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Annual Review of
Progress and Learnings
2018-19



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By **AD Research & Analysis** with the **Centre for Sustainable Energy** for the
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Foreword



I am pleased to highlight, through this second independent Smart Living review, the progress made with our portfolio of innovative locality-focused and energy related demonstrators.

As highlighted in our recent “Prosperity for All: a Low Carbon Wales”, innovation will play an important part in delivery of our vision for a future energy system. The holistic integration across the whole power, heat and transport spectrum continues to grow in importance to help support our decarbonisation agenda and delivery of multiple social, environmental and economic benefits for Wales.

Such changes bring challenges but, more importantly for Wales, it leads to opportunities too. Within Wales, we are committed on achieving lasting and sustainable change to underpin our people’s wellbeing and bring economic prosperity to all parts of the country. It is about a good quality of life, which is a key principle underpinning ‘smart living’.

Therefore, smart energy and smart living are very timely topics particularly as we rise to the challenge of net zero carbon. I have accepted the UK Committee on Climate

Change advice to increase the ambition of our decarbonisation targets in Wales. However, I believe whilst accepting the CCC advice, we must go further. Therefore, our ambition is to bring forward a target for Wales to achieve net zero emissions no later than 2050.

On the 29th April, the National Assembly of Wales made history becoming the first national Parliament in the world to pass a binding motion, in favour of a declaration of a climate emergency. This should set the tone for our work to achieve the 100 policy actions outlined in Prosperity for All: A Low Carbon Wales.

It also highlights the importance of using demonstrators to help reduce risks when the future is uncertain. In particular, with choices of different technological options, increased speed of change, decarbonising mobility, wider digitalisation and communication via social media, an improved understanding of the implications of different options becomes paramount.

In terms of renewable energy, in 2017 we set ourselves a target of achieving 70 per cent of our electricity consumption to come from renewable energy sources by 2030 and a target of one Gigawatt of renewable electricity capacity in Wales to be locally owned in the same timeframe. We have also indicated that all renewable energy projects are to have at least an element of local ownership from next year.

The demonstrators in Smart Living cover energy innovations and the transition to

smart energy systems feature in all the demonstrators but to widely varying degrees. Some of the Demonstrators primarily focus on clean energy technology and solutions; others arise primarily from work to secure the overall wellbeing of people within communities as they transition to a low carbon economy.

So, much of the value to date is based on what has been learnt through actual practice, by working together and in the capacity built within and across Demonstrator places and projects. The review provide opportunities of sharing the experiences and learning to help inform developments of new opportunities arising for Wales.

The wide range of practices described in the activities are helping to draw together multi-stakeholders from different disciplines and sectors and I believe this approach will form the basis for future working as we strive to develop and deploy the new energy revolution vision. With good progress made from their original concept, I look forward to seeing deployment of the initial demonstrators in the near future.

Lesley Griffiths AM

Minister for Environment, Energy and Rural Affairs

Executive Summary

This is the second Annual Review of the Welsh Government's Smart Living Initiative, providing a progress report and reflections on 20 Demonstrator projects, which are included among those supported by the Government. This is an independent report from ADR&A and CSE, which have been involved with the Smart Living Initiative since its early days and are in a well-placed position to review progress against the baseline and original aspirations for the Initiative.

The Smart Living Initiative catalyses and supports place-based projects, which aim to create innovations on the pathway to a low carbon Wales: the Demonstrators are described as 'place-based and needs-led'. Some individual projects also inform and contribute to cross-cutting themed developments, and these are also included in this Review.

Energy innovations and the transition to smart energy systems feature in all the Demonstrators but to widely varying extents. Some of the Demonstrators are primarily focused on clean energy technology and solutions; others arise primarily from work to secure the overall wellbeing of people within communities as they transition to a low carbon economy.

This 2019 Review involves a stocktake of progress and current activity in 20 Demonstrator projects distributed across 15 places. In each place, the review process involved an analysis of key documents and interviews with the 'owner' or host organisation of each project; in many cases a project partner was also included (eg. an academic researcher, or consultant). In eight of the places, face-to-face interviews were conducted, usually in the form of site visits.

The Review findings were analysed and reported either as single place-based case studies, or cross-project theme studies. This report on the Review presents four place 'portraits', and four

cross-project 'themes'. An overview of the 20 Demonstrators included in the Review is provided in the following table along with headline outcomes from the projects to date.

The report also includes reflections across the whole Initiative, on the nature and potential of 'smart' energy innovations and solutions, and on the evolving nature and value of the Smart Living Initiative. Points on the value of Smart Living to date include:

- Smart Living is helping to deliver the high-level policy goals of the Wellbeing of Future Generations Act, and more recently Prosperity for All: A Low Carbon Wales. At the same time, it is giving substance to those policy statements through the creation of change on the ground by the Demonstrator projects, which it has funded and nurtured.
- Smart Living has provided an increasingly clear picture of what the transition to a decarbonised energy system and to smart services will require, and where it may lead.
- The Initiative is drawing in academia, Catapults, best practice and private sector expertise to increase the capacity of individual place-based developments to innovate and learn from experience.
- The Initiative is helping to take partner organisations along the decarbonisation journey by helping to manage and anticipate risks, and by providing support to keep the momentum going when barriers and challenges occur.
- In many Demonstrators innovative technologies and solutions are being built and deployed; as these become connected together so the 'smart' aspects will be enabled, resulting in service transformation which can benefit

people of all kinds.

- As a complex system, or system of systems (made up of multiple projects), it is hard to measure the value of the Smart Living Initiative, talk about its effectiveness, or attribute causality. However, across the Demonstrators supported by Smart Living substantial value has been created so far (see headlines in the overview table below). Much of the value to date is based on what has been learnt through practice, and in the capacity built within and across Demonstrator places. Quantitative value tends to be more emergent: carbon savings for example are not yet apparent, but are imminent in the next few years as projects move into the construction and launch phase, then go live.

The Review closes by providing recommendations for the Welsh Government in continuing and accelerating the substantial progress made by the Smart Living Initiative since its launch in 2015, and particularly over the last year. These recommendations include that the Welsh Government should:

- Continue to support Demonstrator projects across a wide range of activities and entry points, including heat, power, transport, people, and business. Smart Living should continue to provide vital start-up funding, and then support to catalyse that innovation including through helping to bid for and secure substantial follow-on funding, for instance for capital investments.
- Provide additional support to enable closer networking between Demonstrators, such that Smart Living can also become a learning system, designed to accelerate innovation and progress towards a zero carbon Wales, and to help successful projects to spread to other places and to scale up, so their benefits to Wales can be maximised.
- Whilst there are expected quantifiable outputs from demonstrators, these may be claimed by others as part of commitment to their delivery. Therefore, there is a need for Smart Living to

explore how best to measure progress and value across the Initiative in terms of both its catalysing and pathway role. Partners should be involved in codesigning share metrics to capture the full value of the work (qualitative, quantitative, and emergent value). Through supporting Demonstrators to develop approaches to self-measurement which meet their own needs and fit in with their own ways of working, and the design principles of Smart Living, Demonstrators can better understand how they are adding value, and delivering on the multiple layers of policy objectives which invariably shape them.

- Extend the profile of Smart Living and the Demonstrators in order to reach out to potential partners across sectors to promote the benefits of getting involved in smart energy innovations, and to advocate for adopting a place-based, needs-led approach (in this way ensuring that benefits to places and people of Wales are maximised no matter which sector leads the work).
- Wait... because the benefits from smart innovations and systems are emergent, and take time to materialise, but the evidence in this year's Review is clear that they are coming. Smart Living should keep pushing the pace of transformation, but at the same time, keep being patient.

Place	Projects	Portrait / Theme	Headline Outcomes to Date
Cardiff	Low Emissions Transport	Theme	The Ultra Low Emissions Vehicles and sustainable mobility strategy and planning process have encouraged a change towards longer-term strategic thinking by local authorities and a more collaborative, area-based and regional approach.
Flintshire & Denbighshire	Electric Vehicle Planning	Theme	
Gwent	Electric Vehicle Planning	Theme	
Monmouthshire	Ultra Low Emissions Transport	Theme	
Rhondda Cynon Taf	Hydrogen in the Valleys	Theme	Knowledge sharing between stakeholders, facilitated by Smart Living, has already been beneficial. Involving industrial partners will lead to a better developed supply chain, with local businesses set up to provide skills for design, build and operation of hydrogen systems. Continued learning from the pilot projects, within and outside the Smart Living Initiative, could inform national policy making to support different types of hydrogen technologies and applications.
North Wales	Hydrogen Cluster	Theme	
South Wales	Hydrogen Cluster; Hydrogen Research Centre (U of S Wales)	Theme	
[All Wales]	Hydrogen Reference Group	Theme	
Caerau	Better Energy Futures	Theme	'No one left behind' has emerged as a key theme in the Smart Living Initiative, not just as a policy aspiration but as a practical challenge for local authorities as they deliver on the ground. This is particularly apparent in the projects now undertaking the transition to decarbonised transport. At national policy level, the smart social inclusion work pioneered by the Demonstrators will help inform development of Welsh Government's forthcoming plan to tackle social inclusion.
Anglesey & Gwynedd	Angle DC	Theme	The Smart Living Demonstrators provide the opportunity to see with clarity, at a micro level of the electricity system, what is going on as we move towards a low carbon future. It is clear in many of these innovative projects that the current configuration and operation of the electricity network is not set up to help them achieve their objectives for innovative generation and rapid decarbonisation.
Flintshire	Local Virtual Private Wire	Theme	
Milford Haven	West Wales 'Zero Carbon Area'	Theme	

Continued ...

Bridgend	Town Centre District Heating Scheme Geothermal (Mine Water) Scheme (Caerau) Streetlighting Upgrades Decarbonising Bus Transport Smart Energy Storage Solutions (post-use EV batteries)	Portrait	Bridgend CBC has become a focal point for helping understand the steps needed to transform a local area with decarbonised heat, as well as smart systems and processes, and potential new services. Heat schemes can be very complex, and nationally the task ahead for meeting decarbonisation targets for heat is significant. Having Bridgend CBC participating in the vanguard of smart systems and heat has been extremely beneficial for Wales to help generate and capture learning and innovation, whilst also helping spread this to other Demonstrators, and through project partners' wider networks.
Blaenau Gwent	Catalysing Local Energy: Business/ industrial platforms	Portrait	Understanding the key drivers of local businesses and the characteristics of industrial estates and business parks has provided value in ensuring that the offer to businesses is suitably differentiated. The pilot has shown the potential for an increase in resource efficiency practices by businesses through quick-win measures and through brokerage of demand reduction services.
Neath Port Talbot	Smart Low Carbon Development	Portrait	Smart Living's aim is to catalyse opportunities and increase the potential for step change using smart technology, systems and processes to deliver on future ambitions of what low carbon wellbeing should look like in terms of smart energy, heat and mobility. Helping to put in place the building blocks, which then translate projects into major programmes is an ideal solution, and can be considered one measure of success.
Torfaen	Wellbeing in Blaenavon	Portrait	Over the course of the project, partners have learned that significant investment and genuine commitment is needed to achieve the PSB's Wellbeing Objectives. Each service has focused on delivering different objectives, and a key challenge is to ensure the 'shared' objective of supporting healthy lifestyles is recognised amongst the many other priorities that individual public bodies have.

1) Introduction

This report provides a snapshot of the Welsh Government's Smart Living Initiative as it stood in June 2019. The review was commissioned by the Smart Living team from Andrew Darnton at AD Research & Analysis (ADR&A), working with a team of researchers at the Centre for Sustainable Energy (CSE) led by Nicky Hodges.

This is the second Annual Review of Smart Living to be published by Welsh Government (WG). As with the 2018 Review, this is an independent report from ADR&A and CSE. They are well-placed to conduct it having been involved with the Smart Living Initiative since its early days. Together they ran a programme of informal consultation with stakeholders across Wales in 2015, which helped shape the development of the initiative. This fed into WG's Framework for Smart Living, the governing document including a vision, principles, and the criteria by which Demonstrator projects could be selected.

The Smart Living Initiative catalyses and supports place-based projects which aim to create innovations on the pathway to a low carbon Wales: the Demonstrators are described as 'place-based and needs-led'. Energy innovations, and the transition to smart energy systems, feature in all the Demonstrators, but to widely varying extents. Some of the Demonstrators are energy technology driven; others arise from work to secure the wellbeing of people in communities as they transition to a low carbon economy.

As the Framework document makes clear, Smart Living is hard to define: it is better expressed as a Vision, a set of Principles, and the governing Criteria for Demonstrators. In one sense the Initiative is idealistic: it holds a vision which is in line with the Wellbeing of Future Generations Act and its overall goal to secure the health of Wales and its people now and into the future.

The Principles set out basic ways of working for the Initiative, and these are extended to partners through the Criteria by which Demonstrators are selected.

As Smart Living has evolved over five years, a number of interlocking priorities have clearly emerged for the Initiative and its Demonstrators:

- The wellbeing of Wales, its places and people, now and into the future.
- Innovative energy technologies and applications, as part of a smart energy transition.
- No one left behind: increased inclusion and decreased inequalities.
- Economic prosperity, both in terms of thriving places, and in ensuring that Wales is well-placed to contribute and compete globally.
- Rapid decarbonisation, and an accelerating transition to a low carbon economy (e.g. in line with WG's declaration of a climate emergency, April 2019).

As this Review seeks to illustrate, above all Smart Living is best understood through the work underway in a set of Demonstrator projects in different settings across Wales, and the themes and learnings that can be drawn out across them.

This 2019 Review is based on a stocktake of progress and current activity in 20 Demonstrator projects distributed across 15 places (see Table 1 in the Executive Summary). Even assembling the 'sample' for this Review has revealed the complex nature of the Initiative, which mirrors the complexity of the transition to a low carbon future. The projects reviewed here are all Demonstrators, in that they fit the Smart

Living Criteria. Most have received funding from WG via the Smart Living Initiative – yet nearly all are also supported by other funding streams, and are partners in other initiatives and research programmes. There are other places and projects across Wales, which have received in-kind support from the Smart Living team: these are not itemised here. What results is a comprehensive (but not definitive) set of Smart Living Demonstrators as the Initiative stood in early 2019.

Working with the Smart Living team, the 20 projects were selected for inclusion in the Annual Review exercise. The ‘owner’ or host organisation of each project was contacted, and in many cases a project partner was also included (eg. an academic researcher, or consultant). Working with these lead organisations and partners, we drew together progress to date, potential next steps, and emerging learnings. We reviewed key reports and papers developed by each Demonstrator, then we held an interview with the key actors in the lead organisation. In eight of the places, these interviews were held face-to-face, as ‘site visits’; in these, and all the rest, detailed phone interviews were undertaken. All this interview evidence was transcribed and analysed by the research team.

The complete body of evidence from the 20 projects was written up as long-form case studies; seven final case studies were chosen and produced. Both the lead organisations and WG Smart Living were invited to write into the case studies, particularly to add their learnings and reflections. Final sign-off of each case study rested with the lead organisation. The case studies were then summarised by the research team, and those summaries make up the body of this report. Four are based on places; three are written around themes, which cut across multiple projects.

Having built up this picture, the report draws out learnings for Smart Living, before closing with a set of recommendations for WG as to how to sustain and build upon the momentum and innovation that the Smart Living Initiative and its projects have demonstrated to date.

2. Four Demonstrator Portraits

‘Pen portraits’ of four of the Smart Living Demonstrator projects in 2019 follow here. These portraits summarise the detailed place-based case studies which were prepared for this Review, with input and approval from the project ‘owners’ (the local authority, in each of these cases – though that is not true of all Demonstrators).

- 1. Bridgend**
- 2. Blaenau Gwent**
- 3. Neath Port Talbot**
- 4. Torfaen**

These four Demonstrator places were chosen for inclusion in the Review report as they illustrate a spread of projects indicative of the diversity across the 20 Smart Living Demonstrators as a whole, including in terms of the following dimensions:

- **Local capacities**
eg. geographic and demographic types; industrial profiles; renewable resource potential.
- **Stakeholders and communities**
eg. cross-sector partners; government, business and householder audiences.
- **Smart Living priorities**
varying across: wellbeing goals; fuel poverty focus; energy technologies; economic prosperity; decarbonisation pathways.

- **Levels of funding**

including from Smart Living, in a range from £5k to £250k per Demonstrator over the four years of the Initiative to date- but with some Demonstrators having secured funding and expertise worth over £25m from multiple sources across the same period.

- **Duration**

most are Phase I Demonstrators – some dating back to 2015 and the beginnings of Smart Living – with Torfaen being a Phase II project, new in 2018.

This selection of Demonstrators also supported the analysis of findings according to some of the dominant themes arising from the Initiative, including ultra low emissions transport, hydrogen, smart energy social inclusion, and network innovations (see the Themes section on p29).



