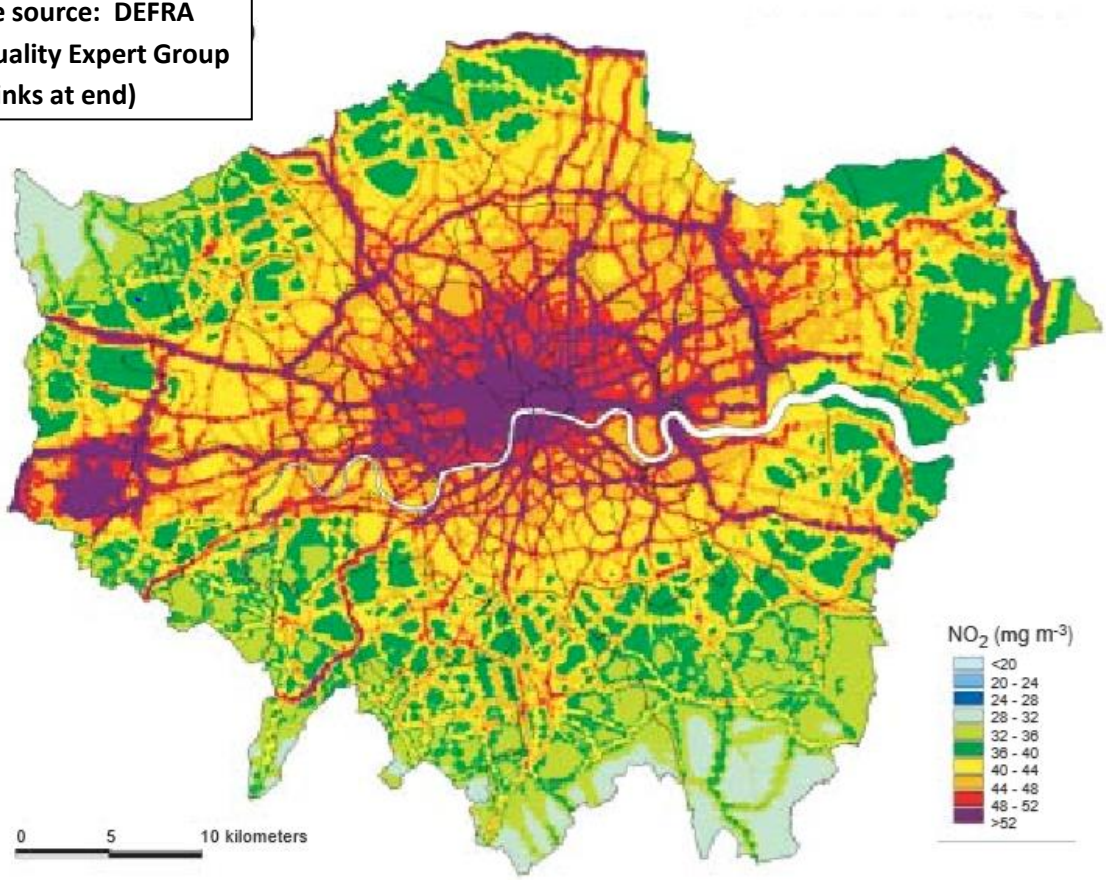
NOx

Implications for Data Centre Operators

March 2019

Image source: DEFRA Air Quality Expert Group (see links at end)

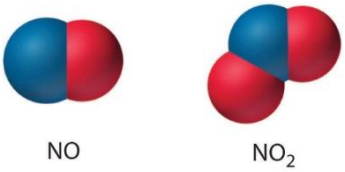


The mention of NOx should send a shiver down the spine of most data centre operators, and the larger the facility, the larger that shiver. NOx are oxides of nitrogen, air pollutants that come from multiple sources including combustion. UK Government is extremely anxious to reduce NOx levels in our air and is implementing an aggressive policy agenda to achieve this. Data centres with diesel generators are squarely in the firing line.

