From project development to turnkey design and construction, Black & Veatch has worked with project developers, utilities, lenders and government agencies on biomass projects utilising over 40 different biomass fuels throughout the world.

**BLACK & VEATCH IS RECOGNISED AS ONE OF THE MOST DIVERSE AND BROAD RANGING PROVIDERS OF BIOMASS ENERGY SYSTEMS AND SERVICES**

Black & Veatch has capabilities in a wide variety of wet and dry biomass applications:

- Biomass heat, power and cogeneration
- Municipal waste to energy
- Biogas and landfill gas production, optimisation, recovery and utilisation in CHP (Combined Heat and Power)
- Biogas upgrade for vehicle fuel and biomethane to grid
- Ethanol, biodiesel and second-generation biofuels

Black & Veatch offers a full scope of services to the biogas industry:

- Resource studies
- Feasibility studies and technology characterisation
- Engineering, procurement and construction (EPC)
- EPC Management
- Transmission access studies and interconnection support (electrical and gas grid)
- Environmental permitting and licensing
- Technical and financial due diligence
**BIOGAS CHP SERVICES**

**SEWAGE SLUDGE PROCESS PLANT IMPROVEMENTS AND ADDITIONS | Anglian Water | Colchester STC |**

Black & Veatch improved Anglian Water Services' existing sludge treatment centre facilities at Colchester Sludge Recycle Centre in a Design Build contract to take the output from 11tDS/d conventional digestion to 35tDS/d enhanced treated product. The new 35tDS/d plant provided the client with a regional sludge facility to process indigenous sludge from Colchester and imported sludge cake from multiple satellite sites.

The plant produces Enhanced Treated (Class A) biosolids for land application. The biogas produced (c. 565 m³/hr) is used in the combined heat and power plant with integrated CHP engines to produce 2.2 MW electrical output for the site or for export to the grid, and steam boilers which utilise the CHPs' waste heat to raise steam for the HpH (hydrolysis) plant and digesters. The existing digesters were retained in service during the construction to ensure the Client's overall ROC and energy generation targets were met.

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**DAVYHULME WWTW SEWAGE SLUDGE PROCESS PLANT IMPROVEMENTS AND ADDITIONS | United Utilities |**

United Utilities sludge treatment scheme at Davyhulme Wastewater Treatment Works (WwTW) in Manchester is a 121,000 tonnes dry solids / annum (tDS/a) enhanced sludge treatment plant and one of the largest design-and-build thermal heat and power projects completed in the world. The purpose of the project was to increase the capacity and improve the quality of treated sludge by providing a central sludge processing facility comprising a pre-treatment process upstream of the existing mesophilic anaerobic digesters. Black and Veatch provided Engineer, Procure and Construct services for the project, as well as Project Management expertise, process design, MEICA design, civil design, asset optimisation, operational efficiency, operator training, HAZOP and HAZCON services.

The scope included:
- New Thermal Hydrolysis Streams
- New imported cake facility
- Modifications to existing AD tanks
- New biogas holders and biogas clean-up plant
- New steam plant
- New CHP plant (12 MWe)
- New digested sludge storage
- Existing HV electrical infrastructure modifications


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**CHP AT FOOD MANUFACTURING SITE | InSource Energy (CTEL) |**

Black & Veatch was appointed to undertake the design development of a biogas plant to treat the food waste arising at the ready meal factory site using anaerobic digestion technology. The plant design involved the segregation of food waste from packaging, pasteurisation and anaerobic digestion of the organic fraction and dewatering of the digestate to allow it to be used as a fertiliser.

The biogas was then used in a CHP engine and the generated heat and power was supplied to the main factory. Black & Veatch was responsible for the development of the scheme, including the preparation of EPC enquiry documentation for the design and construction of the project. With technical input from Black & Veatch, the project secured capital funding from WRAP Wales.

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**CHP SYSTEM | OWNER’S ENGINEER SERVICES |**

Black & Veatch undertook feasibility work for a 1 MW CHP system design to run on biogas produced by factory effluent. The concept design report included the determination of future biogas yield, system sizing, optimum system configuration and expected costs.

Black & Veatch then produced a basic design report covering more detailed (budget) costs and system design, contracting and interface issues.

Thereafter, Black & Veatch carried out detailed engineering and assisted with procurement, followed by supervision of site installation activities.

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**CHP FEASIBILITY STUDIES | Thames Water |**

Black & Veatch was commissioned to undertake a technical and economic feasibility study of existing CHP systems based upon spark ignition engines (200 kWe to 5 MWe) at 13 sewage treatment sites to determine whether the plant should be augmented or replaced in view of future biogas production and higher efficiency available from new engines.

