

A circular approach to energy renovation

Dora Vancso | P5 presentation

1850

**Each stripe represents
the average annual global temperature**

Virgin material input



Waste

Take



Take



Make



Take



Make

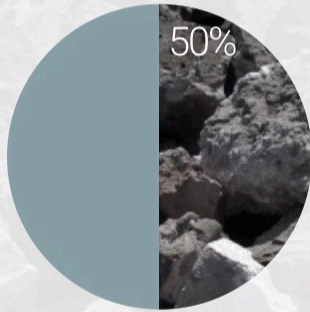


Dispose

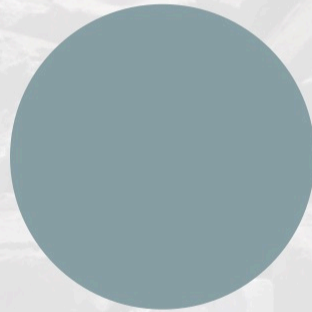


The built environment and construction industry

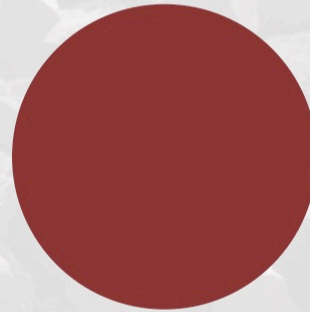
Total
Material use



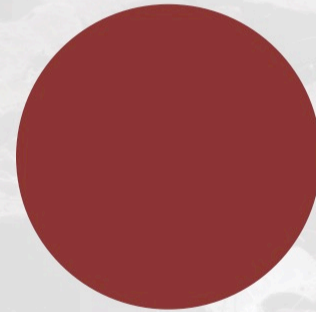
Total
Waste stream



Total
Energy use



Total
CO² emissions



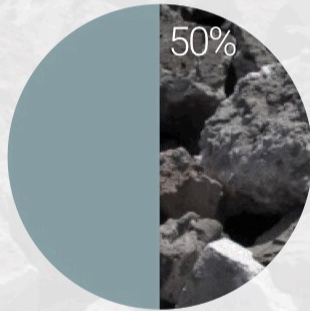
Other



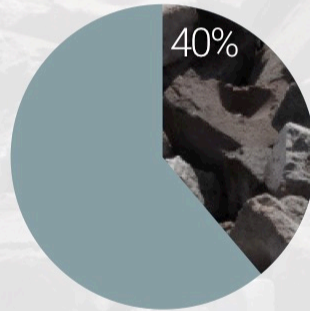
Built environment and construction industry

The built environment and construction industry

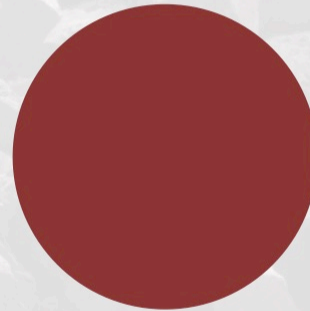
Total
Material use



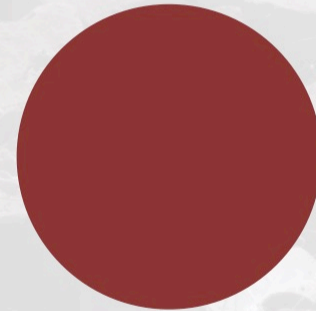
Total
Waste stream



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Energy use



Total
CO² emissions



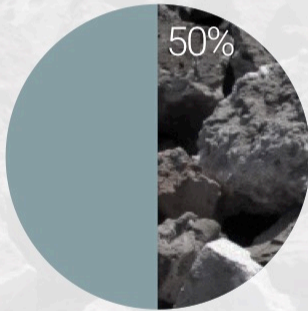
Other



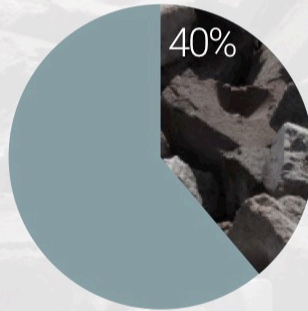
Built environment and construction industry

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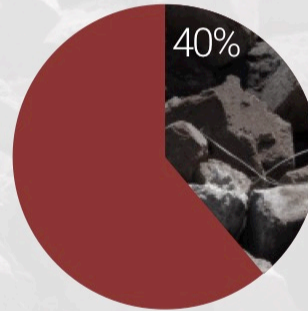
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Material use



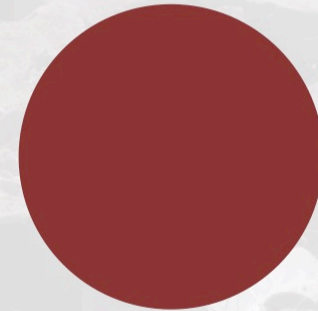
Total
Waste stream



Total
Energy use



Total
CO² emissions



Other



Built environment and construction industry

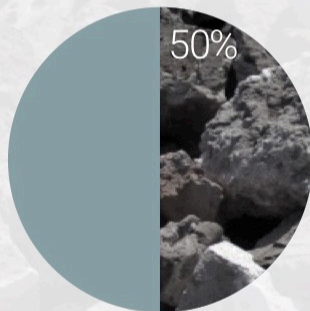
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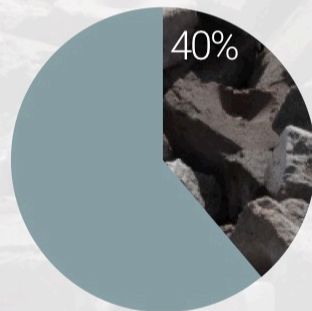
Built environment and construction industry

The built environment and construction industry

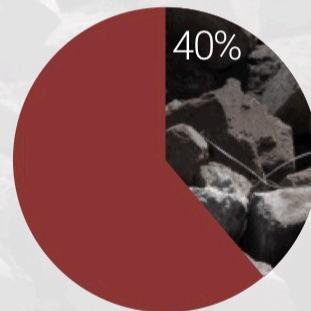
Total
Material use



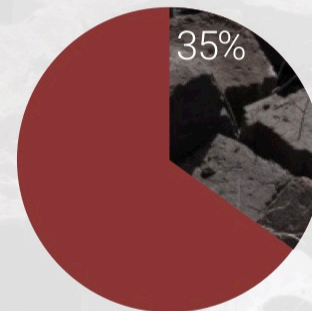
Total
Waste stream



Total
Energy use



Total
CO² emissions



Other



Built environment and construction industry

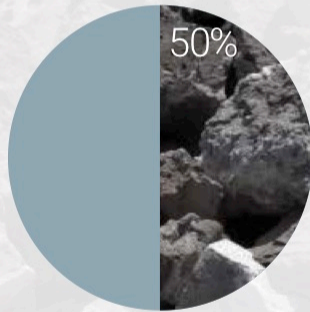
Other



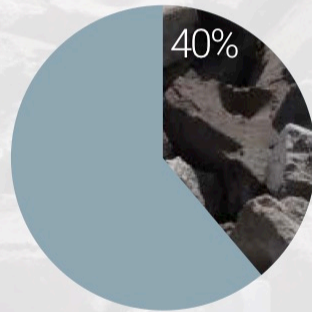
Built environment and construction industry

How could we find a solution?

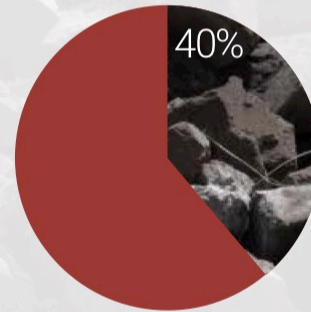
Total
Material use



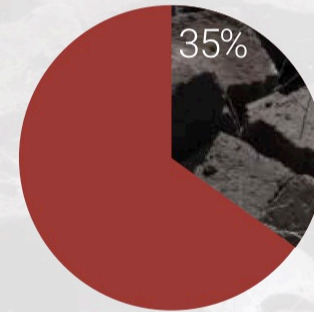
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Waste stream