Emma Fryer, 2019

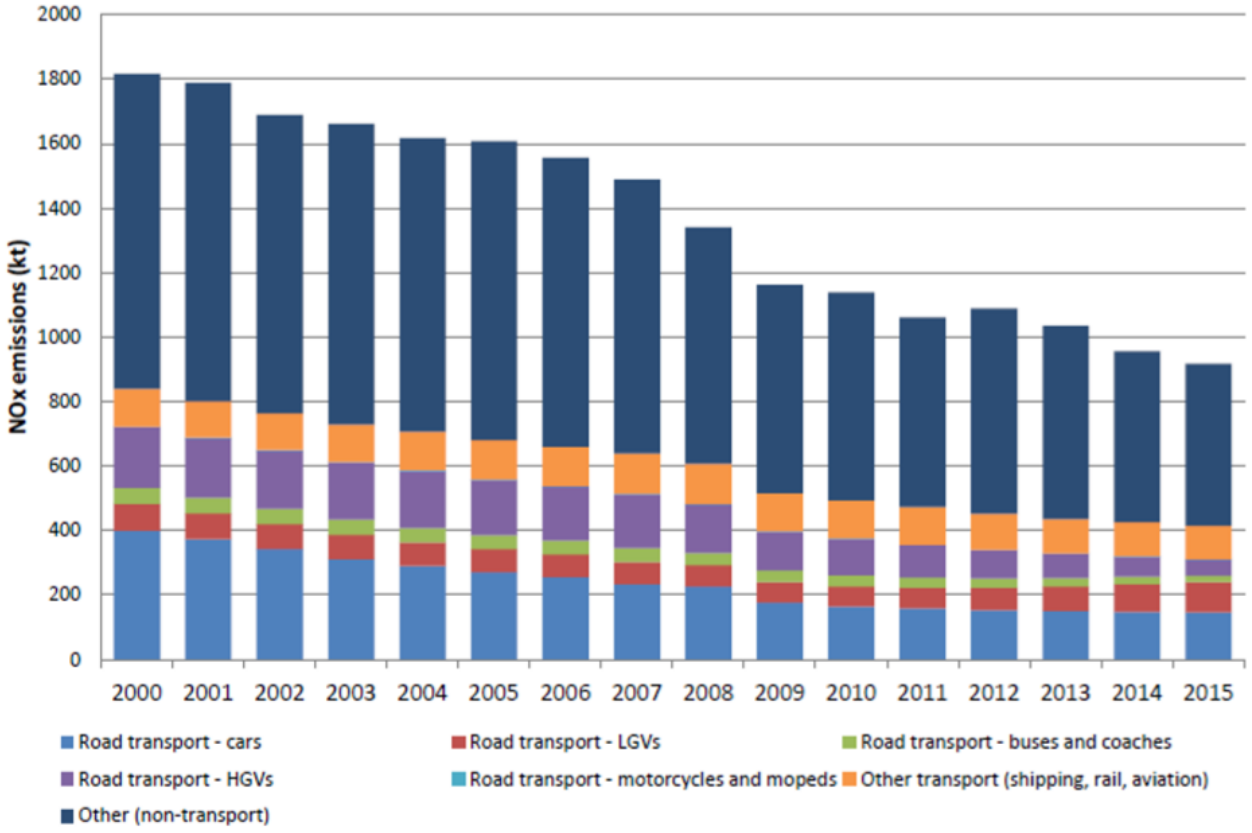
What are NOx and why do they matter?

The letters NOx stand for Oxides of Nitrogen collectively: Nitrogen Monoxide (NO) and Nitrogen Dioxide (NO_2). When fuel is burned nitrogen reacts with oxygen to form Nitrogen Monoxide and can then be further oxidised to form Nitrogen Dioxide: $2NO + O2 \rightarrow 2NO_2$. NOx are bad: they have a material impact on human health. NOx kill people, they shorten lives, aggravate existing respiratory disorders and cause new ones. You may also have heard of Nitrous Oxide (N_2O) which is laughing gas. N_2O will not trouble us here.