2.1 Bridgend: Smart Systems and Heat Programme

Vision

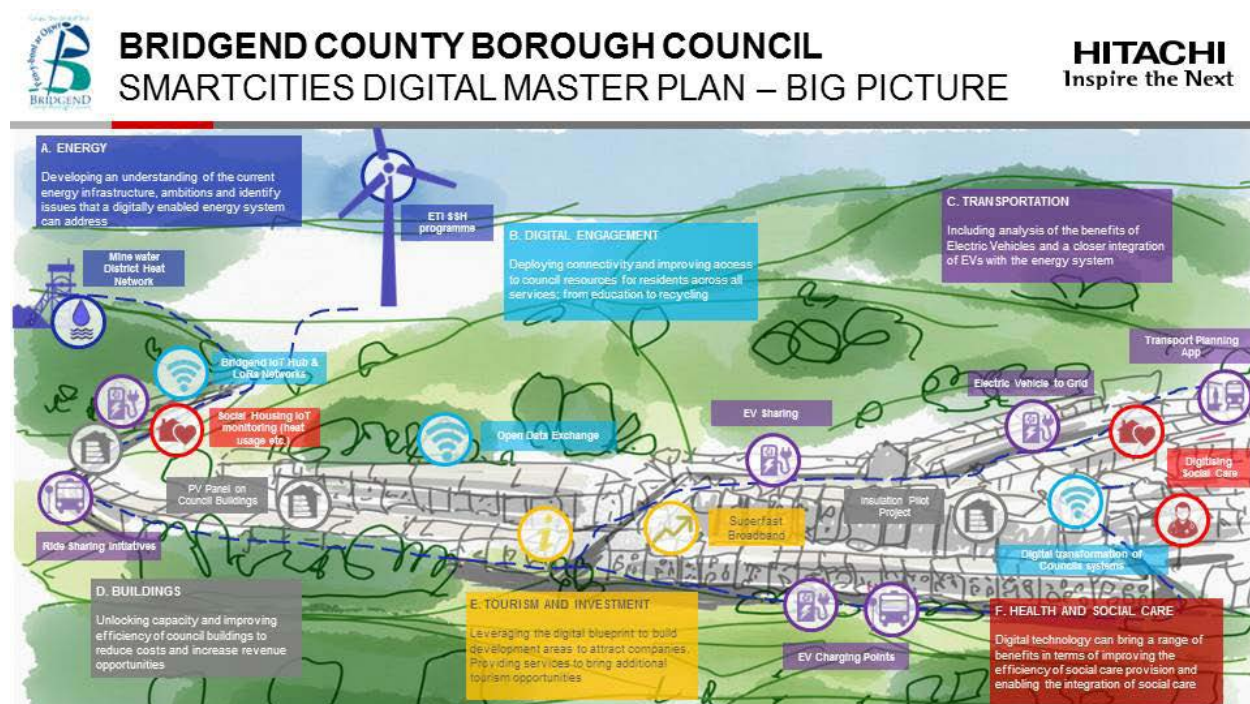
Bridgend County Borough Council (BCBC) has a vision to make Bridgend a “decarbonised, digitally connected smart County Borough”. In doing so it will transition from the current national, centralised energy system to a future low carbon, decentralised energy system that works for its individuals, communities and businesses.

The Council’s aim in pursuing this vision is not only to decarbonise the energy sector, but also to stimulate economic growth: providing new job opportunities to residents and attracting new and existing businesses to trial initiatives and grow within the County Borough. This aim aligns with the vision outlined in BCBC’s Regeneration Strategy (2008-2021), that; “By 2021, Bridgend County Borough will be recognised as a self-contained, productive sub-regional economy with a skilled and utilised workforce in a place where people and businesses want to be”.

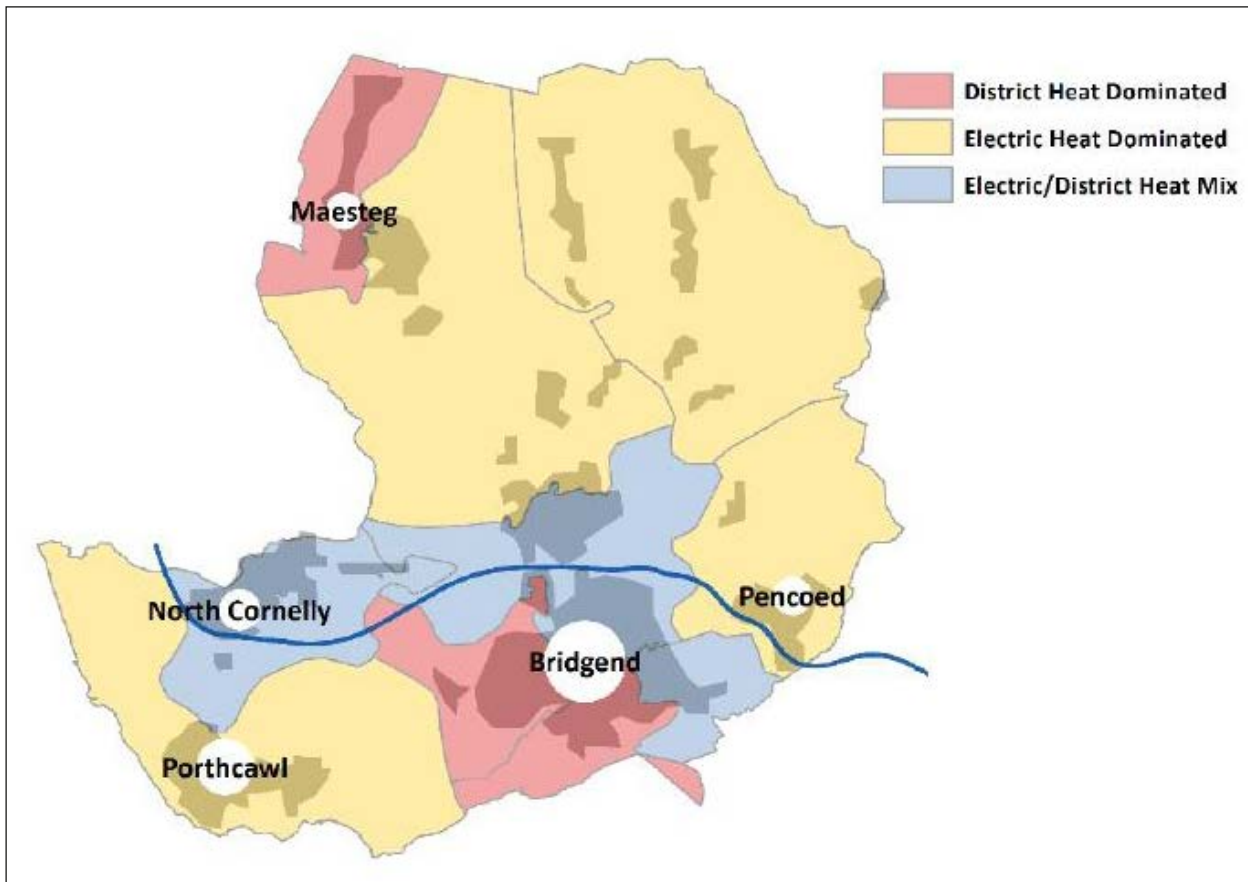
Overview

In October 2014, The Energy Technologies Institute selected Bridgend County Borough Council (Bridgend CBC) to be part of the UK Smart Systems and Heat (SSH) Programme, alongside Greater Manchester and Newcastle. This ambitious programme marks out Bridgend as one of the leading low carbon local authorities in the UK.

Following the transfer of the SSH Programme to the Energy Systems Catapult (ESC) Bridgend CBC undertook extensive heat and decarbonised energy planning, deploying the ESC’s EnergyPath Networks local area energy planning tool to create a decarbonised strategy for Bridgend County Borough to meet UK Government 2050 decarbonisation targets. In parallel to SSH Hitachi were contracted to develop a Smart Digital Masterplan for Bridgend, providing an open platform design for integrating public services originating with energy and expanding to other



Area map for decarbonisation by 2050



areas. The Smart Living Initiative identified Bridgend as a Demonstrator, and provided ongoing support to Bridgend throughout this journey, including start-up funding as individual projects emerged from the planning process.

Phase 2 of the SSH Programme has created a Smart Energy Plan for BCBC, covering the period 2019 to 2025, which puts Bridgend County Borough on a pathway to delivering the Bridgend CBC Energy Strategy vision for 2050. Approved by Cabinet in February 2019, the Plan is the governing document for Bridgend CBC on its pathway to decarbonisation by 2050. It translates across Bridgend's Smart Energy Plan to 2025, which contains a pipeline of current and proposed smart or innovative projects, which the Council are progressing.

The Plan includes an Area Map which shows geographically by 2050 how each part of the

County will be decarbonised. The Bridgend Smart Energy Plan is the main planning instrument for the pathways to 2050, effectively a place-based scenario-modelling tool.

In terms of delivery up to 2025, the SSH Phase 2 Plan contains three deployment projects, and five innovation projects. Smart Living has been working closely alongside Bridgend CBC's energy and heat team throughout the SSH journey, and has actively supported a number of the longer-running projects. In addition, the Welsh Government Energy Service has provided specific support for the development of an outline business case for the town centre heat scheme. Five of the eight projects covered by the Phase 2 Plan are included in this Smart Living Review, as follows:

- i) A Bridgend town centre district heating scheme involving public and civic buildings, a leisure centre and homes.

- ii) A pioneering geothermal scheme in Caerau, utilising groundwater in former mine shafts in the Llynfi Valley along with heat pump technology, to provide heat to 150 local homes.
- iii) A design project for Smart Intelligent Bridgend seeking to integrate, heat, power and transport including decarbonising bus transport in Bridgend, funded by a grant from the Industrial Strategy Challenge Fund – Prospering from the Energy Revolution.
- iv) A Smart Energy Storage Solutions project to repurpose post-use EV car batteries as community-based energy storage (in households or neighbourhood heat hubs).
- v) Streetlighting upgrades with forward planning to ensure compatibility with forthcoming 5G network capability.

Current activity on each project is described more fully below.

Activity

i) Town centre district heating scheme

The heat network will connect civic buildings, a leisure centre, commercial office/leisure, Primary Care Centre and 59 houses.

“We’ve been developing the project for several years and its now close to delivery ...” [BCBC project lead]

The Council approved the outline business case in April 2018 and the detailed design passed RIBA stage 3 in March 2019.

“We will be offering more than in a conventional energy bill: the users won’t need to buy or maintain the heat equipment in each property which is a challenge to explain and show that the heat network scheme offers real value for money”.

Draft heads of terms with the customers of the scheme and a procurement is underway

to appoint a contractor for the design, build, operation and maintenance of the heat network. The aim is to be operational by the end of 2020. It is believed that Bridgend town centre will be the first heat network at scale in Wales involving retrofit to existing buildings.

“Perhaps it’s not that innovative but the difference is we’re actually delivering it. We can say ‘we’ve done Phase One and we can do this’. It’s something tangible that we’ve proven we can deliver and that we can point to when we talk about the rest of our plans. It is great to be getting something done we’ve been developing for a long time...”

ii) Caerau mine water scheme

In 2015, modelling studies were undertaken around the borough to identify potential sites where mine water could be used as a heat resource. Caerau was identified as the optimum site, and a feasibility study was commissioned September 2016.

The feasibility work established the mine water was at a temperature of 20.6 degrees C. This was higher than anticipated, and exceeded minimum requirements for the project to proceed. In parallel, community engagement work was undertaken: in part to counteract any possible negative response to the (feasibility study) bore-hole drilling but also to promote the scheme and encourage participation in the future.

European Regional Development Funding is crucial to the delivery of this scheme, the completion date for the project is June 2023. Construction is currently scheduled for 2021. This is potentially longer than the original timeline due to the challenging, innovative nature of the project.

“A normal heat network, like the one in the town, is hard. This is a good three notches up from that” [BCBC energy/heat lead] – particularly because it is mine water, and it involves private homes rather than council buildings or public sector assets.

Techno-economic analysis is now underway; interim results suggest that pricing will be at a similar or slightly lower cost to householders than their current energy bills.

A community consultation was undertaken in late 2018, based around a survey of 1,600 local households. This achieved a response rate of 12% - 60% of whom expressed willingness to sign up to the network. The survey covered topics including: house characteristics; patterns of occupancy; current energy bills; mine water/heat perceptions; other comparable contracts already signed up to (e.g. digital/mobile services). The Cardiff Geophysical Research Group have been geo-mapping the responses: they have a map of 'willingness' and other dimensions and this could inform the phased build-out of the network (e.g. starting in places where consumer demand is strongest).

A number of householders want to know the practical detail of how the system will look and feel in their homes (as well as the costs). These details are only just coming into view. Notably, last year the assumption was each home would have a heat pump. Work by Challock Energy now suggests bigger 'neighbourhood hub' heat pumps will be more effective. Meanwhile, the Energy Systems Catapult have begun to test the market for providers to install and run the network hardware. This in turn helps inform the economic modelling – which provides better detail for householders.

The indicative cost for grid reinforcement for the heat network at Caerau was over £1m. Hitachi have completed a study looking at alternative options to a grid connection. The study concluded that it would be viable to lay a private wire from a windfarm on the ridge above Caerau. A private wire solution would also be in keeping with a grant awarded to Caerau by the Lottery's Building Communities Trust fund in 2016- £1m to develop community renewables (PV and wind) capacity. Both these sources could power the neighbourhood heat pumps, meaning the scheme would be supplying 100% community energy, all of which is renewable and off-grid.

iii) Decarbonising bus transport

Bridgend CBC participated in a bid to the design stream of the 'Prospering from the Energy Revolution' competition, which sits under the UK Clean Growth Strategy. The Bridgend CBC consortium featured Hitachi, Cardiff University, First Cymru and Cenin Renewables – who have a site generating power from PV, wind and anaerobic digestion (AD).

First Cymru have two bus depots from which they operate services across the County Borough and beyond. The current sites are cheap to run but will need to decarbonize in the future. The costs for reinforcing the network to bring a supply into the sites able to charge electric buses are likely to be significant. The project idea is to move the depots to the Cenin site where there already exists a renewable power source, effectively creating a decarbonized bus depot. The design task is to match First and Cenin's needs for generation and use. Hitachi's interest is in providing a digital wrap-around provision, such as an on-demand bus service with mini buses making pooled journeys for example.

There are many technical challenges, beginning with practical difficulties powering electric buses in hilly landscapes but the study aims to address these and understand how buses within Bridgend will be fuelled in the future.

The final design plan is due by the end of June 2019 and then Bridgend CBC plans to re-bid for the detailed design phase, which would run up to December 2021.

iv) Smart Energy Storage Solutions (SESS) with post-use EV batteries

The SESS is a 12 month feasibility study led by the University of South Wales. It features a consortium comprising the University of South Wales, Ford and Cacar. Project funding comes from ERDF.

Cacar is a local company supplying wind energy, while Ford has a plant manufacturing petrol engines, which is two miles from Bridgend. The University of South Wales has the biggest battery testing facility in the UK.

There are significant electric vehicle batteries which have to be disposed of each year at a cost to the manufacturer. At this point, each battery has 80% of its life left, but has to be removed according to the relevant standards. The batteries still have a financial value and the question is how to reuse or extend the battery life. The feasibility study centres on the plan to use the batteries for energy storage at a domestic level or as part of hub-based storage for community heat schemes, such as will feature in the Caerau heat project.

v) Smart Streetlighting upgrade programme

Bridgend CBC's Highways Department have an LED street lighting lanterns replacement programme, and the Energy/IT team are encouraging them to install smart lanterns. The Highways Department are in the process of setting up a trial for these smart integrated lighting columns (summer 2019). The lanterns could provide a WiFi mesh across the County Borough and could provide the infrastructure for the implementation of the BCBC Smart Digital Master Plan.

Outcomes

Bridgend CBC, together with the ESC, has formed a focal point for helping understand the required steps needed to transform a local area with decarbonised heat, as well as introducing smart systems and processes, and potential

new services. Decarbonising heat schemes can be very complex, and nationally the task ahead for meeting decarbonisation targets for heat is significant. Having Bridgend CBC participating in the vanguard of smart systems and heat has been extremely beneficial for Wales to help generate and capture the learning required to make this transition.

Designing a proposal, which combines heat, power and transport, will enable Bridgend and other towns to develop integrated systems and services, which maximise these assets to improve services and reduce costs. Starting with heat and then moving on to deliver the Bridgend Digital Masterplan is ambitious, and will require all parts of the Council to come together. However this pursuit of a holistic smart solution is one which other boroughs will need to consider for the future.

Development of a source of heat from mine water is innovative, and Bridgend's is the first plan at scale in the UK, and the first in the world to connect up private households. The successful scheme will be of interest to other parts of Wales, including those with previous coal mining communities, especially if a 100% community renewable offer can be created.

One of the key principles for Smart Living is the need to be place-based and driven by needs in the area. In the case of Bridgend, they started with a proposed heat scheme, which they wanted to decarbonise but with ambitions for a wider decarbonisation agenda has set the context for the Demonstrator. As a result they have had to work through the different building blocks needed to achieve an overall solution spanning from individual householders up to interaction with the local networks. Working with the ESC has helped them to think differently about heat for the future including different business models such as 'heat as a service', which moves away from charging based on units of energy consumed to the outcomes people are seeking, for instance in terms of comfort.

Over the five years of its development, the Bridgend SSH Plan has moved from a conceptual agenda to a tangible delivery plan, with projects visible to residents, and which are scheduled to come on stream in the next year or two. At the same time the Plan has moved to occupy the centre ground in the Council's strategy architecture, and carries much of the burden of decarbonising Bridgend by 2050, as well as delivering on the Regeneration Strategy up to 2021. Links to the SSH Plan are now been written into the Local Development Plan for BCBC (up to 2030). Whilst most of the SSH Phase 2 Plan is concerned with retrofit, it is critical there are also new developments, and this link is therefore a welcome result.

Bridgend is now fulfilling its potential as one of the UK's leading locations for Smart Systems and Heat programme development. The Energy/Heat team is enjoying a greatly enhanced profile, which makes it easier for them to attract project partners and secure significant funding. As one indication of this, the team held its first stakeholder conference in 2019, and attracted senior leaders from a range of commercial and academic organisations, who travelled to spend a day working together in Bridgend.

