Environmental Product Declaration

In accordance with ISO 14025 for:

Double skin faced sandwich panels for thermal insulation with a core made of polyurethane or polyisocyanurate

NAV SYSTEM S.p.A.

Programme:	The International EPD® System www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-01017
ECO EPD Reference number:	00000484
Publication date:	2017-02-09
Validity date:	2022-02-02
Geographical scope:	*International*

Sommario

1. Company's description

NAV SYSTEM S.p.A., thanks to its 45 years' experience, is a leader company in the engineering of cold stores and food processing plants.
NAV SYSTEM was established in 1962 under the name NAVARRA ISOLAMENTI, and later became EDILPLASTIC (cold storage rooms and industrial insulation) before finally, in 1988, becoming NAV SYSTEM (design and construction of cold storage rooms and facilities for the food industry). Since 2010 NAV SYSTEM started the manufacture of sandwich panels, specifically featured for food storage and processing rooms. The modularity and flexibility of its "custom tailored" solutions make it possible to meet any operational requirement of food industry and industrial refrigeration.

NAV SYSTEM operates a continuous panel production plant that is among the most advanced in Europe in terms of flexibility and functionality: a state-of-the-art facility for manufacturing our innovative products, situated in the heart of Emilia-Romagna region. The NAV SYSTEM produces and markets the sandwich panels with a clear awareness that the quality of each individual component is essential for assuring optimum performance of the finished product. The suppliers of steel, and of the entire range of facing materials and coatings, are attentively selected by a purchasing department with wide expertise in this sector. The technological core of the product, the polyurethane (PUR) foam insulation, is the result of years of international research and development; and this work continues to be pursued in the modern new laboratories. Technological innovation is the main goal of the company, and will continue to inspire the company to always offer the best on the market.

More information can be found at http://www.nav-group.com/index.aspx?lng=2 and http://silexsrl.it/group.aspx.

2. Products' description

Thermal insulation panels are *metal double skin faced sandwich panels with a core made of polyurethane or polyisocyanurate* designed for wall and roof applications. NAV SYSTEM provides different solutions aimed for the construction of buildings, low and medium temperature industrial cold stores and roofs. All products are manufactured in the same production plant located in P.le Piero Sraffa 45 – 47521 Cesena (Forlì-Cesena district), Italy.

The production process starts with the coils' profiling procedure, which defines the shape of the top and bottom metal sheets. In addition, in order to improve the PUR foam adhesion to the metal sheet a corona treatment is carried out. After a preheating treatment is performed. Then the PUR foam is laid down over the steel sheet. The next step is the foam curing in a double rolling mill. After that, the panels are cut to the required length. Panels are then left in a cooling room for some hours. Finally, the packaging procedure is completed and the products are ready to be sold. Below a detailed scheme of the production process is reported (Figure 1).

As described above, both wall and roof panels are manufactured in the same production site, since they are made from the same components but with different purpose.

In the case of wall panels, the core material (polyurethane or polyisocyanurate foam) is specially moulded at the joint to ensure perfect continuity of insulation. They are designed to provide insulation as well as protecting the building against moisture and condensation: the special double tongue-and-groove joint in fact creates a moisture-tight barrier that is essential for a variety of applications, in particular industrial refrigeration and cold stores in the food sector.

On the other hand, panels for roof applications are self-supporting appliances with five corrugations, insulated with polyurethane or polyisocyanurate foam, for pitched roofs having a slope of at least 7%. They are designed to satisfy the manifold requirements of residential, commercial and industrial buildings. Roof panels are versatile components that offer insulation and energy-saving performance coupled with mechanical strength and ease of laying.

In order to guarantee the technical performances, all the products present a wide range of certification for fire reaction (B-s1,d0; B-s2,d0); fire resistance: (EI 30-45-60; REI 30) and fire resistance for roof (B_{ROOF} certificate). More details can be found at http://silexsrl.it/certificazioni.aspx.

Table 1 reported below collect all the main information for the selected products suitable for the EPD certificate.

Table 1: Product's characteristics

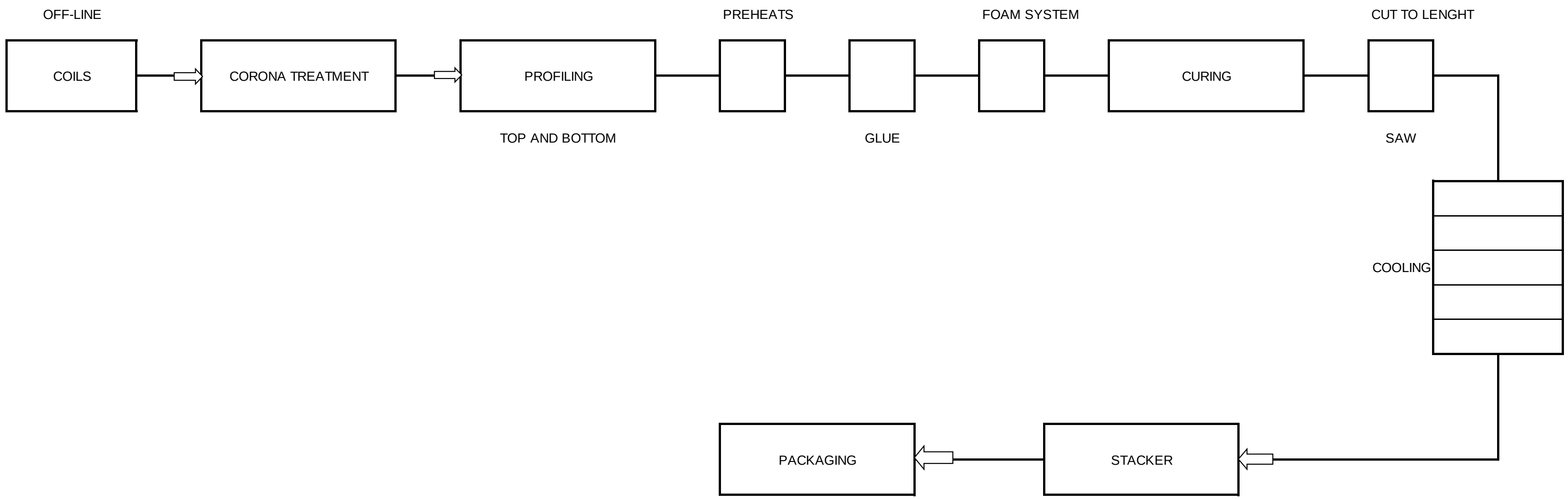
Application Area	Wall applications	Roof applications
Products specification COMMERCIAL NAME, thickness (mm), thermal resistance (measured in accordance with EN 14509 m²K/W), weight (kg/m²)	• WIND/TWISTER, 40mm thick, R1.67, 10.0kg/m²; • WIND/TWISTER/WET/ICE, 100mm thick, R4.44, 12.3kg/m²; • FROST/TWISTER/WET, 150mm thick, R4.44, 12.5kg/m²; • FROST/ICE, 200mm thick, R9.09, 16.1kg/m²; • FROST/ICE, 240mm thick, R11.11, 17.7kg/m²;	• RAIN, 20mm thick, R1.05, 8.3kg/m²; • RAIN/CORTEX, 40mm thick, R1.92, 8.1kg/m²; • RAIN/CORTEX, 100mm thick, R4.55, 11.3kg/m²; • RAIN, 150mm thick, R6.67, 13.2kg/m²;
Products conductivity EN 14509 W/m²K	• WIND/TWISTER - 40mm C0.6; • WIND/TWISTER/WET/ICE - 100mm C0.23 ; • FROST/TWISTER/WET, - 150mm C0.23; • FROST/ICE - 200mm C0.11; • FROST/ICE - 240mm C0.09;	• RAIN - 20mm C0.95; • RAIN/CORTEX - 40mm C0.52; • RAIN/CORTEX, 100mm C0.22; • RAIN - 150mm C0.15;
Declared unit	1 m² of panel with a specific thermal resistance value (R)	1 m² of panel with a specific thermal resistance value (R)
Functional unit	1 m²·K/W	1 m²·K/W
Time period under review	2015	2015
Geographical Coverage	International	International

The EPD® declaration was accomplished in accordance with ISO 14025:2006 (Environmental labels and declarations - Type III environmental declarations - Principles and procedures) [1] and EN 15804:2014 (Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products) [2]. The Life Cycle Assessment (LCA) analysis was performed according to the Product Category Rules (PCR) for the Insulation Materials (multiple UN CPC codes, Version 1.0, dated 2014-07-2) [3], developed in the framework of the International EPD® System, and the CONSTRUCTION SERVICES 54 (CPC VER. 2 CODE 54) [4].

