Herefordshire Economic Evaluation

Opportunities to grow our local renewable energy economy

TEEconomy :

Establishing the Potential of a Transition Enterprise Economy

Detailed report : Energy Sector

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reconomy Herefordshire

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PLEASE NOTE: Footnote references may be found in the bibliography, which is a separate document.

Background

This report into the Energy Economy of Herefordshire forms part of a larger piece of work in the county under the title “TEEconomy - Establishing the Potential of a Transition Enterprise Economy in Herefordshire”. A report on the county’s Food and Drink Economy is already complete and one on its Housing Retrofit Economy will follow shortly.

The TEEconomy work in Herefordshire is itself part of wider ‘economic evaluation’ project being undertaken in Totnes, Devon (South Hams District Council) and Brixton (London), thus covering a rural county, a market town and an inner-city area. The intention is to use the work done in these three areas to develop models for application nationwide and as a springboard to further work.

The work is commissioned by the Transition Network with funding from the Calouste Gulbenkian Foundation, and the Tudor Trust among others. It takes place under the auspices of the nationwide REconomy Project which supports Transition Initiatives across the UK, including the Herefordshire in Transition Alliance (HiTA) which brings together transition groups in Herefordshire.

The principal outcome is intended to be :

> ***Better informed strategic economic planning and decision-making that will help build the resilience of the local economy, and so the local community, in the face of economic uncertainty, rising energy prices and climate change.***

What the report addresses

The report draws together and analyses information from diverse sources. It sets out the results of initial research into the potential for strengthening the local economy by localising production and purchasing of renewable energy, in the forms of electricity and heat in the county. In so doing, it provides an assessment capable of underpinning ‘better informed strategic economic planning and decision-making’ in Herefordshire.

The report does not include consideration of transport energy, although figures suggest that expenditure on transport fuel exceeds all other energy expenditure. This is because while there are comparatively well-advanced renewable technologies already capable of replacing energy used in properties, and comparatively good data sources for this area, the same is not yet true for transport. We readily acknowledge there is useful work to be done in that respect also, however it is beyond scope here.

The following questions are addressed:

Economic analysis

- How to define the Herefordshire Energy sector?
- How much is spent on purchasing energy in Herefordshire?
- Where does the money go and on what types of energy?
- How many businesses operate in the sector and how many energy-related jobs are supported?
- What is the economic potential of Herefordshire’s renewable energy assets?
- What would it cost to develop these assets?
- On balance, what scale of benefit to the local economy would be created?

Social & environmental implications

- What would this projection mean for local jobs and skills?
- What would this mean for the local community, the local environment, the wider environment?

Each of these questions carries challenges and while this report produces estimates which serve the stated purpose, it does not pretend to have satisfied all questions fully. There are gaps in the information publicly available, much of the information required is commercially-sensitive and therefore hidden from view, and it has been beyond the resources of the project to engage in primary research or to purchase commercial-quality data. Therefore at this stage some answers can only be partial or to some extent conjectural, requiring further in-depth investigation or primary research to follow where needed, and where resources are made available.

That said, this report produces useful information and establishes parameters which - taking the stated assumptions into account -can be used to inform present considerations and decision-making.

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How to define the Herefordshire Energy sector?

In assessing the various characteristics of the 'energy sector' it is important to be as clear as possible regarding use of the term and what is included or excluded. Generally the most useful way to define sectoral boundaries is by means of the Standard Industrial Classification (SIC) index, which categorises every form of economic activity and thus provides the analytic basis for most governmental statistics. The Scottish government proposes the following selection of SIC 2007 codes to describe the 'Energy including renewables' growth sector [1]:

Scottish Government 'Energy including Renewables' Sector : Description by SIC code	
SIC 2007 Code	**Description**
05	Mining of coal and lignite
06	Extraction of crude petroleum and natural gas
09	Mining support service activities
19	Manufacture of coke and refined petroleum products
38.22	Treatment and disposal of hazardous waste
35	Electricity, gas, steam and air conditioning supply
36	Water collection, treatment and supply
74.90/1	Environmental consulting activities
71.12/2	Engineering related scientific and technical consulting activities

However the document notes there are serious limitations to this approach. Firstly, it does not take into account the wider supply chain in construction and manufacturing which is rapidly arising from the development of a new sector around renewable energy. Activities actually associated with renewable energy presently still fall under other SIC classifications - such as construction or manufacturing –and there is insufficient resolution within the SIC index to identify these. It is also particularly difficult to distinguish renewable or low carbon activities where organisations cover a wider range of business activities. Further, it explains that while SIC 36 'Water treatment and supply'

[1] SCOT - 1

is not associated with energy production it is unfortunately necessary to include this, due to 'disclosure issues' which require that SIC 35 has to be combined with SIC 36.

It is therefore not straightforward as to what SIC categories to include in describing the sector. The provisional outcome of deliberations on the issue is shown below. Some categories (such as mining and extraction) although included in the list are not currently present in Herefordshire, while others (such as logging, sewage treatment and roofing) although present are not included, being activities where energy production is potentially possible (as biomass, biogas and photovoltaics respectively) but where the proportion of energy-related vs. unrelated is presently unknown.

Herefordshire Energy Sector : Description by SIC code used in this research	
SIC 2007 CODE	**DESCRIPTION**
0220	Logging
05	Mining of coal and lignite
06	Extraction of crude petroleum and natural gas
09	Mining support service activities
19	Manufacture of coke and refined petroleum products
35	Electricity, gas, steam and air conditioning supply
3821	Treatment and disposal of non-hazardous waste
3822	Treatment and disposal of hazardous waste
4321	Electrical installation
4322	Plumbing, heat and air-conditioning installation
71122	Engineering related scientific and technical consulting activities
74901	Environmental consulting activities

The above codes formed the basis on which data describing the Herefordshire energy sector was filtered from the Office for National Statistics (ONS). As will be noted in greater detail below, an example of the unsatisfactory nature of the present situation is the exclusion from some data of companies producing or distributing insulation products in Herefordshire. Hopefully, refinements will be made to the SIC index and to the related databases enabling much better definition of the sector in future.

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How much energy is consumed in Herefordshire?

- ***Context and Externalities***

The purchase cost of energy does not account for its full cost. Climate change, ecological damage, social injustice, and human health problems are some of the additional costs of energy production and delivery which are "externalised" from usual accounting methods. These costs are not reflected in the prices which domestic, commercial and industrial customers pay for their energy – prices which are therefore nominal rather than real.

In some cases, these externalised impacts are reflected in costs which manifest elsewhere in the national economy and can sometimes be quantified, such as in greater costs for health care and environmental remediation. However these impacts also create other economic losses not so easily quantified – such as in lost agricultural production due to climate instability.

In addition, there are geopolitical and ethical dimensions to the consequences of policies determining energy sources, production and supply – such as the unequal distribution of pollution impacts whereby some communities suffer greatly while others little, and the question of who bears responsibility for the decisions which lie behind this disparity. These dimensions are not easily translated into economic analyses, but must nevertheless be weighed.

We recognise therefore that the production and supply of energy from whatever fuel or technology entails additional, difficult-to-quantify costs, however this report will of necessity confine itself to the quantifiable monetary aspects of local energy production, supply and consumption.

Current Herefordshire lifestyles and the present configuration of the local economy have been made possible by abundant sources of cheap energy that power the county's homes, farms, businesses, offices, and factories. However it is widely accepted that this picture cannot be sustained indefinitely. The bulk of the county's electricity and its heating are produced by fossil fuels which emit carbon dioxide and other pollutants into the atmosphere, contributing to global warming and climate change. Government policy is designed to dramatically limit these emissions – 80% reductions by 2050 are required by the Climate Change Act 2008, and the Herefordshire Partnership[2] has also signed up to meeting this target locally. In 2011 renewable energy accounted for only 3.8% of national energy consumption.[3]

Change is inevitable and with change comes opportunity. What this could mean for Herefordshire will become clear by the end of this report. Let us begin by identifying the present state of the local energy sector.

- ***Herefordshire in relation to national energy expenditure***

As a starting point, we can view Herefordshire in the light of national average expenditure on energy. Nationally, UK end-users (including domestic, commercial and industrial) spend £134 billion each year on energy including transport fuels, or about £2,121 per capita[4]. If we exclude transport fuels, that figure is halved to£66 billion[5] or about £1,059 per capita. If we apply this national rate to the

[2] HP1. Herefordshire Partnership consists of key local and regional organisations which have developed and signed up to the Community Strategy for Herefordshire.
[3] DECC – 14 p16
[4] DECC – 1 / ONS – 4 : UK population 63.2 million in 2011
[5] DECC - 1

population of Herefordshire[6]it would mean about £195 million is spent on energy each year in the county, excluding transport.

However, this begs the question as to where the county stands in relation to national and regional energy averages. Most obviously and significantly, Herefordshire's energy infrastructure, energy options and energy prices necessarily reflect the fact that it is very rural and dispersed : of 34 areas in the West Midlands it has the lowest population density at 82 per sq km; for the UK, England and West Midlands the figures are 257, 401, and 420 per sq km respectively, or between 3 and 4 times as dense; only nineteen districts in England and Wales are lower[7]. To compare Herefordshire with other areas where economic evaluation projects are located, the figure for South Hams in Devon is similar at 94 per sq km whereas Inner London (including Brixton)at 9,656 is over 100 times as dense., there is good reason to believe that Herefordshire would not conform to national averages for energy consumption. There is some evidence that extrapolating Herefordshire expenditure from national figures could provide slightly too high an estimate : the ONS reports that expenditure on 'housing, fuel and power' is 6% less in rural areas compared to urban[8].

However, only some 40% of those living or working in villages, hamlets and isolated locations in England have access to mains gas, relying instead on oil, LPG, solid fuel and electric – all more expensive than mains gas – whereas in towns and cities the proportion is over 80%[9]. This fact points towards higher-than-average energy costs for over half of Herefordshire.

A recent DEFRA report[10] cites fuel poverty statistics for 2009 to illustrate that across England rural domestic heating costs averaged some £350 per year more than urban, that consequently nearly 23% of rural households are in fuel poverty compared to just over 17% urban, and that this in turn reflects that 36% were off gas grid compared to only 8%.According to the "Hereford Renewable Energy Study"[11] (HRES), Herefordshire far exceeds the national off-grid average in that no less than 44% of Herefordshire homes are off the gas grid (22% above average).

Average fuel costs for households using heating oil were twice those of households on mains gas, and as oil prices increased 16.9% in 2009-10 against a modest 1.4% increase in the cost of mains gas[12], the differential in energy costs between urban on-grid and rural off-grid areas is growing rapidly. Although no similar figures have yet been obtained comparing rural-urban industrial or commercial consumption, we may safely say that Herefordshire energy expenditure is set to exceed national averages by ever-greater margins.

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[6] CENS – 1; the 2011 census gives Herefordshire population as 183,500.
[7] ONS - 1
[8] ONS - 2
[9] CF - 1
[10] DEFRA - 1
[11] HRES – 1, page 25
[12] DECC - 2

Expenditure on energy : Herefordshire using national averages

If Herefordshire conformed to the national **average** for per capita expenditure on energy, then across domestic, commercial and industrial sectors (excluding transport) the county's expenditure would total some **£195 million per year**.

However as it is sparsely populated with **22% more households off gas-grid** than the national average, there are good grounds to believe that the county's **energy costs exceed the average**.

- ***Energy sources considered in this report***

The £134bn total UK energy spend referenced above includes all energy types consumed, including gas, electricity, transport fuels, coal, and oil. Although at this point in the report we are taking account of all types of present energy usage - non-renewable as well as renewable - when it comes to assessing the economic potential for localising energy production and spend, only the economic potential for renewable forms of energy in Herefordshire will be considered, as other forms are not sustainable and therefore not to be encouraged. However, 'renewable energy' is a category that includes many different technologies and resources. For the purposes of this report, we will focus only on those renewable technologies that could possibly provide a significant portion of the needs for Herefordshire in the short term – three to five years.

Primarily, this means considering electricity and heat production from solar photo-voltaic (PV), solar thermal, wind turbines, and some biomass technologies. These technologies are mature, well matched to the energy resources that are readily available, and easily deployed in the short term. This does not mean other technologies are not important or could not also be developed in the longer term – the scope of this report is necessarily limited.

- ***Gas and Electricity consumption in Herefordshire***

Having considered above the national context for expenditure on energy and the implications locally, we now turn to examining the current levels of electricity and gas consumption in Herefordshire.

Due to the regional basis for some of the relevant statistics, it is worth a quick look at Herefordshire energy consumption in relation to the region in which it sits, the West Midlands. DECC figures for 2009 show that while Herefordshire domestic electricity consumption per metering point was 9% higher than the regional average at 4,163 kWh, gas consumption was 10.5% lower at 13,731 kWh[13]. No explanation is offered but this information serves to emphasise that regional figures do not provide an accurate guide to consumption patterns in the county - as does the fact that in 2009 Herefordshire's carbon footprint was 1.54 million tonnes (MtCO2) or 8.6 tonnes CO2 per capita, whereas figures for the UK as a whole and the West Midlands are some 20% less at 7.4 tonnes and7.1 tonnes respectively[14]. CO2 emissions being related directly to energy usage[15], these figures could suggest that Herefordshire energy consumption may be some 20% above the regional average.

[13] ONS - 3
[14] HC - 1
[15] Only 4% of Herefordshire CO2 emissions are attributable to agriculture, ibid

According to the Department of Energy and Climate Change (DECC) domestic, commercial and industrial users in Herefordshire taken altogether consumed 1,226GWh of gas and 980.6GWh of electricity in 2010[16]. See Table 1:

Table 1 – Herefordshire : 2010 Electricity and Gas consumption in Gigawatt hours

	Domestic				Industrial/Commercial				Total	
Type	GWh	%	MPANs*	%	GWh	%	MPANs	%	GWh	MPANs
Gas	662.6	54%	49.1	99%	562.9	46%	0.6	1%	1,226	49.8
Electricity	390.7	40%	80.8	89%	589.9	60%	10.0	11%	980.6	90.8
Combined	1053.3	48%	129.9	92%	1152.8	52%	10.6	8%	2206.6	140.6

*MPANs : Metering Points (thousands)

DECC : Total sub-national final energy consumption 2010

This data covering gas and electricity presents a starting point for assessing Herefordshire's overall energy consumption. It will be noted that :

- Domestic consumption and industrial/commercial consumption of gas/electricity total 2.2 Terawatt hours (TWh) and are nearly equal at about 1.1TWh each.[17]
- Domestic customers account for only 48% of combined consumption, but represent 92% of all metering points (MPANs). This means that average industrial/commercial energy usage is thirteen times as intensive as average domestic usage, at 109 GWh per 1000 metering points compared to 8 GWh.