Next Steps

SSH Phase 2 implementation continues up to 2025, focussing on the three deployment projects and the five innovation projects. Of these, the town centre heat scheme will move into the construction stage first, with works expected in 2020 subject to further funding. The Caerau mine water network is scheduled for delivery in 2022. The two design projects, through the Industrial Challenge Fund, and the Smart Energy Storage Solutions project, are expected to produce interim reports in 2019.

2.2 Blaenau Gwent: Catalysing Local Energy

Vision

Blaenau Gwent recognised the difficulties of developing low carbon solutions for their Borough; a report by BRE forming phase one of this Demonstrator highlighted such difficulties. However, the report also recognised there were opportunities and potential to catalyse local energy, structured around three or four energy platforms. The Demonstrator has been pursuing the development of this potential.

Overview

Blaenau Gwent County Borough Council (CBC) is pursuing opportunities to develop an 'Energy Catalyst' model for the borough, through creating a number of smart platforms for energy which would eventually connect commercial and business premises and private and social housing. This could offer opportunities for the bundling of services to residents and businesses. Communication and education about energy behaviours will also form a key element of the wider project.

A Phase One study by BRE outlined the potential scope and recommended next steps to create individual energy platforms. In Phase Two, Re-fit programme supported by the Council and WG has focused on the public sector energy platform, whilst Smart Living has focused on the potential development of a business/commercial energy platform. A first step has been to explore the energy needs and interests of a sample of local businesses as well as investigating opportunities for their collaboration in smart energy systems that generate, store, move and use energy.

This Demonstrator has sought to understand the steps required to build a successful low carbon multi-vector energy platform in Wales from a low base of natural renewable resource generation (and use). 95% of households within Blaenau

Gwent are on mains gas – persuading financially constrained households to shift from this readily available cheap heating fuel to renewable energy has been identified as a significant challenge, not only in Wales but across the UK.

The aspiration in trialling a local area energy model is to create low carbon opportunities, improve resource efficiency, alleviate fuel poverty and encourage industry/commerce to invest in the region, thereby improving energy efficiency and reducing carbon emissions across all of Blaenau Gwent.

Activity

Welsh Government has helped Blaenau Gwent CBC develop the Energy Catalyst proposal, across the two phases of work. The Smart Living Initiative provided up to £50k to support delivery of the Phase One scoping exercises in 2017/18, and then supported the Phase Two research and analysis into the business platform with a further £50k, in 2018/19.

For the second phase of work under Smart Living, it was agreed that two key aspects relating to the business/industrial platform should be explored - the energy behaviours of local businesses (conducted by Miller Research) and technical analysis of business parks (conducted by AECOM).

The Miller Research interim report identified a range of issues. The cost of utilities was a key concern for local businesses across Blaenau Gwent, with businesses expressing interest in engaging in actions to achieve longer term reductions in energy costs. The study identified several businesses with potential excess electricity generation or assets, including land or roof space for energy generation.

Follow-up site visits and landlord interviews found that businesses were interested in:

- Energy generation. Businesses would welcome a simplified process for acquisition of renewable technologies and help in navigating the planning system.
- Streamlined energy purchasing and protection from loss of supply. Small businesses are often tied into contracts with hefty exit fees and face a confusing array of different tariff rates from energy suppliers. Larger businesses may bulk buy energy for multiple sites.
- Energy efficiency improvements to business premises.

Businesses were keen to understand how an energy platform could drive economic benefits and recognised potential benefits from increased networking and local procurement.

AECOM's interim technical report explored a variety of options for Blaenau Gwent CBC to support carbon emission reduction across businesses parks in the borough, including an energy brokering service, bulk purchase of LED light fittings and installations of solar PV.

AECOM conducted a combination of desk-based analysis and site visits to assess the realistic opportunities for generation across the 24 business parks and industrial estates in the borough. AECOM also checked with the distribution network operator (DNO) on constraints, recognising that sizing of any PV installation would need to take account not only of potential for on-site generation but also the impact on the wider grid.

Blaenau Gwent CBC moved the Demonstrator forward into Phase 2B to test out the initial findings on a selection of four business parks. This involved more detailed engagement with businesses on the selected parks to explore their energy needs from a socio-technical perspective, to reflect their behaviours, needs and aspirations and the building's technical energy demands. Each business park had a different combination of needs and opportunities, including for ground-

mounted and/or roof-based solar PV sites and for lighting system upgrades.

The Phase 2B research, conducted in 2018, included interviews and detailed site visits with businesses across four business parks to establish a more detailed picture of energy needs. Up to 25% of businesses on each business park participated, including from the IT services, horticultural retail, manufacturing, and food sectors. The Phase 2B final report is due for completion in summer 2019.

Outcomes

Much of the value created by the Demonstrator to date relates to organisation capacity building across the Borough, and the development of tools to support this. For instance, AECOM's analysis led to the development of a 'model business park' tool, against which the business parks in the project could be mapped. The tool will have transferable value as it enables business parks to be profiled across relevant dimensions in order to generate differentiated recommendations for improved low carbon measures and future energy solutions.

The work has strengthened the links between local businesses, the Council and Welsh Government, with opportunities for expansion, business funding and advice/guidance being shared with the Council and Welsh Government business support. The creation of clusters of like-minded businesses with an interest in energy ventures has the potential to act as a nucleus for further phased modular work with others.

Understanding the key drivers of local businesses and the characteristics of industrial estates and business parks has provided value in ensuring that the offer to businesses is suitably differentiated. The pilot has shown the potential for an increase in resource efficiency practices by businesses through quick-win measures and through brokerage of demand reduction services. These business benefits would also result in reduced

carbon emissions, through increased renewable energy generation and demand reduction. For their part the Council now has a detailed understanding of the needs of different businesses from a future energy platform offer. The Council are now defining possible legal structures and support structures which underpin the platform; these arrangements will continue to evolve as the final offer for businesses is refined.

Blaenau Gwent CBC gelled together the behavioural and technical aspects of the research in a practical, authentic way. Its role in supporting long-term community investment and benefit meant that businesses were willing to trust the Council as impartial. The local authority valued the research process in itself as an opportunity to listen to businesses' stories and needs and to celebrate their activities.

"I found the people are really passionate about what they do, their aspirations, how they have developed primarily from indigenous home grown start-ups and how they are driving innovation across the Borough in a variety of ways." [BGCBC Project Officer]

Blaenau Gwent CBC has been notably successful in gaining access to EU funding as well as funding for district heating scheme development and there is recognition that any further work should connect up with other ongoing EU-funded activities in the borough.

The Demonstrator has led to an improved understanding of businesses and their key drivers by the local authority. The outcomes of this project will help to inform better models of support from Local Authorities and a better understanding of how to motivate local businesses to participate in developing smarter energy solutions.

Next Steps

The ambitions of Blaenau Gwent are comprehensive: a successful Smart Living local energy catalyst Demonstrator would include:

- Development of an energy platform that can integrate renewable energy sources, district heating, flexibility and storage.
- An offer of a better choice of low cost energy for local businesses, public sector and the community.
- Reduced energy costs for SMEs through energy efficiency measures, behaviour change and renewable energy technologies.
- Increased renewable energy generation, and use of lower carbon energy sources in the district.
- A collaborative business culture and community, based on better understanding their needs.

"I'd like to think we get an offer for the businesses, get them all round the table... might be incremental steps...but that we have something tangible out of it, and then it starts that catalyst. It moves into the wider retail, the town centres, the homes, the leisure, the outdoor spaces...so that it becomes a business in itself."

[Blaenau Gwent CBC Project Officer]

To maintain the momentum, the immediate priority is to shape Phase Three, including a road map of actions to provide assurance and stimulate further discussion between the partners. Blaenau Gwent CBC recognises a need for project management capability to be built into the business case development.

2.3 Neath Port Talbot: Smart Low Carbon Development

Vision

As part of their ambition for making Neath Port Talbot (NPT) a smart low carbon borough, the Council set their vision for Smart Living support as follows:

Low carbon technology and smart applications will be embraced in innovative ways, to provide multiple benefits, which meet the needs of businesses and residents of NPT.

Using a Smart Cities Maturity Model – adapted for smart towns – the framework, informed by best practice, led initially to four, and subsequently to three, proposed pilot projects with the potential to be progressed by the Council.

Overview

Neath Port Talbot (NPT) has been part of the Smart Living Initiative since 2016. The project aimed to understand whether a smart city framework is a tool which is adaptable and suitable for a town, and what form that might take. Community engagement featured as important for work in an area blighted by poor air quality and with a history of heavy industry.

The staged process developed three smart/low carbon Demonstrator proposals to take forward: public and business engagement; smart/low carbon business and industrial applications; education and skills development.

At the point of completing phase 2 activities and considering next steps, the Flexible Integrated Energy Systems (FLEXIS) project emerged as a significant energy-focused research operation with its own demonstration area in Neath Port Talbot, extending from the Tata Steelworks to the Swansea Bay Tidal Lagoon. FLEXIS is a partnership of Cardiff University, Swansea University and the

University of South Wales funded by the Wales European Funding Office (WEFO) with £24m invested over five years. FLEXIS aims to develop an energy systems research capability in Wales, building on the world-class capability that already exists in the universities in the area. Alongside FLEXIS, the Swansea Bay City Deal and the evolving UK industrial strategy were other wider factors in the changing context for Neath Port Talbot County Borough Council (NPT CBC).

With limited capacity to meet the requirements of these two major programmes, Neath Port Talbot CBC focused their efforts to establish some early momentum. Neath Port Talbot CBC recognised participating in and supporting the FLEXIS programme as well as the City Deal as significant opportunities, particularly with the FLEXIS demonstrator located within the Council's boundary. Following the signing of a Memorandum of Understanding, FLEXIS and Neath Port Talbot CBC went on to agree a number of 'traction' projects to take forward in partnership, of which some would benefit from Smart Living contributions and principles.

Activity

Neath Port Talbot CBC and Smart Living concluded work on smart/low carbon activities in August 2017. Welsh Government Smart Living Initiative had contributed funding for initial scoping and feasibility phases of the smart/low carbon project, whilst NPT CBC contributed staff project costs. The finding from the two pieces of work were summarised in a report by Jacobs in November 2017, which was finalised in June 2018. It was agreed NPT CBC would consider what support would be provided by FLEXIS before pursuing any next steps.

During this period, discussions between Neath Port Talbot CBC and FLEXIS resulted in an

expanded demonstration scope for FLEXIS, encompassing many of the Council assets and proposed activities. In November 2017, FLEXIS and Neath Port Talbot CBC announced their formal partnership with a funding period of five years. Subsequently the two partners agreed to initiate a programme of work based around the following 8 ‘traction projects’:

- i) Smart Towns
- ii) Swansea Bay Technology Centre
- iii) Grid Constraints
- iv) EV and Low Emission Vehicle Strategy
- v) Minewater
- vi) Cefn Coed Mine Museum
- vii) Real Time Energy Monitoring
- viii) Air Quality Monitoring Programme

Following the decision by Neath Port Talbot CBC and FLEXIS to progress the traction projects, Welsh Government wished to capture potential learnings from the Smart Living process and transfer them through to the wider FLEXIS programme of work. As a result, Jacobs has produced a dissemination report for Smart Living, FLEXIS and Neath Port Talbot CBC documenting the developments and aligning them to FLEXIS to help ensure existing work contributes to future actions with the traction projects. It sets out how Smart Living Demonstrator proposed options map across onto the programme of support and activities, which FLEXIS will provide for Neath Port Talbot CBC. Key points are:

- **Citizen, Community, Business and Visitor Engagement Programme:** This was to be an overarching programme of engagement for Smart Living. The traction projects fit with the concept of an interlinked and multi-vector approach to energy system transformation. Citizen engagement has a narrower focus than was proposed by the Smart Living work.
- **Non-Domestic Buildings:** Implementation of Intelligent Applications is reflected in the Swansea Bay Technology Centre and Cefn

Coed Mine Museum as live demonstrators for specific technologies and solutions.

- **Business and Industrial Programme:** The FLEXIS traction projects do not have an explicit focus on supporting accelerated uptake of technologies by existing industry. However, there is scope for this area to progress through existing links between FLEXIS and TATA Steel.
- **Educational and Skills Development:** The traction projects do not have an explicit focus on education and skills. The Real Time Energy Monitoring project will support behaviour and culture change.
- Key elements of Smart Living will be reflected within the Smart Town traction project.

Outcomes

Smart Living’s aim is to catalyse opportunities and create potential for step change using smart technology, systems and processes to deliver on future ambitions of what low carbon wellbeing should look like in the world of smart energy, heat and mobility. Putting in place building blocks, which then inform and translate projects into mainstream or major programmes is an ideal solution and considered to be a relevant measure of success.

The introduction of two major programmes of work relating to the Swansea Region City Deal and FLEXIS in the NPT area inevitably has led to a rationalising and evolving of the different programmes as they settle into their defined projects/activities. Initially FLEXIS expanded their area to encompass NPT assets covering existing work packages. Then NPT asked for their traction projects to be included, requiring FLEXIS to adjust some of their work packages (and in the process ensuring continuity with Smart Living objectives and activities).

With the principle that Smart Living should not displace existing activity and instead should aim to fill gaps in provision, with FLEXIS operating

in the area, there was no need for Smart Living to continue to influence the development of emerging projects. The embedding of NPT's traction projects within FLEXIS and City Deal should ensure that relevant Smart Living work with the Council will have helped them to realise their ambitions, while the transfer dissemination report will help to continue to shape the thinking behind those projects.

For Smart Living, the transfer dissemination report in itself is an innovative outcome, as it provides a possible model for other demonstrators as they mature, and their owner organisations identify new funding partners to enable sustainable delivery at scale. The report will also provide the opportunity for learnings to help test out scaling and replicability principles of the Smart Living initiative.

The work with NPTCBC has highlighted the catalyst role that Smart Living plays. Yet it also presents a 'chicken and egg' scenario, in terms of how and when best to engage with a range of key stakeholders including senior leaders. On the one hand, it may be important to consider potential routes to delivery earlier in the process, rather than towards the end and then trying to make projects fit retrospectively. Taking a more strategic approach may also mean needing to engage sooner with more senior Council leaders and/or different Council departments than just those currently responsible for energy, carbon, or transport. On the other hand, until the catalyst role has developed sufficient evidence and weight, engagement with key stakeholders and senior management can be difficult as there may be little justification for having the conversations based upon only a visionary statement of intent. On reflection, it may be prudent to develop a 'top down and bottom up' approach: for instance, based on an Expression of Interest at the beginning, setting out the concept, aspirations, intentions and timescales for when more substantive material would be provided. This could underpin the current Smart Living approach of working with key officials to build the case,

before engaging senior leaders with updates and substantive proposals when ready.

Next Steps

The future appears bright for the collaboration between NPTCBC and FLEXIS, providing a route for developing the traction projects, which in turn will have encompassed some of the adopted Smart Living ideas for their initiation. Next steps for NPT are focused on delivery of the traction projects.

For Smart Living there are opportunities for taking the learnings from the tools, processes, and experience gained through this project into other Demonstrators, and to replicate and scale potential opportunities in other areas of Wales.

2.4 Torfaen: Wellbeing in Blaenavon

Vision

Torfaen's Public Services Board set out seven objectives in its Wellbeing Plan that will seek to improve wellbeing across the County Borough. The objectives will: develop a healthy and functional natural area, make the area climate ready, provide the best start in life, support healthy lifestyles and ageing well, tackle poverty and develop economic resilience, improve local skills, and support safe, confident, and cohesive communities.

Objective Four attempts to deal with the prevention or limitation of chronic health conditions by supporting healthy lifestyles and

enabling people to age well. This objective encompasses interconnected variables such as health promotion, but also other factors such as physical activity, fuel poverty, housing conditions including access to energy and heating, transport and mobility, the environment and community, social cohesion, and academic achievement. Linking of these variables can create mutually reinforcing conditions so the cycle of disadvantage can be broken with an intervention at any one of a number of entry points (or indeed a combination of several acting concurrently).

The high-level objectives under Objective 4 include a place-based project supported by the Smart Living Initiative, as follows:

Explore In the short-term where we expect to make achievement in the first 5 years	Realise In the medium-term where we expect to make achievements over 10 years	Transform In the long-term where we expect to make achievements over 10 to 15 years and beyond
<p>i. Undertake a place-based pilot in Blaenavon supported by Welsh Government's Smart Living Programme.</p> <p>This will:</p> <ul style="list-style-type: none"> • Explore the effectiveness of existing approaches. • Identify good practice e.g. Integrated Well-being Networks and locality based well-being hubs. • Identify how innovation and technologies can support healthy lifestyles and ageing well. • Develop a blueprint of how public services can use their collective assets and activity to exemplify the five ways of working. • Identify lifestyle behavioural change required. • Develop operational and business modelling for seamless delivery. • Provide a pathway for delivery with key milestones. • Future-proof proposals. 	<p>ii. Scale up successful approaches identified through the pilot.</p> <p>iii. Use our influence to shape the Regional Partnership Board's Area Plan and align activity across the partnerships to embed smarter approaches which work.</p>	<p>iv. Deliver a stronger service model around prevention and early intervention, embedding the integrated well-being network, and well-being hubs across NCN's.</p> <p>v. Create multiple place-based smart and resilient communities which:</p> <ul style="list-style-type: none"> • Adopt smart approaches to the use of resources and assets. • Strengthen community action by building skills and confidence among citizens, so they can better manage their own health and care needs. Also see objective 6.

Work is in progress covering the main work packages to address key questions in developing a blueprint for the delivery of place-based wellbeing.

