ABSTRACT

South Hook LNG Terminal sponsors, Qatar Petroleum International, ExxonMobil and Total, are evaluating a
innovative concept of building a combined heat and power plant (CHP) at the terminal. This integrated
concept would improve heat efficiency resulting in a reduction of fuel use and regional CO2 emissions by
greater than 20% as compared to vaporizing LNG and generating the power separately. Commissioned in
March 2009, South Hook LNG Terminal at Milford Haven, Wales, enhances UK energy diversity and security
with the ability to deliver 2.1 billion cubic feet of natural gas daily into the national grid. In the current LNG
vaporization process, natural gas is consumed as fuel to gasify the liquid LNG. The combined heat and
power project, which is currently being evaluated by the terminal sponsors, is aimed to replace vaporization
fuel use with the residual heat of the power plant. The heat generated by the gas combustion in the power
plant would be used three times to maximize efficiency: (1) direct combustion in a gas turbine to produce
electricity, (2) exhaust from the gas turbine generates steam to drive a steam turbine for additional electricity,
and finally, (3) residual low grade heat from the steam turbine is used to vaporize the LNG. The key project
challenges are developing the integrated design and engineering the LNG combustion vaporizers to ensure
effective use of the heat.

INTRODUCTION

Qatar Petroleum International Ltd., ExxonMobil Power Ltd. and Total Gas and Power Business Services
S.A.S have announced they are considering building a combined heat and power (CHP) plant within the
existing boundary of the South Hook Liquefied Natural Gas (LNG) Terminal.1 This integrated concept would
improve thermal efficiency resulting in a reduction of fuel use and regional CO2 emissions by greater than
20% as compared to vaporizing LNG and generating the power separately.

Fully commissioned in 2010, South Hook LNG Terminal at Milford Haven, Wales, enhances UK energy
diversity and security with the ability to deliver 2.1 billion cubic feet of natural gas daily into the national grid.
In the current LNG vaporization process, natural gas is consumed as fuel to submerged combustion
vaporizers which gasify the liquid LNG. The combined heat and power project, which is currently being
evaluated by the terminal sponsors, would aim to replace vaporization fuel use with the residual heat of the
power plant.

The proposed CHP Plant will have an installed capacity of up to 500MWe (MW electrical) and produce
sufficient electricity to meet the existing power needs of the LNG Terminal and export surplus electricity. The
heat generated by the initial gas combustion in the power plant would be used three times to maximize
efficiency: (1) direct combustion in a gas turbine to produce electricity, (2) by-product steam drives a steam
turbine for additional electricity and, finally, (3) residual low grade heat from the steam turbine is used to
vaporize the LNG.

1 Nothing in this document is intended to override the corporate separateness of local entities. For convenience and
simplicity in this document abbreviated references are sometimes used to describe specific affiliates or affiliate groups
as well as global or regional operational organisations or business lines.
BACKGROUND

The South Hook LNG Terminal was fully commissioned in 2010 and is one of the largest LNG receiving terminals in Europe. The Terminal is designed to be capable of meeting up to 20% of the UK’s gas demand. In 2011, it received enough liquefied natural gas to meet the needs of over ten million UK households. Each of the five storage tanks is big enough to hold London’s Albert Hall. Today, the Terminal uses imported energy and natural gas combustion to turn LNG back into natural gas for supply to the UK gas grid. All the electricity used by the Terminal is currently imported from the electricity grid. Since the Terminal has a significant requirement for both heat and power, it presents an excellent opportunity to co-locate a CHP plant and deliver world-class efficiencies. Indeed, Milford Haven and Pembroke were identified in a 2008 Pöyry Energy Consulting report commissioned by Greenpeace as one of nine UK areas with the greatest technical potential for the construction of large-scale CHP close to heat demand.

