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Smart energy communities, a national framework for italian smart sustainable cities

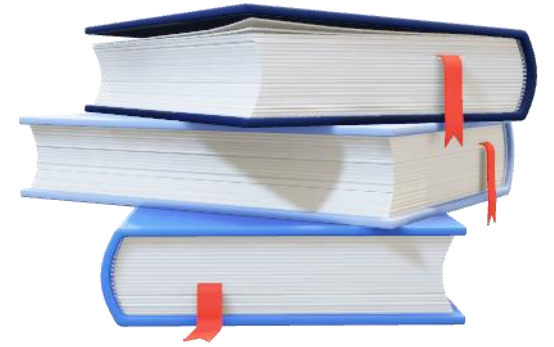


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Agenda

- paper purposes
- smart urban energy system approach
- smart RECs design and management
- italian geoportal for Renewable Energy Communities
- place-based approach using Geographic Information System (GIS)
- decision support tool for all stakeholders (with indexes to evaluate the energy, environmental, economic, social performance of RECs)
- ENEA's tools in support to the establishment of RECs
- ENEA's Local Token Economy model
- conclusions



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Paper purpose

The paper describes a holistic approach for design and management of the smart urban energy systems, decentralized, decarbonized, electrified and digitalized, in which renewable energy communities (RECs) are a key elements.

The new energy system should be framed in the smart city paradigm.

The new energy system is based on an active role of citizens and the sharing of energy between citizens at local level with the use of digital and ICT technologies at grid, district, RECs and building level.

A new approach is described for RECs design and management integrated in the smart urban energy system, that overcomes current administrative and sectoral approaches.

“Holistic Approach for Sustainable Cities and Communities: Best Practices in Living Labs “, https://doi.org/10.1007/978-3-031-54118-6_28



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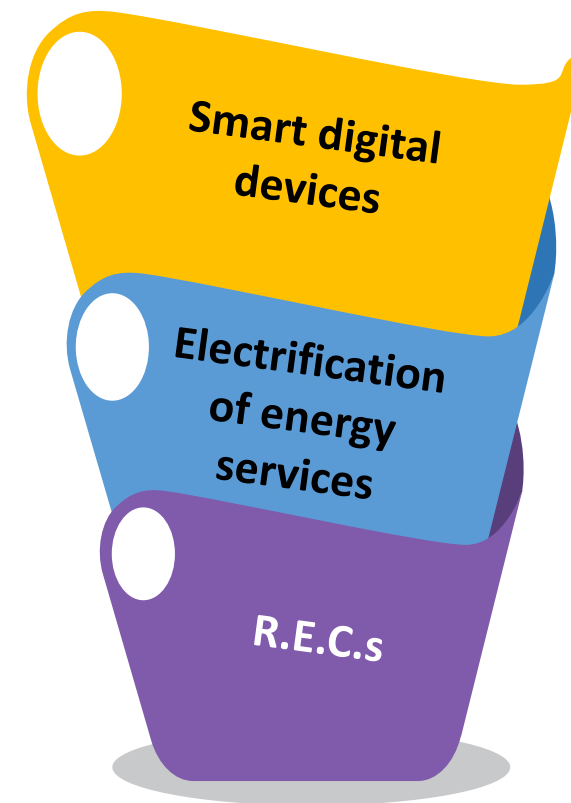
Smart urban energy system

Smart sustainable resilient city is the paradigm to face city challenges and improve citizens urban well-being,

This new governance model evolves from traditional silo-based organization to a more cross-cutting, integrated and citizen-driven and informed decision making.

Urban energy system in smart city is likewise based on a *community-centered integrated approach* and on the use of smart devices, DSO controllable local systems as heat pumps, PV inverters and storage, wall-boxes EV, smart meters, and building management systems.

Such approach is highlighted in the Italian standard of UNI/TC 058, “Sustainable cities, communities and infrastructures.”



