

The Embodied Carbon of Building Services Systems in Houses

Roger Birchmore MCIBSE with permissions and contributions from David Dowdell - BRANZ and Lindsay Wood - Resilienz



Background

- New Zealand has committed to achieving net zero greenhouse gas (GHG) emissions by 2050
- The Building and Construction accounts for around 20% of New Zealand's carbon emissions through the energy and materials used in buildings.
- The Ministry of Business Innovation and Employment has developed draft methodologies to calculate embodied carbon, for consultation in 2024
- The only compulsory reporting on services is on HVAC

Building System	Mandatory: must be included in the assessment	Voluntary: may be reported independently within the assessment
Building services	<ul style="list-style-type: none">• HVAC⁴ equipment	<ul style="list-style-type: none">• Water, drainage, electrical services• Other building systems such as fire and security systems



Current Embodied Carbon Tools

- Tend to focus on building
 - Groundwork
 - Structure
 - External Envelope
 - Non-structural internal elements
- Vary between an element and a complete building focus
- Services tools are rare and focus on components

Current progress

Most advanced and comprehensive:

Bullen L. and Dowdell D.,(2023) BRANZ Study Report SR479 *Embodied carbon of New Zealand office and residential building services*

- Reference Buildings for Standalone houses, Medium Density Housing , Apartments and four Office Buildings
- Suite of internationally available Environmental Product Declarations (EPD) and equivalents BRANZ tools and recognised databases
- System quantities from Beca (offices)and Ortus International Ltd (residential)
- Over a 50 year Life Cycle