Total
Energy use



Total
CO² emissions



Other



Built environment and construction industry

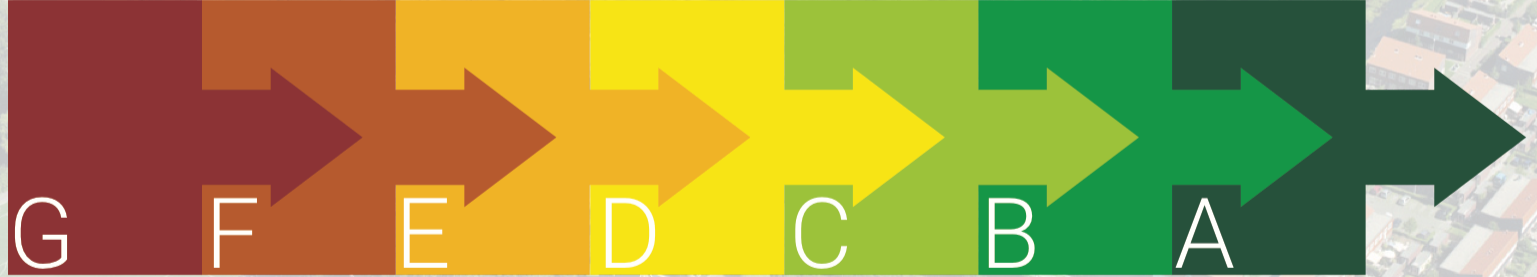
Other



Built environment and construction industry

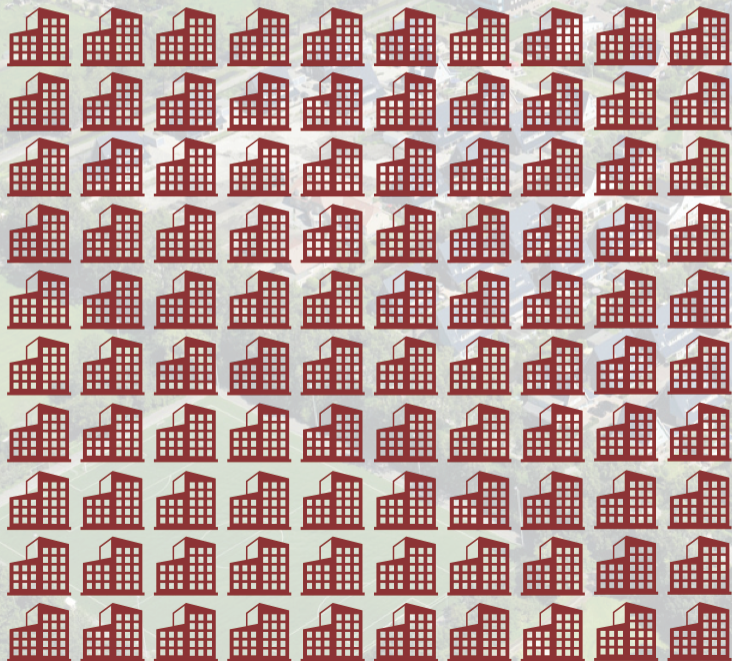
**Energy intensive
building stock**

**(nearly) zero energy
building stock**



Existing building stock

Poor energy performance



New buildings

High energy performance

Housing stock

Uses 61% of the energy



New buildings

High energy performance



From linear economy

Take



From linear economy

Take

Make



From linear economy

Take



Make



Dispose



From linear economy

Take



Make



Dispose



To circular economy



Energy use + Material use



Energy use

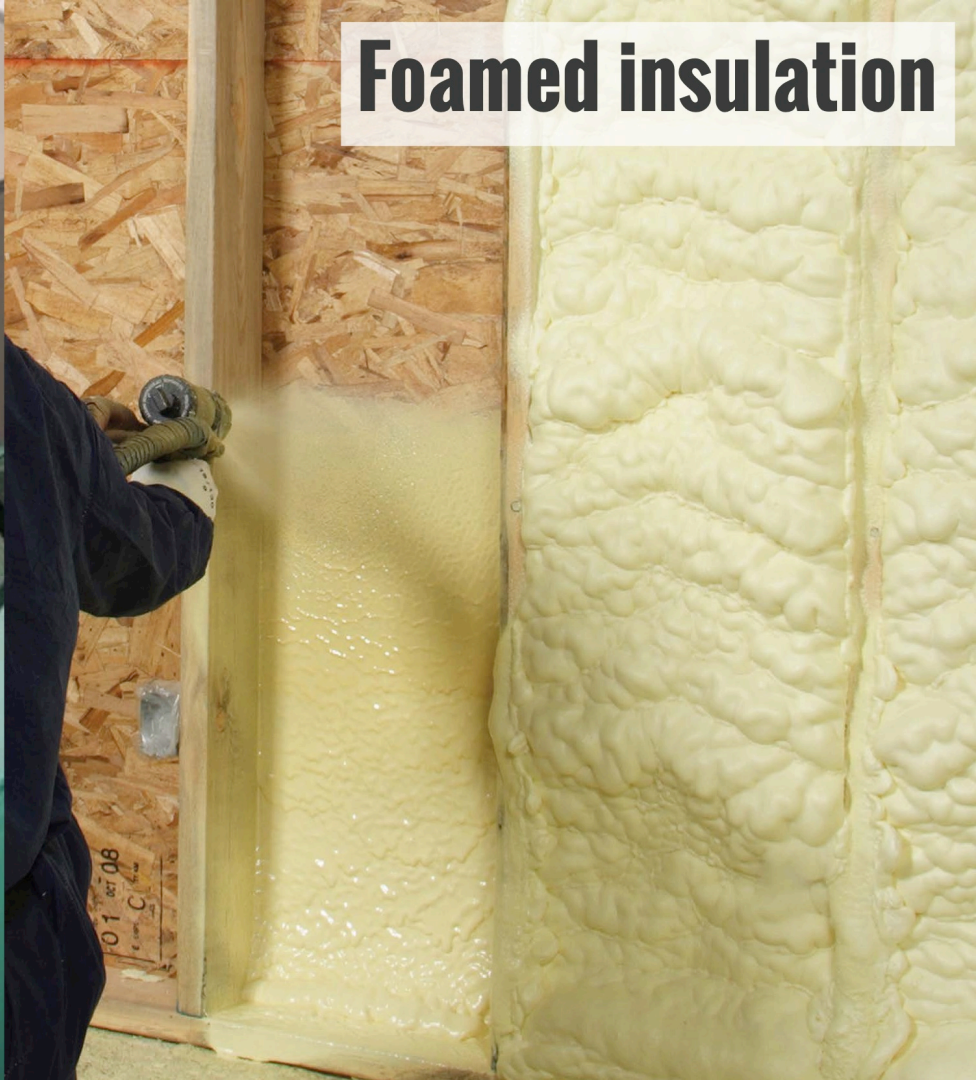
+

Material use





Coated glass

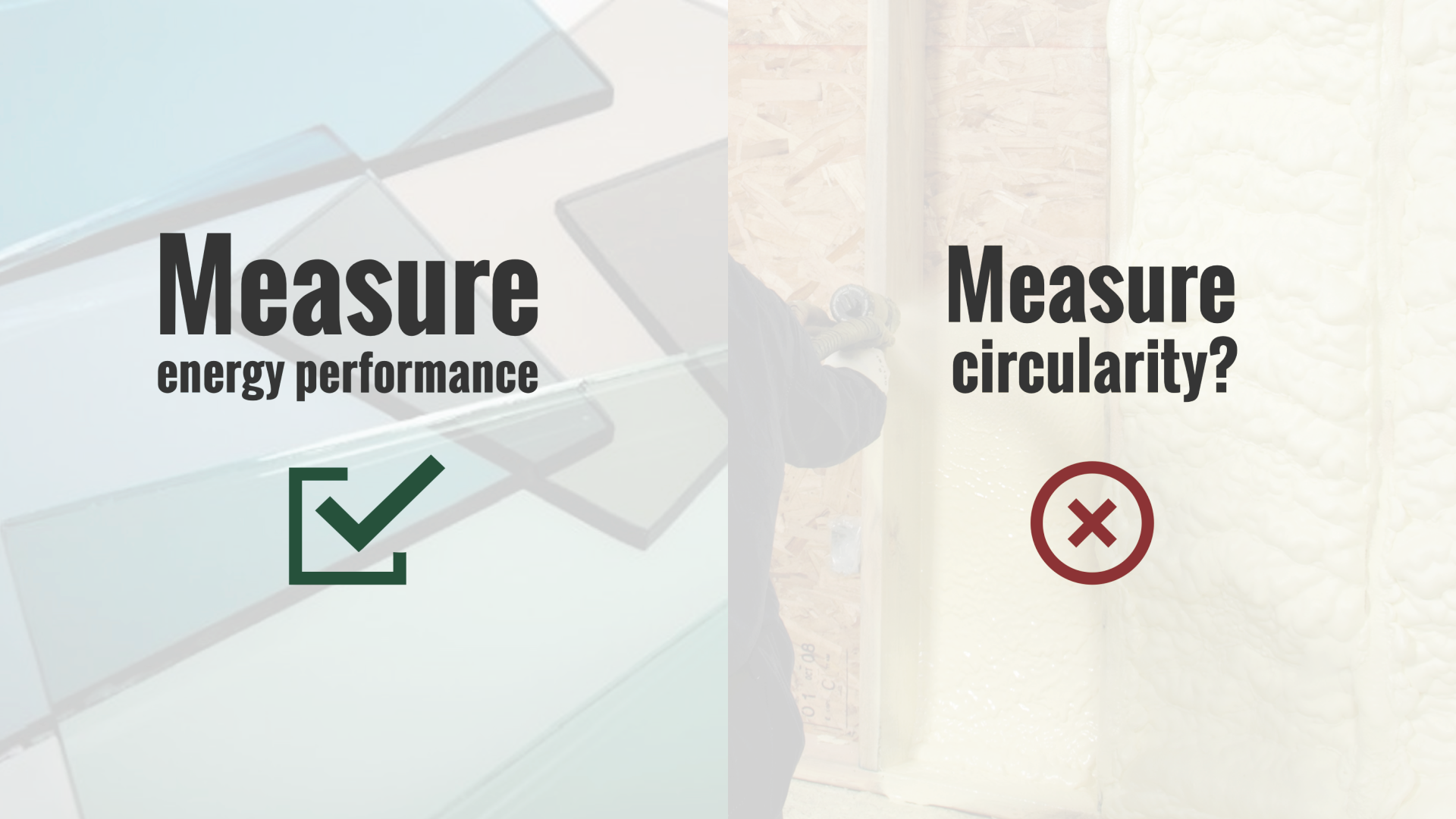


Foamed insulation

Measure
energy performance



Measure
circularity?



There is a lack of knowledge on how to design a circular building, and how to integrate this with energy renovation. This is because

- energy renovation can result in building design which does not lend itself for circularity and
- there is a lack of consensus and understanding about how circularity in buildings can best be assessed.

