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Welsh Government Smart Living Initiative

Review of Progress and Learnings from initial eight Demonstrator projects in Wales to March 2018

By **AD Research & Analysis** with the **Centre for Sustainable Energy** for the **Decarbonisation and Energy Division, Welsh Government**

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Foreword



Although still at an early stage, I'm pleased to highlight through this first independently authored Smart Living review the progress in developing our major portfolio of innovative locality-focused and energy related Demonstrators.

I believe innovation in the smart energy space across the whole power, heat and transport spectrum will be a key ingredient in helping support our decarbonisation agenda and delivery of multiple social, environmental and economic benefits for Wales.

In particular the transition to a low carbon economy and capturing the benefits will contribute to delivering my three priority areas of using energy more effectively, reducing reliance on fossil fuels and maximising the role of renewable energy. All of these are reflected in the principles of the Smart Living framework and anticipated benefits arising from the Demonstrators.

Looking forward, this report also aims to disseminate information about what we are learning as a result of Smart Living activities against the background of having clear long-term aims but uncertainty about the most effective immediate steps to take, with choices of so many clean-growth technological options under development in Wales and globally.

Working closely with multidisciplinary stakeholders drawn from businesses, academia, utilities, local authorities, statutory bodies, regulatory authorities and UK Government departments, whilst we may know where we want to be, we recognise the pathway to get there is uncertain against the background of:

- the low carbon and decentralised energy-technologies revolution;
- widespread digitalisation and speed of introducing new technology and connected systems;
- decarbonising mobility including the coming of battery and other low-carbon vehicles as well as autonomous driving systems; and
- social media and changes in the pace of communication which will be very important in a much more customer-centric energy world.

All these elements feature within the individual Smart Living Demonstrators and are helping build a picture of how we might lead and manage these transitions both at national and local levels. Each Demonstrator has a slightly different focus reflecting the resources, opportunities and challenges of their locality and all are firmly based in the reality of where we are at the moment.

We are fortunate in Wales to be able to adopt a joined up approach at local and national levels of

government to deal with these challenges and opportunities. This will become ever more vital with the local integration of power, heat and transport with its increasing system complexities and the growing importance of citizen wellbeing.

Wellbeing is at the heart of the over-arching Welsh Government 'Prosperity for All' agenda. It provides clarity about the essential developments for Wales and how we want government and all stakeholders to be part of a new approach to delivering priorities. Prosperity is not just about material wealth – it is about every one of us having a good quality of life, and living in strong, healthy and safe communities. This is also at the heart of 'smart living'.

Adopting Smart Living as an innovative initiative to look at the different issues is helping us move forward. To deal with change, Wales needs good leadership with strong strategic direction against the background of a strong narrative on how we should progress. I believe the details of the activities described in this report help illuminate this narrative and I look forward to a continuing dialogue on the opportunities which 'smart living' in its widest form could present for us all.

Lesley Griffiths

Cabinet Secretary for Energy, Planning and Rural Affairs

Introduction

This report provides a snapshot of the Welsh Government's Smart Living Initiative as it stood in June 2018. The review was commissioned by Smart Living from Andrew Darnton at AD Research & Analysis (ADR&A), working with the Centre for Sustainable Energy (CSE) and led by Nicky Hodges, supported by Karen Smith and Ellie Stevens.

ADR&A and CSE have familiarity with Smart Living, going back to its inception – together they undertook a programme of informal consultation with stakeholders across Wales in 2015, which helped shape the development of the initiative, and the criteria by which Demonstrator projects could be selected.

The 2018 Review is based on a stocktake of progress in an initial eight of the 12 Demonstrator projects live at the time of writing. Working with the lead organisations and partners in each Demonstrator we drew together progress to date, potential next steps, and emerging learnings. In doing so we reviewed key reports and papers developed by each Demonstrator, then held an interview with the key actors in the lead organisation (in two cases, these interviews were held face to face, in 'site visits'). This body of evidence was written up first in long-form case studies (of 10 to 15 pages), then summarised into the short-form cases included here (of between three and six pages in length). Both the lead organisations and WG Smart Living were invited to write into the draft case studies, and were particularly encouraged to add their learnings and reflections. Final sign-off of each case study rested with the lead organisation.

The resulting summary case studies make up the body of this report. They are supplemented by an initial commentary on the findings. This provides an overview of the Demonstrator projects and the range of activities they are undertaking. It then explores the value achieved and emerging from the work in each place, before synthesising the learnings arising from across the eight Demonstrators. The commentary ends with a set of conclusions, and recommendations for how best to continue the good work begun by Smart Living, the lead organisations and all the partners featured in these innovative projects.

The Smart Living Initiative

Smart Living was initiated in January 2014 as a result of reference in the "Energy Wales Programme: A Low Carbon Agenda".

Desk research was conducted and meetings held with all Local Authorities in Wales. Proposed opportunities for Smart Living were highlighted and proposals were put forward for scrutiny with a range of key stakeholders.

Workshops were held in 2015 supported by the Centre for Sustainable Energy **[1]** and a report recommending the way forward was produced by ADR&A **[2]**.

Using this information and the overwhelming response from the workshops for Wales to proactively

take steps to encompass innovation opportunities, a Smart Living Demonstrator Framework was submitted and confirmed with Ministers in 2015.

The Smart Living Demonstrator Framework [3] contains the scope, principles and governance considerations which have informed the Demonstrators set out in this update.

For governance, Smart Living has a cross departmental Project Board and a Smart Living Technical Group was established with its first highlight report in 2016 [4] and last met in 2017 to discuss smart homes and buildings link [5].

A Hydrogen Reference Group met in April 2017 to consider the activities Wales should be pursuing to facilitate the role and use of hydrogen in Wales. A copy of the first report of the group can be provided on request.

Currently Smart Living facilitates aspirations for innovative solutions to problems which are place-based and needs-led.

“Smart Living is not reflected in theoretical or practical definitions as it encompasses a wider scope than others that are already defined in the public domain such as Smart Homes, Business Powerhouses [6], Smart Cities and Smart or Smarter Grid. Smart was thought to encompass aspirations of Interactive-Connected-Intelligent-Flexible but it was difficult to define in isolation from different technologies and practices. It was recognised that defining Smart Living was critical to inform the Framework but it appears to have multiple meanings for individuals depending on who is asking the question and the circumstances of the individual responding” [WG SL Framework 2015].

Accordingly Smart Living is best defined as a Vision with a supporting set of Principles (which were set out in the Smart Living Demonstrator Framework) and is best understood through examples from practice – hence the Demonstrators and the criteria which bound them.

The Vision set out for Smart Living in the WG Framework (2015) reads:

“Wales has the opportunity to influence how we live with energy and resources in the future through Demonstrators that will innovatively transform homes, businesses and communities providing multiple benefits for all.”

FOOTNOTES

- 1 www.cse.org.uk/projects/view/1303
- 2 www.adranda.co.uk/single-post/2016/02/02/Welsh-Government-Smart-Living-Collaborative-Workshops-PostWorkshop-Report
- 3 http://democracy.blaenau-gwent.gov.uk/aksblaenau_gwent/images/att4108.pdf
- 4 <http://gov.wales/docs/det/publications/161019-smart-living-en.pdf>
- 5 <https://documents.hf.wales.gov.uk/id:A17530717/document/versions/latest>
- 6 Now known as ‘Buildings as power stations’

The Demonstrators

1. Selection

At the time this Review was commissioned, in March 2018, twelve projects were either in the first phase of development, or formed part of Phase Two for facilitation by Smart Living on account of their fitting the Framework Criteria.

For ease of reference, the Demonstrators were divided into two batches or 'Phases' based on when Smart Living initiated involvement. By March 2018, Phase One projects were underway for at least 18 months with planned proposals for Phase Two proceeding in the 2018-19 financial year.

With the development process involving initiation and scoping activities as part of Phase One, some projects did not proceed to Phase Two until much later. Gaps associated with changes in staffing, or external factors, both affected lead organisations' capacity to progress e.g. the Zero Carbon Area Demonstrator as well as Blaenau Gwent and the Hydrogen Valley project.

PHASE 1

	Proposal	Location
1	Smart Systems and Heat	Bridgend
2	Angle DC	Isle of Anglesey
3	Zero Carbon Area	Pembrokeshire Milford Waterfront
4.	Catalysing Local Energy	Blaenau Gwent
5.	Smart Low Carbon Programme	Neath Port Talbot
6.	Hydrogen Valley	RCT Area
7.	Local Virtual Private Wire Network	Flintshire
8.	Sustainable Fuels	Cardiff

PHASE 2

9	Healthy Living Concept Wellbeing Pilot	Torfaen
10	Sustainable Fuels (Hydrogen)	Monmouth
11	Sustainable Fuels and Mobility (Rural)	Flintshire & Denbighshire
12	Fair Futures and Fuel Poverty	Bridgend

What is immediately apparent from the above list is this is a place-based initiative and that Smart Living will be worked out on the ground in different forms, each reflecting the different resources, communities, and attributes of each place. The portfolio of projects will still be aligned with the Smart Living vision and principles, shaping a consistent approach to the rollout and scalability of proposals.

For the purposes of this Review, it was agreed to focus mainly on the Phase One projects as they were further forward in their development. This decision recognised that it was still early days but important to catch the learning from these Demonstrators as soon as possible. An exception was made for the inclusion of project 9 for Torfaen, to explore the premise that Phase Two projects are too early

in their lifecycle to have generated substantive value or meaningful learnings. Finally given resource constraints, it was agreed the Review should cover eight Demonstrators with the others set up to collect data for inclusion in next year's report. As Cardiff's activity was closely linked to additional work being undertaken in Phase 2 it was decided it should feature in next year's report, which would allow the inclusion of Torfaen this year.

2. Overview of the eight Demonstrators

Given the place-based nature of the Smart Living work, it is important that the eight selected Demonstrators cover a wide variety of location types. They are distributed around all parts of Wales, from Anglesey in the North via Milford Haven in the West to Torfaen in the South East.

The Demonstrators also span a wide range of energy and system innovations, which can be divided into simplified types as in our following schema developed on the basis of our categorisation of Demonstrators:

Smart Serviced Communities System of Systems e.g. Bridgend Intelligent Town Demonstrator							
Technological			Conceptual			Regulator Financial	Social Economic
Angle DC	Blaenau Gwent Energy Platform	Hydrogen Valley	Bridgend Smart Systems & Heat	Milford Haven Zero Carbon Area	Neath Port Talbot Smart/ Low Carbon Programme	Flintshire Virtual Private Network	Torfaen Wellbeing Concept in Blaenavon

It can also be noted that in the majority of Demonstrator projects the lead organisation is the local authority. Again, this chimes with the Smart Living Framework, which advocated place-based pilot projects, and emphasised the need for local authority leadership if all relevant stakeholders are to be brought together to deliver the innovations and transformations that communities most need.

The two exceptions to this pattern among the eight Demonstrators featured here are: Angle DC, a project which is currently dominated by technological and engineering challenges (to install a medium voltage DC link between Anglesey and the mainland), and which can be considered core business for the distribution network operator (DNO) Scottish Power Energy Networks and the West Wales Zero Carbon Area, which is being led by the Port of Milford Haven, who oversee the running of the Milford Haven Port and Waterfront, the centrepiece of the proposed zero carbon area, and scene of ongoing redevelopment (including several renewables sites). In both these cases, the local authorities are closely involved in the governance of the project, though they are not leading the work.

Table: List of Demonstrators					
	Demonstrator place	Demonstrator title	Innovation focus	Lead organisation	Core partner organisations
1	Bridgend	Smart Systems and Heat	Heat & Geothermal Schemes (inc. mine water)	Bridgend County Borough Council	Welsh Government* Energy Systems Catapult ETI Hitachi Cardiff University / SPECIFIC / FLEXIS Valleys Task Force
2	Anglesey	Angle DC	Medium Voltage Direct Current (MVDC) Transmission	Scottish Power Energy Networks (SPEN)	Welsh Government* Isle of Anglesey County Council Gwynedd County Council Cardiff University GE Power Conversion WSP
3	Milford Haven	West Wales - Zero Carbon Area	Zero Carbon Areas	Port of Milford Haven	Welsh Government* Pembrokeshire County Council Cardiff University/FLEXIS Community Energy in Pembrokeshire
4	Blaenau Gwent	Catalysing Local Energy	Energy Platforms (business/industry)	Blaenau Gwent County Borough Council	Welsh Government* Cardiff University
5	Neath Port Talbot	Smart Low Carbon Programme	Smart Towns	Neath Port Talbot County Borough Council	Welsh Government* Initial discussions FLEXIS
6	Rhondda Cynon Taf Valley	Hydrogen Valley	Hydrogen Technologies (fuel cells; renewable generation)	Valleys Authorities	Western Power Distribution Wales & West Utilities University of South Wales Welsh Government*
7	Flintshire	Local Virtual Private Wire	Virtual Private Wire Networks (VPN)	Flintshire County Council	Scottish Power Energy Networks (SPEN) Welsh Government* Npower SPECIFIC Cardiff University/FLEXIS
8	Torfaen	Healthy Living and Wellbeing in Blaenavon	Understanding delivery of the Wellbeing of Future Generations Act healthy living concepts as part of a place-based solution	Torfaen Public Services Board	Welsh Government* Natural Resources Wales Aneurin Bevan Gwent Public Health Team

*Smart Living works cross departmentally and so different parts of Welsh Government will be drawn into the proposals as relevant e.g. Innovation, Sectors (Energy and Advanced Materials and Manufacturing), Energy Efficiency and Fuel Poverty, Decarbonisation and Energy, Transport, Health and Local Government.

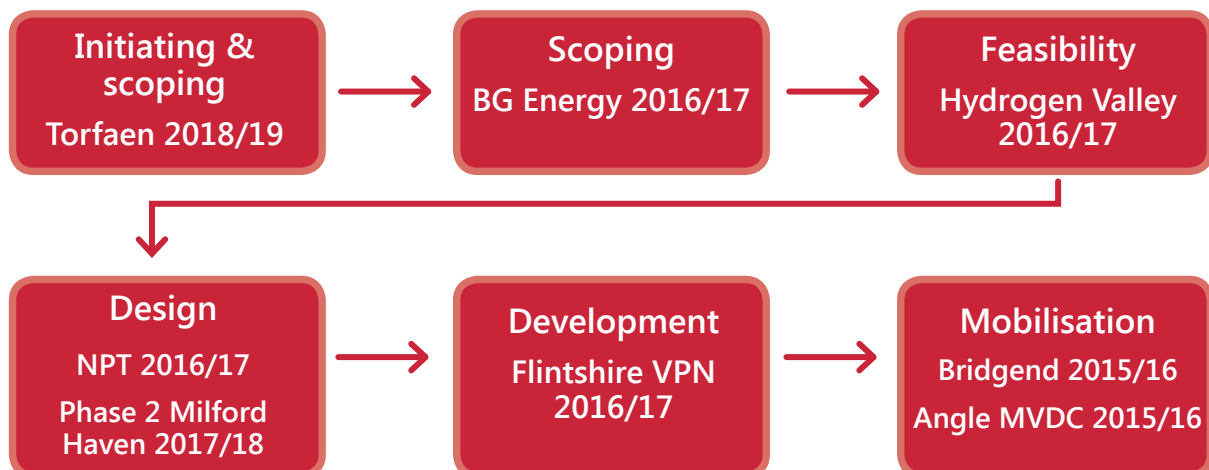
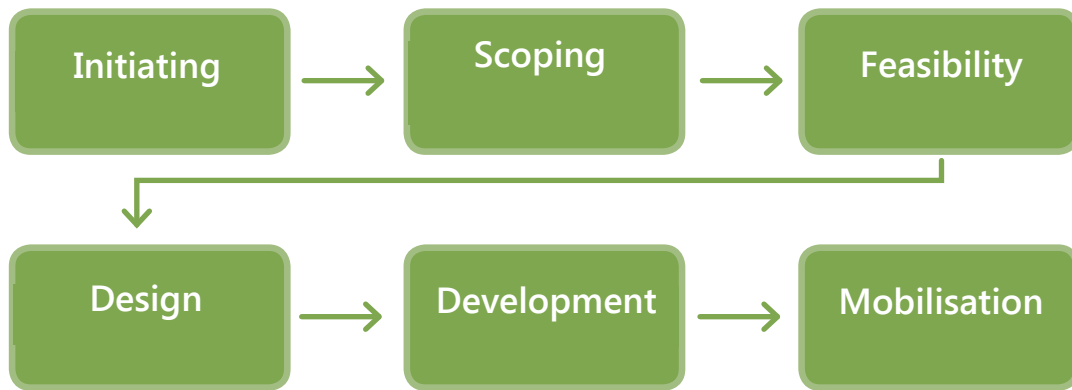
3. The diversity of the eight Demonstrators

It is informative to plot the Demonstrators to show their positions on different dimensions, relative to one another. This enables us to explore their diversity further, and to see differences between them.