- ***'Other Fuels' consumption& Off Gas-Grid properties***

We now need to look beyond gas and electricity. As noted above, the HRES study estimates that 44% of Herefordshire homes are off the gas grid – about 36,614[18]. Many of these homes use night storage heaters and that consumption is captured in the figures above for electricity consumption. However, other off-gas-grid homes use heating oil, LPG, coal and/or wood, or a combination of these, and this consumption will therefore not be captured in the figures above.

The study estimates that half of all off-gas-grid homes use night storage heaters and half use heating oil, with an estimated annual energy consumption for heating of about 15MWh per year per dwelling[19]. On this basis we would expect the demand for non-electric off-gas-grid household heating (provided mostly by oil)to be in the region of 275 GWh[20].

At the time of writing this report DECC figures for 2010 do not yet incorporate tables for 'other fuels' (i.e. non-gas, non-electricity) energy, however the 2009 tables do show this information : domestic consumption of coal, manufactured fuels (such as anthracite) and petroleum (including both heating oil and propane gas) totalled 424 GWh in 2009[21]. As this is 50% more than the preceding figure, the assumptions made in the HRES may need to be reviewed.

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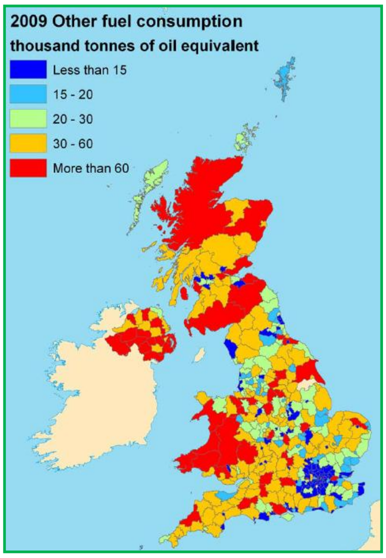
16 DECC – 3
17 1000 Gigawatt hours (GWh) equals 1 Terawatt hour (TWh)
18 HRES - 1
19 Ibid. p25
20 i.e. 36614 households x 15 MWh / 2
21 DECC - 4

On the basis of the foregoing it would follow that some 149 GWh of 'other fuels' domestic consumption took place in households which were on mains gas - meaning that gas was either not used at all or was supplemented by burning oil, coal or manufactured fuel. Note that these figures appear not to include wood pellets or woodchip under 'manufactured fuels', and certainly do not include firewood which is widely used in the county. Biomass consumption including wood products is categorised separately under 'renewables and waste' and the figure given is not broken down between domestic and industrial/commercial sectors.

The matter of so-called 'other fuels' calculations is highly complex and the subject of a special report to DECC which includes the following map, showing Herefordshire as a high-end user along with areas principally in Wales, Scotland and Northern Ireland. [22]



There was a very uneven pattern of increases and decreases in energy use between 2006 to 2009, so it is not possible to identify any trend on which to make an estimate of the likely figures for "other fuels" for 2010 : there was a 0.2% increase in 2008-9 preceded by a 12% increase 2007-8 and an 8% drop the year before that. However, as shown in Table 2 below, the final consumption figures for gas and electricity consumption show only a slight variation (0.4% decrease) 2009 to 2010. [23]

Table 2 – Herefordshire : Gas & Electricity consumption 2009 –10, GWh									
	Domestic			Industrial/Commercial			Total		
Energy Type	GWh' 09	GWh' 10	% Change	GWh' 09	GWh' 10	% Change	GWh' 09	GWh' 10	% Change
Gas	668.4	662.6	99.1%	566.6	562.9	99.3%	1235.0	1226.0	99.3%
Electricity	387.6	390.7	100.8%	593.5	589.9	99.4%	981.1	980.6	99.9%
Total	1056.0	1053.3	99.7%	1160.1	1152.8	99.4%	2216.1	2206.6	99.6%

DECC : Total sub-national final energy consumption 2009& 2010

For the purposes of this report therefore we can reasonably rely on the 2009 figures in determining overall consumption. Table 3 and Charts 1 and 2 which follow are therefore based on this dataset.

[22] AEA - 1
[23] DECC - 3

Table 2 shows combined consumption of gas and electricity, presently stable at 2.2 TWh (2200 GWh) per annum. However when "other fuels" energy sources are included the total increases by over 50%, to 3.5 TWh; see Table 3 below.

Table 3 – Herefordshire : Energy consumption in Gigawatt hours, 2009 (exc. transport)

	Domestic			Industrial/Commercial			Total	
Energy Type	**GWh**	**% Domestic**	**% Total**	**GWh**	**% Industrial**	**% Total**	**GWh**	**% Total**
Gas	668.4	45%	19%	566.6	30%	16%	1235.0	36%
Electricity	387.6	26%	11%	593.5	31%	17%	981.1	28%
Subtotal	1056.0	71%	30%	1160.1	61%	33%	2216.1	**64%**
Coal	70.2	5%	2%	82.2	4%	2%	152.4	4%
Manufactured Fuel	57.3	4%	2%	6.3	0%	0%	63.6	2%
Petroleum	296.6	20%	9%	666.7	35%	19%	963.4	28%
Subtotal	424.2	29%	12%	755.2	39%	22%	1179.4	**34%**
Renewables & waste *							77.3	**2%**
Total	**1480.2**	100%	**43%**	**1915.3**	100%	**55%**	**3472.8**	100%

* Breakdown between industrial/commercial and domestic is not available for Herefordshire, but see Chart 4 & Table 6 below. Figures do not include renewable/wastes used for electricity generation [24]

DECC : Total sub-national final energy consumption 2009

Table 3 shows that energy from 'other fuels' comprises 34% of the county's total consumption, with petroleum by far the greatest part of this.

The Renewables and Waste category is examined in greater detail below – see Chart 4 and Table 6.

It should be noted that there is a considerable discrepancy between the figures derived above from DECC giving energy consumption for the county, and the different calculations and result to be found in the HRES study. This study concludes that 'energy demand' for the county in 2010 (excluding transport) was 2,541 GWh/yr, of which 731 GWh/yr was for electricity.[25] The former is only 73% of the figure given above in Table 3 for total consumption and the latter only 75% of the figure for electricity consumption.

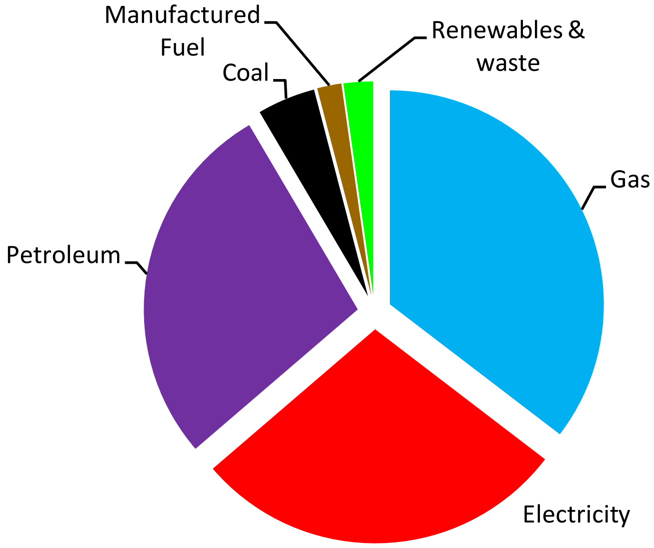
The reason for this discrepancy is not yet clear. HRES points to the perennial problem of this kind of research – lack of data : "The heat and power mapping of Herefordshire has proved to be a difficult exercise with data not being readily available, therefore a number of approximations have been required to achieve the results presented below."[26] It is not within the scope of this report to compare methodology between DECC and HRES, or energy consumption figures against those for energy demand, however it appears that to do so would be helpful and perhaps necessary.

[24] DECC – 5; see cell A460, footnote (4)
[25] HRES – 1 page (6). See also HRES - 2
[26] HRES – 1 page 7

- ***Energy Consumption : Summary and Comparative Analysis***

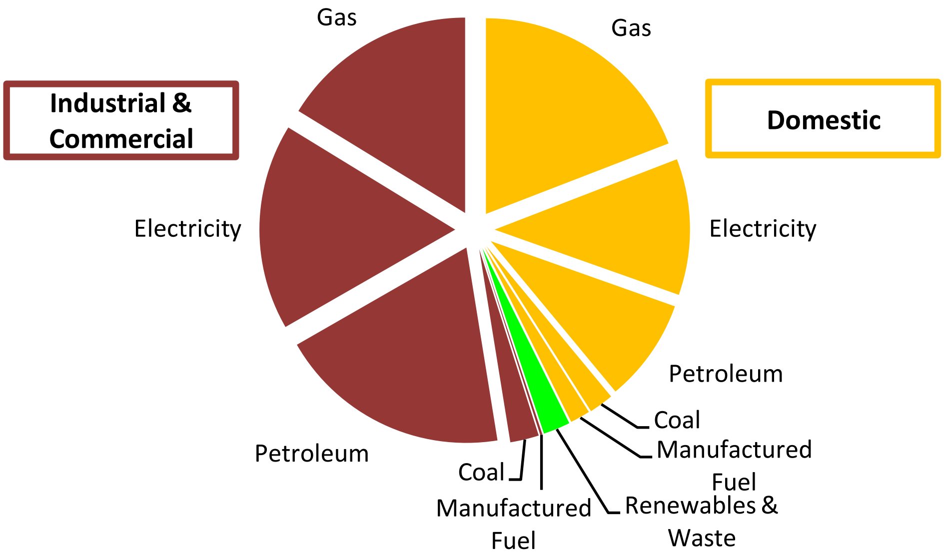
Chart 1 below graphically summarises the contribution of each energy type, and Chart 2 analyses this further by comparing domestic and commercial/industrial consumption by type.

Chart 1 : Herefordshire Energy Consumption by Energy Type 2009
(excl Transport)



DECC : Total sub-national final energy consumption 2009

Chart 2 : Herefordshire Energy Consumption by Sector & Energy Type 2009 (exc Transport)



DECC : Total sub-national final energy consumption 2009

Domestic consumption accounts for 43% and industrial / commercial for 55%; the remaining 2% is attributable to energy from renewables and waste which is not broken down by sector (note that the renewable/waste category does not include electricity generation – see Table 3 footnote).

Gas provides 35% of the total and electricity 28%. Remarkably, petroleum provides almost exactly the same contribution as electricity at 28% of the total. Further, 70% of this petroleum consumption takes place in the industrial/commercial sector, where it is in fact the largest source at 667 GWh, providing 35% of all energy, exceeding electricity usage by 13% and gas by 18%.

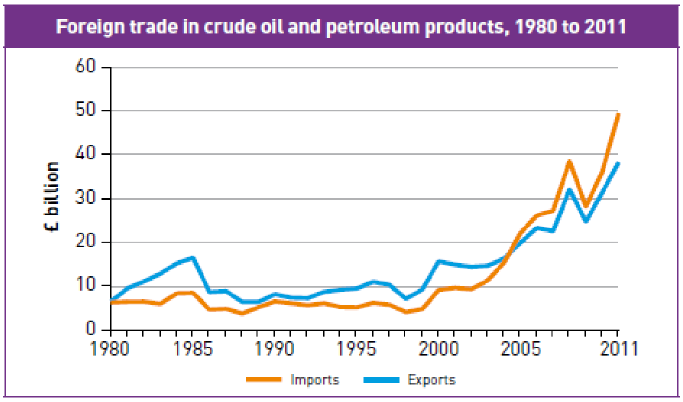
A significant part of the explanation for this feature is the inclusion of agricultural energy-use: although road transport is excluded from the figures, on-farm usage (e.g. in tractors) is not. Agriculture contributes 190 GWh or 28.5% of total industrial/commercial consumption.[27]

There are wide variations nationally in the industrial/commercial sector usage of petroleum : the figure for the UK is slightly lower at 26%, for the West Midlands only 19% and for Greater London even less at 4%; however South Hams in Devon is significantly higher at 33%.[28]

Analysing local features of energy consumption such as the above in a comparative way is important, as it points firstly to where Herefordshire is most vulnerable to changes in supply and pricing, and secondly to where the potential lies for changing present dependencies so as to strengthen the local economy. This is the central purpose of this report.

- ***Energy Dependency : Resilience and Vulnerability***

What is immediately apparent from the above, is the vulnerability of Herefordshire generally - and especially its industry and commerce – due to higher-than-average reliance on petroleum, an energy form which is prone to geopolitical instability in supply and hence price, and on which the UK is rapidly widening its export-import gap : up from £5bn in 2010 to £11bn in 2011 - see below[29].