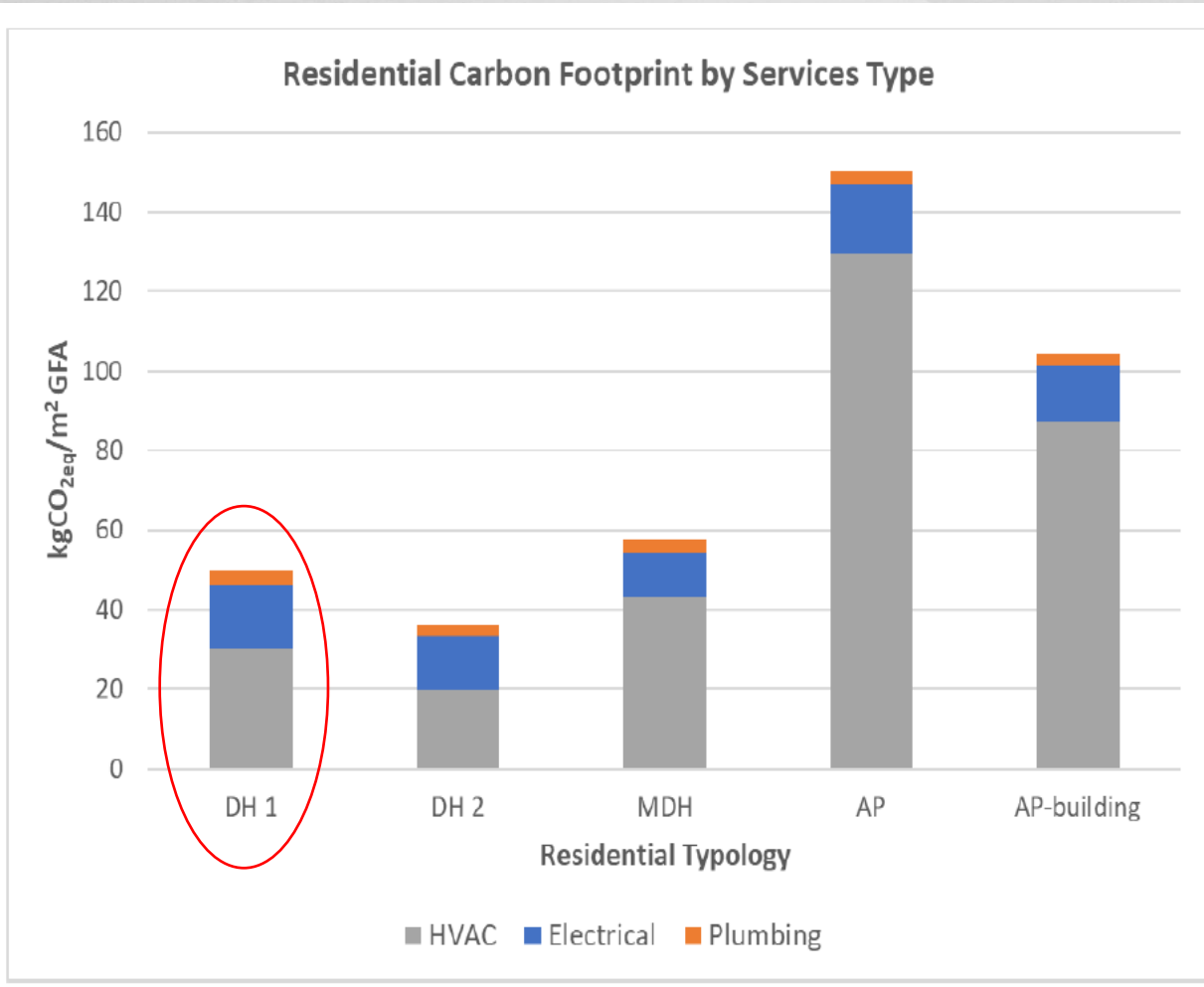
This work

Clearcut® - long-established cost estimating software with a major extension to also encompass a range of carbon assessments

- Reference Building for Standalone house 150m²
- Suite of internationally available EPD's and equivalents BRANZ tools and recognised databases
- Electrical quantities “as supplied” by an electrical contractor
- Plumbing quantities from architectural layouts and system schematic
- Over a 50 year Life Cycle



Results- BRANZ

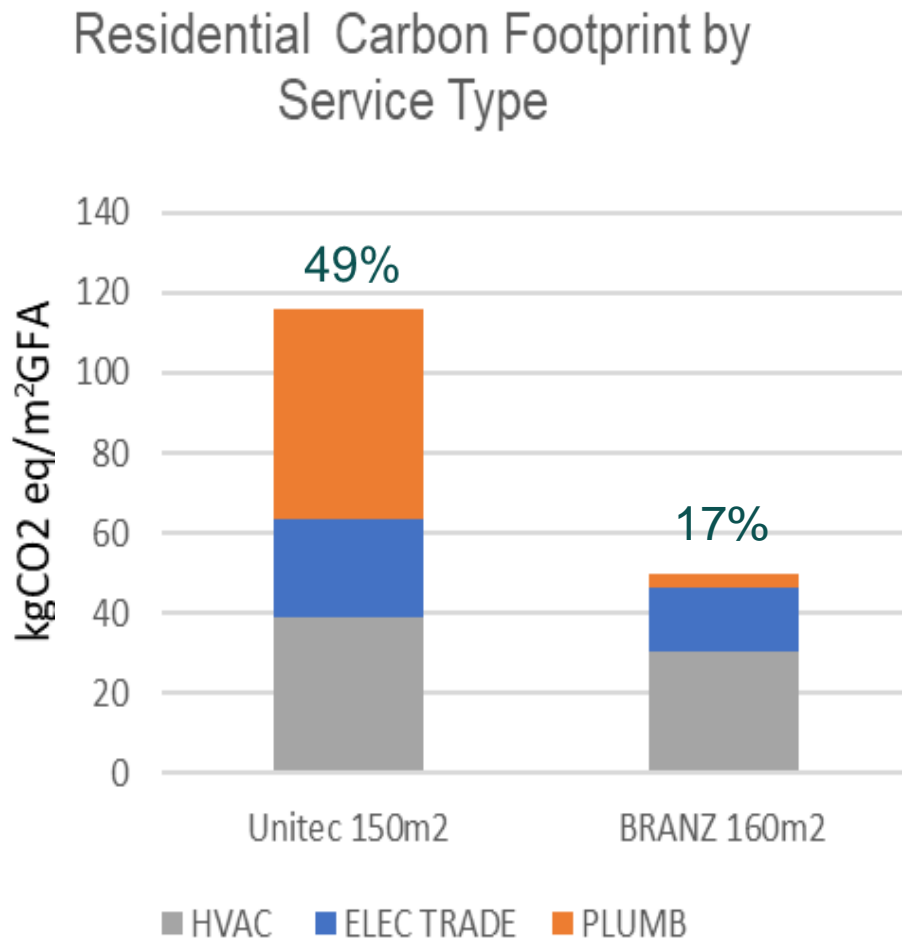


BRANZ

Table 4. Comparison of residential building embodied carbon footprints and services carbon footprints.

