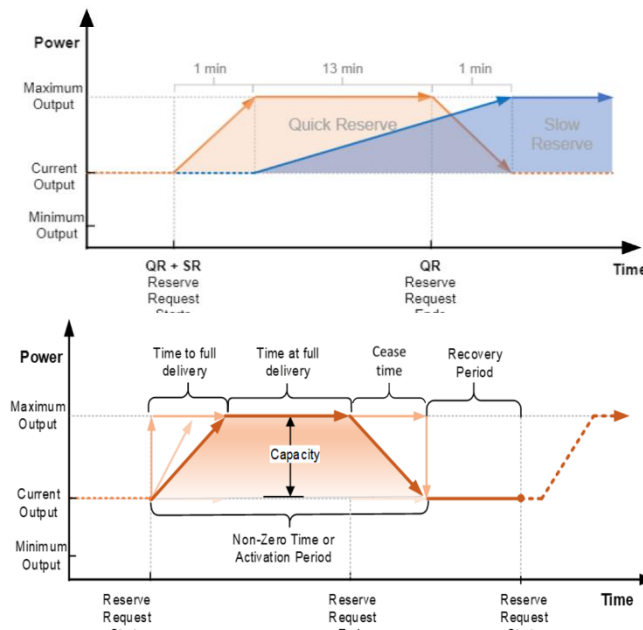


Bowman eTurbo Systems StartIQ™ **for the UK Gas Peaking Market**

NESO PQR Background

The UK National Energy System Operator (NESO) has continually been upgrading the UK national grid requirements to better cope with fluctuations in grid frequency caused by an increasingly large volume of intermittent renewable power generation. A new service, Quick Reserve (QR), has recently gone live. It is primarily designed to react to pre-fault disturbances to restore energy balance quickly and return the frequency to 50.0 Hz. It is intended to be operated by units for short periods, before handing over to other slower reacting units which can be brought online within 15 minutes to replace the QR units (the 15 minute balancing will be serviced by units operating in the upcoming Slow Reserve (SR) market).



QR is separated into Positive Quick Reserve (PQR), (where units are requested to increase generation) and Negative Quick Reserve (NQR) (where units are requested to increase demand, or consumers to reduce demand). The PQR market is designed using the following parameters:

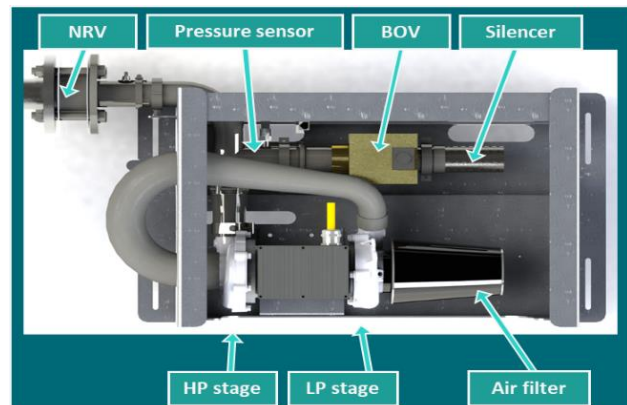
- Time to full delivery – Less than 60s after the 'Reserve Request Starts'
- Time at full delivery – Minimum 3 minutes, maximum 13 minutes.
- Cease time – Maximum 60s after the reserve request ends
- Activation Period – Equal to 'Time to delivery' plus 'Time at full delivery' plus 'Cease time', minimum 5 minutes, maximum 15 minutes
- Recovery period – Maximum 3 minutes

<https://www.neso.energy/industry-information/balancing-services/reserve-services/quick-reserve#Technical-requirements>

Bowman StartIQ™ - Technology

Bowman eTurbo Systems have developed a 55kW, electric compressor (eCompressor) system (StartIQ™) which, when applied to high-speed generating sets, has been proven to successfully eliminate turbocharger lag to significantly enhance genset transient load acceptance capability.

The system consists of a high-speed, two-stage radial eCompressor, valves and pipework which connect to the host genset engine's exhaust manifold, upstream of the turbocharger turbine. These are controlled by means of a Power Electronics (PE) connected to the local 3-phase 400Vac, 50/60 Hz grid. The system has been developed with ease of integration in mind - there is no need for cooling or lubrication, and minimal signals are required to and from the genset for automation. When required, the StartIQ™ system is operated, delivering air from the eCompressor into the engine's exhaust manifold, accelerating the turbocharger, rapidly increasing the fuel and air mass delivered to the engines cylinders (increasing generated load). The technology greatly increases the load acceptance capability of modern natural gas peaking gensets, enabling them to perform 0% to 100% load ramp times, previously considered impossible.



