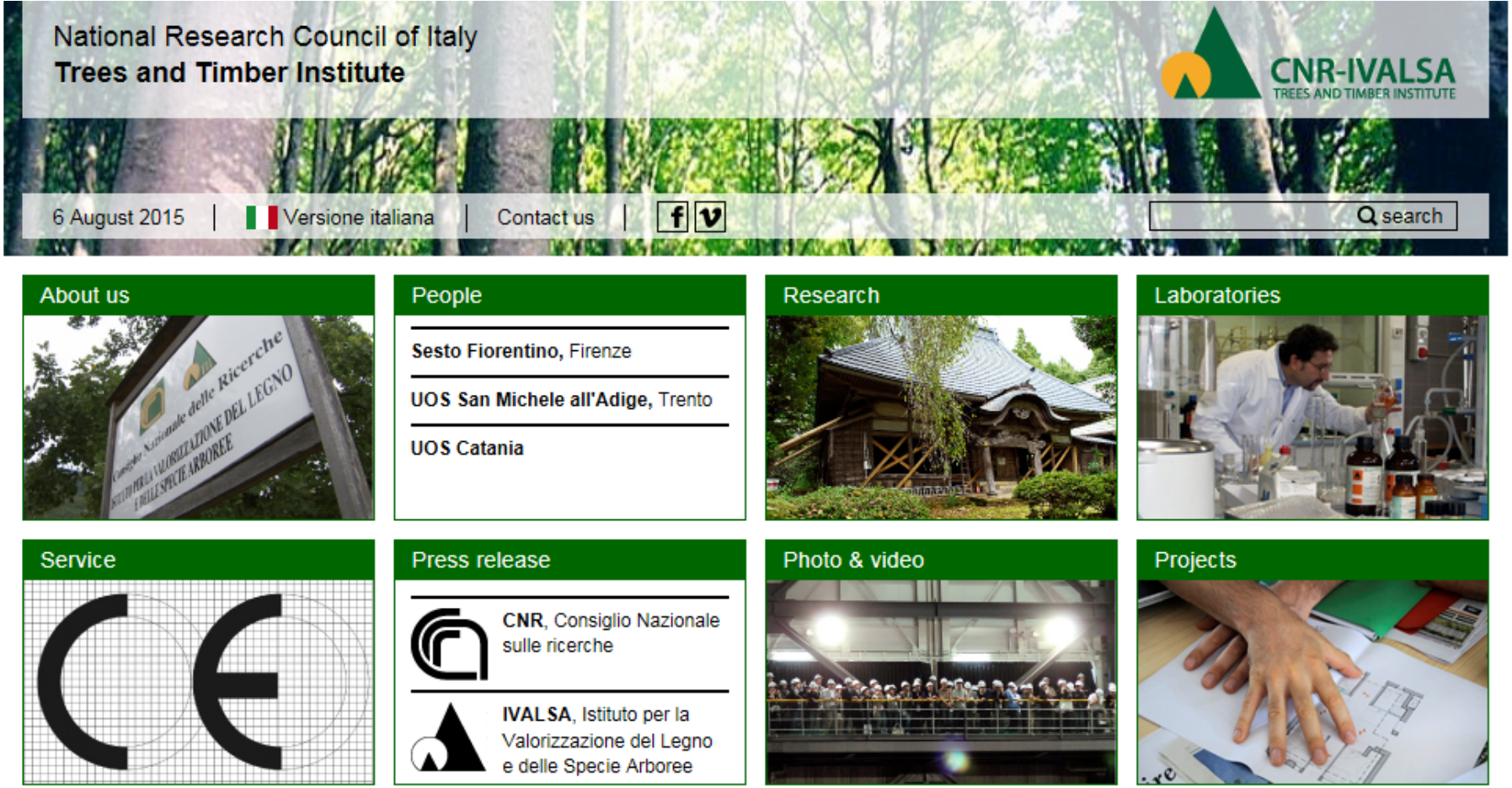

LCA of ThermoVacuum treated softwood timber with comparison to untreated and preserved cladding

M. Marra, O. Allegretti, S. Guercini

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COST Action FP1407 1st Conference
"Life Cycle Assessment, EPDs and modified wood"
Koper, Slovenia
August 25th – August 26th, 2015

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ThermoVacuum4NeWood project

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- This study covers the LCA commissioned by ThermoVacuum4NeWood project, co-founded by Eco-Innovation Initiative of the European Union.

ThermoVacuum4 neWood

- LCA assumptions are based on information provided by industrial project partners:
  - Italian plant producer,
  - French sawmill,
  - Sweden end-user.

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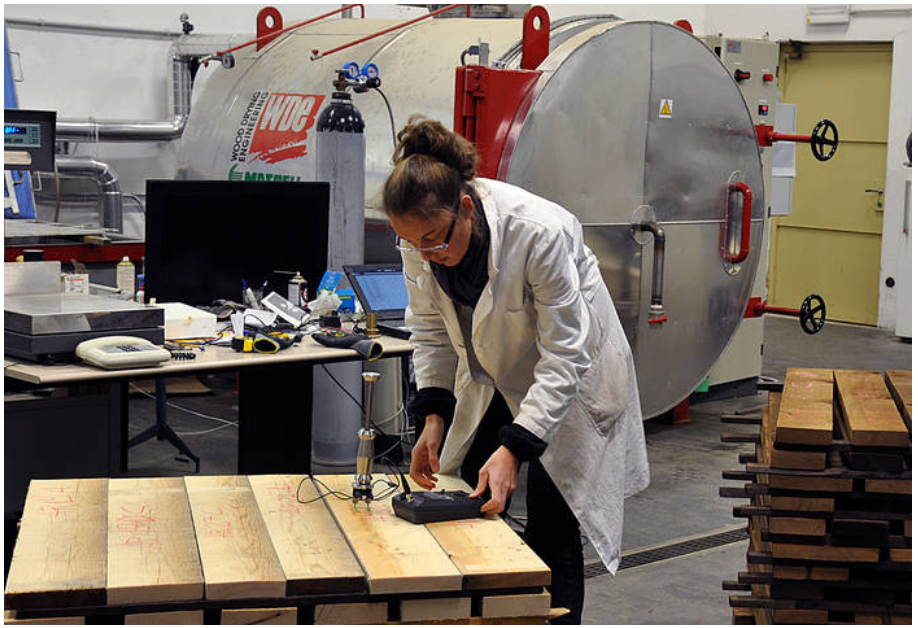
Thermal modification

- Thermal modification is a widely industrial treatment applied to improve wood properties such as stability and durability.
- Softwood species, like Norway spruce (*Picea abies* Karst.), are characterized by:
  - low durability, which reduces the long-term life cycle,
  - low permeability that affects the chemical preservation treatment.
- This prejudices the extensive use of these species.
- Thermal modification increases durability of wood species three or four times.
- Wood modification is achieved by high temperature in an oxygen-free environment to avoid combustion.

