NP4B – Energy and Infrastructure

1. Energy consumption

The latest available data is for 2014 and details domestic electricity and gas use and number of meters by Lower Super Output Area. These nest neatly into the 4 Belper Wards. Non-domestic gas and electricity use is given by Middle Super Output Area which encompass a wider area than Belper itself. However, given that the vast majority of non-domestic use will be in Belper itself this should make little difference.

The non-domestic electricity use measured through half hourly meters is proportional to the Amber Valley total number of meters as this data is only available at local authority level and relates to high users.

	Domestic Electricity	Domestic gas	non-domestic electricity	half hourly meter electricity (proportional to AV total)	Non-domestic gas	Total
Total consumption (kWh)	37,533,067	127,591,613	16,647,456	72,571,676	35,298,642	289,642,453
Total number of meters	10,183	9,530	834	65	87	20,699
Mean consumption (kWh per meter)	3,686	13,388	19,961	1,121,511	405,732	
CO 2 emissions (kg)	20,755,786	26,921,830	9,206,043	40,132,137	7,448,013	104,463,810
emissions per meter	2,038	2,825	11,038	620,196	85,609	
ave bill per meter	£601.90	£708.25	£3,259.63	£183,142.75	£21,463.20	

CO_2 emissions and costs – data from Nottingham Energy Partnership – see:
http://www.nottenergy.com/energy_cost_comparison/

It is worth noting the comparative data for 2009 and the per domestic meter reduction in electricity and gas use:

Ward	Electric meters	Electric use (kWh)	Average electricity per meter (kWh)	Gas meters	gas use (kWh)	Average gas per meter (kWh)	total domestic energy use (kWh)	Average dual fuel energy (kWh)
Belper Central	2,579	10,483,524	4,065	2,356	40,346,756	17,125	50,830,277	21,190
Belper East	2,517	10,442,207	4,149	2,361	37,965,443	16,080	48,407,652	20,229
Belper North	2,249	8,635,682	3,840	2,132	38,053,099	17,849	46,688,781	21,688
Belper South	2,573	9,965,626	3,873	2,363	37,702,678	15,955	47,668,304	19,829
Total	**9,918**	**39,527,039**	**3,985**	**9,212**	**154,067,976**	**16,725**	**193,595,014**	**20,710**

In order for Belper to be self-sufficient in buildings related energy we would need to generate 290,000 mWh of electricity and gas combined.

2. Solar PV

A study commissioned by Transition Belper in 2012 used a desk-top study to assess the potential for solar pv in Belper. The study looked at every building and conservatively estimated that:

- 36,748 panels could be installed in Belper generating some 7,167,211 kWh annually – or about 2% of current energy use
- Some of the findings of the study were checked on the ground by T4 Sustainability who considered the results to be conservative. They estimated that the projected results could be increased. A more realistic figure is 62,582 panels generating 12,206,234 kWh annually – approximately 4.2% of total energy demand or 32% of the domestic electricity demand.

- The study excluded buildings such as the East Mill and Whitemoor Medical Centre as they could not determine the roof configuration
- An average 3.8kW system, given storage, will satisfy the electric demand for the average domestic dwelling in Belper
- Advances in PV technology could result in a clear film becoming available that could be applied to all South facing (plus SE and SW) windows to increase the generation potential of solar pv
- Home owners, landlords and businesses should be encouraged to install solar pv and either a new CIC or the Town Council encouraged to find the funds to develop a rolling solar pv installation fund that would pay the up-front costs of installation to be repaid through FiT payments and electricity bill savings.

3. Hydro electricity

Approximately 2.12 million kWh of electricity is already generated by hydro schemes at Belper's East Mill and at Milford but the River Derwent affords much greater scope for electricity generation. There is the potential, at least, to install hydro schemes at Ambergate and another scheme at Milford.

Current generation:

- East Mill, Belper 1,767,000 kWh (electricity for 479 homes)
- Milford 971,000 kWh (electricity for 263 homes)

Potential generation

- Ambergate 1,300,000 kWh (electricity for 353 homes)
- Milford 500,000 kWh (electricity for 135 homes)

If we are looking locally one would assume that the electricity generated at Ambergate would be used to power Ambergate homes and businesses. Hydro power has the potential, therefore, to provide electricity for 877 homes in Belper or around 8% of homes. It should be noted that ADVyCE – Amber and Derwent Valley Community Energy – have developed proposals for a hydroelectric scheme at Ambergate that have had to be shelved as the scheme is not viable with the current levels of Government support.