In accordance with PCR and GPI, this certificate records all the information required to meet the standard of the EN 15804. The main goal of this certificate is to provide data for an EPD® for business-to-business and business-to-consumer communication.

The term EPD® refers to a third-type voluntary label, based on the application of the LCA methodology, aimed to evaluate the environmental performances of products and services subject to certification. It represents an international tool to improve communications among the parts of the entire product chain (producers, suppliers and consumers) and pursue the principles of green e circular economy. In general, EPDs within the same product category but from different programmes may not be comparable. In addition, EPDs of construction products may not be comparable if they do not comply with the requirements of comparability set in EN 15804.

Figure 1: Manufacturing process for the NAV system's panels



3. LCA description: methodology, system boundaries, scope and assumptions

LCA is a standardized methodology, according with EN ISO 14040-14044 [5-6], able to predict potential environmental impacts of products, processes and systems in the whole life cycle. It is structured in four conceptual phases, such as the Goal and Scope definition, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA) and the results Interpretation.

The life cycle thinking is a key concept to assess the environmental sustainability and to identify the main criticalities within the entire production chain. LCA is also considered a valuable tool to analyse the performances of two or more products, and provide a standardized evaluation based on accredited approach and results. For all these reasons, the LCA methodology is required to achieve the EPD® certificate in accordance with ISO [1].

This certificate, together with the project report revised by an external verifier, was compiled by EMC Innovation Lab S.r.l. an innovative company working in the fields of the environmental consulting and research, and collects all the information necessary to achieve the EPD® certification for the selected products.

5.1. System boundaries

The Goal and Scope definition is the first stage of a common LCA, in which the system boundaries and the functional unit should be explicated declared. In this study, a "*cradle-to-gate with options*" approach was applied (Figure 2) using the declared unit of $1m^2$ to collect and analyse the data.

The analysis includes all the stages required by the specific PCR: Manufacturing phase (A1-A2-A3-A4) and End of life (C2-C3-C4). In addition, in order to inform the readers with further data concerning the recyclability potentials of the End of life products, results from module D were also included and reported separately as disclosed in the PCR. Table 2 shows the life stages included in the LCA evaluation and phase which were voluntary excluded since not relevant.

Table 2: Description of the system boundaries

GPI module	Asset life cycle stages	Inclusion in the EPD®
Upstream	A1 - Raw material supply	✓
Core	A2 - Transport	✓
	A3 - Manufacturing	✓
Downstream	A4 - Transport	✓
	A5 - Construction, installation process	not relevant
	B1 - Material emissions from usage	not relevant
	B2 - Maintenace	not relevant
	B3 - Repair	not relevant
	B4 - Replacement	not relevant
	B5 - Refurbishment	not relevant
	C1 - Deconstruction and demolition	not relevant
	C2 - Transport	✓
	C3 - Waste processing	✓
	C4 - Disposal	✓
Other environmental information	D - Reuse, recycle or recovery	✓

The LCA analysis was carried out by the use of SimaPro [8], a licensed LCA software, and the Ecoinvent database (v.3.1) [7]. The latter was selected as reference library to fill all the background data concerning the processes (e.g. feedstock and resources extraction, etc.) and services (e.g. transportation, electricity, etc.) of the upstream/core and downstream stages. In accordance with PCR and General Programme Instructions (GPI) [9], Ecoinvent database is recognized by the International EPD System as one of the reference libraries to be used to cover the "generic data" for Europe.

5.2. Life cycle inventory

In LCI step data should be collected from several sources and then modelled to fit the LCA scenarios. In general, higher is the quality of the input information and more reliable are the final results (LCIA stage). For this reason, only **primary data,** directly provided by the company for the year 2015, were used in order to simulate the manufacturing phase (stages A1-4). In addition, all the background data taken from library (see above) are less than 10 years old. On the other hand, in order to complete all the life cycle stages outside the company (C2-C4 and D) **average secondary data** and some assumptions were necessary.

In accordance with standard rules, the inventory was compiled using the declared unit of $1m^2$. A declared unit is defined by EN 15804 as the "quantity of a construction product for use as a reference unit in an EPD for an environmental declaration based on one or more information modules"; " it provides a reference by means of which the material flows of the information module of a construction product are normalized (in a mathematical sense) to produce data, expressed on a common basis".

3.2.1. Manufacturing phase – A1-A2-A3-A4

As shown above, this step includes four different stages: the raw materials extraction (*upstream*), their transportation to the production facility in which the *core* process takes place, and the distribution of the final products to users (*downstream*). Primary data to fill the inventory were extrapolated from a dedicated internal database which tracks the entire manufacturing process: from the resources and utilities acquirement up to commercialization. NAV SYSTEM has made available a set of specific reports that mark each input and output flow which enters or leaves the factory boundaries. The LCI stage was completed by EMC operators with the supervision of internal experts.

The LCIs flows are quite similar from product to product, only few changes are detected in the amount per m^2 since panels have different thickness, shape, working hours and distribution (to final users). The main chemical components are: methylene diphenyl diisocyanate (MDI), a polyols mixture (both used as precursors in the PUR/PIR polymerization), an amine catalyst and the pentane, which has the function of blowing agent. Polymerization occurs by the use of nozzles, made from polyethylene (PE), and metal knives (cast iron) both periodically substituted. Therefore, the amount substituted per m^2 was estimated for both wall and roof products. The panels' double skin is made of virgin steel (INOX, coated, coated with plastic film etc.) and/or aluminium (natural or coated), since strictly influenced by the model. In addition to the core and skin, a polymeric seal (made from polyethylene) with a polypropylene adhesive is applied to the panels to protect them during transportation and installation procedures. The line requires a defined amount of process water (1.04E-6m^3 per m^2 for all the products), which has the function of washing agent. In addition, in some cases a specific quantity of wax is necessary to facilitate the separation of panels. In order to complete all the operations, electric energy (EE) is requested by the whole plant. NAV SYSTEM has installed an integrated PV system which is able to cover the 18% of the entire request. Therefore, EE needs are covered for the 82% with the Italian mix (modelled for year 2015 using literature data [10]) and the rest with solar panels. In order to simulate the entire process describing a final product ready to be sold, resources to complete the packaging were also included, such as: cardboard, polystyrene blocks (usually made from recycled plastic) and LDPE films. Finally, to complete the supply chain, all the transportations of the raw materials were included. Distances (in km) were taken from NAV SYSTEM internal report. On the other hand, no information were available concerning the vehicles used, thus it was assumed to be covered by an average 16t lorry. However, this assumption seems not affect the whole results of the LCA. The same simplification was carried out to simulate the distribution of the final products, by multiply their average weight with distances collected in the internal database (primary data from NAV SYSTEM). Moreover, as requested by PCR all the emissions (in water and air) were included in the models. The small amount of process water (7.1E-4kg per m^2) leaving the factory boundaries is treated in a dedicated waste water treatment plant. Distances (furnished by NAV SYSTEM) are supposed to be covered by an average 16t lorry. These information were taken from dedicated registers used during the control phase of the environmental emissions performed by a third part verifier (Italian Environmental Protection Agency: ARPA ER).