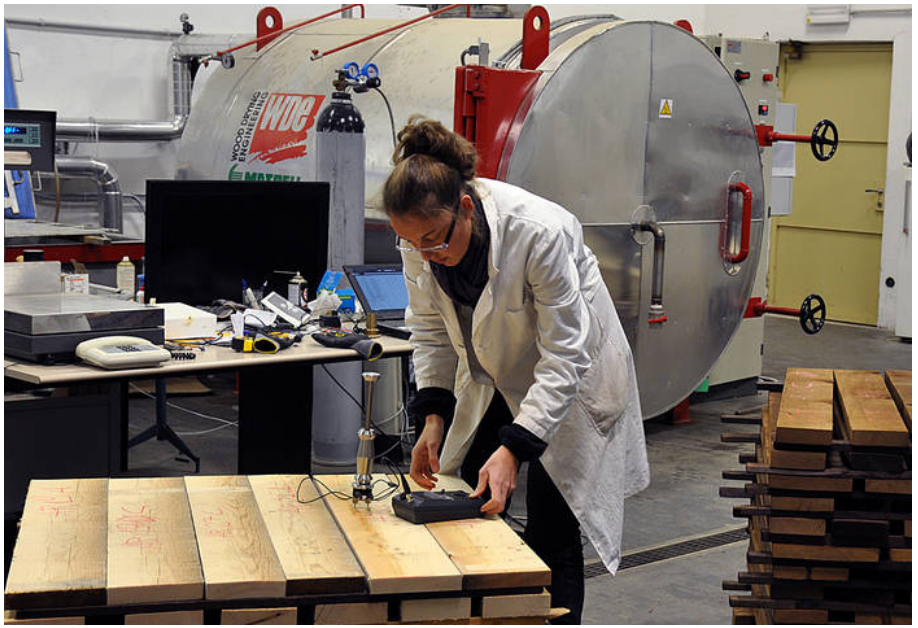
ThermoVacuum treatment

- ThermoVacuum system is a patented technology in which oxygen is substituted by partial vacuum and heating is provided by forced convection.
- The vacuum pump continuously removes all volatile compounds from the reactor.
- These conditions ensure low rate of wood mass loss, low air emission by an induced condensation, high energy efficiency and low corrosion.



ThermoVacuum plant

- Cylinder walls are heated by diathermic oil circulating between double layers of steel.
- Water ring pump equipped with a heat exchanger.
- Fans transfers heat. 635 r/min at 1013 mbar - 1930 r/min at 200 mbar.
- Temperature 220° C - Vacuum 200 mbar - 3-4% oxygen concentration.
- 8 m³ timber - 7 hours.



Goal and scope

- A cradle-to-grave life cycle assessment was performed to identify the environmental impacts related to ThermoVacuum treated timber used for cladding purpose and to compare to alternative products.
- A model of the ThermoVacuum process life cycle was created and used to calculate inputs and outputs during production, treating, use, and disposal stages.
- A similar inventory model was developed for
  - untreated cladding
  - preserved cladding.

LCI

- Life cycle inventory inputs, outputs and impact indicators were quantified using functional units of 33,3 m² of representative cladding:
  - 1 m³ ThermoVacuum treated timber,
  - 1 m³ preserved treated timber,
  - 3 m³ untreated timber.
- Secondary data are provided by Ecoinvent v3.1 and JRC ILCD databases.

In/Out	Process	Unit	ThVacuum	Untreat.	Preserv.
from Nature	Water	kg	51,3		
from Technosph.	Sawn wood, softwood, raw, kiln dried	m³	1,44		
	Sawn wood, softwood, planed, kiln dried	m³		3	1
	Electricity, low voltage {FR}	kWh	253		
	Transport, freight, lorry 16-32 metric ton	tkm	1152	67	67
	Planing	m³	1,30		
	Wood preservative, organic salt, Cr-free	kg			10
Emission to air	Water	kg	46		
	10 substances	kg	9,8		
Waste treatment	Waste water treatment	kg	25		
	Landfill of biodegradable waste (tar)	g	48		
	Waste incineration of untreated wood	kg	605	1350	450

Network flow chart

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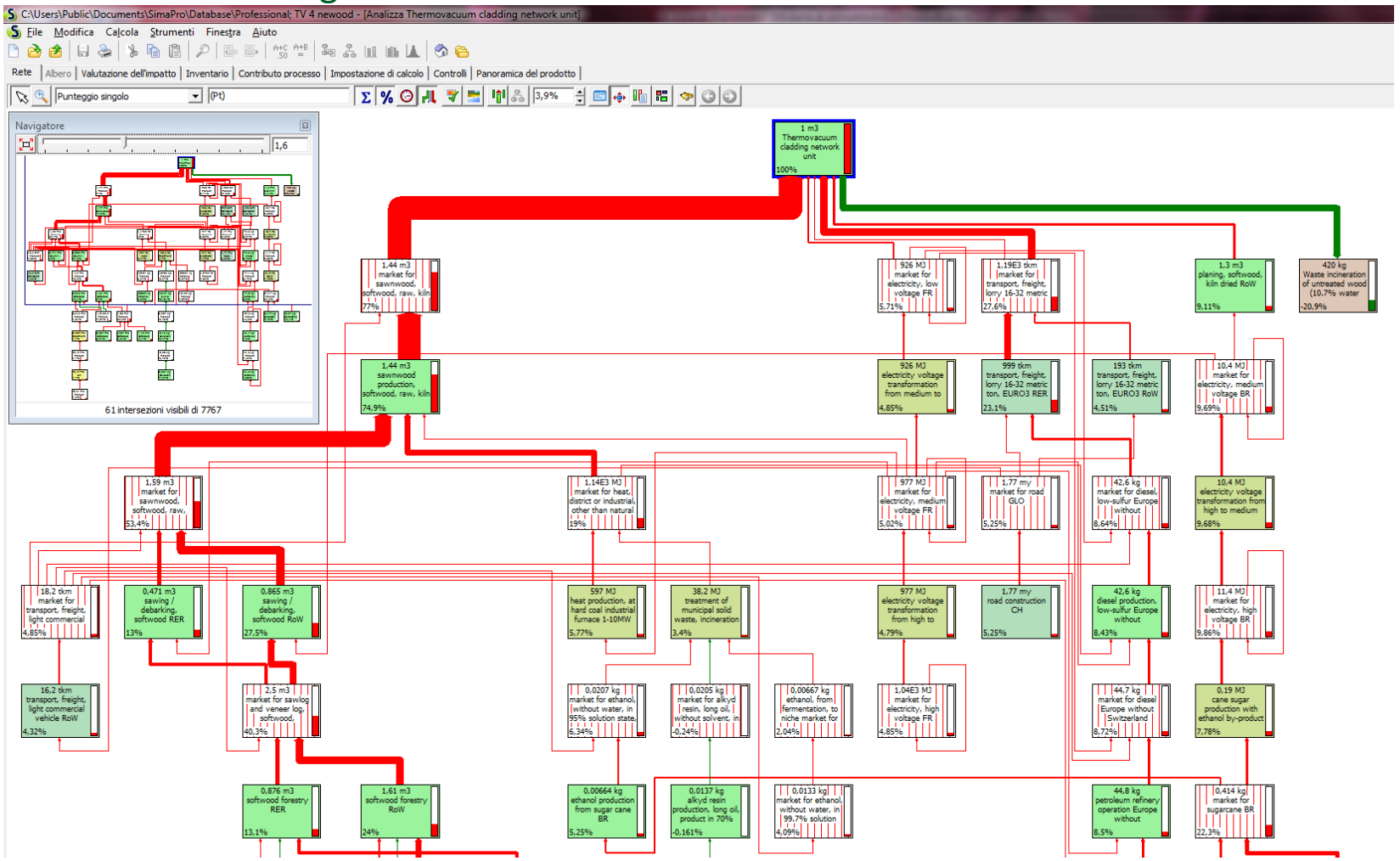
Thermovacuum cladding network flow chart



