Carbon and Environmental Footprinting – Thinking Globally, Acting Locally.
23rd Sept 2008

Embodied Energy & Carbon Data for Footprinting Studies

23rd Sept 2008

Presented by **Craig Jones**

Sustainable Energy Research Team (SERT)
Department of Mechanical Engineering
University of Bath, United Kingdom

Embodied Energy (EE) & Embodied Carbon (EC)

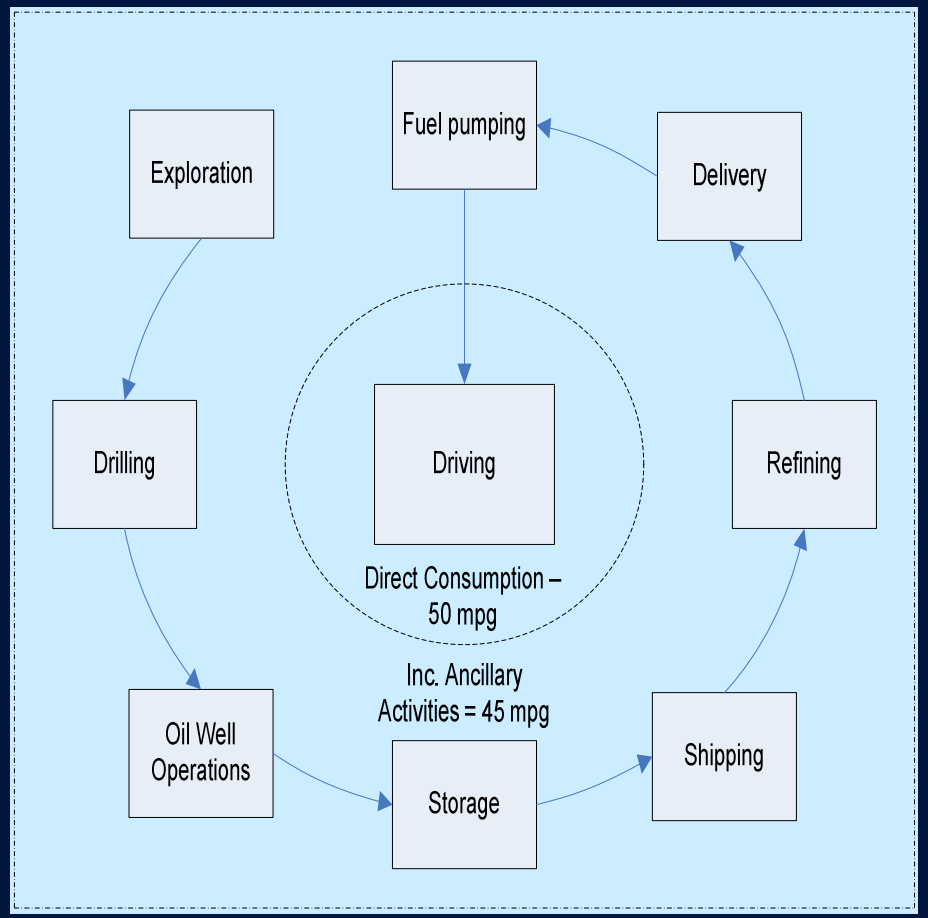
Embodied Energy (Carbon) may be taken as…

…the primary energy consumed (carbon released) to extract, process, transport, and fabricate a product (or activity).

This ideally includes all energy & carbon sources associated to the product i.e. all energy flows must be traced upstream.

Life Cycle Thinking

- e.g. driving a car
- Fuel consumption = 50 mpg (5.65 ltr/100 km)
- ……but this is only the direct fuel consumption!!
- Ancillary activities = extra indirect impacts

