GELCLAD

GELCLAD: Development of a Novel Façade Panel with Nano-insulation Properties for Energy Efficient Buildings

"ENERGY in BUILDINGS 2017“

International Conference

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HIGHLY EFFICIENT CLADDING ECO-PANELS WITH IMPROVED NANO-INSULATION PROPERTIES

Partners

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SGGCCS SLOVENSKI GRADBENI GROZD CONSTRUCTION CLUSTER OF SLOVENIA
bre
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Duration

3 years

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Grant Agreement

723425

Funding Programme

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HORIZON 2020

Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing

Topic EEB 01-2016: Highly efficient insulation materials with improved properties

Why GELCLAD?

Conventional external insulation and building façade systems still impose some technical, economic and environmental issues:

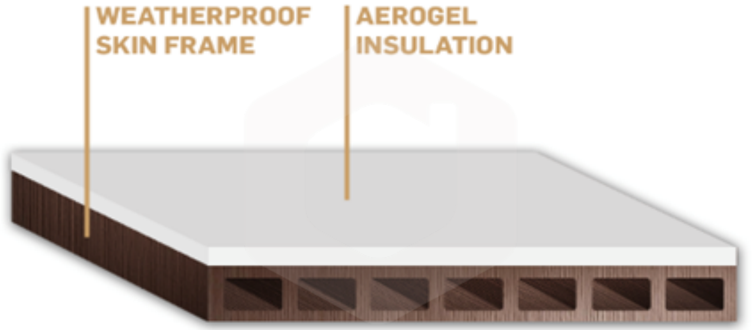
- ✓ Too much dependent on traditional and inefficient insulation materials and upon heavily virgin embodied energy materials driven from non-renewable resources
- ✓ Short service life (15 years), mostly requiring a high level of maintenance
- ✓ Based on hard labour and time consuming multi-material layers application
- ✓ Costly and skilled personnel required for application and maintenance
- ✓ State of the art nano-insulation materials (e.g. aerogels, VIPs) still largely unaffordable and imposing huge technical restrictions during installation/service.

These are just some factors that still hinder a large scale implementation of high performance external insulation systems, as a tool for a large sustainable and highly energy efficient renovation programme of urban areas.

GELCLAD
Product Concept

GELCLAD project aims to generate a novel advanced cladding system for building envelopes. Specially designed for retrofit activities and targeting the major EU building renovation action in progress, GELCLAD™ system panels will combine an outer protective weatherproofing composite skin layer and a nano superinsulation aerogel core, all in one and ready-to-use, sustainable and durable eco-panel composite solution, able to attain high energy efficiency goals.

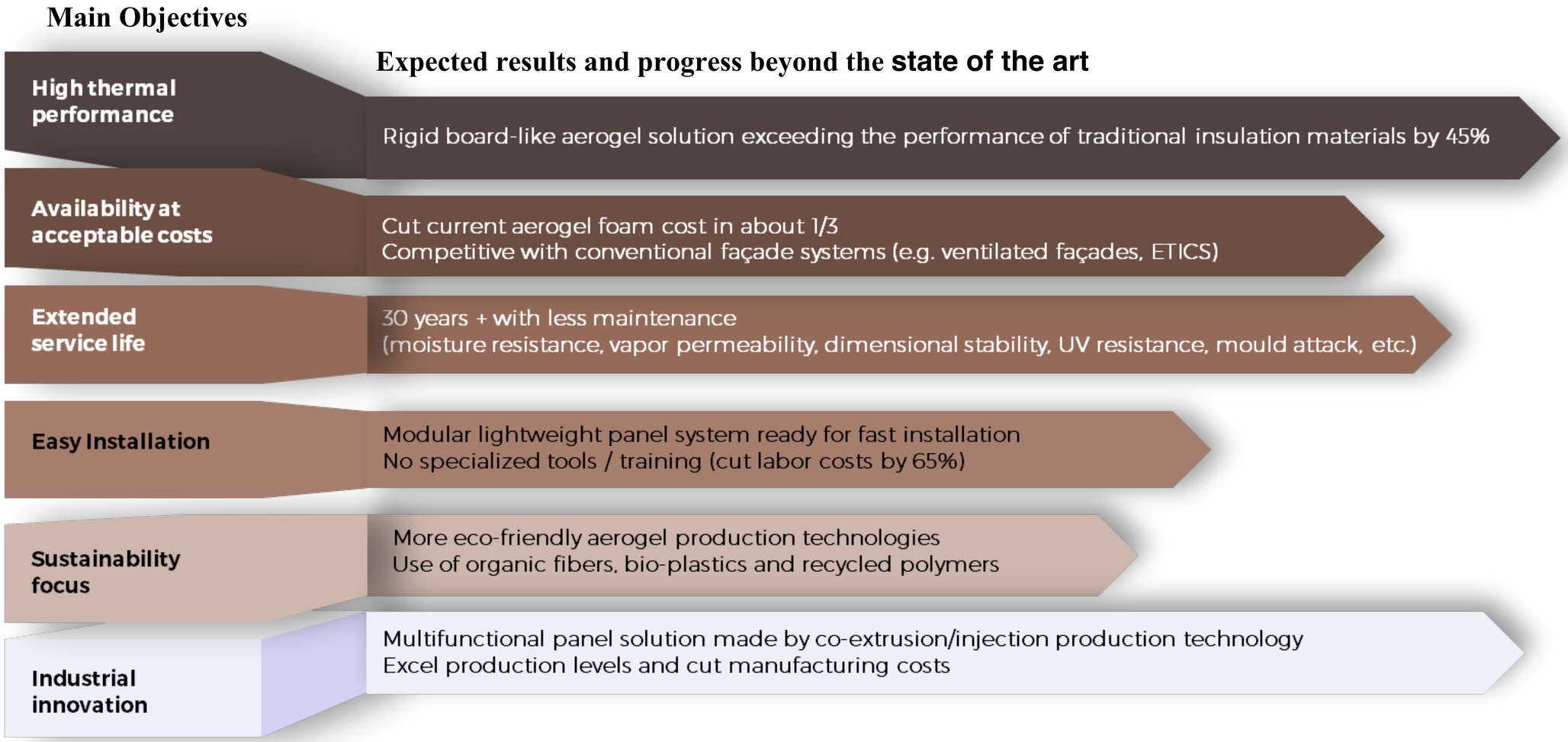
With the advantage of being a modular external insulation system that can be considerable thin and light, GELCLAD easy to handle **unit** will allow for a much simple and swift installation, when compared with conventional façade solutions, thus aiming to be recognised as a cost-effective tool for building's energy efficiency.