Crude oil and petroleum products — **£ billion**

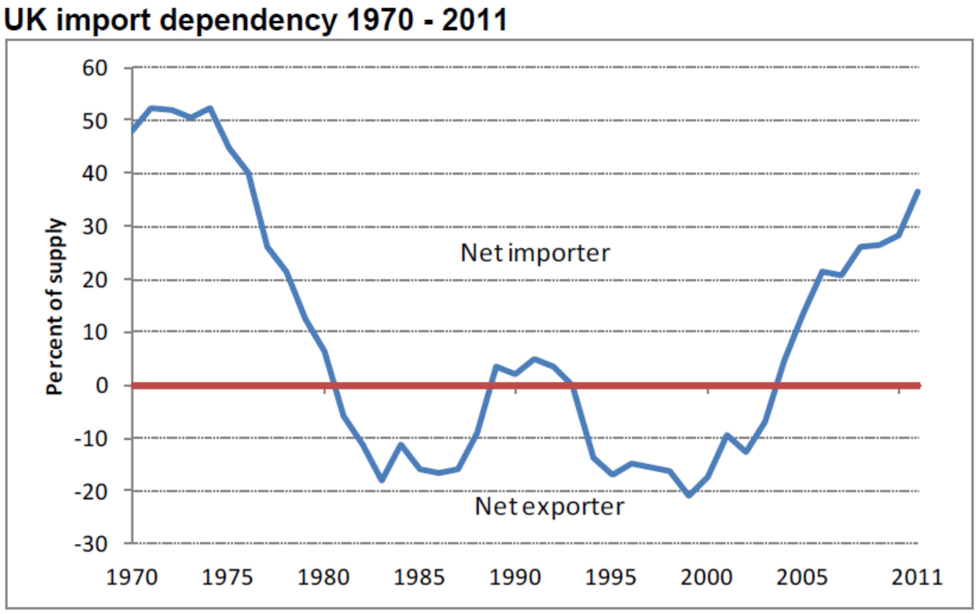
	1980	1990	2000	2008	2009	2010	2011
Exports	6.5	8.1	15.6	32.0	24.7	31.3	38.2
Imports	6.2	6.4	9.0	38.4	28.1	36.0	49.4
Net Imports	**-0.3**	**-1.6**	**-6.6**	**6.5**	**3.4**	**4.7**	**11.2**

Source: Office for National Statistics

UK Energy in Brief 2012, July 2012, DECC

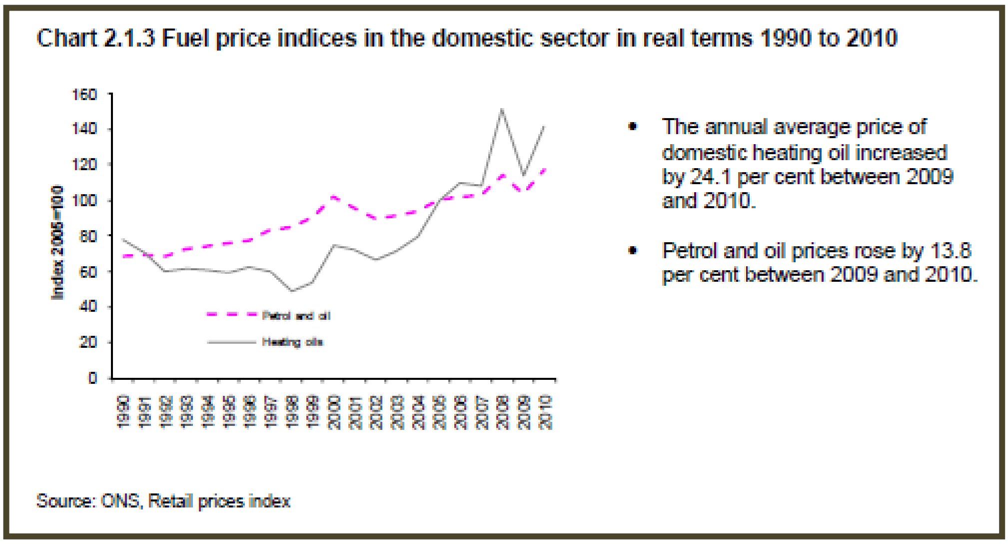
Since 2004 the UK has become a net importer of energy, its dependency on imports rising in only seven years from zero to 36% in 2011, as shown below. [30]

[27] DECC - 5
[28] Ibid.
[29] DECC - 9
[30] DECC – 15 p3



Press Release July 2012, DECC

Real-terms prices to domestic consumers also reflect this worsening situation – as the diagram below illustrates – with the price of heating oil rising 24% 2009 to 2010.[31]



Quarterly Energy Prices, December 2011, DECC

Considering the combination of carbon emissions, resource scarcity and volatility in supply, petroleum is neither environmentally nor economically sustainable; and in terms of fossil fuel dependency and import dependency, the wider picture on energy-use is no better : as mentioned above, renewables provide only some 3.8% of all energy while 'low-carbon fuels' altogether (including nuclear) total only 12%, meaning that the UK is 78% dependent on fossil fuels. The fossil fuels coal, gas and oil together make up 72% of UK electricity supply (excluding electricity imports) and the UK is now 36% dependent on energy imports : in 2011 43% of gas supply was imported (nearly half of this by tanker in the form of liquefied gas) and coal imports tonnage exceeded domestic production by 75%[32].

[31] DECC - 10

[32] DECC – 9 pp11, 12, 20, 28, 29

The above figures taken together indicate an overall lack of resilience in Herefordshire's energy supply and some areas of particular vulnerability. By collecting together information such as the above it is the intention of this report to highlight present weaknesses and, in the following sections, we will outline and quantify ways in which this situation can be altered, so as to improve economic and social resilience.

More analysis and better information are still required. For example no local figures have been available to define the amount of energy consumed in Herefordshire in the form of firewood, woodchip/pellet or other biomass, so that this has had to be extrapolated from national statistics and for that reason could be inaccurate[33]. As will be explored below, producing local energy in the form of biomass is an area of great potential.

Energy Consumption in Herefordshire(2009) : Summary

Across domestic and commercial/industrial sectors (excluding transport energy)in 2009 Herefordshire **consumed 3.5 TWh(terawatt hours) of energy**; domestic consumption accounted for 43% of this and industrial/commercial for 55% (plus 2% renewables).

Gas and electricity together accounts for **64%** of all consumption, but **petroleum** supplies a further**28%,**equal to electricity.

In the industrial/commercial sector, **petroleum** is the greatest single energy source supplying 667 GWh or 35%; of this, agriculture accounts for 190GWh.

The county is in the **highest band nationally for use of 'other fuels'**(not gas or electricity) which totals **1.2 TWh** annually; 82% of this is **petroleum** (heating oil).

Only **2%** of the county's energy consumption was drawn from **renewable** sources (including wastes).

44% of households are off-gas-grid and - along with electric night-storage - rely on use of 'other fuels' (principally petroleum) which account for possibly 275 GWh or 19% of total domestic energy.

In keeping with the national picture, local energy supplies are **highly dependent both on fossil fuels (78%) and on importation (36%)**, so that present consumption is insecure and unsustainable.

Local energy consumption reveals **particular vulnerability in two related areas**: properties (including businesses) which are **off-gas-grid**; and **reliance on petroleum**, by the industrial/commercial sector especially.

* * * * *

[33] See estimate derived from national figures in Table 6 : 24.5 GWh of domestic wood-burning.

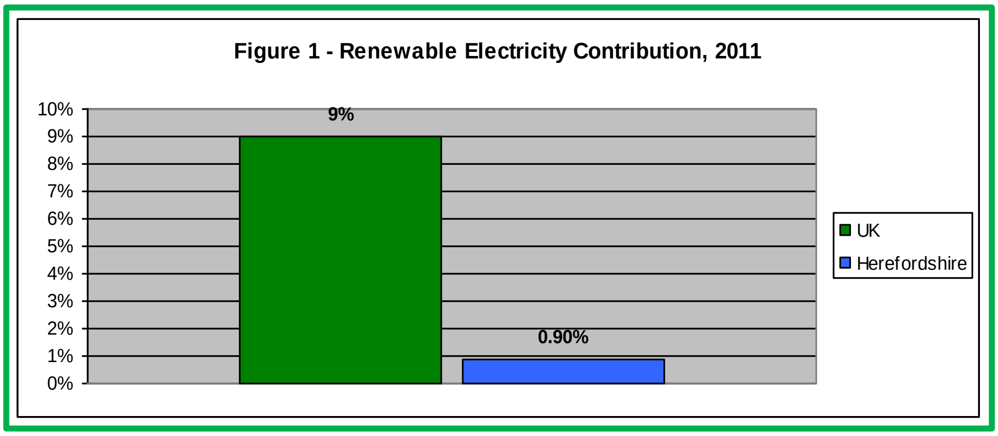
How much is spent on purchasing energy in Herefordshire and where does the money go?

Now that we have identified the quantity of energy consumed we can move on to establishing its economic value. The intention of this part of the report is to develop a current estimate of likely expenditure on energy in Herefordshire, excluding transport.

- ***Where does the money go?***

It is not hard to answer this second part of the question. Nearly all of the energy consumed in Herefordshire is produced from non-renewable sources far outside Herefordshire by the "Big Six" national and international companies: British Gas, EDF, E.On, Npower, Scottish Power, and Scottish & Southern. About 9% of the nation's electricity supply comes from renewables[34], but virtually none of this is produced in Herefordshire.

DECC's Feed in Tariff Registry[35] lists about 1,800 small-scale solar PV installations in Herefordshire and a couple of dozen other installations, including small scale wind, micro hydro, and micro CHP. We estimate their contribution at about 8-9 GWh of electricity per annum, or about 0.9% of the county's total electricity demand, plus an amount of heat not yet measured.



National Renewables Statistics, DECC

So to all intents and purposes, all of Herefordshire's energy is presently imported from outside the county. Indeed, approximately 6.2 TWh of electricity and 400.7 TWh of gas are imported from abroad[36], which as explored briefly above raises questions about national energy security and resilience, and economic issues relevant to this report.

- ***How much is spent on gas and electricity?***

As noted above, the most recent consumption figures at local authority level across all energy types relate to 2009, however gas and electricity consumption was nearly stable through 2010. As far as annualised tariff rates for the various energy types, the most recent cover 2011. For the purposes of this report, we will assume that energy consumption continued through 2011 at the same rates as in 2009 and we will apply 2011 tariffs, so as to create a preliminary estimate of expenditure for 2011 - subject to later adjustment as consumption figures are updated.

[34] DECC - 10
[35] DECC - 6
[36] DECC - 7

Based on figures from DECC for sector-specific tariff rates per kWh in 2011, and using these in conjunction with the 2009 consumption figures as explained above, a minimum of £43 million would have been spent in Herefordshire on gas by domestic and industrial/commercial customers in 2011, and a minimum of £102 million on electricity[37] - see Table 4 below.

These are cited as minimum figures, because DECC cites tariffs for the domestic sector, the industrial sector and the commercial sector separately, so that an accurate figure would only be possible with knowledge of the split between industrial and commercial consumption, which has not yet been identified. Commercial tariffs run 20% higher than industrial for gas and 43% higher for electricity. "Production" including manufacturing accounts for only 19% of the county's GVA[38], but to what extent this reflects industrial / commercial energy use is at this stage conjecture. If we used the higher commercial rates for all industrial/commercial consumption the previous figures would rise to £46m for gas and £124m for electricity, making a high-end to expenditure at £170m and a low-end at £145m.

Table 4 – Herefordshire : Estimated Spending on Gas & Electricity 2011

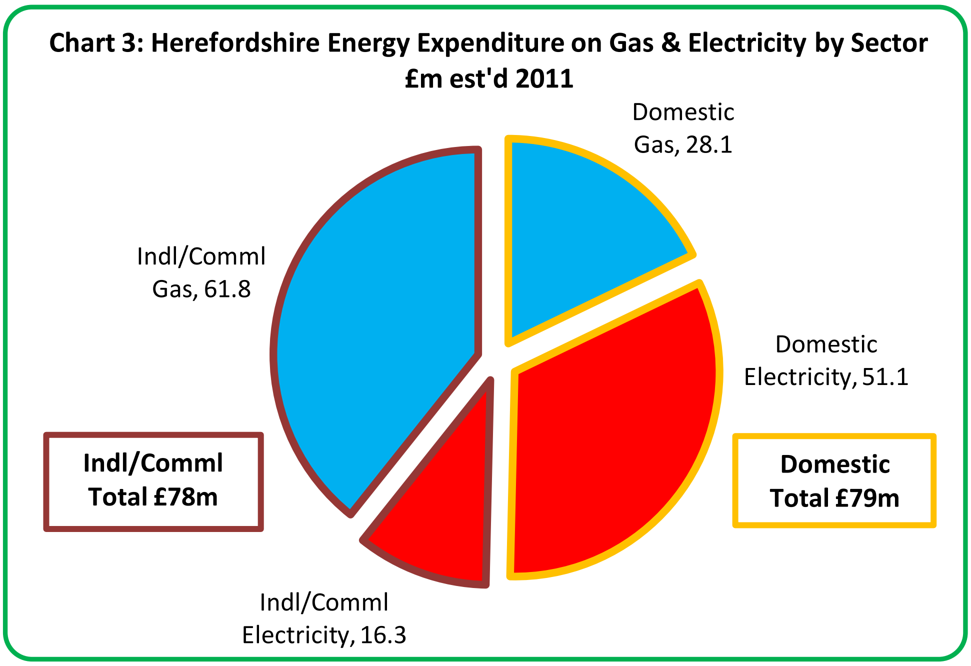
Energy Type	Domestic GWh 09	Domestic p / kWh *	Domestic Spend £m	Industrial/Commercial GWh 09	Industrial/Commercial p / kWh **	Industrial/Commercial Spend £m	Total GWh 09	Total Spend £m
				At Industrial tariff				
Gas	668.4	4.20	28.1	566.6	2.61	14.8	1235.0	42.9
Electricity	387.6	13.18	51.1	593.5	8.56	50.8	981.1	101.9
Total	1056.0		**79.2**	1160.1		**65.5**	2216.1	**144.7**
				At Commercial tariff				
Gas				566.6	3.14	17.8		45.9
Electricity				593.5	12.26	72.8		123.9
Total				1160.1		**90.6**		**169.7**
				Average Tariff				
Gas				566.6	2.87	16.3		44.4
Electricity				593.5	10.41	61.8		112.9
Total				1160.1		**78.1**		**157.2**

* includes VAT at 5% ** includes Climate Change Levy &VAT at 20%; based on 2009 consumption and 2011 prices

Based on Digest of UK Energy Statistics : Sales of electricity and gas by sector, DECC

The 'average tariff' figures in Table 4 above have been used to generate Chart 3 below.

