Update of Life Cycle Assessment of ETICS End of Life Treatment of Expandable Polystyrene

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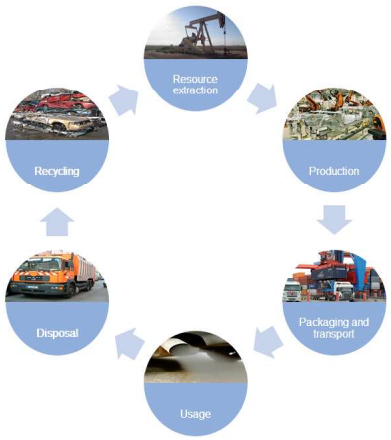
Life Cycle Assessment (LCA) of ETICS End-of Life treatment

- LCA is a technique to assess the potential environmental impacts of products or processes throughout their entire life cycle – including production, use and end of life
- Consistency with ISO 14040:2006 and 14044:2006
- Scope of the study: provide a comparative LCA for the end of life treatment options
  - Energy recovery (status quo)
  - PSLoop

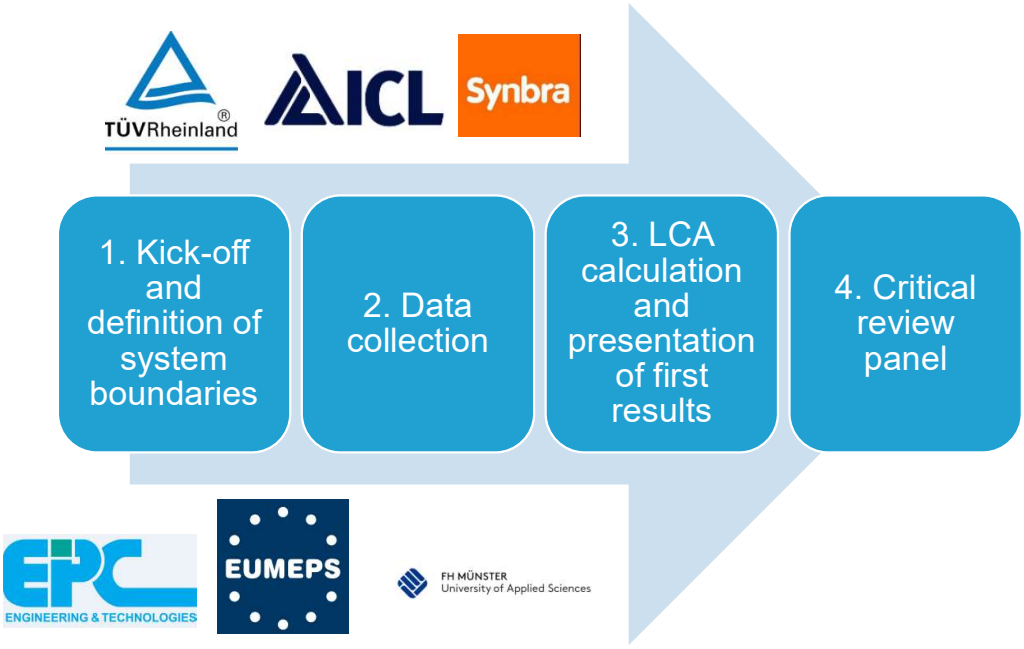
of 1 ton of EPS coming from External Thermal Insulation Composite System (ETICS) from dismantling of houses in Germany, Austria and Switzerland

→ Economic feasibility is so far not covered by this LCA!