Research questions

Main question

To what extent can circularity be implemented in the designs of energy renovation projects?

Sub question

How will the circularity and energy use be assessed in the case study energy renovation project so this assessment supports the design of circular buildings and contributes to consensus and understanding about assessing circularity?

Sub question

How can the case study energy renovation project be designed so that the highest level of circularity possible is reached?

Research questions

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How can the case study energy renovation project be designed so that the highest level of circularity possible is reached?

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Sub question

How can the case study energy renovation project be designed so that the highest level of circularity possible is reached?

A photograph of a residential street in the Ramplaankwartier neighborhood. The street is paved with cobblestones and lined with two-story brick houses. Several cars are parked along the street, including a white car with license plate HH-948-S and a silver car with license plate HH-948-S. The street is shaded by large, leafy trees, and the sky is clear and blue.

Case study project Ramplaankwartier



**Dwelling
typology**

Case study dwelling



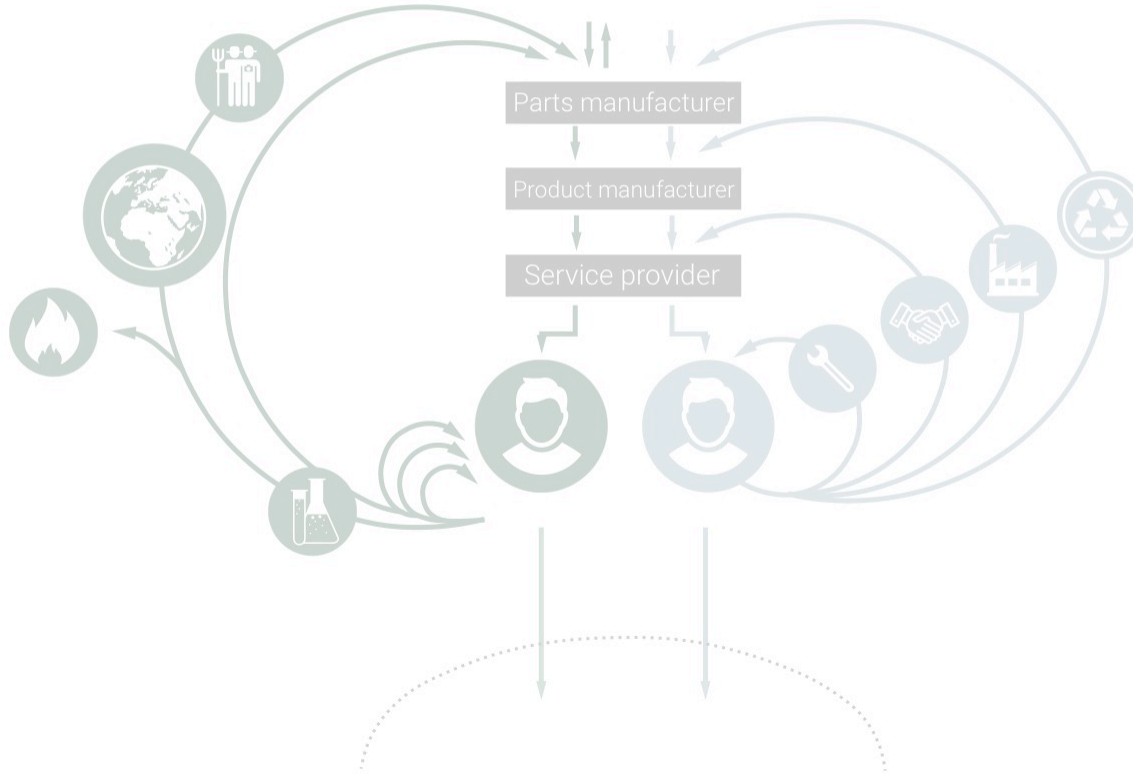
Definition circular economy

“A circular economy is a global economic model that aims to **decouple economic growth** and development from the **consumption of finite resources**. It is **restorative** by design, and aims to keep **products, components and materials at their highest utility and value**, at all times. The larger goal is to address human needs and fairly distribute resources without undermining the functioning of the biosphere or **crossing any planetary boundaries.**”

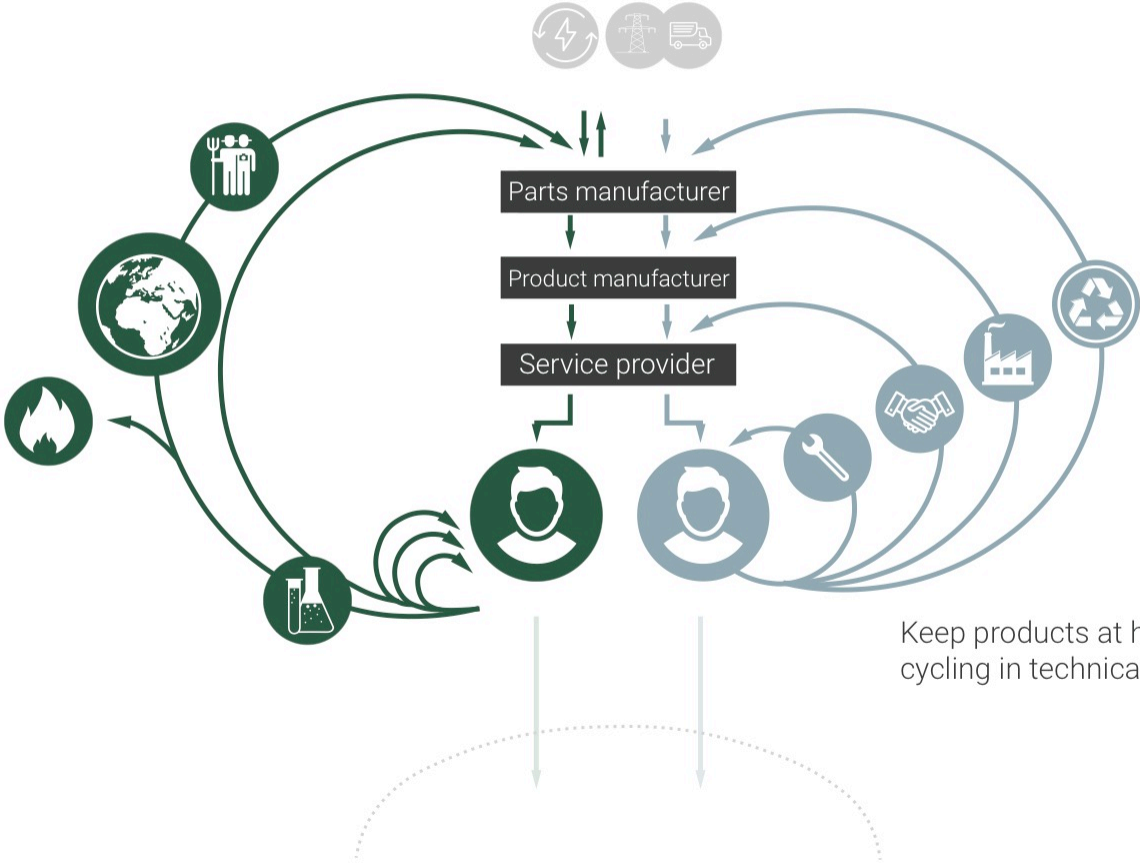
Definition circular economy



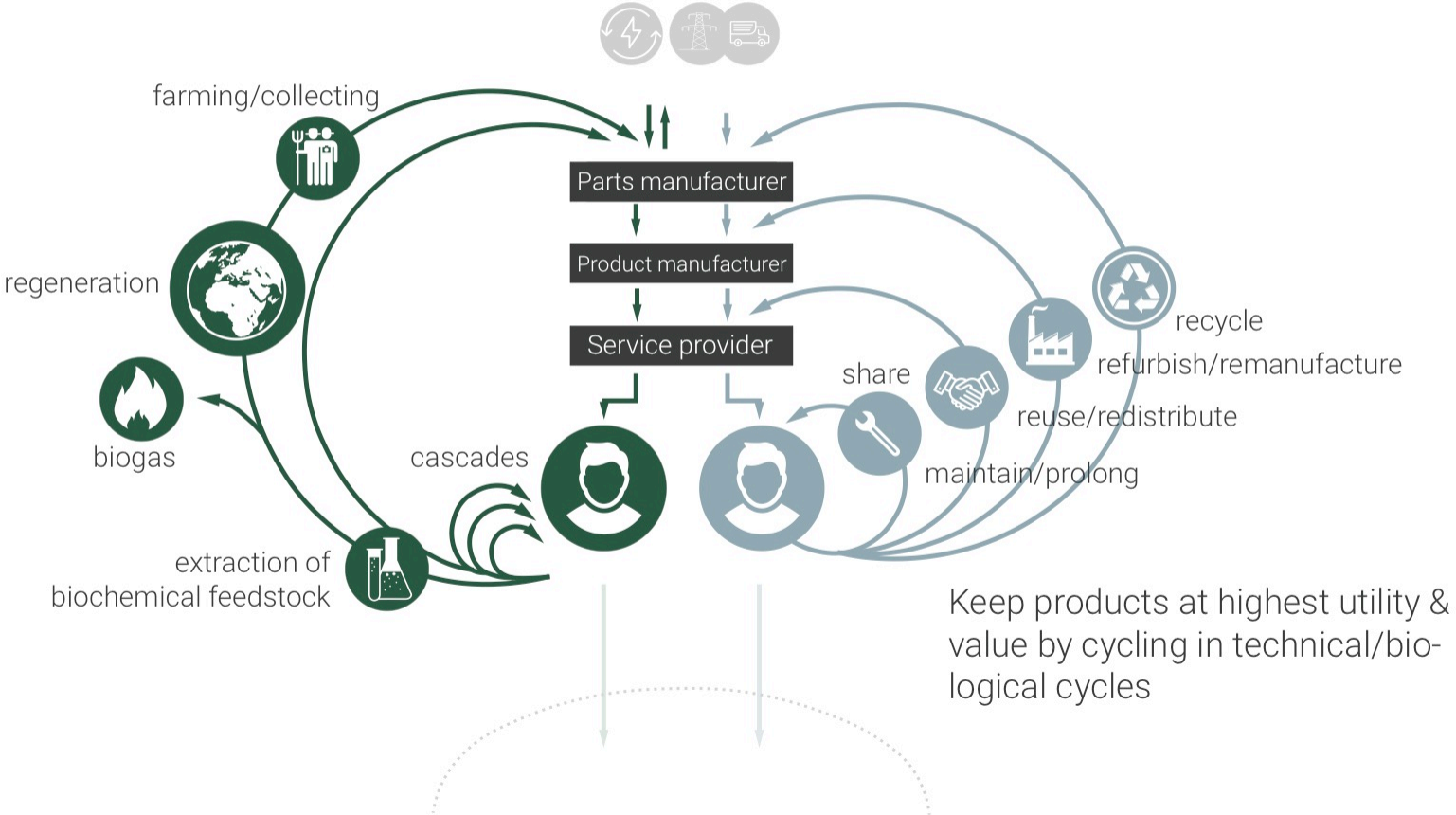
- Enhance and preserve natural capital
- Controlling finite stocks
 - Balancing renewable resource flows