GELCLAD

Prototype Panel

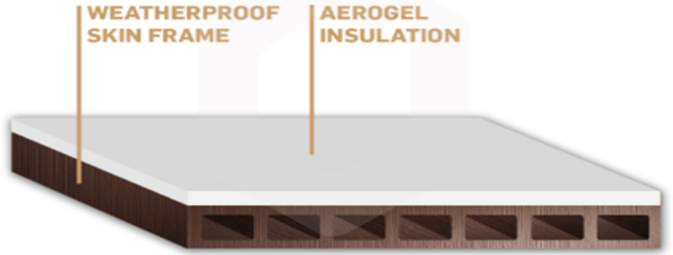
GELCLAD
Main objectives and results



GELCLAD
Main features

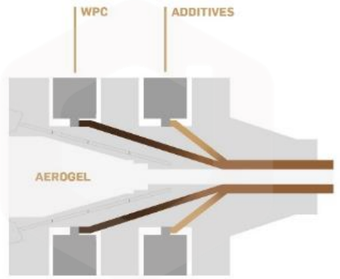
GELCLAD façade panel product

1. Inner, rigid and non-dusty high-performance aerogel core
2. Outer wood polymer composite (ecoWPC) protective skin frame with different optional and functional surface layers



GELCLAD integrated production system

Hybrid co-extrusion and/or injection technology



Complementary features

·Smart automatic air flow cavity ventilation system using SMM

GELCLAD ecoWPC SKIN LAYER

❖Environmental friendly engineered bio and recycled wood-polymer composite (ecoWPC)

Largely **made of low-embodied energy** and reduced carbon footprint **bio-resins and recycled polymers,** mixed with renewable and affordable fillers (e.g. hardwood wastes) and bespoke additives - **fiber contents up to 80% (**reduced oil-based content).

❖Superior performance, great aesthetics and swift installation

Modern WPC cladding solution for exterior walls with improved mechanical properties and the ability to protect the thermal insulation provided by the nanotechnology-driven aerogel core. Possible to be enhanced by an outer hydrophobic and weather/UV thin co-extruded and resistant layer, for maximum performance, durability and aesthetic advantages, including many different colours.

❖Market opportunity for GELCLAD

WPC are still a niche application for façade applications (mostly used for porches, decks, sidings, railings, etc.).

GELCLAD ecoWPC SKIN LAYER

❖Base materials

- Up to 100% bio-based and renewable thermoplastics (e.g. PLA), and lignin-based resins along with organic additives
- Recycled polymers
- Blends of the previous
- Natural reinforcing fibres (wood flour) and special fillers.

❖Additives

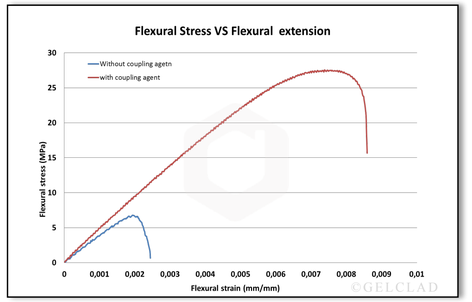
- Coupling agents
- Flame retardants
- UV inhibitors and stabilisers
- Anti-fungus, pigments and colourants
- Processing additives, plasticisers and lubricants
- Surface agents, etc.

❖Compounding and extrusion technology

- Producing GELCLAD ecoWPC compound blends and granules
- Pilot development/adaptation of GELCLAD ecoWPC extrusion line
- Evaluating a co-extrusion ecoWPC tool for functional surface layer

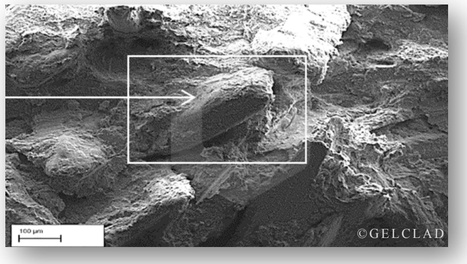
Polymer granules


WPC compound samples

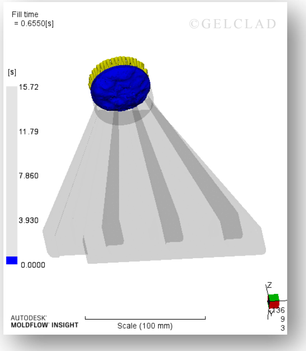


Mechanical properties evaluation

Fibres embedded into polymer matrix, strong interface between the polymer and fibre