The study included the following tasks:
- Condition survey of existing CHPs and biogas system
- Creation of a technical/economic model to evaluate options over the next 15 years

**Options modelled:**
- Base Case continuing with current plant operation
- Enhanced maintenance to increase existing load factors and availability to maximise electrical and heat output
- Complete CHP replacement of low efficiency engines with new CHP and/or increase generation capacity based on biogas availability
- Detailed evaluation of site data
- Calculation of the existing CHP efficiency, engine heat to power factor, plant availability and load factor, digester heat demand
- Review of existing and future gas production figures
- Review of electrical system review and DNO connection
• Location for any new CHP plant and its auxiliaries
• Carbon savings for each option
• Preparation of CAPEX and OPEX estimates
• Recommendations supported with annual savings, IRR and payback

BIOMETHANE SERVICES

BIOGAS UPGRAADING TO BIOMETHANE TO GRID | Thames Water | Didcot STW
Black & Veatch acted as design verifier, representing Thames Water’s interest on the Didcot Sewage Treatment Works. The plant is designed to treat 100m³/hr of biogas and produce c.60 m³/hr of biomethane for injecting into the grid. The biogas is upgraded by using water scrubbing technology. The Black & Veatch team consisted of a project manager, a commissioning manager and an engineer to cover the aspects of process, electrical and controls. The project was a partnership between Thames Water, Scotia Gas Networks and British Gas (Centrica).

BIOMETHANE ROADMAPPING | Scottish Water Horizons |
Black & Veatch was appointed by Scottish Water Horizons to review the feasibility of upgrading the biogas produced (230m³/h) at Dalderse Wastewater Treatment Works to biomethane and compressing it for use solely as fuel for their vehicle fleet based at Dalderse.

The feasibility study included:
• Identification of biogas quality for the site
• Biogas to vehicle-fuel review including upgrading requirements
• Compressed versus liquefied biomethane
• On-site space availability requirements
• Slow filling versus fast filling
• On-site gas filling station versus transport of biomethane
• Fuel storage requirements
• Location of filling stations
• Review of environmental issues
• Review of initial permitting and planning needs
• Preparation of budgetary Capex and Opex for a complete biogas to vehicle fuel plant
• Recommendations for a roadmap for a technically viable plant

TROWBRIDGE STW GAS TO GRID TECHNICAL CONSULTANCY | Wessex Water Services |
Black & Veatch was appointed by Wessex Water Services to provide technical consultancy for a proposed biogas upgrading plant at Trowbridge Sewage Treatment Works.

The biogas flow rate arising from a new anaerobic digestion plant proposed by Wessex Water was 420m³/h, from which 120m³/h was diverted to a new biogas boiler to provide heat for the digestion process. The remainder (300m³/h) would be available for upgrading for injection to the gas grid.

The feasibility study included:
• Review of Wessex Water raw biogas quality
• Development of an outline biomethane gas quality specification
• Overview of contaminants and problems that these may cause
• Review of the commercially available biogas upgrading technologies
• Review the performance of UK and European biogas upgrading installations
• Identification and assessment of any further treatment required of the ‘waste’ gas stream and rejected ‘out-of-specification’ gas
• Assessment of the Biomethane to Grid plant
• Preparation of budgetary cost (Capex & Opex) for complete biogas upgrading and injection plant
• Identification of potential project risks
• Summary of contractual requirements and options between Wessex Water, the local network operator and the biomethane purchaser

BIOGAS ENERGY RECOVERY TECHNOLOGIES AND SYSTEMS | Confidential Client |
Black & Veatch identified the most promising technologies and integrated systems in three areas of biogas energy recovery; biomass digestion, biogas conditioning, and biomass gasification / methanation, recommending technology providers who posed the most applicable technology with proven performance. Recommendations were based on a set of criteria including technology risk, cost, environmental performance, location requirements (permitting and construction timelines) and gas quality standards. Black & Veatch developed a high-level conceptual design on the feedstock inputs and the product quality. Equipment needs were identified for anaerobic digesters, gas conditioning plants for pipeline injection and biomass gasifiers. Black & Veatch performed technology and cost analysis for gas cleaning options that would remove sulphur, carbon dioxide, water, foam / sediment, and siloxanes.

RESOURCE ASSESSMENT AND POLICY ACTIVITIES

ANAEROBIC DIGESTION FOR THE UK | National Non-Food Crops Centre |
Black & Veatch was commissioned by the National Non-Food Crops Centre to carry out a UK-wide assessment of the potential of anaerobic digestion for the treatment of organic waste. The aim of the study was to establish optimal ways to develop the AD sector in the UK.

The feasibility study included a review of:
• Current AD activity
• Feedstock suitability and availability in the UK
• Digestion technology processes
• Upgrading technology processes and biogas uses
• Optimal AD technology per feedstock and biogas usage
• Optimal locations for AD plants in the UK

Black & Veatch presented its findings to a group of stakeholders, to understand their willingness to implement biogas plants, the constraints they face in their corresponding sectors and the recommendations they might make.

BLACK & VEATCH ARE COMMITTED TO DELIVERING THE BEST OUTCOME FOR OUR CLIENTS
BUILDING A WORLD OF DIFFERENCE®

Black & Veatch is an employee-owned, global leader in building Critical Human Infrastructure™ in Energy, Water, Telecommunications and Government Services. Since 1915, we have helped our clients improve the lives of people in over 100 countries through consulting, engineering, construction, operations and programme management. Our revenues in 2015 were US $3.0 billion. Follow us on www.bv.com and in social media.

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