



Lockleaze Loves Solar



The Story So Far

Next Generation Energy

Interim Learning Report



Lockleaze Loves Solar – The Story So Far

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Acknowledgements. *Without funding from Power to Change, and support from the Centre for Sustainable Energy this project would not be happening. We are truly grateful that such support is available for innovation in community energy. And when the time comes to wrap this stage of the project, there will be far more people to thank. Thanks a lot to everyone...*

Disclaimer. *Humanity is at the crossroads, and we have misused fossil energy and now need to put things right. Lockleaze Loves Solar is a community energy project which, like many others, is working to lay local foundations for a clean energy future for humanity. The field is very complex – all of life is energy – and any writeup is inevitably partial and flawed. All errors or omissions are my fault and will cheerfully be corrected, and hopefully forgiven!*

Introduction

This report describes the learnings of the Lockleaze Loves Solar project in developing and implementing a new community business model for solar energy on domestic roofs. Lockleaze Loves Solar is funded by a Next Generation Energy grant from Power to Change

Between 2011 and 2019, solar installations were subsidised by government feed in tariffs, resulting in about 13MW of solar in Bristol, on about 1 in 48 roofs. To meet city plans to decarbonise by 2030, Bristol needs at least 350-500MW of solar PV on 50% of all roofs. This will require installing far faster than hitherto, and new business models to make it all work.

This challenge is worth solving. The potential is not just to tackle climate change with renewable energy, but to generate it locally, with communities and local people owning the means of generation and benefiting from lower fuel bills – because solar energy is getting cheaper, and locally generated solar should also result in reduced distribution charges.

An integrated business model would balance fundraising, installation and operation, and not require any upfront investment from people who cannot afford to pay for solar, yet still pass on the benefit of low cost solar energy. The initial business model planned for community fundraising and ownership, with monitoring and billing by the local Bristol Energy company.

This would make it easy and risk free for customers, not requiring investment to come from them. Community or institutional finance would fund solar installations, and the energy company would charge people for discount solar energy as part of regular energy bills. To bring this about requires a new kind of partnership between community and energy retailer.

In practice this is easier said than done, and while falling solar and storage costs improved the business case, operating and other costs weakened the returns. This interim learning report documents the learning process from an initial feasibility study, to the application for a Next Generation Energy grant, and the various project stages until August 2020.

The disposal of Bristol Energy by Bristol City Council was a blow, but the hiatus caused by Covid allowed time to develop a 'Pivot' plan. LLS will offer solar systems to home owners (not renters initially) at a discount, with an option of consumer finance to pay for the PV. Households will get their solar energy 'for free', plus export earnings on their energy bill.

The whole field is fast moving, with solar and battery prices expected to continue to fall, and retail energy companies motivated to develop value-added offerings that will enhance the use of solar hardware – by charging electric vehicles, offering vehicle to grid services, optimising the use of storage, and more. Costs and benefits should improve over time.

By the end of the project others should be able to apply the model quite easily, and renters should be factored back in. At this stage, we present a report that covers the twists and turns, the learnings so far, remaining questions and opportunities, and notes and appendices with more detail about context, and the challenges that forced a pivot strategy.

The aim here has been to be quite comprehensive, and to create a detailed learning record. This will be added to in the stages that follow, and the complexity can be distilled into simple messages for people wanting the benefits of cheap and abundant solar energy, and into processes that communities can use to implement their own solar strategies.

Tackling Climate Change with Renewable Energy

Since November 2018, Extinction Rebellion have done a great job of bringing the climate emergency to the attention of politicians and the public, calling for direct action, and proposing that Citizens Assemblies be used to determine the best course of action.

For the last decade, community energy groups have been engaged in practical action to tackle climate change, investing hundreds of millions of pounds in renewable energy projects supported by government grants and subsidies, learning how to create an emission free renewable energy future. (See [CEE](#)).

Low carbon energy now supplies over 50% of UK electricity. This still includes nuclear and biomass, but the use of coal, the fossil fuel with highest emissions, has been almost entirely phased out.

Both solar and wind energy have been growing exponentially, as costs fall following technology learning curves. With one or two more doublings of wind and solar, the UK will have practically ended fossil fuel generation and emissions for electricity, and paved the way for the modal shift from fossil fuelled transport to renewably powered vehicles.

The big opportunity is for ordinary people and communities to take the lead, using domestic and community roof spaces to generate a significant part of the UK's energy, and eliminate a lot of the carbon emissions, while cutting energy bills at the same time.

Citizens Assembly - Your City Our Future

Bristol is running a citizen survey prior to a [November 2020 Citizens Assembly](#) about how people want Bristol to be after Covid. Survey responses already show that people want a greener future, and the Green New Deal. Lockleaze Loves Solar can be part of the evidence.

“Covid-19 has caused great disruption to our lives and livelihoods. The city will need to recover and we now have a once in a lifetime opportunity to rethink what kind of future we want for Bristol. In November we will hold Bristol's first citizens' assembly which will discuss and aim to build consensus on issues where people disagree about the best way forward. The citizens' assembly will be representative of Bristol's diverse citizens.”



The Elephant in the Room, on Bristol's Prince Street Bridge during XR September Bank Holiday action.



Overview

Following the award of a Next Generation Energy grant by Power to Change, Lockleaze Loves Solar initially followed the trajectory planned during the R&D stage. But there have been learnings on the way, and circumstances changed, making it necessary to alter the plans.

As planned, Lockleaze Loves Solar is a 1 Megawatt urban rooftop solar farm, a virtual power plant with free solar panels installed on the roofs of 300 homes in Lockleaze. The electricity they produce will be sold to the households at a discount. Surplus energy will be sold to an energy company on an export arrangement – or shared with neighbours, also at a discount.

The project relies on a new kind of partnership between the community who are developing the scheme and an energy retail company – to monitor generation and use, and handle the billing. Initially this was Bristol Energy, but the sell off by Bristol City Council forced a rethink – which has resulted in a ‘pivot’, at least in the short term, to a group purchase scheme.

The project grew from a discussion paper inspired by Energy Local, followed by a Feasibility Study sponsored by Low Carbon Gordano. This report tracks the evolution of the project, starting with Energy Local’s breakthrough in developing a post-subsidy business model for community energy – working with a retailer to link households directly to an energy source .

Having identified a possible project that would need development finance to bring to fruition, the Next Generation Fund came along with impeccable timing. The finance and support on offer, as well as the community focus of Power to Change, meant it was possible to field a strong team to develop the project, and to attract the necessary partners.

This is charted through the R&D phase, and phases 1 & 2 of the project implementation, up to the point of readiness to recruit household and start installations. At this point the Corona Crisis and the sale of Bristol Energy created the opportunity and need for a re-think – and to meet challenges around operational costs, and opportunities with new lower solar pricing.

This learning review is presented as a narrative, interspersed with paragraphs in italics reflecting on progress and learnings. There are appendices with extra pieces that felt out of place in the main narrative. We hope this format works – it can be changed if needed...

Summary of Key Learnings

The journey from feasibility study to the point of implementation has been eventful, but has so far confirmed that the new business model will allow communities to invest in solar energy, and households to get savings on their energy bills without any outlay upfront.

The project has been trimmed to meet changing circumstances, and much remains to be done before it can be declared a success. But falling costs of solar technology keep nudging it in the right direction. A new source of initial finance has been found, and other energy companies are developing services that will support community-led rooftop solar energy.

These initial learnings will hopefully lead to a successful pilot, and by the end of the Next Generation programme there will be a template that can be readily financed and implemented – and adapted as part of any community’s climate action programme.

The points below summarise key learnings, which are described in more details in the Key Learnings Section – following the description of the learning journey through the stages of the Next Generation energy programme, from R&D stage to readiness to recruit and install.

A Stable Base. Communities are often challenged to find development funds for projects. So it is profoundly helpful to develop this new community business model with Next Generation funding that supports steady and sustained development, with expert support.

A Strong Team. It works well to have a team that has a strong track record in innovation and delivery of community energy on the one hand, and which is deeply embedded in a well organised and progressive physical community on the other hand.

Solar Technology. The project is working with a technology that's on a learning curve, with continuous improvement in price and performance, and an ecosystem that attracts steady innovation, plus the crucial advantage of being suitable for installation 'behind the meter'.

Modelling. The spreadsheet model from the feasibility study showed relationships and dependencies, and allowed for comparison of scenarios and testing of assumptions. This has continued to be important in decision making – e.g. on the need to 'pivot'.

Marginal Business Model. So soon after the end of subsidies, any model was bound to be marginal. Wishful thinking does not improve it, but a general optimism seems reasonable – that the market is moving to support distributed renewable energy and local generation.

Adaptability and Endurance. Things keep changing – flexibility is required and plans are adapted. The overall goal remains clear, and sometimes there's the opportunity to make improvements, and other times it's necessary to simply endure and wait for the next shift.

Swings and Roundabouts. The model gets better as solar and finance costs improve, and worse when upfront or operating costs are higher than expected. The pivot strategy eliminates some costs, but makes it harder to help those in fuel poverty.

Feasibility Checkpoint. At current install prices, a group purchase scheme looks viable to end users even when financed over ten years, while a shared rooftop solar farm with added runnings costs needs up to 20 years to pay back, though the panels last for 40 years or more.

An Integrated Solution. This limited pilot is not yet an integrated smart energy solution to decarbonise a whole area or city. But building a growing base of solar generation creates a stable platform to add other features – energy sharing, EV charging, vehicle to grid, etc.

Convergence of Smart Systems. There has been a shakeout in the first generation of new smart energy companies competing with the Big 6. The best of the survivors are creating new features that increase customer benefits, which should increase the project viability.

Energy Efficiency and Retrofits. The solar business model is not strong enough yet to be able to finance energy efficiency retrofits. There may be synergies with a state subsidised retrofit program aimed at energy efficiency and achieving carbon emission reduction goals.

Proof of Pudding. *Good progress has been made, and challenges met, but solar panels have not yet been put on roofs to fully prove this business model. Nor has it yet been shown that the model will appeal to a majority and be popular. The real test is about to begin...*

Origins of Lockleaze Loves Solar

At a conference ‘Hacking Energy’ in Manchester in November 2016, Mary Gillie, a founder of Energy Local described their novel project in Bethesda, Wales. Energy from a hydro scheme is shared with members of an energy club, who get hydro energy at a discount, with the hydro scheme receiving a higher price for their energy, encouraging further investment. This was a breakthrough in direct supply of renewables to a community, and the business model involved working with Co-op Energy to supply all the administration, as well as the balance of the energy used by club members, who have smart meters and are on time-of-use tariffs.

At the 2017 Regen Spring Conference in Exeter, Energy Local retold their story, after which Zero Carbon Bristol circulated a discussion paper, [100% Renewable Energy](#), suggesting how Energy Local’s approach to energy sharing could apply to rooftop solar. Smart systems would integrate this with electric vehicle batteries to store daytime solar for night time use, and hydrogen would store summer excess solar energy for use in winter and in transport.

The use of EVs and hydrogen seemed far-fetched that spring, but at Regen’s November conference in Bath, the MD of Nissan Renewable Energy, and the Head of Hydrogen on the Leeds City Gate H21 project explored both ideas. This turned heads at Bristol Energy Network and Zero West, and at Zero West’s Zero Carbon Bristol conference in spring 2018, Low Carbon Gordano suggested a simpler and more cautious exploration of energy sharing.

Energy Sharing Feasibility Study – May-August 2018

A [spreadsheet model](#) of Low Carbon Gordano’s Moorhouse Farm array was used to see if their solar farm could adapt Energy Local’s model to share solar energy with neighbouring Lawrence Weston. Solar farm income would increase while reducing consumer energy bills, and re-financing the array could free up equity to invest in new solar farms and rooftop PV. The numbers were tight, because time-of-use tariffs are lowest when solar is generating.

Current core team members Suzanne Wilson, Chris Stuart-Bennett and David Saunders met in March 2018 at a Forum for the Future event on community business, and discussed the idea of a solar farm on people’s roofs in Lockleaze. David had developed Bristol Power Co-op’s pilot project on 23 roofs in Lockleaze, and Suzanne has worked with [Project SOLA](#). Low Carbon Gordano commissioned a [feasibility study](#) and a new spreadsheet model was built to look at the finances, focused on the transition away from government subsidies.

The model explored two main scenarios. The first looking at direct sales of solar electricity to households, supplemented by the tiny remaining feed in tariff and export tariff – and the second to see if the numbers still stacked up once the feed in tariff and export tariffs had gone completely – selling a household’s excess solar energy to neighbours in an energy sharing scheme or to a power company. The model balanced install costs, finance costs, operating expenses, and the price customers would need to pay to make it all work.

The model evolved around a hypothetical £1m ‘rooftop solar farm’ project for which Low Carbon Gordano would raise the finance to put solar PV on 300-350 roofs. This model was then shared with Co-Op Energy to get their feedback. They were supportive of the idea of sales for self use, but not so encouraging about energy sharing – it seemed they could not entirely avoid network charges. This was a challenge – with solar costs at that time, the income would cover operating costs and interest charges, but not capital repayment in full.

During the feasibility study, Neil Williams from Tilix Consultants helped guide the process, acting as a critical friend. He audited the model, as did Andrew Baker, an FCA and co-founder of Bristol Power Co-op. The team also got helpful input and feedback from Fuad Al-Tawil at Teign Community Energy, and Maurice Dixon, a consultant working with Westmill Solar Co-op. Everyone in community energy was looking at a future of unsubsidised renewable energy, wanting community energy to thrive – and searching for viable paths forward.

*One value of the spreadsheet model was that discussions and suggestions easily translated into changes in pricing and returns, reducing subjectivity. The model showed what was viable at a given price or finance rate – and what would be needed for the model to work. The main conclusion was that given the right numbers, there **was** a post-subsidy way for communities to develop solar energy. The results were written up in August as a [Feasibility Study](#) report – which was clearly not a fully developed business plan. The team then took a break.*

Next Generation Fund – November 2018

“Luck is when preparation meets opportunity” – attributed to Seneca

In November the Centre for Sustainable Energy announced the Next Generation Fund from Power to Change. The feasibility study model had included a 10% development costs for the hypothetical £1 million project – but where would this £100,000 come from? Low Carbon Gordano’s board and investors could not be expected to support an experimental project. The appearance of Next Generation with ten £100K grants seemed like perfect timing.

An Expression of Interest was written for the first tranche of 5 awards. Power to Change emphasised the need for applicants to have strong community connections and a track record of delivering energy projects. P2C had themselves teamed up with the Centre for Sustainable Energy to run the Next Generation project as P2C lacked experience with community energy. The EOI emphasised bringing Low Carbon Gordano and Lockleaze Neighbourhood Partnership together, to have the necessary strengths in one team.