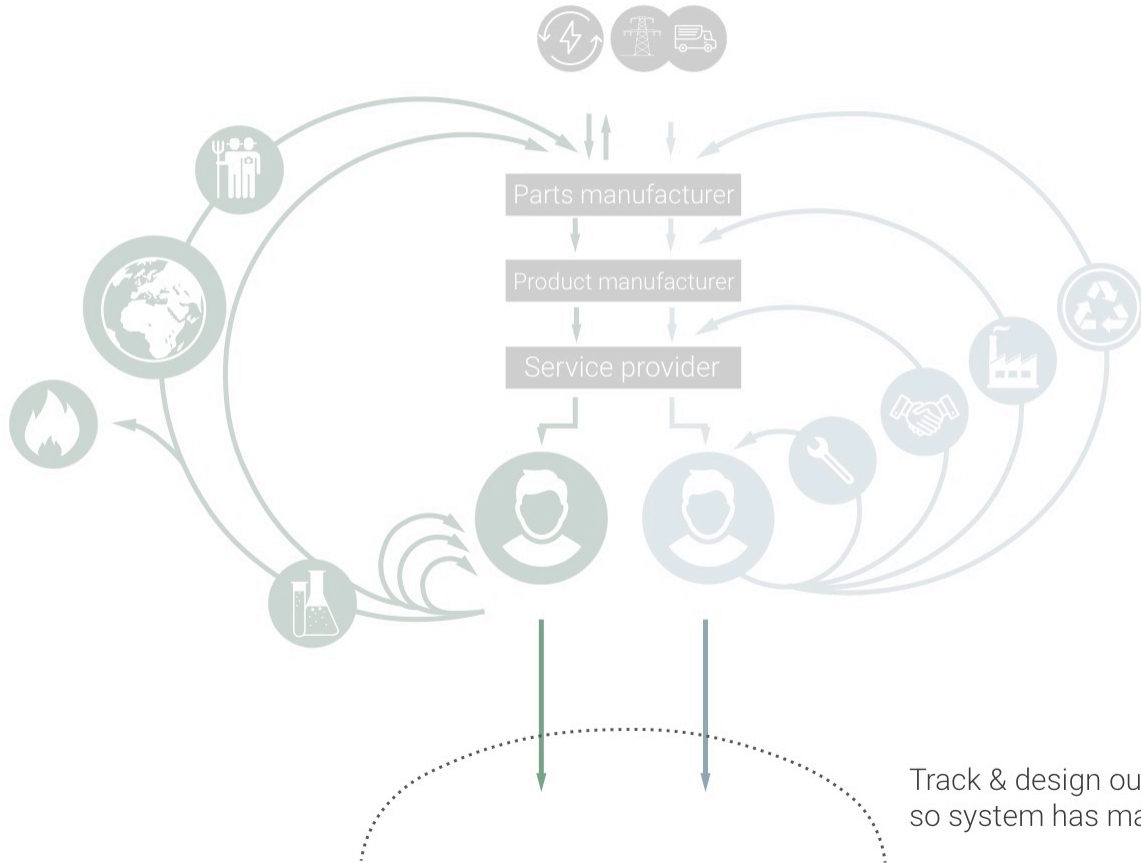
Definition circular economy



Definition circular economy



Definition circular economy



**Assessment
methodology circularity**



**Design
by research**



**Results
assessment**



**Conclusions
& recommendations**

**Assessment
methodology circularity**



**Design
by research**



**Results
assessment**



**Conclusions
& recommendations**

**Assessment
methodology circularity**



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**Results
assessment**



**Conclusions
& recommendations**

**Assessment
methodology circularity**



**Design
by research**



**Results
assessment**



**Conclusions
& recommendations**

Assessment methodology circularity

MAT1



Intensity
of use

MAT2



Environmental
cost

MAT3



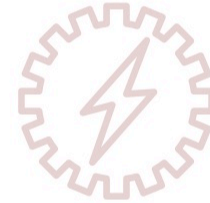
Design for
disassembly

MAT4



Design for
circular
life cycles

E1



Energy efficiency:
EPC

Assessment methodology circularity

MAT1



Intensity
of use

MAT2



Environmental
cost

MAT3



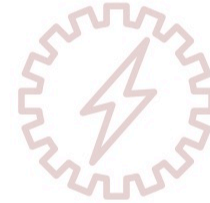
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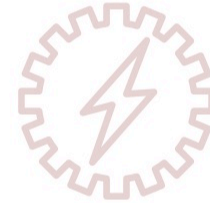
Design for
disassembly

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Design for
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Energy efficiency:
EPC

Assessment methodology circularity

MAT1



Intensity
of use

MAT2



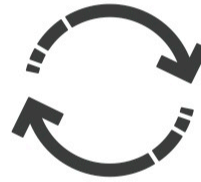
Environmental
cost

MAT3



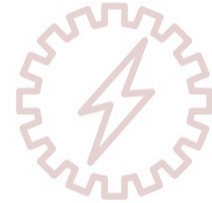
Design for
disassembly

MAT4



Design for
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E1



Energy efficiency:
EPC

Assessment methodology circularity

MAT1



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MAT2



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cost

MAT3



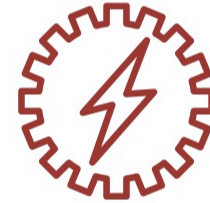
Design for
disassembly

MAT4



Design for
circular
life cycles

E1



Energy efficiency:
EPC

Assessment methodology circularity

MAT1



Intensity
of use



Unnecessary material use needs to be prevented & minimised

Assessment methodology circularity

MAT1



Intensity
of use

→ Unnecessary material use needs to be prevented & minimised

new design

(...) kg materials



existing roof structure

(...) kg materials



Assessment methodology circularity

MAT2



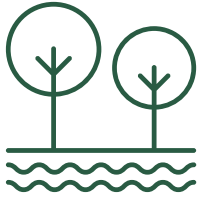
Environmental
cost



Evaluates 'shadow costs' of used materials: toxicity etc.
Impact materials on environment should be minimised

Assessment methodology circularity

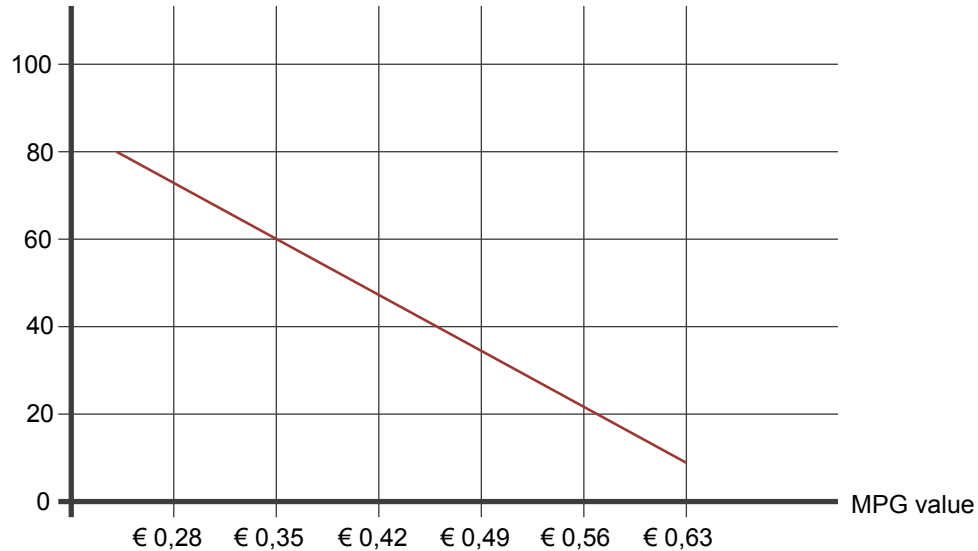
MAT2



Environmental
cost



Evaluates 'shadow costs' of used materials: toxicity etc.
Impact materials on environment should be minimised



