D2N2 LEP

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This document has been produced for the D2N2 Local Enterprise Partnership (LEP) by Nottingham City Council to provide detailed analysis of greenhouse gas emissions across the area. Emissions analysis runs across domestic, industry/commercial and transport sectors. Further work has been undertaken to develop D2N2's business-as-usual scenario and the science-based emissions reduction pathway requirements or the region to be consistent with national and international policy and targets.

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Contents

Glossary 2
D2N2 Region 3
Emission Trends 3
Energy Consumption 5
Energy Generation 6
Sector Breakdowns 7
Domestic 7
Industry and Commercial 8
Transport 14
Regional Carbon Sinks 16
D2N2 Carbon Budget, BAU and Emissions Reduction Pathway 20
Priority Areas for Emissions Reduction across D2N2 21
Exposure and Risks from a Low Carbon Transition 23
Appendix 1. Data Limitations and Knowledge Gaps 26

Appendix 2. Dominant Emitters Unique Site List 29
Appendix 3. D2N2 EU ETS Installations 31
Appendix 4. Implied Capacity and Rate of Installation 33

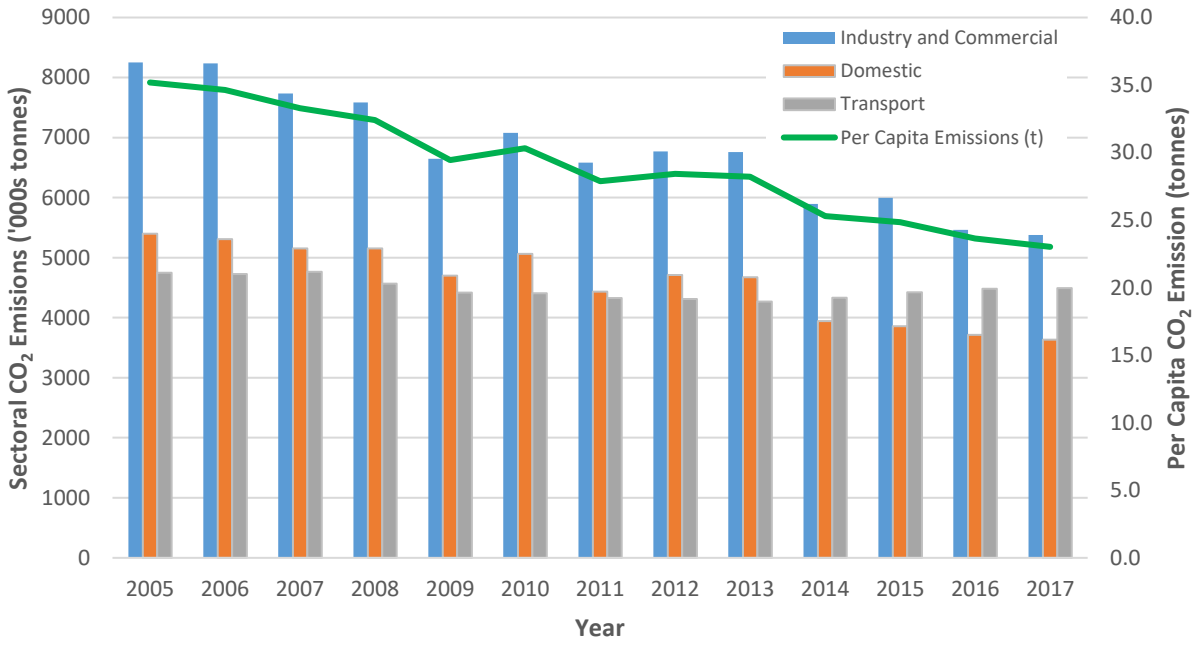
Glossary

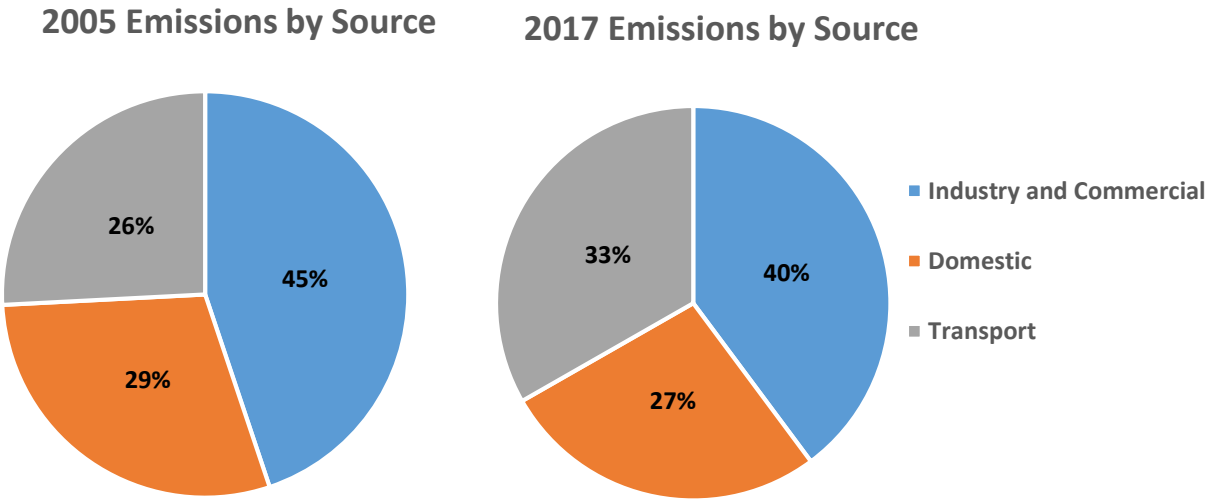
BAU	Business as usual
CCGT	Combined Cycle Gas Turbines
CHP	Combined Heat and Power
EfW	Energy from Waste
EPC	Energy Performance Certificate
EU ETS	European Union Emissions Trading Scheme
FITs	Feed in Tariff scheme
IPPC	Integrated Pollution Prevention and Control
LA	Local authority
LSOA	Lower Layer Super Output Area
LULUCF	Land use, land-use change, and forestry
MW	Megawatt, equal to $1x10^6$ watts
MWth	Megawatt thermal - refers to the thermal power produced by a plant
PV	Photovoltaics
RHI	Renewable Heat Incentive - the data includes deployment data for the uptake of renewable heat in the non-domestic sector.
UA	Unitary Authority
ULEV	Ultra Low Emission Vehicles

D2N2 Region

Emission Trends

Total Carbon Dioxide emissions from direct and indirect energy use across the D2N2 area in 2017 were 13.5 $MtCO_2$, a 26.6% reduction from 2005[1] and a 3.8% share of UK CO_2 emissions[2]. The sectoral emissions mix demonstrates that the largest emitting sector is Industry and Commercial (40%), followed by Transport (33%) and Domestic (27%) sectors. Whilst the Industry and Commercial sector contributes the most to D2N2's emissions, it has seen considerable progress in emissions reduction since 2005: contributing 58.7% of the total overall emissions reduction, compared to the Domestic sector's contribution of 36% and Transport just 5.3% to the overall reduction. D2N2's population has increased by 6% (population has increased in all authorities since 2009); with the largest increases seen in Nottingham (12.3%) and South Derbyshire (12.3%). Per capita emissions have reduced by 32% to 6.1 tonnes of CO_2 in 2017, when taking this population increase into account.





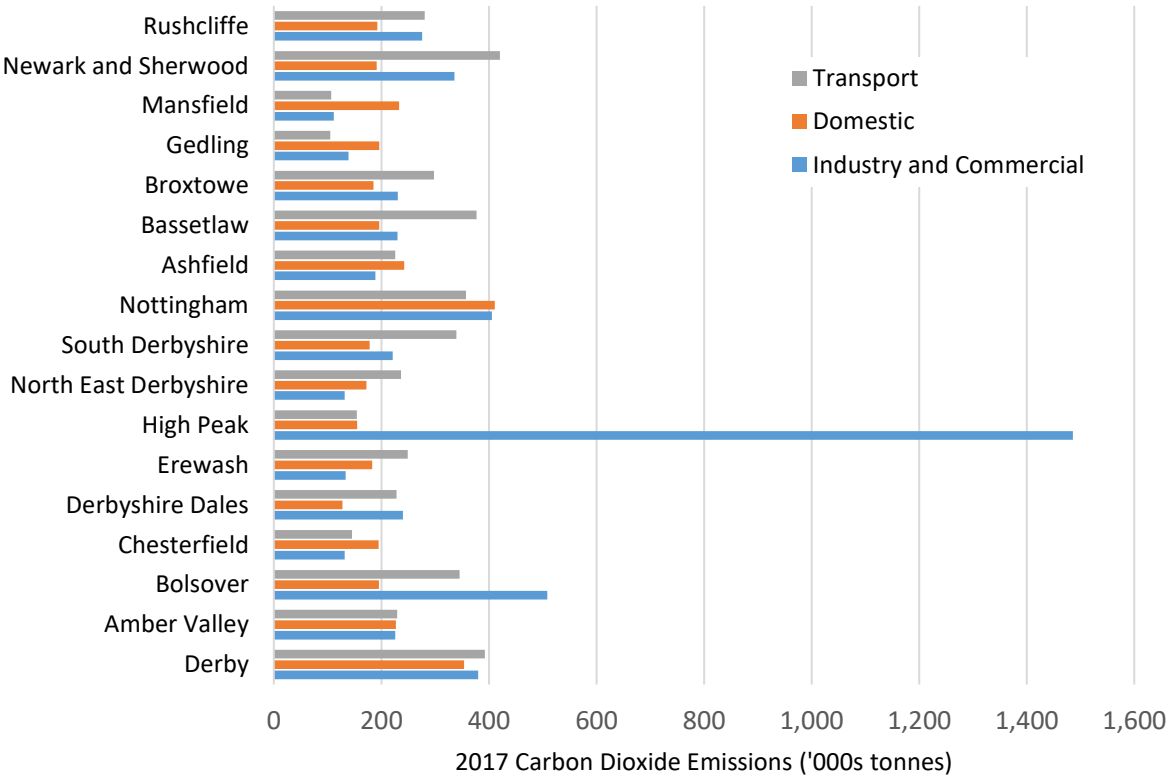
[1] This relates to energy only CO_2 emissions which does not include: aviation, shipping, cement and LULUCF at a local authority scale. See Tyndall Carbon Budget Tool for additional explanations https://carbonbudget.manchester.ac.uk/

[2] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2017

Total CO_2 emissions have reduced by an average of 2.45% annually, whilst each sector has seen varied emissions reduction trends over the 12 year period. Transport emissions have reduced by just 0.45% p.a., whilst Domestic emissions have reduced 3.02% p.a. and Industry and Commercial by 3.33% p.a.. These varied reduction rates mean that Transport's proportional contribution to total D2N2 emissions has grown, whilst the other sectors have reduced relatively, as seen in the figures above. Each of these sectors is broken down further later on in this document.

Sectoral Emissions per Local Authority in D2N2

Carbon dioxide emissions are not equally shared across the D2N2's 17 local authority (LA) areas. The two cities tend to have the largest total emissions with a relatively equal mix across the three sectors and are home to the largest domestic sector emissions - coinciding with the larger populations living within them. Transport and Industry/Commercial emissions are a lot more varied across the different LAs. The Transport sector is the largest emitting sector for nine LAs, where the largest emissions come from Newark and Sherwood. Industry and Commercial emissions are dominated by High Peak, almost three times higher than the second highest LA, Bolsover, and over nine times higher than either of the two other sectors in High Peak[3]. The graph below identifies where within D2N2 the main sources of emissions occur across the three main sectors and clearly identifies LAs that should be considered as priorities for reducing overall emissions, such as High Peak, Nottingham, Derby, Bolsover and Newark and Sherwood.



[3] Appendix 1 outlines data limitations, including what is not included in the emissions mentioned here.

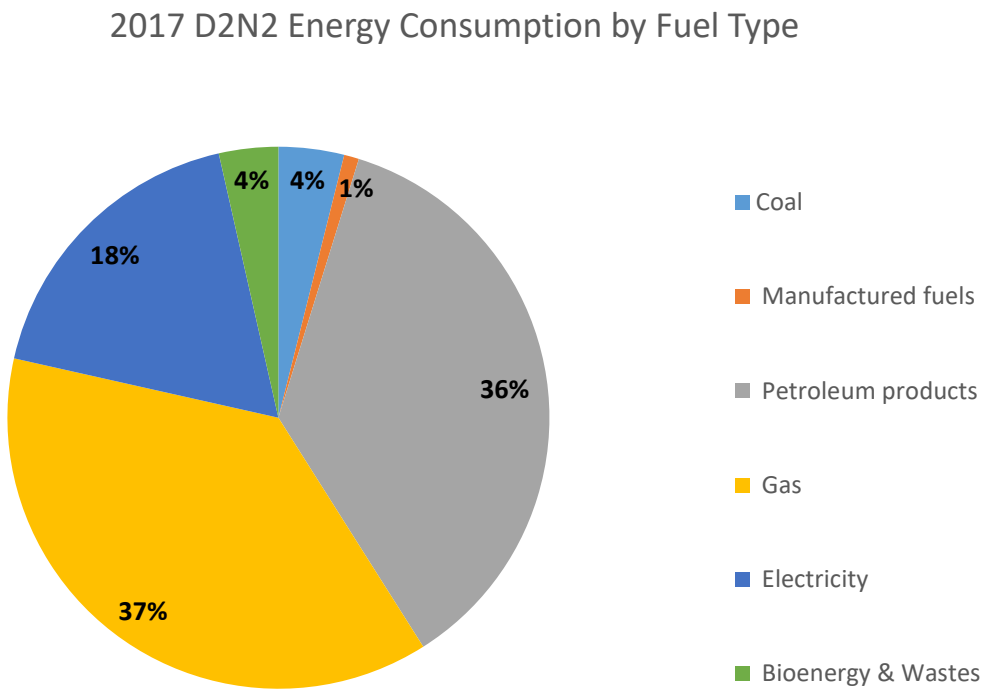
Energy Consumption

Energy usage in the D2N2 area has decreased by 15% since 2005, to 50,982 GWh in 2017[4]. This is slightly lower than England's energy usage reduction (17%) over the same period[4]. The D2N2 reduction is mainly due to Industry and Commercial energy consumption decreasing by 23.5% and Domestic by 20.7%. Meanwhile, Transport energy consumption has only decreased by 1.9%.

Overall, gas usage has decreased by 23.6% and electricity usage has reduced by 15.9%. However, in 2017, gas consumption still accounts for 37.5% of the total energy usage (split 63.2% for domestic use and 36.8% for industry and commercial use). Though Domestic, and Industry and Commercial sectors' energy consumption is decreasing, their gas use accounts for over a third of total energy consumption in D2N2.