In writing the Expression of Interest, the team came together. At one point it met for a ‘writing day’, all having written pieces towards the EOI. Suzanne Wilson had loaded the EOI pro forma and her contribution into Google Docs. The four in the core team had a really productive day with three notebooks adding to and editing the document simultaneously. In the end it felt like the team had gelled, and a strong workmanlike bid had been created

By then, the end of Feed in Tariffs was well within sight, and any expectation of making use of the tail end of government subsidies was gone. The single path remained of collecting cash from customers for energy. Energy sharing was, at best, on hold. Peer-to-peer trading of energy seemed over-complex and too risky. It seemed best to avoid doubling up on energy

bills. To keep things simple relied on partnering with a retailer. Bristol Energy agreed with this vision and approach and supported the [Next Generation EOI](#) with a Letter of Intent...

R&D Phase – May-June 2019

Lockleaze Loves Solar was shortlisted for interview, and was delighted to become one of 5 projects in the first cohort entering a funded R&D phase to develop a full grant application.

During the R&D phase the whole cohort met with several of the experts that P2C and CSE had assembled. Felicity Jones from Everoze went through the model in depth with the project team. The model showed the dependence on the right combination of install costs, finance terms and the proportion of solar energy that consumers used. It passed muster, in part because the team was hearing encouraging news about solar install costs.

The R&D phase tested the team and model in ways that were useful. A challenge about panel performance and the proportion of self use that consumers would make was defended with real operating data from the Bristol Power Co-op pilot project in Lockleaze. As community energy was in a fragile state after the end of subsidies, the team was keen to base the model in reality, keeping changes to a minimum and avoiding new risks.

CSE's expert team encouraged not giving up on energy sharing, and to look at storage and the potential to trade in balancing services. The team met with [Aura Power](#), developers of the UK's biggest battery – 15MWH used for balancing service, which just happened to be in Lockleaze. It helped to understand the cost, benefits and risks of storage in more depth, but it felt risky – better to leave the complexity of flexibility markets to bigger players.

It was helpful to be paid while developing the grant plan in depth. The amount of work done in the R&D phase more than used up the funds available, even when discounting daily rates – doubling the budget would have been terrific, but all help was gratefully accepted. The final [Grant Plan](#) developed at this stage included detailed budget, [timeline](#) and a good risk assessment. Possible challenges with Bristol Energy were identified – but not Covid!

Phase 1: Initial Setup – Aug-Oct 2019

The immediate tasks for Phase 1 were to select PV Installers, legal support and a partner energy retailer, as well as to engage with council, housing associations and community. Some of the bids from lawyers and installers fell outside the viable range, but suitable partners were found – Foot Anstey for legal work, and IDDEA Renewable Energy as installer.

More than anything, the model depended for its success on creating an innovative relationship with an energy company, and Energy Local's slow progress with Co-Op energy showed both the possibility and the challenges. There were strong political and practical reasons for going with Bristol Energy, if at all possible. Fortunately, from the first project meeting, Bristol Energy fielded a strong and enthusiastic team, who engaged right away in detailed thinking and planning around customer experience.

The plan included a reasonable lead time to adapt a billing system to monitor solar panels and bill customers for the solar energy they had used themselves. But Bristol Energy suggested that for a smaller initial group of installs, they could handle billing with manual

adjustments. This created the possibility to start earlier than expected with a trial batch. And Low Carbon Gordano had enough cash in hand for a limited pilot with 20 or so households.

This simplified recruiting households, lowering the bar for the first round of engagement with the people of Lockleaze. It would also make it easier to prepare a share offer or bond issue later – if a pilot was already running with 20 or 30 households, there would be income coming in, and experience with the new model and its risks. Low Carbon Gordano's investors would see a going concern and could make up their own minds about subscribing.

Western Power Distribution were also more positive than expected. It turns out they are required to allow up to 3.84KWP of solar on any domestic roof (this is 240 volts times 16 amps), and do not charge for providing any needed network reinforcement. They simply said it would be a courtesy to be informed in advance of any large clusters of arrays that might necessitate reinforcement work. It was good to find there was no barrier here.

There were two housing projects in Lockleaze that seemed worth talking to. United Communities were working with Bristol Community Land Trust on 50 or so homes at Shaldon Road. This would have been a nice chunk of a 300 roof project, and a great start. But the developers had already made plans and did not want to change them. We learned that we would need to engage earlier with new builds, and with more of a track record.

Forty percent of people in Lockleaze rent from the council, including many people in fuel poverty. Earlier experience with Bristol Power Co-op showed that these people want solar energy as much as everyone else. But then as now, and despite support from councillors, the time was not right for the council to work with us at this stage. This was disappointing, but the council does include solar PV in the One City Climate Strategy, so hopefully council tenants will get solar energy at some point.

Bristol had declared a climate emergency the previous November, and Extinction Rebellion had formed. Interest in tackling climate change had leapt. During this phase the team met with Regen, Green Capital, Council, Community Energy England, Bristol Energy Network and others, and attended community events in Lockleaze. All of these were opportunities to present the concept, get feedback, and adapt and improve – or improvise. And Stuart Urquhart from TLT solicitors joined Low Carbon Gordano's board, bringing really good ideas – e.g. how councils might guarantee PPA incomes for community projects.

Both City Leap and Bristol's One City Climate Strategy mention the importance of solar energy, though City Leap only mentions 40-142MW of solar potential – not citing the space for 600MW shown by the council's solar map. Both talk of the importance of engagement with the community and the central place of democratised energy in any climate change solution. When this starts, it will hopefully be by linking with existing community initiatives.

This initial set up phase concluded with enough in place to be confident to move forward. While the plan was for a megawatt of solar, a trial on 10 or 20 roofs would test the model. Carrying that through to 300 roofs would itself demonstrate the potential for scaling.

Phase 2: Launch and Preparation – Nov 2019-April 2020

The second phase was focused on community engagement and recruitment, making plans with the installers, and getting the legal support in place for roof leases. By then the project was being mentioned at community events – talking about plans as they were unfolding, sounding out support, and getting contact details from interested people. It was good to find that there was real interest and enthusiasm from local community members.

Without the long lead-time to get billing software up and running, plans gently eased towards an earlier trial with a small batch of homes. A visit was scheduled from Barbara Hammond at Oxford's Low Carbon Hub to coincide with the community launch event. She was working with Power to Change to assess and guide our project, and a positive afternoon meeting was followed by the launch in the evening – which was recorded for [Youtube](#). Barbara spoke encouragingly about her hopes for the project's success and replicability.

People started signing up to register interest in having solar on their roofs. A first [flyer](#) was created, and feelers put out for people in Lockleaze who might join a steering group for the project. Installers IDDEA ran a training with Karen Edkins, a community engagement worker with Lockleaze Neighbourhood Trust, who had spare hours available that could be used to recruit and sign up the trial batch of homes. This included creating a protocol with IDDEA, for Karen to take photos of roofs, meter spaces and so on – to accelerate the process.

Bill Kirkup, from CAG Consultants who were working with Power to Change, visited to assess progress. He saw the area and interviewed the team, writing the visit up as a [case study](#) with an illustrative [diagram](#), as part of a longer [report on the Next Generation project](#).

Momentum was gathering and better printed materials were needed, as well as a Logo. Stuff Advertising had produced a flyer that worked well for Bristol Power Co-op, and came in with an acceptable quote. They made a [draft flyer with a great Logo](#) – and graphics inspired by Lockleaze children who had drawn homes with solar roofs on a painting day. The final edit that would pitch it at recruiting households was put on hold – Covid was coming into view...

So far, so good, but things were lining up that would force some re-evaluation and a rethink.

Winds of Change

The project was established and making progress, as envisaged in the schedule in the grant plan. Much was being learnt in the process, and circumstances were evolving quite rapidly. Opportunities and challenges started showing up in early 2020 that forced a re-think. In the course of a few weeks the project slipped from steady progress into a growth crisis...

Covid was approaching and the team agreed that if schools closed, as seemed likely, the project would be put on hold. Power to Change were expected to go along with this, and the plan would be to reschedule community engagement and installations for after the crisis. The impact was small at first as there was lead time built into the schedule for Bristol Energy to develop suitable solar billing software. Power to Change were indeed up for a Covid hiatus, but rumours started to emerge that Bristol Energy would be put up for sale.

Solar Pricing. In February, a chance contact put the group in touch with Midsummer Energy, solar wholesalers with innovative software 'Easy PV' for designing solar roofs and specifying the kit required for an installation. For the volume that was planned (1MW), they offered wholesale prices for complete solar kits of £400-500/KW – for instance a full 5KW kit for £1967, delivered (plus VAT). The same size system from installers IDDEA was £3943 – but installed on roofs, of course. So does it really cost a further £2000 to put the PV on a roof?

Operation. At the same time it was suggested that operating expenses might be higher than budgeted for – with admin, insurance, annual inspections, monitoring and inverter replacements adding up to as much as £105 per system per year – a third of revenue. A core aim of the model had been for the retail partner to do most of the admin in their billing system, monitoring the systems at near zero cost the the project. So what was the truth? The model is only as good as the numbers fed into it, and the numbers came into question.

Discount Rates. As part of our planned project activity, Brian Titley, Low Carbon Gordano's finance director, applied an 'Ubermodel' with monthly costs, cash flows, tax etc. This would allow comparison of Lockleaze Loves Solar with other projects on a standardised basis. The cash flow showed that a project financed with bonds or stocks at 3% to 5% could be fully owned by Lockleaze within 20 years. But applying even a modest discount rate of 4% to future cash flows showed the project did not give an adequate financial return.

Bristol Energy. The council had invested a reported £37million developing Bristol Energy, and were under political pressure to start getting a return on their money, or at least avoid making further investment. A new MD was appointed for Bristol Energy with experience in turnarounds and sell-offs, and EY consultants were appointed to advise. It looked like the project was about to lose the retail partner that had been critical to the business model.

Octopus to the Rescue? Power to Change and CSE had encouraged developing alternatives to Bristol Energy, even though Bristol Energy were not too happy about this, . Co-Op Energy had passed their customer base to Octopus Energy, who, together with Midshires Co-op set up Co-op Community Energy, to promote and develop community energy. CCE let us know that Octopus were planning a billing system to enable commercial investment in rooftop solar, and that communities could use it for free. Hopefully available by December 2020.

Contingency Report

During April and May, the Covid hiatus created time to prepare a [Contingency Report](#), triggered by the potential demise of Bristol Energy as well as project delays from Coronavirus. Chris Stuart-Bennet's model was adapted, so that several scenarios could sit side by side, allowing the comparison of 'like with like' so that the impact of reduced solar hardware costs could be seen separately from the effect of increased operating expenses.

Five cost scenarios were explored, ranging from the initial solar pricing, with higher operating expenses added in, to lower solar install costs, including where pricing might be in 12 months. Five options were considered – from calling a halt, to changing the approach:

1. **Walk away.** Consider this a good learning but too complicated to run operationally right now.

2. **Tread water.** Wait for Covid to pass and for things to improve.
3. **Proceed with caution.** Continue to develop these new options, and work on costings and efficiencies. Maybe online consumer engagement?
4. **Switch.** Develop a group purchase scheme as a contingency and alternate option.
5. **Network.** Keep an eye open for what others are developing as options, post subsidy, and for Green New Deal. Adopt and integrate. e.g. Riding Sunbeams?

On June 4, the day before a June 5 team meeting, Bristol City Council's cabinet took the decision to sell off Bristol Energy, with the slightly face-saving explanation that council was well over £100m overspent due to Covid, and they needed all the cash they could get.

Pivot Plan

The team chose to develop and present option 4, a Pivot Strategy, to Power to Change, based on moving ahead with a group purchase scheme – offering solar roofs and possibly battery storage to householders, at a discount to current retail market prices. With good fortune and serendipity, consumer finance was available for solar projects at Bristol Credit Union, who offered advantageous terms to LLS for a consumer solar rooftop offer.

This consumer finance model looks to create a membership organisation with a small annual contribution collected alongside loan repayments, to encourage expansion of the scheme and take advantage of future opportunities around data sharing, energy sharing etc. The amount raised for LLS is likely to be quite small and therefore of questionable value but potentially a city-wide scheme could do better. We will explore with Bristol Energy Network and others how this might benefit communities and community energy in Bristol.

See Appendices on Contingency Planning and Pivot Strategy

Next Steps

Energy Sharing. The July technical seminar for Next Generation Energy groups saw a welcome return of Energy Local. Their key concept is a 'match price', agreed between community energy users and community generators, giving the former a good discount and the latter a guaranteed income better than a Power Purchase Agreement. Keeping network charges in check is still a challenge, but adding energy sharing to the Lockleaze Loves Solar mix would extend the project benefits to homes without solar roofs, and increase income.

Climate Action. The lottery's new Climate Action Fund is specifically aimed at helping communities develop their own Climate Action Plans. A group of Bristol neighbourhoods including Lockleaze, working with the Green Capital Partnership won a first round award of £375K which will allow them to develop plans that will no doubt include solar. This opens a potential growth path and initial replication strategy for Lockleaze Loves Solar.

Energy Retailers. The project ran into problems with Bristol Energy, and realistically is not yet big enough to attract retailers to adapt their billing systems to accommodate the Lockleaze billing model. Bristol Energy helped the project get to this point, along with the

pioneering work of Co-op Energy with Energy Local. If the project is to get back on its initial track, parallel to the pivot strategy, future work includes getting things right with retailers.

Convergence. This is not the first time a community energy project has been damaged by the collapse of a retail partner. Community energy groups and energy retailers need to see the advantages of working together to deliver community owned generation assets. Communities need to converge on models of shared ownership of energy generation and transport – electric charging and carpools. And Energy retailers would do well to develop integrated offerings that appeal to communities – handling energy generation and billing, energy sharing, storage management, EV charging, vehicle to grid and grid balancing.

Key Learnings

The project has not followed a linear route and has had to remain flexible. But the idea of solar as an increasingly viable low cost renewable energy source for communities has remained constant, and when one door has closed, another has opened. When the project has been implemented, it will hopefully have cleared a channel that others can easily follow, with community rooftop solar set to become a mainstream energy source.

Stable Base. Communities now have ten years of experience with government subsidised energy schemes. A consensus has emerged that energy should be renewable, decentralised, democratic and community owned. Generating their own energy may be the single biggest contribution communities can make to tackling climate change. If progress can be as fast in the next 10 years, carbon neutrality by 2030 could be a real possibility.

Resources. Communities struggle to find resources to develop projects, and waste time learning the same lessons. Communities only own 1% of current UK renewable generation, and with the end of subsidies, progress slowed. It seems that Power to Change created Next Generation Energy precisely to accelerate this next needed next round of growth. The aim is to make projects replicable, and open source – so less time is spent reinventing the wheel.

Strong Team. Community energy groups are often small groups of enthusiasts, experts and investors, lacking wider engagement in their community. Lockleaze Loves Solar has brought together Low Carbon Gordano (LCG), an energy group with a track record in project management and delivery, with Lockleaze Neighbourhood Trust (LNT), a neighbourhood group deeply embedded in the community, and with experience of energy projects.