4. Green Gas

Energy Company, Ecotricity, have developed a viable model for converting grass to biomethane gas that can be fed into the gas network and used for heating, cooking etc. as now.

What is Green Gas?
Green Gas (or biomethane) is a type of gas created from biodegradable material (such as plants) that can be used in the same way as traditional fossil fuel gas for cooking and heating in the home.

Biomethane is created by turning biodegradable material – in Ecotricity's case, it's grass – into gas using a process called Anaerobic Digestion. This creates a biogas and a natural fertiliser.

The biogas is then purified using a method called "scrubbing" to produce biomethane (or Green Gas), which can be injected into the national gas grid alongside traditional gas (which is fossil fuel-methane drilled from underground).

The main difference between biomethane and fossil fuel-methane is that biomethane is virtually carbon neutral, so doesn't contribute to Climate Change.

This is because biomethane recycles existing carbon in the atmosphere, which is absorbed by plants as they grow, while fossil fuel methane introduces new carbon into the atmosphere that had been stored harmlessly underground.

What are Green Gas Mills?
Green Gas Mills are Ecotricity's method of using Anaerobic Digestion to:

- Produce gas from grass
- Improve soil quality
- Support food production
- Financially assist local farmers
- Create wildlife habitats and replace inputs that damage the environment in conjunction with FWAG, Defra and Natural England.

What is Anaerobic Digestion?
Anaerobic Digestion (AD) is a commonly used process that uses bacteria to breakdown (or decompose) biodegradable material – in Ecotricity's case, it's grass – in an oxygen-free container. As the grass decomposes, it releases a biogas and creates a natural fertiliser.

(NOTE: The Anaerobic Digester or AD plant is similar to a large compostor, except the process is in an oxygen-free closed loop environment).

The biogas is then 'scrubbed' to purify it, leaving biomethane that can be injected straight into the gas grid as a replacement for traditional gas (which is fossil fuel methane).

Why is grass used to create Green Gas?
Ecotricity will use grass as our main input because it is readily available and consistent in quality – which is vital given the high quality and purity of gas required by National Grid.

1. The first source of grass will be from marginal grassland pasture that is little used for grazing. The latest statistics[i] from the Department of Environment, Food and Rural Affairs (Defra) shows that the UK countryside has 8.4 million hectares of marginal land nationwide.

Also the amount of grassland used for grazing cattle has almost halved since 1990, meaning an increased availability of under utilised grassland that can be harvested.

NOTE: Grazing livestock numbers have declined over the last decade mainly due to changes in subsidies(the transition from a 'per head' based agricultural subsidy scheme to a 'per acre' based scheme, meaning market forces will determine grazing livestock numbers). Also farming styles have changed over the past two decades with much livestock now housed in large barns for much of the year rather than grazing in fields.

2. The second source of grass will be a break crop (i.e. grown in rotation for 2-4 years), on lower quality farmland that is currently used to grow feed crops for livestock animals. We will not use medium to high quality land that is used to grow food without providing additional food crop benefit to the land and its environment.

How do Green Gas Mills improve land quality?
The Green Gas Mills concept improves land quality in two ways:

1. Introducing crop rotation, with a grass crop grown for 2-4 years, helps break disease and fungal cycles in the soil and its environment
2. Applying a natural fertilizer, created during the AD process, onto the soil will replace synthetic fertilizers.

Both these changes will help to improve soil health/condition and reduce dependence on synthetic chemicals and fertilisers – meaning after just two years this lower quality land will have improved to the point that it will now support food production for humans rather than only feed production for animals.

In addition, the reduction is synthetic fertilisers and other chemicals will help the surrounding environment and water quality, which can be severely damaged by the over-application of nitrogen-rich artificial fertilisers and other chemicals such as pesticides.

How do Green Gas Mills support food production?
The Green Gas Mills concept will support food production in two ways:

1. Improving soil health/condition (see above) to the point that food crops for humans (such as wheat or potatoes) can be grown on the land in rotation with the grass crop – rather than growing feed crops for livestock
2. Providing the opportunity to improving margin by growing food crops (instead of lower value feed crops) in rotation with grass crops.

