

The role of electricity in future energy transition: a multi-dimensional vision

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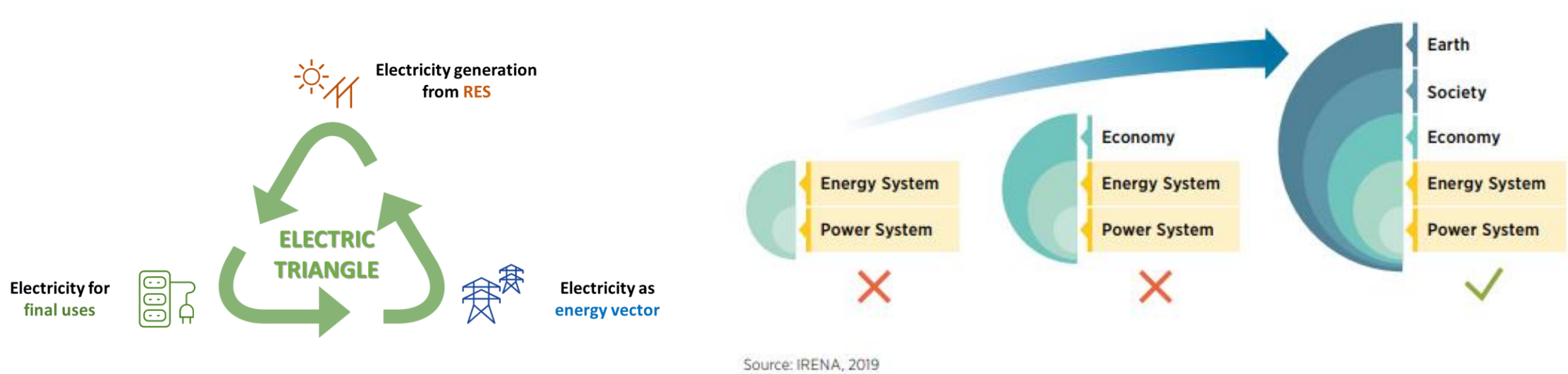
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Research context and motivation

The challenge of worldwide energy **decarbonisation** is crucial to assure a sustainable development. The advocated transition should pursue the wider **deployment of renewable energy sources** (RES), thus stimulating the process of **electrification** of final uses.

The power system needs a strong transformation, to accommodate increasing variable generation from renewables. These elements will surely require a substantial transformation of the current system, increasing the **needs and opportunities for cross-border (international and intercontinental) electricity exchange**.

However, this **energy system transition**, to be achieved, calls for a strong policy framework. Indeed, the energy transition cannot be separated from **socio-economic system**, since policies should be set accounting the existing interactions between energy and socio-economic sectors. The research aims to define simplified evidence-based tools which can help decision makers in developing policy scenarios and transition roadmaps that clearly outline the path to long-term 2050 targets at different scales.

