Programa Ambiente, Alterações Climáticas e Economia de Baixo Carbono

'Programa Ambiente'

Espaço Económico Europeu (EEA) Mecanismo Financeiro 2014-2021

07_Call#2_CircularBuild – Desenvolvimento e Validação do Conceito de Circularidade Aplicada à Construção Pré-Fabricada Modular

Accordingly, with the Articles 25.2.j) and 29.4 of the 'Applicants Guide for Financing of Projects Supported by Environment, Climate Change and Low Carbon Economy Programme'

https://www.eeagrants.gov.pt/media/2994/applicants-guide-for-financing-eea-grants_environment-projects_28112019.pdf

ATIVIDADE A.1 – Estudo e Definição das Exigências Funcionais dos Materiais Alternativos

D.1.2 – Avaliação do Ciclo de Vida – LCA – Solução Base UnusHouse

Operador do programa:

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Resumo

O Projeto ***"CircularBuild – Desenvolvimento e Validação do Conceito de Circularidade Aplicada à Construção Pré-fabricada Modular"***, visa a investigação de materiais alternativos para os painéis que viabilizem a completa circularidade do sistema construtivo Pré-fabricado Modular CircularBuild, reduzindo o consumo de recursos e a produção de resíduos, potencializando o reaproveitamento dos componentes, e contribuindo para o novo paradigma de ***"Edifícios Carbono Zero"***.

O Projeto CircularBuild, financiado pelos ***EEA Grants*** e operado pela ***Secretaria-Geral do Ambiente e Ação Climática***, ao abrigo do Programa Ambiente, apresenta as seguintes seis atividades:

- **Atividade 1 –** Estudo e Definição das Exigências Funcionais de Materiais Alternativos;
- **Atividade 2 –** Preparação de Amostras e Validação Industrial;
- **Atividade 3 –** Ensaios de Validação Funcional – Âmbito Laboratorial;
- **Atividade 4 –** "Construção Piloto" CircularBuild;
- **Atividade 5 –** Promoção e Disseminação de Resultados;
- **Atividade 6 –** Gestão do Projeto.

Este documento reúne os elementos explicativos e documentais inerentes à Atividade 1, nomeadamente à formalização do entregável ***"D1.2 – Reporte com Análise do Ciclo de Vida – LCA - Solução Base UnusHouse"***.

Índice

1. Introdução

1.1. Aspetos Gerais

No âmbito da ***“Atividade 1 – Estudo e Definição das Exigências Funcionais de Materiais Alternativos”***, encontra-se definida a execução das seguintes tarefas:

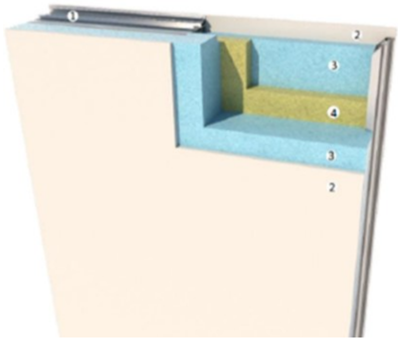
- T1.1 – Estudo de Materiais Alternativos face à Solução Existente;
- T1.2 – Identificação de Requisitos Regulamentares Aplicáveis Face ao Sistema Construtivo em Estudo;
- T1.3 – Avaliação do Processo Produtivo do Painel Face ao Sistema Construtivo em Estudo;
- T1.4 – Elaboração de Declaração de Desempenho Ambiental do Sistema Construtivo Modular.

A ***“Atividade 1 – Estudo e Definição das Exigências Funcionais de Materiais Alternativos”***, é composta por 3 entregáveis, tal como apresentado abaixo, sendo alvo deste documento o ***“D1.2 – Reporte com a Análise do Ciclo de Vida – LCA - Solução Base UnusHouse”***:

- D1.1 - Relatório de Estudo dos Materiais Alternativos e Requisitos Aplicáveis;
- **D1.2 - Reporte com a Análise do Ciclo de Vida – LCA;**
- D1.3 - Ficha Técnica dos Novos Painéis.

O sistema construtivo modular pré-fabricado base *UnusHouse* encontra-se descrito no ***“D1.1 - Relatório de Estudo dos Materiais Alternativos e Requisitos Aplicáveis”***. O sistema é composto por painéis pré-fabricados que se encontram descritos no Documento de Homologação (DH 955, 2022) e que são constituídos por perfis de alumínio, isolamento térmico em XPS, isolamento acústico em lã de rocha e painéis de gesso cartonado, que proporcionam a construção de edificações com necessidades energéticas baixas (***Figura 1***).

Solução de Base UNUSHOUSE



- 1. Estrutura de Alumínio
- 2. Exterior: Glasroc X Gesso Cartonado
- 3. XPS 100 mm
- 4. Lã de Rocha 40 mm
- 3. XPS 40 mm
- 2. Interior: Glasroc X Gesso Cartonado

Figura 1. Representação gráfica da solução base.

Com base na análise da constituição do painel o mesmo tem a massa indicada no Quadro 1.

Quadro 1. Massa do painel UnusHouse por unidade de área superficial.

MATERIAL	MASSA POR UNIDADE DE ÁREA DE PAINEL (KG/M^2)
PLACA DE GESSO	10.0
XPS (4 CM)	1.3
LÃ DE ROCHA (4 CM)	3.4
XPS (10 CM)	3.2
PLACA DE GESSO	10.0
PERFIS E PEÇAS DE ALUMÍNIO	5.6
TOTAL	**33.5**

2. Metodologia

O método baseado na avaliação do ciclo de vida (ACV), permite avaliar o desempenho ambiental de um edifício e dos seus materiais, processos e sistemas e pode ser realizada seguindo a norma (EN 15804:2012+A2:2019/AC, 2021; ISO 14040, 2006; NP EN 15978, 2019), que define:

- a descrição do objeto de avaliação;
- a fronteira do sistema aplicável ao nível do edifício;
- o procedimento a utilizar na análise de inventário;
- a lista de indicadores e procedimento para o cálculo destes indicadores;
- os requisitos para a apresentação dos resultados no reporte e comunicação;
- os requisitos para os dados necessário para o cálculo.

A abordagem adotada na norma (NP EN 15978, 2019) abrange todas as etapas do ciclo de vida do edifício (Figura 2, Figura 3 e **Erro! A origem da referência não foi encontrada.**) e é baseada nos dados obtidos nas Declarações Ambientais de Produto (DAP) e nos módulos de informação como definido na norma (EN 15804:2012+A2:2019/AC, 2021) e em (Soust-Verdaguer, Llatas e García-Martínez, 2016).

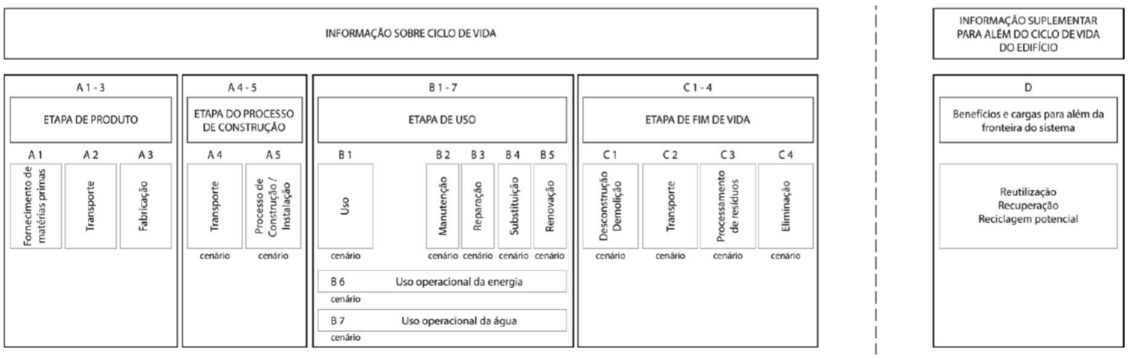


Figura 2. Esquema dos módulos de informação para as diferentes etapas da avaliação do ciclo de vida de edifícios com base na norma EN 15978.

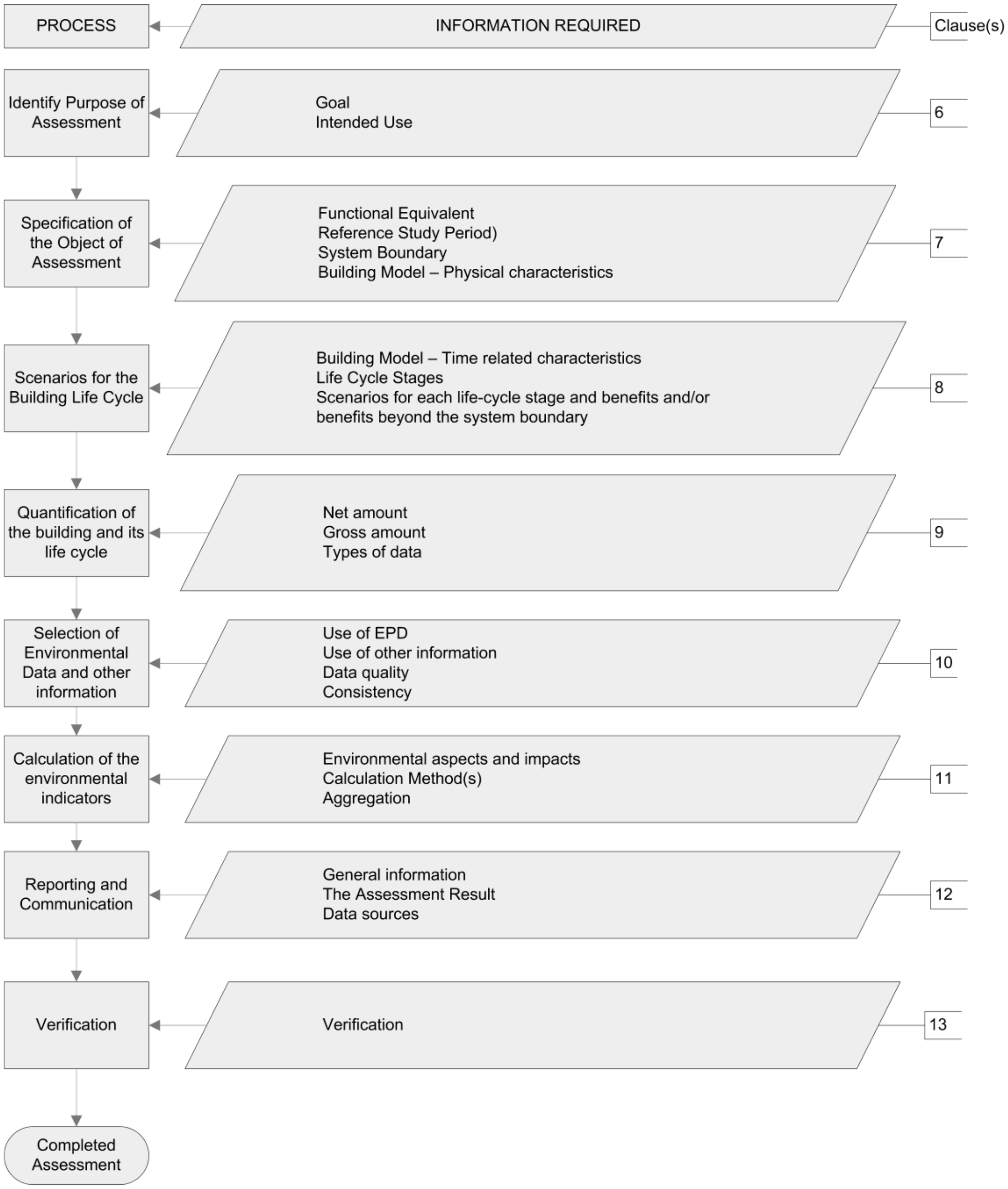


Figura 3. Fluxograma do processo de avaliação do desempenho ambiental do edifício.

A metodologia da avaliação do ciclo de vida (ISO 14040, 2006; Pinto, 2008) é composta por 4 fases (Figura 4):

- Fase 1 - Definição do objetivo e do âmbito da análise (unidade funcional);
- Fase 2 - Inventário dos processos envolvidos, com enumeração das entradas e saídas do sistema (tabela de inventário);

- Fase 3 - Avaliação dos impactes ambientais associados às entradas e saídas do sistema (classificação, caracterização e normalização);
- Fase 4 - Interpretação dos resultados;
- As fases de normalização e ponderação são facultativas.

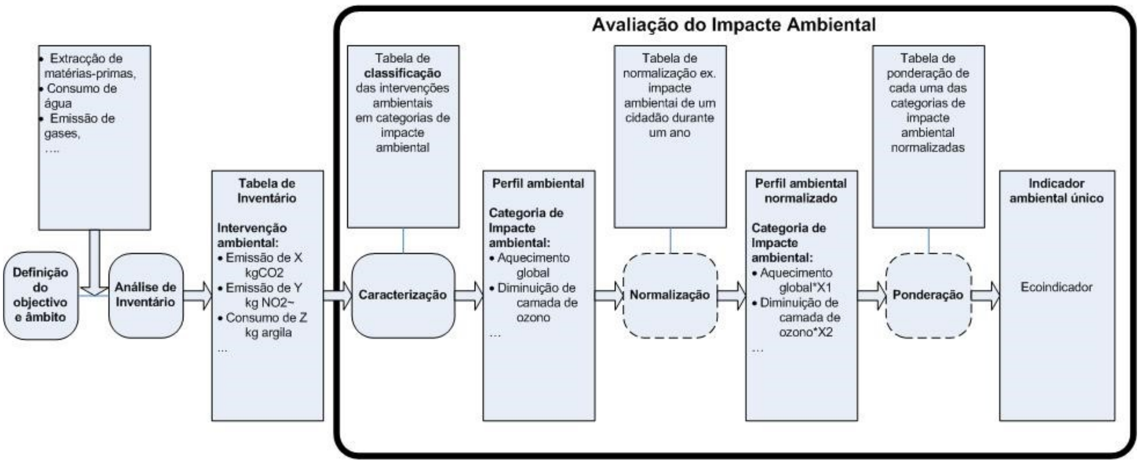


Figura 4. Metodologia de avaliação do ciclo de vida (Pinto, 2008).