How do Green Gas Mills financially assist local farmers?
The Green Gas Mills concept will financially assist farmers in three ways:

1. Creating a 'share-farming' scheme that introduces a new commercial opportunity to grow grass, helping farmers to diversify and capitalise on land that may be underutilised and needs natural improvement
2. Improving margins by growing food crops (instead of lower value feed crops) in rotation with grass crops
3. By reducing the cost of using expensive synthetic fertilisers and pesticides and contribute towards renewable food production.

How do Green Gas Mills create wildlife habitats and replace inputs that damage the environment?
The Green Gas Mills concept will benefit the environment three main ways:

1. Harvesting marginal grassland pasture that is little used for grazing, will encourage the growth of wildflowers, creating new habitats for birds and insects such as pollinating bees which will increase biodiversity and improve the seed bank
2. Providing a natural fertilizer that reduces the need for oil based synthetic fertilizers that have a negative long-term impact on soil quality, water quality and are responsible for 5% [ii] of Britain's carbon emissions
3. Making green gas that virtually carbon neutral that replaces high carbon fossil fuel gas will help to reduce the UK's overall carbon emissions.

What makes Green Gas better than Fossil Fuel Gas?
Fossil Fuel Gas (also known as 'natural gas') is methane, extracted from underground – either by traditional drilling or via fracking.

Green Gas (also known as biomethane) is also methane but it's derived from living biodegradable material, like plants or algae, which grow by atmospheric carbon sequestration.

What makes Green Gas better than Fossil Fuel Gas is that Green Gas is carbon neutral, so it doesn't introduce more carbon dioxide into the atmosphere and contribute to Climate Change.

This is because Green Gas recycles existing carbon dioxide taken out of the atmosphere, and absorbed by plants as they grow, while Fossil Fuel Gas introduces new carbon dioxide into the atmosphere that had previously been stored harmlessly underground.

Green Gas can displace Fossil Fuel Gas that is currently imported from overseas and makes such a large contribution to UK carbon emissions. It is also a viable alternative to future fracking.

Isn't Anaerobic Digestion already common in Britain?
Yes. Anaerobic Digestion is a proven technology that is already very common across Britain, with more than 300 plants operating at farms, factories, and water treatment works around the country.

The biodegradable material used at these sites might be slurries (animal manure), crop waste, food waste, human sewage, etc...but the resulting biogas it is primarily burned to create electricity.

So Green Gas isn't already common in Britain?
Not biomethane. Fewer than 20 of the over 300 AD plants around the UK produce Green Gas that's made by converting the biogas into biomethane and injecting it into the National Gas Grid.

Most of those 300 existing plants burn the biogas to generate electricity, often to power their on-site operations on the farm, factory, or water treatment works.

The tough part in the Green Gas process is producing a biogas that has a consistent quality or purity, so that it can be converted into biomethane using a process known as scrubbing.

To achieve this, you need a consistent quality or purity of biodegradable inputs. Which is why we are using a grass feedstock to give us a consistent quality of input.

What happens if you don't have consistent quality of biodegradable material?
The biogas that is produced is far more difficult to scrub and convert into biomethane of sufficient quality to meet the strict gas specifications stipulated by the National Grid.

