Response to BEIS and Ofgem call for evidence on a smart, flexible energy system

The Anaerobic Digestion and Bioresources Association (ADBA) is the trade association that represents the range of interests and matters related to the anaerobic digestion of organic materials (AD) across the UK, including the collection of waste for use as feedstock. ADBA understands the complex range of skills required by developers of new AD plants, from feedstock management through technology to energy production, markets and resource to land.

The organisation has over 400 members from across the AD industry, including plant operators and developers, farmers, local authorities, waste management companies, supermarkets, food processors, energy and water companies, equipment manufacturers and suppliers, consultants, financiers and supporting service companies. Anaerobic digestion can make a significant contribution to renewable energy, climate change, and critical resource preservation targets, subject to the right policies being in place.

Why should the government invest in AD?

Following strong growth in recent years the UK's AD sector now has a capacity of 750MW electrical-equivalent. This is more than double the capacity of the Uskmouth coal plant – enough power for 850,000 homes.

AD produces biogas which can be used to generate baseload electricity and supply heat for district heating systems 24 hours a day. It also offers flexibility, with plants able to dispatch electricity to meet high demand periods, whilst supplying the gas grid with biomethane for the remainder of the year.

AD offers an excellent return on the government's investment. This return includes:

1. Energy security from domestic green electricity

Biogas is good for UK energy security. It is generated in the UK and supplies are constant and reliable. AD is delivering home grown green power to the electricity grid and biomethane to the gas grid here and now. AD can contribute to energy security by delivering around 30% of either domestic electricity or gas demand.

2. Cost effective carbon abatement

AD has already reduced UK greenhouse gas emissions by nearly 1% annually. Supporting the technology further could reduce carbon emissions by 4%. Our calculations suggest that continuing to support the technology would reduce government expenditure by £755m from 2017 to 2040 in GHG abatement, compared to the average renewable heat technology.

3. Economic productivity and global competitiveness

A sector already employing around 3,500 people, with the potential to employ over 30,000 more, many in rural areas and manufacturing jobs, is worth protecting. A thriving UK sector can export to the world – the global AD market is worth billions. BSI and HSE standards are sold and adopted abroad providing the opportunity to pull through the UK AD supply chain which has developed over the last 5 years.

4. Strengthening the Rural Economy

Recycling digestate back to the land boosts crop yields and improves Britain's soils, the poor quality of which is costing the UK £1.4bn a year according to recent Parliamentary Office of Science and Technology estimate. Integrated into farming, AD also helps stabilise farming businesses, improving their ability to withstand fluctuations in global commodity markets.

5. Meeting recycling targets

The government will not be able to meet its recycling targets without separate food waste collections, which will require more food waste AD capacity to treat and recycle the resulting separated food waste.

Consultation questions

Question 25. Can you provide evidence to show how existing Government policies can help or hinder the transition to a smart energy future?

During the last 15 years the energy generation from renewables has increased tenfold, from around just 2.5% of the UK's supply in 2000 to 24.7% in 2015[1]. Financial incentives such as the Renewables Obligation, Feed-in Tariff and Renewable Heat Incentive have been instrumental in helping create a vibrant renewable energy industry in the UK. In particular, the electricity generation support has helped usher in the fourth industrial revolution, with prices falling and unprecedented deployment across the renewable technologies. The government has belatedly realised that the back up to large amounts of wind and photovoltaic power has to be flexible rather than baseload. The result has been flexible capacity auctions that have resulted in large subsidies being paid to high carbon and polluting gas, diesel and even coal powered systems that seriously threaten UK carbon targets.[2]

In regard to the UK's energy future all four of the scenarios presented in National Grid's Future Energy Scenarios report (FES 2016) suggest this pattern will continue and that the future will be renewable, with differences only in the speed and scale of deployment.[3] Throughout the world, investment in renewable technologies is increasing, with 2015 seeing over half of all new capacity from renewable sources.[4] The UK's renewable energy provision to date is important in terms of the generation of low carbon energy but also indicates the level of financial investment going toward renewables and economic impact. With thirty different technologies now generating electricity in the UK, National Grid's Future Energy Scenario 2016 report recognises renewable energy generation as ushering in a "period of unparalleled transformation".[5]

