SUREFIT

SUstainable solutions for affordable REtroFITof domestic buildings

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Technology Transfer Plan 1

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Publishable summary

This document, deliverable D9.7 “Technology Transfer Plan 1”, contains the initial analysis on the Technology Transfer strategy for SUREFIT results. Technology Transfer is the heart of every research and entrepreneurial ecosystem. It indicates the movement of knowledge, skills, know-how, and other valuable assets of the organization which is driven by profit (Solutions, 2022). The definitions and concepts of Technology Transfer have been discussed in many different ways based on the disciplines of research and according to the purposes of the research (Bozeman, 2000).

In this deliverable, the definition of Technology Transfer is explored, the Life Cycle of Technology is presented, along with the basic Technology Transfer Models that are found in Bibliography.

Furthermore, in order to give to the reader of this Deliverable the whole scope of the present research, the SUREFIT Innovating Technologies - Passive and Active - are analysed.

In Technology Transfer process, stakeholders are very important. Therefore, a thorough analysis of the Internal Stakeholders and the technology that they will own (if it occurs) is thoroughly presented. Additionally, we mention the External Stakeholders and we indicate how they can take advantage of SUREFIT Technology.

To continue, the Dissemination strategy is mentioned to emphasize its importance as well as the Exploitation strategy, adding more information about the commercialization of the possible outcomes.

Finally, the deliverable concludes with the Technology Transfer Goals, Performance Measures and Reporting method.

This document can be used as an internal manual by partners to engage correctly with Technology Transfer. The information will be updated regularly and will be monitored. In the following months, when the installation of the technologies will be realised and their performance will be monitored, a more specific and tailor-made Technology Transfer Plan will be devised. In addition, an updated version D9.8 “Technology Transfer Plan 2” will be submitted in M48.

Introduction

The aim of the SUREFIT project is to demonstrate fast-track renovation (40% reduction in implementation time) of existing domestic buildings by integrating innovative, cost-effective, and environmentally conscious prefabricated technologies. The project is about to reach the target of near zero energy through reducing heat losses through the building envelope and energy consumption by heating, cooling, ventilation and lighting, while increasing the share of renewable energy in buildings. This will be achieved through a systematic approach involving key stakeholders (building owners and users, manufacturers, product, and services developers) in space heating, cooling, domestic hot water, lighting and power generation, as well as a demonstration phase in five representative buildings in different climates.

In summary, SUREFIT aims to achieve:

1) Reduction in primary energy use and carbon emission by 60%;
2) Reduction of cost by 50%;
3) Reduction of time for renovation by 40%.

Technology Transfer initiatives are at the core of SUREFIT mission. The target is to disseminate & exploit research that will result in using data and innovation to promote access to opportunities and innovations.

This Technology Transfer plan outlines the people and organizations involved in the process, the activities they undertake, and the desired outcomes to help assure that the SUREFIT technologies will be adopted. The Technology Transfer Team will be led by the WP9 leader and will identify the steps needed to ensure the new technology is helpful, can be used and will be used as widely as possible. When writing this plan, the goals were to maximize the positive impact of the findings on the public good.

1 Technology Transfer – The Basics

1.1 Definition

Technology Transfer is the heart of every research and entrepreneurial ecosystem. Technology Transfer indicates the movement of knowledge, skills, know-how, and other valuable assets of the organization which is driven by profit (Solutions, 2022). The definitions and concepts of Technology Transfer have been discussed in many ways based on the disciplines of research and according to the purposes of the research (Bozeman, 2000).

Technology Transfer needs to be understood in terms of three objectives (Hoffman, 1990):

- the introduction of new techniques by means of investment
- the improvement of existing techniques and
- the generation of new knowledge.

In addition, it should be kept in mind that Technology Transfer does not only transfer the technical know-how (knowledge) required to produce a product but also the capacity to master, develop and later produce autonomously the technology underlying the products (Chesnais, 1986).

1.2 The Importance of Technology Transfer

Technology Transfer as a process is important for several reasons, such as:

- It develops early-stage intellectual property into tools for direct use by the research community
- It develops early-stage intellectual property as a basis for new platforms, products, or services to be made into products for public use
- It helps promote the research institution and its commercial partners
- It influences the economic performance of nations and firms (Mansfield, 1975)
- It is a strategic mean of meeting challenges posed by the globalization of business

1.2.1 Technology Life Cycle

Technology management involves the implementation the following five stages (Rani, 2018):

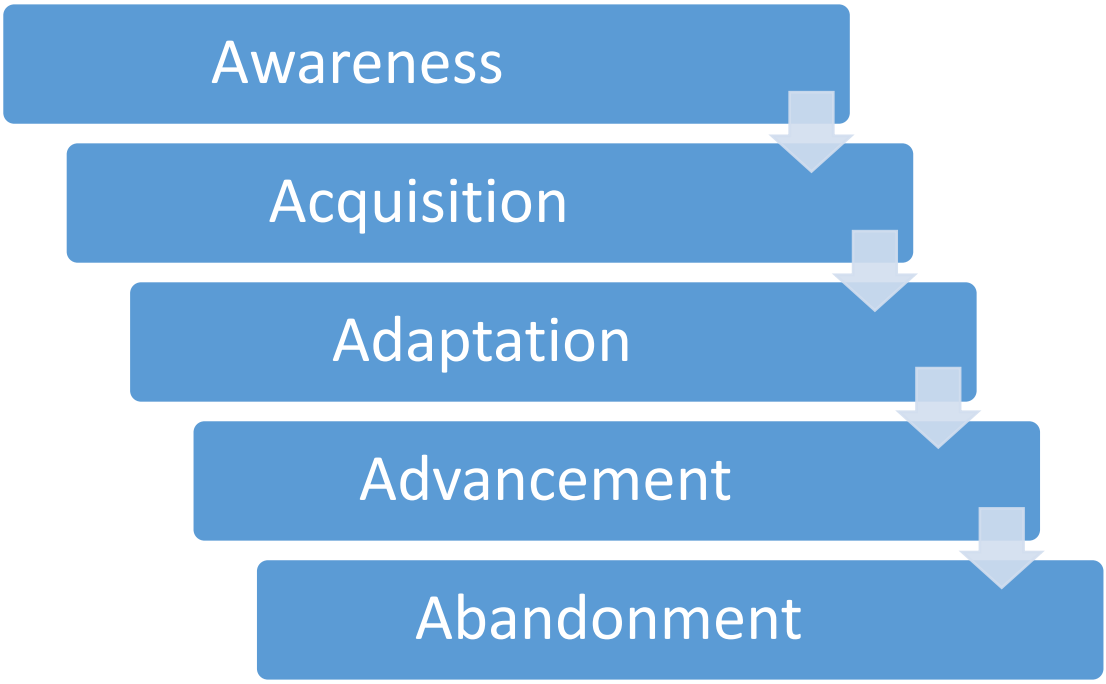


Figure 1 – Technology Life Cycle

1. **Awareness phase** is the initial phase of the technology life cycle. The company in this stage creates a formal mechanism to learn the emerging technologies needed.
2. **Acquisition phase** deals with the actual acquisition of a specific technology. It includes the preparation of a technical feasibility study as well as an economic - commercial feasibility study before deciding how to deal with the technology (develop or outsource).
3. **Adaptation phase,** every company ends up with a technology for its needs and uses it to perform business and produce goods.
4. **Advancement phase**, at this stage the exploitation of the technology starts. The technology must advance (i.e., improve) to keep the company sustainable and secure its growth.
5. **Abandonment phase** is the last step of the technology life cycle and very critical since decisions are made concerning the future of the technology with a possible rapid discarding if needed.