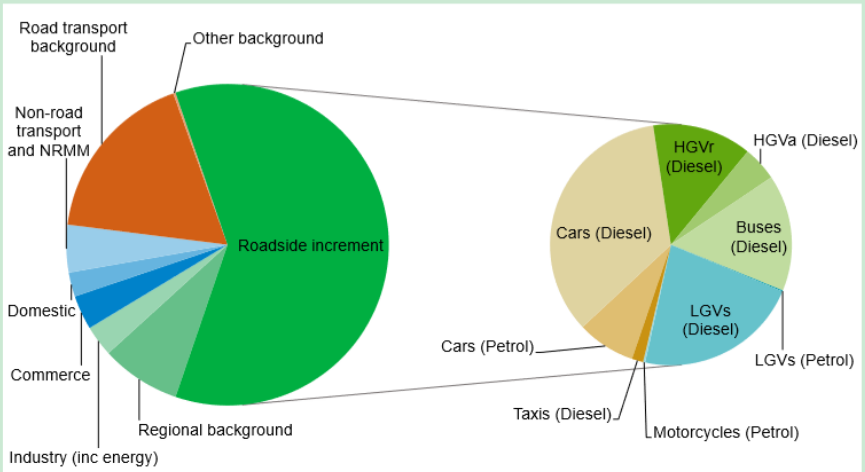
We measure and report NOx at national level where we must meet thresholds imposed by the EU. We must also comply with local NOx thresholds. The good news is that our national NOx emissions have fallen significantly over the last two decades.

Annual UK emissions of NOx since 2000



Unfortunately, reductions have slowed down in the transport sector over recent years. 49% of national NOx emissions and 80% of roadside NOx are attributable to transport. This is the result of government policy that encouraged the increased use of diesel vehicles on the basis of fuel economy. Diesel engines emit much more NOx, SOx (sulphur equivalent) and particulates than petrol. The result: illegal and sometimes dangerous levels of pollutants in the air. We absolutely must improve air quality in the UK; poor air quality can, and does, kill. So, government has been busy gold plating European legislation and adding extra measures.

Figure 3a: Breakdown of UK national average NO_x roadside concentration into sources, 2015



Note: The 'Roadside increment' in the large pie chart is the estimate of the proportion of NO_x roadside concentrations contributed by local traffic, which is shown in greater detail in the smaller pie chart. NRMM = Non-Road Mobile Machinery; LGV = Light Goods Vehicles; HGVr = Rigid Heavy Goods Vehicles; HGVa = Articulated Heavy Goods Vehicles.

Extract from DEFRA's Draft Revised Air Quality Plan 2017, plus quote.

"Although non-transport sources of NOx are considerable contributors (Figure 2) road transport is responsible for some 80% of NOx concentrations at roadside, with diesel vehicles the largest source in these local areas of greatest concern …… This is due to both the significant growth in vehicle numbers, particularly diesel vehicles, and improvements in real world testing showing that laboratory test-based emission standards have not delivered expected reductions under real world driving conditions"

NOx Levels in the UK

Despite these reductions the UK is exceeding some of its NOx thresholds. While 41 of 43 UK zones are below the maximum allowed mean hourly levels, London and South Wales both exceed these limits. Moreover, 37 out of 43 zones fail to comply with mean annual limits (see extract from DEFRA). There is therefore a strong policy focus on factors that impact local air quality and in particular on London, which happens to be where the majority of the UK's data centre estate is located.