Source. TÜV Rheinland, 2017

Timeline: LCA incl. critical review panel 2016 - 2017



Quantis

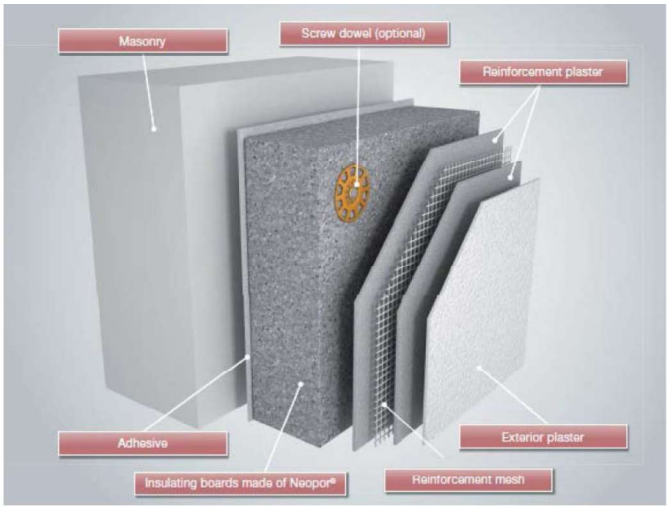
Prof. Kind, Karlsruhe

BKV PLASTICS CONCEPTS RECOVERY

1. Kick- off and definition of system boundaries

Masses of installed ETICS components to this day

31,6%	**10%**	32,2%	1,5%	24,2%	0,6%
adhesive	EPS	plaster	fabrics	finishing coat	dowels

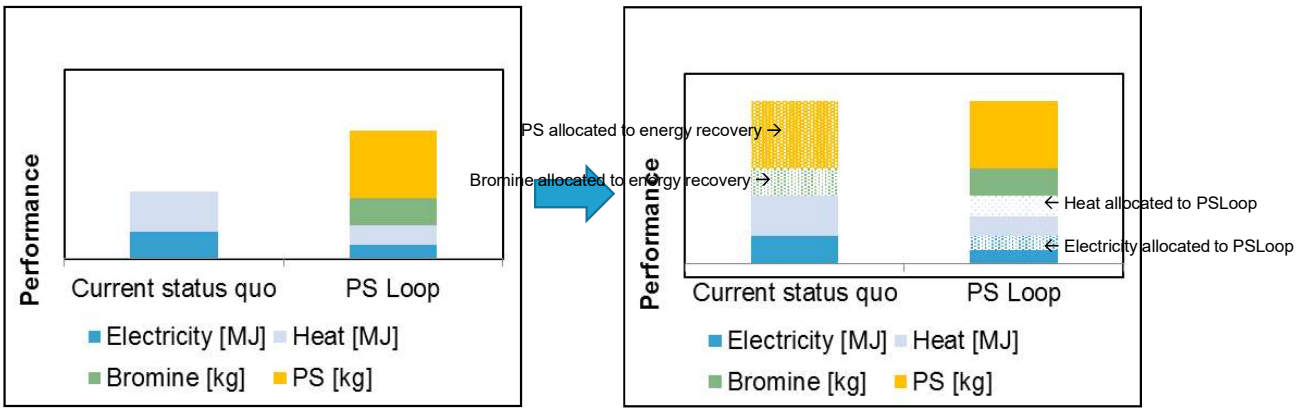


Source:
Albrecht, W. und Schwitalla, C. 2014: Fraunhofer Institut fü Bauphysik IBP-Bericht BBHB 019/2014/281: Rückbau, Recycling und Verwertung von WDVS „Möglichkeiten der Wiederverwertung von Bestandteilen des WDVS nach dessen Rückbau durch Zuführung in den Produktionskreislauf der Dämmstoffe bzw. Downcycling in die Produktion minderwertiger Güter bis hin zur energetischen Verwertung“ ; ISBN-978-3-8167-9411-0, Fraunhofer IRB-Verlag