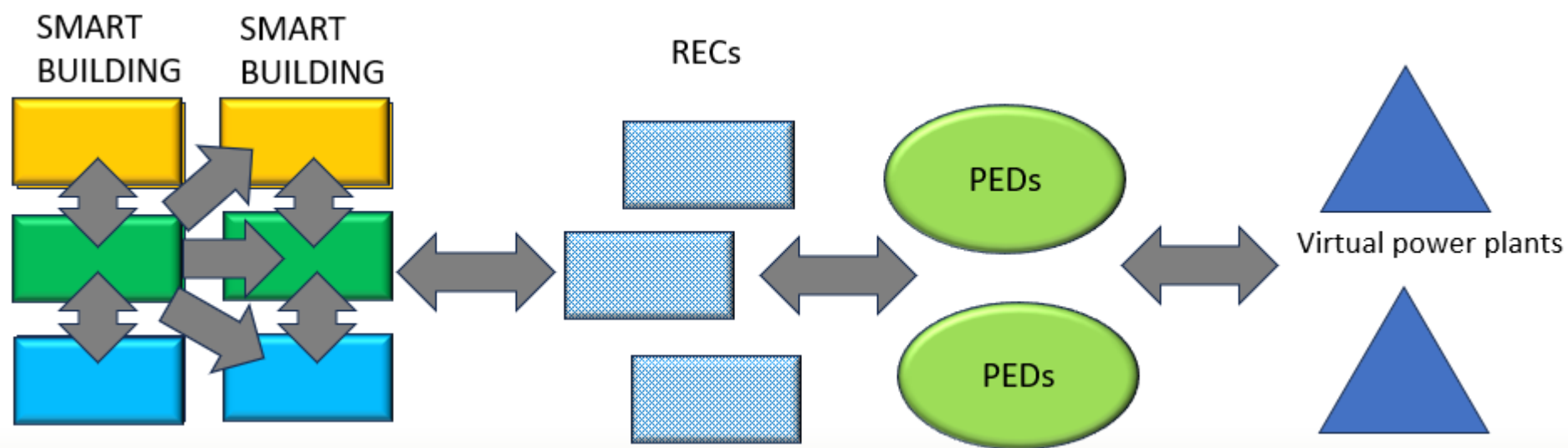
Urban smart energy system



Smart urban energy system approach

The systemic approach considers the integration and reciprocal interlinks at spatial scale between buildings, energy communities and districts and takes into account policies, financial, regulatory and business model framework.

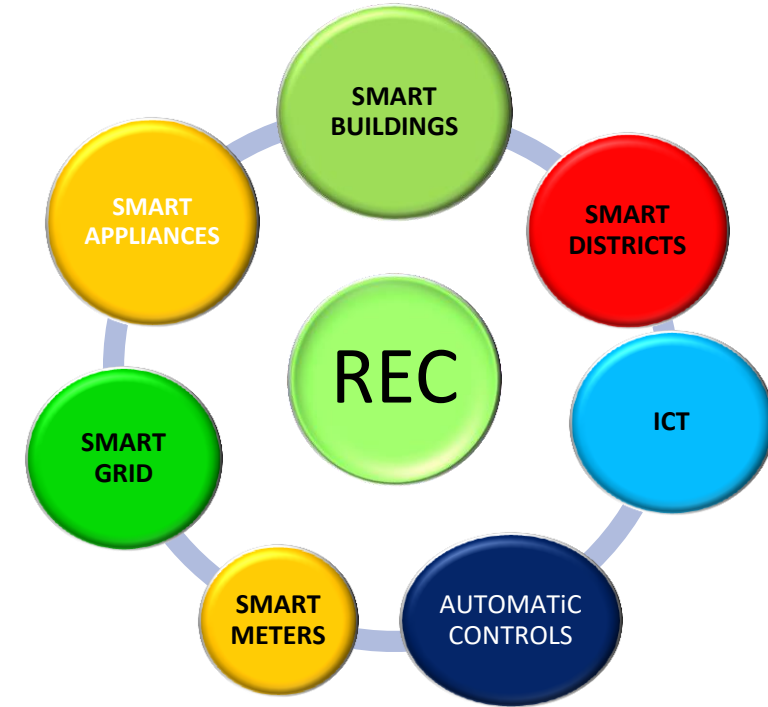
RECs, community virtual power plants, positive energy districts and smart buildings allow sharing energy and data.



Smart RECs

In smart cities smart energy management uses technology to optimize energy production, distribution, and consumption and sharing in a way that promotes efficiency, cost-effectiveness, and sustainability.

The integration in RECs of smart grids, flexibility and aggregation, energy-efficient and smart buildings and appliances, smart meters, the implementation of real-time energy monitoring and management systems with digital technologies makes energy communities **smart**, more efficient, profitable and allow more accountability for all members.



Smart RECs design

RECs integrated energy planning and mapping, supported by a designated coordination unit or a public-private partnership in spatial planning allow the reduction in emissions, integration of renewables and reduction in peak loads can be carried out by including energy flexibility in buildings.

For a better RECs design, the analysis of energy phenomena at the urban level (atlas) provides analysis and aggregation tools for maximizing the benefits that can be obtained by communities.

