



The first double duct residential air
conditioner with near-to-zero
Global Warming Potential natural refrigerant

LAYMAN'S REPORT



With the contribution of the LIFE Programme of the European Union.
LIFE17 CCM/IT/000026

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PROJECT NAME:

The first double-duct residential air conditioner with near zero Global Warming Potential natural refrigerant

PROJECT ACRONYM:

LIFE ZEROGWP

PROJECT REFERENCE:

LIFE17 CCM/IT/000026

TYPE OF PROJECT:

LIFE CLIMATE CHANGE MITIGATION

START/END:

1 July 2018 - 30 June 2021



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Sustainable solutions for air conditioning: the current legislative context

Today, those who develop and manufacture air conditioning equipment are working in an ambivalent context. On one hand, market growth projections, also linked to global warming, suggest a rosy economic future. On the other hand, there is growing awareness that whether by the direct emissions linked to the refrigerants used or the indirect emissions linked to the energy they consume when operating, these appliances are now, as they will be in future, playing a significant role in instigating climate change.

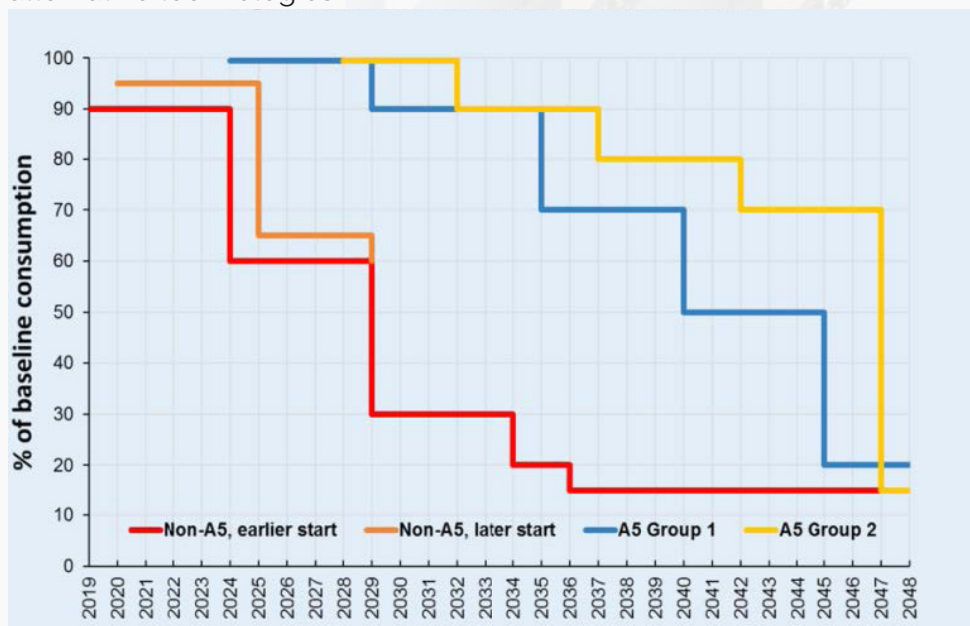
Climate change poses a serious threat to the global economy, human health and the integrity of ecosystems. The costs of doing **“business as usual”** will be much higher for society than what it would cost to implement mitigation measures.

Aware of this, the European Union has made the fight against climate change one of its political priorities. To significantly reduce greenhouse gas emissions and to try to limit the rise in global temperatures well below the 2°C, compared to the pre-industrial era, as provided for by the Paris Agreement, the EU has adopted and will be adopting a series of regulatory measures that involve all its production sectors and that aim at a **better use of energy and resources** as well as a simultaneous reduction in emissions of climate-changing gases.

The European regulations encourage and boost industries towards a green and circular economy in which the “reuse” and “preparation for reuse” are the keywords to reach an Innovating-to-Zero, ideal future at zero emission, zero waste, zero not-recyclable products.

The problem of the effect of refrigerants on climate is not just an issue considered important in Europe. In October 2016, the world community agreed on an amendment to the Montreal Protocol - the Kigali Amendment. Effective on 1st January 2019, the Kigali Amendment added HFCs to the list of controlled substances under the Protocol. It also provided for a global reduction of these molecules that would lead to a reduction in emissions of circa 80 gigatonnes of CO₂ by 2050.