By stage of maturity

The first of the two graphics below shows the progression of a project along the Smart Living scale.

The second shows how close to realisation or 'launch' the Demonstrators are, respectively.



These main groups relate to the different stages in the project's lifecycles:

Delivery Mobilisation

In which the projects have firm timings for their build and launch phases. For instance, the Angle DC project is proceeding through six Work Packages (and is currently in WP2). Bridgend is proceeding with their heat schemes with a required construction commencement date of 2019/20.

Design and Development

Where projects have been determined to be feasible and more detailed design and development of the business case is required. For instance, Milford ZCA is in Phase Two of its feasibility work, and now developing a business case for the Waterfront and a 'techno-economic' feasibility study for establishing the wider Milford Haven area as a zero carbon area. Similarly Neath Port Talbot and Flintshire are in the design and development phase having been through a feasibility analysis on potential opportunities.

Feasibility

This stage builds on the scope agreed in the previous phase activities. It tests and challenges the proposals to ensure they are feasible and have the right ingredients to meet design and development characteristics required for business case development.

Initiation and Scope

At the earliest stage of development, lead organisations are pulling together their ideas and collaborators, with support from Welsh Government Smart Living. In Torfaen, one of the second phase Demonstrators, work has yet to begin, and the project description is based on early ideas and strategic positions. For Blaenau Gwent further analysis is required for scoping the proposals to ensure the robustness of the gathered data reflects the business proposition required.

Maturity is used here to show the closeness of a project to 'going live', even in a pilot format (note that 'maturity' is also used in the Smart Cities work area, for instance with five dimensions against which the maturity of a city can be measured – see the work in NPT). This is related to how long a project has been live, but the relationship is not always linear; some projects have been running for a relatively short time but are growing fast in maturity.

What is notable about the technological projects is they are building on existing foundations; for instance, RCT already had hydrogen fuel cells running in public buildings and private homes, prior to this project (which aims, in part, to scale them up). Similarly SP Energy Networks obviously has the technical and engineering skills to support their project in Anglesey – and is the owner and maintainer of the existing wires infrastructure- whilst Blaenau Gwent is receiving support from AECOM to help understand the technical complexities relating to catalysing energy for their business platform.

It is important to emphasise that project development can operate on a feedback loop with reiterations of project development phases. Each project is different, and follows its own trajectory at its own pace. Nor is it the case that all will reach full maturity, and be launched as live projects – some will be abandoned during feasibility testing (but that also is not the same as saying they will fail – especially if the learnings across their lifetime have been captured).

By funding level



This diagram shows the relative level of total funds available to each Demonstrator. However, it is vital to note that these total funding levels are based on those reported by lead organisations during the interviews and included in each project's long-form case study. The funding picture is complex (another form of complexity in the Demonstrator initiative) as different projects are funded from multiple pots or programmes of work – for instance, where they deliver wellbeing, health or regeneration objectives as well as innovations in energy and systems. Projects in the earlier stages of development are clearer to cost out, as there is little matched funding alongside that from Smart Living- except for staff time contributed in-kind, which can be quite significant.

Four main groups can be identified here, by funding bands and development stages:

£ millions

Angle DC won £13.5m from Ofgem's Network Innovation Competition, and the lead organisation Scottish Power Energy Networks (SPEN) has also put in £1.5m of its own funds. Bridgend CBC has secured £6.5m from WEFO for the Caerau mine water geothermal scheme, and is seeking further match funding. Bridgend is also funded through other sources for their wider Smart Systems and Heat work.

£150k

Both Demonstrators in this band (NPT and Milford Haven) have been funded by Welsh Government Smart Living. Both phases of the feasibility work in Milford Haven have been funded by Smart Living (to a total of £105k), while Neath Port Talbot has received £101k to date. Both of these have involved significant in-kind staff time. Both projects are now working on business cases, which are designed in part to bring in further funding and from other sources than WG. Default expectations are that lead organisations will start to match-fund Smart Living support.

£50k

The next group of Demonstrators have been funded by Smart Living, in the region of £50k each. Torfaen and Blaenau Gwent are both developing their initial proposals, while Hydrogen Valley (with £36k to date, all from Smart Living) has worked up positioning papers about the potential role of hydrogen in the UK energy mix, as well as on the ground in the Rhondda valleys.

£5k

Flintshire has been supported as required to convene meetings and push forward conversations between the local authority, the district network operator (the DNO: SPEN) and other system actors about setting up a Virtual Private Wire Network (VPN) between local authority buildings and renewable energy sites. The next step will be to draw in expertise from Cardiff University to help develop more detail in the case to take a proposal to Ofgem around network charging for discussion.

It is important to note the wide range of costs here, which also reflect the development phase of the projects. At the top end budgets are high; this of course reflects the fact that these projects are in (or nearing) mobilisation phase. At the opposite end of the scale, budgets are next to nothing: Flintshire is effectively a test case for negotiating equitable charging structures for creating virtual private wires. Partners' main contribution here is time costs. While it is true (as commented above) that there is no clear continuum or pipeline, it is notable that many of the Demonstrators will need to secure multi-million pound funding in the medium to long-term if they are to deliver on their plans and proposals.

With the £150k bracket, apart from investment in time, the main funder is Smart Living. This observation suggests that Smart Living is in part a catalyst fund, with the aim of initiating project proposals which can then be worked up into business cases, before being more substantially funded from other sources. In some cases those sources turn out to be also connected to the government in some ways: e.g. through BEIS or Ofgem innovation schemes funded by the UK Government, or through WEFO.

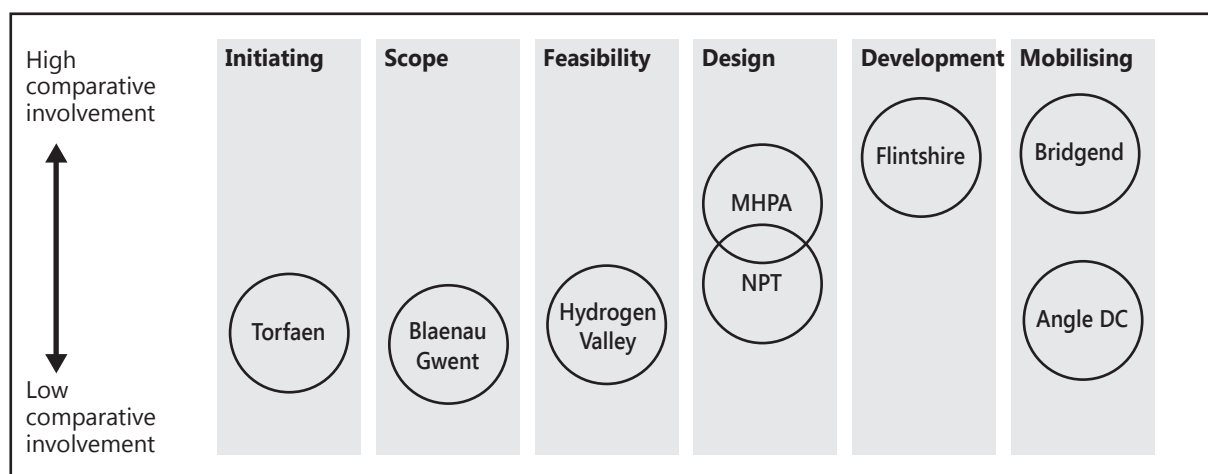
One advantage of this apparent dependence on public sector funding (at least in the earlier stages of maturity) is it guarantees a focus on community benefits and benefits for Wales, rather than focussing on more commercial imperatives. It also helps turn aspirational initiatives into reality on a sufficient scale to serve as a basis for making the case for support to the lead organisation's senior management.

Funding by Smart Living also ensures that Welsh Government has access to the generated material and learning experiences to support other developments as part of dissemination activities of the initiative. Similarly, lessons learned can help inform new policy development to help maximise the value of investment. By partnering on the journey with all the Demonstrators Welsh Government has insights which otherwise would not be apparent to help with related developments.

By Welsh Government involvement

The table below highlights the level of Welsh Government Smart Living involvement in each of the Demonstrators across the current portfolio, for instance as inputs to governance and project management meetings. This varies with the projects during different stages of development but there is a trend for the initiation and scoping phases to be mostly interactions with consultants until there is a sure feasible output of value which the sponsor can then use to draw others into the wider stakeholder discussions. Subsequent phases see the creation of formal governance structures, and regular meetings to support the development.

Table – Current comparative level of involvement of Welsh Government Smart Living within the portfolio



High level of Welsh Government involvement

This group includes projects where Smart Living is putting in considerable effort to attend governance and support meetings, helping bring partners together, and to focus them in on fruitful areas for a proposal. In the case of Bridgend, this involves interaction with the Energy Systems Catapult through operations and project board meetings, together with internal meetings supporting development of the heat schemes. As a consequence of the loss of personnel during development of the proposals, a high level of involvement has been required to keep the strength of the proposal progressing in Demonstrators such as Flintshire and Blaenau Gwent, where the capacity of the team was reduced due to retirement and ill health respectively.

Low level of Welsh Government involvement

It is interesting to note that the three proposals with the most technical issues are receiving less involvement from Smart Living during their initial and middle stages of development. This is due to the expertise required to analyse and prepare the initiation, scope and mobilisation phases which tends to be provided by in-house or consultancy input, who in turn oversee the relevant pace and management of progress. In the case of Angle DC, the lead organisation SP Energy Networks retains control over the project, as the proposal is in early design and build stages of the work programme. SPEN works with WG as one of a (large) number of stakeholders, while at the same time emphasising that its support was a key factor in their ability to progress the project.

Intermediate level of involvement

Two Demonstrators form a loose grouping here, in which involvement is broadly shared around the stakeholders and with the lead organisation. As the project moves into the later stage of development it is expected there will be a change in the level of involvement of Smart Living. Currently the ZCA proposal is receiving intensive support to design the proposed scheme, while NPT will need support to progress proposals to the development phase. Due to changing external factors and constrained resources, NPT relied on consultants to ensure the Phase 2 report was prepared and completed for discussions to take place with potential stakeholders going forward.

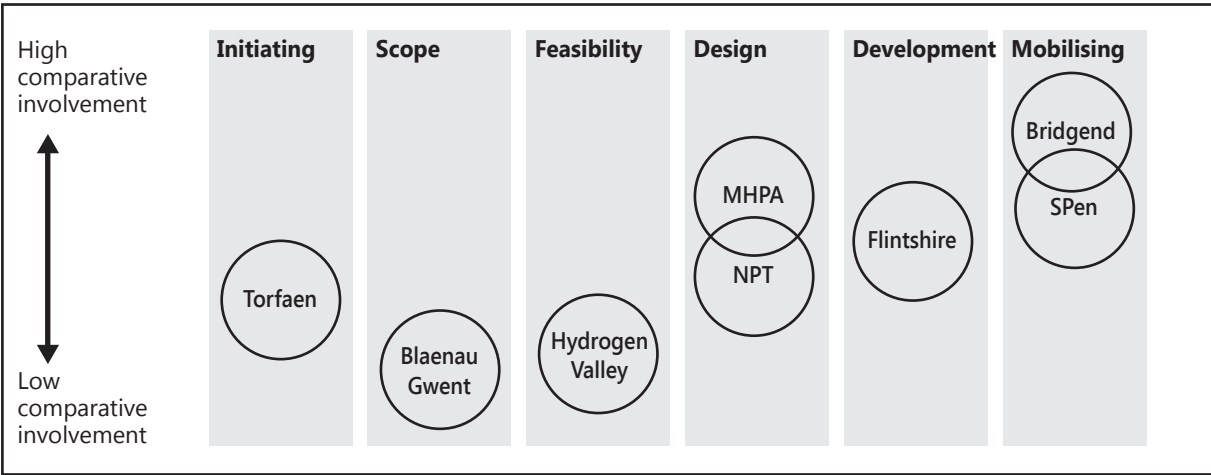
By degree of ownership

Whilst the commitment of individual key officers in lead organisations is strong, it is noticeable the level of involvement of Smart Living does bear some relationship to the degree of local senior ownership within the current portfolio. In some cases occasional misalignments between the two levels of governance has led to some delays in the progress of proposals where the level of ownership has been overlaid with other competing priorities. To some extent, these mismatches are to be expected, until a proposal reaches a suitable stage of clarity and the potential opportunities and benefits it presents to its local lead organisation become clear.

These tensions are further compounded by the fact that proposals need to reach a certain stage of development to seek formal governance and project support arrangements from senior management. Current experience with Smart Living suggests this point of clarity is reached around the Design stage when the feasibility of the project has been tested.

Despite variations between projects, it should be noted that WG is involved in the governance of all the Demonstrators. It is hard to read relative levels of ownership (leadership and governance arrangements are two topics which Demonstrators would benefit from opening up to discussion with one another). Much of the analysis here derives from the research team’s observations and perceptions based on undertaking interviews (including ‘site visits’) to compile the case studies and feedback from Smart Living.

Table – Current comparative level of ownership of developing proposals by lead organisations within the portfolio



All the projects have key officials in the lead organisation involved in the development of the proposals. The interaction with other internal colleagues and development of the proposals varies between different organisations depending on the stage of development of the Demonstrator.

What is noticeable is Welsh Government’s involvement in Demonstrators can be accompanied by apparent low local levels of ownership at specific points in a project’s development. It is hard to say what the causal relationship is here, but one role for Smart Living (as stated in the Framework) is to step in and build capacity in local authorities for working on smart energy and systems.

While the reverse appears to be true at the other end of the spectrum (high internal ownership means less Smart Living involvement in some cases – and arguably less is required), the middle ground includes projects which have modest but equal leadership both locally and nationally as well as projects where there are notably close relationships with WG and high levels of local ownership (eg. Bridgend, Milford ZCA).

By fit with Smart Living Framework criteria

Review of Demonstrators against the Smart Living criteria at this point in time can only consider their potential opportunities. The approach taken is that individual Demonstrators must compile a business case where strategic fit and proposed performance measures are essential components. In initiating the current eight Demonstrators the fit with the criteria was considered.

The tables below describe how fully each Demonstrator fits the criteria of the Smart Living Framework, in lead organisations' own words.

Several of the Demonstrators sit in the middle ground, where they have developed proposals – and for some, feasibility studies – but have yet to secure funding or turn those proposals into delivery plans. In each case the Demonstrator criteria are embedded in the work, but it is too soon to say whether the energy and system innovations which are planned will go on to deliver the wide range of community benefits they foresee. For one or two of these projects, the proposals have only just been initiated.

It is striking that the most technical Demonstrators only partially fit the criteria: their challenge is focused, though once achieved it will have ripple effects across the system. For instance, the work in Angle DC could result in Anglesey being able to generate and export from the island much larger quantities of electricity, including from renewable sources. In turn this could catalyse a transformation not just of the energy systems but of the whole economy and society on the island. But for the moment at least, the lead organisation is focussed on overcoming the technical challenges, without which none of the benefits will flow.

