Compressor Emissions Reopener

Industrial Emissions Directive Supporting Information

January 2018

The legislation and how it affects us

Environmental legislation has been developed over recent years introducing new standards to ensure industrial activities have a limited impact on the environment. The legislation aims to reduce the quantity of air, water and land pollutants which are responsible for damage to the environment and to human health. National Grid's gas turbine driven compressors are impacted by the legislation as a result of emissions of nitrogen oxide (NOx) and carbon monoxide (CO) to the environment from the combustion of natural gas.

It is mandatory for all EU countries to comply with the new minimum standards. The impact of BREXIT on environmental legislation although uncertain is considered unlikely to reduce the requirement set by these minimum standards.

This section covers the background of the two initial pieces of relevant emissions legislation and then goes on to discuss how these were brought together in the Industrial Emissions Directive (IED) and the effect of this new legislation on our compressor units.

Large Combustion Plant (LCP) directive 2001

The LCP directive applies to all combustion plants with a thermal input of 50 MW or more. Such combustion plants must meet the Emission Limit Values (ELVs) as defined in the directive. An ELV is the maximum permissible rate at which a pollutant can be released by an installation. The ELVs set out in this directive can be met in one of two ways: (1) Choose to opt in: comply with the ELV or plan to upgrade and achieve compliance by a pre-determined date or (2) Choose to opt out and comply with one of two restrictions defined by the derogations: Limited Lifetime Derogation or the Emergency Use Derogation.

Integrated Pollution Prevention and Control (IPPC) Directive 2008

Under the IPPC, any installation with a high pollution potential is required to have a permit. One of the pre-requisites for this permit is that Best Available Techniques (BAT) are used to prevent or reduce the emission of these pollutants. BAT assessments are required when developing a solution to avoid or reduce emissions resulting from industrial installations and to reduce the impact on the environment as a whole. They take account of the balance between costs and environmental benefits over the full lifecycle of the installation.

The impact of IPPC means that all of our compressor units are required to have a permit which specifies the maximum ELVs to air for that unit. We have an overarching IPPC strategy as agreed with the Environmental Agency (EA) and the SEPA (Scottish Environmental Protection Agency) which allows us to review our compressors as a fleet on an annual basis, targeting those sites that emit high levels of NOx to maximise the environmental return. This process is called the Network Review and to date we have undertaken three phases of IPPC works and we are currently in the process of agreeing Phase 4, which is covered within this consultation.

The Industrial Emissions Directive 2013

Subsequently, the IED brought together existing pieces of European environmental legislation, which include the LCP directive and the IPPC directive. The four major provisions of the IED which impact on National Grid and our compressor units are as follows;

1. The use of permits for installations

The IED specifies that all installations must be operated with a permit. These permits specify the ELVs for polluting substances, which are likely to be emitted from the installation concerned and also determines the environmental risk of that installation. This mirrors the specifications set out in the IPPC whereby installations have to comply with the ELVs set out in their permit, which are based on BAT.

2. Establishment of BAT Reference documents

The IED also introduces an increased emphasis on the status of the BAT Reference (BREF) documents. These BREF documents draw conclusions on what the BAT is for each sector to comply with the requirements of IED. This then forms the reference for setting the permit conditions mentioned above.

3. The updating of ELVs for installations above 50 MW

The IED states that for installations with a thermal input over 50 MW it is mandatory for the following ELVs to be complied with;

Carbon Monoxide (CO) – 100mg/Nm3
Nitrogen Oxide (NOx) – 75mg/Nm3 for existing installations
Nitrogen Oxide (NOx) – 50mg/Nm3 for new installations.

The IED mirrors the requirements set out in the LCP directive. These new limits introduced through IED affect 17 of 64 units in the National Grid compressor fleet. Compressors that could not meet the new ELVs for CO and NOx had to stop operating on 31st December 2015, unless the unit had received a derogation.

4. Limited Lifetime Derogation (LLD)

The requirements for a Limited Lifetime Derogation state that from 1st January 2016 to 31st December 2023 combustion plant may be exempted from compliance with the ELVs for installations above 50 MW provided certain conditions are fulfilled:

(a) The operator makes a declaration before 1st January 2014 not to operate the plant for more than 17,500 operating hours within the derogation period, which started on the 1st January 2016 and ends on the 31st December 2023;
(b) The operator submits each year a record of the number of operating hours since 1st January 2016

We have already made the declaration referred to above and have been permitted to utilise this derogation for some of our currently affected units. A number of our highest utilisation sites are operating under this derogation as the Emergency Use Derogation described below would not give sufficient hours to continue to operate the site. Additionally, if the installations can achieve the ELVs for new installations (rather than existing) using emissions abatement technology before the 2023 deadline, the unit would be deemed compliant.

5. Emergency Use Derogation (EUD)

The IED also makes a provision for emergency use for gas turbines and gas engines which applies to gas plant operating less than 500 hours per year. As with the Limited Lifetime Derogation, this has been applicable from 2016 and we have been allowed to utilise this derogation on some of our currently affected units.