Table 1: Statutory[9] limit values for NO_2

Averaging period	NO_2 limit value[10]
One hour	200 µg/m^3 not to be exceeded more than 18 times a calendar year
Calendar year	40 µg/m^3

Table 2: UK zones meeting statutory NO_2 limit values in 2015

UK zones meeting statutory NO_2 limit values in 2015	
Meeting hourly mean limit value for NO_2	All forty-three UK zones except: Greater London Urban Area South Wales
Meeting annual mean limit value for NO_2	Brighton/Worthing/Littlehampton Blackpool Urban Area Preston Urban Area Highland Scottish Borders Northern Ireland

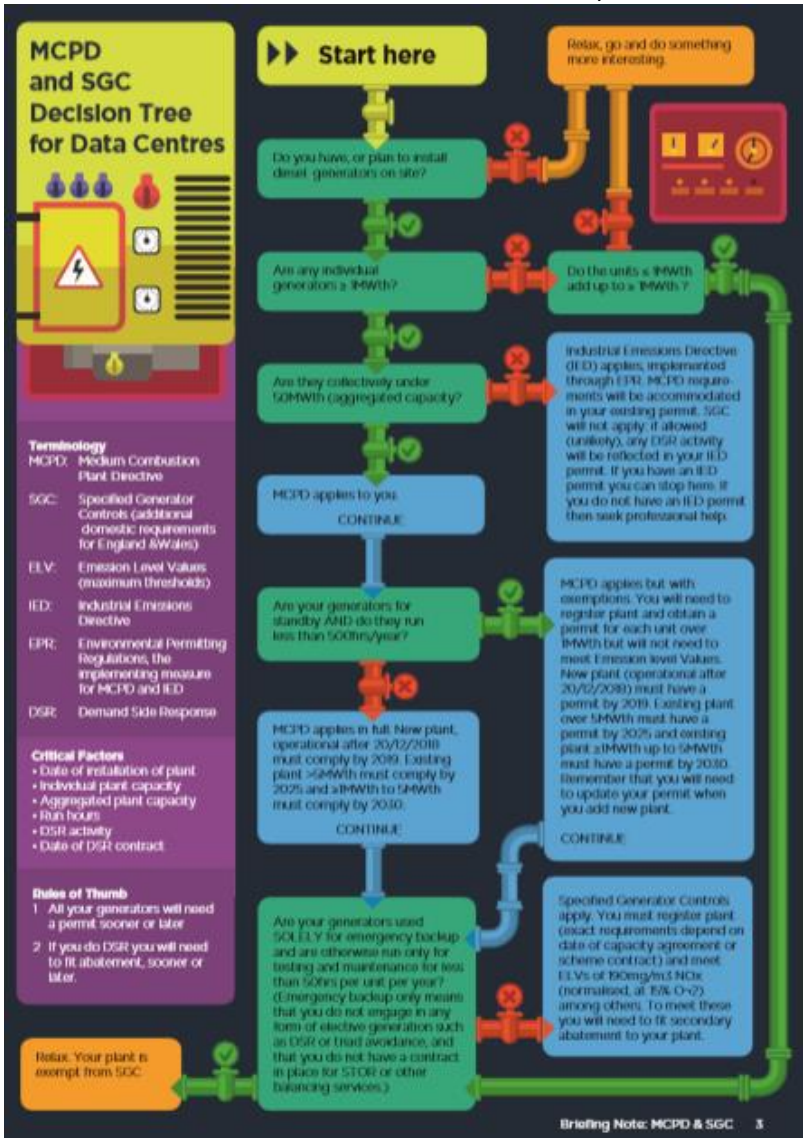
Extract from DEFRA's Revised Air Quality Plan, 2017[i]

Why are data centres being targeted?

Data centres are not being targeted. NOx are politically sensitive, so government is determined to bring levels down. It will take time before our existing transport stock is replaced by more sustainable equivalents so in the meantime, we can expect enhanced scrutiny of any NOx emissions coming from fixed points. Data centres with installed diesel generating capacity are point sources of NOx. This is because, although the generators rarely run, they have the potential to emit NOx into their local environment. Many data centres are located in areas where local NOx emissions are approaching, or regularly breaching, legal thresholds.

