The Economic and Social Impact of Small and Community Hydro in Wales

Report for: Hydropower Stakeholder Group

BY:

Jemma Bere – Centre for Regeneration Excellence Wales

Calvin Jones – Cardiff Business School

Stuart Jones – University of South Wales

Contents

Cover photograph courtesy of ©Keith Jones National Trust

©Keith Jones National Trust

1 INTRODUCTION AND BACKGROUND

1.1 ABOUT THIS PROJECT & HOW TO READ THIS REPORT

This report examines the economic and social impacts of small scale and community-owned micro-hydro in Wales. It is intended to present a factual picture of the economic benefits of small scale hydro projects in Wales. As such it will be of interest to those working in the fields of rural development and community regeneration. While the contribution that micro hydropower schemes make to meeting Wales' overall energy demand is significantly <1% and which will not itself likely lead to regionally significant employment or carbon-mitigation impacts, the amounts of electricity and income generated may be significant for local communities. This project seeks to estimate and contextualize the social and economic benefits of past and potential small hydro developments in Wales. It is part of a wider project, managed by the Hydropower Stakeholder Group, to develop an appropriate and efficient permitting and management framework for smaller hydro projects. The Stakeholder Group is coordinated by Natural Resources Wales and includes representatives from the hydropower industry, environmental groups, landowners, community groups and local government. It provides a forum to discuss the competing claims on water resources in Wales and deliver appropriate solutions.
In this context, this report should be read within the wider set of hydropower guidance, Government policies and hydropower consultations. This report does not suggest that the benefits arising from Hydro development are the only ones that can be delivered by a particular stretch of inland water. Indeed, later parts of this report seek to compare these benefits with competing (or in some cases synergistic) developments.

This report reveals the reality of a sector currently wholly dependent on subsidy: and with that subsidy decreasing year-on-year. An annual scramble to make installations operational within a higher FiT window is evident, and a number of our respondents evidenced some pessimism about sector prospects due to the changing subsidy regime. The feeling was that, a window of perhaps 2-3 years for smaller externally/community funded projects remains (somewhat longer for projects that are internally funded).

The sector is then caught in a 'pincer' of decreasing subsidy (latest DECC consultation notwithstanding) and potentially increasing competition for funds. Recent community share offers, in both hydro and solar have reached their target investment, but only after extended offer periods, suggesting that further growth based on established techniques may be problematic (although the success of these offers may conversely spur growth).

With this context in mind the objectives of this report are as detailed in Table 1.1

©Keith Jones National Trust

TABLE 1-1 REPORT OBJECTIVES

1.	To estimate the across-Wales employment and gross value added impacts of 'characteristic' small hydro scheme(s) over (a) the feasibility, construction and (2) operational periods
2.	To present this information in relation to key ratios: to include potentially, per kW installed; per kWh estimated generation and per £ of gross expenditure,
3.	To comment on the proportions of Welsh economic impact that arise within defined local communities,
4.	To qualitatively assess the wider impact of Schemes on local communities using a range of case study materials. Avenues of inquiry to include (flexible to case study findings), I. Impact on social capital II. Transformative or enabling impact of income III. Impact on wider behaviours related to climate change and appreciation/use of local environments
5.	To determine whether the elements detailed in 1-4 are dependent on the ownership model of the project, and to identify other influencing factors,
6.	To contextualise the above elements 1-4 with reference to other energy investments in Wales,
7.	To qualitatively asses the above impacts in terms of ecosystem services delivered with reference to potentially competing or synergistic uses of the relevant water resources,

The objectives above closely follow the original remit delivered by the Stakeholder Group. However, two additional objectives: (8) To present a stylised example(s) of appropriate hydro scheme/proposals that optimise socio-economic and other impacts, and (9) To provide recommendations to NRW on whether there is the potential for improving the licensing process based on the above findings are excluded.

In the first case, the research team considered that the presentation of a stylized 'good' scheme would obscure the significant heterogeneity and complexity of the sector, and would be counterproductive. Rather, we comment specifically on these elements within the sector economic analysis and social impact case studies. The latter objective will be folded into wider Stakeholder group activities and the work of Natural Resources Wales in process improvement and the preparation of advice and guidance.
It should be noted that this report is primarily aimed at relatively sophisticated and engaged policy, community and industry audiences. We do not therefore rehearse the wider Hydro or energy context in Wales in this report. Interested readers are directed to contact the Hydropower Stakeholder Group, or visit the Welsh Government's energy webpages[1].

1.2 REPORT COVERAGE

Initially, this project was intended to cover (or at least concentrate on) small scale community micro hydro developments in Wales. However, for a number of reasons the report – in terms of economic impact at least – includes an assessment of the extant commercial and charity/other sector in Wales.

Firstly, the limited number of operational small scale or community schemes in Wales means that operational data from other ownership models is a welcome benefit to the modelling process (as will be revealed later, differences in operational approach are minimal between different ownership models). Secondly, the inclusion of all small hydro enables a better contextualization of the particular benefits of community ownership. Thirdly, many of the lessons learned and innovative developments encountered in the non-community sector are of interest for sector development and impact more widely.

There was a measure of debate as to what definition of 'micro' or 'small' hydro should drive this report. This was driven reactively, as the research team encountered different sizes of projects and this report can now be considered to cover site developments greater than 10kW and up to 1MW.

We do not in this report seek to estimate the overall impact or potential of small hydro in Wales as this is determined largely by topographical, ecological and policy considerations which we are not qualified to assess. This report therefore concentrates on the potential for a 'typical' development (at a site or bundle of sites).

1.3 CONTENT AND STRUCTURE

Section 2 of this report outlines the position of small hydro in Wales within its energy, political, environmental and socio-economic contexts (bearing in mind many readers will be very familiar with these). Section 3 sketches our economic modelling methodology; its strengths and weaknesses and its history of use in Welsh policy determination. Section 4 presents our economic impact results and a qualitative assessment of the sector and developments' actual and potential impact.

Section 5 places these benefits within the context of, other energy developments in Wales and with respect to other potential economic uses of watercourses in Wales (as far as the very limited data allow). Section 6 includes a brief qualitative commentary on the economic structure and challenges facing the sector, using our Scottish case data as an interesting (if very contextually very different) comparator. The second part of the report (Section 7 on) details the social impact of hydro developments, drawing on our case study work. A final, concluding Section sums up the overall socio-economic and sector situation, commenting on the potential for the sector as well as critical barriers to sector development.

2 SMALL AND COMMUNITY HYDRO IN WALES

2.1 HYDROPOWER AND RENEWABLES IN WALES

The Welsh Government Low Carbon Baseline Study published in early Summer 2014 suggests there are 163 hydro projects operational across Wales, with a capacity in total of 152MWe and delivering an estimated 274GWh of electricity (Table 2.1).

TABLE 2-1 LOW CARBON ENERGY GENERATION IN WALES, 2012[2]

Technology	Number of projects	Capacity (MWe)	Capacity (MWth)	Estimated generation (MWHe)	Estimated generation (MWHth)	CO2 saved (tonnes CO2 per annum)
Anaerobic Digestion	5	0.800	–	4,558	–	2,07
Biomass	414	0.060	38.033	421	137,577	33,382
Fuelled	4	69.655	–	488,915	–	222,226
Heat pumps	1,228	–	12.107	–	23,348	2,123
Hydro	163	152.217	–	273,539	–	124,332
Landfill gas	23	40.048	–	193,083	–	87,762
Offshore wind	2	150	–	460,215	–	209,182
Onshore wind	550	498.439	–	1,168,974	–	531,334
Sewage gas	11	9.974	0.1	39,344	0	17,883
Solar PV	30,635	121.153	–	90,272	–	41,031
Solar thermal	3,191	–	8.355	–	5,127	1,239
Nuclear	1	490	–	2,572,909	–	1,169,464
Total	**36,227**	**1,532.346**	**58.595**	**5,292,231**	**166,053**	**2,442,029**

Hydro makes a significant contribution to the Welsh renewable landscape, comprising 15% of all renewable capacity in Wales and 10% of all renewable electricity generation[3]. However, the vast majority of this capacity is (relatively) large and old, even excluding (as these figures do) the pumped storage facilities in North Wales that formerly served to match Wylfa's generation to daily peaks and troughs of demand.

The UK Digest of Energy Statistics for 2013 lists five larger (>10MW) commercial developments in Wales, totaling 112MWe of capacity[4]– around three quarters of the Welsh Government total 2012 estimate, leaving a notional 40MW for other small commercial, community and third sector. Less than 1% of new renewable installations in 2012 were Hydropower.

Allowing for error and post-2012 developments, smaller hydro in Wales then comprises around 40-50MW of capacity; perhaps 5% of renewable capacity and an uncertain (though probably similar) percentage of renewable generation. In terms of overall energy generation and supply (these are different things), hydro in total in Wales accounts for roughly 1-2%, and with small hydro then considerably below 1%.

For topographical and other reasons explored later in this report, natural flow hydro (of any scale or ownership) is unlikely to experience very strong growth in capacity in either the short or medium term in Wales. It is clear then that this report and the sector in general should not be considered using the same metrics and cost benefit analyses as applied to existing or potential large scale electricity generation technologies, either renewable - (e.g. the aspiration for 2,000MW of onshore wind) - or non-renewable - for example the Pembroke CCGTs that have a capacity of 2000MW alone, or a new Wylfa nuclear development that may be much larger still.

In these latter cases (and for novel technologies that may have potential at scale such as marine renewables), Welsh Government analysis has focused on their employment generation, economic impact and climate change mitigation at a Wales-national scale. This is inappropriate for natural flow hydro – and thence for small hydro – which will not itself likely lead to regionally significant employment or carbon-mitigation impacts. Readers are asked to remember this when reading later sections.

As this report will show, however, small hydro developments can have significant local socio-economic impacts, often in very challenged communities and places. Moreover, the often innovative and constructive behaviours evidenced in this sector and this report have, we believe, a number of lessons for other activities in Wales, inside and outside energy.

2.2 THE CURRENT & FUTURE DRIVERS FOR HYDRO DEVELOPMENT

In common with other renewables and nuclear development, the current driver for the installation of new generation capacity is (UK-National) government subsidy and, to a lesser extent EU interventions. This is, like so much of Wales, a subsidized economic landscape. Hydropower (from developments below 100kW) attract around 20p of feed in tariff per kWh generated, and with the potential for further earnings if the power is exported to the grid. For a large number of streams (and depending on the cost of capital) a small hydro development can provide a significant surplus over the 20 year FiT period, comprising either additional income for a private household, profit for a developer firm or income for a community that controls a scheme. In many cases there are of course potential co-benefits in terms of reduced electricity purchases from the national grid. Whilst future installations are almost wholly dependent on the future implementation of the FiT regimes, any schemes that are implemented under the current regime are guaranteed that level of FiT income (index linked) for the first 20 years of operation. Thus, a 30kW installation, generating 3,500 kWh per kW per annum would generate some £20,000+ gross per annum in FiTs, with perhaps another £4-6,000 in export earnings dependent on availability and individual negotiation with electricity purchasers (see Table 3.2).

A number of things determine the scale of demand for small hydro schemes (independent of any permitting constraints);

- The number and distribution of appropriate natural watercourses (or in the case of Dwr Cymru Welsh Water, opportunities within the public water supply network);
- the level of the FiT (per kWh) in the period when the development becomes operational or when full permissions are granted;
- The opportunity to earn, and level of, any export tariff (currently around 25% of the FiT level, but negotiable case-by-case);
- The cost of required capital, including both the appropriate interest repayment level and the (often fixed) cost of advertising and managing the investment process;
- A minimum level of interest in, and capacity to undertake, a complex and time consuming development from either the landowner; or a commercial, public or third sector entity with access to appropriate water; or a relevant local community or community of interest.

Abstracting from the above, a few critical aspects will drive the demand for any particular development (across one or more sites): does the capacity exist to start and drive the development? And are the consequent benefits of a significant scale to tip the balance in any explicit or intuitive cost-benefit analysis? These benefits may be solely in terms of financial return and the use of surpluses (as might be the case for private or small commercial developers) or there may be co-benefits, with these often centering on the use of renewables developments to engage communities in conversations around climate change or energy, or on the selling of the 'sustainability' credentials of the operating organization[5].

The remainder of this report should be read remembering these limiting factors: the uncertainty of the FiT over time makes hydro development less likely, particularly as the relatively mature technology involved has not seen the precipitate fall in cost per kW installed as has Solar PV. For community groups however, a current DECC consultation on providing grants to 'higher cost' community renewable developments may in time provide additional scope for viable development[6].

It is fair to summarise that across most of Europe the political winds blow away from the support of small scale renewables via feed in tariffs paid for from electricity surcharges. This is for a variety of reasons, including issues of social equity and the resultant cost of electricity (irrespective of the validity of these impressions).
In the UK case there is an emphasis towards continued large scale, centralized, subsidized electricity generation (offshore wind, nuclear), combined with shale gas-fired generation, as the answer to our myriad energy security, energy cost and climate concerns. This UK policy approach largely shared by the mainstream political parties, is unlikely to advantage small hydro in future years.

2.3 THE BROAD WELSH POLICY CONTEXT

Neither energy markets, nor renewable subsidies, nor large scale generation are devolved matters for Wales, and hence the fundamental economic question around the viability of hydro developments is answered at UK National scale. However, the Welsh policy context, and implementation of those policies, matters hugely for hydro. The Welsh Government is broadly extremely supportive of renewable installation in principle and with hydro very much part of this picture. As recently as spring 2014, the delivery plan for Energy Wales A Low Carbon transition made plain the importance of distributed generation[7]. Indeed, the Welsh Government emphasizes its openness to development on its own estate[8]. Meanwhile, the development of community energy is a repeated and important theme in the 2014-2020 Rural Development Programme[9].