MAT3



Design for
disassembly

Assessment methodology circularity



If a building can't be disassembled, materials/products can't be reused/recycled/remanufactured in biological/technical cycles

MAT3



Design for disassembly

Assessment methodology circularity



If a building can't be disassembled, materials/products can't be reused/recycled/remanufactured in biological/technical cycles

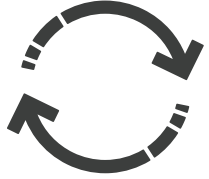
Main methodology			
Method	Weight	Weight	
Theme: Information			
1. Information quality (I)	1	1	1
Theme: Speed and comfort of assembly & disassembly			
2. Assembly duration (A2)	0.5	1	0.5
3. Assembly change (A3)	0.8	1	0.8
4. Assembly ergonomics (A4)	0.7	1	0.7
5. Disassembly (D)	0.7	1	0.7

Theme: Possibility to separate different functional groups and replace functions			
6. Type of fastener (TC)	1	1	1
7. Type of material join (TC)	1	1	1
8. Functional separation (TC)	0.5	1	0.5
9. Type of coating (TC)	0.5	1	0.5
10. Use of glue (TC)	0.5	1	0.5
11. External fixings (TC)	0.5	1	0.5
12. Internal fixings (TC)	0.5	1	0.5
Theme: Connections & Interfaces			
13. Type of connection (TC)	0.5	1	0.5
14. Separation of material (TC)	0.5	1	0.5
15. Separation of product parts (TC)	0.5	1	0.5
16. Reuse (TC)	0.5	1	0.5



13. Type of connection (TC)	Accessory external connection or system	1
	Direct connection + fixing devices	0.8
	Direct integral connection + inserts χ pin	0.6
	Direct integral connection	0.5
	Accessory internal connection	0.4
	Filled soft chemical connection	0.2
	Filled hard chemical connection	0.1
	Direct chemical connection	0.1

MAT4



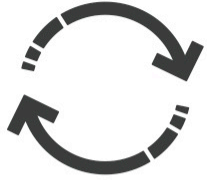
Design for
circular
life cycles

Assessment methodology circularity



Materials/products/components need to cycle for as long as possible at high quality in biological/technical cycles

MAT4



Design for circular life cycles

Assessment methodology circularity

Materials/products/components need to cycle for as long as possible at high quality in biological/technical cycles

1. Is the building part to be assessed a component, element or material? (and if component, can it be taken apart in its constituent elements/materials?)

2. Does the building part contain biological, technical materials or both?

3. What is the performance/technical lifetime of the building part?

4. Does this technical lifetime fit with the function (building layer) of the part?

5. Can the building part cycle in one or more of the biological or technical cycles? If not, then what happens to the building part after end of life time?

6. What is the most suited path of cycling for the building part?
Explain why.

7. How likely is it that the part will follow this path of cycling at this point in time?
Explain why.

8. How likely is it that the part will follow this path of cycling in the future?
Explain why.

Information questions: needed for assessment
Assessment questions

Component | Element | Material

Biological | Technical

0-25 years | 25-50 years | 50-75 years | 75-- | Unknown

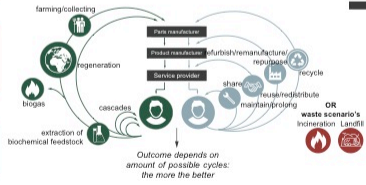
Yes | No | Not entirely

Not likely | Possible | Likely

Not likely | Possible | Likely

Outcome is 'bad' | Outcome is 'neutral' | Outcome is 'good'

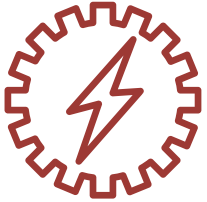
Outcome is | Outcome is | Outcome is



- Analyze possible cycles: the more the better
- Analyze most suitable path of cycling
- Analyze if currently follows suitable path of cycling
- Analyze if in the future could follow suitable path of cycling

Assessment methodology circularity

E1

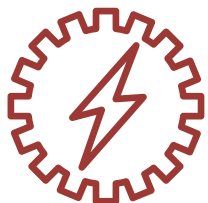


Indicator measuring energy performance of dwelling

Energy efficiency:
EPC

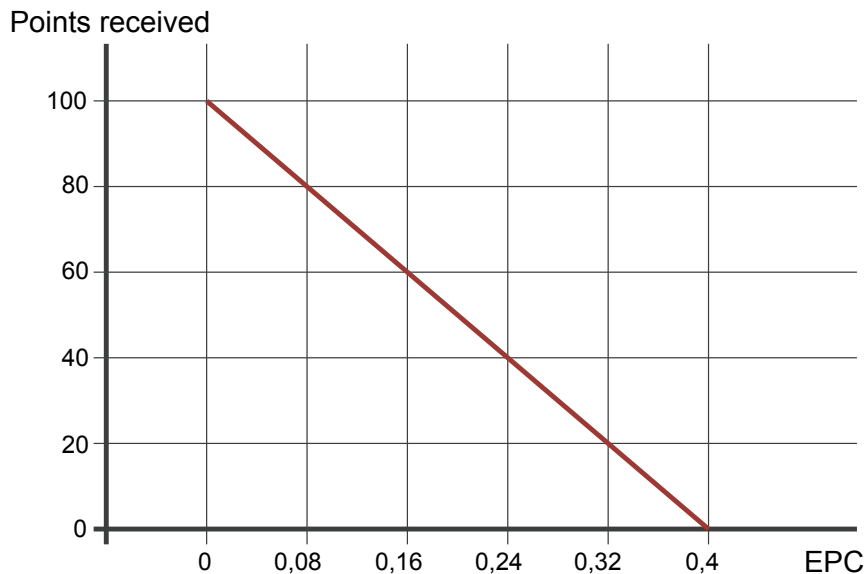
Assessment methodology circularity

E1



Indicator measuring energy performance of dwelling

Energy efficiency:
EPC



Design by research

How can the case study energy renovation project be designed so that the highest level of circularity possible is reached?

Design by research

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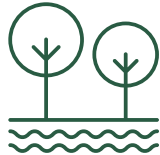
Highest level of circularity = optimal combination between indicators

MAT1



Intensity
of use

MAT2



Environmental
cost

MAT3



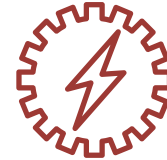
Design for
disassembly

MAT4



Design for
circular
life cycles

E1

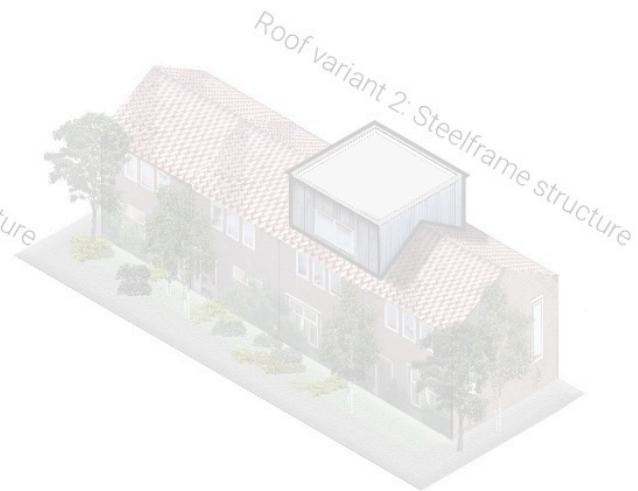


Energy efficiency:
EPC

Design by research



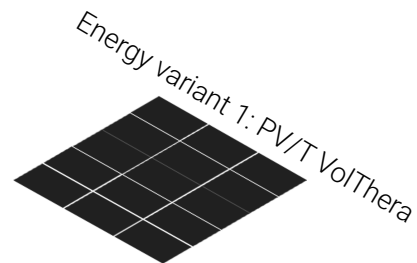
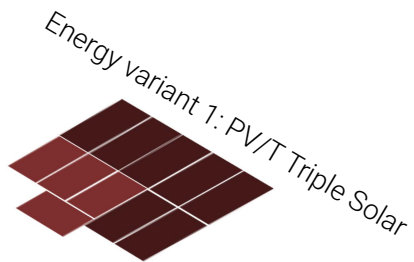
Design by research



