



Five Fords Energy Park

Welsh Water is a not-for-profit water company serving around three million customers in Wales and Herefordshire. Operating over 4200 sites to deliver a 24/7 service uses a lot of energy, almost 500 GWh a year. Over the last 8 years, the amount of energy generated has increased from just 2% to 20%. By 2020, when current investments are fully online, that proportion will have reached 30%. Welsh Water's long term vision is to meet all its own energy needs by 2050.

Meeting such an ambitious goal needs innovative thinking, not just investment. At Five Fords Waste Water Treatment Works near Wrexham that's just what Welsh Water have done. Near to an industrial estate just outside the town, an unremarkable sewage works is being transformed into an innovative Energy Park that aims to maximise the energy generation and carbon reduction potential of the site. It already integrates a large (2.5MW) solar array (PV), an anaerobic digestion (AD), a 1.2 MW combined heat and power plant

(CHP) and an innovative bio-methane injection (gas-to-grid) project. Over the coming years the AD will see a further upgrade to triple its gas output and the existing technologies

available biogas but then widened out as the potential became clear for maximising benefits for the company and its customers by utilising multiple renewable

energy technologies in tandem (AD, PV, CHP and gas-to-grid). We looked at the site and asked ourselves "How can we maximise the energy potential of this site?" All renewable energy technologies were considered and matched against the characteristics of the site (available space to develop, an open aspect and few immediate neighbours).

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will be complemented by wind and hydro. The site is now well on the way to becoming a net exporter of both electricity and gas, and shows a significant reduction in carbon emissions as it moves towards true energy self-sufficiency.

Plans and objectives

The project originated from a desire to make best use of the

- Available brownfield or low quality agricultural land in and around the operational site suited solar PV,
- an open aspect and few neighbours suit wind,
- an existing intermediate pressure gas main combined with forecasted increasing gas production from sewage bio-solids is ideal for bio-methane injection,
- and the elevation of 35m above the river even makes small hydro a possibility.



The project set out to achieve a range of objectives.

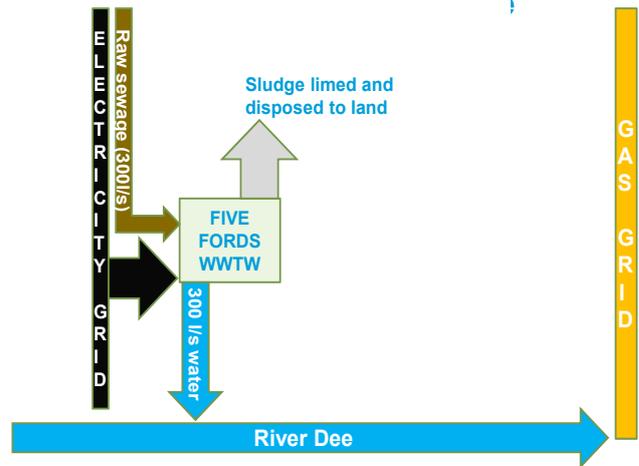
- **Financial benefits** which, with its not-for-profit model, mean savings to keep bills down (Welsh Water has kept bill changes below inflation for the last 9 years) and to retain money to re-invest in the business. The not-for-profit model means that Welsh Water can invest its own money in projects without the need for external project finance. Thanks to this approach the total budget for investment into energy projects for 2015-20 has been almost doubled.
- By creating a **sustainable** and **energy neutral** (or energy-positive) operation at Five Fords, Welsh Water is taking another step towards its stated vision of being energy neutral by 2050.
- It also increases **flexibility** and raises **resilience** providing multiple ways to generate energy depending upon prevailing and operational conditions.
- Finally the investment in the AD enhancement also provides **improved treatment** quality for sewage bio-solids enabling it to meet the new standards set by Water UK's Bio-solids Assurance Scheme.

Development phases

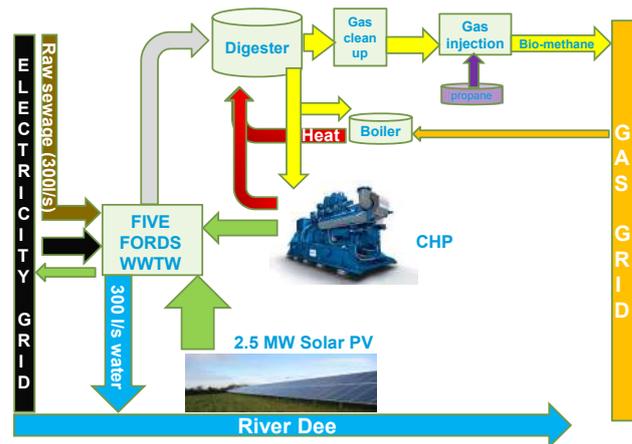
The key developments to date have come in three phases.