Anaerobic digestion bestows flexibility onto the energy system and can help transition the UK to a smart energy future in several ways:

- **Baseload or dispatchable electricity.** AD plants are able to export low carbon electricity to the transmission system or distribution network via a single half-hourly meter capable of independent control. AD plants, be they gas to grid or CHP, attempt to ensure their supply of power to the electricity grid is maximised at times of peak demand under the existing Triad scheme forgoing gas injection opportunities and any scheduled maintenance. Further expansion of this policy would certainly help the transition to a smart energy future. As our case study, below, demonstrates other countries are taking advantage of AD's flexibility in different ways.
- **Dispatchable energy and Demand Side Response.** With appropriate market incentives AD plants are able to alter electrical generation supply to meet consumer demand for both household and industry.
- **Decarbonising supply to meet Carbon Budgets.** The grid and energy supply of the future must be low carbon. To limit warming to 2°C in line with the Paris Agreement the IEA recommends Scenario 450, the limiting of GHG atmospheric concentrations to 450 parts per million of CO_2. To achieve this the emissions of energy generation must fall to around 80kg of CO_2 per MWh by 2040 – only renewables provide for this future.[6] Because farm and food waste left to decay on fields and in landfill eventually decays to greenhouse gases, the carbon footprint of AD is particularly low. Electricity can be generated by AD from

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/533218/ET_5.1.xls
[2] https://www.theguardian.com/business/2015/dec/11/diesel-farms-built-subsidies-national-grid-auction
[3] National Grid's Future Energy Scenarios (hereinafter FES) 15-21.
[4] http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf 5
[5] FES 76.
[6] http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html

waste with a carbon footprint that is around 40 times less than natural gas, 45 times less than fracked-gas, and 70 times less than diesel.[7] New diesel generators were particularly favoured in the government's recent flexible capacity auctions.[8]

- **Energy security.** With the right policies in place AD can deliver around 30% of either UK domestic gas or electricity demand. Evidence from Germany and the UK suggests that an all-renewable electricity supply 24/7, 52 weeks of the year, is achievable with around 80% of solar and wind power as long as it is backed up by between 15-20% of flexible bio-electric *power*.[9] The AD bio-electrical *energy* requirement is around 25%, comfortably below the currently projected 30% limit. This, the most secure of electricity scenarios, could have been achieved in the UK by 2025 had it not been for the drastic cuts to onshore wind, solar and AD subsidies.[10] As the consultation document recognises, ensuring intermittent generations are balanced with baseload provision along with successful management of grid flexibility leads to energy security.[11]

The smart flexibility of AD: dispatchable power and power to gas in Germany

AD plants may be operated so as to enter into a pulse mode to dispatch electricity when demand is high. In Germany, where there is extensive biogas infrastructure, this dynamic application arose following the amendment of their Renewable Energy regulations to introduce a 'flexibility tariff' for dispatchable electricity generation. The flexibility rate has a total cap of 1350MW to help ensure that the sector is predominantly providing baseload electricity. Individual AD plant operators receive financial support once they have increased the installed capacity of the plants. Generation of this sort is further supported by priority connection rights to feed into the grid.

E.g. An operator of an AD plant with an installed capacity of 500kW is permitted to increase the capacity of its plant by 50% to 750kW. For the additional 250kW capacity the operator receives the additional flexibility rate The flexibility rate is guaranteed for ten years.