6. 1,500 hours derogation

The IED legislation provides for a further derogation for gas turbines which were granted a permit before November 2002. This applies to units which do not operate for more than 1,500 hours per year as a rolling average over a period of 5 years, increasing the emission limit value for NOx to 150 mg/Nm3, with the limit for CO remaining at 100 mg/Nm3. However, our compressor units produce more NOx than the limit specified in this derogation and therefore this does not represent a viable option.

Upcoming Legislation: Medium Combustion Plant (MCP) directive

The MCP directive will apply specific limits on emissions to air from sites below 50 MW thermal input. This legislation will introduce ELVs that are differentiated according to the plant's age, capacity and type of installation. The gas compressor stations impacted by MCP directive are exempt until 1 January 2030, after which point the units would be restricted to 500 operating hours per year, as a rolling average over a period of five years.

What this means? Each compressor site is impacted in different ways by the legislation. There are the requirements of IPPC, known impacts of the LCP elements of IED, and the derogations which have already been put into place as well as the future implications of MCP that must also be considered as part of a full economic evaluation. Figure 1 illustrates the different units operating under the LLD and EUD across the NTS.

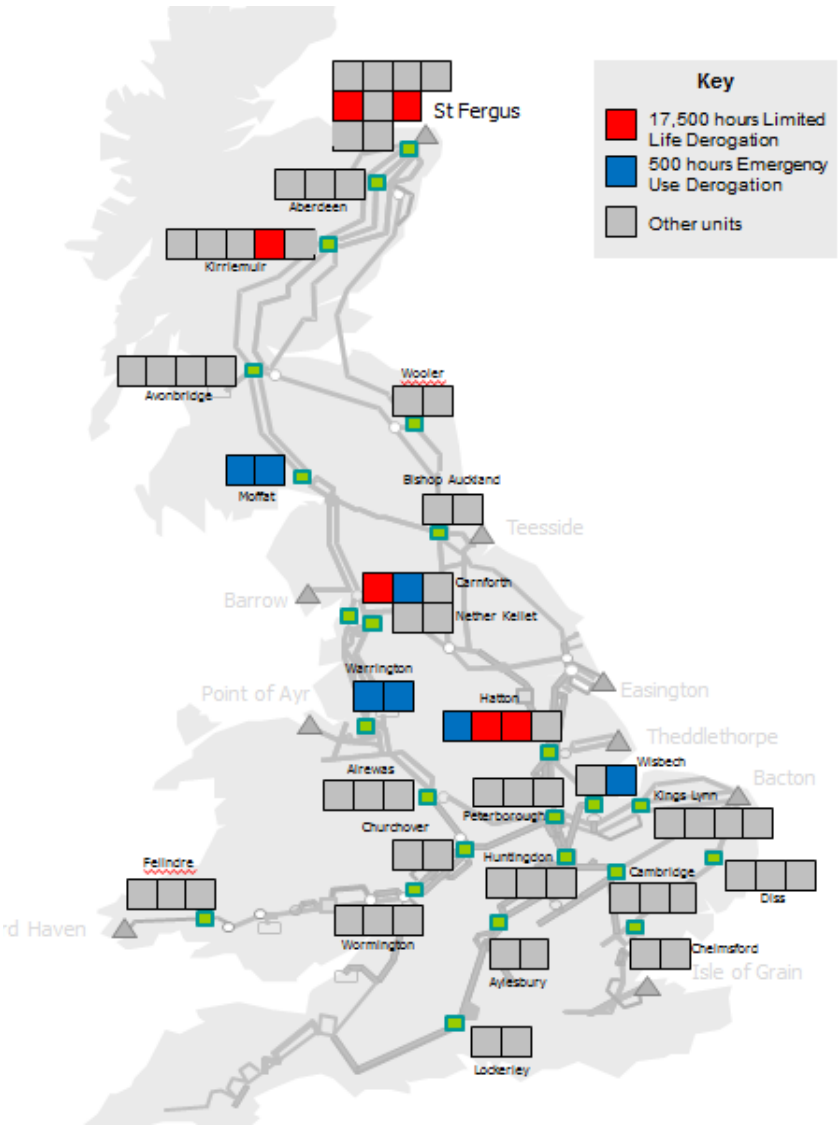


Figure 1: Compressor unit derogations

How we use compressors on the NTS

There has been a significant shift in the way the gas transmission network is utilised. Historically the NTS has operated on a north to south flow pattern with compression used to pull and push the gas from the main entry point at St Fergus to the high demand areas in England. However, over the last 20 years this has changed significantly. There are now more entry points onto the system and these are distributed around the country. The UK continental shelf supplies have declined and in 2004 the UK became a net importer of gas on an annual basis.

The main reasons we have compressors are;

- To transport gas from the supply points to the demand centres
- To maintain pressures within network design safety parameters
- To meet contractual capacity and exit pressure commitments
- To provide system flexibility to meet rapidly changing use and conditions
- To provide network resilience against supply losses or at times of very high demand
- Occasional use to facilitate maintenance

The evolution of the network has resulted in changes to compressor utilisation. Some compressors are now required to support reverse flows: moving gas in the opposite direction from their original design; some compressors have become increasingly important across a large demand range; and some are only used during peak demand conditions or certain supply patterns in order to avoid significant constraints. Figure 2 illustrates the distribution of the different types of units across the NTS.