Innovation. The team is rounded out with Zero Carbon Bristol, a consultancy with a track record of developing community rooftop solar (on Hamilton House) and domestic solar – Bristol Power's 2012-2013 pilot in Lockleaze. Zero Carbon Bristol co-created the first Zero Carbon Bristol event with Bristol Green Capital, worked with Bristol Energy Network (BEN) on the Community Strategy for Energy, and has worked on solar maps and 'Streets of Solar'.

Integration. This core team is complemented by suppliers and partners, and the experts and support provided by Power to Change and the Centre for Sustainable Energy. It feels like a robust partnership, augmented by strong networks and connections into renewable energy, green transport and climate change. If anyone is going to develop a viable new post-subsidy model for community energy, it feels that it should be possible within this group.

A Clear Focus. All the signs pointed at rooftop solar: the decreasing cost of the technology; the amount of available roofspace; the direct connection with customers; the potential to avoid transmission costs by being behind the meter. But so soon after the end of subsidies, the financial case was still marginal. By staying focused, and remaining flexible, a solution has been teased out that looks viable, and which could be replicated and scaled.

Unexpected Allies. Community energy has been focused for a long time on solar, and aiming at carbon neutrality. While the project was in development, Bristol led the nation, being the first city to declare a climate and environmental emergencies, and to aim for carbon neutrality by 2030. And Extinction Rebellion has come into being and focused the public's attention to the threat of climate change, and the need for solutions. This has all helped.

Restricted Options. Increased awareness of climate change and a sense of emergency has not yet translated into a path to work with the city council, social landlords and new building projects in Lockleaze. At the moment this narrows the options to working directly with home owners, and the level of interest has not yet been accurately assessed. The benefits on offer are still quite slim. Are they enough, or are lower costs and further synergies still needed?

Price Rises Slowed. The 'Big 6' retailers were positioned in the media as the public enemy, causing big price rises every winter, fuelling fuel poverty. The big profit margins in energy are actually in the grid and the DNOs which are regional monopolies. But the combination of new energy companies, stimulated by government to increase competition, plus the rise of subsidised (or lower cost) renewables, seems at least to have stabilised consumer prices.

Dances with Wolves? The team decided that trying to trade energy directly was over-complicated. This meant the need to try and co-operate with retailers, a practice pioneered by Energy Local. This is a delicate dance for a small project, and what we are offering is not seen as 100% positive – the project recruits new customers for retailers for free, but with reduce overall income and increased complexity in billing. This is still the big gray area.

Mammals versus Dinosaurs. The mindset of the Big 6 was based on top down generation and distribution. The new retail entrants are leading a strategic shift to locally generated renewables, integrated with local storage, electric vehicles and so on. They are creating a new generation of smart IT systems – and cannibalising the dinosaurs – OVO bought up SSE's customers, and Octopus now run the billing systems for Npower, E.on and Good Energy.

From Top-Down to Networked. In a similar way, community energy is shifting from its initial focus on simply generating renewable energy. Increasingly, consumers will also be the generators of renewable energy, and users of electricity for their homes, for heating, and for transport. Smart energy companies will find their place in making lives better by tying it all together intelligently. Locally generated community energy can help bring this all about.

Tripping over Bristol Energy. It made strategic sense to work with Bristol Energy. The council owned not just an energy company, but a lot of homes and roofs in Lockleaze, so working with Bristol Energy company made sense. There was genuine interest and help from the staff, but, in the end, Bristol Energy was sold off and we will need a new partner.

Solar Prices Falling. As the Corona crisis hit, the loss of Bristol Energy threatened to kill the project. But as the door closed with BE, lower wholesale prices for solar systems, plus

contract installers with competitive rates, offered an overall cost saving of 20-30%. This was enough to make a group purchase scheme for house owners look like an option to consider – it would also avoid complex roof leases and operating overheads, further reducing costs.

The Offer To Homeowners. Low Carbon Gordano decided that at this stage, the risks and costs were high, and the returns marginal, and they could not fundraise with their existing investors until conditions improved – for instance with lower solar prices and better deals from installers and energy companies. So a group purchase scheme with ‘no upfront cost’ to consumers would need a suitable source of consumer finance.

Credit Union Finance. The team learned that [Bristol Credit Union](#) operated a solar roof scheme, and in follow-up meetings they offered favourable interest rates. Their finance is over 10 years, and the return on investment is marginal over that period. However after that, electricity is free and the return is good. Homeowners in the ‘afford to pay’ market may even prefer to pay upfront, and amortise their benefits over the system lifetime.

Current State of Play. The team is modelling alternatives, including batteries, and time of use tariffs as options for group purchase. Batteries increase the amount of energy that is self consumed, and battery costs are balanced by the increased savings. Also, energy costs on TOU tariffs are highest in the evening, just when the batteries are fully charged. Offering choices will give experience in engagement, installation, and operation, while waiting for new retailers to come online, hopefully making the original scheme viable again.

Operation and Integration. With one third of the original budget spent, it is relatively easy to pivot to a group purchase scheme and gain practical experience. If the original scheme comes back into play, the two business models, for group purchase and community owned solar, can feed into plans for 90,000 solar roofs as part of the One City Climate Strategy, and the Green Capital’s work with 6 neighbourhoods to develop local Climate Action Plans.

*There was a stage in the project where the numbers for a shared rooftop solar farm didn’t stack up to offer discount electricity **and** repay the finance over 20 years, but with falling installation costs, greater discounts were possible. With the project pivoting to a simpler group purchase scheme, the repayment time is around ten years, after which households get solar electricity that’s free, plus an ongoing income from solar electricity exports.*

If finances were over longer terms, 20-30 years, as is the case with pension fund or mortgage finance, both approaches – shared community solar and group discount purchase – stack up very well. Learning curves are expected to continue, lowering costs of solar systems and storage. With additional synergies like EV charging, vehicle to grid and energy sharing, the case for these post-subsidy solar business models is near certain to continue to improve.

Questions and Opportunities

Much has been learned, and in parallel, other groups are making progress in the journey from a centralised fossil fuel economy to a distributed renewable energy economy. We have questions about what are the next best steps, and which opportunities will open up, and when, but we can increasingly see that we have a solar business model that’s shifting from marginally viability towards being part of an integrated model that works for everyone.

Who should to own the solar kit? Communities or households? If communities own and operate shared rooftop solar farms, it's easier to include people in fuel poverty and rental housing. And energy prices will fall for everyone as we put solar on more roofs. Our pivot strategy is a shift to individual ownership and maintenance, and early adopters will pay more because solar prices will keep falling. If we can reintroduce our initial strategy when we have the right deal with an energy company, we will get the chance to see which is the best.

What is the real cost of monitoring and maintaining solar kit? This question threatened to derail the project when it was suggested that operating expenses could be as high as 30% of income for our solar project. The initial expectation had been that administration and monitoring would mostly be handled by the energy retail partner as part of the deal. The question drops off if consumers are buying the kit, but it still need to be answered.

Which is preferable: maximise rooftop generation across the city, or optimise solar generation by household? Is it better to install as much solar power as possible on a roof, or to optimise an installation to lower costs and makes best use of any storage – i.e. maximise self consumption. The question is moot, if the cost of an additional kilowatt of solar power is covered by the income received if all the energy produced is exported. To be explored.

Can solar roofs be integrated with a broader programme of energy efficiency measures? Ideally solar roofs would be part of a full energy efficiency package offered to households. One option with Bristol Energy was using 'ECO' grants to matching the solar investment in households, and paying for additional retrofits measure. The idea seemed to be disqualified because it wasn't the household investing in the solar. In a group purchase scheme, the ownership shifts from community to household, so the idea may still be worth exploring.

There was some discussion about funding **C.H.E.E.S.E.** surveys as part of solar installations, but the cost of doing that currently drags the solar roof model into the red. In any case, even when a household knows where heat is being lost, additional finance is needed to pay for the retrofit measures. It looked as though any surpluses from Lockleaze Loves Solar would at best only suffice to pay for a small number of retrofit projects. Not yet a good option.

Integrating solar with the Green Home Grant scheme? The government is offering Home Improvement Vouchers worth up to £5000 for retrofits – which must include insulation and more efficient heating. The household has to pay a third of the cost, and the package does not cover solar or renewable generation. But what if solar purchase loans are extended to covers solar *and* the household's contribution, and they get the £5K from HMG on top?

This idea is worth pursuing – a household or a landlord should be able to find a single source of advice, options and finance to cover all their energy needs, and get a package that pays for itself out of savings and reduced energy costs. No-one seems to have solved this yet – Energiesprong is aimed at exactly this, but their retrofit package is still very costly. Warmer, cheaper, solar homes should still be the aim for councils, communities and energy groups.

If the idea is so good why isn't someone doing it already? In Germany, where feed in tariffs ended a while back, and retail energy prices are higher, [Enpal Energy](#) already offer a similar deal to Lockleaze Loves Solar, funding rooftop solar upfront, and charging for it monthly, as people save on their energy bills. People pay them direct, not a finance company. They have a few thousand customers already, and maintain the kit as well. Worth further exploration.

And then there's Sunny... A software group called Potato showed interest in developing a solar app to help automate signing people up for Lockleaze. They liked the idea well enough to start developing it their own product, like Enpal, closer to the pivot product idea than an energy sharing scheme. Their owners, WPP, laid off the entire Bristol staff of 30 during Covid, but two of the team are still working on the idea of 'Sunny Solar', looking for mortgage company finance, and partnership with [Ark2030](#) – “Join the race to net zero.”

Can the Lockleaze product grow and scale after Next Generation? It's not at that point yet. But if successful, the project will have been developed and launched with £100,000 from NextGen, and have attracted £1m of institutional finance for a first pilot on 300 roofs. There are already potential partner projects (Climate Action Fund, One City Climate Strategy) that could provide development finance, and £50K/million might suffice second time round. Then the model could be made self-sustaining with a £100-200 development fee per home.

What is happening to Energy Companies? The exit of Bristol Energy was challenging. But Octopus Energy have a good enough deal with a their 'Outgoing Octopus' export tariff to make the pivot product work, and their time-of-use tariffs mean that a good offer on solar + batteries is possible as well. They are working with Energy Local on energy sharing, and they also say they will have a product that works for self use of community owned solar. So they appear to be converging on a fully formed community energy package.

This should not be a complete surprise. New entrants like OVO and Octopus competed initially on price and service. New smart systems let them compete on cost, and add features that started to differentiate themselves in a former commodity market. OVO used tools that let them develop software 10x faster than previously, and re-engineered their entire billing system. They can now not just read smart meters, but control smart chargers (see [Tackling climate change with Kafka](#)). This is what let them take over SSE's 3.5m customers. And Octopus now run the billing for Npower, E.on and Good Energy.

Lockleaze is free to work with any of the smart energy companies. They all have specialties – Octopus with export tariffs, solar billing and energy sharing (in development). OVO with smart charging. Social Energy trade storage systems. Energy Planet with a fixed charge, selling energy at cost. These will all overlap and converge. Just as the early microcomputers only ran one or two applications – Visicalc on Apple II, Wordstar and dBase II on CP/M machines. But now all platforms support integrated packages, all compatible at file level.

Is the Energy Revolution like the IT revolution? Mainframe computers were a billion dollar market focused on businesses. But personal computers wiped out the old mainframe computers in less than a decade. And personal computing has become a trillion dollar business focused on end users. If this parallel holds, we can expect to see, and are indeed seeing, energy companies shift from simply selling energy, to selling a range services, all directly aimed at energy end users. If so, Lockleaze Loves Solar is building energy generation infrastructure that these smart systems will improve on with value-added services.

How to integrate Lockleaze Loves Solar with Community Climate Action? Bristol's Green Capital Partnership applied for £3.5m of Climate Action Fund grant from the national lottery and was awarded second prize – a £375K stage 1 grant. Half a dozen community partners, including Lockleaze, have been selected as budget holders to develop local climate action

plans. LLS is one of very few projects that can act as a finance ‘amplifier’, so there is every reason to suppose that more of these partners will also want to replicate the solar project that Lockleaze has been developing. Maybe Lockleaze can develop the solar portion of a Climate Action Plan that can be replicated by all the Community Partners.

How to integrate community efforts with council action on climate change? This is the \$64,000 question. While in development, Lockleaze Loves Solar failed to have productive conversations with the council about putting solar panels on council house roofs, to improve the lives and energy costs of council tenants. But the direction may reverse. The council is developing Climate Action plans that call for solar on 90,000 roofs, – 50% of roofs in Bristol, most of which are not under council control. So now the council needs to engage with the community, and the learnings from Lockleaze Loves Solar may prove timely.

This engagement is starting off with a Citizens Assembly, and a process called ‘Your City Our Future’, that is intended to deepen democracy and set the scene for recovery from Covid. Citizens Assemblies were the third demand of Extinction Rebellion, so the council has the potential to entrain the energy of people who started out as protesters, and enlist them in developing and implementing the solutions. From the Your City Our Future questionnaire it’s clear that the ‘Green New Deal’ is how people want to ‘Build Back Better’ after Covid, so maybe Lockleaze has created useful input to the Citizens Assembly just at the right time.

How could LLS integrate with Bristol City Leap? Bristol City Leap is an ambitious approach to source finance and implement climate change measures with a commercial partnership. At the time of writing, the exact nature of any community engagement with City Leap remains unclear as the tender process is still underway. However there is a proposed structure, which it is anticipated that any successful bidder will broadly buy into, in which funding is provided (at significant levels) to help community energy schemes flourish alongside the larger infrastructural work. We expect that, once the City Leap partner has been selected and the capital becomes available, any future implementations of the Lockleaze Loves Solar v1 model would be able to apply for and benefit from these funds.

Can we source finance to replicate at scale? e.g. Pension Funds? With help from Mark Carney, Extinction Rebellion lobbied effectively against Blackrock and Barclays. Now Pension Funds like Avon Pension Fund and the Brunel Group are publicly committing to divest from Fossil Fuels – but in reality there is a dearth of ‘shovel ready’ renewable projects. This pilot, run with finance from Bristol Credit Union might just be the model they will be looking for.

Is there enough money in the world to finance decarbonisation? In [The Zero Marginal Cost Society](#) and [The Third Industrial Revolution](#), economist Jeremy Rifkin explains that the capital cost of renewable energy is lower than the running cost of the fossil economy, let alone the capital cost. Rifkin explains that in a zero marginal cost society, energy, transport and communication will all have modest capital costs, and then very low running costs which means once established, they don’t need much cash to run. So there will be more capital in the world than is needed to transition to 100% renewable energy. Conventional economic theory says if supply exceeds demand, the costs will go down. So the capital to replicate projects like Lockleaze should be plentiful and cheap. Let’s hope it works out that way.

