The Abergelli Power Gas Fired Generating Station Order

6.2 Environmental Statement Appendices - Volume C CHP

Planning Act 2008
The Infrastructure Planning
(Applications: Prescribed Forms and Procedure) Regulations 2009

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Appendix 5.1

Combined Heat and Power Technical Note

ABERGELLI POWER PLANT

DESIGN NOTE ON COMBINED HEAT AND POWER

NOVEMBER 2017

ABERGELLI POWER PLANT

DESIGN NOTE ON COMBINED HEAT AND POWER

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WSP
Westbrook Mills
Godalming
GU7 2AZ

www.wsp-pb.com

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Prepared by	Russell Bayliss, Ryan Broughton, Mark Eccleshare, Ian Evans, Andrew Jackson, Ignacio Martin Garcia	Alexandra Foden	Alexandra Foden	
Signature				
Checked by	Ryan Broughton Ignacio Martin Garcia	Ignacio Martin Garcia	Ignacio Martin Garcia	
Signature				
Authorised by	Bill Hatfield			
Signature				
Project number	287521B	70034053	70034053	

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ABBREVIATIONS

ACRONYM	TERM
APFP Regulations	Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009
APL	Abergelli Power Limited
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CHP – R	CHP Ready Guidance for Combustion and Energy from Waste Plants
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
GT	Gas Turbine
GTG	Gas Turbine Generator
Ha	Hectare
HCA	Homes and Communities Agency
km	Kilometres
kV	Kilovolt
LCA	Landscape Character Assessment
LCPD	Large Combustion Plant Directive
LEPs	Local Enterprise Partnerships
MWe	Mega Watt Electrical
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
RGE	Reciprocating Gas Engine
OCGT	Open Cycle Gas Turbine

GLOSSARY OF KEY TERMS

ACRONYM	TERM	DESCRIPTION
APFP Regulations	Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009	Sets out the detailed procedures which must be followed for submitting and publicising applications for NSIPs under the Planning Act 2008.
APL	Abergelli Power Limited	A special purpose vehicle which has been set up to develop the proposed Project and has been established by Drax Group plc. Drax is planning to develop flexible gas fired generation assets to support the UK Government drive to a low carbon economy. Drax has its project dedicated personnel sourced through an experienced management company, Stag Energy, founded in 2002.
Applicant	Applicant	Abergelli Power Limited (APL)
Application for Development Consent	Application for Development Consent	The application for development consent made to the SofS under section 37 of the PA 2008 in respect of the Project, required pursuant to section 31 of the PA 2008 because the Project constitutes an NSIP under section 14(1)(a) and section 15 PA 2008 by virtue of being an onshore generating station in England or Wales with a capacity exceeding 50 MWe.
CCGT	Combined Cycle Gas Turbine	Gas plant technology system comprising Gas Turbine(s) fuelled by natural gas, a Heat Recovery Steam Generator(s) utilising heat from the Gas Turbine exhaust gases, and a steam turbine plant with associated condensing system.
CHP	Combined Heat and Power	A cogeneration power station capable of supplying power to the National Grid Electricity Transmission System and also heat to local heat users (such as industry or leisure) through a direct connection to waste heat/steam produced as part of the combustion process.
DCO	Development Consent Order	Consent by a UK Government Minister for a Nationally Significant Infrastructure Project granted pursuant to the PA 2008. A DCO can incorporate or override the need for a variety of consents which would otherwise be required for a development, including planning permission. A DCO can also include rights of compulsory acquisition. A DCO can be made in the form of a Statutory Instrument.
GTG	Gas Turbine Generators	A GTG comprises a Gas Turbine and Generator and associated auxiliaries such as air inlet filter, coolers, equipment skids and control panels. The GTG may be an 'industrial' type unit which are suited to long operational hours and are more efficient but less flexible than smaller class units. To achieve up to 299 MWe, APL would propose to use 1 individual industrial GTG.
ha	Hectare	A unit area (10,000 m^2 / 2.471 acres)
km	Kilometres	Measurement of distance (1,000 metres).
MWe	Mega Watt Electrical	Measurement of electrical power.
NSIP	Nationally Significant Infrastructure Project	Nationally Significant Infrastructure Projects are projects which fall within the definition set out in section 14 of the PA 2008. The Project constitutes a Nationally Significant Infrastructure Project (NSIP) by virtue of s.14(1)(a) and s.15 of the PA 2008, which include within the definition of a NSIP any onshore generating station in England or Wales with a capacity exceeding 50 MWe.
Peaking Plant	Peaking Plant	Peaking plants are operated when there is a Stress Event
Generating Equipment	Power	Gas Turbine Generator and Balance of Plant which are