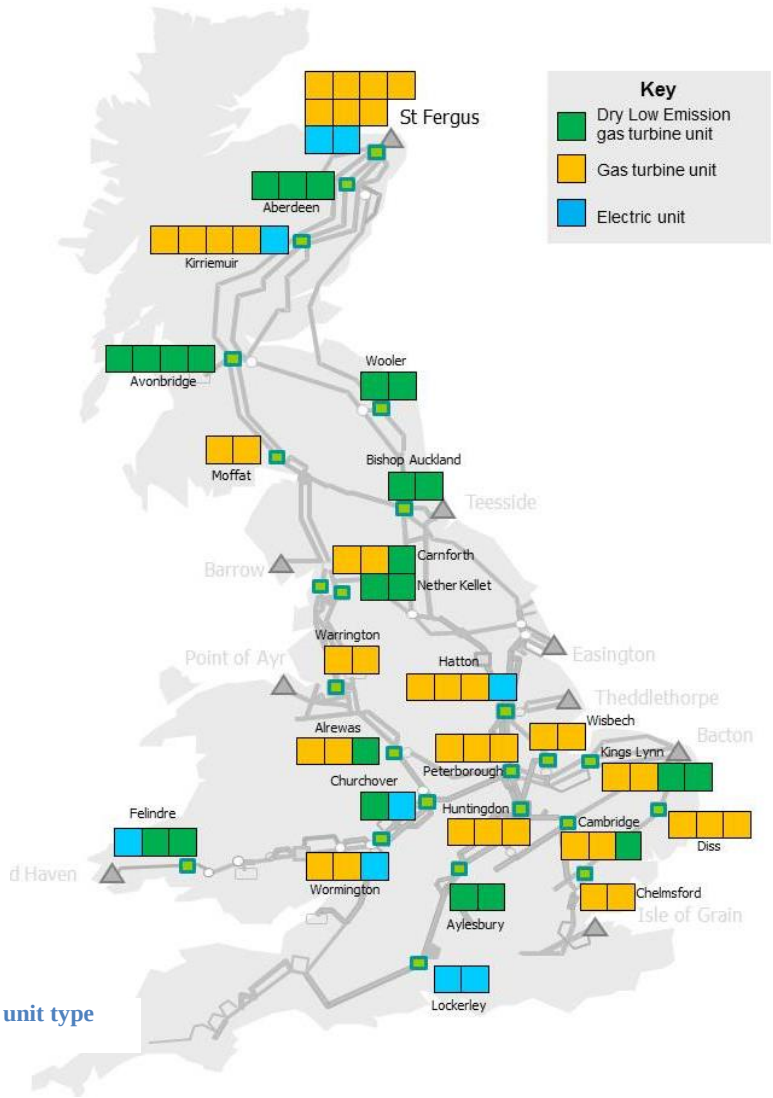


Figure 2: Compressor unit type

Compression in Scotland

There are six compressor sites located in Scotland which support the delivery of north to south gas flow. The utilisation of these sites is strongly influenced by the operational behaviour of the St Fergus entry point. The St Fergus compressor units directly support entry flows from the North Sea Midstream Partners (NSMP) sub terminal, and the other network compressors support the Scotland offtakes and demand centres to the south.

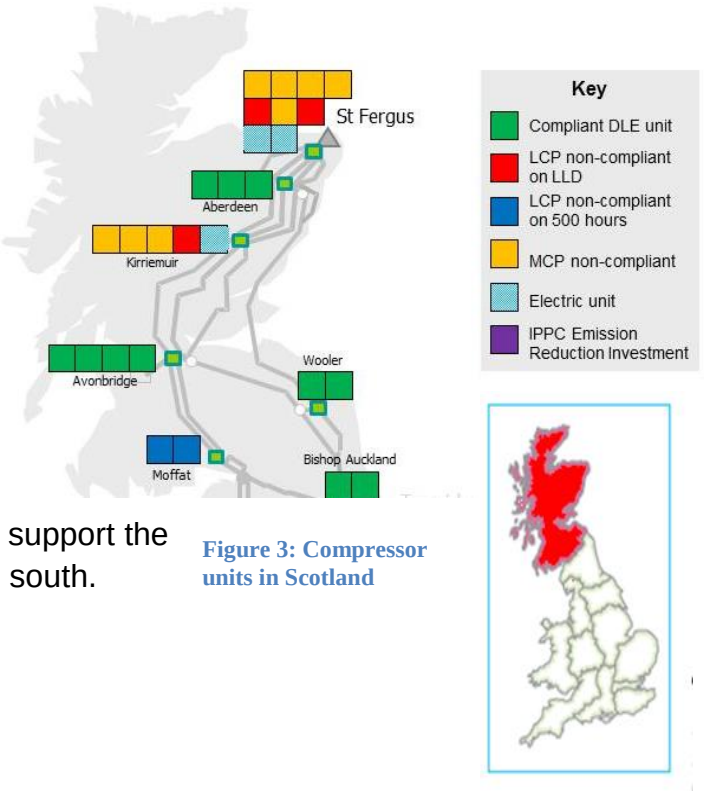


Figure 3: Compressor units in Scotland

Site	Utilisation: Run Hours per year*	Emissions: Kg of NOx per year*	Usage
St Fergus	11,200	170,000	Pressurises gas from the NSMP sub terminal
Aberdeen	4,800	19,300	Required under medium to high St Fergus flows and to maintain Scotland offtake pressures
Avonbridge	4,300	22,000	Supports Scotland offtake pressures
Kirriemuir	2,200	97,400	Required under high St Fergus flows, to maintain Scotland offtake pressures and as back up to Aberdeen and Avonbridge
Wooler	600	1,000	Required under high St Fergus flows and to manage gas stock in Scotland
Moffat	<100	400	Used for network resilience