Neste estudo, a avaliação tem como objetivo quantificar o desempenho ambiental de um painel da construção base com o sistema UnusHouse, para posterior comparação com o painel CircularBuild, tendo em conta as fases A1-A3 (Figura 2, **Erro! A origem da referência não foi encontrada.**), pois as restantes etapas são semelhantes entre os dois sistemas UnusHouse e CircularBuild. Para este efeito, considera-se como unidade funcional uma unidade de área do painel UnusHouse e um período de estudo de referência e a vida útil requerida de 50 anos.

Os módulos A1 a A3 (etapa de produto) abrangem os processos do berço ao portão da fábrica para os materiais e serviços utilizados na construção (EN 15804:2012+A2:2019/AC, 2021). Na etapa de fim-de-vida considera-se a desconstrução e reutilização dos painéis, que sendo uma etapa semelhante nos dois sistemas (UnusHouse e CircularBuild), não afeta o resultado e não é considerada.

Neste estudo, o critério de exclusão para processos unitários é de 1% da energia total consumida e 1% da massa total dos inputs, com particular atenção para não ultrapassar um total de 5% da energia e fluxos de massa excluídos na etapa do produto.

Os seguintes casos não foram considerados neste estudo, pois podem-se enquadrar nos critérios de exclusão:

- Cargas ambientais associadas à construção da infraestrutura industrial e ao fabrico de máquinas e equipamentos;
- Cargas ambientais relativas à infraestrutura (produção e manutenção de veículos e estradas) para o transporte;
- Emissões de longo prazo.

Todos os fluxos de entradas e saídas conhecidas foram considerados, tendo sido realizadas medições de consumos de energia e de recursos e resíduos.

Para processos sobre os quais os produtores não têm influência ou informações específicas, como a extração de matérias-primas, foram usados dados genéricos das bases de dados do Ecoinvent v3.91. O conjunto de dados utilizados para modelar a produção de eletricidade e gás natural foi adaptado à realidade nacional.

A avaliação do ciclo de vida do produto abrange as etapas do «berço ao portão da fábrica») e os módulos descritos de seguida são considerados:

Os módulos A1-A3 incluem os processos que fornecem energia e inputs de material para o sistema (A1), transporte até ao portão da fábrica (A2) e processos de fabrico, bem como o processamento de resíduos (A3).

As restantes fases abaixo indicadas, sendo idênticas nas duas soluções não são aqui consideradas:

O módulo A4 inclui o transporte do local de produção até à obra.

O módulo A5 considera todas as etapas de instalação (como consumo de energia para movimentação dos painéis e aplicação de matérias de revestimento nas juntas do painel) e processamento de resíduos de embalagens (reciclagem, incineração, deposição). Os créditos da substituição de energia são declarados no módulo D.

O módulo C1 refere-se ao processo de desconstrução do edifício e obtenção dos painéis e de outros materiais.

O módulo C2 considera o transporte dos painéis para um processo de reutilização e de outros resíduos para deposição em aterro.

O módulo C3 considera todos os processos de processamento dos resíduos (recolha, britagem, etc.) de forma adequada para a reciclagem.

O módulo C4 inclui todos os processos de deposição em aterro, incluindo pré-tratamento e gestão do local de deposição.

O módulo D inclui os benefícios ou cargas para o ambiente geradas pela reutilização dos painéis, os materiais recicláveis e/ou transportadores de energia que saem de um sistema de produto.

Na avaliação do ciclo de vida são consideradas as categorias de impacte ambiental e indicadores listados no ***Quadro 2***.

Quadro 2. Indicadores ambientais (EN 15804:2012+A2:2019/AC, 2021).

Indicadores ambientais	Indicadores de utilização de recursos	Indicadores de resíduos e fluxos de saída
Aquecimento global [kg CO_2 eq.]	Utilização de energia primária renovável (PERE) [MJ]	Resíduos perigosos eliminados (HWD) [kg]
Aquecimento global (fóssil) [kg CO_2 eq.]	Utilização dos recursos de energia primária renováveis utilizados como matérias-primas (PERM) [MJ]	Resíduos não perigosos eliminados (NHWD) [kg]
Aquecimento global (biogénico) [kg CO_2 eq.]	Utilização total dos recursos de energia primária renováveis (PERT) [MJ]	Resíduos radioativos eliminados (RWD) [kg]
Aquecimento global (uso do solo) [kg CO_2 eq.]	Utilização de energia primária não renovável (PENRE) [MJ]	Componentes para reutilização (CRU) [kg]
Depleção da camada de ozono [kg CFC 11 eq.]	Utilização dos recursos de energia primária não renováveis utilizados como matérias-primas (PENRM) [MJ]	Materiais para reciclagem (MFR) [kg]
Acidificação do solo e da água [mol H+ eq.]	Utilização total dos recursos de energia primária não renováveis (PENRT) [MJ]	Materiais para recuperação de energia (MER) [kg]
Eutrofização da água doce [kg P eq.]	Utilização de material secundário (SM) [kg]	Energia elétrica exportada (EEE) [MJ]
Eutrofização da água doce [kg (PO_4) eq.]	Utilização de combustíveis secundários renováveis (RSF) [MJ]	Energia térmica exportada (EET) [MJ]
Eutrofização marinha [kg N eq.]	Utilização de combustíveis secundários não renováveis (NRSF) [MJ]	
Eutrofização terrestre [mol N eq.]	Utilização do valor líquido de água doce (FW) [m^3]	
Formação de ozono fotoquímico - saúde humana [kg NMVOC eq.]		
Depleção de recursos, minerais e metais [kg Sb eq.]		
Depleção de recursos, fósseis [MJ]		
Consumo de água, privação [m^3 world eq.]		

3. Resultados da ACV

3.1. Inventário

No fabrico do sistema CircularBuild são utilizados os materiais e quantidades por unidade de área identificados no Capítulo 1 (***Quadro 1***). Os materiais possuem Declaração de desempenho Ambiental, como se apresenta nos Anexos.

No âmbito do projeto CircularBuild foi realizada uma auditoria à fábrica e foram identificados os consumos de eletricidade e de resíduos do processo de fabrico (ver anexo). No ***Quadro 3*** apresenta-se um resumo dos dados do inventário.

Quadro 3. Inventário painel UnusHouse – valores por unidade de área (etapas A1-A3).

FLUXO	MATERIAL	VALOR
CONSUMO	Placa gesso cartonado	20.0 kg/m^2
CONSUMO	XPS	4.5 kg/m^2
CONSUMO	Lã	3.4 kg/m^2
CONSUMO	Perfil de alumínio	5.6 kg/m^2
CONSUMO	Cola	0.6 kg/m^2
CONSUMO	Consumo de eletricidade	4.14 kWh/m^2
CONSUMO	Polietileno	24 g/m^2
CONSUMO	Palete de madeira	81 g/m^2
RESÍDUO	Limalhas de alumínio	30 g/m^2
RESÍDUO	Restos do corte do XPS	1.5 kg/m^2
RESÍDUO	Polietileno	24 g/m^2
RESÍDUO	Palete de madeira	81 g/m^2

Cenários considerados (***Figura 2***):

- Considera-se que os vários materiais são transportados para a fábrica desde uma distância de 100 km, num veículo pesado de 26 toneladas (cerca de 90 m^3), EURO 4, com uma capacidade utilizada de 85%.

- Considera-se que os vários materiais são transportados para a obra desde uma distância de 200 km, num veículo pesado de 26 toneladas (cerca de 90 m^3), EURO 4, com uma capacidade utilizada de 85%.
- Nas etapas de uso (B1-B7), considera-se que as dua soluções têm um desempenho equivalente e não serão aqui considerados.
- Nas etapas de fim-de-vida, considera-se em ambos os casos a possibilidade de desmontagem dos painéis (C1), transporte para nova obra de 100 km (C2) e o benefício da reutilização (D) que substitui a utilização de novos paneis.

4. Conclusões

No âmbito do projeto CircularBuild foram realizados os ensaios laboratoriais previstos no âmbito do estudo e que permitem caracterizar o desempenho da solução construtiva pré-fabricada modular. Este documento apresenta as classificações e características de desempenho do sistema CircularBuild obtidas com base em ensaios em laboratório.

5. Bibliografia

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6. Anexo

6.1. Auditoria à fábrica

Na visita à unidade industrial UnusHome, pretendeu-se conhecer os processos de fabrico das placas, que incluem os seguintes pontos:

- Corte dos perfis;
- Cravamento;
- Fresagem;
- Maquinação das placas;
- Colagem.

Para se averiguar o consumo energético associado a estes processos foram realizadas medições no quadro elétrico da fábrica. No corte dos perfis, na maquinação das placas e na colagem tentou-se quantificar as perdas.

De seguida, descrevem-se os ensaios realizados em cada um destes processos e na secção seguinte apresentam-se os consumos energéticos associados a estes processos.

6.2. Avaliação de resíduos

6.2.1. Corte dos Perfis

Os perfis de alumínio “L”, ”I” e ”T” bem como o corte da madeira são realizados pela maquina da

Figura 5, que possui dois discos, podendo cortar simultaneamente os dois extremos do perfil. Primeiramente, é necessário realizar a afinação das medidas para depois se iniciar o corte com 2 discos. Para esta afinação, são utilizados desperdícios de perfis anteriormente cortados.

Figura 5. Máquina de corte.

Para quantificar a perda de massa no processo de corte, pesaram-se os perfis antes e depois de serem cortados:

Quadro 4. Inventário painel UnusHouse – Perdas.

Perfil	Inicio do corte	Peso (g)		
		Antes do corte	Depois do corte	Perda
Alumínio “L”	9:51	779	772	7
Alumínio “I”	10:00	1025	1018	7
Alumínio “T”	10:06	2925	2916	9
Madeira	10:11	1223	1188	35

6.2.2. Cravamento

A cravação é realizada com um sistema hidráulico/pneumático, motores elétricos para criar pressão. A máquina permite realizar a cravação de 2 cantos em simultâneo e normalmente são precisos dois trabalhadores nesta operação dada as dimensões dos perfis.

Às 11:38 iniciou-se o ensaio de cravação dos perfis. Não existem perdas envolvidas neste processo.

Figura 6. Máquina de cravamento.

6.2.3. Fresagem

A fresadora é a máquina que permite fazer os cortes no alumínio conforme se apresenta na Figura 7. Primeiramente, é necessário realizar a afinação dos eixos da máquina para depois se iniciar o corte. Para esta afinação, são utilizados desperdícios.

Figura 7. Fresadora.

O ensaio começou ao 12:20, mas foi invalidado devido a problemas com a medição dos consumos elétricos. Assim, o ensaio válido começou ao 12:37. A perda associada a estes cortes foi realizada pesando-se os perfis antes e depois de serem cortados. Inicialmente o perfil pesava 129 g e no fim dos cortes 103 g, existindo uma perda de massa de 26 g.

6.2.4. Maquinação das Placas

Na maquinação das placas existem dois consumos energéticos associados: CNC e extração de partículas. O corte do XPS é realizado na CNC e os restos são aspirados, sendo recolhidos por uma empresa. Neste ensaio, foram maquinadas duas placas (placa_1 e placa_2) sendo que uma delas frente e verso (placa_2 encaixe e placa_2 infraestruturas), perfazendo três cortes no total. Foi ainda maquinado uma placa de XPS com 5 cm de espessura e com DWD colado. Este ensaio foi nomeado como "experiência exploratória" uma vez que não reunia as condições para ser uma placa "final", pois faltava colar a cortiça.

Figura 8. Máquina CNC. **Figura 9.** Máquina de extração de partículas.

A primeira placa (placa_1) pesava 10.400 g e tinha 10 cm de espessura. O corte desta teve início às 15:36. A segunda placa XPS tinha as mesmas características que a primeira (10.400 g e 10 cm de espessura). Inicia-se o corte da segunda placa no lado com encaixe (placa_2 encaixe) às 15:53. No fim deste corte, vira-se esta mesma placa e inicia-se o corte no lado das infraestruturas (placa_2 infraestruturas) às 16:19. O peso final da placa_2 é 6,55 kg. Note-se que quando a placa é virada, a mesa é aspirada para retirar restos provenientes do corte. Estes restos não foram quantificados.

Todos os painéis de parede levam um quadro de alumínio para assegurar a esquadria do aro do painel e permitir a sua montagem.

6.2.5. Colagem

O processo de colagem consiste na colagem de DWD à placa_2 no lado das infraestruturas. De seguida existe uma placa com 5cm de XPS que já vem colada com DWD e cortiça que vai ser colada à placa_2.

Por forma a quantificar-se a cola utilizada para a colagem da placa com dimensões de 3mx1m, pesou-se o recipiente onde a cola se encontra armazenada antes e depois de ser utilizada. Inicialmente o recipiente pesava 12,70 kg e no final 11,15 kg, sendo gastos 1,55 kg de cola em cada colagem de placas com dimensões de 3mx1m. Salienta-se que existia cola seca no recipiente quando esta foi colocada na placa. Assim, após a pesagem destes “grumos” verificou-se que seriam cerca de 8 g (podendo ter sido mais).

Figura 10. Cola.

Figura 11. Cola na placa antes e depois de espalhada com a espátula de ranhuras.

6.3. Consumos elétricos dos ensaios

Nesta secção apresentam-se todos os consumos energéticos associados aos diferentes processos de fabrico. Importa salientar que também se consideraram os consumos provenientes do compressor.

Os consumos elétricos englobam os 10s antes e depois de existir o pico de consumo. Para os diferentes processos de fabrico, as horas de início e fim foram:

Quadro 5. Inventário painel UnusHouse – Tempos.

