Sustainable agricultural production with the exploitation of innovative geothermal hydroponic Greenhouses
(MED Greenhouses)

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Project Coordinator
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- Introduction of MED Greenhouses
- Pros & Cons
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The project will mainly capitalize results of LIFE+ "Adapt2change" project by promoting, disseminating & transferring innovative Greenhouses in the MED area, minimizing water & energy demand.

**Project full title:** "Adapt agricultural production to climate change and limited water supply"

**Grant agreement no:** LIFE09 ENV/GR/000296,

Finance (50%):
Objectives 2/2

The Innovative Technology of MED Greenhouses aims to address issues related to energy & water efficiency & sustainable agricultural production, contributing to Green Growth & Circular Economy.
Contribute to Climate Change Adaptation, coping with:

- Water scarcity
- Water pollution
Addressing issues of agricultural production:

- Water availability
- Increased cost for energy
- Increased cost of raw materials
- Increased market competition
- Increased demand for product quality
- Loss of agricultural land for other activities
Introduction of MED Greenhouses

Production: **600** tn of tomato/ha/year
Conventional Production: 150-250 tn/ha/year
Introduction of MED Greenhouses
Introduction of MED Greenhouses

- Natural cooling & ventilation system
- Dynamic cooling & ventilation system
- Heating system
  - Geothermal heat pumps
  - Oil boiler
- Curtain / thermal insulation curtain system
- CO₂ Enrichment System
- Air Drying System
- Hydroponics system
  - Closed System
  - Open system
- Central System Control System
Introduction of MED Greenhouses

Natural cooling & ventilation system (Top windows)
Introduction of MED Greenhouses

Dynamic cooling & ventilation system (Blinds, Fans, Sides)
Introduction of MED Greenhouses

Geothermal Energy Subsystem

- The greenhouses’ energy needs for cooling, heating and conversion of water vapour are being covered by a vertical closed loop geothermal system which is built next to the greenhouses, exploiting the available shallow geothermal energy field.

- This system offers significant advantages over other forms of energy as it is a renewable energy source which does not burden the environment with additional pollutants, reducing carbon emissions footprint.

- MED Greenhouses are based on Geothermal Heat Pumps Systems that exploit shallow geothermal energy (exploitation of stored energy of low depth rock and surface / ground water with temperatures <25°C)
Introduction of MED Greenhouses

The system consists of the following 3 parts:

- Geothermal exchangers
- Heat Pump
- Floor Heating System
Introduction of MED Greenhouses
Introduction of MED Greenhouses

Curtain / thermal insulation curtain system
Introduction of MED Greenhouses
CO₂ Enrichment System
Introduction of MED Greenhouses

- **Air Drying System**

  - Concentration of water in the greenhouse by means of a cold heat exchanger
  - Air with high relative humidity passes through a cold heat exchanger
  - Coolant heat exchanger temperature lower than dew point
  - The humidity of the air is converted into water
Introduction of MED Greenhouses

- Hydroponics system
  - Closed System
  - Open system

- Head of hydroponic system with containers of thick nutrient solutions & clean / drainage water
- Preparation of nutrient solution with EC and PH control
- Circular watering
- Growing on rockwool substrate
Introduction of MED Greenhouses

Fresh Water Tank

Drainage Return Tank

Rainwater Tank

Dehumidification Water Tank

Hydroponic Head

Fertilizer

Acid

Non Returned Drainage Water due to its toxicity

F4

F3

Crop Evapotranspiration

Drainage

To Crop

From Crop

TEST GREENHOUSE

CONTROL GREENHOUSE

Non Returned Drainage Water - Open system
Introduction of MED Greenhouses

Central System Control System

- Easy Greenhouse management
- Remote control / setup
Advantages compared to Conventional GH

**Energy Performance**

- The mean Energy reduction (Kwhe) can by up to **67%**.

**Water Efficiency**

- Working as a closed hydroponic system the MED Greenhouses can reduce water consumption by up to **45%**.
- This reduction can reach **70%**, compared to open filed cultivation practices.
- Considering the additional water retention systems installed inside the MED Greenhouses (i.e. rain-water re-circulation systems), the water re-use can reach, in some cases, **100%**.
- The cooling system of the MED Greenhouses (capacity of 150 W m-2) has the potential to increase the water use efficiency by up to **75%**.

