new systems. This made community renewables harder to deliver as financially attractive propositions .

P2P models however, may create a solution to this, something required by community organisations such as WREN without huge capital outlays. P2P could lead to a business case for another surge of community renewables as witnessed in the early 2010s (Long et al, 2017). Prosumers would be able to fulfill the role of a FIT, the P2P market would provide a new submarket where export income may be produced for those with renewables.

WREN Roadmap to P2P energy trading

Below features a roadmap displaying results. This highlights aspects that must be addressed for the workings of a P2P Network. Before beginning the explanation it is important to highlight that; P2P energy trading is not yet possible within the UK. It is still subject to a number of regulatory boundaries hindering implementation. As for timescales these must be taken as broad estimations. The challenge lies in that a decentralised P2P trading network would require a radical overhaul of our existing energy system, this would unfortunately cost billions of pounds and many researchers do not believe this will materialise in the next decade (Nesta, 2021). Although there do exist regulatory restrictions, there are proposals to change this. Ofgem suggested that; innovative solutions such as P2P are very much on their radar, entwining the quickly evolving smart system.

The most commonly cited P2P model is where consumers with their own generation assets such as solar PV want to trade their surplus power with other local consumers. A concept to again help Community Renewables thrive.

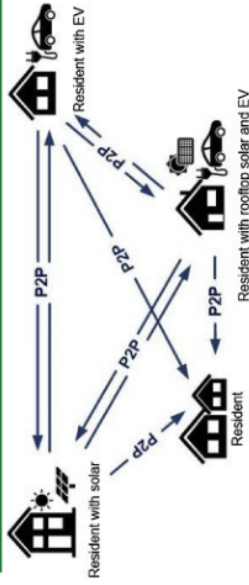


Figure 1: P2P Model. Allows for bilateral trades among communities, 'Residents' are participating, without generation themselves. A boost for the community and enhances local resilience.

Goal: Determine Licensing.

Barrier: Regulatory Boundary. P2P currently not legal. Must be licensed to supply Electricity.

Option 1: Wait for 'Local Electricity Bill' progress. WREN may become an energy supplier themselves if passed. Gives full control.

Option 2: Partner with white label supplier such as 'Your co-op energy'. WREN play the role of 'community aggregator', supplier enables billing and settlement.

2. LICENSING 2022-2025

Storage technology such as batteries and EV charging may boost feasibility with the ability to offer 'Flexibility services'. Worth considering while awaiting regulation changes for P2P. Has opportunities to entwine WREN projects looking at local EV schemes.



1. MOTIVATIONS 2021

Challenge: To define motivations for wanting to have a P2P Network.

These must deliver on multiple baselines: social, environmental and financial

WREN Goals:

- To equalise energy costs across the community.
- To subsidise those in fuel poverty (12.6% of Cornish Households).
- Create a business incentive for community renewable growth to replace FIT. This will lead to opportunities for new development.
- The Grid Network must be paid for.** Motivations can not be to gain revenue via cutting out intermediation and avoiding such costs.

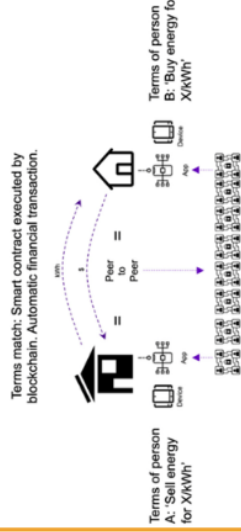


Figure 2: Blockchain technology may facilitate the platform. Through smart meters when terms of peers meet, a mutually beneficial sale is made and recorded on a ledger.

3. Regulation changes 2025

P375: Metering to be moved to the asset rather than at the boundary point. Allows for the balancing ability of prosumers to be recognised by industry. To be implemented June 2022.

MHHS: Market Wide Half Hourly Settlement to be implemented by 2025. P2P would legally require everyone settled this way due to data granularities.

Goal: A P2P Network run by WREN. Will enable new renewable projects to become financially feasible as 'Prosumers' play the role of a Feed-In-Tariff.

Tariffs: WREN will aggregate these, prices agreed by all scheme members. These vary for circumstances:

- Subsidised tariff for consumers in fuel poverty
- Subsidised tariff for WREN community share investors
- Local domestic consumers
- Local business consumers
- An export tariff for generators

4. IMPLEMENT 2025-2030



Ofgem regard P2P a quickly developing field, regulations are being addressed to allow for more flexible and localised energy markets. Trials are happening in the 'Regulatory Sandbox' an area to test new innovation. These ongoing trials will prove what will work and what will not.