Interfacial polymer-fiber bonding mechanisms



Simulation tools

Co-extruder dye kit

Lab scale extruder

GELCLAD ecoWPC SKIN LAYER

Extruded ecoWPC material benchmark - Preliminary evaluation

Physical Properties	WPC/PE -market	WPC/PP -market	WPC/PVC -market	COMP1	COMP2	COMP3
Density	1,1 g/cc	1,1 g/cc	1.2 g/cc	0.960 g/cc	1,03 g/cc	1,10 g/cc
Moisture Absorption Equil.	1,1%	1,1%	1.2 %	1.8%	1,8%	1,4%
Viscosity			1.73 cP			
Linear Mold Shrinkage	1,1%	1,1%	0,9%	0,9%	0.8%	0,7%
ASTM Color			24.5			
Mechanical Properties						
Hardness, Shore D	60	65	70	70	76	80
Tensile Strength, Ultimate	13MPa	18 MPa	15 MPa	10 MPa	10 MPa	8 MPa
Tensile Strength, Yield	16 MPa	21 MPa	18MPa	14 MPa	14 MPa	12 MPa
Elongation at Break	4%	4%	3%	2%	2%	2%
Modulus of Elasticity	1,20 GPa	3,5 GPa	2.84 GPa	3,2 GPa	3,5 GPa	4 GPa
Flexural Yield Strength	25 MPa	32 MPa	81.0 MPa	32 MPa	34 MPa	42 MPa
Flexural Modulus	1,20 GPa	3,5 GPa	2.84 GPa	3,2 GPa	3,5 GPa	4 GPa
Izod Impact, Notched			3.51 J/cm			
Izod Impact, Unnotched	1.28 J/cm	1.28 J/cm	2.28 J/cm	--------	-------	------
Charpy Impact Unnotched	6 kJ/m²	12 kJ/m²	5 kJ/m²	--------	--------	--------
Charpy Impact, Notched	3 kJ/m²	3 kJ/m²	2,5 kJ/m²	--------	--------	--------
Compression Set	25 %	28 %	30 %	--------	--------	--------
Electrical Properties						
Electrical Resistivity	3e+9 ohm-cm	3e+9 ohm-cm	3e+9 ohm-cm	-------	-------	3e+9 ohm-cm
Dielectric Constant	2,8	2,8	2,2	-------	-------	-------
Dielectric Strength	4,8	4,9	2,5.0 kV/mm	-------	-------	-------
Thermal Properties						
CTE, linear	65 µm/m-°C	60 µm/m-°C	55 µm/m-°C	56 µm/m-°C	56 µm/m-°C	52µm/m-°C
Thermal Conductivity	0.18 W/(m·K)	0.16 W/m-K	0.18 W/m-K	0.16 W/m-K	0.16 W/m-K	0.18 W/m-K
Maximum Service Temperature, Air	60.0 °C	90.0 °C	70.0 °C	70.0 °C	70.0 °C	75.0 °C
Deflection Temperature at 0.46 MPa	66.0 °C	98.0 °C	76.0 °C	--------	--------	76.0 °C
Deflection Temperature at 1.8 MPa	70.0 °C	70.0 °C	70.0 °C	--------	--------	70.0 °C
Vicat Softening Point	80.0 °C	80.0 °C	80.0 °C	--------	--------	80.0 °C
Heat Distortion Temperature	73.5 °C	73.5 °C	73.5 °C	--------	--------	73.5 °C
Minimum Service Temperature, Air	-25.0 °C	-25.0 °C	-25.0 °C	--------	--------	--------
Brittleness Temperature	-30.4 °C	-30.4 °C	-30.4 °C	--------	--------	--------
Flammability, UL94	V2	-------	5VB	V1	-------	V0
Flame Spread	10 mm /min	10 mm /min	6.26 mm/min	6 mm/min	0	0
Oxygen Index LOI	20%	20%	26 %	--------	-------	-------
Optical Properties				--------		
Transmission, mat, rough	mat, rough	mat, rough	mat, rough	mat, rough	mat, rough	mat, rough
Processing Properties						
Melt Temperature	160 °C	200	181 °C	182 °C	186 °C	188 °C
Flowability	high	high	sufficient	sufficient	sufficient	sufficient

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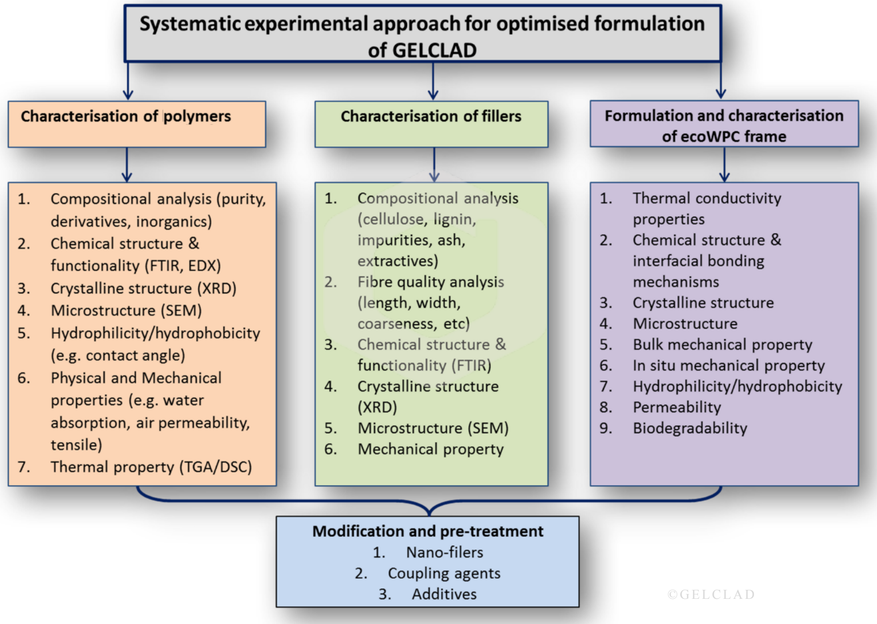
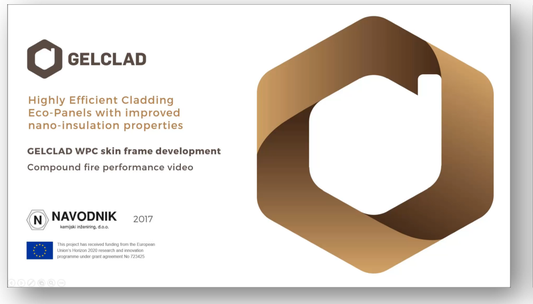




ecoWPC fire performance

still under development
Samples to be preliminary tested following BS 476-7: Fire test on building materials and structures

GELCLAD ecoWPC SKIN LAYER

Extruded ecoWPC evaluation reference parameters and base requirements

Parameters			Requirements	Test method	Expected average results for WPC
Physical characteristics	Linear mass		Individual values ≥ 95%, linear mass and tolerances should be declared	EN 15534-1: 2014, 6.5	0.3559 g/mm
	Thickness, width and length		The relevant dimensional values and their tolerances should be declared	EN 15534-1: 2014, 6.6.2	
	Deviation from straightness		The deviation of straightness and its tolerance should be declared	EN 15534-1: 2014, 6.6.3	0.35 mm
	Cupping		The cupping value and its tolerance should be declared	EN 15534-1: 2014, 6.6.4	
Mechanical characteristics	Falling mass impact resistance		Non-cellular material profiles-No more than 1 test specimen out of 10 test specimens shall show a failure.	EN 15534-1: 2014, 7.1.2.2.1 (EN 477:1995)	Pass (0.03 mm)
			Cellular material profiles- No more than 1 test specimen out of 10 test specimen shall show a failure.	EN 15534-1: 2014, 7.1.2.2.2	
	Tensile properties		MOR (MPa) MOE (GPa)	EN 15534-1: 2014, 7.2 (EN ISO 527-2)	MOR =13.45 MPa N/A
	Flexural properties		Deflection under a load of 250 N ≤ 5.0 mm (arithmetic mean value). MOR (Bending strength - MPa) MOE (GPa)	EN 15534-1: 2014, Annex A (EN 310:1993)	3.15 mm 37.47 MPa 3.09 GPa
	Durability of products against biological agents	Resistance against basidiomycetes	The test result should be declared	EN 15534-1: 2014, 8.5.2 (ENV 12038)	
	Durability of products against ageing and moisture	Resistance to artificial weathering	*DL*, Da*, Db** should be declared Appearance criteria, as defined by the manufacturer	EN 15534-1: 2014, 8.1 (EN ISO 4892-2:2013) (EN 927-6) (EN 16472)	
		Moisture resistance under cyclic test conditions	Deflection under a load of 250 N ≤ 6.0 mm (arithmetic mean value).	EN 15534-1: 2014, Annex A (EN 321:2001)	N/A
		Swelling and water absorption	1) Mean value of swelling: ≤ 10 % in thickness; ≤ 1.5 % in width; ≤ 0.6 % in length; 2) Individual values of swelling: ≤ 12 % in thickness; ≤ 2 % in width; ≤ 1.2 % in length 3) Mean value of water absorption ≤ 8 % in weight. 4) Individual values of water absorption ≤ 10 % in weight.	EN 15534-1: 2014, 8.3.1 (EN 317)	Pass T = 10.26% W = 0.16% L = 1.12% Pass Weight = 9.8%
		Boiling test	1) Mean value of water absorption ≤ 7 % in weight. 2) Individual values of water absorption ≤ 9 % in weight.	EN 15534-1: 2014, 8.3.3	Fail Weight = 9.8%
	Linear thermal expansion coefficient		≤ 50 x 10^{-6} K^{-1}	EN 15534-1: 2014, 9.2 (ISO 11359-2)	
	Resistance to natural ageing		The decrease of bending strength should be declared *DL*, Da*, Db*, DE** or grey scale rating should be declared The change of the modulus of elasticity in bending should be declared The appearance criteria, and the location of exposure and conditions should be declared	EN 15534-1: 2014,8.2 (EN ISO 877-2) (EN 927-3)	L_0= 39.17 a_0= 9.37 b_0= 15.55