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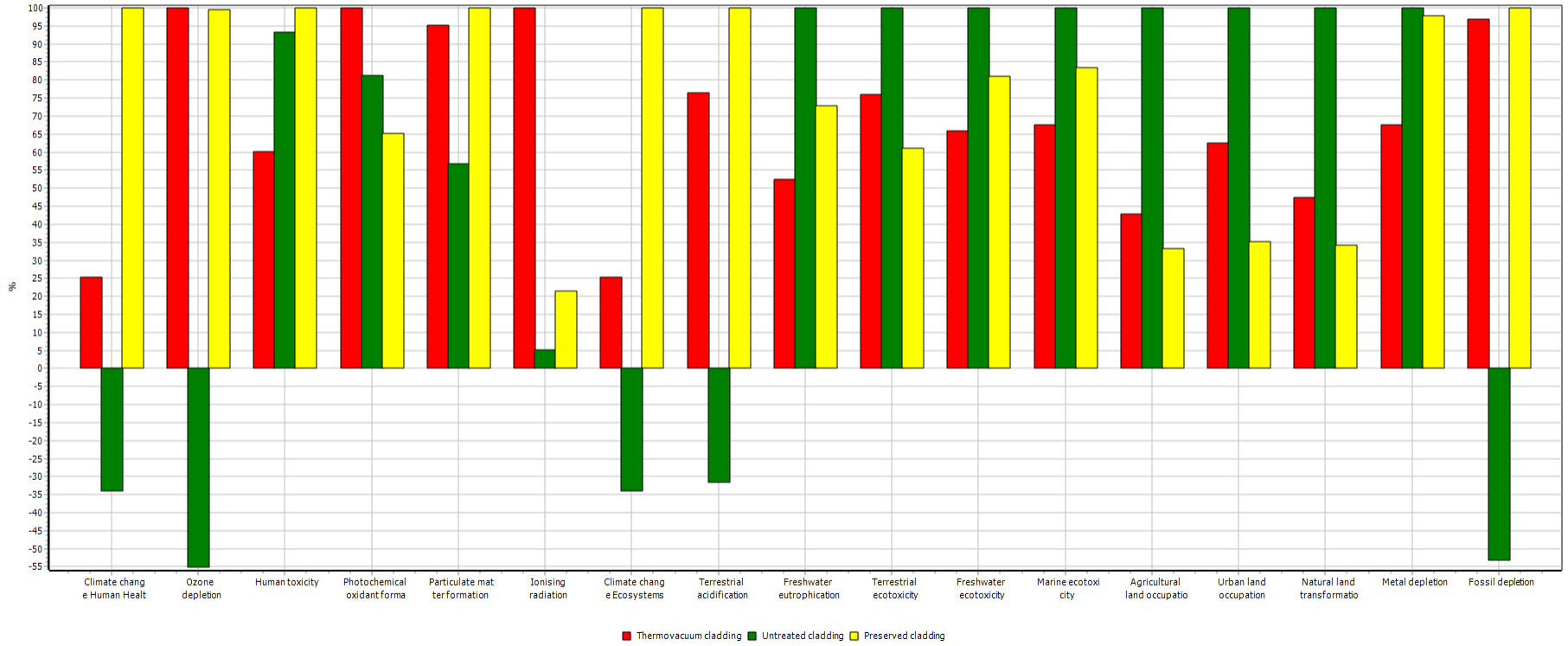
LCIA. 3 claddings. Characterization. Midpoint