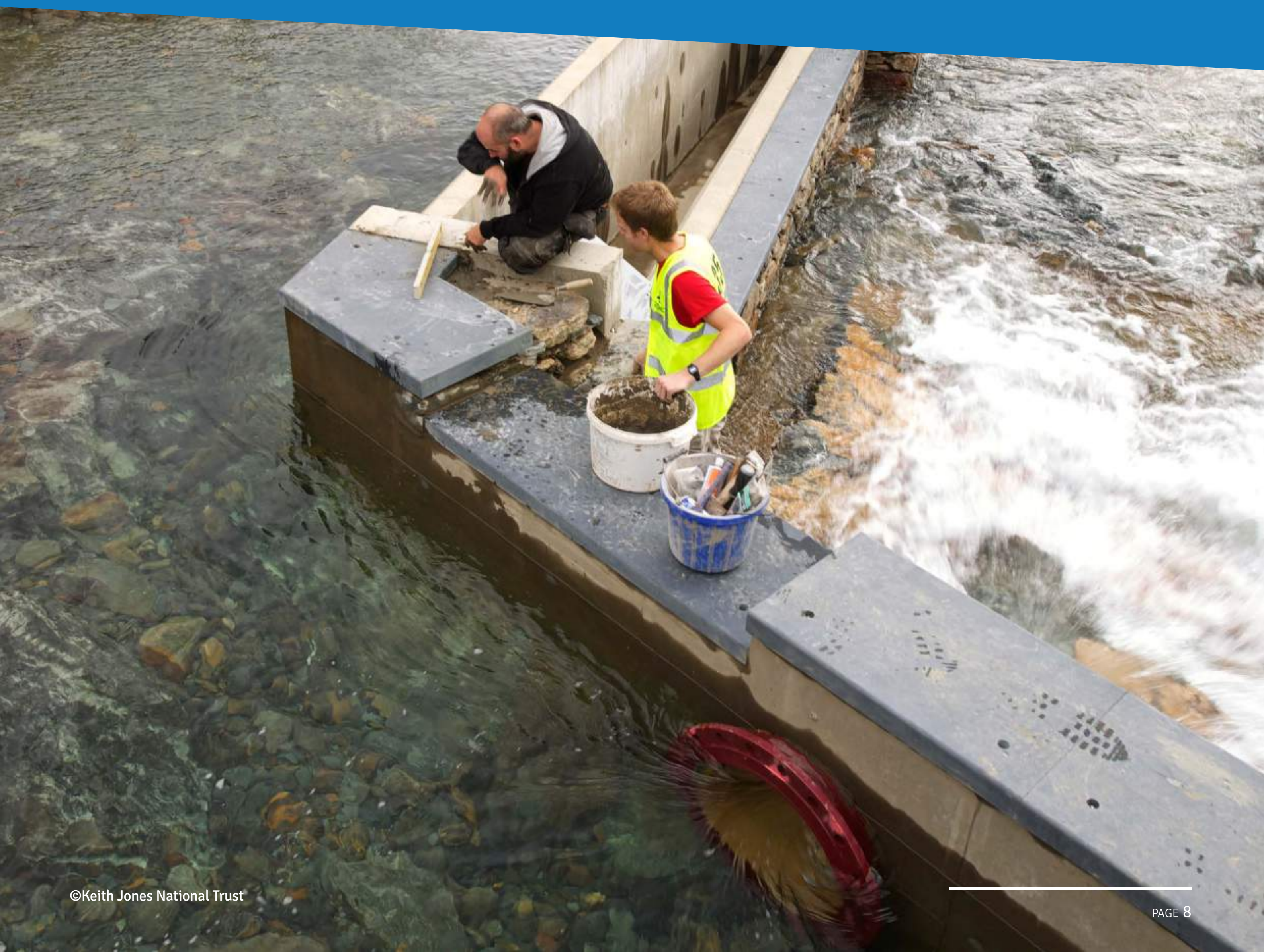
As recently as spring 2014, the delivery plan for Energy Wales A Low Carbon transition made plain the importance of distributed generation[7]

For individual developments, however, it is the planning and permitting regimes that have the greatest impact on the likelihood of developments proceeding to operational phase. These regulatory processes are, theoretically at least, and perhaps with significant lags, reflective of a changing understanding about the best way to manage the Welsh natural landscape and seascape. The broad framework was outlined by former Minister Jane Davidson in A Living Wales, and carried through to present day by subsequent appointees[10]. The establishment of Natural Resources Wales, with a purpose to ensure that the environment and natural resources of Wales are sustainably maintained, sustainably used and sustainably enhanced, together with the Environment White Paper proposals to establish a statutory framework for the sustainable management of natural resources will establish the overarching framework under which hydro developments (and all other developments with an impact on the natural environment) will have to prove their worth[11].

This approach relies critically on developing a holistic understanding of the value of the environment and its benefits, in its existing or developed state, for human welfare. These 'benefit streams' or ecosystem services can arise in a huge variety of ways: for example though the provision of fundamental biological viability (clean water, clean air), through the production of marketable goods and services (such as livestock – or here electricity), and through the increased happiness felt by residents or visitors in a high quality natural environment[12].

Underlying Welsh Government policy then, now and following the implementation of the Well Being of Future Generations Bill and Environment Bill, the Ecosystem Services approach requires an integrated approach to natural resource management to ensure the optimization of economic,social and environmental benefits. For the hydro sector then, the demonstration of sustainable benefits from projects – and, following the Ecosystem Services logic, for residents of Wales – will be a pre-requisite for a favourable policy view, particularly in places where there are demonstrable benefits that would be lost if development occurred (e.g. via biodiversity), or where there are competing development claims on the watercourse in question.

This is all, of course difficult to frame, communicate and implement and the process since the 2010 publication of A Living Wales has focused on the establishment of Natural Resources Wales, the preparation of the Environment White Paper` Towards the Sustainable Management of Wales` Natural Resources and the organization of a few case study/pilots to inform the emerging Environment Bill. Benefit streams are difficult to value, let alone comparatively, and the most basic understanding (e.g. at what spatial scale is this appropriate) is still clouded. Nonetheless, the Ecosystems Services approach suggests that the development of the evidence base is key, and that multiple types of evidence, and of valuation approach are appropriate to consider within the wider cost-benefit structure. In this spirit we now present our assessment of the economic value of small hydro development



©Keith Jones National Trust

Part 1

Economic Impact

3 ECONOMIC IMPACT: METHODOLOGY & BACKGROUND

3.1 ASSESSING THE IMPACT OF ENERGY DEVELOPMENTS

The Welsh Economy Research Unit (WERU has extensive experience of assessing the economic impact of energy investments in Wales, and a longstanding history in evaluating the impact of a range of investments, new facilities and sectors overall. These assessments have been undertaken for a variety of funding bodies across time.

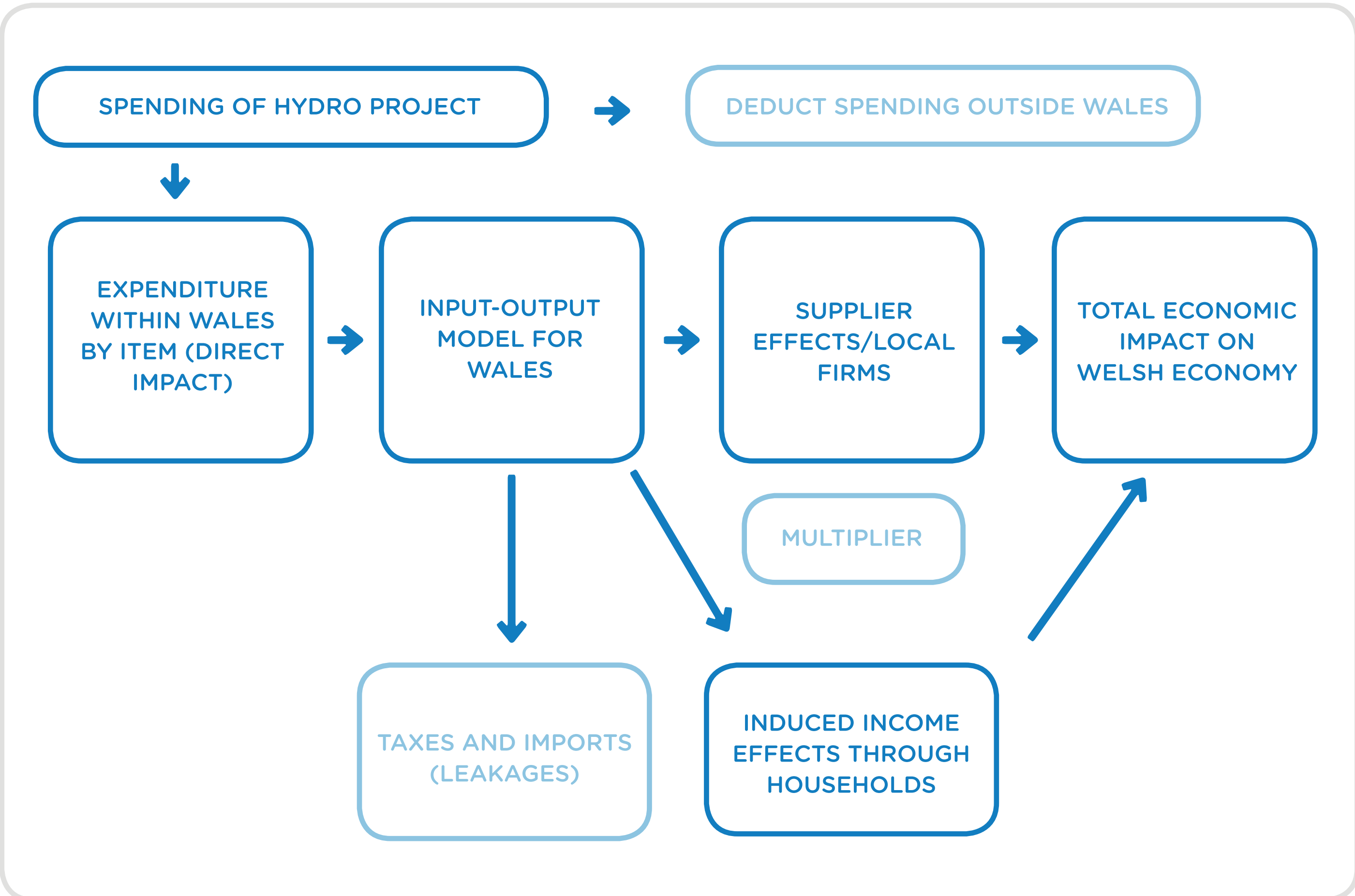
In all cases we strive to retain transparency of approach and comparability (as far as is possible) between projects, hence enabling an assessment of the relative value of different activities, and this is true of the current project. It is important to note that ours is typically a 'supply side' analysis, enumerating the benefits from the development and construction; and operational phases of developments (these are often very different) but not extending to an analysis of what happens to any generated electricity. This is because in prior cases (onshore wind, marine renewables and across a range of other technologies) the non-local ownership of capital means that regional benefits from the sale of electricity are effectively nil, except indirectly where owners of facilities pay into community benefit funds. This is not the case for community (and in some cases other small-scale) hydro where the benefits of the sale of electricity are indeed very local: we have amended our analysis to be flexible to this, and comment later in detail on the relative importance of subsidy, electricity sale, and supply chain impacts.

3.2 OUR MODELLING METHODOLOGY

We base our analysis here on the Input-Output (IO) Tables for Wales, a bespoke 'picture' of the regional economy that has been developed over the last two decades at Cardiff Business School. The IO framework enables an estimation of the 'multiplier' effects of investment in Wales, including along supply chains and as workers on projects spend their wages in part in Wales. The IO Tables produce a number of interesting metrics including economic output, gross value added (GVA) and jobs (or person-years of employment).

©Keith Jones National Trust

FIGURE 3–1 THE MODELLING FRAMEWORK



Following a disaggregation of the energy sector of the IO Tables (sponsored by Environment Agency Wales) they are far more suited to establishing the 'backward linkages' of energy projects and other energy studies have refined this capacity further. Here, however we must also be cognizant that for community and third sector projects particularly[13], economic impact does not stop with the supply chain. Rather, the FiT plus export earnings of generated electricity comprise an additional benefit to communities in Wales, and we enumerate this with reference to the GVA and employment supported, across Wales, by that injection of money using a similar IO method to above.


©Keith Jones National Trust

3.3 CAVEATS

Whilst we have a significant amount of primary information to support this study, and a relatively sophisticated and 'localised' modelling approach, there are a number of caveats that readers should be aware of, and a number of assumptions and simplifications that are made to enable the modelling process. Firstly, Input-Output (IO) modelling is a relatively inflexible tool that, for example assumes linearity in economic relationships – an additional X% of demand leads to an additional X% of supply and of employment. This does not therefore account for 'real world' realities – of economies of scale for example, or a lower propensity to source locally as scale increases (although see later on this point). Secondly, the framework assumes constant prices between commodities, and for inputs such as labour, whereas in reality increased demand might increase prices or wages. Thirdly, the model defaults to assuming an 'industry average' behaviour in supplying sectors. Thus, contractors to hydro developers (not interviewed in this study) are assumed to use the same proportions of labour, raw materials and other inputs as Wales-average construction companies[14].

Whilst these limitations should not be forgotten, IO analysis remains the most appropriate and sophisticated mode of economic analysis for Wales given data and resource constraints, especially as the framework includes environmental modelling (though not within scope here). Additionally our primary research in the field helps soften some of the inflexibilities regarding how the sector actually behaves in Wales.

3.4 OUR DATA

Our analysis of the sector was based upon primary data analysis carried out during 2014. This comprised of a variety of mechanisms intended to glean information on how the sector behaved, economically, in terms of direct and purchasing impacts. A variety of survey techniques were used including of emailed-questionnaires, telephone interviews and site-visits.

In total we achieved:

- Detailed site visit interviews with three social enterprises and third sector hydro developers and installers
- Telephone and email interviews and data collection with three commercial or part-commercial developers/installers
- A detailed questionnaire return from one commercial and one community developer
- Partial questionnaire returns from two more commercial/private developers
- Site interviews with a number of developers/installers in Scotland

The above primary work was supplemented by secondary analysis of relevant documents and websites. In total this economic analysis is based upon detailed information from 15 hydro schemes across Mid, North and South Wales, across profit and not-for-profit developers, and ranging from 10kW to multiple-100kWs. Partial information was recorded for a further 20-25 schemes.

Whilst we believe the information gleaned is more than sufficient to provide a robust analysis, the voice of the commercial sector is rather subdued. Those contacted in the for-profit sector were unable to provide detailed financial information for their schemes, usually due to stated time/resource constraints.

There has been no further relevant financial information forthcoming from industry stakeholders following a meeting of the group in Newtown on May 2014 and hence the impact numbers presented at that time are those in this report.

3.5 OUR ASSUMPTIONS

Following the data collection process we then needed to arrange the data in a way which represented additional spending in Wales arising from project developments, and to present this in terms of a 'typical' project, although this is slightly misleading for what is a very heterogeneous sector. Table 3.1 presents the median size of schemes developed in Wales 2009-2014 (the mean is, in each case much larger).

TABLE 3-1 HYDRO INSTALLATIONS IN WALES, 2009-2014 (MEDIAN KW)

Year	kW
2009	30
2010	20
2011	21
2012	17
2013	28
2014 (part)	34

These assumptions are detailed in Table 3.2 following, and refer to the 20 year guaranteed FiT payment period. Our typical scheme (or bundles), at 99kW and 499kW are chosen to represent the break points of 100 and 500 kW beyond which the FiT reduces (per kWh). No rational developer would submit a scheme just over this limit, and our stakeholder interviews suggest that schemes (or bundles of schemes) much below 100kW are uneconomic for community investment.