1.2.2 Technology Transfer Models

Technology Transfer is a complicated multi-stage process. It originates mainly in the idea creation and results in the capitalization of the technology transfer object transferred by the receiving organization. There are multiple Models. The most popular are presented below:

1.2.2.1 The Chantramonklasri Model

The Chantramonklasri Model depicted by Chantramonklasri in 1990:

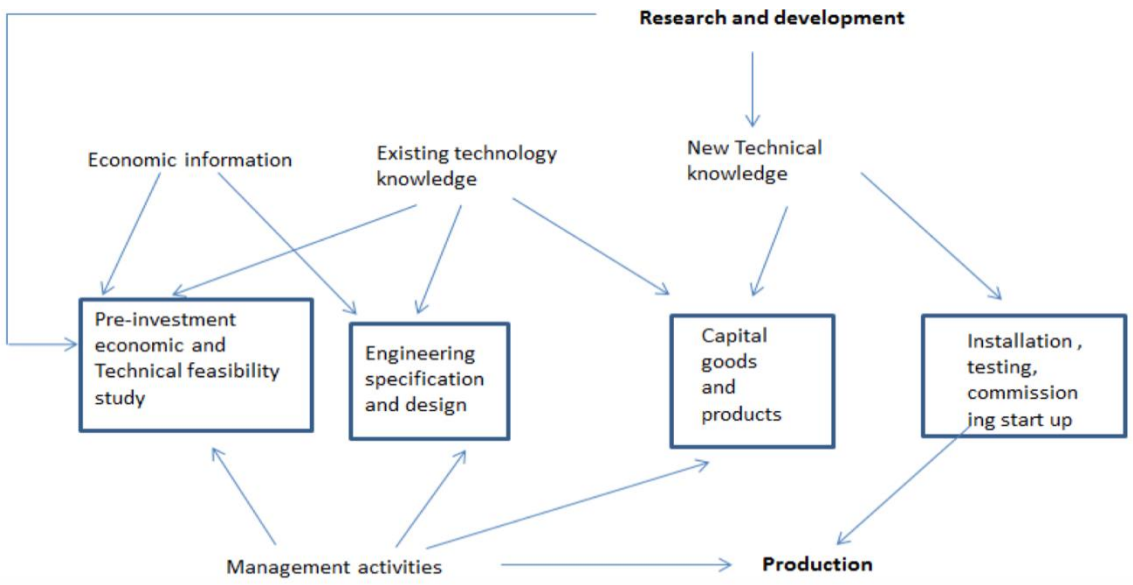


Figure 2 – The Five-phase model of international technology transfer

The five phases of this model are the following (Ramanathan, 2007):

- Carry out a pre-investment and feasibility study
- Develop the engineering specifications and design based on the feasibility study
- Commence capital goods production
- Commission and start-up including comprehensive of the workforce
- Commence commercial production

The first two stages of the Chantramonklasri Model are valid but in theory it is not clear whether the needed capital goods can be produced in the setting unless the transfer arrangement also includes the transfer of technology needed to manufacture these.

1.2.2.1 The Behrman and Wallender Model

Behrman and Wallender (Steenhuis, 2005) mentioned 7 stages for technology transfer. The first three stages occur before to start-up of the business: (1) identifying the proposals for site location (factory) and planning of the procedure, (2) making changes to the product designs, and (3) design and build the facilities. In the following stage (No 4), start-up activities play a major role and this demands high efficient personnel. In the 5th stage the focus of attention is shifted toward improving cost-effectiveness. In the 6th stage, product development takes place, and the

7thstage external support is improved. The last 3 stages of the model deal with production management issues and the actual technology transfer (for example the establishment of technology at a new location etc).

1.2.2.2 The Bar-Zakay Model

Bar-Zakay (1971) developed a comprehensive model based on a project management approach. He divided the Technology Transfer process into the Search, Adaptation, Implementation, and Maintenance stages. The process to be carried out is depicted in detail in this model. There is a special emphasis in the importance of both the transferor and transferee acquiring skills to undertake technological forecasting and gathering of project-related intelligence. But there are some disadvantages in this model as Jagoda (Jagoda, 2007) points out: *"The model has limited relevance today since many of the activities, terms, and ideas expressed reflected the setting of the late 1960s to early 1970s, when buyers of technology were mainly passive recipients who depended greatly on aid programs for the purchase of technology. It was also an era when government controls were instrumental in determining the rate, direction, and scope of technology flows."*

1.2.2.3 The Dahlman and Westphal Model

This model can be considered as an improvement of the Behrman and Wallender model. It emphasizes a lot on the transferee involvement in all the stages of the technology transfer.(Lin, 2012) The model involves the following 9 stages:

1. Pre-investment feasibility study.
2. Preliminary identification of technologies needed.
3. Basic engineering studies technology to be transferred.
4. Detailed engineering study.
5. Selection of suppliers for equipment and subcontracting services.
6. Preparation and execution of a training and education plan.
7. Construction of the plant.
8. Commence operations.
9. Develop trouble-shooting skills (Ramanathan, 2007)

1.2.2.4 The Schlie, Radnor, and Wad Model:

This model proposes a simple, generic model that delineates 7 elements that can influence the planning, implementation, and eventual success of any technology transfer project (Ramanathan, 2007):

1. The transferor.
2. The transferee.
3. The technology (that is being transferred).
4. The transfer mechanism.
5. The transferor environment.

6. The transferee environment.
7. The greater environment.

Closing this section, Bozeman (2000) has indicated a contingent effectiveness model relevant to inter- firm technology transfer. In this model, the key elements of the transfer process are:

- The transfer agent (the transferor).
- The transfer mechanism.
- The transfer object (the content and form of the technology being transferred).
- The transfer recipient (the transferee).
- The demand environment (market and non-market factors vis-à-vis the need for the technology).

2 SUREFIT Innovative Retrofitting Technologies

2.1 Definition of the case

During the past years, the European Environment Agency (EEA) (EEA, 2022) has recorded a significant increase in urbanization trend. City centres are constantly expanding in terms of population numbers, occupied areas, energy demand and pollution levels. Urban buildings constitute 30 to 40% of the global final energy use, while in Europe, domestic houses consume approximately 40% of the continent's total energy. In addition, they are attributed almost 36% of European greenhouse gas (GHG) emissions. Therefore, deduction in energy demand, and decrease of consumption levels are essential in order to challenge the already existing, and forthcoming (due to current global events) energy poverty issues (Alfonso Carfora, 2022); and achieve desired and viable sustainability levels (Cerezo-Narváez, 2021) as enacted by the Paris Agreement in 2015 (UN, 2015).

A CO_2 reduction of 77% in buildings and construction sector is fundamental in order to achieve the limit of 2°C until 2050 (Hamida, Ahmed, Asif, & Almaziad, 2021). In this truck, decrease in domestic energy consumption, and reduction of urban-related GHG emissions can be achieved by incorporating greener building technologies demonstrating lower environmental impact. However, building retrofitting is considered a particular high-priced process, which requires long-time occupation too.

The SUREFIT project aims to provide innovative retrofitting technologies, the combination of which will contribute to the reduction of primary energy use and CO_2 emissions, being at the same time economically efficient and attractive to the stakeholders.

The variable technologies presented hereinafter are categorized into passive and active based on their nature of function and are accompanied by their core properties. In addition, some additional significant results that are considered as Key Exploitable Results by the relevant partners are presented.

2.2 Passive Technologies

2.2.1 Bio – aerogel insulation (panel) – [KER3]

The technology of Bio-aerogel that will be used in the SUREFIT project has been developed by UNOTT. It is made of konjac glucomannan (KGM)/starch-based aerogels. In the boundaries of sustainable-product, bio-aerogels are consisted of natural raw materials from agriculture derived waste, such as wheat straw. Their formation process is attributed very low environmental impact/footprint. The method of freeze-drying administers good thermal insulation and favourable mechanical

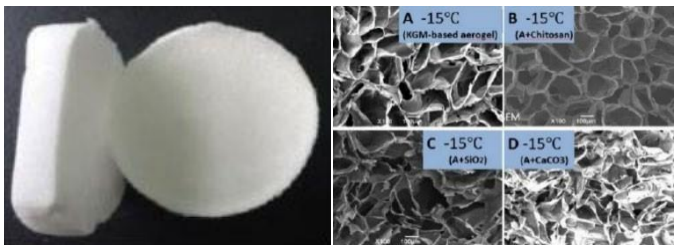


Figure 3 – Bio-aerogel

properties to the final product. Bio-aerogels present high surface area, excellent thermal and acoustic properties, low density and thermal conductivity, high porosity, flame and humidity resistance, low refractive index and dielectric constant. However, this type of aerogels associates with high manufacturing costs, impending to potential low market growth. High production price can be explained by the low product maturity level. Though, with market maturity increase, cost of purchase is reduced. The aerogel market is expected to exhibit growth at a compound of annual-growth-rate between 30.8% and 31% during period 2017-2023. Further analysis of the bio-aerogel technology can be found in the deliverable report D4.1 of the SUREFIT project.

