Title: Impact assessment of the Transitional National Plan (TNP) **IA No:** Defra1931 **Lead department or agency:** Department for Environment, Food and Rural Affairs (Defra) **Other departments or agencies:** Department for Energy and Climate Change (Decc)	Impact Assessment (IA) **Date:** 11/11/2015 **Stage:** Final **Source of intervention:** EU **Type of measure:** Secondary legislation **Contact for enquiries:** Nicola Leeds nicola.leeds@DEFRA.GSI.GOV.UK

Summary: Intervention and Options

RPC Opinion: Green

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2014 prices)	**In scope of One-In, Two-Out?**	**Measure qualifies as**
£5,813.5m	£0	£0	Out of scope	N/A

What is the problem under consideration? Why is government intervention necessary?

The Industrial Emissions Directive (IED), transposed into legislation in 2013, delivers major health improvements by restricting emissions of air pollutants. However, given the timeframe, the scale of change required to achieve these limits means that it is not possible for all large combustion plants to be compliant before January 2016. Reflecting the size of the change, a derogation is available to allow member states time to smooth this transition called the Transitional National Plan (TNP). The TNP looks to balance the potential benefits from reduced emissions against the social cost of restricting supply. The most significant impact of this restructuring is on electricity generation with a smaller impact on heavy energy users including chemical industry and iron and steel production.

What are the policy objectives and the intended effects?

The objective is to deliver the health and environmental benefits of the IED in a way that does not impose disproportionate social costs. The flexibility given under the TNP will assist the market in optimising investments in abatement and provide scope to reduce the number of plants that are offline, helping to protect energy security and resilience.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Business As Usual – The IED restrictions come into force across the relevant plants in January 2016, requiring the closure of non-compliant plants;
Option 1: Implement TNP allowing additional time to smooth the transition to compliance.
Preferred option is Option 1 given that the social benefits are expected to significantly outweigh the social costs, including the small temporary increase in air pollution.

Will the policy be reviewed? It will/will not be reviewed. **If applicable, set review date:** Month/Year

Does implementation go beyond minimum EU requirements?			No		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** No	**< 20** No	**Small** No	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** 195	**Non-traded:**	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible SELECT SIGNATORY: Rory Stewart Date: 14-12-2015

Summary: Analysis & Evidence

Policy Option 1

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year: 2015	PV Base Year: 2015	Time Period Years: 5	Net Benefit (Present Value (PV)) (£m)		
			Low: 5,285.9	High: 6,119.2	Best Estimate: £5,813.5

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	232.2	5	146.1	**962.7**
High	1,115.0		2,369	**2,960.8**
Best Estimate	681.6		1,265.6	**7009.7**

Description and scale of key monetised costs by 'main affected groups'

The monetised costs reflect the increased activity of the plants under the TNP. This will lead to running costs (£6.1bn) and additional air pollution valued (£973.7m). The running costs include fuel expenditure of (£4,521m), investment in abatement technologies to lower air pollution (abatement technology, £681m), CO_2 emissions being offset through the EU Emission Trading Scheme (EU ETS - £908m) and administration costs of the scheme (£0.8m).

Other key non-monetised costs by 'main affected groups'

A range of impacts have not been monetised as it is not possible or disproportionately costly to do so. These include the environmental impacts of air pollution on natural ecosystems, the transaction costs of air pollutant emission trading and any non-monetary costs of investing in abatement technologies.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	Optional		1,307.4	**6,204.1**
High	Optional		3,949.9	**19,077.4**
Best Estimate	N/A		2,428.3	**12,823.1**

Description and scale of key monetised benefits by 'main affected groups'

The benefit of the TNP largely reflects a part of the social value of the output of these plants over the period of the TNP. The monetised value is calculated based on the level of increased supply and consumption of electricity, resulting from the implementation of the TNP.

Other key non-monetised benefits by 'main affected groups'

The monetised benefits do not reflect the benefit to consumers above the price they are required to pay for the electricity (the consumer surplus). It was also not possible to monetise the benefits to society and businesses from improving energy security, which would include wider economic benefits of maintaining competitiveness for businesses which own these plant (e.g. the Iron and Steel industry), encouraging investment via greater market certainty. These omissions mean that the values above are likely to be substantially underestimate the social benefit.

Key assumptions/sensitivities/risks | **Discount rate (%)** | 3.5

The key issue is that the consumer surplus has not been monetised. In this regard the social benefits are likely to be undervalued. A sensitivity test suggests that if the other energy producers were not able to address any shortfall in output there would be major social costs to society. In the event that just 0.5% of the expected production were not replaced, the social cost of the interrupted supply would more than double the monetised costs above. In the baseline it is assumed that all non-compliant plants will close immediately, in reality some may be able to reopen after installing the appropriate abatement measures, or may continue to generate under the LLD. Our high and low scenarios are dependent upon the on the price of fuel.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			In scope of	Measure qualifies as
Costs: 0	**Benefits:0**	**Net:£0**	Out of Scope	NA

Contents

1. EXECUTIVE SUMMARY

Rationale for intervention:

The EU Industrial Emissions Directive (IED), transposed into legislation in 2013, delivers major health improvements by restricting emissions of air pollutants. The IED sets requirements on a wide range of industrial processes, including – but not restricted to – power generation, chemical production and intensive rearing of pig and poultry. For Large Combustion Plants (LCPs), these benefits will start to be delivered from January 2016 when the Emission Limit Values (ELVs) come into force. However, given the scale of investment required to reach compliance a significant proportion of UK large combustion plants are not able to meet the ELVs by this date.

This challenge was reflected in the IED with the introduction of a derogation to allow additional time to smooth this transition. While the impacts of this derogation were reflected in that assessment there was notable uncertainty in this impact and this IA updates that analysis in light of the latest evidence[1]. This derogation allows Member States to develop a Transitional National Plan (TNP) to deliver the air quality benefits while not unnecessarily pushing productive plants into closure, protecting security of supply and avoiding undue increases in energy costs. The TNP delivers these outcomes by allowing plants to reduce emissions more gradually, reaching the IED ELVs by 2020.

Methodology:

The implementation of the TNP will chiefly impact the UK through its effects on **the electricity market (producers/consumers)** and **the environment**. There will also be a smaller impact on heavy energy users including chemical industry and iron and steel production

As a result of the TNP, LCPs will be able to generate more electricity, during the transition period allowed under the TNP. This provides benefits for the consumers of the electricity and producers. It also helps to protect energy security and resilience by allowing additional capacity to remain if required.

However, there will be additional costs from the increased activity allowed under the TNP. Firstly there will be an increase in air pollution which has an impact on human health and the environment. Plants will need to install abatement technologies or purchase emission allowances to comply with TNP emission caps. The higher power generation will result in higher greenhouse gas emissions which must be offset by purchasing EU Emission Trading Scheme (EU ETS) allowances. Finally, the TNP will also result in an administrative cost for producers.

The flow chart in section 7 provides a more detailed overview of the methodology used to assess the overall impact of the TNP. This incorporates the number of plants in the final UK TNP. This assessment has quantified and monetised the following impacts:

- **Increase output -** the value of the additional output allowed under the TNP. The TNP will allow plants more flexibility to remain open. This will result in higher output, either due to the income from selling electricity (for ESIs) or from other operations (for other plants). Our current estimate is that plants will earn additional revenues of between £6.3bn and £19.1bn Net Present Value (NPV), with a central estimate of £12.8bn.
- **Fuel costs –** as a result of higher activity levels, total fuel expenditures by plants on fuels will increase by between £51.1m[2] and £5.5bn – with a central estimate of £4.5bn.
- **Environmental cost –** We estimate additional costs in terms of extra emissions of nitrogen oxides (NO_X), sulphur dioxide (SO_2) and particulate matter (PM or dust) of between £1,006.5m and £679.5m NPV with a central estimate of £973.7m.
- **Abatement costs for plant operators –** Compliance with the TNP will lead to additional costs for some plants, as these remain open and therefore invest in abatement technology, compared with the baseline of shutting down and therefore not investing in abatement. This will result in additional costs to operators of between £231.4m and £1.1bn. Our central estimate is this will lead to an additional cost of £680.8m NPV for businesses.
- **Cost of CO_2 compliance –** As 50% of plants in the TNP will be required to close in the baseline and remain open in the TNP scenario, more CO_2 will be emitted under the TNP. As all large combustion plants fall into the scope of the EU Emissions Trading System (ETS) the impacts are valued using the traded cost of carbon.

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[1] Previous impact assessment available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82613/industrial-emissions-ia-120312.pdf

[2] The difference between the low and high estimate is driven by differences in plant activity but in particular the cost of fuel, which is covered in more depth as an uncertainty to analysis in section 12.

The cost will be a financial (rather than an environmental) cost to UK businesses, as operators will need to purchase EU ETS allowances, although the total amount of CO_2 in the atmosphere will not change. We estimate that traded CO_2 costs will lead to additional costs to businesses of between £0[3] to £5290.1m, and our central estimate is £833.5m.

Table 1 – Overview of Monetised Costs and Benefits (NPV, £million, 2015 prices)

M/£	2016	2017	2018	2019	2020	NPV
Benefits						
Revenues	3734.3	3276.6	2784.3	2096.7	931.2	12823.1
Costs						
SO_2 Emissions	137.7	115.1	101.9	65.8	26.6	447.1
NOX Emissions	152.0	130.8	109.2	62.4	24.9	479.4
PM Emissions	14.0	12.0	9.9	7.9	3.4	47.2
SO_2 Abatement	10.0	11.0	12.4	14.0	7.0	34.4
NOx Abatement	157.5	151.2	143.0	133.0	61.2	646.0
PM Abatement	0.1	0.2	0.1	0.1	0.0	0.6
EU ETS Costs	238.1	213.0	189.0	139.3	54.1	833.5
Admin Costs	0.8	0.0	0.0	0.0	0.0	0.8
Fuel costs	1265.7	1160.4	1042.6	760.8	291.3	4520.8
Total Costs	1955.9	1793.8	1608.2	1183.3	468.6	7009.7
Net Impact						**5,813.5**

Key assumptions, uncertainties and sensitivities

In considering the results set out above the following key considerations should be kept in mind:

- **Non-monetised impacts** – As far as practicable all the impacts have been quantified and monetised. The most significant areas which have not been monetised, due to lack of data, are the consumer benefit derived from consuming the additional electricity, created under the TNP. In addition to this, the higher levels of power generation will also provide a wider societal benefit of improving security and resilience in the electricity market. Taken together, these suggest that the monetised benefits of Option 1 are significantly underestimated. A sensitivity test has been created to demonstrate the extent of the underestimate (see **Section 12.2).**
- **Baseline** – It is assumed that all plants that do not meet the ELVs under the IED in the baseline would close, in order for the UK to avoid EU infraction. Our analysis does not model the impacts of any secondary effects or reactions to these closures. It is acknowledged that in practice, market and policy reactions would be likely to provide some mitigation to the security of supply risks bought about by these closures, which could include increased levels of operation by compliant plants and mothballed plant which can meet the required ELVs returning to the market in response to measures in place to ensure security of supply; for example, the Supplemental Balancing Reserve (SBR) administered by National Grid. However, due to the uncertainties surrounding these potential responses and that we cannot assume these reactions would fully cover the energy supply problem; we do not incorporate these actions into the baseline.
- **Fuel price –** The analysis is highly sensitive to the relative fuel prices of gas and coal. The relative price affects the use of coal and gas fired electricity generation, which is significant as coal plants produce notably higher emissions than gas plants (particularly SO_2 and PM). To assess the significance of this variation low and high coal price scenarios have been modelled.
- **Estimated impact range –** The low and high NPV calculations do not follow the standard approach set out in the BIS (Department for Business, Innovation and Skills) guidance. These do not compare the highest cost and lowest benefit estimates. This is because the high costs and low benefits scenario (and conversely, the low cost/ high benefit scenario) could never occur simultaneously as they are mutually

[3]This value is estimated through applying a zero cost of carbon in the low scenario, which is in line with DECC's traded carbon values for UK public policy: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/360277/Updated_short-term_traded_carbon_values_used_for_UK_policy_appraisal__2014_.pdf

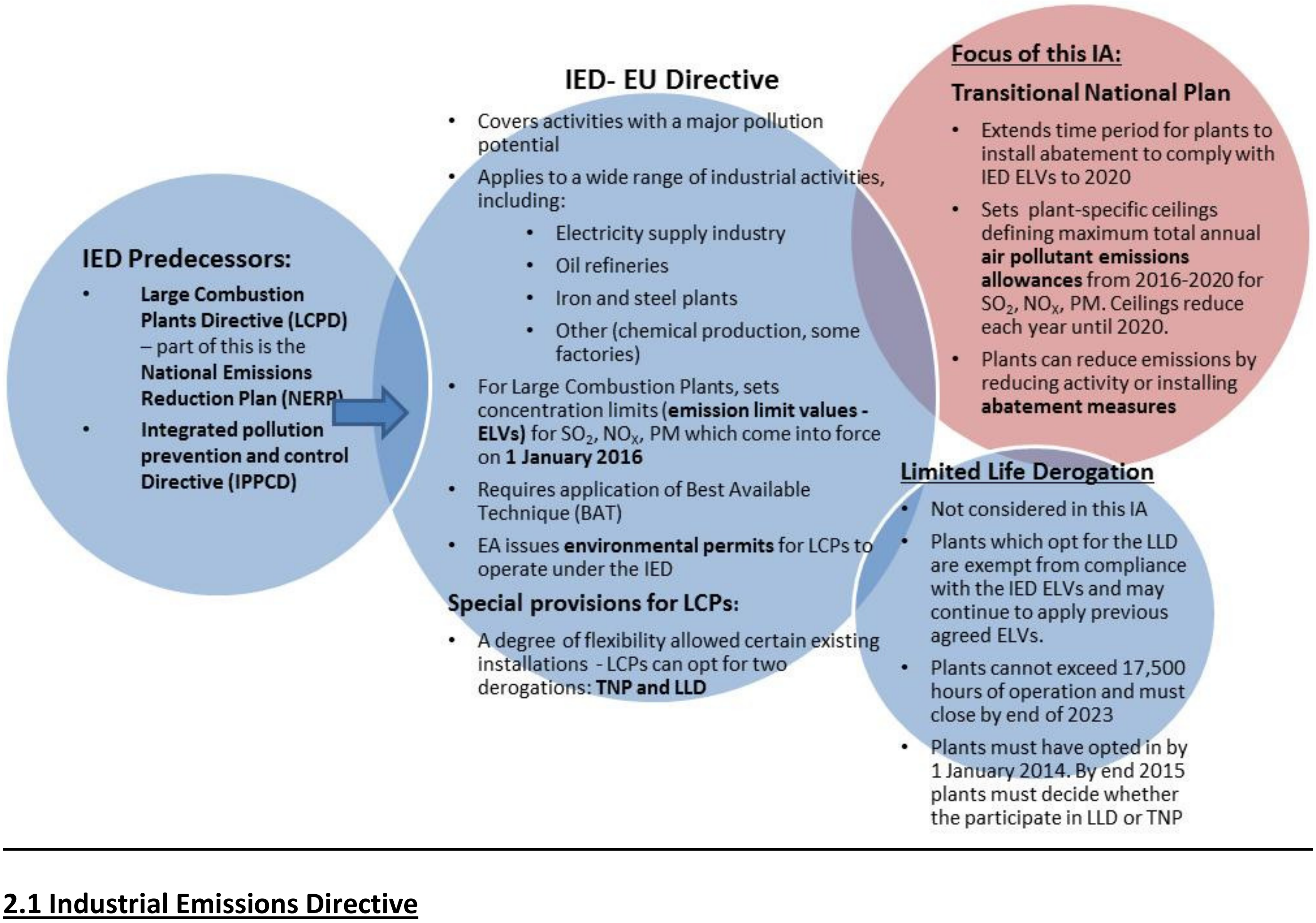
exclusive. For example, a low coal price would imply higher benefits to coal fired power stations as there would be increase uptake. Each of these scenarios is based on separate fuel price projections. Therefore the range of impact has been estimated as the highest and lowest value within a given fuel price scenario.