In addition, petroleum products make up over a third of fuel use in the D2N2 area, 82% of which is from road transport. 12% of petroleum product use is used for industrial and commercial uses, with the remaining 6% split between domestic use, rail, public sector and agriculture.

Use of bioenergy and waste fuels has grown by 103.3% since 2005, though it remains a low proportion of total fuel use in the area.



[4] https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level

Energy Generation

Estimates suggest 2.71% of total energy consumption in D2N2 is from low carbon generation[5]. When transport consumption is excluded, 4.11% is from low carbon generation[5]. It is estimated 13.94% of electricity consumption in D2N2 is from low carbon energy generation[5].

The D2N2 region is home to over 952,000 households (3.4% of UK total), of which 4.1% have Solar PV installed[6] - with an installed capacity of 137 MW. Meanwhile non-domestic solar installations have an installed capacity of 96 MW. The D2N2 area has 4.6% of UK solar installed capacity[6].

Whilst solar is the most prominent type of renewable technology within the D2N2 area, there are also 135 wind installations (total 33 MW of capacity), 17 hydroelectric installations (1.6 MW) and 16 anaerobic digestion sites (14.9 MW). Overall, the D2N2 region has 283 MW installed Feed In Tariffs (FIT) capacity of renewable energy, accounting to 4.5% of the UK share of installed FITs capacity[6].

In addition, there also 620 non-domestic Renewable Heat Incentive (RHI) installations with a capacity of 193 MW, which is 3.9% of the UK total[7]. The below table illustrates the spread of these forms of renewable energy split across each local authority within D2N2.

	Total Installed Capacity (MW)					
	Solar	**Wind**	**Hydro**	**Anaerobic D**	**RHI**	**Total**
Derby	14.9	5.0	0.2			20.2
Derbyshire						
Amber Valley	8.2	4.8			8.0	21.0
Bolsover	6.4	1.4			2.0	9.8
Chesterfield	16.5	0.5				17.0
Derbyshire Dales	8.5	1.9	0.5	0.1	16.0	27.1
Erewash	7.1					7.2
High Peak	4.3		0.3		2.0	6.7
North East Derbyshire	13.8	0.8		0.2	6.0	20.8
South Derbyshire	16.3	0.2			16.0	32.5
Nottingham	21.1				3.0	24.1
Nottinghamshire						
Ashfield	8.7	0.7			4.0	13.3
Bassetlaw	27.9	2.8		4.1	82.0	116.7
Broxtowe	6.7	2.6			1.0	10.2
Gedling	7.2	3.8	0.5	5.6	3.0	20.2
Mansfield	8.2			0.4	6.0	14.6
Newark and Sherwood	28.0	8.7		3.0	25.0	64.6
Rushcliffe	29.6			1.5	19.0	50.2
Total	**233.5**	**33.0**	**1.6**	**14.9**	**193.0**	**476.1**

[5] These estimates are calculated through a number of datasets, as there is no single data source that can provide a full-picture of the installed and operational low carbon capacity across the LEP area. This includes CHP, which if compared to natural gas, is comparatively low carbon.

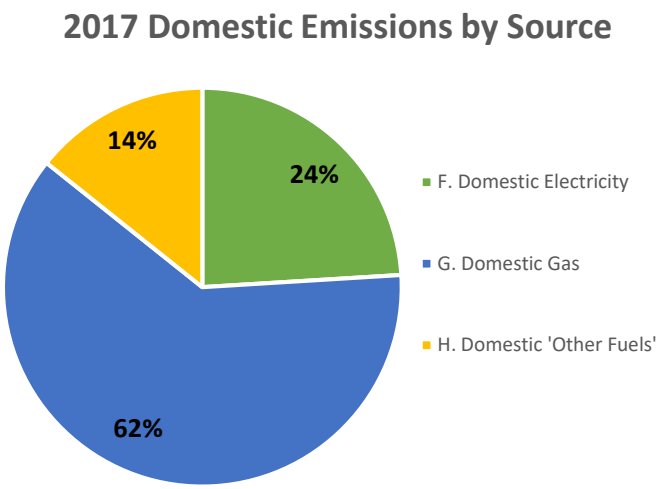
[6] Based on FITs registered data from https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics

[7] RHI data https://www.gov.uk/government/statistics/rhi-monthly-deployment-data-september-2019

Sector Breakdowns

Domestic

Domestic emissions accounted for 3.6 $MtCO_2$ in 2017, the lowest of the three main sectors. The Domestic sector is dominated by gas usage emissions (62%), followed by electricity (24%) and 'other' fuels[8] (14%).

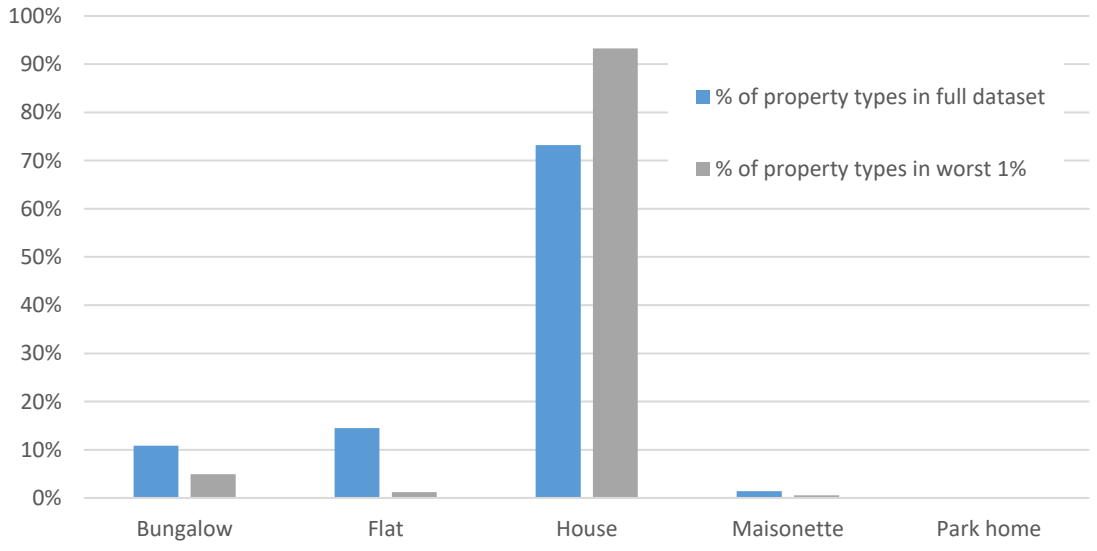


The D2N2 area has an estimated 952,000 domestic properties within it, of which 56.9% have had an EPC assessment (see table below)[9]. Based on using these EPCs as an indicator for the whole D2N2 region, 61.8% of domestic properties are lower than an EPC rating of C. This is slightly lower than the national proportion, where 62.2% of domestic properties in England are below an EPC rating of C[10].

D2N2 Domestic Housing Stock EPCs							
EPC	A	B	C	D	E	F	G
Percentage of Stock	0.2%	10.0%	28.1%	39.7%	17.4%	3.9%	0.8%

For every LA within D2N2, 80-90% of properties are heated by mains gas (88.5% for the whole of D2N2) and the spread of EPCs across local authorities have similar proportional splits[9].

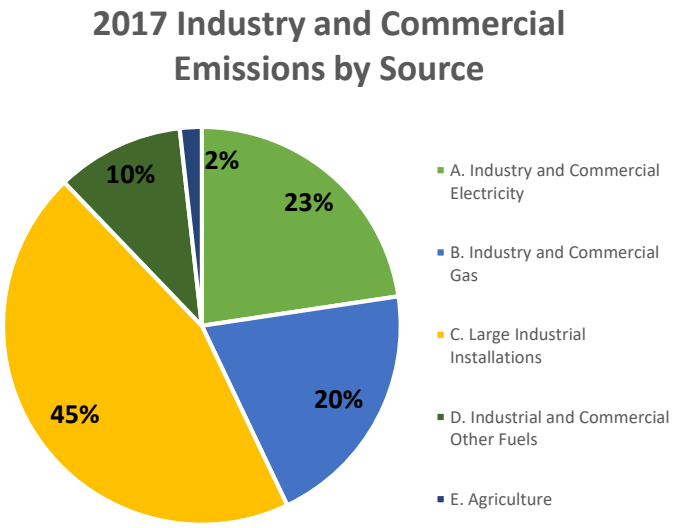
Across the whole of D2N2, the worst 1% of properties account for 119,629 tCO_2 per year, which is 3.32% of D2N2's emissions in 2017. 44.7% of these properties are heated by mains gas, 25.6% by oil, 12.1% by electricity and 9.2% by a form of coal. Of the worst 1% of domestic properties, 93% are traditional house builds.



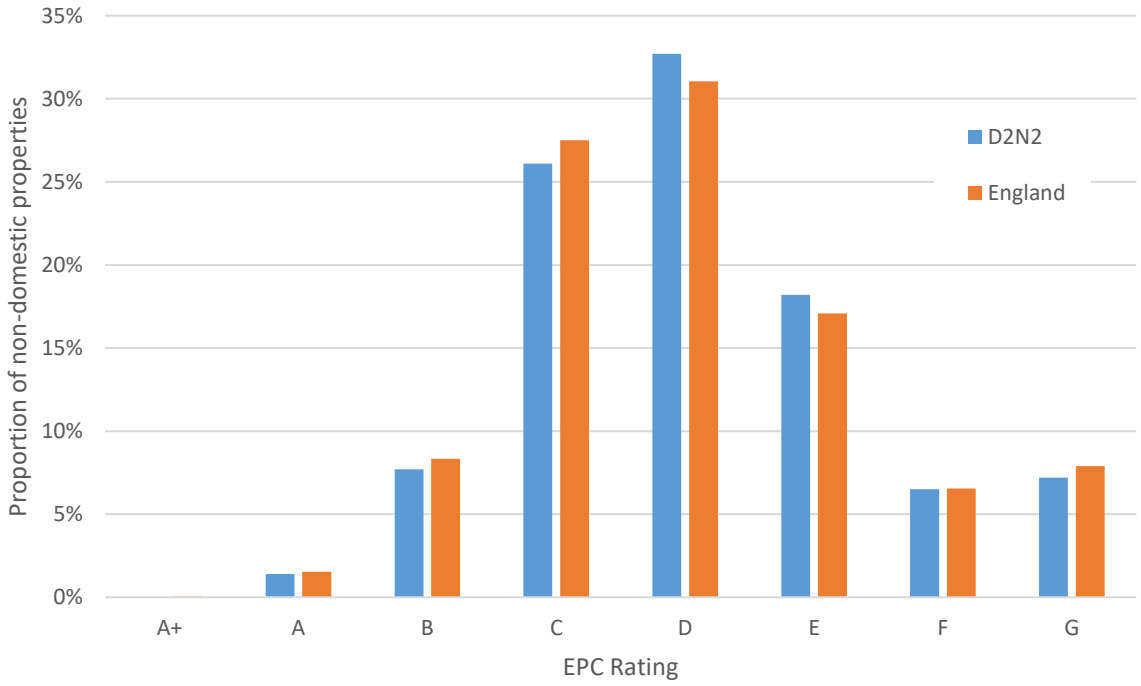
[8] 'Other fuels' consist of solid fuel burnt in boilers and non-boiler appliances
[9] https://epc.opendatacommunities.org/
[10] https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates

Industry and Commercial

Industry and Commercial emissions contributed 5.4 $MtCO_2$ to D2N2's CO_2 emissions in 2017. Large industrial installation emissions account for 45% of these emissions, followed by electricity use (23%) and gas use (20%), whilst agriculture contributes 2% of these emissions.



D2N2 has an estimated 87,000 business units within the region[11] (41% of all units in the East Midlands) of which 22,572 have EPCs available. 13.7% of these are lower than an EPC rating of E and 64.6% are below an EPC C rating[12]. These are below national proportions, where 14.4% of properties are below an EPC rating of E, and 62.6% are below an EPC rating of C. The different proportions are summarised in the graph below.



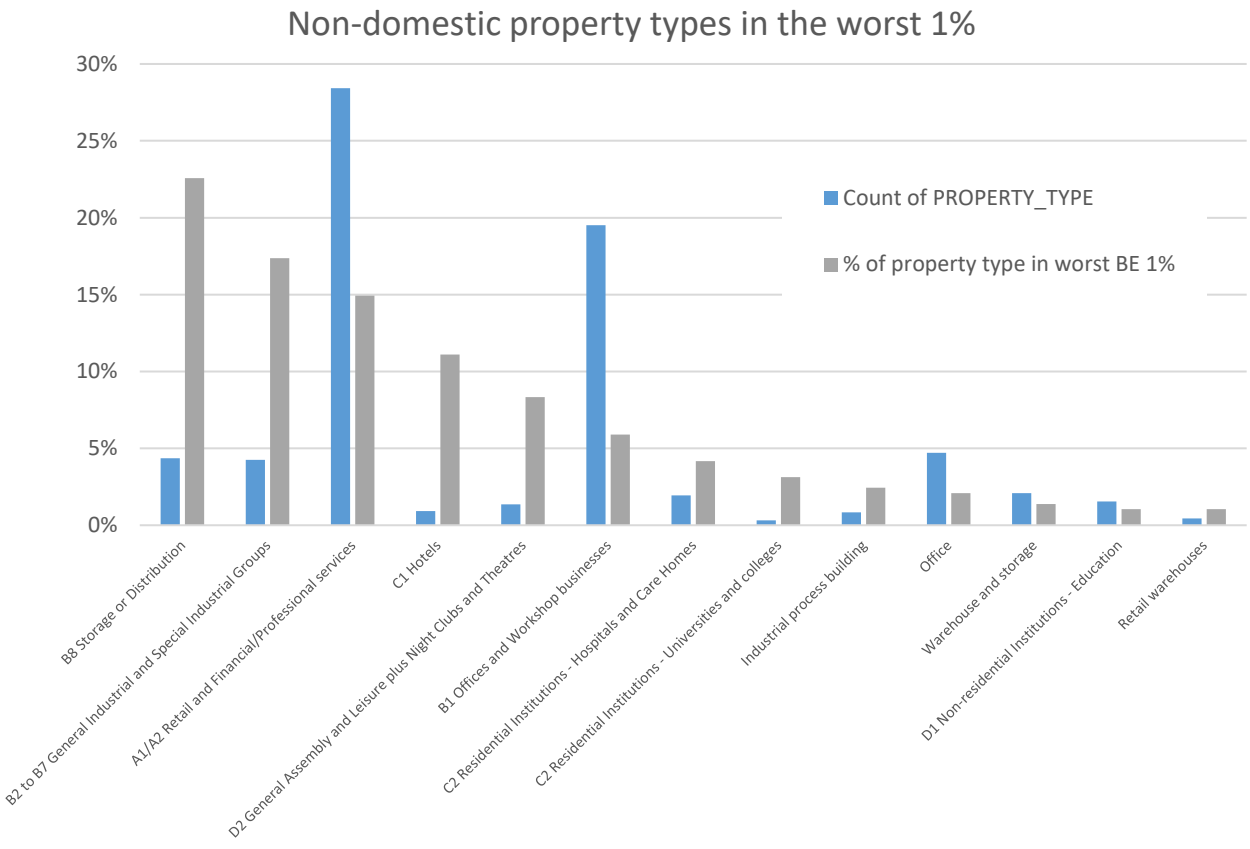
In D2N2, 48.7% of non-domestic properties use natural gas heating, whilst 46.5% use electricity. Non-domestic properties heated by natural gas are on average 2.7 times larger than those heated by electricity. Specifically: Ashfield, Bolsover, Chesterfield, Erewash, High Peak, Mansfield, NE Derbyshire, and Rushcliffe have over half of their non-domestic properties with EPCs heated by natural gas.

