CURRICULUM VITAE MASSIMILIANO RENZI

Assistant Professor at the
Faculty of Science and Technology
Free University of Bozen/Bolzano

Tel. +39 0471-017112

Email: Massimiliano.renzi@unibz.it

Affiliation
Free University of Bozen/Bolzano

Current position
Assistant Professor and Researcher in Fluid Machines and Energy Conversion Systems

Personal data
Born in Loreto (AN), Italy on the 24/12/1983
Nationality: Italian
Residence: Ortisei (BZ), Italy

Education
I achieved the bachelor degree in Mechanical Engineering with the best marks (110/110 con lode) at the Università Politecnica delle Marche in July 2005. At the same University, in July 2007 I achieved the master degree in Thermomechanical Engineering with the best marks (110/110 con lode).
In the academic years 2007-2010 I attended the PhD school in Energy at the Department of Energy of the Università Politenica delle Marche.

Language skills
Italian (motherlanguage), English C1 level (certified), German B2 level (internal University certification)

Research activities
At the university of Bolzano I'm involved in the following research topics:

- **Energy conversion systems for the production of electricity and heat and their integration into the electrical system**
  - **Study of the performance of an internal combustion engine for micro-cogeneration applications operated with alternative fuels**.

The research project aims to study the distributed micro cogeneration systems, fuelled with both traditional and alternative fuels. In particular, the study is carried out by making use of a small-sized internal combustion engine: the reduced cost and high reliability of these systems make them a highly advantageous solution for the distributed generation of electrical energy and thermal energy. A specific test bench has been designed for the evaluation of the performance of the engine powered by alternative fuels. The research activities allow to evaluate the performance of a small sized motor that can be considered representative of distributed generation systems. The output of the engine (in terms of torque, power, consumption), the emissions and the main performance parameters can be estimated.

- **Theoretical and experimental study of micro gas turbines and solutions to maximize their performance.** Micro gas turbines are considered one of the most interesting devices in the distributed cogeneration scenario. One of the most favourable features of this type of machines is the extremely low concentration of polluting products, when compared with other conventional technologies. One of the limitations is, however, the strong dependence of the performance of the turbine and the compressor to varying environmental conditions, in particular the inlet air temperature. For this reason, the research is focused on the study of the solutions to appropriately cool down the inlet air charge (evaporative cooling, direct expansion cycles, fogging, absorption cooling); another solution is the application of steam injection cycles with the aim to increase the electric index of the machine.

- **Hybrid systems for the production of electrical energy constituted by micro gas turbines or internal combustion engines and solar systems.** Renewable energy systems have severe limitations due to the unpredictable and variable nature of the resource. In particular, solar photovoltaic systems can cause problems in the electricity distribution grid if their production is not balanced and controlled under sudden lack of solar radiation. The first step to facilitate the integration of renewables in the electricity network, avoiding the dangerous imbalances, is the introduction of hybrid systems consisting of a renewable energy device and a traditional generation device, able to replace the first one in case of need. In this context, research is focused on the optimization studies in the management of traditional energy systems, especially micro gas turbines and internal combustion engines, coupled with photovoltaic systems. The coupling of these two types of devices can reduce the environmental impact of the energy system without incurring the typical limitations of the renewable energy source.

- **Improving the performance of micro-hydro plants.** The wide availability of water resources in the territory of South Tyrol makes the use of hydroelectric plants in the Province particularly interesting. At the moment, most of the micro-hydro installations are not optimized to fully exploit the availability of the water resource, both in terms of flow rate

and pressure. The objective of the research is to identify solutions to make the hydraulic machine equally efficient in all working conditions, also when strongly variable over time. To do this, it is proposed to insert an inverter between the electric generator and the impeller in order to freely control the rotational speed of the hydraulic impeller and to optimize the operation under varying external conditions. This should ensure the possibility to operate the plant in ideal conditions of operation, even with sensitive variations of the conditions of the water resource available.