This would make a significant contribution to the Paris Agreement objective whilst encouraging the adoption of more climate-friendly alternative technologies.



Kigali Amendment provisions for the reduction in HFCs for the different countries. Europe is in the Non-A5, earlier start group.

(Source: OzonAction Kigali Fact Sheet 5)

Since 2019, Europe has developed the **Green Deal**, a new growth strategy that aims to make it the first climate-neutral continent, where economic growth will be decoupled from emissions and where the economy will generate no net greenhouse gas emissions.

The Green Deal strategy sets emission reduction targets that are significantly more ambitious than current regulations. Whilst the current **EU objective is a 40% reduction of total CO₂ emissions** by 2030, this percentage must necessarily be increased to achieve the Green Deal's target of zero by 2050.

The world of air conditioning is seeing a grand process of transformation. Climate change and the simultaneous increase in the demand for comfort require timely action to **limit direct and indirect emissions** from devices. This urgency finds expression in the legislative context Europe is shaping to achieve a zero-emission economy.

The urgency of the question has now been answered by air conditioning technologies, which, because of their high efficiency, their use of renewable sources and highly sustainable refrigerants, can make an important contribution to the goal of a **decarbonised economy** by 2050.

Actually, now is the ideal time to establish sustainable and future-proof air conditioning technologies.



In this context we understand the importance of projects like LIFE ZEROGWP which developed the **first high efficiency air conditioner** that uses natural propane refrigerant (R-290), without an outdoor unit.

This accomplishment is following precisely in the footsteps of the European Green Deal policies, the F-gas Regulation 517/2014 and global climate protection policies, with the Kigali Amendment in the forefront.





Project OVERVIEW



3 years

Duration



2018

Starting year



4

Partners



940,621 Euro

EU Contribution

The goal of ZEROGWP project is to demonstrate the technical feasibility, full safety and commercial viability of an innovative monobloc residential air conditioning system, called Double Duct (DD) technology, that can be charged by R290 (Propane) with unprecedented environmental performance.

The specific objectives of LIFE ZEROGWP are to:

- 1 Industrialize the first DD-AC R290 system**, perform a pre-serie production and technical validation of this innovative air conditioner to pave the ground for its industrialization;
- 2 Demonstrate the performance** of the new air conditioner through an extensive field test campaign in four European countries;
- 3** Improve the system design to **minimize the risks of use of flammable HC refrigerants** maximizing the refrigerant charge without compromising safety;
- 4** Prove the **environmental efficiency and cost sustainability** of the new product in an LCA and LCC perspective;
- 5** Promote the project through dedicated dissemination channels and networking in order to rise market awareness and pave the way for subsequent **commercial exploitation and wide replication** at the European level;
- 6** **Rise society and consumers awareness** about newer and low carbon residential air conditioning technologies, thus trying to encourage changes in consumers' attitudes, inspire more environmentally responsible behaviors and stimulate European investments in innovative eco-friendly technologies.

Propane for a more sustainable air conditioning

Propane (R-290) is a hydrocarbon found in nature as a component of natural gas and crude oil, from which it is extracted by fractional distillation. At room temperature and standard atmospheric pressure (1 atm at 20-25 °C) the compound appears as a colourless, odourless gas, which can be easily liquefied by compression, releasing or absorbing heat. Because of this property and its **good thermal conduction**, it has always been used also as a refrigerant.

