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# **Net-Zero Bridge Design**

**The Net-Zero Bridges Group**

**Feb 24, 2024**



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Welcome to this reference text for net-zero bridge design.

This is a community-developed open-source project hosted by the *Net-Zero Bridges Group* (NZBG) in the United Kingdom.

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**Note:** The Net-Zero Bridges Group are a community of practitioners representing many of the leading bridge design firms in the UK - check out the [NZBG website](#) for more information.

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The immediate objective of this project is to collate detailed and up-to-date guidance on low-carbon design for UK-based bridge designers. We hope that from the outset this resource will help users design structures that are *best-in-class* from a whole-life carbon perspective.

Importantly, there are two features of this resource that the reader should be aware of.

1. This book is published in an open forum on Github (PROVIDE LINK). Contributions, comments and debate are essential and welcomed *inline* directly in the source repository. Additions to the book are controlled and curated by a rolling panel drawn from the NZBG. Guidance, advice and encouragement for would-be contributors can be found [here](#).

There is a lot to do in a short-space of time. Any help you can lend will be appreciated.

2. This is an example of an [Executable Book](#), an online resource that mixes long-form narrative content, with code and calculations. Think of it like a traditional text book, except that the worked examples are live.

The medium-term goal is that community development of this resource will allow it to evolve swiftly to reflect and embody an accelerating green transition.

Ultimately, with widespread engagement and institutional endorsement, we hope to become a genuine forum for debate and innovation; with real influence and a structure that encourages faster progress in the development of general practice.

It is worth noting that this book willingly steps outside the siloed realm of the bridge designer into other infrastructure disciplines and makes no excuses for doing so. Through challenge and cross-pollination of ideas we seek to better ourselves and the planet.

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**Note:** This resource is published as a **web friendly** text book. A static pdf can also be downloaded from [here](#)...(TODO)

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UK practitioners are likely to be familiar with the publicly available specification [PAS2080:2023 Carbon Management in Infrastructure and Built Environment](#). For convenience this book seeks to align terminology with PAS2080, and in structure it follows the same high-level carbon reduction hierarchy.

*Avoid -> Switch -> Improve*

Finally it concludes with some detailed observations on infrastructure project delivery in the UK context; some specific trends, pressure points and blockers that the NZBG have identified as requiring a step-change in behaviour.

- Why do we build bridges
  - *Why do we build bridges?*
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  - *Heading: part1/heuristics.md*
  - *Keeping Track*
- Low-carbon design is good design
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  - *Glossary*
  - *Index*

## **Part I**

# **Why do we build bridges**





## WHY DO WE BUILD BRIDGES?

Introduction to the “Avoid” part. (split over multiple parts).

Start with the trickiest and most abstract concept for many bridge designers. Often brushed aside.

Acknowledge large chains of command, lack of decision making power etc. Acknowledge that progress needs to be linear, and decisions made need to stick. Acknowledge that not building is not an option. Society needs infrastructure.

BUT.

Even given all this. Observe the context. State of the climate. Extreme times. Open eyes.

Then frame construction industries contribution to this. .. and bridges/transportation infrastructure within this.

We are not going to save the planet on our own. But every community is going to have to prepare for and initiate dramatic changes. This is our bit.

There are many of us who **are** involved in decision making. Whether we are advising clients directly, sitting on review panels, crunching numbers for optioneering exercises, responding to tenders, or commenting in the industry press. It matters that the community has the ability to question the value of what we enable. We are the experts and we are heard, but we have to be consistent to be effective.

SO...

To be able to contribute we must understand how infrastructure decision-making is carried out, and we need to be able to “kick the tyres”. Not least because in a world where carbon emissions are increasingly regulated and aggressively challenged, a weakness in this aspect is a major project risk.

DfT guidance. Local Authorities. Main public clients - investment strategies. Private clients. Scale.

Understand optioneering process. When are the arguments made and how are they judged.

Demonstrate some heuristics. User vs embodied carbon. Discounting over typical life-time. Carbon pay-back. Influence of road geometry. Influence of congestion. Cost of detours. Interaction between carbon price and investment. Carbon cost of infrastructure per unit. Modal shifts. Rail vs Plane vs Car. Land-use change.

If it still makes sense... can we avoid some of it?

Assess marginal impact. Prioritise sub-options. De-scope. Re-scope. Push it back. MVP. Adaptability/safe-guarding resources for future.

Talking about this. Appropriate channels. Communication strategies. Timing. Examples of good professional practice.



## HEADING: PART1/CONTEXT.MD

### 2.1 Heading: part1/construction\_climate.md

### 2.2 Heading: part1/bridge\_tech\_designers.md

Not sure what was meant to go in here.



**HEADING: PART1/HEURISTICS.MD**



## KEEPING TRACK

If a structure is indeed going to be built it is now unthinkable not to plan, track and manage the embodied carbon emitted by the project. Appropriate monitoring of real or projected carbon emissions is absolutely crucial; without quantified carbon assessments it is impossible to effectively optimise for carbon, or convince stakeholders that the work being carried out is responsible.

### 4.1 What to track

To do so bridge designers are advised to follow the guidance provided in....

