Definition of KPIs for quantitative analysis on the evolution of the Italian energy system towards energy transition

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Research context and motivation

- Current energy system is still dominated by fossil fuels and is responsible for most of GHG emissions with environmental drawbacks and large-scale impacts in terms of climate change.
- The energy sector is also responsible for the majority of air pollutant emissions from human activities and these emissions lead to negative impacts on people's health.
- Due to uneven distribution of fossil reserves, many countries are not self-sufficient to meet national demand for fossil fuels and they have a high energy dependency on producer countries
- Fossil fuels reserves are mainly concentrated in politically unstable countries, leading to geopolitical security issues which are even more crucial for non-self-sufficient countries
- Energy transition is a crucial global topic which involves both environmental, technical, economic and socio-political issues.
- Italian energy mix is heavily dependent on fossil fuels (33.6% from oil and 40.9% from gas in 2019 of TPES).

Addressed research questions/problems

- Energy transition involves many stakeholders (private and public) and it is a tough challenge for governments.
- Electrification of final uses and penetration of renewables play a crucial role but they raise many issues related to the reliability of the electrical system (infrastructure) and to the adequacy electricity market (energy price).
- Need to enhance science-based tools to support the decision making and evaluation of strategic choices in the context of energy transition, by considering the multi-dimensional impacts (technical, economic, environmental, social, geopolitical) and interactions between dimensions involved in the process (energy, environment, economy, society)
- In Italy, ENEA provides information on the impacts of energy transition on Italian energy system summarised by the ISPRED (Index of Price Security and Decarbonisation) through the quarterly publication of the 'Analisi Trimestrale del Sistema energetico Italiano'.
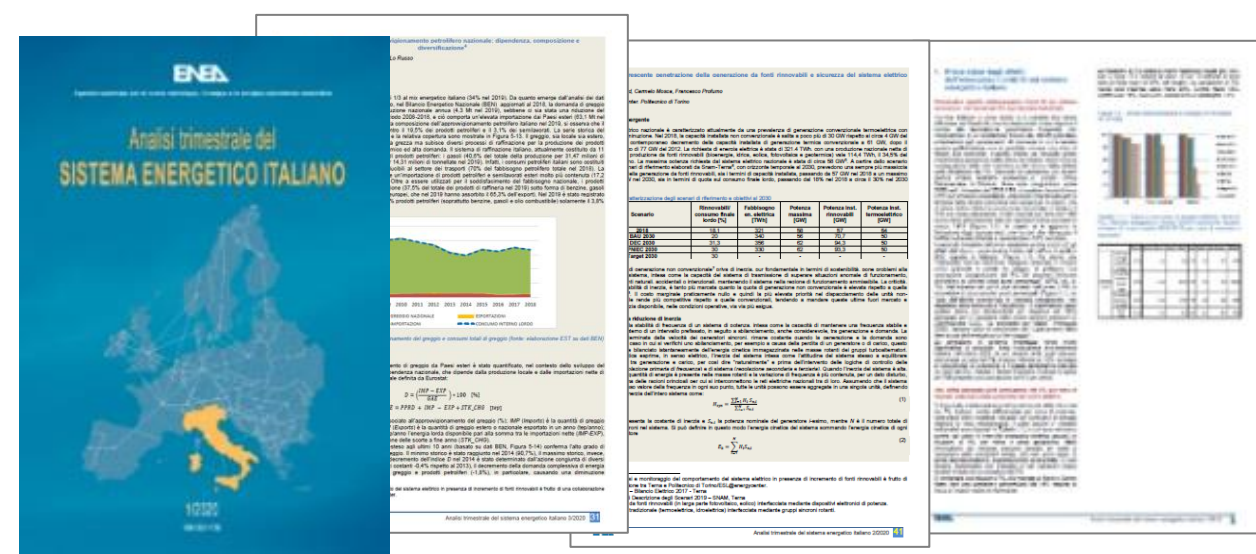
Within this framework, my PhD research is focused on three main objectives:

1. Discussion and revision of ISPRED index (Index of Price Security and Decarbonisation), developed by ENEA to monitor the evolution of the Italian energy transition and proposal of new indices and indicators to improve the current ISPRED index
2. Definition of a systematic methodological approach to handle large amount of information: formal definition, identification and characterization of each data, relating with corresponding data sources and datasets, aggregation into metrics (indicators and indices), collection and organization into proprietary databases.
3. Design and development of an integrated IT tool available online (web interface) to facilitate analysis and monitoring of energy transition's effects in the Italian context with a multi-layer approach. This tool is intended for a broad spectrum of stakeholders belonging to the national energy sector (institutional bodies, companies, public and private) which allows users to evaluate the current state of the national energy system in the context of the energy transition and to analyse the evolution and historical trends.