	Generation Plant	located on the Generating Equipment Site.
Power Generation Plant Site	Power Generation Plant Site	One of the three principal areas comprising the Project Site. The area within which the Power Generation Plant development will occur, at farmland north of Swansea, approximately 1 km southeast of Felindre and 1.4 km north of Llangelyfach.
The Project	The Project	The Abergelli Power Project, comprising the following principal elements: 1) A new Power Generation Plant 2) A new integral Electrical Connection; 3) A new integral Gas Connection. The Power Generation Plant, Gas Connection and Electrical Connection together with their construction access/laydown and future maintenance access/laydown requirements are referred to as the Project.
Project Site	Project Site	This includes the Power Generation Plant Site, Electrical Connection Site, Gas Connection Site and construction access/laydown and future maintenance access/laydown areas. The Project Site corresponds to the limits of the draft Development Consent Order (the Order Limits).
OCGT	Open Cycle Gas Turbine	Gas plant technology system comprising a Gas Turbine fuelled by natural gas. The hot exhaust gases are routed directly to the stack without passing through a secondary steam turbine. The generating technology used for the Power Generation Plant.
Stack	Stack	The structure by which the exhaust gases and waste heat are emitted to the atmosphere. Typically, the GTG unit would have its own dedicated stack. The exhaust gases would be subject to emissions control abatement.

1 INTRODUCTION

1.1.1 Combined Heat and Power (CHP) is the simultaneous generation of electrical power and usable heat in a single process, and is also known as co-generation. A CHP station may either supply steam direct to customers or capture heat from low-pressure steam after it has been used to drive electricity generating turbines, for hot water or space heating purposes. The heat can also be used to drive absorption chillers, thereby providing cooling.

1.1.2 CHP is considered advantageous as generating electrical power and heat together is more efficient than generating them separately. Therefore it can deliver a reduction in both primary energy usage and carbon emissions.

2 PROJECT DESCRIPTION

2.1.1 Abergelli Power Limited (APL) is promoting a new gas fired peaking power generation plant on land at Abergelli Farm, which is approximately 10km to the North of Swansea. The Project Site is located within fields used for grazing, bounded by a mixture of drainage ditches, fencing and defunct hedgerows. The Power Generation Plant will be designed to provide an electrical output of up to 299 megawatts (MWe) and will be fuelled by natural gas.

2.1.2 The Power Generation Plant will use one Open Cycle Gas Turbine (OCGT). The main generating equipment comprises a singular Gas Turbine Generator (GTG). The GTG consists of an inlet air filter, an air compressor, combustion chamber, power turbine, exhaust silencer and generator.

2.1.3 Air is compressed in the compressor of the Gas Turbine (GT) and gaseous fuel is injected into the combustion chamber(s) where the fuel burns producing hot, high-pressure gases. These gases expand across the turbine blades of the GT, which drives both the compressor and the electrical generator. The hot exhaust gases are then routed via a silencer to the stack and emitted to the atmosphere.

2.1.4 It is important to note that for the proposed open cycle, no steam will be produced as part of the electricity generation process.

2.1.5 The plant will be a ‘Peaking Plant’ operating for up to 1,500 hours per year on a five year rolling average, its function being to support the national electricity transmission system by providing additional temporary generation at times of peak demand or to compliment the intermittent nature of renewable energy sources.

3 PURPOSE OF THIS DESIGN NOTE ON CHP

3.1.1 OCGT technology has been selected for the Project. This Design Note on CHP summarises why further investigation into use of waste heat is **not** being undertaken, and provides evidence as to why the proposed thermal generating station **should be excluded** from being CHP-Ready.