GELCLAD NANO-INSULATION AEROGEL CORE

❖Aerogel advantages and drawbacks in building applications

Aerogels are synthetic nanostructured networks of nano silica particles made by sol-gel processes, followed by a supercritical/ambient drying stage, capable of having low density (air/voids 95-99%), outstanding thermal conductivities (as low as 13 mW/mK) and superior hydrophobicity and fire resistance performances.

However, **aerogels still have limited application in the construction sector**:

- **highly expensive**
- **poor mechanical properties** (brittle, dusty and fragile).

❖GELCLAD aerogel paste alternative

Active Aerogels has been developing pasty-like aerogel solutions, combining aerogel powders/granules with a special proprietary binder formulation, capable of being injected/extruded/moulded/sprayed to form rigid and complex geometries.
When dried/cured, this pasty product can have excellent thermal insulation, very low densities and high hydrophobicity ranks, while being mechanically robust and presenting less dust release than traditional aerogel powders - all important features for GELCLAD.
This aerogel material is produced by a synthesis/drying process at ambient pressure, avoiding highly energy and cost consuming supercritical methods.

GELCLAD NANO-INSULATION AEROGEL CORE

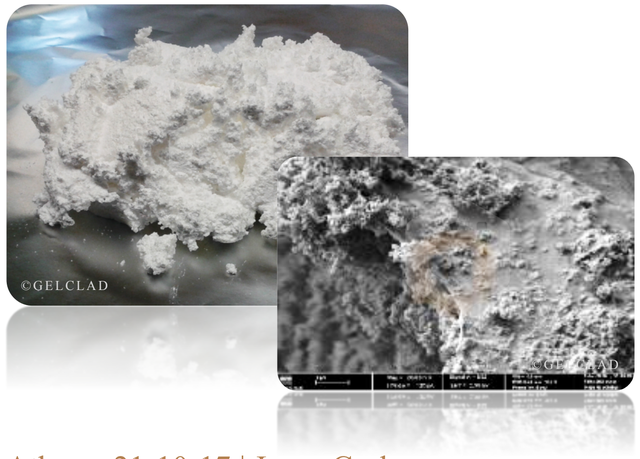
Starting stage – Initial aerogel physical properties and insulation performance

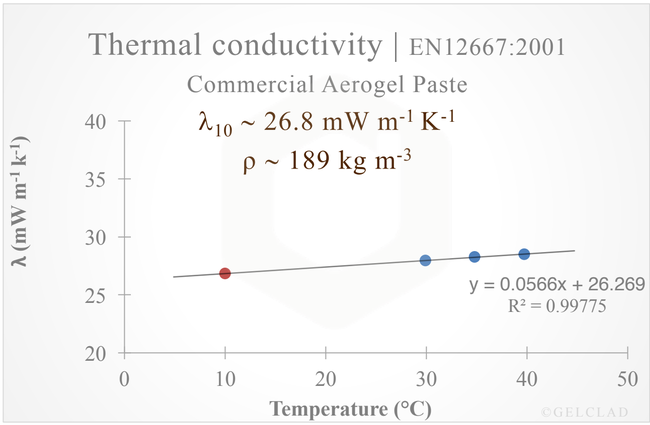
Commercial Aerogel Granules

Properties	Value
Apparent density (kg m^{-3})	139
Thermal conductivity (λ_{10} mW m^{-1} K^{-1}) EN12667:2001	23,0
Specific surface area (m^2 g^{-1})	559

activeaerogels

Commercial Aerogel Paste





GELCLAD NANO-INSULATION AEROGEL CORE

Current Project Status – Present aerogel physical properties and insulation performance

Aerogel production strategy - Ambient Pressure Drying

Supercritical Fluids Drying (SFD) involve complex and costly processes, which hinders a large scale production and inhibits the wide exploitation potential of silica aerogels. The use of much more advantageous surface modification of silica elements with alkyl groups, followed by the gel's APD, makes the manufacturing of silica aerogel more simple and affordable.

AA superinsulation aerogel granules developed for GELCLAD

GELCLAD objective
Aerogel $\lambda \sim 20 mW\ m^{-1}\ K^{-1}$

Properties	Value
Apparent density (kg m^{-3})	70-90
Thermal conductivity (λ_{10} mW m^{-1} K^{-1}) EN12667:2001	~ 17

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GELCLAD NANO-INSULATION AEROGEL CORE

Starting stage – Aerogel rigid board mechanical performance

Mechanical properties	Value
Compression behaviour σ_{10} EN 826	130 kPa EPS&PU 60-100 | XPS 200-300 kPa E = 1 445 kPa
Bending behaviour σ_b EN 12089	203 kPa [EPS 150 σ_b > 200 kPa]
Cohesion σ_{mt} EN 1607	45 kPa EPS&PUR > 50 | XPS > 100 kPa
Adhesion to WPC σ_{mt} EN 1607	47 kPa