TABLE 3-21 MODELLING ASSUMPTIONS

Factor	Assumption	Notes
Scheme Typology/ Capacity	Small - 1x99kW Large - 1x499kW	Chosen at just below FiT break points. 3x30kW also modelled but differences with 1x99kW were minimal, so results excluded. 'Small' project in South Wales most typically exemplified by a bundle of 15-40kW sites developed together. Large (multiple-100kW) developments probably only relevant to natural flow in mid/North Wales.
Load Factor	3,500 kWh per kW per annum	Averaged across a variety of schemes. No obvious correlation with size or location of scheme. Covers a variety of abstraction regimes (% of flow)
Community Funding & benefit	100% community share funded 50:50 capital repayment: community fund Non-metered for export	Based on conversations with community and other developers, and reflects the current norm.
Project total Cost	Small – £7,500 /kW Large - £5,000 /kW	Appropriate mid-points chosen from a variety of sites and data points. Includes all feasibility, development and maintenance cost over the 20year FiT window including one major mechanical overhaul
Local (Wales) Sourcing %	Industrial/mechanical: 50%-70% Turbines – 0% (Large): 80% (Small) Construction: 70% - 90% Professional Services: 70% - 90% Specialist (e.g. plastics): 0% - 20%	Based on interviews and questionnaire returns. Note we assume most turbines here are sourced from within Wales (up to 100kW) as our respondents indicate so, but there is only one company (an SME) currently supplying in Wales so this number in reality is volatile and may be an overestimate for the industry as a whole.
Community Fund	£100-£200 per kW per annum	Surplus over investment cost/repayment. We have chosen an appropriate mid-point but will depend in reality on FiT window, costs, topography, water flow etc.

Following the construction of this assumption set, we are able to model the economic impact of a 'typical' small and large hydro development on the Welsh economy. The following Section presents the quantitative results of that modelling.

4 THE ECONOMIC IMPACT OF SMALL AND COMMUNITY HYDRO

4.1 INTRODUCTION AND RECAP

This section presents our best estimates of the economic impact of a small (99kW) and large (499kW) hydro development on the Welsh economy. Thus, all activity 'onsite', and in Welsh suppliers (of raw materials and services) are included in the impact figures, as well as the impacts that occur as workers on site and in the supply chain spend their wages in Wales (in part at least). A 499kW scheme (chosen here as this would lever higher FiT) is large in terms of third sector or community development. The largest non-commercial development we are aware of is that of around 650kW, operated by National Trust at Beddgelert, although commercial hydro of course can be much bigger.

Our modelling approach does not allow us to formally estimate the local economic impact of this activity, although we have gathered a wealth of material on local impacts, and this subject is discussed qualitatively later.

All numbers presented are per annum – averaged across the 20 year FiT period in terms of both gross value added and employment arising, (and with any pre-operational feasibility, planning and construction impacts included). Of course in reality, the investment and hence impact will be front loaded , occurring mostly as the facility is built (or maintained), whereas community income from FiTs will be more even as this will be consequent mostly on annual rainfall in a given year.

Part of these results relate to all small hydro investments – Section 4.2 dealing with development and operations – and part to only community owned small hydro – Section 4.3 which looks at the impact of FiT consequent community funds. The following Tables present estimates of;

- Output (or turnover) – The additional economic activity arising across Wales as a result of the hydro development. Includes elements that do not directly add to prosperity in Wales, such as UK excise taxes and goods imported without further processing.
- Gross Value Added (GVA) – essentially the sum of earned incomes, self-employed income and profits (or surpluses) plus some taxes. In our opinion, the most appropriate available indicator of the impact of this activity on economic prosperity.
- Full Time Equivalent Employment (FTEs) –Employment generated by hydro investment across the range of relevant sectors and across Wales. Here presented as FTE jobs supported on average across the 20 year FiT period.

We look at two separate elements of impact: that arising from the investment (in terms of planning, development and operational spend) and that arising, for community projects, from FiT and export-electricity funded benefit funds.

4.2 PLANNING, DEVELOPMENT AND OPERATIONS

Table 4.1 presents our estimate of the economic impact of hydro developments arising from the planning, development and operational phases (combined). As the Table shows the 'small' scheme (or bundle of sites) would result in the addition of some £18,000 of GVA to the Welsh economy annualised over the FiT period (albeit with this impact potentially continuing far beyond that of course). This equates to around 0.5 full time equivalent jobs supported for that period.

The typified larger scheme (at half a MW) drives higher levels of GVA and employment generation – but note the levels of activity supported are significantly lower per MW installed. This is due to a number of factors including;

- The economies of scale levered for larger projects, which have the benefit of being more resource efficient – e.g. in building facilities and turbines, hence with lower cost and impact per MW
- A somewhat lower level of local sourcing, especially with respect to the turbine.

TABLE 4-1 ECONOMIC IMPACT: DEVELOPMENT AND OPERATIONS

All per annum (20 years)	Project			Per MW		
	Output/ Spend	GVA	Emp (FTE)	Output (£m)	GVA (£m)	Emp (FTE)
99kW	£43,000	£18,000	0.5	0.45	0.20	6.5
499kW	£111,500	£45,500	1.5	0.22	0.09	3.5
Per MW Installed (mix of large & small)				**0.37**	**0.15**	**5.5**

The impacts of the development and operations spending are spread across the Welsh economy, albeit varying by project (e.g. depending on the location of specific contractors and purchased inputs). Key elements to note include;

- A wide range of impact across a number of sectors. Around 60% of impact is related to initial development and setup and 40% to ongoing maintenance and operations.
- Almost half, 40-50% of development impact occurs in **manufacturing and engineering** activities and products, driven by the cost of materials and machinery.
- The **construction sector** attracts 20-30% of development-phase economic impact.
- During the operational period, significant costs include **land rent and rates**, with the former of course providing important and potentially 'local' incomes to land owners. These costs can together comprise between a half and three quarters of all ongoing (post-development) costs.
- **Direct maintenance costs** are relatively small, even including an assumed refurbishment of a turbine and/or ancillaries once during the 20 year period.

It is difficult to assess how much of this regional impact will impact 'locally' to the development site – some of which are quite some way from population and employment centres. However, both qualitative and quantitative evidence suggests that developers are typically sourcing their services from close to the project: most of the feasibility and other work is done either 'in house' or contracted locally, and we estimate between 40-60% of construction spending is local[15]. This high level of local spending carries through into the operations and maintenance phase, emphasizing hydro in Wales as a very embedded and localised activity.

4.3 COMMUNITY BENEFIT FUNDS

In addition to the 'industrial' impacts of hydro developments detailed above, community-developed hydro brings an additional benefit in that the Feed in Tariff payments, and any payment for exported electricity, are placed into community benefit funds, net of the repayment cost of capital.

These funds have their own impact (dependent on their use) in that they can support additional employment and activities in the relevant communities (geographic or 'communities of interest') in Wales – and with potential 'multiplier' impacts as more activity is supported outside those communities but inside Wales.

The nature and scale of this additional economic impact will depend on firstly, the level of FiT/export surplus, and secondly the use to which funds are (or are intended to be) put. Following our programme of primary research we estimate that our 'typical' small project might generate £12,000-18,000 surplus per annum, and our large 499kW perhaps £40,000 - £60,000 per annum. Our respondents suggested that a mix of educational, community retail and recreational activities were most likely to be supported by community funds, along with a good proportion of physical refurbishment and 'pump priming' for further, low carbon investment. Using the mid-point of these ranges and applying a mix of relevant activities/sectors for our modelling results in the regional economic impact estimates presented in Table 4.2 below.

TABLE 4-2 COMMUNITY BENEFIT FUNDS: ECONOMIC IMPACT

All per annum (20 years)	Project			Per MW		
	Output/ Spend	GVA	Emp	Output (£m)	GVA (£m)	Emp (FTE)
99kW	£25,000	£13,500	0.5	0.26	0.14	5.5
499kW	£71,000	£39,000	1.5	0.14	0.08	3.0
Per MW Installed (mix)				**0.20**	**0.11**	**4.5**

Here, multiplier impacts included, FiT and export-related surpluses deliver some £13,500 of GVA per annum, across Wales for our 99kW project, and £39,000 for our 499kW project. Levels of supported employment are very similar to the development and operations case; 0.5FTEs for the small project and 1.5FTEs for the large.

On a per MW basis, again the large project does not perform as well as the small. This is no longer due to differences in the economic and sourcing profile, but rather due to the lower level of FiT that is payable per kW for installations of above 100kW[16].

It is far more difficult here to judge how far these financial and employment impacts are 'local' to the site(s) in question. This will depend markedly on the nature of the projects undertaken as a consequence of the community benefit fund. Some funds are intended to be directly very closely at a geographic community (hence with likely high local impacts), others are more 'thematically' oriented across a wider spatial area.

The relative evenness between the economic impact arising annually, per MW from development and operations (£150,000 and 5.5FTEs) and from FiT/export income (£110,000 and 4.5FTEs)is notable.

4.4 THE OVERALL ECONOMIC IMPACT OF COMMUNITY HYDRO

For community hydro the 'industrial' and FiT impacts are additive: thus, Table 4.3 presents the overall economic impact, per project and per MW for community hydro, revealing a total impact, per MW of £300,000 in GVA and 10FTE jobs.

TABLE 4-3 OVERALL IMPACT: COMMUNITY HYDRO

All per annum (20 years)	Project			Per MW		
	Output/ Spend	GVA	Emp	Output (£m)	GVA (£m)	Emp (FTE)
99kW	£68,000	£31,500	1.0	0.7	0.3	12.0
499kW	£182,500	£84,500	3.0	0.4	0.2	6.5
Per MW Installed (mix)				**0.60**	**0.3**	**10.0**

It should be noted that the income from FiTs that accrue to private and commercial developments will also be spent, in part, in Wales although with no information gleaned from commercial projects on this, we cannot say how much. Thus the indicative impacts from commercial developments will be somewhere between the figures reported in Tables 4.1 and 4.3.

5 ECONOMIC IMPACT IN CONTEXT

5.1 THE EMPLOYMENT IMPACTS OF ENERGY GENERATION IN WALES

The Welsh Economy Research Unit (with partners) has undertaken a number of prior economic impact assessments of electricity generation investments in Wales, for a number of clients. The most relevant reports are:

- The Economic Impact of Marine Energy in Wales[17]
- Turning Tide: The Economic Significance of Tidal Lagoon Swansea Bay[18]
- Employment and Regional Electricity Generation in Wales[19]
- Economic Opportunities for Wales from Future Onshore Wind[20]

Together, the results of these studies comprise a reasonably comparable suite of numbers that represent the employment impact of different generation technologies in Wales – per MW installed – albeit with a number of caveats.

Different technologies are at different stages of evolution: gas versus marine renewables for example. There are different relevant operational periods: Tidal Lagoon Swansea Bay, may be in place for a century; most Solar PV and onshore wind for perhaps a quarter of that time. Critically here, different technologies imply different scale and hence require a contextualized reading of per MW impacts. For example, the 'per MW' impact of Nuclear is quite modest, but Wylfa might be home to 3,600 of them; meanwhile small hydro across all of Wales totals only dozens of Megawatts.

Despite these caveats we consider worth it presenting employment generation data, per MW and made as comparable as possible. Figure 5.1 does just this for the 'industrial' impacts of investments; that is the planning, development and operational impacts, all annualized, but excluding any other economic impact (e.g. FiTs for community energy).

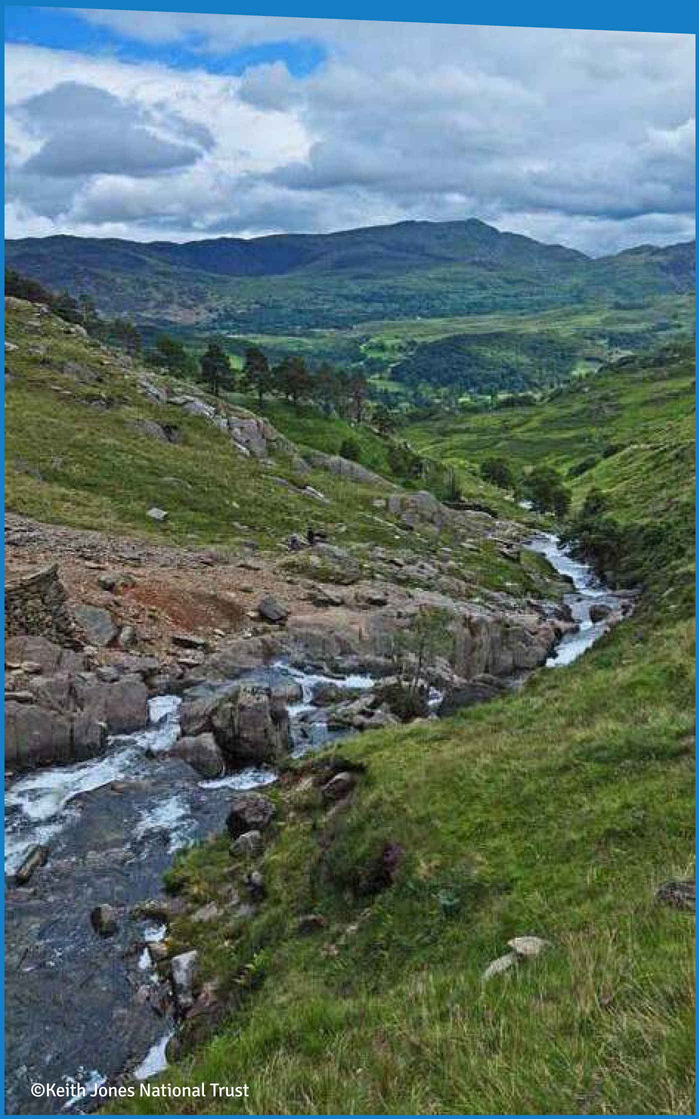


FIGURE 5-1 ANNUAL EMPLOYMENT GENERATION PER MW: DEVELOPMENT & OPS (FTE)

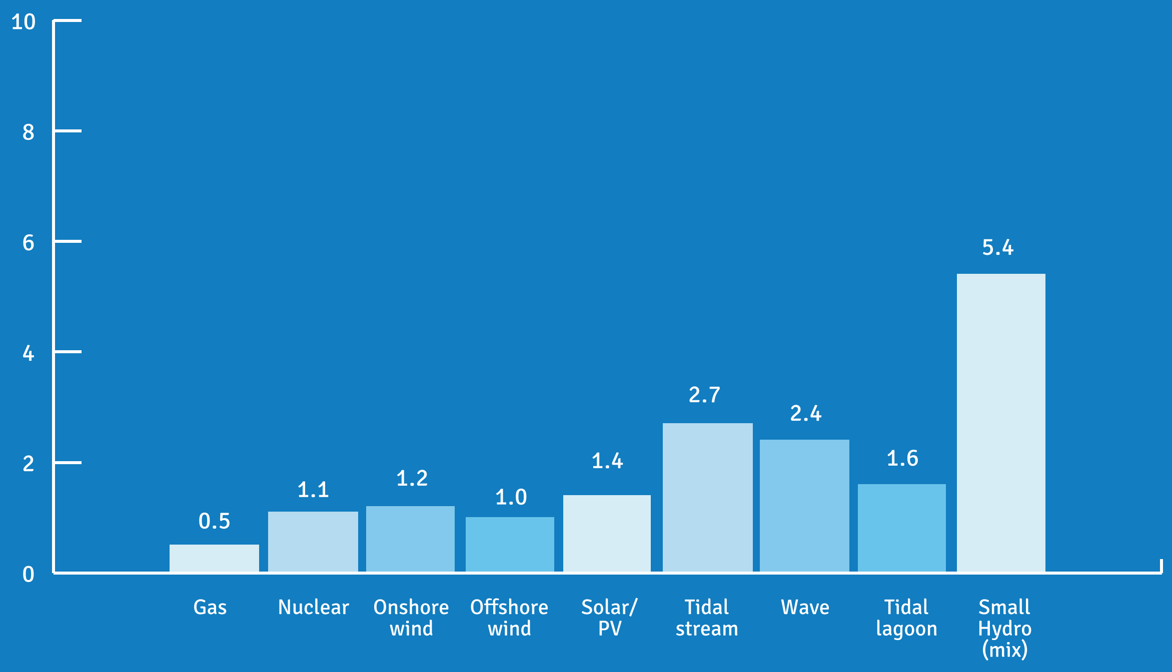


Figure 5.1 shows that small hydro (here a mix of larger and small schemes) generates high FTE employment per MW installed: employment generation, at 5.4FTEs per MW, is twice as high as the next highest. There are several reasons for this.