Implications for operators

The implications for operators are significant: compliance burdens and the potential for reputational damage. Along with other combustion plant, diesel generators are now heavily regulated, primarily through IED (industrial Emissions Directive which has been around since November 2010) and MCPD (Medium Combustion Plant Directive, which has been effective since December 2018). Both these are implemented in the UK through EPR – Environmental Permitting Regulations. Between them these instruments scoop up pretty much any generating plant you are likely to have on site. Large sites (over about 17MW of installed capacity) should already have IED permits in place, smaller sites must obtain MCPD permits for new plant. Existing plant is OK for the moment but will also be scooped up eventually – either by 2025 or 2030 depending on size.



Neither MCPD nor IED are specific to NOx: MCPD covers a range of air pollutants. IED is much more far reaching and covers emissions to air, land and water. Especially stringent rules apply to any diesel plant being used for demand side response (DSR) or load balancing. These, known as "Specified Generator Controls or SGC" are targeted at NOx.

So, is this NOx regulation just a pointless burden for data centres?

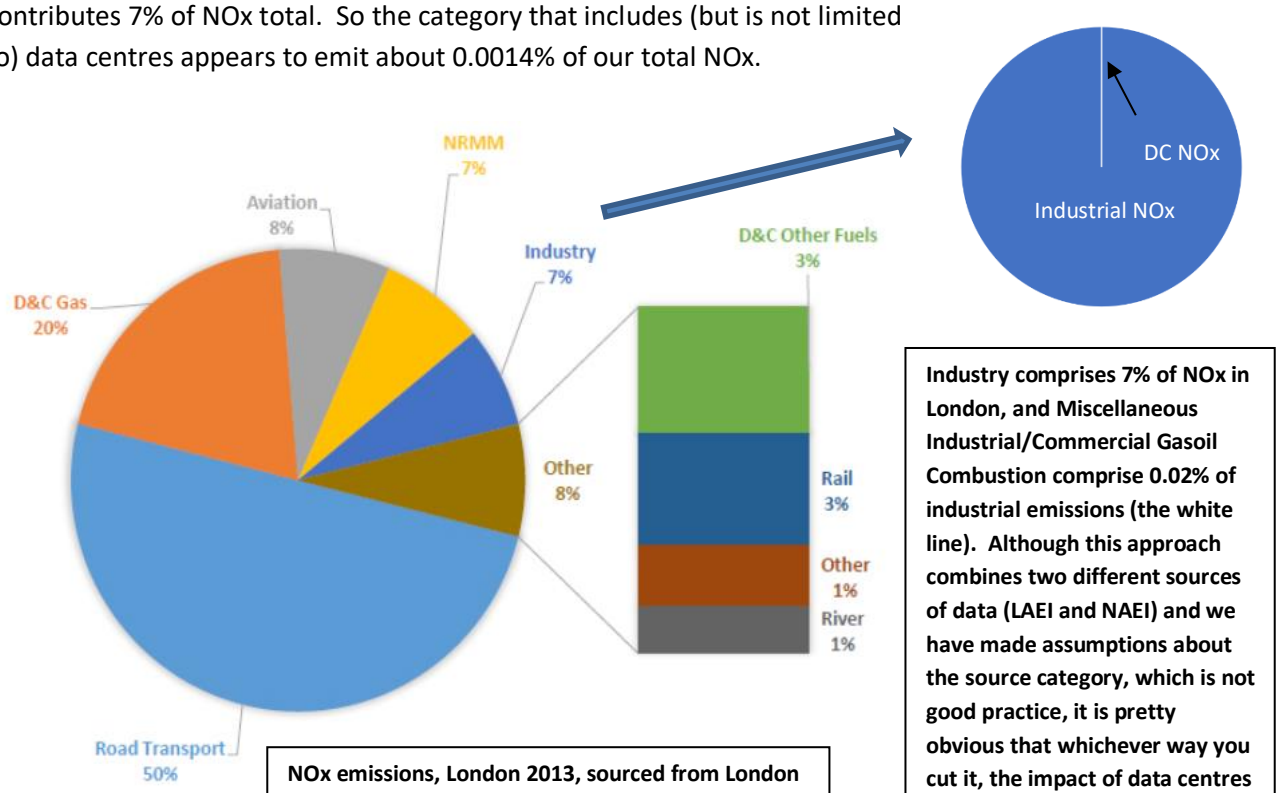
Partially. From an operator perspective, punishing one sector because of policy failures in another seems harsh, and if we are trying to reduce NOx urgently then imposing burdensome regulations on those facilities that are the smallest emitters is at best perverse, at worst, moronic. After all, grid outages in and around London, where air pollution is a significant problem, are so infrequent as to be immaterial. The only other time the generators run is for testing.

