Livscykelbedömningar för hållbart underhåll och renovering av det byggda kulturarvet

Andrea Luciani, Sofia Lidelöw, Carolina Weinz
Luleå tekniska universitet

Farshid Shadram
Uppsala Universitet

Stephan Fickler
Svenska Byggnadsvårdsföreningen

Aim

The aim of the project is to study the maintenance of historic buildings from a **life cycle perspective** and to contribute to an increased understanding of how to integrate **energy-efficiency measures** within built **heritage maintenance**, minimizing the buildings' life-cycle energy use, costs and carbon footprint and respecting cultural values and significance.

Spara & Bevara

Energimyndigheten

Targets and expected outcomes

- Assessing and **comparing different strategies** of renovation and maintenance of historic residential buildings from a life-cycle perspective.
- Exploring the potential to apply **life cycle assessments** in built heritage maintenance.
- Understanding how and in which cases a **sound maintenance** of historic buildings can have beneficial effects if compared to deep renovation solutions.
- Involving different types of **users, owners and managers** of heritage buildings and supporting them in the decision making
- **Supporting heritage professionals** and SME in the field of built heritage preservation
- Providing a better understanding to property owners and building conservators of the **long-term maintenance** of heritage buildings with respect to energy, costs and CO2 emissions from a life cycle perspective

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Energimyndigheten

Case Studies

B420	Gällivare	1911	Parhus	Large real estate	Timber logs
Revelsudden	Luleå	1910s	Villa (Fritidshus)	Private owner	Timber logs
Grevgatan 61	Stockholm	1890s (1930s)	Flerfamiljshus	Small real estate	Masonry/bricks
Hersby Åker	Lidingö	1950	Radhus	Small real estate	Bricks/concrete
Långstugan	Härnösand	1700s	Shop/Hostel/Exhibition	Public property	Timber logs





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Light retrofitting measures.

Focus on the preservation of cultural values and continuity of use

Light retrofitting			
	A: Original 1911s design Ref. Case	**B: Added attic insulation and slightly better windows**	**C: Added attic insulation and slightly better windows**
External walls insulation	As built		
External base walls insulation	85 XPS		
Unheated attic	175 mm sawdust	+200 mm cellulose	+400 mm cellulose
Windows U-value*	Double pane (2.3 $W/m^2,K$)	+New paint, window putty, etc (2.3 $W/m^2,K$)	+New paint, window putty, etc (2.3 $W/m^2,K$)
Ground floor insulation	150 mm XPS		
Bottom floor insulation	200 mm sawdust		

** U-value remains the same but all windows get new paint, putty and new + adjusted frames.*

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Medium retrofitting measures.

Limited impacts on cultural values,
improve buildings' thermal envelope, energy use and cost effectiveness.

Medium retrofitting				
	D: Material change in oblique roof and ground floor, added façade insulation	**E: Material change in oblique roof and ground floor, added façade insulation**	**F: Material change in oblique roof, added façade insulation**	**G: Material change in oblique roof, added façade insulation**
External walls insulation	+30 mm wood fiberboard	+30 mm wood fiberboard	+30 mm wood fiberboard	30 mm wood fiberboard
External base walls insulation				
Unheated attic	+170 mm cellulose (sawdust replaced) and 200 mm cellulose	+170 mm cellulose (sawdust replaced) and 200 mm cellulose	+170 mm cellulose (sawdust replaced) and 400 mm cellulose	+170 mm cellulose (sawdust replaced) and 400 mm cellulose
Window, U-value	+Change original window inner pane (1.8 W/m²,K)	+ Add window pane to original window (1.5 W/m²,K)	+Change original window inner pane (1.8 W/m²,K)	+ Add window pane to original window (1.5 W/m²,K)
Ground floor insulation				
Bottom floor insulation	+change to 200 mm cellulose	+change to 200 mm cellulose	+change to 200 mm cellulose	+change to 200 mm cellulose

+ light retrofitting measures aswell – we are keeping the original windows.

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Heavy retrofitting measures.

Significant impacts on cultural values, focus on reduction of heating energy use.