Firstly, hydro is expensive to install. Our estimated cost per kW for development ranges from £5-8,000, and this is at the very high end of costs across generation technologies. For example, we estimate that novel tidal stream and wave technologies currently cost around £5m per MW - £5,000 or so per kW. The high cost of hydro comes despite the application of mature technology, driven by the absence of large economies of scale and bespoke and often complex installation approaches and locations.

We consider small hydro will unlikely experience significant falls in absolute cost per MW over time as the technology used is relatively mature (unlike novel marine renewables) and installations are always 'bespoke' and complex (unlike Solar PV where kit and installations are very standardized and low cost supplies of panels are increasing). This is bad news for affordability but perversely good news for regional economic impact[21].

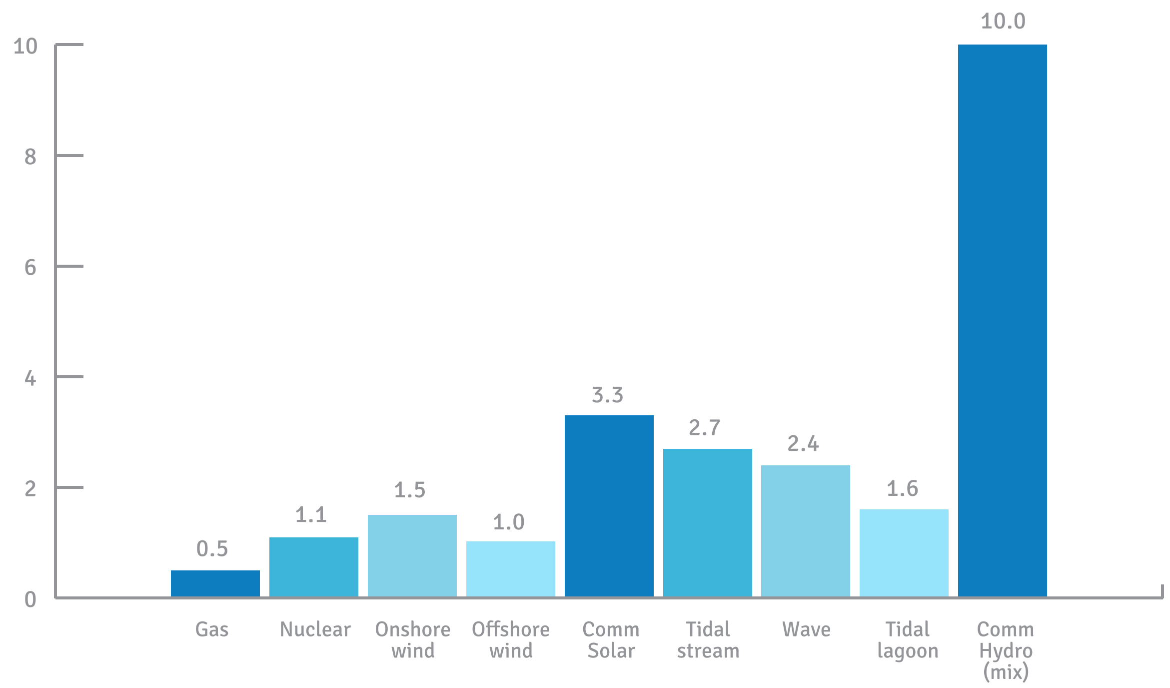
Second, hydro is an 'embedded' economy. With the possible exception of the aspirations of Tidal Lagoon Swansea Bay, energy developments in Wales are usually typified by the import of high value materials, machinery and often services. Because small hydro is small, the characteristics of the industry are quite different, including ongoing, high trust customer-supplier relationships and interactions that are typical of traditional industrial 'clusters' (see Section 6 for more detail). These relationships drive a higher than usual level of regional and local sourcing, and a higher level of regional economic impact.

As earlier Sections have noted, the FiT/Export related benefit of community hydro is almost as significant as spending on development and operations. Figure 5.2 includes these benefits, for not just community hydro but other relevant technologies – the FiT arising from community Solar, and the community benefit funds paid to local communities (at up to £5,000 per MW) by commercial developers in Wales.

As the figure shows, this further increases the relative impact of (now) community hydro compared to other technologies – again always remembering its much smaller scale. Both community solar and onshore wind receive an impact 'uplift' albeit of differing levels given relevant FiTs and community benefit funds.

The relative importance of FiT/Export earnings for community hydro increase its advantage further; employment impacts at 10FTEs per MW are now three times larger than the next best performer (community solar). This graph does however need to be treated with care. In a limited number of cases, benefits from the sale of electricity (and the increased price brought by contract for difference or FiTs) would accrue to Wales but are uncertain, and not included here. The Tidal Lagoon is the most relevant, with TLSB based in Wales and with a number of local shareholders, and a similar case might be made for small scale privately owned onshore wind. The overwhelming majority of generation capacity in Wales is however non-Welsh owned and with incomes from electricity sales leaking from the region.

FIGURE 5-2 ANNUAL EMPLOYMENT GENERATION PER MW: TOTAL (FTE)



5.2 VALUING WATERCOURSES IN WALES

At the heart of the ecosystem services approach (ESA) is an understanding of the different benefits that can flow from a suite of natural resources, often centered on a 'place'. ESA is potentially particularly useful when human activity, or a public policy, can affect the level or sustainability of services arising from those resources. Indeed, where competing (mutually exclusive) uses are a possibility, the 'best' use of that resource or place can be judged using ESA, albeit with significant caveats and data issues.
The situation regarding the development of small hydro installations on upland watercourses is potentially illuminated by the use of ESA. Alternative, and in some cases potentially competing, uses are possible for such streams. Amongst the possible active uses are;

- Installation of a small hydro power plant with associated weir and groundworks;
- Use of the river for coarse or other fishing;
- Active management to deliver downstream benefits – e.g. in terms of flood management
- Explicit management or amelioration to deliver increased or protected biodiversity.
- Abstraction for potable supplies, industrial cooling etc.

In a perfect world we would be able to firstly, decide which (if any) of these uses were competing (and in which cases) and hence required an explicit choice to be made over watercourse use; and secondly, to have clear and comparable 'benefit values' applied to these uses so we could choose the 'best' or encourage the optimization of benefits.

The implementation of ESA in policy determination, in Wales or elsewhere is, however, limited. There is uncertainty about the application: what is the boundary of the 'place' to be studied? Do we value benefits for local, Welsh and other residents equally? How should we treat the optimization of ecosystem services across Wales (for example, we might decide to make different decisions on similar rivers to protect the variety of ecosystem services across the region)? Critically for this case there seems little certainty on the impact of hydropower installations – particularly in terms of the weir and diverted water - on river biodiversity, especially in relation to important invertebrates. This is especially the case as there is ongoing NRW activity to mediate and advise on hydro developments (in terms of design) to minimize potential negative impacts: this is a dynamic human/natural system with important and complex feedback loops.

It is not possible, within the scope of this limited study, to undertake an ecosystem services assessment of Wales' upland watercourses. Rather here we present an indicative estimate of the economic value of different uses. It is important to note we do not, and cannot, say whether these uses are complementary, exclusive or with no cross-impacts: this will vary by location and scheme. We focus on those uses we feel most appropriate or where there are potential policy trade-offs (for example the existence or otherwise of hydro schemes will have no effect on the level or quality of potable water so is excluded here).

It is important also to note that this analysis excludes an assessment of environmental quality and value, which will, again vary by scheme: to give a pertinent example, the National Trust in North Wales has two schemes within close proximity, with different ecological sensitivities and with very different environmental implications and considerations. Such elements are under debate within the Hydropower Stakeholder Group and not included here.

5.3 THE ECONOMIC VALUE OF UPLAND WATERCOURSES

To indicate the relative economic importance of hydropower installations compared to other potential uses, we concentrate on recreational activities, specifically, tourism and recreational angling, It is only for these values that we are able to assign a reasonably transparent and defensible value (per trip) from earlier work. For other economic uses (e.g. flood management) the economic value is far less clear.

In common with earlier parts of this report we default to 'average' values, 'typical' installations and in some cases regional impacts to provide a measure of comparability – despite of course the reality that all schemes are different both economically and environmentally. The reality here is that the available evidence does not allow us to implement an ecosystem services approach which properly reflects the heterogeneity and important of the specific place of development (and this would be true in many other economic impact cases).

Here then we focus on a single development of 30kW to typify our hydro scheme, and assume 30% of the economic impact of our earlier 99kW 'small' hydro case. This is because we feel 30kW is a reasonable upper limit for most hydro developments in South Wales (albeit a few may be bigger), and we wish to exemplify the potential decisions and impacts for one location.

It should be noted that we are presenting here a variety of valuation methodologies. Those for day trips and tourism are closely aligned to the economic impact methodology used for this report, hence comparability is high. For angling activities, a benefits transfer approach is used relying on different valuation methods previously employed by the Environment Agency (Table 5.1).

TABLE 5-1 THE ESTIMATED VALUE OF ANGLING TRIPS

Study	Value for the Benefit Transfer, 2011 prices £s per trip
Trout and Coarse (T&C)	
a) TROUT - Green and Willis (1996) quoted in EA Guidance (2003) pg.59, Table 3.15 It is assumed that the quality of the fishery could improve to 'good' following the implementation of the driver (Dam outflow changes), from moderate. The benefits transfer value relating to this marginal change is £8.47 (2011 prices) per angling trip.	8.47
b) COARSE – Green and Willis (1996) quoted in EA Guidance (2003) pg.58, Table 3.14 It is assumed that the quality of the fishery could improve to 'good' following the implementation of the driver (Dam outflow changes), from moderate. The benefits transfer value relating to this marginal change is £3.06 (2011 prices) per angling trip.	3.06
TROUT & COARSE AVERAGE BENEFIT per angling trip	5.76
Salmon and Sea Trout (S&S)	
c) SALMON FWR Manual (1996) quoted in EA Guidance (2003) pg.59 "...Achieving significant improvements in the quality of existing salmon fisheries (per person per year)..."	36.85

Previous studies then estimate the value of a coarse angling trip (in the UK) at an average of £5.76, and it is this figure that we use to illustrate the relative value of such trips to upland rivers. We also include the value of £36.85 for salmon and sea trout angling (per trip) but make no comment on whether such activities ever actually overlap with hydro on relevant watercourses in Wales. We have equated 'value' per trip provided by these reports with gross value added in our own impact methodology, but these are very different conceptualisations of value and readers are advised to refer to the original reports to understand concepts methods and approaches[22].

Table 5.2 shows the value (also in £2011) of leisure (and other visitation) to Wales. Again we present these numbers not to suggest that visitors will be put off visiting - or indeed encouraged to visit - upland streams as a result of hydro developments, let alone that an entire trip to Wales would be so-influenced, but merely as an indication of relative economic use-values.

TABLE 5-2 GROSS VALUE ADDED AND EMPLOYMENT GENERATED BY TOURISM

	Day Trippers	Short Breaks (1-3 nights)	Long Holiday (4+)	Business	International	All Staying visitors
Gross Value Added (£)						
Per Trip	£12.65	£107	£191	£171	£239	£156
Per Night	£12.65	£52	£47	£74	£46	£51
Employment (FTE)						
Per 1m Trips	560	5,040	8,730	6,660	10,390	7,035
Per 1m Nights	560	2,450	2,170	2,880	2,000	2,280

NB: Assumes overnight international visitors to Wales spend 2 nights outside Wales on average per trip.

Sources:

GB Leisure Day Visits 2011

The UK Tourist 2011

Travel Trends 2011

Levering the above information in contrast to our hydro results provides an indication of the relative value (and for tourism, employment generation ability) of single-site hydro verses this limited set of other uses. Table 5.3 presents this information. We estimate that the regional economic value of a single 30kW hydro site is equivalent to around 860 angling visits per annum (based on an average valuation per trip, inflated to £2014). The far higher estimated value of salmon/sea trout angling means only 140 trips are required to equal the value of the notional hydro development.

In terms of tourism, the economic impact of our hydro case is equivalent to 400 day trips, or 100 visitor-nights. As tourism is very labour intensive, fewer trips are required to match the employment impact of our hydro development – 270 annual day trips and 60 annual visitor-nights.

Community hydro is more 'valuable' to local communities (and hence Wales) due to the disbursement of the FiTs and export revenue. This means that our notional hydro development, if community-managed, equates to 1,500 coarse fishing trips per annum, or 240 salmon/sea trout trips. Some 700 annual day trips are required to match the impact of our community hydro, or some 170 visitor-nights (albeit with these figures somewhat lower again in terms of employment generation; 540 trips and 120 nights respectively).