What is going to happen to solar energy? Initially, solar cells were only used for satellites, and 1KW of solar cells might cost quarter of a million dollars. In 2011 the UK had less than

100MW of solar panels, but way back in 1975 world leading electrochemist James O’Mara Bockris forecast a future energy economy ‘The Solar Hydrogen Alternative’ on a learning curve that would cut the cost of solar, coupled with efficient storage and transmission of energy with hydrogen. Now, this model based on the fundamentals of physics and chemistry is starting to play out in practice. Chris Goodall in ‘What We Need To Do Now’ is explaining in simple terms how wind, plus solar, plus hydrogen can create a zero carbon future.

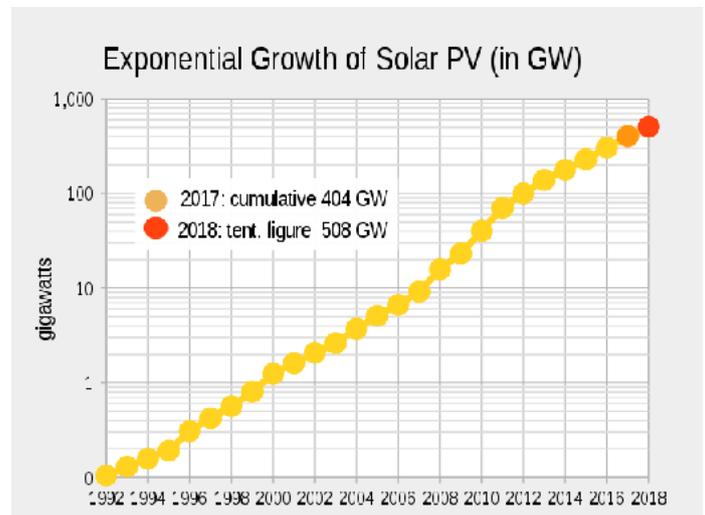
As we see with information technology, the convergence of multiple technologies in processing, storage, miniaturisation, and communication resulted in revolutionary change. Solar energy is going through the same process, so let’s look at where we are headed.

Future Prospects

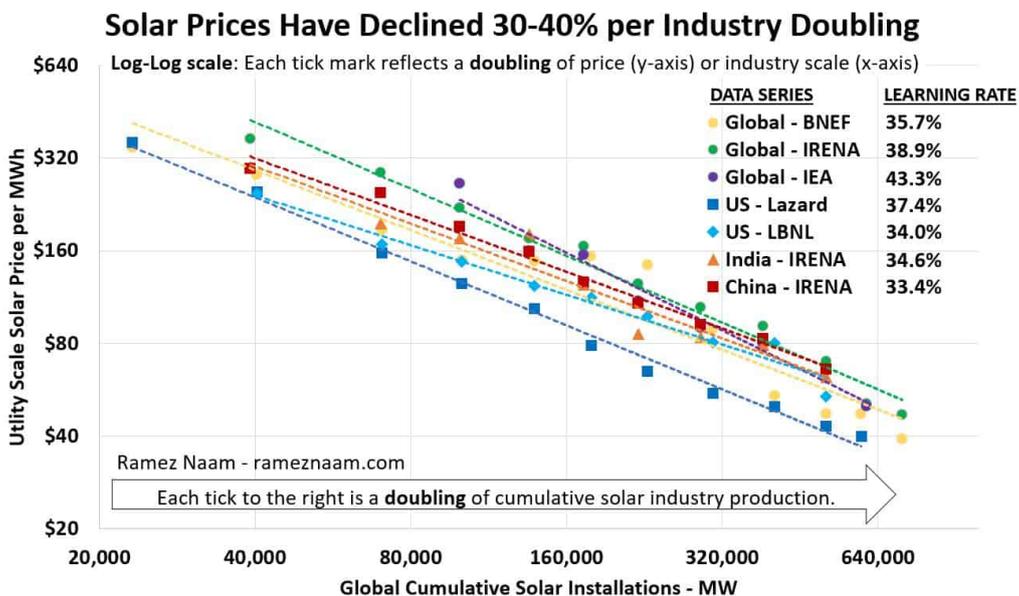
“It’s hard to make predictions, especially about the Future” – Neils Bohr

What is the realistic prospect for solar growth?

The Wikipedia article on [Growth of Photovoltaics](#) says solar has been growing exponentially for 26+ years – growing by a factor of ten every 6-7 years. Ramez Naam’s graph from the Wikipedia article is a straight line on a logarithmic scale – it shows exponential growth. The International Energy Agency consistently underestimates solar growth; few groups produce usable exponential forecasts, and this impacts on government plans. Ramez Naam’s graph from the Wikipedia article is, so far, the best available forecast for the growth of solar energy. So what does this say about the future cost of solar energy?



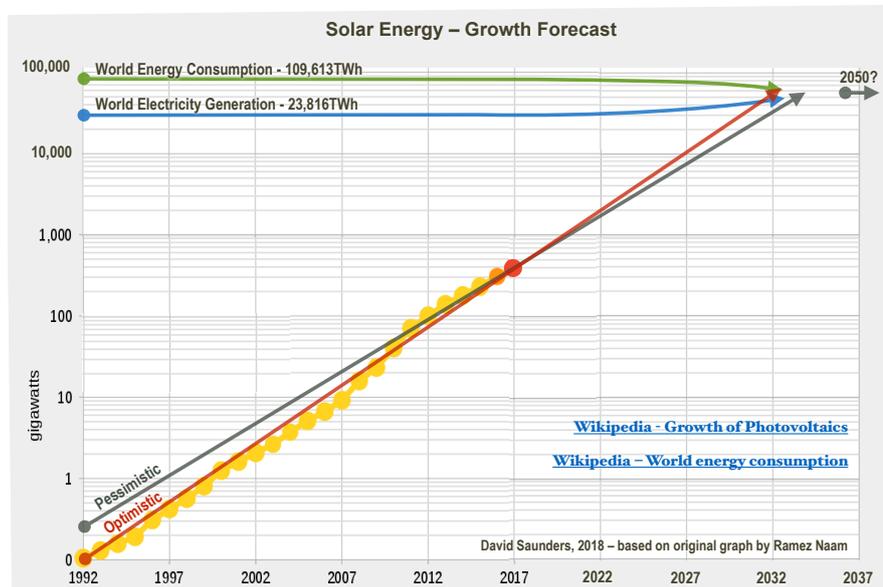
Is Ramez Naam Right? "Solar’s Future is insanely cheap (2020)" In 2011 and 2015 Ramez Naam wrote a series of blog posts on the future of solar, wind, batteries and electric vehicles. He revisited the topic this year and found “Both of those forecasts were wrong. Solar has plunged in price faster than anyone – including me – predicted. And modelling of that price decline leads me to forecast that solar will continue to drop in price faster than I’ve



previously expected, and will ultimately reach prices lower than virtually anyone expects. Prices that are, by any stretch of the measure, insanely, world-changingly cheap."

How many more doublings? The IEA (who are at least accurate about historic data) say that solar plus wind reached 9% of world electricity in 2020, with the solar:wind ratio close to 2:1. World total energy generation is about three times total electricity generation, so there is room for a 30 fold increase in renewables – that’s five more doublings, and five more 30% price drops, which means the price of solar may drop a further 80% from current levels over the next ten years (if growth is times ten every 6-7 years).

What about Paris and the 2050 carbon emission reduction agreements? *Well, quite.* This may be what happens when governments rely on forecasts that are hopelessly inaccurate. The IEA still has its needle stuck on 2050: “By 2050, the IEA foresees solar PV to reach 4.7 terawatts (4,674 GW) in its high-renewable scenario, of which more than half will be deployed in China and India, making solar power the world's largest source of electricity.”



As this projection based on the work of Ramez Naam shows, by 2025 solar energy will reach the level the IEA is predicting for 2050, and by 2032 would be generating 100% of world energy demand. But wind energy is also on track to do something similar in the same timeframe. So if exponential growth continues, we will have largely decarbonised our energy systems by 2030-32 with a pincer movement based on solar and wind. The race is on.

In *The Third Industrial Revolution* ([book](#), [free film](#)) Economist Jeremy Rifkin spells out how this new industrial revolution will play out differently to earlier ones, which led to capitalist extractive economies. This time, think about what it means to have a system of generating energy for which the capital cost is very low, and in any case quickly paid off through lower charges for energy than obtained with fossil energy. Once paid off, the cost of energy is very low – all it needs do is cover maintenance and replacement.

The Zero Marginal Cost Society ([book](#), short [video](#)) develops this theme of the economic implications of the new technologies. The Internet of Things, already being developed by our smart retail energy company partners, brings together these resources – solar roofs, battery

driven EV's that act as storage, local hydrogen generation, hydrogen powered public transport and heavy transport, and a new rethink of the former petrochemical industry.

What We Need To Do Now. In [What We Need To Do Now - for a Zero Carbon Future](#) economist Chris Goodall's proposals include "Building a huge over-capacity of wind and solar energy, storing the excess as hydrogen. Using hydrogen to fuel our trains, shipping, boilers, and heavy industry, while electrifying buses, cars and trucks." Rough calculations suggest this will cost around £4Bn for Bristol, and will halve our energy bills.

Rethinking Humanity

Think tank RethinkX apply the same exponential forecasts that work for computing and solar, to transport, food and materials as well. They say that exponential growth in these 5 key areas will lead to quantum shifts in a decade, with order of magnitude improvements in cost, performance and efficiency, and dramatic reductions in waste. Their report [Rethinking Humanity](#) shows that new civilisations are based on key shifts in these five areas.

"We are on the cusp of the fastest, deepest, most consequential transformation of human civilisation in history."

"During the 2020s, key technologies will converge to completely disrupt the five foundational sectors that underpin the global economy, and with them every major industry in the world today. In information, energy, food, transportation, and materials, costs will fall by a 10x or more, while production processes an order of magnitude more efficient will use 90% fewer natural resources with 10x-100x less waste."

"The knock-on effects for society will be as profound as the extraordinary possibilities that emerge. For the first time in history, we could overcome poverty easily. Access to all our basic needs could become a fundamental human right. But this is just one future outcome. The alternative could see our civilisation collapse into a new dark age."

Let's not underestimate humanity's potential to screw things up. The hyperlink was meant to lead to a world in which we would be just a click away from the most useful information to meet our needs. This would lead to a golden age where technology would help us to achieve our highest potential. This has been turned by Google, Facebook, Twitter and others into feeding on our addictive tendencies so that our clicking will maximise their revenues.

And it led, unpredictably at the outset, but inevitably in hindsight, to Brexit, Trump, Boris, Dominic Cummings, Cambridge Analytica, Russian troll factories, Bolsonaro, and rampant deforestation. We should not underestimate the power of Mammon to subvert our loftiest ideals and aspirations. Tim Berners Lee would be tumbling in his grave but he's still alive to rue the fruits of his labours. Will we do the same with abundant cheap solar energy?

Or are we already in the dark age between civilisations? Are climate change, ecological emergency, Ecocide and Covid the last spasms of a dying extractive civilisation? Are things about to shift to the better? Is community owned solar going to increase people's sense of self determination and independence? We can but try even if the outcome is uncertain.

Glossary and Notes

The Expression of Interest from Lockleaze Loves Solar to Power to Change included a checklist of things to be aware of. As the project grows towards implementation and considers its place in the wider picture, a range of topics impinge on it that don't fit in the main narrative. These notes are intended to flag other issues and remind us of context. Perhaps, from scanning through this, a bigger picture emerges.

Avon Pension Fund. Pension funds have big assets, and are being warned that investments in fossil fuels, deforestation, and other areas could lead to stranded assets and damaging results. Increasingly they are looking to divest and invest in renewables. What if they invested in local renewable energy projects that deliver great returns while creating clean air for pensioners and their grandchildren, jobs for their children, and cheaper energy for everyone? Avon Pension Fund has about £4.8Bn invested and is already committed to divesting from fossil fuels, and to more ethical investment. There is a real opportunity for pathfinder projects like Lockleaze to blaze a trail that pension fund could help get to scale.

Balancing Services. Renewable energy destabilises energy supply, making it challenging to match with demand. The National Grid buys [balancing services](#) to raise supply and lower demand at times of mismatch. Contracts are short term and loaded with risk, and we could not see any way that a solar project could participate effectively. This was something to leave to commercial players. See also **capacity markets**, **storage** and **time-of-use tariffs**.

Bangladesh. Bangladesh gets twice as much incident sunlight as we do, and it's more evenly balanced year-round. A remarkable company called [Solshare](#) has developed a cheap smart meter that connects payments and panels. A home can have one of these plus a panel or two, and/or batteries, and connect to one or more neighbours. Hey presto, a shared mesh grid, with 5 million users, and folks can have light, TV, fridge, phones, tablets. A home with panels can earn money – and without PV, it can still have cheap power. [See the movie 2040](#).

Biomass. The GridCarbon app regularly reports that we are getting a megawatt or more of energy from Biomass. So while Drax has mostly stopped burning coal, it now burns clearcut North American forest as woodchip, and reports this as '11% of our renewable energy is from biomass' – funded by £2 million per day in subsidies. This wholesale destruction of US woodland in the name of renewables is one more reason to redouble our efforts with solar.

Blockchain. Blockchains were a buzzword while we were working up our idea. They were going to make peer-to-peer energy trading work for everyone. We felt this was a techie solution in search of a problem. We believed that energy retailers would have a better, simpler solution, so that blockchains were not directly needed in simple energy trading.

See also [Blockchain technology in the Energy Sector](#) and **carbon credits**.

Bristol City Leap. [Bristol City Leap](#) is a series of energy and infrastructure investment opportunities that represent a big step towards a cleaner, greener Bristol. It is currently in procurement, but it is anticipated that any successful bidder will broadly buy into a proposed structure in which funding is provided to help community energy schemes flourish alongside the larger infrastructural work. We expect that, once the City Leap partner has been selected and the capital becomes available, any future implementations of the Lockleaze Loves Solar model would be able to apply for and benefit from these funds.

Bristol Energy Company. OVO research showed that people didn't trust energy companies as much as their councils, so OVO offered to help communities set up their own energy companies. Bristol chose to go it alone and set up Bristol Energy, but then felt forced to behave like a generic energy company, and did not focus on its local base or develop compelling competitive advantages. Bristol Energy might well have been the best vehicle to deliver Bristol's One City Climate Strategy – but we'll never know. What did we learn? Now Bristol Energy is owned by Together Energy, 50% owned by Warrington Council.

Bristol Net Zero by 2030 - *The Evidence Base*. This is a companion report to the ***One City Climate Strategy*** (see next entry) produced by CSE and others. It shows a feasible route to get to net zero by 2030 starting from decarbonising the heating supply with heat pumps and networks costing £3.175Bn, while eliminating the gas grid. It also calls for 537MW of solar PV on 96,000 roofs, costing £625m. Lockleaze Loves Solar data suggests the price for solar will be lower, and the rooftop potential higher. The gas grid may yet return to fill the gap between solar energy produced in the summer, and electricity needed for heat in winter – the clean solution being hydrogen generation and storage – the Solar Hydrogen economy. Total cost estimated £7-9Bn, with energy bills increasing. Given that costs of renewable generation, storage and transport are decreasing, is there a next generation alternative to this first feasible solution that delivers improved benefits and lower consumer prices?