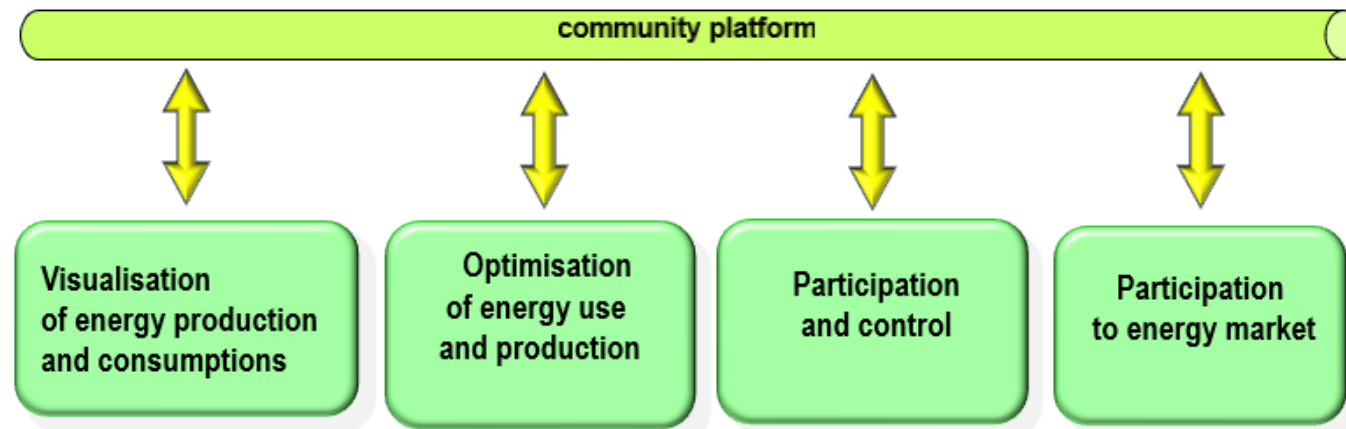
RECs optimal design is based on the selected aggregation of several electric loads for maximize energy shared.



Smart RECs management

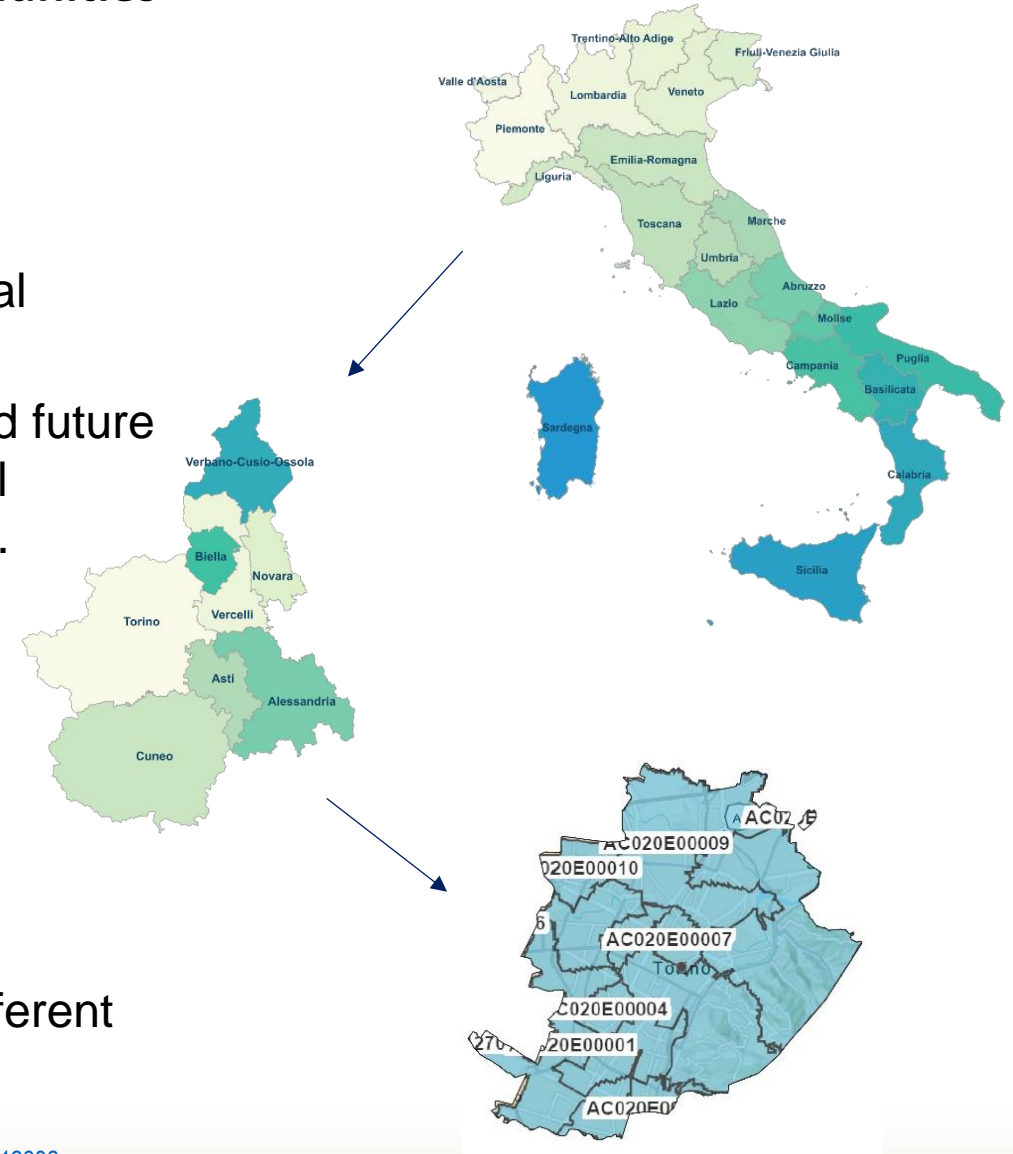
RECs Management Platform could help to every member to visualize how electricity is being produced and consumed within the community, and also show how they could optimize the renewables mix at the household or community level, and how local trading, peer to peer, could impact their economic and environmental objectives.

