International Conference “ADAPTtoCLIMATE”

“PROTECTED CULTIVATION AND ADAPTATION TO CLIMATE CHANGE”
Dr. Polycarpos Polycarpou, et all

Adapt2change
LIFE 09 ENV/GR/000296
“Adapt agricultural production to climate change and limited water supply”
Presentation Outline

• Short Introduction
• Some details about the Project
  “Adapt2Change”
• Project execution and present status
• Testing of the System
• Conclusions
The Importance of Primary Sector in Cyprus Economy

- Addressing the Economic Crisis
- Addressing the Climatic Changes
- An Opportunity for renewal of aging rural and farmers population
- Protection of the Environment
Main Problems of Agricultural Production

• High Cost of Raw Materials (Fertilizers, Pesticides, etc.)
• Lack of Water for Irrigation
• Weather abnormalities due to Climatic Changes
• Loss of good agricultural land in other economic activities (urbanization)
• High cost of Energy (diesel oil, electricity, etc)
• High Quality Standards for agricultural products, imposed by EU Regulations.
• High market competition

— All the above and many other parameters, lead to the need for intensifying Protected Cultivation (cultivation in greenhouses)
Partners in The Project

• TEI Larissa's (Greece): Coordinator
• ARI Cyprus
• TEI of Piraeus (Greece)
• KEK-Europliroforisi A.E.
• It is a Life+ Project: LIFE 09 ENV/GR/000296
• Project Budget 2,576,548€ - 50% EC Contribution
• Project Duration 01/09/2010 – 31/08/2014
• Extension needed
Proposed Solutions offered by “Adapt2Change”

- Growing in Greenhouses using New Technology and Innovative Practices (decrease cost, increase product quality, improve working conditions, incentive for young people)
- Saving Energy with renewable energy applications, such as shallow geothermal.
- Water saving irrigation, rainwater harvesting, application of closed hydroponic systems and condensing air humidity.
- saving fertilizers
- Optimisation of environmental conditions in greenhouses by using smart automation.
Erection Location of the Greenhouses at the Experimental Station of ARI at Zyghi
Diagrammatic Presentation of the Experimental Greenhouses
Diagrammatic Presentation of the Geothermal Heat Pump
Example of a Soil Temperature Profile Throughout a Year
Geothermal Boreholes at the Construction Site
Proposed Solutions of Basic Systems incorporated in “Adapt2Change” Pilot Greenhouse

- Fan and Pad Cooling System
- Geothermal Heat Pumps (2 Units of 35 KW each)
- Air Dehumidification System
- Hydroponic System (Open and Closed)
- Central Control System
Schematic diagram of the open hydroponics system applied
Schematic diagram of the Closed hydroponics system applied

- Fertilizer Mixer
- TANK A
- B
- ACID
- Leachate Tank
- Fresh Water Supply

ACID
Leachate Tank
UV

Fresh Water Supply
Erection of Greenhouses
Geothermal Heat Pump Units
November 2012
Manifold of Geo-Heat Exchanger Loops
November 2012
Air Dehumidification Duct
November 2012
Diagram of Air Dehumidification Process
Dynamic Fan & Pad Cooling System
December 2012
Completion of System Erection

December 2012
Hydroponic Controller and Hydroponic Benches
September 2013
Conventional Heating System in Control GH
Plants in Geothermal Greenhouse

14 Ιανουαρίου 2014
Bumble Bees Hives in Greenhouses for Pollination
Bumble Bee in Action on Egg Plant Flowers
The first Egg Plant Production in Geothermal GHs
- Up December 2012 started the Testing Phase of the Systems.
- Planting of Plants, 20 November 2013.
- Central Control System still Pending.
System Functionality Control
Collection of Environmental Data
Data logger: Campbell CR23X
Uniformity Test of Pilot and Control GH

Τετάρτη 5 μέχρι Πέμπτη 6 Ιουνίου

Τ_ GH1
T_ GH2

Θερμοκρασία σε βαθμούς Κελσίου

0 5 10 15 20 25 30 35 40

Λεπτά μετά τις 08:00 πμ

0 200 400 600 800 1000 1200 1400 1600
System Evaluation

- Energy flows and comparison of energy consumption in the two GHs (Electricity, Fuel oils, Geothermal Heat Gains, etc.)
- Water and Fertilizer balance (comparison of open and closed Hydroponic System, Water reclamation by condensation of air humidity)
- Cultural practices (plant growth, plant protection, etc.)
- Plant Yield (quantity & quality of produce)
- Economic evaluation & Techno-economic study)
Renewable Energy from geothermal heat pumps

Renewable (geothermal) energy $E_{RES}$

Conventional final energy input to run heat pump $E_{final}$

Total energy delivered $Q_{usable}$

Useful heat

(in most cases, not $E_{RES}$ is measured directly, but only $E_{final}$ and $Q_{usable}$)

Renewable portion ($E_{RES}$) of total energy delivered by a heat pump typically is calculated as: $E_{RES} = Q_{usable} - E_{final}$

SPF of a heat pump is calculated as: $SPF = Q_{usable} / E_{final}$

Alternative calculation for $E_{RES}$: $E_{RES} = Q_{usable} * 1 / (1 - SPF)$
System Evaluation

Under Directive 2009/28/EC on Renewable Energy, the amount of geothermal energy captured from pumps and can be considered renewable energy, \((E_{RES})\), can be calculated according to the following formula:

\[
E_{RES} = Q_{usable} \times (1 - 1/SPF)
\]

where:

- \(Q_{usable}\) = the estimated total usable heat delivered by heat pumps
- SPF = the estimated average seasonal performance factor for the heat pumps.

Heat Pumps with: \(SPF > 1.15 \times 1/\eta\)

Where \(\eta\) = The overall efficiency for the production and distribution of electricity

can be considered that it contains a renewable energy portion.
Ground Source Heat Pump Performance Factor During Winter 2013/2014 Vs the Minimum Seasonal Performance Factor

GSHP Performance Factor

Minimum Seasonal Performance Factor

Time Period during Winter 2013/2014
Influence of Air Temperature on the Performance Factor of the GSHP

- **Average T_Out when it was below the set point**
- **Average T_GH when it was below the set point**
- **Performance factor**
Comparison of Heating Cost Among Different Fuels and Electricity using GSHP

**Base of Fuel Costs**
- **Oil (€/L):** 1.01
- **Pellets (€/kg):** 0.3
- **Natural Gas (€/m³):** 0.65
- **LPG (€/m³):** 1.32
- **Electricity (€/kWh):** 0.29
- **Electricity EU27 (€/kWh):** 0.112

**Different Types of Fuels**

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Heating Cost (€/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating oil</td>
<td>1.01</td>
</tr>
<tr>
<td>Pellets</td>
<td>0.3</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>0.65</td>
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<td>GSHP EU27</td>
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</tr>
<tr>
<td>GSHP (EU27)</td>
<td>0.112</td>
</tr>
</tbody>
</table>
Conclusions

• Adapt2Change will attempt to show the possibility to make the greenhouse production in the Mediterranean Region as effective as possible regarding:
  – Water use efficiency
  – Energy efficiency
  – The possibility to introduce the shallow geothermal energy as a Renewable Energy Source option in greenhouse cultivations.
Thank you for your Attendance