Definition of system boundaries*

Intermediate results

System expansion



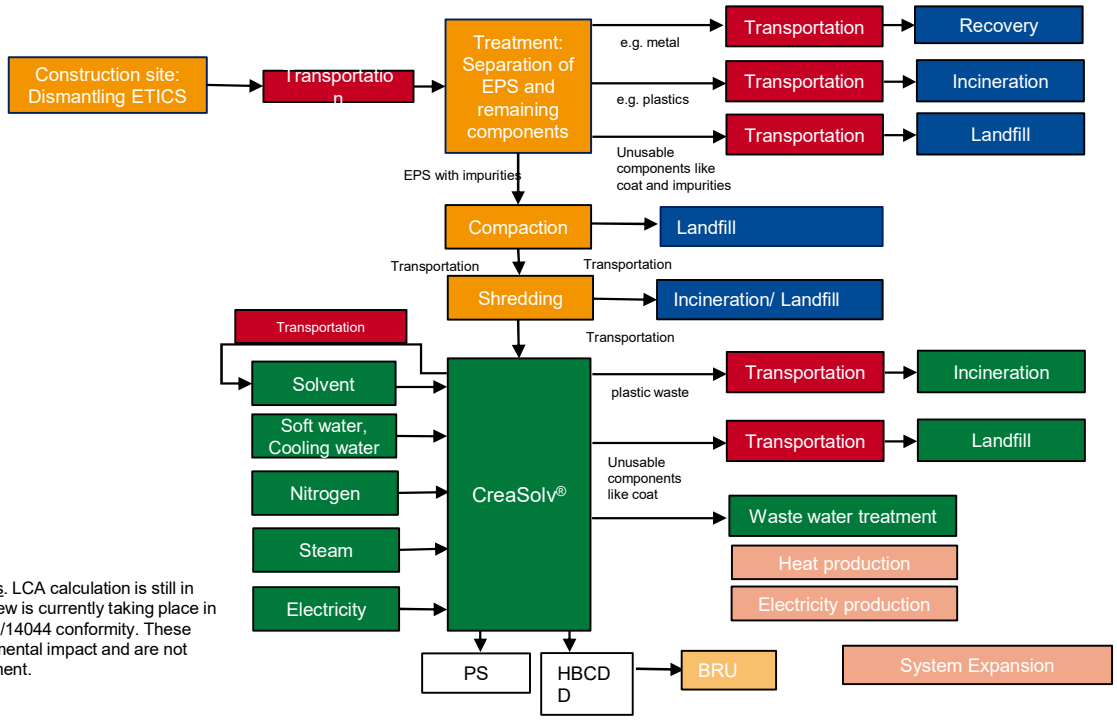
- Thus both systems consider the same amount of electricity, heat, polystyrene and bromine production (same performance).

*These are preliminary results. LCA calculation is still in progress. A critical panel review is currently taking place in order to check the ISO 14040/14044 conformity. These results are based on environmental impact and are not including a total cost assessment.

2. Data collection

Flow Chart: PS Loop Process 1/2*

Intermediate results



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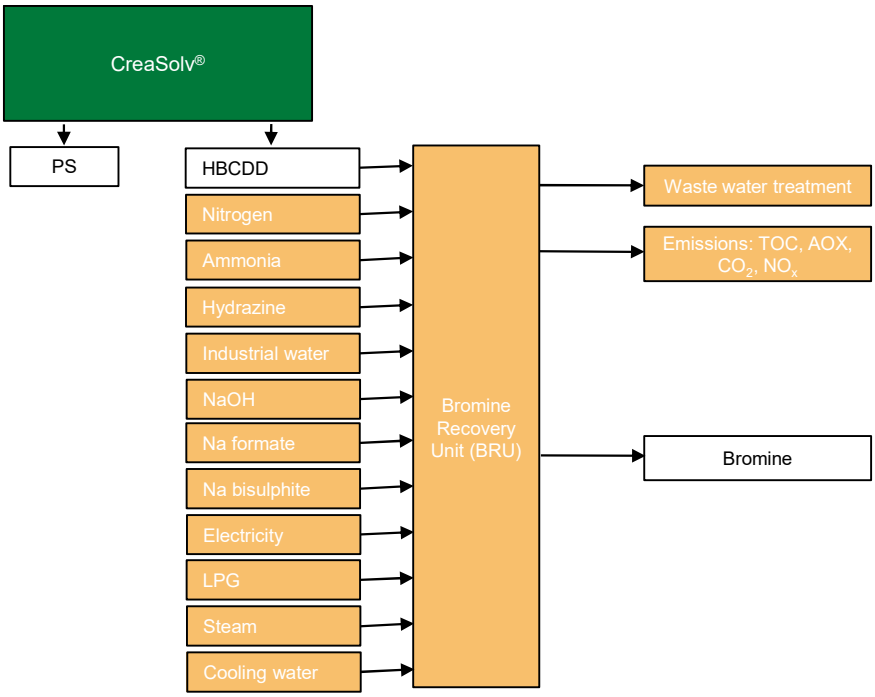
Flow Chart: PS Loop Process 2/2*