It is also worth logging a variation on this theme, in the form of Hydrogen Valley, which is both highly technical, but at the same time placed-based and system minded from the outset (in part due to its interest in hydrogen as a multi vector energy source, which is all about linking other energies and actors together). Alongside this advantage, it should be underlined that the benefits from hydrogen technologies are subject to its being taken up and further developed in multiple settings.

4) Seeing patterns across Demonstrators

Comparing different Demonstrators allows us to see some patterns developing and allows some possible relationships between them. (Note that many of these are echoed in the learnings identified from across the different projects, and synthesised in the section below).

- There is an association between funding and maturity: both increase together. However this is not a linear or a proportional relationship, and there is no one way direction of causality: funds are needed for activity on the ground, but funds result from following the development pathway (proposal, then business case, then funding once the project is shown to be feasible - at least as a pilot).

For the other Demonstrators (NPT, RCT Hydrogen, Fintshire VPN and Torfaen) see over

Addressing Smart Living Framework Criteria				
Smart Living Demonstrator Criteria	1 Bridgend	2 Angle DC	3 Milford ZCA	4 Blaenau Gwent
Creates business opportunities	Strong. Should inform supply chain development as part of construction of the different projects in the Demonstrator	Strong	Strong	Yes supports businesses through the energy platform and associated interactions
Provides value returns on individual or linked projects	Strong as potential interlinked projects	Potentially strong if new markets arise which can link across to marine and offshore wind to offer savings	Strong	Yes forms part of the wider platform being developed
Adopts multi stakeholder project participation and funding opportunities to reflect scope of Smart Living	Very strong creating complex and wide ranging consortia for development and delivery of proposals	Strong	Strong	Yes adopts a range of stakeholder interests as listed in Phase One report
Addresses market failure due to expected higher risk nature of Demonstrators	Strong – although technology exists to create “smart” energy there is still a gap between existing and commercial context for this new sector	Strong	Strong – although technology exists to create “smart” energy there is still a gap between existing and commercial context for this new sector	Yes initial evidence suggests this is the case
Aligns with local needs and objectives to take account of community and stakeholder views	Strong, addressing deprivation, fuel poverty, and maximising learning and job creation	Good strategic fit	Strong, addressing deprivation, fuel poverty, and maximising learning and job creation	This element is being developed as part of the scoping and feasibility research
Flexible structure with scalable and replicable potential for investment	Yes, but not yet proven	Yes, but not yet proven	Yes, but not yet proven	Yes potential
Encourages new business models or activities with multiple benefits in Wales	Strong but not yet proven	Strong - introduces novel approach to proactive management of local network	Strong	Yes potential

Addressing Smart Living Framework Criteria				
Smart Living Demonstrator Criteria	5 NPT	6 RCT Hydrogen	7 Flintshire VPN	8 Torfaen
Creates business opportunities	Yes	Yes	Potential with more renewable energy schemes able to progress	Not directly but indirectly looking at grid constraints will help with local business issues which in turn with jobs affects wellbeing
Provides value returns on individual or linked projects	Yes	Possible if scaling up in one area	Strong. If successful will help to bring forward more schemes	Yes
Adopts multi stakeholder project participation and funding opportunities to reflect scope of Smart Living	Yes	Not yet	Strong. Involves a range of stakeholders	Yes
Addresses market failure due to expected higher risk nature of Demonstrators	Would depend on the project	Yes	Strong. Charging structure currently does not reflect	Promotes excellent service delivery by creating the space to explore how to best interconnect multiple agencies to provide effective services
Aligns with local needs and objectives to take account of community and stakeholder views	Yes	Yes for stakeholders	Strong. Approach addresses a local need	Yes based on bottom-up planning
Flexible structure with scalable and replicable potential for investment	Yes. Aspects of a proposal can be piloted and scaled up	Yes, but not yet proven. Aim of feasibility study Phase Two	Strong. Will facilitate Local Authority solutions for VPN	Yes, to be tested. Pilot is based on one well-being goal in one community
Encourages new business models or activities with multiple benefits in Wales	Potentially yes	Yes	Strong. Will create a VPN charging arrangement	Yes if improved 'modus operandi' emerges

- Smart Living level of intervention and ownership do have some relationship as projects move through the different development stages although it is not always possible to explain the direction of causality and there are some exceptions.
- Whilst Smart Living funding has facilitated the bringing in of expertise to help turn proposals into feasibility studies and business cases, it is worth being alive to the risk of lead organisations (especially local authorities) outsourcing both expertise and ownership.

It is interesting to note that in some of the more technical projects, such as Angle DC, there is a less direct fit with the Smart Living Criteria. Here there is a distinction between the design and operation of innovative technology as part of the network, and other stakeholders capitalising on the network reinforcement achieved to support subsequent delivery of low carbon economic opportunities for wider community benefit.

Creating value

As part of the evidence gathering exercise during the case study development, lead organisations were asked to summarise the value emerging from their Demonstrator projects. In most cases, this was potential value, given the early stages of maturity that most of the projects were at. Lead organisations were clear they would deliver a wide range of benefits spanning the criteria of the Smart Living Framework. It was just that, in most cases, the majority of the value is not visible yet, and is conditional on a Demonstrator reaching its pilot stage, at the least.

In establishing a proposed annual learning report and framework it was recognised there would be limited data available but it is imperative to capture the learning values arising as soon as possible.

The value reported by lead organisations is synthesised below. It is presented in three types (in keeping with the three dimensions of value itemised in the innovative Revaluation methodology [7] for measuring change in complex systems).

Quantitative value

All the quantitative value that is reported in the Demonstrator case studies is potential value, as none of them will be live until 2020. There will be some supply chain benefits for those projects which are in the mobilisation phases, and some of those benefits will be local, but they have not been formally reported to date.

Quantitative data is available for those projects which have passed, or are in the later stages of, the design/development phase. Many of these Demonstrators will have to produce projections as part of their business cases, and these include the following metrics:

FOOTNOTES

7 www.cecan.ac.uk/sites/default/files/2018-01/07%20-%20Revaluation%20%28online%29.pdf

- **Angle DC**
The MVDC link will increase the transmission capacity from Anglesey by 20% (somewhere between 25 and 75 MVA). Just in transmission terms this will save Anglesey £18m from extra investment costs and in reduced losses as the traditional AC network degrades. The increased capacity will also enable Anglesey to export more of the renewable energy it generates, and to generate more. Once built, the link has a projected lifetime of 20 to 40 years.
- **Bridgend Geothermal Scheme**
The main projected saving from the Caerau mine water scheme is from cheaper bills to citizens, though these will take time to appear even after the Demonstrator goes live. In the more immediate term, building is anticipated to start in 2020, and that is projected to create over £7m of opportunities in the local supply chain.
- **Milford Zero Carbon Area**
As with Bridgend, the main projected quantitative impact of the Milford ZCA Demonstrator will be on energy prices. Here the main beneficiaries will be the Port Authority and the businesses and industries that work in the area or move into the Waterfront when it is redeveloped who will benefit from having their sites linked up to the renewable assets (and could reinvest any savings in meeting inequalities in the community). In just one element of the zero carbon area, linking the Port's large PV array to the Waterfront development could offset half of the CO₂ generated by the Port each year (3,900 tonnes).

Two of these projects also report side benefits which have material value (though this is yet to be quantified). In Angle DC, the lead organisation has had to develop a rail safety case to protect the DC cable which runs along the side of the railway bridge from the island. This bespoke innovation could be replicated for use in other settings, and generate revenue in the process. Meanwhile in Caerau, Bridgend CBC is investigating running new broadband lines alongside the pipework for the mine water heat network to connect up the households in the development.

In terms of revenue generated to date, the clearest source of this is in funds leveraged in by those projects which have cleared the feasibility stage. Across the two projects which have done so, Angle DC and Bridgend, £21.5m in funding has been brought in – though as ever this cannot be fully attributed to the work of the Smart Living team (although they are reported to have made pivotal interventions in both cases).

Qualitative value

The greater part of the qualitative value reported by Demonstrators is again potential value, here relating to community benefits which deliver on the wellbeing dimensions of Smart Living Framework (and the Wellbeing of Future Generations Act, which underpins Smart Living). Benefits here include individual and community wellbeing, a better environment, and more inclusive and resilient communities. However, none of these benefits are apparent yet even in the case of the most mature Demonstrators, these benefits are not projected to appear until a few years after the pilots go live.

The qualitative value which is already beginning to emerge mostly relates to learning. The development journey is generating considerable new insight and expertise. Learnings which are specific to each Demonstrator are synthesised in the next section. But here two further types of

learning should be highlighted. The first is about the Smart Living initiative. The Framework document (as cited) notes the ambiguities inherent in the term, and part of the purpose of the Demonstrators was to embody the concept and make it tangible on the ground, in places. There is evidence this is beginning to happen, for instance in the shared language which Smart Living and some of the Demonstrators are beginning to use with partner organisations and with the wider public (and with increasing confidence).

By extension, it is apparent that the public are now beginning to be engaged in smart energy and system innovations, through the work of the Demonstrators on the ground. In specific projects there is engagement work underway – most notably, with communities and households in Bridgend, to ensure they understand the technology of heat from mine water, that they accept the drilling and other engineering works required, and in the end that they get the best from the heat pumps which need installing (in their households or collectively around the area). Informal education work is also underway in Blaenau Gwent, where there is a need to ensure the planned energy platforms meet business needs. Initial consultation work including market research has already been undertaken here.

Relating to this body of learning, there is a material evidence base, with real value to a wider audience of users. This particularly arises from the work of individual Demonstrators, and relates to technical aspects (eg. MVDC conversion and linking, hydrogen generation and storage, use of mine water for domestic heat, and setting up virtual private wire networks). Much of this technological work will be the first of its kind in the UK, which is impressive in its own right, but also establishes Wales as leading host for smart energy work. As well as these technological innovations, there is the more conceptual work to develop smart, including the defining and establishing of zero carbon areas (distinct from related kinds of innovation ‘zones’), and the development of the smart town concept (distinct from smart cities – applied at a smaller scale, and here in the relatively under-resourced setting of Neath Port Talbot, as well as in the wider work in Bridgend). Both the technological and the conceptual innovations once worked up and applied on the ground will be of considerable interest to wider audiences.

One of the strengths of Smart Living is everything is documented and that as a result a significant written evidence base is being assembled. Note however this is currently distributed across projects: bringing it together, and supporting its dissemination will increase the value of this resource and the learning it contains. The proposed drafting of an annual review, supported by the rolling collection of appropriate data, will help support this need.

Relational value

Relational value is to do with neither quantitative nor qualitative value in a system; instead it concerns the connections between the part of the system, including how well connected and robust it is. A resilient system will continue to deliver its outcomes despite disruption from external factors. Given Smart Living is aiming to transform energy networks and systems, change in the quality and capacity of relationships in each place will be critical to achieving its ambitions.

Many of the Demonstrators talk about capacity building when evidencing the value they have created to date. In most instances they point to the development work they have done to identify partners, co-design plans and proposals, and then begin to reach out to local stakeholders, and in some instances citizens themselves.

Specific Demonstrator teams are building up capacity for working on smart energy and systems within their organisations. This is clearly the case in some of the more mature Demonstrators, and in those where there is already internal ownership, such as Bridgend or Milford Haven. It is also the case in Smart Living itself, where the relationships with all the partners in each Demonstrator and a wider network of smart energy experts and practitioners, are building new confidence and expertise within the Decarbonisation and Energy Department.

It is notable that other partners are benefitting from the new expertise and relationships too. Many Demonstrators are collaborating with academic partners, and it is notable that Cardiff University, FLEXIS and SPECIFIC are involved in at least five of the eight featured here with a sixth just initiated. As their contribution to the Angle DC project makes clear, there are substantial reputational benefits to be gained from working on ‘impactful world-first projects’ such as this one. The FLEXIS network is a £24m research collaboration to build capacity in developing energy systems across the South Wales region.

Noting the FLEXIS collaboration, it is striking that most of the capacity building achieved by Smart Living is within each Demonstrator and their places; there is little sign yet of networking going on between projects and places. More of this activity is planned for the coming year, including a Smart Energy conference in July 2018 and dissemination of sustainable fuels and smart mobility events later in the year but it is clear that more value could be created through building more resilient networks within and across the Demonstrators. One benefit of this is it could lessen the reliance of the partner organisations on Smart Living as they could begin to build mutually supporting relationships based on the exchange of all kinds of value, including learning, innovation and potentially business.

Relational value is ultimately where potential value will mostly be generated when projects become feasible, come on-stream, and then mature to deliver community benefits. Smart requires networks of technologies, practices and people. Transformational change towards ‘smart living’ will require these parts to be integrated into new socio-technical (and financial) smart systems. This must happen within a project, across the place where projects are sited, and between projects. There is already evidence of this at local level, with lead organisations beginning to talk confidently about their growing reputation as centres of energy and systems expertise, and how this in turn is driving potential partner organisations to come to them as possible hosts and test-bed sites. In this emerging evidence there are signs of the Smart Living vision being achieved, as places become defined by their capacity for innovation in ways of working and exemplars of low carbon living. This is true of Anglesey, and of Bridgend; Rhondda Cynon Taff, and potentially Neath Port Talbot, may not be far behind (albeit the last is starting from a low baseline, with few energy resources and a post-industrial legacy).

Emerging learnings

As noted above, much of the value generated by Smart Living to date is in the form of learnings arising from the work. In our case study format, and the interviews which helped provide the evidence, we asked explicitly about learnings to date, and invited both the lead organisations and WG Smart Living to write these learnings in to each case study. The results are brought together here.

Project Learnings for Lead Organisations

- Lead organisations highlighted the technical or substantive learnings from their Demonstrators. It tended to be the more mature projects which were in a position to do this. Hence, SP Energy Networks has learned a good deal about options for optimising increase in circuit capacity through an AC cable via use of medium voltage direct current (MVDC) on a 33kV circuit and is monitoring closely the ageing effects of changing from AC to DC on AC cables and overhead lines. The Port of Milford Haven and partners have studied potential zero carbon attributes elsewhere, and have moved their own understanding on as a result. Meanwhile the Hydrogen Valley work though at an early stage of project planning, is generating considerable learning about hydrogen, in a field which is very fast moving and subject to changing regulation and practice (for instance, in how hydrogen can be used better to balance demand on the grid). There are also important trials involving hydrogen elsewhere in the UK, so there is an imperative to share learning and move the sector forward together.
- Across all the Demonstrators, lead organisations highlighted the importance of building strong collaborative relationships; they also felt this was unusual in their experience. Many identified value in building a diverse steering group, commonly including the local authority, network providers, academics, and the Welsh Government. This diverse governance arrangement enables action at a system level. If engaged early it also enables genuine co-design, and this was seen as key to transformation – increasing the potential for different outcomes through doing things differently.
- Several Demonstrators spoke of the importance of engaging with community stakeholders. In some cases this was regarded as education: a chance to provide clear information, and challenge misperceptions. In some projects this is presented as formal education, involving work in schools or setting up community information activities. In others this engagement work is more foundational, designed as consultation or market research, for instance with local businesses and industry.
- Lead organisations underlined how they were not starting from scratch as a place-based approach means building on existing assets. In some Demonstrators that is the work itself – to network existing assets together. In others, it is more a question of bringing local resources to the surface: be those natural (eg. renewable generation potential) or cultural (eg. history, industrial heritage etc). However some places are marked out by a lack of resources – be that post-industrial legacy, a lack of potential renewables and high rates of deprivation (and fuel poverty). Demonstrators working in these settings highlighted the low levels of resource from which they are having to start, and the potentially higher value of the successes they achieve in these places of comparative need.