- **Trade** –The TNP will allow plant operators to sell any unused air pollution emission allowances below the TNP cap. The analysis assumes operators can purchase TNP Air Pollutant Emissions Allowances at the cost of the alternative action that would be required to achieve the necessary emissions reduction for TNP compliance. That is, the annualised abatement cost or loss in revenue (due to reduction in load factor) is assumed to be the cost of trading[4] for individual plants. However, it was deemed disproportionate to develop the methodology further given evidence from the National Emission Reduction Plan (NERP), which suggests operators are often not willing to trade emission allowances with competing plants. Equally, the NERP also alludes that the price and availability of trade emission allowances is not always clear therefore there remains an incentive to install abatement. Also, given that our analysis is understating the benefits of trading any further analysis would only reinforce the current conclusion in this IA.

2. BACKGROUND

Chart 1: Policy Landscape

The diagram below sets out the relationships between the IED, its predecessors and the derogations available for large combustion plants.



2.1 Industrial Emissions Directive

Industrial activities play an important role in the economic well-being of Europe, contributing to sustainable growth and providing high quality jobs. However, industrial activities also have significant impacts on the

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4 This is on the basis that the total emission cap is lower than the emissions that would occur if all LCPs were to continue under current conditions. This means that some LCPs will need to install abatement measures or reduce operation in 2016. In each subsequent year the TNP cap reduces and therefore plants will either install more abatement measures or reduce activity. Given this, the trading prices remain the same as the alternative action, as the supply (TNP cap) and demand fall at the same rate until the TNP ends.

environment. The Industrial Emissions Directive (IED 2010/75/EU) recasts seven Directives[5] related to industrial emissions into a single clear and coherent legislative instrument. It seeks to prevent and control air, water and soil pollution by industrial installations. It regulates emissions of a wide range of pollutants, including sulphur and nitrogen compounds, PM particles and heavy metals.

The IED came into force on 6 January 2011. Chapter III of the Directive includes special provisions for large combustion plants (LCP) with Article 30 and the associated Annex V establishing minimum EU wide emission limit values (ELVs) for SO_2, NO_X and PM. Chapter III includes certain flexibility instruments for large combustion plants such as the Transitional National Plan, Limited Lifetime Derogation (LLD) or special provisions for small isolated systems and district heating plants.

The Directive covers combustion plants capable of burning more than 50 MW of fuel energy per hour (i.e. total rated thermal capacity >50MW), irrespective of the type of fuel used. Chapter III does not apply to the following combustion plants:

- Plants in which the products of combustion are used for the direct heating, drying, or any other treatment of objects or materials;
- Post-combustion plants designed to purify the waste gases of combustion which are not operated as independent combustion plants;
- Facilities for the regeneration of catalytic cracking catalysts;
- Facilities for the conversion of hydrogen sulphide into sulphur;
- Reactors used in the chemical industry;
- Coke battery furnaces;
- Cowpers;
- Any technical apparatus used in the propulsion of a vehicle, ship or aircraft;
- Gas turbines and gas engines used on offshore platforms;
- Plants which use any solid or liquid waste as a fuel other than waste referred to in point (b) of point 31 of Article 3 of the Directive.

According to the Chapter III aggregation rule, if waste gases of two or more separate combustion plants are discharged through a common stack the capacities should be added, but only if total rated thermal capacity of these individual combustion plants is greater than 15 MW.

The requirements of the IED relating to existing large combustion plants will come into effect from 1 January 2016. The Large Combustion Plant Directive (LCPD) is repealed from that date.

Transposition of the IED including the TNP was consulted on in October 2011 (IA NO: Defra 1375)[6]. This assessment placed an implicit cost of £489 million on the TNP. This can be broken down to benefits of £276 million in the form of savings for plants from greater flexibility offered under the TNP to meet IED emission limits by reducing emissions across the sector at least cost, along with costs £973.7m to the environment from higher emissions during the transition period (2016-2020). These values were not explicitly provided in the IED IA but were used to inform on the overall impact of the wider IED. A breakdown of these impacts is provided in Table 2 below.

[5] The titanium dioxide industry related directives (78/176/EEC, 82/883/EEC, 92/112/EEC), the IPPC Directive (96/61/EC, codified version 2008/1/EC), the Solvent Emission Directive (1999/13/EC), the Waste Incineration Directive (2000/76/EC) and the LCP Directive (2001/80/EC).

[6] Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82613/industrial-emissions-ia-120312.pdf

Table 2 Cost and savings of TNP (Amec Foster Wheeler, 2011[7])

	Costs (£m)				Benefits (£m)
	SO_2	NO_x	PM	TOTAL COSTS	
2016	116	81	25	222	75
2017	114	82	24	220	75
2018	107	65	21	193	75
2019	109	67	21	198	74
NPV	**409**	**263**	**81**	**765**	**276**

All prices are £2008. The NPV base year is 2010

However, the TNP had yet to be implemented in the UK. Therefore this impact assessment provides a full assessment of the TNP to establish the costs and benefits for the UK. The previous assessment of the TNP was based on the best available evidence on the value of the derogation at that point in time. The evidence was subject to considerable uncertainty, not least due to the challenges associated with forecasting the future plans of plant operators, including whether or not plants would opt for the TNP derogation. Additionally, at the time of consultation, the TNP was still being finalised therefore the number and type of plants which would apply to be included was not known.

For these reasons the benefits of the derogation have increased substantially over this period from £276 million to almost £6 billion. This is primarily a result of the fact that as action has not been taken in the intervening years it is no longer possible to install the modelled abatement equipment without a major disruption in the supply of electricity, as discussed in Section 4. 2.2 Emission Limit Values

Emission Limit Values (ELVs) set maximum permissible concentrations of specific pollutants from the plant (emission concentration limits). The ELVs, which should be applied, are set in the IED. The IED specifies that LCPs not opting or qualified for either the Limited Life Derogation (LLD) or the TNP must comply with:

- Existing LCPs shall comply with the ELVs set in Part 1 of Annex V. LCPs that were granted an environmental permit under the IED (or submitted a complete application) before 7 January 2013 (provided it's operational no more than one year after that date) are considered to be existing plants; and
- New LCPs shall comply with the ELVs set in Part 2 of Annex V, i.e. LCPs that will be granted permits after 2012. LCPs that were granted an exemption as referred to in Article 4(4) of Directive 2001/80/EC (a limited life exemption under the Large Combustion Plant Directive, LCPD) and which will be in operation after 1 January 2016 shall also comply with the ELVs set in Part 2.

All LCPs considered in the current modelling are existing plants, thus the Part 1 ELVs of Annex V have been applied where appropriate. Special conditions for LCPs firing high sulphur indigenous solid fuel, as well as small isolated systems and district heating plants, are assumed to not be relevant in the UK as no UK LCPs are known to meet these definitions.

There is the potential under the IED for tighter emission standards to be specified through the revision of the Large Combustion Plant Best Available Techniques Reference Document (BREF). The impact of specifying tighter Best Available Techniques (BAT) standards is not assessed within this study as the adoption of the revision of the LCP BREF has yet to occur, so it is not possible to determine whether tighter standards will be specified or what these may be.

[7] Amec (2011) Updated Impact Assessment of the Industrial Emissions Directive (IED): Large Combustion Plants. Final Supporting Report. AMEC Environment & Infrastructure UK Limited

2.3 Transitional National Plan (Article 32)

The Transitional National Plan (TNP) option is available for all Member States between 1 January 2016 and 30 June 2020 and can cover one or more of the following pollutants: nitrogen oxides, sulphur dioxide and PM. According to Article 32, the ELVs for sulphur dioxide, nitrogen oxides and PM laid down in the environmental permit for the combustion plant applicable on 31 December 2015, pursuant in particular to the requirements of Directives 2001/80/EC (LCPD) and 2008/1/EC (IPPC), shall at least be maintained.

All LCPs that were granted the first permit before 27 November 2002 or the operator of which had submitted a complete application for a permit before that date, provided that the plant was put into operation no later than 27 November 2003, can be included in the TNP, with the exception of LCPs in the refineries sector using residues from the refining process, district heating plants which meet the conditions in Article35 of the IED and LCPs opting for the LLD. For gas turbines, only nitrogen oxides emissions shall be covered by the TNP. LCPs with a total rated thermal input of more than 500 MW firing solid fuels, which were granted the first permit after 1 July 1987, shall comply with the emission limit values for nitrogen oxides set out in Part 1 of Annex V.

For each of the pollutants it covers, the TNP sets a ceiling defining the maximum total annual emissions for all of the plants covered by the TNP on the basis of each plant's total actual rated thermal input on 31 December 2010, its actual annual operating hours and its fuel use, averaged over the last ten years of operation up to and including 2010. Thus the reference period for TNP is 2001 to 2010. The approach is as follows:

- The ceiling for the year 2016 is calculated on the basis of the relevant ELVs set out in Annexes III to VII of Directive 2001/80/EC. In the case of gas turbines, the ELVs for nitrogen oxides set out for such plants in Part B of Annex VI of Directive 2001/80/EC are used;
- The ceiling for the years 2019 and 2020 are calculated on the basis of the relevant ELVs set out in Part 1 of Annex V of the IED; and
- The ceilings for the years 2017 and 2018 are set providing a linear decrease of the ceilings between 2016 and 2019.

The TNP extends the time period to install abatement to comply with the IED ELVs. If it were not for the TNP, plant would have to be compliant with the ELVs by the start of 2016.

Below is additional detail on the proportion of LCPs that have opted for TNP (as opposed to opting to meet the ELVs).

Table 3 – Proportions of plants which have opted for TNP by sector

	Percentage of plants in the sector that are in the TNP	Percentage of generating capacity that is in the TNP.
ESI	38%	49% (77,400 MWth)
Refineries	17%	17% (1,700 MWth)
Other	36%	59% (9,800 MWth)
Iron steel	80%	90% (1,600 MWth)
Total	**35% (118 of 337)**	**49% (90,400 of 185,900 MWth)**

2.4 Limited Life Derogation (Article 33)

While this document does not assess the impact of the Limited Life Derogation (LLD), it should be noted that this is an additional derogation allowable under the IED, for those plants wishing to close by 2023. The LLD allows all existing LCPs (as previously defined) to be exempt from compliance with the IED ELVs (Annex V Part 1) if:

- The operator of the LCP makes a commitment not to operate the plant for more than 17,500 operating hours, starting from 1 January 2016 and ending no later than 31 December 2023;
- The ELVs for sulphur dioxides, nitrogen oxides and PM laid down in the permit for the LCP applicable on 31 December 2015, pursuant in particular to the requirements of Directives 2001/80/EC and 2008/1/EC, shall at least be maintained during the remaining operational life of the LCP; and
- The LCP has not been granted an exemption as referred to in Article 4(4) of Directive 2001/80/EC.

However, the largest coal-fired LCPs (i.e. those capable of burning more than 500 MWh of fuel energy per hour), which were granted the first permit after 1 July 1987, shall comply with the emission limit values for nitrogen oxides set out in Part 1 of Annex V. From January 2016, plants which are part of the TNP cannot also make use of the LLD option, and vice versa.

2.5 Limited Hours Derogation (Annex V)

The operator of a LCP has the option to move to Limited Hours Derogation (LHD). This allows plants to operate for a maximum of 1500 hours per year as set out in IED ELVs (Section 2 of Part 1 of Annex V). While this document does not assess the impact of the LHD, it should be noted that this provision is available. LCPs under the LHD:

- Can only operate for less than 1500 hours per year. This is taken as a rolling average over a period of 5 years. Calculation of the five year rolling average for this derogation starts from the date the derogation is taken,
- Are subject to less stringent emission limits for SO2 and NOx that apply to large combustion plants only if they operate for this period of time,
- Must report operating hours to the Commission and the competent authorities must monitor compliance with the requirements.

However, this option is very restrictive for several reasons. The 1500 hours limit obstructs the plants ability to change its type of operation whether that is what it burns or the ability adapt to market conditions. Additionally, while the emission limits are less stringent, this entirely depends on what type of fuel the plant is burning. An example of this is plants burning liquid fuel would have the same limits as a plant operating under the TNP, severely restricting its operations. There has also been no information from plants that this is an option they are considering.
We can also imply from the LLD sensitivity that with a small proportion of firms opting for LLD's and removed from the TNP baseline, we would still see a substantial net benefit. With the restrictive terms from the LHD, we would assume even fewer plants would need to be removed from the baseline and therefore the effects on NPV would be marginal.

In reality, by omitting the LHD option, we could be slightly overestimating the benefits but we have not assessed this option in the baseline or in the scenarios as these restrictions are very limiting and we have no evidence to suggest that plants are considering this option.

3. RATIONALE FOR INTERVENTION

The Industrial Emissions Directive (IED) Emission Limit Values (ELVs) remains a key tool to mitigate air pollution in the UK, as poor air quality remains a significant public health issue. The burden of particulate air pollution in 2008 was estimated to be equivalent to nearly 29,000 deaths a year at typical ages and an associated loss of population life of 340,000 life years lost per year. The IED will help the government maintain and develop protection for human health and the environment. From 1 January 2016 the Industrial Emissions Directive will require a significant reduction in emissions from operators of Large Combustion Plants (LCPs), including power stations and power plants on industrial installations.

Operators of plants which do not meet these requirements have four choices: to close, to invest in IED ELV compliant abatement technology and reopen (this will take 3-4 years for most plants), join the Transitional National Plan (TNP), or, if they made a declaration before 1 January 2014, opt for Limited Life Derogation (LLD). Operators, who opt for the TNP, are allowed until 30 June 2020 to meet the ELVs set in the IED. The TNP sets a total emissions ceiling each year for those plants within it for each of the different air pollutants (nitrogen oxides, sulphur dioxide and PM). It is important to note that greenhouse gas emissions such as carbon dioxide continue to be constrained by the limits set out in the EU Emission Trading Scheme. Plants within the TNP may operate to a higher ELV than would otherwise be allowed under the IED, but ELVs which applied under the previous directive will apply, and total emissions from those plants will be restricted by the ceiling, which reduces each year until 2020.

