GEOTHERMAL ENERGY: Status and Future in the Peri-Adriatic Area
XIV International Conference on Science, Arts and Culture
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**LEGEND project**
Mobilizing ground-source heat pumps investments in Adriatic area

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IRENA – Istrian Regional Energy Agency Ltd.
**LEGEND project**

*General information*

- **LEGEND** - Low Enthalpy Geothermal ENergy Demonstration cases for Energy Efficient buildings in Adriatic Area

- **IPA ADRIATIC cross border cooperation programme 2007-2013.**

- **13 partners**

- **10 pilot investments**
PARTNERSHIP

LEAD BENEFICIARY: Province of Ferrara - ITALY

B2: Geological Survey of Slovenia - SLOVENIA

B3: Istria Region - CROATIA

B4: «Local Development Initiative», Banja Luka – BOSNIA HERTZEGOVINA

B5: Emilia Romagna Region - ITALY

B6: Veneto Region - ITALY

B7: Municipality of Scutari - ALBANIA

B8: Province of Teramo – ITALY

B9: Regional Economic Development Agency for Sumadija and Pomoravlje – SERBIA

B10: Municipality of Kotor – MONTENEGRO

B11: Dubrovnik-Neretva Region - CROATIA

B12: Puglia Region - ITALY

B13: Montenegro Green Building Council - MONTENEGRO

ASSOCIATE PARTNER: EUROPEAN GEOTHERMAL ENERGY COUNCIL - EGEC

PROJECT BUDGET: 3.085.540,00 €

PROJECT DURATION: 10/2012 - 12/2014

27 MONTHS
LEGEND project

General information

Legend:
- Red: area di programma
- Blue: area in deroga territoriale
- Gray: area in phasing out
- Yellow: partner di progetto
- Green: impianti pilota

Map: From Earth to People
LEGEND project
General information

MAIN GOAL

Promotion of geothermal energy benefits in the Adriatic area

Promotion tools

- development of 10 demonstration cases in public buildings utilizing GCHP (Ground Coupled Heat Pumps)
- development of cost/benefit monitoring analysis and policy & financial supporting schemes to overcome market barriers
- knowledge fertilization through training and workshops for energy managers and technicians to get familiar with GCHP potentialities

CAPITALIZATION

LEGEND capitalizes the results of EU funded projects such as GEO.POWER, VIGOR & SEAR in order to address practical application with high transferability potential in 7 countries & 11 regions of the IPA Adriatic area
The Adriatic Area has adequate climatic and geological conditions to fully exploit the potentialities of low enthalpy Geothermal Energy (Ground Coupled Heat Pumps - GCHP) due to the presence of medium temperature basin across the Western Adriatic shore and the shallow geothermal conditions that characterizes the entire Eastern Adriatic Countries.

Severe technology gaps and market barriers are present:

- Lack/poor harmonized regulations at national / regional level regarding heating and cooling permissions.

- Existence of knowledge barriers among policy and decision makers, stakeholders and citizenship such as: insufficient information on applicability prerequisites; cost-benefit calculation; lack of demonstrative successful examples and reliable statistics on the RES H/C applications. They are key obstacles that slow INVESTMENTS in such type of RES.
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Basic assumptions

NEEDS

• Need of promoting the GCHP concept as integral part of the RES options
• Need of demonstrative investments to catalyze the interest of the local administrators
• Need of a better normative setting to facilitate investments

Results

1. GCHP energy requalification (demo-cases) on 10 public buildings
2. 295 tons of CO2 per year not released in the atmosphere
3. 144 toe/year renewable energy production triggered
4. 132 toe/year primary energy saved

from earth to people


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*Basic assumptions – energy potential*
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Heat pump pilot investments
**Basic concepts**

1. **Peak power generation** (*IRENA, LIR, DUNEA (up to 95%)*)

2. **Partial load** (*Ferrara, Skhodra, Teramo, Danilovgrad, Puglia*)

**Ground heat exchanger types**

1. **Closed loop - vertical** (*IRENA, LIR*)

2. **Closed loop – energy baskets** (*DUNEA*)

3. **Open loop** (*Ferrara, Teramo, Puglia, Danilovgrad, Skhodra*)

*from earth to people*
**LEGEND project**

*Heat pump pilot investments*

IRENA – Pjerina Verbanac nursery

Start of activities: July, 2013.

End of activities: March, 2013.

*from earth to people*
Drilling and TRT: July, 2013.

3 boreholes of 100 m depth

Lithological profile: 3 m clay
97 m limestone

Duration: 24 days

Total cost: 17.000 €

TRT results:
- Static temperature along the borehole – 14.7 °C
- Total thermal energy stored in the rock mass during TRT – 127.8 kWh
- Temperature of the working fluid in PE pipes reached at the end of TRT – Tin/Tout – 29.6/27.3°C
- Thermal conductivity 1.92 W/m°C
- Thermal energy per meter gained – 54 W
Main system characteristics


- INTERVENTIONS REALIZED:

1. Low radiant heating/cooling systems – floor, wall, ceiling heating/cooling
2. Fan coils used as backup cooling solutions (for high humidity periods)
3. Ventilation with integrated heat recuperation unit – air coming into recuperation unit preheated/precooled with geothermal heat pump
4. 22 kW geothermal heat pump with active cooling solution (peak heating/cooling 18,9/19,8)
5. **Investment: 73,000 €**
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*Heat pump pilot investments*

IRENA – Pjerina Verbanac nursery

**System in operation**

25 days 24h/day testing period under full load – minimum borehole temperature -2°C
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Heat pump pilot investments

IRENA – Pjerina Verbanac nursery

**System drawbacks and potential improvements**

1. Slow reaction of both ground heat exchanger and inner low radiant systems – improvements needed regarding grouting materials, borehole pipe material. Larger buffer units provide partial solution.