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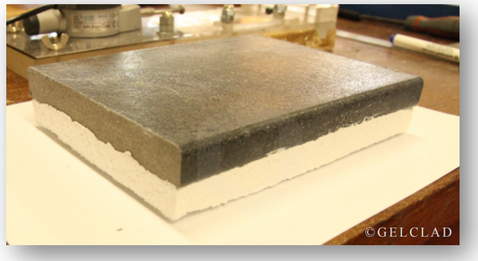
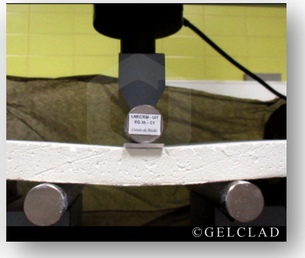
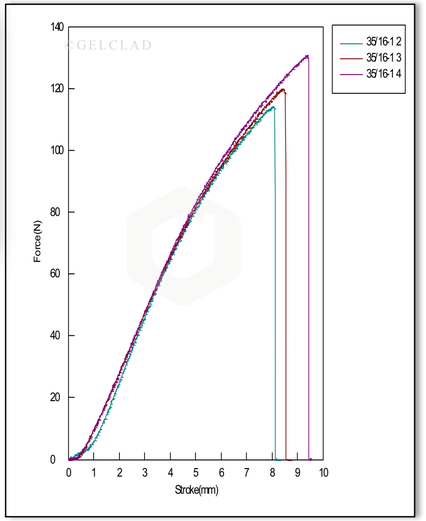


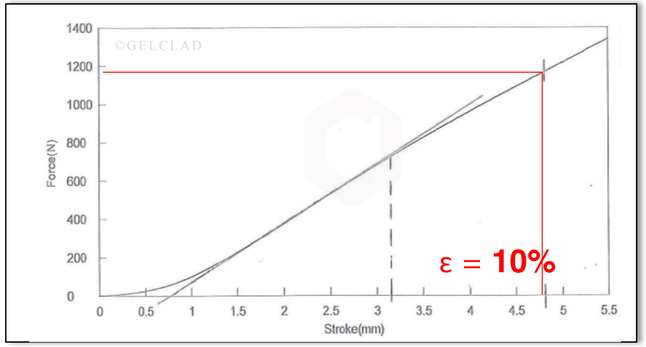
Adhesion tests



Flexural strength **tests**

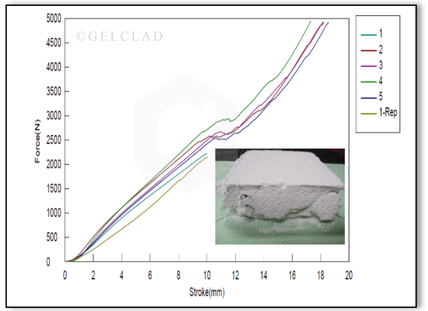


Flexural strength evaluation



Compressive Young's Modulus evaluation

Cohesive strength **tests**



Compressive strength **tests**

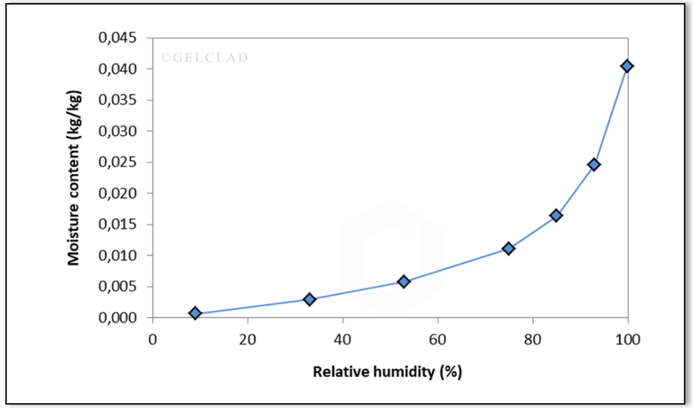
GELCLAD NANO-INSULATION AEROGEL CORE

Starting stage – Aerogel rigid board hygrothermal properties

Hygrothermal properties	Value
water absorption by partial immersion (W_p) **EN 1609**	1 hour partial immersion - Wp = 0.10 kg/m^2 1 day partial immersion - Wp = 0.19 kg/m^2 7 days partial immersion - Wp = 0.28 kg/m^2 EPS: < 0.5 kg/m^2 XPS: < 0.5 kg/m^2 PUR = < 0.5-1 kg/m^2
water vapour transmission properties (μ) EN 12086	μ = 25-30 - dry cup (0-50% RH; 23 ºC) μ= 4-5 - wet cup (0~99% RH; 23 ºC) EPS: μ ~ 20-70 XPS: μ ~ 50-300 PUR = μ ~ 60

water absorption **tests**

water vapour transmission **tests**



Hygroscopic sorption isothermal curve EN 12751

GELCLAD NANO-INSULATION AEROGEL CORE

Starting stage – Aerogel rigid board indicative fire performance

Ignitability tests	Preliminary Results / Comments
EN ISO 11925-2 (construction products)	No ignition/flame spread No smouldering combustion (preliminary results – still under evaluation) EPS: class E/F | XPS: class E/F | PUR/PIR = class E/F/D
UL94	V0 (preliminary results)