Residential typology	Embodied carbon footprint – dwelling	Embodied carbon footprint – services	Total embodied carbon footprint – dwelling and services	Services contribution to total carbon footprint
	kgCO ₂ eq/m ² GFA			
Stand-alone house ⁷	254	43	297	17%
MDH	296	58	354	16%
Apartment ⁸	605	150	755	20%

Unitec comparisons

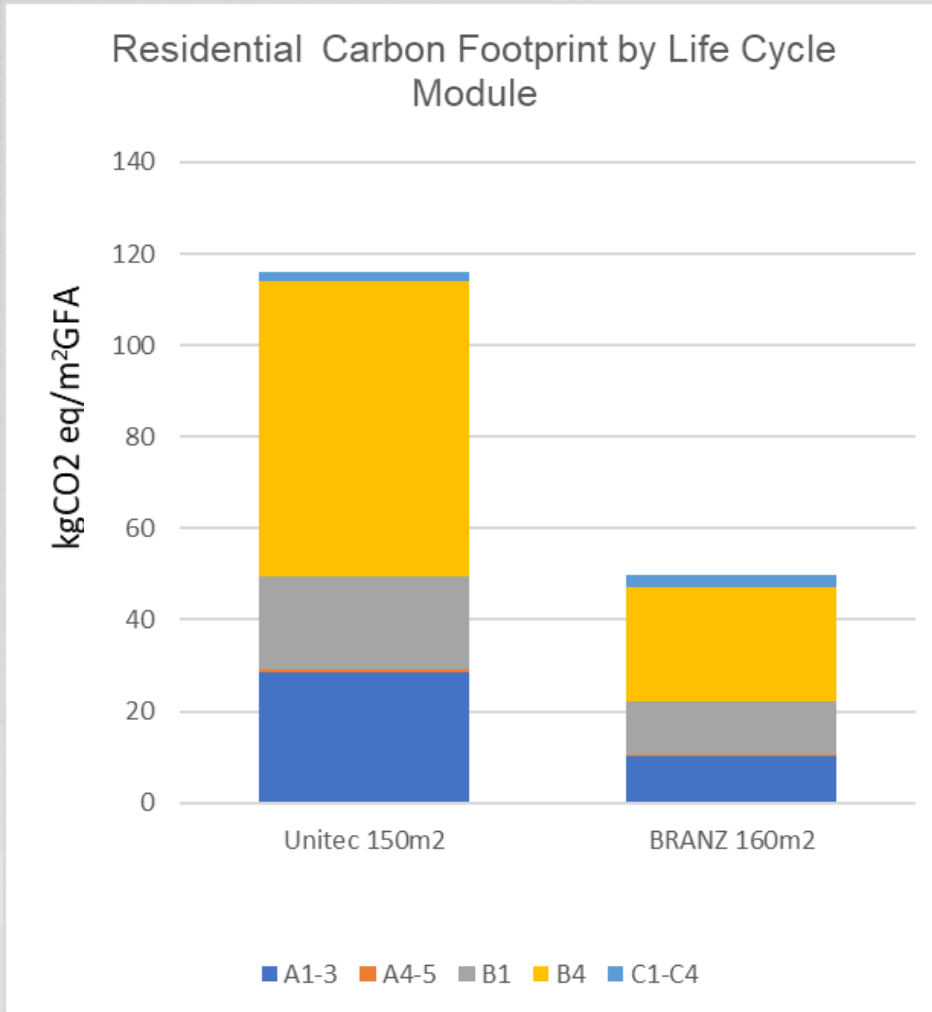


• Differences

- Extent of plumbing service included (valves fixtures and fittings)
- Quantities used in each service