2. Outside temperature sensors issues with high daily(hourly) temperature amplitudes

3. Peak power design – only 30% of borehole potential used. Transfer of heat to adjacent building is planned – this building consumes 110,000 kWh/year for heating (72 kW electric heater). This should significantly reduce the investment payback period (currently 14 years).
Environmental monitoring →

Control of aquifer situation:

- TEMPERATURE
- CHEMICAL DATA
- WATER TABLE LEVEL

from earth to people
Main system characteristics:

**Open loop system**

**Heating only solution**

**Extraction well:**
- 50 m depth, d=140 mm
- Submersible pump at 24 m (2,2 kW)
- Filter from 40 to 50 m

**Injection well:**
- 56 m depth, d=140 mm
- Filter from 28,5 to 56 m
- Flow rate: 12.000 l/h

Building net floor heated area (high temperature radiators) 10.365 m²

Heat pump: 106 kW

Estimated yearly energy production: 360.000 kW/h

Investment: 120.000 €
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Heat pump pilot investments

Province of Ferrara – IIS CIVITA – MONACO DI POMPOSA – MONITORING SYSTEM

Energy monitoring ➔

• Check of energy savings

• Check of CO₂ reduction

• Check of renewable energy production

• Check of economic profit of the investment
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**Heat pump pilot investments**

DUNEA – Elementary school Opuzen

**Main system characteristics:**

Closed loop system – geothermal baskets

- 13 baskets
- 250 m coil length
- Bottom depth – 4,5 m
- Top depth – 1,8 m
- Power output per basket – 2 kW
- Heating only solution
- Heat distribution system – high temperature radiators (to be replaced with low temperature radiators)
- Building net floor heated area (high temperature radiators) 1.500 m²

Heat pump: 35 kW

**Estimated yearly energy production:** 53.000 kW/h

Investment: 70.000 €
MAIN PROBLEM FOR WIDER ACCEPTANCE OF GCHP INSTALLATIONS:

Extreme discrepancy between average salary/investment ratio

Albania – 329/80,000 €
Italy – 1604/80,000 €
Main goals:

- To introduce high school students to basic concepts of geothermal energy exploations

- To design and constructs 15 cost effective ground heat exchangers and significantly reduce salary/investment ratio for ground heat exchanger

- To design and construct heat exchanger field based on 15 different materials/structures commonly found in Istrian county

- To perform 15 TRT tests

- To construct heat pump out of basic elements and use it to heat/cool high school physics cabinet

- To lay foundations to future projects within the school and especially the one in which cost effective heat pump will be designed and constructed - this should significantly reduce salary/investment ratio for inner installations
IRENA – Labin capacity building seminar

Materials/structures tested:

1. Silica sand
2. Bentonite clay
3. Concrete MB 30, vibrated
4. Red soil, dry
5. Red soil, wet
6. Loam
7. Humus
8. Limestone flour
9. Limestone gravel (fraction 0-4 mm)
10. Limestone gravel (fraction 40-80 mm)
11. Dolomite flour
12. River sand
13. Thermo active cement
14. Static water tank
15. Circulating water tank

Location of LEGEND geothermal park – High school Mate Blažine, Labin
IRENA – Labin capacity building seminar

**TRT results:**

<table>
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<tr>
<th>Basket number</th>
<th>Basket name</th>
<th>( Q_{8h} ) (l/h)</th>
<th>( P_{8h} ) (kW)</th>
<th>( Q_{10h} ) (l/h)</th>
<th>( P_{10h} ) (kW)</th>
<th>( P_{Q_{fix}} ) (kW)</th>
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<td>1</td>
<td>Limestone gravel (0-4 mm)</td>
<td>1.100,96</td>
<td>1,05</td>
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\( Q_{Q_{fix}} \) (l/h) 1000,00
IRENA – Labin capacity building seminar

Limestone – different fractions comparison

(0-35 µm)  
(0-4 mm)  
(40-80 mm)
Circulating water tank

General data:
- Construction material: reinforced concrete
- Volume: 4.5 m³
- Tank water flow: 0.2 l/s
- Tap water usage (8 hours): 5.76 m³
- Spiral length: 80 m
- Investment cost: 450 €
- Total output (extrapolated): 18.6 kW

Labin boreholes investment cost: 17,000 €
Total output: 16.2 kW
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Labin geothermal park

**General data:**

- Total investment cost: 10.000 €
- Total output: 33,45 kW
- Investment/kW: 298,95 €
- Optimal solution investment/kW (excluding water tank): 194,73 €
- Labin borehole investment/kw: 1049,38 €
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THANK YOU FOR YOUR ATTENTION

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