		Hora início	Hora fim
Corte	Dois cortes perfil "L"	09:51:29	09:57:29
	Dois cortes perfil "I"	09:59:57	10:03:58
	Dois cortes perfil "T"	10:06:26	10:08:53
	Dois cortes "Madeira"	10:11:27	10:13:44
Cravamento		11:38:17	11:41:49
Fresagem		12:37:56	12:53:31
Maquinação das placas (CNC)	placa_1	15:36:24	15:48:36
	placa_2 (encaixe)	15:53:09	16:09:49
	placa_2 (infra)	16:19:36	16:35:54
	Experiência exploratória	16:59:00	17:22:00
Maquinação das placas (Extração de partículas)	placa_1	15:36:30	15:48:28
	placa_2 (encaixe)	15:53:15	16:09:44
	placa_2 (infra)	16:19:42	16:35:46
	Experiência exploratória	16:59:06	17:21:52

O consumo do compressor durante os diferentes ensaios, apresenta-se no gráfico da seguinte forma:

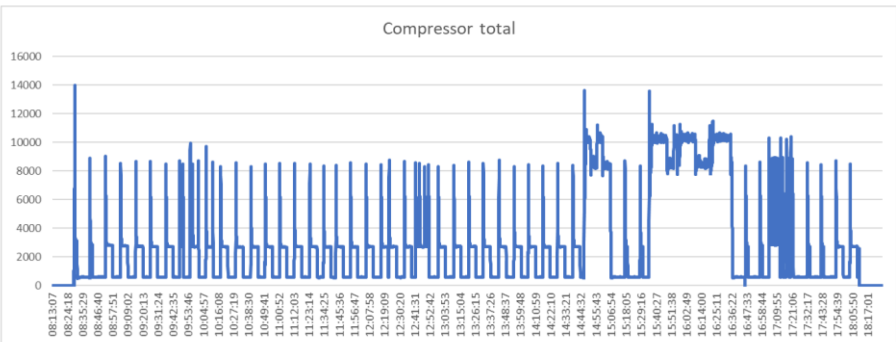


Figura 122. Compressor – Consumo.

6.3.1. Corte dos Perfis

Os consumos elétricos da máquina de corte associados aos perfis de alumínio “L”,”I” e ”T” bem como o corte da madeira são:

Quadro 6. Inventário painel UnusHouse – Máquina de Corte - Consumo Wh.

	Wh
Dois cortes perfil "L"	109,71
Dois cortes perfil "I"	76,83
Dois cortes perfil "T"	43,37
Dois cortes "Madeira"	55,10

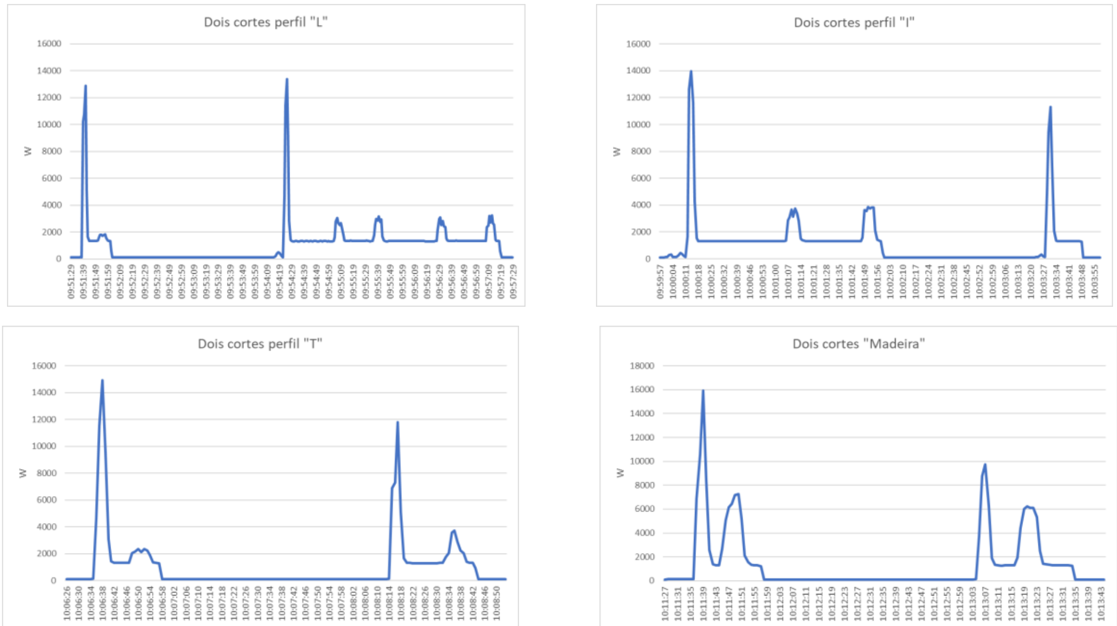


Figura 133. Máquina de Corte – Consumo.

Relativamente ao consumo do compressor, no mesmo espaço temporal:

Quadro 7. Inventário painel UnusHouse – Compressor - Consumo Wh.

	Wh
Dois cortes perfil "L"	200,12
Dois cortes perfil "I"	122,88
Dois cortes perfil "T"	124,55
Dois cortes "Madeira"	75,47

6.3.2. Cravamento

O consumo elétrico associado ao cravamento é de 57,87 Wh. Relativamente ao consumo do compressor no mesmo tempo é de 76,28 Wh. A representação gráfica deste consumo apresenta-se seguidamente:

Figura 144. Máquina de Cravamento – Consumo.

6.3.3. Fresagem

Não foi possível concluir com certezas os consumos elétricos associados à fresagem porque no quadro elétrico existiam shunts. Contudo, obteve-se o seguinte gráfico:

Figura 155. Máquina de Fresar – Consumo.

6.3.4. Maquinação das placas

Como referido anteriormente, na maquinação das placas existem dois consumos energéticos associados: CNC e extração de partículas.

Para se averiguar o consumo dos compressores associado à maquinação das placas, considerou-se a hora de início e fim mais alargada, isto é, a da máquina CNC. Assim, o consumo associado ao compressor é:

Quadro 8. Inventário painel UnusHouse – Compressor – Consumo Wh.

	Wh
Corte placa_1	2066,0
Corte placa_2 (encaixe)	2787,3
Corte placa_2 (infra)	2742,9
Experiência exploratória	1421,7

Nos pontos abaixo mediram-se estes consumos para a placa_1, para a placa_2 lado do encaixe e para a placa_2 lado das infraestruturas.

6.3.5. CNC

No quadro e figuras abaixo apresentam-se os consumos energéticos referentes à máquina CNC:

Quadro 9. Inventário painel UnusHouse – CNC – Consumo Wh.

	Wh
Corte placa_1	1580,09
Corte placa_2 (encaixe)	2164,67
Corte placa_2 (infra)	2108,09
Experiência exploratória	2899,90

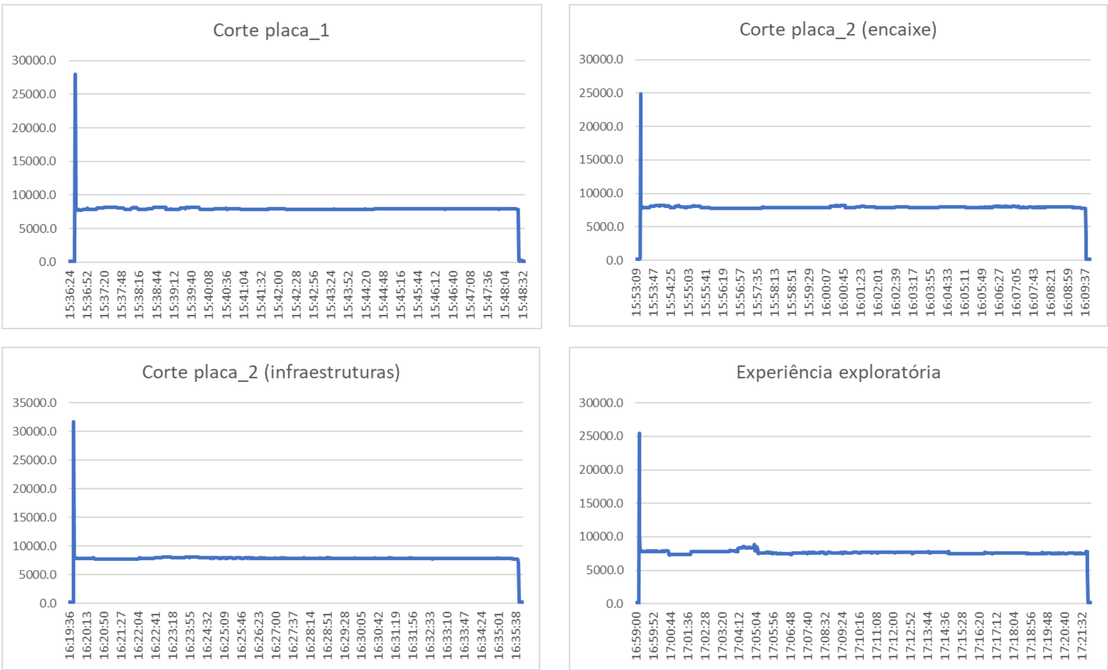


Figura 166. CNC – Gráficos de consumo.

6.3.6. Extração de Partículas

No quadro e figuras abaixo apresentam-se os consumos energéticos referentes à extração de partículas:

Quadro 10. Inventário painel UnusHouse – Aspiração – Consumo Wh.

	Wh
Corte placa_1	436,00
Corte placa_2 (encaixe)	597,02
Corte placa_2 (infra)	579,50
Experiência exploratória	799,55

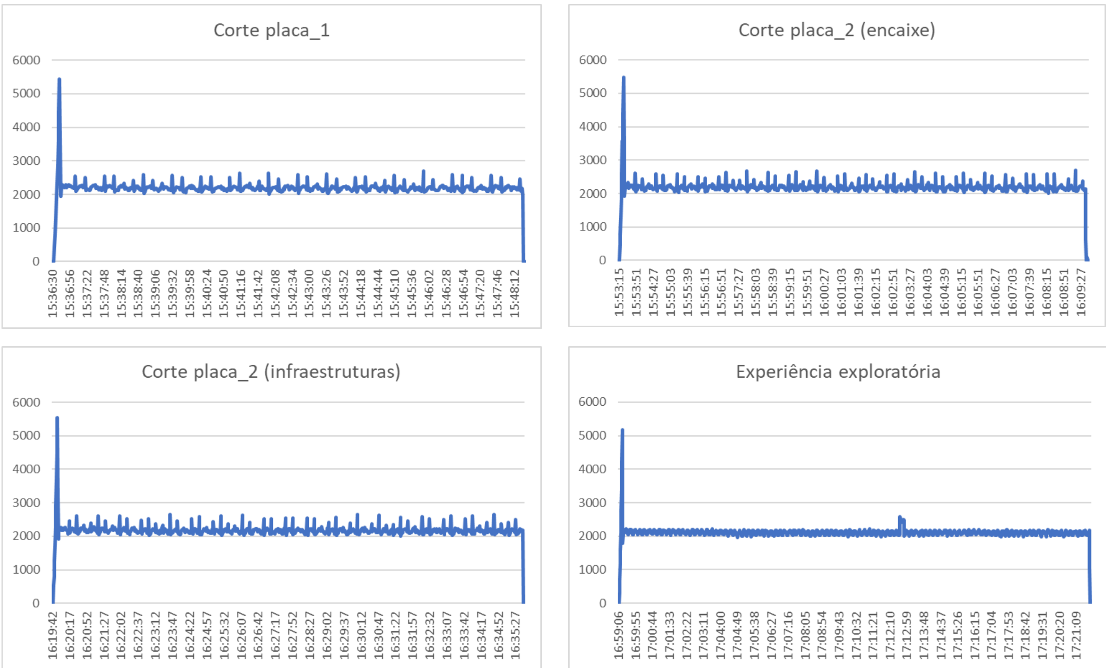


Figura 176. Aspiração – Gráficos de consumo.

6.3.7. Colagem

Não existem consumos elétricos associados a este processo.

7. Conclusões

Com base nas medições realizadas na produção de um painel de XX m^2, são estimados os seguintes consumos de eletricidade e de geração de resíduos:

