Programme Area: Smart Systems and Heat

Project: EnergyPath

Title: EnergyPath Networks Methodology for Assessing Economic Impact of Local Energy Plan

Abstract:

This report provides detail of the methodology that has been developed to assess the economic costs and benefits of implementing a local area energy strategy and providing socio-economic indicators of a low carbon transition impact in a local area to key stakeholders. The methodology takes output data directly from EnergyPath Networks calculates indicative costs and benefits using HM Treasury (HMT) Green Book and Interdepartmental Analysts Group (IAG) guidance where appropriate.

Context:

Energy consultancy Baringa Partners were appointed to design and develop a software modelling tool to be used in the planning of cost-effective local energy systems. This software is called EnergyPath and will evolve to include a number of additional packages to inform planning, consumer insights and business metrics. Element Energy, Hitachi and University College London have worked with Baringa to develop the software with input from a range of local authorities, Western Power Distribution and Ramboll. EnergyPath will complement ETI's national strategic energy system tool ESME which links heat, power, transport and the infrastructure that connects them. EnergyPath is a registered trade mark of the Energy Technologies Institute LLP.

Assessing Socio-Economic Impacts of the Local Energy Plan

Title:	Assessing Socio-Economic Impacts of the Local Energy Plan
Reference Number:	(SS9010) ESC00065 Tool Kit Development Project
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Document Version	Date	Summary of changes	Approved by

1 Contents

2 Introduction

To sit alongside the technical transition elements of the Local Energy Plan (LEP), a methodology has been developed to assess the economic costs and benefits of implementing the plan. The methodology takes output data directly from EnergyPath Networks (EPN) and calculates indicative costs and benefits using HM Treasury (HMT) Green Book and Inter-departmental Analysts Group (IAG) guidance where appropriate.[1,2]

By using data directly from the EPN tool, the framework ensures the accompanying cost-benefit analysis is consistent with all assumptions made in developing the technical aspects of the LEP. For any run of EPN all the relevant data required for the socio-economic assessment will be contained in the EPN databases, this methodology will allow the user to point to the databases for their run of choice, and for an appropriate "reference case" run, and thus re-run the analysis for any run of choice, or "target run".

The methodology will produce an indicative net present value of the direct costs and benefits of the LEP via cost-benefit analysis of the following metrics:

- Energy savings
- Comfort taking
- Carbon savings
- Air quality improvement
- Costs of the transition.

Additionally, the methodology will also provide indicative figures for the potential employment and health benefits as a result of the LEP and the effect transitioning may have on the fuel poor.

3 Overview of Approach

The approach analyses the direct benefits of the transition at small geographic areas within the cluster, consistent with the analysis areas within EPN, which can then be aggregated up to Local Authority (LA) level. This granularity constraint is due to the modelling constraints of the EPN tool; improvements/upgrades to energy networks, for example, happen across an analysis area and so drilling down further than this, e.g. to a ward level, it would not be possible to attribute these costs to the correct location. In performing the analysis at this granularity it means that, although overall costs and benefits of the transition can be analysed, it is not possible to drill down to the benefits of specific interventions. The health and employment impacts can be analysed at this geographic level as well, however, for these benefits

[1] HMT Green Book guidance: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

[2] IAG guidance: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

presenting them at a LA level makes more sense. In order to analyse the effect of the transition on fuel poverty, we need to drill down and analyse the results at building level, this is possible, however again, but it is not possible to extract the effects of different interventions on fuel poverty levels. Although we can analyse the energy savings at a building level and we know in which way each building has transitioned, EPN associates costs and demand to a transition "pathway" for each building. This pathway may consist of both retrofit and heating system upgrades and so it is not possible to extract the benefits for one specific intervention, e.g. how ASHP installations may affect the fuel poor.

A reference case run is required in each instance to use as a baseline for any calculations. As the Local Area Energy Plan runs out to 2050 it is likely that, without intervention, the "Business-As-Usual" (BaU) scenario will look different in 2050 than the current day and so a reference case will account for this. In most scenarios the reference case will be the BaU of EPN, i.e. a run of the tool with no carbon target set, however, for analysis of some of the EPN sensitivity analyses, looking at how changing one variable may affect the solution, the base case, carbon target run, may be used as the reference case.

The method produces a multi-criteria analysis of the socio-economic impacts, for example presenting energy savings benefits in both energy (MWh) and monetised (£). In order to monetise these benefits the future cost of fuel, given the transition, also needs to be calculated. This document outlines all calculations used in the analysis, any assumptions made and details the source of any additional input data, although where possible all data is taken from EPN.

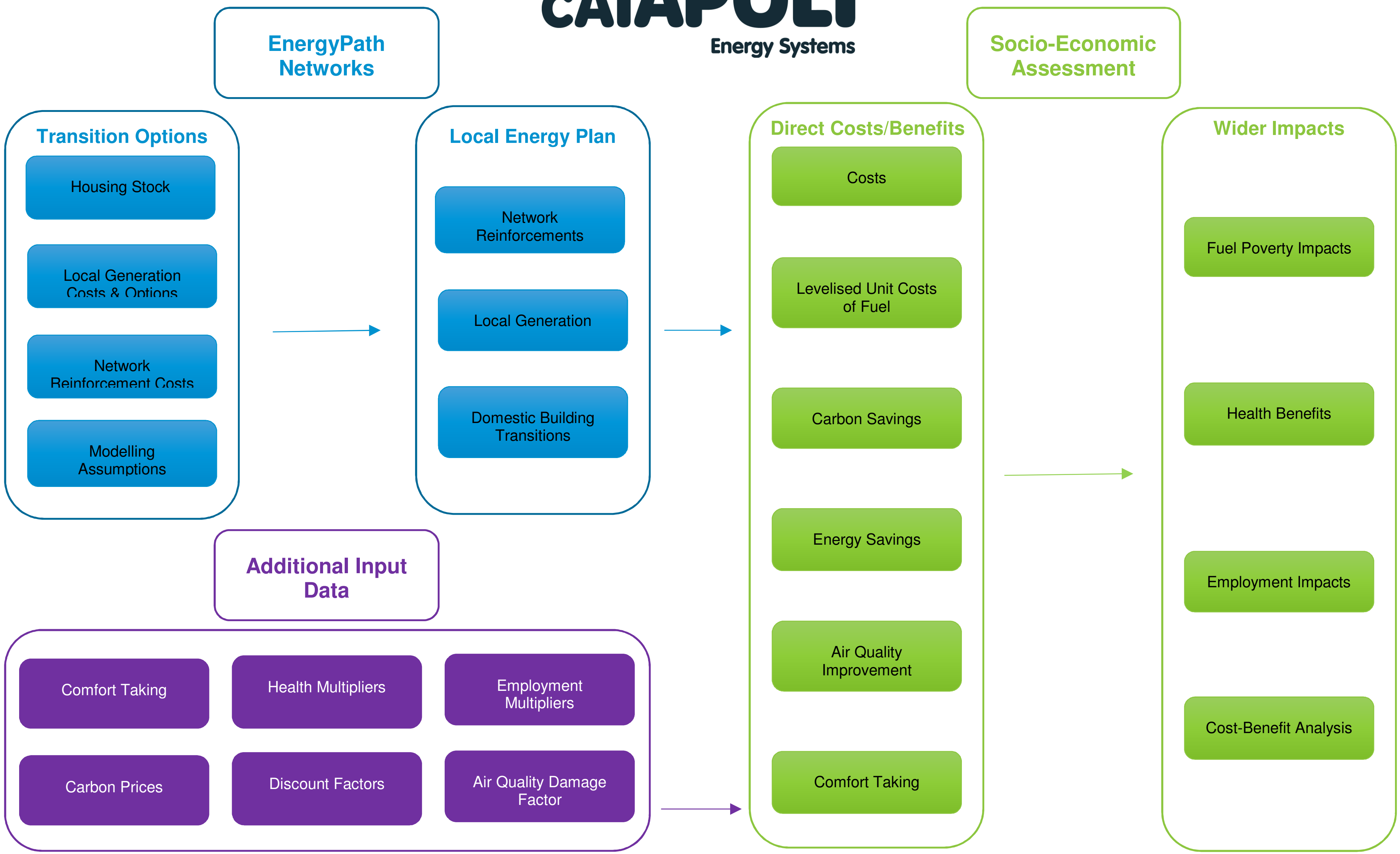

Figure 1: Overview of the framework for assessing socio-economic impacts of the Local Energy Plan