Power to Gas denotes the conversion of renewable electricity into hydrogen using electrolysis. This conversion would be done when production is high but demand is low. This could then be used directly in hydrogen vehicles or a hydrogen gas network if those systems are put in place or, through methanisation, the hydrogen can be converted into methane where it can be used as a renewable energy source, upgraded to be used as a transport fuel or stored.[12]

IEA Task 37 on biogas has undertaken significant research into the potential role of biogas in smart and flexible energy grids.[13]

Addressing policies hindering the transition to a smart energy future

Recent legislative proposals are eroding current electricity support and at too quick a pace. Due to sharp reductions in government support in the principal schemes that have to date supported the development of the AD industry, fewer AD plants are expected. To date, financial support under the Renewables Obligation (RO) and the Feed-in

[7] Daniel Nugent and Benjamin K. Sovacool, *Energy Policy*, 65, 229, (2014)
[8] https://www.theguardian.com/business/2015/dec/11/diesel-farms-built-subsidies-national-grid-auction
[9] Daniel Nugent and Benjamin K. Sovacool, *Energy Policy*, 65, 229, (2014)
[10] ibid.
[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/567006/Smart_Flexibility_Energy_-_Call_for_Evidence.pdf 8
[12] http://www.viessmann.co.uk/en/local-heating-networks/powertogas.html
[13] http://www.iea-biogas.net/files/daten-redaktion/download/Technical%20Brochures/Smart_Grids_Final_web.pdf

Tariff (FIT) has provided a set level of pence per kilowatt for electricity generated, with plants receiving this for a guaranteed period of 20 years. This long term commitment to electricity generation sent a signal to investors and financers that AD and other renewable technologies were suitable options. As the sector has developed renewable technologies have become established as an integral part of the UK energy system.

As the energy system changes these existing support mechanisms are also undergoing change. It is important that as the smart and flexible energy system of tomorrow is developed AD is valued for its ability to provide baseload generation or dispatchable power to suit demand: AD is inherently smart in that it can generate and distribute to suit peoples' changing needs. Other renewable technologies that provide intermittent electricity do not offer such flexibility. In the UK's smart energy future where the end consumer is to be deeply involved in what power they use, when they use it and how much they pay for it, policy should support flexibility and, in particular, take advantage of the AD industry's ability to contribute.

The vast majority of electricity generating AD plants that have commissioned to date receive support through the Feed-in Tariff (FIT). Regrettably, in the recent FIT consultation, government proposals failed to address the important issues facing the FIT and the generation of renewable electricity by AD plants.

The 2016 FIT consultation failed to address the restrictive 20MW annual deployment cap for AD, despite data from the Office of Budget Responsibility showing a reduction in spending predictions for environmental levies by 2020-21 of £0.9 billion, bringing into question the £100 million Levy Control Framework budget that determines FIT support.[14] Some of this saving resulted from reform implemented following the 2015 FIT review but this significant reduction in spending is primarily due to the early closure of the Renewables Obligation, and changes in CfD and the Carbon Reduction Commitment.

As figure 1, below, shows the annual deployment cap and degressed tariffs have resulted in a sharp drop in applications to the incentive. If government proposals are adopted we expect few of the current pipeline of around 400 AD projects with planning permission to continue.

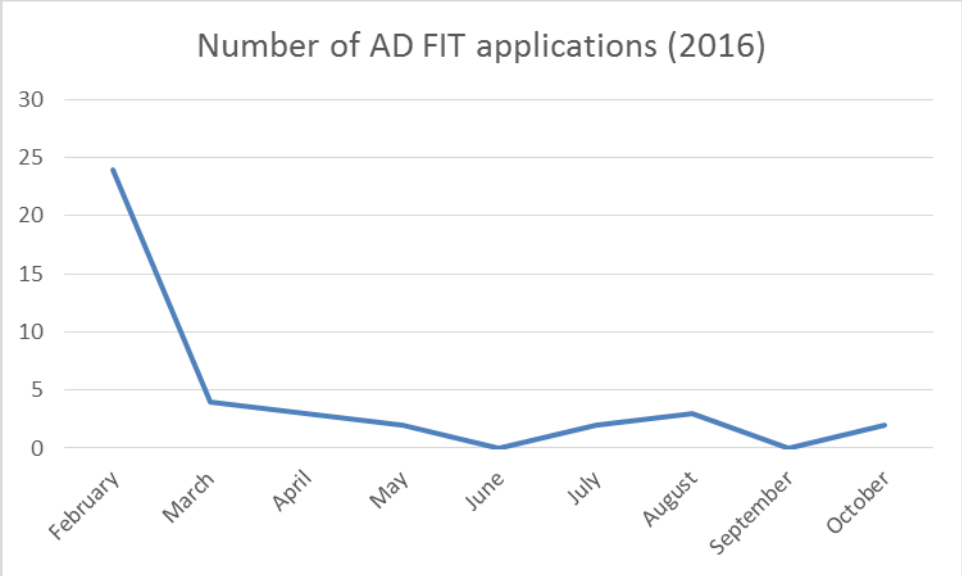

Figure 1. Number of FIT applications from 8 February to 31 October.

