1. Executive summary

Energy Works Hull (the Project) is a milestone project for the UK’s waste and renewable energy sector. It will be one of the largest gasification facilities receiving MSW in the UK, indeed in Europe. It is one of the first advanced conversion technology projects to receive its renewable electricity subsidies through a Contract for Difference, the mechanism by which the UK Government determined to move from Renewable Obligation Certificates following its Electricity Market Reform process. It also plays a significant part of the urban regeneration of the City of Hull. The level of community engagement and benefit has resulted in the project receiving a GBP19.9M grant from the European Union’s Regional Development Fund.
M+W Group is a Global engineering, procurement and construction company with proven expertise in delivering major waste and energy infrastructure. The UK team was preferred EPC for the Project from an early stage and took a proactive role with the development team to ensure the Project reached financial close.

This paper introduces the Project including the site, layout, technical solution, funding and community benefits.

<table>
<thead>
<tr>
<th>Development Value</th>
<th>150 million GBP</th>
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<tbody>
<tr>
<td>Technology</td>
<td>Fluidised Bed Gasification (Advanced Conversion Technology)</td>
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<tr>
<td>Installed Capacity</td>
<td>about 28 MWe</td>
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<tr>
<td>Export Capacity</td>
<td>about 25 MWe</td>
</tr>
<tr>
<td>Construction Period</td>
<td>27 months (+ 3 month advanced work programme)</td>
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<td>Operation Period</td>
<td>25 years</td>
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<tr>
<td>Annual RDF Throughput</td>
<td>240,000 tonnes</td>
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<tr>
<td>Annual Net Electrical Production</td>
<td>190 GWh</td>
</tr>
<tr>
<td>Takeover Date</td>
<td>2017</td>
</tr>
<tr>
<td>Land</td>
<td>Secured</td>
</tr>
<tr>
<td>Planning Permission</td>
<td>Granted</td>
</tr>
<tr>
<td>Grid Connection Agreement</td>
<td>Signed</td>
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<tr>
<td>ERDF Grant</td>
<td>19.9 million GBP</td>
</tr>
<tr>
<td>CFD Strike Price</td>
<td>119.89 GBP/MWh</td>
</tr>
<tr>
<td>EPC Contractor</td>
<td>M+W Group</td>
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Table 1: Key facts of the project

2. Political background to project

The UK Government’s target of diverting over 8M tonnes of household-derived residual waste from landfill was supported by steeply escalating landfill taxation and generous subsidies for the generation of renewable electricity in the form initially of Renewable Obligation Certificates and now Contracts for Difference. Uniquely within Europe, the UK offers significantly better subsidy levels for projects which utilise advanced conversion technologies, including gasification.

Deployment of new waste-to-energy infrastructure in response to the regulatory framework showed a strong increase, such that the forecast contribution of waste-to-energy to the residual waste treatment total will rise from 20 percent in 2012 to 56 percent in 2020.

Nevertheless, the UK Government remains concerned about escalating amounts of residual waste being exported, mainly to mainland Europe. It is also concerned about the increasing net electricity import, now. Around over 1GWe, which is caused mainly by closing generation facilities. Net generation within the UK reduced by 4.4 GWe between the winters of 2014 and 2015. The Government has therefore continued to show strong commitment to the development of waste-to-energy facilities.
Against this background, Energy Works, the Project developer, sought to develop a large scale gasification facility which would have the potential to benefit from the UK environment of investment certainty, as well as receive the higher subsidy threshold open only to advanced conversion technology facilities.
3. Key project stakeholders

Developer – Energy Works,
Planning Consultant – Spencer Engineering,
Permitting Consultant – Fichtner,
Site Lessor/Lessee – Pension Fund/Energy Works Hull,
Fuel Supplier – the facility is merchant in nature, but several European waste management companies provided an underpinning supply contract at financial close,
EPC – M+W Group,
Technology Provider – Outotec Energy Products,
Civils Subcontractor – Spencer Group,
Civils Designer/Architect – Spencer Group,
PPA Provider – Engie,
District Network Operator – Northern Power,
Lead Funding Arranger – Foresight,
Principal Funders – Bioenergy Infrastructure Group, Noy, Hancock Natural Resources,
O&M – Engie,
STG Supplier – Siemens for STG.