Bowman StartIQ™ - Field experience

To date, StartIQ™ systems have been applied, tested and validated on three separate natural gas genset platforms. In each case, the load ramp times, from breaker closed to 100% load, have been successfully reduced from minutes to approximately 10 seconds. Taking the full genset start sequence into account, each



genset platform was able to reliably achieve start command to 100% load (with the genset in cold, pre-heated condition) in less than 60s, as per the 'Time to full delivery' PQR requirement. In each case, the cumulative fuel consumption, CO₂ and NO_x emissions were reduced by 80 to 90% during the load ramp phase.

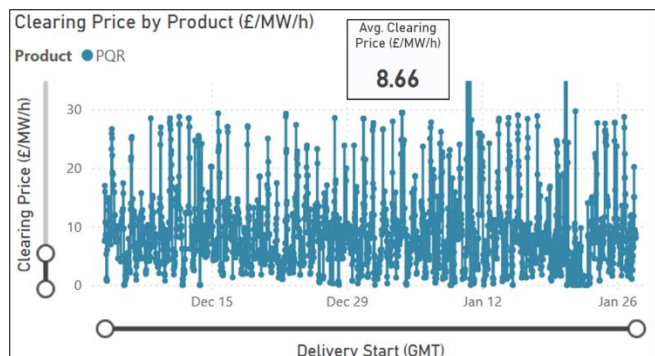
Additionally, StartIQ™ enables the possibility to turn off the fueling enrichment normally required for minutes during the turbocharger lag period. This ensures steady state NO_x emissions are maintained while reducing in cylinder combustion temperatures and thermal stresses throughout the genset load ramp to 100% load.

The lead StartIQ™ customer has been operating a full 20MWe gas peaking site, with ten StartIQ™ systems installed, in the UK since November 2023. The site has been operating fully automated, with performance measured against PQR requirements. The StartIQ™ system has achieved reliability in excess of 99.9%, with the genset start command to 100% load time, 'Time to full delivery' for the genset reliably achieving < 50 seconds. At the time of writing, over 10,000 automated starts with StartIQ™ have been accumulated.

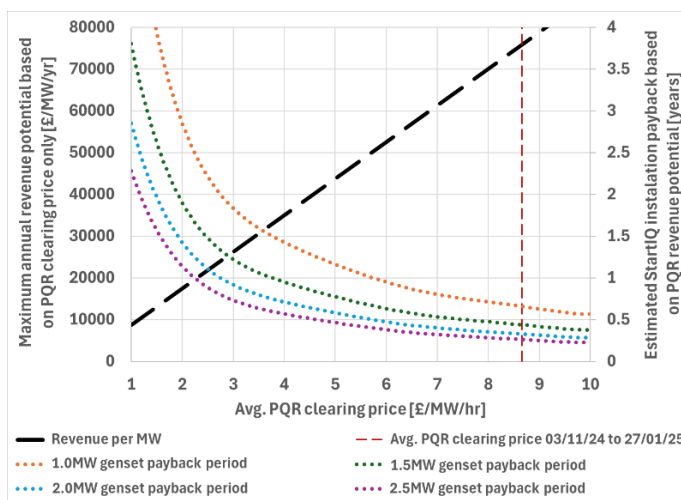
StartIQ™ for PQR - Value Proposition

The UK NESO QR market went live on the 3rd December 2024. The initial auctions have been entirely dominated by Battery Energy Storage Systems (BESS) operators, with the average clearing price for PQR availability achieving 8.66€/MW/hr through to 27th January 2025. Other than occasions when there is a lull in wind generated power, there is no indication the market conditions or clearing price will soften in the near term.

<https://www.neso.energy/data-portal/eac-auction-results>



Unlike BESS, which need consideration and management of run durations, minimum and maximum discharge levels, time and cost to recharge etc., gas peaking gensets can be made available to generate and support the grid continuously. This gives a unique PQR opportunity for gas peaking gensets with StartIQ™ installed, to be available to operate year-round, unlocking the potential to maximise availability revenues.



Taking the average PQR clearing prices to date into account, ~£75,000/MW/yr is feasible for gas peaking gensets with StartIQ™ installed. This provides availability revenues approximately an order of magnitude greater than typically achievable to gas-peakers operating within the Short Term Operating Reserve (STOR) market.

With the complete cost of StartIQ, installed and commissioned, in the range £45k - £55k per genset, payback times are compelling. Even if the PQR clearing price were to in time decrease by two thirds, payback times of less than 1 year would still be achievable for the most common UK gas peaking genset ratings operating today.