The transition to IED ELVs presents a significant challenge and some plants will require more time to adjust to the more stringent ELVs. Utilisation of the TNP would reduce the risk of electricity supply from being constrained in this transition period. Given this, the TNP will overall improve security and resilience in the energy market.

In addition, plants within the TNP, for example those operated by industrial installations to provide the energy needed for their own use will be able to invest in abatement technology in a more cost-effective way. The TNP will allow those operators to sell excess emission allowances to other TNP plants. This supports TNP plants to reduce the costs of abatement.

The TNP sets limits in terms of concentration and absolute emissions which reduce during the course of the TNP, playing an important role in protecting national air quality and acting as a safety net for the level of air pollution across the UK, while also meeting our international obligations.

4. PROBLEM UNDER CONSIDERATION

The UK electricity sector will operate with limited spare generation capacity in the coming years. Ofgem's most recent annual security of electricity supply outlook (Electricity Capacity Assessment Report 2014[8]) sets out the risks associated with closures and potential low levels of investment over six winters (2013/14 to 2018/19). This report shows increased risk to electricity security towards the middle of the decade, with annual capacity margins of between 2 and 8 per cent in the period up to 2019.

As previously discussed, without the TNP, plants would have to be compliant with the more stringent IED ELVs by 1 January 2016. Recent analysis[9] suggests that the type of abatement technology that is necessary for these plants to install in order to achieve IED compliance will take between three and four years to install given the complexity of the technology required. Throughout this type of upgrade a plant would be subject to outages, potentially for extended periods, with consequent reductions in levels of availability and achievable output.

In terms of electricity generation capacity, 49% of the Electricity Supply Industry (ESI) has opted for the TNP. Without the TNP there could be a risk that around 50% of these plants would be required to close during 2016 and potentially beyond while fitting abatement measures. Given these pressures, if the TNP is not implemented, electricity generation in the Electricity Supply Industry (ESI) could fall by up to 39%[10] as some plants would be forced to close, which would have a detrimental impact on the UK economy and consumers.

The TNP allows operators to manage their upgrades in a way that at a system level helps to minimise the amount of capacity that is offline at any one time. The gradual reduction of the emissions caps in the TNP will allow plants to optimise the fitting of abatement technology by allowing plants to spread the capital investment over multiple years but importantly, this approach will also reduce the risk of demand-supply mismatches in the electricity market.

Operators of LCPs are not restricted to the electricity generating sector. Industrial installations also use LCPs to provide energy to their operations, and will therefore also need to comply with the IED. For these plants the opportunity to gain revenues for additional abatement through the sale of tradable TNP allowances (Air Pollutant Emission Allowances) could help fund the investment for the required abatement. For plants where abatement is disproportionately expensive, they can benefit by being able to continue operating through purchasing the additional allowances they require.

However, while plant operators within the TNP will benefit from a longer transition period towards compliance their total emissions will be constrained. This limits the productive capacity of these plants, creating a significant incentive for plants to comply with the IED ELVs, where possible.

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8 https://www.ofgem.gov.uk/ofgem-publications/88523/electricitycapacityassessment2014-fullreportfinalforpublication.pdf

9 PB Power Cost Assumptions 2014
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315717/coal_and_gas_assumptions.PDF"

10 This is based on our current data, which suggests that 50% closure of plants would result in 65-85% reduction in generation capacity for the ESI, depending on the year and scenario. On average, it would be approximately 80%.

5. POLICY AIMS AND OBJECTIVES

The implementation of the TNP will allow a number of plants to continue operating and this will improve for example, security and resilience in the energy market. This however also leads to higher air pollution and therefore has a negative impact on human health. The IED sets concentration limits on plants throughout the EU, which requires investment from plants to comply. This can be particularly difficult for some older plants. The TNP is important to ensure such plants have flexibility, to ensure sufficient time and provisions to transition to the new EU standards. For example, it will allow plants to optimise investment programmes and operation. This minimises individual plant and system costs, which will be reflected in consumer bills, and improved competitiveness of UK businesses.

Plants have been aware of the IED for some years; most have been making significant investments to comply with the Large Combustion Plants Directive (LCPD, the IED predecessor). The LCPD only stops with the introduction of the IED and so plants did not have a sufficient opportunity to make further adjustments for the IED, at the same time. Furthermore, having agreed the TNP flexibility within the directive, plants had a reasonable expectation that it would be implemented in the UK. Both from a financial and operational point of view, businesses could not sustain the required pattern of investments if the TNP is not implemented.

The TNP therefore ensures that plants invest in abatement technology to reduce their emissions to deliver long-term benefits in a way which does not incur disproportionate cost.

6. OPTIONS CONSIDERED

6.1 Option 0: Business As Usual (Baseline)

The baseline scenario assumes all plants that are currently not able to comply with IED ELVs and have indicated to be opting for the TNP would otherwise be required to close.

Our **baseline scenario** assumes all plants that have indicated to be opting for the TNP would otherwise have to comply with the IED[11] ELVs from January 1st 2016. As a result of this, the plants that cannot currently meet the IED ELVs are assumed to close to meet regulatory requirements, as any other action would be non-complaint with these legal obligations. Around 50% of the TNP plants currently would not be able to meet the IED ELVs by January 2016 and therefore these would be required to close[12].

While plants have the option to reopen once necessary abatement technology has been installed, experts from industry advise that coal plants would not reopen in the absence of the TNP, and that for gas plants it is quite unlikely that these would reopen although a few may invest in abatement and reopen. If plants were to install abatement a significant proportion of these would need to close for three to four years, as this is the time period necessary to install the technology needed to comply with the IED.

It is acknowledged that in practice, market and policy reactions would likely to provide some mitigation to the security of supply risks bought about by these closures, which could include increased levels of operation by compliant plants and mothballed plant which can meet the required ELVs returning to the market in response to measures in place to ensure security of supply; for example, the Supplemental Balancing Reserve (SBR) administered by National Grid. However, due to the uncertainties surrounding these potential responses and that we cannot assume these reactions would fully cover the energy supply problem; we do not incorporate these actions into the baseline.

Another uncertainty to the baseline is that a small number of plants (18), which have made a declaration to make use of the LLD, and are also currently in the UK TNP. These plants will need to make a decision by the end of 2015 whether to operate under the TNP, or the LLD. These decisions will be made using a number of commercial and operational reasons.

Overall, these uncertainties would not significantly alter the cost-benefit ratio presented in this document. A detailed assessment of all uncertainties is presented in **Section 12**.

To model this scenario, the activity rate of all plants that cannot meet the ELVs in 2016 is set to zero between 2016 and (31 June) 2020.

6.2 Option 1: Implementation of the TNP

Under this option, the TNP is implemented, which applies an annual absolute emissions cap on plants in the TNP and a less stringent concentration based limits compared to the IED.

Under this option, it is assumed that all plants that have indicated to be opting for the TNP will comply with these limits. It is assumed that plants remain under the TNP for the full transition period (2016-2020).

The emission caps have been calculated by Defra based on the average fuel consumption from 2001 to 2010, and the future emission reductions required from 2016 to 31 June 2020.

Historic emission concentrations for each plant have been calculated using annual emissions and fuel consumption data reported in the LCP inventories for 2010 – 2012[13]. Fuel consumption is multiplied by specific

[11] More stringent ELVs may apply for individual plants due to the requirement to comply with BAT-AELs in the LCP BREF. However, the LCP BREF is still at draft stage (not finalised or adopted) and in our modelling would have no effect on the baseline.

[12] The 50% of plants which are currently compliant will need to reduce activity rate in order to comply with the absolute emissions thresholds set by the TNP. They also provide liquidity to the emissions allowances trading market, allowing non-compliant plants some flexibility to install abatement technologies in the most economically efficient manner.

[13] This is the most recent time period for which data are available. A relatively short time period is used to minimise distortion of the average historic values due to technology changes made at the plant during the period.

flue gas volume factors for each fuel type to calculate the total waste gas volume (for more details of process see section 7 on methodology).

7. METHODOLOGY

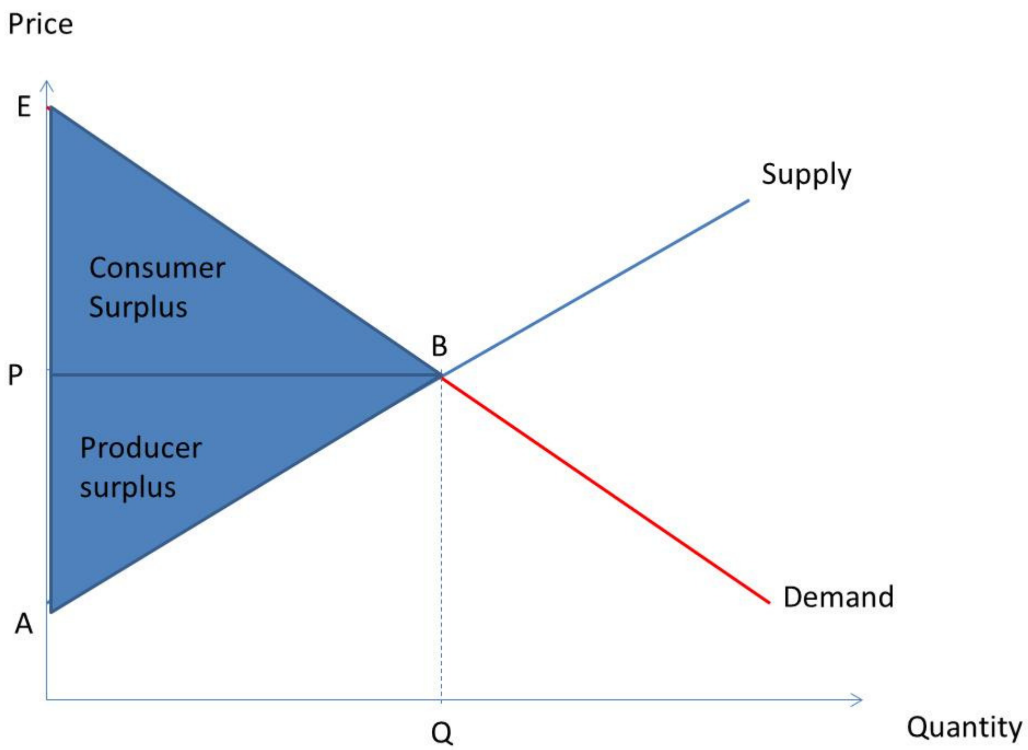
Methodology – high level overview

The implementation of the TNP will chiefly impact the UK through its effects on the electricity market (producers/consumers) and the environment.

Impacts on the electricity market and producers/consumers: The TNP will allow plants more flexibility to operate in the transition period (2016-2020). As a result, LCPs will be able to generate more electricity. This provides benefits for electricity producers, as they sell the additional electricity in the market.

However, plant operators will also incur some costs from the TNP. Plants will need to install abatement technologies or purchase emission allowances to comply with TNP caps. The higher power generation will result in higher pollution and operators must offset some of this (CO_2 emissions) by purchasing EU ETS allowances. Finally, the TNP will result in an administrative cost for producers.

Therefore, the overall impact on producers will depend on the value derived from selling the additional electricity; against the cost of producing it. This difference is the profits to operators (total revenues – total costs). This can be viewed as the 'producer surplus' and the graph below displays it visually. For a given producer that is able to produce (electricity) at the cost A, the surplus to the producer would be the difference between this point and the market price (P). In perfectly competitive market, the distance between A and B would be represented by producers in the market and the overall producer surplus would therefore be the area A, B, P.



Through purchasing and consuming the additional electricity, consumers – both businesses and individuals – would also derive benefit from the TNP.

A simple way of valuing the benefits to consumers would be to assume the price they pay in the market is equal to the value they place on it. However, this is an underestimate of the overall benefit – as some consumers would be willing to pay more than the market price. This difference, between the price a consumer actually pays and the price they would be prepared to pay, is known as the 'consumer surplus' (see graph above). For a given consumer willing to pay price E, the surplus would be the difference between this point and the market price (P).

In practice, the price individual consumers are willing to pay can be difficult to determine and disproportionately expensive to measure. Our assessment is therefore conservative as it does not quantify consumer surplus (although sensitivity on consumer surplus is included in **Section 12**).

This is particularly conservative, given that the TNP is assumed to expand production and the supply would therefore shift to higher quantities, at lower prices. This provides greater consumer benefit, both through ensuring greater energy security and resilience (from higher generation capacity) and wider economic benefits (from lower prices).

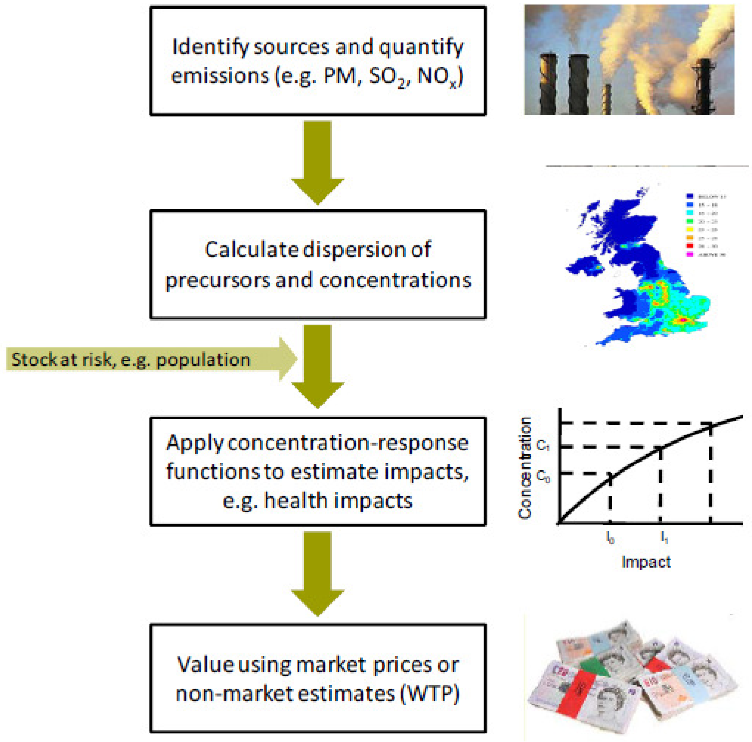
Impacts on the environment: As noted above, the higher power generation will lead to higher levels of pollution and this has an environmental cost to society.

Best practice has established robust methods for assessing environmental impacts; however it is acknowledged that not all impacts can be fully captured and that further work to attempt to capture further impacts was often disproportionate such as a full Ecosystems evaluation. These additional impacts are therefore captured within our non-monetised impacts.

