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Thermochemical Fluids in Greenhouse Farming



TheGreeFa aims to reduce the overall energy consumption in the greenhouses and maximise at the same time the quote of renewable energy used for cooling, heating and humidity control and to water recovery in hot and dry climate zones.

Two different concepts for greenhouse systems will be developed and demonstrated in Continental and Mediterranean climate.



The EU Framework Programme for Research and Innovation

Why TheGreeFa

Today, greenhouse horticulture is related to the **highest productivity of all common methods in agriculture**. The **energy consumption**, especially for heating purposes in Central Europe **are still high**, while in Southern Europe, **growing water shortages** will force to **use seawater desalination**, which may also cause **a quantum leap in energy demand**.



Increase of
energy efficiency



Large use of
renewable
energy



Cost savings

TheGreeFa proposes for greenhouse farming three **innovative solutions** driven by renewable energies, that **recover the latent heat and water from air humidity**.

- Solution 1: Humidity control, heating and cooling in one system through a single process.
- Solution 2: Drying processes for herbs and foods at low temperature to preserve their quality and aroma.
- Solution 3: Water recovery by evapo-condensation strategies, including sorptive drying and evaporative cooling with saline water.

Ways to achieve TheGreeFa's goals

Reduction of energy consumption

- ❖ **Reduction** of the amount of the **energy** required for the temperature control through the **recovery of the latent heat** of the humid air.
- ❖ **Reduction of the heat losses** by **humidity control through absorption** instead by ventilation and air exchange with the outside.
- ❖ **Water recovery** from air humidity, **without water purification and pumping**.

Large use of renewable energy

- ❖ Low temperature heat is **enough** as the driving energy, e.g. solar heat or residual heat.
- ❖ Integration of **free-loss thermal storages**, effective **usage of renewable energy** with seasonal shifting.

Cost effectiveness

- ❖ Use of mainly **plastic component**, no thermal isolation is required.
- ❖ The only rotating machines are standard pumps and air fans **limiting required maintenance**.
- ❖ Thermochemical fluid (TCF) has an energy density up to 10 times higher than water, **reducing the volume required for storages**.

Project's structure

The work in TheGreeFa has been broken down into **five work packages** to achieve the overall project goals within the foreseen time frame.

WP1

In **WP1**, the **concept is before tested and optimised in prototype** before the installation in demonstrators will be explored.

WP2

In **WP2**, the **concept is modelled in a software environment** in order to analyse different operation and control modes as well as for the integration of different renewable energy sources.

WP3

In **WP3**, **case studies are carried out**. They are **providing data for the modelling** of TheGreeFa concept as whole systems (WP2) as well as they **produce data for the potential assessment** (WP3) of TheGreeFa.

WP4

WP4 disseminates the result of TheGreeFa, gaining stakeholders and preparing the future exploitation on the market.

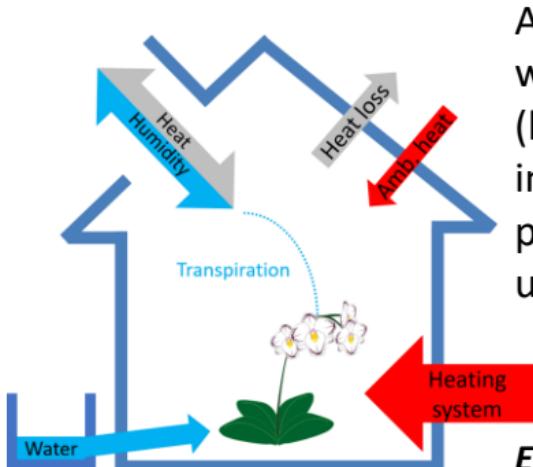
WP5

WP5 builds the framework and management infrastructure to achieve goals in the envisage time frame. It monitors all activities, resources and risks to ensure smooth implementation.

TheGreeFa principles

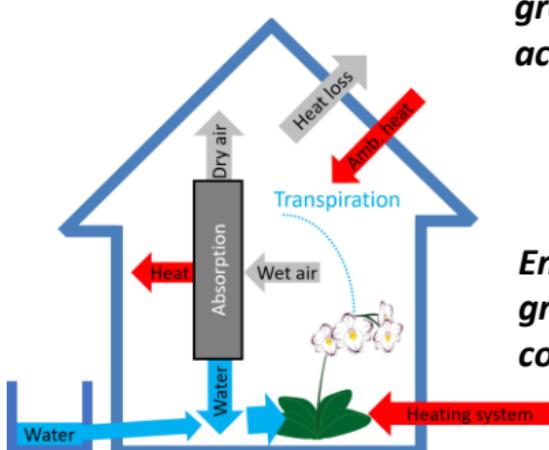
The **reduction of the energy required for heating** is reached in TheGreeFa recirculating the air inside the greenhouse **avoiding the exchange with the external air**. At the same time, the **latent heat** of the humid air is **reconverted in sensible heat** used for heating purpose.

In TheGreeFa greenhouse, it is **not necessary to regulate the humidity opening the windows**. The thermochemical fluid (TCF) removes the excess of humidity produced by the transpiration of the plants, so the **thermal energy losses can strongly be reduced**.



At the same time, the water vapour of the air (humidity) condenses in the absorption process releasing useful heat.

Energy and mass flow in a greenhouse without an active humidity control



Energy and mass flow in a greenhouse with TCF air conditioning



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