

Circular Ecology

Central Lincolnshire Local Plan: Climate Change Evidence base

Task K - Embodied Carbon

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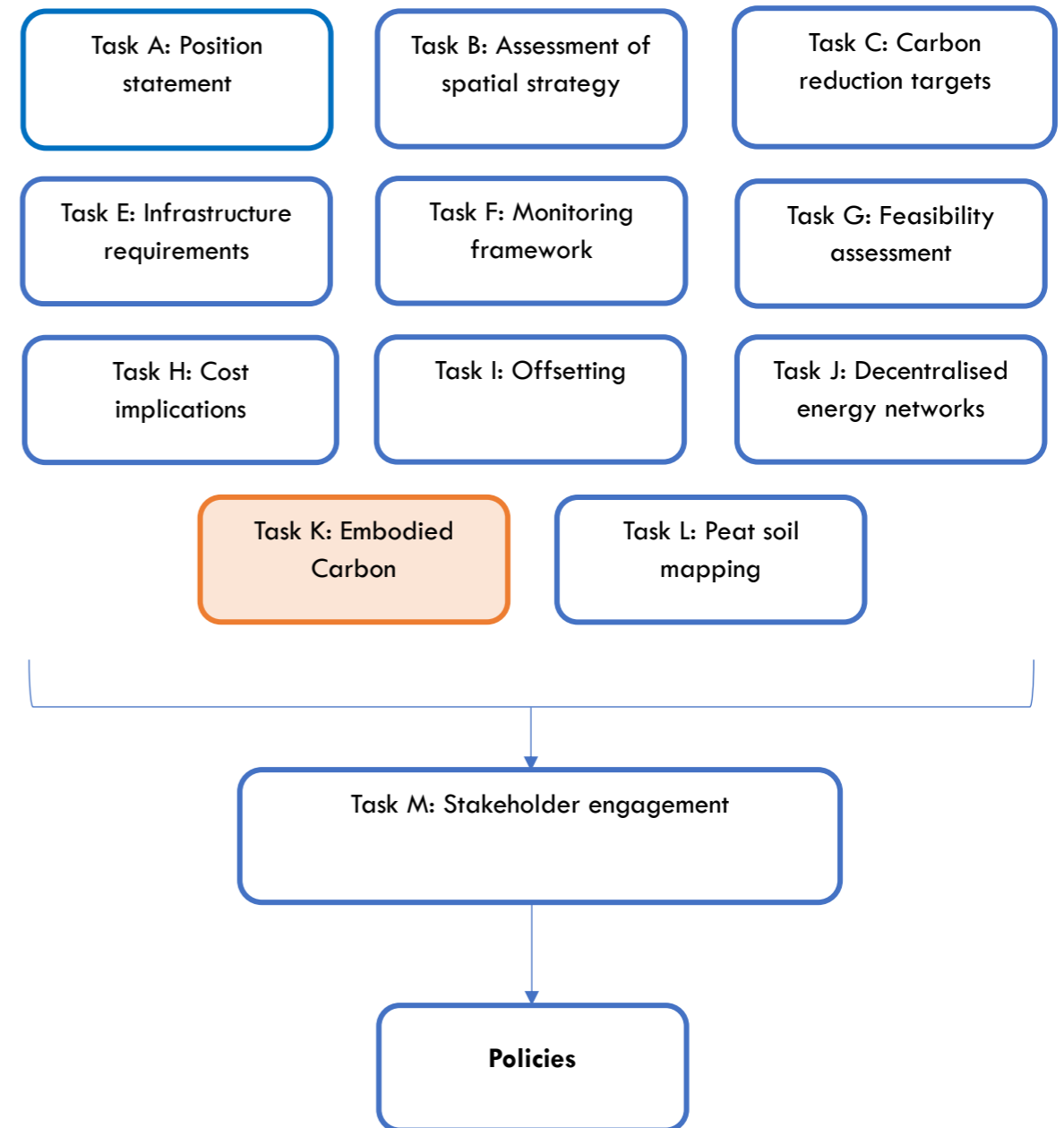


Task K: Embodied Carbon

Using best available embodied carbon data from recent research compiling embodied carbon data from over 1,000 case studies, we have used carbon benchmarks based on kgCO₂e per m² floor area to derive the headline embodied carbon of the plan period's total build out.

