



**BLACK & VEATCH**

APRIL 26, 2021  
PROPRIETARY & CONFIDENTIAL

# Scope Definition – Waste to Energy Study

City of Key West, Florida



Building a World of Difference.®



**BLACK & VEATCH**

**Black & Veatch Corporation**

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April 26, 2021

John Paul Castro  
Utilities Director

City of Key West, Florida  
1300 White St  
Key West, FL 33040

RE: Waste Reduction and Energy Co-Benefit Study

Dear John Paul:

Black & Veatch is pleased to submit the scope of services for evaluating the feasibility of constructing a waste to energy facility for the purpose of reducing waste transport along the Florida Keys, improving recycling and composting capabilities, and generation of useful electricity and/or heat for residential and commercial customers. This scope of services is presented as an outline for how we typically conduct studies of this sort, and is described at a high-level herein. The goal of this scoping document is to inspire and facilitate discussion between the City of Key West and Black & Veatch on the most viable, technologically feasible, environmentally sustainable, and cost-beneficial options.

Black & Veatch has an extensive qualifications and experience record working with waste to energy facilities and in the area of waste resource assessment and utilization, as well as prediction of environmental impacts and mitigation of said impacts.

We look forward to the opportunity to discuss the overall study plan that we have proposed and the detailed analyses that would be required or recommended for each phase of the study. Subsequent to a final agreement upon a scope of services that aligns with the strategic waste management goals of the City of Key West, we can provide a full proposal including a schedule, milestones, and pricings. When you would like to discuss this with our team, please contact us so we may coordinate our schedules to have alignment between our subject matter experts and yours.

Very truly yours,

Lucas Botero  
Project Manager  
Black & Veatch

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# Proposed Project Approach

## TASK 1: RESOURCE ASSESSMENT AND VALIDATION

Black & Veatch will work with the City of Key West to determine the quantity, quality, availability, transport costs and logistics, and other factors to determine what waste and other potential fuel resources are available for sizing of the waste-to-energy (WTE) project. If desired by the City of Key West, this study will also evaluate if there is an economic benefit to receiving waste from other sources (cities, the county, other agencies) as either a revenue adder or to help justify the project. For the purpose of this study, it will be assumed that all waste sources will originate from within the Florida Keys.

One aspect of this study will be the decision process of which combustible waste materials should be considered for power production, which should be recycled or used in another manner (such as composting), and which should be landfilled as-separated. This current scope does not include the assessment of refuse-derived fuels (such as SRF) produced by third-party companies, nor is tire—derived fuel intended to be combusted in this project at this time.

## TASK 2: COMBUSTION TECHNOLOGY ASSESSMENT

Based upon the resource quality and quantity that could be available for the project, Black & Veatch will determine which combustion technologies are most appropriate for handling the waste, what quantity of power and/or steam heat generation is possible, the net capacity factor expected, potential air pollution emissions and what air quality control equipment would be required, and the typical lifespan of the plant. It is expected that a small stoker-fired boiler would be the technology chosen, but the required emissions control equipment for the project will be developed in conjunction with Task 5.

This task will estimate the range of fuel burn rate, air flow, flue gas production, and ash production from up to 10 different mixes/blends of waste to energy fuels. The quantity of SO<sub>2</sub>, particulates, and greenhouse gas emissions from the plant will be estimated. For other pollutants that are highly dependent upon specific vendor equipment offerings (such as NO<sub>x</sub>, mercury, dioxins and furans, and acid gases) only general ranges of potential emissions will be provided based upon the combustion technology and emissions equipment that are installed.

## TASK 3: PROJECT SITING STUDY

Based upon the waste quantities and combustion technology that are most viable, Black & Veatch will estimate the fuel receipt, storage, handling, reclaim, co-located recycling or separation facilities (based on estimates provided by the City of Key West), and the overall plant site area required. The result of this task will help the City of Key West determine which siting options are available as potential project locations, which can also be used to determine if United States Navy land could be used for this project. For the purpose of this study, it will be assumed that the site will be within the Florida Keys, rather than the mainland.

## **TASK 4: CAPITAL AND OPERATIONS AND MAINTENANCE COST ESTIMATION**

Based upon the combustion technology evaluated in Task 2, the capital cost, fixed and variable O&M cost, and the avoided cost from not having to transport waste to the mainland. All cost estimates would be at a very high level at an equivalent accuracy to that of a Class 5 to Class 4 level (although a full AACE cost estimation will not be conducted at this level of study). If the analysis is of interest to the City of Key West, Black & Veatch can also calculate a total life-cycle cost of energy production based upon a specified project life span, and can also determine the payback period (if any) for the project.

## **TASK 5: PERMITTING AND ENVIRONMENTAL CONSTRAINTS**

A high-level assessment will be conducted by the Black & Veatch environmental permitting section to determine which federal, state, and local permitting and environmental constraints may be required for siting and operation of the project. No permit applications will be completed or filed as part of this work, this effort will be a high-level assessment of the permits required and the estimated effort to complete them.

Critical data requirements for the project would include the current and future projections for waste stream quantity and quality, the level of political will for such a project, a detailed breakdown of the waste collection/transport/tipping costs involved, the impact upon the local economy and workforce, and the viability of receiving other waste streams from nearby communities.

# Project Work Plan and Schedule

Due to ongoing and variable COVID-19 travel restrictions, and with the goal of reducing project costs for the City of Key West, our project team will participate in an initial telephone kick-off conference call meeting with City of Key West personnel and other stakeholders. The kick-off meeting will discuss and confirm project objectives, review data needs and availability, and discuss work conducted to-date on evaluation of project feasibility. It is expected that 1-2 Black & Veatch subject matter experts may be required to travel to survey potential project sites.

Either a telephone conference call or an e-mail status report (whichever is preferred by the City of Key West) will be conducted weekly. This weekly status report will detail current work activities, critical outstanding data needs, anticipated changes to scheduling of deliverables, and other necessary information.

## PROJECT REPORT

Black & Veatch will develop a project screening report which will include the following primary sections:

- Introduction and overview.
- Characterization of the WTE resource quality and quantity, as well as the potential availability of receipt of WTE fuel from other sources.
- A characterization of the power plant technology best suited to the project, along with high-level estimated performance and generation capability of the plant. Based upon the results of Task 5, potential environmental pollution control equipment will be discussed.
- The results of the project siting study.
- A capital and operations and maintenance cost evaluation of the project over a lifespan chosen by the City of Key West
- A listing of federal, state, local, and other permits that would be required for the project to proceed, along with a high-level estimate of the time and cost required to comply with required permitting. Also included will be an estimate of the plant environmental limits that will be required as constraints to operation (air, water, ground, noise, environmental heat release, and other limits).

Black & Veatch will issue a draft report for review by the City of Key West, followed by a final report subsequent to comments received. If desired by the City of Key West and allowable during that phase of the COVID-19 travel restrictions, Black & Veatch will send the client manager, project manager, and lead engineer on-site for a final results presentation, discussion, and collaborative session.



## SCHEDULING

Scheduling will be dependent upon the availability of data and personnel from the City of Key West, as well as other potential factors associated with COVID-19 and other influences outside of the control of the project partners. The following schedule is anticipated:

TASK ITEM/MILESTONE	TIMING
Project start.	Within 1 week of contract execution.
Initial data requests sent from Black & Veatch.	Within 1 week of project start.
Task 1 (resource assessment) report section for review with the City of Key West.	Within 2 weeks of receipt of all required data.
Task 2 (combustion technology assessment) report section for review with the City of Key West.	Within 2 weeks of receipt of all required data.
Task 3 (project siting study) report section for review with the City of Key West.	Within 2 weeks of receipt of all required data.
Task 4 (capital and operations and maintenance cost estimation) report section for review with the City of Key West.	Within 2 weeks of completion of Task 2.
Task 5 (permitting and environmental constraints review) report section for review with the City of Key West.	Within 4 weeks of completion of Task 2.
Final deadline for all deliverables.	TBD by mutual agreement between the City of Key West and Black & Veatch.

## BUDGET

Tasks 1 thru 5 as described in this scope of work document would have the following lump sum fees:

TASK SERIES	LUMP SUM FEES
Task 1 – Resource Assessment and Validation	\$7,848
Task 2 – Combustion Technology Assessment	\$23,538
Task 3 – Project Siting Study	\$19,246

<b>TASK SERIES</b>	<b>LUMP SUM FEES</b>
Task 4 – Capital and Operations and Maintenance Costs Estimation	\$8,378
Task 5 – Permitting and Environmental Constraints	\$19,968
Direct Costs	\$1,500
<b>LUMP SUM TOTAL</b>	<b>\$80,478</b>

## CONFIDENTIALITY

Black & Veatch understands that often new capital project screening study work requires confidentially, non-disclosure, or may be executed under attorney/client privilege. Black & Veatch will work with the City of Key West to set up whatever mutually agreeable framework is needed for successful project execution while maintaining confidentiality.

### CITY OF KEY WEST

By: \_\_\_\_\_

By: \_\_\_\_\_  
(Print Name)

Title: \_\_\_\_\_

Date: \_\_\_\_\_

### BLACK & VEATCH CORPORATION

By: \_\_\_\_\_

By: Rafael E. Frias III, P.E  
(Print Name)

Title: Associate Vice President

Date: \_\_\_\_\_



# Qualifications & Experience

A qualifications and experience document detailing numerous representative Black & Veatch waste to energy projects is attached to this scope document.

**Building  
a World of  
Difference.®**

# Waste to Energy

SUMMARY OF  
QUALIFICATIONS  
& EXPERIENCE

**GLOBAL LEADERSHIP IN BIOENERGY TECHNOLOGIES**



**BLACK & VEATCH**

APRIL 2020

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# 1.0 About Black & Veatch

Black & Veatch is more than just an engineering and construction company. We work to create the fundamental framework that enables cities, companies, systems, and civilizations to progress and thrive by understanding and delivering integrated infrastructure solutions.

## 1.1 OVERVIEW

We are the 7th largest employee-owned company in the United States, with more than 100 years of creating a better world for humanity today, and for generations to come. We are characterized by curiosity, a trait that helps us find solutions to our clients' most complex challenges.



Black & Veatch continues to unfold every day in new directions and with growing passion and commitment.