See [Bristol Net Zero by 2030 - The Evidence Base](#) and ***What We Need To Do Now***

Bristol One City Climate Strategy. This is another great example of Bristol Stepping up with ambitious ideas to tackle monumental challenges. Will it take the City in the direction of deeper local democracy and engagement, with Citizen's Assemblies finding the best course of action? Will Bristol work with community networks and energy groups to deliver the solutions? Or will delivery be by a monopoly provider through a City Leap Energy Partnership? Hopefully this is an iterative process which incorporates new learning as we go along.

See [Bristol One City Climate Strategy](#)

Bristol Solar Map (2012). Bristol has its own [Solar Map](#), produced by Kieran Highman and the city's energy team in 2012, with a companion [learning report](#). It appeared on the front page of the Bristol Post newspaper and immediately became the most visited page on the council website. It showed the potential for 600MW of solar PV Bristol's roofs, which was far more than had been guesstimated up till then. People could pop in their postcode and get a fair estimate of how suitable their roof was for PV, and how much PV would fit...:

Bristol Solar Map update (2018). Bristol Solar Map was reverse engineered by geospatial software engineers Lenka Hašová and Tom Statham after a [Bristol Open Data Hackathon](#) in November 2018, where the idea won a £1500 first prize. They replicated work that cost £50,000 first time round. Analytics were improved, and solar maps can be generated for any area. Bristol's solar capacity was re-estimated at 1GW – panel performance has improved by a third since 2011, and east and west facing roofs are now good for solar. See [Report](#).

Capacity Markets. Like balancing services, capacity markets are something created to balance the grid from top down. One bottom-up view is that people in their homes with solar, EVs and help from retailers and smart systems, will optimise their own energy supply and demand, balancing the grid themselves – perhaps not needing a national grid, but

swapping excess electricity back and forth as hydrogen with the gas grid. Balancing local networks at point of use would eliminate the need for capacity markets. We shall see...

See also [Understanding the Capacity Market - Engie](#), and [What We Need To Do Now](#)

Carbon Credits. Having preferred to work with energy retailers rather than blockchains and peer-to-peer trading, we found [Rowan Energy](#) who are setting up a blockchain system to trade solar energy for carbon credits. This may create the opportunity to get an additional income from solar energy generation. Would it mean that the solar production would not count as reducing Bristol's emissions? If that helps make the project viable, and accelerates it, wouldn't that still be a good thing? An interesting opportunity worth exploring. At least, Lockleaze Loves Solar is not carrying any risk exploring the potential of blockchain.

Carbon Emissions. How much carbon dioxide do solar panels save? If we still got all our electricity from coal, burning one ton of coal produces 2,460KWH of electricity. So 4KW of panels, making 950KWH/KW per year for 40 years make as much energy as 61 tonnes of coal – more than the average house weighs. Burning that much coal makes **226** tonnes of carbon dioxide. Our current energy mix uses more efficient fossil fuels (gas vs. coal) and 50% renewables, so lifetime CO₂ savings from 5KW of solar panels are closer to **40** tonnes now.

C.H.E.E.S.E. Project. Reducing emissions is closely linked to renewable generation, like twin strands of DNA. Reducing consumption by increasing energy efficiency can be cheaper than creating renewable energy - **megawatts** versus **negawatts**. But financing retrofits can be challenging after the low hanging fruit have been picked – e.g. loft insulation. CHEESE surveys identify the needs, and [Green Homes Grants](#) may finance the measures. For best results, we need a funded package to deliver renewable energy **and** retrofits – and savings.

See **Cold Homes Energy Efficiency Survey Experts** project – <https://cheeseproject.co.uk>

Climate Action Fund. The National Lottery wants communities to take the lead in tackling climate change, with £100m over 10 years to support this. Bristol Green Capital Partnership helped create a Bristol Climate Action Fund bid with 6 community groups (Climate Partners) including Lockleaze, and a group of projects with useful solutions (Climate Action Partners), including Lockleaze Loves Solar. The Lottery [awarded 14 grants](#) – to 6 projects between £1.25m and £2.5m, and 8 development grants of which Bristol was biggest with £375,000. This may be an opportunity to start scaling Lockleaze Loves Solar up – it an 'amplifier' project – a small investment in engaging with the community and developing a 'shovel ready' project in an area can bring in a multiplier – the additional finance the solar installs.

Community Benefit Fund. It is normal for renewable energy projects to set up a community benefit fund. This is in part because renewable energy is usually sold to the grid or a retailer – households get no discount, and the community gets no direct benefit. Community Benefit Funds are an indirect way to channel benefits from renewables back into the community. Lockleaze Loves Solar creates direct community benefits in the form of reduced prices, and profits are kept to a minimum. Savings could be as much as 30-50% of retail prices for every member/user. Community benefit is maximised when energy prices are minimised.

Decarbonising Energy. The growth of solar and wind is exponential, and forecasts based on this show they could supply all our electricity by 2030-32 – and **all** our energy soon after. But without long term storage we will have an excess of solar generation in summer and an

excess of energy demand for heat in winter. Batteries are fine for overnight storage, but the only realistic candidate to bridge the gap between summer and winter is hydrogen.

See **Exponential Growth**, **ITM**, **hydrogen**, **storage**, and **What We Need To Do Now**.

DNO/DSO – Distribution Network Operator / Distribution System Operator. The backbone of our national energy system is the National Grid, with regional franchises (DNOs) operating the local networks – including substations and the wiring that connects to our electricity meters. The Grid and DNOs charge for use of the networks via tariffs added to our energy bills by retail energy companies. In the southwest, the DNO is Western Power Distribution.

See **TUoS**, **DUoS**, **LUoS**, and **Energy Bills**.

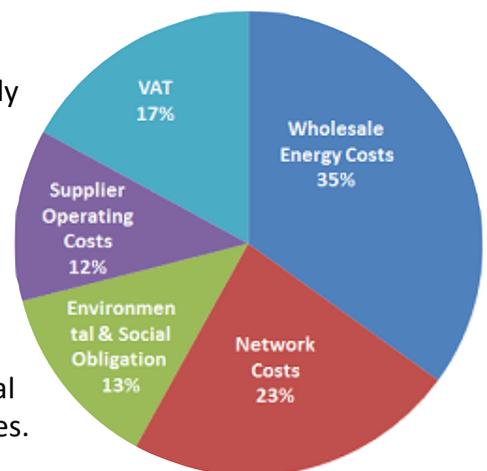
DUoS - Distribution Network Use of System charges. The DNOs and the Grid pass on their operating expenses in the form of network charges (DUoS and TUoS) which are paid by retail energy companies through standing charges and tariffs on consumer energy bills.

Electric Vehicles. The use of electric vehicles and the switch from fossil fuels to electricity for transport are a huge part of the switch to renewable energy and decarbonising our economies. Adoption and growth is exponential, like solar, but on a five year cycle for each 10x growth – faster than the solar 6-7 year 10x cycle, but lagged behind. Supplying the extra electricity needed will require a doubling of electric grid capacity if the extra energy is not generated locally, and/or transmitted through the Gas Grid.

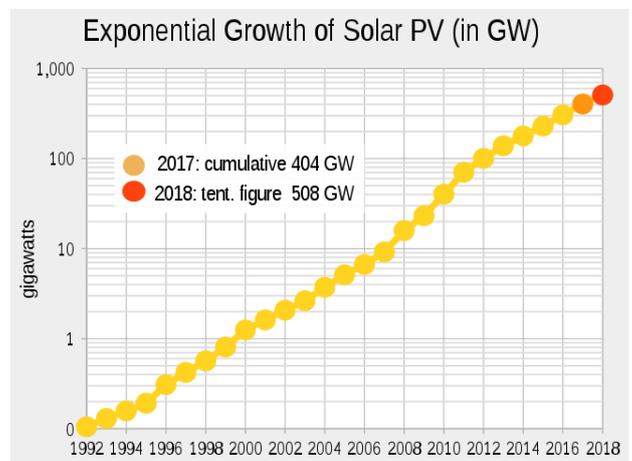
See also **Storage (EV)**, and **Gas Grid**.

Energy Bills. The typical energy bill has many slices. Locally generated renewable energy has the potential to avoid costs and charges, especially network charges when solar energy is generated ‘behind the meter’. Communities can reduce their own wholesale energy costs, and network costs can be reduced by local generation. It can be argued that grid and distribution charges should be lower, or zero, if high voltage networks are not being used. Also, that community energy groups should not be paying environmental and social obligation charges, but be being financed **through** those charges.

See **DUoS**, **TUoS**, **LUoS**, **Match Price**, and **TCR**



Exponential Growth. As the Wikipedia article on [Growth of Photovoltaics](#) states, solar growth has been exponential since 1992, illustrating with a near straight line graph on a logarithmic scale. At the same time solar energy has been following a **Learning Curve**, with costs falling 30%-40% with each doubling of cumulative deployment. Every forecast of linear solar growth has always been wrong, and as solar is now the cheapest energy source, deployment is only going to accelerate. If this trend continued, most of our energy would be solar by 2030-2032. See [Solar's Future is Insanely Cheap](#), a blog article by Ramez Naam.



Energy Local / Energy Sharing. The average house can already generate as much electricity as it uses in a year from solar panels, and the efficiency of panels is going up, and the cost coming down, so more roof space can be used and more energy generated. What follows from this is that we will generate most of the energy we use locally, and switch from top-down networks to local generation. Communities and energy companies will develop tools to expedite this, like **Energy Local's** pioneering scheme in Bethesda, which is being extended to other locations, as well as peer-to-peer trading, and local tariffs from energy companies. Lockleaze Loves Solar hopes at some time to share solar electricity between households.

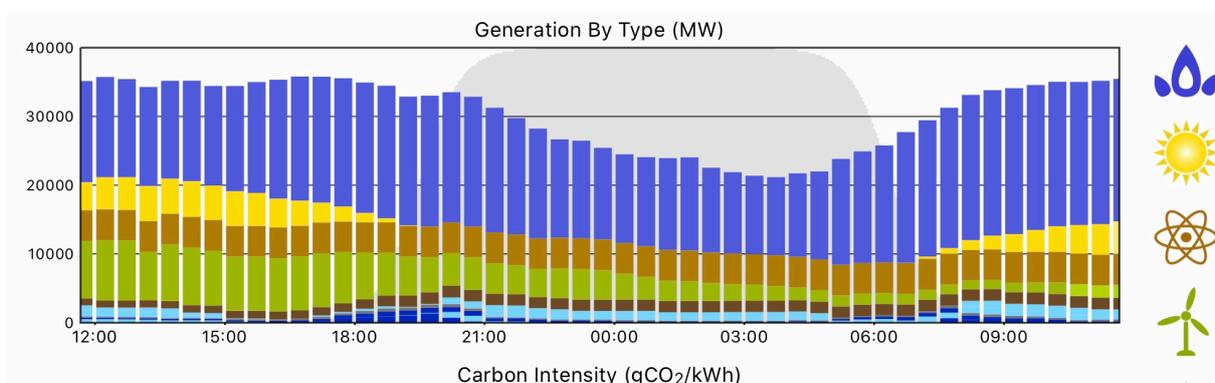
Finland. [Solar cell efficiency](#) is measured by the output from 1 sq meter of solar cells lit by a standard 1KW light. The best cells are approaching 50% efficiency, and commercial panels (1.7 sq m) now come in 330W and even 400W versions. A theoretical measure is how many electrons are activated by an incident photon, and the theoretic limit was though to be 1. Researchers at Aalto University in Finland (which has very low incident light) have recently produced cells with nanostructure involving roads and cones, achieving 1.3% electron s emitted per photon. This should result in even better solar panels in the course of time.

See here [Black silicon photodetector hits record breaking efficiency](#)

Gas Grid. The gas grid carries far more energy than the electric grid, and also stores energy. The gas networks are actively planning to switch from methane, which causes greenhouse gas emissions when burned, to hydrogen blended with natural gas – and even a total switch to hydrogen, which is GHG emission free. See **ITM, What We Need To Do Now** and **WWU**.

Green Homes Grants. We have to make housing stock more energy efficient to decarbonise the economy. This is expensive and and only likely to happen at scale if [funded by grants](#) like the chancellors new £3Bn scheme. Earlier schemes didn't get enough buy-in to have a significant effect. Meanwhile, renewable energy is getting cheaper, and if there were 100% Renewable Energy, there would be no housing emissions. It might be useful to model which is the more efficient approach – cutting household emissions, or zeroing emissions?

Grid Carbon. In the screenshot below from the Grid Carbon app, the off-grid generation from solar rooftops is missing. If it was added in, the midday peak would be 6-7GW higher. When solar generation doubles once or twice more, it will dominate the midday picture, and the midday grid peak will actually disappear because of this off-grid rooftop generation. Imagine that the yellow solar stripe is double the size below, and wind and solar generation are then doubled, and start to double again. Renewables become the dominant energy.



Growth Crisis. The failure of Bristol Energy, forcing this project to develop a Pivot strategy, is a typical growth crisis. Growth crises sound like a dangerous events, but are pretty normal in development projects in business and elsewhere – just as healing crises are quite normal in the progress of a fever. Seed finance helps turn a simple idea from a sketch into a feasibility study or a business plan, but when real development funds are injected, and reality kicks in, it is often necessary to stop and rethink – and incorporate this new learning.

Hydrogen Cycle. For millions of years, plants captured solar energy by photosynthesis, turning water and carbon dioxide into a myriad of organic chemicals. In this **carbon cycle**, the photosynthesis is only 3-6% efficient. Humanity uses biomass and stored fossil energy, burning it to make carbon dioxide – internal combustion engines are 20% efficient, electric power plants 35%, and jet engines 50%. In the **hydrogen cycle**, wind or solar electricity splits water by electrolysis at 80% efficiency, making oxygen and hydrogen. This is stored and recombined with oxygen in fuel cells at 60% efficiency (or burned at lower efficiency) to make water, heat and electricity. The round trip from electricity to hydrogen and back is around 50% efficient, and electric motors are 85-90% efficient. This cycle creates cleaner energy at lower prices, and hydrogen can help create a post-petrol chemical industry.

See also **Solar Hydrogen Economy, ITM Power, and What We Need To Do Now.**

ITM Hydrogen Gigafactory. ITM power in Sheffield are building a gigafactory to produce 1GW of PEM (Proton Exchange Membrane) hydrogen electrolysis units every year. Initial production is being used up in the petrochemical market where there is a ready market for hydrogen. As they scale up, costs will come down, as happens with wind and solar energy. Ten years of factory production is 10GW – enough to electrolyse a quarter of current electricity generation. Modelling will show how much actual hydrogen storage is needed.