Community hydro is more 'valuable' to local communities (and hence Wales) due to the disbursement of the FiTs and export revenue

TABLE 5-3 THE RELATIVE ECONOMIC VALUE OF WATERCOURSES IN WALES

	Value Added	Employment (FTE)
Small Hydro (annual, 30kW)	£5,400	0.15
Community Hydro (annual, 30kW)	£9,450	0.3
Impact per trip		
Coarse fishing	£6.25	-
Salmon/sea trout fishing	£39.25	-
Daytrips	£13.50	0.00056
Staying tourists	£55.50	0.00245
Trips Required to Equal Annual Hydro Impact		
Small Hydro		
Coarse fishing	860	-
Salmon/sea trout	140	-
Daytrips	400	270
Staying tourists	100	60
Community Hydro		
Coarse fishing	1,510	-
Salmon/sea trout fishing	240	-
Daytrips	700	540
Staying tourists	170	120

Sources: See earlier Tables
Staying visitors presents impact per single day/night in Wales
All £2014 approximated

In economic terms therefore, the economic effects of hydro investments, together with. for community hydro, surpluses from FiTs and export comprise a potentially important source of local income compared to alternative uses of the key resources. There will, of course be streams that can attract hundreds of angling visits per annum and where alternative uses are comparable (for reference, we have previously estimated there were 10-20,000 angling visits along the length of the Tywi). In other cases, use levels at a potential hydro site, and at potentially affected upstream locations will be far lower and hence with minimal potential economic opportunity cost. The same case can be made for general recreation and tourism, although here any relationship between a hydro development, through to environmental quality and leisure visitation is very unclear.

It is also worth noting that in the case of community hydro the FiT income is wholly additional to the community and Wales – the money will simply not arrive in the absence of a scheme. For other elements of economic impact, there is less certainty about whether any economic activity is 'net additional' to Wales and/or affected communities. For example, anglers or visitors displaced by hydro schemes may go elsewhere in the locality or wider region and hence this money is not necessarily 'lost' to Wales.

The above then gives, at best, a ready reckoner to judge the economic value of hydro to Wales, and remembering that for both community and non-community schemes, much of the impact would appear 'local' to the site – or as local as population distribution allows. In many ways hydropower ticks many economic and development boxes, especially for communities with limited economic opportunity and available resources. However, the challenging realities facing the sector in Wales should not be forgotten.

Anglers or visitors displaced by hydro schemes may go elsewhere in the locality or wider region and hence this money is not necessarily 'lost' to Wales

6 HYDRO IN WALES: THE CHALLENGES AND OPPORTUNITIES

6.1 INTRODUCTION

Earlier sections of this report have hinted at the small scale of hydro development in Wales (outside of pumped storage and larger longstanding developments). This is the result of topographical realities, limited prior investment due to the relative expense of installation (and hence cost per kWh), regulatory and licensing issues, and availability of capital to non-commercial players. Arguably a continuing focus on large scale centralized generation in the UK (fossil or low carbon) has 'crowded out' decentralized solutions, unlike a number of continental neighbours.

A number of these factors persist, with implications for future sector development. It is no exaggeration to suggest that the small hydro sector in Wales faces significant challenge, at least outside the small commercial/private developments. This Section presents some of the key themes that emerge from our analysis and case study interviews.

6.2 THE ECONOMIC STRUCTURE OF SMALL HYDRO

In many ways, hydro in Wales is an extremely atypical 'energy' sector, irrespective of whether players are commercial, public, community or other third sector. Energy investment in Wales is typified by the dominance of large multinationals (and hence limited local ownership), globally extended supply chains, a high level of capital-ownership turnover and a very narrow range of activity undertaken in Wales.

Our study in contrast has revealed a high level of complex interaction between market actors. We have found examples of;

- Project managers of hydro developments 'hand-holding' suppliers through a period of learning and adjustment as they became hydro-aware and able to deliver a quality service;
- Preference given to local and Welsh suppliers, even where outside competitors were cheaper, or with more extensive experience;
- Soft loans awarded by (relatively) cash-rich organisations to fledgling companies, with the explicit objective of developing local supply chains;
- Extensive cross-subsidization within, and between related, organisations to further advance low carbon capacity in Wales;
- Innovative partnership and financing approaches, and learning (for example on funding and management) that intersects with other low carbon sectors and other community activities;
- A generally high level of networking, trust and willingness to engage.

The very existence of the Hydropower Stakeholder Group and its influence over policy and industry speaks to this context in some degree.

Hydropower in Wales displays many of the attributes of an 'industrial cluster'; so often the focus of policy yet here, as is usual, self-organising. Emerging ESPON/Cardiff University research suggests that these relationships and behaviours may be part of 'regional resilience' and recovery after economic crisis[23]. As earlier Sections attest, collaborative behaviours cross not only the community sector, but also public, other third sector, and commercial players (though evidence for the last is patchy). It appears to be that local ownership, or at least control and autonomy are more important drivers of these characteristics than legal status.

Anecdotally, the sector is also characterized by the efforts of a relatively small number of engaged, able and highly motivated individuals – some of whom are driven (as might be expected) by social and/or environmental concerns rather than surplus or profit maximization. Where such individuals have the backing of communities – geographically or of interest – significant progress can be made, and not just in small hydro development. Many readers will be undoubtedly aware of some of the relevant individuals and contexts.

©Keith Jones National Trust

7 SMALL HYDRO IN SCOTLAND: LESSONS FOR WALES?

7.1 INTRODUCTION

For comparative purposes the study explored a series of micro-hydro schemes in Scotland. We selected projects in Argyll and Bute partly because of the rich diversity of hydro-schemes in this county in terms of scale and type. Moreover, prior research (Joseph Rowntree Foundation, 2012[24]) has revealed Argyll and Bute Council has been proactive in trying to leverage better quality socio-economic and community returns from renewable electricity generation technologies. Four interviews were undertaken with scheme developers/owners. These four interviews are summarised as follows:

- Developer/owner near Lochgilphead with interview covering 6 separate schemes ranging from 15KW to 1.1MW, five of these schemes were operational with one still in planning at the time of the interviews in May 2014.
- Developer/owner near Inveraray, covering one scheme of approximately 1.1MW.
- Developer/owner near Campbeltown, with the interview covering a 45 KW scheme.
- Developer/owner with projects in two parts of Argyll and Bute ranging from 30KW to 2MW.

During the interviews respondents were asked to comment on the development phase of the project, the main hurdles that needed to be overcome, their experience of operating the schemes, and the nature of any social/community/economic returns from the projects. In what follows we summarise some of the main themes that arose from the interviews, particularly where they might relate to future lessons for Wales.

7.2 ORIGINATION OF PROPOSALS

It was very clear from each of the interviews that the respondents were very committed to their projects, and had needed to be to get them though complex planning and development procedures. In three of the cases the current interest in hydro power grew from wider family interest, sometimes going back many years. In one instance: "Our original hydro scheme was built by my grandfather in 2013 and then the first electrical one was 1919 and that is actually still running!"

It was noticeable that projects had normally developed with limited involvement from other organisations i.e. individuals had seen the potential from the resource either in terms of a means of farm diversification, which resulted in the land being better managed or with the hydro scheme being directly linked to another business activity. For example in one case an estate hydro project was intricately linked to a salmon farm. Indeed the diversification of estate/farm income offered by micro hydro (and wind) was a universal theme, and with one developer making the point that income generated from the micro-hydro schemes on his land were largely spent on improving the farm infrastructure, and with this providing further benefits to the local economy as goods and services for doing this were purchased locally. In two interview cases the development of micro hydro sat beside plans to develop tourism facing infrastructure that is being part of wider farm/estate diversification plans.

In each interview case it was clear that considerable personal drive had been needed to get projects through lengthy planning processes. In one case the planning and development phase had occurred over a period of 11 years. In another case:

> "Well we started [scheme] in 2006…in terms of planning and SEPA etc. We started construction in March 2011 and we finished…in September 2012."

Developers entered into planning expecting lengthy delays, and this added to the risk surrounding even smaller projects.

7.3 DEVELOPMENTAL PHASES

The 12 micro-hydro schemes covered by the 4 interviews had faced various hurdles through development. A number of issues were raised by the respondents in regard to their development experiences.

First were problems caused by multiple land holdings around a water body. In this respect one interviewee said that it was very important for one person to have a majority share in a project to drive decisions forward during the planning phase, and that he would not get involved in a collaborative project close to his farm unless he was assured of a majority stakeholding. He said that:

> "Rivers become boundaries very regularly in this part of the world, so there's nearly always different landowners and [scheme] is a classic example; there's five landowners… and they all hate each other! So it's quite a challenge to get a deal where everyone gets a [share]"

Another respondent showed the advantages of having complete 'control' of a catchment:

> "What is important is that we own the catchment, so we have 100% control over the catchment where there are very strict controls on planning, chemical usage etc."

There were the inevitable complaints about some elements of the planning process. In the eyes of some developers there were unjustified concerns about wildlife. One respondent noted:

“So I’ve got this project going on and if a Golden Eagle is distressed they can shut the whole project down. This is the risk. How do you tell if a Golden Eagle is distressed? It doesn’t say ‘I’m distressed’ and of course [when] they are flying over [the scheme] .... I’m going ‘Oh crap!”

General concerns vented covered themes such as case officers in planning authorities and environmental protection bodies being unfamiliar with site specifics and not always visiting sites where surveys were being demanded. A further problem related to internal consistency of decisions across projects during planning. This was seen as a particular problem in the context of fish and wildlife surveys which were considered in some cases totally inappropriate given the physical characteristics of sites. Several respondents also noted that inadequate attention during planning processes was given to the environmental ‘credentials’ of landowners. For example, in one case the owners were keen to conserve scarce sea trout and salmon stocks because this was an important estate asset. Several respondents pointed to the importance of the developer being the farmer/landowner as this resulted in a series of ‘natural environmental safeguards’ that might not be present were an external developer to be involved because the owners might want the land and its resources carefully protected.

Particular problems emerged where projects attempted to develop water storage, and this was not just in terms of environmental protection. One respondent noted that:

“The dam, it’s very significant, no one builds dams and there’s a reason for that; it’s very hard and you don’t get any tax relief on it so you don’t get any capital allowances on the dam.”

Each of the interviewees highlighted that construction and development phases featured high levels of ‘embeddedness’ in terms of locally sourced goods and materials, yet at the same time that small schemes considered created little additional employment. On smaller projects it was more likely that farm/estate labour was used in all but the more technical tasks of turbine and control panel installation and positioning of pipes. The developer of one large project (1MW+) mentioned that:

“We were very proud in that we used local employees throughout.... so really everyone on site was from Argyll...Probably at its peak there were about 25 people on site.... [and] never less that ten during the construction phase.”

In the Argyll and Bute case overall it was suggested that the large number of schemes coming forward had led to some civil contractors in towns such as Lochgilphead actually specialising in hydro installations. One developer stated that: “There’s a whole hub building [up] in Lochgilphead.contractors that rely heavily on [hydro].”

In comparison to wind energy micro hydro projects tended to use UK supplied turbines from firms such as Gilkes, but with generators tending to be imported. Capital costs associated with the largest schemes covered were around £3.5 per installed MW. With smaller schemes capital costs were higher. One respondent estimated the capital costs associated with a 45KW device on his property had been around £220,000. Cost per installed MW clearly varied by scale and the head of water involved.

Some of the schemes covered by the respondents had had problems raising finances. In several cases money was raised using estate/farm land and buildings as the collateral. One respondent observed that it was difficult to borrow against the expected performance of a scheme. The methods of typical financing through long term loan had also meant that banks stipulated that relatively expensive insurance policies be put in place (see below) to cover against loss of income as a result of lack of water, accidents etc.

A further common concern in each case was the quality of the local grid connection and how much generated electricity could be placed onto the grid. The amount that could be placed onto the grid created further uncertainty during the development phase. According to one developer:

“Our issue here is not the amount of energy I can generate, it’s the restrictions on the grid.”

In one case a developer had worked closely with a nearby tidal energy project taking advantage of the dam storage capacity in connection with the limits of the tidal device: “helping to fill their troughs, because twice a day they are not generating anything and twice a day they are generating at the peak of what they can according to that tide.[so we are] effectively borrowing their capacity when they do not need it.”

7.4 OPERATIONAL PHASES

Each of the respondents emphasised that once schemes were in place there was very little involved with operations and maintenance. In two cases the interviewer was shown the real time performance of systems many miles distant. The nature of control equipment meant that even with the largest 1MW plus schemes there was no one typically on site, and with control systems able to shut down turbines remotely where problems occurred. Higher labour input during operations was generally caused by poor design. One respondent noted with a 1MW scheme:

> "That scheme I purchased was built by these London bankers and they really didn't know what they were doing....it's a really poorly conceived project and the filters are awful. So I've basically got a guy permanently employed cleaning filters up there which is stupid, it just wasn't designed very well."

And another in response to questions on maintenance requirements on a 1MW system:

> "No, not really, hardly anything in honesty. We have to clean the pipe, clean it out, which is a day's work. I come down and check it every day and make sure that it is running. There's sort of general maintenance of the building, we have to get the machine serviced, we have to check the runner, check the hydraulics....it's pretty low maintenance really."

And another on a 45KW scheme:

> "To be honest ..... if you spend an hour a month, if this is what you wanted to do...it doesn't need anything – it's a fantastic little thing."

The main 'identifiable' cost categories during operations were insurance costs and rates. According to one respondent:

> "We have a year's worth of loss of revenue insurance which is a big, big element of the cost, about £35,000 [pa]".

And another:

> "Insurance is very, very expensive. Twenty grand a year. Because our policies do different things...we have to have employers liability...also our banking covenants are horrendous so we're expected to have insurance to cover consequential loss for two years. If a machine shuts down an insurance policy will pay the average output for two years."

The respondents identified little by way of socio-economic benefits for the local economy during operations. However, each respondent highlighted how income worked to safeguard farm or estate activities, and with much of the income stream simply reinvested locally, sometimes in other schemes.

For one respondent:

> "It makes this farm viable. If I didn't have hydro on this farm we'd be skint. It means I can go and buy a new quad bike...I've got nice gates and fencing."

However, once operational this was not always the end of problems for operators. One farmer noted:

> "Once you've got over the angst of building the thing, the big stress is [having] borrowing all this money [you think] October it's going to start producing an income and its going to pour with rain all Winter....that's not happening so we're now paying the bank frantically....get to the summer, turbine rotates briefly and no income. So we had a year with no decent income and still handing out fivers to the bank."

7.5 CONCLUSIONS

The case of Argyll and Bute reveals some of the same issues that have affected the development of micro-hydro projects in Wales. One important conclusion from each case was that without the personal passion and belief of the individual developer in each case it is unlikely that the projects would have gone ahead. It was also clear that in spite of the development problems faced by individual developers they were all committed to further micro-hydro projects in Argyll and Bute. Also noteworthy was the belief that one person needed to take charge of a development and with the prospect of increasing decision problems with shared ownership of schemes.

While the schemes covered by the four interviews featured relatively high levels of 'local content' compared to technologies such as wind power, it was also clear that employment opportunities during construction phases on site were limited even with the larger 1MW+ schemes. However, it was clear that investments in Argyll and Bute in aggregate were supporting a UK supply side in turbines, control panels, metal work, piping and civil contracting. The employment supported during scheme operation was small with payments in terms of insurance being perceived as a leakage out of the local economy. However, in each of the schemes covered here the income generated was used by organisations close to where the electricity was generated. Micro-hydro was offering an important diversification opportunity for farms and estates where there were few alternative opportunities available, and moreover providing a relatively stable income stream in comparison to tourism lets and farming. Then one conclusion here would be that the diversification of income stream permitted continued management of the estate/farm land cover.