Heavy retrofitting		
	H: PH windows and added façade insulation	**I: PH windows and added façade insulation**
External walls insulation	+60 mm wood fiberboard	+60 mm wood fiberboard
External base walls insulation		
Unheated attic	+170 mm cellulose (sawdust replaced) and 200 mm cellulose	+170 mm cellulose (sawdust replaced) and 400 mm cellulose
Window, U-value	+New triple pane window (1.1 W/m²,K)	+New triple pane window (1.1 W/m²,K)
Ground floor insulation		
Bottom floor insulation	+change to 200 mm cellulose	+change to 200 mm cellulose

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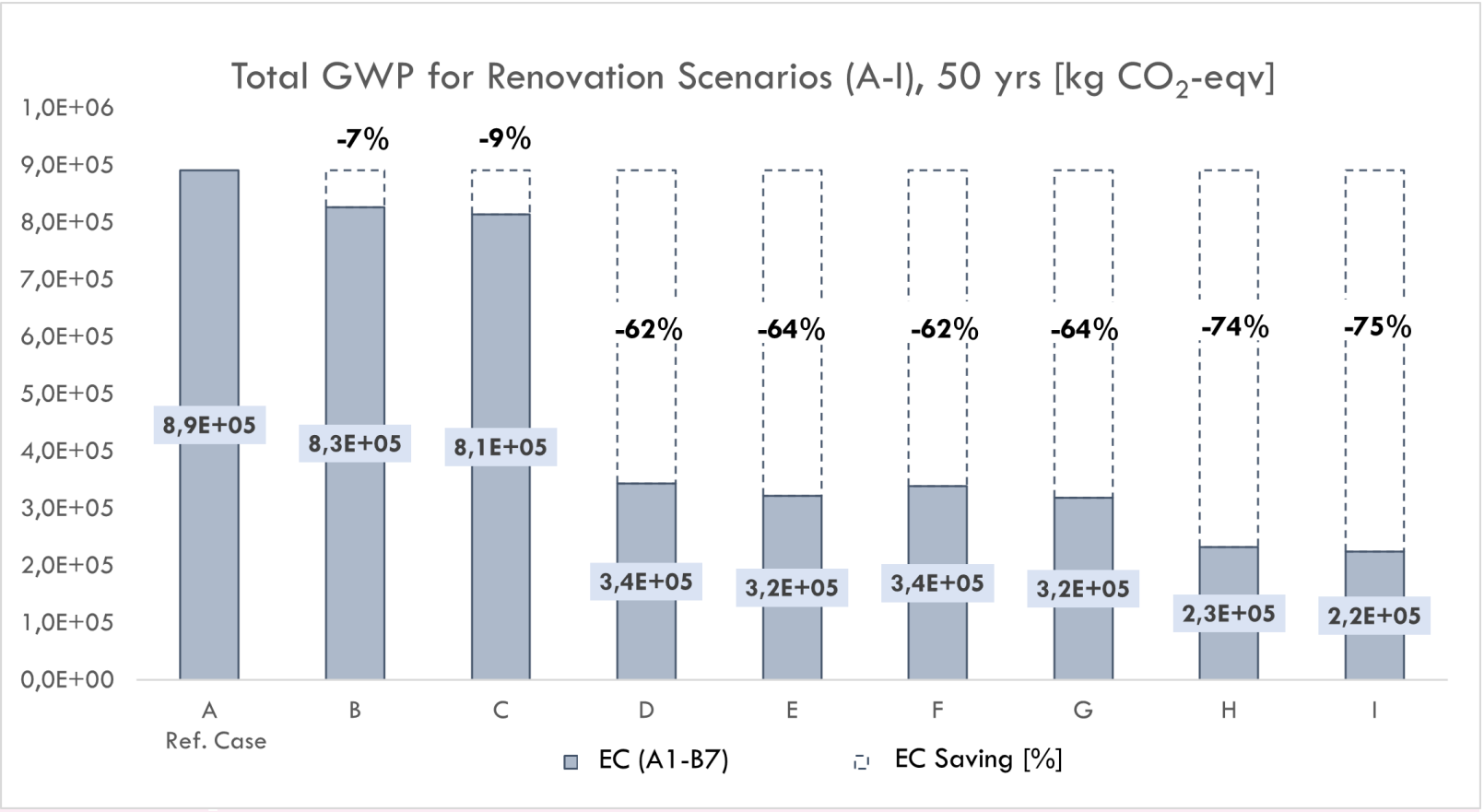

Preliminary results from the Life Cycle Assessment

Total Global Warming Potential (GWP) [kg CO2-eqv] for each renovation scenario (B-I) in relation to the reference case (A). For each scenario, the total saving in embodied carbon is also presented.

Medium retrofitting scenarios (D-G) save considerable amounts of CO2-emissions and still preserve better the cultural values of the building compared to heavy renovation scenarios (H-I).