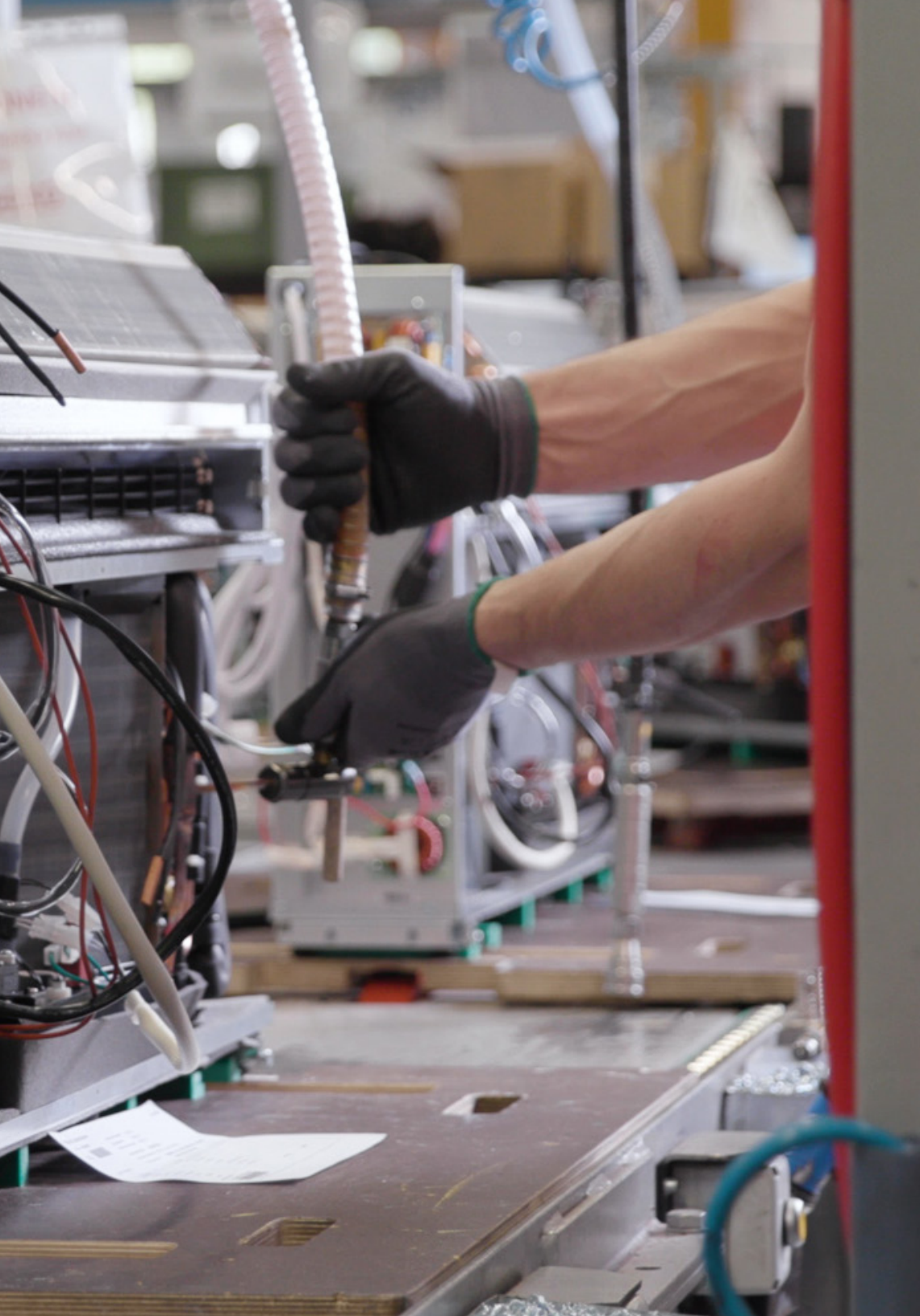
Natural refrigerants have always been part of the history of refrigeration and were the first working fluids used since the advent of vapour compression. However, since the 1930s, refrigeration has separated them out because of certain characteristics. Propane, for example, is **highly flammable**.