Bio-aerogels Properties		
	Value	**Unit**
Materials	konjac glucomannan (KGM)/starch	-
Density	43	kg/m^3
Thermal conductivity	0.037	W/(mK)
Specific heat capacity	2260	J/(kgK)
Moisture permeability	65	GNs/kgm
Overall product thermal	0.024	W/(mK)
Safety	Non-toxicity and biodegradable	-
Lifespan	30	years
Cost - purchase	69.8	€/m^2

Table 1 - Bio-aerogel data

2.2.2 Insulation breathable membrane – [KER9]

Figure 4 - WINCO Skytech breathable membrane

The breathable membrane developed by WINCO achieves a closed envelope when implemented. It increases the tightness against wind (airtightness), promotes prevention of thermal bridges and reflects up to 95% of the radiation, resulting to better indoor comfort levels during summer period.

The incorporation of the insulating membrane will bring also better control of internal conditions since active heating or cooling requirements will be reduced. A 16 dB noise reduction will be also achieved. Installing the breathable membrane requires rafters and wood sheathing. The air tightness capacity in each partner-country's demonstration building will be tested via the pulse technique developed by UNNOT.

WINCO Skytech breathable membrane Properties		
	Value	**Unit**
Thermal conductivity	0.029	W/(mK)
Density	96.15	Kg/m^3

Sound reduction	-16	dB
Available thickness	6, 13, 26	mm
Airtightness	0.16 – 0.18	m^3/hm^2
Thermal resistance	1.50, 1.70, 2.20	m^2K/W
Water vapor resistance	0.022, 0.041, 0.080	m
Vapor resistance	0.11, 0.20, 0.40	MNs/g
Life span	30	years
Cost - purchase	10.80	€/m^2

Table 2 -WINCO Skytech Breathable Membrane data

2.2.3 Photovoltaic vacuum glazing windows – [KER5]

The structure of vacuum glazing window is commercially mature, and it is similar to the double-glazed unit, however the cavity indicates no gas, but vacuum. Vacuum acquires significantly more effective insulation levels compared to any gas. In addition, greater performance in terms of acoustics and sound reduction accompany the VG windows. The PV component on the window is integrated in the form of thin-elastic-films. PVVG exhibits three different components:

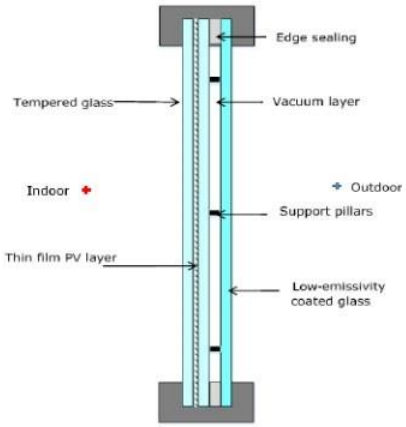


Figure 5 – PV-VG 3 layers configuration

- The self-cleaning coated glass,
- the vacuum-filled layer and finally,
- a thin film PV glass with additional grass cover.

Some of the technical properties are presented in the following Table. Further analysis of the PV vacuum glazing window technology can be found in the deliverable report D4.2 of the SUREFIT project.

PV vacuum glazing window Properties		
	Value	**Unit**
U-value	0.6	$W/(m^2K)$
Density	241	kg/m^3
Thickness	15.1	mm
Light transmittance	50	%
Solar heat gain coefficient (SHGC)	0.39	-
Solar shading coefficient	0.45	-
Lifespan	20	years
Solar to electricity generation efficiency	4	%

Cost - purchase	Under evaluation.	€/unit

Table 3 - PV-VG data

2.2.4 Integration of daylights and electric lighting – [KER13]

Electricity consumed by lighting systems occupies a significant percentage of the overall electricity consumption. To make full use of daylight a layout incorporated in the window is introduced by Koester. Using such systems, the electricity consumption can be reduced, whereas glare issues can be prevented. This configuration facilitates the daylight to be redirected up to 6m into the depth of the room, while the direct sun rays are retro-reflected.

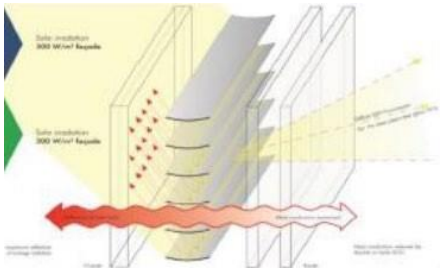


Figure 6 – Light louvers by Koester

2.2.5 PCM (panels) – [KER4]

The working principle of Phase Change Materials is connected to their heat capacity and latent heat characteristic. They constantly release and absorb sufficient energy at phase transition to provide useful heat/cooling. Their constant change of physical state from solid to liquid and vice versa occurs in fixed temperatures and the released/absorbed energy during the transition process is greater than the sensible heat (body exchange heat-thermodynamically) of the medium.

Figure 7 – PCM panels

Introducing PCMs into a building block or panel can increase the energy storage density of material. Additionally, if integrated into the insulation, the transfer of heat to, and from, indoor environment is decreased. Thereof, PCMs are characterised by smooth temperature variations about a set value. UNNOT together with PCM products have developed PCM in form of panels (*Figure 7*). More information about PCM panels is presented in the deliverable D4.3 of the SUREFIT project.

PCM Properties		
	Value	**Unit**
Thermal conductivity	0.21 – 0.23	W/(mK)
Density	765 - 1500	Kg/m^3
Specific thermal capacity	2.2 – 2.42	kJ/kg K
PCM solidification point	2	°C
PCM melting point	164	°C
Lifespan	25	years
Cost - purchase	93.60	$€/m^2$

Table 4 - PCM data

2.3 Active Technologies

2.3.1 Window Heat Recovery unit (WHR) – [KER7]

Ventilation of the living space is often achieved via opening of windows. As a result, significant indoor heat levels are lost, causing increase in heating fuel usage. The WHR system developed by UNNOT can reduce the annual energy bill by 20%. The units constituting WHR systems are small and can be installed/mounted on window frames. WHR operates via exploiting the room's lost heat to preheat the fresh air and save energy. It is presented that it bears the capacity to recover 70% of heat required to achieve indoor temperature/thermal comfort. A broader analysis of WHR system is presented in the deliverable report D4.6 of the SUREFIT project.

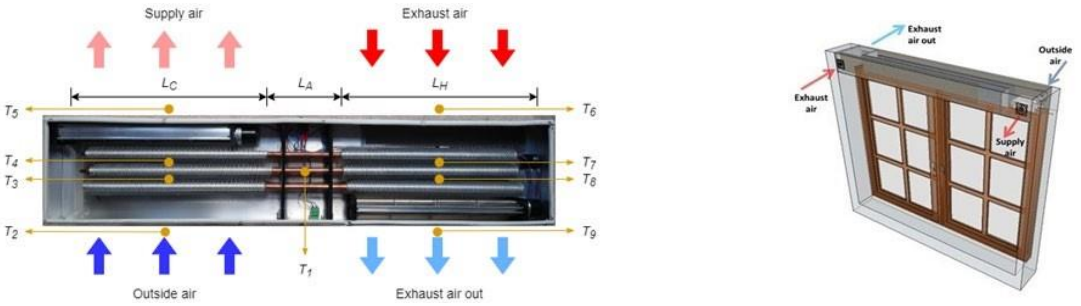


Figure 8 – Window Heat Recovery Unit

WHR system Properties		
	Value	**Unit**
Heat recovery efficiency	>70	%
Ventilation rate	10-60	m^3/h
Max fan power	34	W
Lifespan	20	Years
Cost - purchase	Under evaluation.	€/unit

Table 5 - WHR system properties

2.3.2 Photovoltaic Thermal system (PV/T) – [KER6]

PV/T is a hybrid technology combining Photovoltaics (PV) and thermal energy production (T). This system addresses the paradox regarding the operation principle of PVs. They require sunlight to generate power but suffer a degradation in performance as they get heated. The average efficiency of standard commercial PVs ranges from 10% to 15% conversion of solar radiation to electricity. The rest is depleted as waste heat.

SOLIMPEKS has developed the PV/T system which takes advantage of waste heat and exploits it for thermal heat production. Therefore, only a single panel is required to generate both

electricity and usable thermal energy. The PV module's heat is absorbed to produce hot water; this way, PV efficiency is optimised as heat is transferred into water for DHW production. Moreover, a percentage of the produced thermal energy can be used for space heating. PV/T system is analysed in the deliverable report D4.7 of the SUREFIT project.