**STEVEN L. EDWARDS**

Chairman and CEO



POWER



WATER



TELECOMMUNICATIONS



OIL & GAS



GOVERNMENTS



SMART CITIES



TRANSPORTATION



MINING



DATA CENTERS



## 1.2 SERVICES

We put our clients' minds at ease as their single point of contact, so they can remain focused on their business. We also work with partners as needed to ensure project success. Our service offerings include:

- Asset Management
- Consulting
- Data Analytics
- EPC
- Operations & Maintenance
- Physical & Cybersecurity
- Program & Construction Management
- Sustainability
- Construction

### 1.3 SAFETY & HEALTH

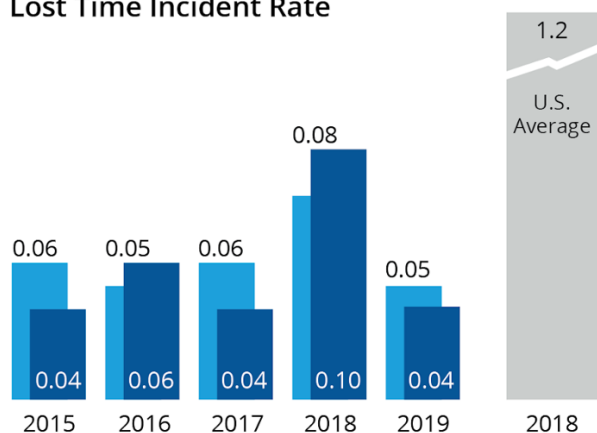
Your safety, that of your employees, and our professionals leads the way in everything we do. It's deeply embedded into our culture, and we believe nothing is so urgent that we cannot take the time to do it safely.

We're committed to work environments where safety and health are pre-planned into every task, one day at a time, with a mindset that every injury is preventable. Strong leadership and commitment coupled with zero incident expectations have resulted in industry credibility; 13 Voluntary Protection Program awards from OSHA; and 90 Gold Awards, 20 Gold Medals, and 10 President Awards from The Royal Society for the Prevention of Accidents in the United Kingdom.

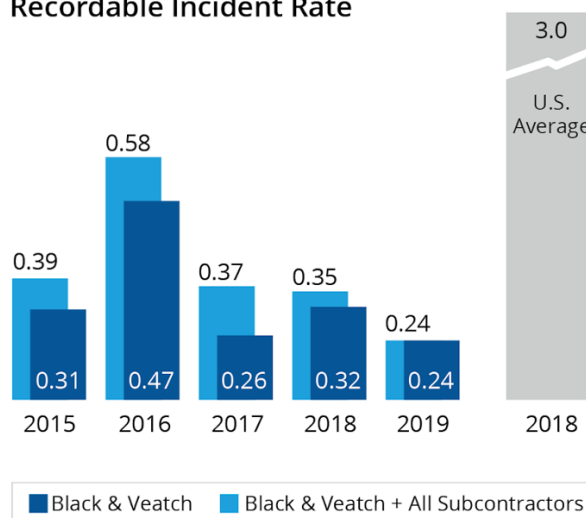


Our incident rates are historically lower than national averages, demonstrating our commitment to sending every professional home safely, every single day.

Lost Time Incident Rate

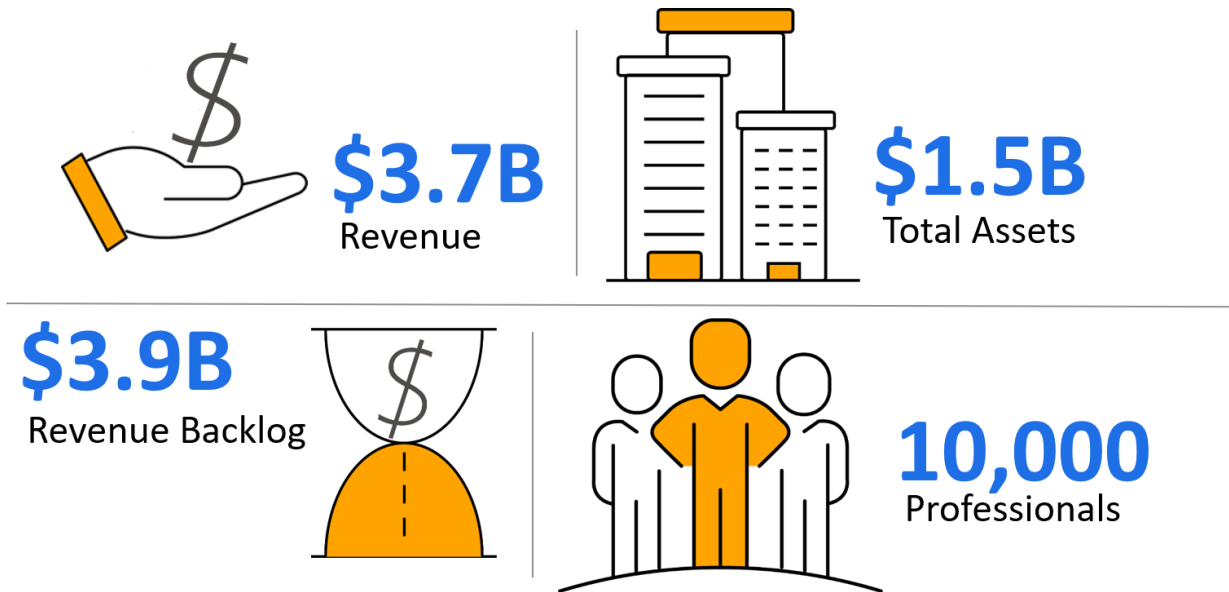


Recordable Incident Rate



## 1.4 BLACK & VEATCH TODAY

We have a reputation for innovative technical solutions and the ability to make the complex manageable. Clients know us for delivering quality, sustainable solutions of lasting value, and operating with the highest level of integrity.



We build strong relationships with each other, our clients, and our business partners as we deliver reliable solutions all over the world. Our continued success is due to the Vision, Mission, and Core Values we all hold deeply.

### Vision

We work relentlessly to solve humanity's critical infrastructure challenges.

### Mission

*Building a world of difference®* through innovation in sustainable infrastructure.

### Core Values

At Black & Veatch, we build strong relationships with each other, our clients, and our business partners based on Safety, Accountability, Ownership, Collaboration, Integrity, Respect, and Entrepreneurship.



## 1.5 POWER BUSINESS

### 1.5.1 Our Markets

RENEWABLE ENERGY



DISTRIBUTED ENERGY



CONVENTIONAL GENERATION



TRANSMISSION



### 1.5.2 Delivering Reliable Bioenergy Solutions

Black & Veatch is a leader in the global bioenergy industry. Our professionals provide engineering, technology, consulting, procurement, construction and asset optimization solutions that span the lifecycle of projects in the biomass power, waste to energy, and waste valorization industries. Clients face changing business and regulatory environments, and they are looking for many of the leading customized planning, conceptual, and detailed design engineering, procurement, and construction (EPC) solutions we provide. With more than 100 global offices, our geographic reach allows us to bring the best the world has to offer, localizing the solutions that you need most. We bring the expertise and capabilities that are critical to the efficiency and reliability of our clients' power portfolios – regardless of the technology, scope or location.

## 1.6 INDUSTRY RECOGNITION

Our expertise and ability to deliver highly reliable solutions result in annual recognition, including industry awards.

Our professionals earn this kind of recognition because they have the expertise necessary to solve complex client challenges, understand regulatory and market issues, and provide reliable solutions and projects.

By listening to our clients and focusing on their needs and objectives, we create and sustain trusted relationships that clients and business partners want to come back for again and again.

### ENR 2019 RANKINGS

#### TOP DESIGN FIRMS

#2 Power  
#2 Fossil Fuel  
#2 Solar Power

#2 Operations & Maintenance  
#5 Transmission & Distribution

#8 Co-Generation  
#8 Nuclear

#### TOP CONTRACTORS

#4 Fossil Fuel  
#5 Transmission & Distribution  
#7 Nuclear Plants  
#7 Solar  
#7 Power

## 1.7 PROVEN IN-HOUSE CONSTRUCTION CAPABILITIES

In-house construction gives greater flexibility as well as increased cost and schedule certainty. Teams have successfully executed projects of complex size and scope globally.

Black & Veatch executes projects through three construction entities.



#### Black & Veatch Construction, Inc. (BVC)

- Union work
- Signatory to all trades



#### Overland Contracting, Inc. (OCI)

- Merit shop work
- Direct hire for all major disciplines



#### Black & Veatch International (BVI)

- International construction
- Offices worldwide with 50+ years of construction experience

### Facts

- More than 2,200 Field Personnel with management and craft expertise
- U.S. Department of Labor – 14 OSHA Star Awards
- National Safety Council – Excellence Achievement Award
- Liberty Mutual – Gold Award for Safety Excellence

## 1.8 EFFECTIVE QUALITY PROGRAM

Black & Veatch's Quality Department includes Materials Applications, Quality Assurance, and Quality Execution (project, supplier surveillance, and site quality). These groups are proactive early in project execution to focus on quality planning, procurement strategy, and constructability; identify quality gaps; drive value and ensure consistent results; execute with the end in mind; and consider what our clients truly value.

Our Quality Management System (QMS) complies with ISO-9001:2015. Nuclear Quality holds NQA1 and ISO-9001:2015 registration, and Field Quality group holds NBIC and ASME S, A, PP, and U certificates.

Quality professionals are strategically placed around the globe to quickly respond to client's needs. In-house supplier surveillance capabilities enable us to perform inspections globally utilizing local and regional resources.

The Black & Veatch Quality brand "Keep Quality REAL" embraces Risk, Execution, Analysis, and Leverage concepts for continuous improvement.





## 2.0 Bioenergy Services and Experience

Black & Veatch has significant experience with many types of biomass, waste to energy (WTE), biogas, and biofuels facilities.

We have strong experience in all of the areas required to successfully develop and execute WTE projects including verification that the waste resource availability is adequate; selection of the best, most cost-effective conversion technology; optimizing system integration for efficient, reliable performance; and satisfying regulatory and sustainability criteria. We have completed technical and environmental due diligence for hundreds of electric generating and transmission facilities in support of asset transactions and financing activities. We have also successfully worked as the independent engineer on several billion dollars of power project financings in the last several years.

Black & Veatch is recognized as one of the most diverse and broad ranging providers of bioenergy systems and services. From project development to turnkey design and construction, we have worked with project developers, utilities, lenders and government agencies on bioenergy projects throughout the world. Black & Veatch was the lender's engineer for the world's largest stand-alone wood-fired power plant (Multitrade), won the *Power Magazine* Power Plant Award for design and construction of the 35 MW wood-burning Grayling Station, and was responsible for the turnkey conversion of the Central Wayne incinerator to a modern WTE plant. We also have been involved in more than 150 bioenergy projects totaling more than 5,000 MW since 1990. Black & Veatch has provided services for more than 50 different biomass and waste fuel types. Projects have included a wide variety of conversion processes including combustion, co-firing, gasification, pyrolysis, plasma arc, torrefaction, and anaerobic digestion.