The amount of water leaving the industrial gate is considered the only output flow characterized as waste (non-hazardous). In fact, all the other output streams (scraps and residues produced during the manufacturing process such as metal, plastic, polymer powder, paper, etc.) are sold to recovery facilities (e.g. metal or plastic recycling plant, energy recovery plant, etc.) and, therefore, not classified as waste but as by-products. In accordance with PCR and GPI documents the LCA model includes the transportation of all these scraps/residues up to the recovery facilities but it excludes loads and benefits from the recovery processes. NAV SYSTEM provided primary data concerning the distances' transportation of these by-products to recovery plants, on the other hand it was assumed they are covered by an average 16t lorry.

3.2.2. End of Life phase – C2-C3-C4

This stage represents the End of Life (EoL) phase of the insulation panels after their usage (intentionally excluded from the boundaries since not relevant for the EPD®).

Nevertheless, the disposal procedure is outside the factory boundaries, the stage was included in the LCA evaluation according with the polluter-pays principle. It was assumed that the panels are separated with a 100% efficiency and sent to the nearest municipal solid waste incinerator (MSWI) with electric energy recovery. Treatment in a MSWI plant (C3-4 phases) it is possible since not constituted by hazardous substances. Incineration was simulated using a dataset created to assess the environmental performances of an already existing waste to energy (WtE) plant located in Rimini (Italy). This dataset is already published in a peer-review publication [11].

In addition, transportation was also simulated assuming an average 100km distance to reach the nearest MSWI plant covered by 16t lorry (phase C2). The main information regarding the EoL stage are collected in Table 3.

Table 3: End-of-Life specification

Application	Wall					Roof			
Thickness mm	40	100	150	200	240	20	40	100	150
EoL panels - kg sent to incineration with energy recovery	10.0	12.3	12.5	16.1	17.7	8.3	8.1	11.3	13.2
Average distance to reach the nearest MSWI - km	100	100	100	100	100	100	100	100	100

3.2.3. Reuse, recycle or recovery – D

Stage D describes the environmental benefits deriving from the energy recovery (in the form of electricity) of the EoL panels incineration. This module describes the avoided kWh production from Italian energy mix (i.e. avoided impacts). Database for an average Italian WtE plant [11] reports an electric energy recovery of 0.58kWh per kg of waste incinerated. The Italian energy mix was modelled using literature data for year 2015 [10].

3.2.4. Product content and assumptions

As requested by GPI, the list of substances and materials included in the LCA evaluation is over than 99.9% of the gross panels weight. The main components for two representative products are collected below, in accordance with the PCR (Table 4). Details are limited due to the degree of confidentiality.

Table 4: Product content in accordance with PCR, for two representative panels (wall and roof applications)

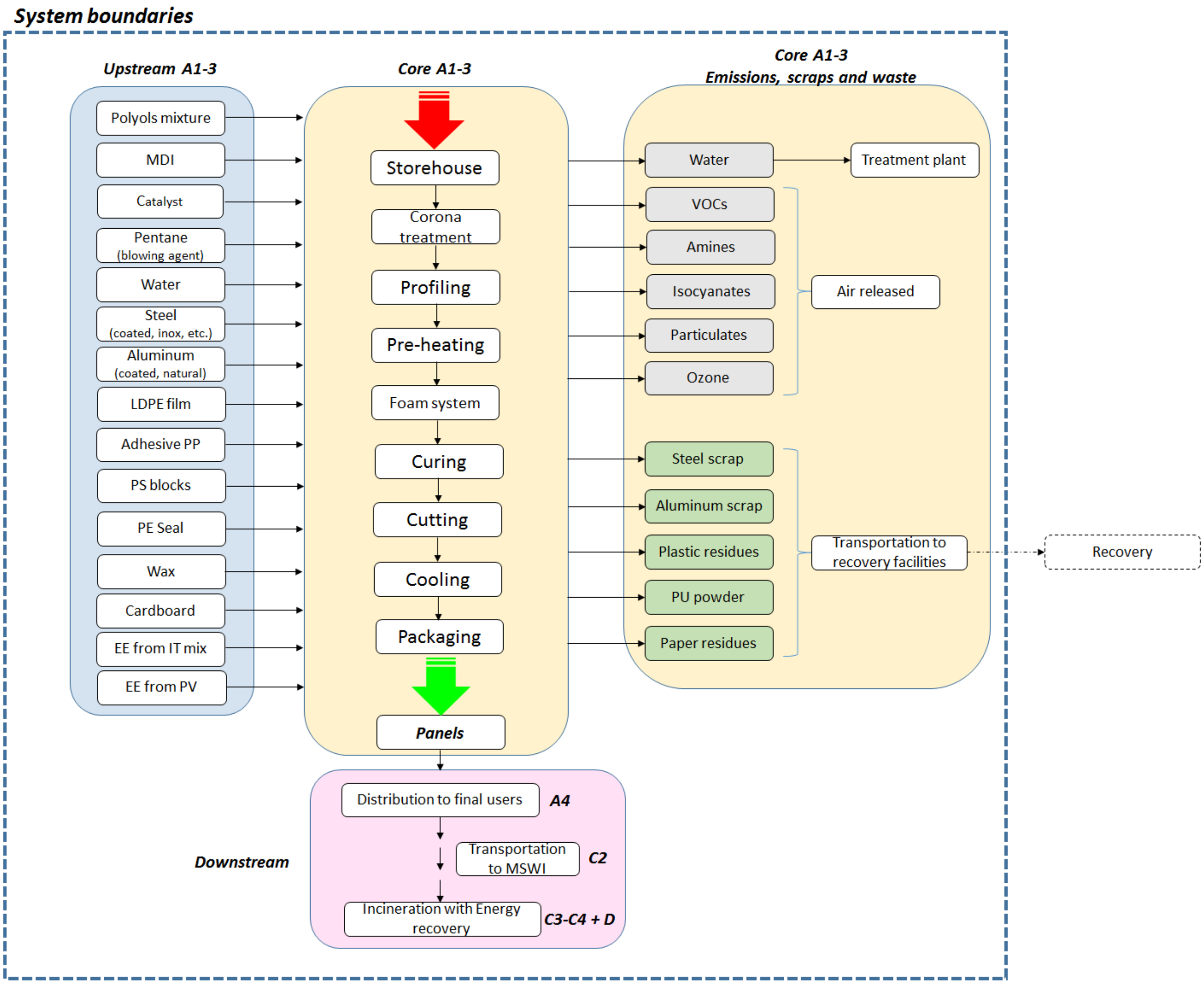
	FROST/ICE, 200mm		RAIN, 150mm	
Product content	***Mass content in kg***	***Percentage content***	***Mass content in kg***	***Percentage content***
Steel total	7.31	47.9%	7.49	55.2%
Insulation foam - total chemicals	7.40	48.6%	5.75	42.3%
Polyethylene seal	0.00	0.0%	0.17	1.3%
Polypropylene adhesive	0.01	0.04%	0.02	0.2%
Packaging total	0.53	3.5%	0.15	1.1%

As written, around 100% of the gross panels weight was included in the LCA study. In fact, less than 0.1% was excluded since not possible to reveal the amount per m^2 of some coating materials. This assumption is expected to not affect the final results. However, in accordance with PCR, these substances are listed in Table 5.