4 REQUIREMENT FOR CONSIDERATION OF CHP IN APPLICATIONS FOR DEVELOPMENT CONSENT ORDERS

4.1.1 In accordance with the Planning Act 2008 (as amended by the Localism Act 2011), the Secretary of State is required to determine an application for an order granting development consent (DCO) for an energy Nationally Significant Infrastructure Project (NSIP) in accordance with the 'Overarching National Policy Statement for Energy (EN-1)' (2011, DECC) and the relevant technology-specific national policy statement ('National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2)' in the case of this project).

4.1.2 The requirement or otherwise for the consideration and/or implementation of CHP, is detailed within Section 4.6 'Consideration of Combined Heat and Power (CHP)' of EN-1.

4.1.3 EN-1 states (at paragraph 4.6.6) that *"under Guidelines issued by DECC (then DTI) in 2006 [the Combined Heat and Power (CHP) Guidance[1]], any application to develop a thermal generating station under Section 36 of the Electricity Act 1989 must either include CHP or contain evidence that the possibilities for CHP have been fully explored to inform the [Secretary of State]'s consideration of the application,"* and that the, *"...same principle applies to [DCO applications] under the Planning Act 2008."*

4.1.4 EN-1 continues: *"The [Secretary of State] should have regard to DECC's Guidance, or any successor to it, when considering the CHP aspects of applications for thermal generating stations."*

4.1.5 The CHP Guidance (at paragraph 24) acknowledges, *"...that decisions on major new power station investments, including the location and anticipated load duty of the station (e.g. base load, mid-merit, peak-lopping, support to local industry, etc.), will primarily be driven by the market..."*

4.1.6 Paragraph 4.6.7 of EN-1 requires that developers, ***"...consider the opportunities for CHP from the very earliest point and it should be adopted as a criterion when considering locations for a project.***" The value of early consultation is also emphasised, in respect of the process of identification of potential heat users (customers), with bodies such as Local Enterprise Partnerships (LEPs) and Local Authorities.

4.1.7 In addition, as part of the examination process for the DCO application, Natural Resources Wales (NRW) will be consulted on the details of the Project and the content of the application, including the developer's consideration of CHP.

4.1.8 Since publication of the CHP Guidance, Natural Resources Wales has published its own 'CHP Ready Guidance for Combustion and Energy from Waste Plants' (2014) (CHP-R Guidance). This guidance states (in Section 1.2) that: *"When consulted by the Planning Authorities on relevant consent applications for new plants, Natural Resources Wales will highlight the need for the plant to be CHP or CHP-R and will make reference to this CHP-R Guidance. Where a DCO is required, Natural Resources Wales will additionally comment on the results of the CHP Assessment."*

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[1] *Guidance on Background Information to Accompany Notifications under Section 14 (1) of the Energy Act 1976 and Applications under Section 36 of the Electricity Act 1989, December 2006.*

4.1.9 EN-1 (at paragraph 4.6.8) states: "*If the proposal is for thermal generation without CHP, the applicant should*:

- *Explain why CHP is not economically or practically feasible for example if there is a more efficient means of satisfying a nearby domestic heat demand;*
- *Provide details of any potential future heat requirements in the area that the station could meet; and*
- *Detail the provisions in the proposed scheme for ensuring any potential heat demand in the future can be exploited."*

4.1.10 The requirements for the provision of information identified in the above policies and guidance are addressed in the remainder of this document.

5 COMPATIBILITY WITH PROVISION OF CHP

5.1 FEASIBILITY

ECONOMIC FEASIBILITY

5.1.1 A primary requirement of a viable and effective CHP scheme is that it should be able to service the heat demand of any user connected to (and reliant on) the scheme.

5.1.2 The application of the CHP concept to an OCGT Peaking Plant is not economically feasible because the profile for the generation of electrical energy from the station cannot be guaranteed to coincide with the required heat demand profile of any potential consumer.

5.1.3 Because of its role in supporting the national electricity transmission system at times of peak or unexpected demand (including forced outages of other thermal generating stations), and in complementing the intermittent nature of renewable energy sources, the load regime for the OCGT station will be inherently unpredictable. Periods of electricity generation from the Project will typically be for 1-2 hours on occasional days, and of limited duration over the year. Given the proposed peaking role for the station, operation will be for no more than 1,500 hours per year on a five year rolling average out of a potential 8,760 hours in a year.