We have capabilities in a wide variety of bioenergy applications:

- Municipal WTE.
- Biomass heat, power, and cogeneration.

- Biogas and landfill gas production, optimization, recovery, and utilization in CHP (Combined Heat and Power).
- Biogas upgrading for transportation fuel and pipeline-quality renewable natural gas.
- Biofuels including ethanol, biodiesel and second-generation biofuels.

We offer a full scope of services to the hydrogen energy storage and power generation industries:

- Project execution services including EPC.
- Project development services.
- Resource assessment studies.
- Feasibility studies and technology characterization.
- Conceptual design and major equipment procurement services.
- Biomass co-firing boiler impact modeling.
- Transmission access studies and interconnection support (electrical and gas grid).
- Environmental permitting and licensing.
- Project technical and financial due diligence.
- Auditing and other regulatory compliance assistance

## 2.1 PROJECT DEVELOPMENT SUPPORT SERVICES

### 2.1.1 Resource Assessments and Characterizations

A critical first step in developing a WTE project is conducting a resource assessment and characterization. The economics and long-term viability of any project are heavily dependent upon a sustainable and economic fuel supply. Resource assessment and characterization studies are local by nature and previous regional resource knowledge is valuable in quickly and economically performing new assessments. These services are almost always performed in combination with other project development services. Black & Veatch is very active in performing resource assessments throughout the US and has performed more than 25 resource assessments since 2000 covering nearly every type of biomass and waste resource. We provide several services to support the identification, sourcing, and transportation of feedstock, including:

- **High-level resource assessment**, which consists of the evaluation of a broad range of biomass fuels on a county level to identify areas rich in biomass resources. This type of study provides rough estimates of quantities available for preliminary studies and helps focus more detailed biomass sourcing studies.
- **Detailed resource assessments** that consist of identifying individual suppliers within a given radius, typically 50 to 100 miles, around the proposed biomass-to-energy facility. In this type of study, a call list is developed with support from state and local agencies and our experience from similar resource assessments. Each potential supplier is contacted to obtain information on quantity available, quality, and price. A detailed supply curve of potential biomass suppliers is developed to understand the cost to provide the required biomass supply for the biomass-to-energy facility.
- **Transportation assessments** that consist of the evaluation of alternative collection and transportation methods to deliver the fuel to the biomass-to-energy facility. We have evaluated regional collection

schemes, delivery by rail, truck, or barge, and co-locating biomass-to-energy projects with industrial biomass producers such as pulp and paper manufacturers or large agricultural operations.

Black & Veatch has experience with a broad range of biomass fuels encompassing agricultural wastes, wood waste, municipal solid waste (MSW), energy crops, and other opportunity fuels. The following list is a sample of the types of biomass fuels Black & Veatch has evaluated for our clients:

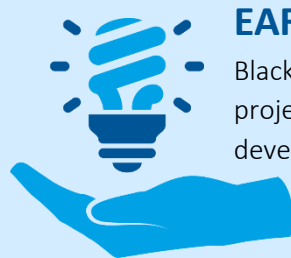
- |                            |                             |                           |
|----------------------------|-----------------------------|---------------------------|
| ▪ Wood Chips               | ▪ Agricultural Residues     | ▪ Landfill Mined Waste    |
| ▪ Whole Trees              | ▪ Rice Hulls                | ▪ Municipal Solid Waste   |
| ▪ Urban Wood Waste         | ▪ Rice Straw                | ▪ Refuse Derived Fuel     |
| ▪ Peach Pits               | ▪ Palm Oil Residues         | ▪ Dried Sewage Sludge     |
| ▪ Sawdust                  | ▪ Bagasse                   | ▪ Whole Tires             |
| ▪ Furniture Factory Wastes | ▪ Coconut Residues          | ▪ Tire-Derived Fuel       |
| ▪ Cardboard                | ▪ Cassava Residues          | ▪ Rubber Wastes           |
| ▪ Landfill Gas             | ▪ Corncobs                  | ▪ Coke Gas                |
| ▪ Digester Gas             | ▪ Switchgrass               | ▪ Paper Sludge and Waste  |
| ▪ Manufactured Gas         | ▪ Banagrass                 | ▪ Refinery Solid Residue  |
| ▪ Ethanol                  | ▪ Distillery Slop           | ▪ Refinery Liquid Residue |
| ▪ Corn Stover              | ▪ Oat Hulls                 | ▪ High Carbon Coal Ash    |
| ▪ Black Liquor             | ▪ Chicken and Turkey Litter | ▪ Waste Bituminous Coal   |
| ▪ Furfural Residue         | ▪ Cow Manure                | ▪ Waste Anthracite Coal   |
| ▪ Compost                  | ▪ Hog Waste                 | ▪ Sub-Lignite Coal        |
| ▪ Peat                     | ▪ Railroad Ties             | ▪ Petroleum Coke          |

### 2.1.2 Feasibility Studies and Technology Selection

Black & Veatch has conducted numerous assessments and evaluations of biofuels technologies for both electric power production and transportation applications to support long-range planning and plant feasibility studies. Many of these studies have been part of larger planning reports. It should be noted that not all feasibility studies conclude that a facility is feasible.

Based on the feedstock quantity and quality, which are often determined via the aforementioned resource assessment or waste characterization, Black & Veatch can recommend specific technologies and plant components for the conversion of these feedstocks into liquid or gaseous biofuels. In addition to selection of technologies that constitute these major subsystems, Black & Veatch will typically identify potential suppliers of equipment in both local markets as well as worldwide, depending on individual project and client needs. The relative benefits and disadvantages can be explored as part of such studies.

A feasibility study goes a step further and provides an initial assessment of the expected performance and cost of a specific facility.



#### EARLY PROJECT SUPPORT SUCCESS

Black & Veatch's experience over hundreds of bioenergy projects makes our teams especially valuable during the development stage of new initiatives in this technology space.

The projects described over the following pages exemplify the value Black & Veatch provides to clients.

# Sustainable Waste Power Systems (SWPS): Swine Waste Gasification Design Review Support

## KINGSTON, NEW YORK

SWPS has patented a novel “wet gasification” process that accepts a variety of carbon-based waste feedstocks and converts them into synthesis gas (syngas), water, and residual ash. Known as the “Garbage In – Power Out” or GIPO process, the technology from SWPS has been developed for applications such as agricultural waste management, alcoholic beverage production, and other niche applications. Black & Veatch served as a technology consultant on the project with a scope of work that included design review consulting services and testing / commissioning plan review. Four Black & Veatch professionals participated in a two-week workshop with SWPS personnel and other consultants. This resulted in a set of design recommendations to simplify and enhance the design, a set of testing recommendations at the prototype subsystem and system-level to evaluate opportunities to improve performance, and a series of follow-on tasks that could assist SWPS in achieving their ultimate commercialization objectives.

### CLIENT GOALS / DRIVERS

SWPS stated at the outset of the project that their primary goal was to improve the performance and energy efficiency of the GIPO process and facilitate the packaging of the technology into transportable shipping containers that could be used on-site to convert waste feedstocks into energy and clean water for reuse. Working within the cost targets set by SWPS, Black & Veatch informed design decisions during the workshop to meet the overall goals of the project.

### BLACK & VEATCH ROLE ON PROJECT

Black & Veatch served as the Technology Consultant. The scope of work included a detailed design review of the major unit operations constituting the GIPO process including feedstock preparation, hot oil circulation, devolatilization, gasification, condensation, and ash handling. Black & Veatch used their vast knowledge of thermochemical conversion technologies to make design recommendations with respect to the reactors and a similar knowledge base was tapped for the balance of plant including the electronics and control architecture. These design recommendations were organized according to a priority level based on the expected impact on SWPS in achieving their goals. A preliminary test plan was also developed to govern the sub-system and system testing, once any pending design changes were executed so that SWPS could proceed rapidly from the prototyping phase to commercialization. These activities resulted in a comprehensive “Independent Engineer Report” that was delivered to the client at the conclusion of the effort.

### INNOVATION

Given the unique nature of the GIPO technology developed and patented by SWPS, Black & Veatch, as the Technology Consultant, paid careful attention to possible knowledge gaps with the existing prototype and submitted design modification recommendations accordingly to support SWPS effort in mitigating identified risks.

<b>BLACK &amp; VEATCH ROLE</b>
■ Technology Consultant
<b>PROJECT ELEMENTS</b>
■ Devolatilization
■ Wet Gasification
■ Balance of Plant
■ Transportable Containment
■ Design Review
■ Testing and Commissioning
<b>SERVICES</b>
■ Biofuel technology assessment
■ Design approaches
■ Identification of commercialization barriers
<b>PERIOD OF SERVICES</b>
4/2016 – 9/2016
<b>CLIENT REFERENCE</b>
Michael Gillespie, CTO/Chief Engineer +1 (347) 276-9941 <a href="mailto:Mike.Gillespie@SWPS-inc.com">Mike.Gillespie@SWPS-inc.com</a>
<b>BLACK &amp; VEATCH CONTACT</b>
Jonathan Cristiani Tel.: +1 919-463-3043 <a href="mailto:CristianiJM@bv.com">CristianiJM@bv.com</a>





# Ofgem: <sup>14</sup>C Protocol for Measuring the Organic Fraction of Waste Feedstocks Technical Review

## ENGLAND, UNITED KINGDOM

The Renewables Obligation (RO) has been the main mechanism to incentivise renewable electricity generation. In case of mixed fuel generation stations, Renewables Obligation Certificates (ROCs) are issued based on the net renewable generation which must take into account the biomass contribution to generation in terms of its energy content. In order to meet RO requirements, a Fuel Measurement and Sampling (FMS) protocol is prepared which describes how samples are to be taken and analysed. The generator is required to carry out sampling and analysis to an agreed timetable and to submit the results to Ofgem for approval so that ROCs can be granted. This method is time consuming and expensive and it has been proposed that it is replaced by a Carbon-14 protocol for measuring the biomass fraction. In 2009 the RO was modified to allow alternative methods for FMS, such as the Carbon-14 protocol.

Black & Veatch acted as an independent advisor and assessed whether an alternative modus operandi for measuring the biogenic fraction of waste feedstock might be implemented as a viable and accurate industry standard.

The Carbon-14 protocol involves the sampling and analysis of the products of combustion to determine the proportion of biomass/biogenic material that could be used as the basis for the issuance of ROCs. The test looks for the Carbon-14 isotope, which proves the presence of biogenic compounds. The study included:

- Literature review;
- Examination of the Carbon-14 principle;

### PROJECT ELEMENTS

- Methodology Assessment
- Cost Estimation

### SERVICES

- Technical Review

### PERIOD OF SERVICES

July 2011

### CLIENT REFERENCE

Richard Bellingham  
Manager, Renewables: Biomass,  
Waste & Co-firing  
[Richard.Bellingham@ofgem.gov.uk](mailto:Richard.Bellingham@ofgem.gov.uk)

### BLACK & VEATCH CONTACT

Laura Martinez  
+441737856510  
[MartinezL@bv.com](mailto:MartinezL@bv.com)

- Assessment of the method and frequency of sampling and analysis; and
- Calculating the cost of utilizing the Carbon- 14 methodology.

