PhD in Energetics

Research Title: Smart Energy Solutions for Sustainable Cities and Policies

Funded by	Future Urban Legacy Lab (FULL) of Politecnico di Torino

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Context of the research activity	Different research groups and institutions are currently working on models and tools to evaluate the energy-use of buildings and they are presently extending the application of such tools at the district and urban level, taking into account local and territorial constraints (i.e. Politecnico di Torino, University of Applied Sciences of Stuttgart, University of Applied Sciences of Western Switzerland, Ecole Polytechnique Fédérale de Lausanne, Tsinghua University). The theoretical issues and procedural approaches need to be coordinated at a higher level harmonizing the necessary database and capitalizing the best available methodologies to improve the existing tools. Moreover, in the next future, all new constructions in the EU will be "nearly Zero Energy" buildings but how it is possible to reach this solution in high-density urban contexts? Models and methods to exploit these scenarios in urban contexts could be useful also the evaluate the harvesting potential of additional renewable energy sources integrated into the envelope/roof of buildings and also in the outdoor spaces. The proposed energy-use models will contribute to energy savings, emission reductions, and to boosting the integration of renewable energy sources supporting strategies on the real building heritage with different results on different districts and municipalities. The models will consider also the different urban morphology characteristics, people behaviour, social and economic conditions, local regulation, and the use of

	public outdoor spaces.
	FULL-The Future Urban Legacy Lab., based at Polito, aims at providing knowledge and action in the field of relevant global urban challenges and to support local decision-making processes. The acronym FULL welds legacy and future, which are intended as the socio-technical products of layering processes in space and time.
	For this very reason FULL participates in the objectives and research programs of DENERG PhD Programme. The shared interest of FULL and DENERG is to bridge knowledge of the past and visions for the future in the urban realm. FULL mission is to explore, imagine and design the future of global and local urban legacy embodied in city form the analysis of databases at territorial scale, optimizing the existing models and creating innovative solutions for a more efficient use of energy (i.e. integrating the available renewable energy sources and new technologies) and performing cost-benefit analyses and the environmental impact evaluations. This work includes the validation of the models and the identification of future scenarios in different geographical areas and built environments.
	The challenge of this works is to develop an interactive instrument, combining the strengths of existing models, for better identify, analyze, model and represent resources, future scenarios, and solutions on a urban scale, is the ideal testing ground of FULL research work. This in order to drive an optimization in the use of energy matching it with the available and more efficient energy sources for the identification of smarter energy policies.
Objectives	Within the FULL research framework, PhD candidates will define their specific research interests in accordance with the FULL topics, namely: provide a replicable method to maximize the harvesting of renewable energy at district scale, contribution to energy savings and reductions of CO_2 emissions for future scenarios with energy self-sufficient districts; investigation of best building retrofitting solutions for an optimal re-tuning of the energy-use model, and finally understand and optimize its behaviour in future scenarios.
	Based on the general themes mentioned above, PhD research work will pursue the three methodological objectives of FULL transformative research framework:
	● exercising evidence-based design and research that is instrumental to transformative action-research based on critical understanding, explicit visualization, social responsibility, reflective practice, continuous monitoring and assessment;

● grounding heritage discourse in present praxis, particularly be making explicit references to the processes of historical layering of innovation in the city and applying design as a research method;

● understanding present global trends by balancing case-based research and broad comparative framework, also handling qualitative and quantitative methods and interfacing with multi-disciplinary problem setting.

The proposed research activity can be subdivided into the following parts:

1. The analysis of energy-use driven variables to evaluate the energy performance of buildings at the urban/district level; some variables (e.g. climate, type of building, volume, age, shape, energy systems, solar exposition, urban form) can be defined fundamental and other variables can be added to improve the accuracy of the results; also the influence of the scale of data should be identified since some data are at buildings scale (e.g. buildings' age and use from the GIS Municipal Technical Map), while others at the block of building scale or at the urban scale (e.g. climate and energy consumption data from Sustainable Energy Action Plans, SEAP).

2. The definition of a procedure to harmonize data from different sources and with different scales (starting from the EU Directive INSPIRE issues); the procedure will be then validated by the design of a platform and its interfaces for data collection and representation.

3. The evaluation of the existing energy-use models at urban scale (e.g. Turin and Stuttgart models) for optimizations of the models for each application with different levels of accuracy; the interaction and the complementary use of bottom-up, top-down, statistical, and dynamic energy models (e.g. CitySim of the Ecole Polytechnique Fédérale de Lausanne) will be assessed. In this study the results of the joint initiative "Urban energy systems. Challenges and solutions for zero carbon cities" (http://www.germaninnovation.org/news-and-events/events-calendar) made with the City of New York can also be exploited.

4. The analysis of existing models to evaluate the potential of renewable energy technologies at urban scale.

5. The validation of the analysed models on different cities (i.e. Turin and Stuttgart) with different buildings' stock, users, climate and available energy sources with the aim to test the capabilities of the models to adapt to different conditions, assessing the demonstration of the replicability potential.

6. The definition of different scenarios for energy self-sufficient districts using the resulted optimized model in different cities; the model will consider also a cost-benefit analysis with the time-varying energy demand and supply with the available energy sources, the different built environments, urban forms, climates and, finally, the existing laws and incentives.

Skills and competencies for the development of the activity	DENERG PhD candidates working in FULL should: - Attitude to be able to work in multidisciplinary team, demonstrate independent and critical thinking in drafting their research statement, have a personal initiative, the spirit of autonomy and independence - Preferably MSc in Territorial, Urban, Environmental and Landscape Planning - Certification ECDL-GIS - Knowledge of: building physics, energy savings and renewable energy technologies - Experiences or specialization courses or research grants on: energy models at urban scale, statistical analysis of big databases, database management, data analysis and visualization, Geographic Information Systems (GIS) - Willingness to work abroad and to interact with different research groups