Project Budget 2.576.548€ - 50% EC Contribution
Project Duration 01/09/2010 – 31/08/2014

International Conference "ADAPTtoCLIMATE"
Filoxenia Conference Centre in Nicosia, Cyprus, 27th & 28th March, 2014.

"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.

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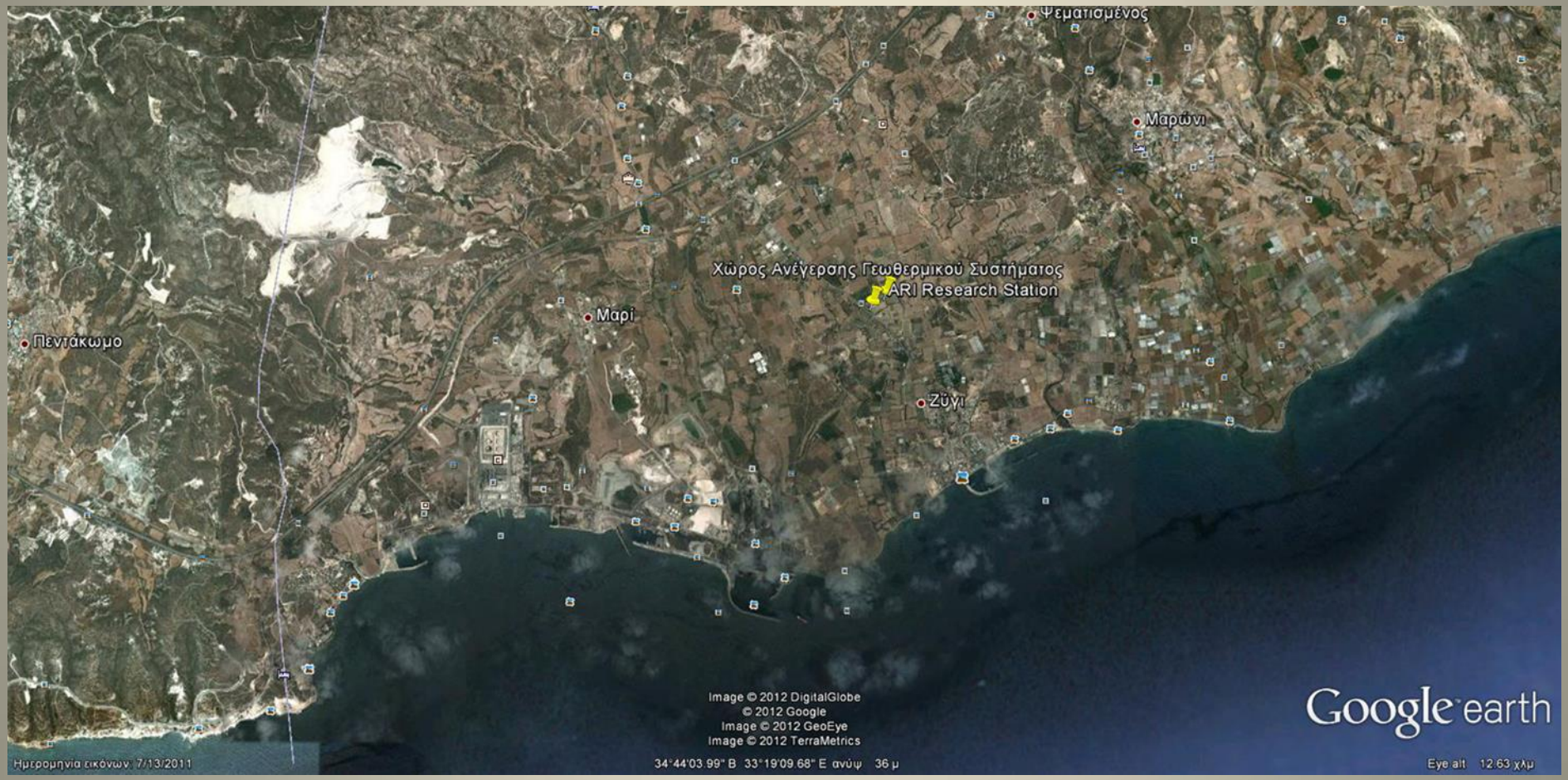
- It is a Life+ Project: LIFE 09 ENV/GR/000296
- Project Budget 2.576.548€ - 50% EC Contribution
- Project Duration 01/09/2010 – 31/08/2014
- Extension needed