5.1.4 Heat demands, where they exist in the locality, are, by contrast, generally steady and persist over some 7 months of the year for residential heating or for the full year for industrial or commercial uses.

5.1.5 Any agreement drawn up between APL and local customers for the supply of heat from the Power Generation Plant would normally guarantee that heat would be available for certain periods of the year and in sufficient quantities to satisfy the agreed demand. This agreement would also normally include financial penalties if heat was not able to be supplied when contractually obliged to do so.

5.1.6 Therefore, the disconnect between the relatively constant demands for heat from residential and industrial users and the inherently unpredictable supply from a Peaking Plant such as this means that the CHP model is not applicable in this situation.

TECHNICAL FEASIBILITY

5.1.7 Conventionally, gas fired CHP plants configured as a CCGT usually provide heating via the provision of steam extracted from the existing steam cycle. As discussed previously, OCGTs do not produce steam as part of the electricity generating process and therefore the provision of CHP capability would require the addition of steam raising plant. The provision of CHP capability to a plant of this type would mean a significant increase in capital expenditure and additional technical challenges.

5.1.8 Compared to CCGT plant, OCGT units typically have a smaller capital cost per MW installed. This is largely because CCGT plants are more complex in their operation, requiring much more plant and equipment (e.g. a heat recovery steam generator (HRSG) and other steam raising plant) to operate. Although this increased capital cost is offset by gains in efficiency, CCGT plants are also typically designed to operate at continuous load, with fewer shut-downs and start-ups.

5.1.9 CCGT plants typically have efficiencies of around 55-60% (compared with 35-40% for OCGT), maximum gains in efficiency, however, are only realised when the plant has reached its operating temperature and is running continuously at full load.

5.1.10 The Power Generation Plant will be a Peaking Plant which would operate for up to 1,500 hours per year on a five year rolling average. Most likely, this would be for short periods of time (typically 1-2 hours). Given that it can take up to 1 hour for a CCGT plant to reach full load, APL considers that the benefits in efficiencies which can be achieved by using a CCGT plant are very minimal and do not justify the additional capital costs of these plants, especially when considering the very short operating windows of the proposed OCGTs.

5.1.11 As OCGT plants are less complex in operation than CCGT or Reciprocating Gas Engine plant, they are also cheaper to construct, operate and maintain.

5.1.12 A further reduction in both cost and visual impact is realised when using an OCGT plant without steam raising plant. In a CCGT plant, the hot exhaust gases are routed through a HRSG, where they generate steam, which then drives a steam turbine. The extraction of energy from the hot exhaust gases to generate steam, means that they leave the HRSG stack at approximately 100°C.

5.1.13 In comparison, the hot exhaust gases in an OCGT plant are discharged direct to the atmosphere at approximately 400°C-600°C This means that the flue gases discharged from a OCGT plant are significantly hotter than those discharged from a CCGT plant, and therefore the gases are much more buoyant. Therefore a much lower stack is required for an OCGT plant to achieve the same dispersion height and rate of its exhaust gases as a CCGT plant.

5.1.14 Maintaining a low capital cost for the Project is essential as the Project will bid into the Government's newly proposed Capacity Mechanism (CM). Plants selected to operate within the CM are chosen based on their ability to deliver fast reliable power at times of peak demand at the most economically advantageous price.

5.1.15 Therefore, significantly increasing capital expenditure on the Project severely limits the ability to successfully bid into the CM. If a higher bid price was successful, then these increased costs would be directly passed to the consumer.

5.1.16 OCGT technology is preferable at the Generating Equipment Site as the water requirement is significantly less than a CCGT, and could be met with the occasional delivery of water by tanker.

5.1.17 Based on the technical discussion above, it is considered that the proposed Project, comprising OCGT's is not suitable to act as CHP plant or need to comply with the requirements of CHP-R.

5.2 MEETING FUTURE HEAT REQUIREMENTS

5.2.1 Industry, commerce and public services are all identified as being prospective users of CHP with the largest, most economic opportunities expected to be found in the industrial sectors where there are often large requirements for process heat.