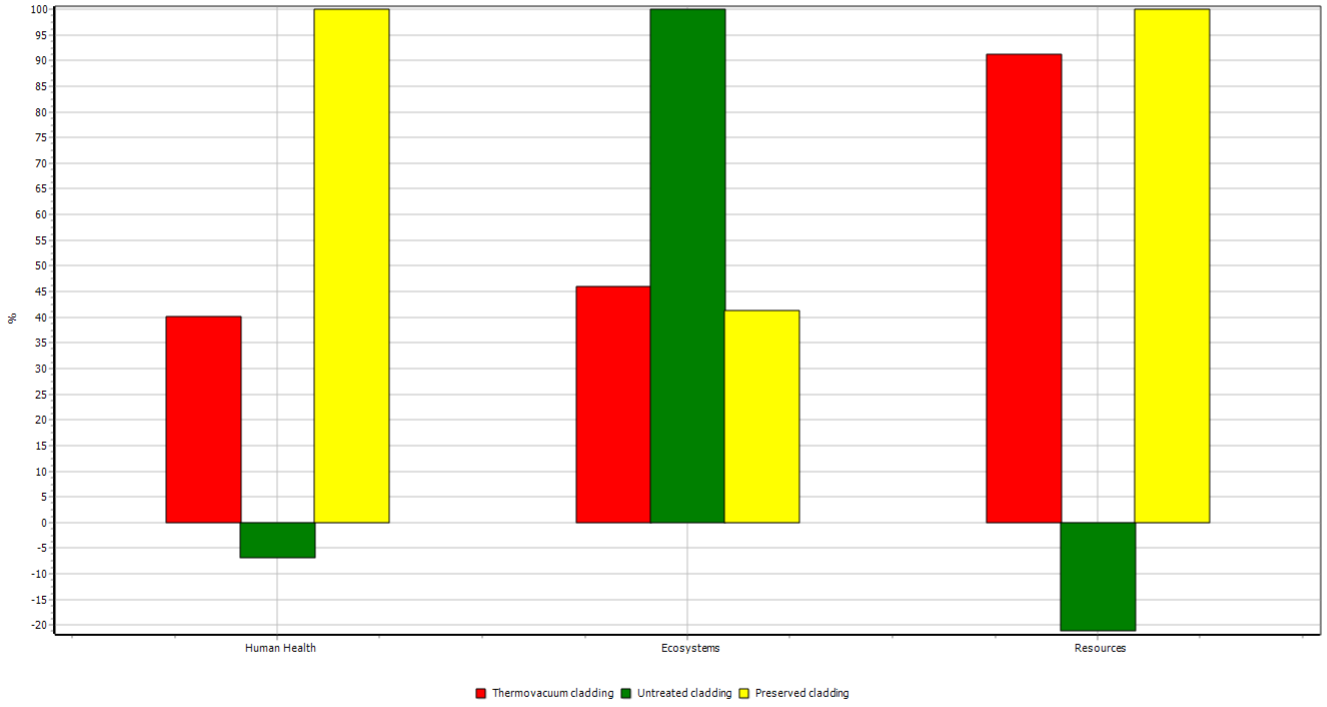
- Thermovacuum and preserved: Ozone depletion, Particulate matter formation, Fossil depletion.
- Thermovacuum : Photechemical oxidant formation, Ionising radiation.
- Preserved: Climate change HH, Human toxicity, Climate change E, Terrestrial acidification,
- Untreated: Freshwater eutroph. and ecot., Terr. ecot., Marine ecot., Agricultural, Urban, Natural land occ., Metal d.



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPe H/A / Characterisation
Comparing 1 m3 'Thermovacuum cladding', 1 m3 'Untreated cladding' and 1 m3 'Preserved cladding';

LCIA. 3 claddings. Characterization. Endpoint

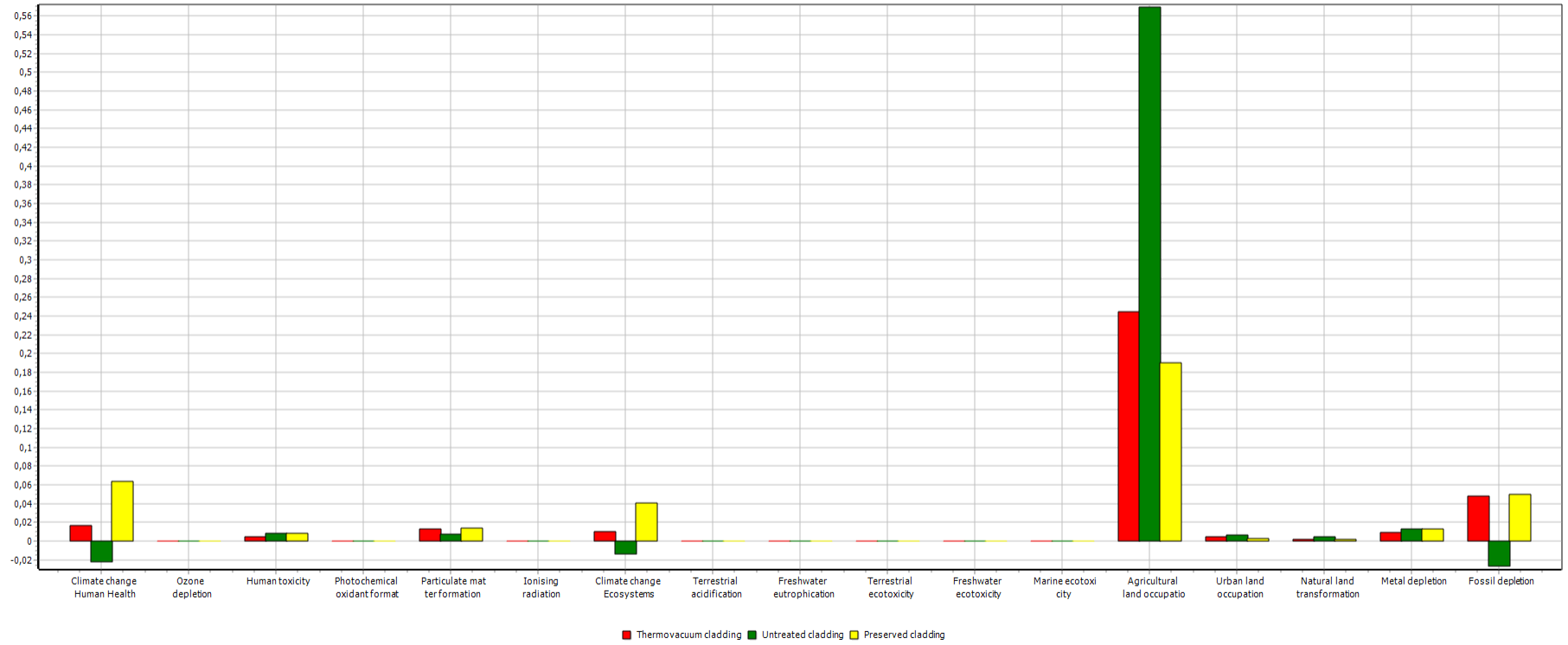
- Human Health: Thermovacuum 60% less than preserved,
- Ecosystems: Untreated 55% more than Thermovacuum and preserved,
- Resources: Thermovacuum 10% less than preserved.