### 4.2 How to track carbon

Important that this is done in a consistent manner.

```
import pandas as pd
import matplotlib.pyplot as plt

# initialise data of lists.
data = {'Material': ['Concrete', 'Steel', 'Asphalt'],
        'A1-3': [20, 35, 5],
        'A4-5': [10, 5, 10],
        'B-D': [5, 5, 30]}
df = pd.DataFrame(data)
df.set_index('Material', inplace=True)
print(df)
ax = df.plot(kind='bar', title="Carbon", figsize=(15, 10), legend=True, fontsize=12)
ax.set_xlabel("Lifecycle module", fontsize=12)
ax.set_ylabel("Carbon emitted/kgCO2e", fontsize=12)
plt.show
```

```
C:\Users\dan.g\AppData\Local\Temp\ipykernel_29064\2215569576.py:1:
↳ DeprecationWarning:
Pyarrow will become a required dependency of pandas in the next major release of
↳ pandas (pandas 3.0),
(to allow more performant data types, such as the Arrow string type, and better
↳ interoperability with other libraries)
but was not found to be installed on your system.
If this would cause problems for you,
please provide us feedback at https://github.com/pandas-dev/pandas/issues/54466
```

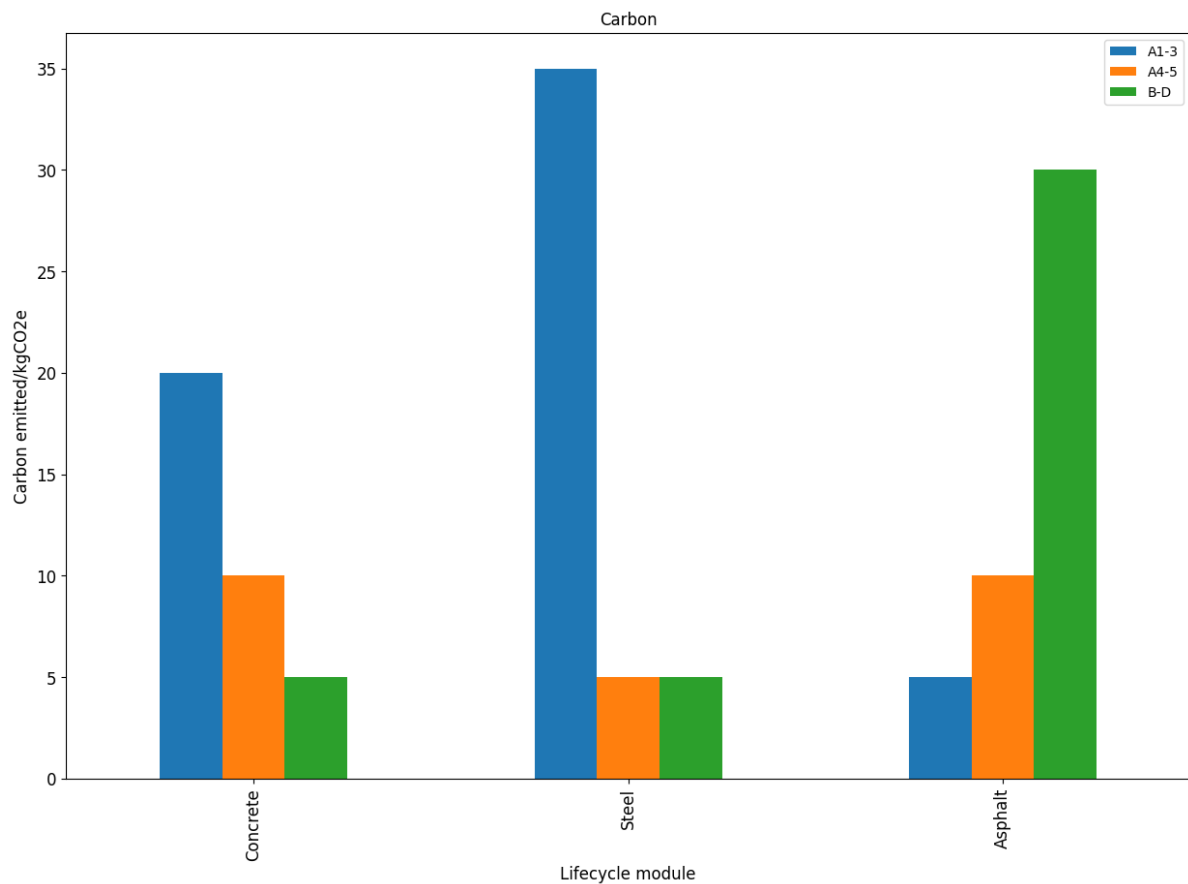
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```
import pandas as pd
```

	A1-3	A4-5	B-D
Material			
Concrete	20	10	5
Steel	35	5	5
Asphalt	5	10	30

```
<function matplotlib.pyplot.show(close=None, block=None)>
```



### 4.3 When to track carbon

### 4.4 How to communicate carbon assessments

To do so



## **Part II**

# **Low-carbon design is good design**



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**7.4 Heading: part2/station.md**

**7.5 Heading: part2/eco.md**





**HEADING: PART2/CARBON\_AND\_COST.MD**

**8.1 Heading: part2/opportunities.md**

**8.2 Heading: part2/prioritisation.md**

**8.3 Heading: part2/communication.md**



## **Part III**

# **Good design is low-carbon design**



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**HEADING: PART3/DESIGN\_CRITERIA.MD**

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**10.5 Heading: part3/safety.md**

**10.6 Heading: part3/services.md**





**HEADING: PART3/EFFICIENT\_DESIGN.MD**

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## **Part IV**

### **Step change**



**HEADING: PART4/INTRO.MD**



**HEADING: PART4/STAKEHOLDERS.MD**





**HEADING: PART4/AMBITION\_IS\_DEFAULT.MD**



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## **Part V**

# **End-game**



**HEADING: PART5/CONCLUSION.MD**



**HEADING: PART5/COMMUNITY\_CONTRIBUTION.MD**



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## **GLOSSARY**

**Net-Zero Bridges Group**

We are a group of bridge specialists, including engineers and architects, committed to helping our industry reduce its carbon footprint as quickly as possible.

**whole-life carbon**

The Global Warming Potential of an asset over its life.

**PAS2080:2023**

Management standard for whole life carbon in buildings and infrastructure.



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