See also **What We Need To Do Now, Wales and West Utilities, and Zero West.**

Learning Effect. Many new technologies follow a virtuous cycle, with costs falling steadily as improvements are made in production, miniaturisation, etc. – and deployment also grows exponentially because costs fall. The learning curve for semiconductors is called Moore's Law, and for solar panels it is Swanson's Law. These laws have proven surprisingly accurate, not least because technology developers know they have to stay ahead of their curves.

See **Exponential Growth** above.

LUoS - Local Use of System Charges. Electricity bills include TUoS (transmission network use of system charges) and DUoS charges (local distribution network) which are paid by all retail energy companies to the networks, based on standardised tariff tables. The network charge for biomass electricity from Drax is the same as for solar energy from a nearby solar farm. As the cost of locally generated renewables falls, this disparity becomes more glaring. A strong case can be made for lower local network use of system charges (LUoS) charges, and local energy tariffs to encourage and support local renewable electricity generation.

Match Price. In the Energy Local model, the wholesale and the retail price for energy is the same – the **match price** agreed by the generator and the customers – typically around 7p. Customers get cheaper energy, and the generator earns a little more than regular wholesale prices – an incentive to make more clean energy. Normally, electricity wholesales for 3-5 pence and retails for 12-16 pence. Energy Local eliminate this gap, which is made up of retail costs, profits, transmission charges, social and environmental obligations, and taxes. All of these could potentially be met from standing charges on energy bills.

See *Energy Bills*, [Energy Local](#), *Net Metering*, *TCR*, and *Energy Bills*

Net Metering. Early electricity meters turned in one direction when power was flowing into a house, and backwards when exporting energy. Customers paid what the meter reading said – their net consumption – so they got a credit for their generated electricity, at full retail price. This practice persists in some states in the USA – the utility companies hate it as they say it ignores operating and transmission costs – but they live well enough on standing charges. If we had net metering in the UK, solar energy would be highly viable right away.

Nuclear Energy. Too cheap to meter? [Hitachi have pulled out of Wylfa in Anglesey](#). And [Hunterston is closing early](#) because of critical safety issues with the core cracking up. The [National Audit Office](#) is criticising the NDA (Nuclear Decommissioning Agency) because of failing Magnox reactor decommissioning contracts and overrunning decommissioning costs. Unions are concerned about job losses, but Greenpeace rightly point out that nuclear is now far more expensive than renewables. Wylfa planned to make hydrogen to balance the grid, but this is best done with the cheapest energy, not the most expensive. Time for a rethink?

Researchers and Students. When community energy groups do something innovative, MSc students are keen to interview them. It only takes an hour, and their MSc writeup is almost certain to have some interesting thoughts and perspectives. It can be really helpful to get a fresh take on the project, from someone who is obviously deeply interested in the energy sector – and maybe studying it from a quite different viewpoint. There is an important overlap between community energy activists and the research community.

Adam Rostron, [Assessing the viability of post-FIT business models](#) (MSc Thesis, 2019)

Joe Pitt, [Tackling fuel poverty in multi-occupancy housing schemes using solar PV](#) (MSc Dissertation, 2019)

James Hoggett, [Towards a decentralised renewable energy system: Community energy and geographies of space, place and time](#). (MSc Dissertation, 2020)

Colin Nolden, Jake Barnes et.al. [Community Energy Business Model Evolution](#) (2020)

Riding Sunbeams. [Riding sunbeams](#) is a project from Community Energy South and the climate charity Possible, to power electric railways with line-side solar systems. The railways get cheap clean energy, and communities sell solar energy at better than wholesale energy prices. There is some potential to sell surplus rooftop solar from Lockleaze to the nearby rail line which is being electrified. This idea could be generalised to connecting community rooftop solar schemes to other enterprises with daytime demand – for mutual benefit.

Roof Lease. Many of the UK's 800,000+ solar roofs came through 'free solar' offers from energy companies and others. High feed-in tariffs made these deals profitable, and they were secured by roof leases giving third parties the right to mount panels, and collect the subsidies – households getting solar electricity 'for free'. Lockleaze Loves Solar planned to use roof leases for its free solar offer to households – though there are complications, for instance with houses sales, which can deter people from signing up. In the pivot scheme, in which the householder owns the panels, these issues don't arise. Ideally, as the project swivels back to offer free rooftop solar, it will find a way to bring communities, households, finance and solar energy together in a way that works for everyone and protects interests.

SEG. The *smart export guarantee* is an obligation set by the government for licensed electricity suppliers to offer a tariff, and make payment to small-scale low-carbon generators

for electricity **exported** to the National Grid. Different energy companies have their versions of this – [Outgoing Octopus](#) currently pays 5.5 pence/unit. With Lockleaze Loves Solar’s original ‘free rooftop solar’ scheme, SEG payments plus energy sales from self consumption would repay the finance used to install solar systems. In the pivot group purchase scheme, SEG payments supplement the savings households make from direct consumption of solar.

Solar Hydrogen Economy. Hydrogen is the most common element and the most efficient way to store and transmit energy, said top electrochemist John O’Mara Bockris in 1975. Physics and chemistry have evolved since and the price of solar energy dropped 300 fold. Making hydrogen by electrolysis from water, and electricity using fuel cells, is even more efficient and cheap. When wind and solar electricity are less than 3p/unit (already 2c/unit in some countries), hydrogen gas will be cheaper than North Sea gas.

See also **Hydrogen Cycle, ITM Power**

[Energy The Solar Hydrogen Alternative](#) (Bockris, 1975)

[The Hydrogen Economy](#) (Rifkin, 2002),

[Hydrogen, Powering a Net Zero Future](#) (free Mitsubishi ebook 2020)

Storage (Battery). More often than not, energy has to be stored after it is captured, for later re-use. Civilisations rise and fall depending on how well they do this. Renewable energy generation needs storage because of the diurnal and annual mismatches in generation and consumption. Early modelling by Lockleaze Loves Solar showed that batteries could balance generation and increase self-consumption, but were too expensive. Costs are falling and batteries being considered as an option with a the ‘pivot’ group purchase scheme.

Storage (Electric Vehicles). Electric vehicles adoption and growth is exponential, like solar, on a 5 year cycle for each 10x replication – faster than the solar 6-7 year 10x cycle – EVs are lagged solar, but catching up. Starting with the 2018 Nissan Leaf, EVs are being built with batteries that can be used bidirectionally. So a large battery came with a car purchase can not just cut the cost of travel, but do dual duty powering homes at night. Charging and discharging can be timed to balance supply and demand, and minimise bills, and further improved to share energy between groups of EVs and households.

see **Vehicle to Grid**

RHI. The Renewable Heat Incentive is an anachronism, given that solar and wind energy are no longer subsidised. Subsidies make sense to bootstrap a process and get it moving along a learning curve, but they don’t work well if the numbers will never stack up. What if a whole system approach thought this through properly? Every step on the way to 100% renewable energy reduces the savings from the next round of emission reduction measures. Maybe it would be cheaper to simply make sure the whole country has cheap renewable energy?

See also **Green Home Grants**

TCR – Targeted Charging Review. Ofgem have been looking at energy transmission charges, to update the system and make it fairer for local generation. They announced their decision in December 2019 – variable charges are being reduced to reflect actual system costs, and this opens up the possibility for lower local transmission charges. Charges of 2p or 3p per unit to transmit solar energy costing 3-4p/unit over short distances are excessive. But this means fixed charges will go up significantly, and those in fuel poverty will be hit hardest. Ofgem doesn’t explain why residual fixed charges will be so high, but note that Western

Power Distribution have actual operating costs of £600m, and revenues including charges of £1.6Bn, filing profits of £1Bn. These are not variable costs, so get factored into fixed charges
See [Ofgem Targeted Charging Review](#), [WPD Schedule of Charges](#)

TUoS. Transmission Network Use of System Charges. The National Grid is responsible for providing a stable and secure national energy supply, and renewable energy disrupts this. London cannot generate all its electricity, so it needs the grid to feed it. Whether the rest of the rest of country should pay for the capital when they will increasingly be generating their own energy is moot, but this is not a battle that community renewables can win just yet.
See ***DUoS, LUoS, Match Pice*** and so on.

Ultimate Battery Company. (UBC) The Ultimate Battery Company have a new architecture for batteries that works with a range of materials – lead, lithium, sodium, aluminium. It reduces weight by a third, making lead suitable for EVs at less cost than lithium batteries. They have \$2m from the US Department of Defence to set up production by March 2022 – the DoD want 170,000 batteries a year. LLS had been expecting domestic Li-ion batteries to cost £750-1000/KWH. UBC will have a £1.44KWH domestic lead battery for £170. This transforms the business case for domestic storage, and creates the potential for a cottage industry for garages to retrofit petrol and diesel vehicles with battery/electric propulsion.
See [Ultimate Battery Company – Key Benefits](#)

Vehicle to Grid. OVO *pay* customers to install smart chargers, and then run them optimally. The Grid would be catastrophically overloaded if everyone had electric cars, and charged them every evening on return from work. But what if the same vehicles are coordinated to charge when energy is cheapest, and power homes and the grid when it is most expensive – and also leave cars charged as much as needed for whatever range of travel is planned? EV batteries average 45KWH and the average home uses 24KWH/day, so a fraction of homes with EVs can balance a neighbourhood's supply & demand, and totally balance the grid.

Wales and West Utilities, and the End of Gas? WWU run the gas grid in the south west, and are not considering an end of gas because of CO₂ emissions. They have comprehensive plans for a future gas network that includes sustainable biogas and hydrogen. WWU have tools to model energy supply and demand in the southwest down to the half hour, and are hence well equipped to develop and explore different strategies for decarbonising the region.
See [Pathways to Net Zero - Decarbonising the Gas Networks in Great Britain](#).
And [The Beginnings of Electricity Supply in Bristol 189-1902](#)

Warm Up Bristol. This was an ambitious programme created by the City's Energy Services team under earlier leadership to retrofit homes using government subsidies via a monopoly contractor recruited through an OJEU sourcing process. *Climate Energy* rode roughshod over local contractors, and abused the community to recruit willing victims for poor retrofit work. When subsidies were cut, Climate Energy folded in an instant, leaving the City in the lurch to fix things and pick up the tab. Hopefully *Bristol City Leap* will do better than this.

What We Need To Do Now - For a Zero Carbon Future. Energy economist Chris Goodall's book [What We Need To Do Now](#) sets out a clearly written logical plan to get the UK to carbon neutral. It has ten key areas for action that parallel Bristol's One City Climate Strategy. His two main points are "*Build a huge over-capacity of wind and solar energy, storing the excess as hydrogen.*" and "*Use hydrogen to fuel our trains, shipping, boilers*

and heavy industry, while electrifying buses, trucks, and cars.” This is different to the One City Climate Strategy, so it’s a good basis for a constructive dialogue about what will be most effective. It should be a key part of the evidence presented to a Bristol Citizens Assembly.

Your City Our Future. Bristol is embarking on a Citizens Assembly that will take place in November 2020 with a programme called [Your City Our Future](#), an exercise in deepening local democracy, engaging with citizens to consider how best to recover from the Covid crisis, and **Build Back Better**. For many respondents to the initial survey, this is closely related to cross-party proposals for a Green New Deal, and to how to tackle the climate and environment emergencies. The preliminary work and these findings from Lockleaze Loves Solar should be valuable input to the process, showing a route for direct community action. There is no reason to delay in putting solar panels on 90,000 roofs across Bristol. This action can bring together households and communities to tackle climate change together.

Zero Carbon Bristol. There have been two Zero carbon Bristol conferences so far, both attempting to look at strategies that could decarbonise Bristol. The first was a think-tank event for the Green capital partnership in June 2010, featuring the Centre for Alternative Technology (and [Zero Carbon Britain 2030](#)) and the World Future Council with [100% Renewable Energy – and Beyond – for Cities](#). The [speaker videos are here](#). In 2011, only around 40% of attendees thought Zero Carbon was achievable by Bristol. The event was reprised in January 2018 by Bristol Energy Co-op and Zero West, and again featured Zero Carbon Britain 2030, and led to Low Carbon Gordano working towards Lockleaze Loves Solar.

Zero West. Zero West is a spinout from Bristol Energy Co-op, created to bring together community groups, businesses, local authorities and the local energy industry to accelerate transition of the south west to a zero carbon future. They have done modelling work using Wales and West’s Pathfinder modelling software, towards understanding what a balanced zero carbon strategy for the region would look like. This has led to work towards an offshore wind farm for the south west, and to the understanding that hydrogen offers a better solution for energy storage and winter heat than the biomass strategies advocated in earlier versions of the Centre for Alternative Technology’s [Zero Carbon Britain 2030](#) reports.

Afterword. *Considering Lockleaze Loves Solar in the context of a constellation of influences is itself an interesting learning. A picture emerges of a renewable energy industry growing on the back of historic fossil energy generation, distribution and regulation, and then potentially subsuming it, leaving real power in the hands of consumers and communities. The smart new energy companies, like OVO, Octopus and so on are all acting to create best value for consumers. Building a power base on the roofs of our communities seems like a good idea.*

This report is intended to share what has been learned so far, but as much as anything it is setting the scene for next stages and further development. The immediate next action, as soon as it is safely possible to reengage with communities, is to go ahead with the Pivot project, as a group purchase scheme. This will give important lessons in community engagement, finance, solar installation and operation. At the same time, other possible steps can be explored, with what’s been learned so far as a guide. Participation in the Climate Action Project and Citizens Assembly both look like obvious and positive directions.