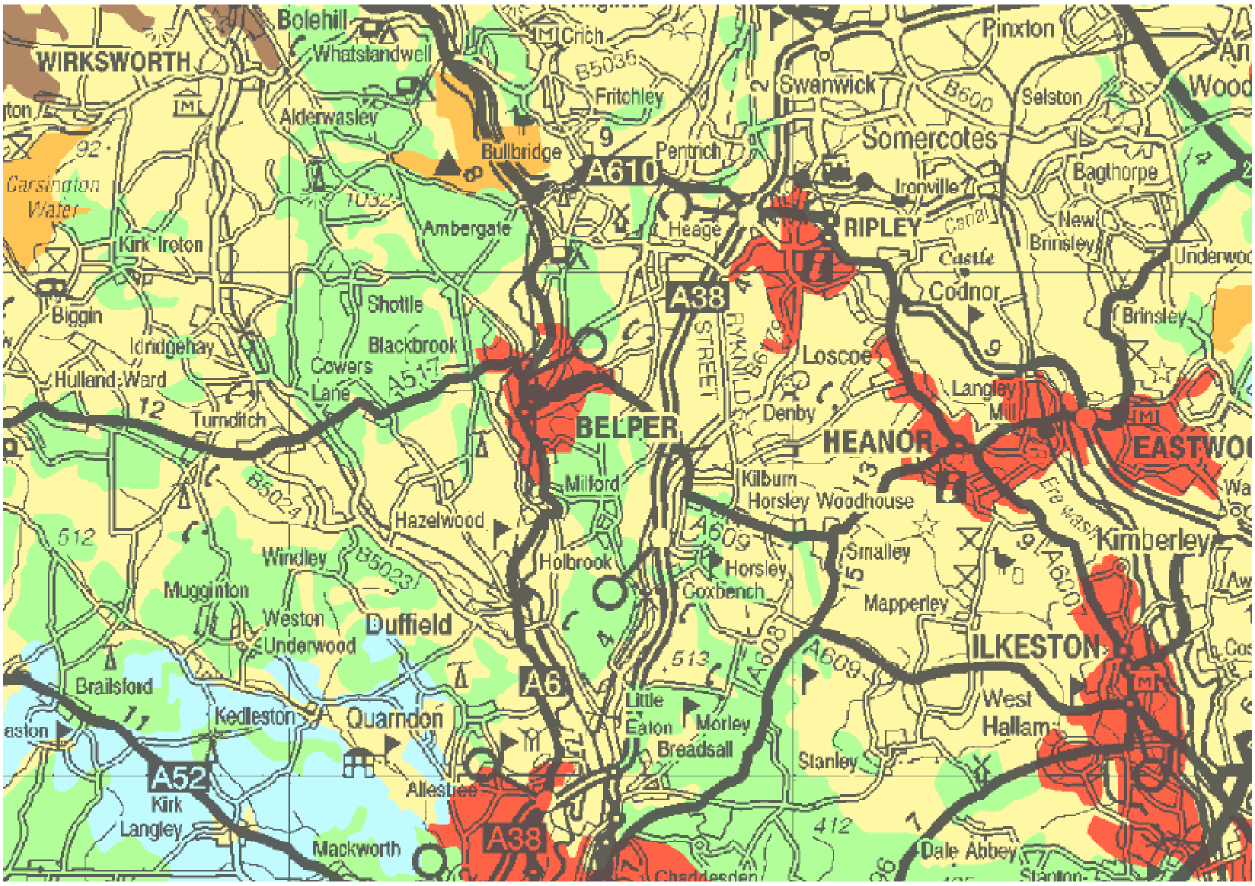
How much land will need to be turned over to growing grass for gas?
For an AD plant supplying almost 6,000 homes we will need 1670 hectares of land or 5% of land within a 10km radius of the plant or 1% within 15 miles.

Won't food production be reduced on the land you use?
We will not be using land that is currently used to grow food for human consumption. Only little used grazing land or lower quality land that is used to grow feed for livestock.

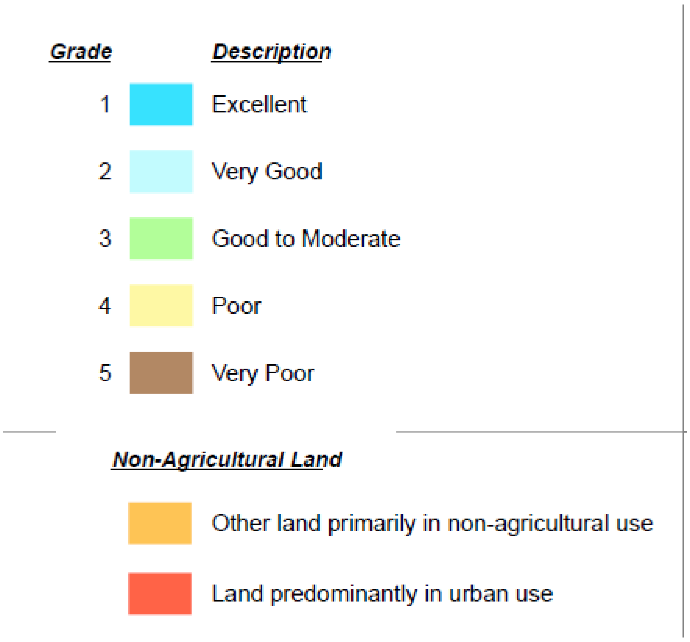
In fact, the Green Gas process will improve the lower quality farmland to the point that food crops for humans (such as wheat or potatoes) can be grown on land – in rotation with the grass crop – that was previously only of sufficient quality to growing feed for livestock.