[11] Business unit data https://www.nomisweb.co.uk/reports/lmp/la/1941962807/report.aspx#tabidbr
[12] https://epc.opendatacommunities.org/

D2N2 Non-Domestic Housing Stock EPCs								
EPC	A+	A	B	C	D	E	F	G
Percentage of Stock	0.0%	1.4%	7.7%	26.1%	32.7%	18.2%	6.5%	7.2%

The largest 1% of emitters for non-domestic buildings account for an estimated 279,256 tCO_2 per year[13], with the four highest emitting properties responsible for almost 10% of this total. This includes Dixons Distribution (Newark and Sherwood), Amazon (Bolsover), T D G Contract Logistics (Erewash) and Tesco Distribution (Bolsover).

28% of the worst 1% of properties are for Storage or Distribution, compared to just 4.35% of properties in the full dataset. Industrial and Special Industrial Groups, Hotels, General Assembly and Leisure, in addition to Night Clubs and Theatres are all also concentrated in the worst 1% of non-domestic properties.



[13] On EPCs, the building emissions rate and floor area are estimated. These have been multiplied together to identify the 1% of properties with the highest estimated emissions per year.

Dominant Emitters

Please note that the methodology for this section is essential to understand the dominant emitter analysis

The BEIS carbon emissions dataset includes combined emissions for large local industrial installations. This data combines information from installations that are in the EU Emissions Trading Scheme (ETS) and operators which are regulated under Integrated Pollution Prevention Control (IPPC) to the Environment Agency for inclusion in the Pollution Inventory. Additionally, some of the data is modelled rather than based on the operators' data. For example where installations may be below the threshold, processes (e.g. glassworks) which are not included in IPPC, or where the IPPC data cannot easily be used (if for example it contains a combination of biological carbon and carbon from combustion.) As a result, although a list of sites which are regulated under IPPC are included in this report, their total emissions cannot be reliably compared to the area emissions.

Both the EU ETS and IPPC datasets have gaps in reporting, and in some years sites will only report to one and not the other. As such, it is difficult to judge whether changes in emissions from one year to another are due to actual changes or represent differences in the scope of reporting between the two datasets. Due to differences in the names of sites and operators between the two datasets, it is also challenging to directly match the datasets. As such, there may be some sites' previous operators in the list of large emitters in the D2N2 region.

The EU ETS focuses on direct fuel combustion and does not capture electricity consumption, to avoid double counting of these emissions. Participation in the EU ETS is mandatory for installations in certain industries (as shown in Table 1). The threshold of 20MWth is used for reporting to EU ETS. The IPPC includes non-ETS combustion using fossil fuels, use of biofuels and some non-combustion processes. Installations are only required to report if their emissions are above a set of 'reporting thresholds'. The reported emissions for the two datasets are thus not fully comparable as they may report an overlap of emissions.

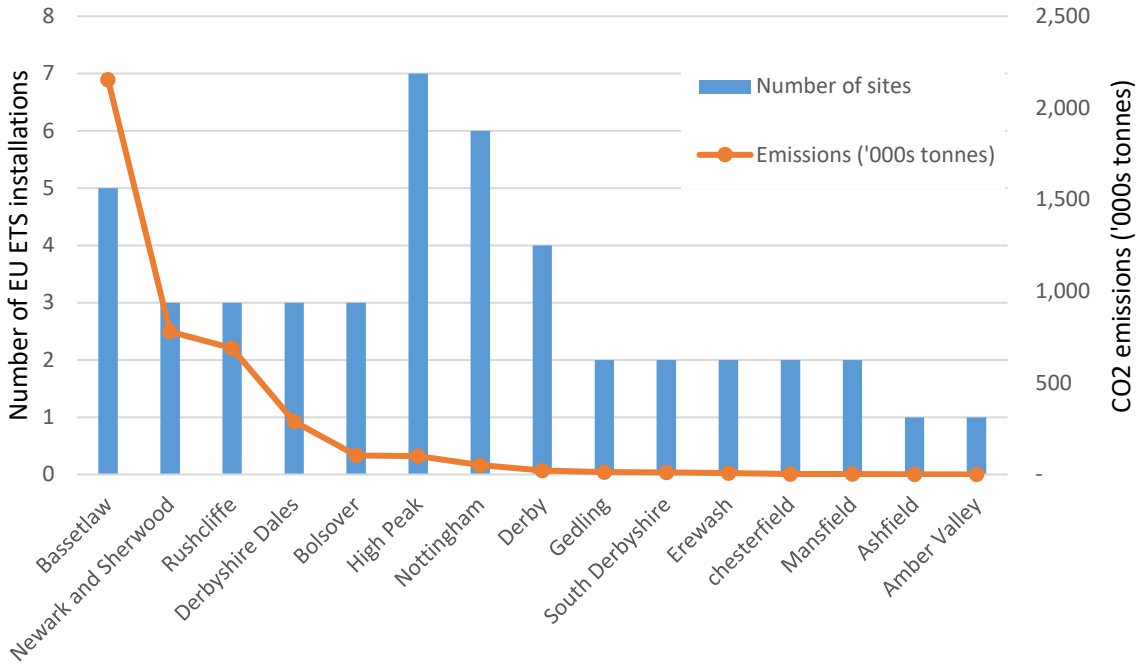
As far as possible, a list of unique sites that are included in the EU ETS and IPPC are included in Appendix 2. Where two sites with the same name and operator have reported twice to the same reporting body, these have been kept as separate entries. In this analysis, it has been assumed that sites listed within the Pollution Inventory with no data reported since 2013 have closed.

There have been several phases of the EU ETS, and thus the scope of what is being reported may have changed over time within these figures (shown in the table below). Only installations as part of Phase 3 are looked at in this analysis of the EU ETS installations, though it is noted that some public sector sites may also be dominant emitters in the region.

Key features	Phase 1 (2005–2007)	Phase 2 (2008–2012)	Phase 3 (2013–2020)
Sectors	Power stations and other combustion plants ≥20MW Oil refineries Coke ovens Iron and steel plants Cement clinker Glass Lime Bricks Ceramics Pulp Paper and board	Same as phase 1 plus Aviation (from 2012) However, many public sector sites (e.g. hospitals, universities) ceased reporting	Same as phase 1 plus: Aluminium Petrochemicals Aviation from 1/1/2014 Ammonia Nitric, adipic and glyoxylic acid production CO2 capture, Transport in pipelines and geological storage of CO2
GHGs	CO_2	CO_2, N2O emissions via opt-in	CO_2, N_2O, PFC from aluminium production

EU ETS High Emitters

There are 46 EU ETS installations in the D2N2 area[14]. The three highest emitting installations (Cottam Power Station, Staythorpe Power Station, West Burton B) contribute more emissions than the other 43 that report CO_2 emissions as part of the EU ETS in the D2N2 region combined[15].



The installations classified as 'major power producers' are 6 of the highest emitting sites in the D2N2 area, and all but one of these are in Bassetlaw. The remaining sectors in the highest 10 emitting installations are 'cement' and 'lime' works. The top 10 for highest emitting sites covers all the installations of each of these sectors, and the remainder of the 36 installations is composed of other sectors. This highlights whilst the highest emitters are power producers and energy intense sectors, other sectors such as 'Food, drink & tobacco industry' and 'Other mineral industries' are still significant in their emissions.

Sector	Number of EU ETS installations	2017 tCO_2
Major power producers	6	3,553,170
Cement	1	282,503
Lime	3	192,745
Food, drink & tobacco industry	5	53,894
Other mineral industries	7	39,506
Vehicles	4	27,570
Waste collection, treatment & disposal	1	19,857
Public administration	5	19,596
Chemical industry	1	14,580
Minor power producers	7	11,512
Non-ferrous metal industries	1	7,182
Paper, printing & publishing industries	2	6,310
Processing & distribution of natural gas	1	954
Textiles, clothing, leather & footwear	1	942
Iron & steel industries	1	32
Grand Total	**46**	**4,230,353**

[14] https://naei.beis.gov.uk/data/map-large-source
[15] The full list of these 46 installations can be found in Appendix 3

Top 10 highest emitting installations	Operator	Local authority	Sector	tCO_2 (2017)
Cottam Power Station	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	792,849
Staythorpe Power Station	RWE Generation UK plc	Newark and Sherwood	Major power producers	741,751
West Burton B	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	679,400
Ratcliffe on Soar Power Station	Uniper UK Ltd	Rushcliffe	Major power producers	667,798
West Burton	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	481,664
Hope Cement Works	Breedon Cement Ltd	Derbyshire Dales	Cement	282,503
Cottam Development Centre	Uniper UK Ltd	Bassetlaw	Major power producers	189,707
Whitwell	Steetley Dolomite Ltd	Bolsover	Lime	100,773
Buxton	Lhoist UK Ltd	High Peak	Lime	52,281
Hindlow Quarry	Tarmac Cement and Lime Ltd	High Peak	Lime	39,691

Pollution Inventory

In the D2N2 region, 99.7% of emissions from installations reporting into IPPC are a result of carbon dioxide emissions (of the 7 Kyoto Protocol gases)[16].

Considering only carbon dioxide, 80.1% of emissions are from power-related installations, 13.8% from cement-related installations – a similar trend to that seen in the EU ETS installations data.

Installation sector	2018 tCO_2 released	Proportion Split
Power	12,091,746	80.13%
Cement	2,077,708	13.8%
Lime	564,017	3.7%
EfW	161,603	1.1%
Food & Drink	106,829	0.7%
Non Hazardous Landfill	45,759	0.3%
Non-Ferrous	25,800	0.2%
Water Industry	16,000	0.1%
TOTAL	15,089,461	100%

The greatest quantity of non-CO_2 emissions is as a result of non-hazardous landfill, resulting in an additional 42,012 tonnes of non-CO_2 emissions. 52.1% of the total gases released are carbon dioxide, 43.9% are carbon dioxide from qualifying renewable fuel sources, and 4% from methane.

The below table highlights the top 10 high emitting sites based on the Pollution Inventory datasets for 2018.

Installation	2018 tCO_2
Cottam Power Station	3,961,700
Ratcliffe-On-Soar Power Station	3,332,539
Staythorpe C Power Station	3,004,145
West Burton Power Station	1,680,000
Hope Cement Works	1,048,805
Tunstead Quarry	859,760
Whitwell Quarry	398,837
Hindlow Works	169,143
Brierlow Lime Works	165,180
Eastcroft Energy from Waste Plant	150,460

[16] https://data.gov.uk/dataset/cfd94301-a2f2-48a2-9915-e477ca6d8b7e/pollution-inventory

Additional Polluters

As there are thresholds for reporting to both the Pollution Inventory and EU ETS, there are likely to be a number of smaller installations that are below this threshold. Specifically, this might include public sector sites, such as hospitals and universities, of which there are a number in the D2N2 area. From publically available data for higher education institutions[17]:

Higher Educational Institution	2017/18 Scope 1 and 2 (tCO_2e)
University of Nottingham	46,826
Nottingham Trent University	11,354
University of Derby	8,692

Hospitals in the D2N2 region include:

- Queen's Medical Hospital
- City Hospital
- Ropewalk House
- Children's Hospital
- Highbury Hospital
- Lings Bar Hospital
- Millbrook Mental Health Unit
- Rampton Hospital
- Retford Hospital
- Chesterfield Royal Hospital
- Hartington Unit
- London Road Community Hospital
- London Road Community Hospital
- Midway Day Hospital
- Royal Derby Hospital
- Walton Hospital

Note on Dominant Emitters

Some CO_2 sources are omitted from the local authority BEIS datasets, either where it would not be appropriate to include them (e.g. aviation and shipping), or due to unallocated methodological differences (including where gas and electricity consumption cannot be allocated to Local Authorities due to confidentiality concerns at high emitting sites). Due to unallocated methodological differences, the UK CO_2 inventory includes an additional 0.9 $MtCO_2$ from large electricity users with unknown/confidential locations than what is included in the local authority inventories. Within the industrial and commercial sector, there is a further 4.2 Mt CO_2 included in the UK CO_2 inventory which is not included within the local authority datasets due to methodological differences.

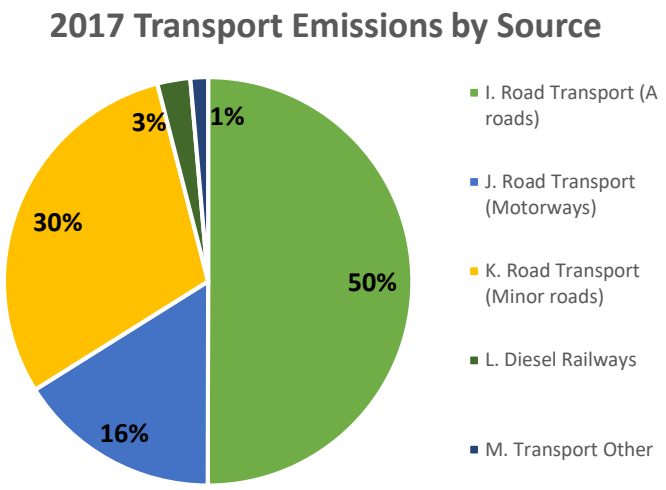
The data considered here is from the 2017 EU ETS reported emissions and the 2018 IPPC datasets. As such, more recent plant closures may have occurred, including some of the power stations mentioned.