The Terminal is operated to the highest operational and safety standards. The Terminal is a significant local employer and purchaser of goods and services. Through its Community Development Programme, the Terminal has supported some 600 local community projects and organisations since it was established.
CHP STANDS FOR COMBINED HEAT AND POWER

In a conventional thermal power plant, fuel (coal, oil, gas) is used to heat water and produce steam to drive a steam turbine. Around 35% of the fuel energy put into the power plant is converted into electricity for export, and a large amount of unused heat is wasted. In a combined cycle gas turbine (CCGT) power plant, gas is used to power a large turbine - technically similar to those used in aircraft. The engine turns a generator which produces electricity. The heat from the turbine, rather than being wasted, is in turn used to boil water and drive a steam turbine, which also generates electricity. This two phase approach to electricity generation gives the technology its ‘combined cycle’ name. In a CCGT power plant approximately 55% of the fuel energy put into the power station is converted to electricity, with the rest being lost or wasted.

WHAT IS COMBINED HEAT AND POWER?

In a CHP scheme, the gas turbine and steam turbine generate electricity in the same way as a CCGT power plant. However, additional and otherwise wasted energy is recovered and used to produce hot water or steam for use in another industrial process requiring heat such as oil refining, chemical production or paper making. The South Hook CHP plant will use the additional recovered energy to convert LNG back into a gaseous state (natural gas). Around 55% of the fuel energy put into the South Hook CHP plant will be converted into electricity. Additionally, when combined with recovery of more than 30% of the input fuel energy as usable heat, this leads to overall CHP plant efficiency of more than 85%. This means the South Hook CHP plant will contribute to reducing overall UK CO₂ emissions.
WHAT ARE WE PLANNING TO DO?

We plan to build a CHP plant on land adjacent to the existing South Hook LNG Terminal, within the site boundary, on an area previously identified for future expansion. The CHP plant will provide heat to replace the natural gas currently used by the LNG Terminal to convert liquefied natural gas back into a gaseous state (natural gas). In the process, the CHP plant will generate sufficient electricity to meet the needs of some 900,000 households. It will also enable the South Hook LNG Terminal to become self-sufficient in electricity. The South Hook CHP plant will be capable of supplying power to existing and new businesses in the proposed Haven Enterprise Zone. The CHP plant will be one of the most efficient in the UK. The plant has the potential to reduce annual UK carbon dioxide emissions by the equivalent of taking almost one million cars off the road.
WHAT MIGHT THE PROPOSED PLANT LOOK LIKE?

At this early stage of the project, many matters remain to be decided. These include the size of the CHP plant, details on building design and visual appearance, its precise location within the boundary and the technology used to provide standby cooling. The structures shown here represent the maximum dimensions of the CHP plant and are shown in simple blocks of colour. The building dimensions shown here represent the upper limits and any final design will be developed in close co-operation with Pembrokeshire County Council and Pembrokeshire Coast National Park Authority to achieve the best visual results. The height of the exhaust stack (‘chimney’) will be set in conjunction with technical consultants and whilst effective dispersion of the products of combustion will be the primary consideration, a balance will also be struck with visual impact considerations.

The stack shown also represents the maximum anticipated height. The required facilities include the turbine building, heat recovery unit, standby cooling system, stack, control room and store room. Safety, technical and aesthetic factors will influence the final layout of the CHP plant. These will be discussed with and agreed by the appropriate authorities. There is considerable scope for improving the visual appearance of the buildings through good design and the aim is to create a facility that blends sympathetically into the landscape.

The first phase of consultation considered two potential sites (a western and eastern option) for the location of the CHP Plant within the LNG Terminal. The western option has been selected as the preferred location for the CHP Plant. This decision has been determined by a careful consideration of the key safety, operational, engineering, environmental, visual impact, and constructability concerns associated with both the proposed CHP Plant and the future operation of the LNG Terminal.
GRID CONNECTION

Large scale power generation facilities, whether conventional or CHP plants, have to be connected to the national electricity grid at high voltage. The proposed South Hook CHP plant will connect to the existing Pembroke 400kV sub-station owned by National Grid Electricity Transmission plc which is adjacent to the new Pembroke Power Station on the south side of the Haven estuary.

