Clean Growth Grand Challenge

Evidence Review Report

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This report was produced by Aly Hendy, with support from the University of Nottingham Business and Local Partnerships, Postgraduate Placements teams, and D2N2 LEP
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Executive Summary

The following section will provide a brief evidence review from multiple sources to present the required information to assess D2N2 performance in the Low Carbon industry.

The shift towards low carbon sources for energy is underway and the carbon intensity of the world’s economy is expected to decrease by 50% by 2040 [5] due to stricter regulations and the transition to renewable and low carbon energy sources. Table 1, shows that the numbers of jobs and the sector's activity have increased compared to the status in 2010.

<table>
<thead>
<tr>
<th>Energy and Low Carbon</th>
<th>Jobs</th>
<th>Local Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count (2016)</td>
<td>LQ</td>
</tr>
<tr>
<td>272: Manufacture of batteries and accumulators</td>
<td>0 0.0 -</td>
<td>0 0.0 -</td>
</tr>
<tr>
<td>351: Electric power generation, transmission and distribution</td>
<td>6,000 2.4 180%</td>
<td>115 0.8 89%</td>
</tr>
<tr>
<td>353: Steam and air conditioning supply</td>
<td>50 1.8 -</td>
<td>0 0.0 -</td>
</tr>
</tbody>
</table>

Source: SQW analysis of BRES and UK Business Counts - Local Units, Nomis

Table 1, Jobs and Local Units Profile by Sector

This activity is only expected to increase, as the efforts made by universities and entities through their research and projects, will only aid with the transitional phase, as evident in table 2.

- **Creative Energy Homes** is a £1.9m project of seven test houses on the University of Nottingham campus. They are living test-sites for leading firms to work with the University to investigate the integration of energy efficient technologies into houses

- **The Community Energy Demonstrator at the Trent Basin** is a large scale regeneration scheme, which includes an integrated smart heat and power micro-grid for low energy demand buildings, ground source heat pumps, and communal battery storage. This is supported by Innovate UK and backed by the University of Nottingham amongst others

- The University of Nottingham’s **Geo-Energy Test Bed** (an Energy Research Accelerator facility) is designated for the testing and ‘ground-truthing’ of borehole sensors and software

- **The Energy Technologies Building** on the University of Nottingham Innovation Park is itself a low carbon building and also hosts research facilities including a smart grid, a prototyping hall and the UK’s first green hydrogen refuelling facility

- **The BGS’ UK Geoenergy Observatories** project will create subsurface energy-research test centres to develop new energy technologies (although the first two centres will be outside D2N2)

Source: SQW analysis

Table 2, Energy Demonstrator Projects
As evident from figure 1, D2N2 performs well in the renewable energy, sustainability and the environment field, as well as the energy field. Showing promise for future investments and research that can help smooth the transition to a sustainable future. D2N2 also performs better than the national average in disciplines of Fuel Technology, Energy Engineering and Power Technology. D2N2 is on par with the UK average in the General Energy and Chemical Engineering. Figure 2, will demonstrate a summarized SWOT matrix of the region to provide an understanding of the contents and purpose of this report.

**Figure 1, D2N2 Strength in Low Carbon Fields (Source: Science and Innovation Audit for the D2N2 Local Enterprise Partnership area)**

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1. Introduction

The global dependency on fossil fuels over the past decades has driven the greenhouse gases to increase to disturbing values. NASA’s [1] studies demonstrate that the carbon dioxide concentrations reached an all time high. This over reliance has driven researchers to explore renewable energy sources in order to tackle the issues surrounding financial vulnerability. Renewable energy sources and energy policies will also aid the process of increasing the security of supply of the resources, as our usage rate will lead to depletion of these resources if we don’t abide by the security measures.

Targeting and analyzing energy consumption data is the key towards unlocking the shift to a low carbon economy. The energy consumption differs for each sector in the UK, differs dependent on the activities of that sector and how energy intensive its requirements are. During the past decades the industrial sector was responsible for a significant portion of the UK’s overall energy consumption, but due to the economic shift in the activities of that sector and the increasing environmental responsibility awareness, the sectors’ energy consumption has been on a decreasing trend.

The following report will demonstrate key areas that govern the Clean Growth sector and analyze the data available to provide a visualization of areas of improvement and key indicators. The report will analyze the emissions, renewable electricity generation and the low-carbon economy in the D2N2 region and provide a comparison to the UK average or standard. The comparison will provide an understanding of how effective D2N2 are as a region in effecting positive change towards a sustainable future.