However, we can't expect data centre standby generators to remain completely unregulated: if this plant were working continuously, emission levels would be an entirely different matter, so there is the *potential* capability to do significant harm – and that is what alerts the regulators. Even when running for short periods, e.g. for testing, a large generator array can have an impact on local air quality. Moreover, the

clustered nature of data centres, often in urban area, presents the possibility of more significant local impacts in the event of a major power failure: if multiple facilities located close together have to resort to their standby capacity at the same time then there is the potential for aggregation. While this scenario is extremely unlikely, operators must be cognisant of any risks they are imposing on third parties.

What impact do data centres actually have on NOx?

Miniscule. Investigating DEFRA's NAEI datasets, it looks like "Miscellaneous Industrial / Commercial Gasoil Combustion" is the most likely category of emitters to include data centres. This category emits 0.000987KT NOx, equivalent to about 0.02% of industrial emissions which add up to 5.4KT. Industry contributes 7% of NOx total. So the category that includes (but is not limited to) data centres appears to emit about 0.0014% of our total NOx.



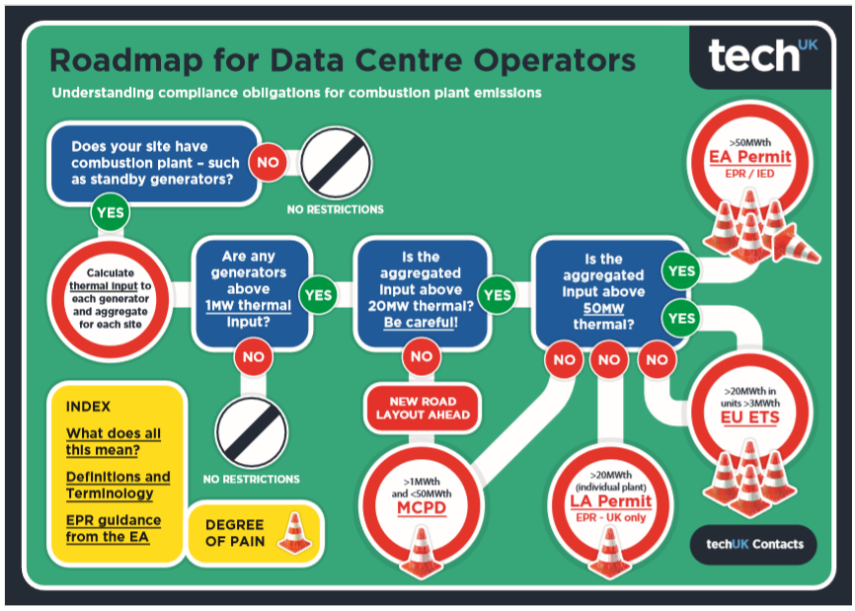
NOx emissions, London 2013, sourced from London Atmospheric Emissions Inventory (LAEI)

Industry comprises 7% of NOx in London, and Miscellaneous Industrial/Commercial Gasoil Combustion comprise 0.02% of industrial emissions (the white line). Although this approach combines two different sources of data (LAEI and NAEI) and we have made assumptions about the source category, which is not good practice, it is pretty obvious that whichever way you cut it, the impact of data centres is tiny.