The method used for this assessment was the impact pathway approach (see figure below). The key steps to this are:

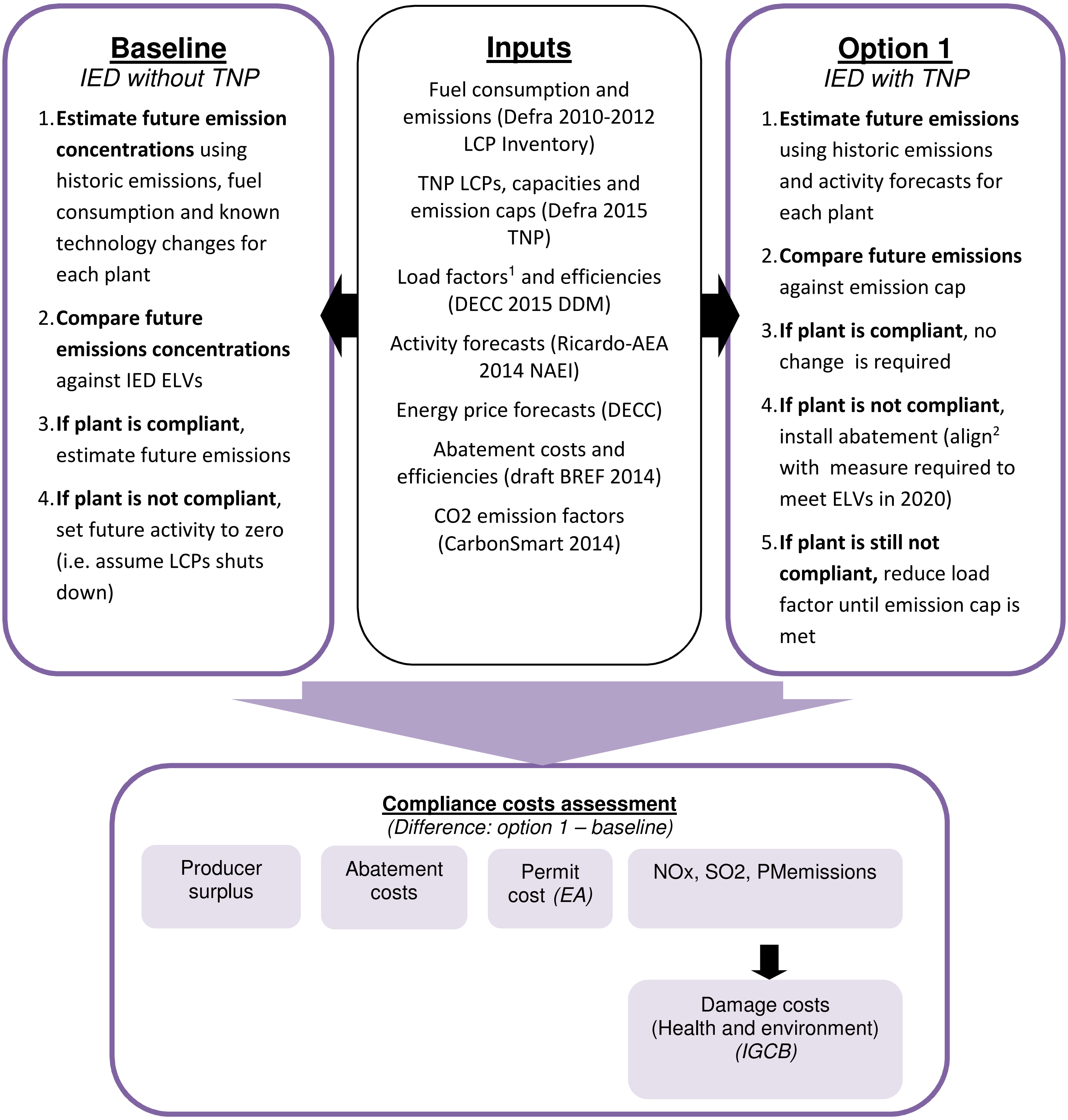
- Quantification of emissions for both option 1 (TNP) and the baseline (no TNP) scenarios;
- Conversion of estimated emissions into relevant exposures for all scenarios;
- Estimation of marginal impacts from the policy option relative to the base case;
- Valuation of the impacts associated with the scenario relative to the base case;
- Comparison of the air quality and other impacts on a consistent basis; and
- Description of the uncertainties, risks and consequently any sensitivity tests.

Figure 1 - Impact pathway approach



The flow chart below, along with the section that follows, provides a technical overview of the methodology used to assess the overall impact of the TNP. In order to do this, the model estimates change in electricity output by plant, identifies the necessary abatement equipment plants would install in order to become complaint with the IED by 2020 and estimates the change in emissions across the TNP period.

Chart 2: Methodology – flowchart



1: Developed by consultant (AMEC) based on inputs from DECC.
2. From 1 July 2020 when the TNP ends it is assumed that LCPs will comply with the ELVs and therefore install emissions abatement measures. It is not realistic to assume that a LCP would invest in a different measure for a few years under the TNP and then invest again in 2020.

7.1 Summary of steps for calculating the baseline

Step 1: Calculate future emission concentrations

Emission concentrations for each LCP are calculated based on the level of pollution emitted relative to the total amount of gas emitted from the plant. This is based on historic total annual emissions, fuel consumption data[14] and specific amounts of flue gas produced for each fuel type. To forecast future emissions concentrations, historic values are adjusted for LCPs known to have installed an abatement measure since 2012 to reflect the abatement efficiency of that measure.

Step 2: Compare future emission concentrations against IED ELVs

For each LCP, the estimated emission concentrations are compared against the relevant IED ELVs. The LCPs that can meet the IED ELVs are assumed to operate as forecast. Those that do not meet the IED ELVs are assumed to close to avoid non-compliance with regulation.

Step 3: Estimate future emissions for compliant plants

Future emissions are calculated using historic emissions (as above) and the percentage change in activity between the historic and forecast future plant activity. In the electricity supply industry (ESI), load factor[15] is used as a measure of activity. The historic average load factor (2010-2012) is estimated using the LCP's capacity, fuel consumption and efficiency. In the refineries, iron and steel and other sectors annual fuel consumption is used as a measure of activity.

Step 4: Set emissions for non-compliant plants to zero

For LCPs which are unable to comply, the future forecast plant activity is set to zero between 2016 and 2020, as these would be required to shut down, in absence of the TNP. For compliant ESI LCPs, the future forecast activity rates were provided by DECC[16]. For compliant refineries, iron & steel and other sector LCPs, the fuel consumption forecasts have been calculated based on National Atmospheric Emissions Inventory[17] projections.

7.2 Calculation for Option 1

Step 1: Estimate future emissions

Future emissions are estimated for all TNP LCPs using the approach described above.

Step 2: Compare future emissions against emissions cap

The forecasted future emissions of plants are compared against the TNP cap to determine if a reduction is required for compliance with the TNP. The LCPs that already comply are assumed to operate as forecasted. Those that do not comply are assumed to either install abatement or to trade air pollutant emissions allowances until they are compliant. ESI LCPs are assumed to also have the additional flexibility of reducing the load factor[18].

A detailed assessment of air pollutant trading has not been modelled (see Risks and Assumptions section for more details). For trading it is assumed that the cost of purchasing of the TNP Air Pollutant Emissions Allowances is the same as the cost of the alternative action that would be required to achieve the necessary emissions reduction for compliance with TNP. That is, the annualised abatement cost or loss in revenue (due to reduction in load factor) is assumed to be the cost of trading[19] for individual plants. Therefore, the results of the assessment do not differentiate between the purchase of emissions allowances and the choice of fitting abatement, or between reducing plant activity and buying emission allowances. There is only differentiation between the decision to fit

[14] reported in the LCP inventories (2010–2012)

[15] Load factor represents the percentage of the maximum capacity that is used over a year.

[16] These load factors are mainly determined based on fuel and CO_2 costs. DECC, 2012, DECC Dynamic Dispatch Model (DDM) Assumptions.

[17] Ricardo-AEA, National Atmospheric Emissions Inventory (2012 inventory UEP48 projections)

[18] This is because plants in other industries are dependent on the energy generated for production of other goods, therefore the costs of reducing load factor are more likely to exceed the costs of abatement.

[19] This is on the basis that the total emission cap is lower than the emissions that would occur if all LCPs were to continue under current conditions. This means that some LCPs will need to install abatement measures or reduce operation in 2016. In each subsequent year the TNP cap reduces and therefore plants will either install more abatement measures or reduce activity. Given this, the trading prices remain the same as the alternative action, as the supply (TNP cap) and demand fall at the same rate until the TNP ends.

abatement and the decision to reduce activity. In practice, this is a complex decision that would be influenced my many other regulatory and economic considerations. Given this, the assessment has been simplified to prioritise the uptake of abatement over a reduction in load factor[20].

Step 3: If plant is not compliant, install abatement; If plant is compliant, no change is required

It is assumed that if an abatement measure is to be installed by an LCP in any year of the TNP, the chosen measure would enable the LCP to also comply with the 2020 IED ELVs. This is because installation takes time and is costly, and an LCP will want to undertake this process just once in order to meet the cap or ELVs in later years as well as the current.

Our analysis also takes into account that LCP would have no long term incentive to install a more advanced and more costly abatement measure than is required to meet the IED ELVs.

The abatement measure that would be required for compliance with the TNP emission cap in 2020 is determined by comparing the 2020 cap with the forecast emissions, to calculate the percentage reduction needed. This percentage was used to identify the appropriate abatement measures needed in order for plants to comply. If the required emission reduction is below 10% it is assumed it could be achieved with improvements to the existing technologies without further uptake of measures. If the required reductions are greater than 10%, then the minimum abatement measure that would still achieve the required reduction is selected. For example if an emission reduction of 60% is required and the possible abatement measures have abatement efficiencies of 50%, 80% and 90% respectively, then the measure with an abatement efficiency of 80% is selected to ensure the required reduction will be achieved. An extensive list of abatement measures (see Box 1) and related data (applicability, abatement efficiency, costs and lifetime) has been updated from the previous assessment (AMEC, 2012) to align with the latest draft of the LCP BREF (2014).

As the TNP emission cap limits total emissions while the IED ELVs affect concentrations, the abatement measure required for compliance with the TNP emission cap is compared against that required for the IED ELVs to determine how LCPs will react. No change is required where the abatement measure is the same. For LCPs in which the high activity rate requires a more advanced abatement measure to be implemented to meet the TNP cap, compared to meeting the IED concentration limit, the abatement measure selected has been changed to that required for meeting the ELV. For each of the previous years (2016-2019), if a reduction is needed, the abatement measure has been aligned to the measures applied in 2020. The future emissions are recalculated to account for the emission reduction achieved by the abatement measures.

The annualised costs of the abatement measures are based on costs in the draft LCP BREF (2014) or PB Power (2014). The source capital costs[21] are presented in cost per unit of power station thermal capacity (£/MWth), therefore these costs are multiplied by the thermal capacity of the plant to which it is assumed to be fitted. The capital cost is annualised over the lifetime of the measure, using a discount rate of 3.5%[22]. The annual operational costs (maintenance and consumables) are presented in the reference sources either in cost per unit of installed capacity (£/MWth), cost per unit of fuel consumption (£/MWh) or cost per tonne of pollutant abated (£/t). The unitised cost is multiplied by the relevant value for the plant to which the measure is fitted. The total annualised cost for the plant is calculated by combining the annual capital cost and the annual operating cost.

Box 1	**Abatement Technology**

Abatement measures considered, split by pollutant include:

- For SO_2:
  - Wet flue gas desulphurisation (FGD-wet)
  - low sulphur coal
  - low sulphur oil
  - coke oven gas (COG) desulphurisation (Iron and Steel)
- For NO_X:
  - selective catalytic reduction (SCR)

[20] Prioritisation has been given to fitting abatement on the basis that the primary purpose of the TNP is to provide a transition period for the take up of abatement. The primary purpose of the TNP is not to restrict the load factor of plants, although plants are able to reduce their load factor to comply. Other derogations under the IED (most notably the Limited Life Derogation) have the primary purpose of limiting the load factor of plants choosing that option.

[21] Where necessary costs are first converted using the relevant currency exchange rate and inflated to 2014 prices using UK GDP inflators.

[22] In accordance with HMT Green Book guidance.

- air staging
- low NO_X burners
- selective non-catalytic reduction (SNCR)
- Dry low NO_X burners (GTs)
- Exhaust gas recirculation

- For PM:
  - PM abatement included in FGD-wet
  - Cyclones
  - Bag filters
  - Electrostatic precipitators (ESP).

Step 4: If plant is still not compliant, reduce load factor until emission cap is met

In ESI LCPs where alignment of the abatement measure means the emission reduction achieved is less than required to meet the TNP cap, the forecast plant activity (and thereby emissions) have been adjusted downwards to the level that enables the cap to be met.

Monetised impact assessment

Once the level of activity for the different plants has been estimated the social impacts of this are then quantified and monetised covering:

- Producer surplus – reflecting the social benefit from the additional output.
- Abatement costs – reflecting the additional necessary abatement required.
- Emissions of air pollutants – assessing the impact on air quality.

Calculate Producer Surplus

Producer surplus (i.e. the benefit to operators of the TNP) is estimated by calculating the difference between the market price of electricity and the costs of production[23]. This takes into account the change in expenditure on fuel based on plant activity levels, which is subtracted from the revenues to obtain annual profits. This calculation does not take into account fixed costs, as these are sunk costs.

Calculate Abatement costs

The abatement costs in the TNP scenario represent the change in annualised cost of installing the appropriate abatement measures. The modelling includes two groups of abatement technologies: one to reduce air pollution (SO_2, NO_X and PM) and a second group of abatement for greenhouse gases (CO_2)

In relation to air pollution, as noted in step 3 of option 2 above, if the total emissions within the TNP exceed the permissible level, additional abatement is required. Once these abatement measures have been applied for each plant, the total cost of abatement is calculated by adding the cost of installing and annual operating the abatement measures.

Trading of air pollutant emissions allowances will be allowed under the TNP, although a detailed assessment of trading is not modelled here. It is considered not to be proportionate to the time required to model an additional scenario based on full trading as while environmental and capital costs of installing abatement would be higher if trading was considered, producer surplus would also be significantly higher. Given this, any further assessments of trading would be expecting to reinforce the current assessment of the TNP and would not meaningfully alter the balance of cost and benefits presented in this IA (for more details see Risks and Assumptions section).

Greenhouse gas emission from LCPs are controlled through the EU Emissions Trading System (ETS). Therefore any increases in CO_2 emissions must be offset across the controlled sources. Therefore these impacts have been valued using traded cost of carbon values set out in the best practice appraisal from DECC IAG (2014).[24]

Consider Environmental Permit cost

Given all existing LCP operators are expected to have an environmental permit, only the cost of amending the existing permit is expected to be necessary for operators.

23 Both electricity price forecasts and fuel prices have been obtained from DECC.

24 This is on the basis that the traded price of carbon should reflect the marginal abatement cost within the controlled sources.

Based on discussion with the Environment Agency, costs estimates developed for the previous IAs [25][26] have been used and these suggest the operators would be expected to pay around £3,256.71 (2014 prices) per permit variation.