2. Carbon Dioxide Emissions

Carbon Dioxide emissions are now a key indicator of the energy profile for any region or entity, and are considered a benchmark in measuring how sustainable a country or an institution is. This parameter is particularly important for the UK, as there is a set target for 2050 to reduce emissions by 80% compared to 1990 Levels [2].

2.1 UK Total CO₂ Emissions and Sectors Contribution

Analyzing the emissions per sector will highlight the areas where improvement is required by pinpointing the sector responsible for the highest emissions. The analysis will help clear up, which sectors are inefficient in their energy operations.
and how these operations have caused emissions to fluctuate over the years, displayed using figures and tables.

**Figure 2**, Total UK Emissions per Sector (Source: Regional CO2 emissions - BEIS)

**Figure 3**, Total UK Emissions Contribution per Sector (Source: Regional CO2 emissions - BEIS)
Figures 1 & 2, demonstrate that the industrial sector’s energy intensive operations have lead to extensive emissions, which have affected the county’s emission profile. The main factor contributing towards the high emissions is process of industrial and commercial electricity generation, responsible for 36% of the industrial sector’s total emissions, followed by industrial gas operations (25%). Emissions due to transportation has been steady throughout the last decade, however, has been increasing since 2014. The transport sector was responsible for 26% of the total UK emissions, now this percentage has increased to 36%. The increasing population will increase the demand on transport vehicles, and although the manufacturer’s are producing increasingly efficient cars, the overuse of these vehicles still results in an alarming amount of emissions.

It is also evident that as emissions from the industrial sector decrease, the transport sector emissions have increased, however the domestic sector emissions have remained consistent, averaging 30% over the years.

2.2 D2N2 Total CO₂ Emissions and Sector Contribution

The UK emissions profile was analyzed to help provide an understanding of how D2N2 performs in comparisons to the UK average. The following figures will display the emissions trend over the past decade and how different sectors contribute to emission levels. These trends and analysis of the sectors will allow for certain areas to be addressed ensuring a sustainable future.
Figures 3 and 4, display that D2N2 emissions profile has been following the same pattern as the UK with minor differences, as the industrial sector is also clearly the biggest contributor towards the total emissions of the region. The emissions from the domestic sector are decreasing over the years, following the national drift, however, the fluctuations are much more irregular than that of the national average. Although the general pattern of emissions is decreasing, it hasn’t been a smooth declination with several emissions’ spikes occurring, especially between 2009-13.

The figures also show that at the beginning of 2005, the industry sector was responsible for 42% of the emissions, with this value decreasing over the years, due to stricter industrial regulations and an increased awareness of the GHG emissions crisis. The industrial sectors’ contribution dropped to 35% by the end of 2016, whilst the transport sector made the opposing change, increasing from its original 25% to 34%, almost displacing the industrial sector as the sector with the most emissions. Unlike the UK trend, with a gap of 4% between the industrial and transport sector’s emissions contribution, D2N2 only has a 1% gap between the two sectors. This highlights that the emissions per capita for the transport sector for D2N2 is higher than the national average. Dissecting the emissions scene in D2N2, analyzing the emissions per capita will provide a more accurate platform to compare D2N2 to the UK average. As this will display whether D2N2 is releasing more emissions than the region should in regards to the area’s population. Figure 5, displays D2N2’s emissions per capita, for every sector; it is clear that the gap between the sectors has decreased. The industrial sector is still the most alarming one, leading all three sectors in terms of emissions release. However, the transport
sector’s emissions have been increasing in recent years (2015-16), and if the same overall pattern continues, the transport sector is on track to overtake the industrial sector. Therefore, many efforts have been shifted towards exploring the feasibility of electric cars and hydrogen fuel cells, with the UK infrastructure plan making £43 billion (AECOM Report) available for transportation funding and investment.

2.3 D2N2 Emissions Profile and the National Average

To compare D2N2’s performance to the rest of the country, figure 6, displays the different regions of D2N2 and their emissions per capita, compared to the national average across the years.
Figure 6, demonstrates that Nottingham and Derby are performing exceptionally, with an emissions per capita trend falling constantly below the national average with no apparent future rise, however, the bigger regions such as Nottinghamshire follow the national average and exceed it in the year 2015, but still proximate to the general trend. Derbyshire recorded a noticeably higher emissions per capita trend than the UK average, which could be due to the fact that Derbyshire is considered a manufacturing intense county, with most of the emissions resulting from industrial operations. Figure 7 below will display the emissions per capita for each sector for the year 2016, as a comparative template to gauge D2N2’s performance.