Project RESULTS



Double duct monobloc propane systems

INNOVA 2.0NR implemented in LIFE ZEROGWP project has very low environmental impact due to many factors, such as:



1 The choice of a refrigerant with strong environmental properties



2 Optimized design, reduced consumption and lower direct emissions



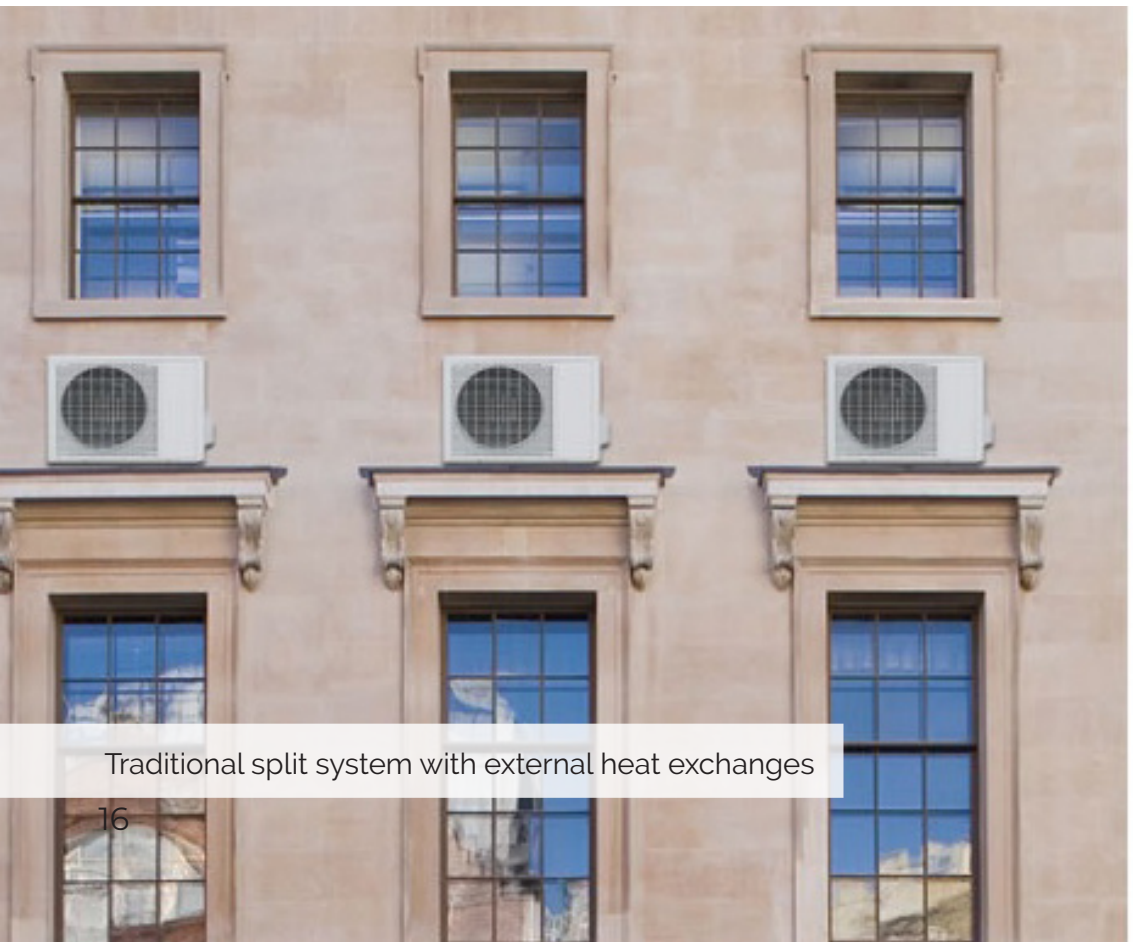
3 The greatest possible reduction of the refrigerant charge

INNOVA 2.0 NR

The result of the development conducted by INNOVA is an air conditioner that indoors, given its minimal depth, **fits into any environment** perfectly. Outdoors it presents with just **two air vents**, that are 162 mm in diameter each.

These vents can be equipped with fixed or mobile fins that will protect the unit from rain, leaves, insects or dust entering it. If the vents are painted like the wall where they are installed, they can become practically invisible even to the most highly trained eye, truly **reducing the aesthetic impact** of the "2.0" air conditioner to zero.

INNOVA 2.0 NR: a new generation of air conditioners with zero environmental impact and high standards of efficiency, safety and convenience.



Traditional split system with external heat exchanges

The conversion of the INNOVA 2.0 machine from the HFC R-410A refrigerant to the R-290 natural propane refrigerant is the technical core of the LIFE ZEROGWP Project.