- Limalhas de alumínio: 30 g/m^2

- Restos do corte do XPS: 1,5 kg/m^2

- Consumo de eletricidade: 4.14 kWh/m^2

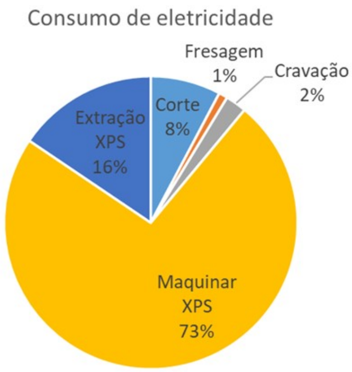
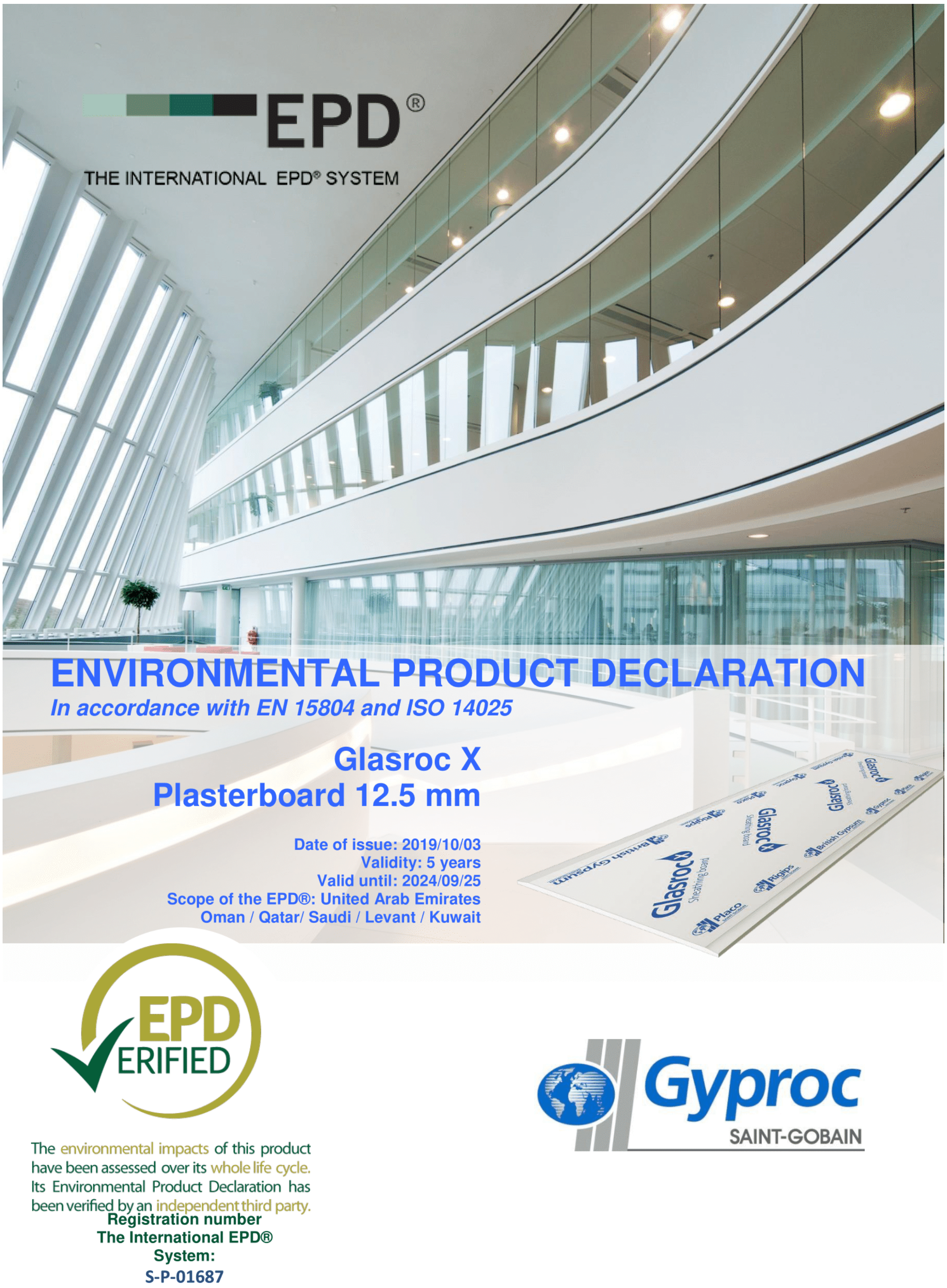


Figura 187. Aspiração – Gráficos de consumo.

Figura 198. Aspiração – Gráficos de consumo.

Placa de Gesso Cartonado



General information

Manufacturer: Saint-Gobain Gyproc

Programme used: International EPD System http://www.environdec.com/

EPD registration number/declaration number: S-P-01687

PCR identification: EN 15804 as the core PCR + The International EPD® System PCR 2012:01 version 2.2 for Construction Products and construction services with reference to the Saint Gobain Environmental Product Declaration Methodological Guide for Construction Products

Site of manufacture: Gyproc Abu Dhabi

Product / product family name and manufacturer represented: Glasroc X plasterboard – Gyproc Abu Dhabi

European Standard: EN 520:2004+A1:2009 Gypsum Plasterboards, definitions, Requirements and test methods Type D, F,I,R

American Standard: ASTM C1396-14a Standard Specification for Gypsum Board Section 5: Gypsum wallboard

Declaration issued: 2019-10-03

Valid until: 2024-09-25

Demonstration of verification: an independent verification of the declaration was made, according to ISO 14025:2010. This verification was external and conducted by the following third party: Dr Andrew NORTON, Renuables based on the PCR mentioned above.

EPD Prepared by: Central Team, Saint Gobain Gypsum. Contact: Yves.coquelet@saint-gobain.com

The declared unit is 1 m2 of plasterboard with a weight of 11,5 kg /m² and a density of 920 kg/m3

Declaration of Hazardous substances: (Candidate list of Substances of Very High Concern): none

Geographical scope: The EPD covers United Arab Emirates/ Oman / Qatar/ Saudi / Levant / Kuwait

CEN standard EN 15804 serves as the core PCR[a]	
PCR:	PCR 2012:01 Construction products and Construction services, Version 2.2
PCR review was conducted by:	The Technical Committee of the International EPD® System. Chair:
Independent verification of the declaration, according to EN ISO 14025:2010 **Internal** ☐ **External** ☒	
Third party verifier:	**Andrew Norton , Renuables** http://renuables.co.uk
Accredited or approved by	The International EPD System

1

Product description

Product description and use: Glasroc X plasterboard consists of gypsum encased in paper liners.

Designed for use in the residential sector, Glasroc X plasterboard.

Description of the main product components and or materials:
Plasterboard is made up of a gypsum core (calcium sulphate dihydrate) with additive and a paper liner.

Technical data/physical characteristics:

REACTION TO FIRE	Euroclass A2-S1, d0 (EN520:2004)
THERMAL CONDUCTIVITY	0,19 W/ (m.K)

Description of the main components and/or materials for 1 m2 of product for the calculation of the EPD®:

PARAMETER	VALUE
Quantity of plaster for 1 m^2 of product	11,50 Kg
Thickness	12.5 mm
Density	920 kg/m³
Surfacing	Paper 720 g/m²
Packaging for the transportation and distribution	Gypsum culls : 0.311 kg/m²
Product used for the Installation	Paper tape, jointing compound, screws

During the life cycle of the product any hazardous substance listed in the "Candidate List of Substances of Very High Concern (SVHC) for authorization" has not been used in a percentage higher than 0,1% of the weight of the product.

The verifier and the program operator do not make any claim nor have any responsibility of the legality of the product.

LCA calculation information

EPD TYPE DECLARED	Cradle to gate with options
DECLARED UNIT	1 m² of installed board.
SYSTEM BOUNDARIES	Cradle to gate with options: stages A1 – 3, A4, A5, B1 – 7, C1 – 4
REFERENCE SERVICE LIFE (RSL)	50 years by default, it corresponds to standard building design life
CUT-OFF RULES	Life Cycle Inventory data for a minimum of 99% of total inflows to the upstream and core module shall be included
ALLOCATIONS	Production data. Recycling, energy and waste data have been calculated on a mass basis.
GEOGRAPHICAL COVERAGE AND TIME PERIOD	Scope includes: Data included is collected from one production site, Gyproc Abu Dhabi. Data collected for the year 2018 Cradle to gate with options study. Background data: Ecoinvent (2015) and Gabi (2013 - 2016)
PRODUCT CPC CODE	37530 (Articles of plaster or of compositions based on plaster)

According to EN 15804, EPDs of construction products may not be comparable if they do not comply with this standard. According to ISO 21930, EPDs might not be comparable if they are from different programmes.

3

Life cycle stages

Flow diagram of the Life Cycle

Product stage, A1-A3

Description of the stage: the product stage of plasterboard products is subdivided into 3 modules A1, A2 and A3 respectively "Raw material supply", "transport to manufacturer" and "manufacturing".

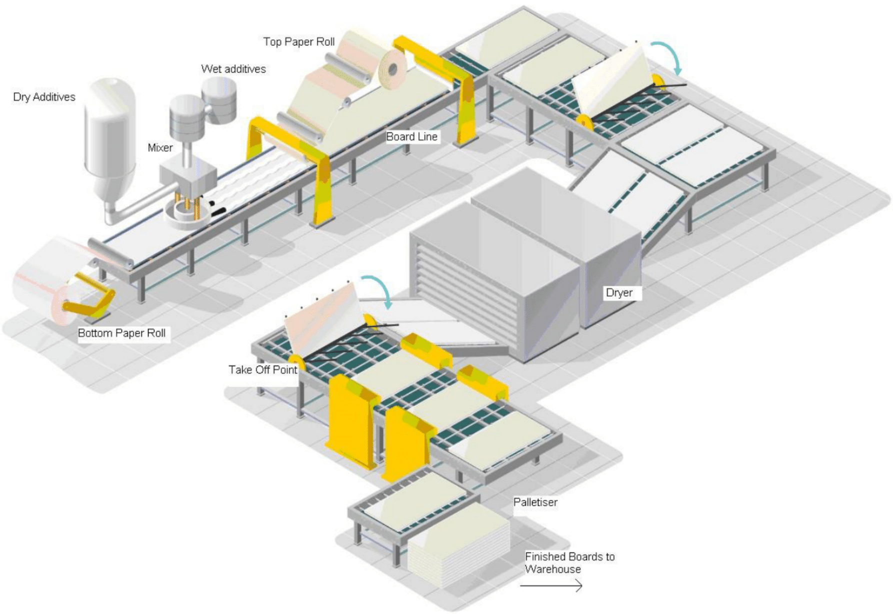
A1, raw material supply
This includes the extraction and processing of all raw materials and energy which occur upstream from the manufacturing process.

A2, transport to the manufacturer
The raw materials are transported to the manufacturing site. The modelling includes road, boat and/or train transportations of each raw material.

A3, manufacturing
This module includes the manufacture of products and the manufacture of packaging. The production of packaging material is taken into account at this stage. The processing of any waste arising from this stage is also included.

4

Manufacturing process flow diagram



Manufacturing in detail:
The initial materials are homogenously mixed to form a gypsum slurry that is spread via multiple hose outlets onto a paper liner on a moving conveyor belt. A second paper liner is fed onto the production line from above to form the plasterboard. The plasterboard continues along the production line where it is finished, dried, and cut to size.

Recycled Gypsum waste is reintegrated back into the manufacturing process wherever possible.

Construction process stage, A4-A5

Description of the stage: the construction process is divided into 2 modules: A4, transport to the building site and A5, installation in the building

A4, Transport to the building site: this module includes transport from the production gate to the building site. Transport is calculated on the basis of a scenario with the parameters described in the following table.

PARAMETER	VALUE (expressed per functional/declared unit)
Fuel type and consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat, etc.	0.38 liters per km
Distance	218 (km)
Capacity utilisation (including empty returns)	58.7 %
Bulk density of transported products	920 kg/m³
Volume capacity utilisation factor	1

5

A5, installation into the building The accompanying table quantifies the parameters for installing the product at the building site. All installation materials and their waste processing are included.

PARAMETER	VALUE (expressed per functional/declared unit)
Ancillary materials for installation (specified by materials)	Jointing compound 0.33kg/m2 board, tape 1.23m /m2 board, screws 8 /m2 board
Water use	0.165 liters/m2 board
Other resource use	none
Quantitative description of energy type (regional mix) and consumption during the installation process	None
Wastage of materials on the building site before waste processing, generated by the product's installation (specified by type)	Board: 0.575 kg Screws: 0 kg Jointing Compound: 0.017 kg Jointing Tape: 0.00021 kg
Output materials (specified by type) as results of waste processing at the building site e.g. of collection for recycling, for energy recovering, disposal (specified by route)	Board: 0.575 kg to landfill 95% to recycling 5% Screws: 0 kg Jointing Compound: 0.017 kg to landfill 95% to recycling 5% Jointing Tape: 0.00021 kg to landfill 95% to recycling 5%
Direct emissions to ambient air, soil and water	None

Use stage (excluding potential savings), B1-B7

Description of the stage**:**
The use stage, related to the building fabric includes:
B1, use or application of the installed product;
B2, maintenance;
B3, repair;
B4, replacement;
B5, refurbishment,
B6, Operational energy use
B7, Operational water use

Description of scenarios and additional technical information:
The product has a reference service life of 50 years. This assumes that the product will last in situ with no requirements for maintenance, repair, replacement or refurbishment throughout this period. Therefore, it has no impact at this stage.

Maintenance:

PARAMETER	VALUE (expressed per functional/declared unit)
Maintenance process	None required during plasterboard lifetime
Maintenance cycle	None required during plasterboard lifetime
Ancillary materials for maintenance (e.g. cleaning agent, specify materials)	None required during plasterboard lifetime
Wastage material during maintenance (specify materials)	None required during plasterboard lifetime
Net fresh water consumption during maintenance	None required during plasterboard lifetime
Energy input during maintenance (e.g. vacuum cleaning), energy carrier type, (e.g. electricity) and amount, if applicable and relevant	None required during plasterboard lifetime

6

Repair:

PARAMETER	VALUE (expressed per functional/declared unit)
Repair process	None required during plasterboard lifetime
Inspection process	None required during plasterboard lifetime
Repair cycle	None required during plasterboard lifetime
Ancillary materials (e.g. lubricant, specify materials)	None required during plasterboard lifetime
Wastage material during repair (specify materials)	None required during plasterboard lifetime
Net fresh water consumption during repair	None required during plasterboard lifetime
Energy input during repair (e.g. crane activity), energy carrier type, (e.g. electricity) and amount if applicable and relevant	None required during plasterboard lifetime

Replacement:

PARAMETER	VALUE (expressed per functional/declared unit)
Replacement cycle	None required during plasterboard lifetime
Energy input during replacement (e.g. crane activity), energy carrier type, (e.g. electricity) and amount if applicable and relevant	None required during plasterboard lifetime
Exchange of worn parts during the product's life cycle (e.g. zinc galvanized steel sheet), specify materials	None required during plasterboard lifetime

Refurbishment:

PARAMETER	VALUE (expressed per functional/declared unit)
Refurbishment process	None required during plasterboard lifetime
Refurbishment cycle	None required during plasterboard lifetime
Material input for refurbishment (e.g. bricks), including ancillary materials for the refurbishment process (e.g. lubricant, specify materials)	None required during plasterboard lifetime
Wastage material during refurbishment (specify materials)	None required during plasterboard lifetime
Energy input during refurbishment (e.g. crane activity), energy carrier type, (e.g. electricity) and amount	None required during plasterboard lifetime
Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants)	None required during plasterboard lifetime

7

Use of energy and water:

PARAMETER	VALUE (expressed per functional/declared unit)
Ancillary materials specified by material	None required during plasterboard lifetime
Net fresh water consumption	None required during plasterboard lifetime
Type of energy carrier (e.g. electricity, natural gas, district heating)	None required during plasterboard lifetime
Power output of equipment	None required during plasterboard lifetime
Characteristic performance (e.g. energy efficiency, emissions, variation of performance with capacity utilisation etc.)	None required during plasterboard lifetime
Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants)	None required during plasterboard lifetime

End-of-life stage C1-C4

Description of the stage: The end-of-life stage includes:
C1, de-construction, demolition;
C2, transport to waste processing;
C3, waste processing for reuse, recovery and/or recycling: the entire product is assumed here to be sent to landfill
C4, disposal, including provision and all transport, provision of all materials, products and related energy and water use.