5.2.2 Opportunities however, are also identified in commerce (e.g. hotels, leisure centres, large corporate buildings) and public services (e.g. hospitals, universities, prisons, defence installations, administrative offices and ancillary college or hospital accommodation). There is also sometimes the potential for CHP where heat can be used in absorption chilling to deliver cooling in industry, commerce and the public sector.

5.2.3 Efficient CHP plants are usually designed to meet the demands of an identified heat load. Electrical power generation is utilised, where applicable for local process plant, and the balance exported to the grid. As noted previously, the Power Generation Plant could only service an intermittent heat source.

5.2.4 If a satisfactory steady heat load exists, the potential benefits of CHP schemes can be realised with electricity being generated in direct proportion to the heat load. The size of a CHP scheme, however, is determined by the local heat load which can be supplied at a common point.

5.2.5 For this reason the majority of CHP schemes are small (less than 5 MWe). These small units can offer high fuel utilisation when fully supplying the heat load. However during periods when the heat load is low or absent, the electrical efficiency of these units is rather low compared to conventional power stations.

5.3 PROVISIONS FOR ENSURING FUTURE HEAT DEMAND CAN BE EXPLOITED

5.3.1 Because of the unpredictable operating regime required of a peaking power station to flexibly support national grid demand, the viability of supplying occasional heat to future consumers in the area is negligible.

5.3.2 Moreover, the inclusion of provisions to ensure that future heat demand can be exploited in the equipment proposed for Power Generation Plant would increase capital expenditure of the Project further.

5.3.3 Such provisions could include space in the plant layout to install steam raising plant after the GT exhaust, however, this is not possible due to the constrained nature of the site.

6 POSSIBILITIES FOR CHP

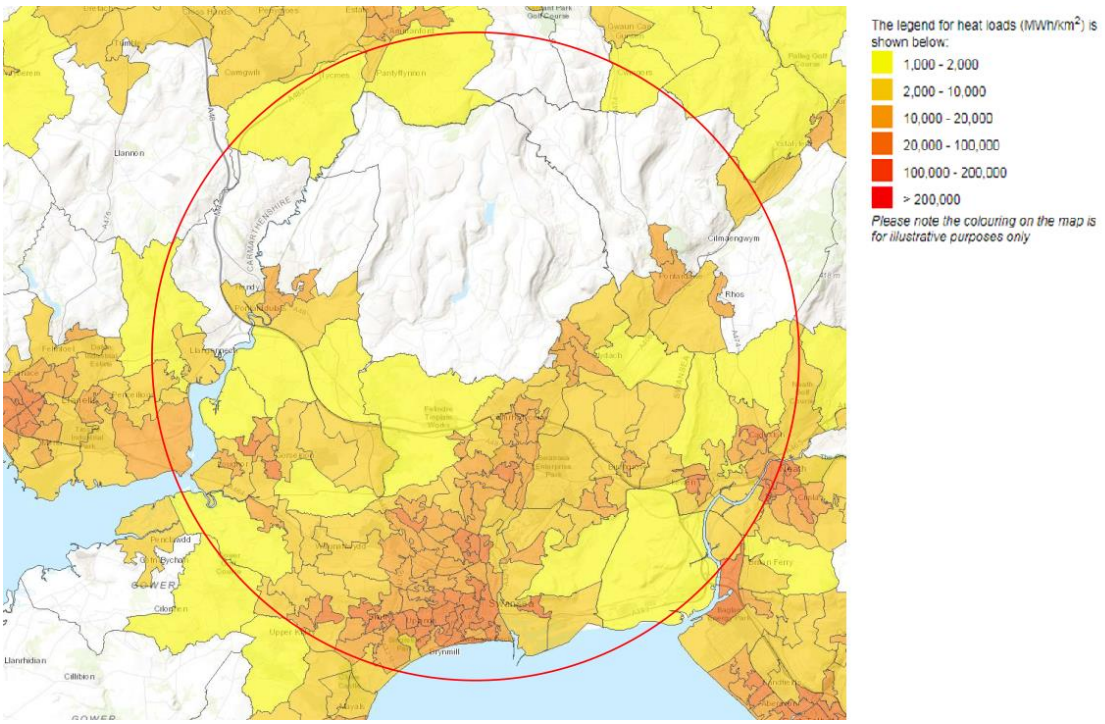
6.1 INITIAL CHP INVESTIGATION

6.1.1 As per Section 5.3 of the Environmental Statement, a detailed feasibility assessment was undertaken which considered a range of sites around England and Wales to support gas fired power generation plants.