Table 5: List of substances not included in the LCI

Material component	**Substance**	**CAS number**	**Weight %**	**Environmental class**	**Health class**
Coating for steel of 127 µm	Polyvinyl chloride (PVC) resin	9002-86-2	<0.1%	NO	NO
Backcoat of 5-7 µm	Epoxy polyurethane foam	9009-54-5	<0.1%	NO	NO
Thermosetting paint 25 µm	Thermosetting paint	Not specified	<0.1%	NO	NO

Figure 2: System boundaries of the LCA study



4. Content declaration

In addition to what written above in the description of the LCIs, it should be highlighted that none outflow scraps (e.g. metal) are reused in the manufacturing process, since all the residues are sold to other facilities outside the plant; there they are recovered to produce new products or energy. This principle is in line with the aim proposed by *industrial symbiosis*[12]: utilization of a waste stream as a starting raw material in a different production.

5. Environmental performances

LCIA stage is the phase in which the evaluation of the environmental performances occurs by the usage of standardized analysis methods included within the software. Among these the CML-IA [13] baseline method (v. 3.02/EU 25) was adopted to estimate the potential impacts divided in seven impact categories:

- global warming potential (GWP_{100}), which describes the negative effects due to the release of greenhouse gases, expressed in terms of kg CO_2 equivalents, during all the life cycle stages considered;
- ozone depletion, measured in kg CFC 11 equivalents, which evaluates the harmful effects upon human and animal health, terrestrial and aquatic ecosystems, biochemical cycles and on materials due to the reduction of the ozone barrier;

- acidification of land and water, expressed in kg SO_2 equivalents, evaluate the effect due to the release of acidifying substances. The time span is eternity and the geographical scale varies between local scale and continental scale;
- eutrophication, includes all impacts due to excessive levels of macro-nutrients in the environment caused by emissions of nutrients to air, water and soil. Nutrification potential is espresse in PO_4^{3-} equivalents;
- photochemical ozone creation, is the formation of reactive substances (mainly ozone) which are injurious to human health and ecosystems and which also may damage crops. It is calculated in terms of C_2H_2 (ethylene) equivalents;
- depletion of abiotic resources (elements), is related to extraction of minerals and expressed in kg Sb equivalents;
- depletion of abiotic resources (fossil), as the former is concerned with protection of human welfare, human health and ecosystem health and it expressed the extraction of fossil fuels. For this reason, is quantified in terms of MJ net calorific value.

Then, in order to evaluate the use of resources (renewable and not) the Cumulative Energy Demand (CED) [14] method was adopted (v. 2.0), which is able to translate the potential consumption in terms of MJ net calorific value.

Finally, in order to complete the whole amount of resources, the quantity of fresh water inlet the factory (process water) and the amount of secondary materials derived from recycle (the polystyrene blocks from recycled polymer) were declared in the report. On the other hand, no renewable secondary flues are directly used in plant, since the main energy source is electricity: from Italian grid and PV. As written above, only the *net water* inlet the factory gate is considered, since (in accordance with GPI) the indicator should not be considered as a water footprint. In addition, the embodied water consumption among the LCA system boundaries is included within the indicators “Renewable and Non-renewable primary energy” of the CED method.

5.1. Results interpretation

The main results of the LCIA analysis are listed in Table 6 and Table 7. They are expressed per m^2 of panel manufactured. As expected, higher the thickness is and greater are the environmental loads of the manufacturing phase (A1-3). In fact, the amount of resources used is strictly linked to the products’ shape, if an equal surface is considered. This trend affects all the impact categories. In the case of mineral depletion (kg Sb eq.) the trend is not respected, since the amount of metal used per m^2 of panel is not so far from product to product: 6.17kg of steel for the 40mm vs 7.02kg for 240mm. On the other hand, looking at the depletion of the fossil-based resources the trend is respected since a higher amount of chemicals are requested per equal surface: it was estimated that the whole amount of chemicals used for the 240mm panel is more than six time higher than the quantity adopted in the manufacturing of 40mm. The same trend is achieved for the roof panels.

Other interesting thing is that the consumption of the “renewable and non-renewable primary energy **raw materials**” (expressed in MJ) is focused mainly in the stage of manufacturing (A1-3). As written above, this impact category simulates the extraction and usage of feedstock (renewable and not) using the net calorific value of each resource. Therefore, it looks clear that the greater exploitation is concentrated in the upstream and core phases where the extraction and assembly procedures are placed. On the other hand, the other life cycle stages mainly refer to “services” in which the resources are mainly used as energy carrier (e.g. fuel for transportation, electricity produced or recovered, etc.).

Looking at module A4 the trend is quite maintained. However, comparing results achieved by the 200mm and 240mm wall panels an inversion occurs: the former presents higher loads, for example in terms of GWP and fossil fuels. This is the results of the selling procedure. In fact, A4 takes into account the kg of panel sold per kilometers traveled (*kg·km*): higher is this value and greater are the environmental repercussions. In the case of 200mm we have 46.8kgkm, instead for the 240mm the value is reduced to 25.9kgkm.

Results for the module C2 are influenced by the distance of transportation of the scraps which was assumed to be 100km for all the scenarios. Therefore, values achieved are quite similar. On the contrary EoL stage (C3-4) and the recovery (D) are strictly related to the average weight of panels treated by the incineration facility: higher is the amount and greater will be the amount of emissions (evaluated on the basis of waste incinerated). At the same time, higher quantity of EoL products incinerated means a greater EE recovery and, therefore, more traditional electricity production avoided. All the LCA studies are common to translate the environmental benefits in terms of negative values: lower the value (given by a greater absolute number) and higher is the reduction of loads.

As written above, all the results presented derive from the evaluation of an equal amount of panels manufactured: $1m^2$. GPI and PCR define this amount the declared unit. However, the environmental performances could be also evaluated on the basis of the products' function: we talk about *functional unit*, able to express the main function of the product under investigation. In the case of panels it is to provide thermal insulation. Therefore, according with PCR, the function is evaluated by the use of the thermal resistance (R) parameter, which is the opposite of the thermal conductivity (W/m^2K): higher is the R value and lower will be the conductivity; this means better insulation properties. The functional unit to perform the comparison between the different products is **$1m^2K/W$**. Thicker is the panel, greater is its own R value (see Table 1). Therefore, to achieve the same grade of resistance ($1m^2K/W$) the panels need different input flows, strictly related to the conductibility of each product. Please check the thermal conductivity values in Table 1.

For this reason, in order to make the EPD® as complete as possible the results of the LCIA stage were also evaluated using the same R value of $1m^2K/W$ per each product. They are listed below in Table 8 and Table 9. As expected, if compared with the trend achieved before for m^2 an inversion of all the values occurs from the thicker to the thinner products: the latter present greater environmental loads as a consequence of the bigger amount of resources required per m^2K/W. This trend, respected for both wall and roof panels, is driven by the amount of panels requested to achieve the same R value: Table 10 collects the quantity (kg) and the surface (m^2) necessary per $1m^2K/W$, evaluated using the panels characteristics.

Given that the input data used in the LCI stage are mainly primary information directly furnished by NAV SYSTEM, results achieved in the LCIA stage should be considered a valuable approximation of the real case.

In conclusion, it should be highlighted that all the LCIA results presented above are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

5.2. Other environmental indicators

In addition to the LCA-based results, other indicators about sustainability were introduced in the report. As suggested by PCR, further details concerning the output flows were introduced, such as the quantity of radioactive, hazardous and non-hazardous waste streams produced during the core process. However, as declared during the LCI phase the only substance leaving the factory gate as waste is the process water implied as washing agent (7.1E-4kg), since the other streams are sold as by-products. Therefore, the waste water flow is sent to the nearest treatment plant able to reduce the environmental load both in terms of organic and inorganic pollutants. The default process, created by the ELCD database [15] developers to simulate this operation, was used in our model. In accordance with PCR and GPI, ELCD database is recognized by the International EPD System as one of the reference libraries to be used to cover the "generic data" for Europe.