4 Discounting

The LEP runs out from present day (2015) to 2050, however, as values of costs or benefits in the future are not representative on the actual worth in the present day (due to inflation etc.) all[3] future costs and benefits are discounted to present day values. In accordance with Green Book supplementary guidance[4] the following long term discount rates are used:

- 0 – 30 years: 3.5%
- 31 – 75 years: 3.0%.

This results in discount factors for the time period as in Table 1 being used for each time period to convert values to present values, calculated using formula (1):

$$D_t = \frac{\sum_{n=i}^{j} \frac{1}{(1+r)^n}}{j-i} \tag{1}$$

Where
$t =$ time period
$D_t =$ Discount factor for time period t
$i =$ number of years ahead start year of time period (time period start - present day (2015))
$j =$ number of years ahead end year of time period (time period end - present day (2015))
$r =$ Discount rate

Table 1: Discount factors calculated using long term discount rates from Supplementary Green Book Guidance

Time Period	Discount Factor
2015 - 2024	0.86077
2025 - 2034	0.61022
2035 - 2044	0.43259
2045 - 2050	0.33293

[3] The calculation of economic impact does not discount the costs before applying the employment multipliers due to the nature of the calculation.

[4] Lowe 2008. *Intergenerational wealth transfers and social discounting: Supplementary Green Book guidance.* HM Treasury.

For the base assessment, the future value of carbon savings, evaluated with a carbon price, will also be discounted with the rates show in Table 1, however, as discounting can dramatically affect results, there is functionality within the methodology to test different discount rates, with functionality built in to test the flat rate of 1.4% as suggested in the Stern report.

5 Levelised Unit Cost of Fuel

For both the reference case and the target run a set of levelised unit costs of fuel needs to be calculated in order to monetise any energy savings for the cost-benefit analysis. As the LEP predicts how the energy networks will change overtime alongside the transitions of the domestic buildings, the costs of delivering this energy will also change. For each time period, the total costs of delivering each of the fuels (including any local generation) are summed and divided by the total energy delivered to give levelised costs for gas, electricity and heat. These costs are taken directly from EPN, socialised across the whole LA area and include:

- UK market price of energy[5]
- Annualised network (transmission & distribution) investment costs, including both new-build networks and network reinforcements (this includes a 3.5% cost of capital)
- Network operating & maintenance costs
- Annualised investment costs for local generation (excluding solar PV)
- Local generation operating & maintenance costs.

Any other resource costs (e.g. biomass or oil) are valued at the assumed UK market price, taken from the Energy Technologies Institute's ESME model[5], consistent with EPN input data. The presented costs are exclusive of any tax or profit for the energy suppliers, consistent with EPN, which presents results as, and minimises on, the total cost of the transition to society.

In the cases of energy centres which are producing both electricity and heat the costs of the energy centre and generation fuel need to be apportioned between the two products so as to be represented in the calculated costs. The apportioning is done based simply on the electricity to heat generated ratio. If an energy centre is producing waste heat in order to access generation electricity then this is counted towards electricity generation not heat.

An additional complication comes in the form of the cost of heat networks for the calculation of the levelised heat cost. When EPN decides to build a heat network it must build it for the

[5] UK market prices of energy are inputs to the EPN tool and taken from the Energy Technologies Institute's ESME model. ESME is a National Energy System Planning and Design Tool, which underpins and informs UK Government's future Energy Policies - see http://www.eti.co.uk/modelling-low-carbon-energy-system-designs-with-the-eti-esme-model/

entire analysis area in one time period[6], even if connections are spread out across further time periods. In order to avoid this modelling simplification skewing the costs of heat, the cost of building heat networks in each analysis area is redistributed according to the uptake of heat connections in that area. In this way, the heat cost is more reflective of the gradual spreading of the network which would take place in actuality.

$$F_{it} = \frac{\sum_j \left(\left[{}^{h_{jt}}/_{H_j} \right] I_{ijt} + O_{ijt} + M_{ijt} + {}^{G_{jit}}/_{\sum_i G_{jit}} \, L_{jt} \right)}{G_{it} + Z_{it}} \tag{2}$$

Where

F_{it} = Levelised unit cost of fuel i for time period t
I_{ijt} = Network investment costs for fuel i, in analysis area j and time period t
O_{ijt}
= Operating & maintenance networks costs for fuel i, in analysis area j and time period t
M_{ijt} = Market cost of importing fuel i, in analysis area j and time period t
G_{itj} = Local generation of fuel i, in analysis area j and time period t
L_{ijt} = Costs (investment and O&M) of local generation in analysis area j for time period t
Z_{it} = Total imports of fuel i in time period t
h_{jt} = Heat connections in analysis area j and time period t
H_j = Total heat connections (over entire time period)in analysis area j
[…] = Step for heat cost only

6 Energy Savings

Energy savings for a LA are calculated at an analysis area level as a total for each time period and then aggregated up to the LA level. As EPN considers only domestic heating and subsequent network level interventions to meet the designated carbon target, with non-domestic buildings, appliance and lighting demand and electric vehicle charging demand (collectively known as 'service demands') being exogenous inputs to the modelling tool, the energy considered is the total energy into each analysis area minus any service demands.

In this way, the methodology considers any fuel imported into the area (gas, electricity, oil, biomass, coal) which is used for domestic heating, either directly in domestic buildings or into energy centres to generate either electricity or heat. Generated energy itself is not included as this should be accounted for by the generation fuel and a reduction of imports in terms of electricity, with the same logic applying to both energy centres and solar PV. In this calculation we do not include heat as a vector, although it may theoretically be imported/exported across

[6] EPN presents its outputs in four different 'time periods' between now and 2050. Rather than assigning a specific year for interventions they are just said to occur within the time period and any costs/change in demand averaged across the time period. Time periods are broken down as follows: 2015 – 2024, 2025 – 2034, 2035 – 2044 and 2045 – 2050 (note how the final time period is shorter than the rest).

the analysis area boundaries, since heat is not exported outside of the study area, at a whole LA level, heat generated vs. consumed will balance out.

After calculating the energy savings for each area and for both the target and reference run, a comfort taking percentage is applied to the total energy savings value to reflect the fact that some households will utilise some of the energy saved to increase the level of comfort in their homes. The target run energy savings are then subtracted from the reference case savings to give total energy saved by fuel, analysis area and time period such that negative values are an increase in energy consumption.

