
Gathering23
Accelerating BIM adoption
CitA

Framework for the automation of Embodied Carbon calculations for Interior Architecture

by Léa Laurent

Research goal

FF+E: Furniture, Fixtures + Equipment

What is the impact of interior equipment on the carbon footprint of a building ?

Construction stage vs life expectancy (60 years)

How can architects calculate it ?

Revit workflow: using Environmental Product Declarations (EPDs) data to assess the carbon footprint value for FF+E.

OCMA

O'Connell Mahon Architects

MTU

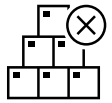
Ollscoil Teicneolaíochta na Mumhan

Munster Technological University

Agenda

Embodied Carbon

Proposed new workflow: Revit and EPDs



Testing the workflow with an exemplar project

Results & Interpretations

Conclusions

Embodied Carbon

The Carbon Dioxide (CO2) and greenhouse gas emissions generated by the manufacture and use of a building.

- Impact of one molecule of carbon dioxide (CO2) over a certain timeframe (100 years).
- Measured in kilogram of carbon dioxide equivalent per kilogram (kgCO2e)

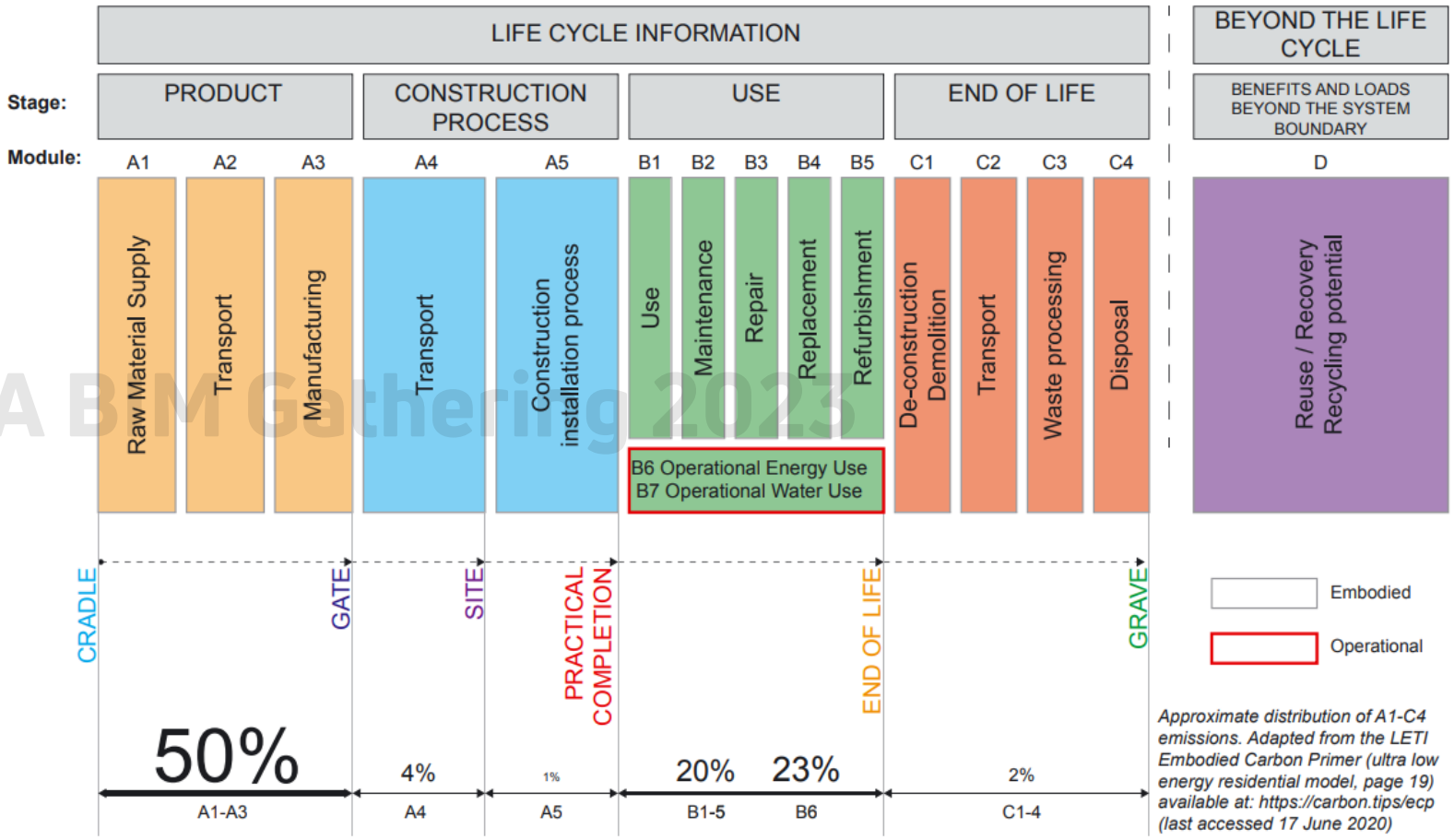


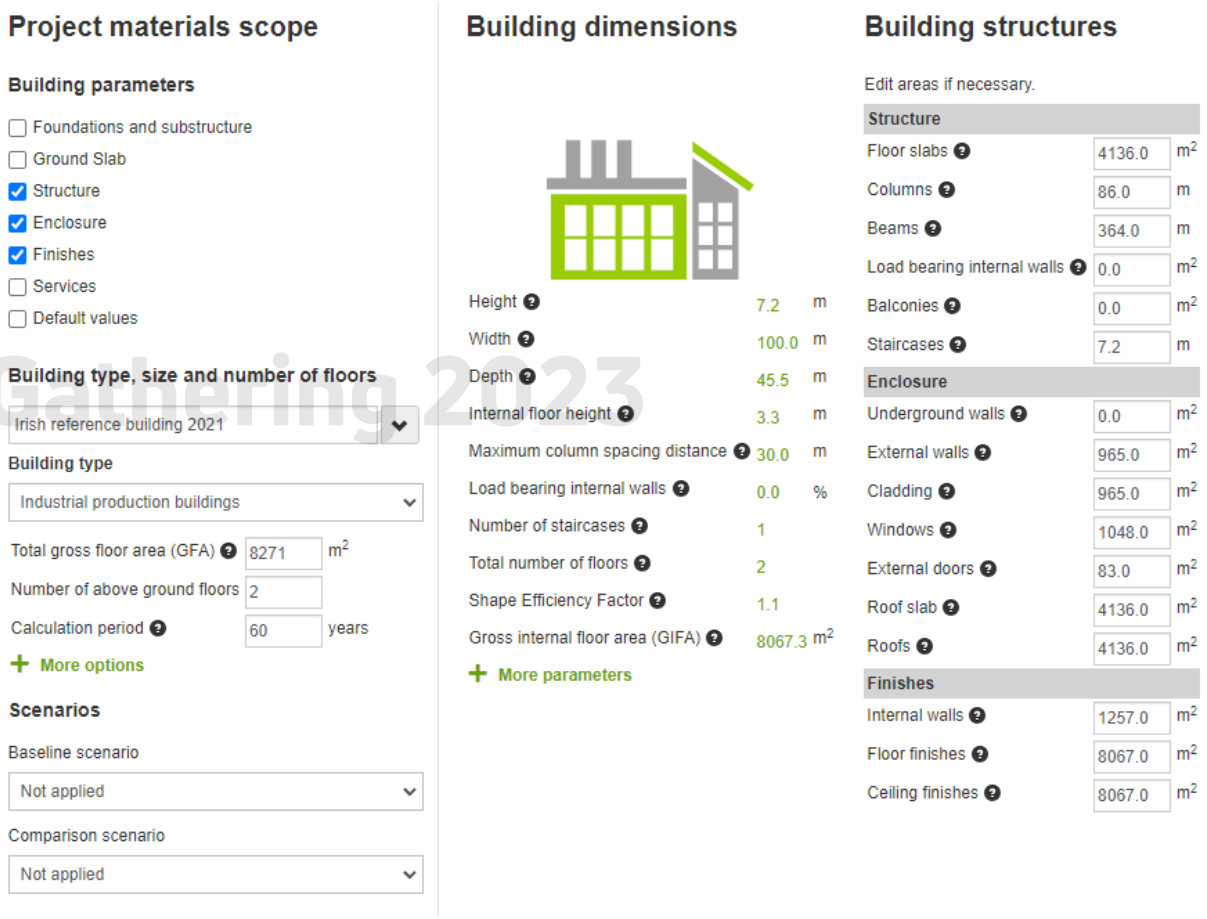
Illustration of BS EN15978 life cycle stages

Life Cycle Assessments (LCAs)

- Typical life expectancy: 60 years
- LCA tools: FF+E usually not included

Interior design

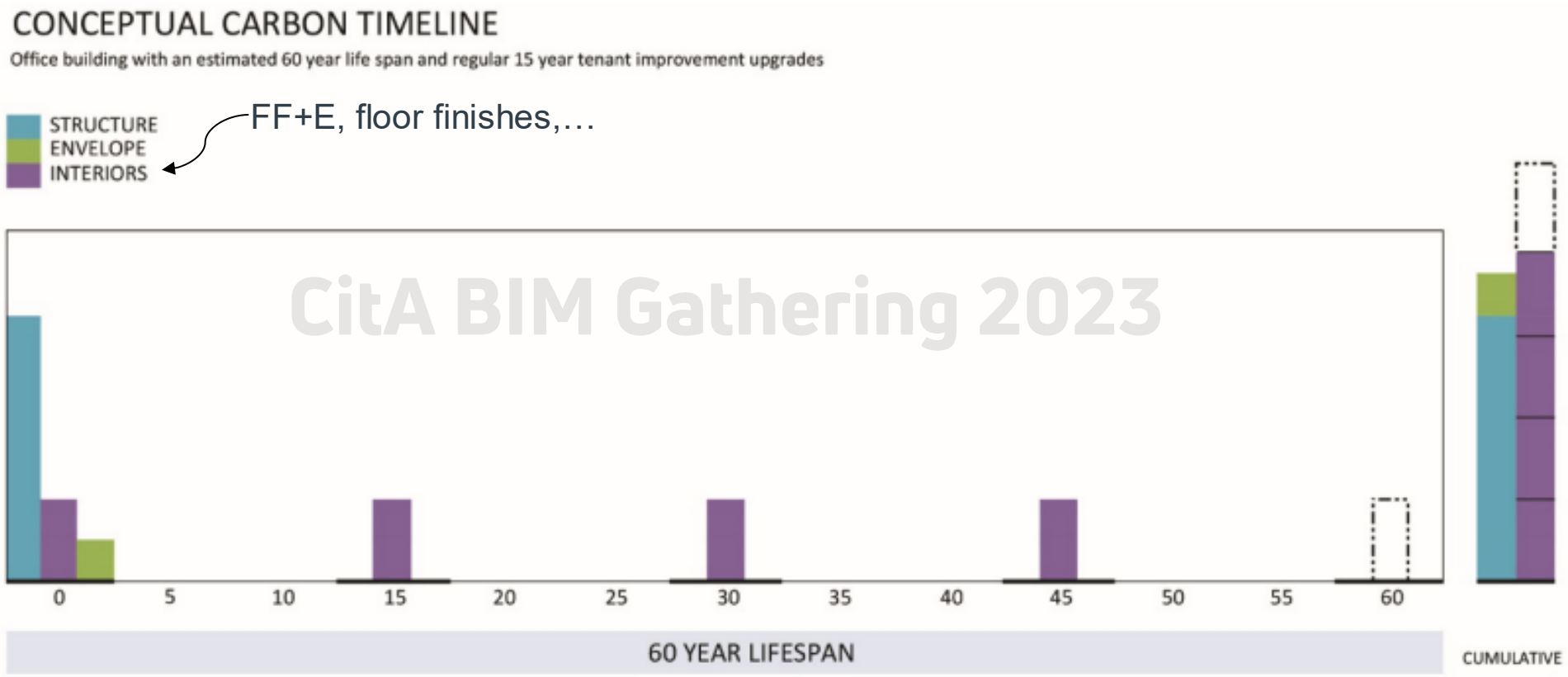
- Interiors can be refurbished every 2 to 15 years on average (restaurants very often, healthcare more sparse)
- Carbon footprint at construction completion will be higher than FF+E but what about over its lifespan ?