- The theme of need was brought up by a number of lead organisations, who were keen to highlight the need for additional funding to support this work. Several mentioned budgetary limits within the local authority and their having suffered from a period of austerity. Against this background were other complicating economic factors – for instance, the price of gas in the domestic market, which means the cost equation is tilted in favour of the status quo and against lower carbon energy sources.
- A few of the Demonstrators specifically spoke about the value they had gained from this learning Review, commissioned by the Welsh Government. In part it gave them a chance to look back and reflect, rather than always looking forward and moving from obstacle to obstacle. Some lead organisations spoke of their appetite for learning from other Demonstrators and sharing best practice. More reflective activity of this sort was felt to increase the potential future value of the Smart Living Initiative.

Learnings for Smart Living

- Welsh Government Smart Living highlighted the need to attend to relationships – despite, or perhaps because of, the complexity involved in the Demonstrator work. In particular Smart Living has highlighted the importance of Demonstrators having the right governance arrangements in place, including effective steering groups which can add value in terms of interrogating ideas, building partnerships, and providing quality assurance. The initiative has arrived at its own recipe for the management team which is needed in a lead organisation, especially where that is a host authority. This template comprises:
 - A political champion in the local authority cabinet willing to lead on the proposal amongst peers;
 - A senior manager who is engaged and has confidence and is willing to allow the lead official reasonable flexibility to take the proposal forward;
 - A lead official who is passionate about the proposal and believes in its ability to bring benefits to the local community and the authority.
- The initiative has learned that equally important as the membership of that group is the timing of establishing the steering group. Too early and the project might not stand the level of scrutiny (for instance, having insufficient data to refer to); too late, and the opportunity for co-design of the proposals could be lost (resulting in major challenges occurring later in the proceedings).
- In common with observations made by some of the lead organisations, Smart Living has found LAs have difficulties with high risk innovative proposals. The argument is they are answerable to the taxpayer, and more tacitly seem uncomfortable to stray into areas (such as energy systems) which are on the edge of their expertise. Smart Living talks of the need to support local authority leads in building a culture of innovation. This incorporates various aspects, including becoming more familiar with the technology, but also feeling less anxious in situations of low control (and higher than usual likelihood of failure). Part of this culture change includes developing ways of handling and responding to risk – for instance by working with others to develop scenarios and mitigation strategies -while over time confidence is built up working in such complex environments.

- Supporting innovative cultures in local government is part of a wider role for the Welsh Government, which Smart Living describes as building capacity for work on innovation, smart energy and systems. There is an education job to be done here, and not just with the core project team but across a whole lead organisation. Smart Living identifies churn as a constant threat, because capacity vested in a few key individuals in a lead organisation can be diminished as quickly as it can be created (as key individuals move on). Wide engagement across the organisation is necessary to build expertise and new ways of working.
- As part of this culture of innovation there is a need to accept and work with uncertainty. This is one of the principal reasons for Demonstrators being at the core of the Smart Living Framework so stakeholders can get to grips with what innovative energy and systems look like on the ground. Some projects feature high levels of technical expertise, and they require an experimental mind set. Others are experimenting by moving in the other direction, by setting up generic sites (like a 'typical' business park, part of the plans in Blaenau Gwent) in which innovations can be virtually trialled, before then being taken up and customised to fit specific sites already existing in the area. In the Demonstrator model, what is worked out in one place can be shown to others elsewhere and in the process becomes the evidence base.
- Smart Living has underlined the importance of capturing data and recording it consistently. This aligns with the point above about Demonstrators becoming the evidence base. Robust and meaningful data can help show progress, build collaboration, and draw in future funding. The initiative emphasises that all this work must be of a high quality, which can be shared with others elsewhere and be seen as robust. This includes market research and public engagement activities, which must represent accurately the views of particular communities. By contrast, not having the right data to hand can prevent the right story being told, such that key partners are hesitant to come on board, or key funding cannot be secured.
- As the point above makes clear, good quality data is important in part because it helps win funding. It also helps Demonstrators report back to funders on the funding they have won (and that includes reporting back to Smart Living and documenting what has been achieved and learnt). Smart Living highlights the way funding has been used and particularly how the tactics of providing pump-priming or seed funding in small tranches has enabled Demonstrators to go on and bid for more substantial funds from other sources as their projects mature. Smart Living sees its role as both providing the initial funding and making a persuasive case in support of bids for follow-on funding.
- Finally, Smart Living echo the sentiments of lead organisations, that the success of Demonstrators – and whether they will ultimately cross over from pilots to rolled-out schemes – is in large part down to external factors, including conditions in the energy market, regulatory and pricing structures, and political vagaries. In particular the fortunes of local government are critical, both in terms of their funding and 'rationalisation', and in terms of their electoral cycles: as organisations they are regularly in flux. The Demonstrators are not isolated from the wider systems beyond them, and Smart Living notes how they and the lead organisations must become adept to responding to constant change in the dynamic systems in which they operate. If they can effectively do that, they can also ensure they are on the front foot, ready to capitalise on the opportunities which arise as part and parcel of working in a dynamic system.

Conclusions and implications

Though it is early days in the lives of the eight Demonstrator projects, it is possible to draw out some main points from across the eight, based on the evidence summarised in this Review. Against each point, we can also draw out implications which can improve and strengthen these conclusions going forward.

Taken together, the Demonstrator projects show that Smart Living itself is living up to its vision of exploring new ways of connecting people and energy for the benefit of communities.

The span of the projects, across technical, financial and social systems, emblematises what Smart is, and can be.

However, the projects need to be firmly networked together for system effects to take place and ensure feedbacks between them to make Smart Living more than the sum of its parts, and more than just an initiative.

Nearly all the projects relate to low carbon energy, and will therefore result in carbon savings if they reach maturity. In this regard, Smart Living will deliver on the Government's 'Low Carbon Agenda'.

Some of the projects are not directly to do with generation however, and will only have an indirect effect on decarbonisation.

However, in some of those cases that effect could be dramatic, for instance by increasing the capacity for renewable generation on Anglesey, or by making full use of spare generation from wind power through the production and use of hydrogen in the Rhondda.

One implication of this is that projects' success should not be solely measured in carbon reductions.

There is growing strong leadership and understanding around "smart" which is essential to develop a clear direction and hold on to it, to draw in key stakeholders and expert partners, and to steer a firm course through ever-changing technical regulatory economic and political climates – whilst also adapting to those pressures. This leadership needs to be local to the place where the innovations are being developed and tried out.

In most cases this places the focus on the local authority, and it is notable that many of the local authorities who are lead organisations for these Demonstrators have strong internal ownership of their projects – which tends to increase as they move through the development phase of the proposals.

Even where that is the case though it cannot be taken for granted: these are long term projects – with R&D phases stretching out several years, and potentially delivery phases then roll-out running for years beyond that. Churn in key personnel is inevitable, and needs to be counteracted: it is notable that the projects that are making the most dramatic progress have strong leaders who have been in place since their inception, and whose expertise grows with the work.

The Welsh Government has a critical role to play to provide continuity where there is churn, to build ownership all across the lead organisations and to hold the Smart Living vision which binds the projects together.

Much of the value created to date is in the knowledge and expertise accruing to the projects. It is notable that Smart Living requires them to document their journeys thoroughly, and to build out from an empirical evidence base.

One clear example is in the technical know-how which is being accumulated: what the projects now know about AC to DC conversion and transmission, about extracting heat from mine water, or the potential for using hydrogen in multi-vector solutions to generation and storage, is of value to the whole energy sector.

Meanwhile, the learnings about governance and human systems will be invaluable to authorities across Wales as they strive to operationalise the ways of working of the Wellbeing of Future Generations Act.

It is however notable that this evidence and experience base is currently distributed across the Demonstrator sites and is in some cases difficult to access. This review begins to collate this data/information.

There is great diversity across the eight Demonstrator projects reviewed here. An unasked question in this Review so far is “to what extent are they Smart?”

Given that Smart is hard to define (as discussed earlier) it is not possible to situate each project on a spectrum of smartness (as we have done with other elements of Smart Living). However, some are clearly smarter than others, being more concerned with interactivity and connections between systems (including through multi-vector energy sources, or by linking up local production and consumption).

Some of the most technically ‘clever’ are perhaps the least ‘smart’ – though it must be noted that as these projects are in their very early design phases, the Use Phase in which people interact with the systems is yet to be reached (let alone its outcomes seen).

For delivery of smart integrated and multiple services which meet people’s demands and needs, it is recognised that over time all Demonstrators will progress towards holistic solutions whatever building block entry was used to create the Demonstrator (e.g. Bridgend using heat as one element in an aspirational smart connected community).

It follows that people (citizens) are less in evidence in the work to date than might be expected. This can most probably be explained by the phase of development that most of the Demonstrators are at.

Many Demonstrators are in early proposal or feasibility study stage. They are in the hands of policy leads and consultants, in discussion with technical actors and engineers.

This is not to say that people are missing from the projects and proposals. In those cases where work on the ground is underway there is already extensive community engagement work underway. Others which are reaching business case stage depend on exploring and demonstrating demand from potential users (eg. local businesses).

Yet it is notable that in some of those cases the lack of understanding of local communities for the aims and activities of Smart Living was felt to be a barrier to progress. Where this has been acknowledged, the proposals are spending more time on creating this understanding e.g. Blaenau Gwent, and ongoing work in NPT.

One of the virtues of the Demonstrator criteria is that they foreground benefits to the people and communities of Wales, ensuring they will not be an after-thought in project proposals and work plans. This is critical, as to be fully mature, smart systems require smart users.

Bounding the projects is a challenge which will increase as maturity of Smart Living progresses.

Those projects which explicitly address low carbon living, such as those exploring zero carbon areas or smart towns, explicitly come up against this challenge, geographically.

There will be further challenges to those working with communities of identity (eg. ageing populations).

Finally, the bounding of Demonstrators by the Framework criteria has also proved problematic in some cases: especially as projects mature, they build more partnerships and more sub-projects (or sub-systems) – Bridgend is the case in point here, and for the case study we simplified the review by focussing on the mine water project not the town centre heat scheme (partly as it was deemed less ‘smart’).

While this has been a live issue for the Review, again there is an ongoing measurement challenge here. With so much going on in a place, and (if the projects are fully mature) so many interconnections between projects, simple understandings of causality (and therefore secure attribution of effects) will be insufficient.

Measuring value for money from Smart Living [as with bounding] will be complex but not insurmountable alongside the journey being taken with the Demonstrators.

According to the lead organisations, the eight Demonstrator projects here have to date received Smart Living funding from the Welsh Government worth £498k up to March 2018. However, two of those projects have leveraged in £21.5m between them (including some from Welsh Government-related European funds such as WEFO). Even these basic accounts illustrate that return on investment is going to be complex for this initiative – as is the case with most innovation-led activities.

Particular aspects of the initiative increase the measurement challenge for Smart Living:

- First, the time period will be five to ten years as some of the community benefits will need time to materialise.
- Second there is how to attribute effects, especially where Smart Living input comes alongside other funding or resourcing: what is the added value of Smart Living?
- Third, there is the accounting for outcomes which are not easily monetised, such as some of those prioritised in the Wellbeing of Future Generations Act.

These are not insurmountable challenges, but an innovative measurement process involving multiple methods and extensive stakeholder participation is likely to be required.

Recommendations

In addition to the conclusions and implications highlighted above, the following key recommendations are directed at Smart Living in the Welsh Government. They are intended to build upon the findings here, and create more value for all the parties involved across each of the Demonstrators, in ensuring they deliver on the aims of the initiative, and against the Wellbeing of Future Generations Act that underpins it, ultimately by speeding the transition to a smart low carbon energy system in Wales.

- Use the Smart Living Demonstrator Framework to shape the initial appraisal of proposed Demonstrators, but also treat each potential Demonstrator on its own merits to avoid rigidity and exclusion of potential good innovative proposals. The alternative would be to apply the criteria rigidly and without exceptions, which would risk excluding projects that don't conform, even where they are high prestige, high value projects.
- Develop the evolving catalyst role of Smart Living as creating a system of systems and facilitation which helps generate supportive network ingredients, and brings them together to create inter-relationships which make them 'smart'.
- Recognise Demonstrators as complex systems involving multiple actors with multiple aims based on multiple theories of change, with high uncertainty about boundaries, desirable endpoints, and the resources needed to reach them, including time and differing levels of control. Adjust Smart Living support to be explicit about this complexity, and to help manage risks and catalyse actions in response.
- Encourage networking by becoming a learning system. Undertake outreach, engagement and capacity building work and encourage sharing of knowledge between Demonstrators, and the pooling of the evidence and developing a shared agenda for discussion and further collaboration. In turn, encourage them to communicate with their citizens about their Smart Living work, and their visions for the areas they govern. Smart should not merely be designed with people in mind, but with people in the room, in order to develop transformational solutions to energy systems which conventionally have only been designed from the top down.
- Undertake reviews of the initiative regularly – and incorporate reflection and learning, as much as the measurement of outputs or progress against indicators. Support Demonstrators in taking ownership of their own measurement, and explore whether there are shared measures which they would like to apply consistently across projects.
- Sustain investment in Smart Living and the Demonstrator portfolio of work. This is a long term capacity building initiative where Welsh Government can bring continuity in a complex environment, and capture the community benefits in the longer term. This is especially important as most community benefits will become apparent only once schemes have reached full maturity.
- Anticipate 'failure' (i.e. the non-progress) of some projects and manage this, particularly in a climate of great financial and political uncertainty.
- Explore innovative methods for capturing the value added by Smart Living, in order to understand how best it can support current and future innovative Demonstrators. Challenges

relating to the complexity of the work will need taking account of, including how to bound the Demonstrator sites, how to isolate their effects from what activity is already underway in a place, and how to be flexible enough to accommodate dynamic changes in the system over time. A fuller understanding of the value of the Demonstrators' contributions would help them to collaborate more effectively, and communicate more directly with key stakeholders around a range of needs, including for funding, investment and strategic direction for the future.

Findings in detail: the eight Demonstrator summary case studies

1. Bridgend Smart Systems and Heat Programme
2. Angle DC
3. Milford Waterfront: Developing a Zero Carbon Area
4. Blaenau Gwent - Catalysing Local Energy
5. Neath Port Talbot smart low carbon development
6. Creating a Hydrogen Valley Demonstrator
7. Flintshire: Smarter Connection – Virtual Private Wire Network (VPN)
8. Torfaen: Wellbeing in Blaenavon

1. Bridgend Smart Systems and Heat Programme

Description

Bridgend County Borough Council (Bridgend CBC) was selected to be part of the UK Smart Systems and Heat Programme in October 2014, alongside Greater Manchester and Newcastle. This ambitious programme marks out Bridgend as being one of the leading low carbon heat local authorities in the UK, which will be evidenced through their development of two demonstration heat projects in the county.

- 1 A pioneering geothermal scheme in Caerau, utilising groundwater in former mine shafts in the Llynfi Valley along with heat pump technology, providing heat to the Caerau Community.
- 2 A Bridgend town centre district heating scheme involving public and civic buildings, leisure centre and some residential.

While developing these Demonstrator projects, Bridgend County is hosting trials of smart initiatives developed by the Energy Systems Catapult (ESC), including 'EnergyPath' - a suite of software tools to assist Local Authorities to create designs for future-proofed and economic local

heating solutions, specific to their location. The developments are beginning to establish Bridgend as an energy innovation area for others to trial heat developments as well as those being driven by the Local Authority. This is exemplified by the hosting of the FREEDOM project which is a hybrid scheme sponsored by PassivSystems, Wales & West Utilities and Western Power Distribution.

This summary case study focuses on the Caerau geothermal project but further details of the other heat schemes are available on request.