The energy savings figure can be presented both in MWhs of energy saved and as a monetised benefit by using the levelised unit costs for each fuel, discounted to 2015 values as discussed previously. The full calculation can be seen in equation (3):

For each fuel type i and time period t:

$$\text{Total energy savings} = \sum_{j} \left((E^R_{tij} - S_{tij})(1-c)[D_t F^R_{ti}] \right) - \sum_{j=1}^{n} \left((E^T_{tij} - S_{tij})(1-c)[D_t F^T_{ti}] \right) \quad \textbf{(3)}$$

Where
$i =$ Fuel type $\in$ (Electricity, Gas, Coal, Oil, Biomass).
$t =$ Time period
$j =$ Analysis area
$E^x_{ij} =$ Energy consumed for fuel type i, in analysis area j, for the reference case ($x = R$) or target run ($x = T$) (MWh/time period)
$S_{ij} =$ Service demand for fuel type i in analysis area j (MWh/time period)
$c =$ Comfort taking (%)
$D_t =$ Discount factor
$F^x_{ti} =$ Levelised unit cost of fuel type i, in time period t for the reference case ($x = R$) or target run ($x = T$) (£/MWh)
[...] = Optional step for monetising energy savings

7 Comfort Taking

Comfort taking is the proportion of energy saved which householders retain and utilise in order to increase the level of warmth in their homes. We exclude this from the energy saved (as in equation (3)), however, increased levels of comfort and warmth in residents' homes is still a benefit to the LA as a result of the LEP and so is calculated as a separate metric.

A value of 15% is used as the percentage of energy savings which are utilised for increased comfort, this is consistent with the assumption used in Government impact assessments of retrofit energy efficiency improvements, e.g. the impact assessment of changes to Part L 2013.

This value can then easily be explored as part of the sensitivity analyses as discussed in Section 15.

The calculation of the benefit due to comfort taking is performed using the same logic as for the energy savings and can be produced in both MWh or £'s, but including the carbon taking fraction directly as in equation (4) (note: the carbon taking fraction is subtracted to produce net Energy Savings as in equation (3)).

For each fuel type i and time period t:

$$\text{Total comfort taking} = \sum_{j=1}^{n}\left(\left(E_{tij}^{R} - S_{tij}\right)(c)\left[D_t F_{ti}^{R}\right]\right) - \sum_{j=1}^{n}\left(\left(E_{tij}^{T} - S_{tij}\right)(c)\left[D_t F_{ti}^{T}\right]\right)$$

(4)

Where
$i =$ Fuel type $\in$ (Electricity, Gas, Coal, Oil, Biomass).
$t =$ Time period
$j =$ Analysis area
$E_{ij}^{x} =$ Energy consumed for fuel type i, in analysis area j, for the reference case ($x = R$) or target run ($x = T$) (MWh/time period)
$S_{ij} =$ Service demand for fuel type i in analysis area j (MWh/time period)
$c =$ Comfort taking (%)
$D_t =$ Discount factor
$F_{ti}^{x} =$ Levelised unit cost of fuel type i, in time period t for the reference case ($x = R$) or target run ($x = T$) (£/MWh)
[...] = Optional step for monetising comfort taking

We assume that when energy savings result in a cost rather than a benefit, i.e. when gas is displaced with electricity, a much more expensive fuel, that there is no comfort taking benefit – households are not likely to improve the level of comfort in their household if it is much more expensive. Indeed, the likelihood is that in cases when fuel is much more expensive consumers are more likely in fact to reduce the energy used in homes, for this reason we still apply the 15% reduction to the energy savings calculation. Therefore, equation (3) remains the same regardless, however in the event the monetised version of (3) < 0 then equation (4) will not be used and total comfort taking = 0.

8 Carbon Savings

Carbon savings for the LA are generated using similar logic to that for the energy savings, but then converted into carbon emissions using emission factors for each fuel. The energy savings (as in (3)) for each fuel type, analysis area and time period, are converted to tCO_2 emitted using the fuel emission contents from EPN. These emission contents are taken from ESME and change over the time period to reflect changes to the national energy system based on the ESME scenario chosen for the run. The values can then be presented either in tCO_2 saved or monetised for cost-benefit analysis using a discounted carbon price.

Carbon prices are from the latest IAG guidance and either "traded" for electricity to reflect the presence of a carbon market in the form of the EU ETS, or valued using a "non-traded" price for all other fuels. Values for the standard scenario can be seen in Table 2 but these can be varied using sensitivity analysis. The carbon price is discounted using a 3.5% discount rate as discussed in Section 4 but again this can be varied in sensitivity analyses, for example to reflect the 1.4% rate advocated in the Stern Report.

Table 2: Traded and non-traded carbon prices (£/CO_2) used to monetise any carbon savings benefit (source: IAG guidance[7])

Time Period	Traded/Non-traded	Carbon Price (£/tCO_2)
2015 – 2024	**Traded**	11.58
2025 – 2034	**Traded**	72.82
2035 – 2044	**Traded**	144.28
2045 - 2050	**Traded**	201.22
2015 – 2024	**Non-traded**	65.37
2025 – 2034	**Non-traded**	82.09
2035 – 2044	**Non-traded**	144.28
2045 - 2050	**Non-traded**	201.22

As with energy savings, the total energy used in the LA is first adjusted for comfort and service demand and then the carbon savings calculated from this value. The full calculation for the benefit of carbon savings is thus as follows:

For each fuel type i and time period t:

[7] Table 3 from supporting data tables 1-20.

$$\text{Total} = \sum_{j=1}^{n}\left(\left(E_{tij}^{R} - S_{tij}\right)(1-c)X_{ti}[D_{tc}C_{ti}]\right) - \sum_{j=1}^{n}\left(\left(E_{tij}^{T} - S_{tij}\right)(1-c)X_{ti}[D_{tc}C_{ti}]\right) \quad (5)$$

Where
$i =$ Fuel type $\in$ (Electricity, Gas, Coal, Oil, Biomass).
$t =$ Time period
$j =$ Analysis area
$E_{ij}^{x} =$ Energy consumed for fuel type i, in analysis area j, for the reference case $(x = R)$ or target run $(x = T)$ (MWh/time period)
$S_{ij} =$ Service demand for fuel type i in analysis area j (MWh/time period)
$c =$ Comfort taking (%)
$D_{tC} =$ Carbon discount factor
$C_{ti} =$ Carbon price of fuel type i (traded/non-traded), in time period t (£/tCO_2)
$X_{ti} =$ Emission contents of fuel type i, in time period t (tCO_2/MWh)
[…] = Optional step for monetising carbon savings

9 Air Quality Improvement

Additional to the direct benefits of energy savings and carbon savings there are also air quality improvement benefits which result from reductions in energy consumption. The IAG guidance provides p/kWh values for the air quality damage associated with different fuels and for different location types[8] (as listed in Table 3) - these are used to quantify the air quality improvements associated with the energy savings made as a result of the LEP. Electricity is not valued at this level as the generation of any imported electricity would not directly affect the air quality in the LA and any local generation will be accounted for in the generation fuel.

Table 3: Air quality damage factors for different fuel types and location types over the time period of the LEP (source: IAG guidance[9])

Time Period	Location Type	Gas Air Quality Damage (£/MWh)	Coal Air Quality Damage (£/MWh)	Oil Air Quality Damage (£/MWh)	Biomass Air Quality Damage (£/MWh)
2015 - 2024	**Inner Conurbation**	1.19	222.61	33.58	466.60

[8] Domestic air quality damage cost are given for the following location types: inner conurbation, urban big, urban medium, urban small and rural.

[9] Table 15 from supporting data tables 1-20.

