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The 'Journey' to a Hydrogen Economy: Wales

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1. Introduction.....	2
2. The Journey to a Welsh Hydrogen Economy	2
2.1 Urban and Rural Wales and Relatively Poor Economic Performance.....	3
2.2 Exploring Possibilities and Producing (Two) Visions: Adaptation, Natural Resources and Existing Infrastructure.....	5
3. Producing the ‘Journey’ to the Welsh Hydrogen Economy	9
3.1 The University-Driven Initiative.....	9
3.2 The Economic Development Agency Initiative.....	12
3.3 Situating Hydrogen Economy Initiatives in the Welsh Policy Context.....	13
3.4 The Role of a Local Authority	14
4. Performing Wales’ Hydrogen Economy?.....	18
5. Conclusion	20
References.....	21

1. Introduction

The material presented here is a draft work in progress for internal UKSHEC members only, building on a number of other working papers and complimenting two further case studies. On this basis we would welcome feedback and discussion from colleagues as part of a process of ongoing analysis.

The purpose of this paper is to explore and outline attempts to develop a hydrogen economy (HE) in Wales. In doing this we broaden out understandings of the development of a hydrogen economy from a dominant way of addressing such processes in terms of economic cost and technical capability issues related to hydrogen economy developments (see Hodson and Marvin, 2004a), to conceptualise the production of a hydrogen economy in terms of the mutually shaping relationships of hydrogen and fuel cell technologies to the ‘contexts’ of their development – here Wales. In particular, through an earlier process of conceptualisation (Hodson and Marvin, 2004b) we highlight a series of three key issues to be addressed in understanding these mutual relationships: (1) the importance of the ‘re-emergence’ of regions and the relationship to issues of technology and governance; (2) regional representations and issues of context; (3) and the performance of regional hydrogen economies, through infrastructure development.

In addressing these themes – and drawing on issues raised in this previous paper – we ask: (1) How is the development of a hydrogen economy in the Wales represented in terms of a ‘vision’? (2) How and why is this vision produced and what interests are included and excluded? (3) How does the vision relate to attempts to develop a hydrogen economy on the ground and what key issues are raised? We address these questions through drawing on a series of interviews with and observations of key stakeholders in this development and also utilising documentary evidence. In doing this we outline the processes through which the ‘journey’ to a Welsh hydrogen economy is taking place, how and why this is happening and highlight a series of issues which arise from attempting to develop demonstration projects which re-embed hydrogen and fuel cell technologies in particular contexts.

2. The Journey to a Welsh Hydrogen Economy

The development of a Welsh hydrogen economy has aspirations to be Wales-wide. In addressing this its geographical reach encompasses both the urban and the rural. It is in this context that the ‘vision’ for a Welsh hydrogen economy is still unfolding. The ‘journey’ to a Welsh hydrogen economy thus seeks to enrol a variety of interest groups in pursuit of a range of aims and objectives. Indeed, it would be more accurate to talk of visions for a Welsh hydrogen economy, and attempts to

align these visions, rather than of a single vision. The basis for this is that two separate ‘but linked’ projects underpin attempts to develop a Welsh hydrogen economy. This is an agenda being developed through the projects H2 Wales and the Hydrogen Valley (HV) initiative. At the time of writing the H2 Wales project has a Wales-wide focus on both the rural and the urban whilst HVI has a specific geographical focus on an area of industrial south Wales encompassing Llanelli to the west, Cardiff to the east and Neath to the north. Although these are two separate but linked projects there are a series of themes which capture and represent their combined efforts to develop a hydrogen economy.

2.1 Urban and Rural Wales and Relatively Poor Economic Performance

The first of these may be characterised, particularly in terms of HV’s focus on industrial south Wales, in terms of poor economic development relative to the EU average and to the UK generally. This relates to issues of both the decline of a previous industrial base centred around heavy manufacturing and the extractive industries, in particular steelmaking and coal. The consequences of de-industrialisation in the 1970s and 1980s included considerable job losses. This said in some areas of industrial south Wales, there is still a dependence on manufacturing within the economy. ‘It’s a weakness, where something like 26/27% of our SMEs are in the manufacturing sector’¹. Additionally steelmaking is still a large employer where, to take the example of Corus’s Port Talbot operation, over 3,000 people are directly employed and ‘indirectly the estimates vary from between about six and eight thousand people who in some way derive a living from the Corus Plant’.

Part of the response to de-industrialisation was in the designation of parts of south Wales from the early eighties onwards as special areas for regional assistance. The setting up of the Welsh Development Agency in 1976 saw it putting itself at the ‘forefront of developing a whole range of industrial sites to be able to attract inward investment projects to replace the jobs that were being lost’. As part of this process ‘there were a whole range of inward investors, some of whom have stayed, some have gone’. A key issue was that ‘in those early days they tended to be production line assembly type jobs and again we were still quite vulnerable in terms of those being seen as branch line operations. So when there was a hiccup in the national economy or the economy of the inward investors, so those brands closed, it’s a simple as that’. Having said that, ‘we had some good stayers though’ including Panasonic and Orion.