Whichever way you look at it, the cumulative impact of data centres on NOx levels is negligible, but this is not what matters – brief spikes in NOx concentrations can do real damage at local level, so we need to understand these short range impacts better.

A lot of modelling has been done by operators, but monitoring is the only way to establish what is really happening. To this effect, the Environment Agency has installed a permanent air monitoring unit on a data centre campus. Hopefully this will help us improve our understanding of the actual levels of risk associated with data centre plant. At the moment all we have is an anecdotal report of recordings from a site in London which registered that emissions from the data centre contained lower levels of pollutants than the ambient air in the street outside! In the meantime, it makes sense for the EA to insist that standby means standby in areas with poor air quality, and it also seems appropriate for operators to familiarise themselves with sensitive receptors (like schools and hospitals) that happen to be proximate, as part of their corporate social responsibility.

So, is regulation disproportionate?



Yes. Keeping a watchful eye on large clusters of combustion plant is one thing; applying poorly targeted, disproportionate regulatory instruments is another thing entirely. Besides imposing significant burdens while delivering minimal benefit, this diverts resource and attention from doing the things that actually make a difference; eating into the funding that might otherwise be used for investment in energy efficiency measures. NOx aren't the only things that shorten lives: the stress of navigating the Byzantine complexity of generator emissions legislation definitely takes its toll on those individuals responsible for data centre compliance.

Unfortunately, the most demanding regulation (IED) applies to all generator arrays above about 17MW capacity, irrespective of the degree to which plant is deployed (this is not uncommon, EU ETS, aiming to reduce carbon and targeted at large scope 1 emitters, is also based on capacity only). Even for the lowest level of generator activity the permitting process, modelling, consultancy, professional fees, verification and licences will generally end up taking well in excess of £100,000 straight off the bottom line.

What would good look like?

We like to see a more proportionate approach to NOx reduction, where the regulatory emphasis is on the most significant sources of these pollutants. We would also like a more evidence-based process and welcome the installation of permanent air quality monitoring at a sample data centre location. To help operators make sense of a bewilderingly complex process we encourage the development, where possible, of Best Available Techniques for data centres and we will contribute to this process wherever we can. This is not always easy because data centre installations are surprisingly varied, and IED is extremely prescriptive so the permitting process tends to be bespoke and there is little scope for one-size-fits-all simplifications. We strongly welcome the changes announced by the EA regarding enforcement and penalties, where the level of risk is considered when penalties are imposed. This allows the regulator to be robust when necessary and pragmatic where infringement has no material impact. In the longer term we would like to see better recognition from policy makers that a significant amount of generating capacity is rarely deployed, so that they can take this into account in future policies.

What are we doing about it?

At sector level we are trying to ensure that operators understand their responsibilities: awareness of some of these obscure but costly regulations has been patchy in the past. Commercial operators have been working closely with the Environment Agency over the last few years to ensure full compliance and, where possible, to simplify the process without compromising rigour. We are also creating opportunities to share information between stakeholders, hosting face to face workshops between operators and the regulators

to iron out specific issues and developing guidance both in terms of the scope of the regulations and how they are implemented and enforced.

In Conclusion….

Jumping through hoops to meet the requirements of an obscure regulation may seem pointless, but we must remember three things:

- Firstly, it is not optional – the law may be inappropriate, contradictory and burdensome but it is the law. A site that does not have the necessary IED, ETS or MCPD permits is operating illegally.
- Secondly, data centres enable our digital future and should be setting an example of good environmental stewardship both at facility level and at sector level.
- Thirdly, compliance matters in terms of reputation and exposure; the most likely time to discover a compliance failure is during due diligence prior to sale or merger, the least convenient moment to reveal a regulatory omission.