Inevitably developers varied in their experiences of organisations such as Scottish Environmental Protection Agency (SEPA) and organisations such as Scottish National Heritage. No interviews were carried out with these bodies but there were concerns about consistency of approach, and case officer engagement and knowledge of projects and local physical conditions. From the interviews it was clear that some case officers were better able to communicate with projects and show why various planning hurdles had to be overcome. In other cases 'distance' between parties had led to mutual mistrust. There was some suggestion from the interviews that projects in development were learning from one another in overcoming hurdles, and learning to avoid costly mistakes in developing applications.

One important conclusion from each case was that without the personal passion and belief of the individual developer in each case it is unlikely that the projects would have gone ahead

8 CHALLENGES AND THREATS: THE SHORT AND LONG TERM

Despite the interesting and potentially high value internal structure of hydropower in Wales, the reality is of a sector currently wholly dependent on subsidy: and with that subsidy decreasing year-on-year as FiTs degress. An annual scramble to make installations operational within a higher FiT window is evident, and a number of our respondents evidenced some pessimism about sector prospects due to the changing subsidy regime. The feeling was that allowing for repayment of capital, a window of perhaps 2-3 years for smaller externally funded projects remains (somewhat longer for projects that are internally funded, or that are hydrologically very blessed). Indeed, this prospect may also be insufficiently pessimistic. A strong UK (or at least South East) property market and lower levels of unemployment have prompted recent signals by the Bank of England that the era of extremely cheap money may be ending – albeit not imminently. The attractiveness of the returns from energy investment, fixed and FiT related, will decline as alternative uses of investment capital become more lucrative (i.e. as interest rates increase).

The sector is then caught in a 'pincer' of decreasing subsidy (latest DECC consultation notwithstanding) and potentially increasing competition for funds. Recent community share offers, in both hydro and solar have reached their target investment, but only after extended offer periods, suggesting that further growth based on established techniques may be problematic (although the success of these offers may conversely spur growth).

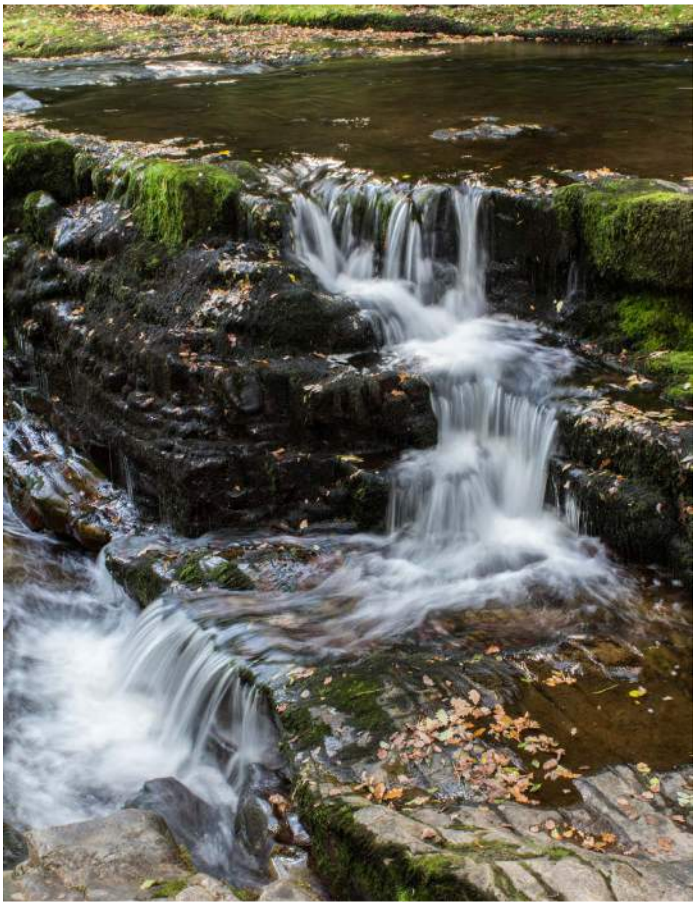
This potential growth constraint is matched by some scarce capacity on the supply-side. There are a small number of companies involved in the hydro supply side in Wales (both in terms of materials/machinery and installation) and there is limited capacity for short term growth.

This rather pessimistic outlook is concerning as, in the longer term, it may be that hydropower will stand without subsidy as a viable and competitive source of electricity. Currently, export prices per kWh are some 25% of the FiT value but that ratio will change, both as FiT decreases and as the cost of electricity increases, in the short and medium term. Electricity (and gas) prices for UK households doubled between 2004/5 and 2009/10 and continue to increase[25]. A working paper from the IMF has a 'central scenario' of the doubling of world oil prices by 2020, from their already historic highs[26].

In the UK we will not escape this energy price trend: our replacements for obsolescent fossil or nuclear generation and declining North Sea reserves are either heavily subsidized (onshore and offshore wind; nuclear) or geopolitically, or socially and environmentally problematic (gas; fracked or otherwise).

A case can be made then for small hydropower as part of an energy mix, albeit restricted to where co-benefits are evident (e.g. in supporting industrial or cluster development, or community renewal); where there are local uses for the generated power; or for conversion to heat (especially away from gas grids); or as a small balance to other intermittent generators.

The risk here is that financial pressures around FiT degression, limited strategic capacity in both the sector and the public sector or a problematic interface between developers and regulators might slow or halt investment and installation in Wales, except at the most 'economically efficient' sites and by the most 'economically efficient' developers. This might then exclude community developments that are more complex, sometimes higher cost and perhaps less mobile in terms of available streams. At a much larger scale, one can see how the abandonment of nuclear in more energy-rich times has led to the depreciation of capacity and skills in the UK, with the result that new nuclear is now largely foreign built and foreign owned. There may be a lesson here for hydropower in Wales.



Part 2

Social Impacts

9 SOCIAL IMPACTS OF SMALL HYDRO

9.1 BACKGROUND

This research was conducted by researchers from the Centre for Regeneration Wales and the University of South Wales, the latter funded via the Welsh Government's Strategic Insight Programme. Each researcher was funded for five days giving a total of ten research days. Thus whilst the resources available to the research are capable of generating some useful insights into the social impact of Community Micro Hydro, the research is at the same time only scratching the surface of a complex and under-researched subject.

The available resources were also important in informing our approach, with the research team making a conscious decision to concentrate upon Community Micro Hydro initiatives, as it was here that the social impacts were likely to be most pronounced (more on this and the definition of Community Micro Hydro later). Whilst this approach has enabled the research team to make best use of their resources, it has also inevitably meant that the social impacts of other micro-hydro ownership models have not been explored. This is a potentially fruitful area for future research as the research team did encounter tentative evidence to suggest that these other models could generate significant, if more indirect, social gains.

9.2 METHODOLOGY.

The methodological design consisted of a three staged process which unfolded as follows:

- Stage 1: Review of existing evidence on social impacts. This review drew upon a combination of academic literature, government publications and so called "grey" literature. Out of necessity the review focussed upon community energy generally rather than Micro-Hydro specifically. Whilst, we are confident that the literature review was able to identify major aspects of the debate around the impact of community energy initiatives, the time available to the research team means that we cannot claim that this was an exhaustive review of all the available evidence.

- Stage 2: Case Study Selection and Visits. Evidence from the literature was then used to identify the following selection criteria for the case studies: An established micro-generation scheme (under 100kw); which has been running for over 1 year; is community developed and owned; and has evidence of wider community engagement. As is discussed further in section 8 the selection of these criteria was based on the fact that existing research evidence suggests that projects with these characteristics are most likely to generate positive social impacts. From this, two projects were identified in South Wales as suitable case studies alongside a third initiative based in the English Peak District. The principal reason for other projects not being selected related either to the ownership and development model or that the initiative was still in its preparatory stages and couldn't therefore be expected to have generated an impact at the point at which the research was conducted. The purpose of these visits was to interview key members of the project staff in order to explore their perceptions of the project's development and the impacts which it had had upon their organisation and the community it was situated within. The researchers were also keen to explore the extent to which the projects had collated any evidence about the impacts their initiatives had had within their community (e.g. in terms of how revenue streams were spent, any information they had collected through their own monitoring mechanisms or any research that they had previously commissioned).

- Stage 3: Questionnaire Design and Delivery. As is discussed further below, two key themes to emerge from the literature were the potential impacts which Community Energy Initiatives might have upon attitudes and behaviour in the community that they serve and the lack of robust research evidence about whether these impacts had actually occurred. For this reason the research team developed a short questionnaire survey framed around the key areas of anticipated social impact and which was delivered via Survey Monkey. However, whilst providing some tentative insights into the wider community impact the survey results should be interpreted with caution for a number of reasons. First, it was only possible to deliver the survey in two out the three case study initiatives, as staff from the third initiative felt that the particular way it had developed meant that there was unlikely to have been a wider community awareness of its presence. Second, time and resource constraints meant that the survey was delivered with minimal publicity and to a short completion deadline resulting in a low response rate (n =25).Third, the sample has not been compared against local demographic and socio-economic profiles and so there is no way of knowing how representative the sample is of the particular community in question. Indeed, the likelihood is that it is not particularly representative and that its coverage extends principally to participants who are closely associated with the initiatives and are already community energy 'converts'. Whilst, in an ideal world the survey would have generated a higher response rate and more comprehensive/representative community coverage, it was recognized from the outset that this was an ambitious aim for a project of this size. As such the principal aim was to develop and pilot a research tool which could be made available to initiatives in the hope that they could utilize it to build the evidence base on a project by project basis. The initial results from the survey suggest that with some minor refinements it is an effective means of assessing wider community impact.

9.3 TECHNOLOGY

There is some evidence to suggest that the particular technology is a significant factor in the social impacts, with more visually intrusive energy production technologies, such as wind energy tending to prove more controversial. For example, Walker et al (2010) suggest that the use of wind turbines played a role in the exacerbation of social divisions which resulted in one of their case study initiatives. However, this was felt to be a relatively minor factor in relation to the ownership, development and profit distribution model of that particular initiative. Although Community Hydro initiatives create little visual impact, concerns about their impact on river ecological systems, and in particular on the aquatic organisms that sustain fish stocks, have been raised as an issue and indeed form a key backdrop to this research. As is noted earlier in this report this is not something that the authors are equipped to comment on other than to note that as yet this is an unproven and unknown impact.

There is therefore a need for research specifically focussed on this issue and the extent to which it pertains across different types of river systems.

At a broader level consideration also needs to be given to the potential for cross disciplinary research which considers how river systems can be managed in a way that is both sustainable and which meets the multiple demands expected of them (e.g. power generation, flood risk management, uplands carbon storage, leisure/ recreation and bio-diversity).

9.4 MULTIPLE DEFINITIONS.

A recurring theme within the literature was the wide ranging nature of meanings and models attached to the notion of community energy and a related lack of a commonly agreed terminology. The community energy sector is an incredibly broad church which includes a diverse range of goals, activities, ownership and benefit distribution models. As such the "community renewables" umbrella includes: privately owned schemes generating private profit but which claimed to be community energy initiatives by virtue of their small scale; co-operative type models in which the community was not necessarily geographically defined but was instead comprised of a pool investors who made up so called 'communities of interest'; and initiatives which were community owned and/or existed for the benefit of a particular, usually geographically defined, community, and whose profits were spent accordingly (Walker et al. 2007). As Community Energy Scotland (2012) notes, a distinction can also be drawn between those initiatives which generate energy for revenue and those which generate energy to support the running costs of community facilities.

The diversity of meanings attached to community energy reflects a long standing and ongoing debate within the social sciences about what the defining characteristics of community, the multiplicity of ways in which it is defined and even whether or not it can be said to exist at all. There is not the space in this report to delve further into this debate but Day (2006) is a useful source for those who are interested.

One aspect of this debate which does hold particular relevance for this research is the way in which the inherent ambiguity of community makes it vulnerable to being appropriated for nefarious means. Walker et al (2007) make a similar point, suggesting that whilst this has positive effects in the sense of opening up space for experimentation and innovation, it also carries the danger of the term "community" being appropriated and misused. In later work (Walker & Devine-Wright 2008) they suggest that community renewable energy initiatives should be distinguished by the open and participatory nature of their development and/or their local and collective outcomes, whilst acknowledging a much broader and vague grouping of projects with a "community label".

A recent review of evidence commissioned by the Department for Energy and Climate Change (DECC) appears to have adopted similar criteria based upon how the initiative has been developed and how its benefits are distributed, in developing a sample frame which included any: "energy project completed in the last five years that was led by a community group for the benefit of their community" (DECC 2013: 5).

Their definition presents a useful shorthand for an expectation of open and participatory development and a focus on local social gain, but also includes a five year cut off point which reflects the different policy and support frameworks in place at that time. Our sampling criteria (described in section 7.2) excludes this time limit as the focus of interest is on the social impact regardless the particular policy context. Instead our criteria stipulates only that the project must have been in existence for more than a year in order that it may realistically have had the chance to develop the wider community impacts discussed below.

9.5 THE IMPORTANCE OF DEFINITION.

The principal reason why the definition of community energy is so important is that the available research evidence points to a wide differentiation of social impacts across different models. Those initiatives which are community owned and whose profits are spent for the local social good appear most likely to produce strong social gains. Those which have more restricted ownership models and profit distribution tend to produce fewer social gains, and in some instances are reported to have had negative social impacts. This was particularly exemplified in a survey based analysis of six community renewable energy initiatives which found a spectrum of social impacts which ranged from strong gains in some initiatives to profoundly negative outcomes in others (Walker et al 2010). Although the authors emphasise the importance of the specific community dynamics and caution against making broader generalisations, they identify a range of pertinent factors:

- The extent to which the technology was obtrusive and controversial
- The scale of the project
- The extent to which benefits were collective or private
- The extent to which the development process was perceived to be open, participatory and collective

There is also tentative evidence to suggest that the development process and ownership model are critical factors in shaping community perceptions, and are possibly more important than how benefits are distributed. For example, Mussel &Kuik (2011) found significant differences in local acceptance between two wind energy projects of similar scale in East Germany. One of the schemes, Zschadra, is developed and owned by a community with aspirations for energy autonomy .The other scheme in Nossen is wholly owned by commercial companies and was installed simply to provide an income for the community. When asked whether they connected the schemes with a positive future for their children, 92% of those surveyed in Zschadra agreed, compared to only 30% in Nossen.