PV/T system Properties		
	Value	**Unit**
Dimensions	1670x995x60	mm
Gross area	1.66	m_2
Weight	28.4	kg
Nominal power (W_p)	315	W
Short circuit current (I_{sc})	9.94	A
Open circuit voltage (V_{oe})	39.25	V
Max power voltage (V_{pm})	32.18	V
Liquid content	0.85	L
Max operating pressure	8.6	bar
Lifetime	20	Years
Cost - purchase	350	€/unit
Cost - maintenance	70	€/hour of work

Table 6 - PV/T data

2.3.3 Direct Expansion Solar Assisted Heat Pump (DX SAHP) – [KER10]

The solar assisted heat pump displays a combination of solar-air collector with the heat pump technology. UNNOT has developed a heat pump including direct expansion to provide heating and/or cooling and hot water for building. The operation principle of this particular technology towards heating implements utilization of ambient air as the heat source and incorporation of PV panels in order to extract solar energy. Cooling of PV panels will enhance its efficiency. The technology of solar assisted heat pump developed by UNNOT is analyzed further in the relevant deliverable report D4.4 of the SUREFIT project.

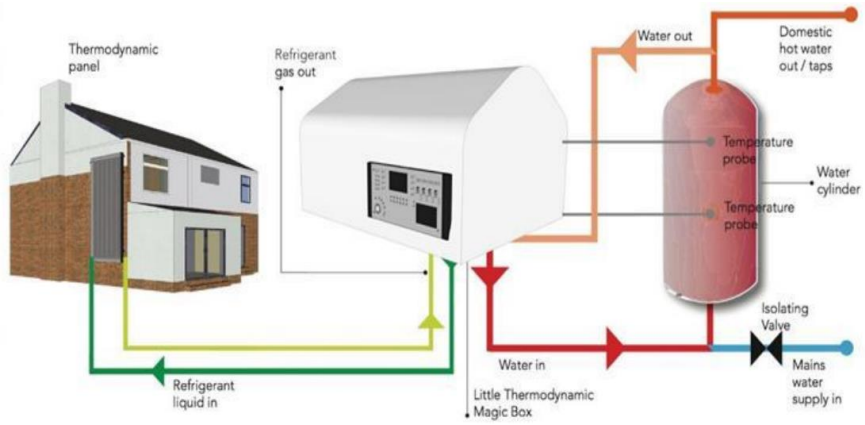


Figure 9 – Solar Assisted Heat Pump layout

SAHP system Properties		
	Value	**Unit**
System capacity	3.0	kW
	5	
	7	
	11	
Heated water output	52	L/h
	80	
	143	
	180	
Suggested water tank capacity	60-150	L
	150-260	
	200-320	
	200-420	
Delivery efficiency	98	%
Solar thermodynamic panels required (for system capacity)	1(3)	Panels per kW
	2(5)	
	3(7)	
	4(11)	
Cost - purchase	Under evaluation.	kW-€/unit
Cost - maintenance	180	€/year/unit

Table 7 - SAHP data

2.3.4 Ground Source Heat Pump (TP GSHP) – [KER10]

The GSHP has been developed by UNOTT. The innovative GSHP exploits hand-held piler for heat source. It brings low cost and easy installation compared with a conventional Ground Source Heat Pump. It is considered optimal for geographies with demonstrating unreachability to drilling. The system consists of thermal pipes which can be sold rods or tubes containing liquid such as propylene glycol/water. The heating of the pump is achieved by circuiting glycol. Some of the technical properties of the system are presented below. More technical information about the Ground Source Heat Pump can be found in the relevant deliverable report D4.4 of the SUREFIT project.

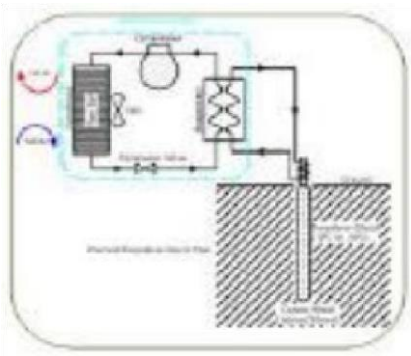


Figure 10 – Ground source heat pump

GSHP system Properties		
	Value	**Unit**
System capacity	1.3	kW
	3.0	
	6.0	
	7.0	
Heated water output	224.1	L/h
	517.2	
	1012.8	
	1344	
Suggested water tank capacity	250-300	L
	300-350	
	500-800	
	500-800	
Delivery efficiency	98	%
Life span	25	yrs
Heat pipe length required (for system capacity)	13(1.3)	meters
	30(3.0)	
	60(6.0)	
	70(7.0)	
Cost - purchase	Under evaluation.	kW-€/unit
Cost - maintenance	180	€/year/unit

2.3.1 Evaporative cooler – [KER8]

Air-conditioning systems consume substantial amounts of energy with an accompanied peak demands on the electricity supply infrastructure contributing to a large proportion of carbon dioxide emissions. Evaporative cooling is a highly energy efficient alternative where applicable. Dew point cooling could decrease the air temperature close to the dew point without moisture increase, so it maximises the cooling capability of the dry air, but most of the dew point cooling heat exchanger is complicated and not easy to make and also costly and not suitable for large airflow. *Figure 11*shows the basic structure of this novel dew point core for the proposed evaporative cooling system developed by UNOTT (UK Patent, Air conditioning, WO 2010/034994). This novel dew point core takes the same structure of the evaporative cooling pad structure. It has both advantages of the evaporative cooling pad, and dew point cooling, but without the drawbacks described above. Two core techniques are included in the novel cores, namely special corrugated plates for dew point cooling, and special sealing technology for the sealing. The core could easily be enlarged to treat large airflow without increase in pressure drop. The initial development of a psychrometric energy core (PEC) prototype has already been carried out by partners. The technology is reported in every detailed in the relevant Deliverable 4.5 of the SUREFIT project.

Figure 11 – Cooling units: PEC indirect cooler (left), PEC core (middle) and fibre cooler (right)

Evaporative cooler system Properties		
	Value	**Unit**
System capacity	0.5	kW
	1.0	
	3.0	
	4.5	
Airflow rate	504	L/h
	1008	
	3024	
	4500	
Water consumption	4.5	L/h
	9	
	27	
	39	
Delivery efficiency	98	%
Cost - purchase	0.5 – 450	kW-€/unit

	1.0 – 675 3.0 – 1687 4.5 – 2700	
Cost - maintenance	0	€/year/unit

2.4 Other significant results

Additional results have been identified as Key Exploitable Results by specific partners and these results are briefly presented below:

2.4.1 Optimum design, operation and control of renovation technologies – [KER1]

This result is considered by UNOTT in the form of a service that can be provided to all relevant stakeholders. It will be based on the relevant experience that will be gained throughout the implementation of the SUREFIT renovation technologies.

2.4.2 Renovation concepts – [KER2]

This result is considered by AALTO in the form of scientific knowledge that can be further used for research purposes. More specifically, this result is related to the expertise that will be gained by AALTO from the SUREFIT project regarding the renovation concepts of specific technologies, buildings and climates with the use of the appropriate software (IDA ICE or other).

2.4.3 User friendly computer program for planning and retrofitting of residential buildings – [KER11]

This result has been considered by ISQ as a user-friendly computer program to support the selection of optimal retrofitting strategies in each building, easing the selection of different technologies for different scenarios. The operational tool to be an open-source application that will help stakeholders to decide different possibilities for building retrofitting and renovation. Given the conditions of a building, the program will display available technologies for a specific function (e.g., façade), or a combination of them, and show how each technology could be installed quickly together with costs involved and potential energy saved.

2.4.4 Methodology and guidelines for buildings 'retrofitting – [KER12]

This result has been considered by ISQ as a brief handbook to give to every end user of the operational tool (homeowner, contractor, etc.) the essential knowledge, the requirements, method and best practices for a guided implementation and decision making and needed for renovation and retrofitting.

3 Stakeholders & Involvement

The most important part in Technology Transfer is to identify the stakeholders involved. A stakeholder is a party that has an interest in a company and can either affect or be affected by the business (Fernando, 2022). Stakeholders are very important since they can finance and adopt the research findings. SUREFIT researchers should identify stakeholders, understand their needs and thoughts and determine how the outcome will address those needs. SUREFIT stakeholders are separated in categories based on their distinct needs:

3.1 Internal Stakeholders

Internal Stakeholders can be considered:

- Those who perform the research (SUREFIT Partners)
- The University faculty of the academic partners
- Students, including those who serve as research assistants
- The EU Commission

The key internal stakeholders of the SUREFIT Project are:

- **Instituto de Soldadura e Qualidade (ISQ) – Institute**

ISQ is a private non-profit making technological association with Public Utility status. ISQ's mission is to contribute to the constant improvement of industry and services, resulting in an expanded international presence, by collaborating with the state, regional councils and businesses with regard to the sharing and development of technology, new products and processes, structured management practices and quality control, hygiene and safety, energy conservation and environmental protection, and systematic maximization of human resources. The strategy of ISQ growth goes through an increasingly important and sustained presence in the world having offices, branches and affiliates in 20 countries.