Table 6: LCIA results per declared unit (1m²) for the wall panels

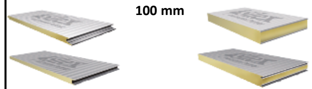
		Declared Unit: 1 m^2																								
		TYPE: WALL PANEL																								
		DOUBLE SKIN: STEEL/STEEL																								
		WIND e TWISTER 40 mm					WIND, TWISTER, WET e ICE 100 mm					FROST, TWISTER E WET 150 mm					FROST e ICE 200 mm					FROST e ICE 240 mm				
																										
Impact category	**Unit**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**
Potential Environmental Impacts																										
Abiotic depletion	kg Sb eq	1.3E-04	3.0E-09	3.9E-07	4.5E-07	-5.3E-06	1.4E-04	4.6E-09	4.8E-07	5.5E-07	-6.5E-06	1.6E-04	7.8E-09	4.9E-07	5.6E-07	-6.6E-06	1.6E-04	1.8E-08	6.3E-07	7.2E-07	-8.5E-06	1.5E-04	1.0E-08	6.9E-07	7.9E-07	-9.4E-06
Abiotic depletion (fossil fuels)	MJ	3.0E+02	1.6E-02	2.1E+00	8.8E+00	-3.8E+01	5.0E+02	2.5E-02	2.6E+00	1.1E+01	-4.7E+01	6.5E+02	4.2E-02	2.6E+00	1.1E+01	-4.8E+01	8.1E+02	9.9E-02	3.4E+00	1.4E+01	-6.2E+01	9.3E+02	5.5E-02	3.7E+00	1.6E+01	-6.8E+01
Global warming (GWP 100)	kg CO_2 eq	1.8E+01	1.0E-03	1.3E-01	9.8E+00	-2.8E+00	2.8E+01	1.6E-03	1.6E-01	1.2E+01	-3.4E+00	3.6E+01	2.7E-03	1.7E-01	1.2E+01	-3.4E+00	4.2E+01	6.2E-03	2.1E-01	1.6E+01	-4.4E+00	4.9E+01	3.4E-03	2.4E-01	1.7E+01	-4.9E+00
Ozone layer depletion	kg CFC-11 eq	5.1E-07	1.6E-10	2.1E-08	1.2E-07	-2.3E-07	5.9E-07	2.5E-10	2.6E-08	1.4E-07	-2.9E-07	6.5E-07	4.3E-10	2.7E-08	1.4E-07	-2.9E-07	6.3E-07	1.0E-09	3.5E-08	1.9E-07	-3.7E-07	6.2E-07	5.6E-10	3.8E-08	2.0E-07	-4.1E-07
Photochemical oxidation	kg C_2H_4 eq	6.9E-03	1.6E-07	2.2E-05	1.0E-04	-4.1E-04	9.3E-03	2.5E-07	2.7E-05	1.2E-04	-5.1E-04	1.1E-02	4.3E-07	2.7E-05	1.2E-04	-5.2E-04	1.2E-02	1.0E-06	3.5E-05	1.6E-04	-6.7E-04	1.4E-02	5.6E-07	3.8E-05	1.8E-04	-7.3E-04
Acidification	kg SO_2 eq	7.0E-02	5.5E-06	7.2E-04	4.3E-03	-9.9E-03	1.1E-01	8.5E-06	8.9E-04	5.3E-03	-1.2E-02	1.4E-01	1.5E-05	9.0E-04	5.3E-03	-1.2E-02	1.7E-01	3.4E-05	1.2E-03	6.9E-03	-1.6E-02	2.0E-01	1.9E-05	1.3E-03	7.6E-03	-1.8E-02
Eutrophication	kg PO_4^{-3}eq	3.3E-02	1.5E-06	1.9E-04	6.7E-03	-3.1E-03	4.3E-02	2.3E-06	2.4E-04	8.3E-03	-3.8E-03	5.1E-02	3.9E-06	2.4E-04	8.4E-03	-3.9E-03	5.7E-02	9.0E-06	3.1E-04	1.1E-02	-5.0E-03	5.9E-02	5.0E-06	3.4E-04	1.2E-02	-5.5E-03
Use of resources																										
Non-renewable primary energy raw materials	MJ	335.0	0.0	0.0	0.0	0.0	560.1	0.0	0.0	0.0	0.0	731.1	0.0	0.0	0.0	0.0	898.8	0.0	0.0	0.0	0.0	1041.3	0.0	0.0	0.0	0.0
Non-renewable primary energy excluding raw materials	MJ	2.7	1.7E-02	2.2	9.1	-38.8	3.4	2.6E-02	2.7	11.2	-47.8	3.6	4.5E-02	2.8	11.4	-48.5	4.0	0.1	3.6	14.7	-62.5	4.9	0.1	4.0	16.2	-68.7
Total use of Non-renewable primary energy	MJ	337.7	1.7E-02	2.2	9.1	-38.8	563.4	2.6E-02	2.7	11.2	-47.8	734.7	4.5E-02	2.8	11.4	-48.5	902.8	0.1	3.6	14.7	-62.5	1046.2	0.1	4.0	16.2	-68.7
Renewable primary energy raw materials	MJ	13.7	0.0	0.0	0.0	0.0	20.2	0.0	0.0	0.0	0.0	24.7	0.0	0.0	0.0	0.0	28.3	0.0	0.0	0.0	0.0	31.5	0.0	0.0	0.0	0.0
Renewable primary energy excluding raw materials	MJ	1.7	2.1E-04	2.8E-02	0.1	-20.6	2.2	3.3E-04	3.4E-02	0.1	-25.4	2.3	5.6E-04	3.5E-02	0.1	-25.8	2.6	1.3E-03	4.5E-02	0.1	-33.2	3.2	7.2E-04	4.9E-02	0.1	-36.5
Total use of Renewable primary energy	MJ	15.5	2.1E-04	2.8E-02	0.1	-20.6	22.3	3.3E-04	3.4E-02	0.1	-25.4	27.0	5.6E-04	3.5E-02	0.1	-25.8	30.9	1.3E-03	4.5E-02	0.1	-33.2	34.6	7.2E-04	4.9E-02	0.1	-36.5
Use of secondary material	kg	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0
Use of renewable secondary fuels	MJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use of net fresh water	m^3	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0
Waste Categories																										
Hazardous waste	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non hazardous waste	kg	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0
Radiactive waste disposal	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7: LCIA results per declared unit (1m²) for the roof panels