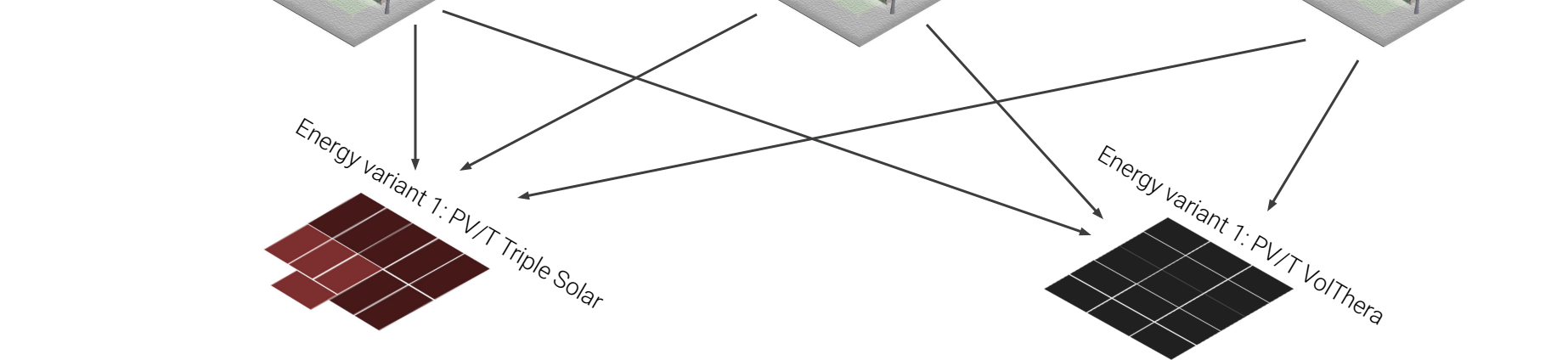
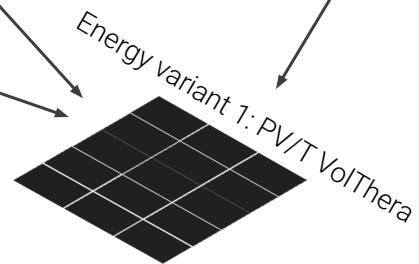
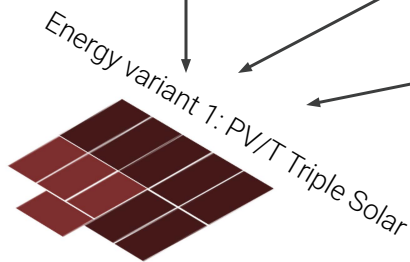
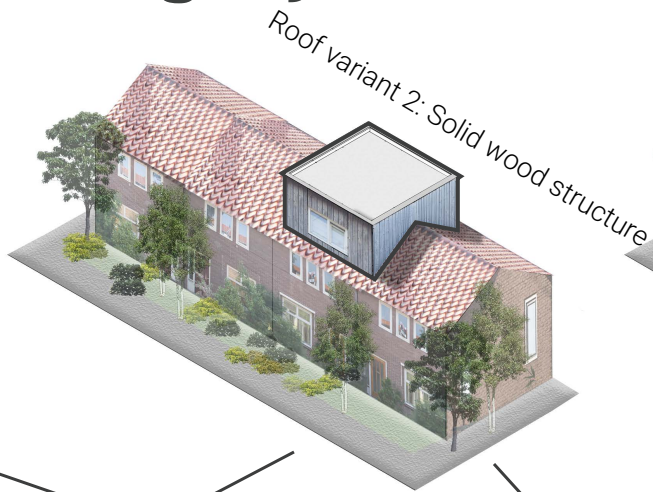
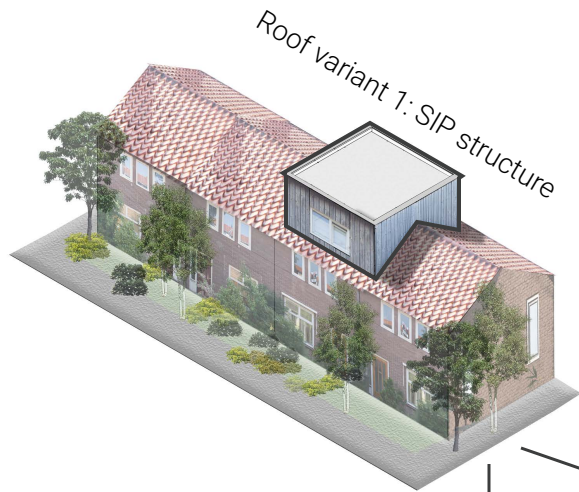
Design by research



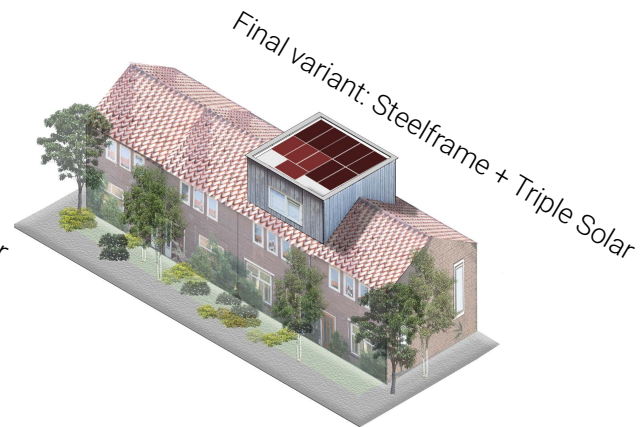
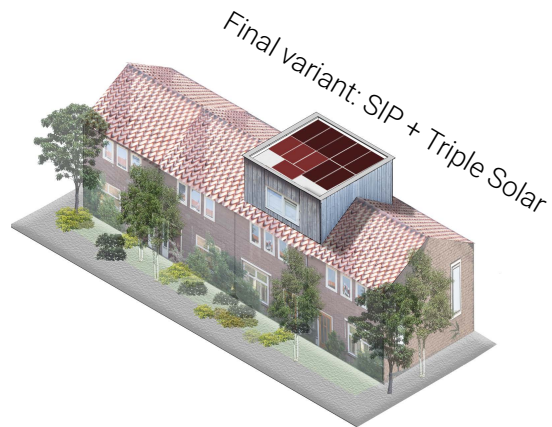
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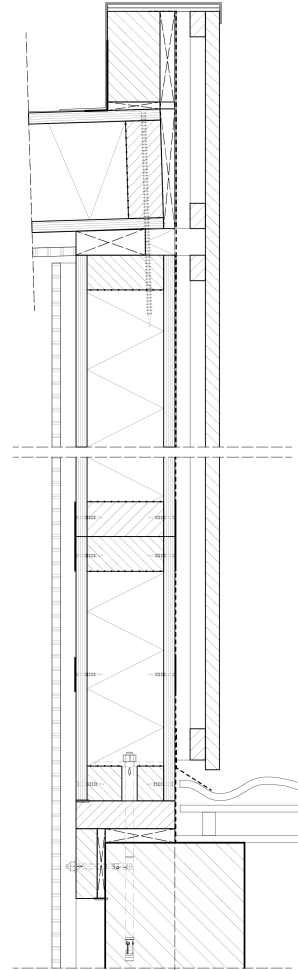
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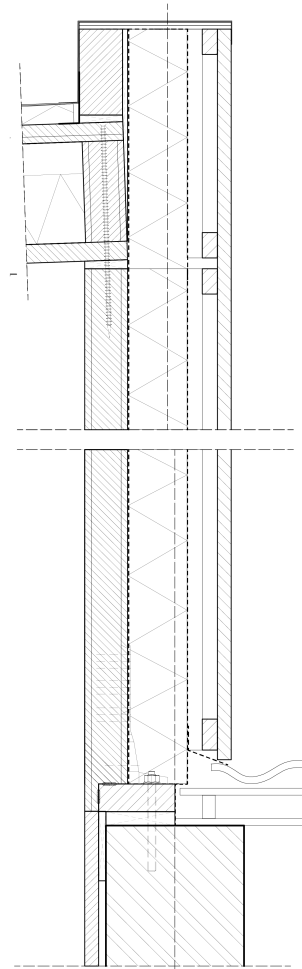
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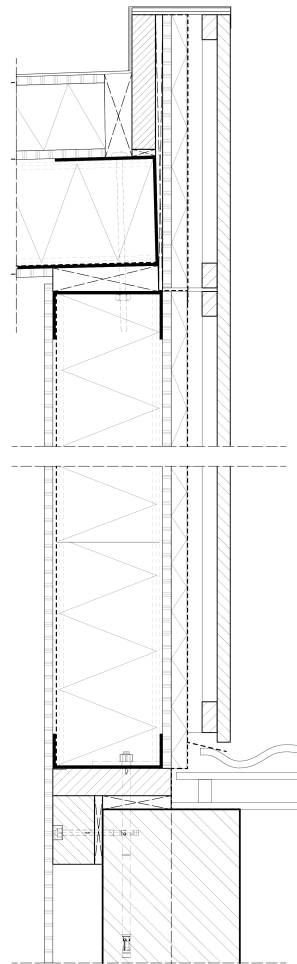
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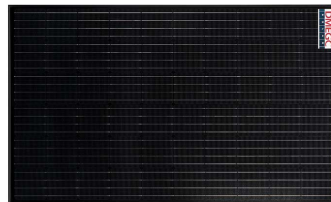
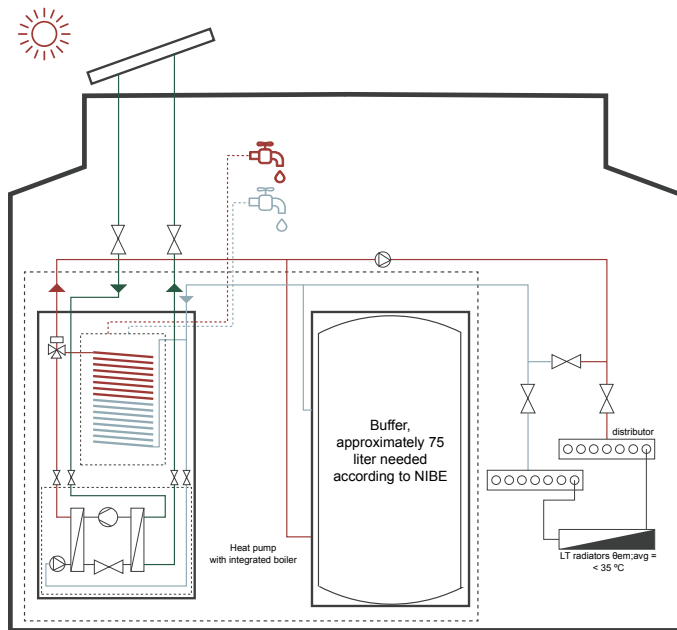
Design by research