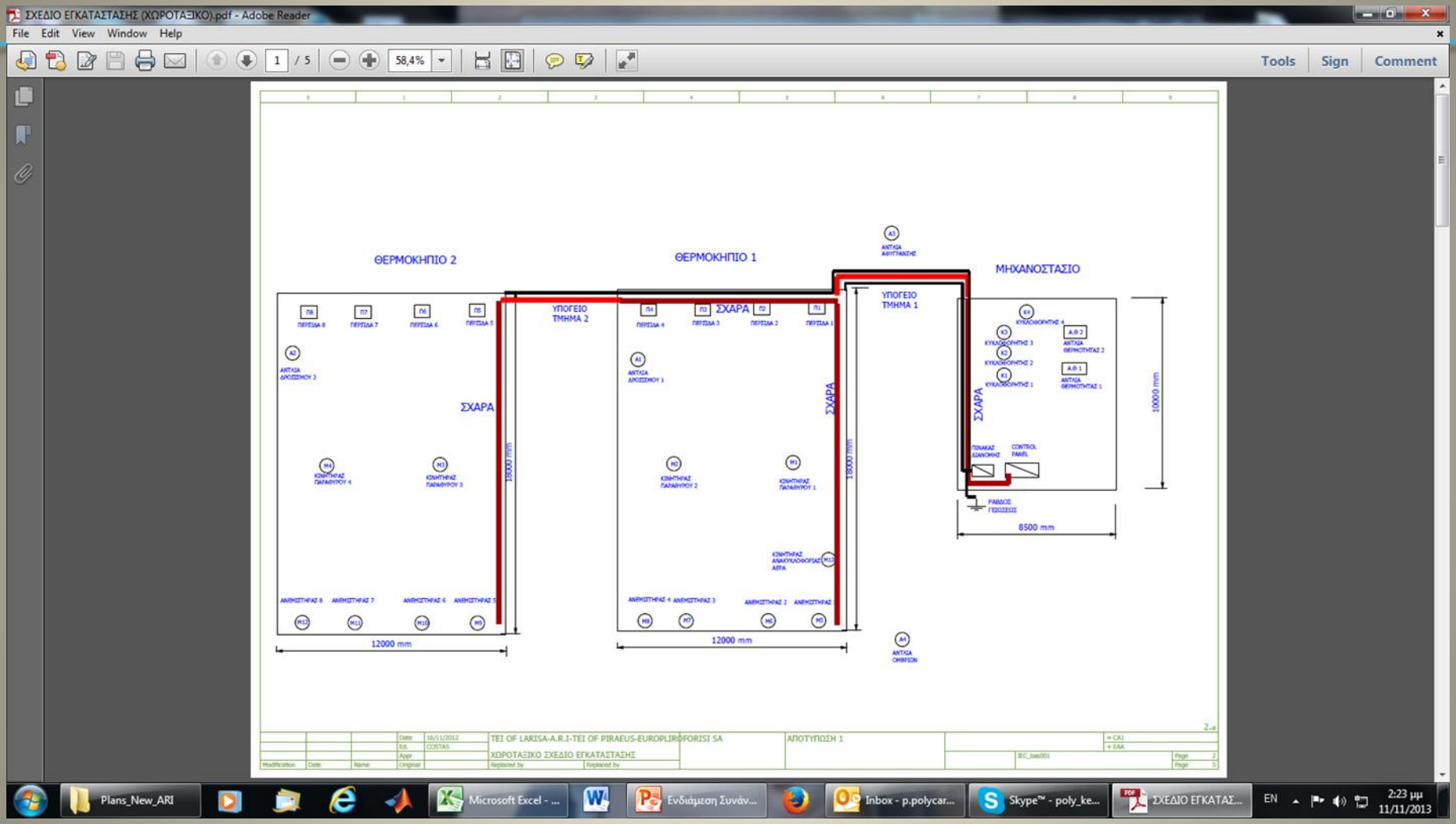
Proposed Solutions offered by “Adapt2Change”

- 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.

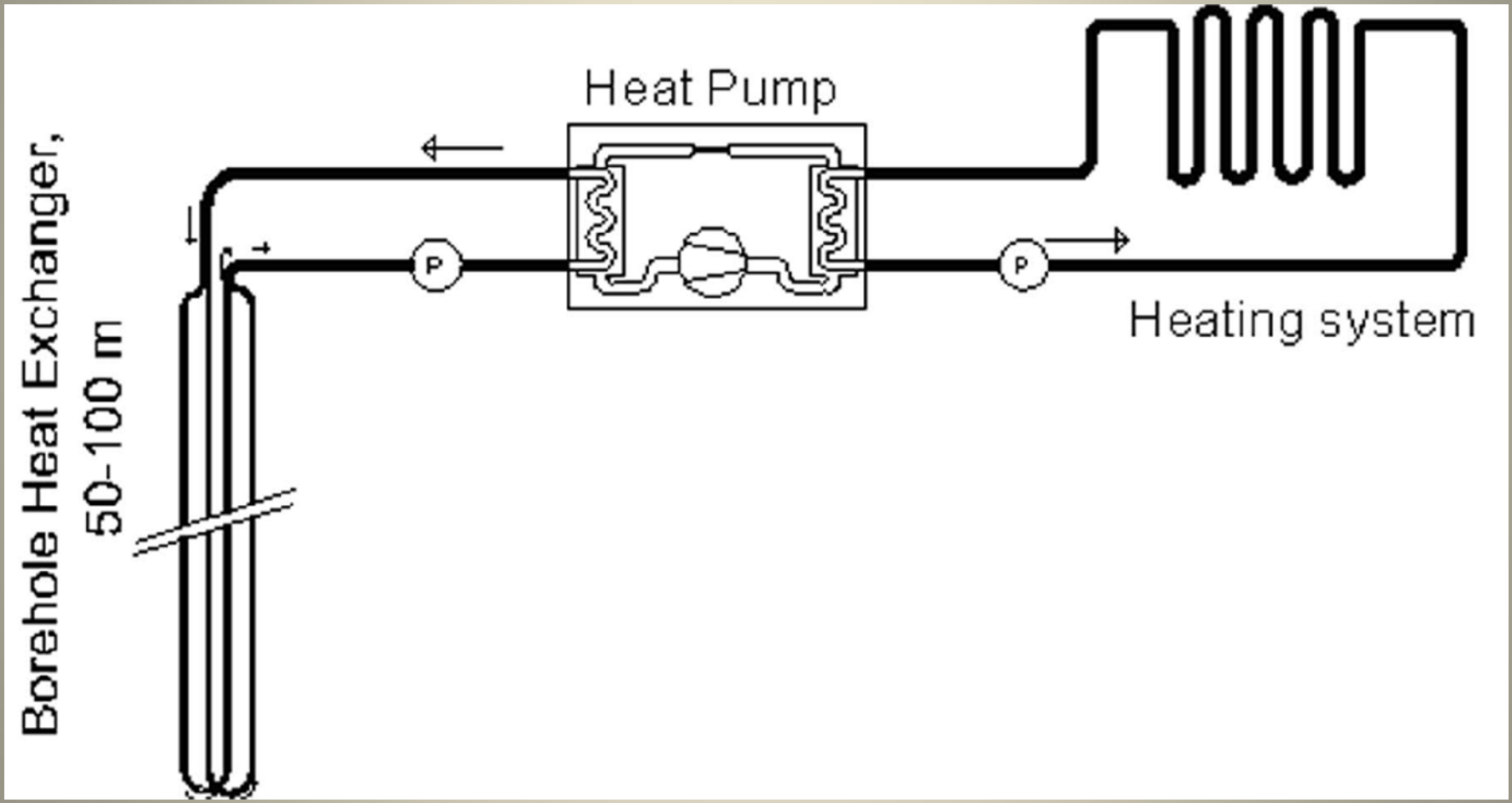
Erection Location of the Greenhouses at the Experimental Station of ARI at Zyghi