1. A conventional AD site with CHP was built in 2012. At that stage, it was intended as a standalone development as part of a wider programme to digest and generate energy from all the sewage sludge across the company.
2. The energy park concept came in 2014 as we developed our next investment programme and looked to how our energy potential could be maximised. Feasibility and stakeholder engagement followed the same year, and the decision was taken to invest £7m, using internal financing, into an innovative membrane based gas-to-grid plant and a 10,000 panel solar array. Welsh Water's not-for-profit structure means it can reinvest money which would otherwise be paid in dividends into further projects to benefit customers through improved water quality or reduced costs (contributing to keeping bills low).
3. With the first two phases complete, the site can look forward to a third phase of development over this and the coming two years. The AD from 2012 is seeing the addition of thermal hydrolysis pre-processing as part of an expansion in bio-solids processing capacity. The additional plant will come online in 2019 and bring total investment in the energy park to £36m. It is also intended to complement these with a wind turbine by 2020 and a possible hydro. The latter would complete a project conceptualised in 1993, provisioned for in the pipeline design but never completed due to the challenging economics of delivering such small renewable energy schemes that were, and still are, ineligible for financial support.

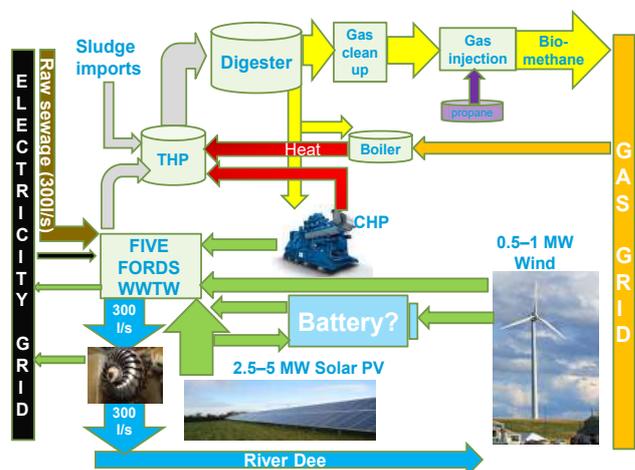
Energy Flow: Before



Energy Flow: Now



Energy Flow: Now



Operations and benefits

The gas to grid plant currently produces around 12 GWh gas per year. This is sufficient to provide heating to about 1000 homes which, in turn, has a carbon saving of over 2000 tonnes CO₂e. These numbers are set to triple once the thermal hydrolysis pre-treatment stage has been added to the digestion plant. This allows greater sludge throughput and increased gas yields (which the gas-to-grid plant has already been sized to accommodate).



Two 600kW CHP engines are used to complement the gas to grid generating at peak times when our demand for electricity is high, when the price of imported electricity is high or when additional heat is required for the processes on site. The 2.5 MW solar PV array generates over 2GWh a year of electricity per year, power which is mainly used on site. These operational components of the Energy Park have saved significant energy costs and 3,800 tonnes CO₂e/year through reducing the electricity required from Grid.

Savings will rise substantially when the remaining elements are completed. Each individual component has been a success but the real value is gained by operating them in an integrated way. Generating energy from the sun when it is shining (and eventually from the wind when blowing), heat and electricity from CHP when we need it for the treatment process, and exporting the gas to the local gas grid when we don't. There in the local community, people will be cooking their tea with gas created from what they flushed away a couple of weeks earlier. A real circular economy in action.

Complex and innovative projects are often filled with obstacles and lessons learnt the hard way. Whilst there was learning throughout, this project can be looked on as a real success story. Some of this success may be due to the extensive

stakeholder engagement that was done before any consents were even applied for. Branding the combined elements as a waste water "Energy Park" also proved valuable. That combined everything into a sizable investment with 'green' credentials

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that local stakeholders could recognise and support.

Despite the gas-to-grid being the first membrane technology plant to be used for sewage gas clean up (other water companies use a water wash process), that element of the programme and the solar arrays were both delivered to tight timescales to hit tariff deadlines for Renewable Heat Incentive for bio-methane injection and Feed in Tariff for solar PV. Once operational, the gas-to-grid has run very reliably, being happiest when left to run in a steady state and have the CHP engines modulate around it depending on gas available and external conditions. We have also benefitted from having someone on site during working hours dedicated

monitoring, maintaining and optimising the digestion, CHP and bio-methane injection processes. Having originally been designed to rely on external specialists, having some internal expertise has been a real benefit.

Innovation in action

The innovative nature of the project is underlined by the gas-to-grid project being both the first membrane technology gas-to-grid plant built by a UK water company and the first (and still the only) operational gas to grid plant in Wales.

By combining multiple renewable technologies at Five Fords we have created a showcase site which is attracting wide interest as well as support from local stakeholders. The Energy Park is an important part of our energy strategy at Welsh Water and the concept of combining multiple technologies is one that the company is pursuing on other sites albeit none offer quite such scope as Five Fords.

At Five Fords we are managing the electrical, gas and heat demand and meeting those needs from renewable sources. In doing so, we are well on the way to creating a microcosm of the 'Smart Network' thinking that could take place on the macro level in the UK and deliver long term savings and sustainable operations.

Author's profile:

Dr Mike Pedley leads Welsh Water's energy strategy including energy purchasing, optimisation, generation and carbon reporting whilst also bringing a commercial background, including acquisitions of renewable energy assets, as well as environmental and technical experience.