9.6 ANTICIPATED SOCIAL IMPACTS

The wider literature on Community Renewables, the stated aims of organisations developing these initiatives and the underlying rationale for a number of different policy initiatives all allude to a range of different social gains that they expect these initiatives to produce. These include:

- A positive impact on capacity and skills development within the organisation developing the initiative.
- The generation of new revenue streams which can be used to subsidise support social facilities and initiatives.
- The strengthening of social capital and cohesiveness within community served by the initiative as the act of developing the initiative and the activities supported by its income creates new social linkages and strengthens pre-existing relationships.
- Facilitating attitudinal and behaviour change within the wider community. More specifically it was hoped that community renewables would promote more positive attitudes towards renewables (against a backdrop of vociferous opposition of onshore wind) and increase the uptake of renewable technologies on a domestic scale. In addition it was hoped that community initiatives would help foster a sense of "discursive conscientisation" (Warburton 2008) around issues of climate change and energy security in which people would become more aware of these issues and adapt their energy consumption behaviours accordingly.

It is under these four areas that the social impacts of the case studies explored in this report have been grouped. Whilst, the first three (organisational capacity and development, support for social facilities and the development of social capital) are generic to most community development initiatives, the fourth (attitudinal and behaviour change) is more specific to community renewable initiatives, though by no means unique to them. It is also an area in which a great deal of hope has been invested against the growing realisation that getting people to think and act differently is far more complex than simply providing them with the right information. At the same time there is also growing recognition of the importance of societal scale changes to everyday behaviours if we are to make the transition to a more sustainable future.

9.7 A WEAK AND INCONCLUSIVE EVIDENCE BASE:

Headline findings from the Department of Energy and Climate Change's (DECC) 2013 review of evidence included the following observations:

- "The evidence base for community energy is limited and does not provide a complete picture of current activity in the UK.
- Much of the evidence that does exist does not meet the standards ideally required for policy making." (Databuild Research and Solutions ltd 2013:6)

The report went on to outline a series of key evidence gaps which included a lack of detailed and robust empirical evidence about the added value of community energy projects and which also emphasised the difficulty of measuring social benefits.

This research encountered a similar lack of robust empirical evidence but also found that the evidence base is stronger in some areas than in others. Thus, the evidence base tends to be stronger in relation to the impacts upon organisations such as their organisational capacity, skills acquisition, sense of self confidence and resilience. For example, in 2012 Community Energy Scotland conducted a questionnaire survey of 56 facilities based projects with 7 revenue based projects on impacts (Community Energy Scotland 2012). In Wales a consortium made up of the National Trust, Shared Assets and the Clore Leadership programme produced a research report exploring the social impacts of community energy which was based on 30 qualitative interviews with practitioners (Walton 2012).

Whilst both studies provide a wealth of evidence about the impacts on the organisations themselves their methodological approach doesn't allow them to draw firm conclusions about the wider community impact. Indeed, there appears to be no systematic and robust monitoring of the wider social impact of community energy initiatives in the communities that they seek to serve. This is likely to be attributable to a number of factors which include: a tendency within the community sector to focus on 'getting on and doing' rather than on measuring; a lack of physical capacity and financial resources; lack of specific research skills and expertise; and a lack of established methodological frameworks.

In relation to the latter the New Economics Foundation has worked with the Cheshire village of Ashton Hayes to develop an evaluative framework for its "going carbon neutral" strategy (New Economics Foundation 2012). The resulting methodological framework, which is based around similar principles as the Social Return on Investment (SROI) work pioneered by the NEF, looks to have the potential to comprehensively and robustly capture social impacts. However, actually implementing this framework would be a sizeable and costly undertaking which is likely to be beyond the means of any community organization without specific funding for this purpose. The possibility of it being rolled out across the sector is therefore remote. The questionnaire survey developed for this research is by no means as comprehensive or carefully researched as the Ashton Hayes framework and is only capable capturing attitudes and reported behaviour (as opposed to actual behaviour). However, it is designed around the anticipated social impacts discussed above, is capable of providing some insights into these areas and would be relatively straightforward for any community organisation to implement with only a minimal investment of resources. For this reason the survey design has been made available to any group which chooses to use or adapt it as an as an appendix to this report and is also available on the Centre for Regeneration Excellence Wales (CREW) website. (**www.regenwales.org**)

©Keith Jones National Trust

10 THE CASE STUDY INITIATIVES

©Keith Jones National Trust

10.1 TALYBONT ON USK ENERGY

Location: Talybont on Usk Energy
Website: www.talybontenergy.co.uk
Established: 2006
Landownder: DwrCymru

Overview

Talybont is a small rural settlement in the Brecon Beacons National Park with a population of approximately 750. Talybont on Usk Energy Ltd is the body that developed Wales' first community micro-hydro scheme. The 36kW hydro electric turbine works off the compensation flow from Talybont Reservoir and can power approximately 25% of the village. The income from the electricity generated is sold to the grid and invested back into the sustainable community projects. This includes PV installation on the Community Hall which is used to power the hall and the community owned electric car. A community fund, administered by the Town Council is also being trialled and various energy saving and energy transport initiatives have been piloted through the income generated.

Power Generation:
36Kw turbine

Income Range:
£25k-30k per annum

Ownership model:
ToUE is a Company Ltd by guarantee.

Project finance: BBNPA SDF Funded feasibility study carried out by WDA. Awards for All, ClearSkies and Powys SECRET ERDF fund secured for Capital.

Aims:

(1) To reduce local community's energy consumption

- by raising awareness,- by facilitating energy saving measures, and- by pioneering alternative ways of doing things.

(2) To convert as much as possible of local community's energy consumption to renewable sources

- by maintaining the Talybont hydro,- by introducing further renewable energy sources, and- by helping community members to convert to renewable energy sources and suppliers.

Complemetary projects

Energy Savings & Generation:

ToUE is supporting the local community hall shift its energy requirements to renewable sources. To date, they have funded 2 sets of 4kW PV panels for the roof of the hall together with the first phase of air source heating.
Installed in 2011, the 16 x 245watt PV panels supply the hall's electricity needs and also create a small income by selling surplus energy back to the grid via Good Energy (the same company that the turbine sells to). The electricity is also used to power the vehicles for the car club. In the sunny first days the panels were producing an average of 17kwhs per day.

Energy Meter Trial: Energy Meters were trialled in a small section of the community in 2008, administered and evaluated by ToUE in order to monitor energy usage and behaviour change. 9 of the 10 trial households reduced their consumption during the trial period by an average of 9%. In contrast, the control group consumption rose by an average of 5% over the same period. As well as some interesting results, the trial also concluded a number of design recommendations for smart meters and appliances.

Woodland group: Talybont Woodland Group was formed in 2013. The idea of a group had been discussed within the ToUE group but the lack of a suitable woodland proved to be an obstacle. However, the group was approached by a local landowner who asked if they would be interested in siting themselves in some 10 acres of unmanaged woodland on the farm. There are some 12 core members of the group. Under the guidance of The Green Valleys CIC, the woodlands will be managed according to a ten year plan, clearing sections of the woods one at a time to remove dead timber and to fell some trees in order to provide space and light for others. The first crop of firewood is due to be processed late summer 2014, and the group is reported to be flourishing and attracting new members


©Keith Jones National Trust

10.2 CWMCLYDACH COMMUNITY DEVELOPMENT TRUST

Location: Clydach Vale, Rhondda Valley, RCT
Established: 2011
Landownder: RCTCBC

Scheme Overview

Hydro Scheme developed in watercourses which were developed as part of the landscaping and reclamation of a former colliery site.

Power Generation:
55Kw

Income Range:
15k-25k per annum

Ownership model:
Development Trust

Project finance:
(DECC) LCC

Aims:

Work began on the process of developing the micro-hydro scheme in 2006 and was developed through a partnership between the Cwmclydach Development Trust and the Communities First team for Clydach Vale. Following an initial feasibility study it was originally hoped that two micro-hydro initiatives could be developed on an engineered watercourse which forms part of a former colliery site. It was hoped that the income generated from this could then be used to support the development of a mini alternative energy centre on the site which could be used for educational visits and as a springboard for renewable energy take up and reduced energy consumption in the local community. This would have been realised through a wide range of initiatives on the colliery site, with local organisations such as schools and with local residents. However, despite initial success in securing funding from the UK government Low Carbon Communities Challenge and the Community Facilities programme the group faced numerous barriers in actually drawing down this funding and a range of different bureaucratic barriers erected by various government departments. As a result it was ultimately only able to implement the smaller of the two hydro initiatives, which whilst technically more straightforward to develop was also considered to be the less economically viable of the two sites. Since then the reconfiguration and refocusing of the Communities First programme means that there is no longer a Communities First team dedicated to the Clydach Vale area. Although the hydro initiative is a significant source of revenue for the local community, the final project represents a considerable dilution of the Trust's original intent. As an interviewee commented: "If we could have developed what we had started we'd be having a different conversation now"

Complemetary developments

Energy Savings & Generation:

Profit generated by the hydro-scheme is used to subsidise staff costs at the local community centre and day care nursery.

Work began on the process of developing the micro-hydro scheme in 2006 and was developed through a partnership between the Cwmclydach Development Trust and the Communities First team for Clydach Vale


©Keith Jones National Trust

10.3 TORRS HYDRO NEW MILLS LIMITED

Location: New Mills, Derbyshire
Established: 2008
Landownder: New Mills Town council on a 40 year lease. (Fixed at a nominal rate of £600 per year).

Power Generation:
55Kw

Income Range:
18K-19K as a naverage but can be as low as 12k or as high as 33K, depending on rainfall

Ownership model:
IPS (Shareholders)

Project finance: Community Shares, Loan and Grant Finance

Scheme Overview:

Torr's Hydro is a community owned energy scheme in New Mills, Derbyshire. On the border of the Peak District National Park and approximately 15 miles from Manchester, the town has a population of 10,000. Torr's Hydro was the first Community Hydro Share Offer in England. The scheme is located on the site of Torr Mill, a textile mill built in 1790 which was destroyed in a fire in 1912. The turbine sits in location of the original mill pit, where the water wheel would have been sited. Torrs Hydro New Mills Limited was founded in 2007, incorporated as an Industrial and Provident Society (IPS) so that the scheme could be supported by a community share offer. The scheme has 230 shareholders and in the years of surplus generation, the majority of profits from the scheme fund a community grants programme. The majority of shareholders are from the local area. The schemes profits are currently limited due to high loan repayments, however a newly launched share offer aims to repay this in full in order to maximise the best use of any future surplus.

Objectives

- Help regenerate the community and environmental sustainability of the New Mills area
- Advance education, particularly concerning asset based community development and enterprises with a community or environmental focus
- Provide an opportunity for public-spirited people and organisations to contribute financially to the community, with the expectation of a social dividend, rather than personal financial reward

Complementary developments:

The scheme has 230 shareholders and in the years of surplus generation, the majority of profits from the scheme fund a community grants programme.

The profits of the scheme are also limited by the turbine design (a reverse Archimedes screw) which is limited in periods of dry weather where water flow drops below a certain point. The energy which is generated is sold back to the grid via The Co-operative. Negotiations are currently under way to increase these rates which will make a significant difference to income. The board are keen to support other renewable energy generation projects and support a variety of local community groups to undertake activities and initiatives in the local area although this is unlikely to occur before the capital is raised to address the current loan repayment in full However, once surplus can be generated, there is significant potential for the scheme to have a wider impact, especially with their widespread links to local schools and institutions.

10.4 SOCIAL IMPACTS ATTRIBUTABLE TO THE CASE STUDY INITIATIVES

Organisational capacity and skills development

Community Energy Scotland's (2012) study of the social impact of community energy initiatives documented a wide range of positive impacts for the organisation developing the initiative, grouped around the themes of organisational confidence, wealth and resilience. In many respects these findings were replicated in the case study interviews will all of the organisations reporting that they had developed new skills, knowledge and expertise as a result of developing their community hydro initiative.Most obviously these included knowledge of the practical application of renewable energy technology, which, whilst usually focused primarily on micro-hydro technology, often also encapsulated other renewable technologies that the organisation had either branched into or explored. It also included the development of technical knowledge and expertise of supply and demand within energy markets and the functioning of the National Grid. Organisations also cited a better understanding of the often complex process of acquiring the various permissions needed from different government departments and the various regulatory codes which applied not only to the technology itself, but to funding regimes and ownership models. Skills developed here not only included hard knowledge of navigating the complex mechanisms of local, Welsh, UK and even EU government, but what might be termed the 'soft skills' of knowing who to talk to and how to exert effective influence. One organisation also reported a (sobering) development of their understanding about how theories of behavioural change, community development and sustainability, translated to far messier realities on the ground. As is described further in9.4 there is also evidence of a reciprocal relationship in terms of the organisations links with external individuals and agencies, with all of the case study organisations actively engaged in sharing their knowledge and experience with others, whilst at the same time extending their network of supportive contacts.

However, it also should be noted that whilst the development of micro-hydro initiatives had a positive effect on the organisations' capacity, this impact can also be precarious and fragile with hard won knowledge and experience lost through shifting policy and funding priorities and/or the departure of key personnel. This was particularly evident in Cwmclydach where the reconfiguration and scaling back of the Communities First programme, under whose auspices the project had been developed, resulted in the loss of key personnel, capacity and a considerable dilution of the organisation's focus on community energy initiatives. The end result is that there is a strong sense that the hydro-initiative now represents the endpoint of the organisations ambitions towards community renewables, as opposed to its initial intention for it to be a springboard for more wide ranging actions.

Financial support for community facilities

Although each project operated a slightly different model, all of the case study initiatives used profits generated from their micro-hydro system to support activities and facilities in their local community. However, actual amounts vary across different projects and can vary from year to year depending on weather conditions and whether or not there are unexpected maintenance costs. Out of the three projects these factors seemed to have exerted the greatest effect on Torrs Hydro which reported that its profitability was undermined by a combination of loan repayments, weather conditions in the previous financial year and the need to make interest payments to investors. That said it is was still able to put profits into a community fund most years, whilst Cwmclydach and Talybont Hydro both reported profits of around £20-25,000 per year.

In Cwmclydach, profits generated from the hydro initiative have been used to support staffing costs for the community centre and day nursery. This is particularly significant in terms of building resilience in a community which does not have a strong private sector employment and service base, and which is therefore disproportionately exposed to fiscal austerity programmes. More specifically, the hydro income has been used to support staff costs in community facilities at a time when the refocussing and scaling back of the Communities First programme resulted in the loss of community workers solely dedicated to the Clydach Vale area. We can only speculate about what might have been if funding regimes had been flexible enough to have enabled Cwmclydach to have realised its initial plans and developed a second hydro initiative which had projected annual profits of around £100,000 per year.

©Keith Jones National Trust

In Talybont on Usk the profits generated from its hydro scheme have funded a wide range of different initiatives which meet Talybont Energy's core aims of reducing carbon emissions. To date these have included the installation of renewable technologies and energy efficiency measures at local community buildings, a car sharing initiative which utilises cars run on bio-diesel and electricity, and an electric bikes scheme. The particular focus on green transport initiatives reflects the group's recognition of the high proportion of domestic carbon emissions deriving from transport and the particular challenges of reducing this source of emissions in a relatively isolated rural setting. Although, dealing with smaller sums income generated by Torrs Hydro has also been used to support the development of local environmental and community initiatives, with grants being provided to a volunteer centre, community events, a community orchard group, a school solar initiative and to a local heritage centre.