![Figure 8, 2016 Emissions per Capita (D2N2 & National Average)](Source: Regional CO2 emissions - BEIS)

At first glance, the figure shows several important differences, as it displays that D2N2 exceeds the national average in every sector in emissions. The domestic and transport sectors differ slightly, as they’re higher than the national average by 7% and 4% respectively. Figure 6, previously displayed that Derbyshire exceeded the national average emissions per capita and it was tracked to the industrial installations in the region. Figure 7 emphasizes the previous analysis as D2N2 exceeds the national average in the industrial sector by 33%. Therefore, we can consider the industry sector, specifically in Derbyshire to be a threat to D2N2’s performance and needs to be addressed quickly as to abide by the national targets, of reducing emissions and shifting towards renewable energy sources, for example, cutting the national emissions by 80% by 2050.
3. Renewable Electricity Generation

The previous section reviewed the emissions data, which analysed historic trends and sector contribution. D2N2’s industrial sector is considered to be the biggest contributor to sector emissions. However, the main reason behind this contribution is the sector’s operations to produce electricity. Therefore the electricity was analyzed as a separate sector, as shown in figure 9.

![D2N2 Total Emissions per Sector](image)

Figure 9, D2N2 emissions per sector (add. Electricity) (Source: Regional CO2 emissions - BEIS)

Electricity was the main contributor towards emissions, however, its decreasing trend displays evidence of the introduction of renewable sources of electricity generation. Therefore the following section will analyze the renewable electricity profile in the UK and more specifically, D2N2.

The previous section demonstrated the national emissions profile and dissected the emissions per sector for the UK and more specifically for D2N2. It highlighted some areas in need of improvement when comparing D2N2 emissions to the national average for every sector. The carbon dioxide emissions resulting from the overuse of fossil fuels is one of the main reasons the UK is eager to transition towards renewable energy sources as they don’t result in GHG emissions that negatively impact the environment. The following section will analyze renewable electricity data for 2017, demonstrating the number of sites, renewable energy capacity and renewable energy generation for each region (local authority). The figures will highlight D2N2 performance and the region’s capacity and generation.
The number of renewable energy sites and their capacity for every region is important to know as it shows the region’s potential in shifting to renewable
energy sources in the future. D2N2 seems to accommodate 5% of the UK’s total renewable energy sites (inc. all technologies listed). This contribution shows that D2N2 is not stagnant in the renewable energy scene; however, D2N2’s contribution can increase by exploring more technologies and new technology applications such as mine water heating. Local company Alkane Energy has developed technologies to extract methane gas from underground mine workings, which is then used to power generators and sell electricity to the national grid. Alkane are also developing technology to use warm mine water as a renewable source of heating and cooling at its plant at Markham in Derbyshire.

It’s evident from figure 10, that D2N2 houses 43% of the UK’s Co-Firing capacity, however, in the grand scheme of things, the UK’s reliance on co-firing is minimal and there are only four co-firing sites across country. Other noticeable technologies are Photovoltaic (PV) (5%) and anaerobic digestion (4%); exceeding the UK average by 4% in the aforementioned technologies. Analyzing the generation of these technologies will be more elaborative of their effectiveness then analyzing their current capacity to perform. The technologies’ electricity generation shows its potential future application, demonstrating whether or not the renewable source can be relied on for electricity generation. Figure 11 below displays the average renewable electricity generation per household for each technology, comparing D2N2’s average and the national average.
The renewable electricity generation was analyzed per household as to provide a more comparable view of the electricity generation in regards to the size and population of the region. Calculating the generation per household, gives a clearer display of the region’s ability to produce electricity relative to its population and the type of technology used. Figure 11, compares D2N2 average generation across its local authorities to the average of the local authorities in the UK. D2N2 excels noticeably in the technologies; photovoltaic, anaerobic digestion and co-firing. Co-firing is understandable as D2N2 houses 43% of the technologies capacity. The photovoltaic generation per household shows potential as it exceeds the national average by 31%. This is a great opportunity for D2N2 as it’s predicted that solar and wind energy technologies will account for up to 39% of the UK’s power generation in 2060, increasing from a low 4%\(^3\).