The interesting issue here are the types of interests that have stayed. Philip Cooke (2003, p.3) points out that between 1991 and 1998 ‘Wales was the only part of the UK in which manufacturing

¹ All quotations have been anonymised as agreed in the negotiations to conduct the interviews.

employment was not in decline but actually showing an increase'. Yet between November 1998 and November 2002 'Wales had lost 44,000 manufacturing jobs' (Cooke, 2003, p.3). A key 'stayer' was Ford who had operated an engine plant at Bridgend since 1978 and which consolidated its position when from 1999 it 'became the sole Zetec engine source, producing annually 700,000 of these and 55,000 Jaguar AJ26 V8 engines. In 2001 a new range of Jaguar engines was announced, to be produced at a rate of 325,000 per year' (Cooke, 2003, p.4). Importantly, the wider point is that in terms of 'the automotive industry all of the Welsh and Welsh-based firms are components, systems or engine suppliers' (Cooke, 2003, p.5). Furthermore, 'indigenously developed supplier companies have built a customer base which includes all the UK and major European manufacturers in the automotive industry sector'. On top of this and of 'much greater importance are the supply-chain links from Welsh automotive components firms to UK-based, domestically and foreign-owned assemblers such as Rover, Ford, Jaguar, Nissan, Toyota, Honda, GM and Peugeot'. In terms of figures, 'Welsh suppliers have over sixty direct supply contracts with these firms and some one hundred and thirty in which they supply the final customer indirectly through another member of the supply-chain'. (Cooke, 2003, p.5).

Issues of poor economic development were also a key focus of the H2 Wales project but on a basis which was explicitly more Wales-wide. In this respect, figures from a variety of sources, collected in the Hydrogen Research Unit's *Hydrogen 2003* document, suggests the following (Maddy *et al*, 2003, p. 7 & 9): Of 22 counties in Wales 15 are in areas eligible for Objective One funding. Similarly, 18 of Wales' 22 local authorities are in the top 100 of the index of multiple deprivation. Furthermore, whilst more than one in four people of working age are classed as economically inactive the GDP of workers in Wales is on average 18 per cent lower than the EU average. Wales has a significant rural population of around one third of homes (381,400 homes).

In the case of H2 Wales, the themes have particular resonance with either or both urban and rural Wales. These include not only poor economic development relative to the EU average and the UK generally, but also fuel poverty, natural resources and the link to renewable energy, existing expertise nationally in agriculture, manufacturing and engineering and existing energy infrastructures. Importantly, many areas of rural Wales generally have not only relatively poor transport infrastructures but also a variability in access to energy supply and infrastructures. In addressing this 'Wales is particularly well placed to exploit renewable energy sources because of its climate and geography' (Sustainable Energy Limited *et al*, 2001, p.4). This includes a range of renewables but: 'In the case of biomass, the supply of fuel (from growth of energy crops and

increased harvesting of forest residues and thinnings) can safeguard and create jobs in the rural community' (Sustainable Energy Limited *et al*, 2001, p.5).

2.2 Exploring Possibilities and Producing (Two) Visions: Adaptation, Natural Resources and Existing Infrastructure

The development of a hydrogen economy in Wales needs to be seen within the terms of the Welsh Assembly Government committing Wales to over 10 per cent of renewables by 2010 rising to 20 per cent by 2020 (Maddy *et al*, 2003, p.7). In doing so it draws on and seeks to develop possibilities from existing renewable resources. Not only this but it encourages economic opportunities in rural and industrial communities through the development and implementation of renewables technologies. In doing so the suggestion is that Wales can offer a 'global showcase' for renewable energy technologies and in doing so open up technology export markets (NAfW, 2002).

In 2001 the Welsh Assembly announced its Rural Action Plan which 'is a recovery plan for the whole rural economy containing measures to support rural businesses of all kinds including tourism and support for the development and diversification of farm businesses'². This includes encouraging farm businesses and farm diversification, utilising biomass, timber and woodland.

In terms of the development of a hydrogen economy in Wales the linkage here is to providing this through 'clean' sources of energy available locally. These include wind, wave, tidal and biomass. The link to rural Wales is that: 'Hydrogen can be produced by thermal technologies from woody biomass and potentially, by fermentation of carbohydrate-containing organic matter including agricultural products' (Maddy *et al*, 2003, p.8). The possibilities here are that using biomass to produce hydrogen may be used in both stationary and mobile (transport) applications (Maddy *et al*, 2003, p.8). The benefit for rural areas of Wales would be that:

Decentralised hydrogen energy production would potentially create jobs in rural and deprived areas. As each area would have its own hydrogen production facility, local people could build, run and maintain these stations, bringing much needed revenues in to the surrounding communities and encouraging economic growth. Farming communities would benefit from growing energy crops e.g. on set-aside land or leasing land to wind farm operators (Maddy *et al*, 2003, p.9).

This focus on production of hydrogen through biomass and non-food crops rurally is an attempt to draw on and adapt existing resources to the decentralized production of hydrogen which draws not

² www.countryside.wales.gov.uk/fe/master.asp?n1=6&n2=75 accessed 22/01/2004

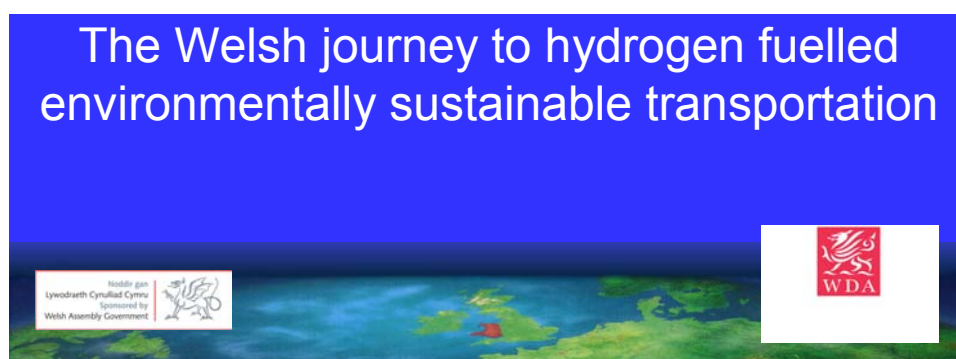
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only on existing expertise and resources but also uses this and the linked processes of hydrogen technologies development to address issues of economic competitiveness and job creation. In doing so it may also broaden the energy mix in rural areas and have consequences for fuel poverty and security of energy supply. However hydrogen production through biomass and non-food crops is at a relatively early stage of development (Maddy *et al*, 2003).