Timeline

- A master planning exercise was completed in early 2016 covering opportunities for heat schemes in the Upper Llynfi Valley area. The report concluded that the most suitable opportunity existed in Caerau, which had potential to exploit mine water as a resource.
- A feasibility study was commissioned in September 2016 from a Cardiff University led consortium. The study was completed in February 2018.
- As part of the feasibility, former colliery workings were accessed through the geo-technical site investigation lasting four weeks in September 2017. Early indications are that water levels are lower than expected which may increase pumping costs, although water is at an adequate temperature of 20.6°C.
- Construction is due to start in 2020 with first homes heated by 2021.

A range of related smart technologies are also being trialled in Bridgend:

- A Home Energy Systems Gateway (HESG) trial started in September 2017 for the winter

Photos © Bridgend County Borough Council



Bridgend council was awarded £6.5m in EU funds to create the UK's first large scale mine water energy project in Caerau.

heating season. This was carried out by Energy Systems Catapult (ESC).

- SolarVenti system (to tackle damp homes through use of renewably-powered technology) in-home trial commenced April 2018 and is ongoing.
- Logisor trial is planned for May 2019. This is an electric radiant heat solution trialling in community centres and registered social landlord homes.
- FREEDOM trial is underway – a collaborative technology trial between WPD and WWU delivered by PassivSystems, testing gas/ASHP hybrid heating solutions in 75 homes in Bridgend Borough.

Aims

The overall aim of Bridgend County Borough Council is to make Bridgend a decarbonised digitally connected Smart County Borough.

Contributing to this overall aim, the Caerau mine water scheme is an important element. Mine water heat recovery is a highly innovative and relatively new technology. The first ever scheme began in October 2008 in Heerlan, Netherlands. This project to capture geothermal energy in Caerau would put Bridgend on the map as the first scheme of its kind in the UK at the proposed scale.

The main objective of this project is to explore the potential for a smart heat scheme in Caerau, utilising innovative geothermal energy technologies. The ultimate aim for Bridgend CBC would be to provide a decentralised energy system with potential to supply competitively priced, low carbon energy, while also addressing the issue of fuel poverty.

The Caerau mine water scheme is designed to deliver against the requirements of the Energy Systems Catapult, and the UK Government's vision for smart energy systems. It is also designed to deliver against the Welsh Government's targets for a decarbonised energy system, in that it will generate energy from renewable sources, as well as making use of 'waste' heat, and ensure that

these resources are locally owned.

The scheme also matches the Demonstrator criteria set out in the Welsh Government's Smart Living Framework.

Partners and stakeholders

The wider Smart Systems and Heat Programme (SSH programme), incorporating both the Caerau geothermal scheme and the Bridgend Town Centre scheme, was originally developed by the Energy Technology Institute in 2012. Energy Systems Catapult has taken it forward since autumn 2015 with BEIS funding the Phase 2 developments.

Welsh Government, Energy Systems Catapult and Hitachi are facilitating the "smart systems" aspects of the Caerau Geothermal project, and the Welsh European Funding Office (WEFO) is also providing funding for the Caerau scheme. Hitachi has conducted detailed research into the local energy market and potential for a local energy tariff.

Further assistance for this demonstrator has been provided by Welsh Government, the UK Heat Network Delivery Unit (HNDU) and a consortium led by Cardiff University. Cardiff University undertook the feasibility study with support from SPECIFIC at Swansea University and FLEXIS Wales.

SPECIFIC at Swansea University have conducted home visits as part of the feasibility study. This was to scope out the logistics of installing heat pumps in homes. This work has raised the option of having centralised rather than individual pumps. Hitachi is now undertaking an independent review of the options for the location of heat pumps.

Both the Coal Authority and Natural Resources Wales have provided helpful advisory involvement as regulatory bodies. Western Power Distribution (WPD), the distribution network operator (DNO) and Wales & West Utilities have also provided helpful advice.

In the context of the wider SSH programme, supply chain businesses are increasingly important partners for Bridgend CBC and small businesses are offering their product/services to be tested as part of the wider programme.

The SSH programme is now linking in to the Valleys Task Force which has been established to improve life for residents of the Welsh valleys.

Funding

WEFO has committed £6.5m towards delivering the innovative Caerau scheme. Bridgend CBC is developing the business case to secure the required match funding from interested parties. In addition, the Bridgend scheme has received funding from other sources including Smart Living.

Creating value

The majority of the work on the scheme to date has involved feasibility and community engagement activities. Hence, the created value can only be captured qualitatively so far. Local people report a sense of pride at having been chosen to host an innovative energy project and are predominantly positive about the scheme which will build a legacy of their mining past.

“We were heated by the mines before and we will be heated by them again”.

Anticipated benefits include:

- The potential to generate a legacy of training and educational opportunities to address severe economic deprivation in Caerau so that it no longer ranks amongst the most deprived areas in Wales.
- Supply chain development opportunities for local businesses, estimated at £7.75m value to supply chain through procurement.
- The research tool Home Energy Services Gateway (HESG) has been designed to facilitate a two way dialogue between service providers and customers in order to set requirements and expectations for domestic heat use. Thirty households from across the borough have been recruited to host various domestic smart energy devices as part of the trials, which are being conducted by ESC. ESC will feed back to Bridgend CBC and Welsh Government about the tool’s potential implications for future energy strategies

- Use of the smart platform is being trialled to link homes with health and social services.
- A potential reduction in household bills from the Caerau geothermal scheme.
- Positive health impacts through the creation of better quality, more energy efficient, comfortable housing.
- Improved air quality and reduced carbon emissions, with careful management of natural resources to safeguard the interests of future generations.
- A new business model for this project which is innovative in its approach to comfort and warmth as a service rather than a commodity.

As an unanticipated benefit of the scheme, it may prove possible to lay a fibre optic broadband network alongside the heating infrastructure, bringing communities faster digital access as well as cheaper, low carbon heating.

The project was awarded third place in the NEA Energy Impact Awards in 2017. The prize money awarded will pay for a primary school engagement project called ‘Heat Beneath Your Feet’, run by STEM ambassadors from the University of Cardiff.

Learnings

The Caerau project as part of the SSH Programme, will generate a bank of evidence for other projects to learn from.

As may be expected when delivering a large and complex project in a residential community setting, the project team has faced challenges, and anticipates further complications. Bridgend CBC noted that producing this case study for the Smarter Living Framework had been beneficial as it caused them to reflect on what has been achieved so far, rather than move from multiple barriers/ issues as a usual routine:

“We’re constantly looking forward to barriers yet to be overcome rather than looking back at things we’ve already tackled.”

The feasibility study has involved addressing many

different considerations and required a variety of forms of expertise. This meant that the study needed to be delivered by a consortium, which has required complex management and coordination arrangements.

Bridgend CBC has found that the number of invested partners can complicate decision making about key choices- as exemplified by the need to choose whether to use individual or centralised heat pumps. As the lead partner, the council has to make the final decision where it is not obvious which is the best choice. This requires the council to accept a level of risk, which makes it more difficult when there is a need to obtain resources.

Community acceptance of the scheme is essential to its success, as two-thirds of properties in Caerau are privately owned. Helping to raise awareness in the community has proven important to help people's understanding of what the activities are and be involved in development of the project. An early example of this was the need to manage the on-site drilling to carry out technical scoping during the feasibility study. Raising awareness included some residents visiting a small-scale mine water heat scheme in Neath. This provided a positive response.

The growing status of heat decarbonisation projects and publicity around the project has resulted in considerable interest from supply chain businesses. This has enabled Bridgend CBC to establish a valuable and growing network of supply chain businesses keen to see their products used in technology trials. Two such businesses have products which are going to be used as part of the technology trials in the borough. In turn this has positioned Bridgend CBC as a locus for developing

innovative projects and utilising the latest novel technologies.

"The relationships we've developed with technology companies are really valuable, allowing us to test and benefit from some of the latest innovations in renewable heat. Being part of SSH and Smart Living has meant suppliers contact us and we are on the map as a forward thinking local authority."

Next steps

- Complete technical analysis for the mine water scheme, including modelling of ongoing heat levels. Although the temperature of water is adequate, water levels are lower than expected which could increase pumping costs. There is also a need to look into water flow and its impacts on heat recharging, to ensure that the level of geothermal energy will not reduce over time. Innovative methods of recharging heat will be explored.
- Review technical advice from Hitachi regarding location of heat pumps within homes or at a central site, and decide upon the best option to progress with.
- Develop outline business case and match funding for the Caerau heat scheme.
- Develop wider power and transport activities in the area to fit with decarbonisation aims.
- Continue community engagement to ensure concerns of local residents are addressed and that the scheme directly benefits them.



View over Caerau.

Photos © Bridgend County Borough Council

2. Angle DC

Description

The Angle DC project is a live Demonstrator of a novel network reinforcement technique being delivered in North Wales which will enable future low carbon economic growth in the region. Angle DC demonstrates a novel network reinforcement technique by creating a medium voltage direct current (MVDC) link on a section of the existing 33kV circuit between Anglesey and the mainland. Monitoring equipment will enable understanding of the effects of DC on AC circuits. A back-up AC circuit will provide network security.

This proposal provides a potential alternative to the traditional capital-intensive solution of network reinforcement. The new link is expected to operate for 20-40 years after the project ends to continue to provide long-term benefits for the network on Anglesey.

Wales is experiencing network constraints at a time when its aspirations for decarbonisation and renewable energy generation are important ingredients in the future wellbeing and prosperity ambitions for Wales. The project is viewed as a supporting enabler for realising the economic ambitions of Anglesey as an 'Energy Island' with minimal environmental impact for the region's high quality natural landscapes.

Timeline

The Angle DC project is running from January 2016 and will continue to February 2020. It has six main work packages:

- Detailed preliminary design including AC system studies, development of the HCCM and MVDC converter technical specifications and development of the protection and control strategies.

- MVDC link work activities required to design, manufacture, install and commission the MVDC link.
- Design, plan, install and commission the back-up AC circuit.
- Manufacture, site preparation, installation and commissioning of the holistic cable condition monitoring system.
- Continuous monitoring, recording and analysis of the MVDC link performance to build confidence in the MVDC technology. The development of MVDC technical guidance and policy documentation.
- Knowledge dissemination and review of project learning and dissemination of lessons learnt.

The project is now in second phase (WP2); the MVDC link should be manufactured and installed in three years. The new AC circuit (WP3) could then take two years to install and commission.

The construction and connection to the grid of new renewable generation schemes, new housing and other new economic investment is expected to continue beyond the completion of the new circuit, with the hoped-for economic and regeneration benefits enabled by the project coming to fruition up to 5-10 years after the investment is completed, and continuing beyond that.

Aims

The aims and objectives of the project relate both to network innovation ambitions of the electricity industry and regional ambitions for transformational economic growth on Anglesey and in North Wales, around the common aim to demonstrate a novel network reinforcement technique.

SP Energy Networks's specific objectives for the Angle DC demonstration project include:

- Increased capacity of the existing circuit without cable and line reinforcement;
- Greater precision in the control of power flow through the circuit;
- Active control of voltage at either end of the circuit;
- Active control of reactive power flow at the end of the circuit;
- Reduced losses in the distribution network.

For SP Energy Networks, the Angle DC project will contribute towards a long-term aim to create a new market for MVDC converter technology. They will deem the project a success if Angle DC provides the best net present value compared with competing technologies and conventional reinforcement. A detailed cost benefit analysis will be carried out at the end of the project following a one year of operational performance review to ascertain how far this has been achieved. In the longer-term, there is the potential opportunity for the technology to be market-ready to apply in other settings, enabling network and associated economic benefits to be secured.

The Welsh Government, local government and other local partners identify the project as an enabler of aims to achieve transformational growth on Anglesey Energy Island and in the region, including:

- To overcome the limitations of the existing infrastructure on the Isle of Anglesey and achieve at least a 20% increment from the existing circuit, creating more capacity in the system.
- To accelerate the distributed energy generation connections and demand connections on the Isle of Anglesey, enabling wind, tidal, biomass and solar energy streams to be harnessed.
- To facilitate a low carbon economy and so contribute towards the achievement of economic, social and environmental gains for Anglesey and the wider North Wales region.

These objectives fit well with the criteria set by the Welsh Government for Smart Living Demonstrator projects. In particular, Angle DC will create new business opportunities (in renewable energy, but also in housing, and the wider economy), and build new multi-stakeholder networks capable of generating new projects and funding opportunities. However it is not yet known whether the innovative technology will prove replicable in other locations.

Meanwhile Cardiff University, in their role as academic partner, are looking to Angle DC to increase the recognition of the University as a producer of impactful research. Success for them will be measured in terms of the dissemination of results to a wider academic and industrial audience.

Partners and stakeholders

The idea for the project came through discussions between power electronic experts at WSP and SP Energy Networks. The nature of the Anglesey networks and engineering challenges it faces meant the converted circuit and local network could provide a great deal of valuable industry learning.

SP Energy Networks is the project lead organisation. Cardiff University has been appointed as academic partner and will use real-life data supplied by the project to generate and disseminate more broadly applicable learning regarding performance optimisation and other related technical areas. GE Power Conversion is contracted to design, supply and install the equipment for the two MVDC converter stations.

The project has a steering group, consisting of government bodies to help coordinate the development of the Angle DC Project and provide guidance to find more effective ways of overcoming key challenges. Members of the Steering Board include the Welsh Government, Isle of Anglesey County Council, Gwynedd County Council and Cardiff University. The Welsh Government has been an active member of the steering group, providing both strong and proactive support as well as valuable governance to SP Energy Networks.

Other stakeholders supporting the proposals include Anglesey Enterprise Zone and Anglesey Energy Island programme, Menter Mon (tidal) and the Offshore Renewable Energy (ORE) Catapult, Western Power Distribution (WPD), Electric Power Research Institute (EPRI), Energy Networks Association (ENA), Power Electronic Society, Scottish Hydro Electric Power Distribution (SHEPD), WSP, Flexible Elektrische Netze (FEN) GmbH and The National HVDC Centre (MTTE).

Funding

SP Energy Network's successful bid to Ofgem Network Innovation Competition (NIC) secured £13.5m funding. SPEN has committed a further £1.5m funding. Without the NIC award, developers of future low carbon energy generation on Anglesey seeking to connect to the network would have had to pay significant amounts of money for conventional network reinforcement.

Creating value

"The project will help put Wales on the map in the emerging world of DC technology" Andrew Moon, SP Energy Network.

This demonstrator is trialling the first flexible MVDC link in the Great Britain distribution system. It will pilot the conversion of an AC circuit to DC operation to enhance circuit capacity – and real-time holistic circuit condition monitoring of a DC circuit converted from AC. It seeks to create a market for MVDC links in the UK as a competitive alternative to other conventional solutions.

Renewable, low-carbon energy is an important driver of economic growth for the region of North Wales, including the Isle of Anglesey and Gwynedd, with plentiful opportunities for wind, solar and tidal generation. There are already large generation schemes in operation and in the pipeline, including wind, solar, tidal and hydro. The Isle of Anglesey often produces more energy than it uses: surplus energy is transmitted to mainland Wales. Demand for electricity is also projected to grow, associated with regeneration, housing and economic growth on the island and mainland

North Wales.

The actual benefit and value to the network and local connections will not be clear until completion of the project in 2020. The longer-term economic benefits to which the project can contribute are likely to take even longer to fully achieve. Short term benefits to the energy network are projected to include the release of network capacity of around 25- 75 MVA.

Angle DC needs to create a market for MVDC links in the UK to fully realise the predicted benefits. If successful, the UK could see several other similar projects completed between now and 2040. The level of uptake depends largely on what the cost reductions of power electronics are achieved between now and 2040.

MVDC technology is already connecting to medium voltage AC networks as an interface between the DC networks linking low carbon generator arrays, for example wind turbines or tidal stream generators. Should Angle DC be successful, MVDC links situated within medium voltage networks could help DNOs manage increasing penetration of distributed energy resources. For SP Energy Networks, even if the trial shows that the technology offers poor prospects for wider application, this will be important learning for the industry regarding alternative techniques for network reinforcement.