Power stations	Operator	Local authority	Open/closed	Type
Cottam Power Station	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Decommissioned September 2019	Coal
Staythorpe Power Station	RWE Generation UK plc	Newark and Sherwood	Staythorpe C is open	Gas - CCGT
West Burton B	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Open	CCGT
Ratcliffe on Soar Power Station	Uniper UK Ltd	Rushcliffe	Open	Coal
West Burton	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Open	Coal
Cottam Development Centre	Uniper UK Ltd	Bassetlaw	Open	CCGT

[17] https://www.hesa.ac.uk/data-and-analysis/estates/environmental

Transport

Transport emissions equated to 4.5 $MtCO_2$ in 2017, making it the second highest sector for emissions. 50% of these emissions arise from road transport on A roads, 30% from minor roads and 16% from motorway transport.



Since 2009, there has been a 13% increase in the number of vehicles registered in the D2N2 area to 1.3 million registered vehicles[18]. Notably, diesel cars and vans make up 45% of all vehicles registered in the region, and the combined number of these has increased by 54% since 2009 (65% increase in diesel cars).

There are only 5897 ULEVs within the D2N2 area, less than 0.5% of the total number of vehicles. 21% of these ULEVs are registered in Derby, 12.2% in Chesterfield, and 9.8% in Nottingham. These three authorities, with Erewash, are the only authorities in the region with more than 0.5% of registered vehicles as ULEVs. The remaining ULEVs are split between the other local authorities in the region.

Road miles in the D2N2 area account for 3.6% of the total miles driven in Great Britain in 2018, and this proportion has remained constant since 2009[19]. However, traffic road miles have increased by 6% in the D2N2, with the largest increase in Nottinghamshire (8.5%), followed by Derbyshire (6%). Though miles in Nottingham and Derby have also increased, these have done so at a much lower rate (1% and 2% respectively). For Nottinghamshire, Derby and Derbyshire, over 60% of the increase in road miles is due to increased car and taxi miles. In Nottingham, this proportion is only 30%, with other motor vehicles accounting for the rapid increase seen.

[18] https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01
[19] https://roadtraffic.dft.gov.uk/local-authorities

Region/Local Authority	2019 Q2	Total licensed vehicles (2018)	Percentage of ULEVs compared to all vehicles in each LA	Percentage of ULEVs per LA compared to total ULEVs in D2N2
Derby UA	1,247	56,127	2.22%	21.1%
Chesterfield	719	115,736	0.62%	12.2%
Nottingham UA	577	68,819	0.84%	9.8%
Erewash	427	67,930	0.63%	7.2%
Rushcliffe	395	139,772	0.28%	6.7%
Amber Valley	290	87,216	0.33%	4.9%
Newark and Sherwood	276	68,207	0.40%	4.7%
Gedling	259	58,094	0.45%	4.4%
Broxtowe	232	63,171	0.37%	3.9%
North East Derbyshire	229	70,999	0.32%	3.9%
South Derbyshire	222	112,323	0.20%	3.8%
Derbyshire Dales	215	76,896	0.28%	3.6%
Bassetlaw	201	75,529	0.27%	3.4%
High Peak	178	61,725	0.29%	3.0%
Ashfield	173	72,844	0.24%	2.9%
Mansfield	151	79,624	0.19%	2.6%
Bolsover	106	50,592	0.21%	1.8%
TOTAL	**5,897**	**417,210**	**1.41%**	

In addition, the number of passenger journeys on public transport in the D2N2 area has decreased by 8.9% since 2009 until 2018[20]. There has been almost no change in the number of bus journeys in Nottingham during this time, although there has been a 109% increase in the number of tram passenger numbers[21]. Meanwhile, there has been a 6.5% decrease in Derby bus journeys, and 18.6% and 19.5% decreases in Nottinghamshire and Derbyshire local bus passenger journeys.

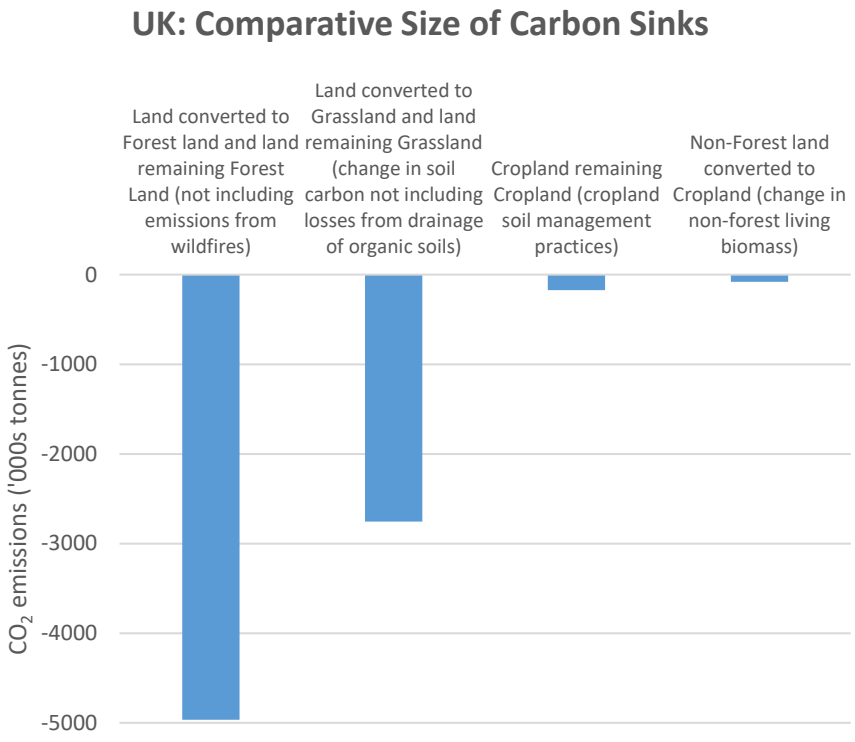
Based on the historic trend, a projected 14.3% population growth between 2016 and 2050[22] could result in an increase of 14.7% in road vehicle miles. To help avoid exceeding the carbon budget, D2N2 would need to shift towards increased use of public transport, reduce road vehicle miles, alongside an increased use of low carbon modes of transport.

[20] https://www.gov.uk/government/statistical-data-sets/bus01-local-bus-passenger-journeys
[21] https://www.gov.uk/government/statistical-data-sets/light-rail-and-tram-statistics-lrt
[22] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2

Regional Carbon Sinks

In total, net -158 $ktCO_2$ was sequestered through land use, land-use change, and forestry (LULUCF), a 231% increase from 2005 levels. On average, -9.3 $ktCO_2$ is sequestered per local authority, although in reality LAs are very varied in their LULUCF emissions. Newark and Sherwood, North East Derbyshire, High Peak and Derbyshire Dales account for 62% of D2N2s LULUCF emissions. All local authorities within D2N2 had a net removal of carbon through LULUCF activities in 2017, except Bassetlaw which had positive emissions[23]. *Please note these emissions are net, meaning they are a calculation of all LULUCF emissions minus the carbon sequestered through LULUCF.*

At a UK level, the greatest carbon removal comes as a result of forest growth and land converted to grasslands[24]. The graph below indicates the different types of carbon sinks in the UK and the comparative size of these sinks.



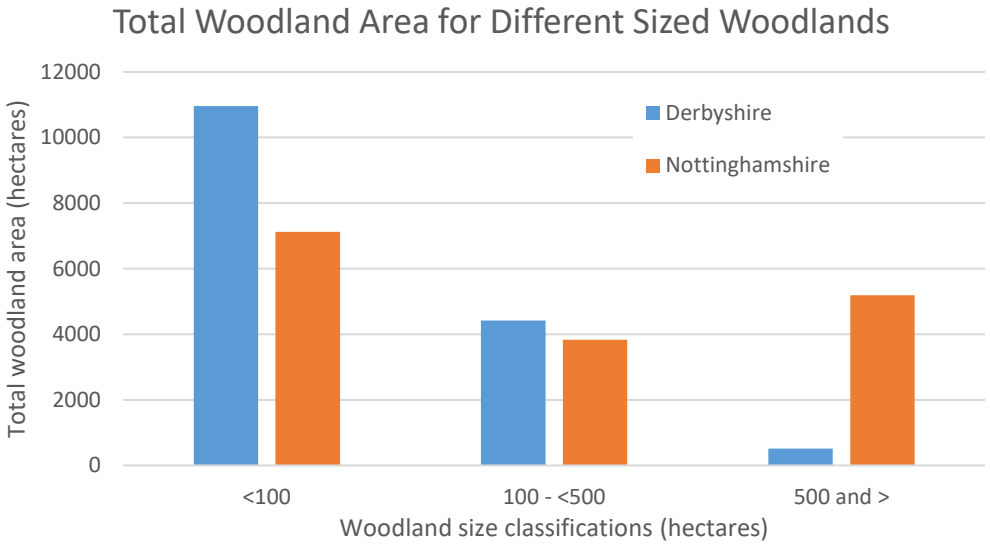
[23] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812153/LULUCF_Local_Authority_mapping_report_2017.pdf

[24] Bogs, peat, marshes and fens are assumed to be for grazing and are included in the grassland category.

Woodlands

Woodland has been considered at county scale for Derbyshire and Nottinghamshire. Using the national forest inventory (1998) woodlands of over 0.1ha account for 7.4% of the total area for Derbyshire, and 8.0% of total area for Nottinghamshire. This is slightly below the coverage for all of England, of 8.4%[25].

	Number of woodlands >0.1 hectares	Woodland proportion of total area (includes inland water)
Derbyshire	19,513	7.4%
Nottinghamshire	17,298	8.0%



In Derbyshire, 69% of woodland area is less than 100 hectares in size, with just one woodland over 500 hectares, accounting for 3% of total woodland in Derbyshire.

In Nottinghamshire, the woodland area is more equally split between the different woodland sizes: 44% of woodland is less than 100 hectares in size, 24% between 100 and 500 hectares, and 32% greater than 500 hectares in size (3 woodlands).

Overall across D2N2, there are 41 woodlands that are over 100 hectares. This dataset, however, does not specify which woodlands the data refers to.

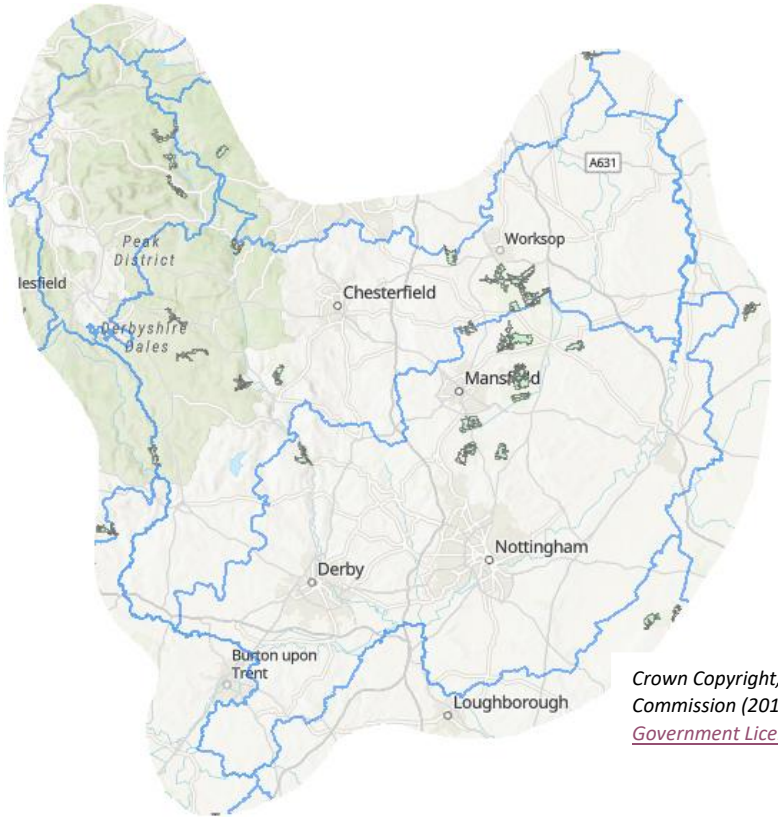
The most recent National Forest Inventory for Woodland in England in 2017 shows 27 woodlands in D2N2 with over 100 hectares area[26], a 34% reduction since the 1998 Forest Inventory. These 27 woodlands are all either broadleaved or conifer, and are listed below with their area in hectares and the name of the wood/forest[27], alongside a map showing the location of these woodlands[26]. For 2017, woodlands over 100 hectares in D2N2 accounted for 2.2% of England's woodlands over 100 hectares and all woodland within the D2N2 region are estimated to account for 3.26% of England's woodlands. There are no areas over 100 hectares of grassland identified within D2N2.

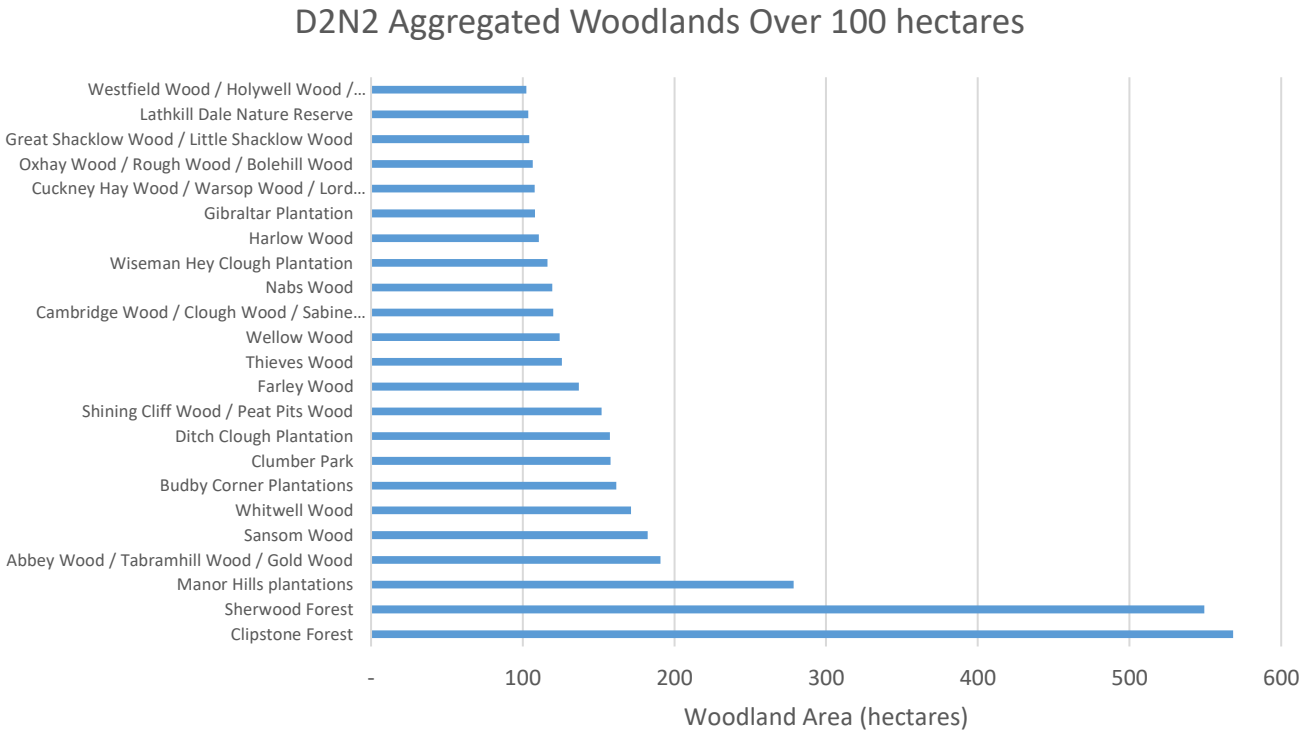
[25] https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/national-inventory-of-woodland-and-trees/national-inventory-of-woodland-and-trees-england/

[26] https://www.arcgis.com/home/webmap/viewer.html?panel=gallery&suggestField=true&url=https%3A%2F%2Fservices2.arcgis.com%2FmHXjwgl3OARRqqD4%2Farcgis%2Frest%2Fservices%2FNational_Forest_Inventory_Woodland_England_2017%2FFeatureServer%2F0

[27] Location names taken from https://www.bing.com/maps and https://www.openstreetmap.org; woodlands with different tree types but the same name have an aggregated total area shown in the graph.