Overview

The Demonstrator starts from the obligation on public bodies to deliver the Wellbeing of Future Generations Act; the Smart Living Initiative is also designed to contribute to the delivery of the Act's Goals. In Torfaen, the Act is primarily to be delivered through the Public Services Board's (PSB) Wellbeing Plan 2018-2023. The Plan sets out the Council's seven Wellbeing Objectives and outlines the collective steps it will take to meet these objectives.

The Demonstrator is sited in Blaenavon, in order to test a place-based approach to the delivery of Objective 4: supporting healthy lifestyles and enabling people to age well. In the long term, it aims to improve wellbeing by building community resilience, which will in turn help manage demand for public services.

The focus on health outcomes is new to the Smart Living Initiative; while links to energy and transport are not yet evident in the Demonstrator, it is clear that they will be important from a community resilience perspective. Work elsewhere shows that smart systems can have a key role in transforming health and social care delivery and outcomes and this proposal will consider that potential from the healthy and ageing perspective.

The Demonstrator is exploring how public services can best work together and utilise their assets to respond meaningfully to the Wellbeing of Future Generations Act. It will also test the assumption that a place-based approach helps to improve community resilience, and that this will ultimately reduce future demand for public services.

Phase I of the work will generate a place-based 'blueprint' of what works well and what does

not, so that learnings can be transferred to: the other six Wellbeing Objectives; to other similar communities in Wales; and to other Smart Living Demonstrators, who are all required to use place-based approaches to deliver Wellbeing Goals.

Members of the steering group for the Demonstrator include Torfaen County Borough Council, the Blaenavon Town Council, Aneurin Bevan University Health Board, Natural Resource Wales, Welsh Government and the Miller Research team.

Activity

Welsh Government provided £50,000 funding through its Smart Living initiative for Phase One to kick start the developmental process. Torfaen County Borough Council and Blaenavon Town Council have both committed delivery resources based on some of the early findings.

Phase One ran from April 2018 to March 2019. It involved reviews of wellbeing issues and services plus consultation and engagement with stakeholders. Two stakeholder workshops were held, the first involving knowledge sharing and community asset mapping, the second focussed on establishing joint priorities across services.

The Phase I work will be brought together in a final report which will incorporate:

- The Torfaen healthy ageing review- including a theory of change, logic model, community centred health approach, and improved co-location.
- A place-based blueprint- outlining the ways of working that PSB may wish to adopt to better support community resilience – and associated measures of success.

Outcomes

By bringing together community groups, service providers and other stakeholders in Blaenavon, a stronger network is being established to support future developments. In-depth understanding of each other's ways of working, and new ways of aligning them for mutual benefit, should mesh together service provision effectively. There is a need to be responsive to emerging regional partnership activity, but this flexible way of working has been beneficial to the scheme overall. The development of new relationships is an important outcome to date and is likely to have wider positive impacts on service provision, for instance, early indications from widening the service delivery offer to the primary care resource centre are promising.

The partners involved have learned that to achieve improved wellbeing and resilience requires a long-term approach, co-ordinating the multiple services provided by different organisations. The five year term of the initial stage of the Wellbeing Plan makes it difficult to embed long-term preventative approaches, with some supporting initiatives operating for just a few years. New initiatives need time to breathe and come to fruition so it will be important for deployed proposals to be given ample time to demonstrate their worth.

Over the course of the project, partners have learned that significant investment and genuine commitment is needed to achieve the Wellbeing Objectives. Each service has focused on delivering different objectives, and a key challenge is to ensure the 'shared' objective of supporting healthy lifestyles is recognised amongst the many other priorities that individual public bodies have.

The Demonstrator has involved a degree of complexity arising from working with several initiatives launched around the same time and based on a variety of different models. At an overarching level, working in the area of health (which was new to Smart Living) added to the complexity, making this a challenging Demonstrator in which to be testing the place-based platform concept. These challenges led to changes in emphasis as the project has moved through its different work packages. Yet this iterative process has resulted in a clear proposal which appears to have a strong fit with the strategic objectives of the Council and PSB to introduce and improve community resilience, which can in turn lessen demand on public services in a positive way.

Next Steps

Within the next year, the PSB will have considered the choices that the project will articulate for them, and decide on the degree of emphasis that place-based approaches will carry for the remainder of the current Wellbeing Plan.

Smart Living's next steps will involve a review of the toolkit and processes with Torfaen, and consider options for case studies to expand and test resilience modelling across different scenarios.



3. Four Demonstrator Themes

While a central criterion of Smart Living is that work is placed-based, the Initiative deliberately supports work with similar aims in different locations. In this way, Demonstrators can each develop place-based applications according to local needs, while the Smart Living Initiative can draw together learnings across places, and help to accelerate the uptake of technologies and solutions, which are common across different places.

It is likely that if successful most place-based Demonstrator projects will feed into scaled themes as they progress, with some of the more developed projects already contributing to one or more themes.

This year's Review clusters together a selection of Demonstrators under four themes:

- 1. Ultra Low Emissions Transport**
- 2. Hydrogen**
- 3. Smart Social Inclusion**
- 4. Grid Issues**

The first two themes are innovation clusters, which bring out commonalities between places. Notably, those commonalities are also brought together in the way the projects work: the Demonstrators working on Electric Vehicles and Ultra-Low Emissions Transport were included in an all-Wales review, and their host organisations came together at the end of the work at a pair of dissemination events. Likewise, the Demonstrators seeking to find and deliver applications for the decarbonisation of energy using hydrogen were invited by Welsh Government to form a working group, the Hydrogen Reference Group. Their work has continued to proceed informed by one another.

The third theme of social inclusion reflects a constant and evolving concern across many of the Demonstrator places, which can also be summed up under the heading of 'no one left behind'. Fuel poverty, or the differential distribution of benefits across different subgroups of people and places which can result in cold homes and health inequalities, has been an ongoing focus of work in the energy sector. However, the advent of innovative technologies and smart solutions brings with it the prospect that these inequalities may widen as well as diminish as the transition to a low carbon energy system gathers pace. Demonstrator projects which are focused on decarbonising energy alongside other means for increasing Wellbeing are beginning to deal with the realities of smart social inclusion issues.

The fourth theme is one which has emerged during the course of this year's Review. Given the inclusion of innovative energy technologies and multi-vector solutions in most of the Demonstrator projects reviewed here, it is inevitable that connectivity issues will arise, include practical interaction with DNOs and the regulator. Bringing together these considerations from across a wide range of projects is an obvious way to increase the potential learning flowing from the Smart Living Initiative, and this Review.

3.1 Ultra Low Emissions Vehicles and Sustainable Mobility

Ultra Low Emissions Vehicles and Sustainable Mobility

Overview

This set of Demonstrators aims to accelerate the Welsh transport sector's move towards the use of more sustainable fuels and towards more sustainable mobility in Wales. They recognise that *"a step change will be required in terms of processes, systems and investment in technologies"* and that this will require the collaboration of multiple stakeholders. The demonstrators have explored a number of areas including: how to mobilise local authorities, how councils can begin to transition their own vehicle fleets to sustainable fuels; what is needed to improve the infrastructure to enable wider uptake of Ultra Low Emission Vehicles (ULEV) and the various dimensions and challenges associated with achieving sustainable mobility in both rural and urban Wales. A key strand has been to explore what the role of local authorities should play in directing and enabling the transition towards low carbon transportation.

The Smart Living Initiative has facilitated a three-phase approach with each of Cardiff, Monmouthshire, Flintshire and Denbighshire Councils.

Smart Living's involvement has facilitated thinking on the roles and responsibilities, which public sector bodies wish to pursue as part of the transport decarbonisation agenda – noting that these roles will vary according to the circumstances of each local area.

i) Activity

In each of Cardiff, Monmouthshire, and North Wales (Denbighshire and Flintshire), a three-phase process applies:

- a review of the current 'state of play' for each Council and research into best practice in other areas;
- a stakeholder workshop to explore and test the relevance of opportunities and ideas identified;
- a final report with a set of short, medium and long-term recommendations for development. Additional work to explore EV charging infrastructure across the Gwent region has followed, led by Caerphilly council. Two dissemination events were held in North Wales and South Wales in February 2019, attended by 170 delegates, at which demonstrator local authorities shared progress and updates with a wider audience of stakeholders in Wales. These experiences and opportunities are also captured in a dissemination event summary report (Jacobs 2019).

ii) Cardiff

The journey began in Cardiff, in response to the UK Government's draft Clean Air Plan 2017 and Welsh Government legislation calling for the public sector to achieve carbon neutrality by 2030. The City of Cardiff Council sought advice from the Welsh Government on potential roles and responsibilities and best ways to encourage a shift towards Ultra Low Emissions Vehicles to achieve air quality and carbon emission reduction goals.

The three stage process of 'State of Play Analysis', stakeholder workshop and final report was first tested out in Cardiff. Recommendations from the final report formed the basis of Cardiff's Low Emission Transport Strategy, which received approval in March 2018, and is now being implemented.

The Strategy outlines a process towards the use of more sustainable fuels, as part of a wider approach to improve energy management,

transport, improve air quality and reduce carbon emissions. Ultimately it seeks to position Cardiff as a “catalyst for change”. The Strategy features seven key areas for action, as follows:

1. Council fleet procurement: These include vehicles that the Council has immediate control over and through which a transition to ULEVs can demonstrate leadership.
2. EV charging infrastructure: Currently, the Council is undertaking a detailed study on the most beneficial siting for charging points, such as suburban residential areas with a lack of off-street parking but with high demand for EV charging.
3. The Council’s energy supply role: Some of the energy required to support the increasing demand for LEVs and ULEVs could be supplied from the Council’s emerging renewable energy generating assets.
4. Council procurement strategies: Cardiff Council is seeking to encourage the transition to LEVs in the supply chain.
5. Influencing local partners: to accelerate the deployment of low emission public transportation, including upgrades to EU6 standard buses, electric or hydrogen buses, and the uptake of ULEV taxis and private hire vehicles.
6. City growth: setting the local policy infrastructure to enable access to the necessary infrastructure for a wide range of sustainable travel choices.
7. Supporting innovation: Exploration of opportunities for Vehicle-to-Grid and Energy Storage projects, the social purposes of EV hubs, and the introduction of low-emission zones.

iii) Monmouthshire

Opportunities for Monmouthshire County Council (CC) resulting from the ‘State of Play’ analysis

focussed on three themes: hydrogen generation; alternative fuelled fleet; and alternative fuelled passenger transport. Monmouthshire CC is now progressing a number of initiatives. These include:

- the Riversimple Rasa hydrogen fuel cell fleet trial in Abergavenny, including a hydrogen cell fleet vehicle for Monmouthshire CC;
- a fleet replacement strategy;
- a public transport study; and
- a policy to support charging points in public car parks in Monmouthshire’s four main towns [picture, overleaf].

iv) North Wales

The Demonstrator in North Wales involved both Flintshire and Denbighshire County Councils, where issues of connectivity in rural areas are a more pressing concern than air quality, with rates of private car ownership expected to remain high. Both have sought to investigate low emission solutions to rural connectivity issues. Denbighshire CC has sought to understand the different fuels for **Low Emission Buses** in an area with rural and hilly routes, typically over longer average distances, whilst Flintshire CC reviewed the potential for **trialling EV shuttle buses**.

Low carbon and business efficiency are important twin considerations for both councils who are working with Urban Foresight to introduce ultra-low emission vehicles and infrastructure. This is exploring options, such as fleet replacement strategies and investigating technology requirements and locations to establish an EV charging infrastructure network across North Wales, to support fleets, residents and tourists.

Whilst certain priorities are common to both counties, their differing circumstances and opportunities has meant some distinctive project ideas and priorities emerged from the Smart Living process.



Riversimple car at the charging point in Abergavenny bus station

Flintshire

Although largely rural, Flintshire also encompasses the Deeside industrial and growth area, which is situated alongside key transport routes out to the ferry terminals and into the north-west region of England. Related opportunities identified include:

- Exploring the potential for large fleet options to transition to EV and hydrogen technologies.
- Potential for creating an 'Energy Park' at Deeside, to supply energy to the industrial park and integrate electric bus transport to the park, as well as to link into a £250 million investment for Welsh Water to create an energy park outside Wrexham. The existing Parc Adfer Energy from Waste facility could be integrated into these proposals, potentially being used to provide electricity for vehicle charging and/or hydrogen fuel production.

Denbighshire

Denbighshire has sought to focus on the role of the Council in leading by example, addressing its own fleet and supporting infrastructure, as well as addressing the Council's procedures and governance around vehicle procurement, alongside their carbon management objectives. Another concern has been to consider what the appropriate role of the Council is in **directing and facilitating installation of EV charging infrastructure** to support take up of EV vehicles by the broader community and protect the value to the area from tourism.

v) Gwent

A regional study is currently exploring EV charging options and the strategic positioning of charge points across the Gwent area – encompassing Blaenau Gwent, Caerphilly, Monmouthshire,

Newport and Torfaen – in association with Natural Resources Wales, Emergency Services and the Health Authority. Caerphilly Council is leading the collaboration, which connects with the work in Monmouthshire. Caerphilly, along with the other participant Councils, identified that an area-wide, collaborative approach would provide greater value and insight than their initial plan for a district-wide study. Support from Urban Foresight and Energy Saving Trust is assisting the Gwent area with reviews of potential EV infrastructure sites and fleet reviews. In turn, their work is helping inform the wider Cardiff Capital Region deliberations in this area.

vi) Dissemination Events

The Smart Living Projects have helped initiate a better understanding of the potential roles local authorities could consider and progress as part of the sustainable mobility agenda. The projects have helped highlight examples of best practice to help influence local authority thinking about future opportunities: examples such as Cardiff's successful trial of an electric bus trial in the city centre in summer 2018 and the UK government award of funding to Riversimple and Monmouthshire Council for the Riversimple clean mobility fleet of 17 cars, including a hydrogen fuelled vehicle in the Monmouthshire council fleet. An increase in demonstrator actions by local authorities is providing a clearer market and policy direction towards sustainable mobility in Wales.

The Smart Living dissemination events have provided the opportunity to share success stories and report on the outcomes to date, as reported in the Outcomes section below. The events provided the opportunity for local authorities, businesses and organisations to network and develop new initiatives. It challenged other local authorities committed to sustainable transport to take the next steps. There was a clear consensus that technological solutions are now available to improve air quality, reduce carbon emissions and support the community and that some local authorities are already making the most of the

opportunities available. There is still more work to be done to ensure every local authority and public sector body in Wales is supporting the transition to ultra-low emission vehicles to be able to meet the target of a carbon neutral public sector in Wales by 2030.

vii) Outcomes

These dissemination events were an opportunity for each of the local authorities to share the progress made in achieving key milestones. The ULEV and sustainable mobility process have encouraged a change towards longer-term strategic thinking by local authorities and a more collaborative, regional approach.

• *Benefits to the local economy*

The economic benefit arising from the transition towards sustainable fuels is seen as a longer term form of 'future-proofing'. More pro-active and co-ordinated action by local authorities to promote the creation of network of EV charging points in appropriate locations should both support uptake of EV by local residents and help to secure the tourist economy. MCC expects the Hydrogen Refuelling Station in Abergavenny to attract significant interest and open up opportunities as the sector grows.

• *Smart network benefits*

Distribution Network Operators (DNOs) are conducting innovation projects looking at the impact of EVs on the network and pursuing options of how the increase of EVs can benefit the network rather than creating issues. The more strategic and co-ordinated role of local authorities in identifying the requirements for a network of charging points will add value. The demonstrators have also helped to progress the linkages between local generation and vehicle charging, including in Cardiff and potentially in Flintshire.

• *Health and regeneration benefits*

The demonstrators are expected to reduce carbon emissions and improve air quality, subsequently producing positive health benefits. In addition to promoting the uptake of ULEVs, some councils

such as Flintshire, Denbighshire, Torfaen and Caerphilly are encouraging active travel through electric bikes to help improve the overall wellbeing of the community.

- *Environmental improvements*

In the long-term, the uptake of sustainable fuels and ULEVs will help carbon reduction and associated improvements in air quality. This is particularly crucial in areas that do not meet current air quality standards, as is the case in Cardiff and Caerphilly.

In 2018, Cynnal Cymru – Sustain Wales were commissioned to help manage a public engagement process for Cardiff City Council on their Transport and Clean Air Green Paper. The process included consultation to gather views on new ideas such as realigning the bus services network, integrated ticketing, zero carbon bus fleet, active travel zones, cycle routes, clean air zones and parking levies. In February 2019 it was announced that Cardiff will be deploying a new fleet of 36 electric buses after receiving funding from the Department for Transport grant scheme, and it has been announced that the Council's white paper and clean air business case is due later in 2019. This example illustrates how a modular approach to development can achieve success on the journey to implementing sustainable mobility principles.

- *Innovation benefits*

In Cardiff, the City Council is looking at constructing its own solar farm on a former landfill site for EV charging. This could prompt development of rooftop solar photovoltaics across the public sector to self-generate energy to charge their EVs. In Monmouthshire, research conducted by Jacobs has been invaluable to the Council by raising awareness of: what stage the industry is at; what developments are happening elsewhere; and potential interested partner organisations.

- *Social benefits*

The ULEV projects in Flintshire and Denbighshire will help connect isolated communities in rural areas where much of the population currently rely either on the use of carbon intensive private

transport or patchy public transport. Furthermore, having a regional network of the same type of EV infrastructure is expected to encourage travel across the Gwent area and Wales.

- *Smart living benefits*

The Cardiff demonstrator has gone furthest in making interlinkages with other smart initiatives in the city, whereas other demonstrators have further developmental needs to achieve relevant linkages e.g. Torfaen, Blaenau Gwent and Flintshire.