- **Advanced Management Solutions Ltd (AMS) – SME**

AMSolutions Ltd is an SME, founded in 2004 with the goal to provide state-of-the-art technical services and contract research to both public and private companies. Its activities are focused on two main areas:

- "Turnkey eco-solutions" improving the energy efficiency of the buildings.
- Research, production, integration and application of various environmentally friendly materials to improve energy efficiency in building, including new insulating materials and coatings.

- AMS has great experience in large civil engineering projects gathered during the Athens Olympics preparations. It has extensive experience regarding advanced industrial applications, having successfully commissioned over 100 projects.
- AMS has cooperated to the development and implementation of innovative eco-solutions with numerous companies active in building and the energy sector, ranging from oil processing to solar panel manufacturing.

- **University of Nottingham (UNOTT) – University**

University of Nottingham (UNOTT) is a research-led University in the United Kingdom with annual research awards totalling €190 million. It has the largest number of top-rated (by Higher Education Funding Council) Departments in UK Universities for research following Cambridge, Oxford and London Universities. It is the home of many ground-breaking discoveries and inventions such as magnetic resonance imaging and is also the 4th ranked UK University for research grant income from private industry.

- **SOLIMPEKS Solar Energy Corp. (SOLIMPEKS) – SME**

SOLIMPEKS is a market leading provider of cutting-edge technology in the solar energy field, established in Konya (Turkey) in 2009. It is part of a global network expanding over 70 countries, with over 40 years of experience in developing, manufacturing and distributing high end products for commercial and residential use. SOLIMPEKS manufactures the highly acclaimed aesthetically appealing Hybrid PV-Thermal (PV/T) solar collectors to achieve both hot water and power generation from the sun as a clean and free energy source. A combination of solar PV and solar thermal in a single unit, it is capable of delivering twice as much renewable energy in the same rooftop footprint as standard solar, therefore also delivering twice as much carbon displacement.

- **Winco Technologies (WINCO) – SME**

Founded in 1988, WINCO Technologies is a French company specialized in thermal and acoustic insulation. Acting in different countries all over Europe, Asia and America, WINCO Technologies has historical partnerships in automotive, iron and steel, petrochemical and military industries. In 2003, WINCO Technologies decided to share its know-how to the world of construction by providing innovative thermal insulation solutions. Based upon permanent innovation, responsibility and entrepreneurship, WINCO Technologies vision is to improve energy efficiency, comfort and safety.

- **PCM Products Limited (PCM) – SME**

PCM Products Ltd. (PCM) specialises in phase change material (PCM) technologies/HVAC systems and their applications. The company has research and development facilities and also manufacturing base in the UK and license outlets around the world which offer bespoke products to meet unique customer and application requirements. The company has expertise in chemicals and materials including desiccants, PCMs and adsorbents. PCM is committed to providing

alternatives and improvements to current storage, heating/cooling technologies by offering more energy efficient and environmentally- acceptable solutions. For more than a decade, the company has been involved in the development of PCMs, energy storage, desiccant and HVAC systems. With unrivalled experience in designing and advising on PCM storage installations and applications, it continues to push the boundaries in desiccant materials usage for the benefit of its ever-growing customer base. In addition, PCM Products Ltd has been providing full consultancy and product development services for more than two decades.

- **KÖSTER Lichtplanung Ltd (KOST) – SME**

KÖSTER Lichtplanung Ltd.'s daylight technology is worldwide applied for more than 20 years with over 400,000 m² glass roofs and facades. Here are some of the recent construction projects with daylight systems from the office KOST Lighting design: Bank Santander in São Paolo/Brazil; BlueWin Tower in Zurich / Switzerland; Headquarters of the SCHOTT Glass AG, Mainz/Germany; Highrise of the Energie AG, Linz/Austria; Triple Towers, Sofia/Bulgaria; Kassenärztliche Vereinigung KVWL, Dortmund/Germany; Standard Bank of South Africa, Johannesburg/South Africa; Central Bank of Kuwait; Laboratory building Hoffmann-La Roche, Basel/Switzerland; Building projects in Beijing/China; Office building BNP- Paribas, Paris/France.

- **Fundación Santa María la Real (FMS) – Foundation**

FMS (Santa María la Real Foundation) is a non-profit organisation founded in 1977, whose fundamental mission is to promote sustainable development initiatives based on heritage and the natural and human environment of this heritage. It undertakes interdisciplinary works on the patrimony objects restoration, including architects, engineers, historians and restorers. Main activities are related to restoration or conservation of the old buildings, preserving their integration in a natural environment. Today, the institution has become a prime example that heritage can fuel economic development in an area. Moreover, the Santa María la Real Foundation has created a development model based on heritage that is being successfully exported to other places, regions and countries. In each and every one of Fundación Santa María la Real departments encourages the generation of ideas and projects based on the principles of quality, efficiency, and innovation so that heritage itself can become an element in generating socio-economic development.

- **Aalto University (AALTO) – University**

The New Energy Technologies Group (NEW) at Aalto University (formerly Helsinki University of Technology) in Espoo- Otaniemi, Finland is actively involved with the science and research of advanced energy technologies and systems. The Group has some 20 members working on solar cells, fuel cells and urban energy systems, including materials and complex systems work. The Group has worked in the past with PV-facades, BIPV technologies, Intelligent Buildings, Building Energy Simulations, Solar Cities, Polygeneration, among others. The New Group has operated in the past a test site for multifunctional facades, in particular advanced PV designs, such as thin film PV, translucent PV, and PV façade elements. This included also a fully controlled PV

test room. The Group has several in-house simulation codes for advanced building energy simulations, incorporating multifunctional façade elements to whole building simulation environment including a range of building related RES technologies. This includes also polygeneration systems.

- **Cândido José Rodrigues, SA (CJR) – SME**

Founded in 1970, the CJR Group is a multinational business group, headquartered in Guimarães, Portugal, with projects in more than 20 countries. This group is segmented by two main companies, CJR, SA, being its core business the construction of roads and buildings and CJR Renewables, specialized on renewable energy sector. Over 50 years of operation, the company has been expanding its operational reach. The CJR, SA started its journey renting heavy machinery, an activity still in operation, alongside the construction of roads and infrastructures, becoming a full scope engineering and construction company, also acting on buildings, rehabilitation, urban projects and environmental projects. CJR Group is well known by its projects in engineering, construction and renewable energy.

- **Oncontrol Technologies, LDA (ONCONTROL) – SME**

Oncontrol Technologies is a SME dedicated to engineering, automation, control and information technology systems. The company has large expertise in designing and deploying control infrastructure to industry. It offers services in all automation levels, from instrumentation to high level corporate information. Its solutions include energy monitoring, advanced control, artificial intelligence and process monitoring & visualization. It employs Artificial Intelligence, Machine Learning and Fuzzy logic in its services to industry, in order to create value and gain insights from process and/or shop floor. It is also expert in remote monitoring solutions, specializing in systems where it is needed a PLC-based control. In these situations, its solutions provide data collecting and direct access to PLC for programming and system maintenance, which is different from other solutions in the market. The company has a complete portfolio of solutions to operational-technical-strategic levels. The company major success is an advanced control system, based on Fuzzy Logic, for mill optimization, to the cement and mining industry. Its control system has achieved improvements in the order of 4-10% and reduction of specific energy consumption (KW/ton) in the order of 5-20%.