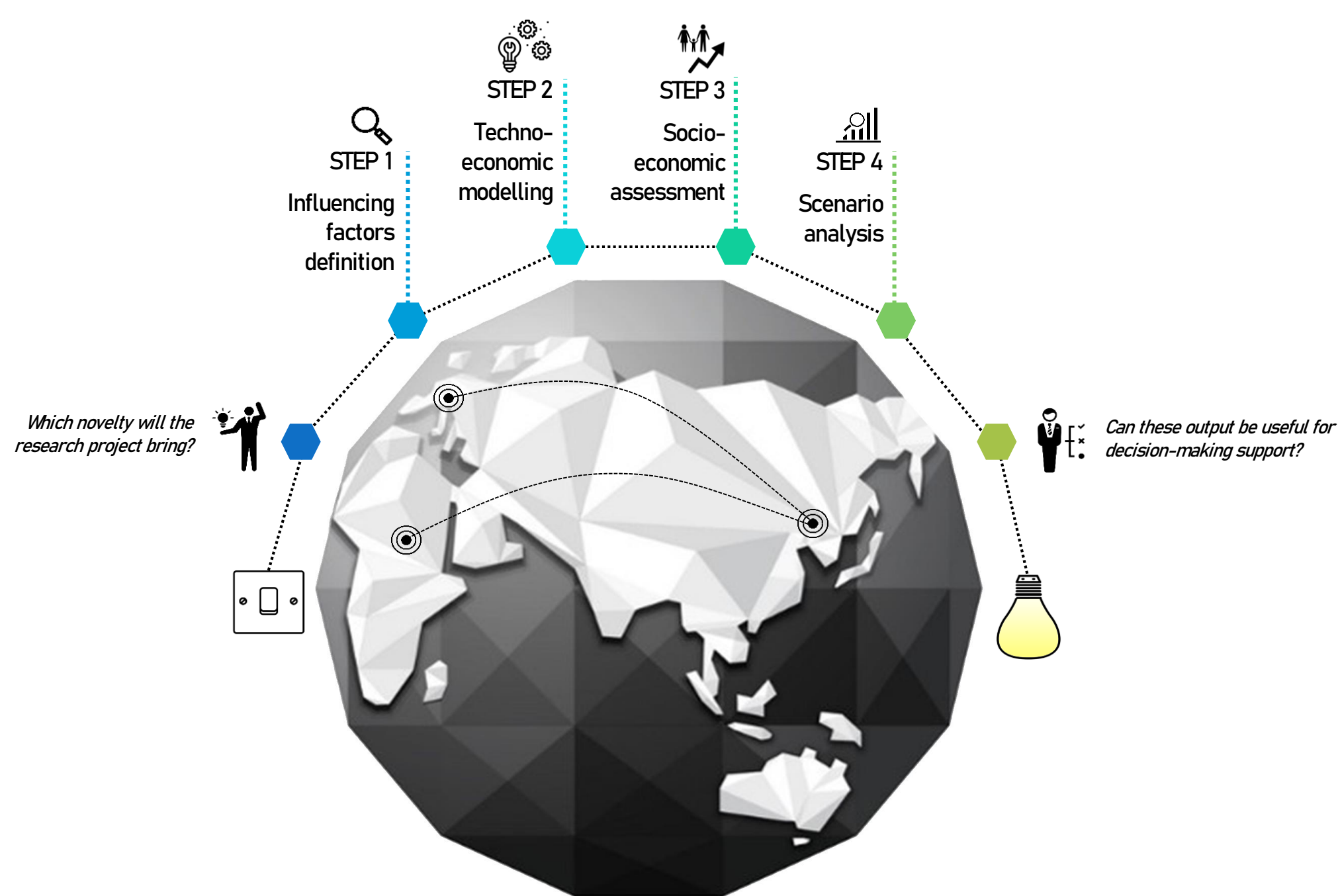


Addressed research questions/problems

The research focuses on the theme of **transmission and generation expansion planning** in the view of globally interconnected network and on the development of **science-based tools for policy decision-making support**.

The work aims to research on the following points:

- Which are the main influencing factors, when considering the planning of intercontinental transmission system? Which are the main **stakeholders** involved, their interests, as well as the obstacles they perceive?
- In order to deal with a **socio-technical transition**, how to integrate different layers together, in order to provide integrated evidence-based tools for policy decision-making?
- How to use these models for forecasting scenario analysis for supporting long-term energy policies for achieving the advocated clean transition?