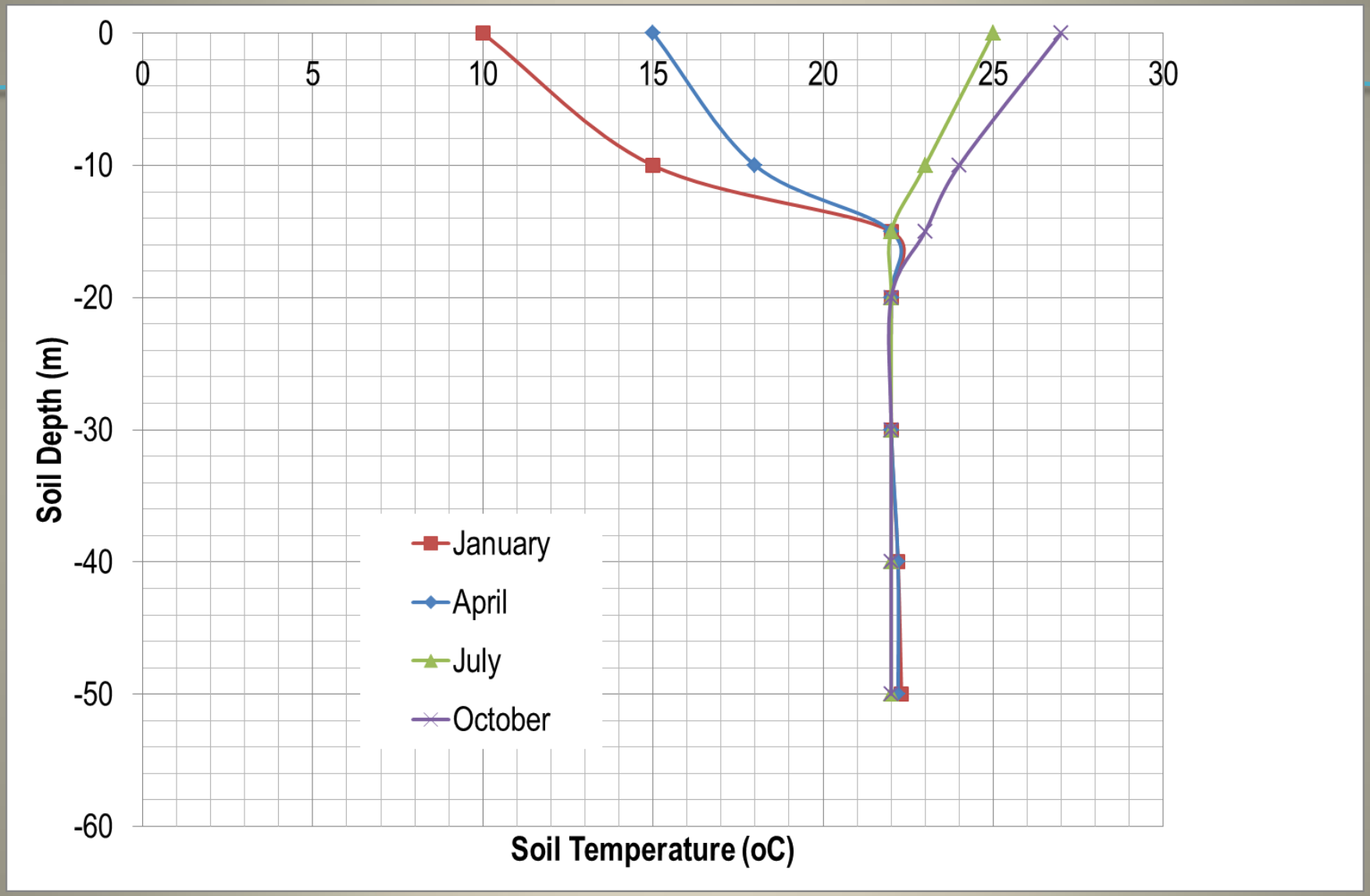
Diagrammatic Presentation of the Experimental Greenhouses