2025 - 2034	**Inner Conurbation**	1.41	271.64	41.03	568.75
2035 - 2044	**Inner Conurbation**	1.72	331.13	50.01	693.30
2045 - 2050	**Inner Conurbation**	2.02	387.57	58.54	811.47
2015 - 2024	**Urban Big**	1.19	163.93	24.98	345.91
2025 - 2034	**Urban Big**	1.41	199.49	31.13	421.61
2035 - 2044	**Urban Big**	1.72	243.17	37.94	513.94
2045 - 2050	**Urban Big**	2.02	284.62	44.41	601.54
2015 - 2024	**Urban Medium**	1.19	104.31	15.17	219.03
2025 - 2034	**Urban Medium**	1.41	127.33	18.39	267.40
2035 - 2044	**Urban Medium**	1.72	155.22	22.42	325.96
2045 - 2050	**Urban Medium**	2.02	181.67	26.24	381.51
2015 - 2024	**Urban Small**	0.00	65.12	9.44	138.36
2025 - 2034	**Urban Small**	0.00	79.23	11.32	168.36
2035 - 2044	**Urban Small**	0.00	96.58	13.80	205.23
2045 - 2050	**Urban Small**	0.00	113.04	16.15	240.21
2015 - 2024	**Rural**	0.00	28.92	4.19	59.15
2025 - 2034	**Rural**	0.00	35.37	5.66	72.15
2035 - 2044	**Rural**	0.00	43.12	6.90	87.96
2045 - 2050	**Rural**	0.00	50.46	8.07	102.95

As can be seen in Table 3, the air quality values can vary greatly dependent on the location type. In order to accurately represent this, each analysis area will be evaluated using the air quality value most appropriate for that location. In order to decide which location type to use for each analysis area, the *Office for National Statistics dataset of Rural Urban Classification (2011) of Lower Layer Super Output Areas in England and Wales*[10] is used to define appropriate rurality across the LA, for example Figure 2. The net energy savings (i.e. adjusted for comfort) can then be converted into discounted air quality improvement benefits across the analysis areas using equation (6):

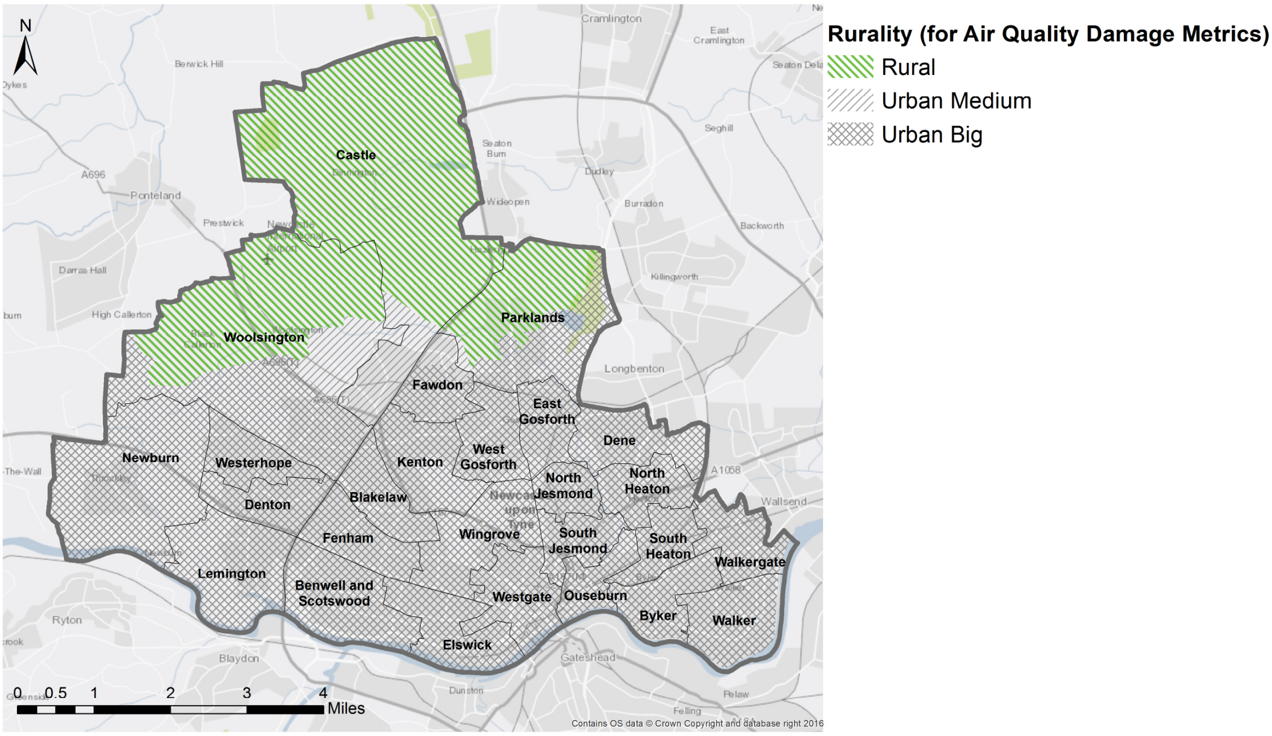

Figure 2: Example of how the LA should be broken down into different location types for assessing the air quality improvements of the LEP.

For each fuel type i and time period t:

[10] http://geoportal.statistics.gov.uk/datasets/9855221596994bde8363a685cb3dd58a_0

Total air quality improvement

$$= \sum_{j=1}^{n}\left(\left(E_{tij}^{R} - S_{tij}\right)(1-c)D_t A_{tij}\right) - \sum_{j=1}^{n}\left(\left(E_{tij}^{T} - S_{tij}\right)(1-c)D_t A_{tij}\right)$$

(6)

Where

$i =$ Fuel type $\in$ (Electricity, Gas, Coal, Oil, Biomass).

$t =$ Time period

$j =$ Analysis area

$E_{ij}^{x} =$ Energy consumed for fuel type i, in analysis area j, for the reference case $(x = R)$ or target run $(x = T)$ (MWh/time period)

$S_{ij} =$ Service demand for fuel type i in analysis area j (MWh/time period)

$c =$ Comfort taking (%)

$D_t =$ Discount factor

$A_{tij} =$ Air quality damage factor of fuel type i, in time period t for analysis area j (for location type) (£/MWh)

10 Cost-Benefit Analysis

Cost-benefit analysis can be performed on the LEP using the previously calculated, monetised, benefits (energy savings, comfort taking, carbon savings and air quality improvement) and the costs of implementing the transition to give an overall net present value (NPV) of the transition.

The costs of implementing the plan for the target run are once again discounted and compared to the reference case. As the cost of any network reinforcement, network running costs, local generation and energy imports are accounted for in the calculation of the levelised unit costs of fuel, the cost of the transition in this instance is just the cost of installing any domestic interventions, i.e. changes to heating systems or retrofit installations. For assets with an economic life which stretches past 2050, the costs are adjusted to represent only the proportion of the asset's lifetime which is present during the LEP.

All these costs are taken directly from EPN outputs which include any regional adjustments where applicable (e.g. network costs will be specific to the network serving the LA) and any assumptions on future cost projections.

The costs for the target run are subtracted from the reference case run meaning that an increase in costs are negative values and a decrease in costs are positive values. These values are then summed with the benefits to give an overall NPV of the transition, either at LA level or for each individual analysis area.

11 Employment Impacts

The potential employment impacts of the LEP are evaluated separately from the calculated direct benefits and are included in addition to the NPV. The estimated impact of the transition covers both installation jobs for domestic interventions and new energy networks/reinforcements and additional maintenance jobs generated as a result of the interventions. The impacts are calculated using a broad approach of estimating the employment impact based on the amount of money spent. Using data from a range of studies estimating the employment impact of expenditure on domestic energy renovations[11], a value of 18 FTE per £m spent is utilised.