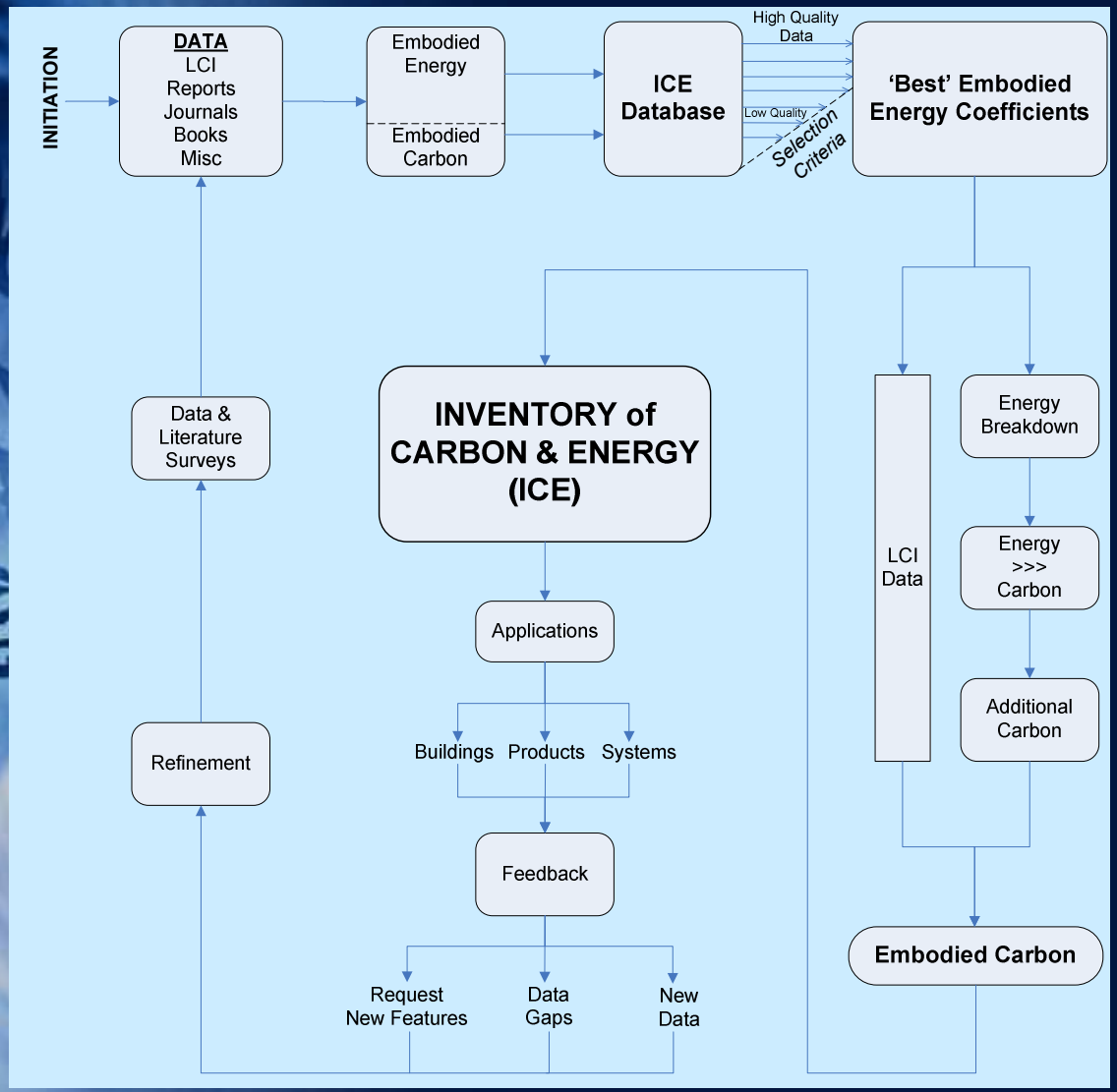


Actual fuel consumption = 45 mpg (6.3 ltr/100 km)

Creation of an Embodied Energy (EE) & Embodied Carbon (EC) Database

- Created as a result of a Carbon Trust and EPSRC research project - BMT
- Aim: EE & EC of typical buildings
- Requires EE & EC of many materials
- Requires a robust and reliable database for a broad range of materials...
- ...was considered unavailable
- Therefore we developed our own database…