Diagrammatic Presentation of the Geothermal Heat Pump



Example of a Soil Temperature Profile Throughout a Year

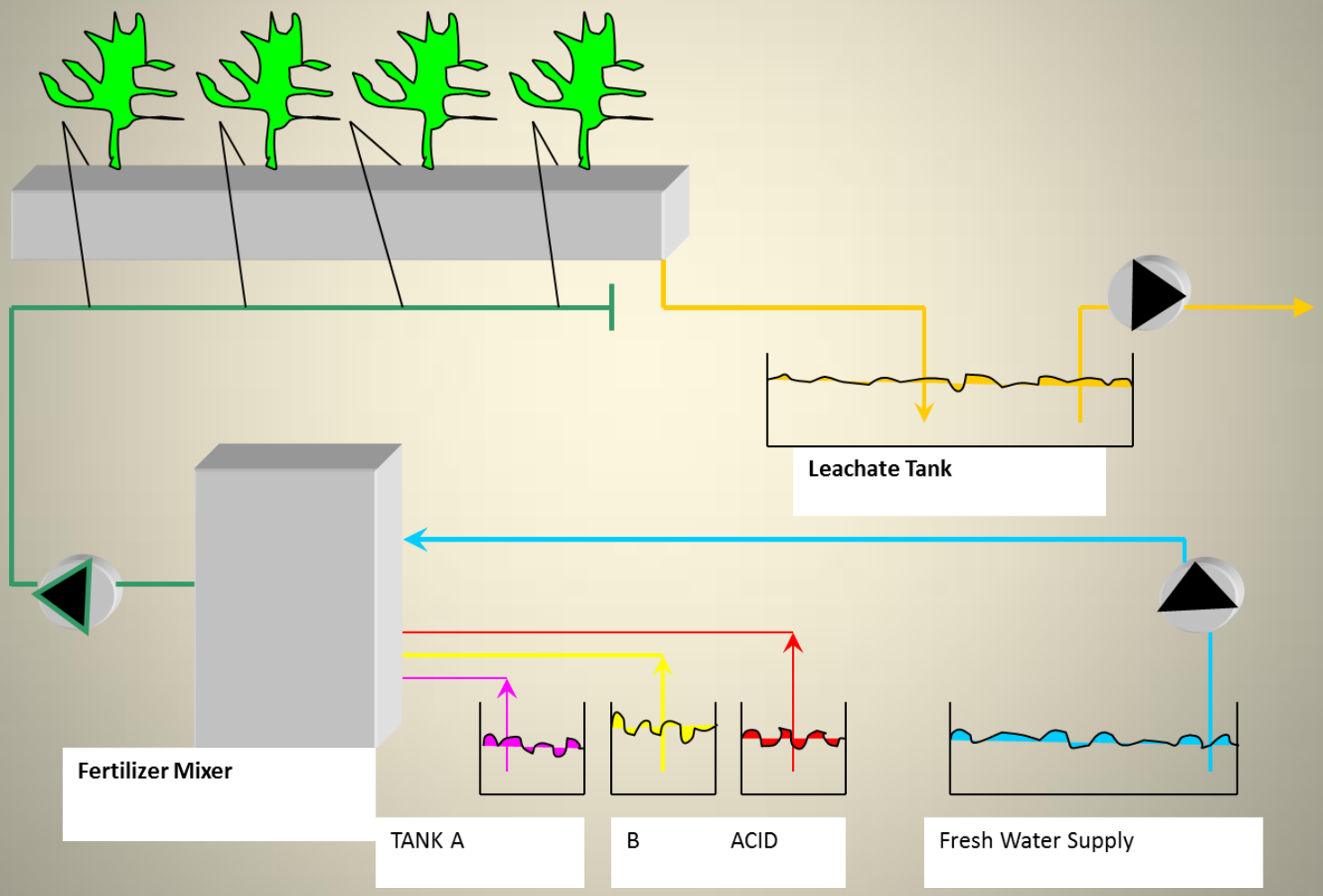


Geothermal Boreholes at the Construction Site

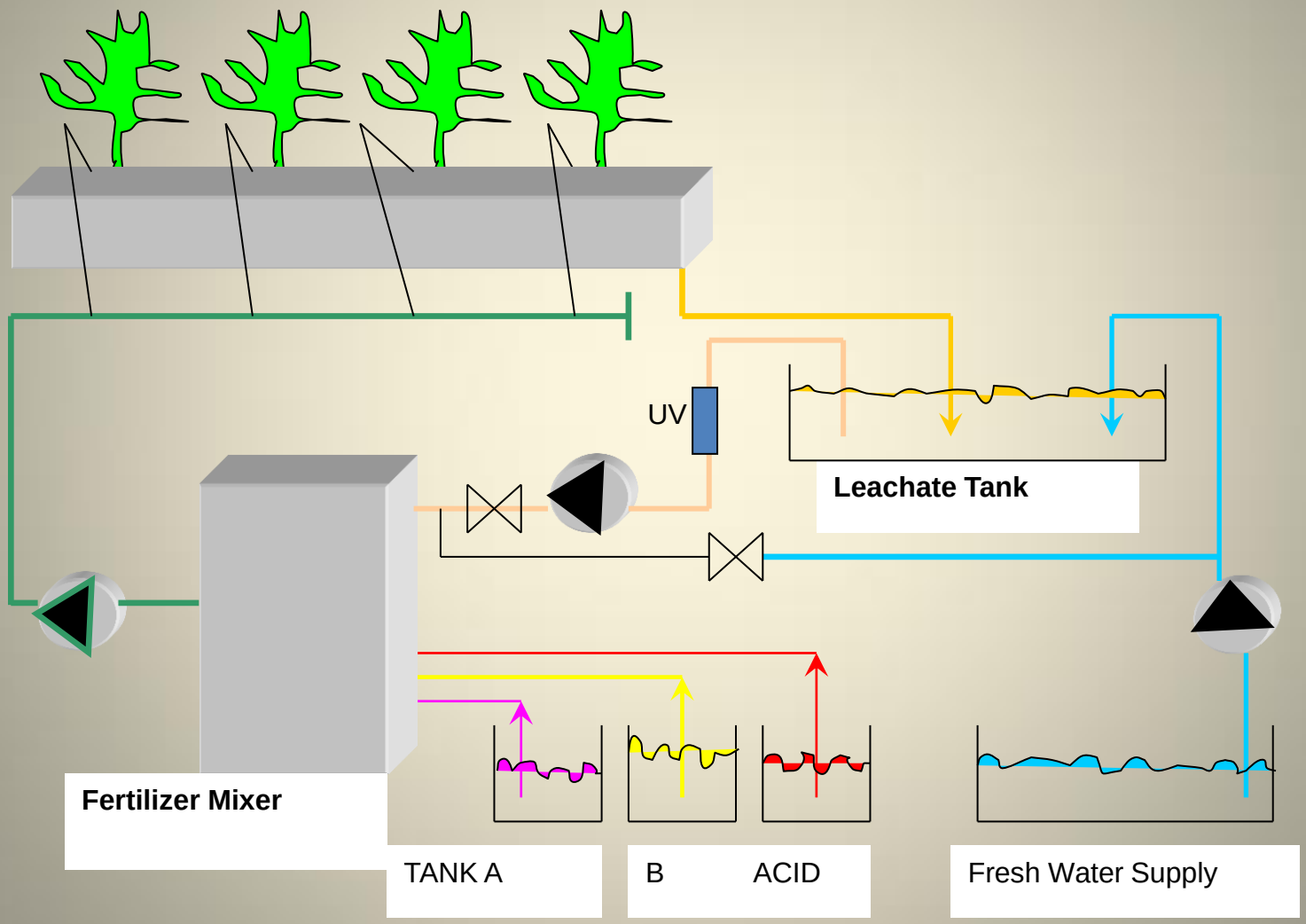
Proposed Solutions of Basic Systems incorporated in "Adapt2Change" Pilot Greenhouse