4. Timeline

Notwithstanding a comprehensive and well managed planning application process, the project still took five years from site acquisition to financial close. The project timeline was not assisted by the intervening Electricity Market Reform which meant it straddled Renewable Obligation Certificates and Contracts for Difference.

Figure 4: Project timeline

In order to be ready to qualify for the first CfD auction process and provide enough price-certainty to ensure the developer knew the price at which to bid for subsidy, M+W Group was contracted to undertake significant preliminary design work in advance of financial close and thereby at the developer’s risk.

Optimising the funding structure took up some valuable months at the end of the process to financial close. However, even with this delay, the project was the first in the UK to reach close under the new subsidy regime and achieved it more than four months earlier than the prescribed milestone date.
5. Feedstock suppliers and specification

The RDF which feeds the facility is derived from municipal, household and commercial and industrial sources.

The fuel suppliers which provided an underpinning contract at financial close included both National major waste management companies and access to smaller regional waste management companies.

The specification of RDF which formed the design basis of the facility is commercially sensitive, but represents very typical RDF composition from the mentioned sources, with a CV range of 8 to 20 MJ/kg as received at the reception.

6. Site and layout

The site of the facility is located in the centre of the City of Hull, only ½ mile from the main shopping area. Whilst predominantly industrial in nature (both heavy and light), several nearby areas comprise residential elements, including a local traveller community.

The site itself was formerly the location of a kerosene plant and as such remediation of site contamination is extensive.

Hull was also heavily bombed during World War 2, leading to the possibility of discovering unspent munitions. Numerous other below ground obstructions are evident.

The River Hull is adjacent to the site and indeed delivery of feedstock by river was provided for in the planning approval, although the permitted dock is not currently within M+W Group’s scope or works.

The access to the site is via main roads, but given the central location of the site, several road closures will be necessary for the delivery of boiler sections weighing up to 200T.
7. Buildings and architectural

The final design of the buildings ensures that the facility will be a landmark in the City of Hull, consistent with the City’s industrial heritage.
The planning consent required no special architectural treatment. Unusually, the majority of the gasification process plant will have no building over/around it. It is only screened from public view.

Figure 8:
Visualisation of the final project

Figure 9:
BIM model showing the whole facility, with the Gasification facility encompassed by the green support structure.

8. Electrical connection
The HV point of connection is very close to the site, on the other side of Cleveland Street – a 132KV substation.

The non-contestable works were minor, comprising:

- 132- 11KV transformer,
- 11KV – MV panel.
9. Technical solution

Materials Recovery

The plant is required to allow the facility to receive low quality RDF whilst still meeting the gasifier fuel specification.

The plant reduces the particle size of the RDF, and significantly reduces the level of inert materials, both metallic and non-metallic.

This is achieved by 2 stages of shredding, ferrous metal and non-ferrous metal removal and air density separation to remove non-metallic inerts.

Figure 10: Interior structure of the project

Figure 11: Gasification process
AD

This aspect is not within M+W Group’s scope of works.

10. Mass and energy balance

Figure 13: The Mass and Energy Balance flow for the facility
11. Funding

The Project investigated several funding structures before settling on an all-equity solution and reaching financial close in November 2015. Financial close represented the conclusion of nearly five years of financing discussions. A critical early milestone of the project was its successful award of a grant in 2013 from the European Regeneration and Development Fund of GBP 19.9 million – one of the largest of its kind in the UK. Whilst on the one hand this attribute of the project was a significant positive to help attract other funding sources – and a major success for inward investment into the city of Hull – on the other hand, it did represent an additional layer of contractual and due diligence complexity to accommodate the requirements of the European Union.

Late in 2013, the project’s sponsor, Charlie Spencer, Chairman and founder of Spencer Engineering, ran a process to select a lead arranger which was secured by the London based Foresight Group with its highly experienced and established environmental team. The quality and commitment of these key stakeholders cannot be over-stated and is an essential part of the foundation of a project destined to be successful.

An EPC contractor selection process was run but M+W Group did not participate due to its other commitments at the time in closing 2 other gasification projects. As it transpired, some 9 months after the original EPC contractor had been selected, the project realised that it would not conclude bankable commercial terms with its original Contractor and Foresight and Spencer approached M+W Group to step in and develop a solution capable of securing Project Finance.