In Wales, unlike England, new large power stations (including CHP plants) and their grid connections are not treated as a single planning application but are handled separately. Depending on the nature of the grid connection, it may be necessary to apply to the Secretary of State for a separate Development Consent Order. The project sponsors are currently reviewing grid connection options. The project sponsors have been working with local and national power distributors and engineering consultants to determine the options available for the grid connection to the Pembroke sub-station. These studies are on-going and the exact means of connecting to the Pembroke sub-station has not been determined. The assessments undertaken to date, however, confirm that a grid connection between the proposed CHP plant and the Pembroke sub-station is feasible. Two key options for the Haven crossing are being evaluated and assessed. The first is to cross using submarine cables buried in trenches in the bed of the Haven; a number of route corridors are currently being assessed. The second is the construction under the Haven of a tunnel through which cables would pass. In both cases the project sponsors intend to connect from the CHP Plant to the crossing and from the crossing to the Pembroke Power Station electrical sub-station using buried cables wherever practical to do so. Neither option, therefore, is likely to involve significant use of overhead lines.
BENEFITS TO THE LOCAL COMMUNITY

During construction, several hundred jobs will be created and to the extent possible, we will maximise the use of local labour. Once operational, the CHP plant will create around 30 new full-time jobs. Again, we will seek to maximise the use of local labour. Both the construction and operational phases will create opportunities for local contractors and suppliers. A recent study by Cardiff Business School demonstrated that the Haven energy industries already account for around one-fifth of Pembrokeshire’s total economic output. The South Hook CHP plant will reinforce the role of Milford Haven as the UK’s ‘Energy Capital’ and will also potentially act as a catalyst to make the proposed Haven Enterprise Zone a success. The South Hook LNG Terminal over the years has played a major role in supporting local community activities. The South Hook CHP project similarly affirms its commitment to be a ‘good neighbour’, for example by sponsoring the ‘Green Award’ in Radio Pembrokeshire’s upcoming ‘Local Heroes’ initiative.

PROTECTING THE LOCAL ENVIRONMENT

South Hook LNG Terminal is already dedicated to minimising its impact on the environment and South Hook CHP is committed to following the same standard. Prior to the start of construction, all aspects of the natural environment will be reviewed and plans agreed with the relevant authorities to minimise the CHP plant’s impact. Issues such as air quality, marine ecology, plant, animal and bird habitats and archaeology will be carefully assessed. Visual amenity and noise will also be assessed. Detailed surveys will be undertaken of all aspects of the environment before work begins and mitigation plans will be agreed with the relevant authorities. Through careful planning, we will seek to minimise the effect the project has on local communities during construction and operation of the CHP plant.
SAFETY

CCGT technology, which lies at the heart of the proposed South Hook CHP project, is a well proven and safe technology. There are at least 40 such plants operating in the United Kingdom alone. Combined heat and power projects depend for their viability on proximity to a use for their recoverable heat and are therefore less common. They are, however, often co-located with industrial sites in the UK and elsewhere. The extensive design, engineering, project management and operational expertise of the project sponsors will be drawn upon to ensure the proposed CHP plant is safely built and operated to the highest standards. The project sponsors will work closely with its neighbour South Hook LNG Terminal to ensure a smooth transition with minimum disruption to the Terminal's operations and the local community.

CONCLUSION

Qatar Petroleum International Ltd., ExxonMobil Power Ltd. and Total Gas and Power Business Services S.A.S are evaluating an innovative concept of building a combined heat and power plant (CHP) at the terminal. Since the South Hook LNG Terminal has a significant requirement for both heat and power, it presents an excellent opportunity to co-locate a CHP plant and deliver world-class efficiencies. This integrated concept would improve thermal efficiency resulting in a reduction of fuel use and regional CO$_2$ emissions by greater than 20% as compared to vaporizing LNG and generating the power separately. The South Hook CHP plant will use the additional recovered energy to convert LNG back into a gaseous state (natural gas). Around 55% of the fuel energy put into the South Hook CHP plant will be converted into electricity. Additionally, when combined with recovery of more than 30% of the input fuel energy as usable heat, this leads to overall CHP plant efficiency of more than 85%. This means the South Hook CHP plant will contribute to reducing overall UK CO$_2$ emissions. The CHP plant will be one of the most efficient in the UK.