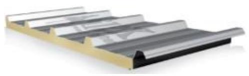
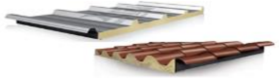
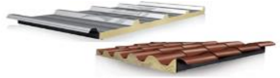
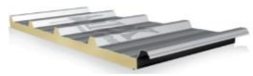
		Declared Unit: 1 m^2																			
		TYPE: ROOF PANEL																			
		DOUBLE SKIN: STEEL/STEEL																			
		RAIN 20 mm 					RAIN & CORTEX 40 mm 					RAIN & CORTEX 100 mm 					RAIN 150 mm 				
Impact category	**Unit**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**
Potential Environmental Impacts																					
Abiotic depletion	kg Sb eq	1.3E-04	4.4E-10	3.2E-07	3.7E-07	-4.4E-06	1.3E-04	2.5E-09	3.1E-07	3.6E-07	-4.3E-06	1.3E-04	2.9E-09	4.4E-07	5.1E-07	-6.0E-06	1.5E-04	9.6E-09	5.1E-07	5.9E-07	-7.0E-06
Abiotic depletion (fossil fuels)	MJ	2.5E+02	2.4E-03	1.7E+00	7.3E+00	-3.2E+01	3.1E+02	1.4E-02	1.7E+00	7.1E+00	-3.1E+01	5.0E+02	1.6E-02	2.4E+00	9.9E+00	-4.3E+01	6.4E+02	5.2E-02	2.8E+00	1.2E+01	-5.1E+01
Global warming (GWP 100)	kg CO_2 eq	1.5E+01	1.5E-04	1.1E-01	8.1E+00	-2.3E+00	1.8E+01	8.7E-04	1.1E-01	7.9E+00	-2.2E+00	2.9E+01	9.9E-04	1.5E-01	1.1E+01	-3.1E+00	3.5E+01	3.3E-03	1.8E-01	1.3E+01	-3.6E+00
Ozone layer depletion	kg CFC-11 eq	5.0E-07	2.4E-11	1.8E-08	9.5E-08	-1.9E-07	4.9E-07	1.4E-10	1.7E-08	9.3E-08	-1.9E-07	7.2E-07	1.6E-10	2.4E-08	1.3E-07	-2.6E-07	6.1E-07	5.3E-10	2.8E-08	1.5E-07	-3.1E-07
Photochemical oxidation	kg C_2H_4 eq	6.4E-03	2.4E-08	1.8E-05	8.2E-05	-3.4E-04	7.0E-03	1.4E-07	1.7E-05	8.0E-05	-3.3E-04	9.7E-03	1.6E-07	2.4E-05	1.1E-04	-4.7E-04	1.1E-02	5.4E-07	2.9E-05	1.3E-04	-5.5E-04
Acidification	kg SO_2 eq	6.1E-02	8.1E-07	6.0E-04	3.5E-03	-8.2E-03	7.3E-02	4.7E-06	5.8E-04	3.5E-03	-8.0E-03	1.2E-01	5.4E-06	8.2E-04	4.8E-03	-1.1E-02	1.4E-01	1.8E-05	9.5E-04	5.6E-03	-1.3E-02
Eutrophication	kg PO_4^{-3}eq	3.0E-02	2.2E-07	1.6E-04	5.5E-03	-2.6E-03	3.2E-02	1.3E-06	1.6E-04	5.4E-03	-2.5E-03	4.4E-02	1.4E-06	2.2E-04	7.6E-03	-3.5E-03	5.1E-02	4.8E-06	2.5E-04	8.9E-03	-4.1E-03
Use of resources																					
Non-renewable primary energy raw materials	MJ	278.2	0.0	0.0	0.0	0.0	348.3	0.0	0.0	0.0	0.0	561.6	0.0	0.0	0.0	0.0	716.3	0.0	0.0	0.0	0.0
Non-renewable primary energy excluding raw materials	MJ	2.2	2.5E-03	1.8	7.6	-32.1	2.0	1.5E-02	1.8	7.4	-31.4	3.6	1.7E-02	2.5	10.3	-44.0	4.3	5.5E-02	2.9	12.1	-51.3
Total use of Non-renewable primary energy	MJ	280.3	2.5E-03	1.8	7.6	-32.1	350.3	1.5E-02	1.8	7.4	-31.4	565.2	1.7E-02	2.5	10.3	-44.0	720.6	5.5E-02	2.9	12.1	-51.3
Renewable primary energy raw materials	MJ	12.2	0.0	0.0	0.0	0.0	13.9	0.0	0.0	0.0	0.0	27.4	0.0	0.0	0.0	0.0	22.8	0.0	0.0	0.0	0.0
Renewable primary energy excluding raw materials	MJ	1.4	3.1E-05	2.3E-02	0.1	-17.1	1.3	1.8E-04	2.3E-02	0.1	-16.7	2.3	2.1E-04	3.2E-02	0.1	-23.4	2.8	6.9E-04	3.7E-02	0.1	-27.3
Total use of Renewable primary energy	MJ	13.6	3.1E-05	2.3E-02	0.1	-17.1	15.1	1.8E-04	2.3E-02	0.1	-16.7	29.7	2.1E-04	3.2E-02	0.1	-23.4	25.6	6.9E-04	3.7E-02	0.1	-27.3
Use of secondary material	kg	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0	2.1E-02	0.0	0.0	0.0	0.0
Use of renewable secondary fuels	MJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use of net fresh water	m^3	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0	1.0E-06	0.0	0.0	0.0	0.0
Waste Categories																					
Hazardous waste	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non hazardous waste	kg	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0	7.1E-04	0.0	0.0	0.0	0.0
Radiactive waste disposal	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8: LCIA results per functional unit (1m²K/W) for the wall panels

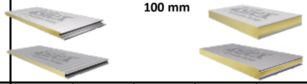
		Functional Unit: 1 m²K/W																										
		TYPE: WALL PANEL																										
		DOUBLE SKIN: STEEL/STEEL																										
		WIND e TWISTER 40 mm					WIND, TWISTER, WET e ICE 100 mm					FROST, TWISTER E WET 150 mm					FROST e ICE 200 mm					FROST e ICE 240 mm						
																										