3.1.1 Possible exploitation routes (technology) per partner

The following Table summarizes the possible exploitation routes for the initial key exploitable results of the SUREFIT per partner:

No.	Key Exploitable result	Main owner	Possible exploitation routes
KER 1	Optimum design, operation and control of renovation technologies	UNOTT	Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 2	Renovation concepts	AALTO	Use for further research activities

KER 3	Next generation bio-aerogel panel	UNOTT	Cooperation agreement/Joint Ventures, Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 4	PCM panels	PCM	Cooperation agreement/Joint Ventures, Selling own products/services
KER 5	PV vacuum glazing windows (PV-VG)	UNOTT	Cooperation agreement/Joint Ventures, Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 6	Solar thermal and PV systems	SOLIMPEKS	Cooperation agreement/Joint Ventures, Selling own products/services
KER 7	Window heat recovery devices	UNOTT	Cooperation agreement/Joint Ventures, Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 8	Evaporative coolers	UNOTT	Cooperation agreement/Joint Ventures, Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 9	Membrane wrapping	WINCO	Selling own products/services
KER 10	Innovative multi-purpose heat pumps	UNOTT	Cooperation agreement/Joint Ventures, Use for further research activities, Spin-Off activities, Licensing IP rights, Selling IP rights
KER 11	User friendly computer program for planning and retrofitting of residential buildings	ISQ	Cooperation agreement/Joint Ventures, Use for further research activities, Licensing IP rights, Selling IP rights
KER 12	Methodology and guidelines for retrofitting	ISQ	Use for further research activities, Licensing IP rights, Selling IP rights
KER 13	Integration of daylight and electric lighting	KOESTER	Selling own products/services

Table 8 -Exploitation routes for the Exploitable results of the SUREFIT (D9.4)

3.2 External Stakeholders

3.2.1 End Users (building owners/users, manufacturers, product/services developers)

This group of stakeholders will be evidently privileged by the research findings since they will be able (when the technology is available to them) to reach the target of near zero energy through reducing heat losses through building envelope, and energy consumption by heating, cooling, ventilation and lighting, while increasing the share of renewable energy in buildings.

In the following period, all partners will contribute in identifying the most appropriate stakeholders for the SUREFIT technologies in their country and abroad. The second step, will be the dissemination of the SUREFIT outcomes to as many relevant stakeholders as possible, through the participation in conferences, workshops, publications etc.

3.2.2 Governments/associations

This group of stakeholders drives the majority of our research. The government bodies are addressed to help define the problems that SUREFIT researchers should solve. The Consortium relationship with these groups is utilised in order to set up meetings where their specific needs will be discussed and clarified. These groups include:

- Local authorities & EU/national/regional public bodies (Câmara Municipal de Mafra endorsed the project with a letter of support)
- Policy makers working in energy and environment departments of local/national/EU governments
- Energy efficiency building associations (Enercoutim endorsed the project with a letter of support)

In the following period, all partners will contribute in identifying additional local authorities and public bodies, policy makers and associations. The next is to disseminate the SUREFIT results to the relevant stakeholders through every possible dissemination activity.

3.2.3 Industry

Industry stakeholders bring unique input to the table and often give an opportunity for SUREFIT researchers to expand the scope of their thoughts and their research. In addition, industry partners can get advantage from the technology SUREFIT is developing. Furthermore, industry partners can facilitate the dissemination of our results far beyond the immediate reach SUREFIT consortium. These group includes:

- Professionals (engineers, academia, researchers, and students) in areas of energy, building design and construction, building materials, building services and manufacturing
- Building product/construction companies and SME contractors
- Management members of the relevant industries
- Architects and relevant associations (AICCOPT endorsed the project with a letter of support)

3.2.4 Academia

This group (universities, schools, academic institutions) is considered the earliest adopter group and offer a unique help to enhance our dissemination and technology transfer efforts.

3.3 Involvement

Every stakeholder group have its own needs for the technology offered. Therefore, stakeholders will help to guide what research we will undertake. Communication at every stage of research is the key to assisting stakeholders. As already mentioned above, as the results are generated will be held workshops, PR Events, training sessions, videos, emails and demo site demonstrations in

order to establish a more interactive way to exchange information and focus on how results might be implemented.

If stakeholders want to use the technology, the Consortium can be consulted and guide the process. If there is need to create EU policy or legislation, SUREFIT partners will assist policy makers to understand fully the concepts and the results. Tools like training materials, guides and fact sheets will be developed.

4 Dissemination of SUREFIT Results

The main goal of WP9 is to communicate all SUREFIT results and create awareness to the stakeholders. A specific and intense communication strategy was developed to make the greatest impact. All members agreed to participate and engage in dissemination activities. All these activities are held under a common visual identity, with key scientific findings translated into simple word for the wide public.

Dissemination will take place:

a) *Internally:* dissemination of the results will be made by publishing and circulating technical documents and memoranda that will be treated as confidential if any commercially sensitive information is included. Dissemination to the Commission will be made by reports as outlined in the grant agreement.
b) *General dissemination:* to the industrial, academic, and public will be made through public demonstration, seminars and workshops, open days, publication in journals, conferences, exhibitions, website, newsletters, and media.

4.1 Key Message

Overall, the research results derived from the project are classified as (1) technical items including design drawings, testing prototypes, validated simulation/optimization tool, and simulation/experimental results; (2) operational items such as the prototypes produced in factories and installed in buildings and field-trial results; and (3) social economic items including manufacturing/installation standards, economic and environmental assessment results, and building impact analytical tool/results.

The Key messages of all SUREFIT dissemination activities will be adapted to each Stakeholder's viewpoint and will follow the 7 Cs of Communication:

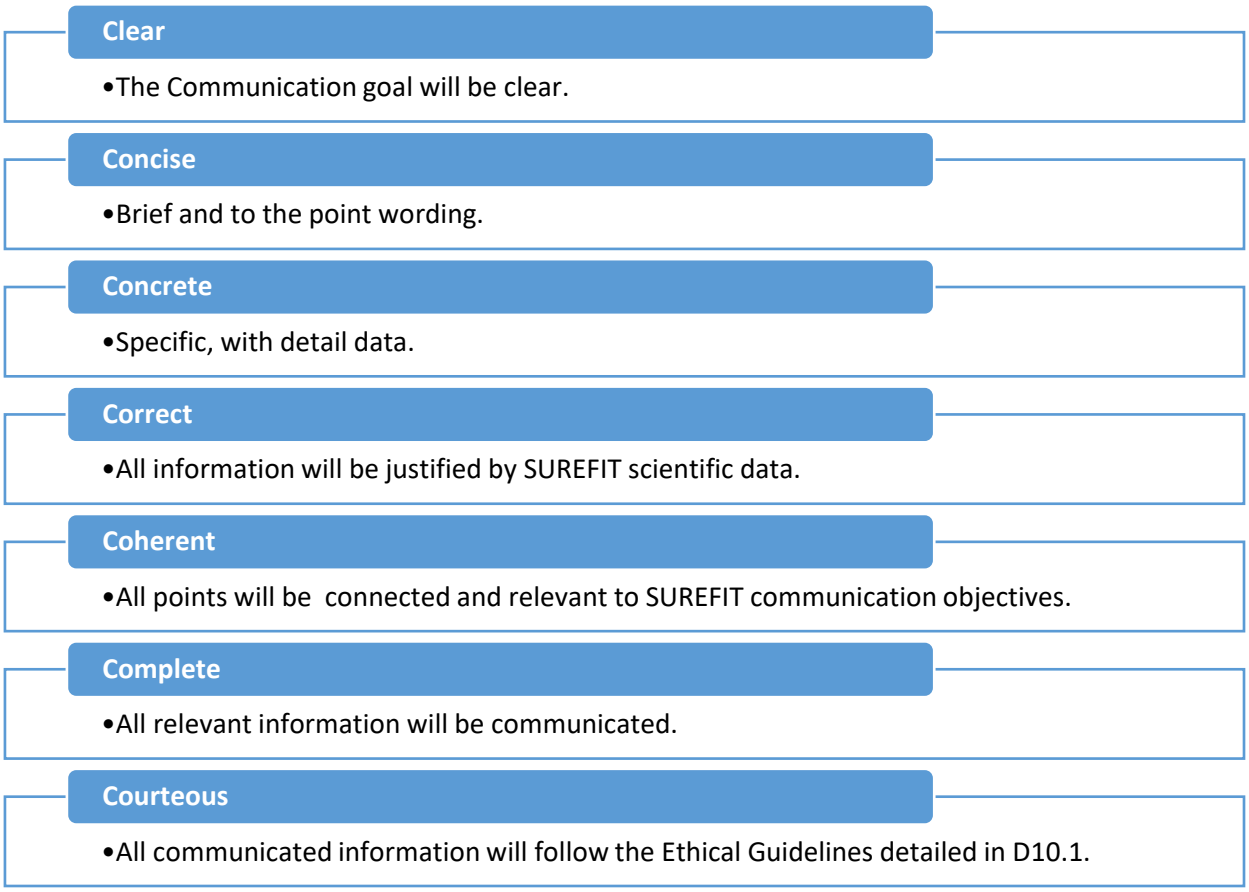


Figure 12 – 7 Cs of SUREFIT Communication

4.2 Methodology & Frameworks Used

Wilson performed a survey of conceptual dissemination frameworks from which three practical theories occurred: persuasive communication, diffusion of innovation and social marketing (Wilson, 2010).