Once completed, the MVDC link should deliver benefits for customers in North Wales. Benefits to Anglesey and North Wales area because of the Angle DC trial include £18.67m potential savings by 2050. This is in the form of net capital investment savings associated with the incremental capacity; and £7.57m for potential area loss reduction by the end of 2030 and £15.77m by the end of 2050.

If successful, the roll-out of the Angle DC solution, at the GB level, could bring a total saving of £69.2m by 2030 and £396m by 2050. This could bring benefits for customers across the UK by minimising losses on the network and maximising network capacity to allow more low-carbon generation to connect.

The academic partnership with Cardiff University

is expected to provide a wider understanding of the technology performance and options for optimisation as well as theoretical comparisons against those being developed by a commercial provider for the MDVC link. This collaboration should increase engagement between academic and industry expertise which will be of longer term value to the electricity industry, including for the emergence of future academics and engineers with experience of working on real-world network energy issues. The academic partnership on a world-leading innovation has also led Cardiff University to invest its own time and money to the associated academic work above their contractual commitments, motivated by the opportunity to enhance their ranking as a producer of impactful research and to build their linkages with industry and other universities worldwide.

“The team at Cardiff University are keen to contribute where we can to the success of the MVDC demonstrator. Our involvement in this world first project strengthens our reputation for doing impactful research”

One of the outputs of Cardiff University’s work on the project will be a web portal, for those seeking a connection to the network on Anglesey to view the capacity uplift achieved. This will provide a more accurate picture than is currently available to those planning renewable generation connections in North Wales; advising of the potential capacity for new connections in different locations.

An unintended benefit of the project has arisen in response to concerns from the rail network operator about possible safety risks of running a DC cable near a railway bridge. This led SP Energy Networks to develop a bespoke rail safety case for AC to DC near railway infrastructure. The safety case developed for the Angle DC project will potentially be of use within the industry as a reference case for future projects. This could help reduce the costs involved in the development of future projects involving DC cables near rail infrastructure.

Learnings

Technical lessons learned to date for networks operators include: familiarity with the various basic design approaches which a possible MVDC converter market can offer; and the availability of multiple different MVDC converter design approaches all within the project budget. A further key area of technical learning relates to the comparative ageing of the circuit between AC and DC cable. This learning will be critical in determining whether future AC to DC conversion on existing circuits is feasible. A holistic cable condition monitoring system will be installed as part of the project.

Process learnings include those relating to the building of new industry relationships with national and local government actors, together with various academic institutions, both local and international. The enthusiasm and pro-action of Welsh Government officials has been particularly valued by SP Energy Networks, fostering a collaborative relationship. The local authority bodies have appreciated the opportunity to be involved as part of the project steering group; their input into overcoming early project challenges has benefited the project delivery.

Accommodating challenges. A number of these have been encountered and addressed on the project so far, including:

- Sourcing the right technology via a multistage tender process in absence of off-the-shelf solutions.
- Carrying out a detailed safety assessment covering compatibility of the MVDC link with rail infrastructure.
- Technical challenges integral to the project and delivery timescale issues, with extra time built in to address unforeseen challenges that frequently arise in innovation projects.
- Appointing the most suitable academic partner to extract and disseminate learning to key stakeholders, so that the benefits reach a wide variety of stakeholders.

Capturing and sharing learning has been

designed into the project from the outset. As a world leading real-world application of MVDC technology, the project has attracted significant interest from industry and academia, both in the UK and internationally. Learning has been shared at international conferences, workshops and webinars. Cardiff University has been tasked with extracting technical learning from the project and disseminating knowledge to key stakeholders, including network and grid operators, generators and academic audiences worldwide. Finally, the involvement of the local authorities on the steering group is expected to be particularly important for promoting awareness and understanding of the project amongst local communities. This may include educational opportunities for local school children.

Next steps

Current and future stages in the delivery of Angle DC involve a wide range of activities reaching beyond the technical developments. These include design work, commissioning of monitoring data,

events to share technical learning, steering group meetings, wayleaves and consent issues, and production of a report on project learning.

For the project to create a market for MVDC, it both needs to prove successful and be replicated in the UK between now and 2040, generating growth in the number of MVDC converters deployed. This uptake is dependent on a reduction in the cost of power electronics and increased efficiency in deploying MVDC links within distribution networks.

SP Energy Networks is committed to delivery of the project as a well-managed innovation trial that delivers a solution that is suitable for Anglesey. There is a clear-sighted recognition that the trial may find the MVDC solution is not cost-effective compared to a conventional solution. This would be as much a valuable real-life finding from the innovation trial as a finding that the MVDC solution is a cost-effective solution.



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Britannia Bridge, Anglesey

3. Milford Waterfront: Developing a Zero Carbon Area

Description

The project is piloting the process of developing zero carbon areas. In 2016 Welsh Government and West Wales Local Authorities, Swansea, Carmarthenshire, Pembrokeshire and Neath Port Talbot participated in a proposal to develop the concept of zero carbon areas and to identify potential demonstrator areas. Three candidate areas were identified in West Wales for further detailed analysis and testing for deployment.

The idea of a ZCA was originally initiated due to the rising concerns over decarbonisation and air quality, particularly as West Wales has strong tourism and yet historic industrial legacies. The emerging smart technologies, systems and processes, emerging energy markets, increased level of renewable energy generation and climate change all offered the potential and opportunities for considering how all these key ingredients could be brought together to create zero carbon areas.

Milford Haven emerged as the most promising location for a zero carbon area, with Milford Waterfront as a strong location for a catalyst project within a wider Milford Haven ZCA. It is a 420,000 square foot retail, leisure and residential development on land wholly owned by the Port of Milford Haven (PoMH). The location offers opportunities to achieve economic and social benefits in an area of significant disadvantage.

Milford Waterfront Development is forecast to make a substantial contribution to the Pembrokeshire economy- £81m GVA during construction and £15.7m annual GVA once the development has been completed. Clean energy looks set to help provide the impetus for future growth in West Wales, with a major marine renewable energy development in Pembroke Dock and Milford Waterfront's deployment of clean energy and smart living principles.

Low carbon and smart energy opportunities in the area include: a catalyst project to install a private wire from the Milford Haven Port Authority's operational 5 MW Liddeston Ridge Solar Farm; a smart grid master plan; a community-owned anaerobic digestion plant for baseload renewable energy; opportunities for conversion of rooftop solar PV to thermal or chemical storage at the port; a potential electricity-to-hydrogen-to-electricity project; and increased use of sustainable modes of transport within the area. There is already active community engagement in relation to specific low carbon opportunities.



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Timeline

The development is structured in two phases. A Phase One study supported by the Welsh Government and West Wales local authorities in 2016 was conducted by the Centre for Sustainable Energy and Eunomia Research and Consulting Limited. Phase Two commenced in 2018 and will run to March 2019 and is being overseen by a Cardiff University consortium.

Aims

This Demonstrator aims to establish the first ZCA in Wales and provide a flexible blueprint for application elsewhere. Specific objectives have been set for both phases of the work.

Phase One was aimed at defining ZCAs and developing a route map tool to help in identifying the most promising sites. It resulted in the selection of Milford Haven as the ZCA.

Phase Two aims to test and refine both the definition and the route map tool, in order to identify further zero carbon opportunities within the ZCA. Phase Two will consist of four work packages:

- 1 **Engagement and communications liaising with external stakeholders.**
- 2 **Mapping, modelling of infrastructure and socio-economic influences.**
- 3 **Techno-economic model, establish ZCA roll-out model aligned with stakeholder agendas.**
- 4 **Business plan development to bring in additional funding.**

The demonstrator will complement other projects being developed as part of the wider Swansea Bay City Deal. Over a longer time frame, success will include the Port continuing to develop as a vibrant, energised Demonstrator of Smart Living. Value generated through proposals and trialled in Milford Waterfront would be encouraged to spread to other ports in Wales, UK and Europe.

The aims and objectives of the Milford Haven ZCA fit well with the criteria of the Welsh Government's Smart Living Framework. A wide range of community, environmental and economic benefits will be incorporated for delivery subject to the plans being successfully progressed. It would then remain to be seen whether the ZCA model could be replicated with similar benefits in other locations in Wales.

Partners and stakeholders

Key partners involved in the initial Phase One stage included the Centre for Sustainable Energy, and Eunomia, commissioned by partnership between the Port of Milford Haven, Pembrokeshire County Council and the Welsh Government.

These three partners have now initiated the more detailed work in Phase 2 which has procured a consortium which is overseeing the detailed development of the zero carbon area demonstrator led by Cardiff University's award-winning Geoenvironmental Research Centre.

Community Energy in Pembrokeshire (CEP) is working with Capestone Organic on development of the AD plant for the Port. CEP is commissioning an updated study for the plant (funded by Local Energy) in response to changes in renewable subsidies, and to explore wider markets and the potential to increase the plant size from 500kW to 1.5MW

Other groups involved in wider stakeholder consultation include:

- **Business Wales (Haven Waterway Enterprise Zone), third party developers and partners including Haven Energy Bridge and Hoare Lea smart grid research consultancy.**
- **Key infrastructure enablers, including National Grid, Wales and West Utilities and Western Power Distribution.**

Funding

The initial phases of development have been supported by Smart Living. The Phase One study cost £30,000 and the Phase Two contract is up to £75,000 until March 2019.

Creating value

The added value obtained through more effective use of resources in the area will be determined as part of Phase Two developments and will encompass potential opportunities for developing economic, environmental and social value. Anticipated benefits for Pembrokeshire and the Port are the creation of new employment and educational opportunities both within the proposed ZCA and beyond with labour sourced locally where possible.

Specific new markets are being opened up through planned activities. These include:

- piSCES project supporting energy development to help facilitate the local fishing industry for the future.
- New construction developments in building the zero carbon area.
- Development of multi vector solutions to inform new markets and demonstrations.

The Port's carbon emissions in 2017 were 3,900 tonnes CO₂e, the majority of which arose from marine craft missions and electricity indirect emissions. With decarbonisation activities already put in place, generation from port building-mounted solar PV and from Liddleston Ridge (5,070,000 kWh) was equivalent to carbon emissions offset of 1,800 tonnes CO₂e.

At the core of the business case for Milford Waterfront is the premise the PoMH (as an electricity user) and its tenants would benefit from renewable generation sites with surplus power used to supply both local households and businesses. In 2014 the Port used around 1,600 MWh of electricity in all its operational sites (not just within the confines of Milford Waterfront). Liddleston Ridge Solar PV farm commenced

generation that year and has three times the capacity to that needed by the port.

The Port Authority has already demonstrated its commitment to low carbon ways of working as part of the journey to decarbonise the area. The Port Authority has changed the Milford Waterfront's Gold Anchor marina, promenade and Christmas lights to 100% LED. In March 2018, the Port's board approved capital expenditure to convert the commercial office units at Cedar Court at Milford Waterfront to air source heat pumps. The Port has also commenced conversion of its operational transport fleet to electric with the purchase of a Nissan e-NV200 for its IT team.

Learnings for the Port Authority and its partners

Part of the value already generated by the Demonstrator has been in the shared learning, and lessons learned through practice. These learnings include the following points:

Developing the concept of a zero carbon area -

The project has developed a workable definition of a "ZCA" with guiding principles, based on existing low carbon developments. Part of this task involved looking at best practice examples of zero carbon areas. Although this included references to some zero carbon developments including Masdar City in Abu Dhabi and Rotterdam and Barcelona Ports, the lack of ZCA examples which combined both port and the wider surrounding hinterlands means this development is treading a pilot pathway.

Shared leadership and learning

Initial experience has highlighted early engagement with infrastructure providers, including network operators at design stage is critical. Strong leadership, supported by investment and commitment, have proved important in driving the ZCA. Engagement with key government and academic colleagues has also been vital, to share the vision and align with relevant policy and strategies.

Shaping the strategic direction of the Port

There has been significant engagement with local businesses as part of the development for

the Port and Waterfront and this will continue to be strengthened as part of Phase Two activities. Different organisations have come together with different skills and expertise to contribute to a shared vision for Milford Haven. This is needed to generate the transformational change which the new “smart” sector developments require.

Integrating design, build and operation of assets

There are lots of assets in place or planned at Milford Waterfront which need to be interlinked to consider balancing demand, use and storage. Designing how to piece them together to take full advantage of those assets and add value for all major stakeholders, identifying barriers and testing solutions along the way, will be core to developing the ZCA. Current technology exists to achieve this but is proving more difficult to deploy in practice than expected. The learning provided by this pilot will help to inform this.

Flexibility of accommodating emerging challenges

As well as learning from effective practice, much has been learnt by the Port Authority and its partners from the challenges that have arisen during the work to-date. Changes in FIT/RHI subsidies affected the proposed AD plant where Community Energy Pembrokeshire is

actively exploring ways to support and expand the development of the plant. The regulatory framework and financial viability of the cost of the private wire also represent some of the challenges involved in this venture.

Next steps

Phase Two outlines several work streams which will be focused on key elements of testing and developing the underpinning detail for framing the zero carbon area in Milford Haven Waterfront development.

It will consider if and how this can be achieved. If the finding is that the ZCA cannot be achieved, this will generate new learning about the barriers and issues which need to be overcome for this type of development to proceed. If however the Phase Two report concludes that a development at Milford Waterfront is feasible and the ingredients for success are available, then potentially Phase Three could develop the business case, road map, pathway and timelines and instigate communication and interaction with likely sponsors.



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4. Blaenau Gwent - Catalysing Local Energy

Description

Blaenau Gwent County Borough Council (BG CBC) is pursuing the potential for developing an 'Energy Catalyst' model for the district, which would consist of creating smart platforms for energy demand management which would connect commercial and business premises and private and social housing. This could lead to the bundling of resources or services to residents and businesses. Communication and education about energy behaviours will also be a key element of the project.

Timeline

When Blaenau Gwent (BG) was identified as a potential Demonstrator area within the

Smart Living Programme, internal discussions began about the possible projects which would be suitable in the area. This exploration was manifested in the BRE Phase One report which outlined options for a Smart Living Demonstrator in BG, published in June 2016. This covered options for Business/Industrial, Public, and Social/Domestic energy platform opportunities. Subsequently the public sector platform was focused on retrofit solutions, and the other two sectors were carried forward for further exploration in Phase Two.

With ongoing support from Welsh Government, BG CBC focused initially on the business/industrial platform, which has been split into energy behaviour research (conducted by Miller Research) and technical analysis (conducted by AECOM). Phase Two interim reports were produced in June 2018. They found that energy is a key issue



Abertillery in the county borough of Blaenau Gwent

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for businesses in Blaenau Gwent and there is significant interest (in some cases latent at this point) in taking part in collaborative actions to bring about lower energy prices for the longer term. Collaboration opportunities on the basis of environmental commitment or fears about energy security are less easy to identify and may take time to develop. The AECOM report then provides a high level strategic assessment of the market opportunities and identifies, by way of a route map, the most appropriate platform to deliver energy and potentially other associated services to the business (industrial and commercial) sector in BG.

During 2018/19 Phase Two will continue to provide more detail on both strands as lessons learned will help to better understand how best to facilitate and support the business community in energy developments. A specific proposal involves creating a typical business park with characteristics and proposals which are reflective of the multiple parks in BG CBC. The intention would be to use this 'typical' park to model interventions and scenarios which could then be replicated across the many other business parks in the county.

Aims

The focus for this demonstrator is for Wales to gain an understanding of how to create the building blocks and ingredients to build a successful multi-vector energy platform from a low natural resource base. By catalysing a local area energy model, the aspiration is to alleviate fuel poverty in the county borough, encourage industry and commerce to invest in the region, improve energy efficiency and reduce carbon emissions across all of Blaenau Gwent.

These objectives fit closely with the criteria for Demonstrators set out in the Welsh Government's Smart Living Framework. Specifically the work involves multiple stakeholders, and aims to deliver a platform solution which drives value for local businesses, and is replicable in other settings. The approach foregrounds community benefits, and is grounded in research into business and community needs.