It is possible to capture these attempts to represent the Welsh hydrogen economy under a number of key themes. The HV initiative is premised on south Wales' historic role in the production of automobiles the perceived challenge that 'global competitiveness' in the automobile industry presents and attempts to develop 'supply chains' as a means of not only supporting existing large automobile interests, but also in encouraging adaptability in line with the development of a hydrogen economy and thus the research and development of 'new' technologies, and also the attraction of inward investment.

The HV initiative thus talks of the Welsh 'journey' to hydrogen fuelled environmentally sustainable transportation and commerce where there is an important role for the development of 'clusters'. This is on the basis of Wales having a strong automotive sector of around 30,000 employees (circa 22% of the manufacturing workforce), accounting for a £3bn a year turnover, and which involves 50 '1st tier' companies and 250 smaller companies³.

The Welsh 'Journey' to the Hydrogen Economy



³ Notes from H2 Wales Dissemination Event, Glamorgan Business Centre, Treforest, 8th December 2004

In addressing this the HV initiative has a 15 year journey plan from the short term – present to 5 years – to organise and manage the network; to demonstrate the technology, and to fuel demand; through the medium term – 5 to 10 years – a stage of commercial exploitation; to the long-term – 10-15 years – a period of growth and sustainability; and ‘Vision establishment’ – 15+ years.

H2 Wales’ agenda included: developing Welsh industry in technologies related to hydrogen production, storage, distribution and use; possibilities for rural economic growth through diversification into energy crops for hydrogen generation; the construction of networks of key stakeholders to work together strategically; the development of ‘an expert knowledge base to inform industry and to support decision-making by those responsible for developing a sustainable energy policy in Wales’⁴; and to identify ‘the most viable demonstration project(s) for a Phase 2, including costs and sources of funding’⁵. HVI, as an initiative of the Welsh development Agency had a more specific focus on the automotive sector – particularly prevalent in south Wales – and in achieving ‘a zero emission energy based economy supported by sustainable business community through the exploitation of leading edge technologies and stimulation of emerging niche markets’⁶.

The broadening out of this agenda may be seen in relation to the development of a Vision for the hydrogen economy for Wales undertaken by members of the HRU. This can be seen in terms of four phases: the first being one of early development and demonstration – next 5 years – where there is an importance placed on demonstration projects and the development of ‘political will and leadership’ where a ‘clear vision and long term strategy are needed which require political courage and leadership’ in addition an emphasis is also placed on ‘Wales being part of international collaborations, forums, platforms and lobbying’; this is followed by a process of ‘early commercialisation’ – 5-15 years; ‘market development and technology growth’ – 15-30 years; and the achievement of the Vision – 30+ years (see also *A Vision of the Hydrogen Economy in Wales...*).

We are thus only at the start of the journey to producing and achieving a Welsh Vision(s). In terms of the first phase - both projects – around the development of demonstration projects there has been

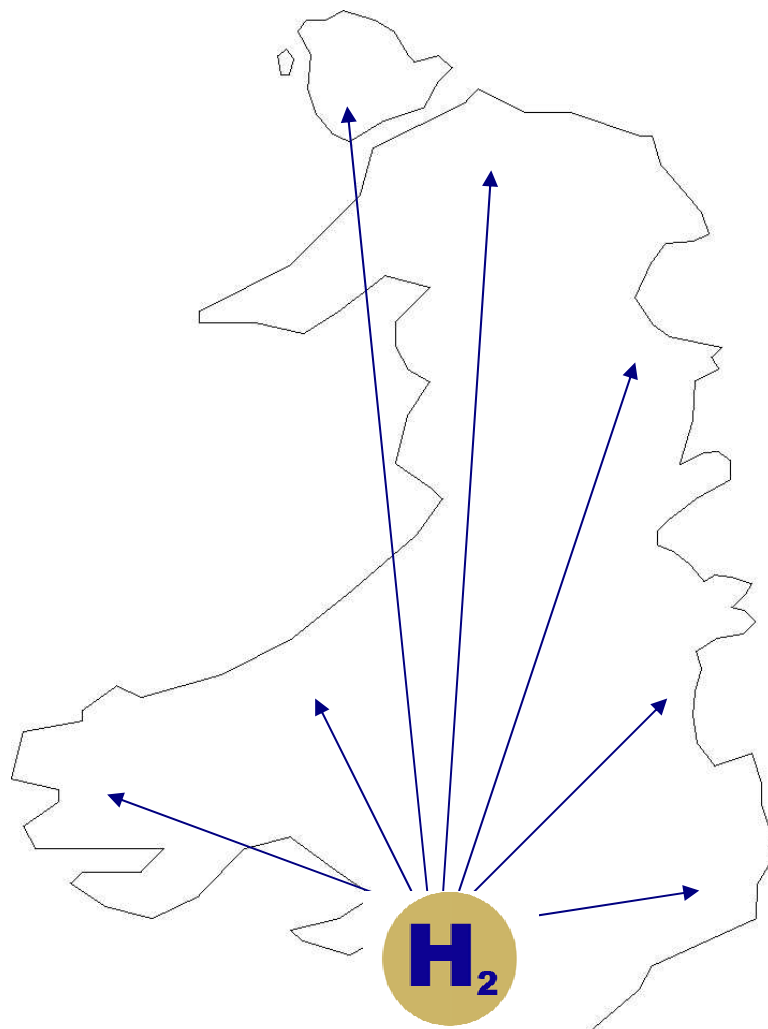
⁴ Presentation: ‘A Sustainable Energy Supply for Wales: Towards the Hydrogen Economy – Project Overview’ presentation 11th June 2003.