[37] DECC - 8
[38] HC - 2



- ***How much is spent on other fuels?***

To the above figures for gas and electricity consumption we now add figures for "other fuels" : coal, manufactured fuels and petroleum (principally heating oil and gas oil but also including propane). These costs have been calculated using a variety of DECC information sources, using 2011 prices.[39]

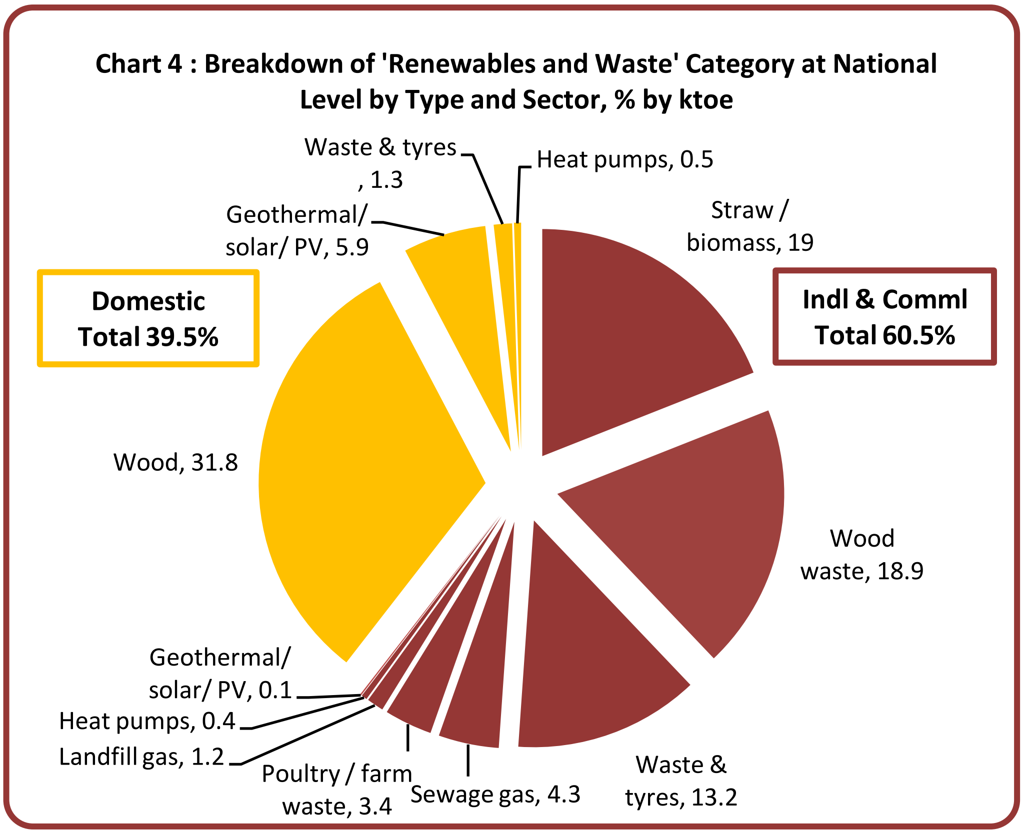
Table 5 – Herefordshire : Estimated Spending on Other Fuels 2011								
	Domestic			**Industrial/Commercial**			**Total**	
Energy Type	**GWh 09**	**p / kWh ***	**Spend £m**	**GWh 09**	**p / kWh ****	**Spend £m**	**GWh 09**	**Spend £m**
				Average Tariff				
Gas	668.4	4.2	28.1	566.6	2.87	16.3	1235	44.4
Electricity	387.6	13.18	51.1	593.5	10.41	61.8	981.1	112.9
Total	1056		**79.2**	1160.1		**78.1**	2216.1	**157.2**
Coal	70.2	3.83	2.7	82.2	1.24	1.0	152.4	**3.7**
Manufactured Fuel	57.3	3.92	2.2	6.3	1.27	0.1	63.6	**2.3**
Petroleum	296.6	5.98	17.7	666.7	6.19	41.3	963.4	**59.0**
Total	424.2		**22.7**	755.2		**42.4**	1179.4	**65.1**
* includes VAT at 5% ** includes Climate Change Levy &VAT at 20% based on 2009 consumption and 2011 prices								

Compilation from various sources referenced above, DECC

[39] DECC - 12

- ***How much is spent on energy from renewables and waste?***

No breakdown is available at county level for the category "Renewables and Waste" included in Table 3 above, but DECC does supply these details at national level and this information has been used to generate Chart 4 below[40].



Digest of United Kingdom energy statistics, DECC

By applying this national-scale breakdown to the overall consumption figure of 77.31 GWh for Herefordshire 'Renewables and Waste' in Table 3, we arrive at Table 6 below, which estimates a value of about £4.7m for this energy type.

The assumption here is that, as the percentiles are worked on an oil-equivalent basis, we can reasonably use oil prices to predict spend for all energy subtypes quoted – however it is acknowledged that closer investigation of the correlation is needed.

The proportion of 'Renewables and Waste' is presently very small – particularly because the figures given exclude use in electricity generation[41] - but is a focus of interest in this report for its growth potential and therefore worth further attention. Regionally, West Midlands production of renewable electricity is presently not accelerating : the year 2009-10saw a slight increase of 1.2% but the following year – against a background of substantial increases elsewhere in the UK - this dropped by a remarkable 8%[42].

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40 DECC - 13
41 DECC – 5; see cell A460, footnote (4)
42 DECC - 16

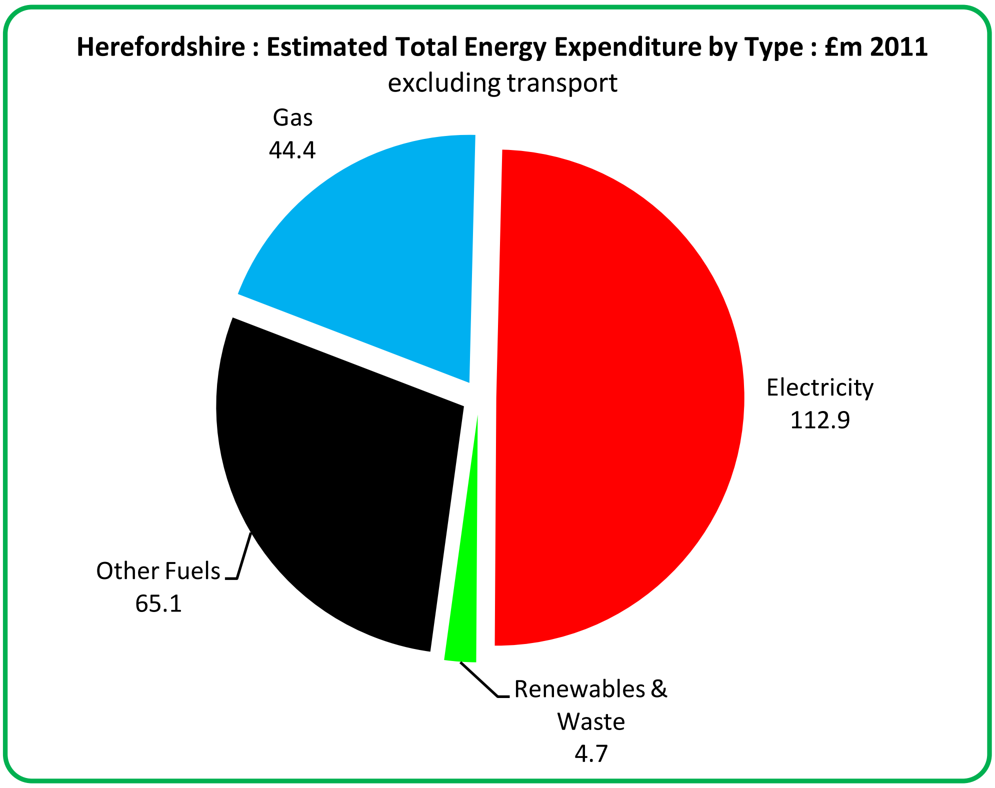
Table 6 – Herefordshire : Estimated Spending on Renewables and Waste, 2011										
	Domestic				Industrial & Commercial				Total	
Energy Subtype	%	GWh	p/kWh *	£m	%	GWh	p/kWh **	£m	GWh	£m
Wood	31.8%	24.59	5.98	1.47					24.59	1.47
Wood waste					18.9%	14.61	6.19	0.91	14.61	0.91
Straw / biomass					19.0%	14.69	6.19	0.91	14.69	0.91
Poultry/ farm waste					3.4%	2.63	6.19	0.16	2.63	0.16
Waste & Tyres	1.3%	1.01	5.98	0.06	13.2%	10.21	6.19	0.63	11.21	0.69
Geo / Solar / PV	5.9%	4.56	5.98	0.27	0.1%	0.08	6.19	0.00	4.64	0.28
Heat pumps	0.5%	0.39	5.98	0.02	0.4%	0.31	6.19	0.02	0.70	0.04
Landfill gas					1.2%	0.93	6.19	0.06	0.93	0.06
Sewage gas					4.3%	3.32	6.19	0.21	3.32	0.21
Total	**39.5%**	**30.54**		**1.83**	**60.5%**	**46.78**		**2.90**	**77.31**	**4.72**
* Percentages given by DECC are expressed in tonnes of oil equivalent therefore the value is taken as the cost of domestic heating oil as in Table 5 ** Percentages given by DECC are expressed in tonnes of oil equivalent therefore the value is taken as the cost of commercial gas oil as in Table 5. Both based on 2009 consumption and 2011 prices										

Compilation from various sources referenced above, DECC

- ***Summary of expenditure : totals by energy type***

Based on the foregoing, we can summarise estimated overall spend on energy in Herefordshire for 2011 :

Table 7 – Herefordshire : Total Estimated Spending on Energy 2011, excluding transport						
	Domestic		Industrial/Commercial		Total	
Energy Type	GWh 09	Spend £m	GWh 09	Spend £m	GWh 09	Spend £m
Gas	668.4	28.1	566.6	16.3	1235	**44.4**
Electricity	387.6	51.1	593.5	61.8	981.1	**112.9**
Other Fuels	424.2	22.7	755.2	42.4	1179.4	**65.1**
Renewables & Waste	30.5	1.8	46.8	2.9	77.3	**4.7**
Total	**1510.7**	**103.7**	**1962.1**	**123.4**	**3472.8**	**227.1**



Energy expenditure in Herefordshire : using DECC statistics

In the opening section, we calculated that if national averages applied to Herefordshire its energy expenditure would total £195m a year (excluding transport).

Using 2009 consumption figures from DECC with 2011 tariffs, total Herefordshire expenditure on energy (excluding transport) in 2011 is calculated to be some **16% higher than average at £227m**.

Expenditure on **electricity** accounted for almost exactly half this total, at **£113m**.

The largest area of expenditure overall was on **industrial/commercial electricity at £62m**, followed by **domestic electricity at £51m**.

Expenditure on **'other fuels'** (i.e. non-gas/electric) came second only to electricity at **£65m** (29% of the total).

At **£59m, petroleum** (including heating oil, gas oil and propane) accounted for 90% of this expenditure. And 70% of this petroleum (£41m) was used by the industrial/commercial sector, dwarfing its spend on gas (£16m).

£23m was spent by households on 'other fuels'– nearly 80% of this on petroleum – which reflects the rural nature of the county where 44% of households lack access to mains gas.

Mains gas accounted for £44m or 20% of total expenditure and most of this(63%) is by households.

* * * * *

How many businesses operate in the energy sector in Herefordshire and how many jobs are supported?

Another way of stating what the previous section established is to say that approaching £¼million each year is drawn out of the local economy to pay for energy. A significant portion of this in turn leaves the UK to pay for imported fuels and energy, a trade which is responsible for creating additional carbon dioxide emissions as well as a host of unaccounted for "externalities." This money goes to supporting companies and jobs outside Herefordshire and to a large extent outside Britain, rather than benefitting the local economy.

If at least some of this money was instead spent on purchasing locally-produced renewable energy, how many more local companies and jobs would it support? To answer this question let us begin by looking at how many energy-related companies and jobs are already in the county.

Data related to commercial operations is regarded as sensitive and not easily obtained. Even data as to numbers employed is available only in anonymised and therefore approximate form – as in Table 8 below.

Given that Herefordshire imports nearly all its energy, it is hardly surprising that there are few companies in the "energy sector" of the local economy. The HRES study points out that there are presently no large-scale power plants in the county[43]. However, there is a functioning anaerobic digestion plant run by Welsh Water in Hereford, a functioning community PV project at Leominster, a projected wind power project at Reeves Hill on the boundary with Powys, , and a projected community woodfuel project at Woolhope southeast of Hereford. Other than for the community projects, we are not aware of other companies located the county primarily focused on energy production.

So far as secondary or tertiary activities in support of conventional energy production and delivery, internet searches reveal two companies involved in distribution of domestic heating oil and LPG –and there will be others involved , such as electrical or gas installers. As noted above in discussing the definition of the 'energy sector', detailed information is not yet available due to the way the SIC index is categorised. According to ONS data found on Herefordshire's Facts and Figures website[44], employment statistics based on SIC codes show none employed in the "Electricity, gas, steam and air conditioning supply" category.

On the renewable front, a search of the Microgeneration Certification Scheme (MCS) database[45] lists 34 companies in Herefordshire certified to install solar PV, solar water heating, wind turbines, heat pumps, biomass boilers, hydro, and micro CHP. Of those, the majority are certified for PV installation. They list no local manufacturers of these systems. The National Biofuel Supply Database[46] lists five suppliers of wood or biomass fuel in the county.

Information supplied by the Herefordshire Corporate Policy and Research Team suggests that about 1200 are employed locally in energy related jobs (less than 2% of all employment), with about 1000

[43] HRES – 1, page 5 (18)
[44] HC- 3
[45] MCS - 1
[46] BEC - 1

of those employed in the construction category and involved with electrical or plumbing installation. See Table 8 below.[47]

Table 8 : Employment in Herefordshire Energy Sector		
Industry SIC 07		**Number Employed**
0220	Logging	-
05	Mining of coal and lignite	-
06	Extraction of crude petroleum and natural gas	-
09	Mining support service activities	-
19	Manufacture of coke and refined petroleum products	-
35	Electricity, gas, steam and air conditioning supply	100
3821	Treatment and disposal of non-hazardous waste	100
3822	Treatment and disposal of hazardous waste	-
4321	Electrical installation	500
4322	Plumbing, heat and air-conditioning installation	500
71122	Engineering scientific & technical consulting activities	100
74901	Environmental consulting activities	-
	Herefordshire Energy Industry	**1,200**
	All Herefordshire industries	72,000

Data derived from ONS BRES 2010 via NOMIS accessed 7Sep12

These figures do not distinguish employment specifically involved in renewable energy and it is therefore not even certain whether the statistics above include all such. Given that renewable energy companies tend to be small and that the MCS identifies only 34 in the county, we might estimate employment among the renewable energy companies based in the county at up to 200. In addition, there will of course be other renewable energy companies based elsewhere but with employees working in the county.