Calculate Emissions (SO_2, NO_X and PM) costs

The change in emissions resulting from the change in activity rate and abatement measures has been calculated by comparing the emissions of the scenario against the emissions of the baseline. The potential impact of the SO_2, NO_X and PM emission changes have been estimated through the application of the damage cost functions developed by Defra IGCB[27].

25 Amec (2012) Updated Impact Assessment of the Industrial Emissions Directive (IED): Large Combustion Plants. Final Supporting Report.
26 Amec (2014) Assessment of the Potential Costs and Benefits of a Proposed EU Directive Establishing Emission Limit Values for Medium Sized Combustion Plants
27 IGCB (2007): Economic analysis to inform the Air Quality Strategy. Final report, July 2007.

8. RESULTS

8.1 Key costs and benefits of Option 1 implementing the TNP

Table 4 presents the results of the monetised impacts for the central estimate. These results are built upon a number of assumptions, therefore they should be considered within the context of the sensitivities and uncertainties set out in section 12.

Each of the monetised impacts are discussed in more detail below:

- **Producer surplus** – Profit, used as a proxy for producer surplus, is the additional benefit that plant operators receive above the price they willing to sell electricity for. The difference between the costs of fuel inputs and the price of electricity is used to calculate this[28]. This calculation does not take into account fixed costs, as these are sunk costs. Under the TNP, we estimate profits would be £8,152m higher than if it was not implemented, as plants are able to continue operating during the transition period and are not required to close.
- **Environmental cost –** The main cost of the TNP will be the impact on air pollutant emissions. Allowing greater flexibility will enable plants to keep operating and emitting pollutants, negatively impacting on the environment. We estimate additional costs in terms of extra emissions of nitrogen oxides, sulphur dioxide and PM of between £679.5m & £1,006.5m NPV with a central estimate of £973.7m. This figure captures both chronic mortality effects (which consider the loss of life years due to air pollution) and morbidity effects (which consider changes in the number of hospital admissions for respiratory or cardiovascular illness) – in addition to damage to buildings (through building soiling and impacts on materials).
- **Fuel costs –** As a result of higher activity levels, total fuel expenditures by plants on fuels will increase by between £51.1m and £5.5bn – with a central estimate of £4.5bn..
- **Change in abatement costs for plant operators –** Compliance with the TNP will lead to additional costs for some plants, as these remain open and therefore invest in abatement technology to reduce their emissions of NO_X, SO_2 and PM. This will result in an additional to operators of between £231.4m and £1.1bn. Our central estimate is this will lead to an additional cost of £680.8m NPV for businesses.
- **CO_2 Emissions** – Certain measures intended to reduce emissions of air quality pollutants also affect CO_2 emissions from UK plants. As LCPs fall into the scope of the EU Emissions Trading System (ETS), emissions in Europe as a whole will not change, however costs to UK businesses of purchasing extra EU ETS allowances from abroad will need to be considered, therefore any change in CO_2 emissions in the UK is valued using the traded cost of carbon. We estimate that traded CO_2 costs will lead to additional costs of £0 to £5290.1m, and our central estimate is £833.5m.
- **Administrative costs –** These costs include regulator time and effort for processing a variation of an environmental permit (the cost is assumed to be passed on to operators by the regulator), and the cost to operators of applying for the permit variation. We estimate the TNP will result in an administrative cost to business of £0.8m.

Table 4 – Overview of Monetised Costs and Benefits (NPV, million, 2015 prices)

M/£	2016	2017	2018	2019	2020	NPV
Benefits						
Revenues	3734.3	3276.6	2784.3	2096.7	931.2	12823.1
Costs						
SO_2 Emissions	137.7	115.1	101.9	65.8	26.6	447.1
NOX Emissions	152.0	130.8	109.2	62.4	24.9	479.4
PM Emissions	14.0	12.0	9.9	7.9	3.4	47.2
SO_2 Abatement	10.0	11.0	12.4	14.0	7.0	34.4

[28] Both of which were obtained from DECC.

NOx Abatement	157.5	151.2	143.0	133.0	61.2	646.0
PM Abatement	0.1	0.2	0.1	0.1	0.0	0.6
EU ETS Costs	238.1	213.0	189.0	139.3	54.1	833.5
Admin Costs	0.8	0.0	0.0	0.0	0.0	0.8
Fuel costs	1265.7	1160.4	1042.6	760.8	291.3	4520.8
Total Costs	1955.9	1793.8	1608.2	1183.3	468.6	7009.7
Net Impact						**5,813.5**

In addition to the monetised impacts a range of non-monetised impacts are also expected. The most significant of these impacts are:

- **Energy security and resilience –** Overall the implementation of the TNP is expected to lower the risks of supply disruptions in the energy market. The TNP allows operators to manage their upgrades in a way, which at a system level, helps to minimise the amount of capacity that is offline at any one time. Any reduction in the total generation capacity that is on outage i.e. unable to generate, at a given time, reduces the risk~~s~~ of the electricity system demand exceeding the UK's available generation capacity, which is a significant benefit to the society in terms of reduction of uncertainty and the implications this has e.g. for businesses in their investment decision making and consumers assurance they have access to electricity. This will also limit the potential for price rises. If the TNP plant exited the market, capacity margins would fall and, in general, prices would rise, ultimately to a theoretical level that covers capital and operating costs for a new plant. Models of capacity margins are typically very non-linear and, often within a range of interest, sensitive to small variations. Hence a small change in capacity might lead to a large change in prices. In addition, this will have knock on effects in terms of improved efficiency for the wider economy, given the reduced risk of blackouts.
- **Wider economic benefits –** If plants are required to close without the TNP, this may impact on market share, output and competitiveness of the businesses that own these plants – which may be particularly relevant for example in iron, steel and other sectors. This may mean they are unable to recover for a long period of time (greater than the 5 years modelled in this IA and perhaps permanently). However, assessing the impact on these other sectors with a reasonable degree of confidence is disproportionate given that the benefits of the TNP are high, and also because the impacts in those sectors can be expected to be lower than the electricity generating sector which has been estimated. Further details in Section 12.
- **Non-monetised health impacts –** The damage cost approach does not take into account all impacts on health. For example, the damage cost for PM only reflects the long term chronic impact on life expectancy from fine particles and does not include impacts such as acute mortality, morbidity or indirect health impacts.
- **Ecosystem damages –** It is challenging to value the impacts on ecosystems and therefore these are usually considered relative to the estimated level at which harmful effects are expected to occur, commonly known as critical loads. There are also impacts through effects on the acid and nutrient status of soils and waters, such as eutrophication, which have not been possible to monetise.

8.2 Direct impacts on businesses

The following results are presented using three scenarios (low, central and high). This has been done in order to reflect the uncertainty associated with fuel prices of gas and coal, which the results are highly sensitive to. This is because the relative price affects the ratio of coal fired versus gas fired electricity generation. This is significant as coal plants produce notably higher emissions than gas plants (particularly SO_2 and PM). The low scenario uses DECC's low fuel price projection, where the relative price of coal (compared to gas) is low; the high scenario uses DECC's high fuel price projection, where the relative price of coal is high. The central estimate uses DECC's central estimate.

All other uncertainties and sensitivities are covered in **Section 12**.

8.2.1 Change in producer surplus

It is assumed that at the margin, the costs of electricity production are driven primarily by the fuel costs and when the market price for electricity exceeds them, the operator would choose to generate. This is consistent with a pricing model in a situation where capital costs are paid off or unrecoverable (sunk), such as would apply if there was overcapacity.

The financial impacts on the electricity generating companies in the TNP result mainly from changes in their running patterns and to a lesser extent from changes in the electricity prices. Both their earnings (revenues) and costs (from changes in fuel use) are affected by running patterns. The combination of changes in revenues and costs are used to calculate the profits in each fuel price scenario (High/Low/Central).

The following table estimates the impact on revenues. This calculated using the change in electricity generated under option 1 compared to the baseline, which is multiplied with the electricity price (from DECC[29]) to estimate the total change in revenues for plant operators.

Table 5 – Change in Revenues

Revenues (£m/yr)			
Year	**High**	**Low**	**Central**
2016	5,257	2,033	3,865
2017	5,070	1,868	3,510
2018	4,724	1,692	3,087
2019	3,826	827	2,406
2020 (up to 31 June)	1,987	349	1,106
Total NPV	**19,080**	**6,249**	**12,823**

The table below shows the change in fuel expenditure for operators in option 1 compared to the baseline.

Table 6 – Change in Fuel Costs for Electricity Generators in the TNP

Cost (£m/yr)			
Year	**High**	**Low**	**Central**
2016	£1,806	£18	£1,310
2017	£1,397	£16	£1,243
2018	£1,311	£15	£1,156
2019	£1,013	£5	£873
2020 (up to 31 June)	£517	£1	£346
Total NPV	£5,549.6	£51.1	£4,520.8

Positive values indicate an increase in costs.

Comparing the results from the two tables above (on revenues and fuel price changes), this tables shows the net impact on profits for electricity generators in the TNP.

Table 7 – Change in profits

Revenues (£m/yr)			
Year	**High**	**Low**	**Central**
2016	3,451	2,014	2,555
2017	3,673	1,852	2,267
2018	3,413	1,677	1,931
2019	2,810	822	1,533
2020 (up to 31 June)	1,470	348	760

29 by DECC, September 2014 (corrected 23 December) - https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2014

Total NPV	13,528	6,197	8,302

Positive values indicate an increase in profits.

Explanation of results

The assumptions used in the sensitivity tests (i.e. the high and low scenarios) are covered in the section 12 on risks and assumptions. The key driver behind the differences in profit is the difference in DECC's estimated fuel price forecasts of coal and gas.

As the tables above show, plant operators will be expected to see increased revenues under option 1. The net impact on profits over the TNP period is expected to be £8.1bn (central estimate, NPV). This is used as a proxy for producer surplus – the benefit to operators of the TNP.

8.2.2 Change in abatement technology costs

Plant operators will need to install abatement technology to be compliant with the TNP. The following shows the difference in abatement technology costs in TNP and the IED.

Table 8 – Change in abatement technology costs, central prices scenario

Abatement cost (£m/yr) total				
Year	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	- 10.4	163.0	0.1	152.8
2017	11.8	162.0	0.2	174.1
2018	13.7	158.6	0.1	172.4
2019	16.0	152.6	0.1	168.7
2020 (up to 31 June)	8.3	72.7	0.1	81.1
Total NPV	**34.4**	**646.0**	**0.6**	**680.9**

Negative values indicate benefits due to the TNP.

Sensitivity Calculations

The assumptions used in the sensitivity tests are covered in the section 12 on risks and assumptions. The key driver behind the differences in the figures below is the differences in fuel costs and the relative price difference between gas and coal.

Table 9 – Change in abatement technology costs, low prices scenario

Abatement cost (£m/yr) total				
Year	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	- 0.7	59.8	0.1	59.2
2017	- 0.4	61.1	0.2	60.8
2018	3.6	60.6	0.1	64.3
2019	6.2	54.8	0.1	61.1
2020(up to 31 June)	1.4	26.7	0.0	28.1
Total NPV	8.7	239.6	0.5	248.9

Negative values indicate benefits due to the TNP.

Table 10 – Change in abatement technology costs, high prices scenario

Abatement cost (£m/yr) total				
Year	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	23.5	239.8	0.1	263.4
2017	44.4	240.9	0.3	285.6

2018	42.3	241.4	0.1	283.9
2019	37.5	224.1	0.1	261.7
2020 (up to 31 June)	19.0	111.9	0.1	130.9
Total NPV	151.0	963.8	0.6	1,114.5

Negative values indicate benefits due to the TNP.

Explanation of results

The TNP is expected to lead to the take up of abatement technologies (for plant which choose not to reduce load factor) in order for plants to comply with the emission caps. Therefore, for the transition period the TNP can be expected to lead to an increase in abatement costs over the baseline in which plants that cannot meet the IED ELVs, cease operation, and therefore do not fit abatement.

As shown above, this is the case for NOX and PM for all three fuel price scenarios (low, central, high).

However, for SO_2 in the low scenario (2016, 2017) and the central scenario (2016), the negative costs imply savings in the TNP compared to the baseline. This is because the results are significantly influenced by a single, large plant that has already fitted abatement by 2016 to comply with the ELVs (and therefore is able to continue operating in the baseline). This plant would not need to apply SO_2 abatement in the low (2016, 2017) and central (2016) scenarios to meet the cap. However, it would need to apply SO_2 abatement in the alternative baseline and therefore the scenarios show a cost saving.

8.2.3 Administration Costs

Given the scale of the administration costs the estimates developed for the previous IAs[30],[31] have been retained. Key assumptions for administrative costs include:

- The costs for a simple variation for a site's environmental permit were considered in the analysis – this was estimated to cost the EA approximately £2,300 (2011 prices – updated to 2014 prices). This cost covers the authorities' time and effort for processing such a variation;
- Application fees were not considered since the LCP operators would have in their possession an environmental permit;
- Based on discussions with an operator it was indicated that a simple variation of their permit would probably take about 5 days of their time; and
- The hourly wage for the operator was taken from the ONS UK[32] using the medium pay for the electricity sector (£16.38; 2012 prices). This wage was updated to 2014 prices with a 30% mark up for overheads. This resulted in an hourly cost of £22.11 (2014 prices).

It is assumed that the cost incurred by the EA will be passed on to operators as a fee. Based on these assumptions the transitional administrative/permitting costs for competent authorities and operators were estimated to be approximately £3,256.71 (2014 prices) per permit variation.

Guidance suggests that permits will be varied upon entering the TNP and then again at the end of the TNP period to transition to the IED. It is also likely that those going straight to the IED are likely to have their permit varied. Therefore the main administration cost of the TNP is assumed to occur at the end of the TNP period upon entering the IED.

8.2.4 Monitoring Costs

It is unlikely that the TNP will result in any significant changes in monitoring costs. We understand from our internal experts that LCP's have already installed continuous monitoring equipment in their plants, which is required for the IED and is likely to be used in monitoring the TNP. Our consultant (AMEC) and DECC do not

30 Amec (2012) Updated Impact Assessment of the Industrial Emissions Directive (IED): Large Combustion Plants. Final Supporting Report.

31 Amec (2014) Assessment of the Potential Costs and Benefits of a Proposed EU Directive Establishing Emission Limit Values for Medium Sized Combustion Plants

32 ONS UK. Patterns of Pay: Results from the Annual Survey of Hours and Earnings, 1997 to 2012; table:Full-time employees' pay by industry sector (SIC 2007)c, United Kingdom, April 2008 - 2012; data: Median hourly earnings excluding overtime (£); sector -Public administration and defence; compulsory social security, 2012p

foresee any major differences between the monitoring under the TNP and IED. The running cost of monitoring equipment does not represent a significant cost and if plants were to close down, these would be disposed. Given this, we have therefore assumed that there are no significant cost impacts for this category.