Method: ReCiPe Endpoint(H) V1.12 / Europe ReCiPe H/A / Damage assessment
Comparing 1 m3 'Thermovacuum cladding', 1 m3 'Untreated cladding' and 1 m3 'Preserved cladding';

LCIA. 3 claddings. Normalization. Midpoint

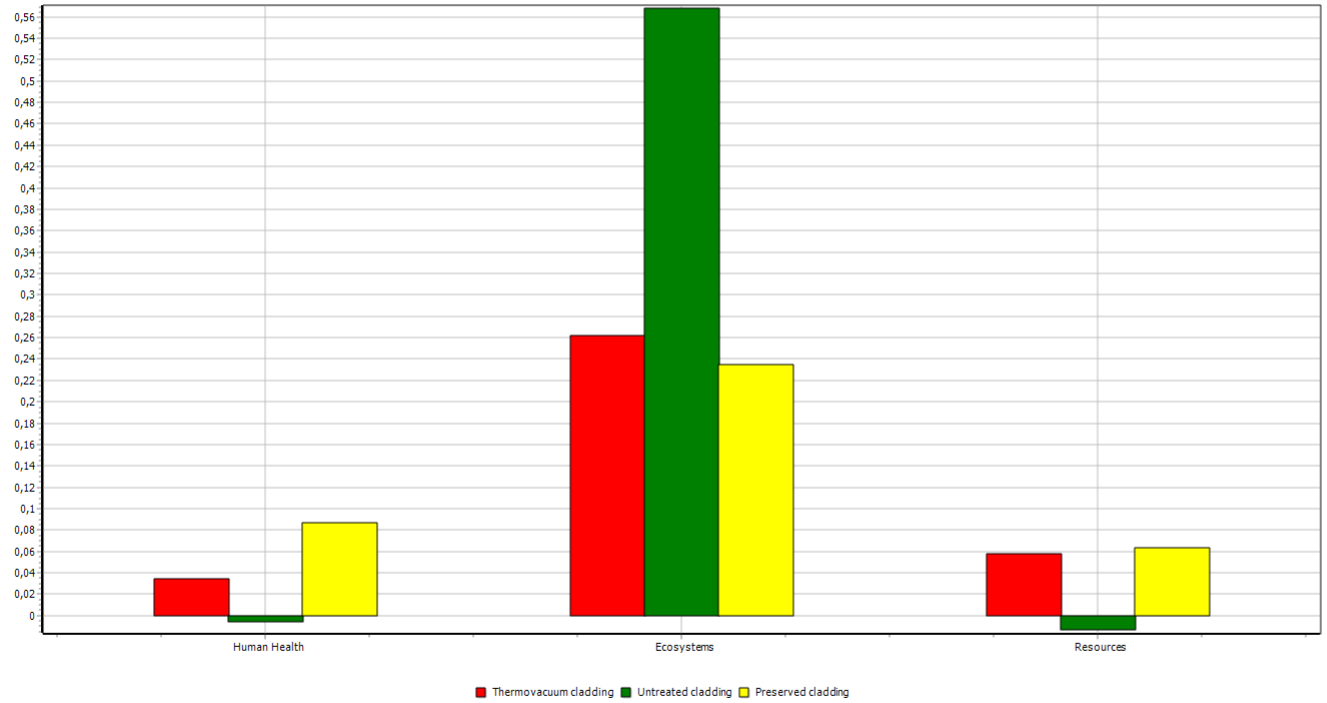
- Thermovacuum and preserved: Ozone depletion, **Particulate matter formation**, **Fossil depletion**.
- Thermovacuum : Photechemical oxidant formation, Ionising radiation.
- Preserved: **Climate change HH**, **Human toxicity**, **Climate change E**, Terrestrial acidification,
- Untreated: Freshwater eutroph. and ecot., Terr. ecot., Marine ecot., **Agricultural**, Urban, Natural land occ., **Metal d**.



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPeH/A / Normalisation
Comparing 1 m3 'Thermovacuum cladding', 1 m3 'Untreated cladding' and 1 m3 'Preserved cladding';

LCIA. 3 claddings. Normalization. Endpoint

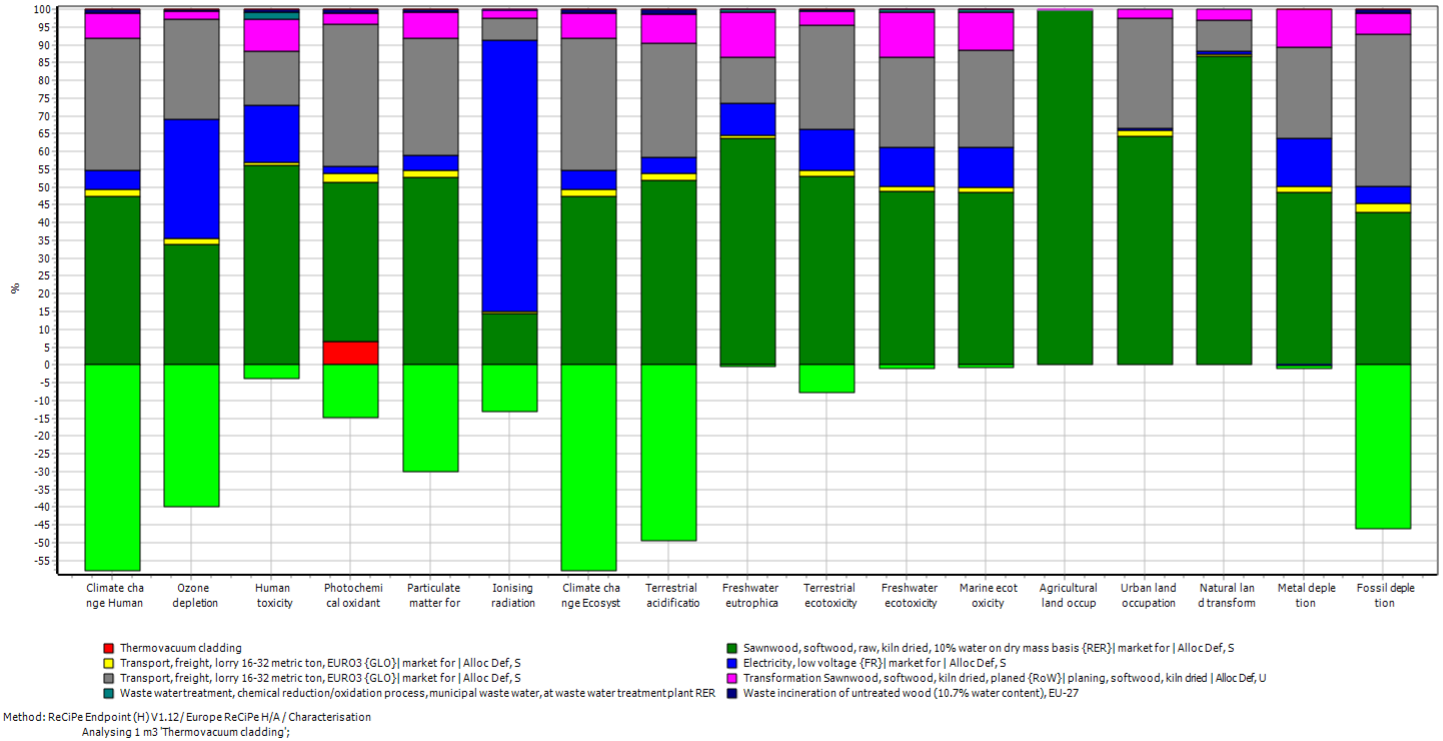
- Principal damage category is Ecosystems: Untreated is 3 times more than Thermovacuum and preserved,
- Human Health: Thermovacuum is half than preserved,
- Resources: Untreated has negative damage.