We have used Task A to scope the opportunity to influence developers use of low carbon materials and construction methodologies. From this we have made an estimate of the likely carbon saving potential of the implementation of these policies.

This is part of a wider set of analyses (shown in diagram to the right) to support the relevant local authorities in their stated commitments to combat climate emergency by transitioning their entire areas to net zero carbon by 2030 (Lincoln and North Kesteven) or no later than 2050 along with the national legislated goal (West Lindsey, and Lincolnshire County Council). It is also relevant to Lincolnshire County Council's Green Masterplan¹.



Embodied Energy (Carbon)

1. Recommendations

- 1.1. A policy for embodied carbon measurement and reduction efforts to be required for developments over a specified threshold of floor area or £ value.
- 1.2. Add more specific embodied carbon reduction requirements in future years.
- 1.3. Requirements should be for embodied carbon, not embodied energy.

2. Introduction and Overview

- 2.1. The aim of this task is to advise whether or not the Local Plan could reasonably include a policy which required developers to build using materials of low embodied energy, with an indication of the amount of embodied CO₂e (CO₂ equivalent) from new builds, amount of reduction of CO₂e that can be expected, and the cost implications.

3. Method and Results

- 3.1. The embodied carbon (EC) of domestic and non-domestic buildings was estimated for the duration of the Central Lincolnshire Local Plan. The number of new build properties was estimated using historical new build data from a reference period of 2010-2020 for Lincoln, North Kesteven, and West Lindsey (Hereafter referred to as the 'scope areas').
- 3.2. The key data for non-domestic dwellings was provided directly by the Central Lincolnshire Local Plan team. Estimating the number of new non-domestic properties was more challenging. The key data sources for the non-domestic buildings were records of Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs). Both EPCs and DECs cover new and existing buildings. Therefore, the proportion from new constructions needed to be estimated.

Non-Domestic Energy Performance Certificates (EPCs)

- 3.3. The EC for non-domestic buildings was generated using EPC data from (Ministry of Housing, Communities & Local Government, 2020). This supplied information on the number of EPCs lodged in the scope area by yearly quarters, and the type and size of property these lodgements belonged to. Data from the reference period was used, and older data was omitted from the data analysis as it was considered too old. From this information, the sum of the yearly four quarters was calculated to give yearly totals for the number of lodgements and floor area for each building type in the scope areas.
- 3.4. Using data from (Ministry of Housing, Communities & Local Government, 2020), it was estimated that 17% of lodgements per year were placed for new builds and conversions, with the remaining 83% of lodgements assumed to be renewals. Therefore, yearly totals for buildings built per year and total floor area built were based on this 17% new-build rate.

- 3.5. The embodied carbon footprint of the 'building types' was estimated using the Scottish Futures Trust embodied carbon benchmarks (Scottish Futures Trust, 2019). Building types in the EPC datasheets were matched as closely as possible to the benchmarks. Property type 1 (Administration, Business, Commerce) was taken as 'offices', Property type 5 (Law & Order, Emergency Services) was taken as 'mixed use', and Property type 6 (Transport) was taken as 'leisure' to match the benchmarks. These benchmarks gave the embodied carbon per metre squared of gross internal floor area for each building type for the scope areas. The percentage contributions of each building type compared to average number of buildings built in the reference period was used to estimate the total embodied carbon for the scope areas.

Table 1: Estimate of New Build Properties, based upon EPC data

Area	Estimated Non-Domestic Properties per Year	Average Floor Area - m ²	Total Floor Area - m ²	Estimated Embodied Carbon - tCO ₂ e per Year	Average Embodied Carbon per Property - tCO ₂ e
Lincoln	30	695	20,911	12,288	409
North Kesteven	20	462	9,093	5,657	287
West Lindsey	18	584	10,528	6,417	356
Central Lincolnshire	68	598	40,532	24,361	359

Non-Domestic Display Energy Certificates (DECs)

- 3.6. The embodied carbon for the remaining non-domestic buildings was calculated using DEC data published by the Ministry of Housing (Ministry of Housing, Communities & Local Government, 2020). This data gave information on the number of DEC lodgements placed per year for the scope areas, and total floor area of the yearly lodgements. The methodology for data analysis was handled in a similar way to the EPCs, including the 17% assumed new-build rate. However, different building types were not provided with the DEC data, therefore, the median EC footprint benchmark for all types per metre squared of floor area was used to calculate the EC per year for the scope areas.