Some of the above benefits are prospective and depend on the projects progressing through to implementation for them to be fully delivered. Nevertheless, the ULEV Demonstrators have already created considerable learning among the Councils involved, and for the Smart Living team. A key challenge common to the smaller Demonstrator local authorities involves the capacity to move from outline plan to delivery. This suggests a need for the Welsh Government to encourage councils to sustain the shift towards a long-term planning approach and to pool their experiences, as well as to raise awareness of forthcoming funding competitions. The Welsh Government has an ongoing role to stimulate the matching of local and regional challenges, for example by encouraging the involvement of Connected Places Catapult interactions in Wales and helping to capture opportunities from the wider hydrogen economy.

The innovation context for the ULEV Demonstrators adds a level of complexity, causing concerns to councils about the potential financial risks of investing in the 'wrong' technology. In some cases, Councils are aware that currently there are no optimal solutions suited to their situation, eg for low emission heavy fleet vehicles. In others, Councils recognise that future advances in EV technologies- including bigger batteries and faster chargers- would help build the business case for investment in ULEVs without the need for council intervention to stimulate mass uptake.

Across all the Demonstrators, it was observed that being part of the Smart Living initiative has helped local authorities better understand the opportunities for sustainable mobility and de-risk some of the pathways to pursuing these opportunities, addressing market failures. Interviewees emphasised the benefit from the systematic look at best practice elsewhere, as exemplified by the stakeholder workshop and follow-up visits to exemplar projects undertaken by Cardiff councillors and officers to initiatives in Dundee, Newcastle and Fife.

Next Steps

Cardiff

Stepped delivery work is underway in each of the seven action areas outlined in the Low Emission Transport Strategy, which links to the council's broader Transport and Clean Air strategy. In February 2019 it was announced that Cardiff will be getting a new fleet of 36 electric buses after receiving funding from the Department of Transport grant scheme.

Gwent

For the Gwent area, the next steps involve gaining approval from all partners, local authorities and senior management on the final report covering EV infrastructure and hydrogen, due to be published in 2019. This will be accompanied by a report on their fleets to provide a comprehensive picture of potential opportunities.

Monmouthshire and North Wales

Monmouthshire Council will be piloting a Riversimple vehicle in their fleet in the next year, linked to UK Government funded Riversimple clean mobility fleet of 17 cars. The results of a fleet review strategy will be used to develop a fleet replacement strategy for Monmouthshire. Flintshire and Denbighshire, with the neighbouring borough of Wrexham, are working with Urban Foresight to determine optimal locations for ULEV infrastructure along key highway routes.

Smart Living will continue to work with two Demonstrator clusters developed in South and North Wales, to pull through the smart elements arising from 'connections' including data, transport sharing, and energy storage. Smart Living will follow through on the learnings arising from this exercise, and ensure information is disseminated for others to access for future reference.

3.2 Hydrogen

Overview

Hydrogen is a multi-vector fuel with possible applications across transport, heat, energy and storage. The Committee on Climate Change endorsed Hydrogen as a future option for decarbonisation of the energy sector in November 2018.

Hydrogen's role as part of a diverse energy mix, which can deliver an affordable and secure means of achieving legally-binding carbon targets, is included within the Welsh Government's 'Prosperity for All: A Low Carbon Wales' document, published in March 2019. The Welsh Government has an interest in exploring the extent to which the deployment of hydrogen-based technologies could have a transformational impact on the energy system in Wales by bridging the gap between a system that is heavily reliant on fossil fuels to one that includes greater deployment and utilisation of lower carbon alternatives.

A diversity of projects across Wales at different levels of scale have already taken place, involving different sources of hydrogen, including larger scale academic and industrial innovation projects. The HyNet project led by Cadent Gas, based in the north west of England but extending into north-east Wales, is trialling carbon capture, utilisation and storage (CCUS) alongside distribution of hydrogen within the existing gas network. This project links to hydrogen production facilities and infrastructure across Liverpool, Manchester and parts of Cheshire.

South Wales is host to a cluster of potential hydrogen projects with academic involvement, including work at the Hydrogen Research Centre in the University of South Wales and demonstrated at the Baglan Energy Park, as part of the FLEXIS programme.

Smart Living has been supporting the development of hydrogen technologies and applications in Wales since its inception in 2015. In 2017, Smart Living established the Hydrogen Reference Group (HRG) to assist with the development of opportunities for the testing and development of hydrogen technologies in Wales. The HRG consists of a cross-section of key stakeholders across the public sector, industry, academia, private sector consultants and utilities.

A number of the Smart Living Demonstrators take the form of smaller hydrogen developmental projects, such as the Hydrogen Valleys projects in Rhondda Cynon Taff (as described below). Several of the low emissions transport projects described in the previous chapter involve hydrogen fuel cells. This includes the Riversimple Smart Living hydrogen-fuelled vehicles and refuelling station in Monmouthshire.

The rest of this chapter provides an overview of some of the activities taking place in the hydrogen sector in Wales, and highlights the extent of the innovation already underway.

Activity

The Hydrogen Reference Group

The Welsh Government established the cross-sector Hydrogen Reference Group to support the development of the hydrogen economy in Wales. The first HRG event was held in 2017, and led to the production by WG of their 'Hydrogen Pathway for a Smarter Low Carbon Wales' paper. However a lack of clarity at UK-level during 2018 regarding the direction of hydrogen-related policy limited further activity with the Group. There is an expectation that the Group will focus primarily on the development of demonstrator projects up until 2030. Meanwhile a review by WG will identify barriers and opportunities for current and future development, and highlight where there may be potential for knowledge and asset sharing collaborative working, and partnering between members including in securing further funding.

The Welsh Government is in the process of appointing a contractor to support the Group and act as a focal point. The contractor will coordinate Group activities and lobbying, keep a watching brief on sector developments and help position Wales to take advantage of relevant opportunities.

This will include tapping into an internal network of staff working on hydrogen across transport, energy intensive units and economy, business supply chain, innovation, energy and innovative housing at Welsh Government. The Smart Living HRG, with cross-cutting WG support, can act as a catalyst to facilitate opportunities for exploitation.

Smart Living will continue to promote hydrogen initiatives in Wales, through the Demonstrators, and in collaboration with others, including the South Wales Decarbonisation Cluster, the National Grid NIA project for South Wales, the North Wales Economic Ambition Board Growth Deal, and FLEXIS.

North Wales

North Wales has strong links with the Merseyside hydrogen cluster, with additional interest in hydrogen for the Isle of Anglesey and for community ventures within the North Wales Economic Ambition growth deal. A number of studies, including on strategic hydrogen opportunities (Jacobs 2019) affordable off-gas grid potential (also Jacobs 2019) and multi-vector opportunities (Siemens) will help with development of hydrogen opportunities within the North Wales growth deal.

South Wales

Work on hydrogen in South Wales takes a range of forms, including ultra-low emissions transport (see section above) and new opportunities for generation and deployment (see Rhondda Cynon Taff BC's Hydrogen Valleys, discussed below). FLEXIS's work with Neath Port Talbot CBC includes a hydrogen component in one of its 'traction projects'.

As well as FLEXIS, hosted at the University of Swansea, the University of South Wales Sustainable Energy Research Centre includes a Hydrogen Centre. This was set up in 2008 and aims to bridge the gap between early and late stage R&D activities (i.e. towards applied R&D and commercial development). The Centre was intentionally sited in the industrial centre of Neath Port Talbot, and works closely with businesses in this area, including TATA Steel. Research carried out at the Centre focuses predominantly on renewable hydrogen (via electrolysis), industrial-scale storage and vehicle fuel cells. The Centre also has an active hydrogen fuelling station.

At TATA Steel steelworks, the Centre is working on a project to recover hydrogen from the gases used and produced during steel production and to reduce wastage. This work has the potential to generate 44,000 tonnes of hydrogen per year. The potential quantities of recovered hydrogen from the steelworks are huge, so the Centre is looking at other possible uses in transport, heat and industry. They are also engaging in dialogue with other, mainly industrial, partners to better understand the interplay between hydrogen production and use, which could foster a South Wales decarbonisation cluster.

Rhondda Cynon Taff (RCT) Hydrogen in the Valleys

The original scoping study for hydrogen demonstrator projects in Rhondda Cynon Taff Borough Council (Rhondda Cynon Taff BC) was supported by the Smart Living Initiative, and produced in 2017. In the year since then, Smart Living has funded hydrogen specialists Ynni Glan to collaborate with Rhondda Cynon Taff BC on the second phase of this project, which explores the technical feasibility of three of the potential opportunities for development put forward in the phase one report. Two of the projects explore the potential for using fuel cells to power Council offices, and link these to surrounding buildings using microgrids. The third project is exploring applications for hydrogen to be generated by electrolysis from a community windfarm.

- **Fuel Cell CHP and Microgrid, Williamstown**

Ty Elai is a large council office with significant electric load and which experiences cooling issues during the summer. It could benefit from the heating and cooling provided by a fuel cell, initially powered by natural gas but with the intention to transfer to hydrogen (FCH). The proposal includes the potential to create a microgrid arrangement connecting with a neighbouring primary school.

The project has established that fuel cells and microgrids are a viable technical solution at the scale suitable for Ty Elai. However, fuel cells at a similar capacity (c.80kW) have not yet reached 'market maturity' in the UK. The current initial high capital costs mean that work is needed on building the innovation and business case, in order that the project could work as a viable 'first of a kind' demonstrator to provide practical learning and pave the way for further deployment of fuel cell-based microgrids in Wales. Subject to stakeholder appetite, such a Demonstrator project could form the basis for a joint funding bid.

- **Fuel Cell CHP, Microgrid and Transport Solution, Abercynon**

Ty Trevithick is the Council 'Education Office', with high heating and cooling demand. It is located next to the Navigation Park business park, which includes the Council-owned 'Valleys Innovation Centre'. There is also a nearby car dealership, which will need to install and power EV charging points in the near future. The project is exploring the feasibility of a modular approach to installing large-scale FCH technology at Ty Trevithick to generate electricity, heating and cooling from renewable sources. The fuel cell network could include a microgrid to connect to the neighbouring sites, including to enable EV charging. Such a microgrid could offer demand balancing benefits by incorporating smart capabilities.

As with Ty Elai, the feasibility study for Ty Trevithick found that it is a viable technical solution but with high capital costs, and next steps could look at how to address this.

- **Renewable (Wind) Energy Storage, Senghenydd**

The project is exploring applications for hydrogen storage of renewable energy generated by a community-owned wind turbine in Senghenydd. The turbine appears well suited to producing hydrogen via electrolysis because of local grid constraints which mean it could only export 300kW of the 900kW it will be capable of generating.

The Senghenydd project has explored the technical and commercial feasibility of the scheme, including looking for partners to contract with the community to buy up the hydrogen their wind turbine will be capable of generating. Western Power Distribution, the local DNO, responded to the community's approach by reconfiguring the local grid such that they could feed in all of the 900kW the asset could generate. However, the current low level of Feed-in Tariffs still made this unattractive for the community to develop and operate the turbine.

Initially transport partners were sought, on the assumption the green hydrogen generated could power fleet vehicles, but no firm offers were forthcoming. Conversations then led to Wales and West Utilities (WWU) who are interested in the potential injection of hydrogen into the local gas pipeline infrastructure as they respond to policy imperatives to decarbonise the gas network. WWU's plans revolve around biomethane (rather than hydrogen per se), and they are supporting work at University of South Wales' BioGrid project based at the Treforest Campus, which involves bacterial methanation (to combine green hydrogen with CO₂ – from anaerobic digestion (AD) processes, for example- to generate biomethane).

The Senghenydd community group has now partnered with a local AD plant owned by Bryn Group. A viable pathway has been found, which would involve a pilot project reacting hydrogen produced from the wind turbine with CO₂ from Bryn Group's anaerobic digester site in order to produce renewable methane, under the

bacterial methanation process. Further policy developments which could significantly influence the market for biogas are awaited, notably the UK's government's green gas consultation, due in summer 2019.

Outcomes

Knowledge sharing between stakeholders, initially facilitated by Smart Living, has already been beneficial. Involving industrial partners would lead to a better developed supply chain, with local businesses set up to provide skills for design, build and operation of hydrogen systems. Continued learning from the pilot projects, within and outside the Smart Living Initiative, could inform national policy making to support different types of hydrogen technologies and applications.

While studies to date have shown promising results for the future commercial viability of hydrogen applications, grant funding remains necessary to get demonstrator projects off the ground. There is a clear role for the Reference Group to work together to coordinate applications for funding for projects in Wales, and for Smart Living to continue to facilitate new partnerships that can add value and enhance proposals for funding, thus improving their chances of success.

Smart Living has a direct role to play in networking to develop funding streams, to lobby the UK government and make the case for investment in Wales.

An industry-led approach is valuable to ensure technology solutions are developed that are in line with commercial needs and to build relevant skills within the local supply chain. However, strategic direction from Welsh Government remains important to achieve adequate coverage across Wales of hydrogen refuelling facilities, to accelerate the spread of innovations, and to promote the uptake of hydrogen systems, especially in Mid Wales.

There is now evidence that political buy-in for hydrogen pathways is improving, as demonstrated by new UK funding routes, including the £170m 'Decarbonising Industry' and the £66m 'Transforming Foundation Industry' funds. Both funds require industry to collaborate with the public sector. For this to work well, clear and consistent direction is needed to increase business and public sector confidence and reduce the risks associated with investment in this innovative technology. Public concerns about the safety of hydrogen need to be addressed. Awareness of its potential benefits should be raised on a wider scale. There remains a challenge to transfer appropriate skills and expertise into Welsh businesses to maximise economic and social benefits.

Next Steps

The next steps for Welsh Government and the Hydrogen Reference Group include working to strengthen the profile of the sector and increase engagement with UK and EU governments, supported by a long term action plan. An active Group can catalyse the formation of consortia to bid for competitive innovation resources. The Smart Living Demonstrators in the RCT Hydrogen Valleys, require further technical work before seeking funding to cover the capital costs.

In the longer term, if Wales is to succeed in its decarbonisation ambitions, it is essential that hydrogen becomes an established, commercially viable element within the Welsh energy system, with lessening reliance on government support and grant funding. The emergence of systems that enable hydrogen to be used as a medium for network-balancing storage would support greater market penetration of these low carbon generation. This would enable hydrogen to be pivotal role in providing versatility and resilience to the energy system in Wales.

3.3 Smart Social Inclusion

Overview

One of the key themes of the Smart Living Demonstrators included in this Review is a focus on social inclusion. This is in keeping with the Smart Living Initiative as a vehicle for delivering the Wellbeing of Future Generations Act; one of the Criteria for the selection of Demonstrators is that they explicitly address the Goals set out in the Act. Yet being designed to contribute to the smart energy transition, the Smart Living projects bring a dynamic quality to the goal of social inclusion. This is summed up in the theme emerging from the Review as ‘no one left behind’: ensuring that, while innovative technologies and solutions are developed to decarbonise the energy system, the opportunities to benefit from those innovations are equitably distributed across all social groups, and all geographies. In this way, the smart energy transition can contribute to the wider wellbeing of Wales and its people by ensuring both that fuel poverty now is reduced, and that energy inequalities do not grow any wider as we move along the transition to smart systems.

The theme of social inclusion through the smart energy transition is the explicit focus of one of the Smart Living Demonstrator projects included in this Review. The **‘Better Energy Futures’** project is a partnership between Cardiff University and Energy Systems Catapult. It has aimed to explore the potential impacts of smart systems and technology in terms of fuel poverty and disadvantage, based on fieldwork conducted in an ex-mining community in Caerau (within Bridgend County Borough, but also within the FLEXIS project area – see the Bridgend, and the Neath Port Talbot, place portraits above). The Cardiff and ESC project has sought to understand how people struggling to meet the costs of their energy needs would cope with the energy revolution and whether there are differences which will need to be taken into account to ensure they are not left behind or treated less favourably

by not participating in innovations as part of the transition.

These concerns around ‘no one left behind’ are also apparent in other of the Demonstrators, especially those with a wellbeing focus. The **Torfaen ‘Wellbeing in Blaenavon’** project is designed to explore how Council services (and other stakeholders) need to work together to deliver the objectives of the Wellbeing Plan for Torfaen, with a specific focus in the Smart Living Demonstrator on ‘Ageing Well’. Including older people in service provision is a central concern, both to ensure their health and resilience are improved now, and that these attributes will be improved through the transformation of service delivery that is anticipated, across all public services and especially in relation to social care.

Mobility issues are a fundamental dimension of social inclusion, as people can be excluded from access to services and wider opportunities through lacking means of transport. This is apparent from the Smart Living Initiative, where social inclusion appears as a cross-cutting theme in the Demonstrators which are working on **ultra low emissions transport**. Exclusions based on mobility are already an issue in some of the places participating in Smart Living, particularly those with rural populations and limited transport service provision. These concerns are current in the Demonstrator places which are moving forward with the planning process for electric vehicle charging infrastructures, or looking at decarbonising public transport. That this provision is widely available, and is affordable to all groups of the public, is a pressing challenge. It is also a core issue for Councils aiming to deliver their decarbonisation goals, which will require that no one or place is left behind.

Activity

Better Energy Futures

This Demonstrator project aims to use social science research exploring energy vulnerability

to create guiding principles for fuel poverty interventions to ensure they meet people's needs. This recognises that energy resilience and fuel poverty are not just about a lack of money, but also result in a loss of capabilities, that is, of real opportunities for people to participate fully in wider society. The research focussed on peoples' lived experience of energy use, in order to improve understanding of the dynamic nature of fuel poverty and the conditions that allow people to move out of fuel poverty.