Intermediate results



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Assumptions 1/2*

Intermediate results

- Energy demand for demolition and separation: 0.2 MJ/kg (TÜV Rheinland).
- Quality of recycled polystyrene (CreaSolv®** Process) and bromine (Bromine Recovery Unit) are equal to virgin material.
- Composition of solvent for CreaSolv® process reflects a worst case assumption (EPC).
- Incineration of EPS and further ETICS components (rough estimation) is based on generic datasets.
- Location of Enf of Life process is Europe.
- Transport distance from deconstruction to separation plant: 100 km
- Transport distance from pre-treatment to CreaSolv®: 250 km
- Transport distance from CreaSolv® to incineration plant: 100 km

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**CreaSolv® is a registered trademark of CreaCycle GmbH

Assumptions 2/2*

Intermediate results

- Assumptions concerning end of life treatment:

Process	Material	Treatment	Source
Current process, demolition	Material mix A	87.9% incineration of inert matter 12.1% incineration of polystyrene	FH Münster
PS Loop	Material mix B (87,4%)	100% incineration of inert matter	FH Münster
	EPS (12%)	100% recycling (CreaSolv® process)	-
	Plastics (0.1%)	100% incineration	-
	Metals (0.5%)	90% recycling/10% landfill	-

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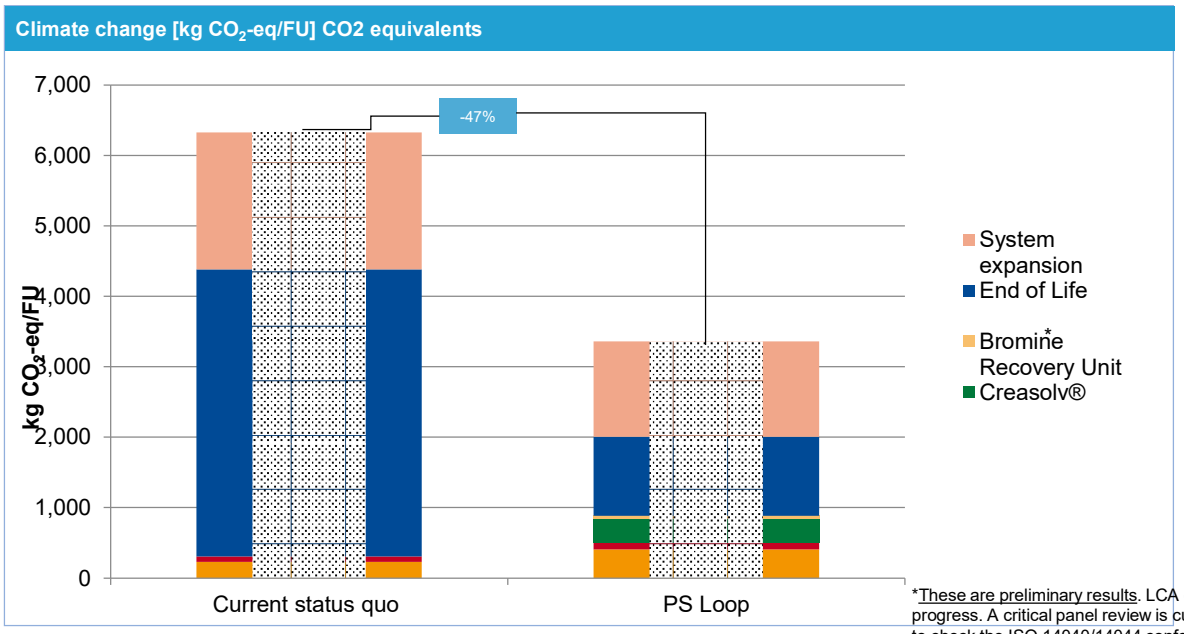
3. LCA calculation and presentation of first results