*Four year average for the site from 2013/14 to 2016/17

Compression in the North and West

Compressor stations within the North region support the delivery of north to south gas flow. With variability in gas flow pattern, these compressors are required to provide increasing flexibility in their operation. Compressor stations in the west are most influenced by the flows of the Milford Haven entry point; compressing gas east when flows are high, or moving gas west into South Wales when Milford Haven supplies are low.

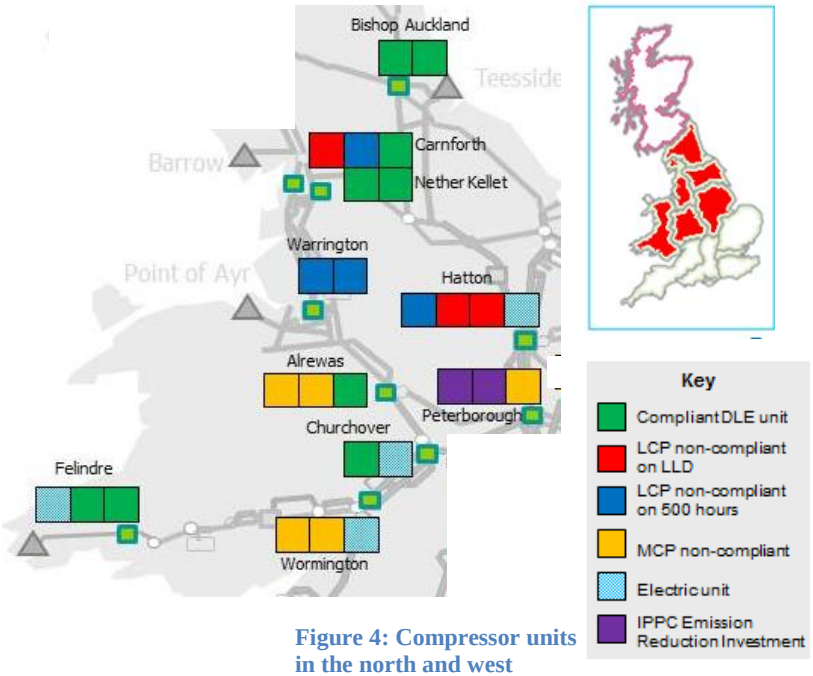


Figure 4: Compressor units in the north and west

Site	Utilisation: Run Hours per year*	Emissions: Kg of NOx per year*	Usage
Peterborough	5,200	79,200	Transmission of gas south, east and west and system flexibility
Hatton	3,500	94,100	Supports the Easington baseline and north to south flows on the East coast. Supports East to West flows including Teesside, Theddlethorpe and the I-UK interconnector.
Carnforth & Nether Kellet	2,400	5,800	Supports high flows north to south and high Easington flows
Bishop Auckland	2,000	3,800	Supports high Teesside and St Fergus flows
Wormington	1,500	500	Facilitates low and high Milford Haven flows and supports pressures in the South West and Wales.
Churchover	1,000	<100	Facilitates low and high Milford Haven flows and supports pressures in Wales.
Alrewas	100	600	Facilitates high Milford Haven flows and supports North West storage and pressures in Wales.
Warrington	<100	200	Specific activities e.g. maintenance and resilience
Felindre	<100	<100	Facilitates high Milford Haven flows

*Four year average for the site from 2013/14 to 2016/17

Compression in the South and East

Compressor stations located in the south of the system are most influenced by the southern demand whilst those in the east are most influenced by the performance of Bacton and Isle of Grain terminals. Variable supply and demand patterns create a need for flexibility in the compression in this area.

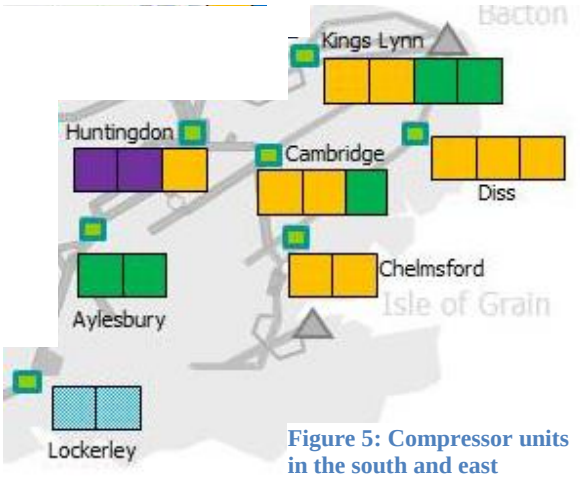
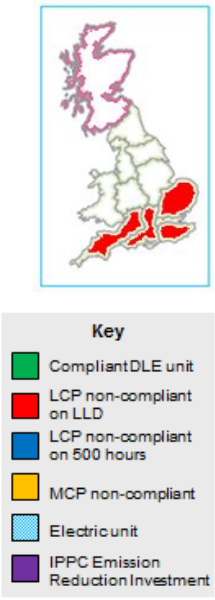