Inventory of Carbon & Energy (ICE) Methodology



- Gather All Possible Data
- Build ICE Database
- Select Best Coefficients

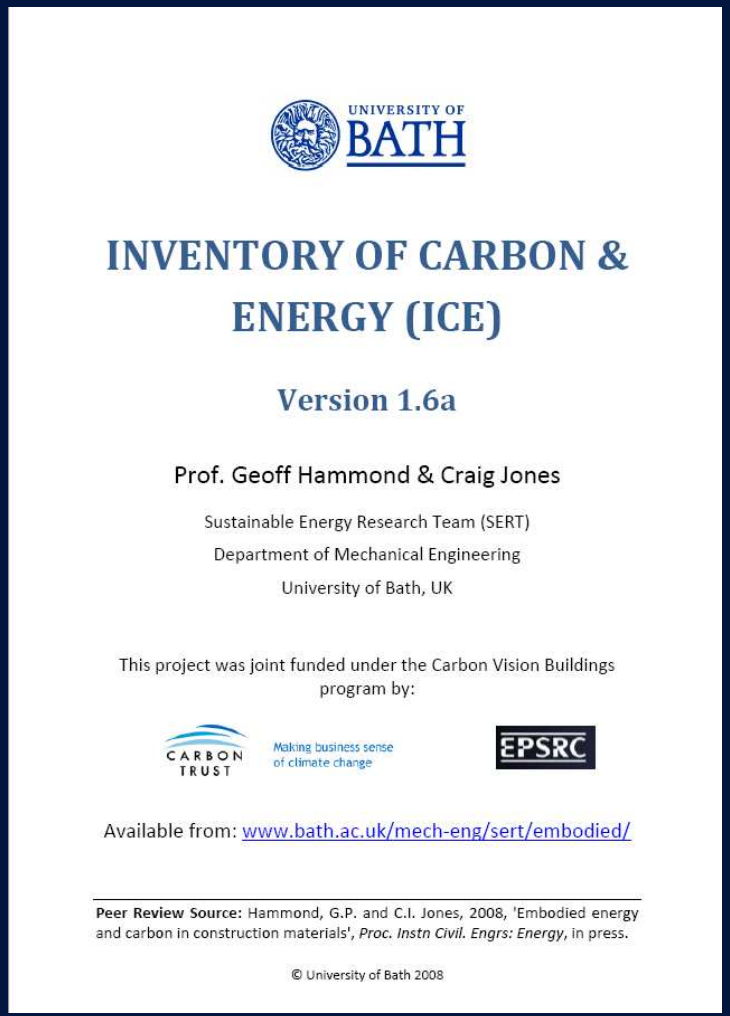
EMBODIED CARBON

- Energy by Fuel Source for typical UK manufacture
- Carbon Producing Energy
- Extra Carbon Released / Absorbed, i.e.
  - Cement
  - Timber

Inventory of Carbon & Energy (ICE)

- ICE is an embodied energy & embodied carbon database
- Primary focus: Construction Materials...
- …although has a broad application domain
- Embodied Energy & Carbon Coefficients for 400 + selected values (EE & EC)
- Aim: Typical & usable market products
- Identifies primary & secondary materials
- Freely available at:

www.bath.ac.uk/mech-eng/sert/embodied



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INVENTORY OF CARBON & ENERGY (ICE)

Version 1.6a

Prof. Geoff Hammond & Craig Jones

Sustainable Energy Research Team (SERT)

Department of Mechanical Engineering

University of Bath, UK

This project was joint funded under the Carbon Vision Buildings program by:

CARBON TRUST Making business sense of climate change

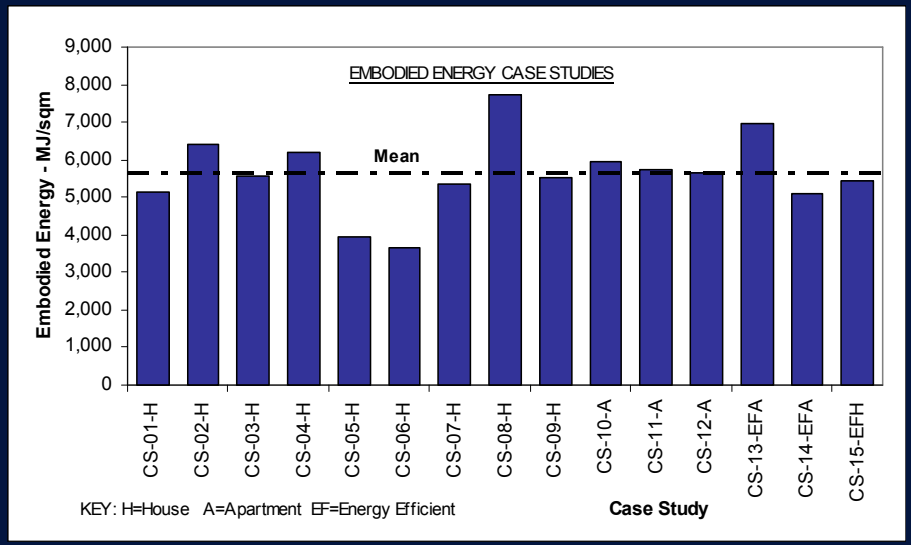
EPSRC

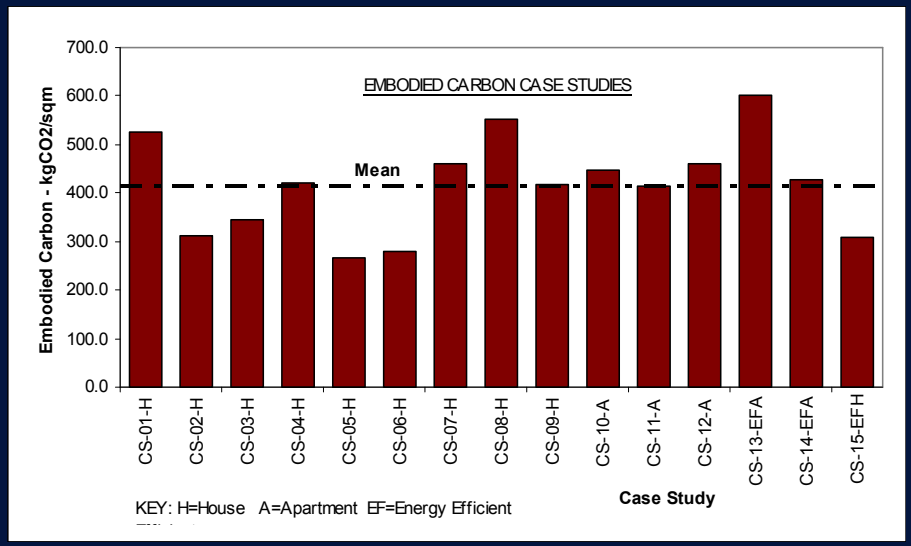
Available from: www.bath.ac.uk/mech-eng/sert/embodied/

Peer Review Source: Hammond, G.P. and C.I. Jones, 2008, 'Embodied energy and carbon in construction materials', *Proc. Instn Civil. Engrs: Energy*, in press.

ICE - Validation of the Data

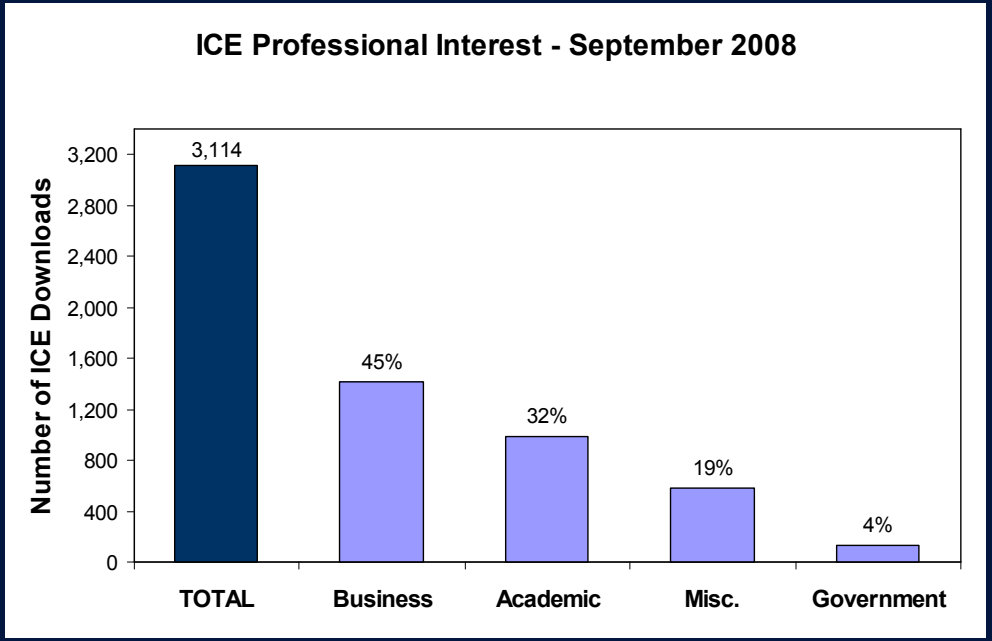
- Validation of the dataset through application and comparison of final results
- Case Studies…
  - Domestic Buildings (See Graphs >>>)
  - Non-Domestic Buildings
- …Comparison with BedZed estimates (BRE Data)
  - Embodied Energy = ICE was Within 1%
  - Embodied Carbon = ICE was Within 10%
- Unexpected differences in final results can often be explained