Table 2: Estimate of New Build Properties, based upon DEC data

Area	Estimated Non-Domestic Properties per Year	Average Floor Area - m ²	Total Floor Area - m ²	Estimated Embodied Carbon - tCO ₂ e per Year	Average Embodied Carbon per Property - tCO ₂ e
Lincoln	13	3,864	52,223	33,423	2,473
North Kesteven	6	2,679	15,212	9,736	1,715
West Lindsey	7	2,335	15,601	9,984	1,494
Central Lincolnshire	26	3,209	83,035	53,143	2,054

Table 3: Estimate of All New Build Non-Domestic Buildings

Area	Estimated Non-Domestic Properties per Year	Average Floor Area - m ²	Total Floor Area - m ²	Estimated Embodied Carbon - tCO ₂ e per Year	Average Embodied Carbon per Property - tCO ₂ e
Lincoln	44	1,678	73,133	45,710	1,049
North Kesteven	25	958	24,305	15,392	607
West Lindsey	25	1,057	26,129	16,401	664
Central Lincolnshire	94	1,319	123,567	77,504	827

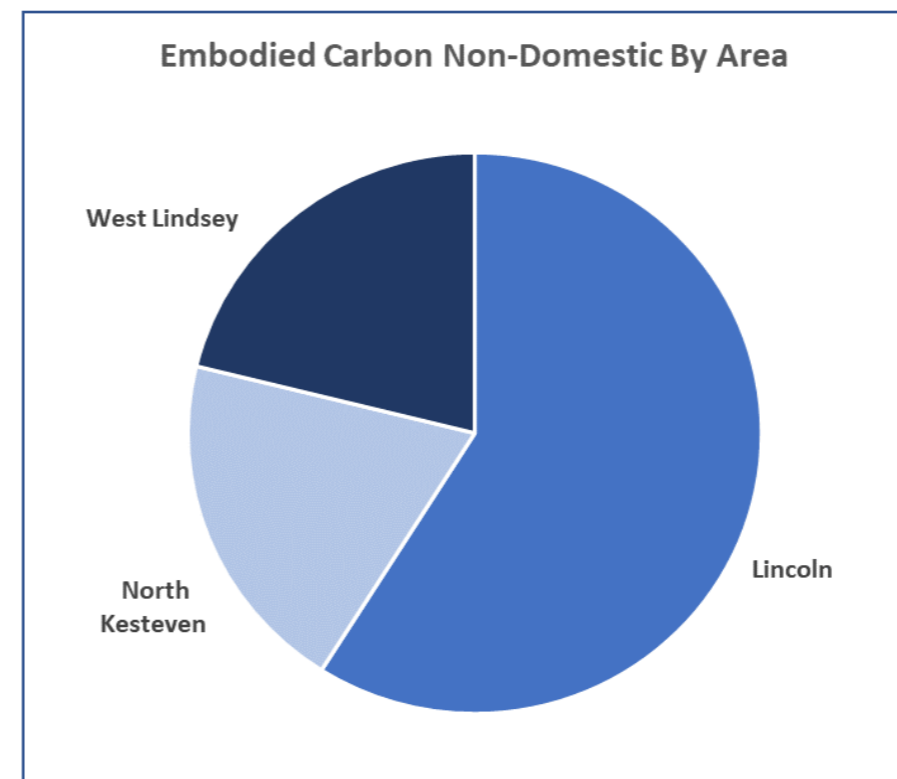


Figure 1: Embodied Carbon, Non-Domestic Properties by Area

Residential Dwellings

3.7. Information on the number of domestic properties built in the scope areas in 2019 was provided by the Central Lincolnshire Plan Team, in addition to the housing type. Housing types were matched to those found in the English Housing Survey (Ministry of Housing, Communities & Local Government, 2018), based on the assumed number of rooms, in order to estimate the average floor area of each property type. Studio apartments and 1-bed properties were categorised as 'flats', 2-bed properties were categorised as 