Partners and stakeholders

Welsh Government has helped BG CBC develop the proposal for a Smart Living Demonstrator.

BRE Wales conducted Phase One exploration of potential options for developing a Demonstrator project in Blaenau Gwent. As part of this development the study provided a list of potential stakeholders who were consulted and contributed to the report. BG CBC has established relationships with both AECOM and Miller Research through becoming a Smart Living Demonstrator area.

The focus on building the business community platform has already established a small focal group from the business community and this relationship will be enhanced as part of the next phase of development.

Funding

Initial funding has been provided by the Welsh Government Smart Living programme for the scoping exercises up to £50k in 2017/18. Some prior work in the valley was undertaken by Welsh Government as preparatory work for Smart Living in 2016.

Creating value

As the Demonstrator is a development project, value created to date is less than the potential value to be generated when the project moves into design and delivery phases. So far value created relates mostly to capacity building, including by bringing together the business community through the preparatory research, and indirect benefits through helping these local stakeholders to build new connections.

When the Demonstrator matures, it is intended it will bring significant business benefits, primarily through the local energy platform itself, which will focus on addressing local needs. Meanwhile, the development process should help generate local jobs, improved skills among local workers and the potential for supply chain development. It is ultimately hoped the project will lead to an increase in private sector investment in the county,

as a result of novel energy systems for businesses and industry created by the energy platform.

There may well be a positive reputational effect for BG CBC; building on previous work undertaken in the county. BG CBC has been successful in capturing EU funding across several projects as well as funding for district heating scheme development which has fed through into this Demonstrator proposal for the technical analysis.

Learnings

Blaenau Gwent is one of the more deprived and densely populated areas in Wales, with the highest prevalence of fuel poverty in the country. It also has one of the lower levels of renewable energy generation of any Welsh county, but the local authority has high aspirations in terms of improving quality of life and housing conditions and delivering low carbon energy. There are some topographical and geographical limitations to exploiting further renewables, as well as local resistance due to visual impacts. As such, much of the learning relates to how the Demonstrator will navigate the challenges likely to arise from working in a more deprived setting such as Blaenau Gwent.

The area is well served by mains gas; currently gas is one of the cheapest, mainstream fuels for consumers, but the business community is more heavily reliant on electricity whilst the domestic/social consumer is dependent on gas. The relatively low cost of gas can make it difficult to leverage sufficient savings to justify alternative energy initiatives on a multi-vector basis.

Historically, BG CBC has been successful in delivering complex proposals. The “Works” is the regeneration of the former steelworks site in Ebbw Vale which is widely recognised across Wales and the UK as a major sustainable regeneration project. It contains an energy centre which provides for its renewable energy needs, and further development opportunities exist.

Finally, in a context of austerity which BG and other Local Authorities are experiencing, securing funding for implementation of projects is seen as a huge potential challenge.

Next steps

The Phase 2 draft interim reports drawn up by AECOM and Miller in June 2018 outline potential opportunities and risks. Following receipt of these, BG CBC plan to hold internal workshops which will work through the content and explore the options for projects detailed by the reports. Any agreed outcomes will require political sign off before any next steps are progressed to strengthen specific details on both strands and form the basis for building the case for actions.

BG CBC acknowledges that resource limitations are a reality and that developments will need to look at how project management support, guidance and resource for delivery of these proposals- particularly at the later stages of the project- will be taken into account in business case developments.

Future phases of the project will look at the third strand, the domestic/social platform, and then bring together how all platforms can be catalysed for the whole area.



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Cae Felin street in Llanhilleth

5. Neath Port Talbot smart low carbon development

Description

The Neath Port Talbot smart low carbon development programme aims to demonstrate how the effective use of smart technologies can be utilised to enhance services, help deliver against local and national climate change and energy targets, and generate positive impacts for citizens, communities and businesses. Demonstration projects in the Neath Port Talbot County Borough Council (NPTCBC) area are driven by five broad low carbon reduction agendas: smart technology, low/zero carbon technology, energy efficiency, water efficiency, and sustainable transport. The work so far has enabled aspirations to be turned into proposals with a sound evidence base and support from key stakeholders. This provides a solid basis for the proposals to develop further and to respond to the fast-changing external environment.

Timeline

Phase One involved initial scoping of proposals for smart/low carbon demonstration projects, and commenced in 2016. The initial development team consisted of representatives from NPTCBC, Jacobs, Urban Tide and Welsh Government.

Phase One used a ‘smart cities maturity model’ (adapted from work by IDC) to map existing smart initiatives in the area and to frame the vision for smart developments in the wider council area and Swansea Bay region. Five potential Demonstration project options were identified in Phase One. At the same time the FLEXIS demonstration area was independently created based around Tata Steel Port Talbot steelworks.

In 2017, Phase Two evolved from Phase One and was influenced by the changing landscape

of Swansea Bay City Deal projects, technological advances, UK Clean Growth and Industrial Strategy, and wider discussions. To expand the organisations involved and increase their input into development of smart/low carbon developments in Neath Port Talbot, a day-long workshop was held in June 2017 with 39 staff from 19 key stakeholder organisations including BT, TATA Steel, Energy Saving Trust, and Smart Energy GB. One of the outcomes of the workshop was to focus subsequent work on a shortlist of three demonstration project proposals – the first of which will be taken forward for business case planning in Phase Three (though no timescales have yet been set):

- 1 Citizen, communities, businesses and visitor engagement.
- 2 Intelligent applications into smart/low carbon non-domestic buildings.
- 3 Education and skills programme.

Aims

Neath Port Talbot’s Smart Living Demonstrator programme is centred on citizen and community engagement, and aims to support improvement of the geographical area as a focal centre for embracing and increasing smart/low carbon innovation. “Low carbon technology and smart applications will be embraced in innovative ways to provide multi-faceted benefits that meet the needs of businesses, communities and residents of Neath Port Talbot” [NPTCBC vision for smart/low carbon development].

The aims of the Neath Port Talbot low carbon development programme fit well with the criteria set by the Welsh Government for Smart Living Demonstrators. Specific objectives for the NPTCBC programme include to:

- Understand whether a city-wide framework and tools (eg. the ‘smart city maturity model’) can be modified for town use and what benefits they may bring.
- Facilitate inclusivity in an area suffering from high air pollution, heavy industrial and heritage past moving into a decarbonised context.
- Gain better understand of how to bring citizens, businesses, visitors and communities to an increased awareness and engagement with changes happening in their community, and to create a feedback loop to inform these changes.

Whilst these objectives are softer than in some major infrastructure projects, their importance in gaining consumer insights and understanding are critical to the success of any Smart Living project.

Partners and stakeholders

Neath Port Talbot County Borough Council is overseeing the initiative, supported by the Welsh Government. The Council is best placed to lead developments because they are able to cover the scope and diversity required for successful delivery. Jacobs and Urban Tide have undertaken Phase One research and Phase Two further development and feasibility work. In addition learnings from the proposal will contribute to the Swansea Bay City Deal, as well as the Valleys Task Force.

There are other notable low carbon and smart energy projects within Neath Port Talbot and surrounding areas, which will have links with any NPTCBC programme activities including:

- FLEXIS (Flexible Integrated Energy Systems) is a £24 million research operation designed to develop an energy systems research capability in Wales. It is led by Cardiff University, Swansea University and the University of South Wales. The FLEXIS demonstration area stretches along Swansea Bay and includes potential for varied energy generation sites.
- SPECIFIC (Sustainable Product Engineering Centre for Innovative Functional industrial Coating). This centre is developing steel and glass coated with photovoltaic cells to enable walls and roofs in new and existing buildings to generate, store and release energy. This is a collaboration between Swansea University, Tata Steel, the Low Carbon Research Institute and the local authority.
- SOLCER House – smart carbon positive energy house.
- Swansea Bay Campus – Active Classroom.
- Port Talbot Harbourside - A multi million pound re-development of the town’s former docks quarter to transform the area into a knowledge-focused business hub.

Photo: istock.com



- Port Talbot Waterfront Enterprise Zone Based around established employment sites in the area (Baglan Energy Park, Baglan Industrial Estate, Harbourside and Port Talbot Docks) which have significant capacity for supporting further business investment.

Funding

The Welsh Government Smart Living initiative has contributed funding for Phase One of £35,000 and for Phase Two £66,000 in total for project development, stakeholder engagement and building the strategic case. NPTCBC has contributed staff project costs for Phase One of £20,400 and Phase Two of £27,200.

Creating value

The proposals are focused on key benefits in line with the Smart Living Demonstrator criteria. Individual projects will work through full business cases which will include quantitative and qualitative measures of the benefits they will potentially generate. Value created to date mostly relates to capacity building in the NPT area. Research and stakeholder engagement during Phases One and Two have facilitated useful conversations and galvanised interest in smart/low carbon developments that extend beyond this project. As a result proposals have received predominantly positive support

Learnings

The project has turned outline aspirations into proposals which have been through a process of gathering evidence and fact finding based on

local consultation and UK and international best practice. This is an emerging field and keeping up to date with changes in the broader landscape of local and UK regeneration and smart initiatives is a challenge. The project activities have taken account of the fast changing external environment and the demonstrator has evolved as a result.

Next steps

Further development of the proposals will take place collaboratively between NPTCBC, Welsh Government and other partners identified in the Phase Two report.

Phase Three is projected for 2018/19, and will focus on developing the 'Citizen, community, business and visitor engagement' proposal to funding and implementation. Progress on the other proposals will occur in parallel. To do so will require NPTCBC senior management commitment, representation from Welsh Government and proposed partners as well as involvement from financial, legal and procurement experts. Potential Phase Three activities could include: identifying funding source(s) and funding criteria; refining the proposal on an ongoing basis; and setting up governance arrangements including a steering group, and project management support. A further task is to refine the proposal title to ensure it is meaningful to the target audience; this may form the first stage of a branding exercise with specialists to support future funding applications.

6. Creating a Hydrogen Valley Demonstrator

Description

Rhondda Cynon Taf County Borough Council (RCTCBC) was the first Welsh borough to install a hydrogen fuel cell (FCH) in a public building in 2014. It has more widely adopted the technology and installed 15 micro fuel cell combined heat and power (CHP) units in care homes, schools and offices in the county.

As a result of this existing baseline and interest in this vector, an initial scoping study was conducted on behalf of Smart Living to look at further opportunities which could be considered as part of a natural development of hydrogen within the Valleys.

The aspiration was to explore the potential of scaling up use of hydrogen technologies to medium and large scale fuel cells, and to investigate hydrogen generation from renewable sources which faced potential grid constraints.

Timeline

A Phase One study ('From Mountain Ash to Mount Fuji. How hydrogen and fuel cells are shaping smart energy') was commissioned and completed in 2017. This included an exploration of global best practice, a review of existing stakeholders in Wales, and a review of potential development projects at different scales (micro fuel cell and hydrogen (FCH) to multi-MW), and wind-to-hydrogen via electrolysis for transport applications as well as micro-hydrogen energy storage and fuel cells.

The study prepared a number of outline financial assessments and recommended some potential opportunities for development. The Phase Two study commencing in 2018 will develop feasibility studies for three distinct (but potentially complementary) proposals, as follows:

1. Prospective micro grid, Williamstown, a large office with significant electric load and cooling issues during the summer which could benefit from the heating and cooling provided by a FCH. This offered potential to create a micro grid arrangement.
2. Developing power, heat and possible fleet opportunities within a business park where the feasibility of a modular approach to utilising large-scale FCH technology to generate electricity, heating and cooling from renewable sources offers opportunities. The assessment will incorporate storage and/or heat storage solutions for flexibility of supply. It could also offer sustainable fuel opportunities.
3. Hydrogen energy storage will be investigated and linked with a community-owned wind turbine. The turbine may be suitable for producing hydrogen via electrolysis because it has limited capacity to export to the grid and the Feed-in Tariff support has dropped during the development of the project.

The Phase Two report will detail how the individual projects could be developed with hydrogen and fuel cells into an exemplar Demonstrator area, from which successes can be rolled out to other areas. It will provide an understanding of the opportunities, benefits and risks associated with the developments, which together have the potential for supporting an open-learning platform.

Aims

Becoming smarter in the use of existing electricity, gas, transport and heat infrastructure to provide decarbonisation and an improved healthier environment encourages us to explore multi vector opportunities. Storage is currently expensive and so maximising different uses of energy rather than

rely purely on storage will help the transition. Hydrogen is a natural vector to consider as it has flexibility to provide heat, power and sustainable fuel for transport.

There is poor understanding of hydrogen technology amongst the general public. Community and business engagement is needed to create wider understanding of its potential role in the energy mix and the benefits it offers. This was highlighted in a Frontier Economics report for BEIS (2018) which explored the market and regulatory frameworks required for a low carbon gas network using three 2050 scenario models (one of which included Hydrogen). It concluded that whilst radical changes in current market and regulatory frameworks are not required for the evolution of a low carbon gas network, it was essential to invest in information and invest in keeping options open.

The Valleys Demonstrator aims to explore the development of hydrogen opportunities in the Valleys area in Wales to contribute to the decarbonisation agenda and learning and building on local capacity and needs. At its current stage the objectives are to:

- Assess the feasibility of developing heat, fleet and power Demonstrator proposals.

- Assess accompanying storage solutions opportunities.
- Improve understanding of how hydrogen can be utilised in the energy mix, reducing grid constraints and optimising the use of renewables.
- Reduce risks through better understanding of its potential.
- Improve understanding about hydrogen with communities.

The Demonstrator aims to proceed in a modular fashion so that small to larger scale development is possible over time and is therefore more replicable.

Should this process be successful it would stimulate commercial acumen and technological development, which eventually (but not too distantly) would result in economies of scale and reduced capital and installation costs.

Below: a hydrogen fill-up in Poland. Opposite: the pressurised hydrogen tanks in a car chassis.



Photo: istock.com

Partners and stakeholders

Hydrogen is a new area of development compared to other low carbon sources. The UK Department of Business, Energy and Industrial Strategy are facilitating pilots of this element of the energy mix through providing funding opportunities (eg. the £20m Hydrogen Supply Initiative). The Welsh Government is a member of the UK Hydrogen Interest Group, and they have initiated a Hydrogen Reference group to help with developments in Wales.

There are several potential Local Authority stakeholders who have an interest in hydrogen development. RCTCBC has been the most proactive to date in utilising micro fuel cell CHP and are well placed to understand potential opportunities arising from use of this vector.

Ynni Glan conducted the Phase One scoping work in partnership with TM Energy Solutions, and it will lead on the Phase Two feasibility studies.

Two of the local distribution network operators (DNOs) are already taking steps to increase the use of hydrogen in the energy mix. Western Power Distribution has developed a Hydrogen Heat and Fleet proposal which is currently being reviewed, while Wales & West Utilities are already replacing iron pipes with plastic 'hydrogen ready' pipes across the county.

Other potential interested stakeholders include FLEXIS, the University of South Wales, ITM Power, private sector and buildings as well as any fleet development of interest to Arcola and Riversimple.

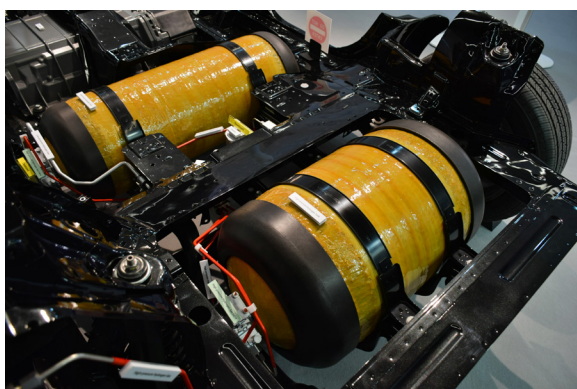


Photo: istock.com

Funding

The initial phases of development have been supported by the Welsh Government's Smart Living Framework. The Phase One study cost £11,000 and the Phase Two feasibility contract is for £15,000 up to March 2018.