Preliminary fire performance tests
small flame - 30 s attack– edge and surface

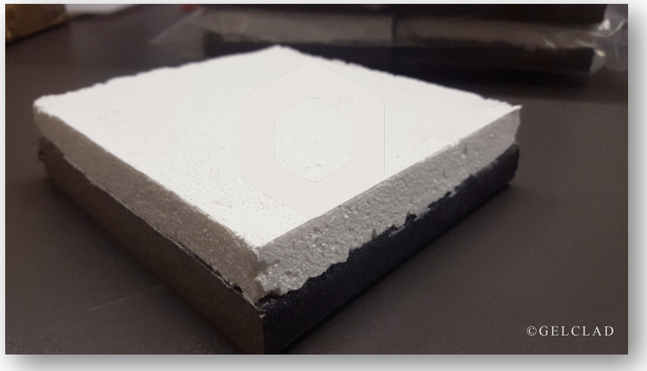
GELCLAD NANO-INSULATION AEROGEL CORE

Current Project Status – Aerogel paste RTD processability tests

AA aerogel paste

AA aerogel material extrusion tests

AA aerogel extruded samples

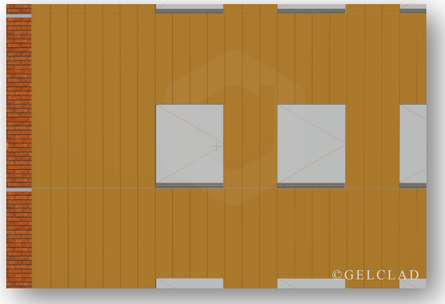


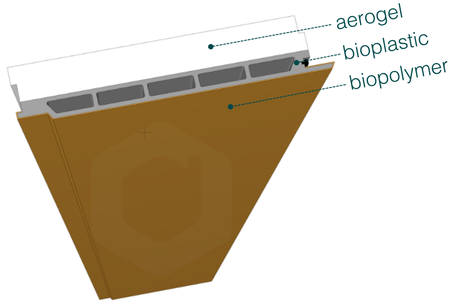
Dried AA aerogel paste on a WPC

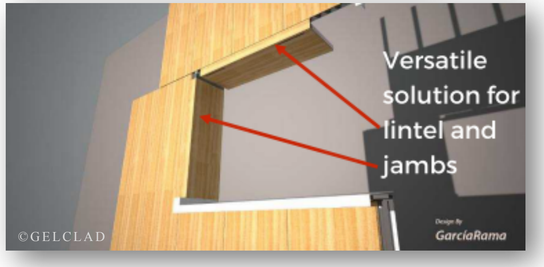
GELCLAD
Installation

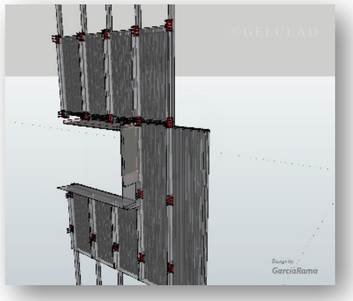
GELCLAD Features

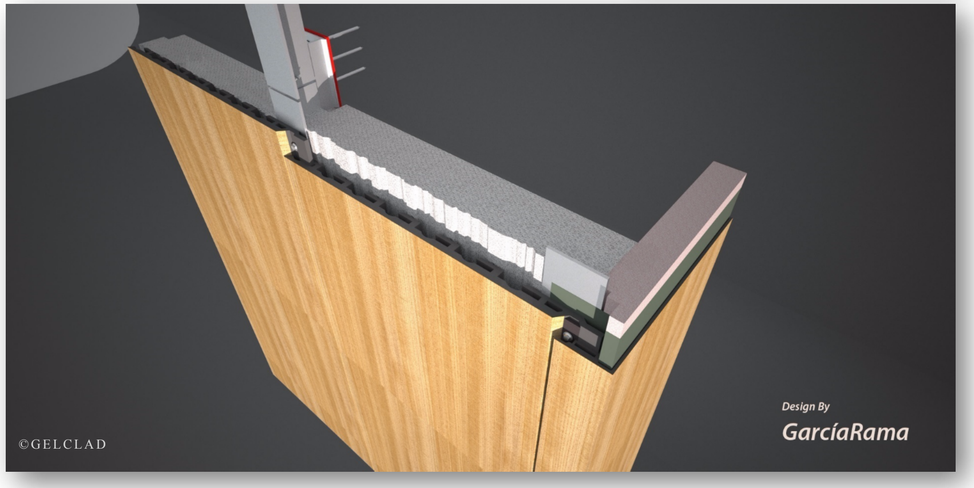
- **Fast and easy installation with standard fixing elements and tools**
- **Vertical installation - easily connectable panels, fastening to the wall with adhesive mortars/anchoring or Al fixings**
- **Easy to handle and cut on-site**
- **Corner finishing possibilities**
- **Possible to assembly to lintels, jambs and window sills**
- **UV resistant and weatherproof**
- **Maintenance friendly - no painting, protection or special aftercare after installation**
- **Stylish exterior wall cladding with different aesthetics and colours possible.**







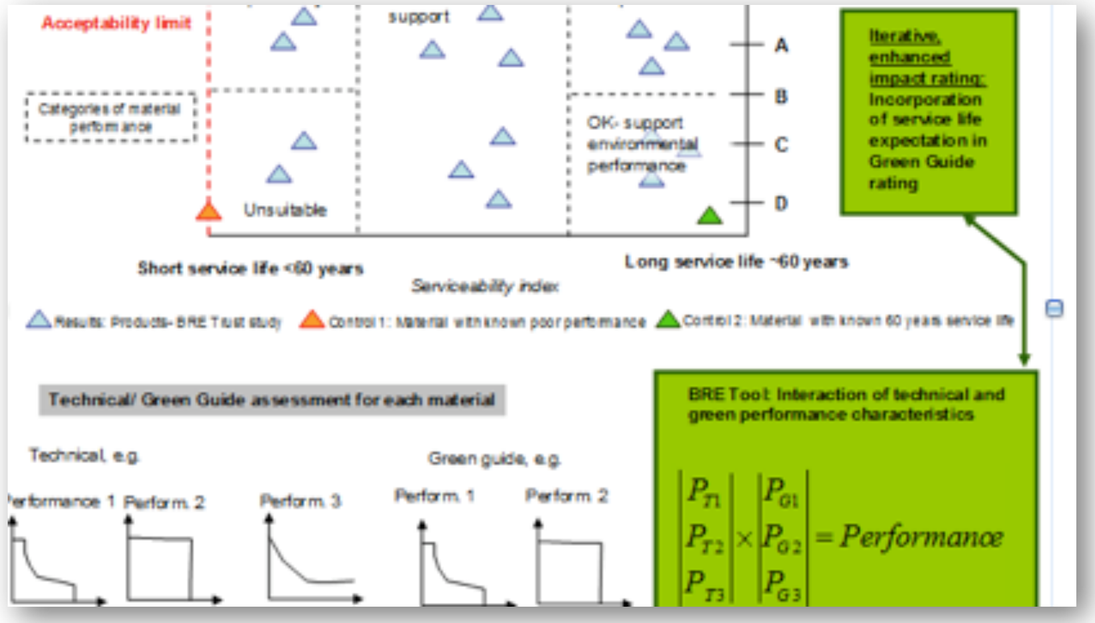




GELCLAD
Environmental and Economic Analysis

Interaction of performance requirements:

- **Thermal**
- **Fire**
- **Structural**
- **Durability**
- **LCA/ environmental**
- **Costs**
- **Energy**



LCA decision making matrix example

Cross-disciplinary decision making and optimisation matrix

GELCLAD
Environmental and Economic Analysis

GELCLAD evaluation procedure

- Using SimaPro (and similar) to collect, model and analyse LCA data
- **NOTE: multidisciplinary aspects are being mapped- not just LCA**
- Defining goal/ scope of Gelclad function, including inputs relate to performance expectation and also relative to established systems.
- Complete life cycle inventory, including processes, product stages
- Assemble database information.