Money spent for this calculation is evaluated slightly differently than the overall costs of the transition calculated for the NPV. The money spent is again taken relative to the reference case but unlike the NPV calculations **does not include** the following:

- Any cost of capital associated with the LEP
- Any fuel/resource imports
- Any discounting.

With the inclusion of the reference case as the “baseline” for this calculation the effect of “deadweight” (any jobs which would have occurred anyway) is accounted for within the calculation. An adjustment does have to be made, however, for “leakage”, i.e. the proportion of generated jobs that would benefit those outside the LA’s area. A leakage value of 17.3% is used which is the sub-regional mean leakage value for capital projects as estimated by BIS[12].

Employment impacts are evaluated at the whole LA area, as, for this purpose, looking at an analysis area level would prove inaccurate and un-meaningful. The job impact can, however, be broken down by category/employment source and either by time period or transition (results of EPN come out in two “transitions” where interventions occur – as more “business-as-usual” transition towards the beginning of the plan and a “low-carbon” transition out towards 2050).

As part of the sensitivity analysis it will be possible to vary both the employment multiplier and the leakage percentage. If data were available, it would also be possible, with little modification to the source code, to define different employment multipliers for different costs categories, e.g. one for domestic interventions, one for network reinforcements and one for network operating and maintenance etc.

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[11] The following two studies provide summary statistics of the findings of a range of studies:
http://www.ukace.org/wp-content/uploads/2012/11/ACE-Research-2000-09-Energy-Efficiency-and-Jobs-UK-Issuesand-Case-Studies-Case-Studies.pdf
http://www.neujobs.eu/sites/default/files/publication/2013/01/Energy%20renovation-D14-2%2019th%20December%202012_.pdf

[12] BIS Occasional Paper No. 1: Research to improve the assessment of additionality:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191512/Research_to_improve_the_assessment_of_additionality.pdf

12 Health Benefits

The LEP will lead to a number of improvements to the housing stock within the LA, such as improved building insulation, more energy efficient and lower carbon heating, and upgraded energy networks. This will lead to an increased level of comfort due to housing that is warmer and less damp and air quality in the house should also be better as fossil fuels will not be used directly in the home. These factors should help to improve the health of residents who have existing medical conditions such as respiratory, cardio-vascular and circulatory problems, and also help to prevent new cases developing. This will lead to better health of the general population of Newcastle – this can be quantified using domestic energy savings as a result of retrofit or heating system interventions[13].

Energy savings are converted to *Quality Adjusted Life Years (QALYs)*, as recommended in the HMT Green Book. For each property type and fuel type, an average MWh/QALY value is derived using QALY per measure estimates from DECC's framework for future action on poverty and the respective energy savings of these measures. The calculated value of a QALY is then applied to the time period energy savings for each property and fuel type and then monetised using a value of £30,000 (the widely accepted monetary value commonly used in the healthcare sector), discounted to 2015 values as described in section 4. As with previous calculations the benefits for the target run are then subtracted from the reference case to give a monetised health benefit from domestic energy efficiency improvements as a results of the LEP.

13 Impact on Fuel Poverty

A key driver for LA's is the impact of any LEP on the fuel poor. A household is considered to be fuel poor, according to the *Low Income High Costs (LIHC)* definition, if they have fuel costs that are above average and, if they were to spend that amount, they would be left with residual income below the official poverty line. Although EPN can give an indicator of how fuel costs for a household may change over time, income levels are out of the scope of the tool. Therefore, it is not possible to accurately quantify the number of households who will leave or enter fuel poverty as a result of the LEP, instead the analysis tfocuses on how the cost of delivering energy to households may change.

The methodology considers how the energy demand for heating a household changes across the time period of the transition and, using the levelised unit cost of fuels, how the cost of delivering this energy to the household may change. As with the rest of the analysis, this calculation excludes any tax or profit which may apply to the price of fuel, due to the uncertainty of these over time.

Calculated energy demand is generated on a per household basis, as a result of any retrofit and heating system transitions; in some instances, there are two different, potential "pathways" a group of households may follow, in these cases the households are split, probabilistically,

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[13] Any energy savings as a result of solar PV installations are not accounted for in this calculation as these will translate to health benefits via comfort taking, not due to increased energy efficiency.

between the pathways. Similarly, solar PV is assigned within EPN as a m^2 value to an entire analysis area. This is broken down to a household level using an assumption of 15.6 m^2 per household and probabilistically assigning the panels to suitable housing. Using assumptions consistent with FIT, we assume 50% of this is exported back to the grid and 50% used in house, which is offset from the household demand. We also make the assumption that the households themselves do not benefit from the FIT payments. Any demand as a result of lighting and appliances is not included in this analysis as these are exogenous inputs to EPN and thus consistent across all runs.

Demand is then monetised, using the levelised costs for each fuel, on an individual household basis for both the reference case and target run, these are then subtracted from each other in order to quantify how the cost of delivering energy to that household may change over the duration of the LEP. As the analysis is performed at a household basis, properties whose energy delivery costs have changed (either reduced or increased) can then be mapped up to see how these properties correlate with the fuel poor.

In instances where the cost of energy delivery has increased, the value of this increase can be used to determine policies for any subsidies which may be required to ensure homes don't fall into fuel poverty as a result of the transition.

14 Additional Impacts not Included in Analysis

In addition to the socio-economic impacts discussed in this methodology there are also some potential impacts which are not considered/evaluated by this methodology. These are any incentive payments and balance of payment impacts.

As previously mentioned, EPN, and thus the LEP, considers the total cost to society of the transition (i.e. exclusive of any tax) and incentive payments. As these are transfer payments between two parties, the benefits of incentive payments are not included. This includes, but is not limited to, any of the following:

- VAT
- FIT tariffs
- RHI tariffs
- ECO funding.

Balance of payments impacts are not considered when assessing the impact of the LEP as these are not directly relevant at a LA level.

Additionally, no regional or social adjustments are made. EPN accounts for regional adjustments where applicable, for example the housing stock is LA specific, and costs are regional specific where necessary as previously mentioned. Social adjustments cannot be made in the methodology due to lack of data and the granularity (analysis area) of the methodology.

15 Sensitivity Analysis

Any economic analysis spanning out to 2050 is inherently uncertain by nature and then amplified by the uncertainty within the LEP itself; there are many potential pathways a LA could follow, with no one “correct” choice. To try and reflect this in the methodology the economic analysis should be performed on a range of EPN scenarios for any one LA, all results can then be presented as an average with a range of +/- one standard deviation across the runs. In presenting the results in this way, as a range, the analysis will capture the uncertainty in the future energy system

Additionally, part of the functionality of the methodology allows for sensitivity analyses of the economic specific parameters to be easily performed. The methodology allows for certain sensitivities to be performed as standard, alongside the base assessment, these include testing the impact of:

- Carbon price (high & low)
- Stern carbon discount rate of 1.4%
- Employment multiplier

These sensitivities, however, are likely to vary the results in a much more predicable way than performing the analysis on a range of the EPN sensitivities. For example, in increasing the carbon price used then the carbon savings only will increase or reducing the employment multiplier will result in a direct reduction in the estimated number of jobs created.