This also opens up opportunities for community members to participate and feel more engaged. Such an interface could give community insight into how their energy assets could participate to energy market.



Objectives of an Italian Geoportal for Renewable Energy Communities

- Development of an **Italian Geoportal** for planning **Renewable Energy Communities (RECs)**.
- **Decision support tool** for the most suitable areas and optimal configuration:
 - ✓ Identification of available renewable resources, actual and future energy production and consumption, spatial and temporal evaluations, site-specific constraints, cost/benefit analysis.
- **Multi-objective approach:**
 - ✓ Energy, environmental, economic and social indicators; application of optimization techniques based on place-based and top-down analyses.
- **Spatial-temporal scale and place-based methodology:**
 - ✓ Collect, pre-process and integrate data and models at different scales and time periods.



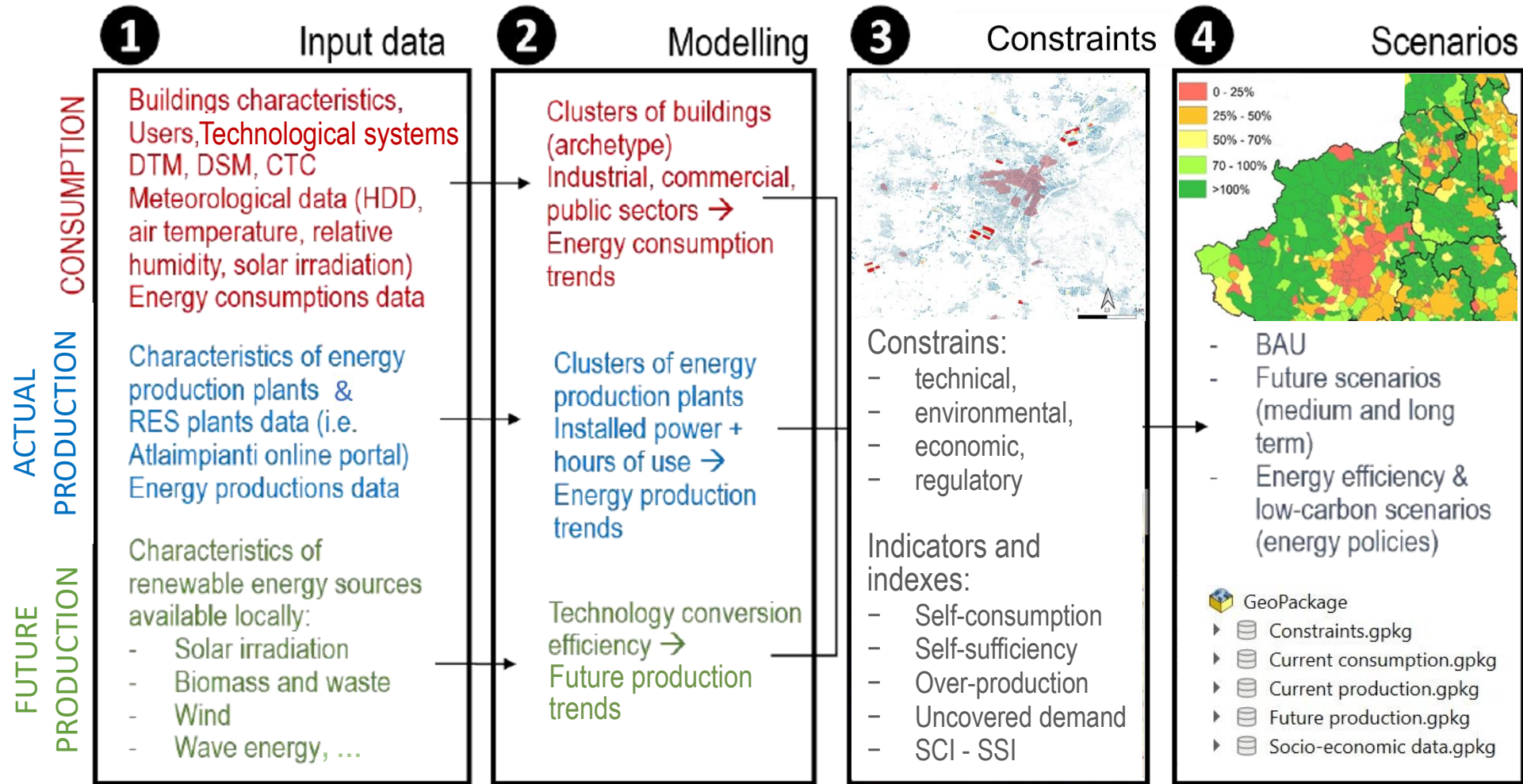
"A Clean Energy Atlas for Energy Communities in Piedmont Region (Italy)", <https://doi.org/10.18280/ijdne.150308>