8.2.5 CO_2 Costs

Under the TNP several UK LCPs are expected to continue operating that would otherwise be required to close. This results in an increase in fuel consumption and therefore greenhouse gas emissions for these installations[33]. As all LCPs are in the EU Emissions Trading Scheme, they need to purchase EU ETS allowances. It is worth stressing that this is a separate emissions trading market to air pollutant emissions trading as described in sections 7.2 and 12.2. There are therefore costs to UK business as EU ETS allowances are purchased by plants. There is no environmental cost as the quantity of emissions in the traded sector is fixed, and an increase by one segment of the traded sector necessarily will not result in an increase in emissions in the overall system.

Certain measures intended to reduce emissions of air quality pollutants to comply with the TNP caps can also affect CO_2 emissions. The change in profile of abatement measures between the scenarios and baseline therefore has been estimated to have an impact on CO_2 emissions. Relative to the CO_2 emissions associated with the generation of electricity this impact is minimal (<1%).

The change in emissions has been calculated by multiplying the increase in fuel consumption by standard CO_2 emission factors[34]. This is then valued using the traded cost of carbon (using values from the IAG spreadsheet tool for valuing changes in greenhouse gas emissions, 2014).

Table 11 – CO2 Costs, central prices scenario

Year	Central	Abatement measures		Change in operation		Total	
	£/tCO_2	Emissions (ktCO_2)	Traded cost (£m)	Emissions (ktCO_2)	Traded cost (£m)	Emissions (ktCO_2)	Traded cost (£m)
2016	5	78	0.4	52,848	246.4	52,926	246.7
2017	5	76	0.4	48,949	228.2	49,025	228.5
2018	5	72	0.3	44,956	209.6	45,028	209.9
2019	5	62	0.3	34,304	159.9	34,366	160.2
2020 (to 31 June)	5	27	0.1	13,780	64.2	13,807	64.4
NPV							**£834.8m**

Positive figures represent a reduction in the carbon costs to business due to the delayed uptake of abatement measures.

Sensitivity Calculations

The assumptions used in the sensitivity tests are covered in section 12 on risks and assumptions. The key driver behind the differences in the figures for the scenarios above is the price of carbon and the relative price between gas and coal.

33 This may be offset as under the baseline if TNP plant shut down electricity generation from other sources will increase. This has not been accounted for in this assessment as there is uncertainty over what alternative sources would be used and to what extent the generation gap could be filled.

34 Defra, DECC, Ricardo-AEA, CarbonSmart, 2014. Greenhouse Gas Conversion Factor Repository. Available on: http://www.ukconversionfactorscarbonsmart.co.uk/, for all fuels except blast furnace gas and coke oven gas which are not included and therefore instead taken from:
Carbon Emission Factors and Calorific Values from the UK Greenhouse Gas Inventory (Ricardo-AEA, 2014) to Support the EU ETS. Available on: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313306/2014_euets_cefs_gcvs.xlsx

Low prices scenario – The forecast traded cost of carbon under the low scenario is 0 £/tCO_2 for 2016 to 2020 (up to 31 June), therefore the cost of carbon attributed to this scenario is £0.This represents a scenario with continued chronic oversupply of allowances in the carbon market as a result of which the carbon price up to 2020 is zero, in line with DECC/Green Book guidance. This scenario is presented for the purpose of undertaking sensitivity analysis and does not reflect a view from Government that the market price is likely to reach zero in reality.

Table 12 – CO2 Costs, high prices scenario

Year	High	Abatement measures		Change in operation		Total	
	£/tCO_2	Emissions (ktCO_2)	Traded cost (£m)	Emissions (ktCO_2)	Traded cost (£m)	Emissions (ktCO_2)	Traded cost (£m)
2016	20	90	1.8	58,968	1,159.1	59,058	1,160.8
2017	21	89	1.9	55,841	1,166.4	55,929	1,168.3
2018	27	83	2.2	51,551	1,377.7	51,634	1,379.9
2019	34	72	2.4	39,895	1,346.8	39,967	1,349.2
2020 (to 31 June)	40	34	1.4	19,916	789.9	19,950	791.2
Total NPV							**£5,298.8m**

Positive figures represent a reduction in the carbon costs to business due to the delayed uptake of abatement measures. All monetary values are discounted (2015 price base).

The high scenario implies higher costs than the central scenario due to the difference in forecast traded cost of carbon.

8.3 Environmental Impacts

The following sections cover the environmental impacts. Section 8.3.1 assesses the damage costs associated with SO_X NO_X, while section 8.3.2 covers CO_2 costs.

8.3.1 Damage Costs of Emissions

A change in air quality pollutant emissions is estimated as a result of the TNP. This can be attributed to the change in the uptake of abatement technology being required for a number of LCPs, compared to what is applied to comply with ELVs.

The potential impact that may be realised, if the calculated SO_2, NO_X and PM emission changes are achieved, have been valued in line with best practice as set out in Green Book Supplementary guidance[35]. While the Impact Pathway approach was considered the damage cost approach as deemed more appropriate, particularly as the environmental impacts are marginal in comparison to the other impacts assessed in this document.

The table below provides an overview of the damage costs used in this assessment. For PM, it should be noted that two different damage costs have been applied, depending on the emission source. For LCP emissions, the "PM ESI" damage cost has been used; and "PM industry" value has been applied to emissions from Iron & Steel, other industry and petroleum refineries.

Table 2 – Air quality damage costs per tonne

Damage Cost Valuations (£/tonne)				
Year	**SO_X**	**NO_X**	**PM Industry**	**PM ESI**
2016	1,953	2177	30,180	2,902
2017	1,993	2221	30,783	2,960
2018	2,032	2265	31,399	3,019
2019	2,073	2310	32,027	3,080

35 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197893/pu1500-air-quality-greenbook-supp2013.pdf

2020	2,114	2356	32,667	3,141

http://www.defra.gov.uk/environment/quality/air/air-quality/economic/damage/

An indicative value to society of this change in emissions can be estimated through the application of damage cost functions. The results for each scenario are presented below.

Table 14 – Damage Costs of Emissions, central prices scenario

	Total emissions (tonnes)			Damage Cost (£)			
Year	**SO_2**	**NO_X**	**PM**	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	72,950	72,272	3,111	137.7	152.0	14.0	303.7
2017	61,895	63,119	2,843	115.1	130.8	12.0	257.9
2018	55,567	53,457	2,535	101.9	109.2	9.9	221
2019	36,452	30,997	1,844	65.8	62.4	7.9	136.1
2020	14,926	12,554	748	26.6	24.9	3.4	54.9
Total NPV				447.1	479.4	47.2	973.7

Sensitivity Calculations

The assumptions used in the sensitivity tests are covered in the section 12 on risks and assumptions. The key driver behind the differences across the scenarios is the relative price between gas and coal, which changes the activity levels of plants.

Table 15 – Damage Costs of Emissions, low prices scenario

	Total emissions (tonnes)			Damage Cost (£m)			
Year	**SO_2**	**NO_X**	**PM**	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	53,318	55,093	1,993	100.6	115.9	10.9	227.4
2017	47,394	50,420	1,814	88.2	104.5	9.1	201.8
2018	40,872	45,920	1,635	74.9	93.8	7.4	176.2
2019	12,178	13,711	676	22.0	27.6	4.7	54.3
2020	4,391	4,963	272	7.8	9.8	2.1	19.8
Total NPV				**293.5**	**351.7**	**34.3**	**679.5**

Table 16 - Damage Costs of Emissions, high prices scenario

	Total emissions (tonnes)			Damage Cost (£)			
Year	**SO_2**	**NO_X**	**PM**	**SO_2**	**NO_X**	**PM**	**Total NPV**
2016	72,699	72,687	3,384	137.2	152.9	14.8	304.9
2017	62,975	63,865	3,167	117.1	132.4	12.9	262.4
2018	57,095	54,133	2,846	104.7	110.6	10.7	226.0
2019	38,390	32,297	2,153	69.3	65.0	8.7	143.1
2020	19,182	16,027	1,072	34.2	31.8	4.3	70.2
Total NPV				462.5	492.7	51.4	1006.5

As can be observed in the tables above, the TNP represents an increase in emissions in all cases. It can be observed that for some years (e.g. 2016), the SO_2 emissions in the central scenario are slightly higher than those in the high scenario. This is a consequence of variation between the central and high case load factors underlying both the baselines and scenarios. Also, some plants do not need to fit abatement by 2020 in the central case scenario and are therefore modelled to also not fit it in the other years (2016-2019). As a result, the way that these plants will comply with the cap is by reducing their load factor which results in a lower emissions reduction than fitting abatement. However, these plants are projected to fit abatement in the high scenario, and therefore they are modelled to reduce emissions by more than in the central scenario (i.e. the final emissions are lower).

As mentioned above, there are different damage cost functions applied in the ESI and industry sectors, therefore when the emissions increase and the damage costs are totalled for all sectors it is possible to have an increase in emissions but a decrease in damage costs.

It is important when applying and interpreting damage cost functions to note that a number of impacts are not taken into account in the quantification; this includes impacts on ecosystems and cultural heritage. Therefore, the benefits estimated through the application of damage cost functions may be underestimated.

8.3.2 CO_2 Emissions

As all LCPs are in the traded sector the impacts are valued as financial (rather than as environmental) – see section 8.2.5. There is no global environmental impact as the quantity of emissions in the traded sector is fixed, and an increase by one segment of the traded sector (i.e. the UK) will not result in an increase in emissions in Europe overall (assuming trading occurs).

Within this context, the estimated increase in UK CO_2 emissions is presented here for transparency.

Table 17 – CO_2 Emissions, Central prices scenario

Year	CENTRAL SCENARIO
	tCO_2-eq
2016	53,332
2017	49,395
2018	45,364
2019	34,612
2020 (up to 31 June)	13,903

Sensitivity Calculations

The assumptions used in the sensitivity tests are covered in section 12 on risks and assumptions. The key driver behind the differences in the figures for the scenarios above is the price of CO_2 and the relative price between gas and coal.

Table 18 – CO2 Emissions, Low prices scenario

Year	LOW SCENARIO
	tCO_2-eq
2016	35,503
2017	32,480
2018	29,549
2019	11,637
2020 (up to 31 June)	4,130

Table 3 – CO2 Emissions, High prices scenario

Year	HIGH SCENARIO
	tCO_2-eq
2016	59,510
2017	56,352
2018	52,022
2019	40,256
2020 (up to 31 June)	20,096

9. COMPETITION ASSESSMENT

The competition assessment guidelines[36] set out four questions to establish whether a proposed policy is likely to have an effect on competition. In particular, the assessments need to establish whether the Transitional National Plan would affect the market by:

- Directly limiting the number or range of suppliers in the electricity, oil refinery, iron and steel and other manufacturing industry markets?
- Indirectly limiting the number or range of suppliers?
- Limiting the ability of suppliers to compete?
- Reducing suppliers' incentives to compete vigorously?

A brief summary of the four questions are presented in the following Table.

Summary of the Competition Test

Question	Response
Q1......Directly limiting the number or range of suppliers?	No
Q2...... Indirectly limiting the number or range of suppliers?	Yes
Q3...... Limiting the ability of suppliers to compete?	No
Q4...... Reducing suppliers' incentives to compete vigorously?	No

The TNP gives LCP's flexibility in meeting the IED requirements through providing installations under the TNP with gradual reductions in overall emissions rather than being subject to the IED ELV's that otherwise must be met by 2016. Participation in the TNP is optional for the LCPs where plants were first permitted before 27 November 2002 or for those where an environmental permit application had been made by that date and was put into operation within a year of that date. New operators are unable to enrol in the TNP and must meet the ELV requirements.

The TNP will increase the number of suppliers in the ESI, through reducing or delaying the number of plant closures that would have resulted through the requirement to meet the IED ELVs in 2016. Given this, the key impact of the TNP on competition, is that it will ensure industries benefit from greater competition and security in the electricity market.

The TNP may give a cost advantage to those opting to enrol in the TNP compared to those that will have to meet the ELVs. However, the impact of the TNP in deterring new entrants is unlikely to have a significant impact on the ESI, refineries and iron and steel LCPs due to other barriers to entry, that are likely to be more significant. One of the main barriers to entry in these sectors is from very high investment costs (e.g. infrastructure, network distribution etc.) and has resulted in these industries being dominated by larger multinational companies. The impact may be greater to some of the industries within the 'other' category where the barriers to entry may not be so significant. Within these industries, electricity is only one of several other inputs and any potential impact should be considered against an overall increase in electricity suppliers, which these industries will also benefit from. Therefore, this impact is likely to be minimal.

[36] Office of Fair Trading (2007) Completing competition assessments in Impact Assessments Guideline for policy makers. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191489/Green_Book_supplementary_guidance_completing_competition_assessments_in_impact_assessments.pdf

10. DISTRIBUTIONAL EFFECTS ON DIFFERENT SIZED FIRMS

Small and micro-businesses are thought to be burdened disproportionately by new regulations and all new regulatory burdens should be designed and implemented in a manner aiming to mitigate disproportionate burdens. The Better Regulation Framework Manual defines micro and small businesses according to staff head count. Micro-businesses are those employing up to 10 FTE staff members while small businesses employ 11 and 49 FTE staff.

LCPs considered under the assessment are plants that have aggregate combustion units greater than 50MWth and tend to be operated by large operators and businesses. Overall, the key sectors include the Electricity Supply Industry (ESI), Iron and Steel, Petroleum Refineries and others, including the chemical, pulp and paper, food manufacturing and manufacturing of cars amongst sectors. Most of the plants in these sectors tend to be owned by large businesses corporations with large staff numbers and are unlikely to fall under the definition of small or micro-businesses. Small operators which are likely to operate for less than 500 operating hours are not covered by the emission limit values and therefore would not be affected by the TNP or IED.

The assessment of the number and size of businesses likely to be affected was based on Dukes (2014) and the LCP inventory (2010 - 2012).The descriptions set out below reflect the number of LCPs within the LCP inventory, rather than the number of plants within the TNP.

10.1 Electricity Supply Sector

There are approximately 140 large combustion plants within the electricity supply sector operated by about 30 different companies, including E.ON, Centrica, AES, EDF and Rolls Royce amongst others. Overall the operators within these sectors tend to be large corporations employing tens of thousands of employees or large plant operators, for example Energy Power Resources Ltd with 201-500 employees and Drax Power ltd with 500 – 1000 employees. It is unlikely that companies operating in the electricity supply sector will fall into the small or micro-business category.

10.2 Refineries

The inventory indicates that there are approximately 54 combustion between nine refineries in the sector. Of these only 9 have opted for the TNP. The ownership of these plants is large multinational corporations, such as, Phillips 66, Ineos Manufacturing, Morzine Limited, Conoco Phillips, ExxonMobil, Total, and Valero Energy Corporation.

10.3 Iron and Steel Sector

There are 10 LCPs within this sector which are owned by Tata Steel Europe and Saharaviya both of which are large multinational corporations employing tens of thousands of individuals.

10.4 Other Industrial Sectors

A wide range of sectors appear on the UK LCP inventory including, chemical, pulp and paper, food manufacturing, manufacturing of cars, gas compressor stations and specialist utilities. A number of the plants are owned by large corporations (e.g. Jaguar, DS Smith, Millennium Organic Chemicals) employing thousands of individuals but there are also smaller corporations employing only hundreds of people, for example British Salt, who is estimated to employ less than 200. Despite this category having a more diverse range of employees it is unlikely that there are any corporations that fall under the small or micro-business size.