End-of-life:

PARAMETER	VALUE (expressed per functional/declared unit) / DESCRIPTION
Collection process specified by type	12.0 kg collected with mixed construction waste
Recovery system specified by type	0.60 kg for recycling
Disposal specified by type	11.45 kg to municipal landfill
Assumptions for scenario development (e.g. transportation)	On average, Gypsum waste is transported 25 km by road from construction / demolition sites to end of life treatment or disposal.

Reuse/recovery/recycling potential, D

Description of the stage:
Module D has not been taken into account

8

LCA results

Description of the system boundary (X = Included in LCA, MNA = Module Not Assessed)

CML 2001 has been used as the impact model. Specific data has been supplied by the plant, and generic data come from the GABI and Ecoinvent databases.
All emissions to air, water, and soil, and all materials and energy used have been included.

All figures refer to a declared unit of 1m² of plasterboard with a weight of 10 kg/m²

PRODUCT STAGE			CONSTRUCTION STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport	Construction-Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MNA

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ENVIRONMENTAL IMPACTS

Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Global Warming Potential (GWP 100) - *kg CO_2 equiv/FU*	3,64E+00	1,15E-01	2,34E-01	0	0	0	0	0	0	0	5,27E-02	1,37E-02	5,51E-03	1,78E-01	MNA
	The global warming potential of a gas refers to the total contribution to global warming resulting from the emission of one unit of that gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of 1.														
Ozone Depletion (ODP) *kg CFC 11 equiv/FU*	3,16E-07	1,76E-17	1,58E-08	0	0	0	0	0	0	0	7,18E-18	3,17E-12	1,11E-09	9,96E-16	MNA
	Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbons or halons), which break down when they reach the stratosphere and then catalytically destroy ozone molecules.														
Acidification potential (AP) *kg SO_2 equiv/FU*	1,14E-02	4,59E-04	7,41E-04	0	0	0	0	0	0	0	1,85E-04	5,57E-05	1,89E-05	1,02E-03	MNA
	Acid depositions have negative impacts on natural ecosystems and the man-made environment incl, buildings. The main sources for emissions of acidifying substances are agriculture and fossil fuel combustion used for electricity production, heating and transport.														
Eutrophication potential (EP) *kg $(PO_4)^{3-}$ equiv/FU*	2,07E-03	1,12E-04	1,25E-04	0	0	0	0	0	0	0	1,08E-05	1,41E-05	2,53E-06	1,15E-04	MNA
	Excessive enrichment of waters and continental surfaces with nutrients, and the associated adverse biological effects.														
Photochemical ozone creation (POPC) *kg Ethylene equiv/FU*	1,40E-03	1,68E-05	8,81E-05	0	0	0	0	0	0	0	1,24E-05	2,29E-06	2,62E-06	8,38E-05	MNA
	Chemical reactions brought about by the light energy of the sun. The reaction of nitrogen oxides with hydrocarbons in the presence of sunlight to form ozone is an example of a photochemical reaction.														
Abiotic depletion potential for non-fossil ressources (ADP-elements) - *kg Sb equiv/FU*	6,31E-06	1,53E-09	2,21E-06	0	0	0	0	0	0	0	1,31E-09	1,19E-09	1,34E-09	6,07E-08	MNA
Abiotic depletion potential for fossil ressources (ADP-fossil fuels) - *MJ/FU*	5,96E+01	1,60E+00	3,54E+00	0	0	0	0	0	0	0	6,57E-01	1,85E-01	9,72E-02	2,38E+00	MNA
	Consumption of non-renewable resources, thereby lowering their availability for future generations.														

RESOURCE USE

Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials *MJ/FU*	3,61E+01	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Use of renewable primary energy used as raw materials *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) *MJ/FU*	3,61E+01	3,67E-02	2,03E+00	0	0	0	0	0	0	0	2,13E-03	1,10E-02	7,34E-04	3,12E-01	MNA
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials - *MJ/FU*	6,16E+01	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Use of non-renewable primary energy used as raw materials *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) - *MJ/FU*	6,16E+01	1,60E+00	3,68E+00	0	0	0	0	0	0	0	6,59E-01	1,86E-01	9,83E-02	2,46E+00	MNA
Use of secondary material *kg/FU*	2,55E-01	0	1,43E-02	0	0	0	0	0	0	0	0	0	0	0	MNA
Use of renewable secondary fuels- *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Use of non-renewable secondary fuels - *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Use of net fresh water - *m^3/FU*	1,57E-02	1,22E-05	1,08E-03	0	0	0	0	0	0	0	3,93E-06	1,86E-05	1,07E-05	6,19E-04	MNA

WASTE CATEGORIES															
Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Hazardous waste disposed *kg/FU*	1,99E-05	5,75E-09	1,00E-06	0	0	0	0	0	0	0	8,11E-11	1,03E-08	2,39E-12	4,19E-08	MNA
Non-hazardous (excluding inert) waste disposed *kg/FU*	4,90E-02	1,95E-05	9,15E-01	0	0	0	0	0	0	0	9,69E-05	1,56E-05	8,49E-07	1,14E+01	MNA
Radioactive waste disposed *kg/FU*	3,86E-04	1,87E-06	3,37E-05	0	0	0	0	0	0	0	8,12E-07	3,80E-07	1,14E-08	3,26E-05	MNA

OUTPUT FLOWS															
Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Components for re-use *kg/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Materials for recycling *kg/FU*	1,86E-02	0	9,32E-04	0	0	0	0	0	0	0	0	0	6,00E-01	0	MNA
Materials for energy recovery *kg/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA
Exported energy, detailed by energy carrier *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MNA

LCA results interpretation

The following figure refers to a declared unit of 1m² of plasterboard with a weight of 11,50 kg/m²

[1] This indicator corresponds to the abiotic depletion potential of fossil resources.
[2] This indicator corresponds to the total use of primary energy.
[3] This indicator corresponds to the use of net fresh water.
[4] This indicator corresponds to the sum of hazardous, non-hazardous and radioactive waste disposed.

Global Warming Potential (Climate Change) (GWP)
When analyzing the above figure for GWP, it can clearly be seen that the majority of contribution to this environmental impact is from the production modules (A1 – A3). This is primarily because the sources of greenhouse gas emissions are predominant in this part of the life cycle. CO2 is generated upstream from the production of electricity and is also released on site by the combustion of natural gas. We can see that other sections of the life cycle also contribute to the GWP; however, the production modules contribute to over 80% of the contribution. Combustion of fuel in transport vehicles will generate the second highest percentage of greenhouse gas emissions.

Non-renewable resources consumptions
We can see that the consumption of non – renewable resources is once more found to have the highest value in the production modules. This is because a large quantity of natural gas is consumed within the factory, and non – renewable fuels such as natural gas and coal are used to generate the large amount of electricity we use. The contribution to this impact from the other modules is very small and primarily due to the non – renewable resources consumed during transportation.

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Energy Consumptions
As we can see, modules A1 – A3 have the highest contribution to total energy consumption. Energy in the form of electricity and natural gas is consumed in a vast quantity during the manufacture of glass wool so we would expect the production modules to contribute the most to this impact category.

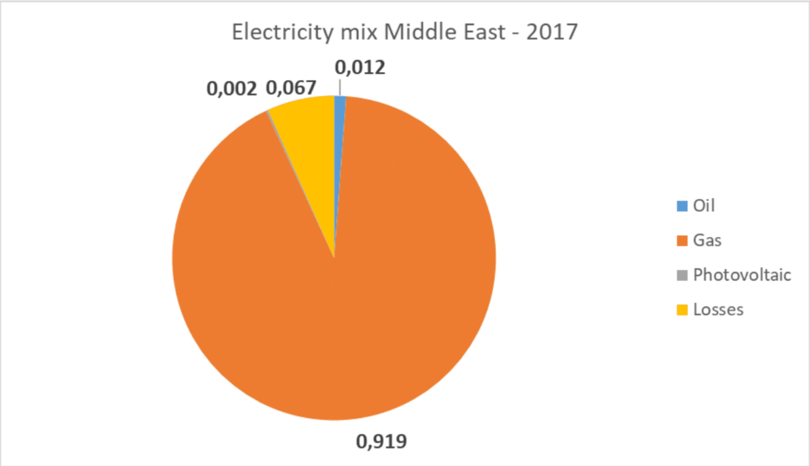
Water Consumption
We can see that water consumption is mainly during the production phase. For the production phase, water is used within the manufacturing facility and therefore we see the highest contribution here. However, we recycle a lot of the water on site so the contribution is still relatively low.

Waste Production
Waste production does not follow the same trend as the above environmental impacts. The largest contributor is the end of life module. This is because the entire product is sent to landfill and recycling treatment once it reaches the end of life state. However, there is a still an impact associated with the production module since we do generate waste on site. The very small impact associated with installation is due to the loss rate of product during implementation.

Additional information

Electricity description

TYPE OF INFORMATION	DESCRIPTION
Location	Representative of average production in Middle East
Geographical representativeness description	**Split of energy sources in Middle East** - Natural gas: 92% - Oil: 1% - Photo: 0.2% - Losses: 6.7%
Reference year	2017
Type of data set	Cradle to gate from Thinkstep
Source	International Energy Agency -2017



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References:

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2. The International EPD System PCR 2012:01 Construction products and Construction services, Version 2.2
3. EN 15804:2012 + A1:2013 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products
4. ISO 21930:2007 Sustainability in building construction – Environmental declaration of building products
5. ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures
6. ISO 14040:2006 Environmental management. Life cycle assessment. Principles and framework
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9. Standards : EN 520:2004 and ASTM C1396

Iceland Liechtenstein Norway grants

REPÚBLICA PORTUGUESA
AMBIENTE E AÇÃO CLIMÁTICA

XPS

ENVIRONMENTAL PRODUCT DECLARATION

In Accordance with ISO14025 and 15804:2012+A2:2019 for

fibranxps

Programme	The International EPD® System, www.environdec.com
Programme operator	EPD International AB
EPD registration number	S-P-02372
Publication date	2020-12-14
Valid until	2025-12-14

fibran

EPD®
THE INTERNATIONAL EPD® SYSTEM

PROGRAMME RELATED INFORMATION

Programme:	The international EPD System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

EPD Based on Product Category Rules (PCR)	The CEN standard EN 15804 serves as the core Product Category Rules (PCR) PCR 2019:14 Construction products (EN 15804:A2); Version 1.1; 2020-09-14 C-PCR-005 "Thermal insulation products (EN 16783:2017)
PCR review was conducted by	The Technical Committee of the International EPD® System.
Independent third-party verification of the declaration and data, according to ISO 14025:2006	☐ EPD process certification ☒ EPD verification
Third party verifier:	Vladimir Koci Approved by: The International EPD® System
EPD Prepared by	ENVIROMETRICS Ltd Envirometrics.gr
Procedure for follow-up during EPD validity involves third party verifier	☐Yes ☒No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

1

COMPANY INFORMATION

FIBRAN S.A. was founded in Greece, Thessaloniki, in 1974. Ever since, FIBRAN S.A. has been designing and manufacturing products and solutions for the thermal insulation, acoustic insulation and fire protection in building, industrial and marine applications. Since 1995, it plays a leading role as a producer of insulation materials both in Greece and in Europe.

Today, FIBRAN has 6 production units, utilizing the latest technology for the manufacture of insulation products (Extruded Polysterene, Stone wool and Expanded Polysterene), as well as Gypsum Boards.

In Greece, in the industrial plant located in Terpni, Serres, FIBRAN produces stonewool insulation products with the brand name FIBRANgeo and extruded polysterene products with the brand name FIBRANxps. Other extruded polysterene production units are located in Ovar, Aveiro, Portugal, in Rousse, Bulgaria and in Sodrazica, Slovenia. In Italy, FIBRAN has invested in the production of gypsum products (gypsum boards and bagged products), as well as in the distribution of insulation, waterproofing and dry construction materials. Finally, in North Macedonia, FIBRAN produces expanded polysterene.

Purpose of FIBRANproducts and solutions is to bring energy efficiency in building, industrial and marine applications.

PRODUCT DESCRIPTION

FIBRANxps is the commercial name of extruded polystyrene as produced and supplied by FIBRAN. It is a thermal insulating material made of polystyrene and blowing agents. Most of the FIBRANxps mass consists of transparent, general purpose and high heat-resistant polystyrene, and for the achievement of foaming, inflating gases are added at 5-8% of the total mass. The product is used in building applications, such as roofs, floors and walls, as well as in industrial applications and underground applications like: perimeter basement walls, swimming pools, foundation slabs, bridges, roads and railways.

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A typical material composition along with technical specification of the product are presented below:

Material	Composition (%)
Polystyrene	>86
Blowing agents	<10
Additives	<4

Technical Specifications	
Density (kg/m^3)	29-37
Thermal conductivity, W/mK	0.032-0.040
Reaction to fire (BS EN 13501-1:2002)	E

No substances included in the Candidate List of Substances of Very High Concern for authorization under the REACH Regulations are present in the FIBRANs products, either above the threshold for registration with the European Chemicals Agency or above 0.1% (wt/wt).

This EPD covers the products listed in the table below:

Products	
Maestro	300
FABRIC	400
ETICS GF	500
ETICS BT	700

The total recycling content is between 20 to 30% for all 4 factories in Greece, Bulgaria, Slovenia and Portugal.

MULTIPLE MANUFACTURING SITES

To develop this EPD, the data from 4 manufacturing plants of FIBRAN in different countries in Europe have been taken into account.

