Fostering the use of low temperature geothermal sources through the development of operational exploitation guidelines and green energy solutions of enterprising

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# Agro-industrial residuals for enhanced food production in geothermal greenhouses

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Fostering the use of low temperature geothermal sources through the development of operational exploitation guidelines and green energy solutions of enterprising

# Project overall objectives

- ✓ Promotion of technological exploitability of geothermal fields and the comparative economic advantages of the use of geothermal energy.

- ✓ Contribution to establishing Strategic Planning for the Region to implement programs for sustainable energy use for various applications

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# Summary

- Introduction
  - Geothermal greenhouse technology
  - $CO_2$ enrichment in greenhouses
- Proposed technology
  - How and why using biogas from biomass digestion
- Prototype design and construction

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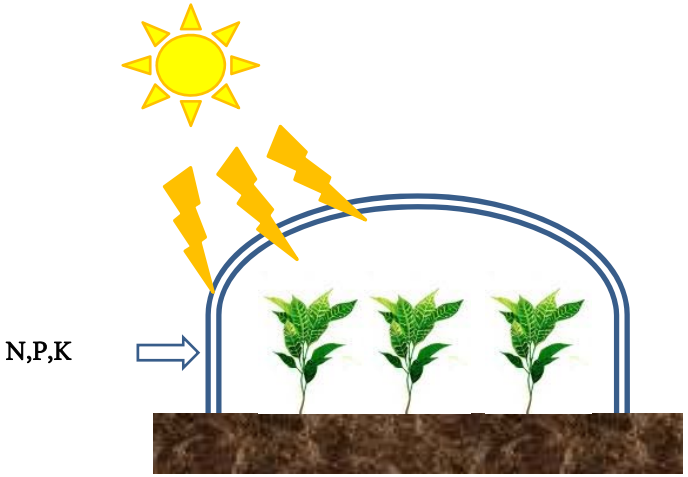
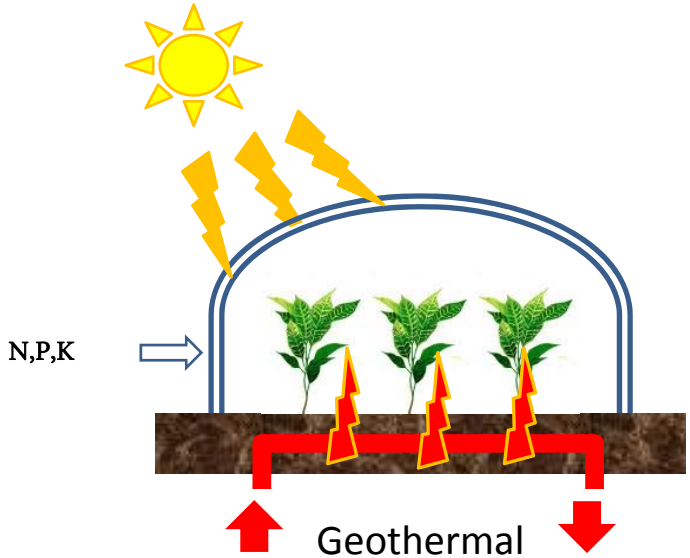
# Greenhouse technology

- Traditional and geothermal greenhouse




Greenhouse heating by solar energy




Greenhouse heating by solar and geothermal energy

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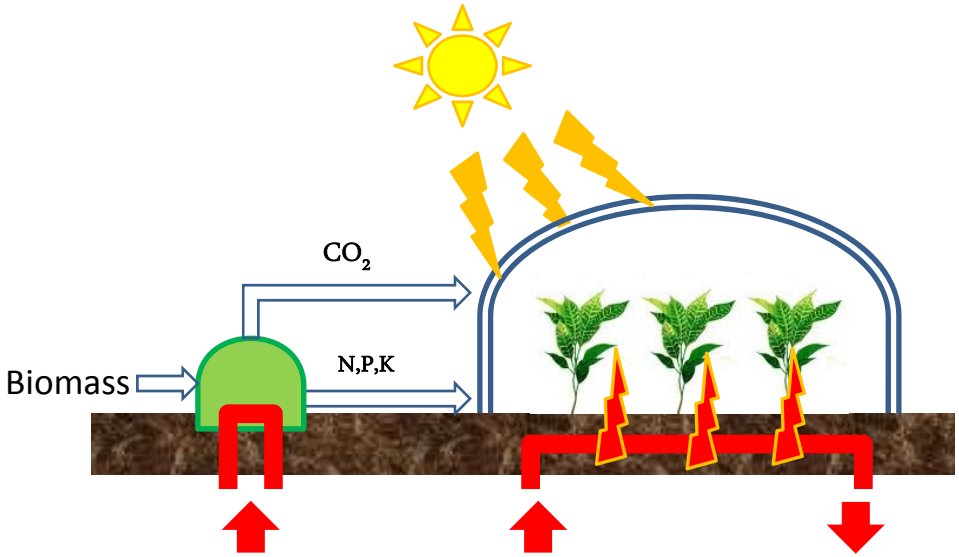
# Greenhouse technology

