CHECKING THE EXPECTED ENVIRONMENTAL BENEFITS OF A R&D PROJECT BY LCA

A BIOBASED NIPU FOAM CASE STUDY

Javier Sanfelix, Loïc Poussard, Jérôme Mariage, Bruno Grignard, Olivier Talon
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FUTURE MATERIALS...

ADVANCED MATERIALS FOR ENERGY APPLICATIONS

INNOVATIVE AND SUSTAINABLE POLYMERIC MATERIALS

CELLS FOR MATERIALS AND CELLS

MULTIFUNCTIONAL SURFACES

LIFE CYCLE THINKING

CHARACTERIZATION PLATFORM

... MADE BY TODAY’S PEOPLE
Is CO$_2$ Green a green project?
Should be.
There is green in the title.

$\text{CO}_2\text{Green}$
And it is financed by a program with green in the title.

WBGreen
And it is a project about biobased products.

And bio is green. Isn’t it?
Well.
That’s exactly what needs to be checked...

Is bio always green?
CO$_2$Green project
GREEN ASSETS OF THE PROJECT

BIO-BASED PRODUCTS

NON-ISOCYANATE PUS

CAPTURED CO₂ FOR CYCLOCARBONATION STEP

FOAMS FOR INSULATION APPLICATIONS

CAPTURED CO₂ FOR FOAMING STEP
LCA of CO$_2$Green
LIFE CYCLE OF PU BENCHMARK

petrol-based chemicals

polyol

isocyanate

PU

pentane

benchmark PU foam

use as insulation material

energy

end of life

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[avniR] conference
 LIFE CYCLE OF NIPU1

- Petrol-based chemicals
- CO₂
- Energy
- Vegetable-based fatty acid
- Energy
- Petrol-based chemicals
- Energy
- Cyclo carbonated PEG
- NIPU1
- CO₂
- Energy
- Use as insulation material
- End of life
LIFE CYCLE OF NIPU2

1. **Vegetable Based Fatty Acid**
   - Energy
   - Petrol-based Chemicals

2. **Energy to Oligo Amide**
   - Soybean Oil
   - Carbonated Soybean Oil
   - CO₂
   - Energy

3. **NIPU2 Foam**
   - Use as Insulation Material

End of Life
The 3 foams should be compared based on a similar functionality:

1 m² foam with a heat transfer coefficient

$U = 0.14 \text{ W/m}^2\text{K}$
**FIRST RESULTS**

- **Climate change**
  \( \text{kg CO}_2 \text{ eq} / \text{m}^2 \)

- **Ozone depletion potential**
  \( \text{kg CFC-11 eq} / \text{m}^2 \times 10^7 \)

- **Water consumption**
  \( \text{m}^3 \text{ eq} / \text{m}^2 \)
Not as green as expected...
**Where does it come from?**

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>NIPU1 Foam</th>
<th>NIPU2 Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg CO₂ eq / m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incineration</td>
<td></td>
<td></td>
<td>200</td>
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<tr>
<td>Polyol</td>
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<td>50</td>
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<tr>
<td>MDI</td>
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</tr>
<tr>
<td>NIPU</td>
<td>50</td>
<td></td>
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</tr>
<tr>
<td>Others</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mostly from end-of-life...

... which is similar for the 3 models.

The amount of foam required is the main issue.
Need to improve the foaming process

→ decrease $\lambda$ and density
ANTICIPATION OF FURTHER PROGRESS...

Scenario A

5 kg
39 kg
74 kg

Scenario B

5 kg
5 kg
5 kg

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NEW RESULTS WITH SCENARIO B

Climate change
kg CO₂ eq / m²

Ozone depletion potential
kg CFC-11 eq / m² * 10⁷

Water consumption
m³ eq / m²
Much better.

So NIPU foams could indeed lead to reduced climate change (-50%).

(but with potential increase of other environmental impacts)
CONTRIBUTION ANALYSIS

Identification of hotspots, main contributors to the impacts

→ enable focusing optimization efforts
Come on! Show them a single score result!

Don’t do that. Single score is bad. It’s a nonsensical aggregation of results obtained with methods that are not equally reliable...

Who cares? It’s easier to understand. Show.

Do not. They’re scientists. They should be able to understand a sophisticated and complex message.

Yeah... They should, they should... You don’t have time for that. Show. Single score. Now.
The oligoamide synthesis is probably where efforts should be focused (once the foaming step will be optimized)
SENSITIVITY ANALYSIS

INFLUENCE ON GLOBAL LIFE CYCLE IMPACTS OF MODIFYING THE ORIGIN OF THE FATTY ACID USED FOR OLIGOAMIDE SYNTHESIS
Differences between coconut-NIPU2 and palm-NIPU2 may be higher than between PU and average-NIPU2!
Conclusions
• Bio may be green. Or not.

• LCA can be used to evaluate this.

• LCA will help identifying where eco-design efforts are most relevant.

• Precise origin of the renewable resources used may have high influence on the global environmental performance of the product.

• NIPUs do have a potential for being green (but ours are not yet).
Thanks for your attention

www.materianova.be

olivier.talon@materianova.be

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