Country	Carbon Footprint of Electricity Residual mix (g CO2eq/kwh)
Greece	601,4
Bulgaria	437,4
Slovenia	364,1
Portugal	256,0

The variation of each manufacturing site from the average EPD result is lower than ±10 % for stages A1-A3 in regard to the GWP-GHG indicator. Consequently, the results presented in this EPD concern the average production.

4

ENVIRONMENTAL PERFORMANCE RELATED INFORMATION

Declared unit	The declared unit is 1 m^2 of FIBRANxps with λ=0.032-0.040 W/mK. The density is 30 kg/m^3 and the thickness 30 mm.
Reference service life (RSL)	At least 50 years (as long as the lifetime of the building in which it is installed)
Product group classification	UN CPC 369 ''Other plastics products''
Goal and Scope	This EPD evaluates the environmental impacts of the production of 1 m^2 of FIBRANxps with λ=0.032-0.04 W/mK from Cradle to grave and module D.
System Boundary	Cradle to grave and module D (A + B + C+ D)
Cut-Off Rules	For this LCA study, 1% cut off rule applies.
Background Data	The most recent version of Ecoinvent database (V3.7) was used as a source of background data.
Data Quality	Data on raw materials, transportation, energy, waste and water is collected by FIBRAN S.A.
Time representiveness	All primary data used in this study is for the entire year 2019.
Geographical Scope	Worldwide
Allocations	There are no co-products in the production of FIBRANxps manufactured by FIBRAN. Hence, there was no need for co-product allocation.
LCA software	openLCA v. 1.10.3

SYSTEM BOUNDARIES

Product stage			Construction stage		Use stage							End of life stage				Resource recovery stage
Raw Materials Supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction and demolition	Transport	Waste processing for reuse, recovery and/or recycling	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Description of the system boundary (X = Included in the study, MNA = Module Not Assessed)

PRODUCT STAGE

Product stage include raw material supply, transportation and manufacturing.

A1: Raw Material Supply

Production starts with raw materials supply. This stage includes raw material extraction and processing along with processing of secondary materials. The raw materials are mainly polystyrene, blowing agents and additives. Also, in this stage included the production of the packaging materials (polyethylene film and paper).

A2: Transportation

Some of the raw materials are locally sourced while others are transported from different countries all over the world with lorry 16-32 tonnes and containers for sea transportation.

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A3: Manufacturing

Manufacturing processes include all the production activities within the plant with all the associated impacts. These include:

1. Extrusion
2. Cutting, edge & facing addition
3. Packaging
4. Storing

CONSTRUCTION STAGE

Construction stage includes transportation from the factory to the final user and installation in the building.

A4: Transportation

The transportation concerns either to reseller close to the final user either the final user. For this stage an average distance of 500 km delivered by lorry 16-32 tonnes was assumed.

A5: Installation

FIBRANxps is installed in the building manually. No ancillary material, water or other resource used in this stage. However, Waste materials on the building site before waste processing, generated by the product's installation, should be included. It is assumed that 5% waste of the material generated from the product installation which is transported to landfill by lorry 16-32 tonnes over a distance of 50 km.

USE-STAGE

The use stage is divided into the following modules:

- **B1: Use**
- **B2: Maintenance**
- **B3: Repair**
- **B4: Replacement**
- **B5: Refurbishment**
- **B6: Operational energy use**
- **B7: Operational water use**

FIBRANxps does not require maintenance, repair, replacement or refurbishment during use in standard conditions and if correctly applied. Also, after installation

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FIBRANxps does not use energy or water during use of the building. As a result, the environmental impacts for use stage is zero.

Note that in this stage, potential energy savings are excluded

END OF LIFE STAGE

The end-of-life stages begins with the deconstruction and demolition of entire building in which FIBRANxps is installed and then they are transferred for recycling and disposal. Though it is possible the 100% recycling of polystyrene, this does not happen because of not developing the appropriate separation process of the different materials yet.

C1: De-construction, demolition

The environmental impact is assumed to be very small and can be neglected since the de-construction and/or dismantling of insulation products take part of the demolition of the entire building.

C2: Transport to waste processing

The product is assumed to be 100% landfilled as it is. Hence, a distance of 50 km by lorry 16-32 tonnes from construction/demolition sites to disposal sites has been chosen as a conservative assumption.

C3: Waste processing for reuse, recovery and/or recycling

The environmental impacts are zero since the product is considered to be landfill without reuse, recovery or recycling.

C4: Disposal

The product is assumed to be 100% landfilled.

BENEFITS AND LOADS BEYOND THE PRODUCT SYSTEM BOUNDARY IN INFORMATION MODULE D

Module D consists of avoided burdens related to the potential reuse and/or recycling of the product after its end-of-life stage. Since the product is only disposed, there are no benefits deriving from the reuse or recycling of the product after its end-of-life stage, and neither any energy recovery from incinerating the packaging materials.

ENVIRONMENTAL PERFORMANCE INDICATORS

The environmental performance indicators are shown in the following tables for the declared unit of $1m^2$ at 30 mm thickness (0.030 m^3). For stages A1-A3 the results are aggregated.

ENVIRONMENTAL IMPACTS PER 1 m^2 of FIBRANxps

ENVIRONMENTAL IMPACTS	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-total	kg CO2 eq	3,86E+00	7,61E-02	3,48E-02	0,00E+00	0,00E+00	7,41E-03	0,00E+00	4,95E-01	0,00E+00
GWP-fossil	kg CO2 eq	3,85E+00	7,61E-02	3,48E-02	0,00E+00	0,00E+00	7,40E-03	0,00E+00	4,95E-01	0,00E+00
GWP-biogenic	kg CO2 eq	1,29E-02	2,57E-05	6,78E-06	0,00E+00	0,00E+00	2,50E-06	0,00E+00	4,19E-06	0,00E+00
GWP-luluc	kg CO2 eq	8,79E-04	2,58E-05	4,69E-06	0,00E+00	0,00E+00	2,51E-06	0,00E+00	3,12E-06	0,00E+00
GWP-GHG[1]	kg CO2 eq	3,85E+00	7,61E-02	3,48E-02	0,00E+00	0,00E+00	7,40E-03	0,00E+00	4,95E-01	0,00E+00
ODP	kg CFC-11 eq	7,15E-08	1,74E-08	1,63E-09	0,00E+00	0,00E+00	1,69E-09	0,00E+00	2,57E-09	0,00E+00
AP	mol H+ eq	1,54E-02	3,81E-04	5,06E-05	0,00E+00	0,00E+00	3,71E-05	0,00E+00	2,36E-04	0,00E+00
EP-freshwater	kg $PO4^{-3}$ eq	1,48E-03	1,58E-05	3,16E-06	0,00E+00	0,00E+00	1,54E-06	0,00E+00	2,38E-06	0,00E+00
EP-freshwater[2]	kg P eq	4,84E-04	5,15E-06	1,03E-06	0,00E+00	0,00E+00	5,02E-07	0,00E+00	7,77E-07	0,00E+00
EP-marine	kg N eq	2,63E-03	1,33E-04	4,57E-05	0,00E+00	0,00E+00	1,30E-05	0,00E+00	6,28E-04	0,00E+00
EP-terrestrial	mol N eq	2,74E-02	1,45E-03	1,95E-04	0,00E+00	0,00E+00	1,41E-04	0,00E+00	1,12E-03	0,00E+00
POCP	kg NMVOC eq	1,05E-02	4,14E-04	6,81E-05	0,00E+00	0,00E+00	4,03E-05	0,00E+00	5,40E-04	0,00E+00
ADPe	kg Sb eq	1,00E-05	2,12E-06	2,33E-07	0,00E+00	0,00E+00	2,06E-07	0,00E+00	2,33E-07	0,00E+00
ADPf	MJ	8,39E+01	1,16E+00	1,37E-01	0,00E+00	0,00E+00	1,13E-01	0,00E+00	1,75E-01	0,00E+00
WDP	m^3 eq	2,18E+00	5,16E-03	1,65E-03	0,00E+00	0,00E+00	1,78E+00	0,00E+00	3,89E-01	0,00E+00

[1] This indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide emissions and uptake and biogenic carbon stored in the product. with characterization factors (CFs) based on IPCC (2013)

[2] Eutrophication aquatic freshwater shall be given in both kg PO4 eq and kg P eq.

RESOURCE USE PER 1 m^2 of FIBRANxps

RESOURCE USE	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PERE	MJ	1,14E+00	1,34E-02	3,45E-03	0,00E+00	0,00E+00	6,71E-01	0,00E+00	2,81E-01	0,00E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	1,14E+00	1,34E-02	3,45E-03	0,00E+00	0,00E+00	6,71E-01	0,00E+00	2,81E-01	0,00E+00
PENRE	MJ	7,02E+01	1,03E+00	1,43E-01	0,00E+00	0,00E+00	4,14E+01	0,00E+00	1,68E+01	0,00E+00
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	7,02E+01	1,03E+00	1,43E-01	0,00E+00	0,00E+00	4,14E+01	0,00E+00	1,68E+01	0,00E+00
SM	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	2,18E+00	5,16E-03	1,65E-03	0,00E+00	0,00E+00	1,78E+00	0,00E+00	3,89E-01	0,00E+00

OUTPUT FLOWS AND WASTE CATEGORIES PER 1 m^2 of FIBRANxps

OUTPUT FLOWS AND WASTE CATEGORIES	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
HWD	kg	1,13E-05	3,02E-06	2,93E-07	0,00E+00	0,00E+00	9,78E-06	0,00E+00	4,81E-06	0,00E+00
NHWD	kg	1,17E-01	5,56E-02	6,60E-03	0,00E+00	0,00E+00	9,13E-02	0,00E+00	7,04E-02	0,00E+00
RWD	kg	7,06E-05	7,94E-06	7,74E-07	0,00E+00	0,00E+00	6,29E-05	0,00E+00	1,61E-05	0,00E+00
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0.00E+00	0,00E+00
EE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0.00E+00	0,00E+00

ADDITIONAL ENVIRONMENTAL IMPACTS PER 1 m^2 of FIBRANxps

ADDITIONAL	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PM	Disease incidence	1,19E-07	5,44E-09	1,22E-09	0,00E+00	0,00E+00	9,69E-08	0,00E+00	2,62E-08	0,00E+00
IR	kBq U235 eq	2,34E-01	6,06E-03	7,19E-04	0,00E+00	0,00E+00	2,17E-01	0,00E+00	3,08E-02	0,00E+00
EF	CTUe	1,57E+00	2,04E-01	1,49E-01	0,00E+00	0,00E+00	1,24E+00	0,00E+00	4,82E-01	0,00E+00
HT-c	CTUh	3,08E-08	1,55E-09	9,57E-10	0,00E+00	0,00E+00	2,44E-08	0,00E+00	7,50E-09	0,00E+00
HT-nc	CTUh	8,00E-08	1,11E-08	4,57E-09	0,00E+00	0,00E+00	6,44E-08	0,00E+00	2,74E-08	0,00E+00
LU	Dimensionless	7,50E+00	1,17E+00	1,61E-01	0,00E+00	0,00E+00	8,95E+00	0,00E+00	1,74E+00	0,00E+00

RESULTS INTERPRETATION

Concerning the contribution of the different stages, as can be seen in *Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.*, the life cycle environmental impacts of FIBRANxps are mainly dominated by **Product Stage** (A1-A3) following by **transportation of product** (A4) and **disposal** (C4). Installation stage (A5) and transportation to waste processing site (C2) are negligible.

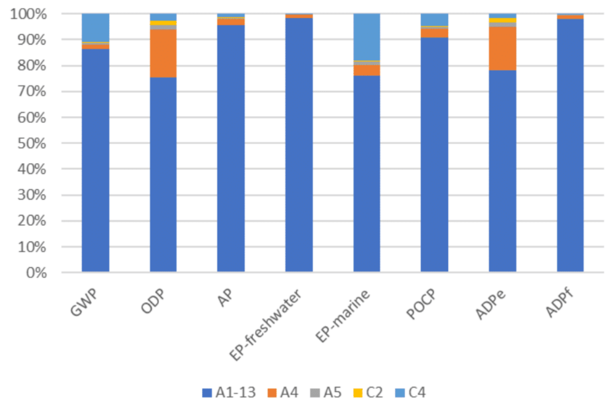

Figure 1 Contribution of each stage in various environmental impacts

Regarding to the Global warming potential (GWP-GHG) of the **production phase (A1-A3)**, each plant has various contributions for the different stages. However, it is common for all plants that the most important contribution comes from the polystyrene production, 80-85%, followed by electricity production, 5-14%. The transportation of raw materials is up to 3,5% while the rest is mainly due to the production of the blowing agents and production of packaging materials.