6.1.2 To understand the likely heat demands in the area local to the identified Project Site, an assessment of the BEIS online heat map[2] was carried out.

6.1.3 Figure 6-1 and Table 6-1 below show the results of the assessment of the BEIS Online Heat Map tool. The Natural Resources Wales guidance suggests that for all plants less than 300 MW a search area of 10 km is used. No individual large industrial heat loads were identified within this area.

Figure 6-1 Approximate total heat load within a 10 km radius around the Project site



[2] http://chptools.decc.gov.uk/developmentmap/

6.1.4 Table 6-1 shows the potential heat loads within the 10 km search area. It shows that the largest potential heat users are domestic with an approximate requirement of 795 MW. The second largest potential heat users are 'Government Buildings' with an approximate requirement of 44 MW; the third largest potential heat users are 'Small Industrial' with an approximate requirement of 39MW. Remaining heat requirements of other potential users in the area range from less than 1MW to approximately 35MW.

Table 6-1 Total heat loads within the CHP search area

SECTOR	SHARE	TOTAL MWH
Communications and Transport	0.04%	713
Commercial Offices	0.61%	11,516
Domestic	85.87%	1,621,774
Education	2.46%	46,376
Government Buildings	0.52%	9,767
Hotels	0.54%	10,278
Large Industrial	4.74%	89,528
Health	0.39%	7,318
Other	0.21%	4,040
Small Industrial	3.17%	59,809
Retail	1.04%	19,672
Sport and Leisure	0.25%	4,759
Warehouses	0.17%	3,123
Total heat load in area:		**1,888,673**

6.1.5 Although there appears to be a large heat load in the area for domestic heat users, this is unlikely to represent a viable CHP opportunity in the area based on, principally, the discussions presented earlier in this document under 'Feasibility' regarding intermittent loads from Peaking Plant and distance from the site. In addition to these discussions, however, the comparatively low density and age of housing in the region would make installing a new district heating network technically challenging and thus have associated cost implications.

6.1.6 The results of studies undertaken by APL, which were informed by the changes as a result of the Electricity Market Reform and the Government consultations on the delivery mechanisms provided by the Energy Act 2013, have formed the basis for the selection of the Peaking Plant concept for the Project.

6.1.7 The Project is being developed to provide vital support to the National Electricity Transmission System as electricity demand increases and the nature of supply of electricity changes to incorporate a likely greater share of renewables in the generation mix.

6.1.8 Therefore, whilst consideration of the potential for the provision of CHP was considered as part of the site selection studies, the intentions for the Project meant that the provision of CHP was not the principal factor in the site selection process. It is, however, considered that this is in accordance with paragraph 2.2.1 of NPS EN-2 which states: "it is for energy companies to decide which applications to bring forward and the government does not seek to direct applicants to particular sites for fossil fuel generating stations."

7 CONCLUSIONS

7.1.1 Based on the information above, it can be concluded that there are four prohibitive barriers to the application of CHP for the Project:

- There is no existing regional heat market. From local searches, there are no suitable heat users of applicable scale available and no heat users able to accept the unpredictable supply of heat available.
- No potential future heat requirements in the area have been identified and none that would match the operational pattern of a Peaking Plant.
- The intermittent and peaking modes of operation of OCGT are incompatible with the likely continuous demands of heat users. Because of the lack of applicable heat demands, provisions in the proposed scheme for exploiting any potential heat demand in the future can be excluded.
- OCGT plants do not produce steam as part of the electricity generating process and therefore the provision of CHP capability would require the addition of steam raising plant resulting in an increased capacity tariff (£/kW/year) and additional technical challenges.

7.1.2 Accordingly, this Design Note on CHP demonstrates that the Project does not need to undertake further investigation of CHP for the proposed thermal generating station, and provides evidence as to why the proposed thermal generating station should be excluded from being CHP- Ready.