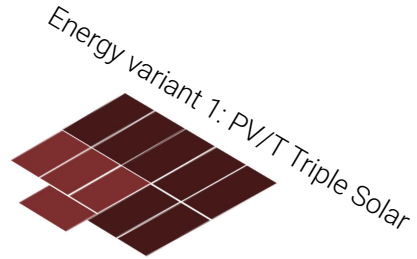
Design by research



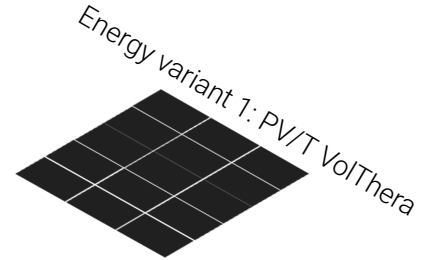
Design by research



Design by research



- Higher heat transmittance
- Not very demountable
- Additional 4 regular solar panels



- Lower heat transmittance
- More demountable





Before



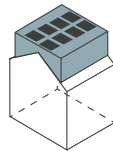
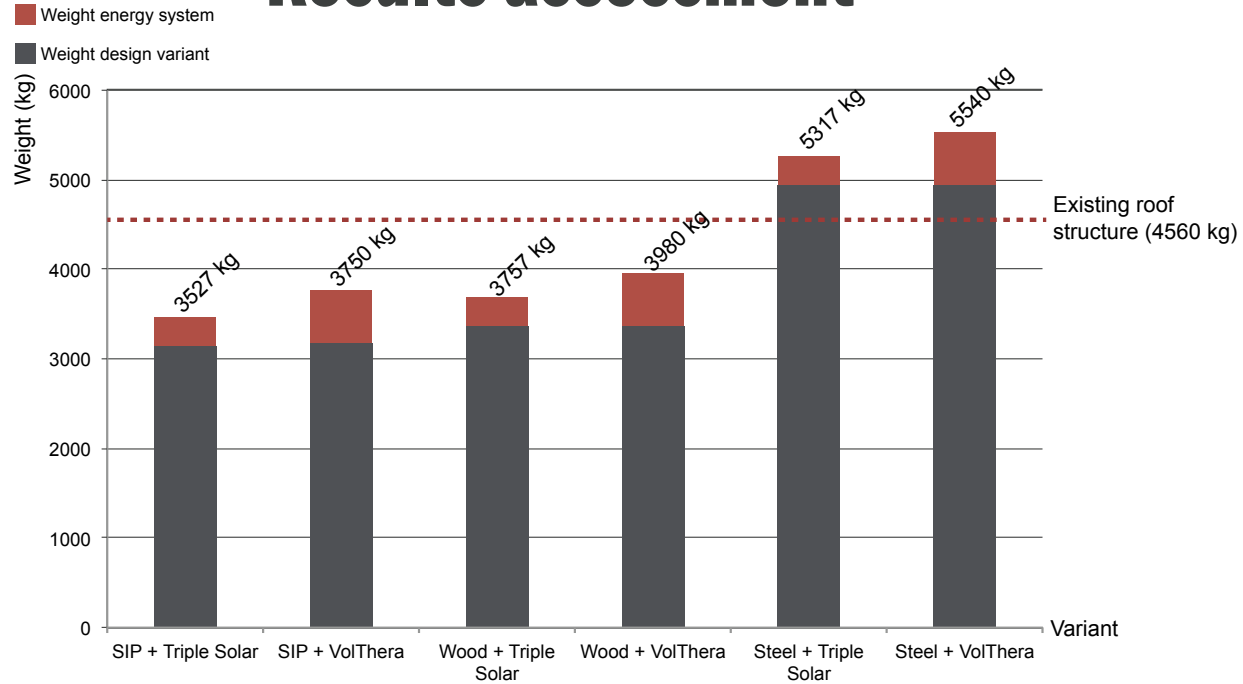
After

MAT1

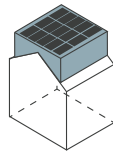


Intensity
of use

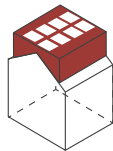
Results assessment



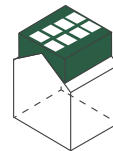
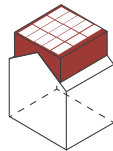
SIP STRUCTURE VARIANT