- **Study of cogeneration and district heating plants fuelled by solid biomass**. The research aims at evaluating the performance of a cogeneration and district heating systems fuelled by biomass in the province of Bolzano. These systems provide the combined production of electricity and thermal energy using local solid biomass, which significantly reduces the environmental impact of a generation system. The cogeneration plants that are analysed use a technology called Organic Rankine Cycle (ORC): these systems operate with a siloxane fluid that allows the application of vapour cycles also with very low operating temperatures. For this reason, coupling a biomass boiler with an ORC system optimally suites the demand of the users. The heat that is taken from the condenser of the ORC plant is used to power a district heating network with clear advantages in terms of overall emissions and energy efficiency. Plants were monitored and the experimental data were used to define a simulation tool of the plant operation.

- **Concentrating solar power.** The high concentration solar technology is one of the most innovative and interesting for the production of electrical and thermal energy from the solar resource. I have carried out studies on both the technologies for the production of thermal energy and those for the direct conversion of solar radiation into electrical energy (photovoltaic concentration)
  I have designed and developed a series of prototypes of concentrating photovoltaic systems, consisting of the following main components: the solar tracker, the primary and secondary concentration optics and solar cell. Concerning the solar thermal technology, I have supervised the design, the theoretical and experimental study and the construction of a solar heliostats plant for small scale civil applications.

- **Cooperation with international and national research groups.**
  Dr. Massimiliano Renzi has collaborated with several international research centres as part of the "Annex 54", coordinated by the International Energy Agency (IEA). The IEA is an international organization that aims to ensure reliable, affordable and clean energy for its 28 member Countries. The IEA has identified a number of research topics and entrusted various Universities and international research centres to develop tools to facilitate the introduction of solutions for a more efficient and clean energy. Among the various lines of research I have contributed to the realization of the Annex 54 "Integration of Micro-Generation Energy and Related Technologies in Buildings", which involves the participation of Belgium, Canada, Denmark, Germany, Italy, Japan, Korea, the Netherlands, United Kingdom, United States of America.

The aim is to supply a detailed analysis of the micro-cogeneration systems and develop control strategies for hybrid systems (renewable and traditional sources) in order to overcome the existing barriers to their increased market penetration. In particular, I was involved in the definition of a model of an internal combustion engine, used as a cogenerator, and a model to describe the behaviour of a high concentration photovoltaic system.

Professional experience

From January 2009 to May 2015 I have collaborated with the university spin-off S.TRA.TE.G.I.E. Srl. I was involved in the field of cogeneration using traditional fuels: in particular, I dealt with micro gas turbine and the technologies for the repowering of this kind of cogeneration systems. I also studied micro-cogenerative systems and designed a heat recuperator to improve the performance of a Stirling engine cogenerator for household applications.
I dealt with the study and the design of concentration solar systems for energy conversion purposes. I simulated the performance and designed the solar receiver of a cogenerative solar system using a Stirling engine. I also studied, designed and realized prototypes of concentration photovoltaic systems and concentration thermal systems. I also designed the optics of solar concentrator systems.

Courses taught at the Free University of Bolzano

Academic Year 2012-13
Lecturer in charge of the course of Fluid Mechanics within the undergraduate degree in Mechanical Engineering. The activity involved the preparation of teaching materials, exercises, office hours and the examinations. Lectures and exercises were carried out in 60 hours of teaching.

Academic Years 2013-14 and 2014-2015
Lecturer in charge of the course of Fluid Machines (Free University of Bolzano, Faculty of Science and Technology, Master of Science in Mechanical Engineering) held in English.
Teacher in charge of the course of Thermal Engines (Free University of Bolzano, Faculty of Science and Technology, Master of Science in Energy Engineering) held in English.
The activity involved the preparation of teaching materials, exercises, office hours and the examinations. Lectures and exercises were carried out in 120 hours of teaching.

I was also supervisor of several final degree thesis both in the Bachelor and in the Master course.

Other appointments

I’m in charge of the safety aspects for the laboratory FaST C 0.01b "Electrical Machines and Fluid Machines”

Head of laboratory FaST C 0.01b "Electrical Machines and Fluid Machines" AA 2013/2014

Member of the Academic Board of the PhD program in "Sustainable Energy and Technology" (AA 2013-14)

Other skills

Use of Office tools; 3D CAD (Solid Edge, Solid Works); Matlab/Simulink; ANSYS (Fluent); laboratory equipment.

The use of personal datas according to the legislation “ D.lgs.n.” 196/2007 is authorized.