Based upon the same information as in the table above, Herefordshire Council Research Team has produced the following estimation of Gross Value Added for the sector [48]:

[47] BRES - 1
[48] Ibid.

Table 9 : Gross Value Added of Herefordshire Energy Sector		
County of Herefordshire 2009	**GVA**	**Value attributable to 'Energy Sector'**
SECTOR	**(£m)**	**(£m)**
Agriculture, forestry and fishing	238	0
Production	518	6
Construction	220	54
Distribution; transport; accommodation and food	543	-
Information and communication	78	-
Financial and insurance activities	89	-
Real estate activities	176	-
Business service activities	209	3
Public administration; education; health	559	-
Other services and household activities	111	-
Total GVA	**2740**	
Total GVA from Energy Sector		**63**
Energy Sector as % Total GVA		**2.2%**
NB : Figures above are anonymised& therefore appear to be incorrectly added		

There are also companies which manufacture or distribute goods or supply services representing the 'energy efficiency' side to the energy sector, such as insulation materials or double-glazing. A particularly notable example locally is Kingspan Insulation Plc, part of an Irish multinational employing over 400 people in Herefordshire[49]. Known locally and worldwide for manufacture of insulation boards over the last 25 years, the company also has an 'Environmental and Renewables' division supplying solar thermal, air-sourced heat pumps, hot water storage and rainwater harvesting. It is reported to turnover £400m on insulation alone or £1.3bn overall[50]. Clearly the company has a significant place in relation to the energy sector, locally and nationally.

However this company is listed at Companies House under SIC 07 code 43999 : "Specialised construction activities (other than scaffold erection)". Therefore it does not fall into the 'energy sector' as defined above in Table 8 and its employees will not have been counted. However as it does fall under construction its contribution to the county's GVA will have been included in Table 9.

Present businesses and employment in Herefordshire Energy Sector

Contributing only about 2% to employment and 2% to GVA in the county, the energy industry in Herefordshire is at this point hardly existent.

There is however a nucleus of renewables companies which together form the beginnings of an industry that has potential and could grow more robust under the proper conditions.

* * * * *

[49] HT - 1
[50] IT - 1

What is the economic potential of Herefordshire's renewable energy assets?

If renewable energy capacity were developed locally, it would generate economic benefits to the county beyond just heat and electricity- but we may begin by looking at the potential value of that heat and electricity.

According to the HRES study, Herefordshire enjoys relatively abundant renewable energy sources well matched to a range of available technologies. The study examines in some depth the resources, applicable technologies, and policy options for an effective long term renewable energy strategy.

We will use the results of that study as a starting point to estimate the potential economic value of the principal resource/technology options detailed therein. We will indicate the economic benefits both of deploying local renewable energy systems and also of developing a local renewable energy industry. The intention here is to focus on the most salient short term opportunities, rather than to examine every possible resource/technology combination. Therefore we will focus on those pathways most easily pursued over the next three to five years.

- **Wind Potential**

The generation of electricity from wind energy has been proven to be one of the most cost effective renewable energy strategies available. The HRES notes that there are no large scale wind turbines currently installed in Herefordshire, however they calculate that there is a theoretical capacity for about 174 x2.3MW large-scale turbines in the county.

If we accept the conversion factor used by HRES (which at 34% may be high for Herefordshire), these could generate close to 1.2TWh of electricity per annum: enough to meet half of all present consumption of gas and electricity combined; or enough to meet all present consumption of gas; or seen another way, all consumption of 'other fuels'. That is, if appropriate systems were available to make full use of this electricity – such as electric vehicles and infrastructure – it could replace the need for petroleum, coal and manufactured fuel. All of these are fossil fuels contributing damage to the local and global environment and to the county's carbon footprint, and they also add vulnerability to the local economy.

However, the potential for wind-generated electricity estimated by HRES has been questioned in a critique by Peter Linnell[51], which suggests that these estimates are overstated due to lack of road access and grid capacity at many of the sites identified – a suggestion borne out in practice by experience at the Reeves Hill site where construction has yet to commence due to delays caused in part by the absence of road access.[52]

That being noted, the HRES study itself does suggest that a practical deployment in the short run would focus on only 30% of the resource: 52 large scale turbines generating 354 GWH of electricity. Medium scale wind turbines capacity are also examined within a similar methodology, yielding a theoretical capacity of 403 x 225kW turbines generating 227 GWh, and a practical capacity of 81 turbines generating 45GWh of electricity.[53]

[51] PL - 1
[52] HT - 3
[53] HRES – 1 page 15

The HRES also quantified the theoretical potential of small-scale wind turbines. Because Herefordshire is rural and sparsely populated, domestic-scale wind could potentially be viable for a large number of homes, farms, and businesses. HRES maintains that as many as 20,592 small turbines, comprising 1.5kW, 6kW, and 15kW capacities could be installed. In the near term, however, they recommend that 20% of this resource could realistically be deployed. Table 10 below summarises the HRES position.[54]

Table 10 – Herefordshire Wind Generation Capacity, MWh

	Theoretical Capacity		Practical Capacity	
Scale	**Turbines**	**MWh**	**Turbines**	**MWh**
Large	174	1,180,756	52	354,227
Medium	403	227,131	81	45,426
Small	20,592	266,496	4,118	53,299
Total		1,674,383		452,952

Data from HRES

Large scale wind generators earn money by selling their electricity into the grid and by selling Renewable Obligations to the major energy companies. The Renewables Obligation has been in place since 2002 and is designed to support development of large-scale renewable electricity projects, such as wind farms. The Renewables Obligation Certificates (ROCs) are issued to generators of renewable electricity, who can then sell these on to electricity suppliers who are obligated to generate renewable electricity, or buy ROCs on the open market. The ROC price is currently set at £40.71 per MWh and we will assume that price, although market prices may vary. Wholesale electricity prices also vary and we will assume for our purposes here a price of £40 per MWh.

For smaller scale wind generators, the Feed in Tariff (FIT) would apply rather than the Renewable Obligation. The FIT also applies to a number of other renewable technologies and will be referred to quite often below. A medium scale generator would earn a FIT subsidy based on electricity generated and an export tariff for electricity fed back to the grid. For our purposes, we will assume that medium scale generators are feeding all of their output to the grid. FIT values will decline over time, however we will use the current figure for our estimates : 20.5p/kWh for installations below 500kW, or two medium scale turbines. The export tariff at the time of writing is 3.2p/kWh.[55]

Although the FIT applies to small-scale(or domestic-scale) turbines, it is recognised that a significant portion of electricity produced is actually consumed on site rather than exported to the grid. For our purposes, we will assume the 2012-13 FIT applies to turbines between 1.5kW and 15kW,and that half the electricity generated is consumed on site.

Based on the practical capacity figures in Table 10 above and applying revenue and subsidy streams at their current rates, Table 11 below shows that a large scale turbine fleet could generate over £28mper year and a medium scale fleet could earn almost £11m, or about £39.4m per year combined.

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[54] HRES – 1 pages 15, 53

[55] OFGEM - 1

Table 11 – Herefordshire Wind Generation Capacity, £m						
Scale	**MWh/yr**	**ROC/FIT ***	**Subsidy £m**	**Price/tariff ****	**Wh'sale value £m**	**Total £m**
Large	354,227	£40.71	£14.42	£40.00	£14.17	**£28.59**
Medium	45,426	£0.21	£9.36	£0.03	£1.45	**£10.81**
Small	53,299	£0.28	£14.92	£0.03	£1.71	**£16.63**
					Total	**£56.03**

* ROC is per MWh for large scale wind, FIT is per kWh for medium scale wind.

** Price is the wholesale price paid to large scale wind generators, the tariff is the export tariff paid to medium scale wind generators as part of the FIT programme.

The large and medium scale installations in the above table could be owned and operated by local companies or by community cooperatives, and in either case a revenue stream of some £39m would be available. With over £16 million from locally-owned small-scale installations, the total revenue of locally generated wind power could be £56m per year at current subsidy rates.

For a sense of scale, referring to Table 5 we see that £56m is more than the annual domestic spend on electricity, and is close to the total annual spend on petroleum. Some of this revenue would be used to repay capital costs and any loans - expenditures which are generally not local - but the remainder would flow into the local economy.

- **Solar Potential (PV and SWH)**

While Britain is blessed with abundant wind resources, it is not known for its sunshine. Nevertheless, Herefordshire has enough sunshine to make solar PV and domestic solar thermal – that is, solar water heating (SWH) - important parts of the renewable energy portfolio. Although some solar can be ground-mounted, the HRES estimates solar capacity for rooftop installations only. They estimate that of the existing 83,080 domestic buildings 19,509 (23%) would be suitable for solar, and propose that half would be fitted with 2kW PV and half with 2kW SWH. According to their estimates, resulting installed capacity would be about 39MW, generating about 33GWh/year.[56]

The study also makes reference to 18,000 planned new homes to be built over the next 15 years, with 9,000 estimated to be suitable for solar[57]. This would add 18MW of capacity generating about 33MWh/year.

Peter Linnell's critique, referenced above, questions whether these un-built homes could not all be built to the highest energy efficiency standards, incorporating both passive and "active" strategies for conservation and microgeneration. Especially in view of the scale of construction proposed, maximising incorporation of the full range of solar generation along with insulation levels would minimise carbon emissions, energy demand and annual 'lost' expenditure on energy. Such an approach could also significantly boost local economic benefits if materials, systems, and labour were sourced locally.

[56] HRES – 1 p28
[57] HRES – 1

There is clearly also potential beyond roof-mounted installations. For example systems can also be ground-mounted on domestic, industrial or even on appropriate agricultural land, where this does not preclude food production. However the number of potential sites is presently unknown. The HRES did not assess the potential for solar 'farms'[58].

Furthermore, there are many more buildings in the county beyond domestic ones - including community-owned, local authority, ecclesiastical, commercial, industrial and agricultural ones- which could host solar PV and in a number of cases have already done so.[59] Plans are underway to develop PV on a number of local authority buildings.

The HRES study estimates that 2,182 of 5,457 commercial roofs (40%), and 1,764 of 2,205 industrial buildings (80%) fitted with 5kW and 10kW PV systems respectively, could generate 9.9GWh/year and 16GWh/year respectively.[60]

However in its policy recommendations the HRES suggests that only 20-25% of this resource – solar PV and SWH - is practical in the short run, but provides little explanation of these "deployment target percentages" other than that they were put forward unchallenged at a stakeholder event[61]. Over the 3-5 year time frame adopted for this report that level of deployment appears rather conservative, however we will for the time being accept these estimates, which are summarised in Table 12 below.

Table 12 - Herefordshire Solar PV and SWH Capacity, MWh

	Theoretical Capacity		Practical % of Theoretical Capacity	Practical Capacity	
	Potential installs	MWh/yr		Potential installs	MWh/yr
Domestic PV	9,755	16,582	20	1,951	3,316
Domestic SWH	9,755	16,582	20	1,951	3,316
New builds PV	9,000	15,300	25	2,250	3,825
Commercial PV	2,182	9,910	20	436	1,982
Industrial PV	1,764	16,035	20	353	3,207
Total	32,456	74,409		6,941	15,646

Data from HRES

- *a. Solar PV*

Firstly we will consider solar PV installations. These qualify for the Feed in Tariff (FIT). The FIT scheme was originally launched with generous rates which have been throttled back in recent months. A mechanism is now in place which will drive tariffs down relative to the rate of deployment. There is also a requirement that applications for the FIT will require that the buildings on which the PV systems are installed meet energy-efficiency requirements, to SAP level D supported by an Energy Performance Certificate (EPC). Community-led projects such as community owned energy companies or schools would be exempt from this requirement.

[58] HRES – 1 p[8]
[59] HT - 2
[60] HRES – 1 p29
[61] HRES – 1 p13

For our purposes, we will use FIT rates effected in November 2012 (current at February 2013), which are 15.44p/kWh for domestic (under 4kW) and 13.99/kWh for systems between 4-10kW. These will be ratcheting downward, perhaps as much 3.5% every quarter. We will also assume all installations meet the energy efficiency requirements. The FIT programme also includes an export tariff of 4.5p/kWh. For domestic installations, as with wind generation, we will assume that half the electricity generated is consumed on site and half is fed back to the grid. For commercial and industrial installations, we will assume a third is fed back into the grid.

Based on the above assumptions, we can calculate the potential annual value of FIT generation and export tariffs for solar PV installations, as shown in Table 13 below.

Table 13 - Herefordshire Solar PV Capacity, £m

	Potential installs	MWh/Yr	Feed in Tariff	Total FIT £	Export tariff	Total Export £	Total £m/yr
Domestic PV	1951	3,316	£0.154	£512,052	£0.045	£74,619	**£0.59**
New builds	2250	3,825	£0.154	£590,580	£0.045	£86,063	**£0.68**
Commercial	436	1,982	£0.140	£277,282	£0.045	£29,433	**£0.31**
Industrial	353	3,207	£0.140	£448,659	£0.045	£47,624	**£0.50**
						Total	**£2.07**

The above table shows that potential income to owners of installed PV systems could be approximately£2m per year at current FIT rates (some of which may be used to repay the costs of installing the system). If there was an aggressive reduction of 3.5% every quarter, the aggregate value could be less than £4m over five years. On the other hand, it may be that HRES estimates of build capacity are too cautious and greater capacity could be constructed over the next 3-5 years. The figures above are therefore subject to revision but provide an indication of the potential value of building solar PV capacity.

- *b. Solar Domestic SWH*

We now turn to SWH systems. These systems are also subsidised but under a different scheme, namely the Renewable Heat Incentive or RHI. At this time the RHI is not totally in place, but when fully implemented will include a per kWh type of subsidy for qualifying domestic systems, much like the FIT. Until then an interim programme is in place called the Renewable Heat Premium Payment (RHPP) scheme. Under this programme, owners of installed systems will receive a one-time rebate payment of £300. These systems will also be eligible for per kWh RHI payments, when they become available. An installed SWH system saves the money that would otherwise be spent on gas or electricity or an alternative fuel to heat water. Thus SWH delivers a combined economic benefit through savings, RHPP payment and, in the near future, an RHI payment : as represented in Table 14 below.