It is estimated 18.2 $MtCO_2$ are removed from UK forestry sinks[28]. In 2019, 41% of the UK's woodland was in England[29]. It is estimated D2N2's woodland cover accounts for approximately 240 $ktCO_2$ removal, with 160 $ktCO_2$ million tonnes from woodlands greater than 100 hectares in area.





[28] https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2016-introduction/uk-forests-and-climate-change/carbon-sequestration/

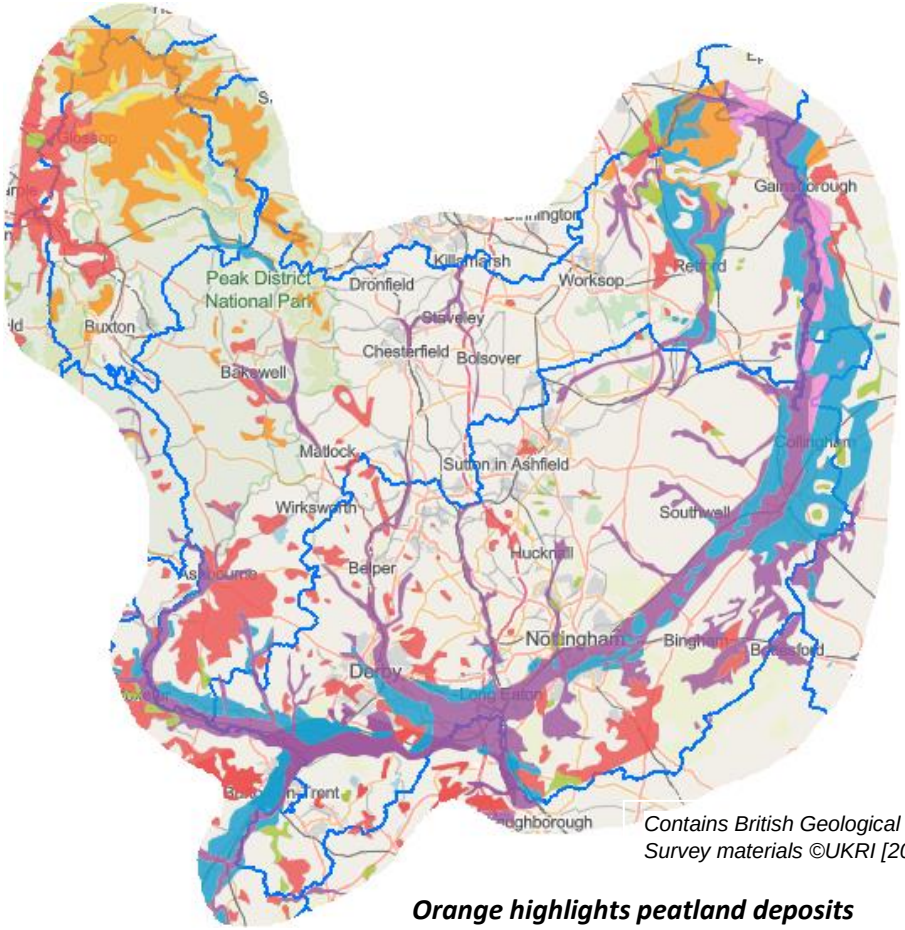
[29] https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/

Peatlands

Superficial deposits in the D2N2 area are shown in the map below[30] – Peat deposits are shown in orange. It is estimated[31] peat within D2N2 covers approximately 190km^2; concentrated in the northern Peak District National Park, with some smaller areas in the south of the national park, and an area to the north west of Gainsborough.

Only the peat in the NE of D2N2 (Tickhill and near Doncaster Sheffield Airport) are considered to be of economic importance[32] in the D2N2 area.

It is noted, however, that the majority of England's peatlands are currently sources of greenhouse gases due to peatland degradation, rather than carbon sinks[33]. Only some areas of the Scottish Uplands, and some of the peat in the Northern Peak District are considered sinks, removing up to 4.11 tCO_2e per hectare per year. For the parts of the peat estimated to be in D2N2, this is estimated to sequester up to 66 $ktCO_2e$ per year.



Contains British Geological Survey materials ©UKRI [2019]

Orange highlights peatland deposits

[30] http://mapapps2.bgs.ac.uk/geoindex/home.html, Superficial Deposits layer

[31] This assumes the shape area is in square kilometres, and uses a by-eye approach to estimating how much of the peat area is within the D2N2 area.

[32] For example, suitable for selling peat for horticultural purposes; peat layer in http://mapapps2.bgs.ac.uk/geoindex/home.html

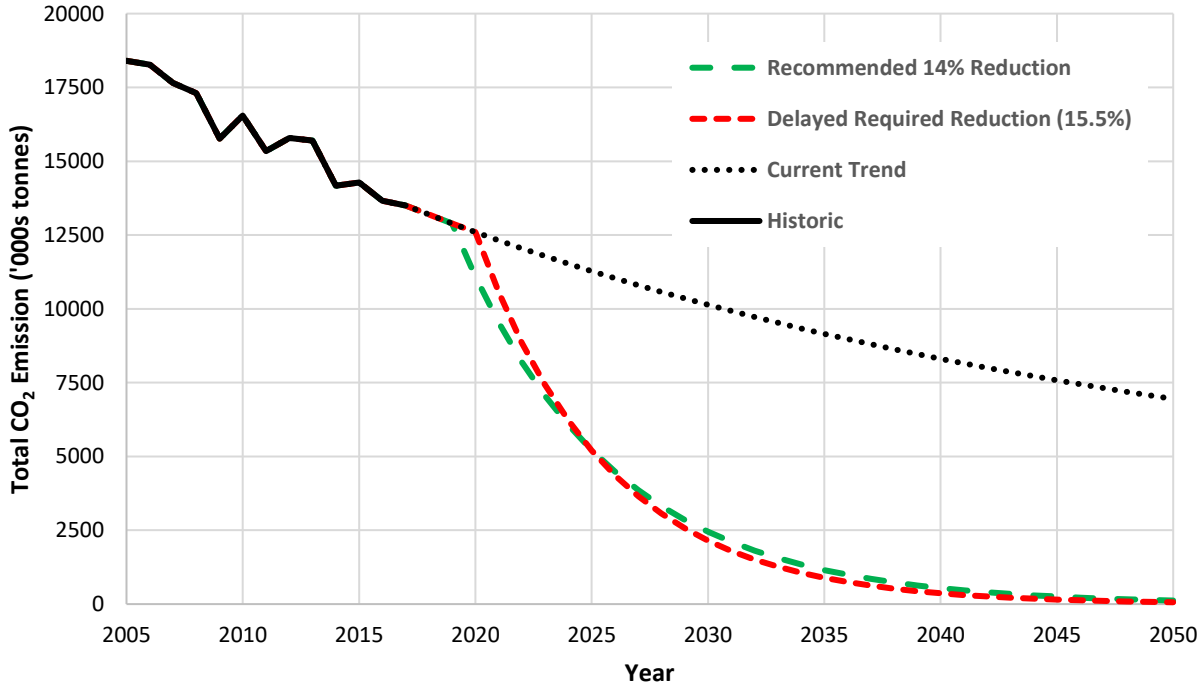
[33] http://publications.naturalengland.org.uk/file/6394909851910144

D2N2 Carbon Budget, BAU and Emissions Reduction Pathway

The Tyndall Centre, University of Manchester, has developed a process to downscale the global carbon budget to local authority areas, which is in line with keeping global temperatures well below 2°C and pursuant of a 1.5°C limit to global temperature rise[34]. Based on these methodologies, the D2N2 area is recommended to keep its cumulative emissions between 2020 and 2100 below 81.3 $MtCO_2$. To put this in context, the total cumulative CO_2 emissions between 2005 and 2017 were 206 $MtCO_2$, over 2.5 times higher than the remaining carbon budget for the next 80 years.

D2N2's business as usual (BAU) emissions scenario has been developed based on extrapolations of emission reduction trends of the three main sectors, over the last 12 year period[35] (see below). This suggests a BAU scenario would follow an average annual emissions reduction of 2% (2020-2100).

Despite a continued reduction in emissions under D2N2's BAU scenario, this recommended carbon budget will be used up in just 7 years, during 2026, and cumulative emissions by 2050 will reach 291 $MtCO_2$, highlighting the urgency in needing to reduce emissions across the D2N2 area beyond that of the current trend.



To stay below D2N2's carbon budget through until 2100, annual emission reduction rates must be in excess of 14%, starting in 2020. Under this pathway, annual CO_2 emissions fall below 1 $MtCO_2$ from 2036 and carbon neutrality is reached in 2040, which is above a 97% reduction from 2005 levels and defined based on the Tyndall Centre definition of where emissions in remaining years fall below 5% of the recommended carbon budget. If the recommended pathway is achieved, 212 $MtCO_2$ emissions will have been avoided by 2050, accounting to 73% of BAU emissions.

[34] Tyndall Carbon Budget Tool https://carbonbudget.manchester.ac.uk/

This pathway requires 1805 $ktCO_2$ to be cut during 2020, which is over four times higher than the average annual emissions reduction of the last 12 years (408 $ktCO_2$). Meanwhile, BAU requires just 291 $ktCO_2$ to be cut, meaning over six times the amount of CO_2 must be reduced for the 14% pathway. This highlights the scale of action required to stay below the D2N2 carbon budget, whereby efforts should be made to reach a 14% reduction in emissions starting from 2020, otherwise this required reduction rate increases to beyond 16.2% to still meet carbon neutrality in 2040, following an additional year of delayed action.

Priority Areas for Emissions Reduction across D2N2

The D2N2 region should stay below 81.3 $MtCO_2$ emissions from 2020 onwards by making every effort to reduce CO_2 emissions beyond 14% annually. This will require a substantial step up in the emissions reduction rates of the three main sectors, with a particular mobilisation in transport emissions reduction. Ultimately, for D2N2 to achieve this, there will need to be more efficient products and buildings, better energy behaviours, cleaner energy sources, accompanied by a reduction in the demand for energy.

Key local authorities to target emissions reductions across the Industry and Commercial sector include High Peak, Bolsover, Newark and Sherwood, Derby and Nottingham. For the Domestic sector, both Nottingham and Derby should be seen as key priorities, whilst the transport sector has key emissions from Newark and Sherwood, Broxtowe, Bassetlaw, Nottingham, Derby, South Derbyshire and Bolsover. These local authorities have been highlighted here as they hold the greatest share of emissions between local authorities, however, efforts must be made in all sectors across all local authorities for the best chance of meeting the 14% reduction target per year. Progress should be measured in absolute terms, however a normalised reduction (such as per capita or per building) can help to inform on how a local authority is performing.

Set out below are key priority areas that D2N2 will have to acknowledge in future policies, plans and strategies.

Improving Building Energy Efficiency

62% of domestic properties and 65% of non-domestic properties across the D2N2 region are below an EPC rating of C. This is a key priority to tackle emissions reductions. Poor household energy efficiency leads to a greater demand for energy to heat buildings and maintain comfortable temperatures, but also, high energy-efficiency is needed to allow low carbon forms of heating to work most effectively such as heat pumps. Moving forward, significant improvements should be made to D2N2's building stock, which will require high level of household and non-domestic building retrofits, with a particular focus on wall (cavity and solid) and loft insulation. Priority should be given to those properties in the worst 1% high emitters, which will enable the greatest opportunity for emissions reductions.

Further to this, there will be an increase in the number of new build homes by 2050, alongside significant new developments expected to take place in the D2N2 Enterprise Zones[36], which should be climate smart in their design and built to the highest possible energy efficiency standards.

Decarbonising Electricity

UK grid electricity has decreased in carbon intensity by 47% since 2010, and is expected to continue to decarbonise into the future as renewable energy generation, such as wind and solar, increases and coal use becomes phased out. D2N2 has been active in helping to decarbonise energy, where the best

[36] http://www.d2n2lep.org/Growth/Enterprise-Zone

estimate of the ratio of the available local electricity generation from low carbon sources to domestic and non-domestic electricity, is 13.9%. Analysis shows, however, that less than 5% of households in the area have solar PV installed, and the installed capacity for other renewable technologies is even lower. Going forwards, D2N2 should make it a priority to increase local low carbon energy generation, with a particular focus on maximizing solar PV and increasing the installed capacity of wind generation, whilst ensuring a varied mix of renewable technologies, small and large scale, to best prepare for a reliable, clean and green future.

Decarbonising Heating and Cooling

Emissions from heat across the UK account for a third of UK greenhouse gas emissions[37]. In D2N2, many buildings are heated by gas (37.5% of D2N2 energy consumption; 88.5% of D2N2 homes heated by gas). Reducing this use of gas is an additional key priority to overcome in order to reduce CO_2 emissions effectively. There will have to be a shift in the way buildings are heated, transitioning away from gas use, towards more low carbon sources, such as electric, heat networks and heat pumps. It is noted, however, that heat pumps are low-temperature heat sources, and thus these would also need to be accompanied by behavioural change and high energy efficiency of building fabric. In addition, there will have to be a shift in the way hot water is heated, transitioning away from gas use to electrical or solar thermal. Hot water stores, however, can play a part in managing future energy systems. There should be a particular focus given to the top 1% emitting domestic properties as these tend to be traditionally built buildings with high carbon producing heat sources, such as mains gas, oil and coal.