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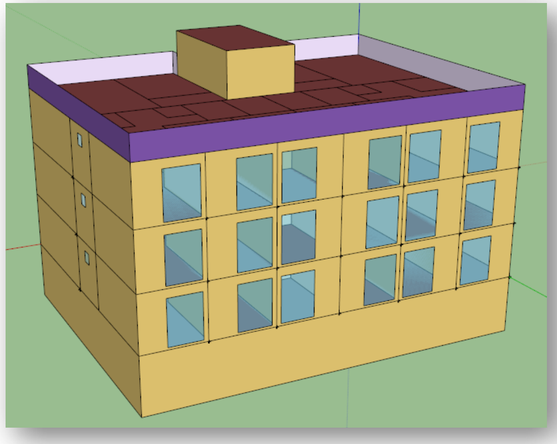
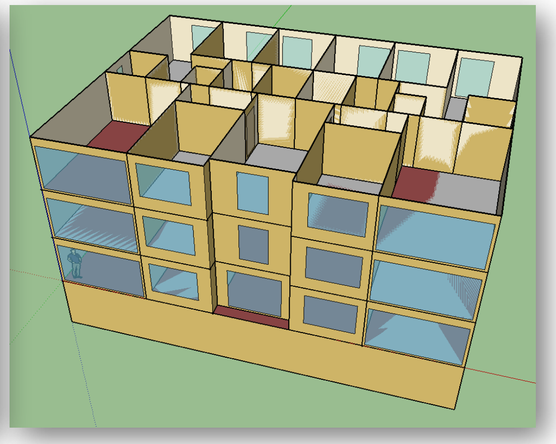
Energy efficiency simulations

Refurbishment of typical old dwelling multi-storey building

Building data

- Treated floor area 640 m^2
- External wall area 402 m^2
- Window area – South 59 m^2, North 57 m^2, East and West 6,5 m^2





Assessment of heating and cooling demands
for three different climates

- Porto, Portugal (Warm)
- Ljubljana, Slovenia (Cold-temperate)
- Stockholm, Sweden (Cold)

Comparison between two types of façade refurbishment

- GELCLAD panel
- Ventilated façade with mineral wool

Heating and cooling demands calculated for existing and refurbished building with each different type of façade lining

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Energy efficiency simulations

Input data and calculation assumptions

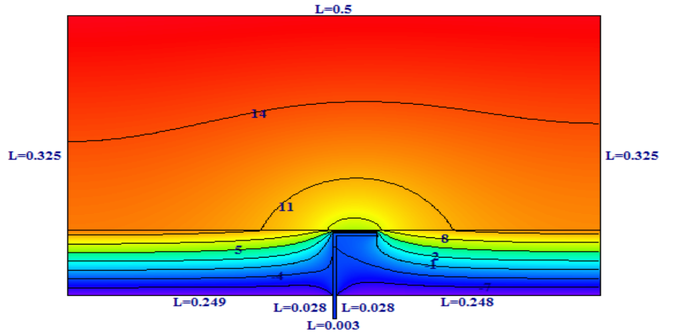
- Refurbishment of buildings following to meet NZEB standard
- All non- transparent building assemblies on building envelope were thermally insulated (e.g. roof, floor, façade)
- U-value < 0,8 W/m²K for windows was taken into account
- Thermal bridges calculated according to EN ISO 10211 with help of HEAT2 software for window installation and for Al fixings through insulation for each façade lining. Other thermal bridges (external wall-basement, internal wall-ground, extension wall-roof, external wall-ceiling) also assessed and the same value taken in all variants.
- For simulation purposes it was only varied the type of façade and thickness of façade insulation
- Thicknesses of thermal insulation for each façade lining selected according similar end thermal performance or similar end thickness of lining
- Internal air temperature set points were 20°C in winter and 25°C in summer time

Thermal conductivities:

- GELCLAD Aerogel $\lambda = 20$ mW m^{-1} K^{-1}
- Mineral wool $\lambda = 36$ mW m^{-1} K^{-1}

Calculation software

- PHPP9 (Passive House Planning Package) (Passivhaus Institute, Germany)
- Heat 2 (Blocon, Sweden) – according to EN ISO 10211
- .



Al fixing (λ = 0,05 W/mK) representing a high thermal bridge

Data for a 15 cm thick MW Ventilated Façade

Building assembly		Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a] 7 Months	Radiation-load cooling period [kWh/a] 5 Months	Fraction of transmission heat losses
North windows	56,7 m²	0,99	1822	1968	16,7%
East windows	6,48 m²	1,05	387	453	2,0%
South windows	58,83 m²	0,99	7520	4358	17,3%
West windows	6,48 m²	1,05	425	446	2,0%
External wall - Ambient	402,11 m²	0,22	211	646	26,1%
Roof/Ceiling - Ambient	229,6 m²	0,16	12	522	11,2%
Floor slab ⌶ Basement ceiling	229,6 m²	0,25			7,1%
Thermal bridges Ambient	345,044 m				17,0%

Note;: Al bracket thermal bridge contributes around 11% to the 17% of fraction of transmission heat losses.

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Energy efficiency simulations