Creating value

This Demonstrator is stimulating the use of new hydrogen technologies which are proven but little utilised at present. The project builds on small-scale experiences in the Valleys on the use of hydrogen fuel cells but otherwise is at an early stage. The possible benefits highlighted in the Phase One study will form part of scoping and developing the business case in Phase Two.

On a micro scale, the hydrogen technology is already proven to offer savings for deployment. An estimate of the annual savings from installing a micro fuel cell CHP including FIT is around £2200. It is expected the market will continue to develop offering further savings at this scale.

For medium to large scale developments it requires some intervention to offset current market failure to bring opportunities forward. Evolving business models would look at affordable, low carbon security and offerings with local economic benefit.

For a large energy user, a pathway of increasing decarbonisation of the energy supply over 10-20 years could bring about a step change in carbon emissions e.g. from utilising

- electricity from the grid, to
- fuel cells and natural gas (up to 50% carbon reduction), to
- fuel cells and green gas (carbon neutral), to
- fuel cells and hydrogen generated from renewable sources or carbon capture and utilisation (carbon-reducing), to
- fuel cells and SNG (synthetic natural gas) generated from renewable sources and CO₂ from biomass (carbon negative).

Creating a hydrogen Demonstrator valley area will raise awareness of the potential opportunities offered by hydrogen technology in heat, power and fuel within different scenarios. It will provide a test-bed and platform to progress technology, products, services and business models to help build potential commercial opportunities for the future.



RCTCBC fuel cell installations

RCTCBC has installed 15 micro fuel cell CHP units. Units can be slightly larger than an under counter fridge with accompanying heating water buffer tank (see photo). The unit is a Solid Oxide Fuel Cell and is the only Fuel Cell Micro CHP product in the UK to receive MCS accreditation and is therefore eligible for Feed-in Tariff support.

The unit provides a contribution to the electrical and heating loads of the building, typically reducing CO₂ emissions by 3.6 tonnes per year. Further reductions can be secured where appropriate by combination with a heat pump, using the fuel cell's electrical output to drive the heat pump.

If applied at scale, there is likely to be greater stability with local micro grids/fuel cells and energy storage, and less reliance on large power stations. The capacity of hydrogen as a transportable fuel for seasonal energy storage promotes energy security and can maximise the use of renewable energy sources. Its role in the pressing issue of energy storage could be a major one.

Learnings

Hydrogen technologies are evolving quickly. Thinking things through, learning from past unintended consequences (e.g. biomass, dirty manufacturing processes in developing countries) and being open and questioning of how hydrogen technologies and their application emerge will help to prevent negative consequences occurring.

The biggest current challenge is the commercial viability of hydrogen projects as technologies. Grants to support the capital costs for pilot projects would ideally be made available, coupled with dissemination, CPD and broader education on the tried and tested nature of the technologies in other countries. This would help to bridge the current market gap and encourage increasing commercialisation, uptake and demonstration.

Regulations around hydrogen quality and standards, and the relationship of hydrogen with the grid in balancing also need to be addressed. Some of these questions are being addressed by current pilots such as those taking place in Leeds and Milton Keynes.

The prominent use of hydrogen will be a step change in energy of the future as part of the overall decarbonised mix.

Next steps

At time of writing, Phase Two of the project is just starting. Subsequent phases are contingent on the outcomes of the Phase Two feasibility studies, and on further funding being secured.

7. Flintshire: Smarter Connection – Virtual Private Wire Network (VPN)

Description

In 2007, Flintshire County Council committed to reducing carbon emissions by 60% by 2021. Working with key stakeholders including Welsh Government, Flintshire CC are now exploring improved ways of modelling and allocating costs for local movement of locally generated electricity for their own use within public sector buildings in the local authority area.

A technical case report is in progress, which compares the merits of physical private wires and virtual private wires. An early draft of this report favours piloting a virtual private wire network (VPN) in Flintshire, which will aim to use existing networks to connect renewable energy sites to Flintshire CC buildings, while creating a more transparent charging approach to ensure all partners can benefit from a VPN. If successful this new approach to charging for self generation and use will help bring forward more renewable energy opportunities, which currently lack favourable business models.

Timeline and development structure

Flintshire was identified as a Smart Living Demonstrator area by the Welsh Government in July 2016. A working group made up of Scottish Power Energy Networks (SPEN), Npower, Flintshire County Council (Flintshire CC), SPECIFIC and the Welsh Government was formed and some initial tasks assigned to each partner.

Since September 2016, the Welsh Government has supported the co-ordination of the project and its working group. A number of development meetings took place throughout 2017 to better understand potential opportunities and barriers,

and Cardiff University have been engaged to help developing the case for introducing local VPNs in 2018.

Flintshire CC provided details of five different sites for solar farms, which would help to test the case for VPNs. There are also opportunities to develop small scale wind, combined heat and power and other renewable technologies as part of the mix. SPECIFIC has provided details of their 'homes as power stations' to be included for consideration.

The outcome of the current phase of work will be a report which forms the basis for discussion with Ofgem and other key stakeholders in late 2018.

Aims

The aim of the project is to explore options for linking future renewable energy generation sites to Flintshire CC buildings, by means of a virtual private wire network. Flintshire CC has provided details of five sites for renewable generation to feed into a proposed VPN, thus supplying energy to their own buildings – consistent with the Council's ambitious Renewable Energy 10 Year Action Plan (2016).

Specific objectives set for the project match well with the criteria of the Welsh Government's Smart Living Framework. These objectives include:

- Understanding charging structures and implications for Local Authorities in smart environment of local generation, use and storage activities.
- Exploring whether opportunities for creation of virtual private network arrangements reflecting the effort of renewable energy aspirations without subsidies can achieve a fairer representation of charging structures;

- Helping to inform the wider charging review discussions with Ofgem.

At this stage, a successful outcome from the project would be an agreed methodology for VPN arrangements, including a charging model which receives mutual approval from all partners. The Council would welcome a pilot VPN to happen. This will require approval from Ofgem once a preferred option for finance and implementation is chosen. The transfer to a VPN could potentially have a transformational impact on energy supply and demand in Flintshire, particularly for council buildings which would be predominantly supplied by own generated renewable energy, including two ground-mounted solar PV arrays that are already operational. If successful, this project would also strengthen the case for virtual private wire arrangements elsewhere in the UK, allowing more local authorities to use their own locally generated energy, and in the process reduce pressure on local networks.

Partners and stakeholders

Flintshire County Council (Flintshire CC) is seeking sites within their ownership which could feasibly host renewable technologies in order to generate energy to feed into the VPN. The aspiration is that this energy would then supply LA buildings.

Welsh Government Smart Living is supporting coordination of the proposals and Cardiff University is contributing to developing the proposals with the Working Group.

Other members of the Working Group include Npower, the main energy provider to the local authority, and SPEN, the distribution network operator, and a key partner involved in discussions about network and distribution charges. SPEN's Future Energy Networks team are working in parallel to find innovative ways to improve and future-proof network operations. SPECIFIC, which is a consortium made up of several academic bodies, has provided details of their 'buildings as power stations' to determine how disruptive technology could be supported by VPN proposals.

Laser Energy is the procurement body for energy for Flintshire CC, and contributed to the initial discussions for developing the proposals. Discussions will be held with Ofgem as part of finalising the detail of the proposal.

Funding

There have been small elements of funding up to £10k for this project to-date to cover support activities for the group, with all other contributions involving in-kind officer and staff time of all involved partners.



Shotwick solar park in Flintshire. Photo from Google.

Creating value

The project is at an early stage and the benefits to date centre mainly on capacity building, and learning. Were the pilot to be successfully implemented, in theory it would be replicable elsewhere and the experience of partners and stakeholders could be shared with others looking into VPNs. The technical learning gained by those involved in piloting a VPN in Flintshire would put them in a good position to offer advice on the process.

A wide range of other benefits are projected, should the project reach fruition. If a pilot VPN charging structure can be adopted, this would facilitate renewable energy schemes to come forward which will benefit the local economy as well as provide wider benefits as part of the proposed template. Any savings would allow Flintshire CC to reallocate budgets to other service areas, while any renewable energy schemes would provide local employment opportunities.

From the DNO's perspective, the project, which in itself forms a smart network, would support SPEN's strategic innovation objectives to better match local generation and demand. VPN and improved local matching should help to alleviate congestion on the local network, which may help network operators by deferring the need for infrastructure investment.

Learnings

Preparing the case for the Demonstrator has involved understanding how the charging structures affect the different elements of the local network and consumer offerings. With ongoing changes and reviews in the industry, continual updating of materials has been needed to keep pace. Working through the complex charges involved in network distribution has been challenging and time consuming, and negotiations for building the case for fairer charges have been difficult.

Flintshire CC has found that working as an effective partnership can prove challenging, as input from various organisations has to be coordinated and

individuals within the working group are required to provide contributions in a timely fashion. As time and effort has been voluntary and based on goodwill gestures it is inevitable this does affect progress. Regular meetings throughout 2017 have enabled progress to be made and monitored successfully.

Overall, network charges are finite and therefore have to be paid; movement of charges results in someone else covering the costs, and this can heighten local inequalities. It is important that proposals provide fair and transparent opportunities with local and widespread sharing of benefits.

Next Steps

Completion of an agreed draft report will be used for initial informal discussions with key stakeholders, including Ofgem. This will help to inform completion of the final document in 2018.

Members of the working group have expressed a need to meet and share learning with other Smart Living project teams within local authorities, to find out about their progress. This may contribute to the development of an overall learning framework for the Smart Living initiative.

8. Torfaen: Wellbeing in Blaenavon

Description

Torfaen Public Services Board's (PSB) wellbeing demonstrator will explore innovations in how local service providers in a specific area work together towards the achievement of national wellbeing goals, as identified in the Wellbeing of Future Generations (Wales) Act 2015. The Smart Living Demonstrator will help determine the optimal ways in which service providers can work together based on the five ways of working outlined in the Act (Integration; Long term view; Prevention; Involve people; Collaborate).

Torfaen PSB's Draft Wellbeing Plan (2017) sets out seven wellbeing objectives, one of which is 'prevent chronic health conditions through supporting healthy lifestyle behaviours and enabling people to age well'. The demonstrator will explore ways to apply the five Future Generations way of working to this priority objective. It will do this through a place-based study in Blaenavon.

The Smart Living Demonstrator will create a place-based 'blue-print' of what works well and what doesn't, so that learning can be integrated into how other objectives are addressed. This will support the PSB's vision for Torfaen in 2045, and develop ways to use the Act to drive transformative change in public services. Ultimately this will inform understanding of how projected future growth in demand for health and social care services for 2030 can be reduced.

Timeline

This is a new project. The inception meeting took place in May 2018, at the same meeting as Torfaen PSB officially launched their Wellbeing Plan.

Phase One of the Demonstrator (April 2018 -March 2019) will involve a year of initial work with

local organisations and the community. This will include: a review of how public services currently work together to address the wellbeing objective, a scoping study to define opportunities for Blaenavon to become smart, resilient and future proofed in consultation with key stakeholders and the developing of delivery proposals for the pilot community project which will maximise the PSB contribution to supporting healthy lifestyle behaviours.

The Phase One work will include an asset-based approach to chart the range of activities in Blaenavon which is led and driven by local residents. This initial engagement is to understand: who are the community leaders, where are the hot spots of community activity, how these relate to the five wellbeing goals, and where opportunities lie to strengthen existing activity. Gaining a better understanding of the interplay of local agencies will also occur through interviews and small group workshops to identify mechanisms of service delivery, and explore where collaborations already exist and could exist in future.

Aims

The main objective for Phase One of the wellbeing Demonstrator is to undertake a detailed study which researches, tests and determines how the PSB can best work together to maximise local wellbeing within the supporting health lifestyles local community pilot, and to report on findings.

The project will discover more about the reality of delivering wellbeing in Blaenavon, a community of around 2,500 households of which over half live on lower incomes (£0-£20,000) and a fifth of residents claim welfare benefits. 34.5% of households are classed as 'in poverty', much higher than in the rest of Torfaen, and Wales. Specific challenges of relevance to Smart Living include the high levels

of residents without access to a car or van and live in a relatively isolated community. Meanwhile the energy grid infrastructure is at capacity and would need significant investment to improve it.

Blaenavon does have many strengths. Housing is affordable, and a high proportion of residents work full time. It is a World Heritage Site that attracts half a million visitors a year, and is home to Big Pit, the National Coal Museum of Wales. It has significant ecological assets in the natural landscape including peatland designated as a Special Landscape Area. 'Dragon's Teeth', an existing 25kW micro-hydro scheme provides long-term revenue for World Heritage Site work.

Torfaen's wellbeing demonstrator will address healthy living in Blaenavon through:

- Technology (including solutions that support de-carbonisation).
- Smarter systems and processes for organisations (including the Integrated Wellbeing Network approaches) that effectively operationalise the five ways of working.
- Integration with the PSB's other wellbeing objectives to tackle the wider social, economic, environmental and cultural determinates of health.
- Behaviour change.

Medium-term goals are to scale up successful approaches identified through the pilot, and to shape and support the Regional Partnership Board's Area Plan (set up in response to the Social Services & Wellbeing (Wales) Act), aligning service delivery and processes across the partnerships to embed smarter approaches which work.

Long-term goals include having a stronger service model around health prevention and early intervention, while specifically embedding the integrated wellbeing network and well-being hubs across the Neighbourhood Care Networks (NCN's).

The pilot targets cross-sector activities to improve understanding of the potential direct and indirect impacts of these activities for health and other areas. There is already a strategic approach to

how health and energy interconnect to achieve direct benefits. Further work is needed to better understand how to maximise the benefits that can be drawn from their interactions.

Partners and Stakeholders

Steering group members for the Smart Living pilot will include:

- **Torfaen County Borough Council** which will co-ordinate the pilot's partnership activities.
- **Natural Resources Wales** will provide advice on how outdoor leisure and active travel opportunities can be achieved.
- **The Aneurin Bevan Gwent Public Health team** can facilitate the growth of the Wellbeing Network and oversee and review the health behaviour improvement initiatives.

An evolving group of organisations will be involved in the project itself. This is likely to include social housing providers and social care organisations like Melin Homes and Bron Afon community housing. A Miller Research Evaluation Consulting-led consortium has been awarded the Phase One research and engagement contract.

Welsh Government has an overview of the pilot in relation to Smart Living, and participates in developments to ensure learnings about barriers/issues are understood and they are better able to help with solutions. Welsh Government health department will also have interests in this work.

Funding

Smart Living has provided the initial £50,000 for Phase One to kick start the development process.

Creating value

The Wellbeing project is designed to deliver long-term value against the healthy lifestyles and ageing well objective from the PSB's Plan. In so doing, it will draw on the future scenarios work commissioned by the PSB in Gwent.

Considering the grid constraints in Torfaen is likely

to form part of the development work. This will be undertaken by working closely with the network operators, with a view to supporting expansion of existing businesses in the area.

Blaenavon is an area of higher than average fuel poverty (19.3-20.8% of households). An expected benefit from increased local renewable electricity or heat generation would be that fuel poverty decreases, with related improvements to health.

Learnings

Shared learning is a key objective for Phase One of the Torfaen Demonstrator. There will be wider benefits arising from delivering whole community solutions using wellbeing ways of working, even when focused on one key objective. The learning and dissemination of findings will help ensure these are captured.

Learnings generated to date include: the need to avoid duplication of effort; the lack of a long-term approach to continuity of grant support from current sources; and the need to manage expectations in a community which has seen numerous comparatively short-term initiatives, yet struggles to access information on the full extent of services available across Blaenavon.

Next Steps

Given the project has recently started, the next steps are the first steps: to begin Phase One activity.





Photo: istock.com

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