10.5 Cost impacts from the TNP

The table below shows the number of plants affected. LCPs considered in the analysis will not have the same level of cost savings as some plants will have to abate more than others.

Table 20 – Number of plants covered by the TNP

LCP Sectors	TNP Impact Low Scenario	TNP Impact High Scenario
ESI		
No of plants that no longer are required to close due to the TNP 2016 – 2020 (up to 31 June)	27	26
% of total plants	19%	19%
Refineries		
No of plants that no longer are required to close due to the TNP 2016 – 2020 (up to 31 June)	2	2
% of total plants	4%	4%
Iron and steel		
No of plants that no longer are required to close due to the TNP 2016 – 2020 (up to 31 June)	2	2
% of total plants	20%	20%
Other		
No of plants that no longer are required to close due to the TNP 2016 – 2020 (up to 31 June)	23	23
% of total plants	18%	18%

11. SOCIAL IMPACT ASSESSMENTS

11. Distributional Impact on Households

Households are most likely to be affected by the TNP through energy prices, which make up a large portion of a households income. An ongoing concern in energy policy is that increases in energy prices may be regressive in nature (i.e. impact more on lower income households) as lower income groups spend a larger proportion of their disposable income on energy compared to higher income groups. An ONS study[37] estimated that the poorest fifth of households spent 11% of their income but the richest fifth spend 3%.

The TNP should reduce the cost of the IED over the duration of the TNP period (4.5 years) for the plants that participate in the scheme. This suggests that the benefits of the TNP are likely to be progressive in nature as a reduction in energy prices disproportionately benefits lower income groups. The actual impact on energy prices is difficult to quantify as it will depend on how much of the cost savings are passed on to households. The amount of cost savings passed on to customers are likely to be affected by the nature of the energy supply industry which is currently going through significant changes with the increase in renewable energy and greater connectivity with Europe. However, the TNP overall is not expected to have a significant distributional impact through affecting in the price of electricity.

With respect to the increase in NO_X, SO_2 and PM emissions, there is potential for lower income households to be more adversely affect than higher income households, under the assumption that residents in close vicinity of the plant are in lower income categories, given the low desirability of living near industrial sites. LCPs are mainly sited at large industrial installations and power stations in rural areas or on the edge of urban areas. Environmental permits normally require conditions (tall stacks, high exhaust gas temperature and velocity) which result in high dispersion (10s to 100s of kms) of air emissions. This high level of dispersion reduces the difference in impact of emissions between individuals living in close vicinity to the plant compared to those living further away. Therefore, higher income sub-urban and rural households are also affected by emissions from LCPs. Detailed dispersion, population concentration and household income profile mapping has not been undertaken in this study due to the large number of plants affected by the TNP and the uncertainty over the actions that individual plant would take.

11.2 Employment

The TNP will allow the plants within it to continue operating and thereby increase employment within the affected areas. It is assumed that under the IED there would be no job losses for refineries, iron and steel and other sectors as it is assumed that boilers which shut down would be replaced. Our analysis suggests that with the TNP in operation, significant number of ESI plants would no longer be required to close (approximately 20%) this may protect regional jobs if the plant are not replaced in the same region.

The TNP may result in a negative impact on the manufacturers and installers of abatement measures from the delayed requirement for meeting the IED ELVs. However, this impact is likely to minimal due to the TNP being operational for only a short period of time.

11.3 Statutory Equality duties Impact Test guidance

The impact of the TNP is not expected to have a material impact so therefore this has not been considered.

11.4 Health and well-being

The impact of the TNP is not expected to have a material impact on health and well-being, beyond the health impacts of the change in emissions to air quantified above using damage cost function, so further impacts have not been considered.

11.5 Human rights

The impact of the TNP is not expected to have a material impact so therefore this has not been considered.

11.6 Justice

The impact of the TNP is not expected to have a material impact so therefore this has not been considered.

[37] Office of National Statistics (2014) Full Report: Household Energy Spending in the UK, 2002-2012. http://www.ons.gov.uk/ons/rel/household-income/expenditure-on-household-fuels/2002---2012/full-report--household-energy-spending-in-the-uk--2002--2012.html)

11.6 Rural proofing

The impact of the TNP is not expected to have a material impact so therefore this has not been considered.

11.7 Sustainable Development

The impact of the TNP is not expected to have a material impact so therefore this has not been considered.

12. RISKS AND ASSUMPTIONS

12.1 Fuel prices

This modelling is sensitive to a number of assumptions and parameters. This section sets out some of the key sensitivities that have been considered and how they alter the results presented above.

The model is highly sensitive to the relative **fuel prices** of gas and coal. This is because the relative price affects the ratio of coal fired versus gas fired generation, which is significant as coal plants produce notably higher emissions than gas plants (particularly SO_2 and PM). As a result, in addition to the central estimate, two scenarios (low and high) have been included to illustrate this sensitivity, where relevant. All scenarios use DECC's fuel price projections. The low scenario represents an estimate where the relative price of coal compared to gas is low; and the high scenario uses a price projection where the relative price of coal is high.

The results are also sensitive to assumptions on abatement costs. This uncertainty reflects the variation between generic costs and the actual costs influenced by site specific factors, as well as general uncertainty associated with identifying costs from literature reviews and stakeholder consultation. To capture this uncertainty, we have applied a low and a high range of costs for abatement[38]. The low abatement cost has been applied in the low fuel price scenario/baseline and the high costs have been used in the high fuel scenario/baseline. This ensures the low and high scenarios present the extremes in possible outcomes. The abatement costs also reflect the most recent information at time of publication.

12.2 Consumer Surplus

A key benefit of the TNP is that it will improve consumer surplus – for both businesses and individuals.

Given the UK's electricity market is operating with limited spare capacity in the coming years, it is anticipated that in the electricity capacity reduction in the baseline is could cause some interruptions in supply and this could impact energy security and resilience[39], which would adversely impact consumer supply. The benefit to consumers of the TNP is that it reduces the risk of these interruptions materialising. But significant uncertainties prevent the estimation of this benefit, including:

- potential changes in electricity supply from e.g. existing (non-TNP) plants and imports; and
- potential changes in electricity prices.

To assess the potential significance of this impact on consumers, an indicative calculation was done using the evidence from supplementary Green Book guidance[40]. This guidance provides an estimate for the value users attribute to the security of electricity supply. Using this, the potential benefit of avoiding any such interruptions would be substantial. For example if under the baseline just 0.5% of the reduced electricity supply were to result in supply constraints then this would more than double the total benefits of the TNP.

While the abovementioned sensitivity provides a good indication of the size of the consumer surplus, the uncertainties meant that it is not suitable for inclusion in the central monetised figures. Further exploration into suitable methods and data would be disproportionate considering the current monetised benefits. This omission results in a potentially significant underestimate of the total welfare gained through the TNP.

12.3 Producer surplus

It is worth noting that this impact is slightly overstated in our current analysis. This is because our baseline assumes some plants that have indicated to be opting for the TNP would be required to close, if the TNP were not to be implemented. In reality, some plants will have the option of opting for the LLD instead (as described below). It is also possible that some may reopen in the final 2 years of the analysis, after installing the necessary abatement technology to be compliant. In addition to this, it is acknowledged that in practice market and policy reactions would be likely to provide some mitigation to the security of supply risks bought about by these closures, which could include increased

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[38] These values are based on LCP BREF, 2014, PB Power, 2014, AMEC MPMD

[39] The Green Book Supplementary guidance (Valuation of energy use and GHG emissions) advises that "A secure and resilient energy system is one in which supply and demand can balance at prices which are not excessively volatile. That is, physical interruptions to supply (which result in excess demand) and price spikes do not occur. Any policy that has a significant impact on the supply of or demand for energy or energy services, including by affecting the way energy markets function, could therefore affect the UK's energy security and resilience.

[40] London Economics –https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224028/value_lost_load_electricty_gb.pdf – Based on the weighted average of domestic and SME users in peak time of a weekday in winter, the report estimates a value of £16,940/MWh.

levels of operation by compliant plants and mothballed plant which can meet the required ELVs returning to the market in response to ensure security of supply; for example, the Supplemental Balancing Reserve (SBR) administered by National Grid. . However, it was deemed disproportionate to model these uncertainties, as these are not expected to have a significant impact on the overall cost benefit ratio presented in the current assessment.

There is also uncertainty surrounding the additional impact on revenue for other industry sectors. However it has not been included for two key reasons. Firstly, it is has not been possible to calculate the impact of closing plants (boilers/generators) would have on saleable products as the firm could have several reactions such as sourcing from elsewhere or replace with a new compliant boiler/generator. Predicting these reactions would be very uncertain. Secondly, the variety of products produced in other industry sectors with LCPs therefore to estimate the change in revenue from each individual type of product would be disproportionate.

12.4 Limited Life Derogation (LLD)

As part of this impact assessment DEFRA and DECC have approached operators to gather information on which of the derogations available under the IED they are likely to take. Along with the TNP, operators can also choose to opt for the LLD. The LLD allows a sub set of the plants in the TNP to commit to operating for a maximum of 17,500 hours and closing by the end of 2023. This creates an uncertainty for our analysis, not least because some operators may choose to use the full allocated hours (17,500) during the transition period, while others may spread their hours over a longer time period until 2023. This makes it difficult to assess how plant activity under the LLD would be different from the activity under the TNP. Overall, the decision on which derogation these operators will opt for will be based on a wide range of commercial and market considerations (including future energy and fuel prices, investment considerations etc.) and the information is highly commercially sensitive. Given this, the LLD option has not been considered under the modelling for this assessment, although future iterations may include this, if appropriate.

By omitting the LLD option, our analysis could be overstating the benefits of the TNP. Chiefly through overestimating the electricity created under option 1 compared to the baseline, as without the implementation of the TNP, some plants would still be able to operate in the baseline (using the LLD derogation) instead of closing.

To assess the potential impact of this omission, we have carried out a sensitivity test. There are currently 18 LCPs that have the option of opting for either the TNP or the LLD. The majority (11) and the largest of these are ESI plants. These plants represent approximately 10,200MW of generating capacity, which is approximately 34% of total ESI generating capacity within the TNP (30,325MWe). We have assumed these plants frontload their activity (17,500 hours) during the four years of the TNP, which means plants will be using approximately 25% of their hourly allowance for each year.

In our sensitivity test, we removed the plants with an option for LLD from the TNP revenue calculation. This resulted in lower revenues (-£5.1bn) and fuel costs (-£1.2bn) and a lower total producer surplus (-£3.9bn). However, if these plants were not in the LLD, it should, overall, lead to an approximately proportionate decrease in benefits (revenues) as well as costs. To reflect this, we have adjusted the costs (emissions, EU ETS, administration costs) down by 34%. Using these adjustments resulted in a central NPV calculation of approximately £2.8bn (compared to the current estimate of £5,813.5m).

This is based on an assumption that on an aggregate level, there would not be a significant difference in activity for these plants, whether operating under the LLD or the TNP. We have tested this assumption in our modelling as well as with experts.

In practice, it is unlikely that all of the plants that have the option of the LLD will choose it, as our analysis suggests some plants achieve a lower load factor in the TNP than the LLD. Given this, the sensitivity above represents the upper bound estimate of this impact. It should also be noted that, unlike the other costs, the abatement costs were not adjusted down, as there is greater uncertainty about what plants would do in the absence of a TNP. Taking this conservative approach, leads to an overestimation of these costs in our test.

It is also important to note that our assessment does not consider the medium and longer term impacts of closures that would result from plants opting for the LLD. If the absence of the TNP leads all 18 plants to opt for the LLD, then this could have a significant adverse impact on the UK's energy security and resilience.

12.5 Trading of air pollutant emissions

A detailed assessment of trading is not modelled. It was deemed disproportionate to develop the methodology further given that evidence from the NERP suggests plants are often not willing to trade with competing operators in practice. Also our analysis is understating the benefits; therefore any further analysis would only serve to reinforce the current conclusion of the overall impact of the TNP.

Assumptions around trading are as follows. The LCPs that cannot meet the TNP emissions cap are assumed to either install abatement or to trade the air pollutant emissions allowances for NOx, SO_2 and PM until they are compliant. LCPs in the Electricity Supply Industry (ESI) are assumed to also have the additional flexibility of reducing the load factor given that for the ESI, electricity is the final output. For other industries, this is more difficult. Most of the LCPs in the industry sectors are boilers producing heat. These plants are sized to meet a particular heat demand required for the production processes therefore it is less easy to reduce activity rate, and they are more likely to install abatement instead.

It is assumed that the cost of trading is the same as the cost of the alternative action that would be required in order for plants to comply with the TNP in that year. That is, the cost of air pollutant emission allowances is assumed to be equal to the cost individual plants would incur from installing abatement, or reducing plant activity[41]. Therefore, in the modelling there is only differentiation between the decision to fit abatement or to reduce load factor.

Overall, the approach in the assessment presents a conservative estimate of the net benefit of trading. If there are a significant number of air pollutant allowances in the market, it is possible the price would be lower than the cost of installing the abatement measures, or reducing activity. If operators choose to buy pollutant allowances instead of reducing activity or installing abatement technologies then emissions levels and environmental damage will be understated in our analysis. Emission levels and environmental costs would be understated more if trading is chosen over abatement technology installation as uptake of abatement often leads to an overshoot of the required emission reduction.

The income to sellers of surplus allowances is not included in the results because if trading does not occur then this income would not be realised; if it does, then this would be a transfer between plants.

It should be noted that previous experience with similar markets suggests that there will not be substantial trading activity in practice. The predecessor to the IED TNP, the LCPD National Emissions Reduction Plan (NERP) also allowed for trading of NOx, SO_2 and PM allowance between LCPs. Under the LCPD NERP although there has been trading, this has been limited and large surpluses have remained at the end of each year which indicates that perfect trading has not occurred[42]. The market provided under the NERP is not a transparent market and the price of trades is not known other than to the seller and buyer of the allowances. The TNP is expected to continue on this basis and the lack of transparency and high uncertainty over the allowance price makes reliance on trading a high risk option for operators. Informal consultation with a selection of operators has also suggested that operators would consider transferring allowances between co-owned LCPs if possible. Given that the TNP has not been finalised and published yet, operators are not expected to rely on trading alone for compliance, particularly in the early years.

12.6 Funding costs

Given the size of the businesses that operate LCPs, the additional financing costs of the capital necessary for TNP compliance (abatement technology) is expected to be funded through internal resources.

Depending on how operators choose to fund the additional costs of the TNP, the financial impact could vary between 0 (share issue) and 5.6% (highest estimate from OFGEM).

The table below presents the cost of abatement technologies. The first column provides nominal cost while the second column adjusts the cost for 5.6% (compound) interest rate in each scenario. The final column subtracts the first two columns, to assess the cost of funding (the additional cost of interest).