'terraces', 3-bed properties were categorised as 'semi-detached', and 4- and 5-bed properties were categorised as 'detached'. The EC per m² of each property type was calculated using the Scottish Futures Trust embodied carbon benchmarks for domestic properties, and the embodied carbon contribution of each housing type was calculated using the percentage of each housing type compared to the total built in 2019. Total floor area built in 2019 for each property type was multiplied by the respective benchmark, to give a total embodied carbon per year.

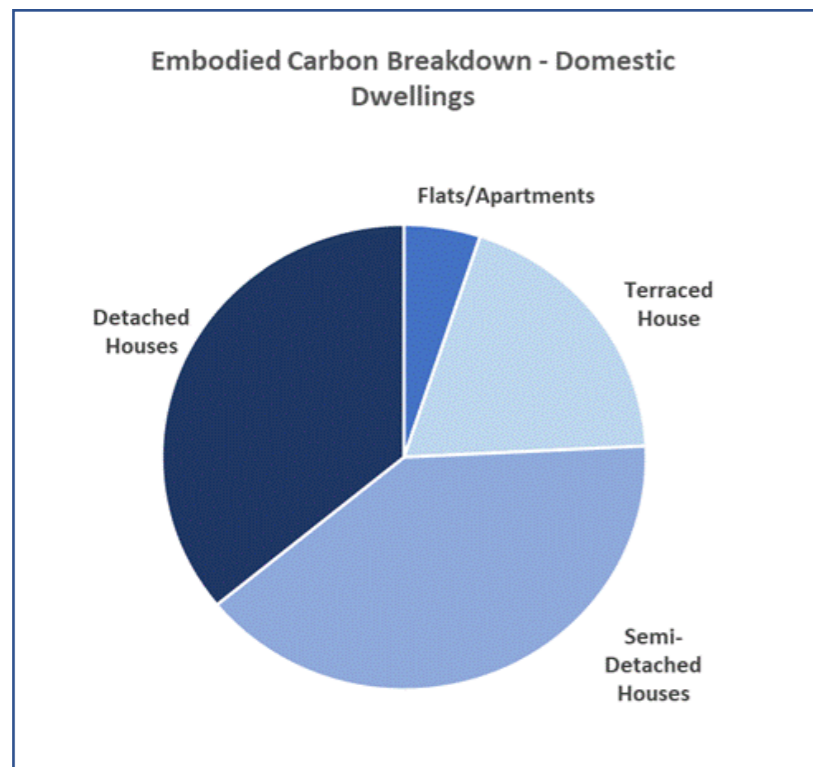


Figure 2: Central Lincolnshire Embodied Carbon Breakdown - Domestic Dwellings

Table 4: Dwelling Types and Embodied Carbon

Dwelling Type	Estimated Dwellings per Year	Average Floor Area - m ²	Total Floor Area - m ² per year	Embodied Carbon-tCO ₂ e per m ²	Estimated Embodied Carbon - tCO ₂ e per Year	Average Embodied Carbon per Dwelling - tCO ₂ e
Flats/Apartments	131	55	7,207	0.49	3,531	27
Terraced House	437	76	33,188	0.40	13,275	30
Semi-Detached Houses	550	93	51,133	0.54	27,612	50
Detached Houses	420	152	63,911	0.39	24,925	59
Central Lincolnshire	1,538	101	155,439	0.48	69,344	45

Table 5: Estimated Dwellings and Embodied Carbon per Dwelling

Area	Estimated Dwellings per Year	Estimated Embodied Carbon - tCO ₂ e per Year	Average Embodied Carbon per Dwelling - tCO ₂ e
Lincoln	205	9,243	45
North Kesteven	760	34,266	
West Lindsey	573	25,835	
Central Lincolnshire	1,538	69,344	45