The P2P Roadmap explained

Step 1-Motivations

P2P models should be seen as preferential to others providing they deliver on multiple baselines. If they are purely financially driven this is not recommended. A P2P Network suggests making a 'mutually beneficial' trade, one by which both producer and consumer gain as a result of the trades occurrence. UK generators currently gain 5.25p per kilowatt hour via export tariffs, while the average price paid by energy consumers per kilowatt hour is 14.37p (UK Power, 2021) Therefore, if transactions are made between these two figures mutually beneficial sales are made. However, the ethical nature of this must be addressed. Currently as energy customers we pay suppliers who pay industry for A: balancing and settlement, and B: maintenance of the energy grid infrastructure (Poles, pylons, wires). True P2P suggests via an online platform, cutting out requirements for such suppliers. This is intrinsically how the model suggests revenues will be made; 'avoiding network costs'. However, even if you sell energy locally from the solar PV system installed at your home, it is being transported to your neighbour through use of the electricity network's physical infrastructure. The issue being here is that somebody ends up picking up these associated costs, if not paid, they do not disappear; the distribution and transmission network's require payment to maintain and provide the system. If P2P is enabled in such a manner, these costs are likely to be passed on to suppliers, who will pass these on to customers. Such a scenario hence, may have potential to increase fuel vulnerabilities for many. Speaking with a WREN director however, they were fully aware of this responsibility such a model would pose: *"We're not trying to shirk responsibility of paying for transmission and distribution costs. We will pay exactly what we need to pay for distribution costs and we will pay fair proportions of what we need for transmission"*. Payment for physics therefore, must be accounted for in all future modelling surrounding the P2P project; without such it is not deemed an 'ethically feasible' platform to pursue.

Accordingly, P2P models should not be utilised as a means to simply financial gain. It should be motivated as a solution for broader challenges and community issues. As community advocates, the most efficient outcome is one which achieves triple bottom lines, it not only delivers energy; but economic, social and environmental returns for local people. WREN are evidently 'motivated' to implement a P2P Network to meet such differing baselines. Three of their core motivations are highlighted below:

1. To have a flexible tariff structure that helps to equalise energy costs across the Community and boost energy efficiency.
2. To be able to put mechanisms in place to subsidise those in fuel poverty.
3. To make renewable energy accessible to all through delivering new community owned renewable energy assets.

Step 2- Licensing

The primary boundary to P2P is licensing. If a P2P network were to be formulated all processes of supply, generation and distribution take place. A licence must be held for all of these activities. Energy Supply is defined clearly in the 'Electricity Act 1989' as; "Supply to premises in cases where it is conveyed to the premises wholly or partly by means of a distribution system, or it is supplied to the premises from a substation to which it has been conveyed by means of a transmission system". All energy transactions must therefore pass through a licensed energy supplier, to which customers may only have one per property (Ofgem, 2021). Therefore 'True P2P' is not yet possible as an individual prosumer or community organisation (aggregating an area of prosumers), as a licence to supply the associated energy is not held. Any case studies of current P2P are therefore intermediated by a licensed supplier. Neither option is yet achievable, but WREN would be represented with two options as to how to proceed:

1. Wait for the progress of the 'Local Electricity Bill'.

Gaining a licence to become an energy supplier currently represents costs well outside the remit of any community organisation. The potential for community energy supply is being blocked by unfair regulations and hugely disproportionate costs (Power For The People, 2021). Becoming a supplier and setting up operation costs millions of pounds due to becoming engaged with complex network balancing codes and industry systems currently controlled by the largest utility companies. The costs need to be made proportionate to the size of business operation, enabling local generators to sell their energy locally rather than to a utilities company. The 'Local Electricity Bill' has been drafted for this reason, 264 cross party MPs are currently petitioning for it to be made law. It would give local organisations such as WREN the opportunity to become energy suppliers. From here a P2P energy system may be facilitated once regulations lift, with WREN in complete control of operation. Greater profits may be reinvested into community schemes. The bill is currently in its second reading in the House Of Commons, and is expected to further unfold later this year. Its progress will be essential to monitor.

2. Form a partnership with a Licensed supplier

The second option would be to partner with a licensed energy supplier such as; Your Co-Op Energy, whom WREN have previously spoken with. The supplier would be able to enable the billing and settlement for the platform as they are licensed to do so. WREN would take on a new role here as 'Community Aggregator'. The responsibilities of this would be getting the community to sign up to the P2P scheme, almost facilitating a 'bulk buying scheme'. From here WREN are able to take the larger 'load profile', or energy generation 'ability' of the community, and sell a far more attractive deal to the supplier than they would be able to

achieve via approaching generators individually. WREN would be helping the supplier to avoid the administration costs of bringing everybody on board with the scheme. There would be two particular benefits of partnering with a licensed supplier.

Firstly, if this is with a green supplier such as Your Co-Op Energy, if locally generated energy does not meet the demand of the P2P network, WREN may ensure that the additional energy supplied to the platform is renewable. Capital is placed in renewables as a method of generation whether local or not.

Secondly, WREN is a community organisation, it is reliant upon volunteers for its operations. Becoming a licensed supplier themselves would require full time staffing and technical operations. If the partnership with a supplier created a financially feasible case for a P2P network, WREN may from here decide to take control of the business in gaining licensing, almost running a feasibility trial in essence.

Industry experts did raise two cautionary points about partnership arrangements in spite of this:

1- May lose community support and investment. Your 'local community' project is essentially providing revenue to a licensed national supplier. This in essence goes against the premises of P2P, decentralisation and de-monopolisation of energy.