One Click LCA project start page, oneclicklca.com

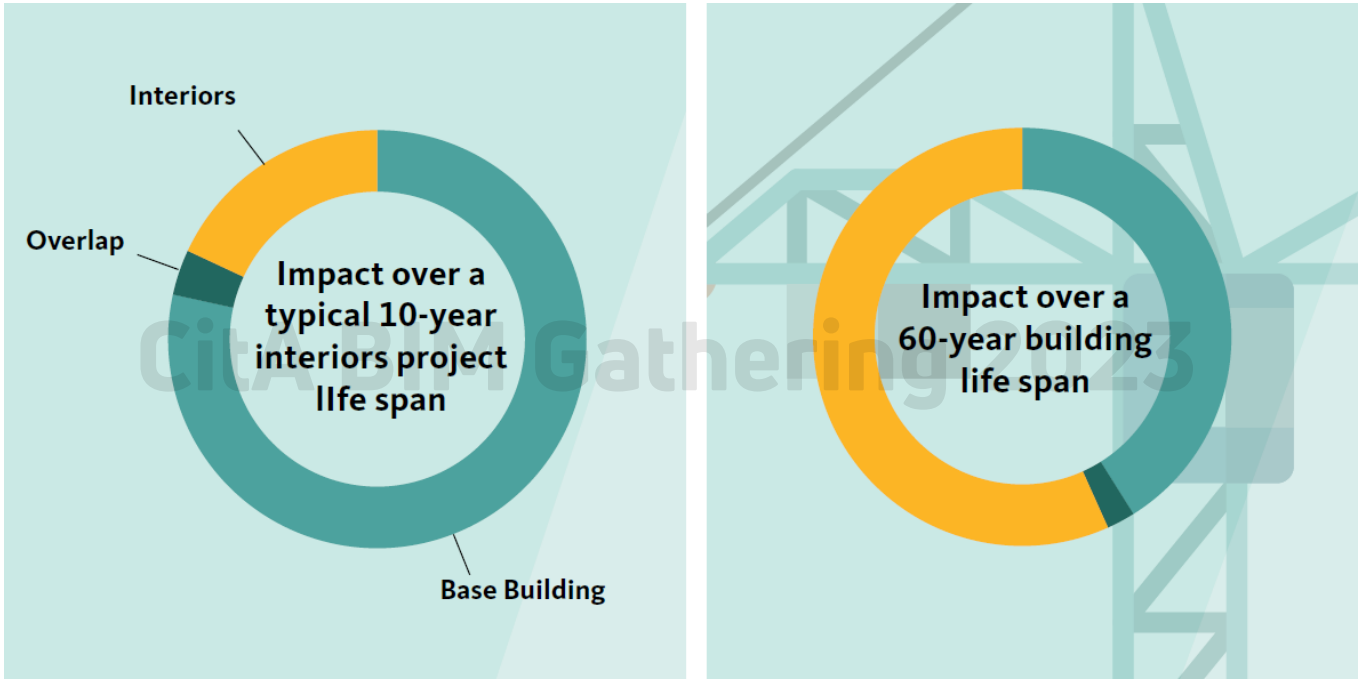
(Compliance: ISO14040, ISO 14044, EN15978, EN158

Carbon footprint & FF+E



Glaser K. et al. (2020), *Designing For the future, Interior Life Cycle Analysis*, published by One Workplace, written by Hawley Peterson Snyder)

Carbon footprint & FF+E



Briefel D. et al (2021), *Quantifying embodied carbon*, published by Gensler Research Institute

Environmental Product Declarations (EPDs)

- Document created by a supplier or manufacturer assessing a product's carbon footprint.
- For one unit of the product.
- It is verified by a third party.
- An EPD can be created for any type of product or system.

- This project focuses only the **Global Warming Potential.**

Impact Category	Units	Total	Material Acquisition & Pre-Processing	Construction	Installation	Use	End-of-life
Global Warming Potential	kg CO2 eq	**44.9**	18.1	4.09	6.65	0.994	15.1
Biogenic carbon	kg CO2 eq	**-16.2**	-27.0	0.0316	0.0186	0.178	10.6
Acidification potential	kg SO2 eq	**0.151**	0.0913	0.0174	0.0216	$3.51x10^{-3}$	0.0175
Photochemical ozone creation potential	kg O3 eq	**1.46**	0.601	0.250	0.388	0.0415	0.182
Eutrophication potential	kg N eq	**1.42**	1.24	0.0166	0.0247	0.0309	0.103
Ozone depletion potential	kg CFC-11 eq	**$3.58 x10^{-6}$**	$1.29 x10^{-6}$	$5.52 x10^{-7}$	$1.01 x10^{-6}$	$8.81 x10^{-8}$	$6.37 x10^{-7}$