4. Total Embodied Carbon Estimate

- 4.1. The EC per year based on EPCs for the three regions in the scope area was calculated by multiplying the average EC contribution of the buildings by the total gross internal floor area (GIA) of the buildings over an average of ten years. The following figures are rounded. Providing estimates of 12,300tCO₂/y for Lincoln, 5,700tCO₂/y for North Kesteven, and 6,400tCO₂/y for West Lindsey. These three figures were then added together to give the total EC per year for the scope area in tCO₂ (30,900tCO₂/y), which was then extrapolated from 2018-2041 to show the cumulative EC for the non-domestic buildings in the Local Plan, based on EPCs.
- 4.2. The EC values based on DEC were 33,400tCO₂/y, 9,700tCO₂/y and 9,980tCO₂/y, for Lincoln, North Kesteven, and West Lindsey respectively, giving a total EC for DEC of 53,143tCO₂/y, which was added to the EPC total to give an EC per year of 77,500tCO₂/y.
- 4.3. Total EC per year for domestic properties was calculated by adding the EC per year for each housing type together, giving a total of 69,300tCO₂/y.
- 4.4. The total EC values for non-domestic and domestic buildings were added together to give a yearly EC of 146,800tCO₂/y. This value was then extrapolated into the future to give the EC for the Local Plan up to 2041.