- *Persuasive communication*, the most popular theoretical approach is based on the Communication-Persuasion Matrix (McGuire, 2012). The matrix describes the process of being persuaded; it consists of five input communication factors and twelve output persuasion steps. The five input factors, which have an impact on the success of the communication, are: source, channel, message, audience, and setting.
- *Diffusion of innovation* (Rogers, 2962) is the second most popular theory. According to Wilson diffusion of innovation "offers a theory of how, why, and at what rate practices or innovations spread through defined populations and social systems. The theory proposes that there are intrinsic characteristics of new ideas or innovations that determine their rate of adoption, and that actual uptake occurs over time via a five-phase innovation-decision process (knowledge, persuasion, decision, implementation, and confirmation).

The included frameworks are focused on the knowledge and persuasion stages of the innovation-decision pro-cess"

- *Social marketing* (Kotler & Zaltman, 1971) represents an approach to planned social change, in which marketing concepts are applied to the problem of promoting social causes.

A **blend** of these frameworks will be used throughout SUREFIT dissemination activities.

5 Exploitation of SUREFIT Results

The Article 28 of the Annotated Model Grant Agreement (AGA) sets the framework for the exploitable results of an EU funded project as well as the obligation of the beneficiary towards the exploitation. Based on the Article 28, the beneficiaries must take measures aiming to ensure exploitation of their results — either by themselves (e.g., for further research or for commercial or industrial exploitation in its own activities) or by others (other beneficiaries or third parties, e.g., through licensing or by transferring the ownership of results). This is a best effort obligation: the beneficiaries must be proactive and take specific measures to ensure that their results are used (to the extent possible and justified).

Furthermore, the Article 28 specifically mentions the obligation of each beneficiary to exploit its result, the contribution of the results to standardization and the consequences of non-compliance with the Article 28.

5.1 Exploitable Results of SUREFIT

SUREFIT involves a variety of technologies that include bio-aerogel panels integrated with phase change materials, photovoltaic (PV) vacuum glazing windows, roof and window heat recovery devices, solar assisted heat pumps/ground source heat pumps, evaporative coolers, integrated solar thermal/PV systems and lighting devices. These will be prefabricated for rapid retrofit with minimal disruption to occupants, ensuring high levels of occupant comfort/indoor environmental quality as well as low risk of moisture-related problems/summer overheating. The work programme will involve optimal sizing and prefabrication of technologies tailored to building design/ requirements; retrofitting/monitoring buildings in different climates with support of advanced building energy management systems; analysing indoor environment quality, energy use, user behaviour/acceptance of the solutions; developing methodology, guidelines/effective operational tools for rapid retrofitting and decision-making; and developing business model involving all relevant actors including, public authorities/investors/users and holistic integration of disciplines across the value chain.

5.1.1 Exploitation Plan

The exploitation plan D9.4 that is submitted and available is structured as follows:

i. firstly, the exploitable results and the main owners of these results are identified
ii. the possible exploitation routes for each one of the exploitable results are presented
iii. a preliminary characterization of the results is performed
iv. the exploitation expectations and claims of the partners are identified
v. a BFMULO analysis is made
vi. the IPR management is presented
vii. the Technology Readiness Level (TRL) is identified

viii. an initial risk assessment is performed.

5.1.2 SUREFIT Research Results Derived

The research results derived from the project are classified as (1) technical items including design drawings, testing prototypes, validated simulation/optimisation tool, and simulation/experimental results; (2) operational items such as the prototypes produced in factories and installed in buildings and field-trial results; and (3) social-economic items including manufacturing/installation standards, economic and environmental assessment results, and building impact analytical tool/results. These items will be carefully identified and for publication through appropriate routes and approaches.

5.1.3 IPR management

The IPR management is very important since it declares the shares that each partner will claim for every result. At this stage of the project, some initial discussions have been performed among the interested parties and the agreed shares are presented in the following Table. As it can be seen, half of the results belong only to one partner and the rest belong to two partners. Based on that, the division of shares of each exploitable result is expected to be a rather straightforward process that will not create major conflicts. Only one result that is related to the renovation concepts is divided to 11 parts and this is due to the fact that the whole Consortium will contribute to this. This information is available in D9.4 in Table 19.

5.1.4 Commercialization process of research outputs

The new technology that will occur through the research program of SUREFIT had to be exploited as GA requires. Therefore, the commercialization of these results is essential to existing and start-up companies. The process is depicted and fully analyzed by Penn State University (Office of Technology Management):

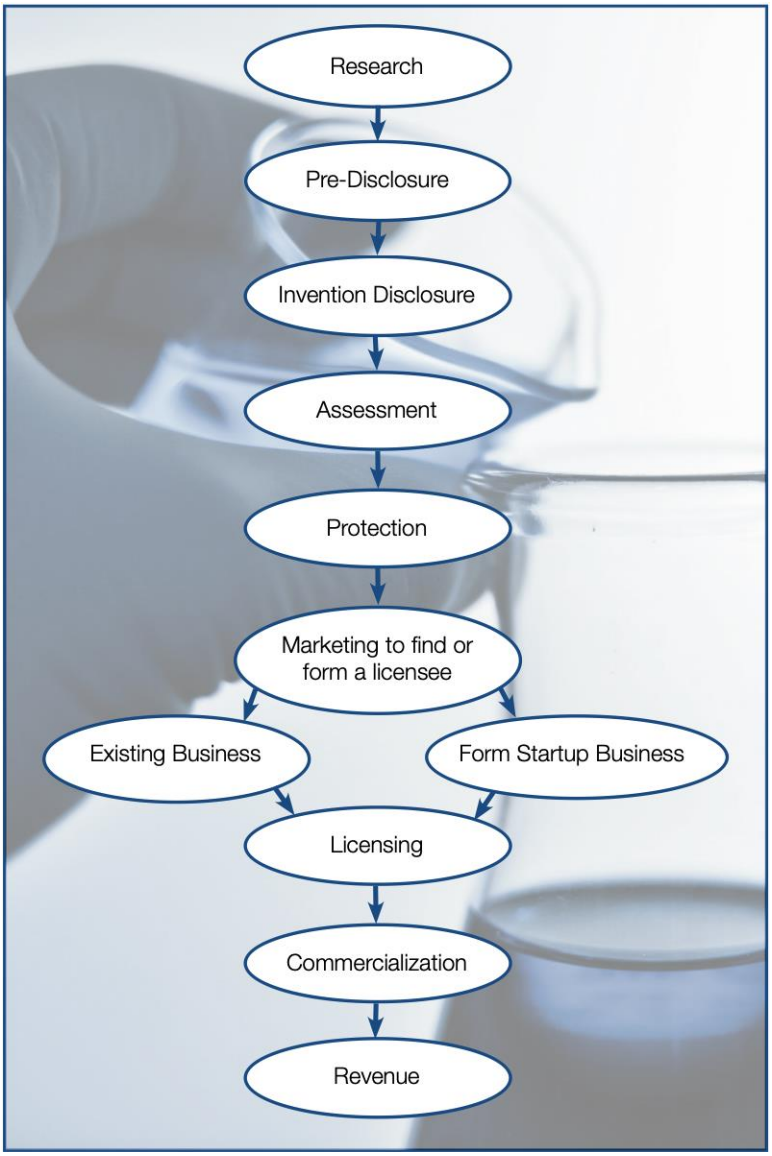


Figure 13 – Commercialization Process

Every step is described below:

1. **Research:** This stage includes any possible outcomes for research.
2. **Pre-disclosure and Invention Disclosure**: At this stage if the research results in a possible invention, then the IPR must be determined.
3. **Assessment**: During this stage a review of the invention disclosure and patent searches are performed, and a market evaluation of competitive technologies is conducted to determine the invention's commercialization potential.
4. **Protection:** At this stage we check if there is market potential the patent rights and copyright documentation will be prepared.