- Advanced geothermal greenhouse (bio-greenhouse)




1. Greenhouse heating by solar and geothermal energy
2. $CO_2$ enrichment from biomass digestion gases
3. Fertilizer supplementation from biomass mineralization

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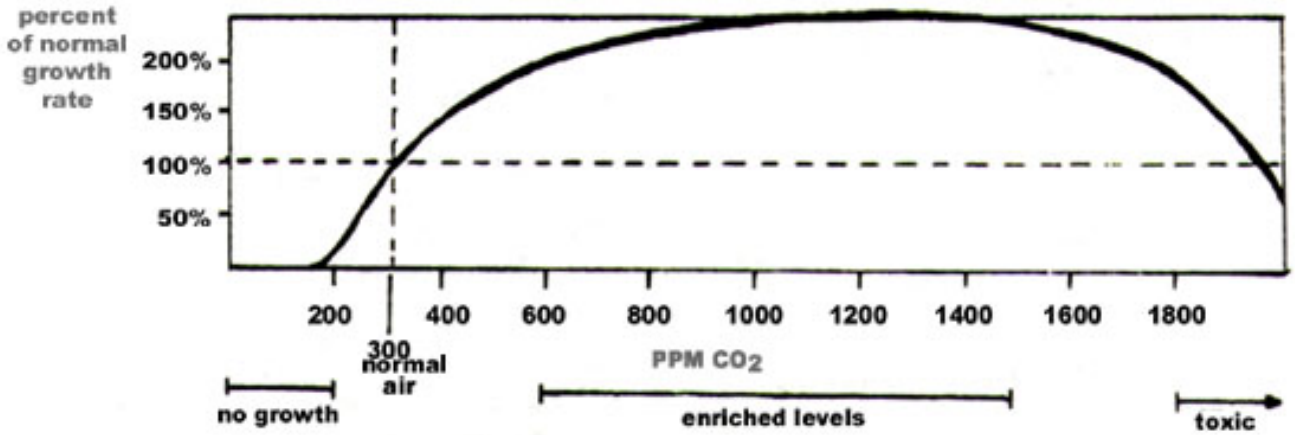
# $CO_2$ enrichment in greenhouses

- Positive $CO_2$ response in vegetation growth

  N.T. de Saussure (1804) Recherchez chimique sur la vegetation

- Optimum $CO_2$ level: 700-1000 ppm
- $CO_2$ enrichment is required during the day time
- $CO_2$ enrichment compensates production losses from limited sunlight (winter period)

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# How $CO_2$ enrichment in greenhouses?

- Burning kerosene and/or propane since 50's
- More than 85% of greenhouses in Scandinavian and North European countries since 70's
- Nowadays burning natural gas or using bottled $CO_2$

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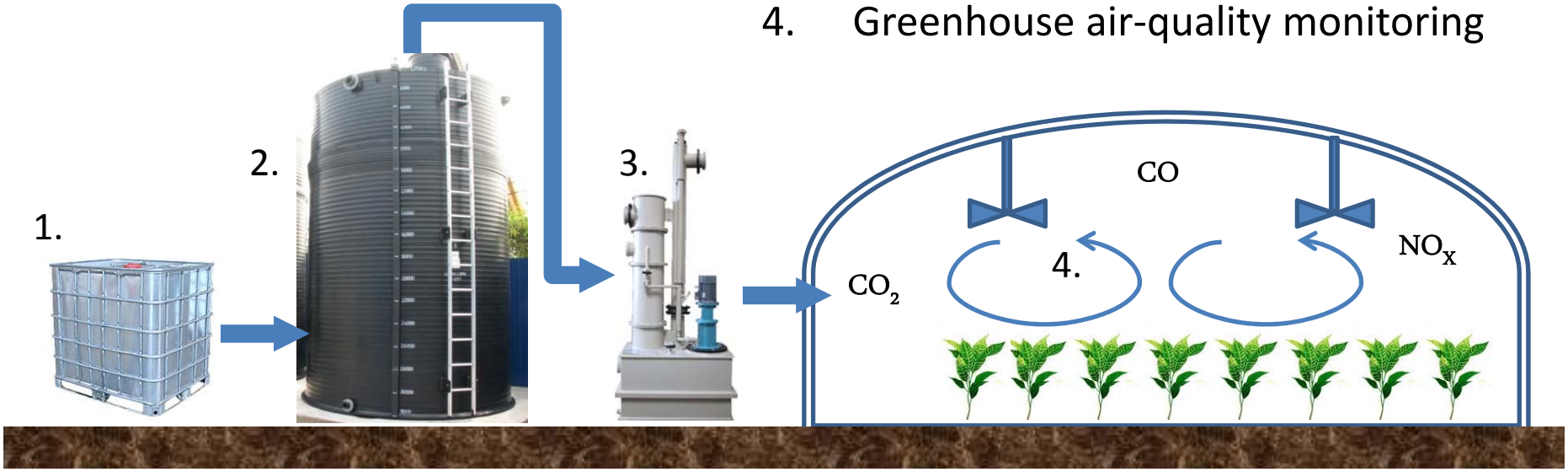
# Proposed technology