Table 14 - Herefordshire Solar SWH Capacity, £m					
	Potential installs	MWh/Yr	Gas savings @ £.042/kWh	RHPP @ £300	Economic Gain £m
Domestic SWH	1,951	3,316	£139,272	£585,300	£0.72

Carrying forward the HRES assumptions, we estimate the potential value of grid savings and the one-time RHPP payments at about £0.7m (£725,000) per year. Given on the one hand likely increases in the cost of gas and other fossil heating fuels, and on the other the awaited RHI tariff, the annual economic benefits accruing to SWH system owners seem certain to rise.

Note that both solar PV and SWH figures are based upon the ‘suggested deployment target’ in the HRES report, which is only 20% of the identified capacity .[62]

- **Biomass Potential**

Herefordshire enjoys considerable biomass potential, including forest residue, waste wood, animal waste, and the potential for growing energy crops. All these fuel sources would require development of appropriate infrastructure to fully realise their potential.

The HRES quotes a 2010 study, “Herefordshire Woodfuel Supply Chain”[63], which quantifies wood fuel capacity in the county. Waste wood from tree surgeons, sawmills, orchards and sustainably managed forest resources could supply a sizeable fraction of the county’s energy needs. Forest residue is estimated in the HRES to amount to about 40,000 ‘oven dried tonnes’ of potential wood fuel per annum, about 30% of which could be developed in the short term.[64]Forest residues could therefore supply about 62,000 MWh of energy potential annually. Waste wood could supply more. The study suggests that 70% of this waste stream could be recovered for its potential energy content of about 259,000 MWh (see Table 15 below).

The study also recommends three energy crops, miscanthus, maize, and short rotation coppicing (SRC) of willow.[65] The first two mentioned would require grade 1-3 land which would displace food production. For our purposes, we will focus on miscanthus which according to the HRES study could provide over 10 million MWh annually, no less than twice the county’s total energy demand by their estimation.[66] A more modest and realisable estimate would be about 5% of that capacity, planted out over 6 hectares, yielding about 517,000 MWh.

Willow on the other hand, would not displace food crops and could potentially be planted on hills if harvesting were possible there. The theoretical capacity for SRC willow is about 339,000 MWh, although a more practical development could be a tenth of that, or about 34,000 MWh.

The foregoing calculations are summarised in Table 15 below.

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[62] HRES – 1 p13
[63] BRC - 1
[64] HRES – 1 p16
[65] BRC – 1 p70
[66] HRES – 1 p17. HRES – 2; HRES – 3 p6

Table 15 - Herefordshire Biomass Capacity, MWh			
	Theoretical MWh/year	**Deployment Target % ***	**Practical MWh/year**
Forest residue	206,382	30	61,915
Waste wood	369,369	70	258,558
Miscanthus	10,331,779	5	516,589
SRC willow	338,986	10	33,899
Total	11,246,516		**870,960**
			* As identified in HRES, p13

In addition to the above, there are several additional biomass resources identified in the HRES that could also be developed, such as animal waste, landfill gas, and so on, which could eventually produce about 64,000 MWh of heat or electricity. As noted above, investments in infrastructure and supply chains would be required to fully deploy any of these biomass energy pathways. To consider each feedstock and match it to the variety of technologies available would be too unwieldy and conjectural for the scope of this report.

On the other hand, biomass boiler technology is mature and straightforward to deploy, would benefit from the RHI incentives, and is well matched to the wood fuel and energy crop resources noted above. It is also identified as a near-term priority in the context of district heating by the HRES. On that basis, we will limit our analysis of biomass potential to those resources noted above and will assume deployment of RHI compliant biomass boilers.

If we take a simple set of assumptions, namely that the forest residue and wood waste would be processed into wood chip, that miscanthus and SRC willow would be processed into pellets, and that all of this fuel would be combusted for heat in biomass boilers, we can develop a rough calculation of potential aggregate revenue at the end of the value chain. In Table 16 below, we can see that the potential retail value of wood chip and pellet fuel processed from local resources would add up to over £31m per year. Assuming that local production is locally owned, this represents economic value that would stay in local hands, benefiting local companies and livelihoods and hence the local economy.

Table 16 - Herefordshire Woodchip/pellet Capacity, £m			
	MWh/year	**End user price/kWh ***	**Total £m**
Wood chips	320,473	£0.03	£9.6
Pellets	550,488	£0.04	£22.0
		Total	**£31.6**
* Data from Biomass Energy Centre[67]			

To take this one step further, the Renewable Heat Incentive would contribute a small tariff per kWh of heat generated by this fuel, if used in a qualifying system. The Herefordshire Woodfuel Supply Chain (HWSC) study cited above, calculates that the waste wood supply it identified – about 369,400 MWh – would correspond to an installed boiler capacity of the about 48MWth[68] - a ratio of 0.13kW installed capacity per MWh annual output. On inspection however this figure seems to be very

[67] BEC - 1

[68] BRC – 1 page 8; MWth : Megawatt thermal

inaccurate : the HRES estimates installed woodfuel boiler capacity at 0.44kW per MWh output[69]and an industry expert advises an approach which resolves at 0.68 kW[70]. For the following calculations we will use a mid-point between these last two of 0.56 kW across all four types of biomass.

On this basis, Table 17 below summarises the required boiler capacity which totals 488 MWth.

Table 17 - Herefordshire Biomass Boiler Capacity, MWth		
Biomass Type	**Practical MWh/yr**	**Installed Boiler Capacity MWth**
Forest residue	61,915	35
Waste wood	258,558	145
Miscanthus	516,589	289
SRC willow	33,899	19
Total	**870,960**	**488**

If we further assume this installed base is composed of medium scale biomass boilers between 200kW and 1000kW capacity, we can calculate the potential RHI value of this resource. The Tier 1 RHI tariff of 5.1p per kWh applies to the first 1,314 hours of generation annually[71]and will be taken to cover all output since in practice few boilers operate longer than this.

Table 18 - Herefordshire Non-Domestic Boiler Capacity, £m				
	Installed capacity MW	**Heat generated MWh ****	**RHI Tariff per kWh**	**Total £m**
Biomass Boiler *	488			
Tier 1 generation		783,864	£0.051	**£39.98**
* Assumes 200kW-1000kW systems				
** Input 870,960 MWh as above and assuming 90% boiler efficiency				

These calculations are indicative only and we recognise that the real situation is more complex, not least as there is an ongoing proposal to construct a 10 MWe/ 30 MWth biomass power plant at a sawmills in the county, which could significantly impact on the supply of woodchip[72].

[69] HRES – 1 p37 (table 4.20)
[70] SHRE - 1
[71] RHI - 1
[72] BRC – 1 p105

- **Summary of Total Renewable Capacity and Economic Value**

Table 19 below compiles the energy capacities and economic values identified in Tables 11 through 18.

Table 19 – Total Herefordshire Renewable Energy Capacity, MWh& £m			
Renewable Energy Type	**Income Source**	**MWh p.a.**	**Value £m p.a.**
Table 11 - Wind Generation Capacity	ROC / FIT	452,952	56.0
Table 13 - Solar PV Capacity	FIT	15,646	2.1
Table 14 - Solar SWH Capacity	RHPP		0.7
Table 16 - Woodchip/pellet Capacity	Retail	870,961	31.6
Table 18 - Non-Domestic Boiler Capacity	RHI		39.98
	Total	**1,339,558**	**130.4**

Firstly, we can see that across the five types of renewable energy resource considered – and there are as previously noted others –£130m of value could be created in the local economy each year. In the first part of this report we calculated total annual spending on energy at £227m, and suggested that virtually all of this value immediately leaves the local economy.

Therefore in numerical terms the potential economic value of renewables - on a short 3-5 year horizon, across a limited range of options and with conservative estimates as to 'practical capacity' – equates to over half of the present spend, which is already considerable. However, below we go on to consider how the 'local multiplier' effect means that this figure is proportionately even greater in terms of its true economic impact.

Secondly, across the five types considered, over 1.3 TWh of energy per year is produced. Referring to Table 3, this figure exceeds each of the figures for gas, electricity, petroleum and 'other fuels'.

Thus, on an arguably conservative range of measures and assumptions, renewables could provide the largest source of energy to the county and could, for illustration, eliminate either bought-in electricity or both coal and petroleum - if the required alternative technology and infrastructure (such as electric machinery or biomass boilers) were deployed.

Renewable Energy : Herefordshire Capacity and Potential Economic Value

Across a range of five immediately-viable renewable technologies and with some conservative assumptions, Herefordshire has the potential to generate some **£130m each year of revenue**.

This equates to **over half of all the county's present annual spend** on energy (excluding transport).

The **'local multiplier' effect** means that if this revenue was spent and circulated locally, its value to the local economy would be significantly increased. Co-operative forms of ownership would support this effect.

At the same time, **1.3 TWh (terawatt hours) of renewable-source energy** would be produced – over a third of the county's energy consumption and sufficient to replace either its present bought-in (non-renewable) electricity or its fossil fuels.

* * * * *

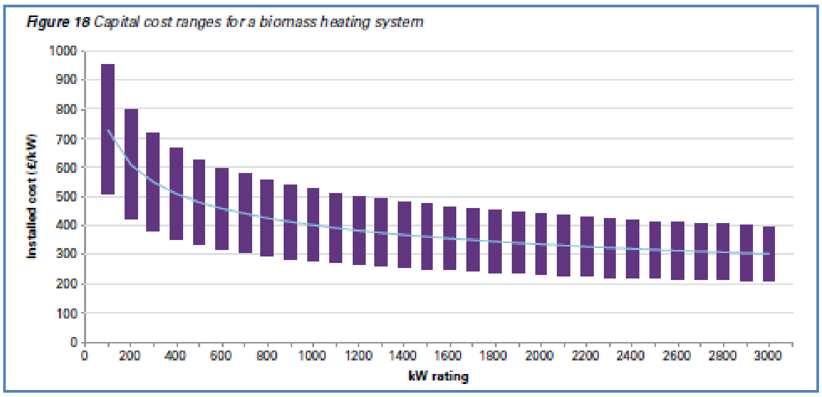
What would it cost to develop Herefordshire's renewable energy assets?

In order to benefit in this way from its renewable energy capacity the county would first have to create the required infrastructure for each technology. Let us now consider in turn what these requirements would be and how much each might cost.

- ***Biomass Costs***

To exploit what the HRES[73] refers to as the "excellent opportunity" of its biomass-energy potential would principally require the installation of suitable biomass boilers (and associated equipment) across the county. Installation costs vary widely, depending on the size of the boiler together with its related storage and handling equipment, and on the proximity of the buildings served together with required pipe-runs. As indicated above, here we are focusing on medium size systems of 200kW up to 1,000 – the scale that would be needed by a school, a leisure centre or an office complex, the type of sites prioritised for development in the HWSC[74].

Domestic systems are usually under 45kW and installation costs for these can be as much as £1250 per kW installed, but larger systems are under £1000 per kW. Costs appear to have risen in recent years : the chart below from the Carbon Trust dated 2008 shows that at that time 200kW systems averaged between £425 and £800, with 500kW systems between £325 and £625[75].



Carbon Trust, 2009

In 2010 the HWSC report estimated that the county council offices at Plough Lane would require a 450kW system costing £450 per kW installed, but this was recently revised to a 389kW system costing £850 per kW installed[76]. The forthcoming 200kW Woolhope Dome community woodfuel co-operative installation is reportedly set to cost £1,000 per kW and information received in confidence from local installers suggests that systems in the range 200 to 1,000 kW can cost as little as £540 or as much as £1000 per kW installed. Even if the boilers are identical, no two installations will ever cost the same due to differing pipe runs and other variable factors, so any average cost will necessarily be very approximate.

From the above it seems reasonable to conclude that at present we could use a figure of £750 per kW installed as an approximation for systems between 200 to 1,000kW ('medium biomass'). If – in

73 HRES – 1 p(7)
74 BRC – 1 p106
75 CT – 1 p62
76 BRC – 1 p103; personal communication with Herefordshire Council Sustainability Officer

keeping with the calculations above on revenue - we assume for our purposes here that all systems will be in this range, then the488 MWth total capacity in Table 18 would correlate to installation costs of about £366m - excluding VAT at 20% which we assume would be reclaimed.

Other substantial forms of investment would also be necessary to 'kick-start the market' in biomass by establishing processing hubs, by building the supply chain[77], by securing land and planting miscanthus and willow. These too are intrinsic to creating infrastructure, as acknowledged in some detail in the HWSC and rather fleetingly in the HRES[78] - however neither report addresses likely costs. Further work is therefore required to quantify these measures and attribute costs.

- ***Solar PV Costs***

Associated with changes to the Feed In Tariffs in 2012, installation costs for PV have declined remarkably in the last year. Commercial-scale installations (around 50kW) which previously cost well over £2,000 per kW now cost half that sum and domestic installations (3 to 4kW) previously costing £2750 per kW now cost £1700 or less. Currently the Energy Saving Trust estimate the typical cost for a 4kW domestic system at £5500 to £9500 (£1400 to £2400 per kW)[79].

In Table 13 above we identified a 'practical capacity' of 1,951 domestic solar PV installations, each being 2kW. Both internet research and interviews with local suppliers confirm these smaller systems can be bought for anything between £2900 up to £5500, depending in part on the quality and branding of the panels and inverters supplied. Using the median of £4200 per system (£2,100 per kW) with the foregoing installations gives an overall cost in the region of £8.2m (including VAT at 5%).

New domestic builds would attract volume savings and we will therefore use the lower end of the range for these. At £2755 per installation (£2900 less VAT), the 2,250 new build installations would cost around £6.2m assuming VAT was recoverable.

So far as industrial and commercial installations, enquiries to local installers and renewables agencies suggest that at this scale costs are in the range £1000 to £1200 per kW installed excluding VAT. Using the median £1100 per kW, the 436 commercial installations assumed at 5kW would cost £2.4m, and the 353 industrial installations assumed at 10kW would cost £3.9m.

Altogether, the costs of installing solar PV as described above total £20.7m.

- ***Domestic Solar Water Heating Costs***

The 'practical capacity' of roofs available for mounting a solar water heating (SWH) system, as calculated above, is taken to be 1,951 – half of all the roofs available for either solar PV or SWH.