Alongside decarbonising heating, as the climate continues to warm on average, and increase in absolute maximum temperatures in the future, it is likely that emissions from cooling will increase unless buildings are more efficient and cooling is achieved through renewable sources like heat pumps.

Decarbonising Transport

1.3 million vehicles are registered on D2N2 roads, a 13% increase since 2009 and the challenge is with a 54% increase in diesel cars and vans, alongside an increase in road miles from cars, whilst the number of public transport journeys has decreased. Decreasing the amount of petrol and diesel vehicles, through increased public transport alternatives, active travel and switching to ULEVs, will significantly help to reduce carbon emissions across the area. Only Nottingham, out of the unitary and two tier authorities in D2N2, has seen an increase in public transport passenger journeys. This though, should be the trend seen across all areas in the future. It is noted, within the BEIS local authority carbon emissions dataset, there is an underlying assumption that all buses are diesel. Although converting bus fleet will reduce carbon emissions, this will not currently be reflected in government published emissions data for LAs.

Reducing Emissions from High Emitting Sites

Emissions from large industrial installations[38] account for 13.6% of D2N2 CO_2 emissions. It is estimated over 80% of these emissions are from major power producers in the D2N2 region. Although some of these have closed since the last available data from 2017 (Cottam Power Station), there are still 2 operating coal power stations (Ratcliffe on Soar, West Burton A) in the area, and 3 Combined Cycle Gas Turbine (CCGT) power stations (Staythorpe C, West Burton B, Cottam Development Centre), which would still significantly contribute to emissions across the D2N2 region.

[37] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf
[38] With cement removed as per the Tyndall Centre methodology.

West Burton A has a contract in place for three of its four units under September 2021; beyond this is uncertain[39]. There are no plans in place to close Ratcliffe on Soar ahead of UK government plans to close unabated coal power generation units by 2025[40]. With these closures, it will be important to replace the resultant energy generation gap with low carbon alternatives.

Although cement production emissions across D2N2 have been removed in the emissions analysis of this report, as per the methodology of the Tyndall Centre, cement installations should still be seen as a priority for emissions reduction for D2N2. Cement accounted for 1.05 $MtCO_2$ emissions in 2017 according to the BEIS pollution inventory and in 2018 accounted for 2.08 $MtCO_2$. These emissions are considerably large and should be acknowledged in future policies and strategies.

All the major power producers, and cement and lime works in D2N2 are among the EU ETS installations with the top 10 highest carbon emissions per year in the D2N2 region. Large industrial installations also include energy from waste, food and drink, non-hazardous landfill, non-ferrous and the water industry, which should all be addressed as priorities for future emissions reduction as they account for a considerable proportion of D2N2's CO_2 emissions. These present a challenge in terms of achieving carbon neutrality, however, as they may be at greater risk from carbon limiting policies.

Exposure and Risks from a Low Carbon Transition

Transitioning to a low-carbon world will have greater risks to some sectors than others, and in policies, planning and strategies the greater risks to these industries and sectors should be recognised. There are risks from the enforcement of an increasing cost to Carbon, from policies that provide disincentives for energy use, and, from market changes away from energy and carbon intensive goods and services. Several of these sectors are outlined below.

Cement Works

Approximately 50% of the cement sector's emissions globally are from the production of clinker, an intermediate product when making cement[41]. As this CO_2 is a result of chemical reaction that occurs during the production of clinker, greater energy efficiency or changing to a low carbon fuel source will not reduce these carbon emissions.

It should be noted that cement production uses Carboniferous limestone and Cretaceous chalk. Carboniferous limestone, in particular, underlies large parts of the Peak District, which also provides an important carbon sink from the overlying peat and woodland. Existing permissions for quarries in D2N2 providing the raw materials for cement production are currently limited to 2042 or before. Loss of this area due to quarrying expansion (e.g. due to need for increased cement production) could thus have twice the impact – greater carbon emissions from cement production, and decreased carbon sink effects, as well as additional negative impacts from environmental degradation.

The Hope Cement Works and Tunstead cement works combined account for approximately 22% of the UK's cement capacity in 2014[42] and contributing £53million to the local economy[43]. Currently in

[39] https://www.power-technology.com/features/seven-up-the-last-operating-coal-plants-in-the-uk/

[40] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672137/Government_Response_to_unabated_coal_consultation_and_statement_of_policy.pdf

[41] https://www.carbonbrief.org/qa-why-cement-emissions-matter-for-climate-change

[42] British Geological Survey Cement Mineral Planning Factsheet, May 2014, from https://www.bgs.ac.uk/mineralsuk/planning/mineralPlanningFactsheets.html

[43] https://www.breedongroup.com/images/uploads/articles/1797_Breedon_HW_eEIA_2018.pdf

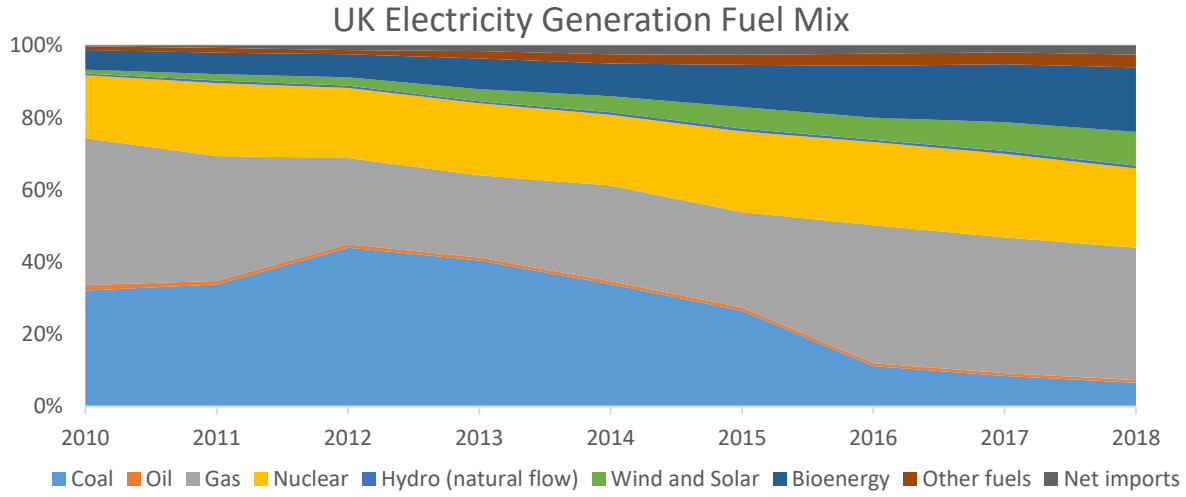
the UK, limestone used in cement manufacture is exempt from the Aggregates Levy[44], and since 2014, cement manufacture has been exempt from the Climate Change Levy[45]. There is the potential that further economic instruments could lead to unequal cement production costs globally and within the EU. This could make the cement works in the UK less competitive, and start to lead to an increase in importing cement. Though this would decrease carbon emissions from the cement works in the D2N2 area, this would have a significant impact on GVA for the region and result in greater imported emissions.

Power Stations

Two of the remaining six coal power stations in the UK are located in the D2N2 area; although Ratcliffe on Soar is due to close in 2025, and West Burton in 2021. These installations are part of the EU ETS. Depending on which source of data used, these two coal-powered sites account for between 1,149 – 5,013 $ktCO_2$ per year[46].

Whilst the closure of these two power stations will lead to a large drop in carbon emissions, this could lead to a large energy generation gap for the UK and D2N2 area. It should be noted, however, that these emissions are not included within the BEIS local authority CO2 emissions, and as such, the closure of these power stations will not affect D2N2's reported carbon emissions. Power stations of this size are considered national assets and infrastructure.

In 2015, many coal-powered stations closed due to the EU Large Combustion Plant Directive (LCPD)[47]. In 2014 (when the UK had 14 coal power plants[48]), coal accounted for 33.9% of the national electricity mix, but just 6.6% in 2018[49]. This electricity generation gap has partly been filled by an increase in the proportion of bioenergy (9.1% to 17.8%), but has also been filled by an increase in the proportion of natural gas (26.5% to 36.7%)[49].



Ratcliffe-on-Soar has a capacity of 2000 MW, whilst West Burton has a capacity of 2012 MW[48]. There is the risk that if filling this capacity gap through burning natural gas, the emissions will still remain

[44] https://www.gov.uk/government/publications/excise-notice-agl1-aggregates-levy/excise-notice-agl1-aggregates-levy#what-materials-are-exempt-from-the-levy
[45] https://www.gov.uk/government/publications/excise-notice-ccl13-climate-change-levy-reliefs-and-special-treatments-for-taxable-commodities/excise-notice-ccl13-climate-change-levy-reliefs-and-special-treatments-for-taxable-commodities
[46] From the Pollution Inventory, in 2018 these two coal-powered sites accounted for 5,012.539 ktCO2. From the EU ETS, in 2017 these two coal-powered sites accounted for 1,149.462 ktCO2. Carbon Brief (2018): Ratcliffe – 10.91 Mt CO2/year; West Burton – 10.99 Mt CO2/year.
[47] https://www.ippr.org/files/images/media/files/publication/2011/05/generation_gap_1521.pdf
[48] http://www.powerstations.uk/coal-countdown/
[49] https://www.gov.uk/government/statistics/electricity-section-5-energy-trends

high, albeit lower than they would otherwise have been. Natural gas is generally deemed a bridge to a lower carbon energy mix, but would need some sort of carbon capture and storage to be part of a carbon neutral scenario.

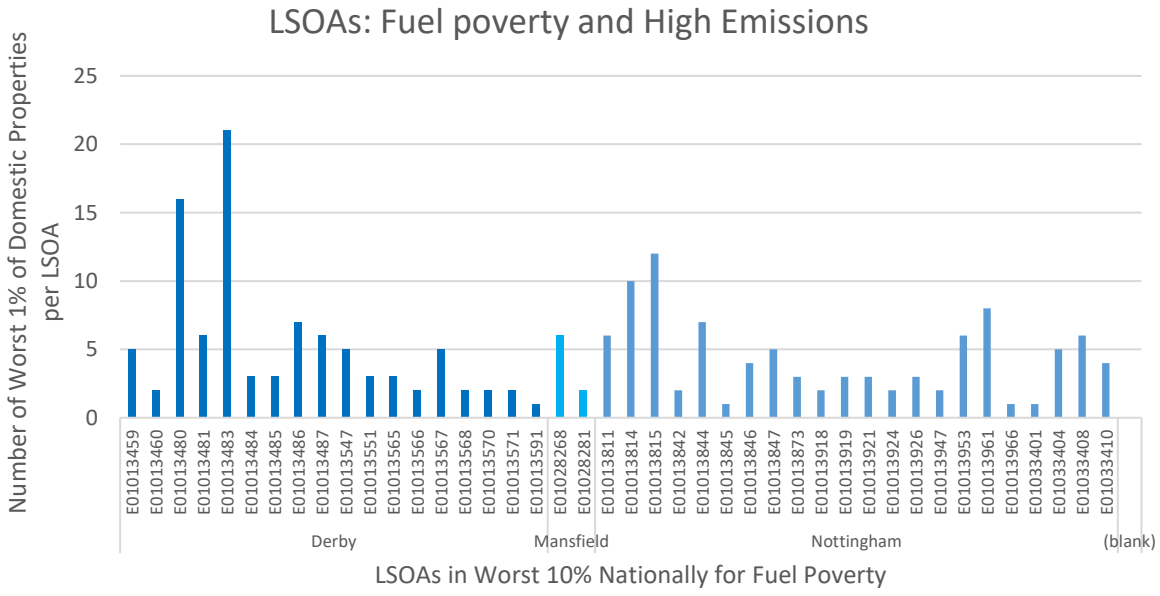
In 2019, the carbon conversion factor for natural gas is 60% of coal for electricity generation. Thus if, when these 2 coal powered power stations close, are instead replaced by burning natural gas, emissions may still be ~689 - 3000 $ktCO_2$. If this was also located in D2N2, these level of emissions is still within the top 10 dominant emitting installations.

Domestic Housing and Fuel Poverty

When considering how to improve domestic building energy efficiency, particularly those for the highest 1% of carbon emitters, it should be noted that some of these overlap with the Lower Layer Super Output Areas (LSOAs) with high levels of fuel poverty.

54 of LSOAs with the 10% highest proportion of fuel poor households nationally can be found in the D2N2 area[50], accounting for 0.08% of UK LSOAs in the top 10% fuel poor LSOAs. This includes 29 LSOAs in Nottingham (16% of all LSOAs in Nottingham), 20 LSOAs in Derby (13% of all Derby LSOAs), 3 LSOAs in Mansfield, 1 in Rushcliffe, and 1 in Bassetlaw.

Comparing these LSOAs with the worst 1% of domestic property emitters shows 94 domestic properties in Derby, 8 in Mansfield, and 96 in Nottingham are in LSOAs, which are in the highest 10% nationally for greatest proportion of fuel poor households. These are shown in the graph below. These properties should be recognised in particular, and the impacts policies and strategies may have on them. The properties here account for 3,919.9 tCO_2 per year, and retrofitting these as a priority would have added social benefit.



[50] https://www.gov.uk/government/statistics/sub-regional-fuel-poverty-2019

Local authority	Number of LSOAs in highest 10% nationally for worst proportion of fuel poor households	Number of LSOAs in worst 10% nationally for fuel poverty and with domestic properties in worst 1% of emitters in D2N2
Bassetlaw	1	0
Derby	20	18
Mansfield	3	2
Nottingham	29	22
Rushcliffe	1	0
TOTAL	**54**	**42**

Appendix 1. Data Limitations and Knowledge Gaps

Carbon Budget

The carbon budget used in this report is an aggregated carbon dioxide budget from the Tyndall Carbon Budget Tool for the D2N2 regions. The methodology for this carbon budget can be found here: https://carbonbudget.manchester.ac.uk/reports/, alongside the assumptions that are used in the process.

Non-CO_2

Carbon dioxide is the main driver of long term warming, however other greenhouse gasses such as methane are still important in affecting rising temperatures. However, due to the varying chemical/physical characteristics of these greenhouse gasses, along with changes in their atmospheric lifetime, the IPCC carbon budgets are for CO_2 emissions as a result of the uncertainties with accounting for other GHGs. In addition, emissions reported here relate to CO_2 emissions as government data does not currently report localised GHG emissions, although this would be a useful development. For more information visit: https://carbonbudget.manchester.ac.uk/reports/.