- 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



Erection of Greenhouses

Geothermal Heat Pump Units

November 2012

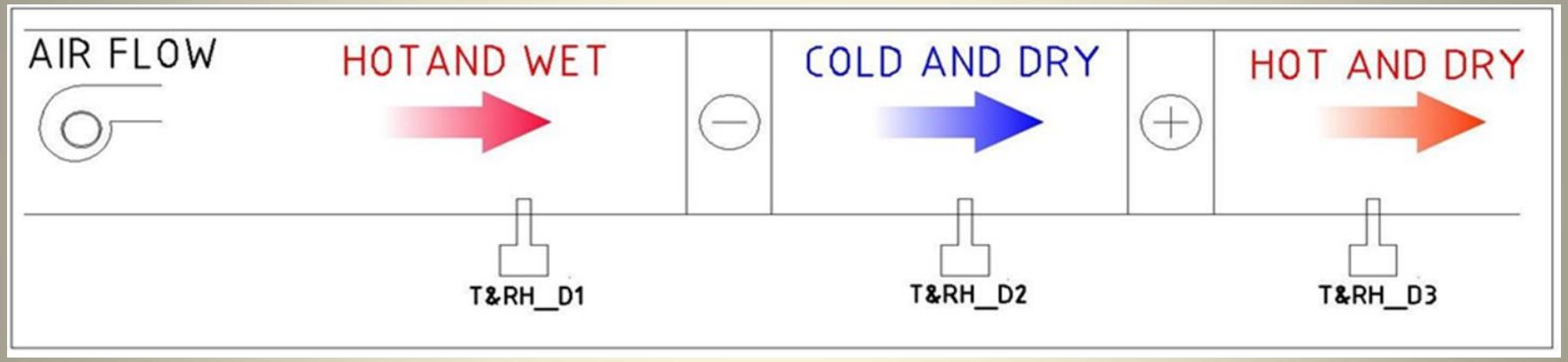
Manifold of Geo-Heat Exchanger Loops

November 2012

Air Dehumidification Duct

November 2012

Diagram of Air Dehumidification Process



Engineering Room

November 2012

Dynamic Fan & Pad Cooling System

December 2012

T.E.I.

ΕΥΡΩΠ

Completion of System Erection

December 2012

T.E.I.

ΕΥΡΩΠ

Hydroponic Controller and Hydroponic Benches

September 2013

Conventional Heating System in Control GH

Plants in Geothermal Greenhouse

14 Ιανουαρίου 2014

Plants in Control GH

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.