Figure 5: Compressor units in the south and east



Site	Utilisation: Run Hours per Year*	Emissions: Kg of NOx per Year*	Usage
Huntingdon	2,400	28,000	Supports southern flows into the South East and South West during high demand
Lockerley	500	0	Supports pressures in the South West during high demand
Wisbech	400	2,500	Supports high flows to Peterborough
Diss	400	900	Supports high Bacton flows and high South East demand
Chelmsford	300	500	Supports high Bacton flows
Cambridge	200	700	Facilitates low and high Isle of Grain flows
Kings Lynn	100	500	Facilitates Bacton high and low flows
Aylesbury	<100	<100	Supports pressures in the South West. (Low run hours due to recent site works)

*Four year site average for the site from 2013/14 to 2016/17

Potential solutions

The existing fleet of standard Rolls-Royce RB211 and Rolls-Royce Avon gas turbine driven compressors will ultimately be non-compliant with the environmental legislation. All the RB211 units are classified under the LCP directive, and are now operating under the 500 hours Emergency Use Derogation (EUD) or with restricted operating life under the IED Limited Life Derogation (LLD). This derogated plant will have to be permanently closed in 2023 or upgraded through emission abatement technology to meet the required ELVs for a new installation.

Looking forward, Avon units captured under the MCP directive are likely to be subject to similar constraints to the Emergency Use Derogation under the LCP directive; run hours limited to 500 hours but with the flexibility that this restriction is applied on a rolling average basis.

Commercial and regulatory options are the first consideration when assessing the various options to meet the network needs, as these solutions potentially avoid the physical use of compressors, and consequently reduce the emissions impact of the fleet overall. Importantly, as a gas transporter we have license obligations to facilitate the gas market. Our aim is to transport gas on behalf of our customers who have invested millions, and in some cases billions to bring gas to the UK market. Typically, the commercial and regulatory options are suited to short term scenarios, meeting a peak demand and supply pattern linked to a single entry point, rather than a complete alternative option to investment in the compressor fleet. In essence, there are three commercial and regulatory options to consider:

1. Reduce Obligated Baselines

The obligated entry capacity levels at specific entry points inform our decision making around network investment requirements. Where these baselines are significantly higher than the peak physical flows through the supply point, this can create uncertainty in the level of investment required. Reducing the baselines at specific supply points would give greater clarity to the required level of compressor investment to meet customer needs. In 2007, a process to reduce baselines was undertaken. This generated significant industry debate and was highly complicated. However, we are in a different environment today and this may be a less contentious option at certain entry points, as seen in the recent reduction of the Fleetwood baseline.

2. Turn up and turn down contracts for constraint management

Bi-lateral contract arrangements at either entry or exit points can be used to manage network flows. For example, to help meet the required pressure level at a distribution network offtake, a turn up contract could be negotiated with the relevant gas shippers at a particular entry point. Flows through that entry point are then increased on request by National Grid, boosting local pressures. A turn down contract at a power station can be used in a similar way. As an alternative to investment in compressor assets, contracts of this type are likely to be the most effective options when linked to single entry points over the short term

3. Disaggregation of entry points

This option would allow for capacity buyback mechanisms to be targeted at a single entry point; sub terminal rather than Aggregated System Entry Point (ASEP). This option is applicable at St Fergus terminal where the compression service carried out by National Grid is directly linked to flows through one individual sub-terminal, rather than the ASEP. If the compressor units were unavailable, only gas flows through one sub terminal would be constrained, and hence the capacity buy back mechanism would be targeted at the sub terminal, rather than ASEP level.

In addition to the commercial and regulatory options, for each site affected by IED there are a number of potential 'asset' options which can be considered either in isolation or in combination:

1) Retain under the Limited Life Derogation
2) Retain under the Emergency Use Derogation
3) Oxidation Catalyst
4) Selective Catalytic Reduction (SCR)
5) Replace with the same capability
6) Replace with different capability
7) Retrofit
8) Mothball
9) Decommission

1. Retain under the Limited Life Derogation

The Limited Life Derogation allows units to continue to operate for a maximum of 17,500 hours from 1st January 2016 to the 31st December 2023, after which time the unit would need to be decommissioned. We currently have six units operating under this derogation. Rather than initiate immediate decommissioning, this option buys time to consider and implement options e.g. replacement.

2. Retain under Emergency Use Derogation

A second option is to use the Emergency Use Derogation. This means affected units can be used for 500 hours per year or less. There are seven units operating under this derogation. Applied to the low utilisation units, this option leads to reduced capability (in terms of duration) and therefore a risk management strategy needs to be considered. For units that continue to operate under this derogation, or the limited life derogation, the age of the assets will mean there is an ongoing requirement for asset health investment.

3. Catalytic Converter: Oxidation of CO using an Oxidation Catalyst

One option to meet the required ELVs is to use a catalyst to treat exhaust gases emitted from the compressor flue stack. Catalytic converters can be used to either oxidise the CO or to reduce the NOx.