[14] http://cdn.budgetresponsibility.org.uk/March2016EFO.pdf [4.74].

Government also supports small scale renewables through the Renewables Obligation (RO) but this closes to new applicants after 31 March 2017.[15] The latest annual report for the RO shows that under the scheme over 14,000 different generating stations have commissioned, with a combined capacity of around 23,000MW.[16]

Question 27. Do you have any evidence to support measures that would best incentivise renewable generation, but fully account for the costs and benefits of distributed generation on a smart system?
Distributed generation reduces reliance on the transmission network and can negate the need for reinforcement and maintenance of the transmission system. AD systems can be sited close to areas of high electricity demand and provide baseload or flexible power so that, transmission network operators (TNOs) save money from a reduced use of the transmission network. Distribution level generation can be factored into TNO network investment in so far as it provides a means of balancing network supply and demand – this results in a more cost-effective system, ultimately meaning cheaper electricity for the end consumer. Over the medium to long term significant cost savings can be made by TNOs through offsetting local demand and some of this saving would be presumed to be passed on to energy consumers.

If smart energy systems made it apparent to energy consumers when local power was available and priced it accordingly we would expect both businesses and individuals to take this up. In addition to the restoration of appropriate feed-in-tariffs, new AD plants would be best incentivised if the bureaucracy, cost and uncertainty associated with gaining access to both the electricity and gas grids were reduced.

Question 48. Do you think these are the right areas for innovation funding support? Please state reasons or, if possible, provide evidence to support your answer.
In addition to the areas specified in the consultation document to receive innovation funding, AD and bioresources should be given innovation funding as part of the UK's strategy on development of the bioeconomy, which is part of the developing Industrial Strategy, given the scale of the opportunity here to transform the cost and scale of the industry.

AD delivers more than just energy. It is one of the leading technologies for mitigating climate change, ensuring energy and food security, improving sanitation and reducing indoor air pollution, thereby reducing poverty and hunger. In a broad context it can be developed into a biorefinery delivering a wide range of products and maximising bioresource recovery in a circular economy.

A robust research community has grown up around the industry but further government investment in research and development is required. In Wilton, North Yorkshire the Centre for Process Innovation (CPI) collaborates with universities, SMEs and large corporates and provides an open-access lab and pilot scale AD facility to help organisations of all sizes de-risk projects before investing in anaerobic digestion infrastructure. Funded by Innovate UK, CPI is leading a £2.78 million UK based collaboration 'SeaGas', which is working on producing biomethane from seaweed through anaerobic digestion. This would open up the industry to a new type of feedstock in addition to agricultural and food wastes allowing for new areas of growth. Such growth will lead to new innovations: "A novel storage system will be developed – to support a 12-month AD operation – to counter seaweed availability and variability." The Crown Estate is the key stakeholder in the project. There are numerous other AD and bioresources innovations being designed, piloted and implemented throughout the UK.

In addition to the technological advancements relating to AD where innovation funding should be directed, bioresources denotes several processes that are also already improving system flexibility and where, with governmental support, could improve it further:

[15] http://www.legislation.gov.uk/uksi/2015/920/pdfs/uksi_20150920_en.pdf
[16] https://www.ofgem.gov.uk/system/files/docs/2016/03/renewables_obligation_annual_report_2014-15.pdf 11.