Based on the results of two independent studies, including the one carried out by Black & Veatch, Ofgem has now accepted the Carbon-14 protocol as an acceptable alternative to FMS subject to agreement of the actual protocol prepared by the generator.



# Sacramento Municipal Utility District: Digester Gas Use for the Cosumnes Power Plant

## SACRAMENTO, CALIFORNIA

Black & Veatch was retained to perform a feasibility study on a project that involves moving the digester gas used at Central Valley Financing Authority (CVFA) Cogeneration plant into the SMUD transmission pipeline where it is to be blended with pipeline natural gas to supply the SMUD Cosumnes Power Plant (CPP). Since the CPP facility operates at an average heat rate of 6,900 Btu/kWh (HHV) compared to CPP average heat rate of 9,500 Btu/kWh (HHV), it is a more efficient way to use the renewable energy created by the wastewater treatment process.

Black & Veatch reviewed design information and observed plant operation. Black & Veatch then developed a test plan to gather data to determine the characteristics of the digester gas before and after the activated carbon scrubber. From the design documents and test data, Black & Veatch established the digester gas characteristics and existing plant operations.

Black & Veatch next evaluated the suitability of transferring the digester gas in the transmission pipeline and supplying CPP plant with blended gas that meets the CPP equipment restrictions/ requirements. From the established digester gas characteristics and pipeline and CPP plant equipment requirements, Black & Veatch determined that additional digester gas cleaning and treatment equipment would be required. The performance impacts and capital costs were also estimated as part of the project.

SMUD is also considering additional gas from dairy gas and from the digester gas enhancement program that utilizes food and waste grease. To accommodate dairy gas, Black & Veatch evaluated the need for a separate gas cleaning and compression, which are recommended with the gas injected with the digester gas downstream of the digester gas compressor.

### PROJECT ELEMENTS

- Evaluate injecting digester gas into SMUD transmission pipeline
- Provide a complete feasibility study for burning digester gas at Cosumnes Power Plant
- Address areas of concern – including regulatory requirements, digester gas characteristics, and the SMUD gas pipeline - and the implementation plan

### BLACK & VEATCH ROLE

- Perform feasibility study involving moving digester gas into the SMUD transmission pipeline
- Develop a test plan to gather data
- Evaluate data, including capital costs

### PERIOD OF SERVICES

2008 – 2009



## RULING OUT FATAL FLAWS

An early Black & Veatch design review helps ensure project viability and provides valuable insight for necessary next steps. Our teams validate your planned financial investment.

### 2.1.3 Conceptual and Preliminary Engineering

Subsequent to establishing the availability and quality of biomass feedstock and feasibility of the project, engineering designs and the associated capital and operating costs can then be progressively refined through conceptual and preliminary engineering phases. These services define the project design basis and clarify the benefits and risks of the project. Site visits are also frequently conducted to support feasibility studies and conceptual engineering, which result in a recommendation for site selection.

In addition to the typical engineering design drawings and documents produced during the execution of conceptual and preliminary engineering services, the following project development support services are often associated with the more comprehensive assignments:

- Specific fuel supply and alternatives, as required.
- Site assessments:
  - Familiarity with site layouts and infrastructure available.
  - Investigations of area surrounding the sites for possible technical or public relations challenges.
- Material handling assessments.
- Technology assessments.
- Air permitting and environmental control requirements.
- Capital and O&M cost characterizations.
- Economic analyses.

#### RELIABLE CONCEPT DEVELOPMENT

Black & Veatch senior engineers guide conceptual design and preliminary planning in close collaboration with our clients' teams.

Our focus during conceptual design development and the early planning stages is to

#### GET IT RIGHT THE FIRST TIME DURING EXECUTION

and create the best possible springboard for project success.

The following pages outline some of our prior work with clients during this phase.



# UK Energy Technology Institute: MSW Gasification and Engine Demonstration Integrated Plant

## REDHILL, UNITED KINGDOM

Black & Veatch has collaborated with Advanced Plasma Power (APP), one of three companies that have been selected to lead a consortium that will compete to design the most cost-effective, economically viable and efficient commercial energy from waste demonstrator plant possible. The ETI project, "Integrated Gasification and Gas Clean-Up for UK Waste Project (Waste gasification)", supports the design, installation and operation of a waste to energy plant to achieve this and to demonstrate the improved efficiencies offered by gasification over other technologies. To encourage development of the best system designs, the project is funded in two phases: a design competition followed by the construction of the winning design in the UK.

For the ETI project, APP has proposed The Tyseley Urban Resource Centre (TURC). The plant will receive approximately 60ktpa of residual and commercial waste. The fuel preparation plant will extract ferrous metal recyclables and produce a refuse derived fuel (RDF) to be used as fuel for the WTE facility. The GasPlasma plant will generate approximately 7 MWe of electricity from syngas using gas engines and ORC (organic Rankine cycle) power systems.

The project was broken down into a series of Work Packages, with the intention that each Work Package would be subject to a contract with a Principal Contractor.

Black & Veatch provided the following services:

- Application to the District Network Operator for electricity connection and consent;
- Application to the statutory water company for towns water supply and discharge to sewer for consents and connections costs;
- Preparation of preliminary process flow diagrams based on the client's preliminary design and using Black & Veatch in-house standards. These included: gas cooling, gas cleaning, utilities and services (water and effluent treatment plant, steam systems, cooling water and compressed air);
- Preparation of first level P&IDs that were suitable for the P&ID HAZOP study across packages, based on preliminary PFDs provided by the client.
- Preparation of a line schedule within the complete facility, consistent with PFDs and P&IDs;
- Preparation of major equipment list derived from PFDs and P&IDs;
- Preparation of package vendor enquiries for the following packages:
  - Waste heat boiler and auxiliaries;
  - Gas cleaning plant based on process information from the client, including ID fan and wet scrubber;

Following the receipt of tender's quotes, Black & Veatch carried out a tender analysis assessment.

### PROJECT ELEMENTS

- FEED

### SIGNIFICANT ASPECTS

- Demonstration of most cost effective WTE process.

### SERVICES

- Process engineering
- MEICA engineering
- Civil engineering

### PERIOD OF SERVICES

May 2012 to January 2013

### BLACK & VEATCH CONTACT

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## ADDITIONAL WTE EXPERIENCE: PROJECT DEVELOPMENT SUPPORT

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
SLTEC	Philippines	135 MW	2020	<a href="#">Solid Refuse Fuel Impacts Study</a> . Black & Veatch performed several studies examining the impacts of solid refuse fuel when co-fired with both coal and local post-industrial waste biomass on a 135 MW circulating fluidized bed boiler. Of critical importance was an assessment of the solid refuse fuel variability and its performance, operations and maintenance, reliability, and air emissions impacts. The EPRI Vista fuel quality impact model was employed for this study.
E-On	UK, Blackburn	95 MW	2018	<a href="#">Municipal Waste Impacts Study</a> . Black & Veatch performed several studies on the impacts of the quality and makeup of municipal and post-industrial waste on the boiler reliability for a bubbling-bed boiler. A separate sand utilization study was performed, as well as evaluation of the sand makeup specification impacts on plant reliability, operations, and maintenance.
Confidential	Eastern US	20 MW	2016	<a href="#">Municipal Waste Stoker Boiler Study</a> . Black & Veatch performed an assessment of the potential for energy generation from diverting a portion of a municipal waste stream post-recycling using a stoker-fired boiler. The EPRI Vista fuel quality impact model was employed for this study.
Orlando Utilities Commission	Florida, US	2x450 MW	2011	<a href="#">Landfill and Bio-Gas Gas Co-Firing Study</a> . Black & Veatch performed an evaluation of co-firing increased levels of landfill gas and waste-derived bio-gas at both Stanton units, to determine the boiler heat transfer, slagging, fouling, and boiler tube erosion impacts from different levels of waste fuel. The EPRI Vista fuel quality impact model was employed for this study.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Gainesville Regional Utilities	Florida, US	250 MW	2010	<a href="#">Solid Waste Co-Firing Analysis</a> . Black & Veatch performed a co-firing study of burning municipal waste alongside domestic and imported coal at the Deerhaven Unit 2 site. Critical considerations for this project were the potential impact of the waste fuel on the air quality control systems and equipment. The EPRI Vista fuel quality impact model was employed for this study.
Confidential	Western US		2008	<a href="#">Digestion Market Analysis and Conceptual Design</a> . Black & Veatch performed a resource assessment that examined energy production potential through anaerobic digestion in the Western US, with special attention given to California. A number of substrates were evaluated including dairy manure, food wastes, brown grease, and municipal biosolids. Conceptual designs for complete mixed anaerobic digesters representing 500, 3,000, and 10,000 head of dairy cattle were evaluated to investigate different business models of creating biogas from dairy manure. The study also evaluated and characterized the technologies and costs associated with cleaning the gas to meet pipeline quality standards. Additional conceptual design work was performed to evaluate different models for production of biogas from municipal wastes streams such as food waste, brown grease, and municipal biosolids. In addition, biogas utilization options were examined, including conditioning and upgrading gas to pipeline quality so that it can be used in a combined cycle facility.
InSource Energy	Newport, South Wales, UK	300 kW	2008	<a href="#">Newport Project Development Support</a> . Black & Veatch provided comprehensive project development support services for food waste to energy projects throughout the UK including resource assessments, conceptual engineering, cost estimates, site screening, environmental



CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
				characterization, and Owner's Engineering services. Over 20 sites/projects were considered as part of the Feasibility phase, after which a project was selected in Newport, South Wales. Black & Veatch then prepared preliminary engineering documentation for the EPC contractor to perform final design and construction of the complete project.
Confidential	USA & Canada - Confidential		2007	<a href="#">Assessment of Biomass and Waste-to-Energy Market in US and Canada</a> . Black & Veatch evaluated a range of factors with respect to biomass power and waste-to-energy market drivers and restraints in the all 50 of the United States as well as Canada. Factors included fossil fuel prices, national and state policies, feedstock costs and availability, air emissions, conversion technology costs, etc. We also analyzed present methods for biomass waste management and utilization, focusing on factors influencing availability of feedstock supplies for potential biomass power generation.
Confidential			2006	<a href="#">Plasma Arc Gasification Development Support</a> . Black & Veatch provided technology and project development support to a company for plasma arc gasification of waste. The proposed technology would convert up to 1600 tons per day of municipal solid waste to syngas for use in a wide variety of processes. Black & Veatch reviewed the plasma arc gasification technology, options for gas clean-up, and the technical requirements of potential end-users. Following the technical assessment, Black & Veatch developed pro forma economic models of several project options including raw syngas sales, clean syngas sales, and power generation.
Orlando Utilities Commission (OUC)	USA – Florida		2006	<a href="#">Co-firing Feasibility Study</a> . Initial feasibility evaluation of co-firing wood and gasified municipal solid waste in a PC boiler.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Panda Energy	Worldwide	30 – 100 MW	2005	<a href="#">Biomass Combustion and Gasification Technology Review</a> . Black & Veatch has been retained by Panda Energy to investigate biomass combustion and gasification technologies and vendors available worldwide and to render an independent opinion as to the viability of each technology. The biomass would be used to generate heat and/or power with project output ranging from 30 to 100 MW. Fuels investigated include wood, woody biomass, cow manure, poultry litter, sewage sludge and municipal solid waste. Black & Veatch evaluated potential technologies / vendors on many aspects, including commercial status, performance, emissions, capital and operating costs, and the range of fuel firing capabilities.
Panda Energy	USA - Texas		2005	<a href="#">Cow Manure Burner Development Support</a> . Black & Veatch was retained by Panda Energy to support preliminary engineering of a large cow manure fired steam plant in Hereford, TX. The proposed power plant will burn up to 2000 tons per day of cow manure to generate steam for an adjacent ethanol plant. Black & Veatch supported numerous activities during project development, including preparing site layouts and advising on technology selection. To support development and financing of the project, Black & Veatch participated in a test burn of the cow manure in the proposed fluidized bed combustion technology supplied by Energy Products of Idaho. Black & Veatch commented on the test protocol, witnessed the test burn, and prepared an independent report documenting the test results.
Confidential	USA- Southeast		2005	<a href="#">Coal Plant Evaluation</a> . Evaluation of sewage sludge and sewage gas at coal plant.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Confidential		30 MW	2004	<a href="#">Plasma Arc Gasification Technology Review and Feasibility Study</a> . Black & Veatch reviewed plasma arc technology for gasification of coal and municipal solid waste. Assessment of feasibility for 30 MW power project.
Utility Management Consultants, Inc.	Missouri		2004	<a href="#">Plasma Arc Gasification Study</a> . Black & Veatch was selected to perform a prefeasibility study of a plasma arc gasification power project in Missouri. Three small municipalities were investigating alternatives to landfilling MSW. The study examined multiple fuel scenarios of plasma arc gasification projects that included a combination of MSW and coal as well as MSW-only. Plasma arc gasification uses plasma torches operating near 30,000°F. Ash products of the gasifier are vitrified by the high temperatures of the reactor. The resulting slag can be landfilled at a fraction of the volume of ash or, in some cases, used for production of value-added products. An alternate objective was generation of steam for ethanol production by combusting the syngas in a boiler.
Los Angeles Department of Water and Power (LADWP)		40 MW	2003	<a href="#">Green Waste Anaerobic Digestion Power Facility</a> . Black & Veatch provided technical due diligence for a 40 MW green waste anaerobic digestion project for the Los Angeles Department of Water and Power. The project proposes to use yard wastes, sewage sludge, paper, and food waste as feedstock for an advanced high-solids anaerobic digestion process. The biogas produced by the digesters will be combusted in a combined cycle power plant.
Tennessee Valley Authority (TVA) / Allen & Colbert Stations	USA - Tennessee & Alabama		2001	<a href="#">Allen &amp; Colbert Stations</a> . Black & Veatch performed boiler modeling for co-firing, digester gas, landfill gas, refuse-derived fuel, tire-derived fuel, biomass and other fuels.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Tire Energy Corporation			2001	<p><b>Tire Combustor Steam Use Evaluation.</b> Black &amp; Veatch was engaged by Tire Energy Corporation to evaluate the economic and technical merits of steam use from their novel tire combustion technology. The system is based on a sub stoichiometric rotary kiln tire combustor developed by Atlantic Pacific Energy Systems, Inc. The objective of the analysis was to screen potential technology options for steam produced by the tire combustion process. Potential steam use options investigated included power production, steam sales, cogeneration, and sewage sludge drying. Black &amp; Veatch provided its opinion on what options might be preferred and the merits of further investigation. Estimates were made for capital cost, operating cost, by-product revenues, thermal performance, and other parameters. A user-friendly economic model was provided to Tire Energy Corporation to allow investigation of the numerous different scenarios under which project development might proceed.</p>

## 2.2 INDEPENDENT ENGINEERING AND TECHNICAL DUE DILIGENCE SERVICES

As part of our independent engineering (IE) and due diligence engineering and management consulting services, Black & Veatch has evaluated a number of conventional and novel technologies for clients near and far. These IE efforts often go beyond just evaluation of technologies and engineering design, whereby a more concerted investigation of project participants, resource availability/pricing, and project economics are considered to provide a more in-depth view of the project in its entirety. This is why many IE efforts are funded by financiers, who are concerned with both the technical, programmatic, and financial aspects of a project prior to closing on a deal. However, not all IE projects support a third party and are sometimes performed for public and investor-owned utilities. As part of these efforts, Black & Veatch can perform site visits, assess a facility's past performance, and provide "strengths, weaknesses, opportunities, threats" analyses.

The following offerings can be included in our IE and due diligence services:

- Technology Reviews
- "Fatal Flaw" Analysis
- Equipment Assessments
- Feedstock Supply Assessments
- Product Off-Take Assessments
- Contracts Reviews
- Performance Reviews
- Site Assessments
- Proforma Financial Modeling
- Construction Monitoring

### YOUR INDEPENDENT ENGINEER

Very few utilities and independent power producers (IPP) maintain the technical expertise and knowledge to cover all areas of the technology options available to them.

As an independent engineer, Black & Veatch will support your staff and represent your interest throughout project development and implementation.

The following pages outline some of our due diligence and independent engineering project experience in the WTE field.



# RePower South Berkeley, LLC: Berkeley Material Recovery and Recycling Facility Independent Engineer

## BERKELEY, SOUTH CAROLINA

Black & Veatch conducted an independent engineering assessment of the Berkeley, South Carolina Material Recovery and Recycling Facility (MRRF) project. The Berkeley MRRF will receive approximately 195,000 tons per year of MSW feedstock from local municipalities and is expected to produce about 57,000 tons per year of recyclable materials as well as 60,000 tons per year of ReEngineered Feedstock (ReEF) fuel, with the residues being sent to local landfills. The ReEF fuel will be sold under a fuel purchase agreement to a local cement kiln to offset their coal consumption.

As part of this assessment, Black & Veatch provided the following services:

- Conducted a site visit to observe an operational facility that uses similar equipment.
- Reviewed general facility design and proposed site.
- Reviewed performance projections and related assumptions regarding the Berkeley MRRF project, including production, processing throughput, and outage event assumptions.
- Assessed operations and maintenance plans and staffing levels.
- Conducted summary reviews of technical provisions in major construction contracts.
- Reviewed operations agreements including supply and offtake agreements.
- Reviewed market assumptions for MSW supply composition and sales of recyclable materials / ReEF fuel.
- Reviewed environmental permits, including compliance assessment.
- Reviewed financial model technical inputs, forecasted revenues, operating expenses, capital expenditures, operating margin, and ability to service debt.

### PROJECT ELEMENTS

- Independent Engineering Assessment
- MSW Material Handling, Recovery, and Recycling

### PERIOD OF SERVICES

May 2016 – Sept. 2017

### BLACK & VEATCH CONTACT

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BLAISE –  
SOURCE  
SEGREGATED  
WASTE PLANT

# CT Investment Partners: New Earth Solutions – Technical Due Diligence

## ENGLAND, UNITED KINGDOM

CT Investment Partners (CTIP) wished to carry out a Technical Due Diligence on New Earth Solutions Group Limited comprising the waste treatment activities of New Earth Solutions (NES) and energy recovery activities of New Earth Energy (NEE). NES specializes in advanced composting systems for the treatment of source segregated waste and MSW.

The main objectives of the technical due diligence were to review NES' existing waste plants and the company's technological road map. Black & Veatch's scope of work included:

- Review of NES' existing waste plants;
- Review of the company's technological road map with reference to the potential use of three short-listed technology providers focused on waste to energy projects;
- Understanding the competitive position that NES' roadmap would provide, from a developer's perspective; and
- Obtaining an appreciation of the technical, engineering and other challenges that NES will face during CTIP's period of funding the company.

The Black & Veatch team visited one of the three existing mechanical biological treatment (MBT) facilities and reviewed its past performance. We commented on the extent to which the three plants were planned, built, commissioned and operated. In addition, we reviewed project management, plant management practice and operational efficiency. Black & Veatch assessed the strengths and weaknesses of the short-listed technologies and their providers and their ability to support NES' forecast roll out timescales and profitable operation. We also carried out a SWOT analysis on NES' technical/operational/management team, and their availability to control the supply chain, technology and engineering, commercial prospects and ability to deliver.

Carbon Trust Investment Partners invested £4m to support New Earth's creation of a waste to energy business.