B,C: Light retrofitting scenarios

D,E,F,G: Medium retrofitting scenarios

H,I: Heavy retrofitting scenarios

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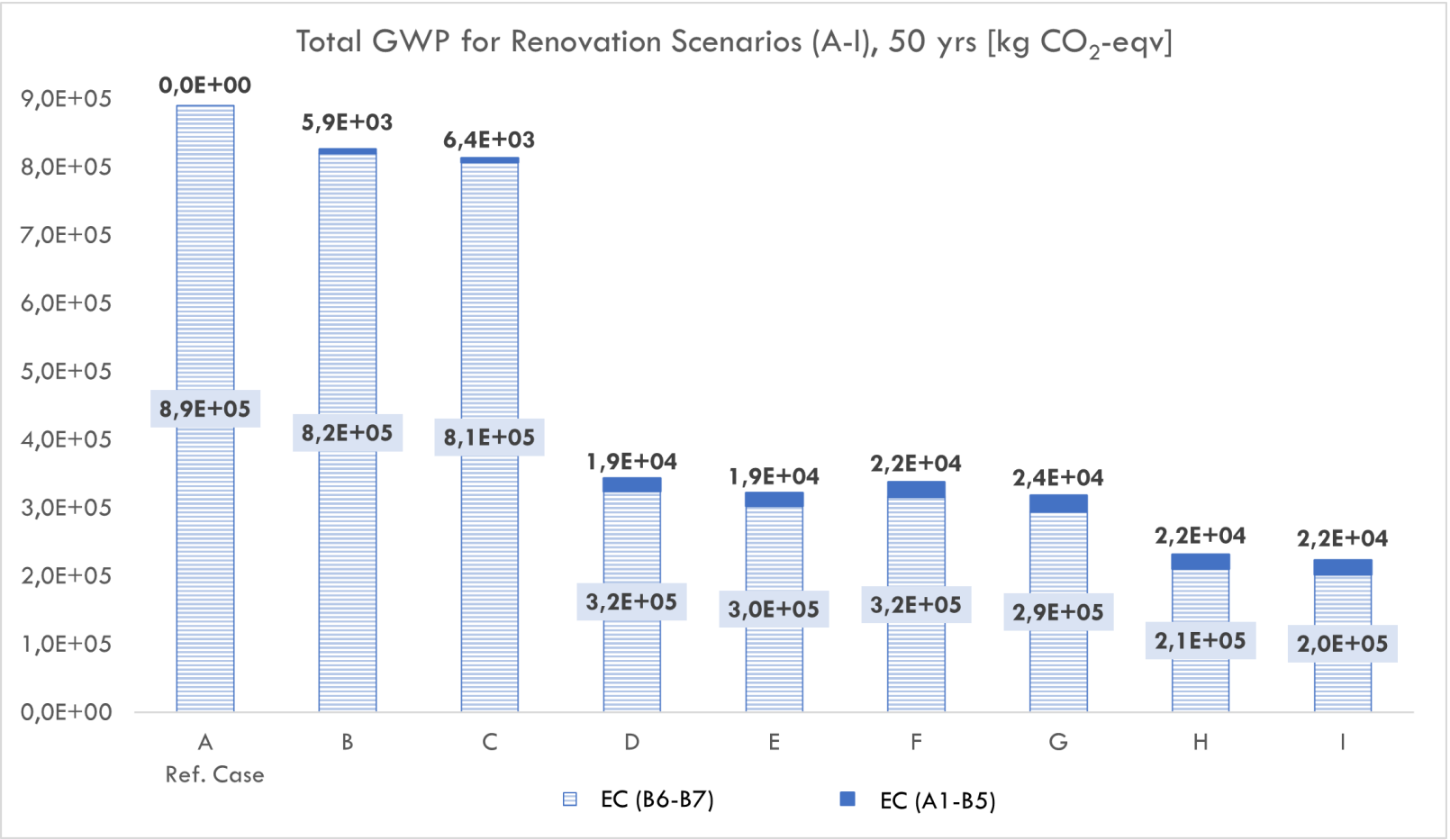

Preliminary results from the Life Cycle Assessment

Total GWP per life cycle stage group. The operational energy use (B6-B7) stands for the main part of the GWP impact for all the renovation scenarios.