⁵ Presentation: ‘A Sustainable Energy Supply for Wales: Towards the Hydrogen Economy – Project Overview’ presentation 11th June 2003.

⁶ Presentation: ‘Hydrogen Valley: The Welsh Journey to Hydrogen Fuelled Environmentally Sustainable Transportation’ presentation 24th March 2004.

a combination of efforts in terms of an initial demonstration project between the HV and H2 Wales. Whilst the HV has a focus on the south of Wales and H2 Wales is Wales-wide they have come together to try and develop a renewable hydrogen demonstration centre at the Baglan Energy Park. There are numerous reasons for the citing at Baglan Energy Park – to which we will return. A key issue in terms of the H2 Wales vision though is that south Wales offers the possibilities for a hydrogen economy developing out of existing infrastructure. Although there are no pipelines, as there are on Teesside, existing infrastructures in Wales generally concentrates around the M4 Corridor and to a lesser extent the A55 in the north. In terms of specific hydrogen production there are seven small and medium sized plants: at Newport (Air Products/Corus – joint facility); Barry (BOC and Cabot Carbon); Port Talbot (BOC x2); Swansea (Inco – nickel refinery – x2). These are predominantly small steam methane reforming (SMR) focused and only around half of these have ‘feasible export facilities’. However as they are only around 20 miles apart, and sit close to the M4, they offer possibilities for alternative refuelling stations and establishing a network of refuelling stations.

‘Rolling Out’ Wales’ Hydrogen Economy



A key facet of the HRU's approach to this project is in trying to identify the 'appropriate technologies' for specific geographical areas – this may vary even 'valley to valley' as does the micro climate. The aim is to identify the 'scope' of the technologies in this respect. The idea is that through the use of demonstration projects various hydrogen 'nodes' can be developed. These nodes initially may be linked together through the network of hydrogen production centres in south Wales and also through transport infrastructures around the M4 Corridor. Eventually the aim is to 'roll out' nodes across Wales.

3. Producing the 'Journey' to the Welsh Hydrogen Economy

The interesting issue that emerges from the representation of a potential future Welsh hydrogen economy is that it is an ongoing – in the words of the HV initiative – journey. There are two principal organisations involved in the development one of which, H2 Wales, is based in an academic context and the other, the HV initiative, which being based in the WDA has a focus on issues of economic competitiveness and job creation. These are two interests which have, and are still, developing visions of the possibilities of the hydrogen economy in Wales both distinctively but also with a degree of overlap. It is useful to understand the production of these visions and aspirations for the development of a Welsh hydrogen economy and to ask: who it involves. What their aspirations, expectations and role is in the development of a hydrogen economy and to examine attempts to align these interests (or otherwise).

3.1 The University-Driven Initiative

The H2 Wales project operates under the auspices of the Hydrogen Research Unit (HRU) at the University of Glamorgan. The HRU have been involved with five hydrogen-focused projects over the last five to six years (funded by, for example, UK research councils, the Carbon Trust, and the European Regional Development Fund). This focus on hydrogen developed out of a previous 30 years' interest in wastewater treatment research. These two themes of research at the Wastewater Treatment Research Unit and HRU constitute the work of the Sustainable Environment Research Centre.

In particular, the HRU started work, in January 2003, on a significant two-year largely ERDF - but also Welsh Assembly/University of Glamorgan - funded project, 'A Sustainable Energy Supply for Wales: Towards the Hydrogen Economy' (otherwise known as H2 Wales). 'The aim of the project

is to place Wales (in particular the Objective 1 region) in a position to create wealth and employment by taking full advantage of the opportunities presented by the ongoing transition to the hydrogen economy'⁷. The approach taken is that: 'The project will research the social, economic and technical implications of moving to a hydrogen economy in the region and deliver a framework through which this can be achieved'⁸. A key point here is that:

So when we came to put together a project we weren't just thinking about south Wales we were talking about the whole of Objective One Wales, which is largely rural. So we were looking at all of the ways in which we could produce hydrogen both from industrial situations such as steam methane reforming but also from renewables.

Five key objectives underpinned this aim. In particular two took as their focus 'investigat[ing] the potential to develop Welsh industry for the sustainable generation, storage, distribution, and utilisation of hydrogen'; and 'identify[ing] the opportunities for growth in the rural economy of Wales through agricultural diversification into a variety of energy crops for hydrogen generation'. In assessing the potential and opportunities there was to be a key role for bringing 'together the main players with a stake in the development of the Welsh hydrogen economy to work together strategically'. This would also inform the development of 'an expert knowledge base to inform industry and to support decision-making by those responsible for developing a sustainable energy policy in Wales'. A final objective sought to 'identify the most viable demonstration project(s) for a Phase 2, including costs and sources of funding'⁹.

Of course these objectives are not necessarily distinct. The focus on assessing the potential and opportunities for Welsh industry and rural economic growth relates to the development of networks of 'main players' and an 'assessment' of 'relevant' technologies. A key facet of the HRU's approach to this project was in trying to identify the 'appropriate technologies' for specific geographical areas – this may vary even 'valley to valley' as does the micro climate. The aim was to identify the 'scope' of the technologies in this respect in relation to perceptions of geography. The idea was that, subsequently, through the use of demonstration projects various hydrogen 'nodes' can be developed. Indeed the first phase of H2Wales, until the end of 2004, was initiated to highlight 'viable' demonstration projects and to 'identify costs and sources of funding' for the second phase of the project. This was done through stakeholders coming together at Demonstration Project Working Group meetings to address Demonstration Project Selection Criteria which fed into a form of 'technology categorisation'. Through the formation of networks this process was also