### PROJECT ELEMENTS

- Technical Due Diligence
- Technical Review
- SWOT Analysis
- Roadmap Review

### PERIOD OF SERVICES

Nov. – Dec. 2009

### BLACK & VEATCH CONTACT

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## ADDITIONAL WTE EXPERIENCE: INDEPENDENT ENGINEERING

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Plasco Energy Group	-	-	2014	<a href="#">Plasco Trail Road Evaluation</a> . In September 2013, Plasco Energy Group entered into a contract with Black & Veatch to provide an independent evaluation of the progress made at their demonstration plant since completion of their autumn 2012 testing with the intent of providing an opinion of ongoing and retired risks as Plasco proceeds toward its first commercial project. As part of the independent evaluation Black & Veatch witnessed portions of the source testing performed at PTR between 30 September 2013 and 5 November 2013. Black & Veatch provided a report based on the performance of Trail Road during the source testing. The conclusions of that report are as follows. As part of Black & Veatch's contract with Plasco to provide opinions about ongoing and retired risks, Black & Veatch visited PTR on April 15 to 17, 2014. Black & Veatch will continue to visit the plant and provide opinions on retired risks as the technology progresses.
JEA	Jacksonville, FL	30 MW	2008	<a href="#">Support Services for Renewable Generating Plants</a> . Black & Veatch provided project management and electrical engineering support of JEA's long-term efforts to obtain electrical energy from renewable energy sources. JEA contracted with Trail Ridge Energy (TRE) and was in negotiations with Evergreen Paper and Energy Company (EPEC) to supply renewable power from landfill gas and yard waste fuel sources at two generating facilities located in Jacksonville, Florida. The Trail Ridge Landfill plant was constructed owned and maintained by TRE and supplies a nameplate of 9.6 MW of electrical energy to the JEA grid. JEA designed and constructed a 35kV distribution class feeder, substation

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
				improvements, and communication requirements to deliver generated electric energy to the JEA grid. The EPEC plant is located adjacent to the JEA Kennedy Generating Station and generates 20 MW of renewable electrical energy from yard waste provided by the City of Jacksonville and other wood waste products. The plant is designed, owned, and operated by EPEC. Black & Veatch provided the necessary guidance and coordination for the JEA and EPEC interfaces during the design and construction phases of the plant.
Biossence Ltd.	UK - England	-	2007	<a href="#">MSW WTE Plant Independent Engineer</a> . Independent Engineer for 500ktpa municipal solid waste WTE plant via autoclave, sorting, drying, flash pyrolysis and gas engine.
Confidential	USA	-	2007	<a href="#">Due Diligence of Waste-to-Energy Gasification Technology</a> . Black & Veatch performed due diligence of a developing WTE gasification technology (which incorporated plasma arc technology) on behalf of a large private equity firm. A site visit was made to the technology developer's headquarters to meet the management team and to the pilot installation, which was in the midst of commissioning. The process design, capital costs and operational costs of the gasification technology were reviewed and compared with those of similar technologies. In addition, the business model was assessed, and market opportunities for the technology were evaluated. The technical strengths and significant concerns associated with process were identified. Based on the findings of Black & Veatch, the client elected to invest in the WTE technology.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Viridis Clean Energy Group	England, UK	Multiple	2006	<a href="#">Norgen Due Diligence</a> . Viridis Clean Energy Group wished to evaluate the potential acquisition of a portfolio of landfill gas to energy (LFGTE) projects located in the UK. The portfolio comprised 34 operating LFGTE projects (60.6MW) and three development opportunities (3.3MW) (the Portfolio). The projects were primarily located in England, with seven located in Scotland and one in Wales. Black & Veatch was retained by Viridis to provide technical due diligence on the portfolio. The principal objective of the technical due diligence work was to verify various assumptions made by Viridis in reaching a valuation of the assets/business.
Confidential	USA, Europe, and Asia	-	2003	<a href="#">Pyrolysis Due Diligence, Business Plan and Pilot Plant Development</a> . Black & Veatch provided a due diligence of a new gasification/pyrolysis process to an investment group. The proposed technology is targeted at waste and biomass fuel applications in the United States, Europe, and Asia. In the first phase of the project, Black & Veatch reviewed the proposed process for critical technological, commercial, and/or economic flaws. Following the review, Black & Veatch assisted the client with development of a 60 ton/day pilot plant. Black & Veatch also prepared a business plan for the process to attract investors.

## 2.3 PROJECT EXECUTION SERVICES

### 2.3.1 Engineering, Procurement and Construction (EPC) Services

Black & Veatch is one of the most diversified contractors in the industry, offering a full spectrum of EPC services. Our seasoned professionals have over a century of experience in design-build on projects of complex size and scope on six continents.

Black & Veatch helps solve clients' problems with EPC and design-build services in the power, water, wastewater, mining, oil and gas, telecommunications, power delivery and renewables markets. Our clients benefit from the best technologies, world-class project management skills and our proven safety programs. This helps ensure a competitive price, schedule certainty and long-term value. Project management is the driving force behind the successful completion of our projects. We execute projects on a lump sum, EPC/design-build contract basis. Our expanded scope projects use a wide variety of commercial formats tailored to our clients' needs.

Our EPC services encompass detailed design engineering; procurement and expediting; construction and construction management; quality control/quality assurance; and startup and training. Major project development and execution can often be a complicated process. From engineering design to the project schedule to choosing the appropriate contracting model – all are critical components to creating a successful end product. Black & Veatch has been working in the EPC industry since the birth of the EPC model in the 1980's. We have successfully executed more than 900 major projects globally across the power and water industries. While there are many EPC firms today with different approaches to this market, Black & Veatch has chosen to be flexible by listening to our clients and devising the best solution for their individual needs and preferences.

Successful projects all start with a conversation – to identify the goals of the project and our clients' needs, desires, and preferences from the standpoint of risk, cost, and schedule. There are many different execution models for EPC contracting, but only one is truly optimum for each client and specific project. Selecting contracting alternatives for developing and constructing any project involves deciding what performance, schedule, cost, and management risks the client is willing to assume. From the perspective of our clients, benefits of a lump sum EPC contract with a single firm can include the following:

- Single Point of Contact for the entire project.
- Fixed cost and schedule.
- Guaranteed performance.
- Minimal need for client involvement post-contract signing – minimal imposition to client staffing and operations.

However, there are other considerations that must be weighed as well:

- Desire to be involved in equipment selection and influence the final design.



Black & Veatch has nearly a century of experience executing projects of complex size, ensuring clients a competitive price, schedule certainty and long-term value.

- Need for changes/modifications during the project in both schedule and design.
- Control over final long-term value versus initial cost.

Our proven success in hundreds of EPC contracts over the past 30 years in multiple industries allows us to support our clients in execution model selection and to provide seamless transitions from the planning phase to mobilization. Our collaborations with clients have included a wide variety of roles: prime contractor, joint venture partner, subcontractor, and both consortium leader and member.



## END-TO-END PROJECT SUCCESS

Black & Veatch's solutions span the entire project lifecycle, and as a one stop integrated project provider, we take a holistic view of our client's strategic vision.

The projects on the following pages are examples of our support for large-scale WTE projects.

# Energy Works Hull Ltd.:

## Energy Works Hull

### HULL, ENGLAND, UNITED KINGDOM

Energy Works Hull is a step-in completion of a partially constructed facility designed by another EPC contractor. The plant is a 29 MW waste to energy facility using gasification with a conventional steam turbine. The gasifier is fueled using refuse derived fuel (RDF) preprocessed in an adjacent mechanical pre-treatment (MPT) plant and fuel conveying system designed by Sutco.

The primary technology to be used is fluidized bed gasification from Outotec, formerly EPI, who Black & Veatch has worked with on other larger biomass projects. The steam raised by the gasification process will be used to drive a conventional steam turbine (Siemens) that will produce the gross power requirement to meet the power export and plant parasitic requirements

#### CLIENT GOALS / DRIVERS

Energy Works (Hull) Ltd. Has clearly stated that their goals are to accelerate completion of the project through Take-Over and Acceptance while ensuring that the project is delivered with high quality and most importantly in a safe manner. Important factors to meeting the goals are to bring the design fuel in early during commissioning and to begin exporting power early in the commissioning period.

#### BLACK & VEATCH ROLE ON PROJECT

Black & Veatch was brought on to conduct a due diligence review of the facility design, provide any engineering required to correct deficiencies, complete engineering documentation necessary, and manage third-party contractors to achieve appropriate health, safety, and environmental certifications. Additionally, Black & Veatch is responsible for site safety, completion of unfinished construction works, demobilization, start-up/commissioning, training, and take-over/performance testing.

#### PROJECT ELEMENTS

- Refuse Derived Fuel
- Waste to Energy
- Thermal Gasification

#### SERVICES

- Engineering Consulting
- Construction Management
- Commissioning

#### PERIOD OF SERVICES

March 2019 – Present

#### BLACK & VEATCH CONTACT

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# Ince Biopower Ltd.: Ince Park Bio Power Resource Recovery Centre

**CHESHIRE, UNITED KINGDOM**

Ince Park Bio Power Resource Recovery Centre is an EPC-Design/Build project, being delivered in joint venture with Montgomery Watson Harza (MWH). The plant is a 21.5MW woodstock biomass energy centre using biomass gasification, with a conventional steam turbine.

The primary technology to be used is fluidized bed gasification from Outotec, formerly EPI, who Black & Veatch has worked with on other larger biomass projects. The steam raised by the gasification process will be used to drive a conventional steam turbine (Siemens) that will produce the gross power requirement to meet the power export and plant parasitic requirements.

## CLIENT GOALS / DRIVERS

As the U.K. looks to move beyond traditional fossil fuel based power generation, renewable energy centres such as Ince Park fulfil that transition. Ince Bio Power Ltd is a Special Purpose Vehicle (SPV) formed of Cogen and Bioenergy Infrastructure Group; who itself is made up of Foresight, Aurium, BBI, and Helios. CoGen is a leading developer in the U.K. waste-to-energy market for projects in the 20MW size range. This project represents their third successfully developed plant under the renewable obligation credit model.

The site is currently green field agricultural pastureland that is being redeveloped. The fuel for the gasification plant is pre-shredded waste wood.

## BLACK & VEATCH ROLE ON PROJECT

Black & Veatch has brought its significant experience in the power generation market, as well as its highly developed large project management expertise to the project. MWH will lead activities on site, with Black & Veatch leading the engineering effort, with process and mechanical design being undertaken from the U.S.

### PROJECT ELEMENTS

- Biomass/Biofuels
- Waste to Energy
- Thermal

### SERVICES

- Engineering Consulting
- Design-Build / EPC
- Procurement
- Construction
- Commissioning
- Public Relations/Community Engagement

### PERIOD OF SERVICES

Oct. 2015 – Mar. 2018

### BLACK & VEATCH CONTACT

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## ADDED VALUE

The Joint Venture worked diligently to develop a schedule that allowed project completion to occur prior to the end of the renewable obligation credit model.

## CHALLENGES

Ground conditions on site were very challenging requiring an innovative solution to developing pile loads to meet the aggressive construction schedule.

## TECHNICAL DETAILS

The EPC Contract for Ince has been created using the Red Book IChemE (4th Edition) 2001 incorporating addendums January 2004 and September 2011. This Contract is Lump Sum with Liquidated Damages applicable against Times for Completion as defined in the therein.

The following major packages are included in the EPC scope of work and, where known, the proposed contractor are identified as follows:

- Gasifier Plant and boiler - Outotec (USA) Inc.
- Air Cooled Condensers - Spig (Italy)
- Fire Suppression - Ultrasure
- Insulation
- Mechanical Installation
- Electrical Installation
- HV Switchgear
- ICA Instrumentation
- Civils - Ward and Burke
- Turbine – Siemens







# Irvine Ranch Water District: Biosolids and Energy Recovery Facility | Michelson Water Recycling Plant (MWRP)

## IRVINE, CALIFORNIA

Black & Veatch provided comprehensive preliminary and final design engineering services for a new \$166 M biosolids and energy recovery facility at the Michelson Water Recycling Plant (MWRP). Black & Veatch is now providing construction phase services to IRWD, including start-up and commissioning support.