Won't Green Gas Mills mean lots of extra truck movements?

There will be localised truck movements but these will be restricted to trucks driving between the local farms providing the feedstock to the AD plant. The farms providing the feedstock will be restricted to a 15-mile radius around the AD plant to keep transport miles and emissions to a minimum. Down the line, a transition to using green gas powered trucks will further improve the technology towards carbon neutrality.



Source Defra 2011



20 Hectares = 450m x 450m and land quality of Grade 3 or worse is needed for a gas mill.

1670 hectares = 16.7km x 100m or 8.35 km x 200m or 4.175 km x 400m which can be in small parcels within 15km of the mill.

An article in Farmer's Weekly in May 2015 appealed for farmers to come forward with potential sites for green gas mills and the grass required to feed them:

Green energy supplier Ecotricity has launched a UK-wide scheme to expand the production of biomethane from farm-based anaerobic digestion (AD).

These will feed gas directly into the distribution grid from leased sites on farms.

Through its Green Gas Mills project, the company is looking for farm sites to build and operate its AD plants in return for a long-term rental payment. It also wants to recruit farmers to supply feedstocks, principally grass for silage.

Ecotricity will cover feasibility, planning, design, construction, operation and plant maintenance costs, and will negotiate power purchase agreements. The farmer or landowner must remain an active farmer and maintain and improve stewardship management.

The firm will not reveal details of how much rental payments will be worth, the terms and conditions of contracts, or how the project is being financed, but a spokesman insisted agreements will be incentivised to make it worthwhile for farmers.

“Our AD plants will be matched to grid injection capacity and most sites are chosen for maximum capacity of 9.4MW thermal. Any larger and they are logistically demanding and less carbon efficient,” he said.

Ecotricity green gas plans

- Farm sites must be on Grade 3 land or poorer
- Crop contracts and digestate spreading subject to controls to minimise carbon footprint
- Contracts will incentivise grass silage production to make it competitive with growing for stock feed
- Host farmers must continue as active farmers
- Each Ecotricity Green Gas Mill will produce enough gas to power almost 6,000 homes

Three sites have been identified and should have planning applications submitted later this year. The first will produce 78.84GWh a year from 75,000t of grass and forage rye silage.

The company has no set target for how many projects it wants to build. “We are at the beginning of a revolution in gas,” said Ecotricity founder Dale Vince. “We can take what we’ve done with green electricity, which last quarter generated 22% of the UK’s electricity needs, and apply it to gas.

“Green Gas Mills will produce gas that is carbon neutral, supports food production and is sustainable, with the process improving the local environment rather than damaging it. It’s the antithesis of fracking.”

Sourcing feedstocks

As with any AD project, securing feedstock supplies is crucial to long-term viability. Ecotricity’s main feedstock will be grass silage to encourage carbon dioxide sequestration and reduce carbon footprint. However, forage rye may also be used, and the firm is looking at supplies from the food industry, such as waste potato peel from chip factories.

Ecotricity says feedstock will be sourced on flexible contracts, which will generally require a minimum area of 20ha incentivised to encourage renewal throughout the life of the plant, expected to be at least 20 years.

It says feedstock will come from marginal land, Grade 3 or poorer, in low grade arable use or under-grazed grassland – within a 15km radius of the AD plant, either from the host farmer or neighbours. All silage will be clamped at the AD plant site.

The firm is keen to minimise the carbon footprint of feedstocks and the entire energy generation process, so will require farmers to follow guidelines for growing crops and spreading digestate.

“To maintain sustainability measures we will rely on accurate, suitable and timely application of digestate to all of the growing areas,” the spokesman says. “This is an expensive part of each project operation but is justified by the saving of chemical fertiliser costs and the improved carbon neutrality of the operation.

“Commissioning each project will be based on its environmental credentials as much as its financial sustainability.”

Returns for farmers supplying feedstock are based on tonnage supplied and would be “sufficient to encourage AD feedstock production as an alternative to feed crop production, with the added benefit of soil improvement,” said the company.

Gas grid constraints

Gas grid connection can potentially be tougher than electrical grid connection and comes at a considerable cost, so projects need to be close to the injection point, said Ecotricity.