- **Energy storage**, of both heat and electricity, is a challenge for some renewable technologies but for biomethane the gas grid provides an existing (and therefore cheaper) means of storage and transmitting biomethane or gas. Further innovation in this area could enable gas generated from the AD process to be transported prior to being combusted to produce electricity. This would provide ideal solutions to remote communities that do not have access to electricity or gas grids. Alternatively, biogas could be converted onsite into batteries or cells, ready for use and without operators incurring grid limitations and costs. The technology for storage, pressurisation and transportation is proven and well-established. Further innovation in this area could expand renewable fuels in transport, where HGVs in particular have scope for expansion. Use of biomethane as a fuel is vital to government efforts to decarbonise the transport sector, reduce UK carbon emissions by about a quarter.
- **Heating buildings and homes** using electricity can be inefficient. Using heat produced by AD plants reduces energy consumption and increases efficiency – and therefore a high return on investment. AD already operates on a local level and, with government infrastructure support, could supply heat for district heating systems as is extensively employed in Denmark and Germany. In 2012 DECC indicated they wanted the number of connected properties on district heating to increase from 2% (just under 200,000 nationwide) to 20% by 2030 and 40% by 2050. Government support of for heat networks through the Heat Network Investment Project is welcome and heat from baseload AD electricity generation is the lowest carbon option. As an example, Gaunts Estate near Wimborne, Dorset has three plants providing heat to homes using AD.
- **Biorefining excess electricity into methane (biomethanation)** is achieved through the biological conversion of carbon dioxide (CO_2) and hydrogen (H_2) (after electrolysis of renewable electricity) to methane (CH_4). With renewable sources gaining market share in the UK electricity composition an increase is expected in the frequency with which wind farms are forced to cut generation. The innovation of biorefining excess wind electricity mitigates this unsustainable practice and could make available large quantities of renewably produced biomethane, which will help the UK achieve its renewable energy and climate change targets. Biomethanation offers a solution to the restrictions and limitations of the electricity network and the inability many projects have of connecting to the electricity network.[17] It will enable additional carbon intensive fossil fuel sources to decommission without fear of capacity crunch.

The technological benefits produced through AD and bioresources will also impact other sectors, beside energy. The diverse potential of AD and its smart flexibility, makes it unique in the renewables sector. Depending on financial drivers, the technology can be implemented for plants producing biogas or combined heat and power or it can contribute to larger processes, harnessing the technology in various ways and to different scales. For example, biogas generated by AD can be harnessed to produce graphitic carbon. This will have implications for medicine (including cancer treatment), water purification, aircraft technology, road vehicles, defence equipment, sustainable food packaging as well as for communications technologies, including smartphones.

[17] https://www.ofgem.gov.uk/publications-and-updates/ofgem-announces-%C2%A317-billion-new-investment-package-and-reduces-pressure-customer-bills

Potential UK export opportunity

If the UK leads research efforts to reduce the costs of building AD plants, UK companies (which already export over £100m-worth of biogas-related expertise and equipment per year[18]) could export at least £5bn per year[19], creating a further 22,000 UK jobs[20] on top of 35,000 jobs created in the growing biogas industry within the UK. Uniting innovation funding for smart energy systems with development of AD technology would put the UK at the heart of the growing international biogas market, which is estimated to be worth £1 trillion.

[18] http://adbioresources.org/adba-market-policy-reports/adba-market-report-july-2016

	anaerobic digestion
PWhe/ yr	5.52
Equivalent TWe if operating at full capacity	0.63
Target CAPEX/ kWe	£2,000
Global market size (capex only) (£ billion)	£1,259
Annual market size over 10 years (capex only) (£ billion)	£126
Assumed UK market share (must account for the proportion of CAPEX which remains in the host country and share vs other export countries such as Germany)	5%
[19] UK annual export potential (£ billion) (over 10 years)	£6.30

[20]

	Anaerobic digestion
Current jobs/ MWe installed (over 1 year: design and construction) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48341/5131-uk-jobs-in-the-bioenergy-sectors-by-2020.pdf	13.96
Factor reduction due to efficiencies (i.e. in order to reduce capex by 50%, fewer design and construction staff must be needed)	0.5
Final jobs/ MWe installed (over 1 year: design and construction)	6.98
Global MWe installed per year for 10 years	62,958
UK potential number of jobs	21,972