BEIS Consumption Data

Energy consumption data has been taken from BEIS data, the data limitations and interpretations for this can be found here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843545/sub-national-methodology-guidance-2019.pdf. In general, the variability of the data quality between different datasets that make up the consumption data should be noted, including that this data does not provide a complete coverage of total energy consumption (as some large industrial users are excluded on disclosure grounds), and that the dates covered by different datasets vary and so this data does not cover a fixed annual period.

Energy Generation

The local installation statistics on renewable energy are based on government reported data for FITs and RHI installations. Currently, government data does not exist for all local installations of renewable energy that are not part of these schemes. Therefore, the data reported here is likely to be an underestimate of the total renewable energy available in the D2N2 region. A noticeable gap in the data for energy generation is an updated low carbon energy opportunities report highlighting the potential capacity of local authorities for renewable energy. The last time such a report was developed was in 2011 and can be found here https://www.emcouncils.gov.uk/write/Emids-low-carbon-energy-

opportunities-Final-Report-07-2011-update.pdf. Updating this would aid D2N2 to realise its full potential for renewable energy and where these opportunities lie.

The estimate for low carbon generation across the D2N2 region has been calculated using a number of datasets, this is because no dataset exists that can give a full picture of the install and operational low carbon capacity across the LEP area. Renewable electricity generation statistics are taken from Renewable electricity generation: (MWh) at Local Authority Level – 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729822/Renewables_methodology_note.pdf. There are multiple approaches to gaining an accurate picture of renewable energy in the UK, as a result of different availability of data. Where data is not readily available gap analysis is undertaken, this can include ad hoc surveys such as the 2014 domestic wood consumption survey. For technologies where surveys are not feasible, market data combined with informed assumptions are used.

Combined Heat and Power (CHP) is also used as part of this estimate, and is based upon generation data extracted by a third party based on postcodes in the D2N2 area for 2018. Further information about this data is included in the CHP Special Feature Report – 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/834160/CHP_Regional_2018.pdf.

Transport

Whilst ULEV and vehicle statistics are available at a local authority scale, these statistics are for vehicles registered in the D2N2 area and may not reflect where these vehicles are driven.

In addition, road traffic miles are based on limited raw data counts (manual and automatic counting) of traffic on particular days and road lengths, which have then been extrapolated out to full year and local authority scale.

Data displaying national bus passenger journeys is likely to show accurate figures and trends, especially for key indicators (passenger journeys and vehicle miles), the local bus sector tends to be dominated by large bus companies, of which many provide data. Although, it should be noted that errors can occur in this data, both from sampling and non-sampling.

Tram passenger journeys is derived from ticket data and as a result supplies an accurate picture for local tram operations.

Population

Population figures are based on projected national growth rates, analysis shows these projections are least accurate for London boroughs and Metropolitan local authorities, whilst D2N2 authorities are not mentioned. Armed forces are treated as static population, for which there are a number of army camps in the D2N2 region but some of these are set to close (e.g. Chetwynd Barracks). This may mean that future population projects are slightly higher than the actual population projections.

EPCs Domestic and Non-domestic

The EPC database records all EPCs for each area and does not remove old EPCs from the system and as such causes duplicate EPCs. These duplicates have been removed for this report by keeping the most recent EPC. However, only 56.9% of domestic properties and 26% of non-domestic properties have a recorded EPC. It is assumed that these EPCs are representative for all properties across the D2N2 region but should be acknowledged when interpreting this data.

Further analysis based on the EPCs, for example emissions, are based on figures which are estimated on EPC records. Analysis of smaller groups of EPC data, for example comparing to fuel poverty data,

may have more limitations, due to the age of the EPCs in the dataset, neglected properties, the EPCs not reflecting actual usage, and unusual property constructions. In addition, records were not included in this comparison if the postcode or LSOA was newer than the fuel poverty dataset which comparing to (2017).

BEIS CO_2 Emissions Data

BEIS provide annual CO_2 statistics for local authorities, the methodologies behind this can be found here: https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2017. Key areas of this methodology to take into account for this report includes:

- Electricity mix is allocated to local authorities as equal shares of coal, gas, oil and renewable generation mix
- Gas usage has been weather corrected and is separated between domestic and non-domestic use through using a gas industry cut-off point. However, BEIS identify this leads to two million small businesses being incorrectly identified as domestic. In addition, approximately 40 power stations and 110 large industrial, commercial or public sector users have their data supressed through non-disclosure agreements. This data whilst included in national datasets is not included in BEIS Local Authority data.
- Road transport data assumes 100% of heavy goods vehicles and buses run on diesel. However, in Nottingham for example there has been a significant shift to low carbon powered buses (biogas and electric) which are not accounted for here. Railways also only show diesel railway emissions.

For data limitations and assumptions for dominant emitters and carbon sinks, please see the relevant sections of this report.

Appendix 2. Dominant Emitters Unique Site List

Site	Operator	Local authority	Sector
Somercotes	Reserve Power Trading Ltd	Amber Valley	Minor power producers
Kings Mill Hospital	Skanska Rashleigh Weatherfoil Ltd	Ashfield	Public administration
Welbeck Anaerobic Digestion Facility	Biogas Meden Ltd	Bassetlaw	Biowaste treatment
Cottam	Edf Energy (Cottam Power) Ltd	Bassetlaw	Major power producers
Cottam Power Station	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers
West Burton	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers
West Burton B	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers
Newark	J G Pears (Holdings) Ltd	Bassetlaw	Food, drink & tobacco industry
Cottam Development Centre	Uniper UK Ltd	Bassetlaw	Major power producers
Cottam Power Station	Uniper UK Ltd	Bassetlaw	Major power producers
Daneshill Landfill	Waste Recycling Group Ltd	Bassetlaw	Non-hazardous landfill
Shirebrook Energy Park	Alkane Energy UK Ltd	Bolsover	Minor power producers
Whitwell	Steetley Dolomite Ltd	Bolsover	Lime
Renishaw	Tarmac Aggregates Ltd	Bolsover	Other mineral industries
Beeston	The Boots Group Plc	Broxtowe	No sector specified
Staveley Landfill	Derbyshire Waste Ltd	Chesterfield	No sector specified
Sheepbridge	Gkn Cylinder Liners	Chesterfield	Iron & steel industries
Chesterfield Mill	SIDCOT GROUP LTD	Chesterfield	Paper, printing & publishing industries
Erin Landfill	Viridor Waste (Exeter) Ltd	Chesterfield	No sector specified
Sinfin, Derby	Rolls-Royce Plc	Derby	Vehicles
Wilmore Road, Derby	Rolls-Royce Plc	Derby	Vehicles
Derby	Rolls-Royce Power Development Ltd	Derby	Minor power producers
Derby STW	Severn Trent Water Ltd	Derby	Water industry
Derby City General Hospital	Skanska Rashleigh Weatherfoil Ltd	Derby	Public administration
Derby	Withion Power Ltd	Derby	No sector specified
Hope Cement Works	Breedon Cement Ltd	Derbyshire Dales	Cement
Ashbourne	Derwent	Derbyshire Dales	Other mineral industries
Darley Dale	H J Enthoven and Sons	Derbyshire Dales	Non-ferrous metal industries
Longcliffe Brassington	Longcliffe Quarries Ltd	Derbyshire Dales	No sector specified
Ballidon Quarry	Tarmac Ltd	Derbyshire Dales	No sector specified
City Campus	Nottingham University Hospitals NHS Trust	Erewash	Public administration
Worksop	Premier Foods Group Ltd	Erewash	Food, drink & tobacco industry
Stanton By Dale	Severn Waste Services Ltd	Erewash	No sector specified
Lodge House Colliery	UK Coal Mining Ltd	Erewash	No sector specified
Dorket Head Brickworks	Ibstock Brick Ltd	Gedling	Other mineral industries
Stoke Bardolph	Sarval Ltd	Gedling	Food, drink & tobacco industry

Stoke Bardolph STW	Severn Trent Water Ltd	Gedling	No sector specified
Arnold	Waste Recycling Group Ltd	Gedling	No sector specified
Hindlow Works	Buxton Lime & Cement	High Peak	Cement
Buxton	Buxton Power Ltd	High Peak	Minor power producers
Dove Holes Roadstone Coating Plant	CEMEX UK Operations Ltd	High Peak	Other mineral industries
Chapel-En-Le-Frith	FEDERAL MOGUL FRICTION PRODUCTS LTD	High Peak	Vehicles
Buxton	Lhoist UK Ltd	High Peak	Lime
Disley Mill	Northwood Tissue (Disley) Ltd	High Peak	Paper, printing & publishing industries
Hindlow Quarry	Tarmac Cement & Lime Ltd	High Peak	Lime
Tunstead Quarry	Tarmac Cement & Lime Ltd	High Peak	Cement
Buxton	Waterswallows Energy Ltd	High Peak	Minor power producers
Mansfield	Toray Textiles Europe Ltd	Mansfield	Textiles, clothing, leather & footwear
Mansfield Power Station	UK Power Reserve Ltd	Mansfield	Minor power producers
Newark	British Sugar Plc	Newark and Sherwood	Food, drink & tobacco industry
Staple Quarry Landfill	Duval Waste Recycling Ltd	Newark and Sherwood	Non-hazardous landfill
Kirton	Forterra Building Products Ltd	Newark and Sherwood	Other mineral industries
Staythorpe Power Station	RWE Generation UK plc	Newark and Sherwood	Major power producers
Edwinstowe	UK Coal Mining Ltd	Newark and Sherwood	No sector specified
D200 Energy Centre	D200 Energy Ltd	Nottingham	Chemical industry
Queens Medical Centre (NUH) CHP Plant	E.on Connecting Energies Ltd	Nottingham	Public administration
Nottingham	Enviroenergy Ltd	Nottingham	Processing & distribution of natural gas
Nottingham	Queens Medical Centre	Nottingham	No sector specified
Nottingham Waste Incinerator	SRCL Ltd	Nottingham	No sector specified
Nottingham	University of Nottingham	Nottingham	Public administration
Nottingham Power Plant	Viridis 178 Limited	Nottingham	Minor power producers
Nottingham	WASTENOTTS (RECLAMATION) LTD	Nottingham	Waste collection, treatment & disposal
East Leake Gypsum Works	Saint-Gobain Construction Products UK Limited	Rushcliffe	Other mineral industries
Ratcliffe on Soar Power Station	Uniper UK Ltd	Rushcliffe	Major power producers
Nestlé Tutbury	Nestlé UK Ltd	South Derbyshire	Food, drink & tobacco industry
Burnaston	Toyota Motor Manufacturing (UK) Ltd	South Derbyshire	Vehicles

Appendix 3. D2N2 EU ETS Installations

Site	Easting	Northing	Operator	Local authority	Sector	Emission (tonnes)
Cottam Power Station	481298	379186	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	792,849
Staythorpe Power Station	476500	353500	RWE Generation UK plc	Newark and Sherwood	Major power producers	741,751
West Burton B	478610	385140	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	679,400
Ratcliffe on Soar Power Station	450300	330100	Uniper UK Ltd	Rushcliffe	Major power producers	667,798
West Burton	479190	385530	EDF Energy (Thermal Generation) Ltd	Bassetlaw	Major power producers	481,664
Hope Cement Works	416575	382316	Breedon Cement Ltd	Derbyshire Dales	Cement	282,503
Cottam Development Centre	481500	379500	Uniper UK Ltd	Bassetlaw	Major power producers	189,707
Whitwell	453500	375400	Steetley Dolomite Ltd	Bolsover	Lime	100,773
Buxton	408700	369100	Lhoist UK Ltd	High Peak	Lime	52,281
Hindlow Quarry	409681	367937	Tarmac Cement and Lime Ltd	High Peak	Lime	39,691
Newark	479170	355190	British Sugar Plc	Newark and Sherwood	Food, drink & tobacco industry	31,268
East Leake Gypsum Works	455400	327700	Saint-Gobain Construction Products UK Ltd	Rushcliffe	Other mineral industries	21,401
Nottingham	458210	339080	WASTENOTTS (RECLAMATION) LTD	Nottingham	Waste collection, treatment & disposal	19,857
Sinfin, Derby	436030	331790	Rolls-Royce Plc	Derby	Vehicles	17,349
D200 Energy Centre	454490	336560	D200 Energy Ltd	Nottingham	Chemical industry	14,580
Newark	480381	369350	J G Pears (Holdings) Ltd	Bassetlaw	Food, drink & tobacco industry	9,723
Dorket Head Brickworks	459200	347620	Ibstock Brick Ltd	Gedling	Other mineral industries	8,175
Queens Medical Centre (NUH) CHP Plant	454810	338760	E.on Connecting Energies Ltd	Nottingham	Public administration	7,939
Kirton	468500	367500	Forterra Building Products Ltd	Newark and Sherwood	Other mineral industries	7,479
Darley Dale	426070	362310	H J Enthoven and Sons	Derbyshire Dales	Non-ferrous metal industries	7,182
Burnaston	442910	333070	Toyota Motor Manufacturing (UK) Ltd	South Derbyshire	Vehicles	5,668
Nestlé Tutbury	421660	329650	Nestlé UK Ltd	South Derbyshire	Food, drink & tobacco industry	5,581
City Campus	445670	334410	Nottingham University Hospitals NHS Trust	Erewash	Public administration	5,310
Nottingham Power Plant	455310	337600	Viridis 178 Limited	Nottingham	Minor power producers	5,045
Stoke Bardolph	463760	341580	Sarval Ltd	Gedling	Food, drink & tobacco industry	4,482

Chapel-En-Le-Frith	405760	381430	FEDERAL MOGUL FRICTION PRODUCTS LTD	High Peak	Vehicles	3,738
Disley Mill	398000	385300	Northwood Tissue (Disley) Ltd	High Peak	Paper, printing & publishing industries	3,323
Nottingham	454700	338100	University of Nottingham	Nottingham	Public administration	3,066
Chesterfield Mill	437280	370681	SIDCOT GROUP LTD	Chesterfield	Paper, printing & publishing industries	2,987
Worksop	445740	338060	Premier Foods Group Ltd	Erewash	Food, drink & tobacco industry	2,840
Derby	435988	332278	Rolls-Royce Power Development Ltd	Derby	Minor power producers	2,453
Shirebrook Energy Park	452800	366700	Alkane Energy UK Ltd	Bolsover	Minor power producers	2,061
Derby City General Hospital	432700	334800	Skanska Rashleigh Weatherfoil Ltd	Derby	Public administration	1,753
Dove Holes Roadstone Coating Plant	408300	377960	CEMEX UK Operations Ltd	High Peak	Other mineral industries	1,625
Kings Mill Hospital	451500	359800	Skanska Rashleigh Weatherfoil Ltd	Ashfield	Public administration	1,528
Mansfield Power Station	452400	359772	UK Power Reserve Ltd	Mansfield	Minor power producers	1,144
Nottingham	457840	339450	Enviroenergy Ltd	Nottingham	Processing & distribution of natural gas	954
Mansfield	456670	361800	Toray Textiles Europe Ltd	Mansfield	Textiles, clothing, leather & footwear	942
Wilmore Road, Derby	435840	331980	Rolls-Royce Plc	Derby	Vehicles	815
Somercotes	442493	354953	Reserve Power Trading Ltd	Amber Valley	Minor power producers	506
Renishaw	445039	377861	Tarmac Aggregates Ltd	Bolsover	Other mineral industries	486
East Leake Gypsum Works	455470	327700	Saint-Gobain Construction Products UK Limited	Rushcliffe	Other mineral industries	339
Buxton	408247	375305	Waterswallows Energy Ltd	High Peak	Minor power producers	156
Buxton	409629	375547	Buxton Power Ltd	High Peak	Minor power producers	147
Sheepbridge	437230	374570	Gkn Cylinder Liners	chesterfield	Iron & steel industries	32
Ashbourne	418104	346615	Derwent	Derbyshire Dales	Other mineral industries	1

Appendix 4. Implied Capacity and Rate of Installation

Three examples were selected to provide an indication of the scale, rate of installation and cost of action required to reduce carbon emissions across D2N2 in an effort to pursue an annual 14% reduction, consistent with the regional carbon budget and national targets for net zero.