ICE - Professional Interest

- Downloadable since April 07
- Over 3,000 copies distributed to individuals worldwide (See Graph)
- Good feedback, word of mouth advertising & recommendations
- Strong commercial interest, e.g. using ICE to develop carbon 'footprinting' tools (such as the Environment Agency Carbon Calculator for Construction)



EE & EC Data - achieving methodological consistency

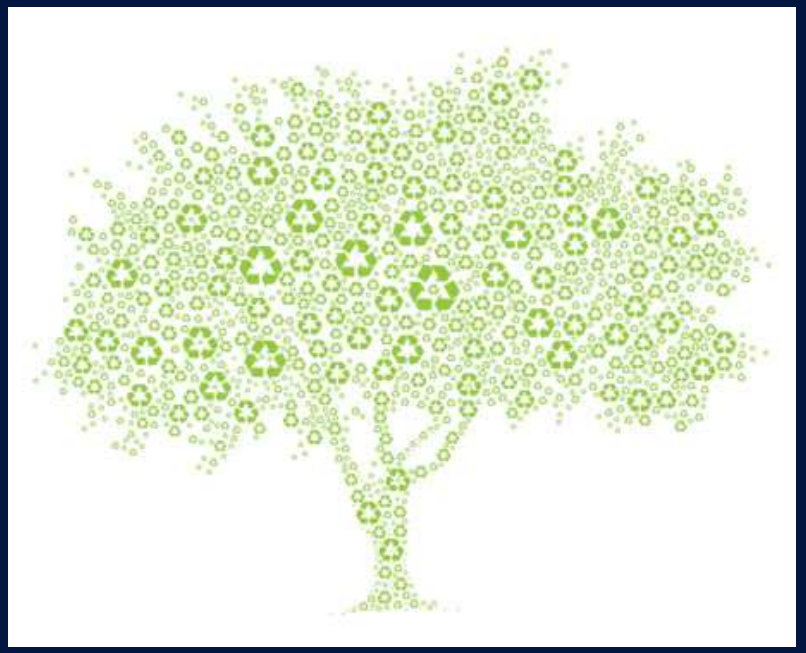
Common Differences:

- Feedstock energy - plastics
- Gross or Net Calorific Value
- Cradle-to –Gate, -Site, -Grave
- Transport
- Incomplete boundaries, i.e. electricity not converted into primary equivalents
- Carbon (dioxide): CO_2 V CO_2e

Further Methodological Variations

Methodological Differences:

- Recycling methodology
  - Recycled content (ICE method)
  - Substitution method (endorsed by the metals industry, i.e. Corus)
  - Other methods (i.e. 50-50 method)
- Carbon sequestration
  - Controversial….to include or exclude?
  - ICE data excludes carbon sequestration
  - If including this effect data must be used with caution (i.e. especially to material waste, such as construction waste!)



Further things to consider

- **Lifetime:** what if material A lasts 40 years but material B lasts 20 years?
- **Waste:** 1 kg of product produced wastage in its production! What happens to this waste?
- **Maintenance:** Maintenance intensive? Re-painting required?
- **Further Fabrication:** Is your product highly fabricated beyond the specifications of materials for the data you are using?
- **Functional units:** You MUST assess materials on an application basis, ***per kg is not a fair comparison***. Consider lifetime, density, strength, durability…etc

Reducing EE & EC

- Concrete - blast furnace slag, fly ash…etc - up to 45% Savings
- High recycled content
- Reuse offers high savings, especially metals
- Design for reuse first, then for recycling. Especially important for temporary items
- Dematerialisation

Reducing EE & EC II

- Anti-corrosion metals (aluminium, stainless steel) may have very high EE & EC, but require no painting (another high EE & EC material)
- Plastics normally suffer reduced properties when recycled but where possible recycled plastics offer energy savings due to recovery of feedstock energy
- Timber, additional energy can be recovered with end of life recovery
- Use of natural, minimally processed materials


Thank You
www.bath.ac.uk/mech-eng/sert/embodied