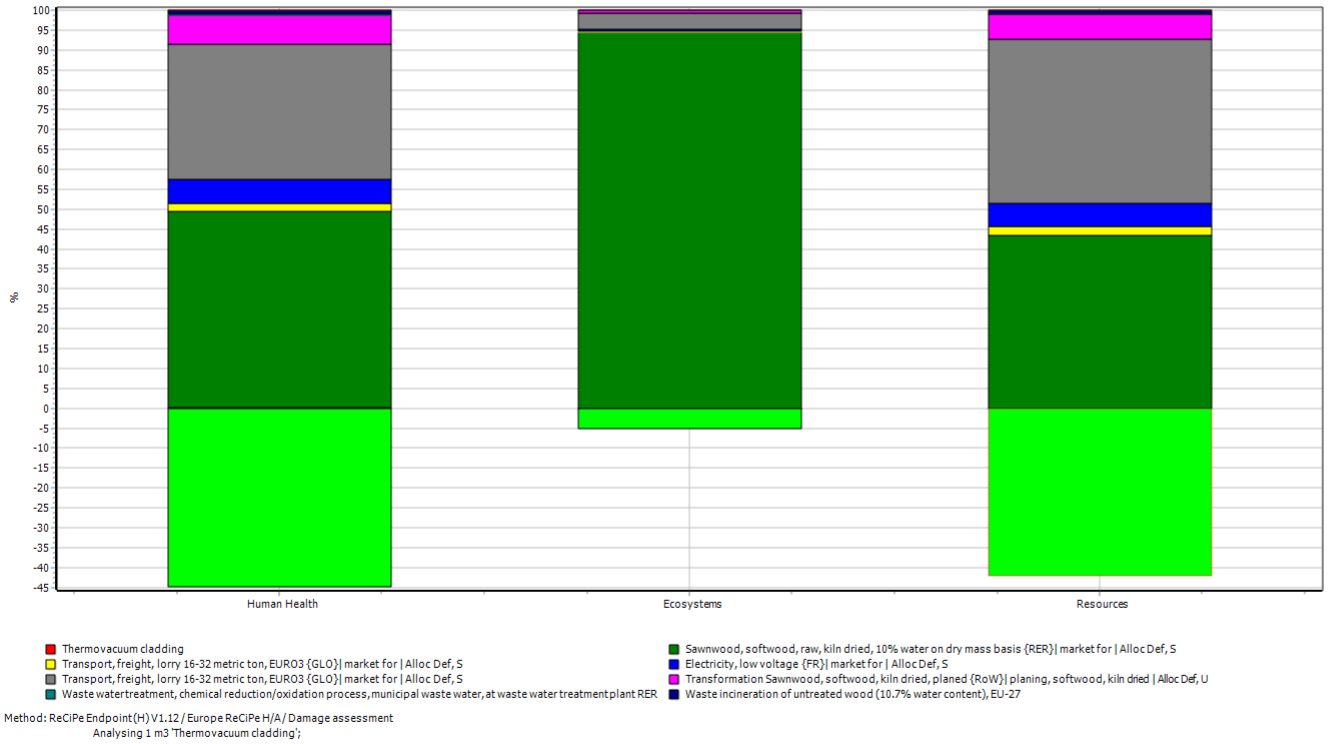
Method: ReCiPe Endpoint(H) V1.12 / Europe ReCiPeH/A / Normalisation
Comparing 1 m3 'Thermovacuum cladding', 1 m3 'Untreated cladding' and 1 m3 'Preserved cladding';

LCIA. Thermovacuum. Characterization. Midpoint

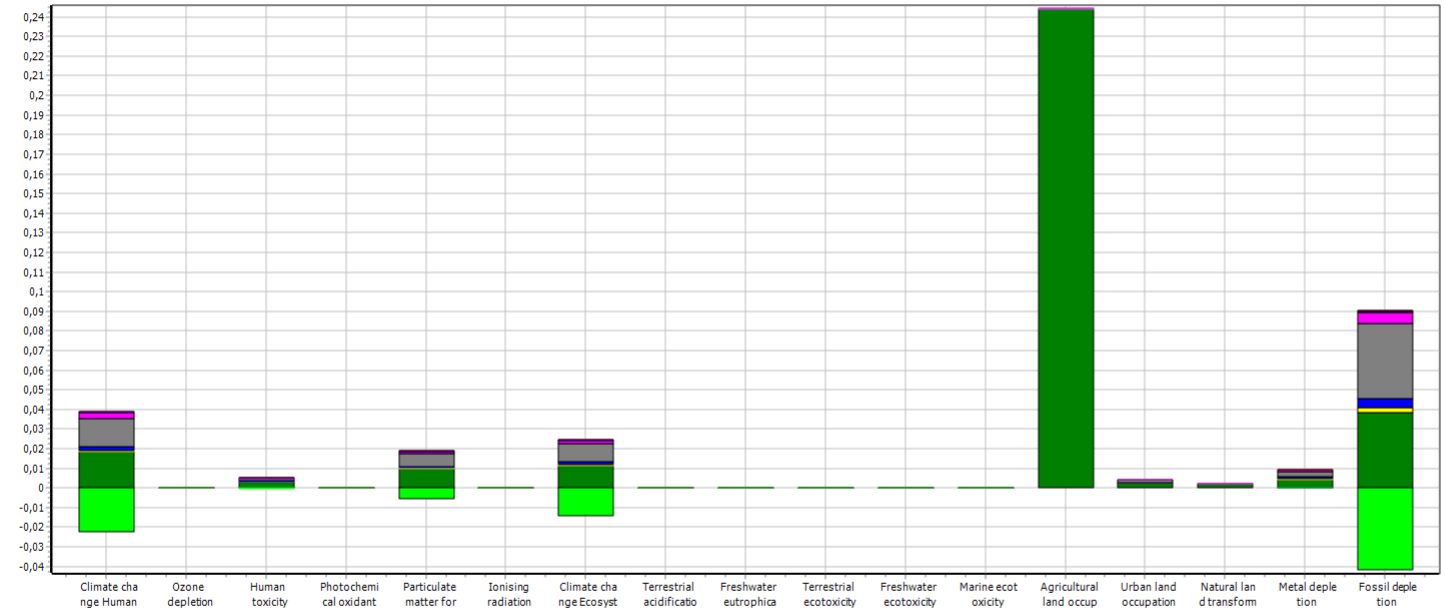
- High impact processes: Sawnwood, Transport and Electricity;
- Negative impact (positive effects) due to avoided production of electricity and heat.