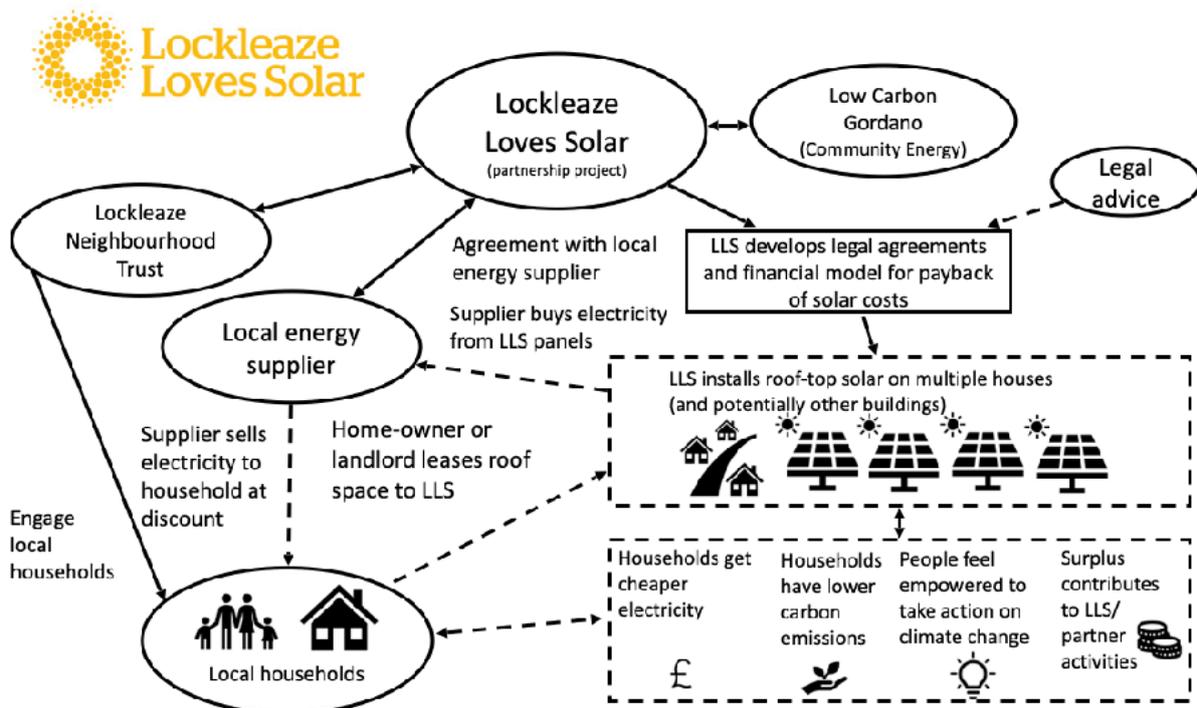
Appendix 1 - CAG Consultants report:

Next Generation case study: Lockleaze Loves Solar

About us:

Lockleaze Loves Solar (LLS) is a partnership between [Low Carbon Gordano](#) and [Lockleaze Neighbourhood Trust](#). The project involves the development and testing of a community owned cluster of solar PV installations that will collectively generate 1 megawatt of power. It is hoped to recruit up to 300 households and potentially one school to host solar PV panels – effectively participants lease their roofs to LLS - the power from which is currently expected to be sold, via a power purchase agreement, to [Bristol Energy](#). Participants will benefit from lower energy bills but wider objectives include helping to raise awareness of climate change and community mechanisms for responding to the climate emergency.

The model is intended to be flexible enough to allow for future growth, but is also intended to be replicable by other communities with a key component of the project being the development of a DIY toolkit which will include, amongst other guidance and supporting materials, standard legal documentation.



Key points for Community Energy groups:

The aim of the LLS is to develop a business model and toolkit which can be used by other community based organisations to establish local community solar initiatives. If successful LLS partners hope to replicate the model in other parts of Bristol but it is also intended to promote it more widely as it has the potential to be applied, at scale and in a variety of settings, particularly within communities within the southern parts of England.

Our learning so far:

The project is still operational and is still very much in a learning phase with activity evolving iteratively in response to real world conditions. To date the project has met and addressed a number of challenges and these have generated multiple lessons of the project partners. Those considered most likely to be of wider relevance are considered below.

Engagement with energy supply companies

The model for this project relies upon having an energy supplier as a partner. The intention is that the energy supplier buys power from LLS and then supplies this, at a discounted rate, to LLS participants (any surplus power is sold onto other customers). Establishing an effective mechanism for dealing with customer billing was seen as a major hurdle for the project and the involvement of an energy supply company was seen as essential. Project partners were initially concerned that suppliers might be unwilling to engage with the project owing to concerns about complexity or simply because the scheme was seen as too small to be worth their while. In practice conversations have been held with three energy supply companies, with Bristol Energy emerging as the projects preferred partner.

The engagement of Bristol Energy is seen as a major success by the pilot, particularly as it has addressed the hurdle of managing the complexities of customer billing. The fact that the project has been able to accomplish this indicates that other groups may also be able to establish similar arrangements, although it is understood that Bristol Energy regard this as a pilot endeavour and one which helps them to address questions of relevance to their own, wider, ambitions in relation to customer engagement in community energy initiatives of this sort. Learning to date suggests, that energy companies are willing to engage with community solar initiatives, but that the extent to which they will do so will, perhaps self-evidently, depend upon the level of overlap between local community and energy supplier objectives and ambitions.

Engagement with social housing providers

The project originally envisaged being able to recruit council and social housing tenants and held initially encouraging conversations with Bristol City Council and two local housing associations. In practice all of these organisations have subsequently indicated that they are not prepared for their properties to be included in the project. In the case of the local authority and one housing association this is because they wish their properties to participate in another scheme. The remaining housing association has decided that participation is overly complex at this point in time. The learning point for other community energy organisations is that local authorities and housing associations will have multiple opportunities to engage with solar PV and other energy initiatives, and may regard these as being preferable to local, community owned, schemes. In short, when

considering the development of local initiatives, community ventures should not assume that social housing providers will wish to be involved in their scheme.

The value of having an experienced and committed installation partner

LLS has chosen to engage [IDDEA](#) as their installer. IDDEA is a commercial organisation with extensive experience of installing domestic solar PV and came to the attention of LLS as a result of their (IDDEA) involvement in Fromes 'Solar Streets' initiative. IDDEA were the installer for this initiative and have subsequently become committed advocates of the concept.

IDDEA's involvement has provided the LLS partnership with an additional source of challenge and expertise, and has contributed to several improvements in the partnerships approach. For example, to minimise upfront costs the original business model assumed the use of a 'dumb' meter which would have required manual reading / checking. However, as a result of discussions with IDDEA, the partnership now plans to install smart meters. Each smart meter costs an additional £120.00, but their use avoids the need for manual checking and allows for real time charging by the energy supply company. Overall, the introduction of smart meters has improved the business case (by removing the cost of manual monitoring) and will better enable potential follow up projects on energy behaviours; something that the Neighbourhood Trust is keen to do in the future.

What we're doing next:

LLS has made significant progress, this has not always been straightforward and the partners have had to flex their approach to accommodate and address the challenges they have faced to date. As the project has developed it has attracted the attention of other community energy organisations and wider stakeholders but at the time of writing two key challenges are still to be addressed.

Recruitment and retention

Owing to the withdrawal of interest from the social housing sector the pilot has had to focus on privately owned housing. Recruitment from this sector has been slower than hoped and has since been disrupted by the emergence of the coronavirus. There is some concern that those who have provisionally signed up to the project may withdraw their interest as the project lead in time lengthens.

Finalising the legal model

The LLS model is based on the establishment of a formal contract of agreement whereby the homeowner, or other property owner, leases the use of their roof to LLS. Finalising the legal documentation that enables this has proven more complex than originally expected and is currently the projects most pressing challenge.

If you want to know more:

Contact Chris Stuart-Bennet – cjsb@neostasis.co.uk

Appendix 2 - Lockleaze Loves Solar – Contingency Plan – June 2020

These are challenging times, and the challenge is not of our choosing or making, but is what our Lockleaze Loves Solar project was designed to address. We need stronger and more resilient thriving local economies, that tackle issues of climate change, poverty and inequality. And locally generated renewable energy has long been identified as a direct way to tackle local renewal, fuel poverty and climate change.

Progress So Far

The business case for rooftop solar energy was still marginal at project outset, immediately post-subsidy – and not all the operational infrastructure was in place. Grant funding has given us resources and leeway to develop the initial partnerships, processes and structures we need for this new community solar business model. Operating costs could only be held down, and energy bills kept simple, through direct partnership with retailers – and working directly with community generators like us is new for them – but they have been open to our ideas, and other retailers are developing similar solar energy offerings. During the development process we have been able to fly trial balloons in the Lockleaze community that would host a rooftop solar farm, and amongst community energy groups. The initial response has been favourable.

Successes and Setbacks

Global pandemic was not identified as a possibility in our risk register, but our initial timeline allowed a whole solar season before we would attempt installs, and we were using this leeway to plan a smaller pilot on 20-30 roofs. The Covid delay would at worst only put us back on the original timeline. We expected to need this time to develop the relationship with a retail partner and to allow them time to add sales of rooftop solar electricity into their billing engine. Working with Bristol Energy we had identified the possibility for manual adjustments to bills that would allow us to do a trial in such an accelerated timeframe. Again, the loss of this option drops us back onto our original timeline.

Risks and Responses

The loss of a key partner was identified as a severe risk, and a real possibility, and it has happened – with the sale of Bristol Energy announced June 4 by Bristol City Council. The council had been under attack for an investment that was perceived as having got out of hand, despite Bristol Energy being central to bring in investment for the Climate Emergency Strategy, and to delivering the plans. The council have exceptional costs from Covid of £103m so far and counting, and further investment in Bristol Energy is deemed untenable despite future plans. The council needs all the funds it can lay its hands on. We took steps at the outset to mitigate by finding alternative providers. Octopus Energy, prompted by Co-op Community Energy, are developing a billing model that will suit us, which should be available in December.

Fundamentals of Solar

The bottom line for our project was that Solar energy has been growing exponentially for over 20 years, and costs have been falling exponentially as well, following an unusually steep learning curve – a 30% drop for every doubling in installations. There are fluctuations in specific markets, mostly caused by the effect of incentives and subsidies for solar and other energy sources. But following the end of subsidies in the UK, solar should track its learning

curve more steadily. The main feature of our model is direct sales of solar rooftop energy, eliminating the retail markup, allowing us to pass solar cost savings directly to end users.

[Solar's Future is Insanely Cheap \(2020\) – Ramez Naam](#)

[Energy firms urged to mothball coal plants as cost of solar tumbles | The Guardian](#)

Reality Bites

Set against this are the many complications of installing solar PV on a large number of small domestic sites. Plus finance costs, and the added operational costs of running a very distributed multi-site operation. And the biggest factor was the limited use that people make in their home of daytime solar generation, limiting the added income we might be able to get by selling them solar energy at a price somewhere in the gap between the retail price they usually pay for electricity, and the wholesale price we might get for what they don't use, which is exported. Our detailed modelling was constantly juggling all these variables.

Breakthrough

Worldwide the cost of solar has dropped to a fifth of what it was ten years ago. But while that cost was £2400/KW in 2010, the best price we could get from installers on a bulk deal as we set the project up was £800/KW. This constrained our model, but did not entirely scuttle it. It meant we could not offer as big a discount as we might have liked, or as high a return on investment, or pay off the investment relatively quickly. Then in February this year we discovered that we could access new low wholesale prices for solar, and favourable rates for contract installs, bringing solar costs below £600/KW and approaching £500.

Operational Costs

At the same time we received warnings that operational costs might be higher than expected, up to around a third of revenues, as opposed to 15% which we had used in our modelling. We cannot ignore this, as we have reports of operational costs from groups operating fleets of solar roofs, using commercial providers of monitoring and maintenance. However, solar systems are notoriously reliable apart from the first generations of inverters which had half lives around ten years. It's now possible to buy systems with 20 year guarantees, and we had expected most of the monitoring and most of the administration to be performed 'for free' by the energy company partners – handling all the accounting and paying for all the energy generated and sold directly or exported, and telling us when systems are not performing.

Operating Scenarios

The five cases in the table below illustrate the progression of solar pricing over the last two years (plus what might be coming), and how this affects our operation and options. Higher operation costs are factored in, but are reduced in the later scenarios, hopefully with smarter systems.

Standard Template Model - single property		£5000 for 4KW	£3875 for 5KW	£2600 for 5KW	£2600 for 5KW	£1884 for 4KW
Scenario:		1	2	3	4	5
		2018	2019	2020	2020	2021
Number of Kw installed		4	4	4	4	4
Installation cost per kw		£1200	£775	£525	£500	£475
Yield factor		950	950	950	950	950
Cost of sale (Incl. roof lease, surveys, etc.)		£325	£325	£325	£225	£150
Cost of finance	3.3%	£175	£117	£83	£76	£70
Total cost of install		£5,300	£3,542	£2,508	£2,301	£2,120
Generation per annum - kwh		3800	3800	3800	3800	3800
Self-use rate (+service charge?) - £/kwh	50%	£0.145	£0.100	£0.100	£0.050	£0.055
Export rate - £/kwh	50%	£0.050	£0.050	£0.050	£0.050	£0.055
Annual income		£371	£285	£285	£190	£209
O&M		£35	£35	£35	£10	£10
Admin costs @ 1% (?)		£54	£36	£24	£23	£18
Insurance		£24	£24	£24	£24	£24
inverters - 50% replaced in 25 years	40	£10	£10	£10	£10	£0
Total Opex		£123	£105	£93	£67	£52
Opex %		33%	37%	33%	35%	25%
Interest payments @ 3%	3%	£159	£106	£75	£69	£64
Annual Surplus		£89	£74	£117	£54	£93
Years to payback (capital + interest)		34.8	30.2	16.8	27.9	17.6
Annual Saving		£0	£86	£86	£181	£171
Energy saving vs retail over 40 years	£0.145	£0	£3,420	£3,420	£7,220	£6,840
Homes per £1m invested		189	282	399	435	472
Annual Savings per £1m invested		£0K	£24K	£34K	£78K	£81K
Annual Surplus per £1m invested		£17K	£21K	£47K	£24K	£44K

Scenario 1 is retail solar pricing as we went into the project. At £1200/KW (£5K for 4KW), even selling electricity at retail price the annual surplus is near zero (£6) and the project take over 100 years to pay back. Verdict – you would not even consider a project like this.

Scenario 2 is at the pricing we got from our installers. If we discounted electricity to consumers as steeply as we hoped – 10p/unit, we only pay back in 34 years, so at the higher

operational cost of 36%, we have to cut the discount. Verdict - project is marginal at best. You would not feel comfortable doing this project.

Scenario 3 - factoring in new lower install costs, and comparing like for like with scenario 2. Payback comes down from 43 years to 21, making a 10p price for electricity fully viable. Plus we can do 400 homes at 4KW average instead of 283. Verdict - very viable and acceptable, has leeway for contingencies.

Scenario 4 - As scenario 3, but modelling reduced cost of sale (no roof lease?) and operation costs (via working with retailer?). Allows sale of electricity to end users at wholesale price, doubling their savings, while maintaining the payback period at 21 years and further increasing number of installations for same investment. Verdict – great option if we can engineer our costs right.

Scenario 5 – modelling further solar cost reductions. (Currently almost available already if we use lowest cost wholesale kits, and squeeze installers, so may well be viable in a year or two). Cost of sale and operation both brought down by effect of our own learning curve on increasing volume. Verdict – a comfortable surplus and payback in 14 years. If achievable this is a very viable business model.

OPTIONS

There is obviously more work to be done, and we have spare time to do it, if that's what we choose. We have five main options right now:

1. **Walk away.** Consider this a good learning but too complicated to run operationally right now.
2. **Tread water.** Wait for Covid to pass and for things to improve.
3. **Proceed with caution.** Continue to develop these options, and work on costings and efficiencies. Maybe online consumer engagement?
4. **Switch.** Develop group purchase scheme as a contingency and alternate option.
5. **Network.** Keep an eye open for what others are developing as options, post subsidy, and for Green New Deal. Adopt and integrate. e.g. Riding Sunbeams?