IMPACTS FOR DIFFERENT THICKNESS AND DENSITY

This EPD covers FIBRANxps products in the range of density between 29 and 37 kg/m^3 and the range of thicknesses between 20 mm and 200 mm. The impacts listed in the tables above concern the product with λ in the range of 0,032-0,040 W/mK, thickness 30 mm and density 30 kg/m^3. To determine the impacts for products with different density and thickness, a conversion factor (A) shall be multiplied with each impact category value. The conversion factor (A) is calculated by:

$$A = \frac{\rho \cdot S}{0.9}$$

Where:

- **ρ** = density of the product [kg/m^3]
- **S** = product thickness [m]

REFERENCES

General Programme Instructions of the International EPD® System. *Version 3.01, 2019-09-18*

PCR 2019:14 *v1.0. Construction products. EPD System. Date 2019-12-20. Valid until 2024-12-20*

C-PCR-005 ''Thermal insulation products'' of The International EPD® System

EN 15804:2012+ +A2:2019, *Sustainability of construction works - Environmental Product Declarations — Core rules for the product category of construction products*

EN 16783:2017 *Thermal insulation products – Product category rules (PCR) for factory made and in-situ formed products for preparing environmental product declaration*

ISO 14025:2006 *Environmental labels and declarations - Type III environmental declarations — Principles and procedures*

ISO 14020:2000 *Environmental labels and declarations - General principles*

ISO 14040:2006 *Environmental management - Life cycle assessment-Principles and framework*

ISO 14044:2006 *Environmental management - Life cycle assessment - Requirements and guidelines*

Ecoinvent, *www.Eco-invent.org*

Residual Energy Mix 2019 *from Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP SA)*

European Residual Mixes 2019 *from Association of Issuing Bodies*

LIST OF ABBREVIATIONS

GWP-total	Global Warming Potential total
GWP-fossil	Global Warming Potential fossil
GWP-biogenic	Global Warming Potential biogenic
GWP-luluc	Global Warming Potential land use and land use change
ODP	Ozone Depletion Potential
AP	Acidification Potential
EP-freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment
EP-marine	Eutrophication Potential fraction of nutrients reaching marine end compartment
EP- terrestrial	Eutrophication potential, Accumulated Exceedance
POCP	Formation potential of tropospheric ozone photochemical oxidants
ADPe	Abiotic depletion potential for non-fossil resources
ADPf	Abiotic depletion potential for fossil resources
WDP	Water use
PERE	Use of renewable primary energy excluding resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources

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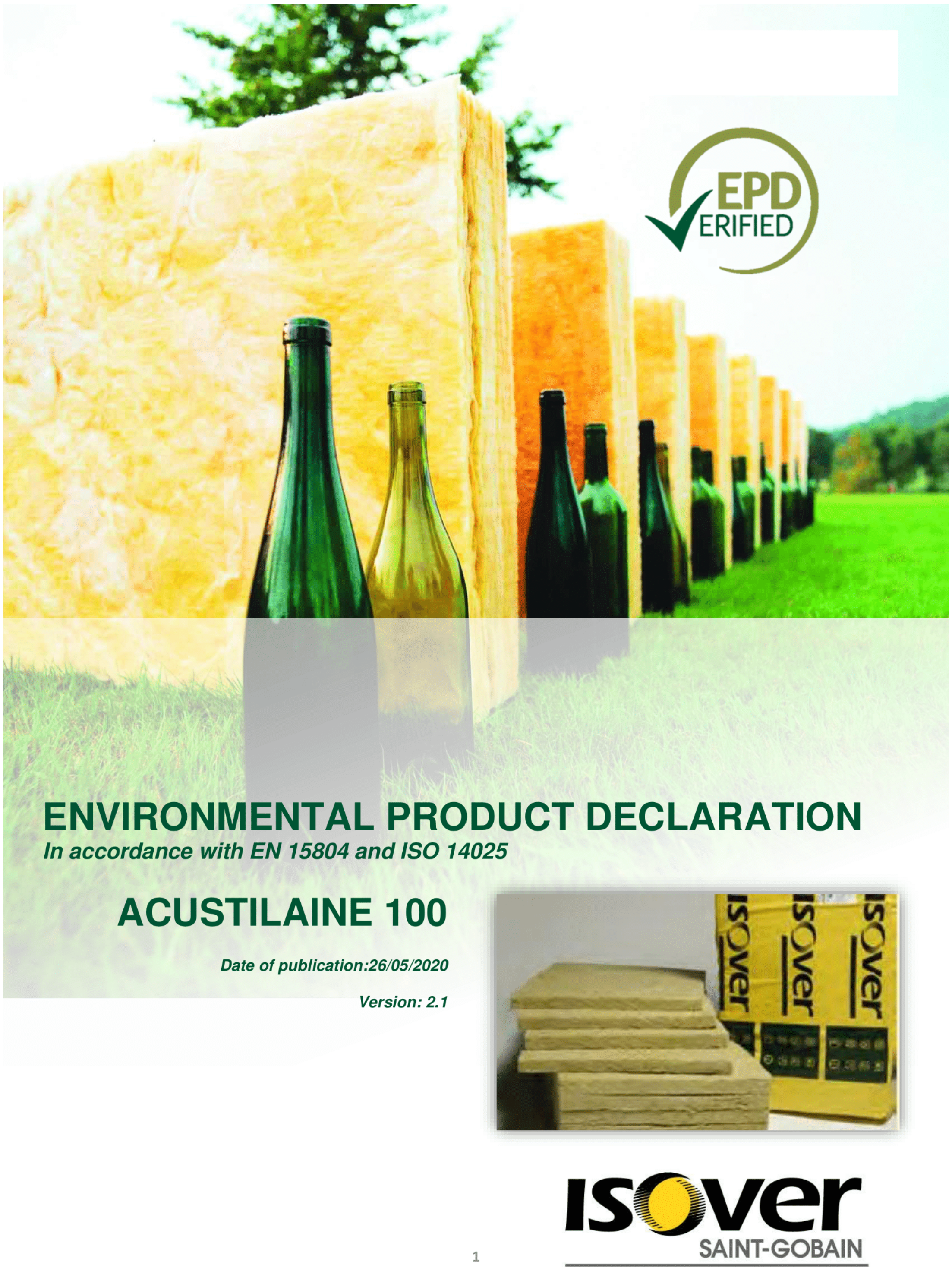
PENRE	Use of non-renewable primary energy excluding resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
SM	Use of secondary material
RSF	Use of renewable secondary fuels
NRSF	Use of non-renewable secondary fuels
FW	Use of net fresh water
HWD	Hazardous waste disposed
NHWD	Non-hazardous waste disposed
RWD	Radioactive waste disposed
CRU	Components for re-use
MFR	Materials for recycling
MER	Materials for energy recovery
EE	Exported Energy

Lã de rocha


EPD VERIFIED
ENVIRONMENTAL PRODUCT DECLARATION
In accordance with EN 15804 and ISO 14025
ACUSTILAINE 100
Date of publication:26/05/2020
Version: 2.1
1
ISOVER
SAINT-GOBAIN

General information

Manufacturer: Saint-Gobain Isover Ibérica S.L. Avenida del Vidrio S/N. 19200 Azuqueca de Hernares
PCR identification: Insulation materials version 1.2 (2014:13)
Product name and manufacturer represented: ACUSTILAINE 100; Saint-Gobain Isover Ibérica SL
Owner of the declaration: Saint-Gobain Isover Ibérica SL
DAP prepared by: Nicolás Bermejo y Alfonso Díez
Contact: Nicolás Bermejo, Alfonso Díez (Saint-Gobain Isover Ibérica SL)
Email: nicolas.bermejo@saint-gobain.com, alfonso.diez@saint-gobain.com
Declared issued: 26/05/2020, valid until: 26/05/2025.

LCA and EPD performed by Saint-Gobain Isover Ibérica SL
Independent verification of the environmental declaration and data according to standard EN ISO 14025:2010
Verifier Nicolás Bermejo nicolas.bermejo@saint-gobain.com
www.isover.es

Product description

Product description and description of use:

This Environmental Product Declaration (EPD®) describes the environmental impacts of 1 m² of mineral wool with a thermal resistance of 1.0 $K\cdot m^2\cdot W^{-1}$.

The product ACUSTILAINE 100 is a rigid panel made of ISOVER stone wool which has an excellent fire reaction since it does not contribute to extent or start a fire in any of its stages. It is a high-density panel for insulation.
The production site of Saint-Gobain Isover Ibérica SL uses raw materials of natural origin and abundant (i.e. volcanic rock or silica sand) in order to using fusion and fiberising techniques to produce mineral wool products. The products obtained from mineral wools are characterized by its lightness due to its air containing structure that keeps immobile between its intertwined filaments.

On Earth, the best insulator is dry immobile air. At 10°C its thermal conductivity factor, expressed in λ, is 0.025 W/(m·K) (watts per meter Kelvin degree). The thermal conductivity of mineral wool is close to immobile air, and its lambda value is between 0,030 W/(m·K) for the most efficient wools to 0.044 W/(m·K) to the least efficient ones.

With its entangled structure, mineral wool is a porous material that traps the air, making it one of the best insulating materials. The porous and elastic structure of the wool also absorbs noise and knocks, offering acoustic correction inside premises. Mineral wools contain mainly organic materials, considered incombustible and do not propagate flames.

Isover's mineral wool insulation (Glass wool, Stone wool, etc) is used in buildings as well as industrial facilities. It ensures a high level of comfort, lowers energy costs derived from the use of the housing, minimizes carbon dioxide (CO_2) emissions, prevents heat loss through pitched roofs, walls, floors, pipes and boilers, reduces noise pollution and protects homes and industrial facilities from the risk of fire.

Mineral wool products last for the average building's lifetime (which is often set at 50 years as a default), or as long as the insulated building component is part of the building.

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Technical data/physical characteristics:

Thermal resistance of the product (R): **1 K·m²·W⁻¹**
The thermal conductivity of the mineral wool is: **0,034 W/(m·K)**
Reaction to fire: **Euroclass A1. (UNE-EN 13501-1 and UNE-EN 15715)**
Acoustic properties: **Until Aw=1**
Water vapor transmission: **μ=1(UNE EN 12086)**

Description of the main components and/or materials for 1 m² of mineral wool with a thermal resistance of 1 K·m²·W⁻¹ for the calculation of the EPD®:

PARAMETER	VALUE
Weight per 1 m² of product	**3,40 Kg**
Thickness of wool	**34 mm**
Surfacing	
Packaging for the transportation and distribution	**Polyethylene 24 gr/m2** **Wood pallet 81 gr/m2**
Product used for the Installation	**Ninguno**

During the life cycle of the product any hazardous substance listed in the "Candidate List of Substances of Very High Concern (SVHC) for authorization[1]" has been used in a percentage higher than 0,1% of the weight of the product.

LCA calculation information

FUNCTIONAL UNIT	Providing a thermal insulation on 1 m² of product with a thermal resistance of 1 K·m²·W⁻¹
SYSTEM BOUNDARIES	Cradle to Grave: Mandatory stages = A1-3, A4-5, B1-7, C1-4. Optional stage = D not taken into account
REFERENCE SERVICE LIFE (RSL)	50 years
CUT-OFF RULES	In the case that there is not enough information, the process energy and materials representing less than 1% of the whole energy and mass used can be excluded (if they do not cause significant impacts). The addition of all the inputs and outputs excluded cannot be bigger than the 5% of the whole mass and energy used, as well of the emissions to environment occurred. Flows related to human activities such as employee transport are excluded. The construction of plants, production of machines and transportation systems are excluded since the related flows are supposed to be negligible compared to the production of the building product when compared at these systems lifetime level.
ALLOCATIONS	Allocation criteria are based on mass

[1] http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp

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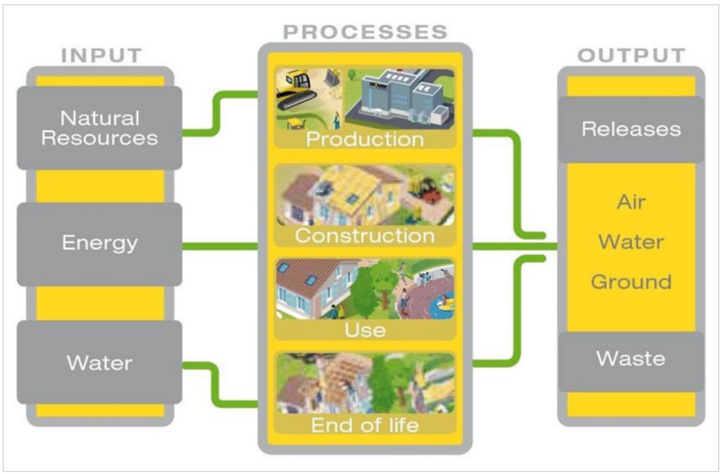
GEOGRAPHICAL COVERAGE AND TIME PERIOD	Spain and Portugal, 2017

- EPDs of construction products may be not comparable if they do not comply with EN 15804"
- "Environmental Product Declarations within the same product category from different programs may not be comparable"
-

Life cycle stages

Flow diagram of the Life Cycle



Product stage, A1-A3

Description of the stage: the product stage of the mineral wool products is subdivided into 3 modules A1, A2 and A3 respectively "Raw material supply", "transport" and "manufacturing".

The aggregation of the modules A1, A2 and A3 is a possibility considered by the EN 15 804 standard. This rule is applied in this EPD.

Description of the scenarios and other additional technical information:

A1, Raw materials supply

This module considers the extraction and processing of all raw materials and energy which occur upstream to the studied manufacturing process

Specifically, the raw material supply covers production of binder components and sourcing (quarry) of

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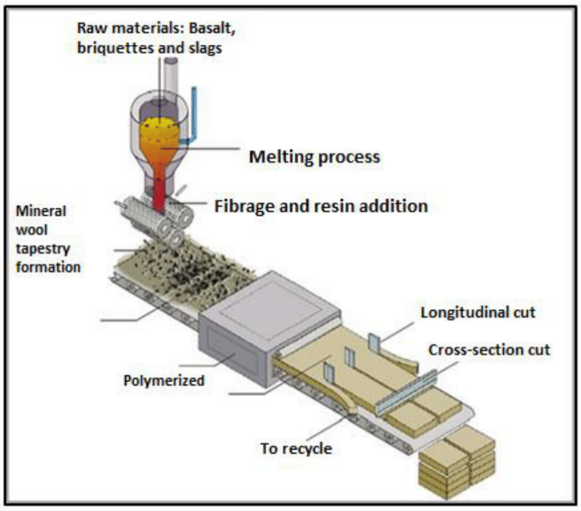
raw materials for fiber production, e.g. sand and borax for glass wool. Besides these raw materials, recycled materials (agglomerates) are also used as input. It's needed to remark that the totality of the electricity used in this stage comes 100% from certified renewable sources.

A2, Transport to the manufacturer
The raw materials are transported to the manufacturing site. In our case, the modeling includes the road distances traveled of each raw material.

A3, Manufacturing
This module includes the manufacturing of the product and packaging. Specifically, it covers the manufacturing of glass, resin, mineral wool (including the processes of fusion and fiberizing showed in the flow diagram), and the packaging.
The production of packaging material is taking into account at this stage.
The product contain in its composition a recycled content above 50% distributed in the following way:
PRECONSUMER 48,1% POST CONSUMER 3,75%

Manufacturing process flow diagram

Rock wool production



Construction process stage, A4-A5

Description of the stage: the construction process is divided into 2 modules: A4, transport to the building site and A5, installation in the building.