Calculation

Impact Category	Units	Total	Material Acquisition & Pre-Processing	Construction	Installation	Use	End-of-life
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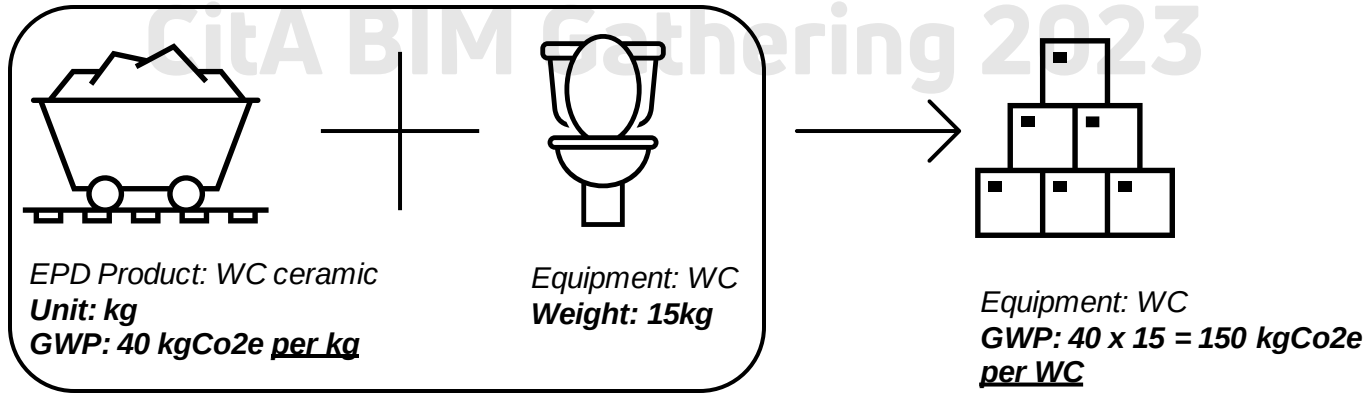


Proposed Revit workflow

Product's actual weight or length

GWP per 1 unit of product

ADBCode	ADBDescription	Count	DAT1_EPD available	DAT2_EPD number	DAT0_Average Unit (per EPD unit)	DAT0_EPD Unit	DAT3_Global Warming Potential (kg CO2 eq)	Total Per Unit	DAT9_Comments
WCH001	WC/toilet pan with seat, 520-550 projection, hospital pattern, rimless pan, vitreous china.	2	Yes	S-P-04163	31.71	kg	2.57	162.9894	Generic EPD for 1kg of average ceramic bathroom product
WCH005	WC/toilet pan with seat, 750 mm projection, hospital pattern rimless pan, vitreous china, HTM64WCHD	27	Yes	S-P-04163	31.71	kg	2.57	2200.3569	Generic EPD for 1kg of average ceramic bathroom product
WCH901	WC, flush plate, stainless steel, dual, pneumatic	29	No		0.7	kg		0	
WKT902	WORKTOP, non-clinical 600D, worktop length to suit drawing as illustrated	1	No					0	
								61212.11208	

Calculated parameter in Revit Schedule

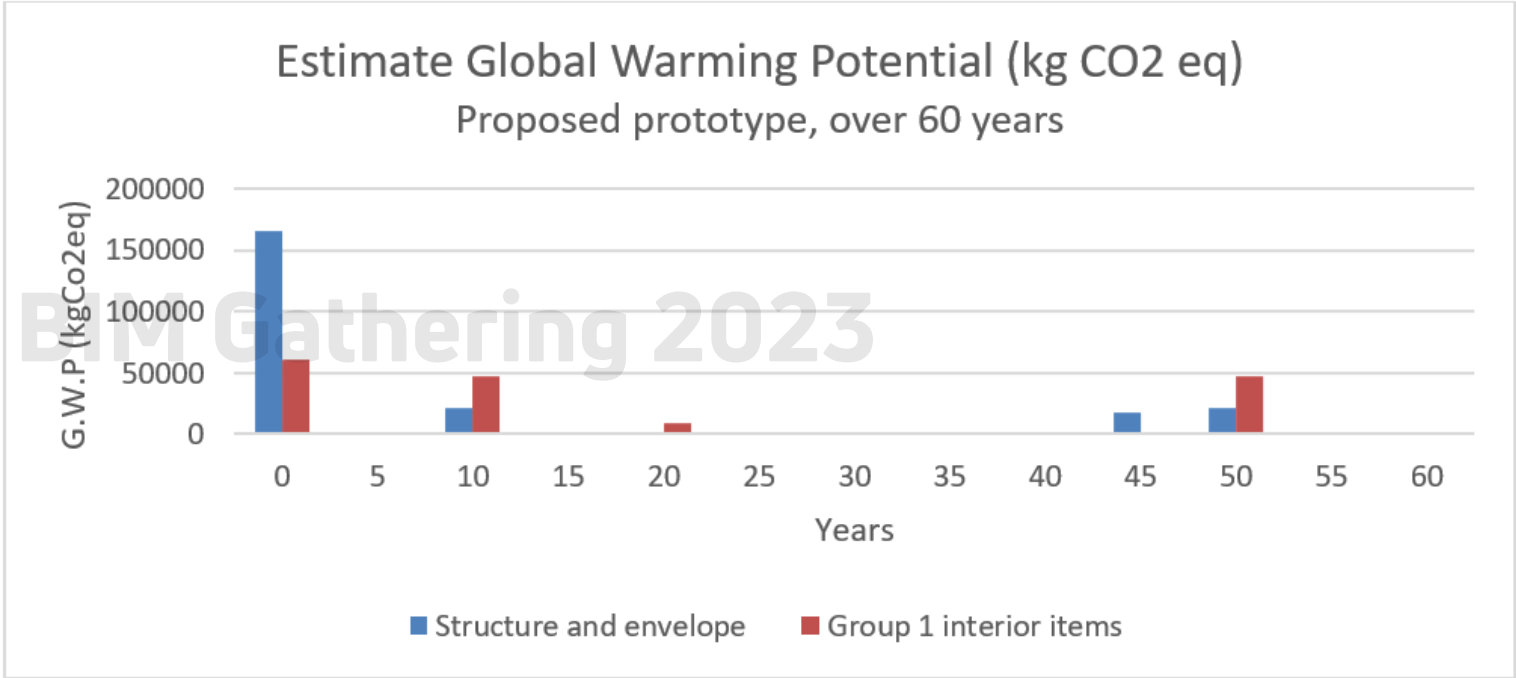
- FF+E (furniture and fitments)
- Group 1 items (specified by the architect and installed by the contractor)
- Typical building lifespan of 60 years