Figures from the Energy Saving Trust give £4,800 as the cost of the average domestic installation, making £9.4m in all[80].

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[77] BRC – 2; BRC - 1 pp118, 122ff
[78] BRC – 1 p74ff; HRES – 1 p55ff

[79] EST - 1
[80] EST - 2

- ***Wind Energy Costs***

Before embarking on this calculation, we acknowledge that in-depth work on the plausibility of successfully deploying wind turbines in the local area in accordance with the HRES has been produced by Peter Linnell MSc. In particular, he has explored the rates of Energy Return on Investment and Return on Capital Employed for different scales of turbine, taking into account Feed In Tariff rates prevalent at the time, and persuasively points out that both rates are exceptionally unfavourable for small turbines below 50kW, whose performance is also vulnerable to poor siting[81].Medium size turbines of 500kW work out best in his analysis. Peter Linnell's work also maintains that there is a likelihood of 'latent opposition becoming manifest' from amongst local residents should large numbers of even the smaller turbines be deployed.

The HRES poses an initial 'practical capacity' of no less than 4,118 small turbines of varying sizes : 1.5, 6 and 15kW. In a 2012 report funded by the DECC Local Energy Assessment Fund Peter Linnell surveys public attitudes in Herefordshire towards wind turbines and concludes that residents are irrationally supportive of small ineffective turbines, but become increasingly opposed as size (and efficiency) increases[82].

Such considerations are unavoidable in relation to assessing the costs of creating a wind-generation infrastructure, because unlike other technologies summarised in this report these are subject to planning restrictions and – for anything more than the very smallest turbines – also to grid connections and road access.

Households are by definition connected to the grid and while there is seldom any problem with nearby siting of either solar PV or SWH or biomass, larger turbines cannot usually be located near dwellings and are often remote from existing grid and road access which must therefore be constructed. Similarly, planning objections and appeals processes can easily prove very costly. Behind these obvious constraints and entailed costs lies the shadow of whether the existing electrical distribution grid in and around Herefordshire would need substantial development before it could cope with local generation of electricity on the scale envisaged in the HRES.

There are therefore a number of grounds on which to query the HRES deployment figures for wind and in his2012report Peter Linnell maintains that, even when considering only the technical constraints, the potential for wind installations suggested in the HRES is "extensively overestimated". A methodology is then suggested for 'eliminating false positives' so that the HRES can nevertheless still be used for searching locations 'viable for true economic deployment' of medium and large scale turbines. However the report concludes, "barriers to [wind turbine] deployment in Herefordshire are a complex matrix of physical, technical, economic, social, political and institutional factors"[83].

Having noted that this technology - more than any other considered here - poses complex problems when assessing barriers to deployment and hence entailed costs, let us proceed to establish some benchmark costs based on the only quantitative assessment currently available, namely the HRES.

Figures obtained from local installers and renewables agencies suggest as follows: that the capital cost of a small 15 kW turbine would be in the region of £50,000, that a medium 225kW turbine

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[81] PL – 2 pp54-6, 63
[82] PL – 3 p9
[83] PL – 3 pii, p17ff, p30

would cost about £600,000, and a large 2.3MW turbine about £3m. In view of the preceding points above, we propose to take out of consideration any turbines smaller than 15kW.

However, these costs represent basic type costs covering supply and construction only. Should there be significant difficulties with road access or grid connection or planning, it has been suggested these could be increased by 50%.If we estimate that half of all installations across all ranges will encounter such difficulties and calculate this 'uplifted' cost we arrive at the following table :

Table 20 – Herefordshire Wind Generation Infrastructure Costs

Scale	No. of Turbines 'Practical'	Basic cost each £m	Basic costs total £m	Uplifted costs *total £m
Large	52	3.00	156	195
Medium	81	0.60	49	61
Small	4,118	0.05	206	257
Total	4,251		**411**	**513**

* Uplift 50% over basic cost for 50% of all installations in respect of additional road access / grid access / planning costs

To implement the 'practical' level of turbine deployment advocated in the HRES – 4,251 in all - would therefore cost at least £411m. Taking account of the likely realities, however, we will make use of the 'uplifted' cost figure, £513m.

Costs of Developing Herefordshire's Renewable Energy Capacity

The costs of installing the 'practical' level of capacity outlined in the Herefordshire Renewable Energy Survey 2010 across four technologies have been estimated in descending order as :

Wind £513 million : for the installation of 4,251 wind turbines across the county and including an uplift to allow for expected additional expenditures beyond basic installation.

Biomass £366 million : for the installation of boilers in the range 200 to 1,000 kW comprising altogether 488 MWth of boiler capacity. Other infrastructure costs not yet quantified.

Solar PV £21 million : for the installation of some 5,000 PV systems producing some 12,000 MWh annually across domestic and commercial locations.

Domestic Solar Water Heating £9 million : for the installation of some 2,000 systems producing some 3,300 MWth annually.

Total for the above measures : £909 million

* * * * *

What benefits would accrue to the local economy if this change of supply was realised?

We are now in a position to assess the economic benefits of creating the new energy-supply outlined above. First, we will summarise all estimated infrastructure costs and compare these with estimated revenues - as calculated above on the basis of current tariffs.

- ***Summary of Costs and Revenues***

To help with comparison, the table following establishes a ratio between costs and revenues for each technology in terms of payback: the period over which revenues would equate to initial costs, assuming present rates for both costs and revenues persist:

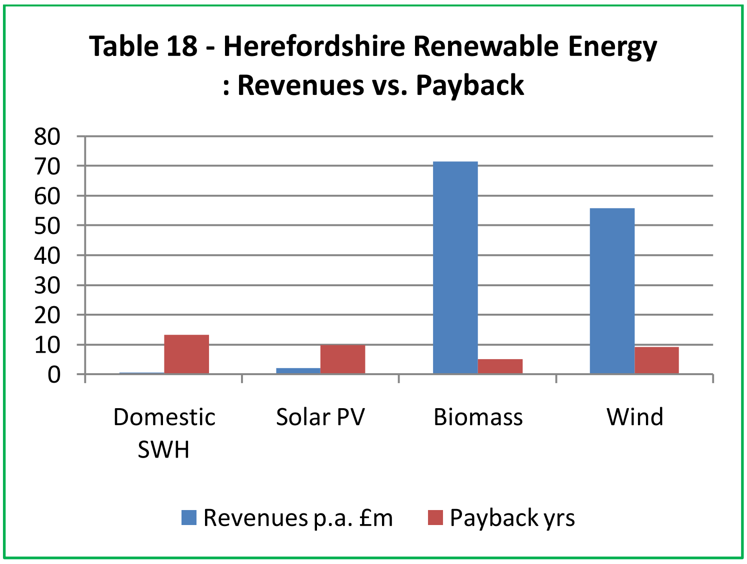
Table 21 – Summary : Herefordshire Renewable Energy Generation : Costs / Revenues / Payback

	Costs £m	Revenues p.a. £m	Payback yrs
Solar PV	20.7	2.1	9.8
Biomass *	365.8	71.6	5.1
Wind	513.1	56.0	9.2
Domestic SWH	9.4	0.7	13.4
Total	**909.0**	**130.4**	**9.4**

*Costs here cover boiler installation only; revenues include both Retail and RHI

This conclusion may be seen graphically in the chart below. Taken together wind and biomass attract revenue streams totalling £128m annually, and with payback periods of under 10 years for wind and only 5 years for biomass these have the potential to impact positively on the local economy in a decisive way, over a comparatively short period. Together they account for 98% of costs and 97% of resultant revenues. We have acknowledged above that further work will be necessary to establish the true cost of creating biomass infrastructure, beyond boiler installation, and it is apparent that wind carries a particularly high infrastructure cost. Nevertheless, the year-on-year benefits to the local economy could quite soon be expected to outweigh these costs.

Overall, £900m of infrastructure costs would be needed to instal capacity generating £130m per year, so that overall initial costs could potentially be defrayed over about 9 years.



Further, we should bear in mind that in many respects the expenditure on infrastructure costs will amount not to a lost outlay but to an immediate investment in the local economy, on the basis that wherever possible construction services, materials and equipment will be procured locally. For example, the table below drawn from a Carbon Trust case study summarises the costs involved in commissioning a 750kW biomass boiler as part of a sawmills operation[84]:

750kW Wood chip boiler and ancillaries	£122,000	9%
Fuel feed system	£20,000	1%
Accumulator tanks	£20,000	1%
Flue system	£18,000	1%
Transport and delivery	£10,000	1%
Boiler house and civils works	£189,000	14%
Mechanical installation	£192,000	14%
Electrical installation	£40,000	3%
Controls	£8,000	1%
Wood chip store	£39,000	3%
Design and project management	£6,000	1%
Total project costs	£664,000	100.0%

Items in italics hold the possibility for local procurement, in part or in whole, and altogether these items account for some 37% of the total cost. Far from being lost, this capital expenditure could therefore to a significant degree remain circulating in the local economy.

In similar vein, Renewable UK (formerly the British Wind Energy Association) maintains that research conducted in partnership with DECC "has shown that for each installed megawatt of wind power, around £100,000 stays in the community during the lifetime of a project."[85]The deployment outlined above in Table 20 totals 200 MW and would therefore imply £20m of long-term investment into the local community and the local economy. It is in this light that we should approach the issue of

[84] CT – 2; costs associated with kilns installation excluded

[85] RUK - 2

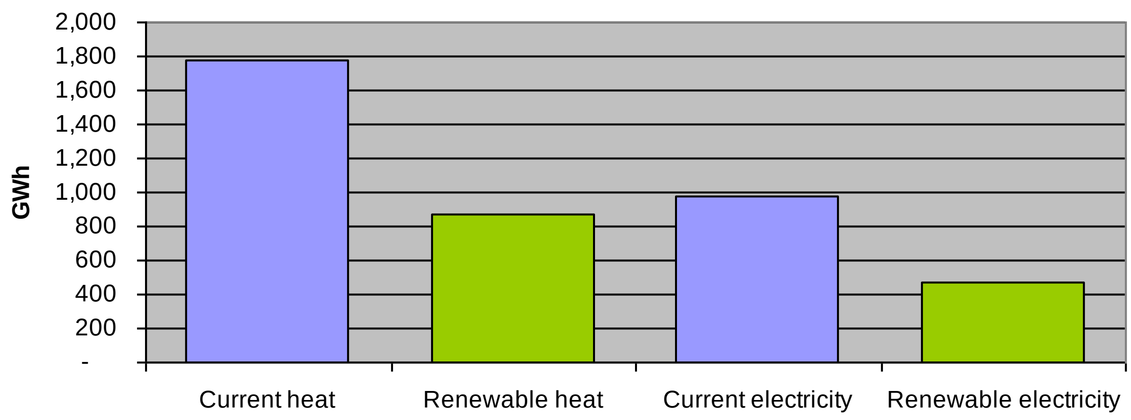
infrastructure costs, seeking to ensure that wherever possible such expenditure 'stays in the community' for the project lifetime.

- ***Summary of Potential Benefits***

Herefordshire enjoys a wealth of potential. Studies such as HRES and others have identified renewable capacity in wind, solar, biomass, hydro, ground and air source heat pumps, which could theoretically provide 20.8 TWh of heat and electricity per year and generate economic value worth hundreds of millions of pounds. While this theoretical capacity is necessarily hedged with caveats, it demonstrates the long-term potential for local renewable energy industries.

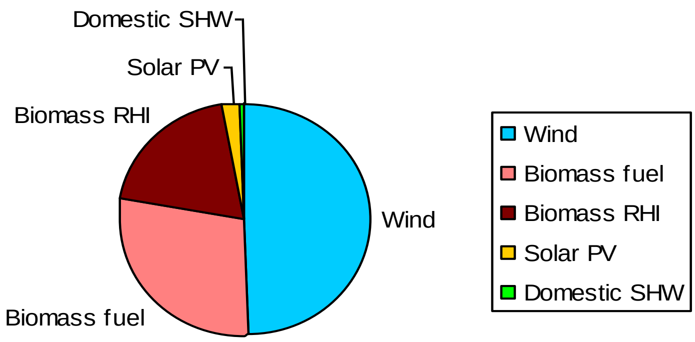
In the shorter term, more practical estimates have been developed above based on HRES recommendations for short term priorities, which they note reflect a range of political, planning, and economic constraints. Adding these capacities together, we find that Herefordshire could supply nearly half of its own energy needs in the short term. See Figure 3, below.

Figure 3 - Current demand vs local renewables



We have calculated indicative economic values for owners of renewable energy systems and suppliers of biomass fuel. These economic values are based on a range of monetary flows, including Renewable Obligations, wholesale electricity prices, Feed in Tariff, Export Tariff, Renewable Heat Incentive, and sales of locally produced biomass fuel. Taken together, these flows amount to about £130 million per year, equal to half the county's current annual spend on energy (excluding transport). As seen in Figure 4, below, the renewables mix is dominated by wind and biomass comprising over 97% of this initial value.

Figure 4 - Local "retail value" for suppliers & end users



Benefits to the Local Economy : Revenues in relation to Costs

Infrastructure **costs of about £900m** would create a renewable energy **revenue stream worth £130m per year** across all five renewable technologies.

This equates to a **payback in 9 years** on an investment which would **create a local energy industry capable of supplying some 50% of present county expenditure** on energy.

Wind and biomass together account for **98% of the costs, and 97% of the resultant revenues**.

By supplanting the imports with local renewables, businesses, households and the local economy would benefit from **greater stability and security** in energy supply.

Assuming local procurement takes place wherever possible, these capital costs would also create a substantial **direct injection of support into the local economy.**

Benefits to the local economy will be **further enhanced by the 'local multiplier' effect and by community ownership**, for example in the form of co-operatives.

* These conclusions do not describe the entire scope for renewables but only those prioritised short-term.

* * * * *

What would the above projections mean for the local economy and for local employment?

The calculations above of the "retail value" of income and subsidy streams flowing to owners of production systems and to suppliers provide an initial indication of potential local economic value. It is likely however, that some of the owners of energy systems - particularly large wind turbine projects for example - may be located outside the county. In this case, profit, dividends, loan servicing, and other costs associated with operations and maintenance would be diverted away from local circulation. To avoid this loss, wherever possible co-operative or community and other forms of local ownership are to be preferred.