£m,	Abatement Technology	Cost at 5.6% Interest	Funding cost

[41] This is on the basis that the total emission cap is lower than total emissions would be if LCPs were to continue under current conditions. This means that some LCPs will need to install abatement measures or reduce operation in 2016. In each subsequent year the cap reduces and therefore more abatement measures need to be installed or plants will need to reduce their activity further. Therefore the trading prices remain the same as the alternative action as the supply (caps) and demand fall at the same rate until the TNP ends.

[42] https://www.gov.uk/government/publications/national-emission-reduction-plan-nerp-quarterly-register

NPV			
High	1,115.44	1,464.75	349.32
Low	231.41	303.88	72.47
central	680.88	894.10	213.23

These costs will represent a relatively small proportion of the producer surplus gains of the TNP as well as the total running cost. To illustrate this, the following table shows the expected expenditures on running costs (fuel, Co2 compliance and administration costs) and producer surplus.

m£, NPV	Fuel costs	CO_2 compliance costs	Administration cost	total running costs	Producer surplus (profits)
High	5,549.56	5,290	0.8	10,840.45	19,080.04
Low	51.06	0	0.8	51.86	6,769.00
central	4,520.79	834	0.8	5,355.13	12,823.13

The table below compares the cost of funding as a percentage of the figures above.

m£, NPV	Funding cost	Funding cost as a percentage of running costs	As a percentage of producer surplus
High	349.32	3.22%	1.83%
Low	72.47	139.75%	1.07%
central	213.23	3.98%	1.66%

The funding in the low scenario could be seen as significant in comparison to the running cost (139.8%), however it should be noted that this result low projected fuel costs and the absence of CO_2 compliance costs. However, in this scenario, the funding costs represent the lowest percentage of the producer surplus (1.07 %) and overall in comparison to the size of these businesses, the cost of funding these investments is small.

As the additional funding cost for abatement technologies does not represent a significant cost to operators and as it is uncertain exactly how operators will fund this, this assessment has applied a social discount rate of 3.5%.

12.7 NO_2 health impact uncertainty

Evidence on the health impacts associated with ambient NO_2 concentrations has strengthened significantly over the past few years. While uncertainties remain, there is now stronger evidence that NO_2 plays a causal role. To reflect the current evidence (September 2015), the analysis has been based on recent advice from the Committee on the Medical Effects of Air Pollutants (COMEAP), which is an independent expert advisory committee of the Department of Health that advises the government on the impact of air pollution.

In line with this, for the central damage cost figure it is assumed that for each 10 $\mu g/m^3$ reduction in exposure to NO_2, the mortality of an exposed population is reduced by 2.5%. In addition to this, the damage cost reflects the direct health impact of exposure to the formation of secondary particles and it is also adjusted for overlap with the impact of PM on health.

However, as uncertainty still remains around the impacts of NO_2 and COMEAP[43] recommended two alternative coefficients (1% and 4%) to the central (2.5%) coefficient. The table below shows the impact of these coefficients on the NPV calculation, along with the relevant associated damage cost per ton. As the results show, the

2015 Prices	low (1%)	Central (2.5%)	high (4%)
Damage cost per tonne (NOx)	£1,256	£2,134	2.923
Total NPV	5,100,000,000	5,600,000,000	5,800,000,000

[43] Uses figures from 12 September 2015 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460398/air-quality-econanalysis-damagecost.pdf

12.8 Other Risks, limitations and uncertainties

- There is significant uncertainty over operator decisions with respect to possible reduction of load factors in order to delay the installation of abatement measures. There are many other considerations beyond the IED that operators would factor in to such decisions, such as other regulatory drivers, contracting arrangements, electricity prices and expectation of actions of competitors.
- There is uncertainty over the LCPs included in the TNP as the UK's TNP plant list has yet to be finalised[44].Furthermore, operators which have already made a declaration that they wish to make use of the LLD option have the option to choose the LLD, and withdraw from the TNP at any time until 31 December 2015. The impact of the LLD is not being assessed in this study and so such an option has been assumed not to be available. The impact of this uncertainty is relatively high as plants expecting to opt of the LLD would not be expected to install abatement measures.
- We do not take account of the potential that plants may close during the TNP period or immediately after it. This could result in an underestimation of abatement cost savings in these cases as such plants would not need to install technology. However, it could also lead to an underestimation of the revenue gains.
- There is some uncertainty over the uptake of abatement measures for gas turbines, so the forecast NO_X emissions for these plants may be a slight under or over estimated. The impact of this uncertainty is relatively small and it should be noted this is in line with the assumption used for the previous studies (AMEC, 2012) which were made available to operators to comment on.
- A key assumption made in the analysis is that in the absence of the implementation of the TNP, all plants that do not meet the IED ELVs would be required to close. Our analysis does not assess the impacts of any secondary effects or reactions to these closures (e.g. short term investment in other technologies, such as renewables, entrance of new plants, the cost of importing electricity to meet electricity demand, the impact it may have on energy prices). Therefore the results should be interpreted in light of these caveats.
- Familiarisation costs have not been included in the assessment as the IED was adopted in November 2010; therefore consideration of the options (TNP or LLD) would have occurred prior to the assessment period.

Assumptions and Uncertainties

In addition to the uncertainties and assumptions outlined above, the following table provides a summary of the assumptions that have been made in this assessment and an indication of the associated uncertainty.

Assumption	Associated uncertainty
TNP: It has been assumed that all plants in the TNP list provided by Defra will remain in the TNP throughout the full period.	The impacts may potentially be slightly overstated if some of these plants are rejected from inclusion or chose not to remain in the TNP before 31 January 2015.
TNP emission caps: It has been assumed that the caps calculated for each plant in the TNP list provided by Defra are the caps that will be imposed for each plant.	The UK's TNP has yet to be approved by the European Commission and finalised, therefore the caps could be revised up or down for some plant.
Load factors in electricity generating plant: DECC has provided plant by plant load factor projections for application in this study. More information on the assumptions behind DECC LF modelling is presented in DECC,	The modelled Load Factors (and consequently the projected AQ emissions) are highly sensitive to the relative fuel prices of gas and coal. This is because the relative price affects the ratio of coal fired versus gas fired generation, which is significant as coal plants produce notably higher emissions

[44] The list of plants has been updated since consultation to reflect new plants joining and some plants opting out of the TNP

Assumption	Associated uncertainty
2012, DECC Dynamic Dispatch Model (DDM) Assumptions.[45] DECCs LF modelling does assume a small number of plants opt for the Limited Life Derogation, therefore for this assessment the LFs for these plant have been adjusted to align with other similar plant to exclude the impacts of the LLD. DECCs LF modelling does not include plant in Northern Ireland, therefore LFs for these plants have been assumed by aligning with other similar GB plant.	than gas plants (particularly SO_2 and PM). To reflect the uncertainty associated with forecasting of future activity each scenario has been assessed using one set of load factors based on a low energy price forecast and one set of load factors set on a high energy price forecast.
Activity projections in iron and steel, refineries and other sectors: Central case forecasts for activity have been used from the NAEI (Ricardo-AEA, 2014) for 2015 and 2020, with linear extrapolation for intermediary years.	Future activity rates in these sectors could potentially be higher or lower than projected and therefore plant in these sectors may need to take more or less action to comply with the emission caps. Therefore the impacts attributed to the TNP in this assessment could be over or understated for these plant.
Fuel mix: It has been assumed that the fuel mix for each individual plant does not change between 2012 and 2016.	A change in fuel mix can affect emissions and emission concentrations and therefore the modelled compliance response in the baseline and the scenarios may be different to what would actually be required if an individual plant does change fuel mix.
Business as usual abatement: It has been assumed for most plants there is no uptake of emission abatement measures between 2012 and 2016. The exception is CCGT plant in the electricity generation sector for which some uptake of abatement is expected to be required for plant to comply with LCPD emission limit values. Assumptions have been made for which plant would take action and what measures would be fitted. The LCP BREF is yet to be finalised and adopted. Once adopted it may impose more stringent emission concentration limits based on BAT-AELs in plant permits. This could potentially remove the flexibility of the TNP for certain plant.	Projected emission concentrations used in the baseline and projected absolute emissions used in the scenarios, and consequently the impacts identified, may be over or understated for plant where BAU measures are different to assumed.
Baseline: The baseline scenario assumes all plants that have indicated to be opting for the TNP would otherwise have to comply with the IED[46] ELVs from 2016. As a result of this, the plants that cannot currently meet	Based on advice from our consultant, DECC and the Energy UK, this is currently our best assessment.

[45] Available from: https://www.gov.uk/government/publications/dynamic-dispatch-model-ddm

[46] More stringent ELVs may apply for individual plants due to the requirement to comply with BAT-AELs in the LCP BREF. However, the LCP BREF is still at draft stage (not finalised or adopted) and in our modelling would have no effect on the baseline.

Assumption	Associated uncertainty
the IED ELVs (around 50%) are required to close to avoid being penalised for non-compliance.	
Cost of trading: It has been assumed that if trading of emissions occurs, to enable individual plants to meet their cap without taking other actions, it will be at an equivalent cost to the action that would otherwise need to be taken (abatement or reduced load factor) for an individual plant to be compliant with the TNP cap.	The impacts of this are covered in detail in section 12.2.
Abatement efficiency: The referenced sources used to collate information on abatement measures show a range of abatement efficiencies (percentage emission reduction) for many of the measures. The mid-point of the range has been used for this assessment.	The actual abatement efficiency of the measures could be higher or lower depending on site specific features. Therefore the selection of abatement measures, and consequently the cost incurred by the plant, and the abatement reduction achieved could be higher or lower than indicated in this assessment.
Emission reduction: Once abatement is fitted it is assumed that the abatement efficiency is the average efficiency for the measure even if the plant only requires a lesser reduction for compliance. i.e. if a reduction of 60% is required and the selected measure on average achieves a reduction of 80%, then the 80% reduction is modelled.	For certain abatement measures it can be possible to alter the design and installation of the measure to tailor to the specific reduction required, potentially with an associated cost saving. Therefore the emission reductions and the costs in this assessment may be overstated.
Abatement uptake: It has been assumed that if an emission reduction of less than 10% is needed that improvements and modifications could be made to the existing equipment for minimal cost and that take up of other abatement measures would not be required.	Some plant may already be optimised and therefore would require abatement to be fitted even for an emission reduction of less than 10%. Therefore the impacts of this assessment may be understated.
Lifetime: No consideration has been given to the remaining lifetime of the plant when selecting abatement measures (or in the combined scenarios whether plants would opt to reduce their load factor or fit abatement).	It is unlikely that plants nearing the end of operating life would make a significant investment in new technology for emissions abatement. It is probable that if the LLD option is not available some plant would close rather than meet the IED ELVs (in the baseline and at the end of the TNP) and therefore when in the TNP would be more likely to restrict load factor or trade than fit abatement. This could mean that the abatement cost savings presented and the loss in revenue are understated and the emissions increase is overstated.
Producer surplus calculation: It is assumed that the producer surplus plants make is equal to the difference between the cost of inputs (fuel) and price they receive for outputs (i.e. the wholesale price of	Non-ESI firms may have different impacts on producer surplus to those in the ESI sector. However, as these are a relatively small proportion of firms and energy production, and calculating the producer surplus in such diverse industries would be very complex, it was not considered

Assumption	Associated uncertainty
electricity).	proportionate to do so.
Consumer Surplus: We judge this to be the key benefit of the TNP to consumers – both businesses and individuals. However, it has not been possible to monetise the impact given the lack of available evidence on the value consumers place on energy beyond the price they pay. Equally, further research would be disproportionate given the current monetised benefits. However given the importance of energy supply to e.g. business operation/ consumers of ensuring homes have electricity, it is likely that the consumer surplus is substantial.	Under the conservative assumption that consumer surplus equals producer surplus, the benefit cost ratio would increase from 3.5:1 to 7:1.
Administrative costs: It has been assumed that the cost incurred by the regulator processing a permit variation will be passed on to operators as a fee.	
The results are presented on an aggregated basis: Although the assessment has been performed on a plant by plant basis, results are only presented on an aggregated basis (by sector and total) to level out uncertainties across individual plant assumptions for activity (load factor), site specific conditions and costs. In several cases, the overall results are significantly influenced by a relatively small number of plants. For some parameters under some scenarios the results for individual plants can be the opposite to the net results for the assessment, i.e. if net results show an increase in costs, the impact on individual plants may differ.	

13. CONCLUSION

If the Transitional National Plan (TNP) is not implemented, plants would have to be compliant with the Industrial Emissions Directive (IED) Emission Limit Values (ELVs) by the start of 2016 or would be required to close. Around 50% of all plants are currently not compliant, and therefore would need to close.

The monetised costs reflect the activity of the plants under the TNP. This will lead to additional air pollution valued at £973.7m. The running costs include fuel expenditure (£4.5bn), investment in abatement technologies to lower air pollution (abatement technology, £680.8m), CO_2 emissions being offset through the EU Emission Trading Scheme (EU ETS, £833.5m) and administration costs of the scheme (£0.8m).

The benefit of the TNP largely reflects a part of the social value of the output of these plants over the period of the TNP. The monetised value is calculated based on the level of increased supply and consumption of electricity valued at the expected marker price. Our central estimate is that producer surplus will increase by £8,152m due to the TNP.

The net benefit to the UK of the TNP, is estimated to be £ £5,813.5m. Although there are also a number of non-monetised benefits that are not included in this figure (notably increases in consumer surplus and wider economic impacts), which makes this a conservative estimate.

Annex 1: Glossary

LCP: Large Combustion Plants - Combustion plants with a rated thermal input equal to or greater than 50 MW, irrespective of the type of fuel used (solid, liquid or gaseous).

IED: Industrial Emissions Directive –EU directive which sets ELVs for all LCPs to meet by January 2016 (see section 2.2)

ELVs: Emission Limit Values - emission concentration limits negotiated under the IED. (See section 2.3)

ESI: Electricity Supply Industry

TNP: Transitional National Plan – a derogation of the IED which allows plants more time to reach the IED ELVs. This is the consideration of this IA (see section 2.4)

LLD: Limited Life Derogation – a separate derogation of the IED (not considered in this IA) which allows plants to continue operating until 2023 without installing the abatement technologies necessary to reach the IED ELVs (see section 2.5)

NERP: National Emission Reduction Plan, part of the Large Combustion Plants Directive, a predecessor to the IED

EU ETS: EU Emissions Trading Scheme – cap and trade scheme for GHG emissions covering power stations and other combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp, paper and board. All LCPs are covered by the EU ETS.

Abatement Measures: Technological installations which lower emissions of large combustion plants. These can take 3-4 years to install

Air Pollutant Emissions Allowances: The allowances of SO_2, NO_X, and PM granted for trading under the TNP

Environmental Permits (permits): Industrial Emissions Directive permits issued to large combustion plants by the Environment Agency

EU ETS Allowances: The CO_2 emission allowances which companies operating under the EU Emissions Trading Scheme buy or receive, which they can trade with one another as needed.

Load Factor: The activity rate of a plant i.e. the percentage of the maximum capacity that is used over a year.