Examplar project

Exemplar project:
Typical hospital ward

- 2025 m2
- 82 rooms (26 bedrooms)
- Total FF+E : 1325 items (less than there would be in reality)
- One Click LCA to calculate conceptual LCA of structure

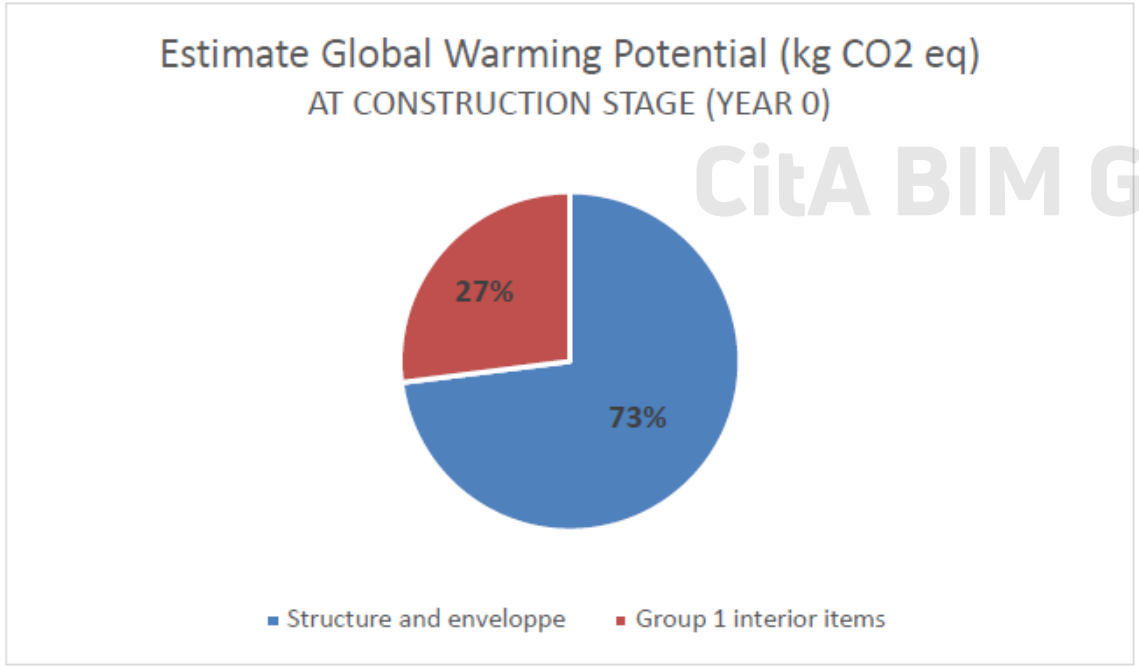
Results



Results

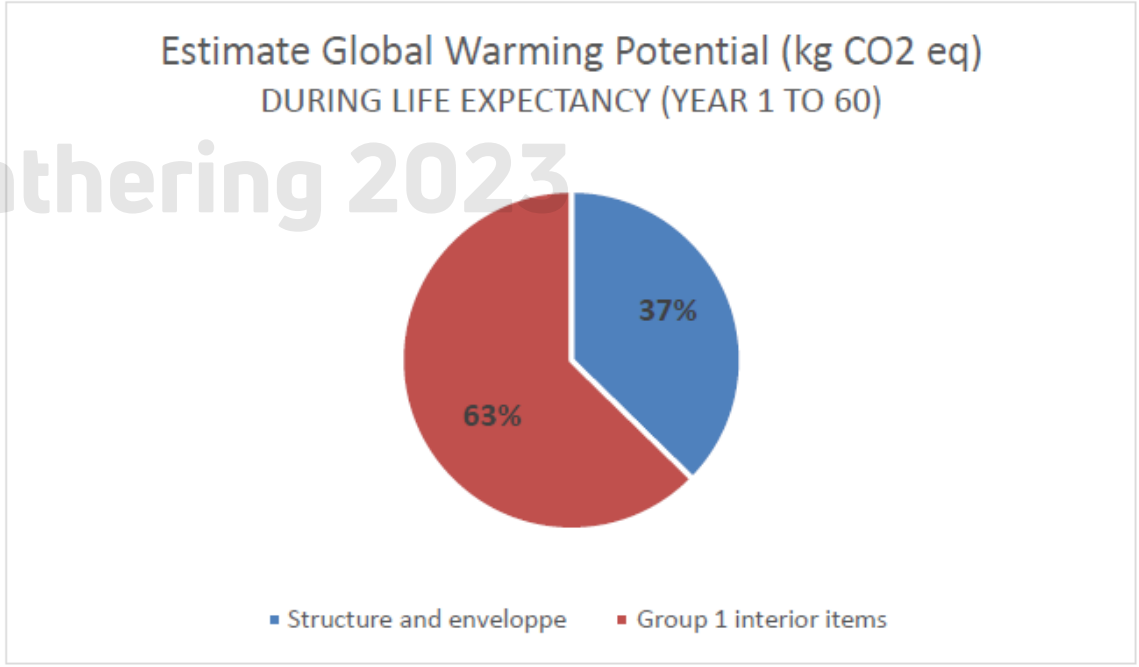
CONSTRUCTION STAGE

GWP calculated for structure & envelope and Group 1 items in example project



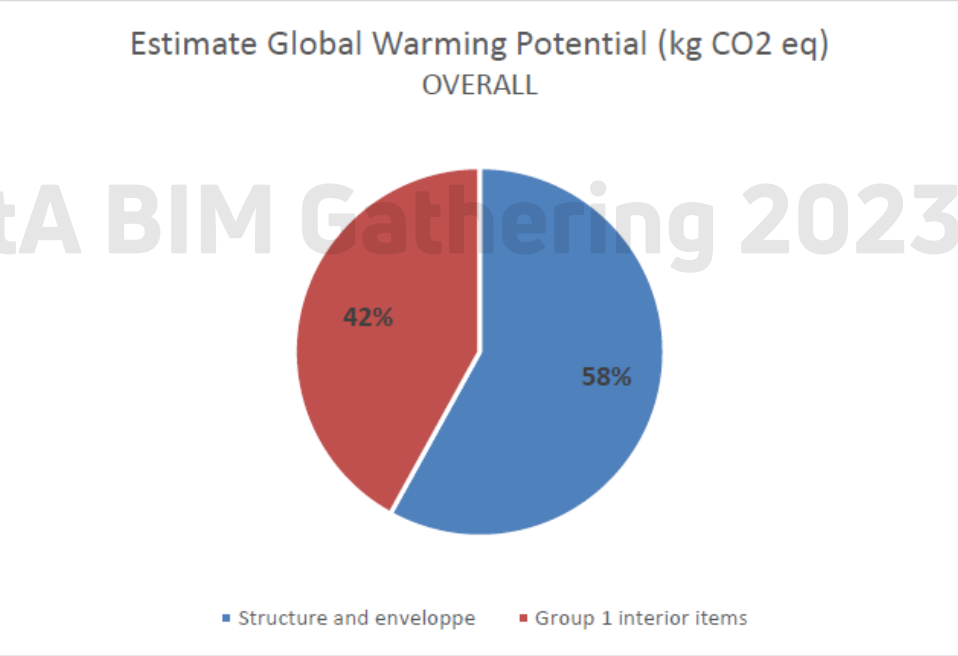