A4, Transport to the building site: this module includes transport from the production gate to the building site.
Transport is calculated based on a scenario with the parameters described in the following table.

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PARAMETER	VALUE/DESCRIPTION
Fuel type and consumption of vehicle or vehicle type used for transport i.e. long distance truck, boat, etc.	Average truck trailer with a **16-32**t payload, diesel consumption 38 liters for 100 km
Distance	1900km
Capacity utilisation (including empty returns)	**100 % of the capacity, in volume** **30 % empty return**
Bulk density of transported products*	**100 kg/m^3**
Volume capacity utilisation factor	**1**

A5, Installation in the building: this module includes:

- Waste produced during the installation of the product (see value in percentage shown in the next table). These losses are sent to landfill (see landfill model for mineral wool at End of life chapter).
- Additional production processes done in order to compensate losses.
- Packaging waste processing, which are 100% collected and recycled.

PARAMETER	VALUE/DESCRIPTION
Wastage of materials on the building site before waste processing, generated by the product's installation (specified by type)	5 %
Output materials (specified by type) as results of waste processing at the building site e.g. of collection for recycling, for energy recovering, disposal (specified by route)	Product packaging waste is 100% collected and recycled. Following a conservative methodology, mineral wool losses are considered to be landfilled, while they are 100% recyclable and/or reusable. 50km distance is set.

Use stage (excluding potential savings), B1-B7

Description of the stage: the use stage is divided into the following modules:
- B1: Use
- B2: Maintenance
- B3: Repair
- B4: Replacement
- B5: Refurbishment
- B6: Operational energy use
- B7: Operational water use

Description of the scenarios and additional technical information:
Once installation is complete, no actions or technical operations are required during the use stages until the end of life stage. Therefore, mineral wool insulation products have no impact (excluding potential energy savings) on this stage.

End of Life Stage, C1-C4

Description of the stage: this stage includes the next modules:

C1, Deconstruction, demolition
The de-construction and/or dismantling of insulation products take part of the demolition of the entire building. In our case, the environmental impact is assumed to be very small and can be neglected

C2, Transport to waste processing
The model use for the transportation (see A4, transportation to the building site) is applied.

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C3, Waste processing for reuse, recovery and/or recycling
The product is considered to be landfilled without reuse, recovery or recycling.

C4, Disposal
The mineral wool is assumed to be 100% landfilled.

Description of the scenarios and additional technical information:

End of life

PARAMETER	VALUE/DESCRIPTION
Collection process specified by type	3,4 kg (collected with mixed construction waste)
Recovery system specified by type	There is no recovery, recycling or reuse of the product once it has reached its end of life phase.
Disposal specified by type	3,4 kg landfilled
Assumptions for scenario development (e.g. transportation)	Average truck trailer with a 16-32t payload, diesel consumption 38 liters for 100 km 50 km of average distance to landfill

Reuse/recovery/recycling potential, D

Description of the stage: module D has not been taken into account.

LCA Results

LCA model, aggregation of data and environmental impact are calculated from the TEAM™ software 5.2. CML v 4.2 impact method has been used, together with DEAM (2006) and Ecoinvent databases to obtain the inventory of generic data.

Raw materials and energy consumption, as well as transport distances have been taken directly from the manufacturing plant (year 2017).

Below, are attached the tables with the detailed LCA results, which corresponds to the referent thickness results (33mm, when R=1). The results for the commercial thicknesses (25 mm) are showed on the annex I.

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ENVIRONMENTAL IMPACTS 34mm																
Parameters	Product stage	Construction stage		Use stage							End of life				D Reuse, recovery, recycling [2]
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Global Warming Potential (GWP) - *kg CO2 equiv/FU*	3.13E+00	2.19E-01	1.53E-01	0	0	0	0	0	0	0	0	1.21E-02	0	1.82E-02	MND
	The global warming potential of a gas refers to the total contribution to global warming resulting from the emission of one unit of that gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of 1.														
Ozone Depletion (ODP) *kg CFC 11 equiv/FU*	1.67E-07	3.98E-08	4.79E-09	0	0	0	0	0	0	0	0	2.20E-09	0	6.10E-09	MND
	Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbons or halons), which break down when they reach the stratosphere and then catalytically destroy ozone molecules.														
Acidification potential (AP) *kg SO2 equiv/FU*	2.95E-02	7.30E-04	1.39E-03	0	0	0	0	0	0	0	0	4.03E-05	0	1.37E-04	MND
	Acid depositions have negative impacts on natural ecosystems and the man-made environment incl, buildings. The main sources for emissions of acidifying substances are agriculture and fossil fuel combustion used for electricity production, heating and transport.														
Eutrophication potential (EP) *kg (PO4)3- equiv/FU*	1.73E-03	1.25E-04	8.93E-05	0	0	0	0	0	0	0	0	6.92E-06	0	2.46E-05	MND
	Excessive enrichment of waters and continental surfaces with nutrients, and the associated adverse biological effects.														
Photochemical ozone creation (POPC) *Ethene equiv/FU*	2.43E-03	2.09E-04	1.28E-04	0	0	0	0	0	0	0	0	1.15E-05	0	3.83E-05	MND
	Chemical reactions brought about by the light energy of the sun. The reaction of nitrogen oxides with hydrocarbons in the presence of sunlight to form ozone is an example of a photochemical reaction.														
Abiotic depletion potential for non-fossil resources (ADP-elements) - *kg Sb equiv/FU*	1.38E-06	4.13E-07	9.09E-08	0	0	0	0	0	0	0	0	2.28E-08	0	1.58E-08	MND
Abiotic depletion potential for fossil resources (ADP-fossil fuels) - *MJ/FU*	2.55E+01	3.30E+00	1.33E+00	0	0	0	0	0	0	0	0	1.82E-01	0	5.18E-01	MND
	Consumption of non-renewable resources, thereby lowering their availability for future generations.														

[2] MND=Module Not Declared

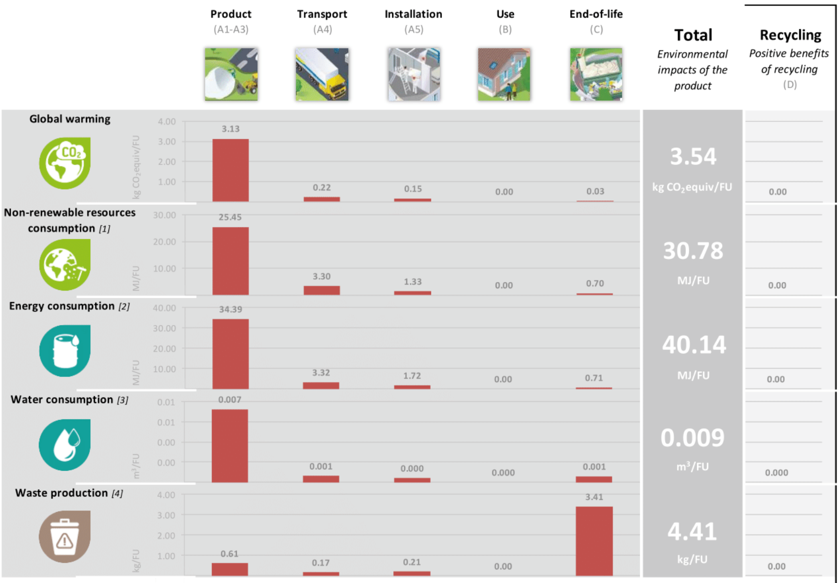
ENVIRONMENTAL IMPACTS 34mm																
Parameters	Product stage	Construction process stage		Use stage							End of life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials - *MJ/FU*	9.68E+00	4.07E-02	4.84E-01	0	0	0	0	0	0	0	0	2.25E-03	0	1.33E-02	MND
Use of renewable primary energy used as raw materials *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) *MJ/FU*	9.68E+00	4.07E-02	4.84E-01	0	0	0	0	0	0	0	0	2.25E-03	0	1.33E-02	MND
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials - *MJ/FU*	2.47E+01	3.28E+00	1.24E+00	0	0	0	0	0	0	0	0	1.81E-01	0	5.15E-01	MND
Use of non-renewable primary energy used as raw materials *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) - *MJ/FU*	2.47E+01	3.28E+00	1.24E+00	0	0	0	0	0	0	0	0	1.81E-01	0	5.15E-01	MND
Use of secondary material *kg/FU*	1.69E+00	0	8.47E-02	0	0	0	0	0	0	0	0	0	0	0	MND
Use of renewable secondary fuels- *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Use of non-renewable secondary fuels - *MJ/FU*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Use of net fresh water - *m3/FU*	7.27E-03	6.33E-04	4.19E-04	0	0	0	0	0	0	0	0	3.49E-05	0	5.67E-04	MND

WASTE CATEGORIES 34mm															
Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Hazardous waste disposed kg/FU	9.08E-02	2.15E-03	4.33E-03	0	0	0	0	0	0	0	0	1.18E-04	0	2.66E-04	MND
Non-hazardous waste disposed kg/FU	5.24E-01	1.72E-01	2.01E-01	0	0	0	0	0	0	0	0	9.50E-03	0	3.40E+00	MND
Radioactive waste disposed kg/FU	2.57E-05	2.24E-05	2.56E-06	0	0	0	0	0	0	0	0	1.24E-06	0	3.44E-06	MND

OTHER OUTPUT FLOWS 34mm															
Parameters	Product stage	Construction process stage		Use stage							End-of-life stage				D Reuse, recovery, recycling
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
Components for re-use kg/FU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Materials for recycling kg/FU	1.50E+00	0	2.21E-01	0	0	0	0	0	0	0	0	0	0	0	MND
Materials for energy recovery kg/FU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MND
Exported energy MJ/FU	2.36E-07	0	1.12E-08	0	0	0	0	0	0	0	0	0	0	0	MND

LCA Interpretation

The product stage (A1-A3) is the stage with a major impact over the life cycle, since it represents between 93% (Eutrophication) and 84% (Ozone Layer Depletion) of the total life cycle impacts. This stage accumulates an 88% of the impacts (generated due the consumption of non-renewable resources), and a 94% of the water consumption over the life cycle. Waste is produced mainly during the End of Life stage (C1-C4), representing 71% of the total impact. This is due the to the fact that 100% of the product is landfilled at the end of its service life.



[1] This indicator corresponds to the abiotic depletion potential of fossil resources.
[2] This indicator corresponds to the total use of primary energy.
[3] This indicator corresponds to the use of net fresh water.
[4] This indicator corresponds to the sum of hazardous, non-hazardous and radioactive waste disposed.

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THICKNESS CONVERSION TABLE

This EPD covers the range of all product thicknesses, using a multiplication factor to determine their individual environmental impacts. In order to calculate the multiplication factors, a reference unit equal to that specified in the product description section has been selected, the thickness to which the indicated results refer.

Espesor del producto (mm)	Factor de Multiplicación
34	1.00
40	1.18
50	1.47
60	1.77
70	2.06
80	2.35
100	2.94
110	3.24
ES	(ES/34)

Bibliography

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- PCR Insulation materials version 1.2 (2014:13)
- UNE-EN 15804:2012+A1:2013 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
- General Programme Instructions for the International EPD® System, version 2.5.
- Análisis del Ciclo de Vida de materiales aislantes Saint-Gobain Isover (2018).
- Guía Metodológica de Saint-Gobain para productos de construcción (*Environmental Product Declaration Methodological Guide for Construction Products*).

IMPACT CATEGORY	UNIT	MODEL ADOPTED AS IN EF	GLOBAL NORMALISATION FACTORS	WEIGHTING FACTORSC (%)
CLIMATE CHANGE	Kg. CO2 eq.	IPCC, 2013	5.55E+13	21.06
OZONE DEPLETION	Kg. CFC-11 eq.	World Meteorological Organisation (WMO), 2014	3.33E+08	6.31
PARTICULATE MATTER	Disease incidence	Fantke et al., 2016	4.11E+06	8.96
IONISING RADIATION	Kg. U-235 eq.	Frischknecht et al., 2000	9.54E+11	5.01
PHOTOCHEMICAL OZONE FORMATION	Kg. NMVOC eq.	Van Zelm et al., 2008, as applied in ReCiPe 2008	2.80E+11	4.78
ACIDIFICATION	mol H+ eq.	Posch et al., 2008	3.83E+11	6.2
EUTROPHICATION, TERRESTRIAL	mol N eq.	Posch et al., 2008	1.22E+12	3.71
EUTROPHICATION, FRESHWATER	Kg. P eq.	Struijs et al., 2009	1.11E+10	2.8
EUTROPHICATION, MARINE	Kg. N eq.	Struijs et al., 2009	1.35E+11	2.96
FRESHWATER ECOTOXICITY	CTUe	USEtox (Rosenbaum et al., 2008)	8.15E+13	1.92
HUMAN TOXICITY, NON-CANCER	CTUh	USEtox (Rosenbaum et al., 2008)	2.66E+05	2.13
HUMAN TOXICITY, CANCER	CTUh	USEtox (Rosenbaum et al., 2008)	3.27E+06	1.84
LAND USE	Pt	Bos et al., 2016 (based on)	1.54E+16	7.94
WATER USE	m^3 water eq.	AWARE 100 (based on) (UNEP 2016; Boulay et al. 2018)	7.91E+13	8.51
RESOURCE USE, FOSSILS	MJ	ADP fossils (van Oers et al., 2002)	4.48E+14	8.32
RESOURCE USE, MINERALS AND METALS	Kg. Sb eq.	ADP ultimate reserve (van Oers et al., 2002)	4.39E+08	7.55

Iceland Liechtenstein Norway grants

REPÚBLICA PORTUGUESA
AMBIENTE E AÇÃO CLIMÁTICA

Assinaturas

Projeto CircularBuild

Nome	
Data e Assinatura	Assinado por: **JAIME ALBERTO FERNANDES DA SILVA** Num. de Identificação: 08127080 Data: 2023.05.05 19:09:30+01'00'
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Nome	
Data e Assinatura	
Cargo/Entidade	