**Environmental Benefits**

- The mean CO₂ emissions reduction can be ranged between **46-52%**.
- The use of fertilizers can be reduced by approximately **30%** compared to an open hydroponic system; this reduction can reach and surpass **60%** compared to open cultivation practices.
# Indicative Construction Cost

<table>
<thead>
<tr>
<th>Item</th>
<th>Price per m² (€/m²)</th>
<th>Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>16,30</td>
<td>16,300</td>
</tr>
<tr>
<td>Reinforcements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato crop</td>
<td>0,50</td>
<td>500</td>
</tr>
<tr>
<td>Top Plastic Cover</td>
<td>1,18</td>
<td>1,180</td>
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<tr>
<td>Sides Polycarbonate</td>
<td>2,33</td>
<td>2,330</td>
</tr>
<tr>
<td>Insect Proof Net</td>
<td>0,19</td>
<td>190</td>
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<tr>
<td>Inside Thermal screen</td>
<td>2,5</td>
<td>2,500</td>
</tr>
<tr>
<td>Outside Thermal screen</td>
<td>6</td>
<td>6,000</td>
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<tr>
<td>Irrigations System</td>
<td>1,88</td>
<td>1,880</td>
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<tr>
<td>Drainage Collection</td>
<td>0,43</td>
<td>430</td>
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<tr>
<td>Climate Control</td>
<td>0,49</td>
<td>490</td>
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<tr>
<td>Cooling System</td>
<td>5</td>
<td>5,000</td>
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<tr>
<td>Assimilation Lights</td>
<td>12,42</td>
<td>12,420</td>
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<tr>
<td>Air Circulation Fans</td>
<td>0,4</td>
<td>400</td>
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<tr>
<td>Electrical Installation</td>
<td>1,42</td>
<td>1,420</td>
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<tr>
<td>Gas Condenser</td>
<td>1,8</td>
<td>1,800</td>
</tr>
<tr>
<td>Boilers &amp; Burners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expansion Installation</td>
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<tr>
<td>Central Dosing CO2</td>
<td>25</td>
<td>25,000</td>
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<tr>
<td>Heat Storage tank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Dosing CO2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport Lines, Pipe, Rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and accessories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Flow Filter</td>
<td>1,72</td>
<td>1,720</td>
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<tr>
<td>Fan Coil</td>
<td>0,4</td>
<td>400</td>
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<tr>
<td>CO2 Dosing System</td>
<td>1,32</td>
<td>1,320</td>
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<tr>
<td>Electricity Generators</td>
<td>0,09</td>
<td>90</td>
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<td>Clean Water Tank</td>
<td>0,97</td>
<td>970</td>
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<tr>
<td>Ground Cover</td>
<td>2,03</td>
<td>2,030</td>
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<tr>
<td>Rockwool Substrate</td>
<td>1,34</td>
<td>1,340</td>
</tr>
<tr>
<td>Ground Gutters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total price</strong></td>
<td><strong>85.71</strong></td>
<td><strong>85.710</strong></td>
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</tbody>
</table>

## Item Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Price per m² (€/m²)</th>
<th>Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse unit, Control system, heating, ventilation and cooling systems, Supporting-Auxiliary building</td>
<td>207.17</td>
<td>89,500</td>
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<tr>
<td>Hydroponic system</td>
<td>108.8</td>
<td>47,000</td>
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<tr>
<td>Thermal screen and CO2 dosing system</td>
<td>53.24</td>
<td>23,000</td>
</tr>
<tr>
<td>Geothermal drillings and heat pumps</td>
<td>186.8</td>
<td>80,700</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>556</strong></td>
<td><strong>240,200</strong></td>
</tr>
</tbody>
</table>
Disadvantages of MED Greenhouses

- The up-front **high capital cost** in order to establish the MED Greenhouse. Although such investment seems profitable, the need for drilling and installing this innovative technology increase the cost of the construction/investment. **Overall, it is worth-while to invest in large scale geothermal greenhouses, payback.**

- A drawback of applying geothermal energy in greenhouse operation is, additionally, the **extended land required for drilling and exploitation.** Generally, the geothermal unit delivers the maximum capacity, as less is the distance between the greenhouse and installed point of the drilling wells. That makes geothermal systems hard to be applied in already established greenhouses, unless a vertical ground source heat pump is used.

- **MED Greenhouses require experts and well trained operators to establish and monitor the whole system,** while proper education and training of the users is also required for its operation.
Transferability factors

- There is no significant geographical limit
- In vertical loops, ground is not the limit but the investment and functional cost demanded to drill to this depth and the accessibility in innovative technologies needed for producing geothermal heat
- Drilling aspects:
  - Geology
  - Hydrology
  - Land availability
- Access by the responsible ministry authority of the area
- An access to the spatial distribution data, therefore, of the area in which geothermal technology intended to be transferred will aid the experts to clarify the feasibility of the system in the specific area
MED Greenhouses – Photo Gallery
MED Greenhouses – Photo Gallery

2/2
Introduction of MED Greenhouses

Our future planning for “Energy Autonomous Greenhouses”
Thank you for your attention!

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