"Building energy consumption modeling at urban scale: three case studies in Europe", <https://doi.org/10.1109/INTLEC.2018.8612382>

"Toward Improved Urban Building Energy Modeling Using a Place-Based Approach", <https://doi.org/10.3390/en16093944>



Place-based approach using Geographic Information System (GIS)



"Indicators and representation tools to measure the technical-economic feasibility of a Renewable Energy Community. The case study of Villar Pellice (Italy)", <https://doi.org/10.18280/ijssdp.160101>

"Statistical Building Energy Model from Data Collection, Place-Based Assessment to Sustainable Scenarios for the City of Milan", <https://doi.org/10.3390/su152014921>

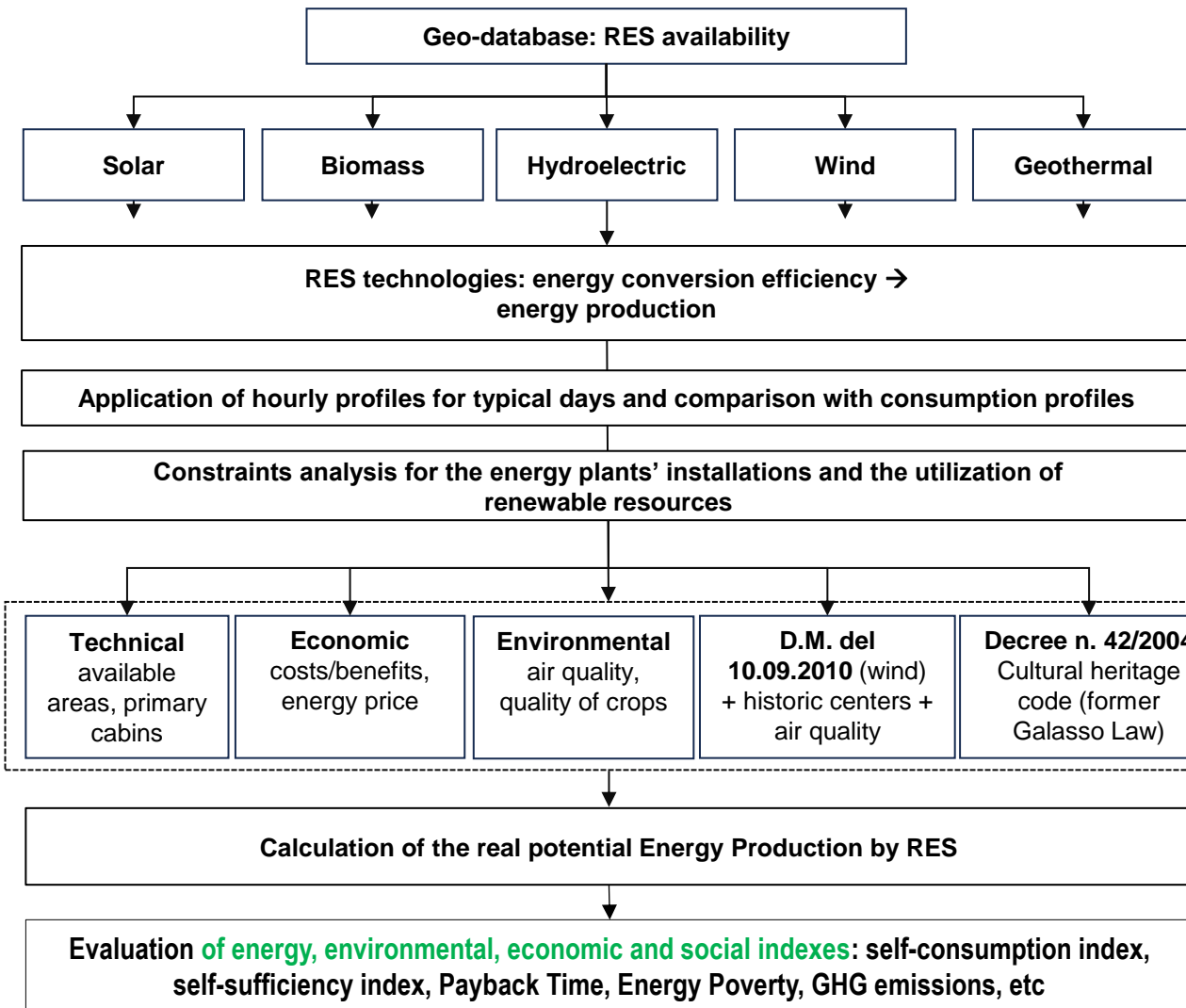
"Urban Building Energy Modeling to Support Climate-Sensitive Planning in the Suburbs of Santiago de Chile", <https://doi.org/10.3390/buildings14010185>