Impact category	**Unit**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**
Potential Environmental Impacts																										
Abiotic depletion	kg Sb eq	7.8E-05	1.8E-09	2.3E-07	2.7E-07	-3.2E-06	3.3E-05	1.0E-09	1.1E-07	1.3E-07	-1.5E-06	3.8E-05	1.8E-09	1.1E-07	1.3E-07	-1.5E-06	1.7E-05	2.0E-09	6.9E-08	7.9E-08	-9.4E-07	1.4E-05	9.1E-10	6.2E-08	7.1E-08	-8.4E-07
Abiotic depletion (fossil fuels)	MJ	1.8E+02	9.6E-03	1.3E+00	5.3E+00	-2.3E+01	1.2E+02	5.7E-03	6.0E-01	2.5E+00	-1.1E+01	1.5E+02	9.8E-03	6.1E-01	2.5E+00	-1.1E+01	8.9E+01	1.1E-02	3.7E-01	1.6E+00	-6.8E+00	8.4E+01	4.9E-03	3.4E-01	1.4E+00	-6.1E+00
Global warming (GWP 100)	kg CO_2 eq	1.1E+01	6.1E-04	8.0E-02	5.9E+00	-1.7E+00	6.4E+00	3.6E-04	3.8E-02	2.8E+00	-7.8E-01	8.2E+00	6.2E-04	3.8E-02	2.8E+00	-7.9E-01	4.7E+00	6.9E-04	2.4E-02	1.7E+00	-4.9E-01	4.4E+00	3.1E-04	2.1E-02	1.6E+00	-4.4E-01
Ozone layer depletion	kg CFC-11 eq	3.0E-07	9.8E-11	1.3E-08	6.9E-08	-1.4E-07	1.4E-07	5.8E-11	6.1E-09	3.3E-08	-6.6E-08	1.5E-07	9.9E-11	6.2E-09	3.3E-08	-6.7E-08	6.9E-08	1.1E-10	3.8E-09	2.0E-08	-4.1E-08	5.5E-08	5.0E-11	3.4E-09	1.8E-08	-3.7E-08
Photochemical oxidation	kg C_2H_4 eq	4.1E-03	9.9E-08	1.3E-05	6.0E-05	-2.5E-04	2.1E-03	5.8E-08	6.1E-06	2.8E-05	-1.2E-04	2.6E-03	1.0E-07	6.2E-06	2.9E-05	-1.2E-04	1.4E-03	1.1E-07	3.8E-06	1.8E-05	-7.3E-05	1.2E-03	5.0E-08	3.4E-06	1.6E-05	-6.6E-05
Acidification	kg SO_2 eq	4.2E-02	3.3E-06	4.3E-04	2.6E-03	-5.9E-03	2.5E-02	1.9E-06	2.0E-04	1.2E-03	-2.8E-03	3.3E-02	3.3E-06	2.1E-04	1.2E-03	-2.8E-03	1.9E-02	3.7E-06	1.3E-04	7.6E-04	-1.8E-03	1.8E-02	1.7E-06	1.2E-04	6.8E-04	-1.6E-03
Eutrophication	kg PO_4^{-3}eq	2.0E-02	8.8E-07	1.2E-04	4.0E-03	-1.9E-03	9.9E-03	5.2E-07	5.5E-05	1.9E-03	-8.8E-04	1.2E-02	8.9E-07	5.5E-05	1.9E-03	-9.0E-04	6.2E-03	9.9E-07	3.4E-05	1.2E-03	-5.5E-04	5.3E-03	4.5E-07	3.1E-05	1.1E-03	-5.0E-04
Use of resources																										
Non-renewable primary energy raw materials	MJ	201.0	0.0	0.0	0.0	0.0	128.8	0.0	0.0	0.0	0.0	168.1	0.0	0.0	0.0	0.0	98.9	0.0	0.0	0.0	0.0	93.7	0.0	0.0	0.0	0.0
Non-renewable primary energy excluding raw materials	MJ	1.6	1.0E-02	1.3	5.5	-23.3	0.8	6.0E-03	0.6	2.6	-11.0	0.8	1.0E-02	0.6	2.6	-11.2	0.4	1.1E-02	0.4	1.6	-6.9	0.4	5.2E-03	0.4	1.5	-6.2
Total use of Non-renewable primary energy	MJ	202.6	1.0E-02	1.3	5.5	-23.3	129.6	6.0E-03	0.6	2.6	-11.0	169.0	1.0E-02	0.6	2.6	-11.2	99.3	1.1E-02	0.4	1.6	-6.9	94.2	5.2E-03	0.4	1.5	-6.2
Renewable primary energy raw materials	MJ	8.2	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0
Renewable primary energy excluding raw materials	MJ	1.0	1.3E-04	1.7E-02	4.9E-02	-12.4	0.5	7.5E-05	7.9E-03	2.3E-02	-5.8	0.5	1.3E-04	8.0E-03	2.3E-02	-5.9	0.3	1.4E-04	4.9E-03	1.4E-02	-3.7	0.3	6.5E-05	4.4E-03	1.3E-02	-3.3
Total use of Renewable primary energy	MJ	9.3	1.3E-04	1.7E-02	4.9E-02	-12.4	5.1	7.5E-05	7.9E-03	2.3E-02	-5.8	6.2	1.3E-04	8.0E-03	2.3E-02	-5.9	3.4	1.4E-04	4.9E-03	1.4E-02	-3.7	3.1	6.5E-05	4.4E-03	1.3E-02	-3.3
Use of secondary material	kg	1.3E-02	0.0	0.0	0.0	0.0	4.9E-03	0.0	0.0	0.0	0.0	4.9E-03	0.0	0.0	0.0	0.0	2.3E-03	0.0	0.0	0.0	0.0	1.9E-03	0.0	0.0	0.0	0.0
Use of renewable secondary fuels	MJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use of net fresh water	m^3	6.2E-07	0.0	0.0	0.0	0.0	2.4E-07	0.0	0.0	0.0	0.0	2.4E-07	0.0	0.0	0.0	0.0	1.1E-07	0.0	0.0	0.0	0.0	9.4E-08	0.0	0.0	0.0	0.0
Waste Categories																										
Hazardous waste	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non hazardous waste	kg	4.3E-04	0.0	0.0	0.0	0.0	1.6E-04	0.0	0.0	0.0	0.0	1.6E-04	0.0	0.0	0.0	0.0	7.8E-05	0.0	0.0	0.0	0.0	6.4E-05	0.0	0.0	0.0	0.0
Radiactive waste disposal	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9: LCIA results per functional unit (1m^{2}K/W) for the roof panels

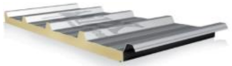
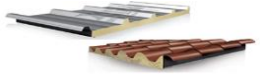
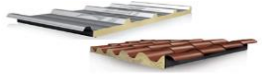
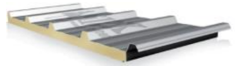
		Functional Unit: 1 m^{2}K/W																			
		TYPE: ROOF PANEL																			
		DOUBLE SKIN: STEEL/STEEL																			
		RAIN 20 mm 					**RAIN & CORTEX 40 mm** 					**RAIN & CORTEX 100 mm** 					**RAIN 150 mm** 				
Impact category	**Unit**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**	**A1-A3**	**A4**	**C2**	**C3-C4**	**D**
Potential Environmental Impacts																					
Abiotic depletion	kg Sb eq	1.2E-04	4.1E-10	3.1E-07	3.5E-07	-4.2E-06	6.6E-05	1.3E-09	1.6E-07	1.9E-07	-2.2E-06	2.9E-05	6.4E-10	9.7E-08	1.1E-07	-1.3E-06	2.3E-05	1.4E-09	7.7E-08	8.8E-08	-1.0E-06
Abiotic depletion (fossil fuels)	MJ	2.4E+02	2.2E-03	1.7E+00	6.9E+00	-3.0E+01	1.6E+02	7.2E-03	8.9E-01	3.7E+00	-1.6E+01	1.1E+02	3.5E-03	5.2E-01	2.2E+00	-9.6E+00	9.7E+01	7.8E-03	4.2E-01	1.7E+00	-7.6E+00
Global warming (GWP 100)	kg CO_2 eq	1.5E+01	1.4E-04	1.0E-01	7.7E+00	-2.2E+00	9.5E+00	4.5E-04	5.6E-02	4.1E+00	-1.2E+00	6.4E+00	2.2E-04	3.3E-02	2.5E+00	-6.9E-01	5.2E+00	5.0E-04	2.6E-02	1.9E+00	-5.5E-01
Ozone layer depletion	kg CFC-11 eq	4.7E-07	2.3E-11	1.7E-08	9.1E-08	-1.8E-07	2.6E-07	7.3E-11	9.0E-09	4.8E-08	-9.8E-08	1.6E-07	3.5E-11	5.3E-09	2.9E-08	-5.8E-08	9.2E-08	8.0E-11	4.3E-09	2.3E-08	-4.6E-08
Photochemical oxidation	kg C_2H_4 eq	6.1E-03	2.3E-08	1.7E-05	7.8E-05	-3.3E-04	3.6E-03	7.4E-08	9.1E-06	4.2E-05	-1.7E-04	2.1E-03	3.5E-08	5.4E-06	2.5E-05	-1.0E-04	1.6E-03	8.0E-08	4.3E-06	2.0E-05	-8.2E-05
Acidification	kg SO_2 eq	5.8E-02	7.7E-07	5.7E-04	3.4E-03	-7.8E-03	3.8E-02	2.5E-06	3.0E-04	1.8E-03	-4.2E-03	2.6E-02	1.2E-06	1.8E-04	1.1E-03	-2.5E-03	2.1E-02	2.7E-06	1.4E-04	8.5E-04	-2.0E-03
Eutrophication	kg PO_4^{-3}eq	2.9E-02	2.1E-07	1.5E-04	5.3E-03	-2.5E-03	1.7E-02	6.6E-07	8.1E-05	2.8E-03	-1.3E-03	9.7E-03	3.2E-07	4.8E-05	1.7E-03	-7.8E-04	7.7E-03	7.2E-07	3.8E-05	1.3E-03	-6.2E-04
Use of resources																					
Non-renewable primary energy raw materials	MJ	264.2	0.0	0.0	0.0	0.0	181.1	0.0	0.0	0.0	0.0	123.6	0.0	0.0	0.0	0.0	107.4	0.0	0.0	0.0	0.0
Non-renewable primary energy excluding raw materials	MJ	2.0	2.4E-03	1.8	7.2	-30.5	1.0	7.6E-03	0.9	3.8	-16.3	0.8	3.7E-03	0.6	2.3	-9.7	0.7	8.3E-03	0.4	1.8	-7.7
Total use of Non-renewable primary energy	MJ	266.3	2.4E-03	1.8	7.2	-30.5	182.1	7.6E-03	0.9	3.8	-16.3	124.3	3.7E-03	0.6	2.3	-9.7	108.1	8.3E-03	0.4	1.8	-7.7
Renewable primary energy raw materials	MJ	11.6	0.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0
Renewable primary energy excluding raw materials	MJ	1.3	3.0E-05	2.2E-02	0.1	-16.2	0.7	9.5E-05	1.2E-02	3.4E-02	-8.7	0.5	4.6E-05	6.9E-03	2.0E-02	-5.1	0.4	1.0E-04	5.5E-03	1.6E-02	-4.1
Total use of Renewable primary energy	MJ	12.9	3.0E-05	2.2E-02	0.1	-16.2	7.9	9.5E-05	1.2E-02	3.4E-02	-8.7	6.5	4.6E-05	6.9E-03	2.0E-02	-5.1	3.8	1.0E-04	5.5E-03	1.6E-02	-4.1
Use of secondary material	kg	2.0E-02	0.0	0.0	0.0	0.0	1.1E-02	0.0	0.0	0.0	0.0	4.7E-03	0.0	0.0	0.0	0.0	3.2E-03	0.0	0.0	0.0	0.0
Use of renewable secondary fuels	MJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use of net fresh water	m^3	9.9E-07	0.0	0.0	0.0	0.0	5.4E-07	0.0	0.0	0.0	0.0	2.3E-07	0.0	0.0	0.0	0.0	1.6E-07	0.0	0.0	0.0	0.0
Waste Categories																					
Hazardous waste	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non hazardous waste	kg	6.7E-04	0.0	0.0	0.0	0.0	3.7E-04	0.0	0.0	0.0	0.0	1.6E-04	0.0	0.0	0.0	0.0	1.1E-04	0.0	0.0	0.0	0.0
Radiactive waste disposal	kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 10: Mass and surface reuirements for each product to reach the define R value of 1 m^2K/W