- $CO_2$ production from renewable biomass sources

1. Biomass storage tanks
2. Biogas reactor
3. Biogas handling and purification
4. Greenhouse air-quality monitoring

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# Progress of the prototype

- **Storage tanks**
- Plastic containers
- Portable mixer
- Feeding pump
- Tubing, vanes, etc

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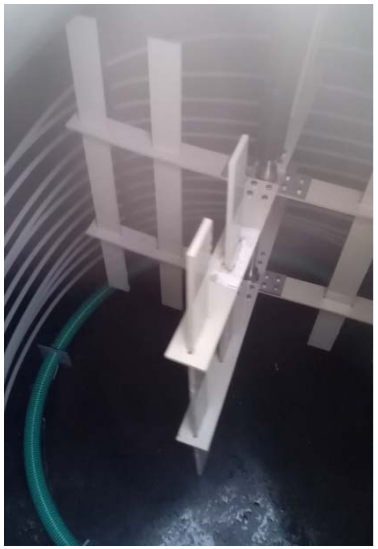
# Progress of the prototype

- **Biogas reactor**
- 8 $m^3$ PE
- Heat exchanger
- Paddle mixer
- Biogas production 5-20 $m^3/d$



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# Progress of the prototype

- **Biogas handling and purification**
- Wet scrubber AISI304
- Gas engine 5 kW
- Gas meter


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# Progress of the prototype

- **Greenhouse air-quality monitoring**
- Compact-portable station
- Electrochemical sensors
- $CO_2$
- CO
- $SO_x$
- $NO_x$


http://mecoeng.gr

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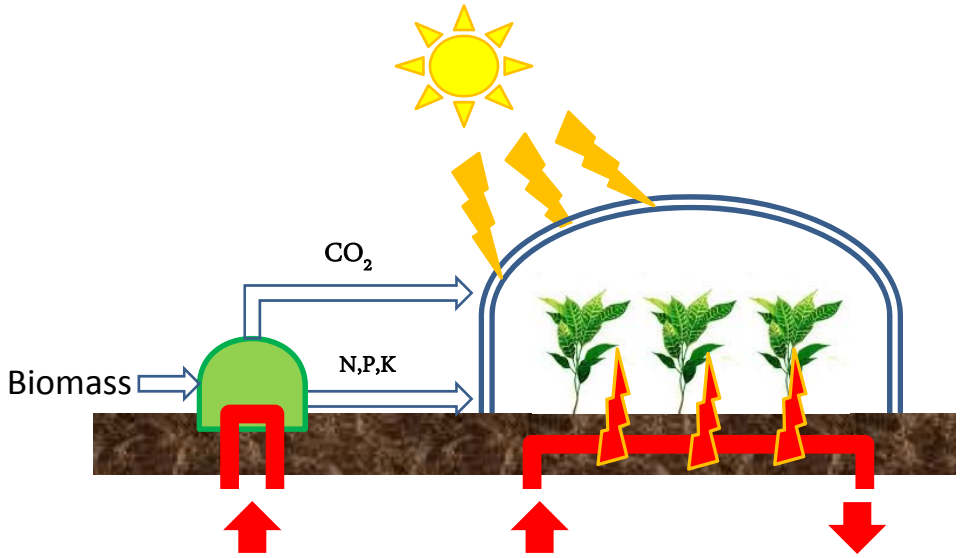
# The following steps

- Digester heating using geothermal energy sources
- Continuous operation using agro-industrial residues
  - Olive mill wastewater
  - Wine lees
  - Cheese whey
  - Livestock wastes

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