OTHER FACTORS

Scaling and Green New Deal. There is a huge debate going on about the need to recover economically from Covid, and to use the opportunity to rebuild our economy while switching to renewables. Bristol has its own Climate Emergency Strategy, and other cities are developing theirs, while many books are also being published. There are some conflicting viewpoints – heat pumps versus hydrogen, and how many electric cars we should have, or should we make the modal switch to public transport? But solar is not contentious, and we appear to have a simple solution that could be scaled and replicated.

BEN and Climate Action Fund. Several BEN member groups have expressed interest in Lockleaze Loves Solar and Bristol seems fairly well set with its Climate Action Fund bid. This would allow us to develop pilots like LLS in several other neighbourhood partnerships. BEN are suggesting that Lockleaze Loves Solar should join BEN, and that we do some scoping work together.

Pension Fund Finance. Bristol City Leap has been put on hold pending the sale of Bristol Energy and a relaunch in July. Meanwhile, activists have been pressing on pension funds to divest from fossil fuels, to de-risk their portfolios, and to invest in renewables – specifically *local* renewables. They are discovering that they are knocking on an open door – both Avon Pension Fund and the Brunel Group of which it is a member are already thinking along these lines. What they need is ‘shovel ready’ projects for pension funds to invest in – indeed there might be an oversupply of finance if pension funds turn themselves round fast. This could only be to the good of our project and the good pensioners of Bristol. They would gain cleaner air to breathe, jobs for their children and grandchildren, and cheaper energy for all.

Action: At Lockleaze Loves Solar June 5 team meeting we chose to progress a Pivot Strategy – option 4, a group purchase scheme, following promising discussions with Bristol Credit Union. Other options are not ruled out, and the pivot option hopefully allows us to move ahead cautiously while reviewing other opportunities.

Appendix 3 - Pivot Strategy

Several factors fed into devising a new plan which would look more like a consumer group purchase scheme, while hopefully not ruling out a community financed install scheme when conditions become favourable. But how long would that take? Suzanne Wilson had the inspired idea to approach Bristol Credit Union about consumer finance.

1. **Bristol Credit Union** had already been offering a solar roof purchase scheme, but with low uptake at 7% interest. They offered us better terms – 3% over 10 years. This is a compressed timescale compared with the life of solar panels, but still affordable – just £1 per day for a decent-sized system. The loans would only be for homeowners, so this would be trimming back on our aspirations to support those in fuel poverty. But it would keep us moving forwards and we could revert at any time. The Credit Union could finance up to 1000 roofs, rather more than we had initially planned.
2. **Octopus Energy** were already offering a scheme, Outgoing Octopus – their version of the Special Export Guarantee – offering 5.5p for unused /exported solar energy. So households could get a fair income for the solar energy they've not used themselves. Octopus are also developing a billing package for self consumption, for commercial solar rooftop projects. Hopefully available in December, they say they will offer it to community groups for free. This would be a replacement for Bristol Energy, and with suitable finance would allow us to resume our original plan for free solar roofs for all.
3. **Installation.** Following the offer of really good wholesale pricing for solar systems, we had talks with a local contract solar installer, around an install-only contract. In further discussions we confirmed we can get fully managed installs, with all necessary surveys and certifications for around £3000. This is 20-25% cheaper than the prices offered by our first installer, who will be offered the chance to re-tender. Given the potential for 1000 roofs, we may end up using both. If we can hit a better price point, it's not actually important whether the installer or a wholesaler supplies the PV kit.
4. **Batteries Included?** With finance, retailer, and installers lined up, we're in a position to move ahead – if not as originally planned. We are thinking of offering systems with batteries, which would allow customers to use a higher percentage of the generated electricity. There is a trade off, as this increases the price of the system. But if it's a purchase funded by consumer credit, it's really the customer's choice. We simply want to make good options available and explain them well, and let people decide.
5. **Simplified.** If households themselves own the system rather than the community, there is no need for a roof lease – this eliminates a cost, as well as something that has become an item of contention with mortgage companies. Similarly, annual inspections and other operating expenses don't have to be factored in, so costs are saved. The community will not end up owning and operating the rooftop assets of owner-occupiers, but there is still potential to run the scheme as a generation co-operative.

We are preparing a revised budget and action plan to submit to Power to Change, following their acceptance of our Contingency and Pivot reports, and generally favourable comments.

Appendix 4 - Power to Change / CSE Response

Approved in principle new project idea for Lockleaze Loves Solar with following conditions:

All were aware that the previous model was quite thin and acknowledge that the current circumstances made the project more difficult to deliver at the moment. The sale of Bristol Energy and them introducing an admin charge mean that the project as it was originally envisioned cannot go ahead. However, the original business model may become viable in the future or/and for other organisations. Therefore it is essential to capture the learnings in a report to the committee.

The committee were impressed by the speed at which LLS recognised that the business model could no longer work and proposed an alternative idea and are supportive of this approach to Next Generation funded projects.

In principle the committee is supportive of this new proposal and is happy for LLS to develop a budget and timeline of activities to be submitted to the committee for approval using the budget remaining from the original project.

The committee agree that this model should create a mechanism for those who do not have the savings needed to purchase pv assets to access the renewable energy market and the potential to participate in flexibility services through aggregation of those assets in the future. It is also great that they will continue working closely with the neighbourhood trust as this partnership/ community engagement does not need to start from scratch. There will also be a great opportunity for learning for the whole community energy sector by engaging with a loan provider.

A critical element of this project which should be dealt with early on will be identifying the partner who is able to provide loans to householders, ensuring that they have the correct license agreement in place and understanding the loan criteria to ensure this is compatible with the householders they plan to engage. It will also be important to gauge the interest in taking up a loan for solar panels with residents in the area early on in this project to ensure there is appetite for this approach.

It is also worth consulting with guidelines from the council of mortgage lenders and being aware if there are any implications of repaying a loan for solar panels on a roof on the ability to sell the house, although this is likely to have a smaller impact than having a lease for solar panels on the roof.

Furthermore, the committee highlighted concerns that this new business model may not be deliverable in the current timescales (ie before September 2021). Power to Change would like LLS to highlight whether this is a potential issue for them as there may be scope for a further extension if needed.

Next steps:

- Report on findings from initial business model written up- LLS please suggest a timescale for this you are happy with
- A new project plan developed. This should include a brief narrative/ expansion on the project proposal if you think there are additional details to include. Most importantly the committee needs to see a delivery plan and budget that you will work towards. RH will provide Next Gen template which you can use if you find it useful. This should be using the budget you have remaining and in the timescale currently available (delivered before September 2021).
- If those timescales do not seem possible please let us know so that PtC can consider the possibility of offering an extension.

Date: 21/07/2020

Appendix 5 - Historical Background

Bristol's Green Roots

“There is not a brick in the City but what is cemented with the blood of a slave.”

– Anonymous

The world is at the confluence of many tipping points. Emmelie Brownlee began her book on Bristol's Green Roots with a discussion on the darker side of Bristol – the slave trade – on which Bristol's wealth was built. “By the late eighteenth century, it was not just the biggest slave port in the UK or Europe, but in the world.” It was also the first city outside London to set up an abolitionist movement. Women were a driving force in this, through campaigning and boycotting products. And of course there were fears about the effect on the economy.

Black Lives Matter and the toppling of Colston's statue show how deeply communities are divided on equality issues. Whatever work needs to be done to restore balance has only just begun. And this same pivot point appears in the climate crisis. In 2008 Andrew Simms, speaking at the Schumacher Lectures, suggested there was a parallel to be drawn – a concern that the environmental movement would damage the economic system, as “infinite and unregulated growth” would no longer be the aim. He said the abolition movement showed how it's possible shift the economy towards a fairer and more just model.

Former chief scientist Sir David King said in 2015 that the renewable race should be treated like an Apollo moonshot for renewables to cost less than coal in the next ten years. Startlingly, that point was passed in 5 years, but it is only half way to the moon. Subsidies boosted renewables into orbit in the decade from 2010 to 2019 – the real moonshot is to get to carbon neutral by 2030. Renewables only get us **to** the moon – to get back, to **reverse** emissions, agriculture must be transformed, and forests and carbon sinks restored.

In this bigger narrative, and in the inflection point caused by the Covid pandemic hiatus, Lockleaze Loves Solar is also taking stock. In the search for a new business model for community energy, much groundwork has been covered, and something like an integrated community energy model is emerging. This report sets out the journey so far, and the major learning points, and sketches out next steps on the path for community owned solar.

The Growth of Community Energy

Feed in Tariffs started in 1990 as part of Germany's energy transition – *Energiewende*. Fukushima in 2011 was a tipping point and a stumbling block – Germany's accelerated phasing out of nuclear energy increased their use of coal and gas as well as renewables. But it also accelerated the production of solar panels, lowering costs so that the Feed in Tariffs became very advantageous. Two solar co-ops formed in Bristol in 2011 to take advantage of this – Bristol Energy Co-op and Bristol Power Co-op, and by the end of 2011 they were sharing a 40KW solar array on the roof of Hamilton House in Stokes Croft.

From 2011 to 2019 the UK government's Feed in Tariff programme promoted renewable energy. Community energy groups took advantage of guaranteed incomes and by 2020, the UK's 300 community energy groups had a total of 193MW of renewable energy of which

155MW was solar PV. UK total installed solar energy in 2019 was over 13 gigawatts so community solar is just over 1%. There are around 800,000 rooftop solar PV installations in Britain, and together they provide around half of the country's solar capacity.

There are now sunny, windy days when renewables supply most of the UK's electricity. The country goes weeks and months without using coal power. Renewable and increased competition in energy markets seem to have halted a previously continuous rise in energy prices. But there is a long way to go still in the transition from top-down centrally generated fossil and nuclear energy, to networked, decentralised smart renewable energy systems, with a high proportion of locally generated – and owned – solar and renewables.

The lessons to be learned and applied are not just about new technology. Community groups are like a David to the Goliath of the philistine fossil energy giants. It will be hard to fight them on their own territory, but communities can build our own energy generation, and store it and share it as needed at prices that fossil energy can't compete with – simply doing away with the need for the old legacy system. Prompt action is needed – the city and community need to find and spend about £4Bn to get Bristol carbon neutral by 2030.

To build such an edifice from apparently small beginnings, it's worth taking a few minutes to look back over the progress so far. To see Bristol's progress and its unique position in the wider context of an environmental movement that was really born about 50 years ago, and which has gradually focused in on renewable energy not just as a way to halt and reverse fossil emissions, but as a way to empower communities, build resilient local economies, and loosen the death grip of capitalism – focused on unsustainable growth and profit extraction.

Origins of Environmental Activism

But how to tell the story of community energy in a couple of pages? For many people the climate crisis was first flagged up in the 1972 Limits to Growth report for the Club of Rome, and Fritz Schumacher's 1973 classic *Small is Beautiful*. The Centre for Alternative Technology was inspired by both of these and was also founded in 1973. And the Centre for Sustainable Energy was founded in Bristol in 1979 with roots in the Schumacher Society. So climate science was established in the 70s, and the seeds for change were planted.

Margaret Thatcher, herself a chemist, came out in favour of the establishment of the IPCC in 1990 – this helped bring together world leaders and activists for the 1992 Rio Earth Summit, which resulted in Agenda 21 and the subsequent appointment of Agenda 21 officers in councils across the UK. There was a further step change in community activism with the foundation of the Transition Movement by Rob Hopkin in 2006. And seeds planted by the Bristol Partnership in 2003 led to the launch of a Green Capital initiative in 2007.

By 2011 Bristol had published a Peak Oil Report, held a first Zero Carbon Bristol conference and a Bristol-Hannover Energy Summit. Bristol Solar Group and Bristol Energy Network both formed, and Emmelie Brownlee documented all this in *Bristol's Green Roots*, a book commissioned by The Schumacher Society to chronicle the growth of the environment movement in Bristol. And, critically, Ed Miliband's 2008 Energy Act led to the start of Feed in Tariffs in 2010, providing stable incomes for communities to explore renewable energy.

In 2012 and 2013 Bristol Power Co-op put solar panels on 23 domestic roofs in Lockleaze in partnership with Lockleaze Neighbourhood Trust – who were a 'front runner' in government

localism plans. This was a test of using renewables to directly tackle fuel poverty. Bristol Energy Co-op went on to put solar panels on more community buildings and develop solar farms – though Low Carbon Gordon pipped them to the post with Bristol’s first community solar farm. Solar energy was clearly viable, and growing despite big cuts in Feed in Tariffs.

The Feed in Tariff program was far more successful than anyone had imagined, including DECC, where they were championed by Ed Davey in the coalition government. The entry of China into the solar panel market in 2011-12 killed off many German and US solar panel makers, but despite trade embargoes, panel prices kept falling. David Cameron’s outright election win in 2015 allowed an accelerated end to Feed in Tariffs under Amber Rudd, so 2015 and 2016 were the golden twilight years of subsidised community solar energy.

Community groups did their best to make the most of subsidies while they lasted, and in 2016 community energy groups in Bath and Bristol raised over £50m for renewable energy projects, creating considerable momentum, and a thirst to do more. Community Energy England had formed, with similar groups in Scotland and Wales, and there was a continuous dialogue about how to pursue investments in renewables in a post-subsidy era. It was clear that solar and wind would be viable in their own right, but how best to make them work?

The key learning point here for solar energy is that the cost of a domestic solar rooftop system has fallen between 2010 and 2019 from £5000 per kilowatt, to £5000 for a full 4KW otop system – it has halved and halved again in the time that government subsidies drove solar installations from 95MW to 13.5GW – seven doublings. At the start, a domestic solar system would only just create enough energy in its lifetime to cover its cost, at retail price.

The subsidies dropped as the cost of panels fell, and the two kept in step for some years, so that at least until 2016 community groups could invest a million pounds in rooftop solar and would get about £2m back in feed in tariffs – more than covering finance and operation costs, and giving a good return to investors. During this time, banks and other finance institutions came to see solar energy as a good investment, and started lending to projects.

The End of Feed in Tariffs

The Feed in Tariff programme had permitted community groups to develop projects with a very simple business model – and a guaranteed income over and above whatever receipts they might get for selling energy. While solar and wind were becoming the cheapest way to manufacture energy, the end of subsidies meant that communities were going to have to develop new business models, and figure out what advantage they might have over commercial energy enterprises. Was there a niche where communities had an advantage?

There was much discussion, and conferences about ‘Life after FiTs’... The British Academy published a report on [Communities of Renewable Energy](#), and Possible (formerly called 10:10) wrote up their research as [Community Energy – The Way Forward](#). Opportunities included the falling cost of renewables, generation ‘behind the meter’ – accessing retail prices, working with ESCos to maximise revenues, community refinancing of commercial renewable projects, and councils engaging with community energy. Which was best to do?

The Lockleaze Loves Solar project described here is one possible answer. Roofs are already there, ready and waiting for solar panels, and right at the point where much of the energy generated can be used directly. It’s not a complete solution, but it feels like a good start.