"Access to mains gas supply is a priority, as is the availability of summertime low consumption on the grid that can accommodate the output from the AD plant.

"Finding gas grid with available capacity is a limiting factor and unlike electrical grid, the gas grid capacity is very difficult to upgrade and in most cases impossible."

See: http://www.fwi.co.uk/business/farm-sites-wanted-for-gas-to-grid+project.htm

Conclusion

So, in order to provide environmentally friendly gas for almost 6,000 Belper homes there needs to be a grid connection point available locally, a site for the green gas mill and farms with sufficient land available to grow the crops used in the mill. If it were feasible and could be brought to fruition it would supply 80,328,000 kWh of gas or 63% of Belper's domestic gas consumption.

5. New Housing and buildings

No new housing or building should be connected to mains gas but should, instead, rely upon biomass boilers, heat pumps and solar thermal for heating and hot water requirements. Where there are new developments of multiple homes or buildings they should be heated through a 'district' CHP (combined heat and power) plant designed to burn locally grown bio fuels for heating all buildings in the development and providing power generated from the combustion. Developers should demonstrate contracts with local farmers/woodland to provide fuel.

Electricity should be provided by solar pv panels on south facing roofs or areas of glazing. The size of system for each building should be commensurate with the projected use of the building. Battery storage of electricity should be provided for.

Thus all new buildings should carbon neutral as well as energy efficient and fully capable of being 'off grid'.

6. Small wind turbines

It may be difficult to identify suitable sites for domestic wind turbines bearing in mind our topography. Where siting a small wind turbine is possible it should be encouraged except where visible from the core DVM WHS area.

7. Existing Buildings

7.1 Note that this section uses combinations of data that were available in 2012. Since then there have been some new houses built and one assumes that more houses have been insulated and become more energy efficient. The extent of these improvements is not likely, however, to have had a great impact on the figures below.

Using a combination of Experian household level data summarised to ward level, insulation installed data from the Energy Savings Trust's (EST) Home Energy Efficiency Database (HEED) and achievable carbon reductions by measure and house type from OFGEM's Community Energy savings Programme (CESP) calculator we can make fairly detailed projections for the four Belper wards for:

- **The number of dwellings by house type and age from Experian data.** Experian do not break their inter-war age band into pre or post 1930 but data from the Valuation Office Agency does so VOA proportions have been applied to the Experian data. Whether houses have solid or cavity walls is largely determined by age – those built before around 1930 generally having solid walls whilst those built later have cavity walls. Post 1980 houses should have cavity wall insulation and at least 150mm of loft insulation.
- **What measures have been installed locally.** The HEED database records all professionally installed measures contributing to the Government's Community Energy Savings Programme targets. It also records much dwelling and insulation detail obtained through surveys, questionnaires and the like. In all HEED has some data for around 40% of all UK homes.
- **The remaining potential for carbon emission reductions.** Using the combined data with the standard reductions as used by OFGEM to calculate whether energy suppliers are meeting their carbon reduction targets we can see what there is left to do in terms of insulation

7.2 The dwelling mix

	Pre 1919	Inter war - solid walls	Inter war - cavity walls	1945 - 1980	post 1980	Total
Flats	238	42	120	126	118	643
Terrace	890	153	430	188	403	2064
Bungalow	55	66	202	502	133	958
Semi-detached	446	277	834	829	736	3123
Detached	305	142	505	759	1343	3055
Total	**1934**	**680**	**2091**	**2404**	**2733**	**9842**

7.3 The full potential as built

The table below calculates the potential carbon emission reductions and assumes:

- Solid wall = solid wall insulation, loft insulation top-up, draught proofing and boiler replacement
- Cavity wall = cavity wall insulation, loft insulation top-up, draught proofing and boiler replacement
- Post 1980 = loft insulation top up, draught proofing and boiler replacement

	Solid wall	Solid wall	Cavity wall	Cavity wall	Post 1980	Total
Flats	336,027	63,069	122,827	130,932	86,543	739,397
Terrace	1,369,735	242,998	456,131	204,352	310,226	2,583,441
Bungalow	132,678	167,031	328,079	813,505	154,450	1,595,743
Semi-detached	1,207,998	462,149	1,392,797	1,379,887	850,632	5,293,461
Detached	1,293,279	463,541	1,214,121	1,818,899	2,281,164	7,071,004
Total	**4,339,716**	**1,398,787**	**3,513,955**	**4,347,574**	**3,683,015**	**17,283,047**