The scope of the Biosolids and Energy Recovery facilities project consists of centrifuge thickening of primary and secondary sludge; anaerobic digestion, including acid phase digesters, methane phase egg-shaped digesters, and sludge storage tanks; centrifuge dewatering of digested sludge; drying/pelletizing with a rotary drum sludge dryer; energy generation using microturbines operating on digester gas; energy recovery using waste heat from the dryer and microturbines; and a fats, oil, and grease (FOG) receiving facility to boost biogas production.

Black & Veatch performed a biogas utilization study to determine the optimal use of the biogas for the project. Five alternatives were evaluated to use the biogas for: (1) heat drying, (2) fuel cell power generation, (3) microturbine power generation, (4) biogas cleaning and sale to the gas company, and (5) powering engine-driven pumps. Microturbine power generation was selected as the preferred alternative and these units will operate on a continuous basis to supplement utility power onsite. Microturbine power also represents a source of supplemental power (in addition to standby power) during power failure from the utility. Biogas storage will dampen gas production fluctuations and allow the microturbines to operate at peak efficiency. Excess biogas will be utilized at the heat dryer or for sludge heating. Acid phase digester gas will be pumped through the methane phase digesters to remove hydrogen sulfide. Methane phase biogas will be treated for removal of moisture, hydrogen sulfide, and siloxanes. The system is designed for complete biogas utilization; however, gas flaring will be furnished for overall system reliability.

### TECHNOLOGY

- Fuel Cells
- Microturbines

### SERVICES

- Engineering Consulting
- Design-Build / EPC
- Procurement
- Construction
- Commissioning
- Public Relations/  
Community  
Engagement

### PERIOD OF SERVICES

2012 - 2013

### CLIENT REFERENCE

Steve Malloy, Principal  
Engineer  
+1 949-453-5695

### 2.3.2 Owner's Engineer Services

Finally, our offerings as Owner's Engineer (OE) include an array of possible services including:

- Project oversight and execution.
- Project management.
- Detailed design or design review.
- Budgetary cost estimates and financial analysis.
- EPC contractor solicitation/selection.
- Construction management.
- Procurement support.
- Start-up and commissioning.

Our collective experience ensures that the Black & Veatch team has a thorough understanding of the complexities of any given infrastructure project, which allows us to provide our clients with high quality services, suggestions, and support they can trust. With seamless integration of construction management teams with our project engineering, procurement, and/or design review teams, we are uniquely positioned to offer our clients thoroughly thought-out projects with no surprises at execution.

#### EXTENSIVE SUCCESSFUL OE ENGAGEMENTS

We provide a unique perspective to our clients as an Owner's Engineer, given our broad base of experience as performing as both an Owner's Engineer and EPC Contractor.

This experience enables us to provide better oversight and constructive input to the project with our in-depth understanding of the full project implementation process.

Black & Veatch has recently, and is currently, supporting a wide range of projects as an Owner's Engineer. The following pages illustrate some of this experience.





# Public Utilities Board (PUB): Deep Tunnel Sewerage System (DTSS) Phase 2

## SINGAPORE

Black & Veatch, in joint venture with AECOM (B&V + AECOM JV), was appointed by PUB in 2014 to undertake the “Professional Engineering Services for the Feasibility Study, Preliminary Design and Programme Management of the Deep Tunnel Sewerage System (DTSS) Phase 2 Project”. The program is the second phase of a nation-wide program that will complete Singapore’s long term vision of a recycled water super-highway that will further enhance its water security and achieve its ultimate objective of being self sufficient to meet the water demands of its growing population and industries.

DTSS 2 complements the existing Used Water infrastructure completed under Phase 1 in the east of Singapore, with a new South Tunnel and a state-of-the-art Water Reclamation Plant at Tuas. Phase 2 adds resiliency to Phase 1 and adopts lessons learned, focusing on energy usage, operational efficiency and minimization of land-take.

DTSS 2 comprises a unique combination of a tunnel conveyance system of approximately 70km of 0.5-2m diameter sewers and 30km of 4-6m diameter sewer tunnels; the Tuas Water Reclamation Plant (TWRP) which at 1,800 MLD will be the world’s largest water reclamation facility; and a 3m diameter, 9.5km long tunneled ocean outfall, with seabed diffusers. The TWRP is to be co-located on a site with a 5,800 metric ton/day Integrated Waste Management Facility (IWMF). The two facilities will be interconnected in order to take maximum advantage of synergies between the two facilities.

### SELECTED PROJECT ELEMENTS

- Biosolids/Sludge Treatment
- Collection/Discharge Infrastructure
- Reuse of Treated Effluent
- Solid Waste Management
- Waste to Energy
- Incineration
- Solids Dewatering and Thickening
- Pumping
- Sewer Pipeline
- Tunnelling
- Membrane – MF/UF

### SERVICES

- Building Information Modelling (BIM)
- Construction Management
- Engineering Consulting
- Engineering & Design
- Feasibility Study
- Frameworks/Owner’s Engineer
- Infrastructure Planning
- Management Consulting
- Modelling
- Optioneering
- Odour Control
- Geotechnical Consulting
- Environmental Consulting
- Permitting/Licensing
- Program Management
- Public Private Partnerships
- Public Relations/Community Engagement
- Study on Deep Cavern Options for Future TWRP Expansion
- Sustainable Design/Energy Optimization

### PERIOD OF SERVICES

April 2014 – February 2024

## CLIENT GOALS / DRIVERS

PUB's drivers for DTSS2 are to maximize Singapore's water and land resources, protect the environment and provide resilience at the lowest cost. Key projects goals include:

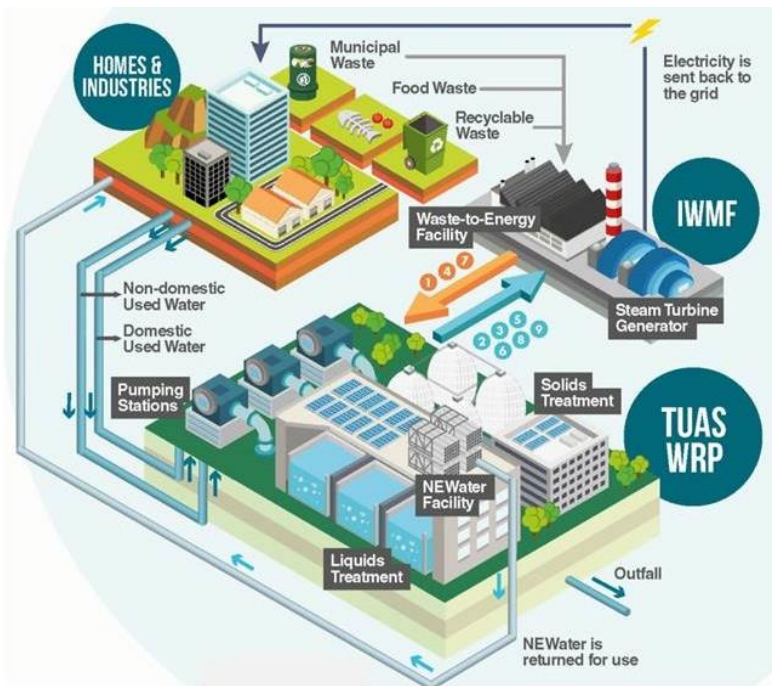
- **Minimizing land take whilst freeing up existing land** - By optimizing the TWRP and IWMF footprint, minimizing the land take of conveyance shafts, and freeing up unnecessary pump station. DTSS2 includes for the decommissioning of two existing WRPs and roughly 30 existing sewerage pumping stations that will return about 100 hectares of very valuable land that can be redeployed for other use.
- **Maximize Integration with Existing Used Water Infrastructure** – By optimizing the resiliency of the overall system, cross connecting with DTSS Phase 1, and providing linkage between the 3WRP:
- **Maximize Water Recovery** when converting used water to NEWater and water for industrial use at TWRP.
- **Minimize Energy usage and Maximize Energy Recovery** – by powering the TWRP and IWMF through energy produced from waste processed in the IWMF.
- **Minimize personnel required for Operations & Maintenance** by reducing the manpower per units of used water and ton of waste treated
- **Benchmarking against the world's best practices** – Through constant innovation, develop world-class solutions and synergies, and incorporating lessons from the world's best water and waste reclamation plants.

## ADDED VALUE

Black & Veatch's local and international expertise on water and wastewater treatment processes allows benchmarking against other projects to bring international best practices and processes to the works. Similarly, our highly respected business and management consultants are leading the cost evaluations and analysis and assistance to PUB to gain governmental approvals to proceed with implementation of the project.

## INNOVATION

Program innovation includes integration of the Tuas WRP with the co-located Integrated Waste Management Facility (IWMF), a 5,800 tpd municipal waste incinerator. This is an example of utilizing the water/energy nexus to the client's advantage. Biogas is sent to the IWMF for incineration and electrical power generation, eliminating the need for gas cleaning, storage and engine generators. WRF effluent is sent to the IWMF for use as process water and wet flue gas cleaning water, eliminating the need for potable supply there. Foul air from the solids handling facility is sent to the IWMF to use as combustion air, destroying the odors while reducing the need for separate odor control facilities. Several other synergies are being implemented between the two facilities that result in a lower overall cost of operation to the government of Singapore.







# National Environment Agency: Integrated Waste Management Facility (IWWMF)

## SINGAPORE

Black & Veatch, in joint venture with AECOM (B&V + AECOM JV), was appointed by NEA in late 2017 to undertake the "Multi-Disciplinary Consultancy Services (Civil & Structural Engineering, Mechanical & Electrical Engineering and Quantity Surveying) for the Development of the Integrated Waste Management Facility".

The IWWMF will comprise four plants – a 5800 tpd Waste to Energy (WtE) Facility, a 250 t/d Material Recovery Facility (MRF), a 400 t/d Food Waste Treatment Facility, and an 800 t/d Sludge Incineration Facility (SIF) – to process Singapore's incinerable waste, household recyclables, food waste and dewatered sludge from the co-located Tuas Water Reclamation Plant (TWRP).