This conversion involved some specific interventions to adapt the traditional components to the reduced charge characteristics of propane. These interventions specifically involved the compressor and the heat exchangers.

The choice of **more robust and durable materials** extends the machine's added value and its service life cycle. INNOVA 2.0NR could be defined as a "plastic-free" machine since there are practically **no plastic components**. The shell of the 2.0NR and nearly all its components are made completely of metal. Moreover, the materials used to make the machine are all recyclable at the end of its life, adding an extra feature to its already **high level of sustainability**.



Innovative double duct proposed in LIFE ZEROGWP

The advantages of INNOVA 2.0 NR

● GREATER SUSTAINABILITY:

- Use of propane instead of a synthetic HFC refrigerant makes this machine much more sustainable compared to traditional air conditioners, which are still using mostly high GWP refrigerants;
- The machine's overall Global Warming Potential (GWP) is further reduced thanks to its higher energy efficiency compared to the similar and already highly efficient machine that uses R-410A.

● LOW AESTHETIC IMPACT

- The compact and elegant design makes it suitable for any type of environment;
- The external aesthetic impact is reduced to a minimum since there is no outdoor unit.

● EASE OF INSTALLATION

- Since the machine is equipped with a hermetically sealed refrigeration circuit, no direct intervention on the circuit is required during installation, thus eliminating the need for an F-gas certified refrigeration technician;
- With no outdoor unit, also the need for fittings or piping is avoided;
- Since this is a decentralised solution, independent of any centralised circuits already found in the buildings, its installation does not require any intervention on pre-existing pipes.

● SAFETY:

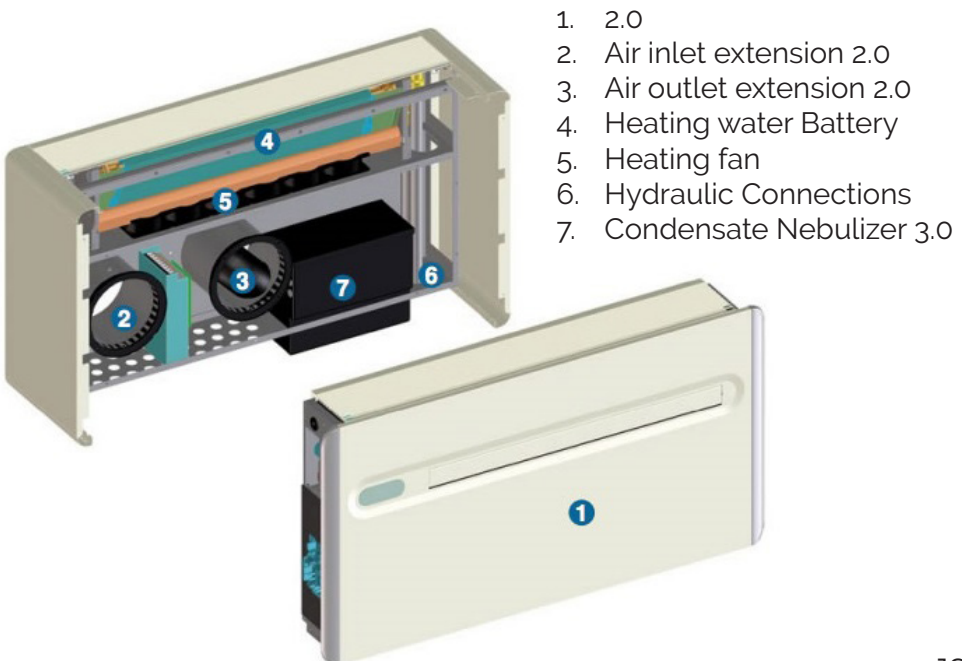
- This machine's compact cooling circuit allows the use of propane charges of less than 150 grams, keeping it in full compliance with the strictest European safety standards;
- The hermetically sealed circuit greatly reduces the risk of refrigerant leaks.

● FUTURE PROOF:

- Use of a very low GWP natural refrigerant makes these machines independent of current and future requirements and standards for synthetic refrigerants and keeps them beyond any controversy over issues such as the environmental sustainability of low GWP refrigerant or the illegal smuggling of fluorinated gases;
- The sustainability of this solution puts it perfectly aligned with the European Green Deal, the Renovation Wave and decarbonisation strategies of the European Commission's "Heating & Cooling" sector, as well as with Regulation F-gas 517/2014.