OPERATION AND MAINTENANCE PHASE

GWP calculated for structure & envelope and Group 1 items in example project



Results

PROPOSED LIFE EXPECTANCY (60 YEARS)
GWP calculated for structure & envelope and Group 1 items in example project)



Pie chart, proposed prototype estimated GWP over 60 years (Excel), total

Results

CONSTRUCTION STAGE

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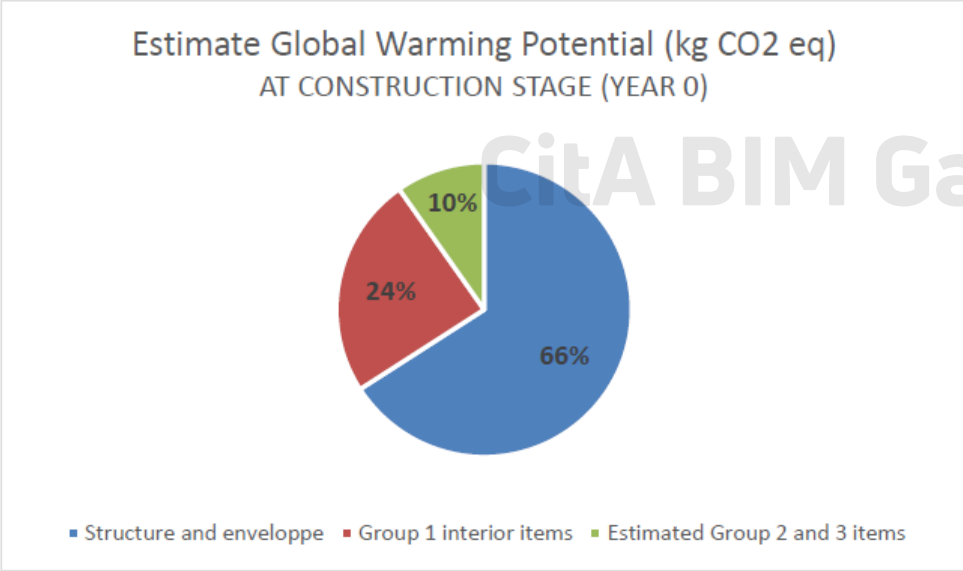