SOLID WOOD VARIANT

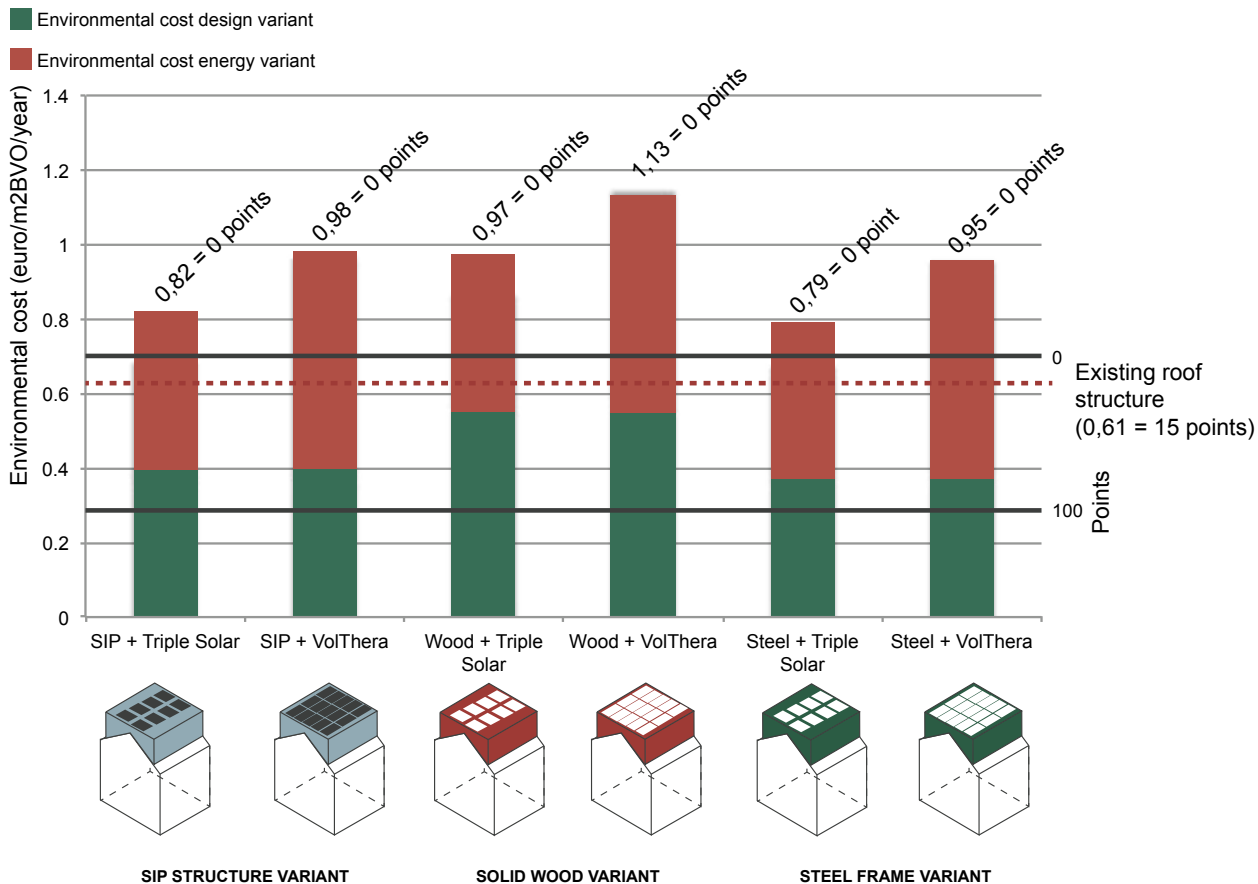


STEEL FRAME VARIANT



MAT2

Results assessment

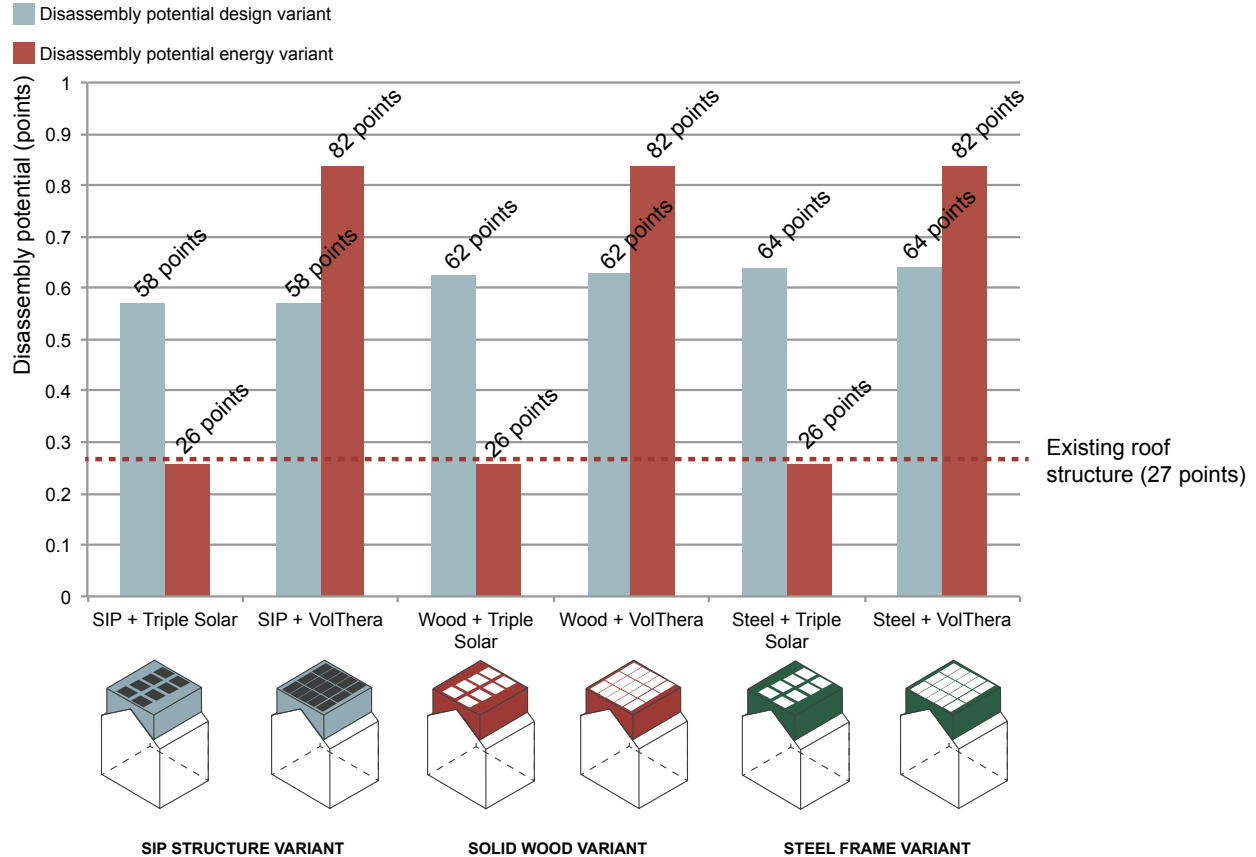


MAT3

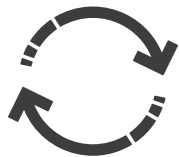


Design for disassembly

Results assessment



MAT4



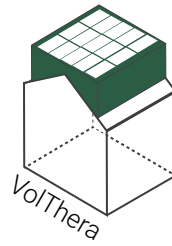
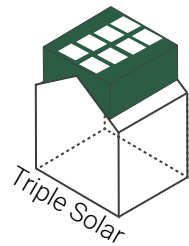
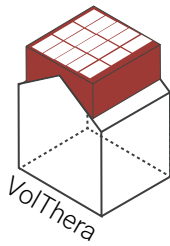
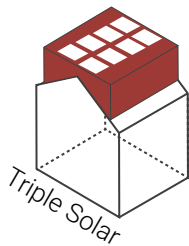
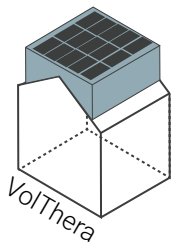
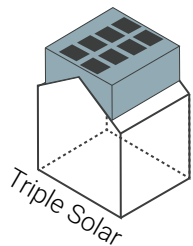
Design for
circular
life cycles

Results assessment

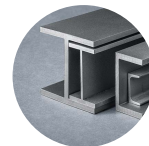
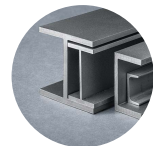
SIP variants

Solid wood variants

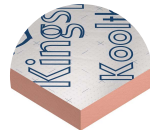
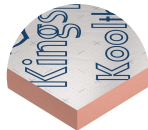
Steel frame variants



Structure



Insulation

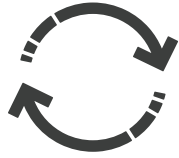


Energy system



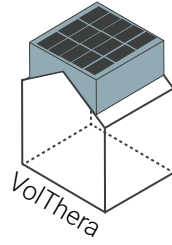
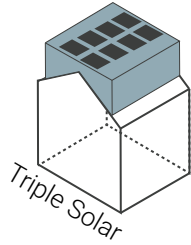
Results assessment

MAT4

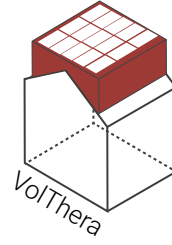
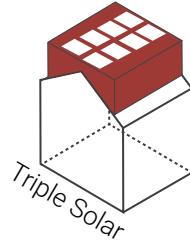


Design for
circular
life cycles

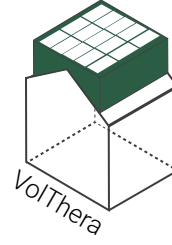
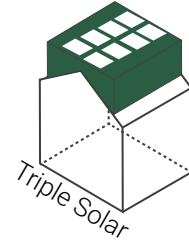
SIP variants



Solid wood variants



Steel frame variants



Least potential for
circular life cycles

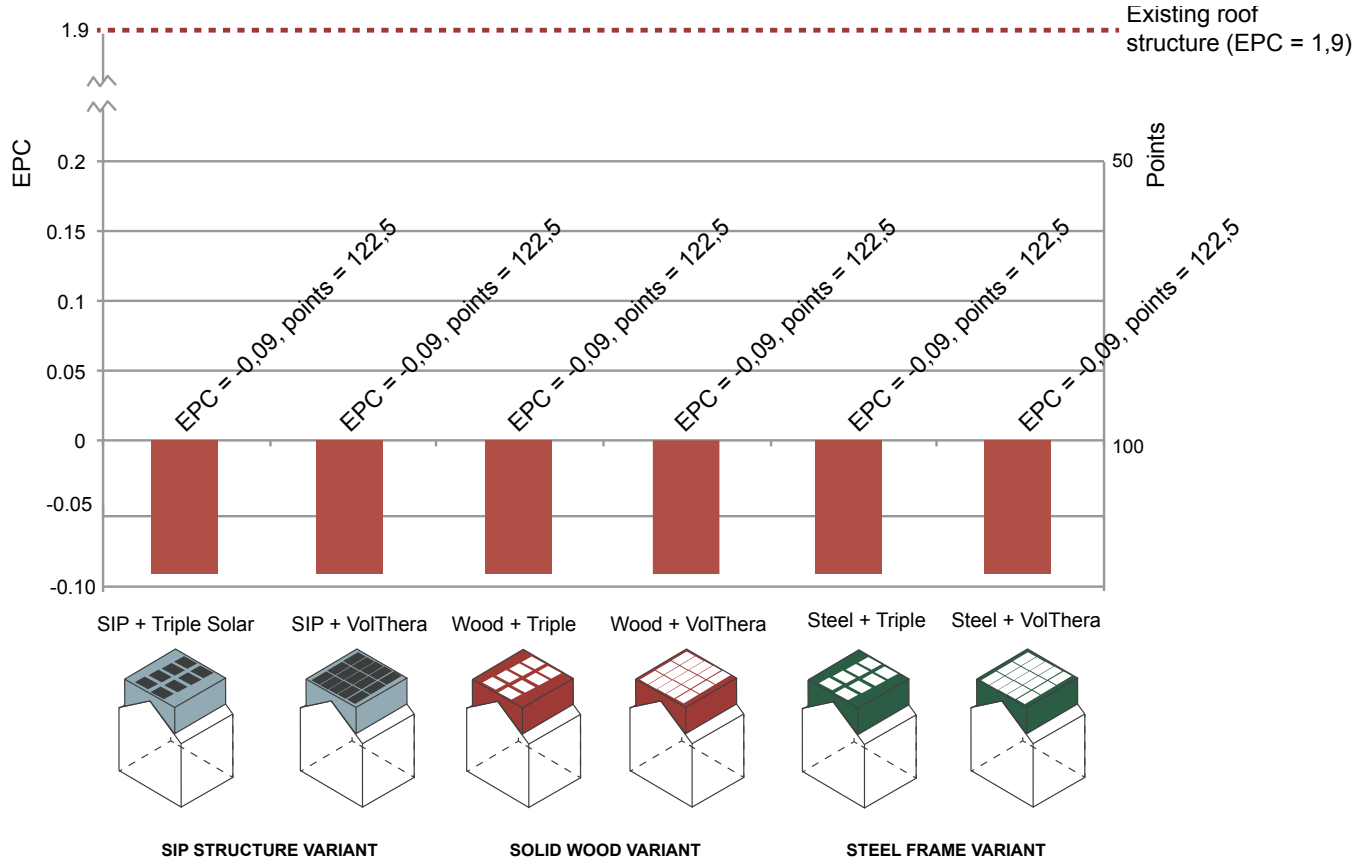
Most potential for
circular life cycles

E1



Energy efficiency:
EPC

Results assessment



Conclusions

To what extent can circularity be implemented in the designs of energy renovation projects?

Price of high energy performance = high environmental cost

Energy systems: high score for design for disassembly + high potential for circular life cycles negative influence energy efficiency

High EPC no negative influence on **design for disassembly** roof structure, **design for circular life cycles** roof structure or **intensity of material use** roof structure

Recommendations

Develop assessment methodology further

- Environmental cost: transform from cradle to grave to cradle to cradle
- Quantify design for circular life cycles

Develop designs further

- Solid wood variant: optimize to cycle in biological cycles
- Steel frame variant: optimize to cycle in technical cycles + speed up building time

Business model

- What could the role of the service provider be?
- Financial feasibility