The outline scope of services to be undertaken throughout the duration of the project include:

- Stage A - Development of the Project prior to signing of Build and EPC contract(s).
- Stage A-1: Preliminary designs, cost estimates including preparation of a detailed financial model, reviews, preparing, calling and evaluating of the EPC tender(s).
- Stage A-2: Design of the electrical substation and calling a Build tender to supply, install, construct and commission the substation.
- Stage B - Implementation of the Project after Build and EPC contract(s) signing

## SERVICES

- Building Information Modeling (BIM)
- Commissioning
- Construction
- 3rd Party Construction Management
- CPS/RE/Inspection
- Engineering & Design
- Environmental Consulting
- Feasibility Study
- Frameworks/Owner's Engineer
- Geotechnical Consulting
- Health, Safety & Security
- Infrastructure Planning
- Modeling
- Odor Control
- Operations & Maintenance
- Optioneering
- Permitting/Licensing
- Planning-Infrastructure/Water Supply
- Procurement
- Program Management
- Public Relations/Community Engagement
- Study
- Sustainable Design/Energy Optimization

## PERIOD OF SERVICES

Nov. 2017 – January 2029

## CLIENT REFERENCE

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+65 67319162  
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- Stage B-1: Project management, design approval and review, supervision of construction, testing, commissioning and handing over.
- Stage B-2: Defects liability period (DLP).

### CLIENT GOALS/DRIVERS

IWMF will be a state-of-the-art flagship facility that is part of NEA's long-term strategy to meet Singapore's future waste disposal needs. It is an integral part of Singapore's solution to environmental sustainability. Key project objectives include:

- (i) **Optimization of the Synergies** between IWMF and the adjacent TWRP resulting from their co-location and the implementation of innovative and proven technologies and design.
- (ii) **Maximization of Energy Recovery** - the IWMF's WtE plant will optimize combustion and use advanced boiler designs to achieve an overall electrical energy efficiency of 28%, making it one of the world's most efficient modern WtE plants.
- (iii) **Maximization of Resource Recovery** - A "clean" Material Recovery Facility (MRF) with a capacity of 250 tonnes per day will use advanced, highly automated sorting equipment to achieve high level quality and removal of the recyclables.
- (iv) **Minimization of Environmental Impact**, including Carbon Footprint - the IWMF will minimize its impact on the environment and reduce air emissions by adopting an advanced Wet Flue Gas Treatment (WFGT) system in both the WtE and SIF plants. WFGT systems are more efficient, minimize emissions and will meet the most stringent international air emission standards.
- (v) **Maximization of System Resilience and Flexibility** – IWMF will achieve a high degree of availability and resilience through modular designs that focus on flexible operations and maintenance. The overall design of the WtE lines for instance, will allow sufficient time for annual maintenance shutdowns and give some buffer capacity to accommodate unscheduled outages. The design will also allow for key installations to be taken out of service without compromising the overall reliable capacity. The WtE's design will be capable of treating waste over a range of LCV's (low calorific values) within the design heat diagram envelope.
- (vi) **Optimization of Land Use** - In land-constrained Singapore, land optimization is critical. Innovative plant design, equipment layout and implementation of high land efficient treatment technologies, including the use of modern large capacity 900 tpd grate / furnace / boiler lines and the location of the ACCs (air cool condenser) on the bunker / reception hall roof, optimize the available land. The IWMF will achieve a land use efficiency level in excess of 500 tpd/ha, compared to a target of 450 tpd/ha.

## BLACK & VEATCH ROLE

As the Owner's Engineer, the B&V + AECOM JV team supported by its technical partner Ramboll, will prepare the IWMF's preliminary design, prepare and manage all subsequent tenders/contracts related to the Project on behalf of NEA. During Stage B, in addition to project management and supervising the construction and commissioning activities, B&V + AECOM JV will assist the EPC Contractors to obtain all necessary approvals (e.g. Certificate of Statutory Completion), handover of the Project to NEA, as well as managing the DLP provisions in the contract.

## ADDED VALUE

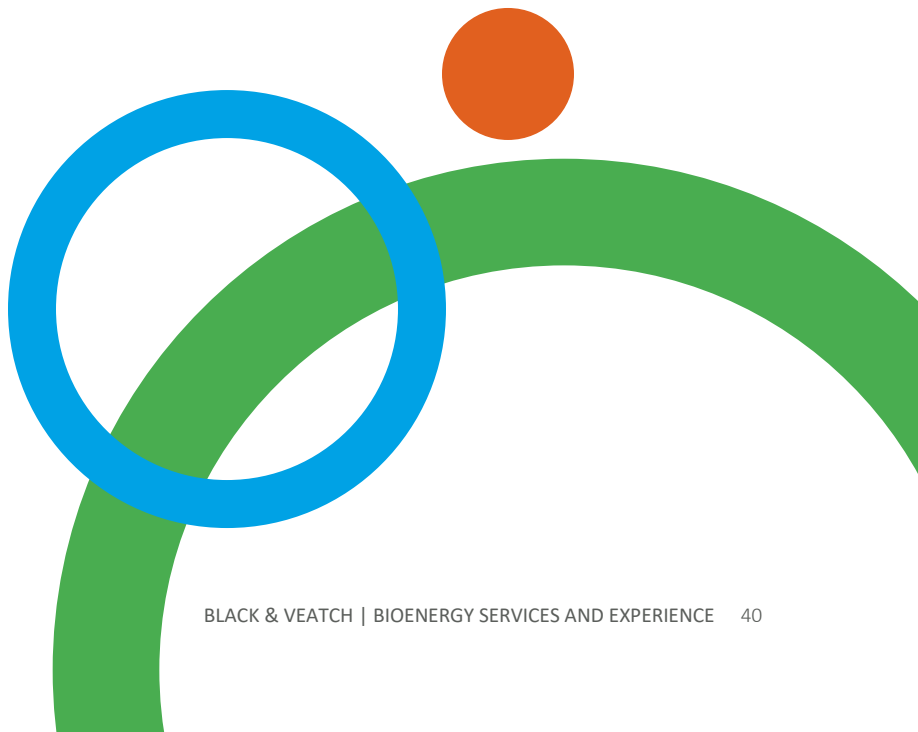
Energy optimization is one of project's prime objectives and delivers significant financial benefits to NEA. IWMF's innovative design will allow for optimized energy output and minimized energy usage within the plant. In addition to optimizing the footprint, our flexible modular design effectively future-proofs the plant to cater for future expansions or upgrades to accommodate new technologies, and more stringent emissions standards.

## INNOVATION/SUSTAINABILITY

The project's innovation includes the integration with the adjacent Tuas WRP, operated by the Public Utilities Board (PUB) and offer opportunities for both NEA and PUB to benefit from the water-energy-waste nexus. Biogas from Tuas WRP will be sent to the IWMF to further improve its energy output. The grit sent from Tuas WRP to IWMF will be further enhanced to include not only the disposal of the washed and classified grit from the Tuas WRP, but also pressed screenings at the IWMF bunker. These, and other material handling and energy synergies to be implemented between the two facilities, will generate sufficient energy to operate both plants with excess green energy supplied back to the grid, resulting in lower overall operational costs for both facilities.

## CHALLENGES

Whilst the co-location of the IWMF with the adjacent Tuas WRP presents integration challenges, it also provides opportunities for exercising the water-energy-waste nexus. Co-location of these large-scale state-of-the-art facilities provides a unique opportunity to improve the performance of these plants even further. The combination of advanced waste treatment technologies and recommended synergies is a highly innovative concept for both solid waste and used water management that help to make this a world-class project.



# Synnove Energy: Owner's Engineer for MSW Gasification Power Plant

## MAURITIUS

Black & Veatch is the owner's engineer for development of a facility on the Island of Mauritius that will gasify MSW for electric power production in a planned 24 MW WTE facility. This OE role includes evaluation of an integrated system with waste separation for composting and residual waste utilization as refuse-derived fuel (RDF) in a fluid-bed gasifier for production of steam and electric power production. Black & Veatch assessed various gasification vendors/technologies, and associated feedstock preprocessing requirements.

To support Synnove Energy's evaluation of the proposed project pro forma, Black & Veatch evaluated parameters including anticipated annual capacity factor and service life; anticipated EPC capital cost for the project, as well as anticipated operation and maintenance (O&M) costs. Black & Veatch also identified equipment or system components that could require significant capital expenditures for maintenance in excess of customary maintenance practices, or replacement, to achieve a service life of 20 years.

Black & Veatch evaluated competing proposals from gasifier vendors to characterize their ability to meet promised performance and cost targets. Black & Veatch also participated in site visits to gather information from key project stakeholders and identified action items for the internal Client/Engineer team to proceed with project development efforts.

Black & Veatch is also addressing interconnection requirements related to delivery of electric power to the grid, including step-up transformer, and associated ratings, capabilities, and technical parameters for interconnection, including engineering cost estimates.

### PROJECT ELEMENTS

- MSW Gasification
- Technology Readiness Assessment
- Preliminary Cost Evaluation

### BLACK & VEATCH ROLE

- Fluidized-bed gasifier analysis
- Fuel Spec Requirements Evaluation for Material Separation/Processing
- Gasifier Vendor Evaluation
- Preliminary Cost Analysis
- Owner's Engineer

### PERIOD OF SERVICES

2013 - 2018

### BLACK & VEATCH CONTACT

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## ADDITIONAL WTE EXPERIENCE: PROJECT EXECUTION

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
Confidential Client	USA - California	-	2015	<b>Owner's Engineer.</b> Black & Veatch supported a confidential client in submitting a bid into PG&E's first energy storage solicitation, as part of California's AB 2514. Black & Veatch's confidential client had a process to convert dairy waste to methane, store it, and combust it on-demand, creating a unique solution for energy storage.
Sun Energy group	New Orleans, LA	80 MW	2008	<b>MSW Gasification Owner's Engineer.</b> Black & Veatch was selected by Sun Energy Group, LLC to be the project's Owner Engineer through development to commercial operation. Black & Veatch has configured the gasification plant, interfacing with the technology provider. The plant will gasify the MSW received from various New Orleans parishes, clean the syngas, and then produce power for export onto the grid. The project site is a brownfield site in an industrial park. Black & Veatch supported Sun Energy negotiations with the local power utility and the port authority. Black & Veatch provided a cost estimate of the capital and O&M costs as well as performed air emissions modeling leading to an air permit application draft.
Central Wayne Energy	Dearborn, MI	24.7 MW	2000	<b>Central Wayne Energy Recovery Facility Rehabilitation.</b> Black & Veatch was selected by the Central Wayne Energy Recovery Limited Partnership, a partnership composed of Constellation Power, Inc. and D.B. Riley Consolidated, Inc., to provide complete engineering, procurement, construction, start-up, testing, and project management services to convert the Central Wayne County Sanitation Authority incineration plant to a modern municipal solid waste-to-energy facility.

CLIENT	LOCATION	CAPACITY	YEAR COMPLETE	PROJECT DESCRIPTION
				<p>The project consists of demolishing three existing incinerators, refurbishing three reciprocating grate systems, and erecting three water wall boilers. Also installed was a 21.6 MW steam turbine generator, and air quality control equipment, including one of the first U.S. applications of activated carbon injection to capture heavy metals in air emissions. The plant rehabilitation and testing were completed in February 2000.</p>



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