⁷ <http://www.h2wales.org.uk/Project/projectscope.html> accessed 26/01/2004

⁸ <http://www.h2wales.org.uk/Project/projectscope.html> accessed 26/01/2004

⁹ <http://www.h2wales.org.uk/Project/projectscope.html> accessed 26/01/2004

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about ‘identifying champions’. This was an important process as: ‘It’s our intention to be a catalyst rather than control anything here’. The use of terms such as ‘technology categorisation’, the construction of networks, and the search for ‘champions’ and funding – and indeed the search for demonstration projects as a final objective of the first phase of the project - suggests that much of the H2 Wales work was either in the ‘laboratory’ or emerging from it. Many of the demonstration projects were at the stage of ‘selection’. The analysis of technologies ‘suitable’ for certain contexts prior to their ‘implementation’ indicates that the development of a hydrogen economy in Wales was in many ways still in the ‘laboratory’. Indeed the first phase of H2Wales, until the end of 2004, was initiated to highlight ‘viable’ demonstration projects and to ‘identify costs and sources of funding’ for the second phase of the project. The Demonstration Project Working Group Meetings [met ?? and consisted of ???]. In addition to this the project had a Steering Group of ‘leading academics, industrialists, government and non-government organisations’ who met formally each quarter and also a Stakeholder Forum.

The production of a Vision document to support decision-making necessitated the cultivation of networks of a variety of stakeholders. There was some sense that interest groups and the building of networks were somewhat more variable than Teesside, for example, with its tight network of the ‘ICI mafia’ and the ‘know-how’ of the ‘village fete’. This may have been because of the wider geographical focus of the HE in Wales than in Teesside, the legacy of a range of large employers in south Wales (as distinct from ICI and its dominance in Teesside), and therefore a much wider array of interest groups and stakeholders with a potential interest in the development of rural and industrial hydrogen economies.

An initial attempt to develop a hydrogen economy vision for Wales was through a one-day workshop at Miskin Manor in March 2004 and a further session in June 2004 in Cardiff. The workshops brought together a variety of ‘key stakeholders’ to discuss a series of issues and questions related to the development of a Welsh hydrogen economy. This was done, in the case of Miskin Manor, through splitting delegates into a number of groups with a facilitator. It addressed three questions: what are the components of a HE? What are the barriers to this? And how may these be addressed? These were asked in relation to five themes (technical, economic, social, political, environmental). The format was in putting post-it notes on to a flipchart addressing the questions against each theme in terms of priorities and timescales. Methodologically there were a number of interesting points in terms of the strong technical focus on developing a hydrogen economy in particular through the language of ‘barriers’. Also there was the artificial carving up of areas of interest (‘political’, ‘social’, ‘environmental’, ‘technical’), the unspecified nature of which

crated difficulties particularly in view of what seemed to be a technical focus of many participants with an R&D background and where ‘social’ issues were often seen in terms of a ‘deficit’ model requiring, for example, the hypodermic infusion of social and public ‘acceptability’. The ‘outcome’ of this process was the document, *A Vision of the Hydrogen Economy in Wales...*, which offered a rationale, a ‘timeline’ and a set of technical, political, economic, social and environmental requirements to achieving a ‘successful’ hydrogen economy in Wales.

3.2 The Economic Development Agency Initiative

A hydrogen project with more geographically-focused aims was the Hydrogen Valley project (HV) – there is resonance here with the metaphor of Silicon Valley but also the valleys of south Wales. The HV was a Welsh Development Agency (WDA) project. The geographical scope of the project was bounded at Llanelli to the west, Cardiff to the east and Neath to the north. In this respect this encompassed areas of traditional heavy industry (steel, coal, car manufacturing) many of which had been under threat in this area. The WDA agenda was one of stimulating economic activity in this area and in particular of attracting particularly high-tech businesses, especially in the automotive sector.

The background to the HV initiative was in terms of an Automotive Strategy and a ‘supply chain development initiative’, Accelerate Wales. The Automotive Strategy was initiated in September 2000 and a draft report emerged in August 2002 which suggested that [?]. The Accelerate Wales initiative was launched in January 2001, involving 35 ‘lead companies’ and a further 300 members with the aim of using ‘networking as a primary means of knowledge exchange’ and ‘to create a ‘one-stop-shop’ for automotive companies’ information needs’ [more]¹⁰.

The HV had as its key aim: ‘To achieve a zero emission energy based economy supported by sustainable business community through the exploitation of leading edge technologies and stimulation of emerging niche markets’¹¹. In pursuit of this it also had a series of strategic objectives including ‘the delivery of technology, research and marketing projects focused on meeting the vision’, the ‘production and supply of low cost hydrogen’, to ‘promote the credibility and viability of hydrogen economy’ to develop ‘zero emission integrated transport networks’, to ‘encourage a low carbon centre of excellence in South Wales’, the ‘identification and acquisition of support funding’, the development of hydrogen fuel filling stations, the ‘development and mass

¹⁰http://www.wda.co.uk/index.cfm/developing_your_business/sectors/automotive/accelerate/accelerate_wales/aims_and_objectives/en7565 Accessed 8th April 2005.

¹¹ Presentation: ‘Hydrogen Valley: The Welsh Journey to Hydrogen Fuelled Environmentally Sustainable Transportation’ presentation 24th March 2004.

production of Alkaline fuel cells’, the ‘evaluation and promotion of vehicle drive cycle’, the ‘identification and enrolment of complimentary partners’, the ‘assessment of environmental impact’, and the ‘development and manufacture of electric/hybrid vehicles’¹².