Novel contributions

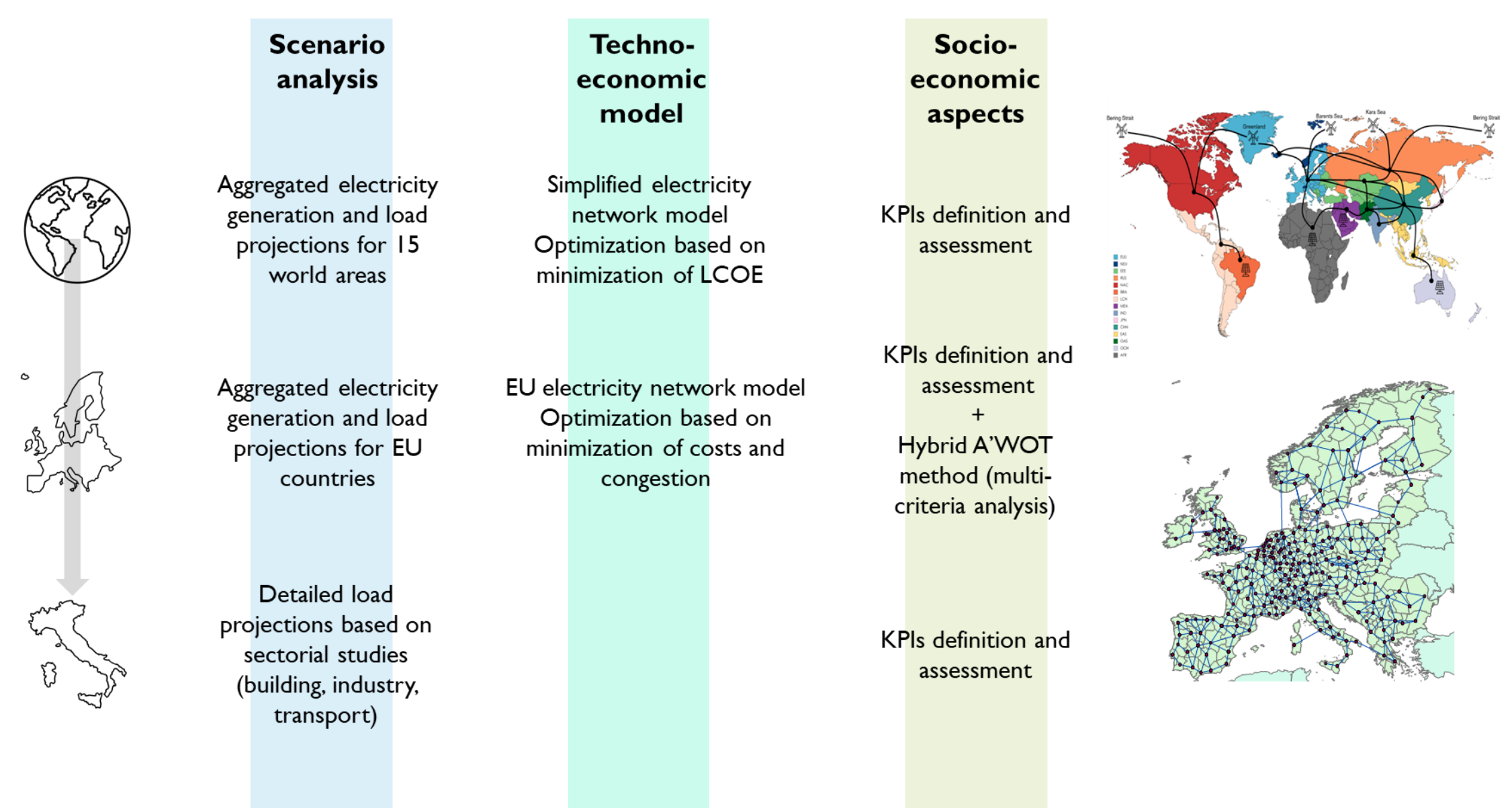
The research demonstrates that a purely physical model is not able to capture all the issues related to the transition of energy systems. The work is intended to define a **multi-disciplinary (multi-dimensional) approach**, able to assess and model the different layers (technical, socio-economical, geopolitical) and their main influencing factors.

The research aims to vertically and horizontally integrate the different investigated dimensions, through appropriate models. This integration will be effective only if **quantitative approaches** are used: for this reason, the research aims at quantifying typical qualitative influencing factors (i.e. geopolitical risk, social acceptance, stakeholder engagement, etc.), in order to build an overall model able to support decision makers at regional, national and EU levels in defining optimized short-term cost-effective policies and measures, as well as long-term strategies in the energy domain.