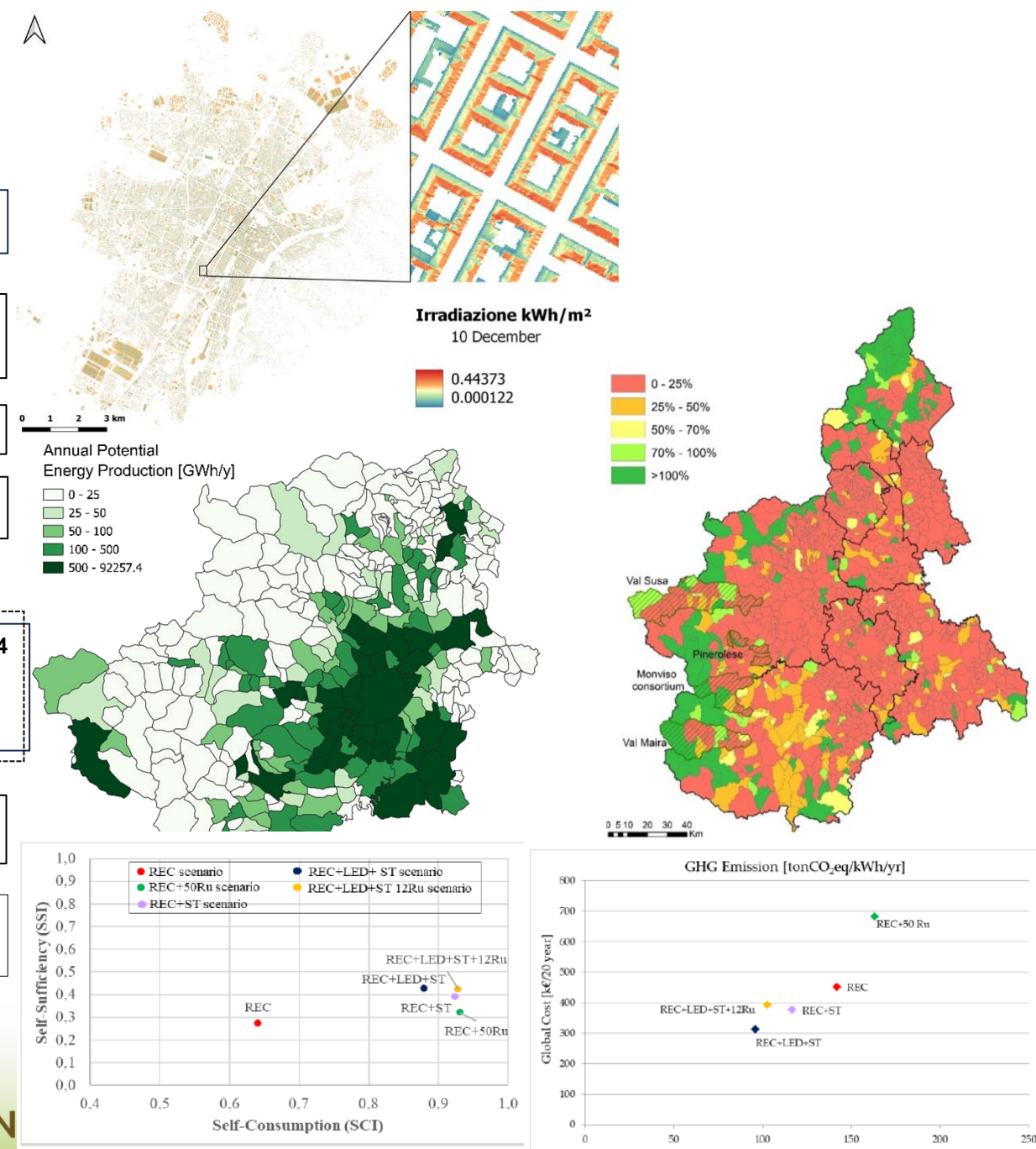
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Decision support tool - Methodology