Climate Change – Overall*

Intermediate results



* Current stauts quo: Material mix A 87.9 % incineration of inert matter, 12.1 % incineration of polystyrene
PS Loop: Material mix B 87.4 % incineration of inert matter, Plastics (0.1 %) incineration, Metals 90% recycling/10% landfill

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Intermediate results – before critical review panel

Intermediate results

- In following impact categories PolyStyrene Loop has a **lower overall environmental impact** compared to the current status quo (energy recovery)
  - Climate change
  - Eutrophication, freshwater
  - Summer smog
  - Resource depletion
  - Human- and eco-toxicity
- For the impact categories “Acidification” and “Eutrophication, marine” PolyStyreneLoop perform slightly better than energy recovery
- System expansion (especially production of polystyrene) influences the results. The pre-treatment has only a small impact on the overall results
- The overall impacts of transportation steps are not relevant for both alternatives. A slightly higher impact for PS Loop occurs caused by a lower utilization rate
- Higher share of EPS (e.g. flat roof applications) leads to no significant changes in this impact category “Climate Change”

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4. Critical review panel

Task of the Critical review panel

- Review of the LCA with regard to ISO 14040 and 14044 conformance
- Compilation of comments from the reviewers (face-to-face meeting)
- Revision/ adaption of the LCA calculations accordingly
- Preparation of final review report and review statements

Feedback from the reviewers

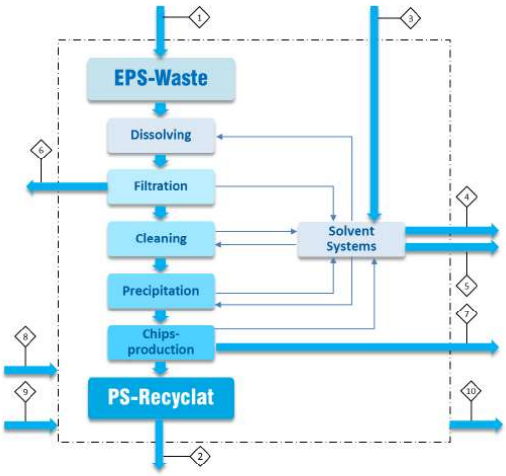
- The form of the study is appropriate and conform with ISO standards, however, study has been calculated as best case
- Lack of data quality → data only an estimate for a plant to be built
- How to deal with losses of product and solvent?
  - e.g. yields of CreaSolv® and BRU , solvent loss during HBCD extraction
  - e.g. recovery of solvent
  - e.g. residual moisture content of extracted solid (SDS?)
  - e.g. input specification for CreaSolv®
  - e.g. quality of PS and Br
- Additional calculations and analysis were proposed by the review team
  - Geographical scope/ transport scenarios
    - Distance of 100 km feasible?
  - Scope of the study
    - e.g. who is the target group?
    - e.g. Basis for decision-making?
  - Technology
    - e.g. energy recovery → what is meant by this? state of the art?
    - PolyStyreneLoop → data based on simulations coming from trials on laboratory scale

→ **Outcome: second calculation is needed ! As consumption data are based on simulations small deviations can be expected during operation of the pilot plant**

Current status quo of the review panel

- Simulation of material balance by providing flow diagrams (sensitivity analysis)
- Determination of break-even points
- Better explanation of system expansion
- Further input data were provided by EPC, Sunpor and ICL
  - Chart of detailed mass flows
  - Data from pilot plant (laboratory scale)
  - Worst-case scenario (e.g. plant shut down)
- Next review panel call: Friday, 10th November

→ **Expected finalization of the review: December 2017**



Source: EPC, additional information for LCA 08-23-2017

We create chemistry