The research was led by social scientists located in the School of Social Sciences and Understanding Risk Group at Cardiff University, who have worked on energy use since 2010. Since 2017, they have been undertaking longitudinal research in Caerau as part of the FLEXIS (Flexible Integrated Energy Systems) project, a £24 million research consortium led by Cardiff University designed to develop an energy systems research capability in Wales. As discussed in previous place portraits, Bridgend falls into the areas of West Wales and the Valleys, and East Wales; the geography includes Caerau, where Smart Living is also already involved in supporting the Smart Systems and Heat work. Cardiff University's social scientists who are conducting their research as part of the FLEXIS project are working both in Caerau and in the wider FLEXIS project demonstrator area. The Energy System Catapult (ESC) were also involved in the Smart System and Heat Programme in Bridgend; through discussions there, the Smart Living team identified the ESC's Fair Futures Programme on fuel poverty as a way to advance their Wellbeing goals in the context of smart energy. Accordingly, Welsh Government put out a tender for a research partner to deliver the Better Energy Futures project, which Cardiff University successfully won. The project began in February 2018 and is due to be completed in 2019; it was funded with £100k from the Smart Living Initiative.

The Cardiff team's methodology built on ongoing longitudinal fieldwork being undertaken in Caerau, as part of the FLEXIS project. Two rounds of interviews were undertaken with residents:

the first explored perspectives on the Caerau minewater project, and everyday energy use. The second wave involved follow-up interviews with the same residents a year later with a more detailed focus on challenges relating to energy. The research revisited residents' lived experiences as energy consumers over the year, including an increased focus on experiences aligned to energy vulnerability and fuel poverty. Following the qualitative research activity, the Energy Systems Catapult (ESC) held a workshop in Cardiff with key stakeholders from communities, social housing and third sector organisations actively working to tackle fuel poverty. The workshop aimed to combine the research findings, Energy Systems Catapult's expertise and stakeholders' experiences to explore how to design effective interventions and support activities.

Ultra Low Emissions Transport

As shown in the Ultra Low Emissions Transport 'Theme' reported above, the work being undertaken by local authorities across Wales is both shaped by, and has implications for, social inclusion and inequality of outcomes – and ultimately of wellbeing. Two aspects of Demonstrators' work on low emissions transport are particularly relevant to issues of social inclusion:

- Air quality

Air quality is a health issue, but also one of social inclusion, as the health impacts of low air quality are more likely to be experienced by those living in disadvantaged communities. For this reason air quality is a prominent objective in Cardiff City Council's Low Emissions Transport Strategy. Air quality is also a feature in the work on sustainable transport being undertaken in Caerphilly, which is in breach of air quality standards. The health agenda here has led the work on low emissions transport to focus on electric bikes as well as electric vehicles.

- Social Isolation

While air quality issues can encourage the development of low emissions transport in urban settings, social isolation is a constant concern for local authorities with more rural geographies and more distributed populations. These concerns are already prominent in public transport planning and delivery, and mobility work in rural Demonstrators focuses on these, with a particular urgency to ensure ‘no one left behind’ – almost literally. There are challenges to decarbonising public transport, with electric bus trials reported to be stalling, as well as with installing networks of EV chargers for private vehicles in rural areas (see e.g. Flintshire; also Bridgend). These concerns are not just to do with social inclusion but also economic prosperity, in Demonstrators in rural Wales where tourism is a significant source of income (eg. Denbighshire). Tourists will need or expect a network of charging points for the electric vehicles they will be travelling in – and here it is rural Wales that does not want to be left behind.

Finally, it is notable that local authorities working the transport and mobility solutions as part of their transition to zero carbon futures tend not to use the language of ‘smart energy’. As will be discussed in greater detail below, it is the services provided by ‘smart’ which tend to be highlighted by stakeholders, and which will ultimately be experienced by householders. As such, social inclusion dimensions from the transition to low emissions transport tend to fit into local authority portfolios around ‘sustainable transport’, ‘air quality’, and ‘fuel poverty’. On the one hand this points to the dominance of siloed ways of working in local authorities (as explored in the Torfaen Wellbeing Demonstrator); on the other, it suggests that ‘smart’ is still a challenging frame for councils to plan and deliver around.

Outcomes

Better Energy Futures

Although final outputs from the Demonstrator are not yet available, a synthesis report is available from the Cardiff University social sciences team on request and a range of academic publications are planned by the Cardiff researchers. Two key outputs derived from the research findings can be highlighted here, as they have transferable value across work to support disadvantaged energy users especially as part of the transition to smart energy systems.

The first is a set of six considerations for understanding fuel poverty in the wider context of peoples’ situations (see Table 1). These were generated from the longitudinal research with Caerau residents. They consider the research findings around how disabling conditions in peoples’ lives can create energy vulnerability by undermining capabilities, whilst enabling conditions can support capabilities. These conditions are often not something within a household but flow from the wider social context around it.

Table 1: Considerations for interventions: understanding fuel poverty in the wider context

1. *Instability and unpredictability*
e.g. Changes in income, unplanned expenditure, health conditions, all of which result in reduced capability to meet needs and participate in society.
2. *Social relationships*
e.g. Difficulties with landlords, caring responsibilities, readiness to aid others in the community.
3. *Multiple meanings of ‘budgeting’*
Budgeting can be about saving across the year, but is also often about ‘just managing’ week to week.

4. Adapting to changing circumstances

This might mean active improvement to circumstances, but could also mean more negative experiences such as 'lowering one's sights', and feeling forced to make trade offs.

5. Dealing with technology

Experiences of unreliability and/or limited utility of smart meters, contrasted with lived experience of residents' own energy saving practices.

6. The Importance of place

Local history provides examples of stable and reliable relationships that can help protect against energy vulnerability.

The findings also highlight that energy vulnerability is itself a condition which involves transitions into and out of financial and other forms of stability, which lead to fuel poverty.

Figure 1 visualises the dynamic nature of energy vulnerability and fuel poverty.

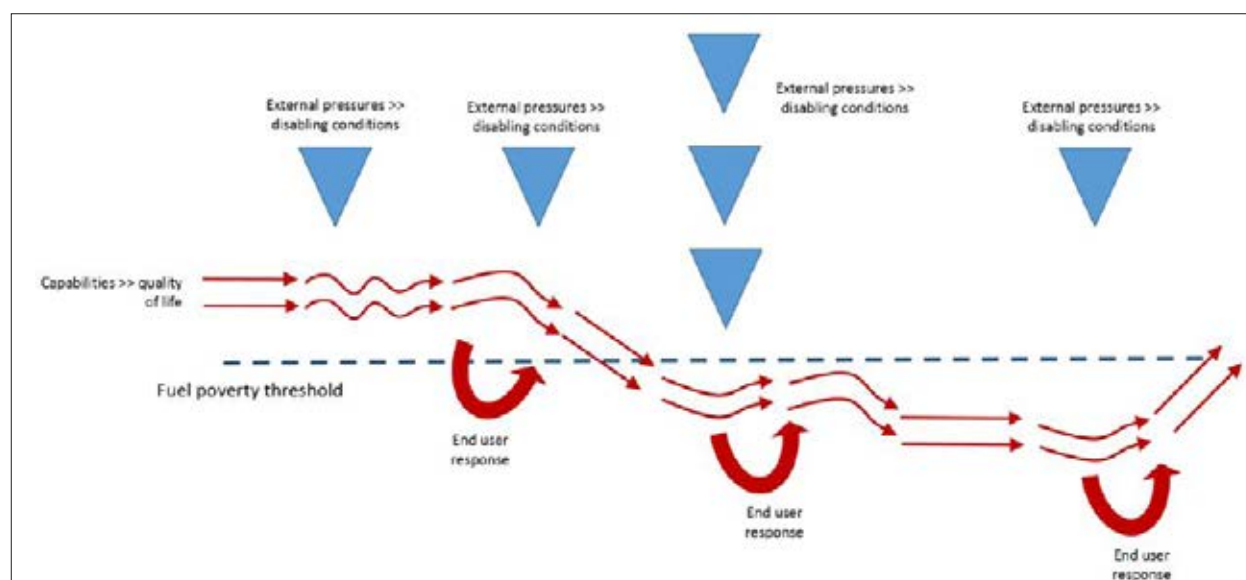
The other outcome of particular resonance to Smart Living's 'No one left behind' agenda is a draft Enabling Framework, which provides

a set of principles for designing effective fuel poverty interventions to actively support users' capabilities. These principles were created through further reflection and analysis by the Cardiff University team of the outputs from both the longitudinal research and stakeholder workshop. The framework provides a set of practical do's and don'ts for practitioners delivering interventions and support to tackle fuel poverty, based on creating the conditions that improve peoples' capabilities, and that support them to find stability.

Table 2: Enabling framework for poverty interventions to meet user requirements

1. *Avoid imposing upfront costs: build financial buffers*
e.g. find ways of pooling financial risk by using proportion of savings from supplier switching or engaging with credit unions
2. *Be sensitive and responsive to user needs*
3. *End-users can have very different needs, and these may change in ways that might be temporary or more enduring, affecting energy vulnerability. Interventions need to be more*

Figure 1: Conceptualising energy vulnerability as a dynamic condition



carefully tailored.

e.g. improve housing, enact quality control for interventions

4. Better standardisation for interventions is needed together with closer focus on the 'needs' of individual buildings.

e.g. incentivise landlords, protect tenants

5. Better regulation is needed together with incentives for taking up interventions that are attractive to landlords and tenants as well as homeowners

e.g. be responsive to local capabilities and expectations

6. Understand what people are already doing to address energy issues and how knowledge is shared in communities. Ensure technologies are built into interventions in ways that work with (not against) people's own practices. Don't rely on self-referral to recruit for participation.

e.g. make place and history matter

7. Consider how interventions can build on community history and capabilities, rather than focusing solely on individual households.

The demonstrator's main value to date has been in the research gathered into the energy needs and behaviours of households in an area of economic disadvantage – and how those needs will vary over time, particularly in the dynamic context of the transition to smart energy systems.

In particular, the research has shown how instability of circumstances is a key characteristic of energy vulnerability, and that the use of technological innovation to address energy use has to take this into account. Attention needs to be paid both to how people's circumstances may change with time and also how they may respond to such changes in ways that impact positively or negatively on their situation. User requirements will shift with these dynamic

changes. The research findings also show the importance of attending to individual circumstances, technological competencies and interests in the development of smart solutions, without assuming that technological development equates with progress. The 'no one left behind' agenda highlights that, whilst smart technologies and applications may positively transform service delivery, they could also contribute to excluding some end-users from the benefits which flow from this transformation. By drawing out a more detailed understanding of people's lives and decision making processes in relation to energy (among other aspects), the Demonstrator has contributed to a fuller understanding of the complexities of people's everyday lives and how emerging smart systems might interact with them. This has improved understanding of the potential consequences of using smart technologies for people's overall wellbeing and resilience.

The Smart Living Initiative has derived considerable value from the findings given their centrality to delivering on the Wellbeing of Future Generations Act (especially the Goal of 'A More Equal Wales'). At the same time, the project has provided detailed insights into how people view 'smart' in their daily lives and how this will help inform approaches and phasing of changes. Reducing risks that parts of communities will not be able to benefit or participate in proposed activities is crucial to delivering both decarbonisation and wellbeing goals. The recognition that social exclusions could happen by default (unless dedicated measures are in place informed by the outcomes of the Better Energy Futures research) is critical.

Smart Living's pivotal contribution to the project has been to bring in social researchers to work alongside the energy innovation specialists in the Energy Systems Catapult. The collaboration arises from Smart Living's consistent contention that 'smart' involves the interaction of people and technologies (ie. that energy is a socio-technical system), and the Initiative's core purpose that the decarbonisation of the energy

system can and must deliver wellbeing benefits for Wales and its people. The partnership which Smart Living brought about in this Demonstrator between Cardiff University and ESC has provided learning opportunities for both partners as their skills, expertise and approach to working differ, including their attitude to sharing outputs and to creating impact. As academics, CU's social scientists and Understanding Risk Group are committed to publishing their research findings and to promoting the applied use of their research to shape the dynamic conditions of energy vulnerability. By contrast, ESC is practice-orientated, and has trademarked the project name 'Fair Futures' in order to continue to develop this area of work as a service to partners and clients. In protecting the IP of the work, the ESC seeks to distinguish the aim of the project (thinking about how to harness innovation to redesign energy support in future) from other work in the area (which tends to focus on modifying existing support approaches to help more today) and thereby increase the impact.

"We do not work in the same way as the Catapult does, we have different contributions to make. But as academics we find that we learn as much through the collaboration as we learn from doing our own research" [Professor Karen Henwood, School of Social Sciences, Cardiff University]

Next Steps

The immediate next steps for the 'Better Energy Futures' team are to finalise the project outputs. The Cardiff team will publish research papers based on the analysis of the fieldwork in Caerau and intend to develop plans to continue the longitudinal research for future waves. The Smart Living Initiative will take stock of the final outputs arising from the 'Better Energy Futures' project, and the follow-on opportunities. A key consideration will be how to apply the principles and guidance in other Demonstrator places, including to pilot and refine the findings to inform future applications.

Looking across a range of the Demonstrator projects in this year's Review, 'No one left behind' has emerged as a key theme in the Smart Living Initiative, not just as a policy aspiration but as a practical challenge for local authorities as they deliver on the ground. This is particularly apparent in the projects now undertaking the transition to decarbonised transport, where health inequalities and social inclusion are twin motivations for councils to pursue this agenda. At national policy level, the smart social inclusion work developed by the Smart Living Demonstrators, including that highlighted here, will play a critical part in the development of Welsh Government's forthcoming plan to tackle fuel poverty. How to ensure that smart technologies and solutions deliver wellbeing for all people in all parts of Wales, and that no one is left behind, will be a key theme in that plan.

3.4 Electricity network innovations

Introduction

The ‘smart’ in smart energy, or Smart Living, is not just about innovation; it is also about connectivity, connecting to the local electricity network, or involving microgrids, private wire or a virtual grid/power plant, so that decarbonised energy can be supplied directly to end users. All those projects which involve innovative energy assets or solutions are beginning to address their connectivity needs. As the Smart Living Demonstrator projects have matured, so connectivity and other grid-related issues have come more to the fore. These issues were always going to be there, but in the previous Annual Review they were often not explicit. It is one measure of how Demonstrators are evolving that network connections and their potential costs have become material concerns for some, as they move from early action planning into more technical feasibility studies and business cases.

Network innovations will be an essential element in transitioning to a decarbonised energy system, as is made clear in the Welsh Government’s ‘Prosperity for All: a Low Carbon Wales’ strategy, published in April 2019. At the macro-level, the Smart Living team is already in dialogue with the National Grid about their respective roles in designing pathways to a zero carbon South Wales in 2050. Various Demonstrators have had conversations with their respective distribution network operators (DNOs) – Western Power Distribution (WPD) for South Wales and SP Energy Networks (SPEN) for North Wales – about what they need in terms of connectivity and how this relates to their plans. This Review provides an opportunity to look across some of the issues arising at local level, through the work of specific Demonstrators who are approaching grid connectivity innovations in a variety of ways.

Overview

The Demonstrator projects whose work in 2018-19 explicitly explored distribution network connections and related issues can be loosely clustered into three types, as below. Each project’s activity in relation to network – or alternative – connections between generation, storage and user, is summarised under these headings.

i) Projects proactively seeking microgrid solutions

Two of the Hydrogen Valleys Demonstrators in RCT are developing business cases for microgrids, connecting fuel cells to be installed in council offices with other nearby buildings (a business park, a car showroom, and potentially primary school). The fuel cells would in the first instance be energised with natural gas through the gas network, but as that grid becomes decarbonised would be adaptable to working on green hydrogen, making them carbon neutral (or carbon negative) systems.

The two business cases articulate the benefits of microgrids, relative to DNO connections, for delivering smart and decarbonised energy solutions. These include: resilience, reliability, a low barrier renewable energy pathway, clean air, sector coupling, low environmental impacts, and the ability to avoid the need for potentially costly and time-consuming grid infrastructure reinforcements. These benefits may also be added to over time because of microgrids’ adaptability and flexible expandability, and the relative costs of sourcing energy directly from distributed energy resources rather than via the DNO. Smart grid devices, and income from demand response services, may further help to increase cost-benefit ratios.

However, potential future changes to the way network costs are recovered from consumers – currently being explored by energy regulator Ofgem – could undermine the commercial viability of projects which depend on avoiding costs by rarely using a network connection and relying

instead on their 'on site' storage, generation or demand flexibility. In future, it is likely that charges will be less driven by the volume of electricity used via network connection and more by the existence and size of the connection. In 2019-20, projects will need to consider more carefully the commercial implications of this shift.

The main challenge identified in the two business cases is the upfront capital costs of installing these new systems. However, it is notable that the bulk of that cost arises from the components – the fuel cells themselves – not the connections.

