

Improving the sustainability of geothermal energy: new solutions evaluated through exergy, exergo-economic, LCA and exergo-environmental analysis.

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SSD: ING-IND/08 – MACCHINE A FLUIDO

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Event offered online (Webex or Google Meet)

Students shall write an email to giampaolo.manfrida@unifi.it to communicate their participation.

Abstract

Geothermal energy is rapidly developing in many countries; Italy has a long tradition and the solutions developed in the 20th century have effectively contributed to develop the worldwide large-scale use of geothermal energy, and to demonstrate that its use can be sustainable and that this is definitely a renewable resource (RES). A specific feature is that the resource conditions of geothermal energy are widely variable across the world, so that each plant must be accurately adapted to the specific location and the performance level – although different and depending on the resource- must be correctly evaluated by specific indicators, including not only thermodynamic performance but also environmental sustainability. Recently technological advancements are proposed, including complete closed-loop operation (reducing significantly the environmental impact), emissions treatment and the possibility of using difficult resources (such as hot dry rocks, low-temperature resources, or high contents of non-condensable gases). The solution proposed (established or novel) should be evaluated and compared using consolidated and effective tools: specifically, exergy analysis is applied. The exergo-economic approach allows not only to evaluate the cost of products (often electricity and heat for geothermal energy), but also to understand the cost build-up along the process, thus paving the way to economic optimization. LCA is applied, and building a single-score value from a validated de-structured LCA approach allows to proceed with an exergo-environmental analysis – identifying the components and processes which are responsible of the major environmental effects during the lifetime (from plant construction/realization to operation and final closure of the wells).

Course programme

The seminar is organized as a two-session event showing the methodology and its application to several cases, including comparison with other renewables and with current production of electricity on the grid. Duration: 2 seminars of 2-3 hours each.

Short C.V.

Giampaolo MANFRIDA

<https://www.unifi.it/p-doc2-2013-200006-M-3f2a3b2a392e2c.html>

Professor, University of Firenze (formerly at Un. of Perugia), 1992 to present (teaching: Energy Systems, Fluid Dynamics, Experimental Methods in Turbomachinery, Environmental Issues of Energy Conversion, Thermodynamics and Thermoconomics)

Education:

- Laurea with honors in Mechanical Engineering (5-year course), Univ. di Firenze, 1977
- Von Karman Institute (VKI) for Fluid Dynamics Diploma with honors, 1981. Theodore Von Karman award as best VKI student of the year.

Research activity:

Renewable energies (solar, wind, geothermal, wave,...). Environmental issues of energy conversion. Power plant optimization (second-law analysis). Energy storage. Design and off-design performance of energy systems and components. Numerical and experimental fluid dynamics of turbomachinery. More than 200 scientific papers in these fields presented at international conferences or published in journals (at 2020).

H-index (Feb 2022): 24 (Scopus).

Teaching/Coordination Assignments:

- Courses (School of Engineering): Energy Systems, Environmental issues of Energy conversion, Models for Energy conversion processes
- Participation to the CAMPUS national pilot program for Undergraduate Level teaching in Mechanical Engineering, Prato, 1995 to present
- Socrates/Erasmus responsibility for student exchange, Mechanical Engineering, 1995 to 1999
- Responsible for short-term technical training programs (IFTS), Università di Firenze, 1999 to 2001
- Local coordinator TEMPUS project with Politechnika Slaska, Poland, 1997-2000
- Dean of the undergraduate school in Industrial Engineering, 1995-2001
- Dean, undergraduate and postgraduate school in Environmental Engineering, 2007 to 2012
- Coordinator of the PhD school in Energy Engineering, University of Florence, 2017-2021
- Scientific coordinator of the ITS Energia e Ambiente, Regione Toscana

Project evaluation/appointments:

- Course for "Evaluator of Quality Systems" ISO9001/2000, organized by CRUI (Conference of the Rectors of Italian Universities) and AICQ (Italian Association for Quality Culture). Qualified as SICEV evaluator for industrial engineering and teaching systems.
- Tutor and Audit Team Leader for quality evaluation of University teaching, CRUI CampusOne project, 2002- 2004;
- Certified Evaluator (CRUI-EURACE/QUACING) for university and professional education courses (2005-)
- since 2007 evaluator of industrial research projects on energy conversion and optimization in industrial processes at regional, national and international level (over 100 projects evaluated)
- 2020 MIUR appointment as member of the working group Energy for Industry, PNR 2020-2027 (Piano Nazionale della Ricerca)

Cooperation with industrial partners:

Since 1978, always through the University. Co-operations with turbomachinery firms (GE/Nuovo Pignone, Ansaldo, Worthington, Goulds), utilities (ENEL, National Power), and many large/medium/small enterprises (KME, Unitech, Global,...).

Editorial boards and Conference Organisations:

ASME J. of Energy Resources Technology (Ass. Ed., 1995-1997)
IJOT Journal (member of editorial board, 1997-)
ENERGY (Associate editor 2008-2011; Subject Editor 2012-)
Energy Conversion and Management (Associate Editor 2008-2012)
Sustainability (Energy section) (Associate Editor, 2019-)
Entropie (member of editorial board, 2019-)
FLOWERS International Conference (1994, 1997), Chairman
ECOS International Conference (1995-), Scientific Committee

Reviewer for:

ASME J. of Gas Turbines and Power, ASME J. of Energy Resources Technologies, Int. J. of Energy Conversion and Management, Revue Generale de Thermique, IJCAT, Int. J. of Refrigeration, Geothermics, Energies, Sustainability, Applied Energy, Applied Thermal Engineering, Energy, Renewable Energy, ...

Memberships: ASME (Member 1987-2002; Fellow 2002-), IAHE, ICAT, VKI ALumini

Link to selected published scientific papers:

<https://drive.google.com/drive/u/1/folders/1L7CwnDK4QNxwcDAQBeVP0u-Kpnmaa6e9>