4. Low Carbon Economy

The idea of shifting towards renewable energy sources has always been practical from an environmental point of view; however, the challenge was the ability of the renewable sources to cover for the electric demand and the technologies’ economic feasibility. The Low-Carbon Economy (LCE) revolves around sustainable businesses, which operate in the renewable technology and clean energy market.
4.1 D2N2 LCE Comparison (LEPs & National Average)

The most updated dataset for the low carbon economy available was for 2011-12. The low carbon economy has been narrowed down to three main categories for each LEP to estimate the performance; the number of companies operational, the number of employees and the amount of sales each LEP achieves. The figures below will compare D2N2 performance in the LCE for every category to the best national performing LEP (excluding London) and the worst performer.

Figure 14, LEPs (inc. D2N2) LCE Sales & National Average
(Source: LCEGS LCE Report 2011-12)

Figure 15, LEPs (inc. D2N2) LCE Companies & National Average
(Source: LCEGS LCE Report 2011-12)
According to the low carbon economy (LCE) data available, visualized in figures 12 and 13, D2N2’s efforts in terms of companies’ activities have resulted in yearly sales, exceeding the national average by a noticeable margin. D2N2 also managed to exceed the UK average in terms of employment measures (figure 14) and number of companies existing in the LCE. The efforts by the city councils as well, like investing in district heating schemes, create jobs and encourage new start-up businesses in the LCE as it shows promise in creating a sustainable future and meeting the 2030-2050 targets.

According to the data available, D2N2 exceeds the national average in sales, companies and employment by 31%, 29% and 32% respectively. These are very encouraging statistics, highlighting that although the region is producing more emissions than the national average, efforts are being made in the LCE to rectify the situation and aid the process of shifting towards a low carbon future.

4.2 D2N2 LCE Against East Midlands LEPs

The next section will display D2N2’s superior position in the LCE compared to other LEPs, specifically in the East Midlands region. Nationally, D2N2 falls 5th in the LCE ranking in terms of overall contribution.

Top 5 National LCE Ranking:

1st – London
2nd – South East
3rd – Greater Manchester
4th – Leeds City Region
5th – D2N2
London is usually excluded from comparisons as the capital is much superior to any other LEP in the country, as it far exceeds the national average and can skew the data. However, including London, D2N2 is still in the top 5 LEPs in terms of contributions towards the LCE. This shows great potential for the years to come, especially with £265 million investments available for efficient electricity storage technologies [4]. D2N2 comparison to East Midlands LEPs can be displayed in the figures below (15 and 16).

Figure 17, D2N2 LCE Sales & Companies Performance versus East Midlands LEPs (Source: LCEGS LCE Report 2011-12)

Figure 18, D2N2 LCE Employment Performance versus East Midlands LEPs (Source: LCEGS LCE Report 2011-12)
D2N2 recording the highest Sales, Employment and Companies, exceeding the East Midlands region average by 56% (shown in table 3). There is potential for growth for D2N2 for the years to come, especially with £265 million investments available for efficient electricity storage technologies [3].

<table>
<thead>
<tr>
<th>LEP</th>
<th>Sales £m</th>
<th>Companies</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2N2</td>
<td>3,924.50</td>
<td>1,556</td>
<td>28,716</td>
</tr>
<tr>
<td>Greater Lincolnshire</td>
<td>1,672.00</td>
<td>665</td>
<td>12,207</td>
</tr>
<tr>
<td>Leicester &amp; Leicestershire</td>
<td>1,963.35</td>
<td>780</td>
<td>14,383</td>
</tr>
<tr>
<td>East Midlands Average</td>
<td>2,519.95</td>
<td>1,000.33</td>
<td>18,435.33</td>
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<table>
<thead>
<tr>
<th></th>
<th>% Increase in Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2N2</td>
<td>56%</td>
</tr>
</tbody>
</table>

Table 1, D2N2 LCE Performance in East Midlands (Source: LCEGS LCE Report 2011-12)

Table 1, emphasizes the figures displaying D2N2 LCE performance in 2011-12, and highlights the LEP’s leading numbers in the East Midlands region, exceeding the average by a promising 56%, displaying the effort put forth by the low carbon entities to better the position of their region in the LCE. D2N2 has the ability to take advantage of its natural reserves, such as the Peak District National Park, Sherwood Forest and the National Forest [3] for implementing low carbon projects.
7. References