B,C: Light retrofitting
D,E,F,G: Medium retrofitting
H,I: Heavy retrofitting

Product stage: A1 (Material supply), A2 (Transport), A3 (Manufacturing)

Construction process: A4(Transport), A5(Installation)

Use stage: B1 (Use), B2 (Maintenance), B3 (Repair), B4 (Replacement), B5 (Refurbishment),
B6 (Operational energy use),
B7 (Operational water use)

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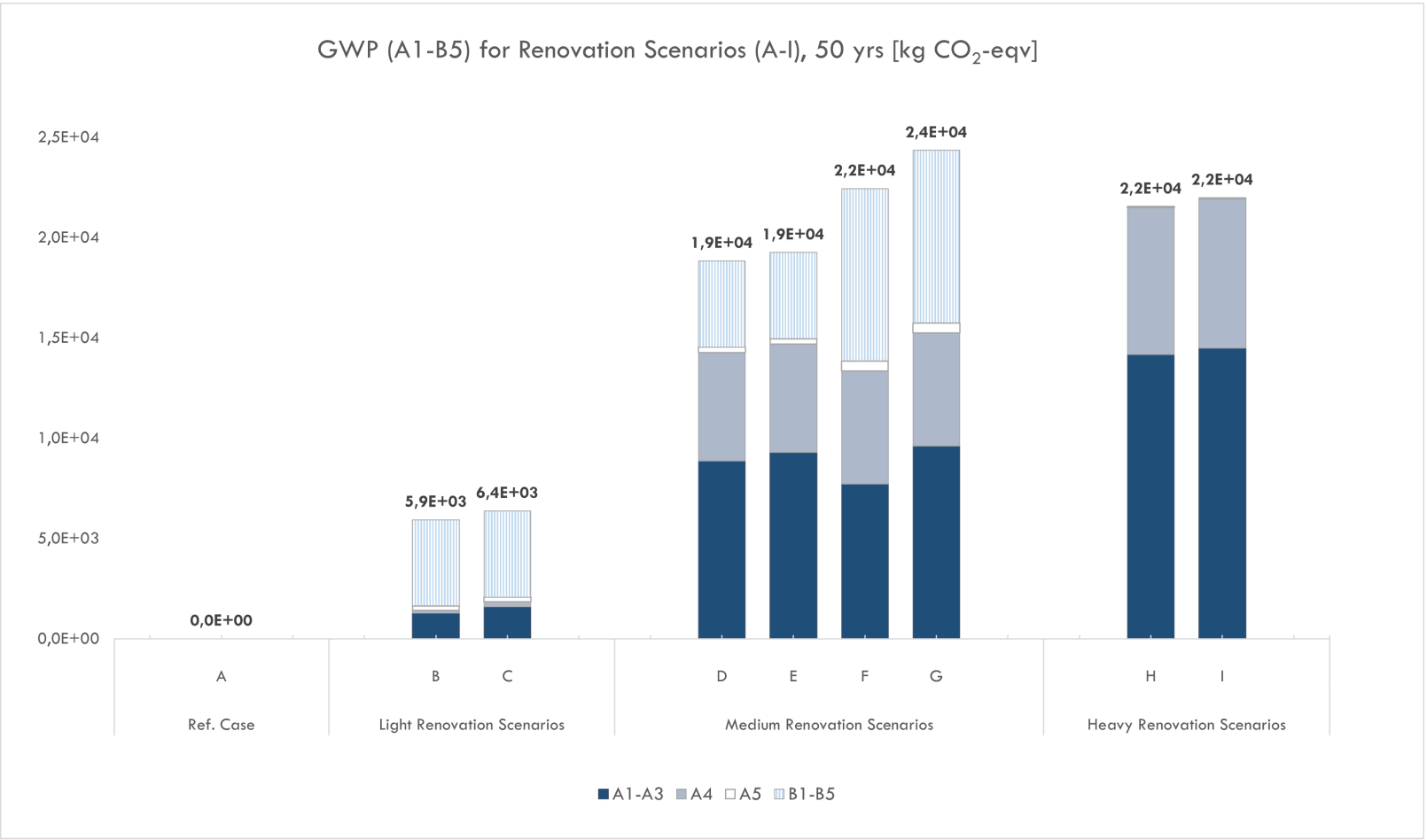

Preliminary results from the Life Cycle Assessment

Total GWP per life cycle stage group excluding the operational energy (A1-B5)

A1-A3 Product stage
A1 (Material supply), A2 (Transport), A3 (Manufacturing)

A4-A5 Construction process
A4(Transport), A5(Installation)

B1-B5 Use stage
B1 (Use), B2 (Maintenance), B3 (Repair), B4 (Replacement), B5 (Refurbishment)

Operational energy and water use are not included

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Ongoing/Upcoming work

- Re-calibrate the energy simulations
- Sensitivity analysis

  In particular: lighter renovation scenarios
  district heating emission factors
  transport distances

- Data collection
- Building of energy simulation model



- Data collection

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Tack!

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Energimyndigheten