The **Smart Systems and Heat** projects in Bridgend are all premised on off-grid solutions: primarily, heat networks, such as the one energised by water from the mine at Caerau. But as the projects have evolved, so more assets have come into consideration for connections to the networks. One of the newer schemes involves the possibility of using reclaimed car batteries to provide storage capacity for the neighbourhood heat pump 'hubs' which will be part of the mine water network. Having identified the benefits of microgrids for delivering community-based low carbon solutions, the Council's heat and energy team are now approaching each project from the default position of not connecting back into the local electricity network. "Connecting a network of neighbourhood heat pumps to the grid is our real last resort."

ii) Projects responding to electricity network constraints

The iterative development process which has been deployed in the Smart Systems and Heat projects in Bridgend threw up the possibility of creating microgrid solutions when the question of connectivity first arose. This was in the context of the **Caerau geothermal project**: attention was initially focussed on the feasibility of using the minewater and constructing a heat network to supply local households. The challenge of how to power the heat pumps only came to the fore later. The original plan was to install heat pumps in each home, but a redesign was triggered when

one of the consultants, Challock Energy suggested 'neighbourhood hub' heat pumps would be more efficient. The question of how to power these hubs led the Council to consult the local DNO for an indicative quote for a network connection. As the network in Caerau is constrained it would need reinforcing, at a significant cost. Forced into a rethink by these simple economics, Hitachi calculated that it would be more cost effective to lay a private wire connection from a wind turbine on the ridge above Caerau. This solution is now seen by the Council as bringing the dual local benefits of a carbon neutral system, and one powered totally by community energy. However, it may be worth revisiting that assumption as there may be an appetite within the DNO for a more innovative solution, in terms of their future plans for the managing the local network constraints.

The Council's energy and heat team have undergone a similar iterative journey in their design process on their **Decarbonising bus transport project**, through the Industrial Strategy Challenge Fund. In this project, decarbonisation was sought through the electrification of two First Cymru bus depots. The first assumption was to connect the depots to the network. A second model involved building two new depots, able to draw energy from the local generation assets including the Caerau wind turbine. An alternative approach would be to combine the depots and effectively move them closer to the (renewable) source, rather than relying on the network to bring the (lower carbon) power all the way to the user. Again, the proposed solution would be zero carbon and potentially off grid – subject to the overall business case being positive.

Similar cost pressures are apparent in projects at even greater levels of scale. The **Port of Milford Haven's Zero Carbon Area** proposals are at a key stage in their business planning. Two different pathways are on offer for the waterfront's ambitions: one is a Business as Usual model, based on using the distribution network to connect up the existing and proposed energy assets and users. The other is based on a microgrid solution to

exploit the multivector, and zero carbon, assets. The latter delivers against the Port Authority's decarbonisation pathway, and has been shown to be more cost efficient over a ten year period – including by delivering returns on investment within seven years. However, this latter model requires a significant capital investment in the next few years. Notably, in this Demonstrator, that cost reflects the high price of building the private wire connections, given that that generation assets will already be in place- as opposed to the RCT Hydrogen Valleys proposals, on a much smaller scale, where the bulk of the capital costs are the fuel cells.

A further limitation of connecting to the electricity distribution network is – or was, for time – apparent in another of the **Hydrogen Valleys** Demonstrators. The project was initiated by a community group in Senghenydd who are developing a wind turbine proposal, and began their business modelling assuming that they would sell the energy generated into the network. They struck two problems making the numbers balance: first, the UK Government cut the level of Feed-in Tariffs during the early stages of project development. Then, the local DNO Western Power Distribution informed them that they would only be able to export 300 kW of the 900kW the turbine could generate to the Grid. Following further negotiation, the DNO changed their position and recalibrated to find capacity for all 900kW. By that stage however, consultants Ynni Glan had identified the turbine as an ideal site for a pilot project based on electrolysed hydrogen, using the surplus electricity which would be generated. Despite the DNO's reassessment, the pilot project is currently proceeding based on the green hydrogen model; recent stages have involved finding a local user for that hydrogen.

It should be noted that the commercial realities of each of these types of projects may well change if potential future changes to the way network costs are recovered from consumers are introduced. That is because the changes will impact on the value of not having or rarely using

a network connection (i.e. the avoided costs) and relying instead on their 'on site' storage, generation or demand flexibility. In future, it is likely that charges will be weighted less towards the volume of electricity used via network connection and more towards the existence and size of the connection. In 2019-20, projects will need to consider more carefully the commercial implications of this potential change in how network charges are calculated since it changes the economics of different connection options between generators and users and any storage options. This restructuring of network charges will need to feed through into the development of the respective business and financial models.

iii) Projects focussed on innovative ways of working with the grid

As well as their work on Low Emissions Vehicles, Flintshire has been host to a Smart Living Demonstrator designed to supply local renewable energy through the existing connections provided by the local DNO. The project involves creating a **Local Virtual Private Network (LVPN)**, effectively a 'sleeving' or transactional arrangement whereby renewable energy generated from four community assets can be bought direct from the local authority, but supplied through the existing wires of the local DNO. The technical and market expertise for this project is being provided by Cardiff University, who describe the LVPN solution as a third way between the status quo of the local grid and a bespoke microgrid network. Other comparable mechanisms include Power Purchase Agreements, and various forms of peer-to-peer energy trading.

The LVPN solution requires both commercial and regulatory innovation, and the project has involved ongoing negotiation with Ofgem. In November 2018, a technical use case report was produced by Cardiff University for testing the status with Ofgem, particularly in view of the seismic changes taking place with the charging regime and other governance and structural changes. Ofgem subsequently responded with

suggestions focussed on creating additional value for the networks. Cardiff's subsequent work has focused on identifying, and quantifying, a range of wider benefits and ancillary services, and this work is ongoing.

The progress of this Demonstrator is important both in terms of its process learnings as well as its eventual outcomes. It is likely that the discussions will inform wider questions about the changing role of DNOs, as they evolve into Distribution Systems Operators as part of the decarbonisation pathway projected for the electricity system. At the current stage of negotiations however, the Flintshire project raises unresolved questions about the priorities of the regulator and the DNO, as they respond to innovation and try to find cost-effective ways to operate and develop the network to accommodate these new approaches, while also decarbonising it.

One other Demonstrator is worth mentioning in this regard: **Angle DC**. Here, on Anglesey, the DNO is trialling a novel network reinforcement technique designed to address the somewhat unique capacity and power flow challenges between the exporting Energy Island and the mainland. The project involves laying a new medium voltage direct current (MVDC) link on a section of the existing 33kV (alternating current – AC) circuit between Anglesey and mainland Wales, across the Menai Strait. The project aims to increase the capacity of the existing circuit, primarily in order to capture the potential of new generation assets on the 'Energy Island'; it will also enable improved control of power flow.

As well as the DC link itself, the project involves two 'inverter stations' on either side of the Strait, to shift the current from AC to DC and back. The project is progressing well, albeit with delays due to the iterative specification process for procurement of the novel hardware required. The connection is due to be on-stream and commence testing in 2020; once live, the project will then contribute to a better understanding of the market case for use of MVDC technology as an

alternative to grid reinforcement in comparable circumstances elsewhere.

Reflections

The electricity system has many of the attributes of a complex system. One such attribute is that it can be hard to see what is going on when the system is considered as a whole. However, when one works in parts of the system, at lower levels of scale, what is going on and what challenges are created by developing new local practices become clearer. The Smart Living Demonstrators provide precisely that opportunity. It is clear in many of these innovative projects that current configuration and operation of the electricity network is not set up to help them achieve their objectives for innovative generation and rapid decarbonisation. Many of these place-based projects are constructing their own microgrids as a workaround, while others are evolving virtual local network solutions in partnership with the DNOs. Interestingly, some of the workarounds are finding solutions which maximise local benefits for their communities which otherwise would not have been explored. It will be up to the DNOs and regulators to respond to these innovations, but taking care to ensure that their actions also adhere to the overarching policy pathways for decarbonisation and smart systems, as set out in government policy, both in Wales and across the UK.

It is also important there is an ongoing engagement at strategic level with the DNOs so that the needs and challenges associated with each of the Demonstrators are considered not just at individual 'substation' or connection level but also within the DNOs emerging strategies for the design and operation of what will be a very different future electricity system.

Complex systems are also characterised by the uncertainty which actors experience when operating within them. That is certainly true of the context in which these Demonstrator projects are operating. All the projects are employing

iterative approaches to business planning in order to respond to the dynamic nature of the energy systems they are working in. Costs of innovating are highly variable – for example, in some of the Demonstrators’ business models capital costs of generating assets are projected to fall sharply over the next ten years, while business as usual costs of grid-supplied energy are expected to rise. Meanwhile costs of connecting to the grid are set by the regulator and are currently undergoing substantial review: one project team describes the regulatory context as “very turbulent”. The policy context is also on the move, with pathways to decarbonisation becoming steeper by the year – in part based on emerging climate science. These are just some of the factors setting the context for innovative energy projects on the ground, and all parties in generating transmitting and storing energy must respond to them.

In view of these ever-changing pressures – and others which cannot even be anticipated in coming years – projects have to be adaptive. One of the advantages of microgrids appears to be that they can be built, rebuilt and rolled out in iterative ways – partly because they can be sealed off from wider influences flowing through the network itself. While this may help the local authorities who are overseeing the deployment of these platforms, the challenge at higher levels of the network remains how best to connect these place-based projects together to maximise benefits for all. There are significant wider benefits of ensuring all of these ‘islands’ (as these microgrids can be characterised) are connected and interdependencies maintained. After all, there are very few islands that do not have a bridge or ferry to the mainland (the equivalent to a network connection) which is used to reach assistance in times of need and, more generally, to trade an island’s surplus produce and to buy goods the island needs but does not produce or are in short supply. There is a critical role for the Welsh Government to play here, ensuring dialogue flows from the local to the national, and across the different stakeholders acting in the system.

4. Reflections across Demonstrators

4.1 Becoming Smart

‘Smart’ is notoriously difficult to define – and hard to point to – at least for as long as ‘smart’ technologies and systems are blueprints, on the drawing board. This central point provides the main rationale behind Smart Living’s approach, grounded in place-based projects meeting local needs: they are there to ‘demonstrate’ what smart means in practice.

The 2015 Framework which provides the governance structure for Smart Living notes how hard it is to define ‘smart’ in isolation from its contexts and applications: smart meters, smart cities, smart grids etc. However, the Framework reports that in the stakeholder workshops which helped to co-design the Initiative, there was general agreement that ‘smart’ activities “encompass aspirations of Interactive-Connected-Intelligent-Flexible”.

When the Smart Living Initiative began, smart was very much an aspiration, or a vision – and an elusive one at that, being both inclusive and dynamic. In the early years, it was hard to find the smart elements in the Demonstrator projects. This may be inherent in the smart journey; it seems to be true at higher levels of scale than the Demonstrators too – for instance, the smart meter rollout, the spearhead of the smart energy revolution, looks certain not to be completed by the target of 2020. Yet in this 2019 Review signs of smart are beginning to appear in the place-based Demonstrator projects. Looking across the twenty projects reviewed here, we can begin to describe better, in a number of dimensions, what smart involves.

i) Making Links

While smart combines many attributes, its essential element is being connected (from there,

intelligence and interactivity can flow). As the Bridgend energy/heat team lead says in this year’s Review: “Smart requires connectivity”.

This is evident in the Demonstrators which have a clear energy innovation focus (hence the emerging emphasis on grids, as discussed above). But it is also true of a project like Torfaen’s Wellbeing Pilot in Blaenavon, where ‘energy’ is not evident in the project activity (and was not mentioned during the case study interviews for this Review). Yet the project is all about making connections, joining up: different levels of policy (eg. the Government’s Wellbeing of Future Generations Act with the Borough’s Public Services Board’s Wellbeing Plan), different silos of public sector service delivery, and adopting ways of working which cut across the different objectives of the different actors – all in order to advance wellbeing for the community in Blaenavon. The expressed objective is to build older people’s resilience, in order that they can have health benefits now and in future, while reducing demand upon Council services over time. The building of resilience can be understood as a connectivity challenge in itself: resilience being an outcome (an ‘emergent property’) of a system which is well connected.

There is indeed little mention of energy at the moment in Torfaen’s Smart Living Demonstrator. But as the connections are built across silos and between providers, it is likely that Torfaen will be well placed to implement some of the smart solutions for health and social care which are emerging quickly in other parts of the world (see eg. the Buurtzorg project).

ii) Joining Up Assets

In some of the energy-focussed Demonstrators smart only emerges from the innovative technologies as they are connected together to become systems. From the project leads’ point of

view, you have to have the assets in place first, and then connect them, before the smart benefits can result. Until that time, they are not smart assets and smart networks, they are assets and networks with the potential to be smart.

This point is seen most clearly in some of the longest-running Demonstrators, who are furthest along the implementation journey. The Bridgend Minewater Heat Scheme began as a project to connect households in Caerau to the heat source coming from the old mine. That meant they required a heat pump solution, which was then solved (or at least, in the current iteration of the project plan) by connecting to the local wind turbine. The result is more than a simple microgrid; it is a multi-vector system which will be regulated by smart technologies, in which the assets will be able to respond to each other in how energy is distributed stored and used. The Energy Systems Catapult, whose EnergyPath Networks tool has been used across the Smart Systems and Heat programme in Bridgend, are clear that this smart system will deliver heat as a service.

The process of connecting of assets together into smart systems continues across Bridgend as other projects are conceived and designed. The Bus Decarbonisation Project is now designed to link into the same windfarm at Caerau, as well as having the potential to draw electricity from the community solar farm which is planned also to connect to the private wire network. The ‘building block’ analogy is very accurate here, as new assets and users come forward, and the system adapts to accommodate them – all the time accelerating progress towards a zero carbon Bridgend. The energy/heat team lead sums the current position up nicely:

“It’s all coming together: all the pieces are falling into place and Hitachi are the ones making this a smart system. Their interest is mobility as a service.”

iii) Transforming Services

The Bridgend Demonstrator can support the assertion that it is not actually the assets, the kit, the wires, which are smart: it is the services that can be supported when they are connected together in certain smart ways. Smart will be experienced by people as a set of services, not as units of electricity or gas. This may be a part of what ‘intelligent’ means in the four part definition generated at the original Smart Living stakeholder workshops: for example smart meters will enable automation of services in the home, not just give the householder feedback on how many units of energy the house is currently using.

Recently in Bridgend the Highways Department has begun a replacement programme for streetlights. This has now been identified by the energy/heat team as an opportunity to put in place connections, which in the future can link into other assets and users in their smart system: for instance, electric vehicles, and health workers. This project is too new to have been included in the Council’s Smart Energy Plan Phase Two, published in February 2019, but it fits perfectly with the work covered in that Plan. As the energy/heat team lead explains:

“The aim is to build the 5G stipulation into the procurement of all the remaining street lighting columns. Hitachi have this in their digital plan: if we have good enough 5G platforms then we can for instance support the health boards so that health visitors can access NHS data and all patient records on their visit. Or we can use it for peer-to-peer energy trading when people are generating their own renewables. It’s an intangible benefit in that I’m asking them to do something that’s five years or more away but we can futureproof it by putting in the smart infrastructure already.”

The dynamic at work here is to put the infrastructure in place now so that smart can emerge in the future. And it will emerge as a set of innovative services – which can barely be sketched out at present, but will co-evolve with the energy systems once in place. These services

could transform how the Council delivers mobility, social care, and energy among other services, but above all they have the potential to improve the wellbeing of people across the Borough.

Smart is likely always going to be hard to define, and to see, even when it is all around us, as part of the services we use everyday. However, in these Demonstrator projects it is beginning to become more visible – on the ground, and over time. Sometimes you have to look hard – as in Torfaen where the connections are not physical and not to do with energy systems. In many cases you have to wait, for the systems to be connected up, and for the applications to come to the fore. This is even the case where the connections are not smart at all – for example in the Virtual Private Wire Network Demonstrator in Flintshire. The project advisor at Cardiff University agrees that it is not smart yet; but by aiming to “embed intelligence into the design and operation of the energy system to engage more players and create a sustainable and affordable system” the resulting solution will necessarily be experienced by users as smart.

One clear conclusion is that smart takes time, but after five years of working on this agenda, smart is beginning to emerge from the Smart Living Initiative, as the Demonstrators will soon be able to show:

“Now we can say ‘I’ve done Phase One, look! We can do this, so the risks aren’t there anymore’. It’s something tangible that we’ve proven we can deliver and then we can show that when we talk about the rest of our plans. It is great to be getting something done we’ve been developing for a long time... Much better than just talking about it!”
[Energy/heat team lead, Bridgend]

4.2 Advancing Smart Living

i) What is Smart Living?

The Smart Living Initiative has many of the attributes of a complex system. These include:

- blurred boundaries (such that it is not clear where the work of Smart Living stops and, say, FLEXIS or the Energy Systems Catapult starts);
- high uncertainty (such that it is hard to see from any one place what is going on – and it takes specific effort to try to build up that picture – like this 2019 Review);
- low control (such that no one person is in charge in different parts of the system – leadership is more likely to be distributed: hence in most Demonstrators we have interviewed multiple people, as well as the Smart Living team in Welsh Government).

Another property of a complex system is that the question ‘what is it?’ is hard to answer... and because the system tends to be adaptive as well as complex (ie. ever changing) the question never goes away. Yet that question is most easily answered on the ground, with reference to specific places and projects. The evidence gathered from 20 projects for this Review provides fresh answers to this question; that another year has elapsed, and the Demonstrators are more evolved than previously, means answers can be shaped with a little more clarity than before. Some answers are offered below, in a number of different dimensions.

- As a definition

The 2015 Framework document notably declined to define Smart Living: partly because of the ambiguities in ‘smart’ (as discussed above) and partly because as a term it had no meaning outside the Welsh Government policy context (it was effectively a new coinage). The Framework chose instead to define it as a vision, with a set of principles, delivered

through criteria by which eligible projects would be selected.