The development of partnerships and networks included institutions and membership from higher education institutions (Swansea University, Cardiff University, University of Glamorgan), local authorities (Cardiff County Council, Neath Port Talbot Council) and other public and private sector bodies. The HV met about every two months with probably 30 or so people. These numbers meant that discussions were starting to become unmanageable. As a consequence the HV initiated an open forum consisting of as many people who wanted to attend and then a steering group which consisted of a much smaller working group of three industrialists, an academic and two people from the WDA.. A series of project groups then reported through the main Steering Group.

A number of potential projects were outlined in one way or another and these included: a Swansea Park and ride transit system, a Swansea Mumbles Tram, the Baglan Bay electric vehicle logistics hub and, a little more vaguely, to build the worlds first class manufacturing facility for AFC and to design and develop a regional hydrogen distribution and transportation system.

3.3 Situating Hydrogen Economy Initiatives in the Welsh Policy Context

It is interesting to situate these developments in terms of the National Assembly for Wales (NAfW). The Assembly has, a seemingly unique, duty under section 121 of the Government of Wales Act to promote ‘sustainable development’. The development of a hydrogen economy in Wales needs also to be seen within the terms of the Assembly committing Wales to over 10 per cent of renewables by 2010 rising to 20 per cent by 2020 (Maddy *et al*, 2003, p.7).

The promotion of ‘sustainable development’ in relation to national economic development was set down in the Assembly Government’s ‘A Winning Wales’ (NAfW, 2002) document, launched in January 2002. It acknowledged that there ‘are significant variations in levels of economic prosperity and performance across Wales with the valleys of south Wales lagging behind on most measures’ (NAfW, 2002, p.6). It highlighted the importance of knowledge, R&D and innovation capacity to Welsh economic development, in particular through so-called ‘incubator’ facilities – and in particular the Technium concept and its ‘rolling out’ - for innovative businesses. This also linked to measures in the strategy calling for a variety of business support measures including improved

¹² Presentation: ‘Hydrogen Valley: The Welsh Journey to Hydrogen Fuelled Environmentally Sustainable Transportation’ presentation 24th March 2004.

support for high growth sectors and clusters, with a key role for the WDA. It, furthermore, outlined the importance of Wales as a 'Learning Country', as a promoter of information and communications technologies, outlined a key role for transport, 'green' business opportunities and clean energy development. In this respect, a key aspect of the document was in its proclamations to establish Wales as a 'global showcase' for clean energy developments with a key role for the Assembly Government in developing a clean energy strategy. Not only was there a focus, in this key strategy document, on 'establishing Wales in the world' but also in 'creating strong communities' and 'supporting rural Wales'.

Although a number of stakeholders were keen to point out that there was a 'political will' to developing the hydrogen economy in Wales, that they have 'direct links to the Assembly and parliamentary team who are very supportive', where there was frequent talk of 'Team Wales' in terms of 'joined up thinking', there was also some sense that talk of a global showcase was wearing thin in that: 'Fine rhetoric. It's about time they started to move on that [agenda]'.

Another stakeholder close to the Assembly suggested that despite the self-proclaimed commitment of NAFW for a sustainability agenda there is 'a fear' in actively pursuing this agenda beyond rhetoric. This individual suggested that they 'despair' that in devolution 'we have become more parochial' and that one of the biggest challenges for a Welsh sustainability agenda is finding leadership and champions. Suggesting a lack of leadership: 'It's too easy to turn your back'. He pointed out, to take one example, that you then have the spectacle of the Minister for Planning and the Minister for Sustainable Development voting against an offshore wind development, and in effect a minister voting against their portfolio.

In this respect the claim was made that politicians needed to be 'nurtured'. Despite the commitment there was also a claim that in framing legislation 'sustainability needs embedding in Assembly legislation'. That is to suggest that contrary to the rhetoric of sustainability and the enshrining of this in legislation there was still a cultural shift that needed to be undertaken within the Assembly with an importance on changing 'mindsets' in addressing such transitions through embedding exemplar projects in planning processes and high visibility projects.

3.4 The Role of a Local Authority

The issue of political leadership and the wider policy context becomes important in relation to the contemporary role of local authorities in terms of economic development in that, for example although local authorities may have 'an economic development strategy, because we were required

by the Local Government Act at one time to have a strategy, if we as a Local Authority wished to invest in economic development the situation has moved on slightly in that we now have a requirement that is much broader based to produce a community plan'. This key player in a south Wales local authority claimed that now 'we tend to slipstream'. That is to say:

So we do have particular issues and themes that we are trying to address. But we take, if you like, direction, inspiration, from national and regional strategies. [In this respect] there is a national economic development strategy known as A Winning Wales.

The point is that 'a lot of the themes that are set out in there are relevant at the local level but there is obviously a limit to what we can achieve as a local authority'. A key issue was that the role of the local authority was one of 'facilitating' and 'enabling' where 'there isn't a lot that we can do. But we should be aware of what we can do'. This suggests – due in large-part to low levels of resource - a relative inability of local authorities to shape economic development. This said there were some interesting examples of trying to do so, for example around the WDA's concept of the Technium. In particular one Technium around sustainable technologies, looking at renewable energy, green chemistry, environmental sciences, was seen as 'a very sophisticated incubation centre' which is 'not about pure R&D it's about business growth'. The Technium was thus a collaboration between the local authority (in this case Neath Port Talbot), the WDA and a higher education institution (in this case University of Swansea), based on the WDA concept of the Technium but relying on a range of funding including 'European' funding, WDA and local authority. The aim being that 'through business and academic links entrepreneurial and innovative activity is encouraged meaning that there is a phase beyond Technium if you like'.

It's about business incubation and growth. We don't want companies to come into Technium, stay there for two or three years and simply remain the same.

The Technium as a WDA concept highlights the ways in which local authorities are engaged in a series of ongoing responses to a variety of other agendas – hence 'there isn't a lot we can do...' – particularly the WDA agenda over the years. The issue is the extent to which the local authority is able to shape an agenda of its own within such constraints and possibilities.