An oxidation catalyst is used to convert CO and hydrocarbons to carbon dioxide and water vapour. When the CO in the exhaust gases is passed over a catalyst it reacts with the excess oxygen to produce CO_2. This solution requires sufficient physical space to fit the exhaust gas catalyst unit and in some cases continuous monitoring of the exhaust gas to ensure a sufficient degree of abatement (see figure 7). The oxidation catalyst can be used in combination with Selective Catalytic Reduction (SCR) for NOx control.

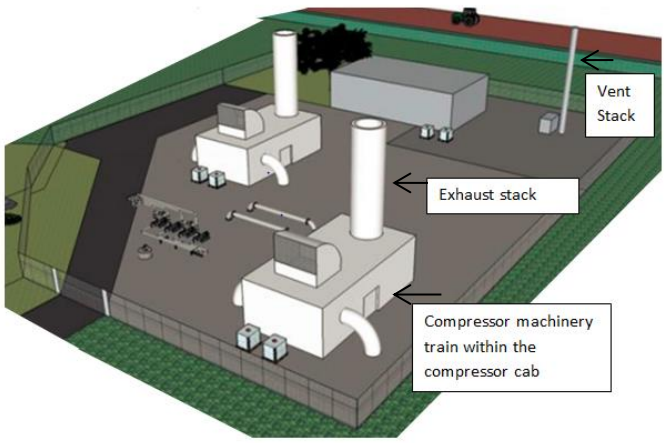


Figure 6: Compressor station overview (without a catalyst fitted)

4. Catalytic Converter: Reduction of NOx with Selective Catalytic Reduction (SCR)

NOx can be reduced to nitrogen and water using SCR. Using this technique, ammonia is typically used as a reducing agent, and is injected in the exhaust gas upstream of the catalyst to break down NOx into nitrogen and water.

SCR is a more complex process to implement than an oxidation catalyst as it includes the catalyst units, storage of ammonia and process control and monitoring systems (see figure 7). Ammonia is considered hazardous and hence subject to its own specific control conditions under the Control of Substances Hazardous to Health legislation. Whilst this technology has not been applied on the NTS, it has been in use at two operational gas transmission sites in Europe. SCR offers significant reduction in NOx emissions; however a limiting factor could be longevity of the other compressor assets, which will continue to incur ongoing asset health issues. SCR options may therefore need to be accompanied with a range of asset health replacements and equipment re-lifing.

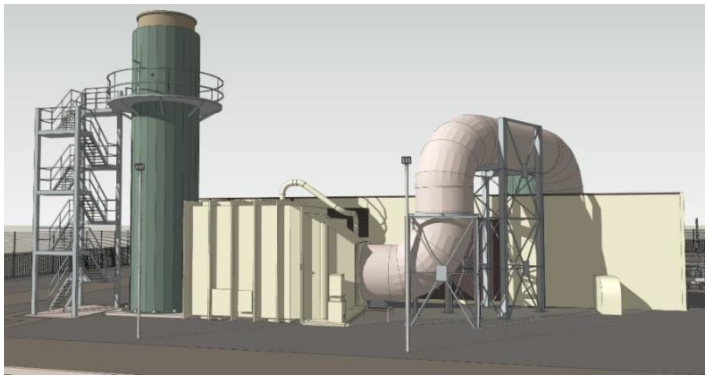


Figure 7: Compressor cab with SCR fitted

5. Replace with the same capability

Under this option the capability provided by each unit would be replaced with the same capability which would result in no change in risk profile. However due to the significant changes in supply and demand patterns over the last 15 years and the way in which shippers use capacity, this may no longer be an optimal solution. A replacement unit would not necessarily be exactly the same type of unit due to changes in technology, and for example, emissions limits for new technology could significantly reduce the operating range of a compressor. This could be addressed by the installation of multiple smaller units to provide the same operating range and capability.

6. Replace with different capability

Under this option, we determine the capability requirement for each site based on forecast flows, operating strategy and legal obligations and replace non-compliant technology with compliant equipment. This enables us to develop solutions that take account of the current and the future needs of the system.

7. Retrofit

A retrofit in this context is the exchange or modification of an aspect of the compressor unit with newer elements which offer lower emissions. Under this option only some of the unit will be upgraded, meaning that the unit as a whole will be limited to its original lifespan. Retrofitting of existing gas turbines is possible but can be limited due to increased space required and conformity with existing equipment. The environmental performance and total cost of ownership can be less favourable compared with a new low emission package. The LCP directive affects the RB211 units, which are all in the region of 30-40 years old. As such it has been determined that retrofit does not represent a suitable solution in this instance.

8. Mothball

Mothball is an option to preserve the compressor unit in working order so that it could be restored and brought back online within a prescribed timeframe if needed. To build a new compressor takes seven years, so this option retains flexibility in circumstances where the future need for the site is not fully known. However, the environmental site permit for a NTS compressor station requires the unit to undergo regular emissions testing. A unit therefore would have to be kept in full working order, maintained in a similar way to a fully operational unit. If moving parts were taken offsite for preservation, the site would lose its permit and for certain sites it is likely that a new permit would not be granted in the future, consequently removing any advantages of mothballing. Hence this option is not one taken forward further.