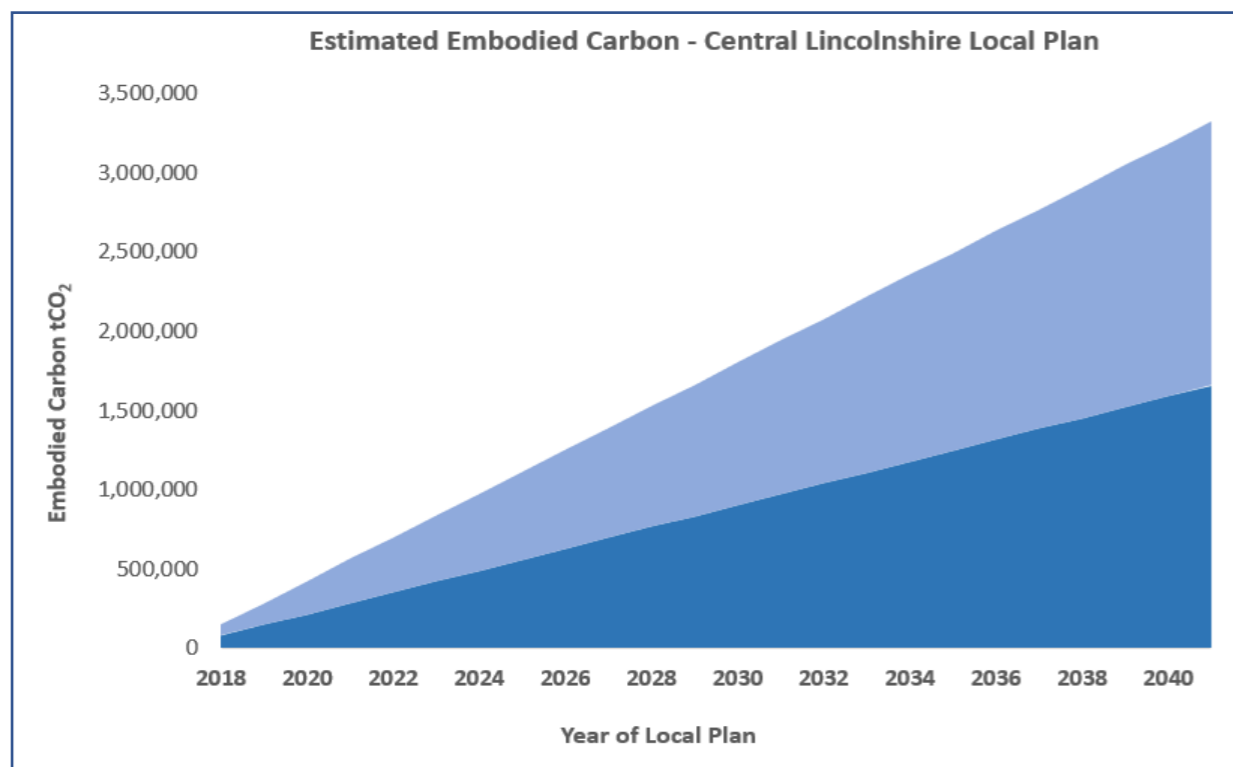


Figure 3: Estimated Embodied Carbon in the Central Lincolnshire Local Plan

5. Embodied Carbon Reduction

New Residential Buildings

- 5.1. Residential buildings would be best targeted on the size of developments, rather than the size of individual dwellings. This would improve efficiency of EC reduction measures, targeting the larger developments. It would also currently be cost prohibitive for one-off and small developments to undertake embodied carbon assessments.
- 5.2. Smaller developments could however be required to reduce EC, through targeting and cost-effective EC reduction measures, such as lower carbon concrete, increased use of natural materials, timber frame, eco-paints, higher recycled content carpets, timber flooring...etc. This approach would be most effective with clear and concise guidance, written for a public audience, outlining a series of simple and cost-effective embodied carbon reduction measures that they could implement.

New Non-Domestic Buildings

- 5.3. For new non-domestic buildings, consideration should be given to setting a threshold on size, such as m² floor area, or construction value, £, to require EC measurement. Larger developments are increasingly completing building life cycle assessments for

the building rating system *BREEAM* credits. These developments should also be required to reduce EC.

New Infrastructure

- 5.4. When implemented correctly, EC can also reduce costs of infrastructure. This should also consider operational carbon, known as whole life carbon. It was concluded that “reducing carbon reduces costs” in the Infrastructure Carbon Review 2013, published by HM Treasury.
- 5.5. An isolated carbon assessment cannot be expected to achieve this. Instead, carbon reduction needs to be embedded within an infrastructure project and organisation, such as compliance with the standard PAS 2080, Carbon Management in Infrastructure.

Relevant Embodied Carbon Initiatives

- 5.6. Royal Institute of British Architects (RIBA) 2030 climate challenge, which sets ambitious EC reduction targets for 2025 and 2030.
- 5.7. Residential RIBA challenge targets, compared with 2020:
 - 2025 = 25% lower EC.
 - 2030 = 50% lower EC.
- 5.8. Non-domestic RIBA challenge targets, compared with 2020:
 - 2025 = 19% lower EC.
 - 2030 = 37.5% lower EC.
- 5.8. These targets are designed as a challenge, but could be implemented more gradually on a timeline.
- 5.9. Scotland is currently developing a Net Zero Carbon method for Public Sector buildings, as a voluntary initiative.
- 5.10. Netherlands has required all residential and office buildings over 100m² to have a building Life Cycle Assessment (LCA) since 2013. Although a larger threshold is recommended, to target larger developments which can accommodate the resource.

6. Conclusion and reasons for recommendation

- 6.1. It is recommended to consider a policy for embodied carbon reduction and embodied carbon measurement.
- 6.2. This should be based upon a threshold of above a specified floor area, m², and / or construction spend, £.
- 6.3. Making it pragmatic. It would be challenging to apply to small projects
- 6.4. Further research would be required to make a recommendation on an appropriate threshold
- 6.5. Requirements on embodied carbon reduction, could be increased on a future timeline. For example:
 - Setting embodied carbon targets once the initiative has been in place for several years.

- Extending to require efforts on reductions, which at first could be targeted to cost effective and practical reduction measures.
 - Extending to smaller projects in the future.
- 6.6. This approach is recommended to target the larger developments, which have a good opportunity to reduce embodied carbon.
 - 6.7. The opportunity to reduce embodied carbon needs to be taken at the start of the project. Once the building is complete, it is no longer possible to reduce embodied carbon of the construction.

Other options considered and reasons rejected

- 6.8. Embodied carbon assessment for all buildings was considered, but judged unfeasible for small, one off residential buildings and refurbs. However, those could be targeted by requiring effort to reduce embodied carbon. Particularly if presented with clear guidance on targeted and cost-effective embodied carbon reduction measures.

Bibliography

[Footnotes]

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ⁱ Lincolnshire County Council (2020), *Environment and Planning: Green Masterplan*. <https://www.lincolnshire.gov.uk/green-masterplan>