The full potential for reductions from the built condition is 17,283 tonnes CO2 or 81,910,000 kWh of gas – enough to heat around 6,000 homes

7.4 Known measures installed

From the HEED data we can get some idea of what has already been installed but, as this is the data least likely to be accurate, it should be borne in mind that this is a projected scenario rather than an accurate measurement:

	Solid wall insulation	Cavity wall insulation	Loft insulation	New Boiler	Draught proofing
Flats	0	281	543	369	607
Terrace	0	841	1724	1170	1951
Bungalow	0	687	808	548	907
Semi-detached	0	1972	2598	1774	2961
Detached	0	2083	2488	1652	2843
Total	**0**	**5864**	**8160**	**5514**	**9269**

7.5 Carbon reductions already achieved

From this we can calculate the levels of carbon reductions already achieved in the Belper area from measures installed:

	Solid wall insulation	Cavity wall insulation	Loft insulation	New Boiler	Draught proofing	Total
Flats	0	63,218	63,049	218,506	34,330	379,103
Terrace	0	207,858	111,431	768,172	139,006	1,226,466
Bungalow	0	276,293	118,238	542,541	65,724	1,002,796
Semi-detached	0	931,300	220,979	1,782,201	271,316	3,205,797
Detached	0	1,676,073	287,895	2,364,994	321,990	4,650,951
Total	**0**	**3,154,741**	**801,592**	**5,676,414**	**832,367**	**10,465,113**

Total CO2 reduction from installed measures (kg)	10,465,113
Total CO2 reduction from installed measures (tonnes)	10,465.1
Revised potential kg CO2 reduction	**6,817,934**
Revised potential tonnes CO2 reduction	**6,817.9**

7.6 Potential remaining measures

When we deduct what has already been achieved from the original built potential we can see what there is left to do:

	Solid wall insulation	Cavity wall insulation	Loft insulation	New Boiler	Draught proofing
Flats	280	83	100	274	37
Terrace	1043	180	340	894	113
Bungalow	121	150	149	409	51
Semi-detached	723	428	525	1349	161
Detached	447	524	567	1402	211
Total	**2614**	**1364**	**1682**	**4328**	**573**

7.7 How much CO_2e can be saved by insulating?

The table below lists typical reduction figures for a range of measures and house types:

Measure	Annual CO_2e reduction per measure (kg)*				
	Loft Insulation (top-up)	Cavity Wall Insulation	Solid Wall Insulation	Draught-proofing (inc double glazing)	Replace Boiler
Flat, 1 bed	78	183	581	41	476
Flat, 2 bed	113	220	700	56	586
Flat, 3 bed	165	266	845	76	735
Mid terrace, 2 bed	58	233	728	66	617
Mid terrace, 3 bed	73	261	815	79	707
Det bungalow, 2 bed	134	385	1,233	68	935
Det bungalow, 3 bed	156	415	1,330	76	1,031
Det bungalow, 4 bed	180	446	1,429	86	1,133
Semi house, 2 bed	76	445	1,451	83	932
Semi house, 3 bed	87	479	1,560	94	1,023
Semi house, 4 bed	100	513	1,670	105	1,119
Det house, 2 bed	94	724	2,306	96	1,242
Det house, 3 bed	108	779	2,479	107	1,370
Det house, 4 bed	125	837	2,663	120	1,510
Average	**80-90**	**400-450**	**1,500**		

Figures (except averages) taken from OFGEM CESP Calculator

This section has described the need for and potential of insulation measures but can see no effective mechanism for achieving such savings in view of lack of funding and the difficulty of insulating solid walls in sensitive areas such as conservation areas and the WHS core and buffer zones. This will only be solved by reinstated government funding to insulate our homes.

8. Summary

It can be seen from the this report that a combination of applied insulation measures where possible and a green gas mill could result in Belper becoming self-sufficient in so far as domestic heating requirements are concerned. It is simply not possible for Belper to become self-sufficient in electricity – our aim should be to match the proportion of UK generated electricity from fossil fuel sources at least. As more renewable and carbon free electricity is generated the CO2 emissions from electricity will diminish and our carbon footprint will, likewise, shrink.

David George

7th April 2016