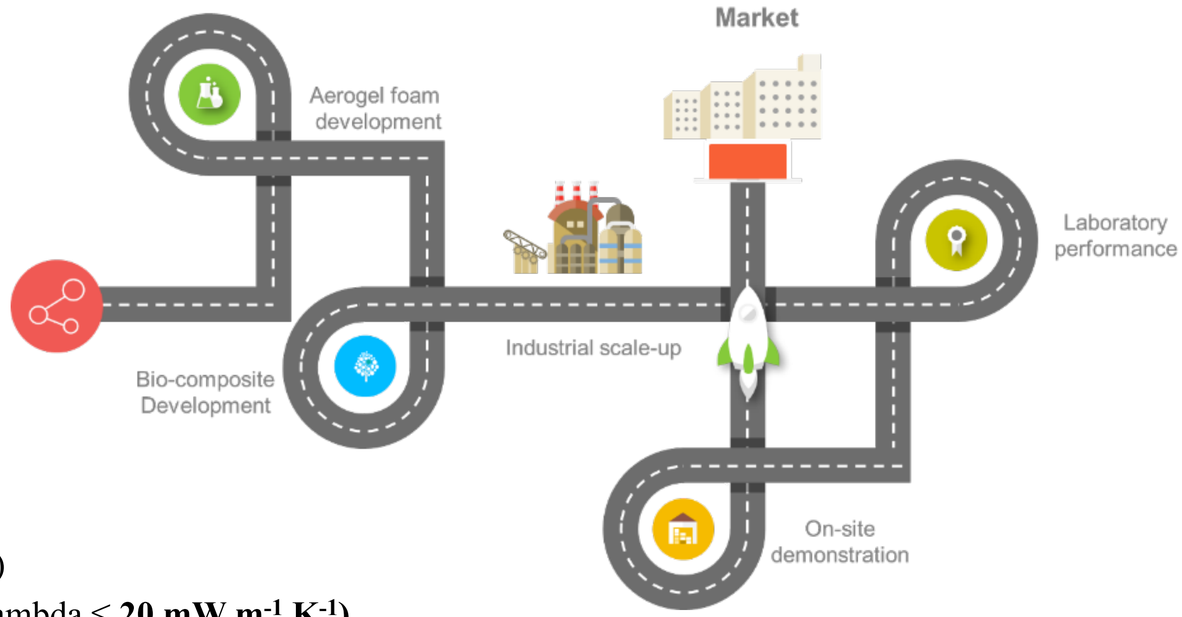
Preliminary results

Location	Climate	building characteristic	Unrefurbished
LJUBLJANA	**Cold-temperate**	Heating demand kWh/(m^{2}a)	258,2
		Heating load W/m^2	104,4
		Cooling & dehum. demand kWh/(m^{2}a)	4,5
		Cooling load W/m^2	21,5
STOCHOLM	**Cold**	Heating demand kWh/(m^{2}a)	341,3
		Heating load W/m^2	123,6
		Cooling & dehum. demand kWh/(m^{2}a)	2,9
		Cooling load W/m^2	19,2
PORTO	**Warm**	Heating demand kWh/(m^{2}a)	83,4
		Heating load W/m^2	44,7
		Cooling & dehum. demand kWh/(m^{2}a)	8,8
		Cooling load W/m^2	15,6

Location	Climate	building characteristic	Façade insulation		
			GELCLAD	Ventilated Façade	
LJUBLJANA	**Cold-temperate**		Aerogel 80 mm	MW 75 mm	MW 150 mm
		Heating demand kWh/(m^{2}a)	15,6	29 ,1	20,3
		Heating load W/m^2	13,5	19,0	15,4
		Cooling & dehum. Demand kWh/(m^{2}a)	1,1	1,0	1,0
		Cooling load W/m^2	6,3	6,8	6,3
STOCHOLM	**Cold**		Aerogel 80 mm	MW 75 mm	MW 150 mm
		Heating demand kWh/(m^{2}a)	23 ,7	41 ,8	30,2
		Heating load W/m^2	16,1	22,2	18,3
		Cooling & dehum. Demand kWh/(m^{2}a)			
		Cooling load W/m^2			
PORTO	**Warm**		Aerogel 30 mm	MW 50 mm	
		Heating demand kWh/(m^{2}a)	1,8	3,8	
		Heating load W/m^2	5,8	7,3	
		Cooling & dehum. Demand kWh/(m^{2}a)	1,7	1,5	
		Cooling load W/m^2	5,4	5,4	

Note;: A GELCLAD system using Al bracket fixings in a cold climate can represent a heating demand around 29 kWh/m^2 and a heating load of 18 W/m^2.

GELCLAD
Road to Market



End-users requirements…

- **Available** and **affordable** (ideally lowering the range of 120-70 €/m^2 to 70-40 €/m^2)
- **Provide superior thermal insulation** performances at reduced thickness (aerogel lambda ≤ **20 mW m^{-1} K^{-1})**
- Support sustainability and **eco-friendly** principles
- Capable of having a modular/**high replication potential** (new and retrofit building systems)
- Fulfil and secure **fire** and **mechanical performance standards**
- **Deliver swift and non-complicated installation**
- **Provide extended service life** with minimum maintenance requirements
- Offer modern **aesthetics**.

GELCLAD
Road to Market

Draft plan for commercialization has been established aiming at maximising GELCLAD market penetration

- Main raw material suppliers: ACTIVE AEROGELS (PT) and TECNARO (GE)
- Western, Central and Northern Europe production/distribution: VANNPLASTIC (UK)
- Eastern Europe production/distribution: NAVODNIK (SL)
- Primary end-users: JUB d.o.o (SL), SGG affiliates (SL) and GARCIA RAMA (ES)

- Special and tailored-made commercial and licensing agreements.

GELCLAD
Nanosafety cooperation

Case study for the identification of potential nanoparticle sources of emissions and exposure levels

Objectives

- **Identification of potential sources of emissions**
- **Assess workers exposure levels to process particles**
- **Physico-chemical characterisation of collected particles**
- **Estimate process particles emission rates and potential background contribution**
- **Use the work environment and far field concentrations to test exposure assessment models.**

http://www.nanocalibrate.eu/home

Calibrate project - **NRCWE**

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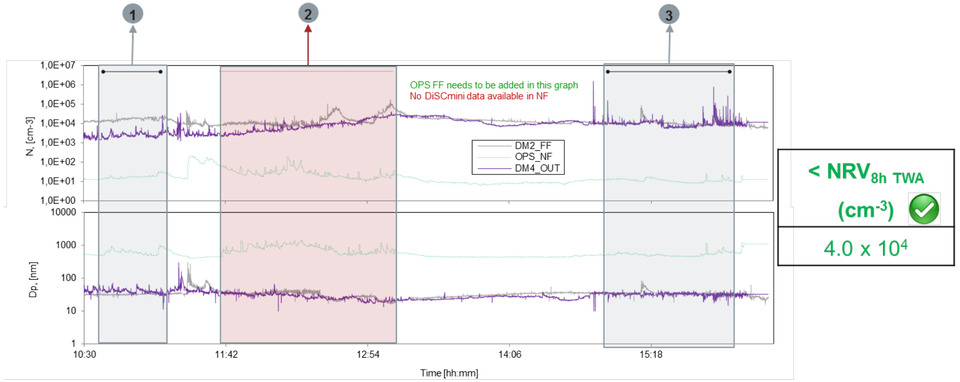
GELCLAD project

GELCLAD
Nanosafety cooperation

Case study for the identification of potential nanoparticle sources of emissions and exposure levels



Activities made:

- **May 2017: Nanoparticle measurements during aerogel manufacturing, Coimbra, Portugal**

Activities planned:

- **During 2018: large scale testing of GELCLAD product**
- **During 2019: installation of GELCLAD product in real buildings façades.**

Calibrate project - **NRCWE**

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GELCLAD project

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Find us next at…

Thank You!

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HIGHLY EFFICIENT CLADDING ECO-PANELS WITH IMPROVED NANO-INSULATION PROPERTIES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723425

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