● REPRODUCIBILITY OF THE MODEL:

The proposed INNOVA 2.0NR model can be replicated not only on all INNOVA 2.0 machines but also extended to water/air machines, as a new European project would like to demonstrate.



Field testing

One of the objectives of LIFE ZEROGWP is to demonstrate the potential for **replicability and transferability** of such technology on a larger scale to similar situations. For this, Between June and August 2020, some units of the LIFE ZEROGWP double duct air-conditioner were installed in Slovakia, Czech Republic and in Italy in different residential contexts for long-life tests, in-field validation and customer evaluation.

All the units were connected with a web server device for complete functional parameters logging and data acquisition. All the data were elaborated to quantify the environmental impact indicators of the project in a holistic LCA perspective.







The European ADDED VALUE

The double duct machine developed in LIFE ZEROGWP Project is introducing new parameters in residential air conditioning in fact, it can be considered a **pilot project** because up to now there have been no known applications of propane refrigerant in a double-duct machine.

The results obtained with the INNOVA 2.0NR have not only indicated that this solution is technically feasible and complies with the most stringent European safety standards, but that it achieves the same results in terms of **energy efficiency and convenience** as the best HFC machines on the market. These features make the INNOVA 2.0NR and the air conditioning model it is offering an excellent replacement for high and medium GWP HFC refrigerant solutions.

The proposed model's sustainability is not limited to environmental protection but also has economic effects. LIFE ZEROGWP is also proposing an appropriate business model for those companies that make up more than 90% of Europe's industrial framework and that have been defined as the backbone of the European economy, SMEs. The economic competitiveness of this product is based precisely on those parameters that establish the superior value of European manufacturing: **ecology**, the **sustainability of materials**, the **safety** and the **aesthetics** of their design. All of this is achieved without relocating production but by creating jobs inside the European Community.

Because of all these features, the LIFE ZEROGWP 2.0NR air conditioner has been nominated for inclusion in the "**Pathway to Zero Greenhouse Gas Emissions for Cooling**", a report prepared by the Kigali Cooling Efficiency Program (K-CEP), the Cool Coalition and the Carbon Trust and that supports the work of the United Nations Framework Convention on Climate Change (UNFCCC) Partnership for global climate action (UNFCCC) and especially possible pathways for climate action to achieve the long-term vision of the Paris Agreement. This report includes a list of HVAC&R products with excellent properties including sustainability and efficiency that are manufactured globally.

LIFE ZEROGWP 2.0NR air conditioner **will become an ambassador of the European values of environmental and economic sustainability** in the world. It can show how air conditioning can become part of the solution instead of a cause of the climate change problem by demonstrating what technological results can be achieved and how economic and environmental objectives can go hand in hand in the same product.



The PARTNERS



INNOVA was born in 2004 and it has always been active in the renewable energy sector, developing advanced systems for climate comfort and Heating, Ventilation, Air Conditioning (HVAC). INNOVA is LIFE ZEROGWP Project Coordinator.



IVAR CS spol.S r. acts as a representative of the commercial and technical representative of various European companies in water, heating, gas, water filtration and treatment, pumping equipment, solar systems and heat pumps, storage tanks, fan coils and air conditioning systems.



Studio Fieschi & soci is a small enterprise that provides international technical and management consultancy in the environment and sustainability sectors. The company is notably active in the fields of life cycle and sustainability assessment, industrial ecology, corporate social responsibility and product environmental communication.



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

The University of Padua was founded in 1222 and comprises 13 Schools. The Department of Management and Technology is involved in the project with a group of teachers and researchers devotes the research activities to thermodynamics, heat transfer, refrigeration technology, heat pumps, air conditioning, thermodynamic properties of refrigerants, nanofluids, applied acoustics.

Contacts



This Layman's Report has been written by Oreste Bottaro, Project Coordinator. The author would like to thank all partners for their valuable input and cooperation working together in a very successful project.



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