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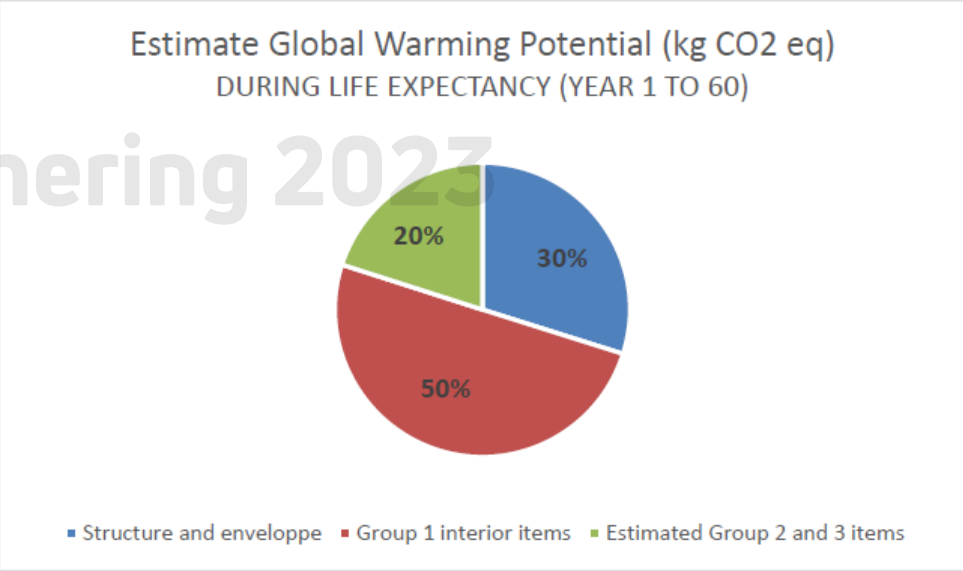
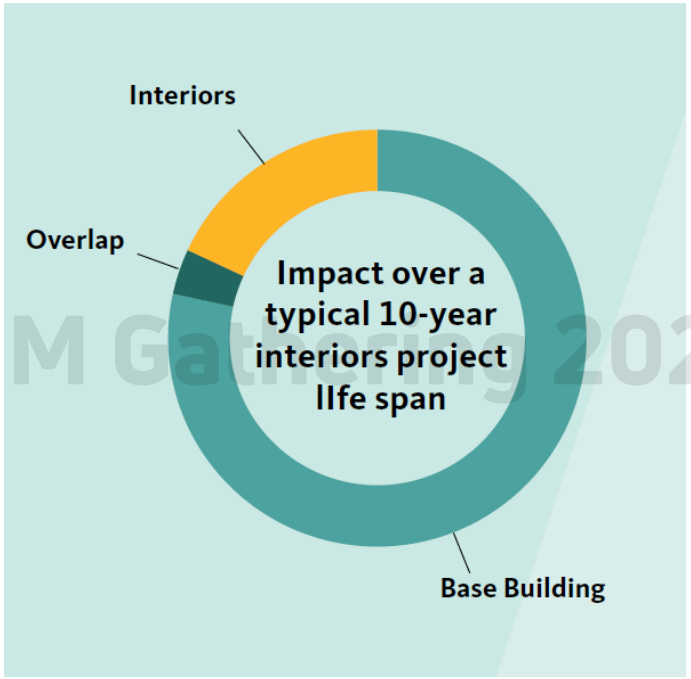
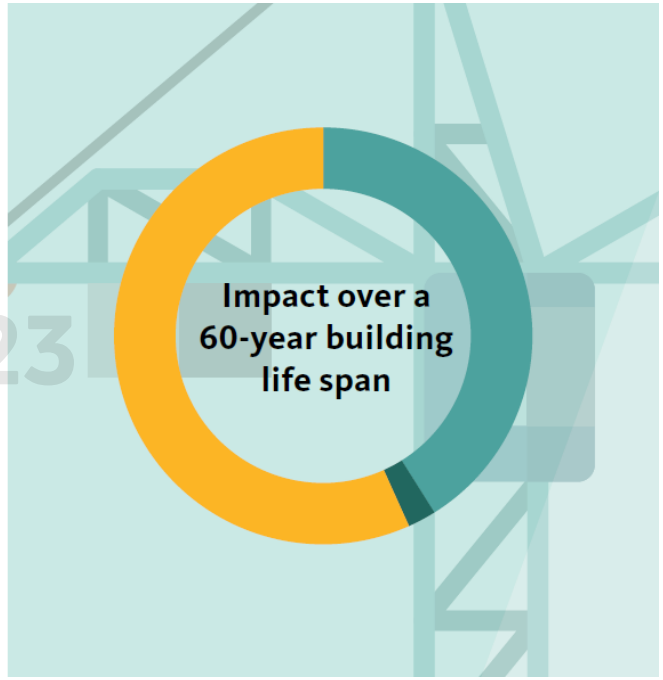


Conclusions

- FF+E has a significant impact on a building's carbon footprint over its lifetime.
- Indicative values from early design stages.
- Used in combination with a LCA tool for the structure & envelope, the information collected will be very valuable.