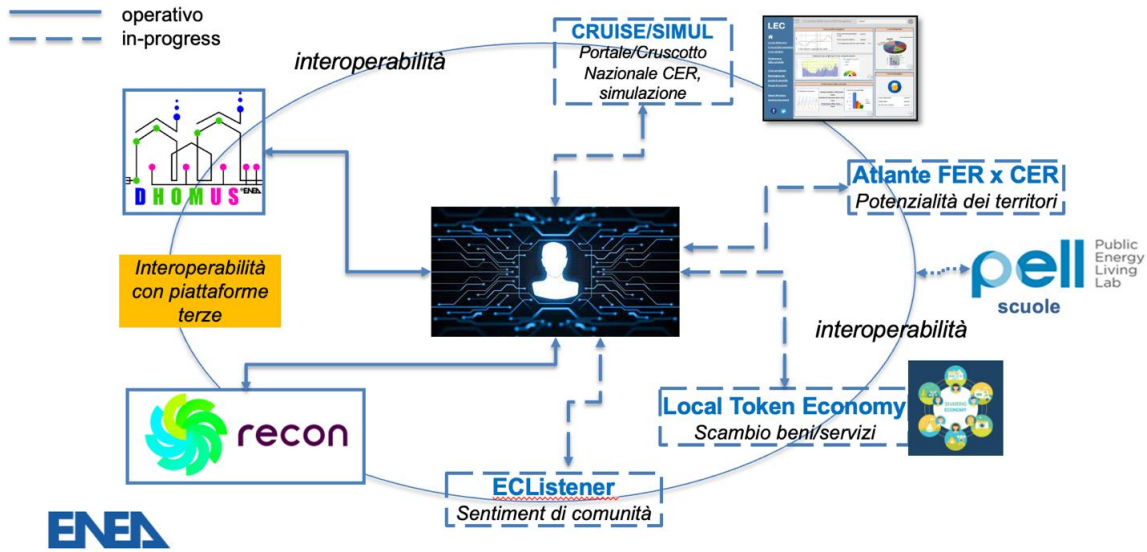


“Optimization of Costs and Self-Sufficiency for Roof Integrated Photovoltaic Technologies on Residential Buildings”, <https://doi.org/10.3390/en14134018> ; “Wind Turbines and Rooftop Photovoltaic Technical Potential Assessment: Application to Sicilian Minor Islands”, <https://doi.org/10.3390/en15155548> ; “Improving energy sustainability for public buildings in Italian mountain communities”, <https://doi.org/10.1016/j.heliyon.2018.e00628>



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ENEA's technologies to support the establishment of RECs



These applications manage a considerable amount of data according to interoperability schemes with the following requirements:

- to analyze strategic data.
- to develop standards and enabling pathways.
- To provide technical and technological support to the institutions.
- To promote the exchange of experiences and good practices.

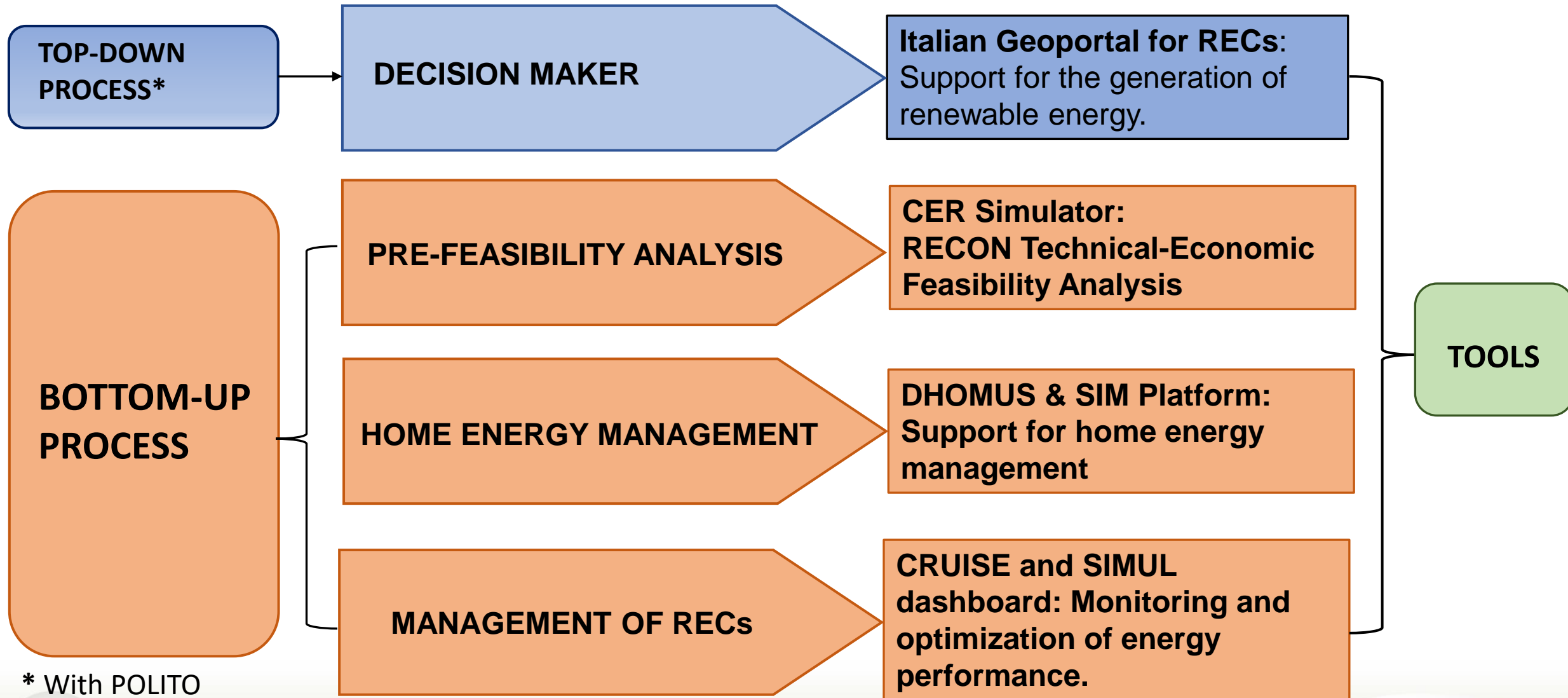
Tools and Services of “Critical Infrastructures and Renewable Energy Communities Division” (TERIN-ICER) of the Department of Technologies and Renewable Sources of ENEA, as support to the design, implementation and management of RECs in Italy