9. Decommissioning

Decommissioning is the option of permanently removing a unit from service. This would include dismantling and disposal of the compressor train, all associated balance of plant and connecting pipework back to the level of the unit plinth. This may not mean that the site itself can be closed as it may have other functions, e.g. as a multi junction.

Stakeholder engagement

Stakeholder engagement is of fundamental importance to us. We have listened to our stakeholders' views and acted on what they told us. As we work to meet environmental legislation and replace ageing assets it is crucial that we are transparent and clear about the tasks ahead, and that we work with our stakeholders to produce a compressor strategy that meets their requirements**.**

In April 2014 we began our initial period of stakeholder engagement. We also publicised the start of the engagement through our Connecting website and a project specific website under the Talking Networks umbrella. We commissioned a video to provide an overview of the IED legislation and its impact on our network and its users.

Then, in July 2014 based on feedback, stakeholder consultations began with an initial workshop and subsequent workshops in September 2014, November 2014 and March 2015. Attendance (22 different attendees across all workshops), represented a wide range of industry participants including shippers, Distribution Networks (DNs) and trade associations.

In the first workshop to get a better understanding of stakeholders' requirements delegates completed a Gas Transmission Network Strategy scorecard, to identify the network capability criteria that are most important to them and why (Figure 9). This formed the basis for the development of a range of site options. On the 17th November 2014 we published the *IED Investments: Initial Consultation* document. In this consultation we asked for stakeholders views on a range of questions including the range of available options for compliance at each affected site.

The *IED Investments: Initial Consultation Stakeholder Feedback* document was then published on 16th January 2015 outlining what stakeholders told us in the responses and what we would do as a result, including providing more information on the different elements of legislation.

In February 2015 we presented at the Transmission Workgroup and we also held a number of bilateral discussions to address particular concerns for individual parties including all four Gas Distribution Networks (GDNs). On the 13th March 2015 we published the *IED Investments: Proposals Consultation*. This was a development of the initial consultation document in light of stakeholder feedback received. It also provided a recommended option to achieve compliance at each site. The consultation received responses from Centrica, RWE, Total, National Grid Distribution and Energy UK.

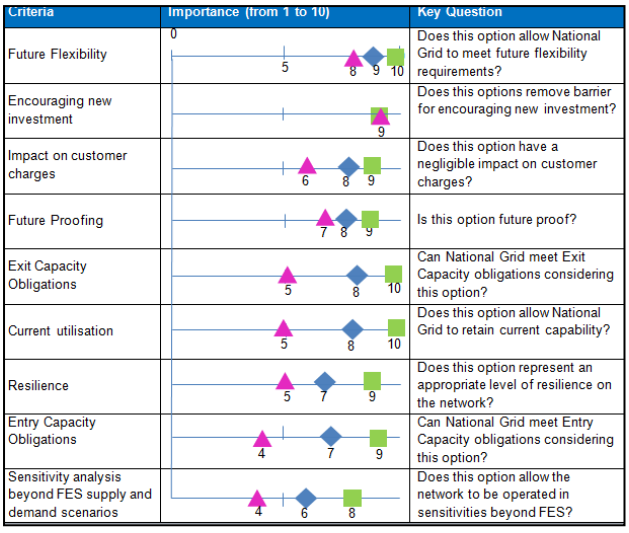


Figure 8: Overview of the network strategy scorecard

In their responses stakeholders broadly agreed with our recommendations. Ultimately this formed the basis for our IED reopener submission to Ofgem in May 2015. Ofgem, whilst positive about the stakeholder engagement process we had undertaken asked for the submission to be resubmitted in May 2018 with further work on costed options.
In preparation for the May 2018 reopener we are looking to build on the positive response from our 2015 stakeholder engagement, developing the factors stakeholders consider important with a robust Cost Benefit Analysis (CBA) methodology for the options presented.

The first events held as part of our second period of stakeholder engagement have been three workshops held in London, Edinburgh and Warwick in November 2017. These events attended by a range of stakeholders, have re-introduced the background to the legislation and provided an updated view on the impact on the compressor fleet. These workshops have also provided insight into the most effective way to continue stakeholder engagement in this second phase.

A key message from stakeholders was views shared in the May 2015 reopener process are
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still very relevant and the themes identified are still appropriate. Having shared the key inputs with the stakeholder groups in November, many of the possible inputs have been captured appropriately in the CBA tool. Where stakeholders identified other factors, we will seek to either include these in the CBA tool, or to capture these within the stakeholder section within each site assessment. These additional factors are grouped under three themes, consolidated from the stakeholder themes from the 2015 reopener process:

- Future Flexibility: delivering a network fit for the future
- Impact on our Customers: minimal effect on consumers and our direct customers
- Resilience: maintaining network access and operation

In some cases the relevant information under each theme will be assessed qualitatively, whilst in other cases e.g. on customer bill impact, financial figures will be presented.

There are a number of bi-lateral meetings now scheduled before a formal consultation is launched in early 2018.

Cost Benefit Analysis (CBA)

In order to quantify the relative benefits of each option, we have built a Cost Benefit Analysis (CBA) tool. The CBA is a mathematical decision support tool, which, based on Ofgem feedback has been developed to quantitatively assess and compare a range of compressor unit options in order to inform the optimal solution. The evaluation includes the costs of implementing each option and the relative advantages of doing so.