What is clear from these examples is that hydro-initiatives can act as a source of long term 'no-strings' income and that this in turn allows the organisations to develop with a greater degree of autonomy than would be possible from income streams such as grant funding, loans or service level agreements. Equally, the income generated by the scheme can act as a valuable source of 'clean money' for programmes with a match funding requirement. In doing so, the organisations are able to come up with flexible and innovative responses to the particular conditions and needs identified within their local community.

Social capital

Social capital relates to the notion that there is an inherent value which exists within social relationships and that this can be a vehicle for progressive social change. As such it is unsurprising that it is a core concept within the community development sector where there is now widespread recognition of the different forms that social capital takes. A particularly influential typology distinguishes between bonding, bridging and linking capital. Bonding capital, refers to the relationships within a particular group and therefore refers to relationships which tend to be inwardly focused. In a community setting it is broadly analogous with notions such as community cohesion, a 'strong' or 'closely knit' community. Bridging social capital tends to refer to more outward facing relationships which between individuals and groups who are more distant from one another but who may share certain common ground, whilst linking capital refers also to relationships which are also outward facing, but which, critically, stretch across power hierarchies.

Within the community energy literature social there is a tendency for social capital to be implicitly understood in terms of bonding capital, with much attention focused on the extent to which initiatives might foster values such as trust, local civic participation, and 'community spirit'. In contrast the impacts on bridging and linking capital appear relatively unexplored, which is surprising when their potential roles in the development of the community energy sector are considered. For example, the development of bridging capital may well create a conduit for the sharing of knowledge and experience which is likely to be highly significant to the potential for project replication. Likewise, the development of linking capital may well involve the development of relationships with government departments, funders and/or policy makers. Although it's not possible to determine the impact of these networks within this research, it was clear from the case study interviews and the organisations' websites that there has been considerable progress in developing both bridging and linking capital. For example, Torrs Hydro online newsletter and blogs document nearly 80 visits from bodies which include schools, universities, like minded community initiatives, energy companies, politicians, government ministers, policy makers, and NGOs. Likewise, interviewees from Cwmclydach and Talybont Energy both reported the development of similar networks, numerous visits and interest from a range of individuals and groups. Indeed, on the very same day that we conducted the interview with Talybont Energy, one of the project team was travelling up to the Isle of Eigg to demonstrate and share the experience of their electric car with a local community group.

The impacts upon bonding capital are not clearly evidenced and none of the case study projects had conducted any of their own research into this area. However, although interpretation of this data is subject to the 'health warning' described above, our survey was able to generate some data about the 'community building' effects of community micro-hydro. This picture painted by this data is far from clear cut. As can be seen from table 9.1 below, approximately half of the respondents felt that the development of their micro-hydro did have a positive impact against each of the three 'community building' measures, but it should also be noted that a similar number reported no impact. Moreover, one individual claimed that there had been a negative effect on local community relationships. Whilst respondent's perceptions of the impact on community relationships can therefore be seen to be relatively ambivalent, the results also showed a clear sense of a more empowered and confident community, with nearly two thirds (64%) reporting that their micro-hydro project had fostered a belief that their community could bring about positive changes. Given the potential sources of opposition to renewable energy it's also important to note that the vast majority of respondents felt that their initiative had not damaged wildlife (91%), the visual appearance of the area (86%) or the quality of local leisure amenities (91%).

TABLE 9.1: IMPACT OF MICRO-HYDRO INITIATIVE ON COMMUNITY RELATIONSHIPS

Impact	% Agreeing with statement	% Neither nor Disagreeing
Brought the community closer together	30	41
Improved the sense of community spirit	20	52
I've met new people in my community	21	33

Finally, although for reasons earlier this research did not focus upon privately owned micro-hydro initiatives we did encounter some anecdotal evidence from a number of sources about the impacts such schemes could have in maintaining bonding capital within farming communities. As one individual commented: "Despite being private in one sense they are really important for communities, they boost farm income keeping farmers in situ and meaning that there is no need to look to expand farm size and effectively destroy rural communities. Farmers and landowners are putting their children's names on hydro paperwork, they see the hydros as a means through which they can guarantee their children will have a certain level of income on the farm and can remain in their community". Clearly, the social impact of privately owned micro-hydro is an issue worthy of further exploration.

©Keith Jones National Trust

Attitudes and behaviour

Although, as is noted above, the evidence base is limited, the wider community energy literature does demonstrate the community energy initiatives can impact upon behaviour and lead to the development of more pro-environmental energy consumption patterns. For example, the Ashton Hayes community survey which was conducted in partnership with the University of Chester, found amongst 59 participating households a 19.5% decline in carbon emissions between 2006 -2010, with a 21% reduction in home energy consumption and 37% reduction in flights (though little impact on car use). **www.goingcarbonneutral.co.uk/village-footprint-survey-2010**. Secondary data from the micro-hydro case studies also shows how such initiatives can be linked to reductions in energy use. Talybont has been particularly proactive in evaluating the impacts of the various initiatives it has funded through its micro-hydro revenues and has published the results of these evaluations on its website.

Noteworthy impacts to date include:

- Energy reduction of 9% in households participating in the piloting of smart meters compared to an increase of 5% in the control group over the same period (Kidd & Williams 2008).
- A trial of electric bikes which was intended to serve the dual purpose of providing an alternative transport mechanism and create an opportunity for local people to try out “an expensive and risky” technology before making that investment themselves. The latest results show that the two trial bikes have now been ridden for a distance of 2,174 miles, with an average of 18 miles per journey and that at least 6 people are known to have purchased bikes as a result of the trial (Kidd & Williams 2009)
- The combined distance of journeys undertaken by the bio-diesel and electric powered cars purchased by Talybont Energy stood at 73,100 miles at the latest count (Kidd 2013). This is equivalent to the annual mileage of 8.9 cars according to data from the 2012 National Travel Survey which estimated an annual mileage per car of 8200 miles (Department for Transport 2013).

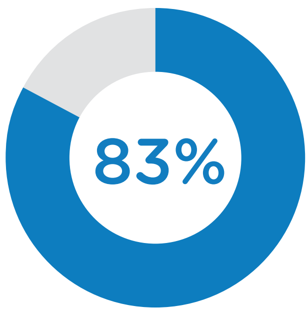
Likewise, as part of its initial funding Cwmclydach, with support from the Welsh Governments Pathfinder programme, conducted some energy reduction work using smart meters and energy saving advice, over a three week period, with households being asked to carry on as normal in their first week, and then instigate small changes in the second and third weeks. The results showed a 13.4% reduction in energy use amongst the 26 participating households, and that when six households were contacted six months later, all reported maintaining these behavioural changes (Community Action for Climate Change Pathfinder Programme 2013).

Results from our survey showed a strong sense of changing attitudes towards both renewable energy and energy consumption patterns. Out of 25 respondents:

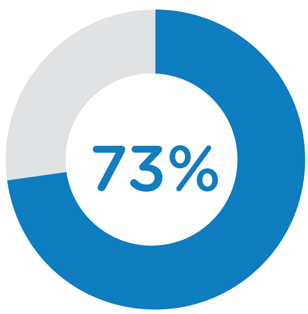
- two thirds (67%) reported that they personally had a greater awareness of climate change and energy security issues,
- three quarters (73%) had “improved knowledge about issues such as renewable energy, energy security or climate change” in the community generally
- over eight out of ten (83%) reported a more positive attitude towards renewable energy
- over half (53%) reported greater awareness of their own energy consumption.

Moreover, respondents also reported key behavior changes with two thirds (65%) claiming to have reduced their energy consumption, nearly half (48%) claiming that they had installed new energy efficiency measures and approximately a quarter (26%) installing a domestic renewable energy system. Thus, although they are occurring on a small scale and there are questions about the long term durability of the changes, there is nonetheless clear evidence of positive behavioural change originating from the case study organisations’ activities.

However, it’s also important to note that these impacts are unlikely to be instantaneous and that evidence from at least two of the projects suggests that there may be a lead in time of anything between 3-6 years between the installation of a hydro system and the development of supplementary initiatives. Indeed, in the case of Cwmclydach these longer term impacts appear to have been circumscribed altogether by the constraints imposed upon the project’s development by the parameters of its various funding sources.



reported a more positive attitude towards renewable energy



had “improved knowledge about issues such as renewable energy, energy security or climate change” in the community generally

11 REFERENCES

1 Currently **www.wales.gov.uk/topics/environmentcountryside/energy/?lang=en**

2 Table taken directly from **www.wales.gov.uk/topics/environmentcountryside/energy/renewable/low-carbon-baseline-survey/?lang=en**

3 This number assumes around 1800MWh generated per MW installed of hydro, which may indicate the estimate is based on a 50% export to grid. We estimate 'at source' generation averages 3500 KWh/KW for small hydro in Wales.

4 **www.gov.uk/government/statistics/digest-of-united-kingdom-energy-statistics-dukes-2013-printed-version-excluding-cover-pages** note this report lists Rheidol at 49MW although other sources place it at 41-42MW; latter number used here.

5 See **www.theguardian.com/environment/2014/apr/23/snowdonia-national-trust-hydro-power-hafod-y-llan-grid** for example.

6 **www.gov.uk/government/uploads/system/uploads/attachment_data/file/310415/Part_C_-_Combining_Feed-in_Tariffs_and_grants.pdf**

7 **www.wales.gov.uk/docs/desh/publications/140314energy-wales-delivery-plan-en.pdf**

8 Low Carbon Energy Generation in Wales, Baseline study of renewable energy p22

9 **www.wales.gov.uk/consultations/environmentandcountryside/wales-rdp-2014-2020-final-proposals/?lang=en**

10 **www.wales.gov.uk/topics/environmentcountryside/consmanagement/nef/?lang=en**

11 **www.wales.gov.uk/topics/environmentcountryside/consmanagement/natural-resources-management/?lang=en**

12 **www.ecosystemservices.org.uk**

13 Where FiT relevant projects are managed by local businesses or households, that FiT will also comprise an additional Welsh economic impact if the money remains in Wales.

14 Interested readers are directed to Miller and Blair (2009) Input Output Analysis: Foundations and Extensions Cambridge University Press ISBN: 9780521739023

15 In the questionnaire 'local' was defined as within 10 miles or within the same Planning Authority (UA or National Park).

16 The FiT Tariff levels are reproduced here **www.ofgem.gov.uk/ofgem-publications/89098/fitpaymentratetableforpublication1october2014nonpvtariffs.pdf** - with schemes studied falling into one of a number of past, present or future tariff time periods, we take our lead from the survey and effectively assume 20p per kWh for up to 100kW and 15p for over 100kW; and 4.5p per export kWh in both cases.

17 **www.wales.gov.uk/newsroom/businessandeconomy/2013/7723909/?lang=en**

18 **www.infrastructure.planningportal.gov.uk/wp-content/ipc/uploads/projects/EN010049/2.%20Post-Submission/Application%20Documents/Environmental%20Statement/6.4.22.1%20ES%20Turning%20Tide_the%20economic%20significance%20of%20the%20TLSB.pdf**

19 **www.wales.gov.uk/topics/environmentcountryside/energy/renewable/employment-and-regional-generation/?lang=en**

20 **www.renewableuk.com/en/news/press-releases.cfm/2013-01-30-new-research-highlights-economic-opportunities-to-wales-from-onshore-wind-energy**

21 Of course we would expect the relative cost of hydropowered electricity (and hence relative economic efficiency) to fall (rise) relative to fuelled options as fossil fuels become more expensive.

22 See WERU (2012) Llyn Brianne: Temperature Regime Change Report for Environment Agency Wales, June 23rd 2012

23 **www.cardiff.ac.uk/cplan/research/economic-crisis**

24 See **www.jrf.org.uk/publications/wind-energy-disadvantaged-communities**

25 Jones (2010) Wales in the Energy Crunch Cardiff University/BRASS

26 **www.imf.org/external/pubs/cat/longres.aspx?sk=25884**

11 REFERENCES (PART 2)

Community Energy Scotland (2012) "Community Energy Projects -2012 Impact Survey"

Community Action for Climate Change Pathfinder Programme (2013) "Community Action on Climate Change: A Guide for Groups", Available at: **www.cynnalcymru.com/sites/default/files/Pathfinder%20guide%20for%20groups_Final_English.pdf**

Databuild Research and Solutions ltd (2013) "Community Energy in the UK: A Review of the Evidence" Department of Energy and Climate Change.

Day, G (2006) "Community and Everyday Life", London, Routledge

Department for Transport (2013) "Statistical Release: National Travel Survey 2012" available from **www.gov.uk/government/publications/national-travel-survey-2012**

Gubbins, N (2010) "The role of community energy schemes in supporting community resilience", Joseph Rowntree Foundation Briefing Paper: Community Assets

Kidd, A (2013) "Four Years Experience of a Rural Car Club", **www.talybontenergy.co.uk**

Kidd, A & Williams, p (2009) "Talybont Energy: Electric Bike Report", **www.talybontenergy.co.uk**

Kidd, A & Williams, P (2008) "The Talybont Trial: Exploring the Psychology of Smart Meters", **www.talybontenergy.co.uk**

Musall,F&Kuik,O (2011) "Local Acceptance of Renewable Energy – A Case Study from East Germany", Energy Policy 39: 3252-3260.

New Economics Foundation (2012) "An Evaluative Framework for Social, Environmental and Environmental Outcomes from Community Based Energy Effeciency and Renewable Energy Projects for Ashton Hayes, Cheshire"

Rogers, J, Simmons, E, Convery, I &Weatherall, A (2012) " Social Impacts of community renewable energy projects: findings from a woodfuel case study" Energy Policy, 42:239-247

Walker, G, Devine-Wright, P, Hunter, S, High, H, & Evans, B (2010) "Trust and Community: Exploring the meanings, contexts and dynamics of community renewable energy" Energy Policy, 38: 2655-2663

Walker,G& Devine-Wright, P (2008) "Community renewable energy: What should it mean ?" Energy Policy36: 497-500

Walker, G, Hunter, S, Devine Wright, P, Evans, B and Fay, H (2007) "Harnessing Community Energies: Explaining and Evaluating Community Based Localism in Renewable Energy Policy in the UK" Global Environmental Politics, 7,2: 64-84

Walton, M (2012) "Social and Economic Benefits of Community Energy Schemes", National Trust, Shared Assets and Clore Leadership Scheme

crew
Regeneration Wales
Adfywio Cymru

University of South Wales
Prifysgol De Cymru

Cardiff University
Prifysgol Caerdydd

Interlink
Rhondda Cynon Taf

Cyfoeth Naturiol Cymru
Natural Resources Wales

Ynni Cymunedol Cymru
Community Energy Wales

SIP