5. **Marketing to Find or Form a Licensee**: At this stage candidate companies with the necessary expertise and resources to market the invention should be found.
6. **Start-up or Existing Business**: During this stage a selection between starting a start-up and working with an existing business is made.
7. **Licensing:** A license agreement will be developed between the institution and a third party for financial and other benefits as this stage.
8. **Commercialization:** At this stage the selected business will advance the technology and make other investments to develop the product or service.
9. **Licensing Revenue**: Revenue is received at this stage and distributed to Technology Owners.

5.1.5 Collection and use of licensing revenues

When applicable, funds from the commercialization of new technology will be used to support new research. Licensing revenue will be distributed according to the Exploitation Plan among involving partners according to prior agreement. As described in the Deliverable each partner distributes the licensing revenue according with their respective technology transfer and intellectual property policies. The Shares intention of the SUREFIT exploitable results as stated in D 9.4 follow:

No	Key Exploitable result	ISQ	AMS	UNNOT	SOLIMPEKS	WINCO	PCM	KOEST	FSM	AALTO	CJR	ONCONTROL
1	Optimum design, operation and control of renovation technologies			100								
2	Renovation concepts	14	5	20	8	8	8	8	8	5	8	8
3	Next generation bio-aerogel panel			100								
4	PCM panels			20			80					
5	PV vacuum glazing windows (PV-VG)			100								
6	Solar thermal and PV systems			20	80							
7	Window heat recovery devices	30		70								
8	Evaporative coolers	30		70								
9	Membrane wrapping					100						
10	Innovative multi-purpose heat pumps	30		70								
11	User friendly computer program for planning and retrofitting of residential buildings			100								
12	Methodology and guidelines for retrofitting	60		40								
13	Integration of daylight and electric lighting							100				

Figure 14 – Shares intention of the SUREFIT exploitable results

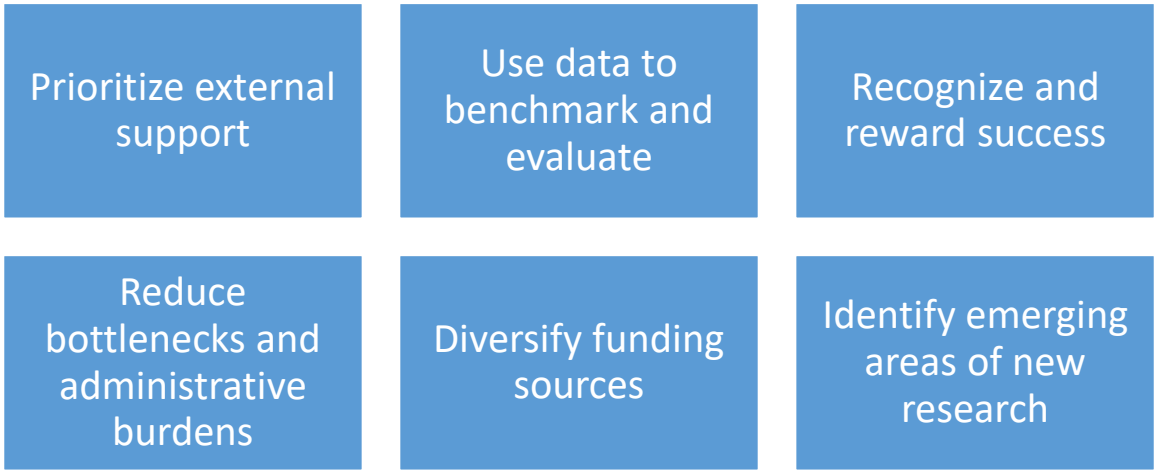
5.1.6 Strategy for increasing corporate research support

To capitalize on this opportunity, a strategic plan focused specifically on several actions to increase externally corporate research funding will be encouraged.

There are many reasons to achieve external funding:

1. Funding allows for research impact
2. The quantity of externally funded support, is a key metric used to see the technology's market elasticity
3. It is a measure of the ROI
4. Externally sponsored projects contribute to our economy

The essential principles followed to achieve the above are (Oregon, 2018):



6 Technology Transfer

In this section SUREFIT technology transfer goals and performance measures are presented. As stated, the core technology transfer will be performed through a systematic approach involving key stakeholders(building owners and users, manufacturers, product and services developers) in space heating, cooling, domestic hot water, lighting and power generation, as well as a demonstration phase in five representative buildings indifferent climates.

The potential stakeholders will understand how developing a renovation project throughout the main steps of the process and will count with a “core methodology” for developing their renovation projects in the future.

6.1 Goals

SUREFIT has the following Goals for Technology Transfer:

- Disseminate SUREFIT results to wide audiences
- Develop inventions, new methodologies, or products
- Demonstrate new technology
- Train Industry Stakeholders to use new technology
- Incorporate or modify new technologies, techniques or practices
- Improve technologies in addressing fast-track renovation
- Adopt new Technology, methods and practices
- Improve fast-track renovation of existing domestic buildings by integrating innovative, cost-effective, and environmentally conscious prefabricated technologies

6.2 Performance Measures

SUREFIT technology transfer goals are connected to performance measures that help to evaluate the effectiveness of the transfer. The following table indicates the possible means of process monitoring:

No.	Goals	Research Performance Measures	Target
Outputs			
Output No 1	Disseminate SUREFIT results to wide audiences	Technical Reports	At least 22 (Deliverable reports)
		Conferences	4
		Workshops	5

		Public Demonstration	10
		Media (Newsletter, Social Media, Site, Press Conference)	50
Output No 2	Develop inventions, new methodologies, or products	New product development	10
Output No 3	Demonstrate new technology	Demo Sites	5
Outcomes			
Outcome No 1	Train Industry Stakeholders to use new technology	Commercial Workshop	1
		Scientific Workshop	2
		Policy Workshop	1
		Exhibition	1
		Training Material	2
		Training Days (on Demo Sites)	5
Outcome No 2	Incorporate or modify new technologies, techniques or practices	Number or New Technologies (based on Exploitation Plan)	13
Outcome No 3	Improve technologies in addressing fast-track renovation	Number or New Technologies (based on Exploitation Plan)	13
Impacts			
Impact No 1	Adopt new Technology, methods and practices	Number of Cases	At least 5
Impact No 2	Improve fast-track renovation of existing domestic buildings by integrating innovative, cost-effective, and environmentally conscious prefabricated technologies	Number of Cases	At least 5

Table 9 - Goals, Research Performance Measures and Targets

6.3 Reporting

The Research outcomes, outputs and impact will be thoroughly monitored by SUREFIT partners. Reporting will allow for making data-driven decisions that generate business value according to the following figure that depicts the reporting procedure (Malysheva, 2022):

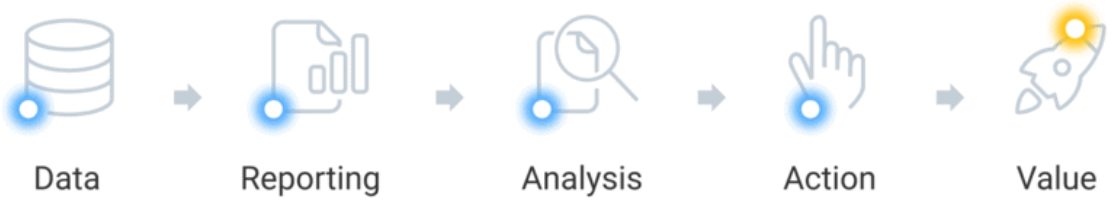


Figure 15 – Reporting Procedure Steps

All initial results will be shared among the Consortium. Then the results will be published according to our Dissemination Plan (reporting) and will outline the tangible results of the project.

All information will be available on SUREFIT website which is used to engage visitors, by determining the number of clicks and downloads.

7 Conclusions

The aim of this deliverable is to provide a first version of the Technology Transfer plan for the SUREFIT project results. Towards this, 3 Outputs, 3 Outcomes and 2 Impacts that will occur have been identified. Moreover, the method and the means that will be used to transfer knowledge and technology have been stated.

In this Deliverable were presented the following:

- the definition of Technology Transfer
- the Life Cycle of Technology
- the basic Technology Transfer Models that are present in Bibliography
- SUREFIT Innovating Technologies
- Internal stakeholders
- External Stakeholders
- Dissemination strategy
- Exploitation strategy
- Technology Transfer Goals
- Technology Transfer Performance Measures
- Technology Transfer Reporting method

The technology transfer plan will be updated during the implementation of the project in order to ensure a dynamic and successful communication of project results and another plan (D9.8) will be created in M48, where all project's aspects would be in the most mature time.

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