Within this context the question is: why would a local authority become involved in hydrogen economy development in south Wales? In following this up we were told on three or four occasions by a key local authority stakeholder that they weren't sure what was in the hydrogen economy for their authority but they felt there might be something there.

I'm not a techie and the technology very often goes straight over my head. My job though if I can summarise it in a few words is to make the energy part relevant to the needs of the [local] community by providing job opportunities and maximising the resourcing opportunities that come out of having large scale projects, R&D projects located [locally]. So it's perceived as a physical regeneration project but it's much more than that.

It was about acknowledging that:

We have very high levels of economic inactivity, we have large numbers of people on long term sickness benefit...Unemployment as such is no longer seen as the big issue, it's economic inactivity - either people who can't get back into the labour market because they lack the skills or people who are disadvantaged and therefore they find it particularly hard to get back into the labour market. And of course there's an element that doesn't want to come back into the labour market.

This led to how the local authority stakeholder would talk to local publics about the development of a local hydrogen economy:

I'd probably talk more about job creation. Hydrogen economy? I'm not really sure if I understand what that means

The development of a hydrogen economy was in this context about job creation and economic development. It was about recognising that although:

[Local] people are used to industry. There is still an expectation that quality of life is going to improve, that we don't return to the bad old days of having high levels of air pollution for instance, total loss of visual amenity is no longer acceptable.

This was part of an understanding that any future hydrogen economy benefits were not only in job creation but also job creation in terms of activities that were not of the 'health affecting' type of the industrial past. The point was that this basis would be taken as a historical backdrop to local authority involvement in the development of a Welsh hydrogen economy. The basis being that:

We have a location which I think is ideally suited to that particular technology. We have a history of working within the chemical industry and within the steel industry. So our population if you like has relevant skills. BOC is just along the road from here, so again there is an understanding of some of the issues to do with gas technologies. So we think we're reasonably well placed and well located in terms of what I understand in the development of the hydrogen economy to be all about. There is obviously a particular or potential fit with the automotive sector...We do have a lot of companies already involved in providing parts for the automotive industry. So in terms of that element of the hydrogen economy it's very interesting. So we seem to have some experience in the relevant

technologies. We have...a site which is readily available. We have this developing sector of sustainable technologies through the Technium. So I think we've identified again a niche market that is there to be tapped into.

There is also then an understanding of the strategic overlaps with other developments such as the Technium which is:

Completely independent, but, I can see opportunities there. I would be very surprised if there is no synergy between Technium and what is happening with Hydrogen Wales and some of the other projects that are around at the moment that are coming out of the Universities for instance.

The issue then was that the development of a hydrogen economy highlighted how a series of relationships informed the development of a hydrogen economy at the local level and how local authorities were able to respond and indeed did respond. In particular this involved the agendas of a range of political and economic actors (including the Assembly the WDA, etc, etc) but it also related to changing international political economy and the role of inward investment:

It's a nicheing strategy if you like. Very often we are part of the whole...measures that are put in place to support both indigenous and inward investment companies...That local people are employed on construction contracts and then beyond that we do our best to ensure that jobs go to local people and that the plant does then make a difference to the local economy through its purchasing power, through salaries, wages being taken back into the local communities

Informing of this were attempts to attract and retain inward investment and a series of historically generated resources and contemporary local socio-economic pressures. So, for example, the pulling out of BP (beginning in the 1990s) from its Baglan site, on the basis of international competitive pressures, was managed in a way which allowed some degree of local authority shaping of a response to this:

Oh I have a lot of time for BP in relation to their sense of corporate responsibility, a social responsibility. They take it very seriously. They've been good partners for us. They could have decided simply to close the site and mothball it, or simple to bulldoze it and leave it as it was. But they worked with us on a very careful exit strategy which leaves them in a position to move on, in a sense with a reputation enhanced. They've worked long and hard with community links. As an organisation they provided financial support to businesses. They've worked with schools and community groups. They've played a very active part I have to say.

The decision of BP to close the site in the mid-1990s thus allowed the development of a partnership between BP, the WDA and Neath Port Talbot Council. Following an initial plan to develop the Baglan site as a centre to attract 'large scale energy hungry projects'. The difficulty was that:

Unfortunately the world moved on and the whole dynamics of foreign direct investment altered. And we've seen evidence of that with the projects going into Czechoslovakia [sic], Hungary, China even. And so along the way we had to find a new sense of direction for the Energy Park. But the grounding was established at that point. So we started talking to various organisations about what we should be doing here and along the way we got into discussion with WDA's Hydrogen Valley project people and also with Glamorgan University, who are running, as you know, the Hydrogen Wales project. So it was a very gradual relationship as far as the hydrogen economy was concerned. It started in a very gradual relationship.

Within this series of relationships, aspirations, expectations and agendas outlined above the issue then becomes how this has translated into the performance of the hydrogen economy through demonstration projects in Wales.

4. Performing Wales' Hydrogen Economy?

By early 2005 the developments of Welsh demonstration projects were still 'aspirational', in the sense that there were no funded projects. This is not to say that there is no activity in seeking to develop ideas for demonstrations and to take them forward as funding proposals.

Although there were no funded projects four were either in the bidding process or under discussion. These included a Hydrogen Energy Farm at the Camarthen hydrogen energy park which drew together a network including, amongst others, Camarthernshire Local Authority, the WDA, The National Farmers' Union, Awel Amer Taiw, National Botanic Gardens of Wales, Coleg Sir Gar, Cardiff University and the University of Glamorgan. They met quarterly and were in discussions around three projects including, not only the Hydrogen Energy Farm, but also H₂/FC powered buildings, a H₂ demonstration vehicle and a Hydrogen Festival. The idea was that the farm would focus on the production of hydrogen or hydrogen rich biofuels in an agricultural and rural setting. The HEF had a Forum and a bid for funding was submitted to the Carbon Trust in November 2004.