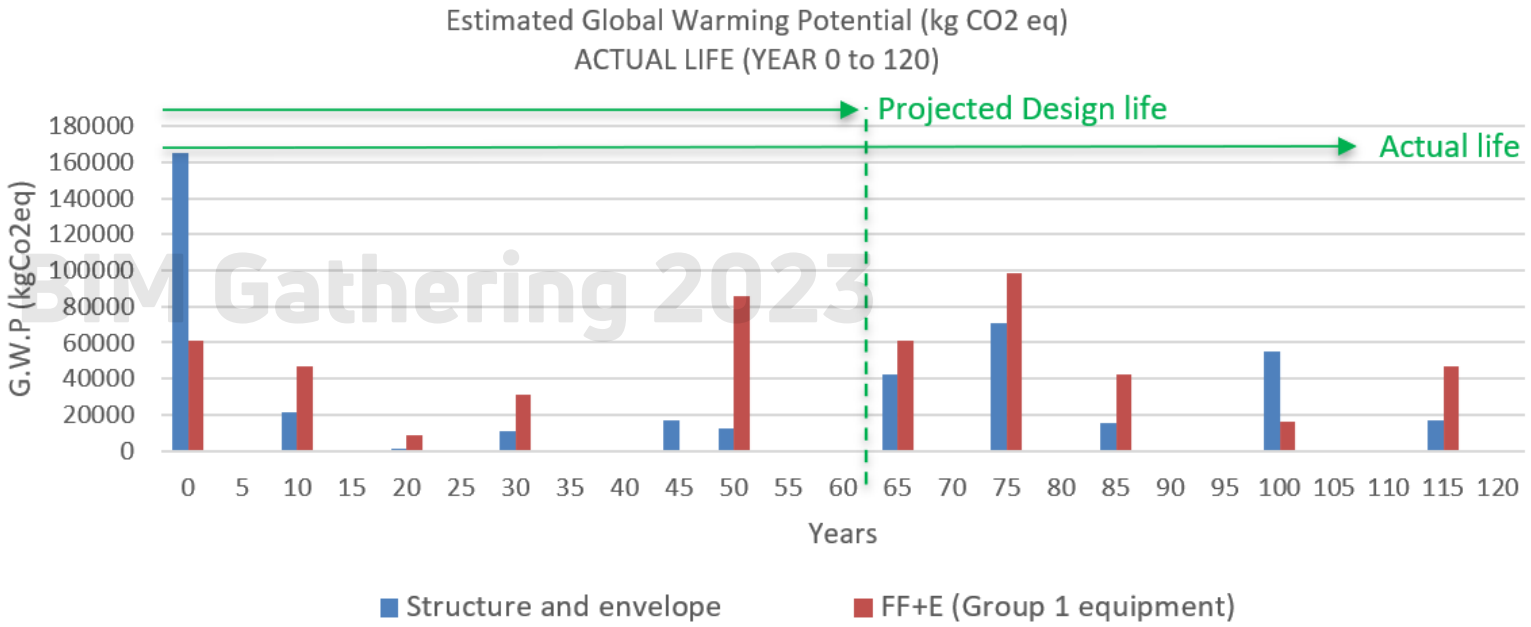




Briefel D. et al (2021), *Quantifying embodied carbon*, published by Gensler Research Institute

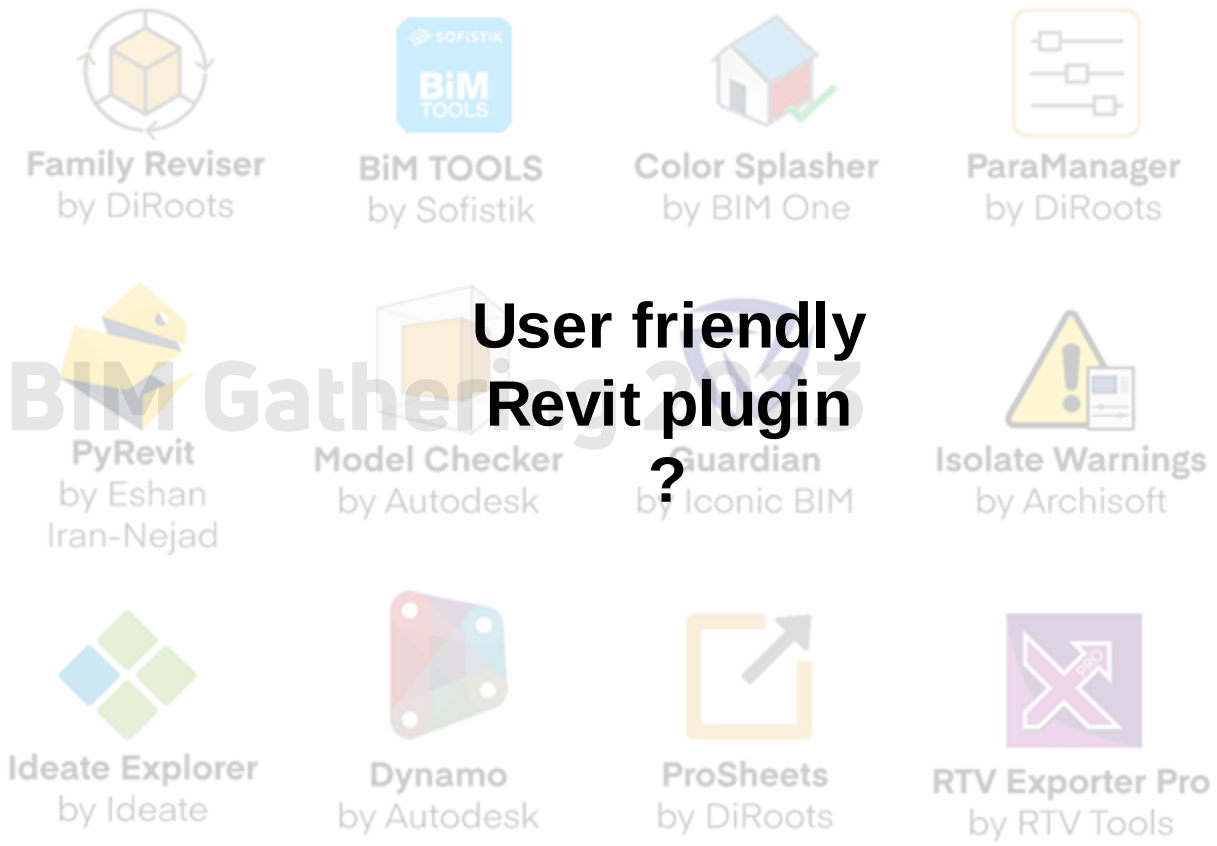
Limitations

- EPDs are tedious to read & still in infancy (not available for everything)
- Values need to be compared to other EPDs. There is no way of knowing if a product is “good” or “bad” just from its EPD.
- 60 years life expectancy: buildings are usually kept in use for much longer !



What next ?

- Test on a real / live project
- Train other users
- Healthcare is particularly suitable : repetition of rooms and equipment



User friendly Revit plugin ?

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Thank you !

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