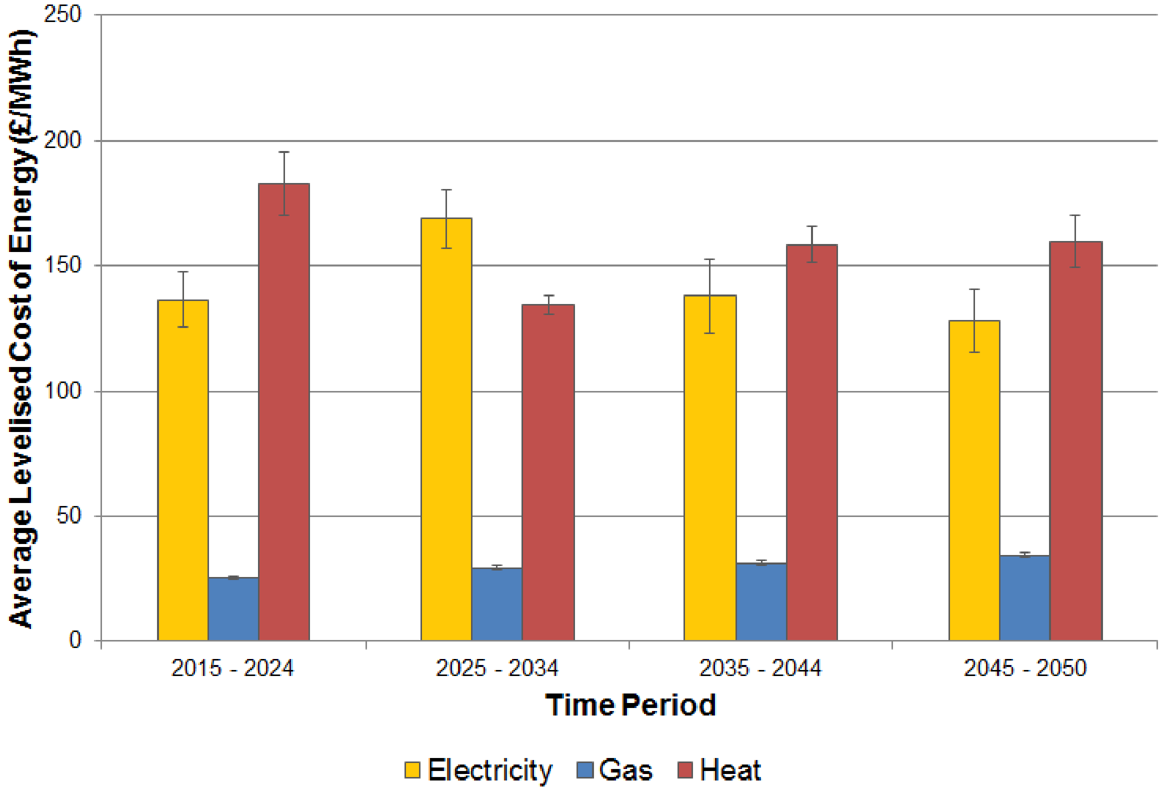
On top of these “built-in” sensitivities the methodology also allows the user to add additional sensitivities for any of the defined parameters discussed in this methodology (e.g. profit proportion for fuel poverty, assumed solar exports, overall discount rate etc.), allowing for a wide range of uncertainty to be estimated. In a similar way, it will also be possible to vary any number of these parameters for a Monte Carlo sensitivity analysis if required.

16 Example Outputs - Economic Analysis of the Local Energy Plan for Newcastle City Council

The following contains results of the economic analysis of the Newcastle City Council (NCC) Local Energy Plan (LEP). The results are average values calculated from a variety of different EPN sensitivity runs for the NCC area. This includes: the NCC “base run”, all 100 Monte Carlo simulations where inputs costs have been varied simultaneously and a series of different runs varying the import price of energy into NCC, all with their relevant reference runs (business as usual runs). All values are presented as an average value with a range of +/- one standard deviation across the sensitivities.

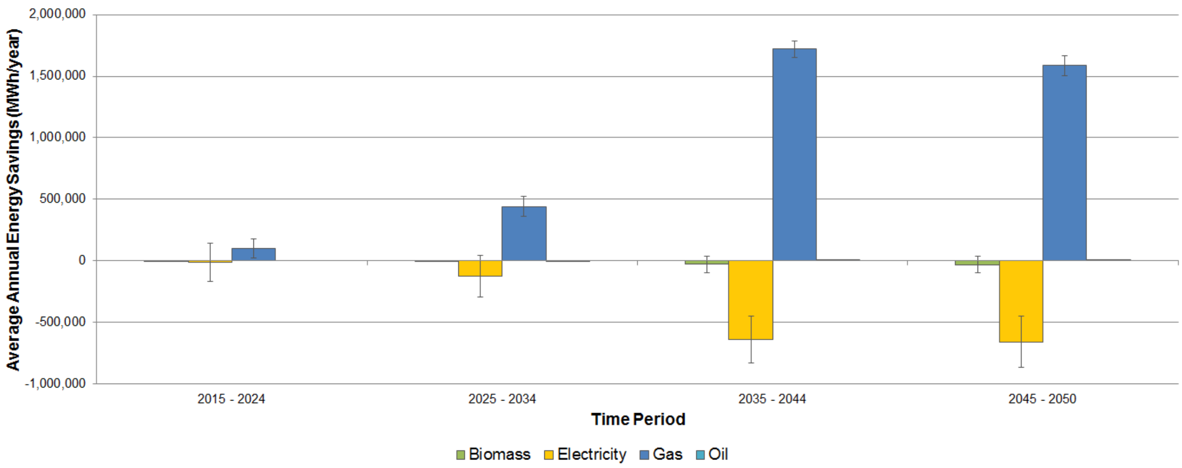
16.1 Levelised Unit Costs of Fuel

Average calculated levelised unit costs of fuel (£/MWh) as a result of the LEP:

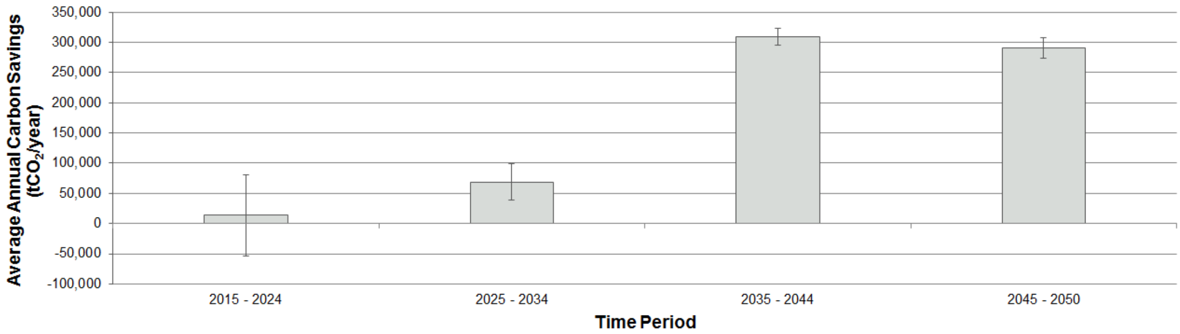


16.2 Direct Benefits

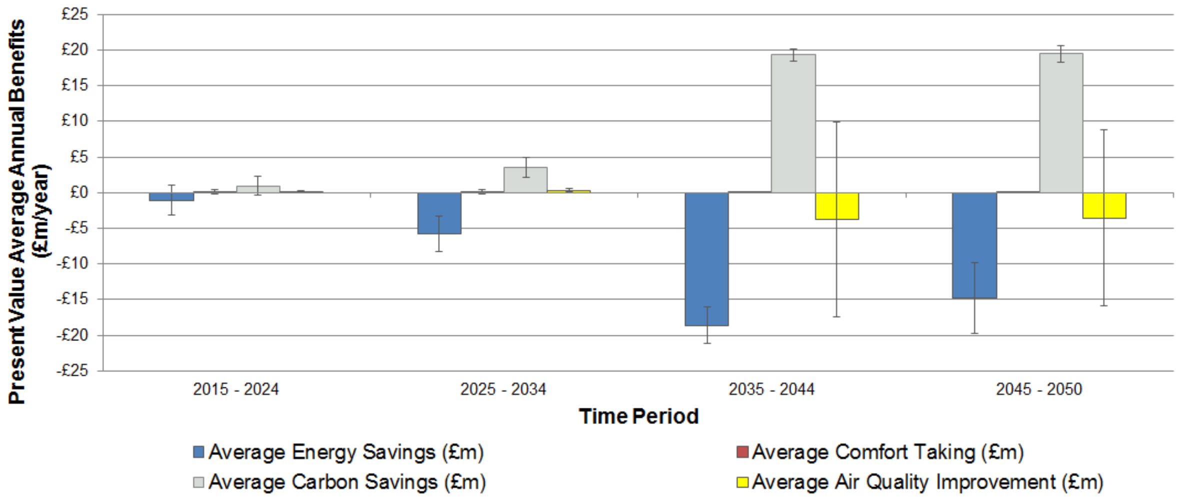
Average energy savings (MWh) as a result of the LEP (across a variety of EPN scenarios all relative to their respective Business as Usual run) for each time period and broken down by energy type::



Average carbon savings (tCO_2) as a result of the LEP (across a variety of EPN scenarios all relative to the Business as Usual scenario) for each time period and broken down by energy type:



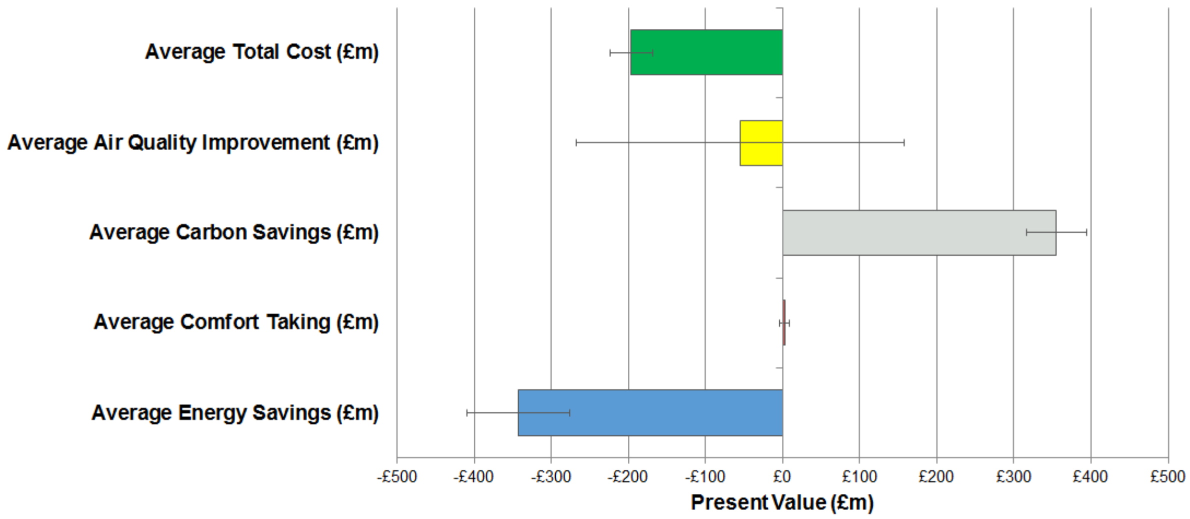
Average direct benefits (£m) as a result of the LEP (across a variety of EPN scenarios all relative to their respective Business as Usual run) Benefits are monetised using levelised unit costs of fuel, a carbon price and air quality damage costs respectively and discounted to 2015 values using a 3.5% discount rate.



There are net positive energy savings as a result of the LEP, however, when these are monetised we see that this results **in a cost to society of £340 million**, as gas is being displaced by more expensive fuels. On average, **more than 5.5 million tonnes of CO_2 are saved as a result of the transition, equating to a benefit of greater than £350 million** when valued with a carbon price. On average there is a net cost of air quality damage as a result of the LEP, however this value is highly variable and doesn't always result in a cost (-£260 - £157 million), dependent on the amount, and location, of biomass installed across the LA.

16.3 Net Present Value

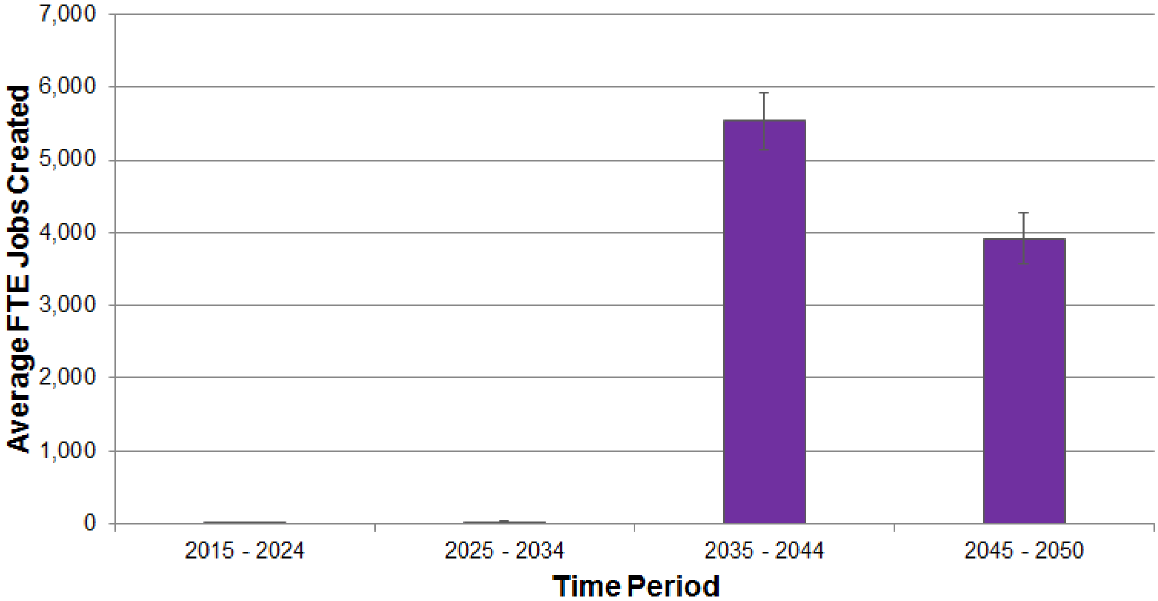
The average discounted cost[14] of the transition (above a business as usual scenario) is approximately £200 million, combining this with the benefits above there is a Net Present Value of the transition is approximately **-£260 million (+/- £160 million).**



16.4 Employment Impacts

Average FTE jobs created from implementation of the LEP:

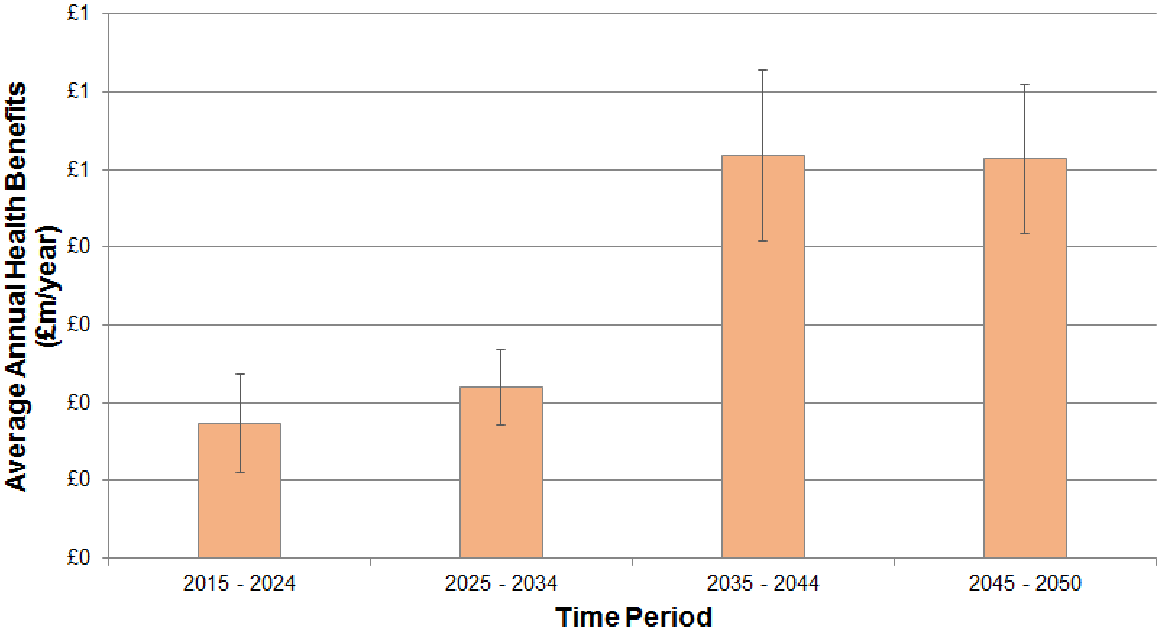
[14] Cost here refers to domestic building interventions as any network, local generation and energy costs are included in the calculation of the levelised cost of fuel.



There is estimated to be **a peak of approximately 5,500 jobs created in the time period 2035 – 2044**, when most of the buildings are expected to start transitioning to low carbon heating systems. This is predicted to fall to **a baseline of approximately 4,000 jobs by 2050** which, due to the nature of the calculation, are expected to span out past this time point.

16.5 Health Benefits

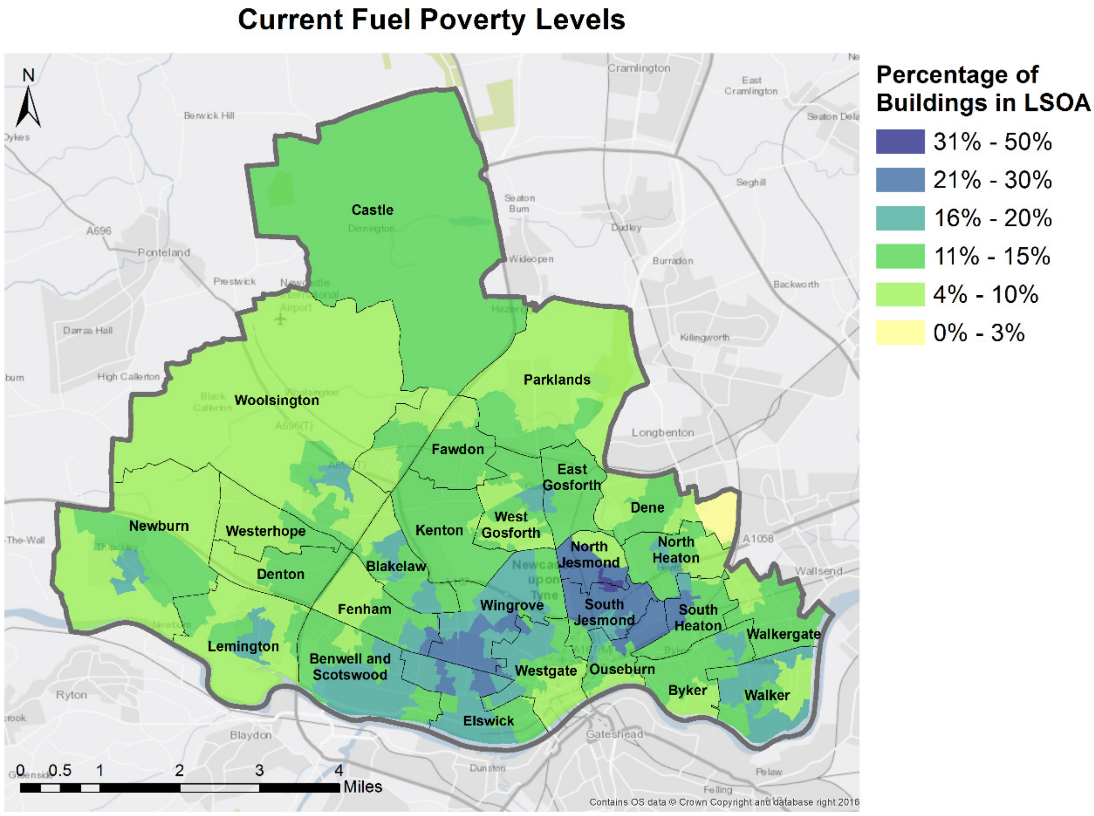
Average, discounted, annual health benefits from implementation of the LEP, evaluated by converting energy savings to QALY's with a value of £30,000/QALY:



The average net health benefit, as a result of energy savings from the LEP, are valued at **£12 million (+/- £2 million).**

16.6 Fuel Poverty/Impact on Fuel Bills

Across a range of scenarios analysed between **9,000 and 21,000 homes are expected to receive a reduction in the cost of delivering energy to their homes**, which should be reflected in their fuel bills. Across all scenarios these homes are concentrated in the following wards: Benwell and Scottswood, Wingrove, Westgate, Elswick, North Jesmond, South Jesmond, Ouesburn and Byker (analysis areas 11, 12, 15, 16, 19), which correlate with areas of high fuel poverty levels.



The average cost of delivering energy to heat a home is predicted to increase out to 2050, even without intervention, however this increase is expected to be greater as a result of the LEP. On average, the cost of delivering the energy required to heat a home in 2050 as a result of the LEP will be approximately twice as expensive as the business as usual equivalent scenario (equating to an increase of approximately £170 +/- £220 after discounting to 2015 values). This increase in cost reflects the fact that the majority of households will be moving from gas-fired heating to a more expensive fuel, electricity or heat, and the additional network reinforcements necessary to accommodate this. The estimated costs do not include any tax or profit margins from the energy suppliers or any subsidies which may be necessary to make this a viable solution for all homes.

16.7 Sensitivity Analysis

In addition to the above analysis, a selection of sensitivity analyses were performed on the range of EPN scenario outputs, these yielded the following results:

- A high carbon price yields an average net carbon saving of £530 million (+/- £65 million), resulting in an adjusted average NPV of the LEP of approximately -£60 million (+/- £260 million).

- A low carbon price yields an average net carbon saving of £170 million (+/- £18 million), resulting in an adjusted average NPV of the LEP of approximately -£410 million (+/- £250 million).
- Using the Stern report flat carbon discount rate of 1.4% yields an average net carbon saving of £590 million (+/- £50 million), resulting in an adjusted average NPV of the LEP of approximately £0 million (+/- £260 million).
- A conservative FTE per £ million spend job creation estimate of 12 FTE per £m results in job creation peaking at approximately 3,600 jobs (+/- 260), dropping to a baseline of 2,600 jobs.
- A high FTE per £ million spend job creation estimate of 24 FTE per £m results in job creation peaking at approximately 7,300 jobs (+/- 500), dropping to a baseline of just over 5,000 jobs.