2- White label, or more socially conscious supplier partnerships are excellent; yet large quantities of them no longer exist and have gone into administration, countless community schemes have dissipated as a result. This may leave the platform without a supplier.

With the current situation surrounding suppliers in the news also prevalent, they may be even more risk averse to engaging in P2P. Forming a partnership with a 'Big 6' utility offers more financial backing, yet community organisations are by nature motivated against such acting to localise energy.

Step 3: Regulation Changes

P375

P375 essentially dictates a change in the 'Balancing and Settlement Code' (Elexon, 2021). Currently the energy system works by measurements at a 'Boundary point meter'. This primarily means although there may be lots of activity behind this boundary, such as on charge electric vehicles; only one figure of 'flow' is taken. Therefore if you are a prosumer and generating 2kWh from your rooftop solar, if the electric vehicles behind the same boundary are using 1.5Mwh of energy, a figure of 0.5kWh will be shown at the boundary point meter. In actuality this is not correct, you are providing the grid a balancing service of 2kWh and not 0.5 as shown. P375 seeks to change this, metering will be moved from the boundary meter to the actual energy asset. This means that prosumers will become 'visible' on industry systems and better able to participate in energy networks. Consequently, the power of prosumers will be better realised and cases for P2P may become more feasible, with operational figures to support their value. P375 is set to be implemented from June 2022 into 2025 after recently being approved by Ofgem.

MHHS

A P2P platform would rely on everyone involved in the network having a smart meter to enable trades. Currently these are the 'SMETS2'. A barrier exists however that to enable, all smart meters must be metered half hourly, MHHS- 'Market-wide Half Hourly Settlement'. Trades would be taking place in real time; generators and suppliers currently trade electricity in the market in half hourly periods (Ofgem, 2021). A P2P must therefore also do this so the system would be able to respond to fluctuations. Many smart meters are not yet settled half hourly, but instead based on the profiles of average consumer usages and their own self meter reads; often taken over weeks and months. Of the approximate 13,000 households in the Wadebridge & Padstow Community Network Area, only around 2,300 of them have a SMETS2 meter (WREN, 2021). As of July 2022 this is set to change with everyone being moved to half hourly settlement in an 'MHHS Reform'. The programme is set to be complete by October 2025. Until then the current smart metering fleet presents a barrier to P2P.

4. Implementation

P2P is not yet a feasible platform. Many industry experts do not believe it ever will be. Many believe if it does become possible this is; 'unlikely to be in the next decade', as regulatory changes take at least four to five years to unfold. Numerous industry players have withdrawn from P2P trialling and research as they deem the markets and regulatory landscapes not ready (Nesta, 2021). Ofgems 'Regulatory Sandbox' must be monitored, this will be the place where P2P is continually trialled. Currently there is a project from 'F and S Energy' in operation. Progress on P2P may pick up once P375 and MHHS are implemented. It will also take the current supplier market a period of time to settle following the current 'crisis'.

WREN also believes the system could have a sliding tariff structure for the local energy, much like the workings for a 'tax system'. Typically those fuel vulnerable use the least amount of energy as they cannot afford to use more. The average electricity usage per month among UK households is about 350kWh (UK Power, 2020). Tariffs therefore, may be structured so that the initial quantities of energy are charged at the lowest rate (first 100-200kWh). Once use starts to surpass the 350kWh figure, the tariff rate may become ever increasingly expensive. The benefits of this arrangement will be that:

A: Helping the fuel vulnerable that consume minimal amounts of energy afford bills.

B: Get the heavy energy consumers to use less energy and act in a more energy efficient manner.

WREN are now embarking upon a new project Net Zero Communities (NZCom). This project is supported by Western Power Distribution and funded by the Network Innovation Allowance. The aim of this is to understand how both vulnerable needs of households and businesses will change as we move to net zero by 2050. Outcomes of this project must be placed into 'motivations' for a P2P network, the project may also give insight from the Distribution Network Operator (DNO)- Western Power, as to where they stand on P2P.

Furthermore, P2P is possible if you are in a 'Private Network'. If you are only connected to one point on the grid you are exempt from using the public 'National Grid' infrastructure as you operate via a network you own yourselves (See 'Trent Basin' case study). Working with Western Power Distribution WREN may explore whether it is feasible to create a 'boundary' around the Wadebrige & Padstow Community Network Area; a potential P2P solution.

Related P2P case studies:

-Ofgem Regulatory Sandbox:

<https://www.ofgem.gov.uk/publications/regulatory-sandbox-repository>

-F and S Energy: <https://www.fs-energy.co.uk/peer-to-peer-trading>

-Trent Basin: <https://www.era.ac.uk/projects-research/trent-basin>

-Cannock Chase Solar Community: <http://chasesolar.org.uk/>

Figures:

Figure 1: Bulb, 2017. *Grid diagram*. [image] Available at:

<<https://bulb.co.uk/blog/where-is-your-green-energy-from>> [Accessed 16 September 2021].

Figure 2: Yikui, L. 2019. *Structure of P2P trading*. [image] Available at:

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Figure 3: Own figure created using Microsoft Office.

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