Over the projects long history, various providers, including banks and funds, were tabled as potential lenders. At this time, the project was running for support under the Renewables Obligation (RO) subsidy mechanism, and the latter option would enable the sponsors to get the deal done more quickly and the facility built sooner. However, the March 2018 deadline for facilities to be built out and commissioned for the RO was looming and the successor subsidy regime, Contracts for Difference (CfD), required participation in an auction process across Q4/14 and Q1/15. The project faced the tri-lemma of:

- uncertain subsidy regime;
- uncertain auction outcome, and consequentially;
- uncertain optimal funding structure, especially given the new CfD regime included strict and penal regulations requiring the project owners to meet rigorous funding and commissioning milestones.

The project was in need of an EPC Contractor with a track record in Project Financed deals in the waste to energy sector to support it through these tricky times.
M+W Group was able to demonstrate its deep understanding of such burdens on projects and in particular, evidence its covenant strength and capability in structuring an EPC contract to make it attractive for Project Finance. M+W Group also understood well the need for the project to hedge its position on subsidy and back both schemes over the transitional period. This resulted in negotiation of an early exclusivity for M+W Group with Spencer and Foresight to develop an EPC solution with sufficient detail to allow both a compelling bid for the CfD auction process and reserve a viable position to allow the project to be built within the ROC deadline.

To achieve these two objectives in parallel, M+W Group needed to dedicate significant resources pre-contract and this required some early financial commitment and payment (from Spencer) to allow M+W to procure some early design from its supply chain as well as underwrite a share of its own investment in an accelerated bid programme and advanced works. With this comprehensive support, the project was able to make a successful bid for CfD in the auction process and in February 2015, the ROC option was dropped and the final march toward financial close began. One of only 3 Advanced Conversion Technology (Gasification) projects to win a CfD contract, the project secured a 15-year strike price of GBP 119.89 (EUR 170.99, USD 181.70) per MWh.

![Figure 14: Illustrative example of CfD mechanism](image_url)

With a CfD contract signed in April 2015, which gave significant underwriting to a substantial portion of long-term revenues, the project then spent - 5 months optimising both its funding package and some of its fuel supply agreements.
Ultimately, the project settled on an all-equity structure – with a view to bringing in long-dated debt financing either during construction or in the early stages of operation. Equity financing for the Project was provided by such sector heavyweights as Infra-capital and the Foresight Group, via the newly-established Bioenergy Infrastructure Group (BIG). BIG, whose other two shareholders are Helios and Aurium Capital, has ambitious plans to become a leading independent power producer in the bioenergy market. The Hull project, in which it has a controlling stake, represents its second deal, following its maiden investment in a biomass plant in Cheshire.

The group is joined on Energy Works by Israeli investor the Noy Fund and US-based timber investor Hancock Natural Resource Group. Meanwhile, project developer the Spencer Group also remains a shareholder in the Energy Works (Hull) Ltd special purpose vehicle. Together, the partners provided around GBP 180 million (EUR 255.4 million, USD 270.6 million) in equity financing – on top of a GBP 19.9 million (EUR 28.2 million, USD 29.9 million) grant that the project received from the European Regional Development Fund (ERDF).

12. Community benefits

The ERDF grant was won on the basis of the project’s regeneration of the brownfield industrial site in Hull along with building and co-location of an Energy Academy teaching facility (affiliated to Hull University). PhD students will be sponsored by the Project company in each year.

In addition, the Project will generate local employment, much of it long-lasting into operations.
13. O&M interface

The Project company has appointed Engie (formerly GDF Cofely) as long term O&M contractor.

As such M+W Group will handover the facility to Engie following commissioning and testing. The funders did not require a detailed interface agreement between the EPC and O&M Contractors.

Figure 16: Turnaround of 6 vehicles per hour
(based on the design point RDF density of 225 kg/m³ and a 20 tonne load size)
Several plants in Germany have been provided with this technology. Figure 8 shows a plant, realised with a dry hydrator for a Ca(OH)₂ production capacity of approximately 3 t/h.

Figure 8: RDF incineration plant EEW Premnitz / Germany

As alternative there is the possibility to install the dry hydrator close to the additive can now be injected directly into the reactor without temporary storage in a silo.

Figure 9 shows such a dry hydrator as well as the corresponding WtE plant.
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