Electricity Supply Board
Aghada Generating Station

Report Title:	Efficiency Audit Report and Opportunities for energy efficiencies improvement / recovery.
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General

ESB Aghada is located in Cork harbour.

The site contains three identical open cycle gas turbines (OCGT), AT1, AT2, and AT4, each rated for 90MWe (nominal), with a thermal cycle efficiency of 31 % (nominal). They are fuelled by either natural gas or liquid gasoil (distillate).

AD2, a combined cycle gas turbine generating unit (CCGT), rated at 432MWe was handed over to the station in early 2010. This unit was constructed as a base load plant with a thermal efficiency in excess of 58%.

The site has planning for a number of additional developments, the first of which, a 38MWhr Battery Energy Storage Solution is currently in construction. The proposed BESS will operate by charging batteries using electricity imported from the national electricity grid. When the stored energy is required, it can be released to provide grid system services such as stabilising the frequency of the electricity network or provide energy during periods of electricity shortages. This battery project will be commercial operational in Q3 2021.

Maintaining Unit Performance & Energy Consumption

Each unit's performance or energy consumption is measured against pre-set operating targets. Variations or degradation in the energy conversion process will arise with operation over time. Temporary losses can be recovered and restored while other degradation is not recoverable. Temporary losses can arise due to increased use of energy in the 'house load' element of the process. Hence the electrical energy used, or 'house load', is optimised by having the most efficient plant in service at any time. Other temporary losses can arise due to water or steam leaks and inadequate heat transfer within the process such as for example fouling of the sea water cooled condenser. As plant ages, there will be degradation resulting in increased energy consumption, that cannot be recovered.

Plant reliability and optimised performance is achieved by undertaking corrective and preventive work, either during short term plant shutdowns or longer plant overhauls, usually on an annual basis.

The station assigns an operating efficiency target to each unit each year. A 100% outturn infers that the fuel allowance is being converted to electrical energy in an optimal way.

Open Cycle Gas Turbines

Open cycle gas turbine running is heavily influenced by variability in wind, availability of interconnectors and starting reliability of larger plant. Work was completed on site to reduce the start-up time and loading rates of these units in an effort to make the units more attractive to the TSO and to better support the DS3 market place, all of which is designed to facilitate penetration of wind and other renewables.

The run hours on the units are summarised as follows;

	AT1	AT2	AT4
Operating Efficiency (Gen) %	99.86% average		
Run Hours	182	105	694
Hot Starts	38	21	87

Run hours were biased onto unit AT4 in this calendar year in the main due to transmission system works which favoured the physical connection point of the unit.

As these units only operate intermittently, for short periods, the energy flows are dependent on starting reliability and component condition. Short term maintenance shutdowns are utilised to ensure that the starting reliability, and equipment reliability of each combustion turbine is maintained.

Air filtration is maintained at F7 levels to ensure compressors remain clean. Despite this, year on year the station has ensured that annual offline compressor washes of each open cycle turbine are completed. This greatly improves the operating performance of the unit.

Combined Cycle Gas Turbine AD2

AD2 is an Alstom KA-26-1 Single Shaft Combined Cycle Gas Turbine based upon the GT26B2.2 technology gas turbine. At full output of 432MWe, the thermal cycle efficiency of the unit can be expected to be in excess of 58%.
As with the open cycle GTs, the site is committed to enhancing the flexibility of the CCGT to facilitate renewables on the Grid. In 2018 the site installed technology to reduce the minimum stable load of AD2 whilst remaining emissions compliant and maintaining high part load efficiency.
In 2019 this was complemented with an upgrade to the turbine to improve base load output and thermal efficiency. Further enhancements to minimum load and other flexibilities are envisaged for delivery in Q2 2021.

	AD2
Operating Efficiency (Exp) %	101.65
GWHhrs Exported GWh	1905.32
Run Hours	6533
Hot Starts	38
Warm Starts	1
Cold Starts	9

- AD2 accumulated 6,533 run hours and 48 starts in 2020.

- Operating efficiency out turn for 2020 was 101.65%. The differential can be attributed in the main to the efficiency improvements accrued from the new design turbine section installed at the outage in late 2019.

  The GT26 MXL2 upgrade allows online switching between M mode and XL mode of operation that results in improved total performance, reduced maintenance costs and increased availability.

Efficiency
M mode for maximum power output and efficiency.
Optimised Maintenance
XL mode extends the inspection interval and improves performance.

The MXL2 upgrade is defined by two modes of operations:

• In M mode, gains in power output of 13.5 MW are possible for the combined cycle, while the efficiency can be expected to increase by 0.7%.

• In XL mode, component lifetime is extended to allow up to an additional 8,000 operating hours before the next type C hot gas path inspection. This increases availability and reduces maintenance costs. In addition, the power output is expected to increase by 3.0 MW and efficiency to improve by 0.5%.

The performance benefits are based on a redesign of the airfoils and the heat shields of the low pressure (LP) turbine. Switching between the M and XL modes is achieved by adjusting the turbine inlet temperature of the new LP turbine.

- The start-up house load target set by the station greatly influences operating efficiency figures. House load is the energy consumed by the plant which cannot be exported to the Grid. Typically, AD2 has a house load of ~ 5.5MWs. On start-up, prior to synchronising to the Grid, fuel and electrical house load are being consumed. If house load is excessive, operating efficiency will drop. House load continues to be monitored and refinements made to start-up and shutdown practices.

- Air intake filtration is maintained at H class filtration. So called 'Hepa' filters help to keep the compressor clean. E11s (fine filters) and F7s (pre-filters)were installed during the 2019 inspection.

- The station policy for online washing of the compressor has changed in light of improved filtration. Opportunistic online washing is conducted in order to wash salts from the compressor inlet. These pass the filters in solution, crystallising out on the clean site at the engine inlet. Washing is no longer conducted as an efficiency activity.

- Performance (corrected power output and compressor efficiency) are monitored using remote monitoring services provided by the turbine manufacturer with diagnostic reports generated and reviewed once per month.

- Post outage performance guarantees were tested by the GT OEM and the site O&M team to validate the efficiency and power output performance improvements delivered during the 2019 outage.

- Parasitic losses from the process are monitored and acted upon. These include:

    - Anti-icing, a parasitic bleed of hot air from the gas turbine compressor to ensure that the intake remains clear of ice.
    - Water Steam Cycle make-up, indicative of excessive chemical blowdown from the drums and of leakage from the process is monitored.
    - Internal leakage or bypassing of the steam turbine through passing steam turbine bypass valves is acted upon as it arises. A full overhaul of the ST valves took place in 2019, including the HP, IP and LP bypasses.
    - Condenser vacuum is optimised for ST load to minimise excessive cooling of condensate and to minimise cooling water pump flow and associated auxiliary load.

An energy efficiency audit was completed for Aghada Generating Station. Due to Covid restrictions a desk based energy audit was completed which focused on the buildings, lighting, heating and power as distinct from the power plant equipment. A detailed report with initiatives was submitted on November 2020.