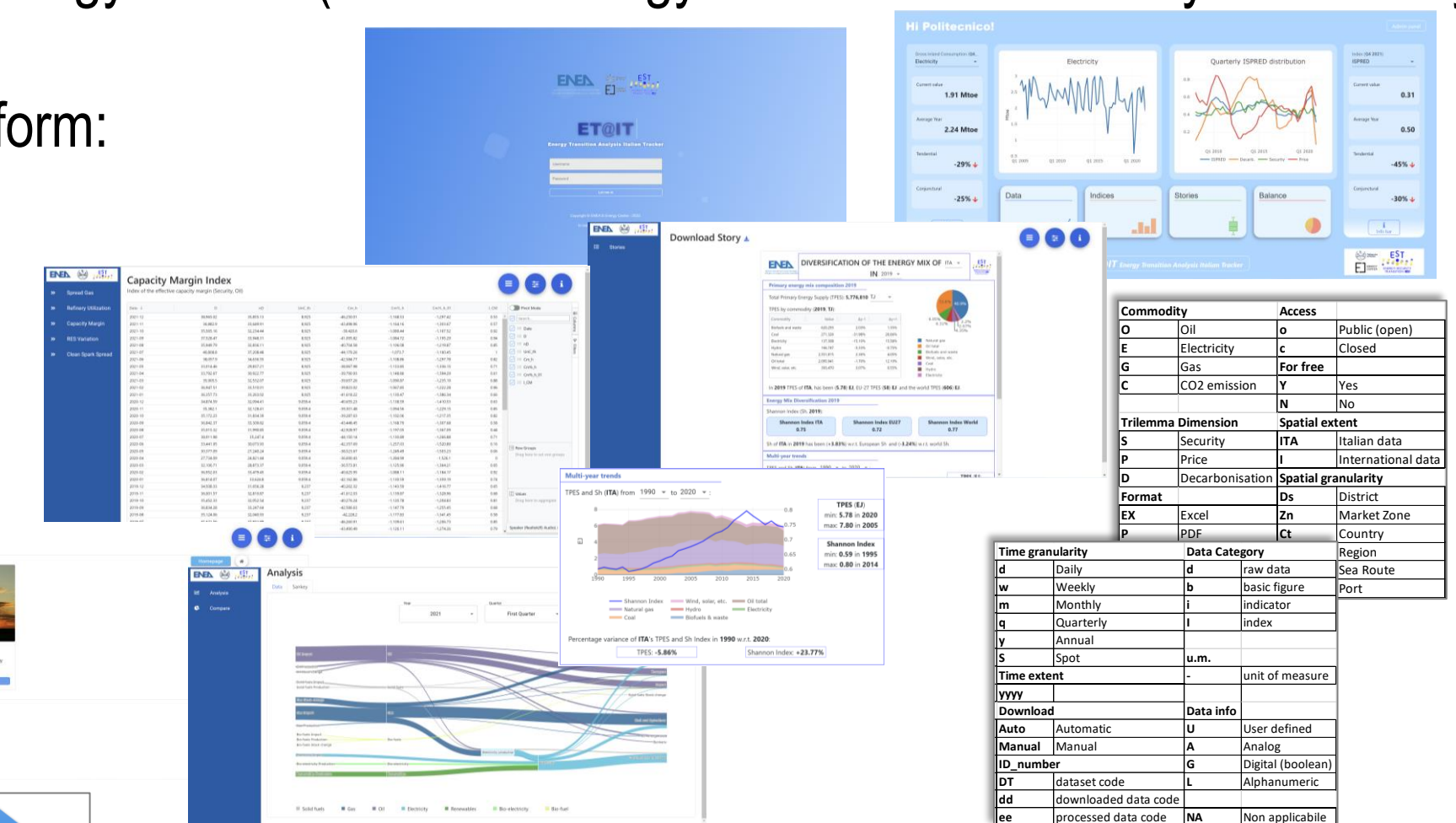## Submitted and published works

Novel contributions

- Classification of database items into 5 categories (raw data, basic figures, indicators, simple indices, aggregated indices) and definition of hierarchical structure of indices
- Data and dataset characterization through "formalization tables"- by means of a set of distinctive attributes
- Design of a single structured database for systemic and hierarchical organisation of data
- Formalisation of calculation functions for computing indicators and indices included in quarterly ENEA's reports
- Review of indices calculation method adopted by ENEA
- Proposal of new indices to assess national energy security (oil, gas, electricity system): Shannon index for import and export, stability index of supplier countries, aggregate index of supplier diversification and stability,..)
- Definition of alphanumeric code to identify data, indicators and indices
- Design of ET@IT platform and development the web interface prototype
- Application of IST (Interactive Story Telling) form to translate specific energy issues by means of narrative, numbers, tables and graphs

Adopted methodologies

The process of ET@IT development involved many steps:
- Identification and tracking of data, datasets and data sources
- Analysis of accessible dataset provided by different data sources (national and international) and available in different formats (excel, pdf, map,..)
- Selection of data sources and datasets suitable for the use of crawlers to automate downloading of data from datasets into the proprietary database
- Creation of a library of functions for computing indicators and indices (constantly updated) easily accessible by users through a web interface.
- Develop a tool to allow the user to perform customised analyses and/or pre-set analyses (stories) and to visualise/download the results in different formats (interactive tables, graphs, maps)
- Implement IST form to energy issues (such as Energy mix diversification by commodity and by supplier)
- Structures of ET@IT platform:
  1. Dashboard
  2. Data
  3. Indices
  4. Stories
  5. Balance

Future work

- Metrics review and proposal of new indices: extension of review activity for the other two dimensions of the energy trilemma: decarbonisation and energy prices
- Enhancement of data formalisation methodology: improvement of the alphanumeric code by including the identification of calculation process
- ET@IT development: extension of functions, increase of stored data input and elaborated metrics, definition and implementation of additional 'stories', enhancement of Balance section

List of attended classes

- 01UNTRV – Managing conflict: negotiation and communication (18/03/2022, 1)
- 01DOPRO – Marine Energy (18/05/2022, 4)
- 01SHMRV – Entrepreneurial Finance (22/04/2022, 1)
- 01SWQRV – Responsible research and innovation, the impact on social challenges (21/04/2022, 1)
- 01SYBRV– Research integrity (21/04/2022, 1)
- 01UNVRV– Navigating the hiring process: CV, tests, interview (21/04/2022, 1)
- 01UNYRV – Personal branding (21/04/2022, 1)
- 02RHORV – Title of the course (21/04/2022, 1)