We are left with a conundrum: laws are imposed to correct market failure and minimise damage to the environment. Exemptions make legislation more complex and create loopholes for unscrupulous people to exploit, and it is very difficult to get this balance right. However, there are some cases where policy makers would have created exemptions had they possessed better market intelligence, and this is probably one of them. Now they do, we can hope for more informed decision making in future.

Further information and references

- **DEFRA, Revised Air Quality Plan 2017**
  https://consult.defra.gov.uk/airquality/air-quality-plan-for-tackling-nitrogen-dioxide/supporting_documents/Draft%20Revised%20AQ%20Plan.pdf
- **Air Quality Expert Group, Nitrogen Dioxide in the United Kingdom**
  Although produced back in 2004, this report provides very useful explanations and impact maps.
  https://uk-air.defra.gov.uk/assets/documents/reports/aqeg/nd-summary.pdf
- **National Atmospheric Emissions Inventory (held by BEIS)**
  http://naei.beis.gov.uk/overview/pollutants?pollutant_id=6
- **Mayor of London Air Quality Strategy**
  https://www.london.gov.uk/sites/default/files/maqs_executive_summary_final.pdf
- **King's College Emissions Inventory Service**
  King's College developed the LAEI (London Area Emissions Inventory)
  https://www.kcl.ac.uk/lsm/research/divisions/aes/research/erg/modelling/emissions-inventory.aspx

techUK publications (compliance oriented)

- **Compliance Healthcheck:**
  https://www.techuk.org/insights/news/item/11707-data-centre-compliance-health-check-november-2017
- **Cones of Pain: Generator Emissions Compliance Roadmap for data centres:**
  https://www.techuk.org/images/generator_emissions_roadmap_FINAL.pdf

- **MCPD and SGC Briefing and Decision Tree for data centres:**
  Briefing note on the implications of the Medium Combustion Plant Directive and Specified Generator Controls on data centres.
- **IED: In or Out? Are you in scope?** Guidance to help operators establish whether they are likely to be captured by the Industrial Emissions Directive:
  https://www.techuk.org/images/IED_IN_or_OUT_V05.pdf
- **Stairway to IED compliance:**
  Guidance on navigating the IED compliance process prepared by SLR Consulting

Summary:

NOx in a Box: Fast Facts

1) The letters NOx stand for Oxides of Nitrogen collectively: Nitric Oxide (NO), Nitrous Oxide (N_2O) and Nitrogen Dioxide (NO_2).
2) NOx have a material impact on human health and life expectancy.
3) NOx levels in the UK are higher than they should be. Local thresholds are the most problematic and are regularly breached in many areas.
4) National NOx emissions have fallen significantly over the last two decades.
5) 49% of NOx emissions come from transport, mainly diesel.
6) Transport NOx is reducing more slowly than other sources because of an increase in diesel vehicles.
7) NOx are politically sensitive so Government is targeting all sources.
8) Data centres with installed diesel generating capacity are point sources of NOx.
9) Many data centres are in areas where local NOx emissions are already high.
10) Large operators should expect increased regulatory scrutiny of their diesel plant.

Contacts

Emma Fryer
Associate Director, techUK
Tel: 01609 772 137
Mob: 07595 410 653
emma.fryer@techuk.org

Lucas Banach
Programme Assistant
Tel: 020 7331 2006
Lucas.banach@techuk.org

techUK represents the companies and technologies that are defining today the world that we will live in tomorrow. The tech industry is creating jobs and growth across the UK. In 2015 the internet economy contributed 10% of the UK's GDP. 950 companies are members of techUK. Collectively they employ more than 700,000 people, about half of all tech sector jobs in the UK. These companies range from leading FTSE 100 companies to new innovative start-ups. The majority of our members are small and medium sized businesses. www.techuk.org

Endnotes

[i] Source: https://consult.defra.gov.uk/airquality/air-quality-plan-for-tackling-nitrogen-dioxide/supporting_documents/Draft%20Revised%20AQ%20Plan.pdf