Moreover, the research is intended to explore the elements of the electricity triangle at **different scales**, from the global level, to the European and the National ones.

Adopted methodologies

Similar approaches are used in order to explore the elements of the electricity triangle at different scales, always in the view of globally interconnected network. The models are correlated, using the outputs of the upper scale models as input for the bottom scale ones. At each scale, socio-economic aspects are accounted, using different approaches. At EU level, a first attempt of integration between techno-economic and socio-economic models was performed, using the results of the hybrid A'WOT method as input for the definition of the optimal location of interconnections to/from EU.



Future work

Future work will involve the exploration of possible methods for integrating socio-economic aspects into the well-known techno-economic models, usually used in the framework of transmission and generation expansion modelling. In particular, the preliminary analysis developed at EU level should be refined and expanded at other scales.

Further investigation is required at national level, for which the modelling of electrical network is needed, using the results of the detailed load and generation projections already performed.

Finally, the work aims to define integrated science-based tools, which could be easily understandable by non-experts in the energy planning field.

Submitted and published works

- Bompard E., Huang T., Grosso D., Crespi G., Han Z.Y., Li D., "Research on the Basis and Demand of Energy Interconnection in Europe", D.T.1.1, Research project "Study on Europe Energy Interconnection Network Development Strategy", collaboration with State Grid Corporation of China
- Bompard E., Huang T., Grosso D., Crespi G., Han Z.Y., Li D., "SWOT analysis of European Energy Interconnection development", D.T.2.1, Research project "Study on Europe Energy Interconnection Network Development Strategy", collaboration with State Grid Corporation of China
- Bompard E., Huang T., Grosso D., Crespi G., Han Z.Y., Li D., "Research on the Development Strategy and Route of Energy Interconnection in Europe", D.T.3.1, Research project "Study on Europe Energy Interconnection Network Development Strategy", collaboration with State Grid Corporation of China
- G. Crespi, C. Becchio, M. Bottero, T. Huang, E. Bompard, S.P. Corgnati, Multi-criteria approach to transmission expansion planning in Europe, 4th Energy for Sustainability International Conference - Designing a Sustainable Future, 24th-26th July 2019, Turin
- G. Crespi, T. Huang, Z. Han, E. Bompard, S.P. Corgnati, A simplified electrical network model for techno-economic analysis of globally integrated electricity market, 4th Energy for Sustainability International Conference - Designing a Sustainable Future, 24th-26th July 2019, Turin
- G. Crespi, C. Becchio, S.P. Corgnati, Retrofit scenarios for emissions reduction in Italian hotels towards a Post-Carbon City, 6th IBPSA International Conference and Exhibition, Building Simulation 2019, 2nd-4th September 2019, Rome
- Z. Han, G. Crespi, T. Huang, E. Bompard, S.P. Corgnati, European Power Grid Development and Its Compatibility with Global Energy Interconnection, 35th Annual Conference of the Power System and Automation of the Chinese Universities, 11th-13th October 2019, Chengdu

List of attended classes

- 01QTZRS – Geomatics and GIS for environmental application and regional planning (18.01.2019, 30 hours)
- 01LEVRV – Power system economics (10.05.2019, 15 hours)
- 01LGSRV – Characterization and planning of small-scale multigeneration systems (13.09.2019, 25 hours)
- 01QSFIV – Global energy trends and outlook (17.07.2019, 10 hours)
- 01RGKRS – Multicriteria analysis and strategic assessment (final assessment to be delivered)
- 01QUGIV – Energy in smart buildings (final assessment to be delivered)
- 01RONKG – Python in the Lab (final assessment to be delivered)
- Scuola Estiva Fisica Tecnica (Italy, 08.07.2019, 30 hours)
- 2019 High Level Doctoral Students SEEPP Summer School (China, 11.08.2019, 30 hours)