Assegno di ricerca EURAC*

1. Research topic:

Multi-dimensional energy system modelling: Methods and tools for the optimization of energy systems considering spatial, temporal and socio-economic features.
Supervisors: Prof. Paolo Baggio (University of Trento) and Dr. Pietro Zambelli (EURAC)

2. Introduction

In the last decades in Europe, the importance of renewable energy is increasing since it could help to mitigate carbon dioxide emissions and to reduce the fossil fuel dependence of European Member States (Directive 2009/28/EC). Different existing tools aid in the design of a 100% renewable energy systems by maximizing efficiency and reducing costs. However, the feasibility of a renewable energy system also depends by the characteristics of the territory such as natural source availability, social and economic features and planning or legislation constrains.

3. Objectives

The candidate should carry out research in "multi-dimensional energy system modelling" with the following particular objectives:

- Identification of existing methods and tools for the development of a multi-dimensional (in space and time) energy systems models;
- Development of innovative methods and tools to perform multi-dimensional energy systems modeling and optimization with special regard to 100% renewable energy settlements (smart districts, smart cities and smart regions)
- Performing energy simulations in order to optimize the resource mix (including generation and storage) to fulfil the energy demand.
- Development of guidelines to minimize environmental impact and support the energy transition process in a territory/region/area.

4. Tasks and methods

- Literature review of existing methods and tools for the characterization and analysis of energy systems models (e.g. Calliope, EnergyPlan, MARKAL/TIMES, PRIMES, LEAP, etc.) , and identify which are the variable consider in the model and which the main features/limits;
- Assess the exploitable energy potential (considering technical, legal, environmental and financial/economic constrains) and the energy demand (considering heating-cooling and electrical demand). In the literature there are several studies dealing with the computation of the energy potential from renewable energy sources by means of Geographic Information System (Mekonnen & Gorsevski, 2015; Palomino et al., 2013; Sacchelli et al., 2013; Mari et al., Zambelli et al., 2012; 2011; van Haaren & Fthenakis, 2011; Kusre et al., 2010; Baban & Parry, 2001), but they usually don't consider the entire set of variables (spatial-temporal and social-economic-environmental) that decision makers and planners face during the planning stage. Starting from these concerns, elaborate innovative methods and tools to perform a spatial analysis of renewable source availability and energy demand including temporal and social-economic-environmental variables, is needed;
- Develop scenarios for a 100% renewable energy systems. Compare the obtained scenarios taking into account the spatial-temporal dimension and the social, economic and environmental

characteristics of a territory. A GIS-based multi-criteria and multi-objective analysis is performed to provide a systematic analysis of the alternatives to support decision makers and planners. The spatial dimension and the analysis of the social-economic and environmental variables of the territory will be used to provide the input data for the energy system simulation models/methods.

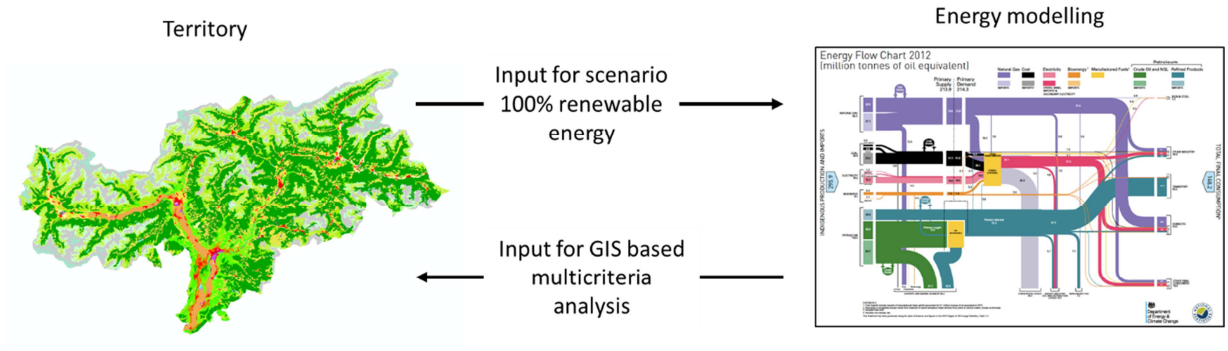

Figure 1: Interaction between the spatial dimension and the energy system simulation

The case study of this work will be the South Tyrol region. We expect that results will show the influence of resource availability and social-economic characteristic of a specific territory in energy planning and energy system simulations.

5. Candidate's work schedule

The student will work with an international team of researcher and will be involved within the tasks and work packages of international research projects participating and presenting his/her work to international project meeting and conferences. It is also foreseen that the student will spend some months of his/her PhD abroad collaborating with international research and university institutions to refine and improve the main research output.

During the first year the student will:

- follow specialization courses to extend his knowledge on the topic and fill the knowledge gaps on useful methods and tools;
- perform an extensive literature reviews of existing scientific methods and tools;
- clarify research objectives and defines a first draft version of the purpose methodology;
- Select one or more case studies to test and validate the methodology.

During the second year the student will:

- Develop an open-source GIS energy systems model that integrates socio-economic and environmental data;
- Identify possible scenarios for the selected case study/ies;

The last year of the PhD will be focused on

- Highlighting optimal/critical energy systems configuration based on multi-criteria and multi-objective analysis

6. Candidate's requirement

University Degree which entitles to emroll in a doctorate (Master's degree); Degree fields:

- Energy/Environmental/Civil Engineering;
- Physics;
- Regional/Urban Planning fields.

Knowledge of GIS tools and analysis is required, preferable if the candidate has experience with open-source tools (e.g. GRASS GIS, QGIS, GDAL, Postgres/PostGIS, fiona/shapely, etc.).

Knowledge/experience of a programming language (Python, R, C, C++, Go, Rust, Matlab, Fortran, etc.) is a plus.

7. Fellowship

Gross amount for Research Fellowship: Euro 19.370,00 per year
Duration of Contract: 36 months
Contribution to cover the expenses related to the participation of the ESR in research and training activities (research-related costs, meetings, conference attendance, training actions, etc.): € 2.800,00

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8. Reference

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