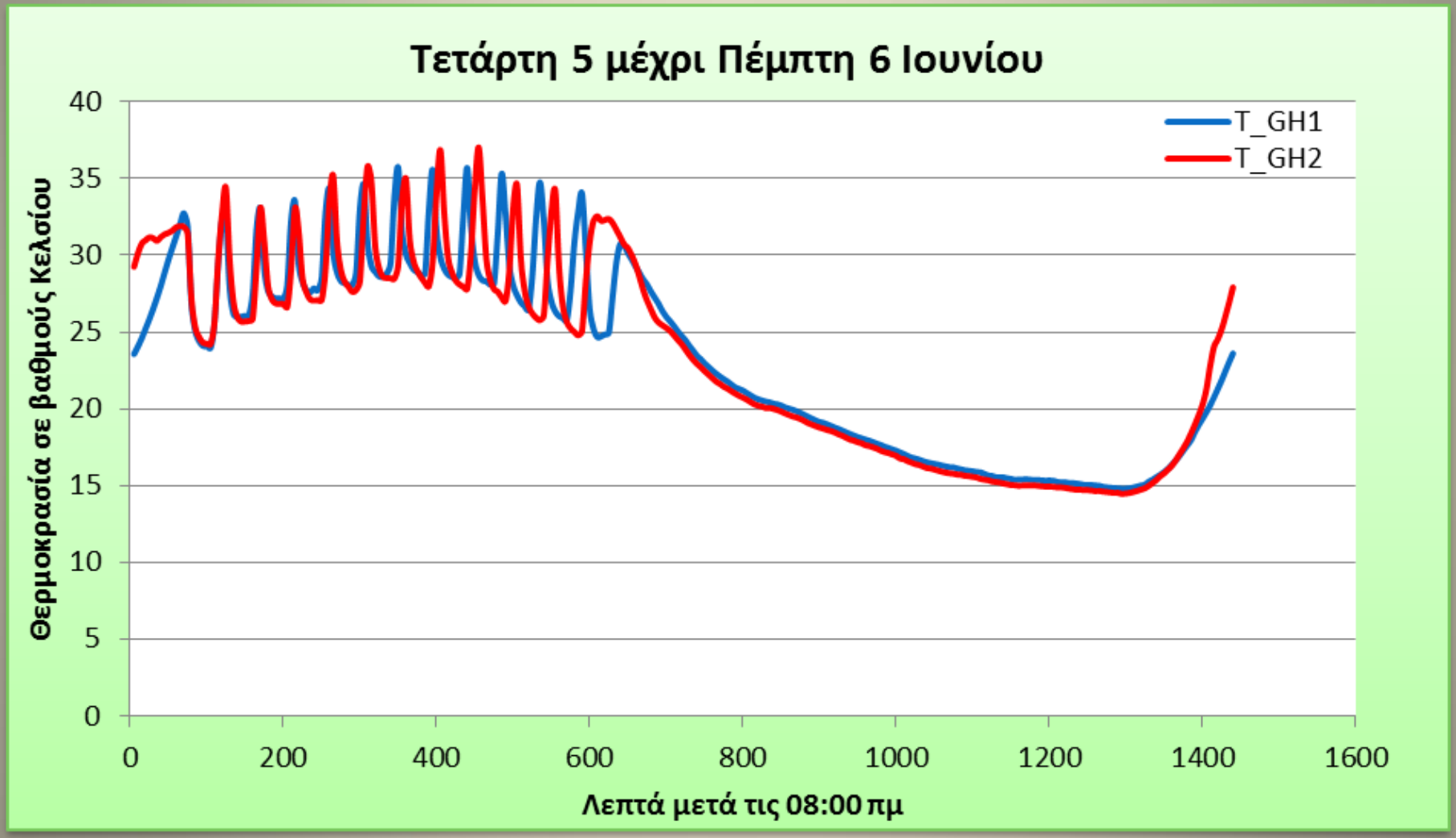
System Functionality Control

Collection of Environmental Data
Data logger: Campbell CR23X

T.E.I.

ΕΥΡΩΠ

Uniformity Test of Pilot and Control GH

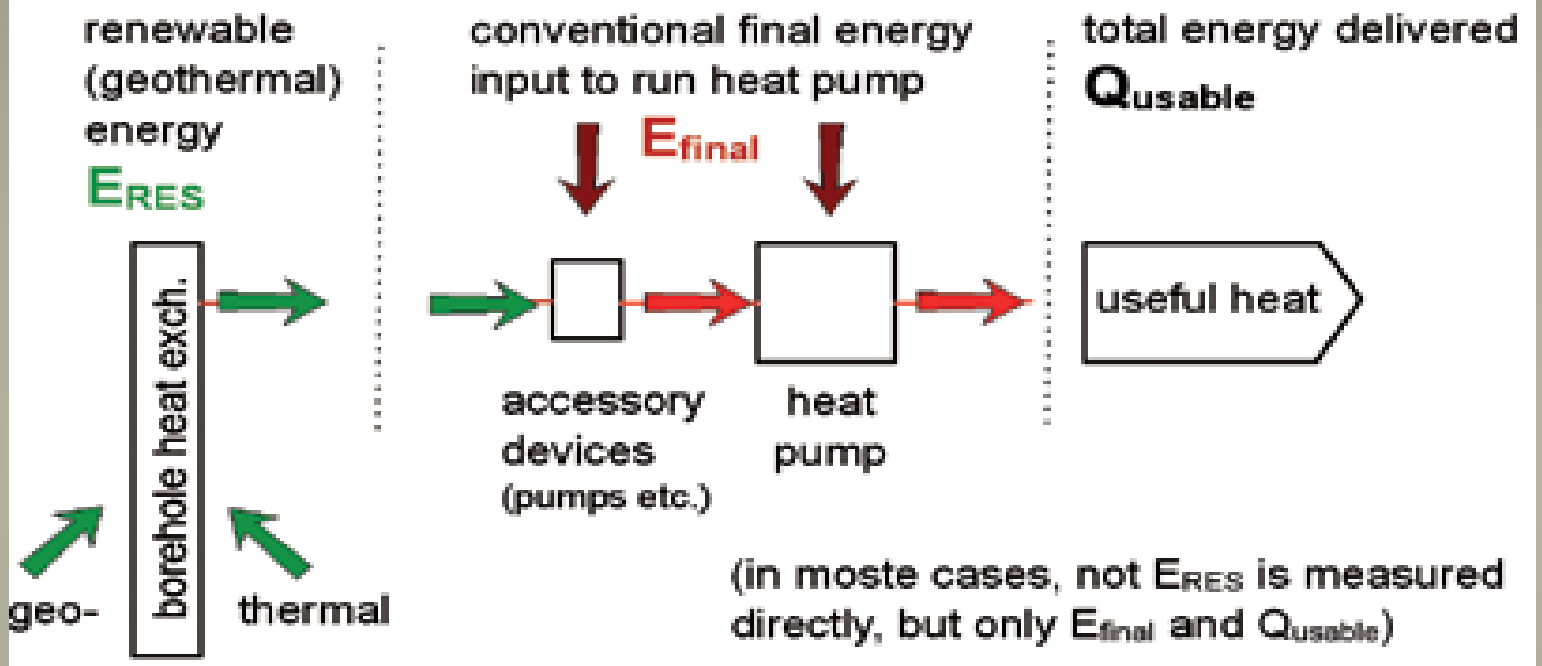


System Evaluation(1)

- 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)

Source: http://egec.info/wp-content/uploads/2011/01/EGEC-Brochure-GSHP-2009.pdf

Renewable Energy from geothermal heat pumps



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(2)

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:

$$E_{RES} = Q_{usable} * (1 - 1/SPF)$$

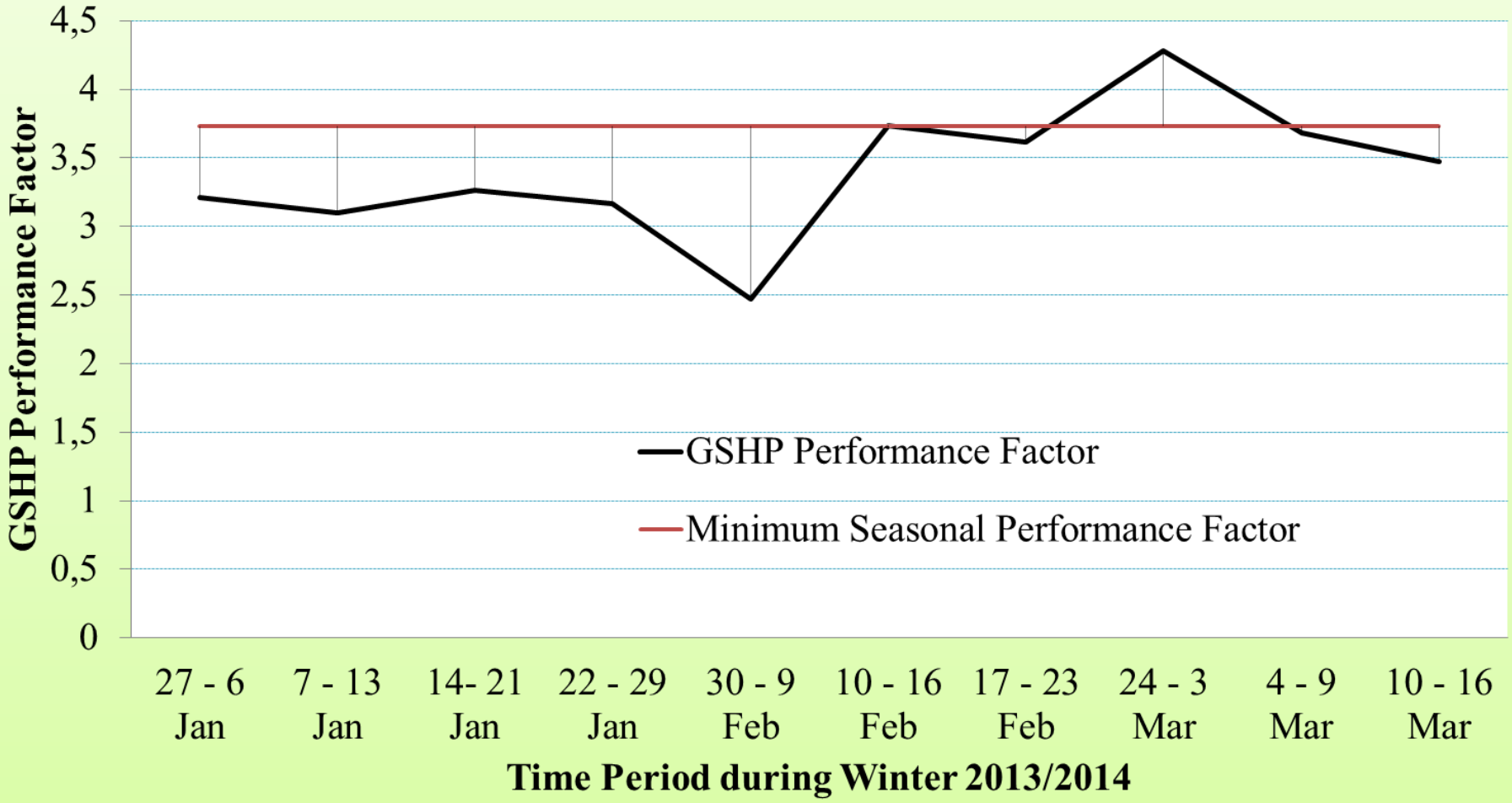
where:

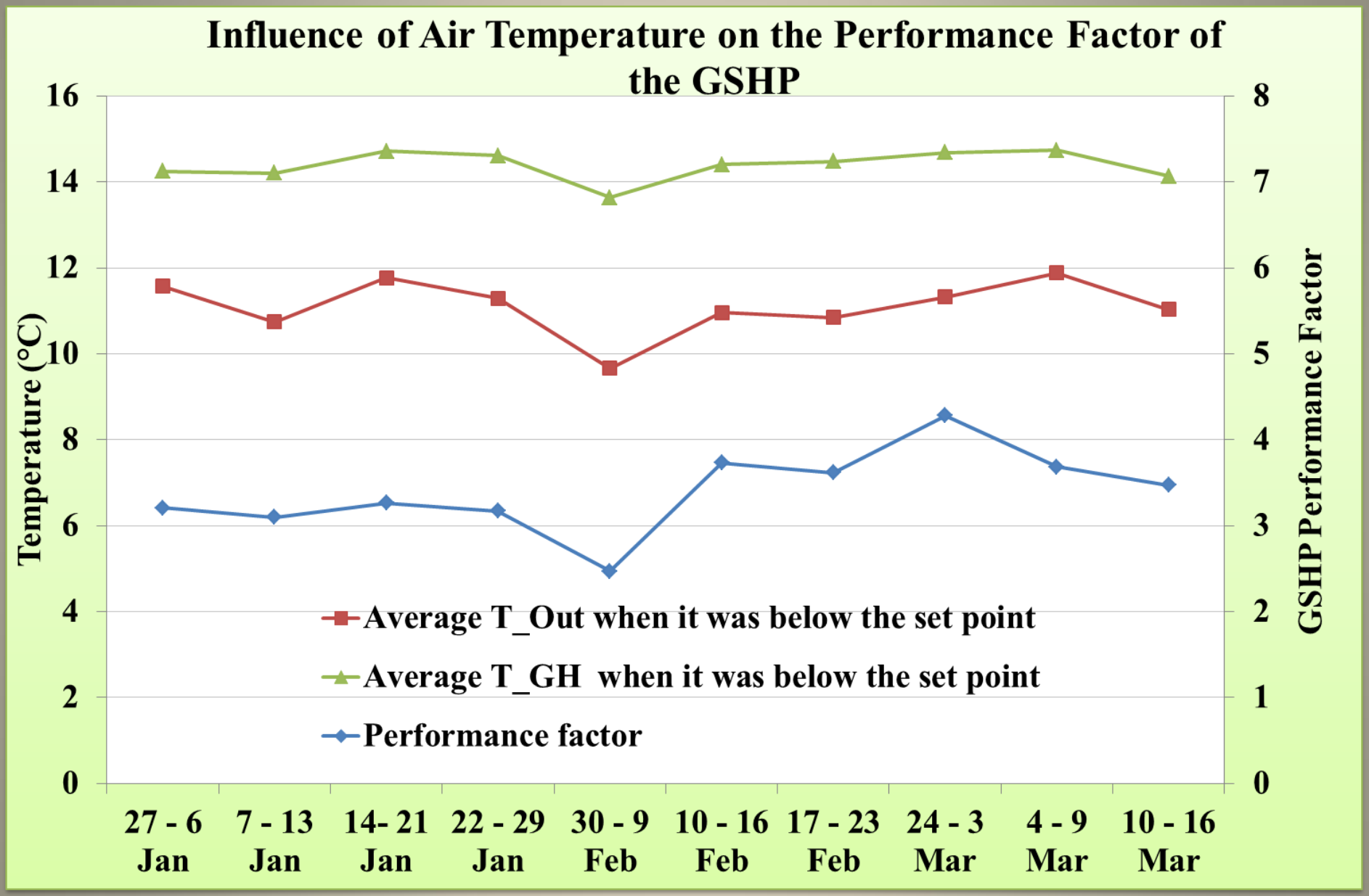
- Q_{usable} = the estimated total usable heat delivered by heat pumps
- SPF = the estimated average seasonal performance factor for the heat pumps.