The tool generates a Net Present Value (NPV) of the options, and runs optional timing analysis. The assessment includes costs of maintaining and replacing assets, fuel usage, emissions costs, site operating costs, the costs of managing constraints and where relevant, the cost of commercial and regulatory options. These costs are spread across the full assessment period in order to represent the impact on consumer bills and to reflect the cost of capital investments, the regulated weighted cost of capital is applied. To allow for comparison between costs occurring over different time periods, future values are discounted using standard rates.

With the long time horizon of the model, out to 2050, most of these inputs have an associated uncertainty. The CBA tool uses Monte-Carlo modelling in order to account for these uncertainties and simulate the potential range of possible outputs. For every variable within the tool, an uncertainty distribution is applied to account for its potential range of values in the future. The Monte-Carlo simulation will pick values for every variable based on defined probability distributions. This process is iterated 10,000 times in order to produce an expected final NPV with an associated range representing the 5th and 95th percentile.

The NPV for each option is then compared against a counterfactual option to produce a relative NPV. The counterfactual option is the option which is closest to the current compressor operations while being compliant with all the relevant elements of IPPC and IED. The relative NPV will inform which of the options provides the greatest benefit to the consumer.

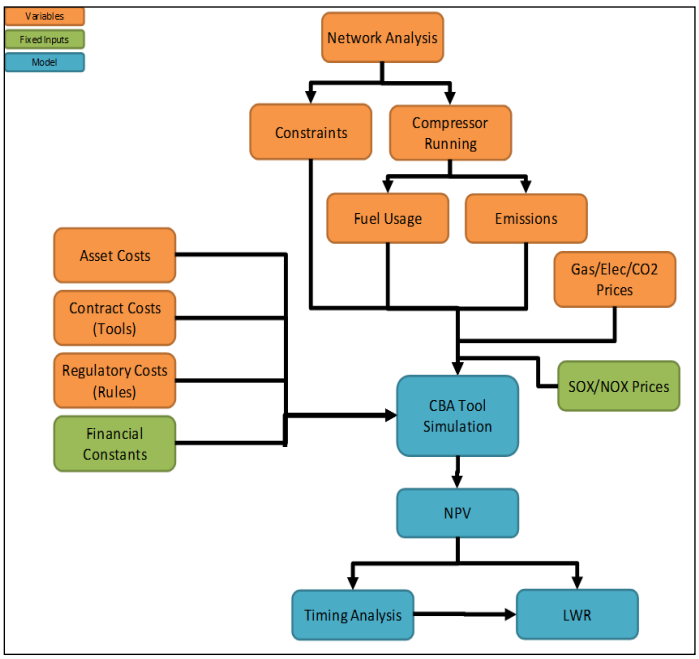

Figure 9: Overview of CBA tool

IED investment to date

Since the introduction of IPPC, LCP and then the combined requirements of IED, we have received funding for six sites to ensure compliance with the legislation.

As part of IPPC Phase 1, prior to RIIO-T1 baseline funding was agreed for works at St Fergus for two electric VSD (variable speed drive) units 3A and 3B, which were operationally accepted in June 2015. Also funded under IPPC Phase 1 was a VSD unit at Kirriemuir. IPPC Phase 2 then established funding for Hatton Unit D, an electric unit which achieved operational acceptance in February 2016.

IPPC Phase 3 was agreed with funding at the start of RIIO-T1 for one unit at both Peterborough and Huntingdon. The early stages of the Front End Engineering Design (FEED) study concluded that the option of electrically driven compressors was not viable at Peterborough, but remained a possibility for the Huntingdon site. The tender process for Huntingdon included the option for suppliers to offer an electrically driven compressor option and a number of bids were received. The BAT assessment of all of the tender submissions, combined with further information on the availability and costs of an high voltage electrical supply to site concluded that the electric drives do not represent BAT. As a result of the assessment, the unit selected to reduce emissions at both sites is a 15.3 MW gas turbine unit. Construction works will begin in 2017. At both sites, it will be necessary to retain all three existing units until the new units have been operationally proven.

Aylesbury falls under the LCP element of the IED and upfront funding received under RIIO-T1 was to fund works on two units at this site. The existing engines at Aylesbury are prototype versions of an upgraded Rolls Royce Avon engine fitted with DLE technology to reduce emissions. These are the only engines of this type that we have within our fleet. Analysis of the performance of the Aylesbury engines showed that whilst they are able to achieve the required NOx limits within their operating range, they are unable to achieve the required ELV for CO. It was established through work with Rolls Royce that the CO ELV could be achieved by the addition of a CO oxidation catalyst in the exhaust stack. The construction phase of the catalyst installation was completed in the last quarter of 2016. Unit B was successfully commissioned to Operational Acceptance stage in early 2017. Unit A is expected to move from its commissioning phase to operational acceptance shortly, following the conclusion of asset health works.

Looking forward to the next phases of work, under IED- IPPC Phase 4 we have considered investment options and have begun further investment at St Fergus, Peterborough and Huntingdon to ensure compliance. Under IED – LCP we are considering commercial and investment options at six sites: Wisbech, Carnforth, St Fergus, Moffat, Warrington and Kirriemuir.