- ***Local Multiplier***

Further research would be needed to say what percentage of the £130m would remain in local hands or be spent locally, but wherever the local beneficiaries of this income - be they householders or local businesses - in turn purchase local goods and services, the 'local multiplier' could make every pound spent into the local economy worth significantly more than face value.

According to the New Economics Foundation (nef), £1 spent in a local shop on locally made goods could be worth as much as £2.20[86] in local economic benefit. In a study done by nef for Northumberland County Council, the local multiplier was calculated at £1.76. It would be impossible without extensive analysis to estimate accurately what a general local multiplier might be for Herefordshire.

If, for the sake of this exercise, we make a conservative assumption that a local multiplier for Herefordshire could be £1.50 (an additional 50% of value due to local circulation), and also assume that 20% of the above £130m leaves the local economy, then the remaining £104 million spent locally could actually be worth £156 million per year to the local economy.

If the local multiplier in reality turns out to be higher, and if a greater proportion is spent locally, then that number goes up, potentially to somewhere in the region of £200m each year. Ultimately what this means for Herefordshire is that more wealth is retained locally, supporting more locally-owned companies and more jobs, providing greater levels of economic resilience along with greater individual and social wellbeing.

Building the renewables capacity outlined above will require substantial investment by developers and those in the local supply chain, as well as by smaller scale domestic and business investors. Investment requires confidence that the outcome will be worthwhile, and that a change of approach will bring greater benefits than a 'business as usual' approach. However the costs of this new build are met, it is clear from the foregoing that there is real potential available to be tapped, in the form of greater energy security for businesses and for ordinary citizens, along with the creation of new skills and jobs at various stages of the value chain. We turn now to consider the employment benefits of taking this action.

[86] NEF - 1

- ***Job Creation : Wind Energy***

According to the Onshore Wind: Direct & Wider Economic Impacts (OW) study[87], job creation corresponds to four lifecycle stages: development, construction, operations and decommissioning. For wind turbines, manufacturing and most of the supply chain originates outside the UK. The study breaks down job creation into categories for the UK as a whole, regional and national, and local, corresponding to categories of work performed according to technical function and geographic coverage. A finance team working for a large developer might be based in London but support projects all over the UK, for example.

While some local jobs can be created in all stages, most direct local job creation occurs in the operations and maintenance stage. Using results from the OW study, about 0.2 full time equivalent (FTE) local jobs are created per installed MW of large wind turbine capacity. Applying this ratio to the assumed build of large-scale wind capacity in Herefordshire of about 120 MW, we can expect about 21 new local jobs and about 6 or 7 indirect jobs.

This may be low, given that some “UK” and “regional and national” jobs may also be created within the county. Another study, “Wind at Work”[88,] provides corroborative evidence finding that 0.33 operations and maintenance jobs are created per installed MW. The majority of local jobs are created in this category of employment and, using this factor, our local job creation estimate would rise to 39.

It is not clear whether these job creation factors would apply to medium-scale wind turbine installations. While most would likely be deployed similarly - i.e. in small farm configurations tied directly to the grid - there would be marginally more installation, operations and maintenance costs per installed MW. In our assumptions above, we look at a build of 81 medium-scale turbines with a total rated capacity of about 20MW, which would imply less than five new jobs. However this is probably too low, failing to account of the fact that smaller scale developments will often be undertaken by local companies, some at least of which would be community owned. This would create more local jobs in development and construction stages than would be the case with large-scale projects. Even then the model indicates 7-10 direct jobs, with a meagre number of indirect jobs also created.

Table 22 - Herefordshire Wind Energy Job-Creation

	Direct	Indirect
Large scale	20	6
Medium scale	8	2.4
Small scale	70	30
Totals	98	38.4

For domestic-scale wind turbines, the situation is quite different due to the fact that, except for manufacturing, nearly the entire value chain will be populated by small companies. A study by Renewables UK[89] indicates that the UK enjoys a strong comparative advantage in the small turbine industry with a robust manufacturing base, making aggressive deployment of small wind turbines potentially a strong job creator for the entire country. According to the report, the sector could create between 5,400 and 8,900 direct jobs, and another 2,900 to 5,300 indirect jobs serving various

[87] BE - 1
[88] EWEA - 1
[89] RUK - 1

functions up and down the supply chain in the UK. For Herefordshire, a strong growth in deployment of small-scale wind turbines could therefore result in supporting a relatively large number of small companies and new jobs.

No major wind energy manufacturing companies are located in Herefordshire at this time, although there are one or two smaller ones. Nevertheless it is probable the county could enjoy strong job creation in this sector, especially in installation, operations, and maintenance functions. We can extrapolate from the models developed in the above study to estimate potential job creation. If small-scale turbines were built according to the assumptions developed above – that is, over 4,000 new installations - about 70 direct and 30 indirect new full time equivalent jobs would be created.

- ***Job Creation : Solar Energy***

In solar PV, most of the job creation will be in the construction and installation stage. According to "Solar Generation 6", a study produced by Greenpeace and the European Photovoltaic Industry Association, as many as 30 FTE jobs are created per MW of solar PV modules manufactured and installed[90]. There are no solar manufacturing plants in Herefordshire, however local jobs could be created in direct employment in assembly, installation, operations and maintenance, as well as indirect employment in sales, marketing, finance and other supporting functions. According to other studies[91], manufacturing accounts for about 25% of direct employment. The remainder is in installation, systems integration, and construction– functions which can be delivered locally and often are.

Taking this into account, local job creation may be approximately 22 direct and indirect jobs per installed MW. The assumption developed above indicates a little over 14MW of capacity could be installed in the short term, implying new job creation of perhaps as many as 300 new direct and indirect jobs in the sector.

Table 23 : Herefordshire Solar PV & SWH Job-Creation

	Direct and indirect jobs
Solar PV	300
SWH	23
Total	323

For solar water heating (SWH), there are few studies addressing job creation, most likely because the sector remains a small niche technology. This is likely to change with the roll-out of the Renewable Heat Incentive and the Green Deal. In the assumptions we have developed above, an aggressive build out of SWH would amount to nearly 2,000 installed systems. Given a similar value chain profile, heavily reliant on post-manufacturing job functions such as systems integration, construction, installation, sales and marketing, the job creation factor may prove similar to solar PV, resulting in around 85 new jobs.

However this may be too optimistic. In the one study identified, which is from Canada[92], the estimate was 6 jobs per 1,000m^2 installed - 1m^2 equates to about 450kWh/year. Working with the

[90] GRP - 1
[91] CRS - 1
[92] CSIA - 1

assumptions above, that would imply creation of about 42 jobs for the entire value chain, with installations comprising about half. This seems low. More study is needed, but for our purposes we will use the most conservative estimate of 23 jobs, following the Canadian study.

- ***Job Creation : Biomass Energy***

Fuel-based renewable technologies are robust job creators. Above we looked at wood waste and forest residue, miscanthus and SRC willow. According to the HWSC study, jobs in a wood fuel supply chain would include biomass installation and engineering, wood fuel processing, woodland management, installation operations and maintenance, and even potential jobs in the local authority. The study cites the Sustainable Development Commission's report "Woodfuel for Warmth" which claims [93].:

> *"Megawatt for megawatt, wood fuel heating creates between five and ten times more jobs than other renewable technologies, and also more than nuclear."*

The study cites research that found 19-25 jobs could be 'sustained' for every MW 'generated' by woodfuel derived from forestry sources and from sawmill waste: 15 to 20 of these would be in construction phase, and a further 4 to 5 would be ongoing in the operational phase.

If we use the figures in Table 17 above for 'installed capacity' and combine 'forest residues' with 'waste wood' - since over 90% of 'waste wood' originates from sawmill, orchard and pruning waste - we have a combined total of 179 MWth. Applying this figure as above suggests that 2,700 to 3,600 jobs could be created in construction phase with a further 630 - 800long-term operational. Disregarding at this point the construction jobs, although these are worthy of note, it seems reasonable to conclude from this information that about 630 or more long-term jobs would be created from the woodfuel component of biomass.

So far as energy crops, a study completed for DECC[94] indicates job creation factors for miscanthus and SRC willow per oven dried tonne at 0.000852 FTE and 0.000945 FTE (i.e. full time equivalent) respectively. Based on our assumptions above, this would indicate about 91 new jobs in the miscanthus production and about 6 for SRC willow.

Table 24 summarises these figures :

Table 24 : Herefordshire Biomass Job-Creation

	Direct and indirect jobs
Woodfuel	630
Energy crops	97
Total	**727**

[93] SDCS – 1 p41
[94] NNFC - 1

- ***Job Creation : Summary***

As shown in Table 25 below, the assumptions developed based on the work of HRES would lead to the creation of nearly 1200 new full time equivalent jobs in Herefordshire. Induced employment has not been included, nor additional employment resulting from new spending across other sectors from renewables workers. These are additional benefits.

Table 25 : Herefordshire Local Renewables Job-Creation

	Direct & Indirect
Wind	136
Solar	323
Biomass	727
Total	**1,186**

Simply counting the numbers, however, does not take into account that these hypothetical new workers will need to acquire the skills required to do the work. Implied in all the considerations above are a range of new skills and categories of work for which the potential job force in Herefordshire will need to be prepared. This poses both a challenge and an opportunity.

The challenge is to facilitate this 're-skilling' in step with the needs at each stage of development. Failure to meet the 're-skilling' challenge would leave the county vulnerable to loss of many of the benefits of instigating local renewable energy production.

The opportunity on the other hand, is for public, private, and community sectors to work together to make available the training and education programmes required by the county's youth, its unemployed and underemployed. This will also entail engaging those in related fields where existing skills and know-how can be adapted, such as in the construction trades. This training programme will in turn have the potential to support or create many jobs.

Benefits to the Local Economy : 'Local Multiplier' and Employment

Money retained in the local economy adds value with each exchange so that £1 can potentially **double its face value** in terms of real economic and social benefit : this is the 'Local Multiplier effect'.

Across the four renewable technologies considered, we estimate that **1200 new, sustainable full-time-equivalent jobs** would be created.

In the **construction phase thousands of additional jobs** would also be created : estimates suggest about 3,000 for biomass construction alone.

Training programmes will be required to 're-skill' the county's youth and its workforce which will in turn support or create jobs in education and in businesses that have the necessary know-how.

* * * * *

What would this mean for the local community, the local environment, the wider environment?

As outlined above, thriving local renewable energy industries like wind, solar, and biomass, would deliver many socio-economic benefits to Herefordshire, such as:

- New companies and new, more meaningful jobs will create opportunities for young people to remain in the area, so helping to address demographic problems caused by over-representation of elderly and under-representation of youth.
- Utilising existing local biomass resources means new livelihoods for experienced agricultural workers, who can also train younger generations in traditional and recently-developed skills.
- New money flowing into the county in the form of company revenues, rents, subsidy payments and so forth, could circulate within the community helping to drive a rise in local spending and saving.
- This in turn could support reinvigoration of high streets around the county.
- Once a biomass industry takes hold, woodlands around the county will increasingly become better managed and more productive, where presently they are often in poor condition producing little.
- This will in turn encourage local biodiversity, the proliferation of local species of flora and fauna, and the growth of outdoor skills, opening up direct opportunities for training, services and manufacture, and spinoff businesses in recreation, tourism and care.

Other renewable technologies such as micro-hydro, ground and air source heat pumps have not been considered here, however they too could contribute locally produced energy and new jobs.

As an exemplar, featured in the county's Economic Development strategy document[95], the county already has a prominent manufacturer which started out in refrigeration and now produces heat-pumps, employs some 85 people and recently won an industry award as an 'environmental pioneer'. Expansion of such businesses would be supported by a strategy of growing a localised energy economy, and they would in turn help to grow that economy in a 'virtuous circle' of development.

Furthermore, in adopting a programme to build renewable energy capacity, the county will also be doing its part to reduce carbon emissions. If the renewable opportunity is realised as described above, it would offer a significant reduction in emissions, helping the local authority to meet its obligations under national policy for both reductions and renewable energy generation.

This could become a point of pride for the whole community- and community wellbeing is at the heart of creating resilience. While there are no fossil-fuel energy plants in the county, reducing reliance on fossil fuels will mean that the county itself and neighbouring communities all benefit from reduced air pollution and concomitant health problems. People might feel more positive about their own future and that of their local community, knowing that they are part of the solution.

Feeling positive towards one's county could set in train other developments, such as perhaps establishing a beacon programme in Herefordshire for renewable energy which would boost eco-tourism, and attract visits from interested professionals and government leaders from elsewhere so further building reputation and civic pride.

[95] HC – 4 p8

With a resilient economy and a resilient community, Herefordshire can be expected to survive future challenges successfully and with minimal damage to productivity, health and social cohesion.

* * * * *

Conclusion

So, the process of creating greater self-reliance in energy makes not just the economy but the community more resilient, too. As awareness grows about clean, renewable energy and its part in growing a stronger local economy, perceptions, attitudes and behaviours in other areas such as food and housing are likely to change also. In those areas too, alternative ways to strengthen the local economy and place it on a sustainable basis are needed and available. These are the subjects of two companion reports to this.

In concluding we return to the principal intended outcome for this work :

> "***Better informed strategic economic planning and decision-making that will help build the resilience of the local economy, and so the local community, in the face of economic uncertainty, rising energy prices and climate change."***

The aims outlined in this report are, we suggest, strongly supportive of the stated aims of the county's economic development strategy "Enterprising County"[96]. These are :

- ✓ Sustaining business survival and growth
- ✓ Increasing wage levels, range and quality of jobs
- ✓ Having a skilled population to meet future work needs
- ✓ Developing the county's built infrastructure so enterprise can flourish

A strategic decision to resolutely set foot on the path towards a strong renewable energy industry in the county could well be celebrated by future generations, as one of the wisest achievements of the present generation of Herefordians.

It is to be hoped that this report - along with the companion reports on food and housing - will engender and inform the necessary conversations and debates leading to that decision.

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With sincere thanks to all those who contributed in any way to creating this report – your advice, input and feedback were greatly valued.

Herefordshire Economic Evaluation - renewables detailed report- final version ns.docx

[96] HC – 4 p7ff