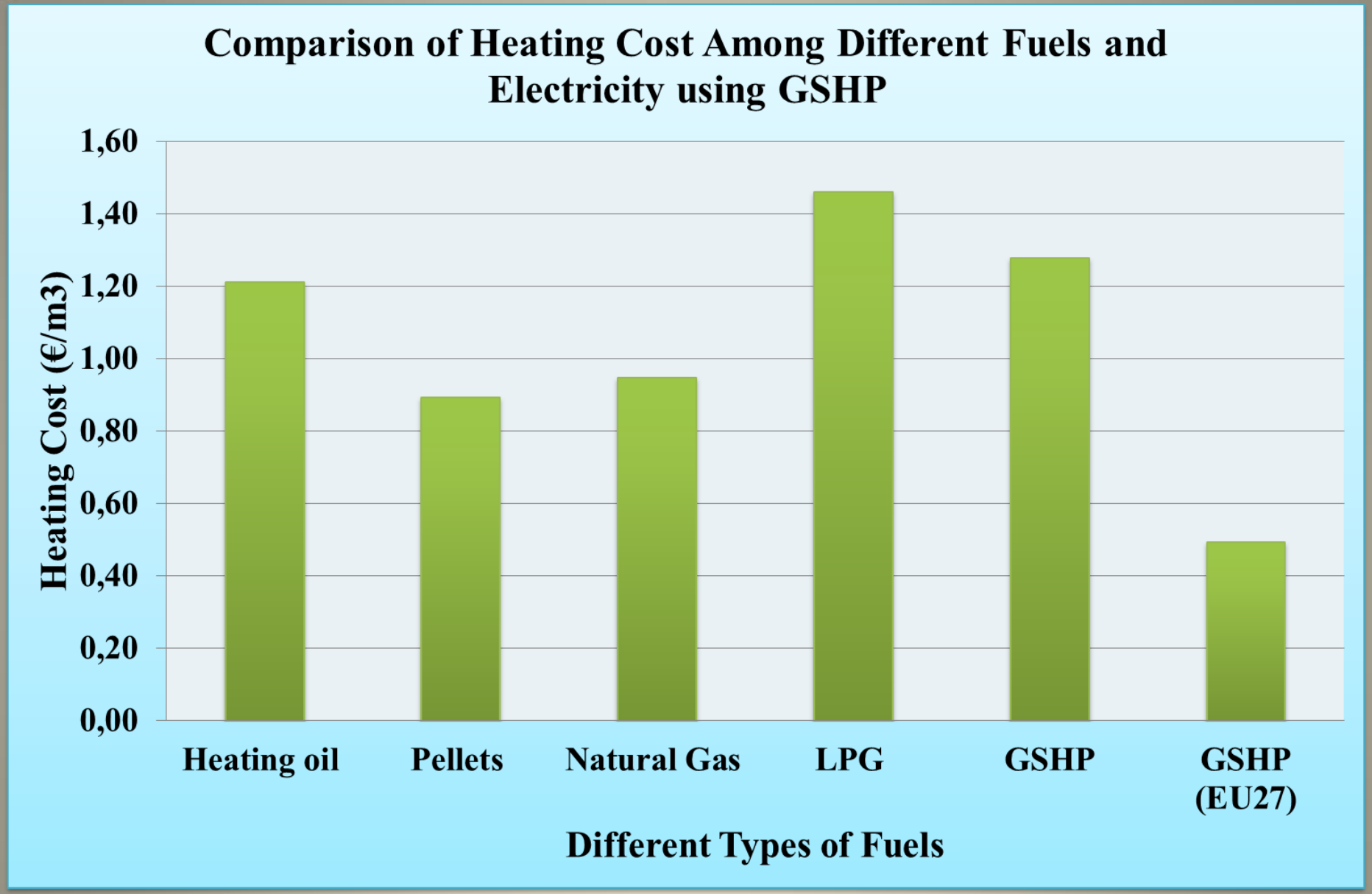
Heat Pumps with: **$SPF > 1{,}15 * 1/\eta$**

Where η = 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
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
GSHP Performance Factor
Minimum Seasonal Performance Factor
27 - 6 Jan
7 - 13 Jan
14- 21 Jan
22 - 29 Jan
30 - 9 Feb
10 - 16 Feb
17 - 23 Feb
24 - 3 Mar
4 - 9 Mar
10 - 16 Mar
Time Period during Winter 2013/2014


Influence of Air Temperature on the Performance Factor of the GSHP
Temperature (°C)
GSHP Performance Factor
16
14
12
10
8
6
4
2
0
8
7
6
5
4
3
2
1
0
Average T_Out when it was below the set point
Average T_GH when it was below the set point
Performance factor
27 - 6 Jan
7 - 13 Jan
14- 21 Jan
22 - 29 Jan
30 - 9 Feb
10 - 16 Feb
17 - 23 Feb
24 - 3 Mar
4 - 9 Mar
10 - 16 Mar



Base of Fuel Costs					
Heating oil (€/L)	Pellets (€ /kg)	Natural Gas (€/m3)	LPG (€/m3)	Electricity (€/kWh)	Electricity EU27 (€/kWh)
1,01	0,3	0,65	1,32	0,29	0,112

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.

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Thank you for your Attendance

T.E.I.

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