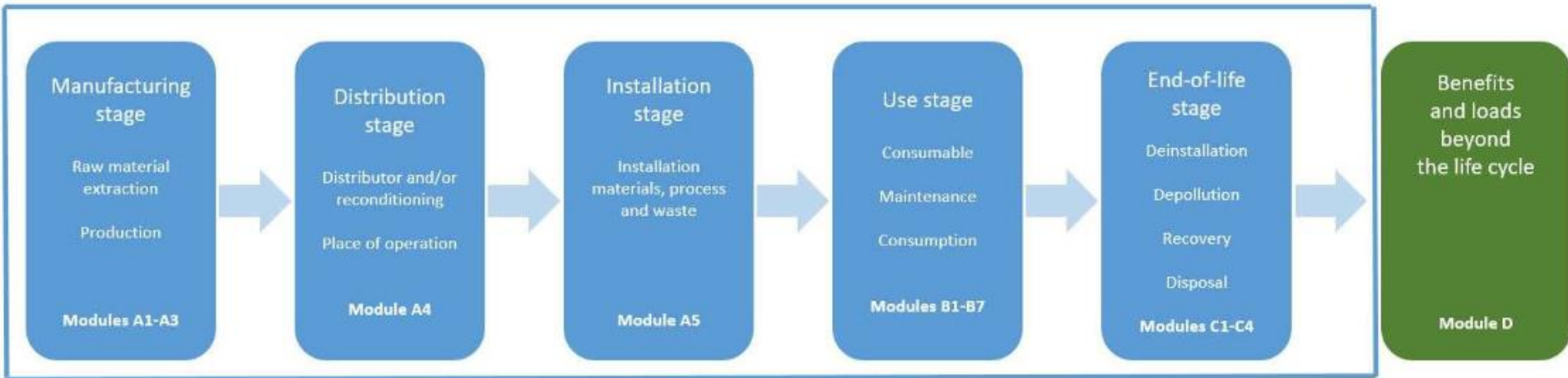
Unitec comparisons

- Differences
 - Replacement cycles



Lessons learned EPDs

- Not all systems are equal
- PEP: EPD comparisons



Lessons learned

- Search engines in EPD databases use manufacturers' data and references which makes interrogation very hard

Results				
<i>Trademark</i>	<i>PEP Designation</i>	<i>Pub.</i>	<i>Lang.</i>	<i>PEP Number</i>
NEXANS	PFSP Cu 1.5-6mm ²	10/2021	EN	NXNS-00006-V02.01
NEXANS	ALSECURE® PLUS/PREMIUM (300/500V)	05/2022	EN FR	NXNS-00020-V02.01

Lessons learned

- System “families” do not always make sense

- ↳ Heating, ventilation and air conditioning equipment
 - ↳ Ventilation and/or Heating and/or Air Conditioning and/or Hot Water Heating
 - ↳ Heating and/or air conditioning and/or hot water heating
- ↳ Hot water heating
 - ↳ Individual storage water heaters
 - ↳ Heat pump water heater
 - ↳ gas water heater
 - ↳ solar water heater
 - ↳ electric water heater

Lessons learned

- Functional units are usually per kg, but other components made of similar materials rarely have weights published.

E.g. PVC pipe and PVC fittings

- Manufacturers make pragmatic simplifications in some of their calculations E.g. socket outlets and switches use the same EPD

Lessons learned

- Official EPD databases should be used rather than manufacturer's websites

Environmental Information

Potential environmental impact

	A1	A2	A3	C1	C2	C3	C4	D	TOTAL	Co-efficient of variation
GWP - total [kg CO2 eq.]	2.22E+00	1.96E-01	1.17E-01	0.00E+00	1.41E-02	0.00E+00	1.47E-02	0.00E+00	2.57E+00	0.28

Environmental Information

Potential environmental impact

	A1	A2	A3	C1	C2	C3	C4	D	TOTAL	Co-efficient of variation
GWP - total [kg CO2 eq.]	4.50E-01	3.92E-02	2.34E-02	0.00E+00	2.82E-03	0.00E+00	2.80E-03	0.00E+00	5.18E-01	0.28



For the future

- Services systems should be included in embodied carbon calculations
- Agree Functional Units for complete services systems
- Grow the ANZ database
- Services system data need development so that small practitioners can apply them easily and reliably.



For the Future

- Beware components targeted to reduce operational efficiency because of their high consumption
- Encourage more use of CIBSE TM65, support its use via engineering student projects