446,089 properties are estimated to be uninsulated, 46.9% of all D2N2 homes, based on the available EPC data for domestic properties across D2N2 (assuming these EPCs are representative for all domestic properties when scaled up). The rate of installation required to be on track for this year on year emission reduction, would be 1188 insulation works per week in the first year (2020). A full breakdown of installation rates from 2020 to 2050 is outlined beneath the graphs.

For all these properties to be insulated, assuming external wall insulation is required, it would cost an estimated £3.2 to £4.6 billion. This assumes the housing mix for Nottingham (detached/terrace/semi-detached) represents broadly the housing stock for D2N2 and then calculating the lower and upper boundary costs[51]. It is worth noting that there are wide range of housing construction types, conservation restrictions and other constraints that would need to be considered for a more detailed estimate, including other insulation measures such as cavity-wall, roofs and windows.

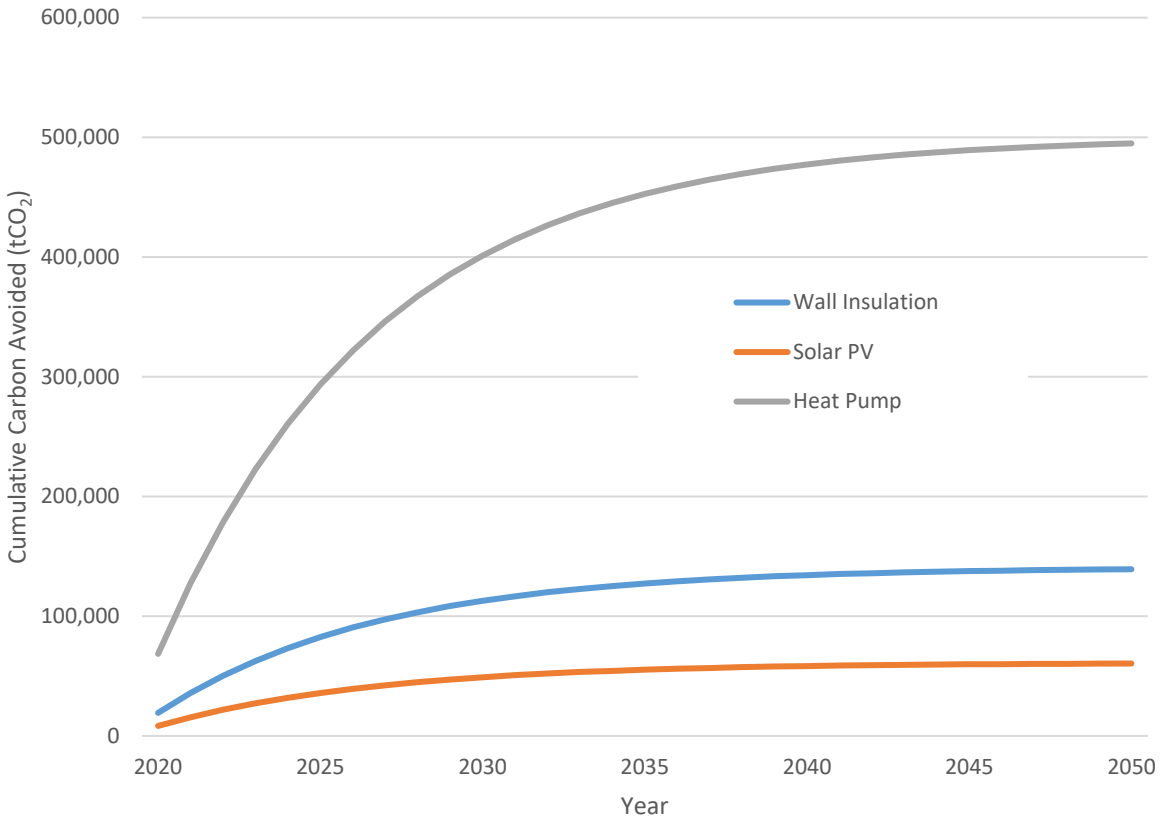
Using East Midlands Council's 2011 potentials for renewable energy report for local authorities[52], D2N2 has the potential for 1.4 GW of solar PV and 4.1 GW heat pump capacity. This would require, for example, 397,349 (3.5kW) household sized solar systems to be installed at an estimated cost of ~£2.38 billion. Meanwhile, to meet the heat pump capacity potential, 512,656 (8kW) heat pump systems would be required (53.9% of D2N2 homes), at an estimated cost of between £3.69-£5.33 billion. Estimates are at today's prices, and it would be reasonable to expect a reduction in costs.

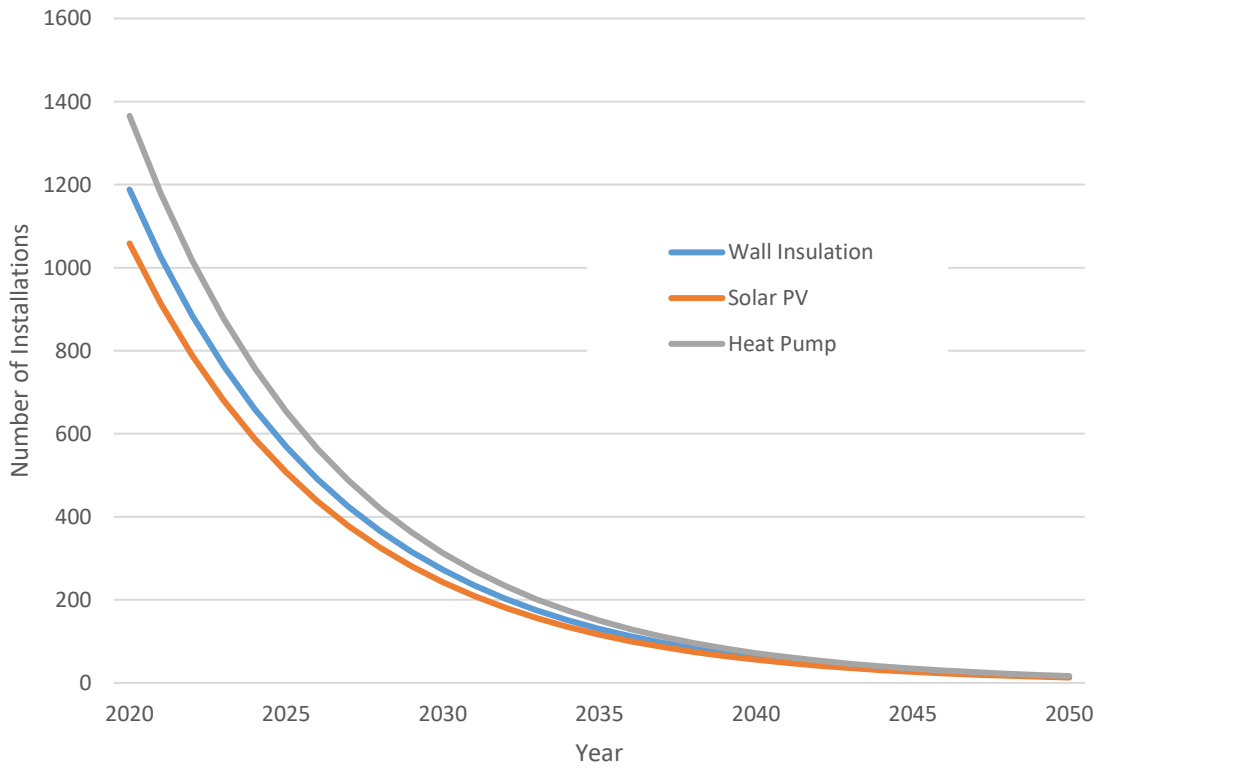
The rate of installation and cumulative CO_2 saved because of these three measures is presented below on the following page[53].

In total by 2050, an estimated 17.4 $MtCO_2$ could be avoided, which would be 6% avoidance of the all BAU projected CO_2 emissions, but 26% avoidance of domestic BAU projected emissions.

Note: the modelling used here is intended to illustrate requirements of matching carbon reduction rates, and not to reflect a realistic programme design or how the market could deliver. Markets and programmes would likely require a more consistent level of demand over time to be sustainable.

[51] https://www.thegreenage.co.uk/how-much-does-external-wall-insulation-cost/
[52] https://www.emcouncils.gov.uk/write/Emids-low-carbon-energy-opportunities-Final-Report-07-2011-update.pdf
[53] Average carbon emissions calculated from: solar & insulation figures https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-report-summary-of-analysis-2018 ; for heat pumps https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/606818/DECC_RHPP_161214_Final_Report_v1-13.pdf


600,000
500,000
400,000
300,000
200,000
100,000
0
Cumulative Carbon Avoided (tCO_2)
2020
2025
2030
2035
2040
2045
2050
Year
Wall Insulation
Solar PV
Heat Pump


1600
1400
1200
1000
800
600
400
200
0
Number of Installations
2020
2025
2030
2035
2040
2045
2050
Year
Wall Insulation
Solar PV
Heat Pump

Year	Required installation rate based on the required 14% emissions reduction trend	Number of properties needing wall insulation	Cumulative carbon saving through wall insulations (tCO2)	Insulation Installations per week required	Insulation Installations per week per LA	Number of properties needing solar PV	Cumulative carbon saving through solar PV (tCO2)	Solar PV installations per week required	Solar PV installations per week per LA	Number of properties needing heat pump	Cumulative carbon saving through heat pumps (tCO2)	Heat pump installations per week required	Heat Pump installations per week per LA
2020	13.9%	61,788	19,276	1188	70	55,037	8,374	1,058	62	71,009	68,515	1,366	80
2021	12.0%	53,323	35,911	1025	60	47,497	15,600	913	54	61,280	127,643	1,178	69
2022	10.3%	46,018	50,267	885	52	40,990	21,837	788	46	52,885	178,671	1,017	60
2023	8.9%	39,714	62,657	764	45	35,374	27,219	680	40	45,640	222,708	878	52
2024	7.7%	34,273	73,348	659	39	30,528	31,864	587	35	39,387	260,711	757	45
2025	6.6%	29,577	82,576	569	33	26,346	35,872	507	30	33,991	293,509	654	38
2026	5.7%	25,525	90,539	491	29	22,736	39,332	437	26	29,334	321,813	564	33
2027	4.9%	22,028	97,411	424	25	19,622	42,317	377	22	25,316	346,239	487	29
2028	4.3%	19,010	103,342	366	22	16,933	44,893	326	19	21,847	367,319	420	25
2029	3.7%	16,406	108,460	316	19	14,613	47,117	281	17	18,854	385,511	363	21
2030	3.2%	14,158	112,877	272	16	12,611	49,036	243	14	16,271	401,211	313	18
2031	2.7%	12,219	116,688	235	14	10,884	50,692	209	12	14,042	414,760	270	16
2032	2.4%	10,545	119,978	203	12	9,393	52,121	181	11	12,118	426,453	233	14
2033	2.0%	9,100	122,817	175	10	8,106	53,354	156	9	10,458	436,543	201	12
2034	1.8%	7,853	125,267	151	9	6,995	54,418	135	8	9,025	445,252	174	10
2035	1.5%	6,777	127,381	130	8	6,037	55,337	116	7	7,789	452,767	150	9
2036	1.3%	5,849	129,206	112	7	5,210	56,129	100	6	6,722	459,253	129	8
2037	1.1%	5,048	130,781	97	6	4,496	56,814	86	5	5,801	464,850	112	7
2038	1.0%	4,356	132,140	84	5	3,880	57,404	75	4	5,006	469,680	96	6
2039	0.8%	3,759	133,313	72	4	3,349	57,913	64	4	4,320	473,849	83	5
2040	0.7%	3,244	134,325	62	4	2,890	58,353	56	3	3,728	477,446	72	4
2041	0.6%	2,800	135,198	54	3	2,494	58,732	48	3	3,218	480,551	62	4
2042	0.5%	2,416	135,952	46	3	2,152	59,060	41	2	2,777	483,230	53	3
2043	0.5%	2,085	136,602	40	2	1,857	59,343	36	2	2,396	485,543	46	3
2044	0.4%	1,800	137,164	35	2	1,603	59,586	31	2	2,068	487,538	40	2
2045	0.3%	1,553	137,648	30	2	1,383	59,797	27	2	1,785	489,260	34	2
2046	0.3%	1,340	138,066	26	2	1,194	59,979	23	1	1,540	490,746	30	2
2047	0.3%	1,157	138,427	22	1	1,030	60,135	20	1	1,329	492,029	26	2
2048	0.2%	998	138,739	19	1	889	60,271	17	1	1,147	493,136	22	1
2049	0.2%	861	139,007	17	1	767	60,387	15	1	990	494,091	19	1
2050	0.2%	743	139,239	14	1	662	60,488	13	1	854	494,915	16	1
Totals	**100%**	**446,327**	**3,484,601**			**397,561**	**1,513,773**			**512,930**	**12,385,742**		