Application	*Product*	*kg / 1 m^2K/W*	*m^2 / 1 m^2K/W*
Wall	WIND/TWISTER, 40mm	6.02	0.60
	WIND/TWISTER/WET/ICE, 100mm	2.77	0.23
	FROST/TWISTER/WET, 150mm	2.80	0.23
	FROST/ICE, 200mm	1.77	0.11
	FROST/ICE, 240mm	1.59	0.09
Roof	RAIN, 20mm	7.86	0.95
	RAIN/CORTEX, 40mm	4.20	0.52
	RAIN/CORTEX, 100mm	2.49	0.22
	RAIN, 150mm	1.98	0.15

Programme-related information and verification

Programme:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com
EPD registration number:	S-P-01017
ECO EPD Reference number:	00000484
Publication date:	2017-02-09
Validity date:	2022-02-02
Product Category Rules:	PCR for the Insulation Materials multiple UN CPC codes, Version 1.0, dated 2014-07-2
Product group classification:	UN CPC VER. 2 CODE 54
Reference year for data:	2015
Geographical scope:	*International*

Product category rules (PCR): *Insulation materials, PCR 2014:13 version 1.0, 2014/04/16*
PCR review was conducted by: *The Technical Committee of the International EPD system. Full list of TC members available on www.environdec.com/TC*
Independent verification of the declaration and data, according to ISO 14025:2006: ☐ EPD Process Certification (internal) ☒ EPD Verification (external)
Third party verifier*: Dott.ssa Valentina Fantin* *Address: Via Pablo Neruda 5, I-40139 Bologna, Italy* Accredited by: *"Approved by the International EPD System"*

Contact information:

EPD owner:	**NAV SYSTEM S.p.A.** P.le P. Sraffa 45, I-47521, Case Castagnoli, Cesena, Italy Web: http://www.nav-group.com Tel. +39 0547 350505 fax. +39 0547 350500 Dott.ssa Angela Galli e-mail:agalli@NAV SYSTEM.it
LCA author:	**EMC Innovation Lab s.r.l.** Viale Italia 29, I-47921, Rimini, Italy. Web: http://www.emcinnovation.it/ Tel: +39 0541 1835510 Dr. Daniele Cespi e-mail: dcespi@emcinnovation.it
Programme operator:	EPD International AB info@environdec.com

Abbreviation

CED	Cumulative Energy Demand
EE	Electric Energy
ELCD	European Life Cycle Database
EoL	End of Life
EPD	Environmental Product Declaration
GPI	General Programme Instructions
GWP_{100}	Global Warming Potential with a 100-years' perspective
kg CFC 11 eq.	kilogram of equivalent chlorofluorocarbon
kg C_2H_2 eq.	kilogram of equivalent ethylene
kg CO_2 eq.	kilogram of equivalent carbon dioxide
kg PO_4^{3-} eq.	kilogram of equivalent phosphates
kg SO_2 eq.	kilogram of equivalent sulfur dioxide
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LHV	Lower Heating Value
MJ	Mega Joule
MSWI	Municipal Solid Waste Incinerator
PCR	Product Category Rules
WtE	Waste to Energy

References

1. ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures.
2. EN 15804:2014 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
3. Product Category Rules (PCR) for the Insulation Materials, multiple UN CPC codes, Version 1.0, dated 2014-07-2.
4. Construction Services 54 (CPC Ver. 2 code 54, http://unstats.un.org/unsd/cr/registry/regcs.asp?Cl=25&Lg=1&Co=54).
5. EN ISO 14040 Environmental Management, Life Cycle Assessment, Principles and Framework, International Organization for Standardization, Geneva, Switzerland, 2006.
6. EN ISO 14044 Environmental Management, Life Cycle Assessment, Requirements and Guidelines, International Organization for Standardization, Geneva, Switzerland, 2006.
7. Ecoinvent Centre (formerly Swiss Centre for Life Cycle Inventories) (2016) Ecoinvent 3.1 Database.
8. PRé Consultants, SimaPro, Amersfoort, The Netherlands, 2017.
9. General Programme Instructions of the International EPD® System. Version 2.01, dated 2013-09-18.
10. Terna 2015, Statistiche di produzione, https://www.terna.it/it-it/sistemaelettrico/statisticheeprevisioni/datistatistici.aspx.
11. F. Passarini, M. Nicoletti, L. Ciacci, I. Vassura, L. Morselli, Environmental impact assessment of a WtE plant after structural upgrade measures, *Waste Manag.*, 2014, 34, 753-762, http://dx.doi.org/10.1016/j.wasman.2013.12.022.
12. M.R. Chertow,Industrial Symbiosis: literature and taxonomy, *Annu. Rev. Environ. Resour.*, 2000, 25, 313–337.
13. https://www.universiteitleiden.nl/en/research/research-output/science/cml-ia-characterisation-factors.
14. R. Frischknecht, N. Jungbluth, H.-J. Althaus, C. Bauer, G. Doka, R. Dones, R. Hischier, S. Hellweg, S. Humbert, T. Köllner, Y. Loerincik, M. Margni and T. Nemecek, *Implementation of Life Cycle Impact Assessment Methods*, ecoinvent report No. 3, v2.0, Swiss Centre for Life Cycle Inventories, Dübendorf, 2007.
15. European Life Cycle Database – ELCD v.3.0, http://eplca.jrc.ec.europa.eu/ELCD3/.