Hyt-Hy is a FP6 project in DGTREN's alternative motor fuels theme. It is a multi-country demonstration project in Europe aimed at accelerating the commercialisation of hydrogen as a transport fuel using hydrogen and hydrogen mixed with compressed gas. Wales is one of seven European countries. UK partners include: Brehan Energy, Neath Port Talbot CBC, Luxfer, the University of Glamorgan and others. The idea was to develop a mixed hydrogen/CNG fuelling

facility at Baglan and also to develop and demonstrate at least five and potentially 35 vehicles over 5 years. Aims included evaluating the optimal balance of emission reductions, efficiency improvements and costs and also to evaluate social learning.

There were also plans to develop a hydrogen boat through the demonstration of a hydrogen ferry in Cardiff Bay. The idea here being that Cardiff Bay is highly visible and this is an important initiative in 'taking publics and decision-makers along' as well. This would be 'right under their [politicians'] noses'. As part of this development planned activities included a feasibility study; research and analysis of operational requirements, power train modelling analysis; boat design and construction for 50 passengers. Initially the hydrogen would be produced from SMR with a move towards renewables in the future. Another issue arising is that refuelling would have to 'be local to the Bay'. It was also an aim to use the development of the boat to cultivate an export market niche to other inland waterways. In doing this the key advantages, amongst a number, would include being the 'first mover', the demonstration of associated infrastructure with a strategy for moving to renewables and the demonstration of safety regulations. This idea emerged from the H2 Wales Steering Group and was proposed by Stuart Energy and several stakeholders. The network being pulled together around this project included: BOC, Stuart Energy, Lloyds Register, the Maritime and Coastguard Agency, Mustang Marines and Cardiff CATS (a Cardiff based boat operator). A bid for funding was under development.

A further demonstration was at the Baglan Bay Hydrogen Energy Park where there were plans for a demonstration of sustainable hydrogen generation based on an existing solar centre (13 KW PV array) and a new hydrogen centre (13 KW PV array). A further 200 KW will be generated from a remote wind farm somewhere away from BEP – there will be a data link. The hydrogen will be generated through electrolysis and will be used in static fuel cells as part of a CHP in a low energy building. The perceived advantages of this project included the demonstration of the renewable production of hydrogen using 'appropriate' resources for south Wales, demonstrating hydrogen utilisation in a range of vehicles, the demonstration of hydrogen utilisation in an energy efficient building and the creation of employment opportunities. The suggestion was that there were opportunities 'in an area of industrial tradition' to raise public awareness and to initiate a hydrogen 'mini economy'. A bid for funding was submitted under Priority 2 Measure 5 of the Objective One programme in June 2004.

One thing to note here is that there are very few funded UK demonstration projects and none in Wales. Why this should be the case is an interesting issue and one we can only scratch the surface

of here. One individual lamented the time consuming nature of bidding for such demonstrations and also mentioned the importance of the ‘filtering criteria’ to ensure good quality demonstrations went forward for funding. This rested on matching ‘organisational fit’, ‘strategic fit’ and ‘wow factor’ through the selection criteria. Initially H2 Wales reviewed literature on international demonstration projects. The message was constantly being pushed that the demonstration projects could form ‘nodes’ to deliver the Welsh hydrogen economy as part of a wider energy mix. These projects, it was claimed, could be internationally significant.

5. Conclusion

In this paper we have outline the ongoing journey to a Welsh hydrogen economy. The key idea here is the notion of a journey in that the development of a vision for a Welsh hydrogen economy is under negotiation and development through drawing on a variety of stakeholders. This process is being led and informed by two separate but linked projects – H2 Wales and HV – which each have their own aspirations and expectations of the future hydrogen economy which both diverge and overlap. This can be seen, for example, in terms of geographical focus and also by the HV initiative’s focus on the automotive industry.

The geographical is also important in the ways in which the development of the hydrogen economy relates to the historical circumstances of particular places. In the south, for example, there was the development of a narrative related to the decline of traditional industries, retaining distinctive aspects of inward investment related to the automobile and engine production and ‘supply chains’ in particular and also the development of a hydrogen economy drawing on parts of the existing hydrogen production capacity of south Wales situated alongside the M4. This is a vision which has been developed in different ways by both of the initiatives. The more rural focus of H2 Wales links historically to economic decline of rural areas and attempts to ‘regenerate’ rural areas through the adaptability of existing land to produce bio-crops and through the construction of relevant infrastructure.

The journey to the visions has undertaken discussion and negotiation with a series of institutions, interests and individuals which acknowledges the geographical spread and focus of hydrogen economy developments across Wales but which also takes account of the role of political will and leadership in the new devolved administration. This political/policy context, alongside the changing political economy of inward investment and local responses to this provides a context within which attempts to align different Wales-wide, particular and local interests are themselves part of the journey.

In particular this relates to different attempts to develop, from within this context, plans for demonstration projects. There are currently no funded demonstration projects in Wales although a number of projects are being developed with some at the stage of being submitted for funding. The idea is to develop demonstration projects as ‘nodes’ and to ‘roll out’ across Wales. There are obviously many issues to be addressed in moving from the development of projects and proposals in networks to getting these developed on ‘the ground’ and ‘rolled out’ across Wales. In the absence of funded demonstration projects the issue may be what can be learned from other cases of attempts to develop demonstration projects in different parts of the UK and how does this relate to the issues we have set up in this paper in terms of the Welsh hydrogen economy?

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