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ENEA's digital tools to support RECs



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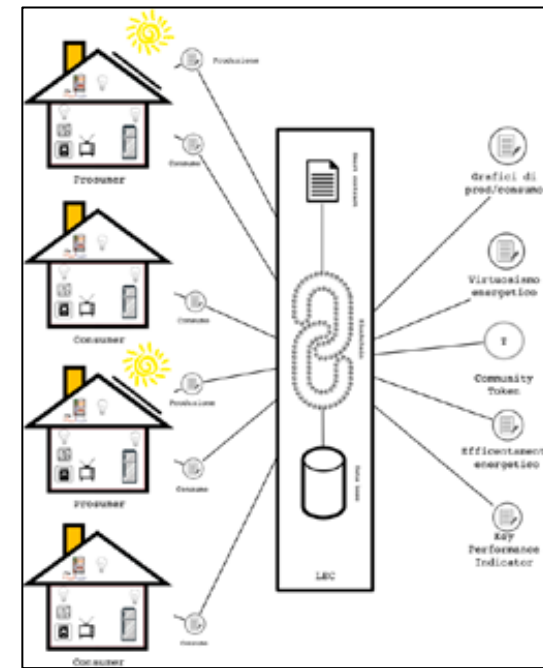


LTE - Local Token Economy for the RECs

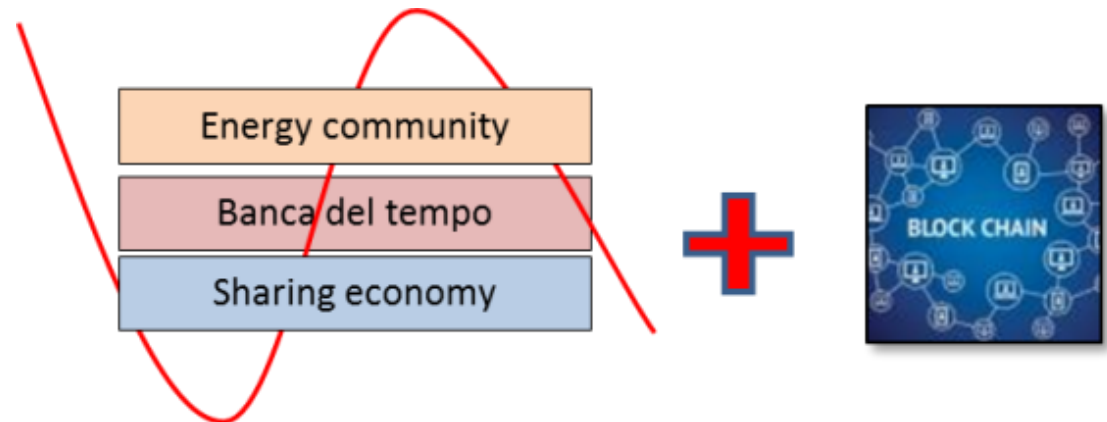
The ENEA's model integrates blockchain technology to create a Local Token Economy (LTE), promoting socio-economic and environmental development.

The model is based on the digitization of the collaborative economy, based on **blockchain technology**, using **tokens** in exchange transactions to promote the economic development of the territory even towards people in energy poverty and with social fragility.

The use of tokens in exchange transactions through technological leverage allows the development of a **community-scale sharing economy** based on trust and transparency and on the participation of all CERs members, also through the implementation of new decentralized services.



ENEA Model for Energy Communities



The elements of the Local Token Economy model



Conclusions

The study demonstrates, with clear research and empirical evidence, references, and exploration of practical implementations, the correct approach to build a new urban energy system and in particular RECs.

Holistic approach to build RECs considers the integration and reciprocal interactions between buildings, districts, and energy communities in a smart sustainable resilient city.

The combined use of tools allow to optimize the use of energy resources with involvement of all actors in the territories and in particular citizens.

Smart RECs design and management require ICT platforms, smart devices and in general a wide empowerment for energy consumptions awareness. Digital technologies in such communities makes energy communities smart, more efficient, profitable and allow more accountability for all members.

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SCIENTIFIC PARTNERS



COMMUNICATION PARTNER