As the Initiative has evolved, what it is and how it works have become clearer – these properties have emerged, so to speak. Smart Living has moved from being a plan to something like a programme of work. As part of this 2019 Review the Smart Living team have contributed to each of the case studies resulting from the 20 Demonstrator projects under review. In one of these case studies (on Neath Port Talbot’s ‘Smart Towns Initiative’) the team defines the aims of Smart Living, alongside the aims of FLEXIS, who are effectively stepping into Smart Living’s role in supporting and funding the demonstration work in the area. The aims articulated by the Smart Living team could serve as a useful iteration, or working definition, of what the Initiative now is:

Smart Living’s aim is to catalyse opportunities and increase potential for step change using smart technologies, systems and processes to deliver on future ambitions of what low carbon wellbeing should look like in terms of energy, heat and mobility.

- As a set of themes or work strands

In the introduction to this Review, we identified a number of themes or strands which are present in the Demonstrators: effectively, their subject matter. These themes could also be thought of as boundary definitions, scoping the areas of work covered by the Initiative. Interestingly these were not defined in the 2015 Framework, though they inform the Criteria against which the ‘fit’ of each project is assessed – including in the case studies for this Review. Note that most Demonstrators do not incorporate all the themes at any one time (though being dynamic, they may touch on them all, over time). The themes or scope for Demonstrators in 2018-19 can be summed up as:

The wellbeing of Wales; Innovative energy technologies and applications; Tackling exclusion and inequalities; Economic prosperity; Rapid decarbonisation

- As Ways of Working

In a complex system, process can be more important than methods; given high uncertainty, how to work is often one of the few features of the work that can be prescribed. Smart Living is characterised by a clear set of ways of working, which also distinguish it from how other layers of governance in the Demonstrators tend to work – be that local authorities, or the Welsh Government, or UK Government.

Smart Living ways of working are designed to fit with those required of all public sector bodies in Wales in the Wellbeing of Future Generations Act: long-term; integration; involvement; collaboration; prevention. Yet, the initiative’s ways of working are also set from the bottom, responding to the complexity and adaptiveness of the places and systems in which the Demonstrators operate. As such they are also: iterative; emergent; place-based.

- As a policy framework

As a vehicle of the Welsh Government, Smart Living is governed by a Framework document (2015); this Annual Review is in one sense part of the governance arrangements for the Initiative, to check its progress against the terms of reference set out in the Framework.

Yet Smart Living also responds to wider policy and strategy frameworks. In line with the complexity apparent elsewhere in the Initiative, these policy and strategy frameworks exist at multiple levels of scale, and also vary over time, as the policy landscape evolves. Part of Smart Living’s connectivity role is to weave these policy requirements together in the practical work in specific places.

Among the policy and strategy documents referenced in evidence from the 20 Demonstrator projects included in this 2019 Review are the following, at different layers of governance:

UK Government: *Regulatory Frameworks (eg. Ofgem); Consultations and Reviews (eg. Green Gas); Industrial Strategies (eg. Decarbonising Industry)*

Welsh Government: *Wellbeing of Future Generations Act; Prosperity for All: A Low Carbon Wales; Declaration of a Climate Emergency*

Local Government: *Area Plans; Transport Strategies; Decarbonisation Plans; Wellbeing Plans; Transformation Programmes; City Deals...*

- As a system of systems

As noted above, one of Smart Living's fundamental ways of working is that it is place-based. This reflects the premise that smart solutions will be worked out on the ground, and will be different in each place they come about – not least because of the different resources available in each place, and the different trajectories they are on. Complex systems can be thought of as systems of systems: it is usually the case in any complex system that you can zoom out to discern a higher level of system than the one in which you are working, or zoom in to find a smaller level of systems within the one in view. In this way complex systems can be described as nested.

It is appropriate to think of each Demonstrator place as a subsystem of the Smart Living Initiative. Within some places are multiple projects, within which specific subprojects or work packages. This nested structure to the Initiative is one of the ways in which it is most obvious to regard it as complex, and the fundamental structural reasons why some of the other complex characteristics (blurred boundaries, high uncertainty, low control etc) also come into play.

- As a team

Most complex systems are living systems, especially those which are adaptive. They have people in. In its daily workings, Smart Living is

most commonly experienced as a team of staff who work for the Welsh Government – albeit a very small team. The human side to the Initiative is vital; it is almost entirely through the human relationships in the Initiative that the connections are made, knowledge is accrued, and the individual projects become a system.

ii) How Smart Living works

The working definition of Smart Living in 2019 set out above – and taken from the Neath Port Talbot Smart Towns case study – is useful in many regards, one of which is that it implicitly outlines a process which Smart Living follows in undertaking its innovative and place-based work. Given that this process has not been apparent before in the Smart Living Framework or Annual Reviews, it may be helpful to sketch it out here in a series of steps, having unpacked it from the working definition:

Smart Living's aim is to catalyse opportunities and increase potential for step change using smart technologies, systems and processes to deliver on future ambitions of what low carbon wellbeing should look like in terms of energy, heat and mobility.

Step 1: Identify Opportunities

The work begins by identifying appropriate projects in places. As the Review has explored in previous years, sometimes the work starts with the project, and sometimes it starts with the place - the Smart Living team work as matchmakers in these instances. Sometimes a place proactively approaches the team with a project they need support with. The Criteria are used to help determine which projects are appropriate for inclusion in the Initiative.

Step 2: Catalyse the Opportunities

'Catalyse' has come to mean 'provide start-up funding'. All but one of the Demonstrators included in the 2019 Review have received some funding from WG through the Smart Living Initiative.¹ Some of the longest running and most

evolved have ceased to receive Smart Living funding; it is notable how some of these projects still talk of the Smart Living funding as essential to them getting off the ground.

Step 3: Increase Potential

This is effectively the ongoing support role provided by the Smart Living team: increasing the potential which is already in the place in relation to the project (note that they are not driving or harnessing that potential: the work must be owned locally, usually by the local authority). Ongoing support for Demonstrators tends to take two forms: incubating the work by providing advice, protection and opportunities to learn and connect with others; advocating for the project to other governance organisations and potential funders. Here the incubation role can move into one of transitioning the project out of the Initiative, by supporting bids for (bigger) follow-on funding elsewhere (and often from the UK Government, or Europe, not WG).

Step 4: Create Step Change

Creating step change means developing innovative solutions which can transform systems, and at scale. Reviewing Smart Living in 2019, this remains more vision or ambition than reality – the Demonstrators have not reached this step yet. That said, there may be one or two examples where whole system transformation is underway locally. Bridgend's whole energy strategy has been redrawn around the Smart Systems and Heat Plan, and there are signs that this will soon transform many other areas of service delivery across the Council – but it is fair to say we are not there yet. Given there is not yet evidence of transformation arising from Demonstrator places, it can also be observed that it is not clear how the 'step changes' will be brought about: how innovations arising from the Smart Living Initiative will spread from place to place, or will be scaled up within the place where they were originated. As the Initiative itself matures, these questions should come into view (see the Recommendations below).

1) Angle DC has not received Smart Living funding. Instead it received a letter of support for its bid to Ofgem

4.3 Valuing Smart Living

Given the complexity inherent in the Smart Living Initiative, it is inappropriate to assess its performance through orthodox evaluation: hence this annual research exercise is framed as a Review, not an Evaluation. This has certainly been the case to date, as the Initiative has evolved from a visionary plan to a programme of support, but it may always be the case with Smart Living.

The fundamental reason to support this position is that orthodox evaluation tends to assess an intervention in terms of its effectiveness in delivering against pre-set objectives: has the policy worked? Or done what it set out to do? In the Smart Living Initiative, as in so many interventions in complex systems, it is inappropriate to set pre-determined objectives, from the 'top' of the system. Smart Living has no fixed objectives: its Framework prescribes a Vision, a set of Principles, and some practical Criteria. It is also designed to deliver against all the interlocking policy and governance requirements which are applied to it at multiple levels, and which change over time. The objectives for the Initiative emerge from the work, reflecting the needs identified in each place as the work develops. For evaluations in complex systems, establishing the objectives is part of the work: based on what different stakeholders (including people at the lowest levels of the system – residents, in this case) value.

It is more appropriate then to talk about measuring the value of interventions in complex systems. The evaluative question for Smart Living becomes how much value has the Initiative created, such that we can understand how to help create more of that value in future. However, even this question is challenging to answer, because of the complexity attributes described above. First, the value that is created will be hard to attribute to any one activity – because relationships in a complex system are non-linear, so direct lines of causality are misleading. Second,

much of the value that is created is latent, and will only become visible after a time lag has elapsed: because the measurable outcomes are the emergent properties of the way the system is connected up (hence they are a measure of its resilience). In the case of the Smart Living Demonstrators we can see this clearly in terms of their quantitative outcomes, like CO₂: all the Demonstrators are designed to contribute to policy goals for decarbonisation, but none has delivered measurable cuts in CO₂ emissions – yet. That does not mean they are not, and will not be, effective.

This section goes on to give an overview of the kinds of value that are apparent in the evidence from the case studies to date. Continuing the point about emergent outcomes, it can be noted that much of the value created to date is foundational, to do with building capacity, or relational, to do with building resilient systems. If the systems are resilient, we know they will produce beneficial, tangible and measurable results for citizens: this enacts the principles of the Wellbeing of Future Generations Act, as will be evidenced by the Wellbeing Demonstrator in Torfaen, if it reaches fruition.

Building Technical Expertise

- Smart Living has facilitated the development of expertise in Wales in specific energy and heat technologies, many of which are- or soon will be- UK firsts. Included in this list of notable innovations are: heat from mine water (domestic, and at scale); EV car battery reuse as domestic storage; powering electric buses (and potentially other heavy fleet and plant); biomethane from green hydrogen; MVDC infrastructure.
- Smart Living has supported projects delivering innovation in the connecting up of assets into smart (or potentially smart) systems, including: heat networks at scale (and including retrofit); green gas microgrids; higher capacity fuel cell microgrids (potentially to be energised with

hydrogen); local virtual private wire networks; local integration of power and transport.

- Smart Living has worked with projects to coproduce principles and processes which are effective in supporting pathways to smart energy systems, including: business case planning processes (derived from the UK Government's 'five case' process); 'transfer reports' (to ensure continuity of activity and objectives between Smart Living and other funders as Demonstrator projects evolve); guidelines for interventions to tackle fuel poverty as part of the smart energy transition (feeding into the Energy Systems Catapult's Fair Futures workstream).

Building Audience Insight

- Smart Living has supported projects which have built understanding of specific audiences and their behaviours in relation to the transition to smart energy and heat systems. These include: local authorities (in terms of their roles and capacities to support the roll-out of electric and ultra low emissions vehicles); businesses (in terms of their interest in, and potential for, adopting energy efficiency measures, and generating and trading renewable energy); householders (in terms of their perceptions, and potential uptake, of heat from mine water) and particularly disadvantaged households at risk of being 'left behind' in the transition to smart energy systems.
- Smart Living has also been involved in projects which have begun to explore how to price and sell innovative heat and energy solutions direct to consumers, through Council-owned platforms or innovative 'sleeving' solutions. This represents a new stage of 'economic' feasibility testing for smart systems.

Building Momentum for Change

- Smart Living has contributed to the building of momentum behind the transition to smart

energy systems in various places at multiple levels of scale. These include: in Demonstrator places (to the point where some now have 'convening power' of their own, and can draw in stakeholders from across the UK and from multiple sectors); in individual Local Authorities and clusters of neighbouring Local Authorities (such that they are co-ordinating and pushing forward their own smart energy, heat and transport innovations, and are linking these into wider policy agendas); at national level (eg. by establishing all-Wales stakeholder working groups for specific technologies including hydrogen, and ultra low emissions vehicles); at UK level (eg. by collaborating with bodies such as the Energy Systems Catapult, and by representing sector interests in Wales to UK regulators and potential funders).

Building Cross-Sector Relationships

- The Smart Living Initiative has led to Demonstrator projects needing to collaborate with stakeholders and delivery partners from other sectors than their own – often this has been a novel process. Examples include: universities working with real estate operating companies, with local authorities, with national energy organisations, and with energy sector experts; Local authorities working or negotiating with grid regulators and network operators; local authorities working with private sector consultants and researchers.
- These cross-sector relationships are not always smooth, and Smart Living has played an active role in mediating between parties, and ensuring that the Welsh Government's objectives are shared and kept in the foreground.

Leveraging in £s

- As Demonstrator projects evolve, and the places which host them develop expertise and momentum of their own, Smart Living has been instrumental in supporting bids for follow-on funding, often of a magnitude beyond that of

Smart Living's resource pot. In these cases the 'catalytic' effect of Smart Living is apparent: the small start-up funds which they provide to Demonstrators have created projects which have then gone on to generate investments from elsewhere often running into £millions.

- Finally, it should be noted that this 'catalytic' dynamic effectively results in the most mature Demonstrators exiting the Smart Living Initiative – in funding terms, they grow out of it, needing to unlock large sums of capital investment in order to take their projects into the implementation and roll-out phase. This presents an operational challenge to Smart Living and the Welsh Government, in ensuring that the projects that start as Smart Living Demonstrators continue to observe the principles and processes which Smart Living co-created them with – in order that they ultimately deliver on their potential for the wellbeing of Wales, and at scale. This dynamic also represents a further measurement challenge for those working on Smart Living: the ultimate success of a project at scale may always be more readily attributed to the involvement of the bigger and more recent funding body.



5. Recommendations for Next Steps

The following points summarise recommendations for next steps in the development of the Smart Living Initiative, derived from the analysis of the twenty Demonstrator projects included in this Review, as conducted in 2019.

i) From funding system to learning system

These recommendations follow each stage of the process model for Smart Living (set out at 4.2 above), which in itself is worth exploring further, and potentially refining before including explicitly as part of the governance structure for the Initiative (eg. alongside the Framework)

- Continue to provide start-up funding to eligible smart/innovation projects around Wales.
- Continue to provide funding to pay for discrete bespoke studies that 'bridge a gap' and enable Demonstrators to move to a next stage towards delivery.
- Continue to support regional and Wales-wide themed sharing and dissemination events, as exemplified by the Sustainable Mobility workshops and regional dissemination events.
- Continue to support applications for large-scale follow-on funding; also explore new potential sources of funding for the significant capital costs which can obstruct promising Demonstrators from moving to the next stage of development and implementation.
- Maintain the focus on effective 'transfer' for Demonstrators who find bigger follow-on funding elsewhere. Continue to refine and sharpen the transfer process to ensure that continuity of the original Smart Living Demonstrator principles is maintained, such that these projects end up delivering wellbeing outcomes for Wales, at scale.

- Initiate efforts to ensure that these evolved/ outgoing Demonstrators continue to connect with the Initiative, and with other less mature Demonstrators who remain in the more active support phase. This would enhance knowledge transfer, encourage replication, accelerate the sense of momentum, and retain the practical link between the evolved Demonstrators and the Initiative (which in turn would better support evaluative claims about the effects of the Initiative).
- Continue and increase the provision of opportunities for learning and reflection within and between Demonstrators – ideally extending beyond this once-a-year Review exercise to include regular sessions at which Demonstrators can come together and reflect on their learnings for themselves and with one another.

ii) From learning to replication

The following recommendations are designed to address the challenge of the final step in the proposed process model: that of replication and roll-out, such that potential benefits already evident in the Demonstrators can be realised at scale. This is both the final step in the Demonstrator's journey, and the next step in the development of the Initiative.

- Having improved the opportunities for Demonstrators to connect together (see above), provide more opportunities for them to connect with stakeholders in other sectors – effectively promoting their work collectively to wider audiences, including potential funders, private sector partners, and other would-be Demonstrator and 'replicator' sites.
- Dedicate time to researching and testing different models of replication of energy

innovation projects, both by learning lessons from elsewhere, and with the most evolved Demonstrators in real-time. Aim to design practical solutions to make real the concepts of 'replication' (spreading) and 'roll out' (scaling) – particularly taking account of how these might be done as part of a place-based approach within a complex systems model (ie. in which innovations will play out differently in each place where they are initiated).

- Similarly, research and monitor practical efforts to translate effective energy innovations and systems from public sector (ie. council-owned) premises across to domestic households and whole communities.

iii) Measuring

- The Smart Living team should begin to devote attention to questions of measurement, in order to ensure they develop a better understanding of what works in their role to catalyse and accelerate energy system innovations, and at the same time be able to evidence the value of their Initiative to others, including within Welsh Government.
- Also encourage Demonstrators to address questions of self measurement, so the value of their projects to themselves, their partners, and their residents, becomes more visible. This should also help them articulate better the value of their work to others, including policy colleagues, and current and future funders.

iv) Connecting

- Continue and intensify the efforts of the Smart Living team and the Welsh Government to reach out across sector boundaries to advocate for the benefits of smart energy systems, and of the place-based needs-driven approach, which they have developed iteratively over the past five years. Such activity would: support the cross-sector work which Demonstrators are having to do themselves place by place;

increase the potential for third party support and investment in Smart Living Demonstrator projects in Wales; accelerate the UK-wide transition to smart energy systems, whilst ensuring the interests of Wales and its people remain foregrounded.

- The Smart Living Initiative should continue to show leadership in convening cross-sector stakeholder groups in specific areas of smart energy innovation, including the Hydrogen Reference Group, and the ULEV/Sustainable Mobility Demonstrator projects. Informed by the analysis in this Review, the Smart Living team might also consider linking in existing network and grid groups to ensure their plans are informed by the experiences of Demonstrators on the ground.

v) Waiting...

- This 2019 Review has shown how much progress many Demonstrators have made on their innovation journeys in the past twelve months. It is imperative the Smart Living Initiative continues to operate at least at the same level of intensity over the foreseeable future, to continue to ensure that the potential benefits from the Demonstrators reviewed here are realised, or move closer to being realised. Our final recommendation is to keep pushing the pace of transformation, and at the same time, to keep being patient.

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