LCIA. Thermovacuum. Characterization. Endpoint

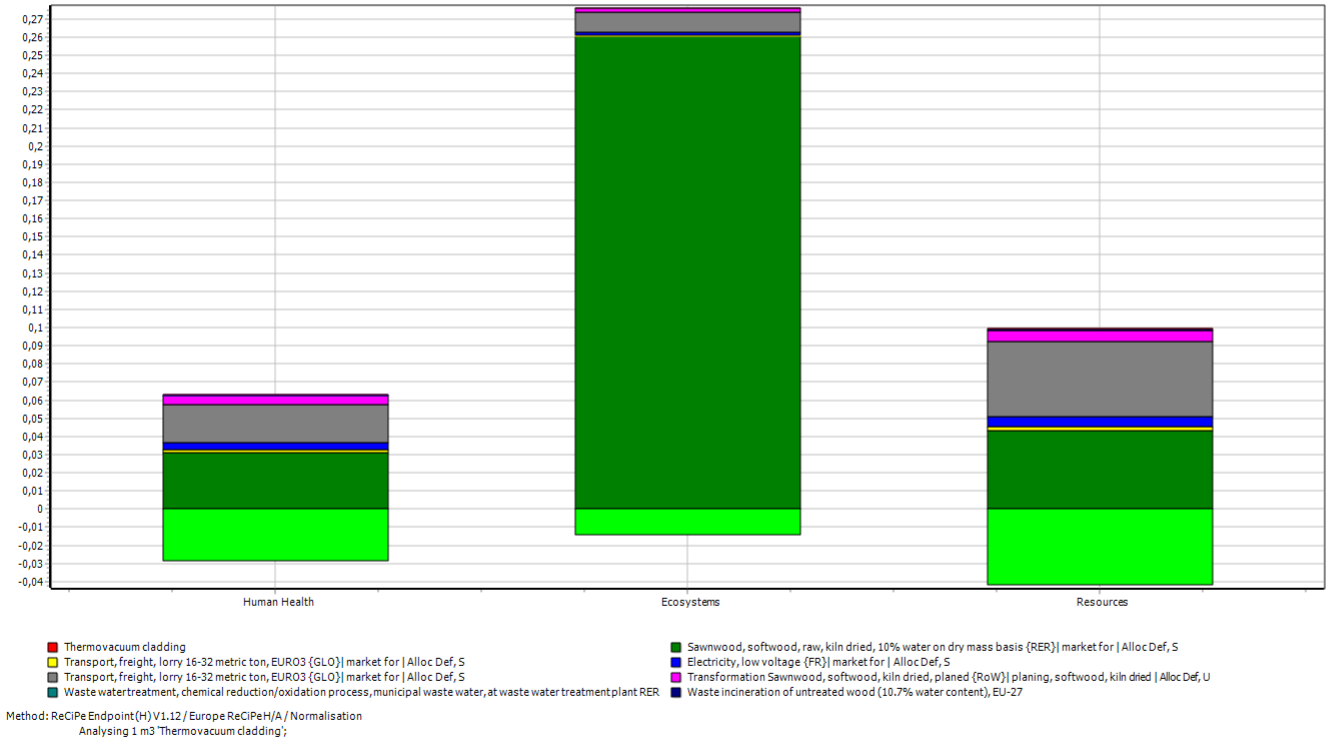


LCIA. Thermovacuum. Normalization. Midpoint

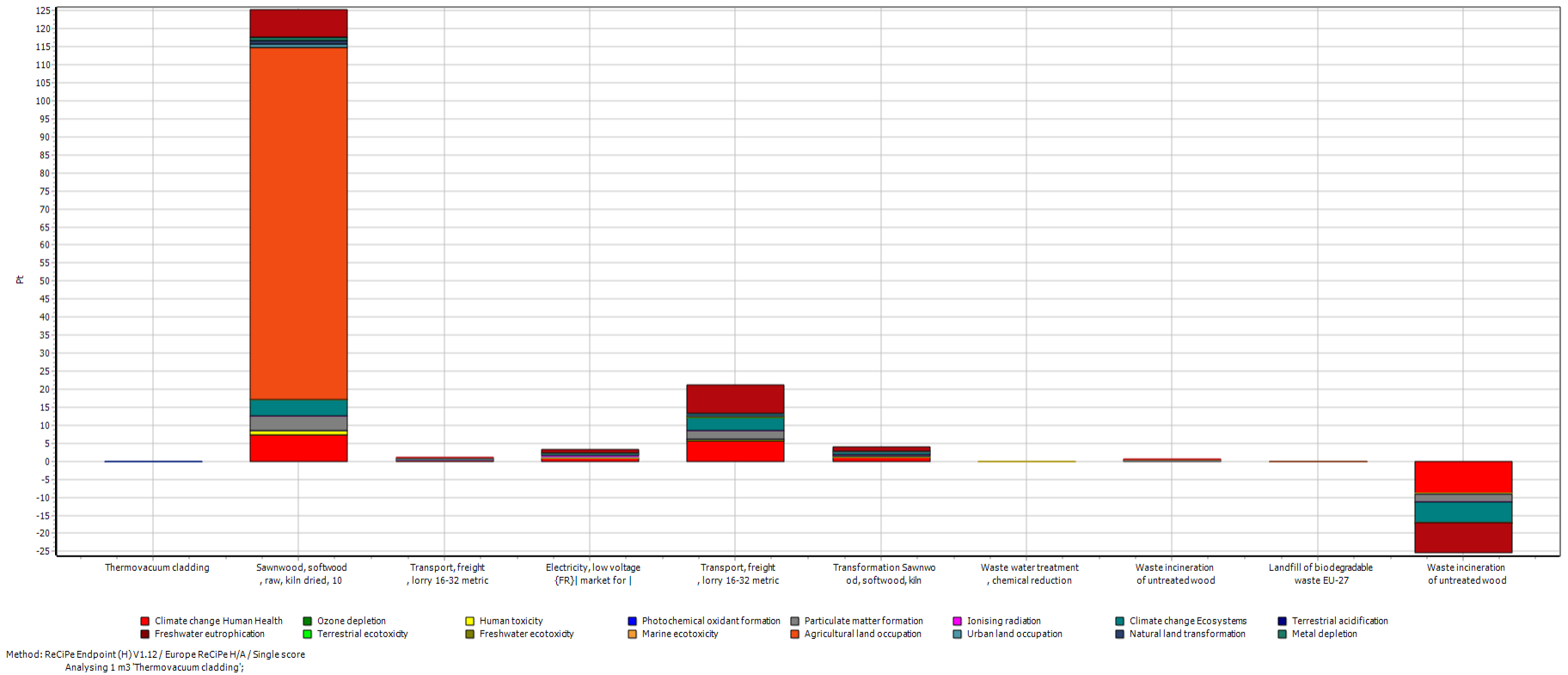


Method: ReCiPe Endpoint(H) V1.12 / Europe ReCiPe H/A / Normalisation
Analysing 1 m3 'Thermovacuum cladding';

LCIA. Thermovacuum. Normalization. Endpoint

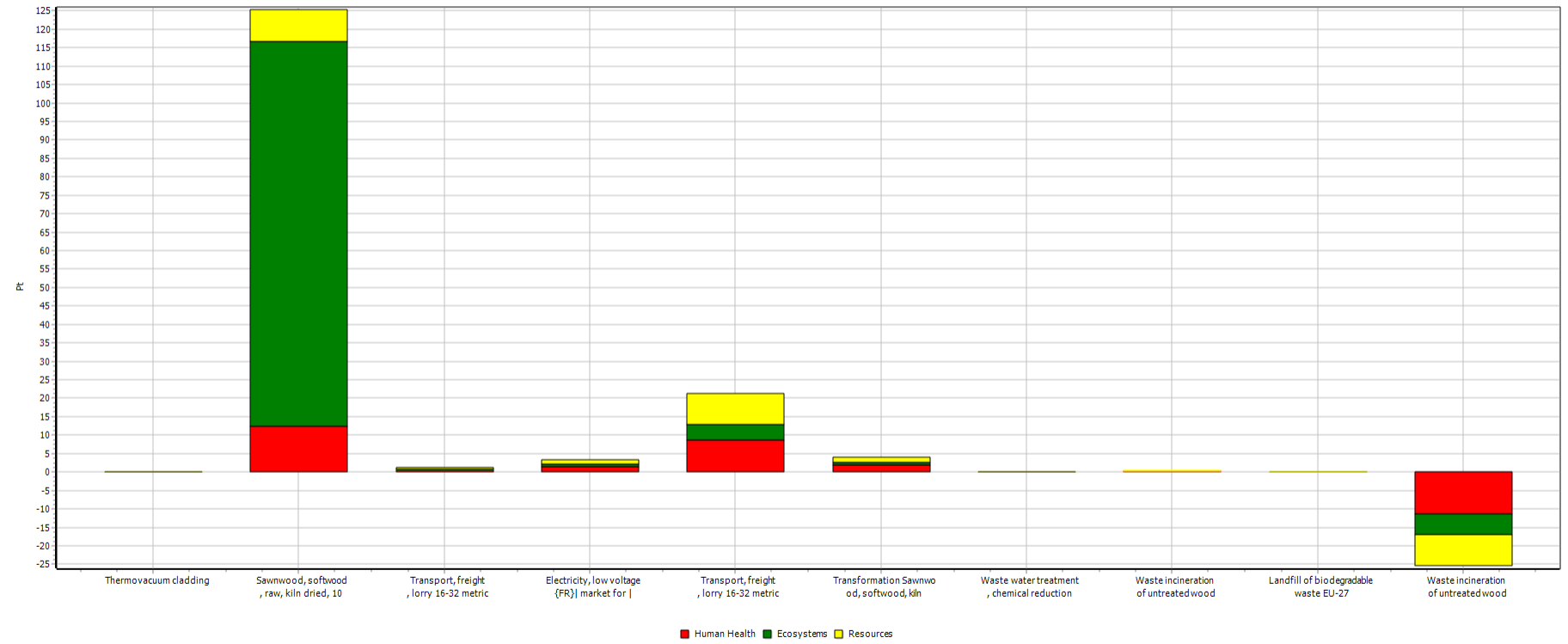


LCIA. Thermovacuum. Single score. Midpoint



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPe H/A / Single score
Analysing 1 m3 'Thermovacuum cladding';

LCIA. Thermovacuum. Single score. Endpoint



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPe H/A / Single score
Analysing 1 m3 'Thermovacuum cladding';

Sensitivity analysis

Sensitivity analysis was done to determine the effects of assumption changes on LCA results.

- Timber thickness. The model assumes claddings are constructed with 3 cm thickness. Changing to 2,5 cm less timber volume is required for the same surface area. Thus, all impact indicators decrease (-12%) and *Agricultural land occupation* reduces to -20%.
- Durability. Extending the use life of cladding reduces impacts in reverse proportion to the life extension. 5 years more cuts annual impacts to -25%.
- Energy resource. The dependence on the electric generation profile was analyzed. When comparing the models, the presence of a higher contribution of nuclear energy appeared to be less favorable when considering the damage to *Human Health* and *Ecosystem* due to *Ionising radiation* impact.
- Transport. The variation on the damage assessments results with the distances were considered. The rise in the distance increases all damages, especially to *Resources*.

Conclusions

- The use of treated timber shows lower *Ecosystems* damage, which is the most important category, due to the impact of *Agricultural land occupation*, because wood is used 3 times less respect to untreated cladding.
- Untreated cladding has a negative impact on *Human Health* and *Resources* damages due to the recovery of energy by incineration and the avoided use of fossil resources on *Fossil depletion* and on *Climate change* impact categories.
- ThermoVacuum cladding damage categories are better than preserved one especially to *Human Health* damage.

Recommendations

- The use of alternative energy source, as biomass, can reduce some impact category values compared to the use of electricity or fossil fuel energy.
- The end use of cladding:
  - Landfill. Disposed treated timber is expected to further increase carbon sequestration by retarding decay.
  - Fuel. Energy produced from the biomass offsets energy production using fossil fuels and their associated impacts.

Thank you

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