



THE 29TH INTERNATIONAL SUSTAINABLE DEVELOPMENT RESEARCH SOCIETY ISDRS *Conference*

11-13TH JULY 2023 | UNIVERSITI KEBANGSAAN MALAYSIA



PROCEEDING

CONFERENCE THEME
"HALF-WAY THROUGH AGENDA 2030:

ASSESSING THE 5Ps OF SDGs
(PEOPLE, PLANET, PROSPERITY, PEACE AND PARTNERSHIP)"



co-organizer



**29TH INTERNATIONAL SUSTAINABLE DEVELOPMENT
RESEARCH SOCIETY (ISDRS) CONFERENCE 2023
Half-way Through Agenda 2030: Assessing the 5Ps of SDGs (People,
Planet, Prosperity, Peace, and Partnership)
Universiti Kebangsaan Malaysia (UKM), Malaysia, July 11-13, 2023**

**Proceedings of abstracts, posters and papers that have been accepted
after a double blind review process in several stages.**

e ISBN: 978-967-26554-1-1

Publisher: Faculty of Law, Universiti Kebangsaan Malaysia (UKM)

Publication year: 2023

Editors: Rasyikah Md. Khalid, Muhamad Sayuti Hassan, Mohamad Rizal Abdul Rahman, Ahmad Azam Mohd. Shariff, Nabeel Mahdi Althabhwani, Haniwarda Yaakob, Rozlinda Mohd. Fadzil, Nor Zalina Harun, Ang Choo Mei, Farah Ayuni Mohd Hatta, Mazzlida Mat Deli, Wan Nur'ashiqin Wan Mohamad

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The role of Renewable Energy Communities in achieving SDG7 targets: an experimental assessment methodology for the Italian inner areas

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Abstract. The transition towards renewable energy sources is crucial in achieving the Agenda 2030 SDGs and the carbon neutrality of cities. The Renewable Energy Communities have emerged as a promising model for sustainable energy production and consumption and they have the potential to contribute significantly in achieving SDG7. In this article, we propose an experimental methodology to assess the positive impact of Renewable Energy Communities in the inner areas through the SDG7, focusing on the help of clean and emerging technologies to achieve that. Assessing the performance of RECs is important to ensure: their effectiveness in reducing greenhouse gas emissions and contributing to carbon neutrality; the alignment with SDG7. The methodology consists three steps: identifying the renewable energy community being assessed with a case study approach; defining, collecting, analysing and comparing data with the baseline values for the SDG7 targets and indicators. The third step should enlighten the strengths and weaknesses of the investigated RECs, also from a technological point of view. The results at this step aim to discuss on the role of the most widely used renewable technologies, but also to assess the potential of the technologies in producing, consuming and storing the energy and their capability to achieve additional targets.

1. Introduction

The decarbonization processes required for the energy transition, with climate change scenarios to 2035, 2050 and 2085 [1] (IPCC, 2019), entrust the role of "energy communities" with an important and in any case "smart and open" task, due to the nature that "energy networks" themselves have of implementing "smart grid" models, where the concepts of consumption and production are internal to the same way in which energy systems and their technologies function in "multi-energy systems" and with high levels of storage and redistribution, making end-users active subjects [2].

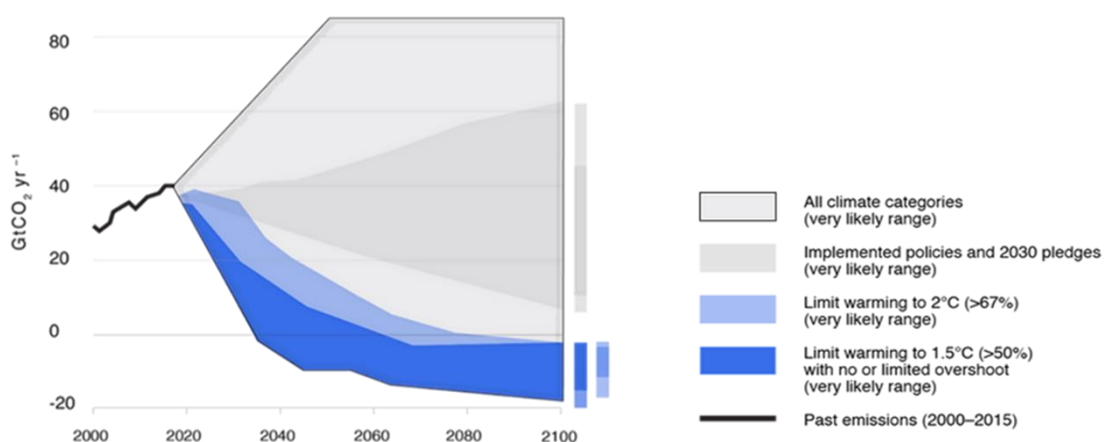
It advances a new approach, which shifts the very concept of decarbonization towards "net-zero" models and founds a new paradigm, which '(...) introduces new benefits for end-users, such as security of energy supply and affordability, while grid operators benefit from deferred grid reinforcement plans and increased diversification of energy supply. At the same time, this paradigm introduces new technical, economic and social challenges for grid operators, end-users and regulators, in particular due to the unreliability, intermittency and non-transferability of most RES' [3].

Energy communities derive many benefits from all energy system networks, but to date with greater incidence from RESs photovoltaic and wind, "it is estimated that by 2030, energy communities could own around 17% of installed wind capacity and 21% of solar capacity [4]. By 2050, nearly half of EU households are expected to be producing renewable energy' [5]. Energy communities and their networks will still remain connected to national energy systems and distribution infrastructures for a long time, but in islands and inland areas autonomous systems could realize innovative consumption, self-consumption and production patterns with advanced technologies. This would de facto change the structure of infrastructures, the spatial systems of inhabited contexts and their energy flow management models, acting within the broader circular models of sustainable resource use and management by users/citizens. In the design of sustainable cities, energy communities become one of the models to be pursued for 'net zero' cities, expressing in highly innovative transformation projects, new performative configurations and energy infrastructures perfectly integrated into the urban landscape, making all the environmental systems involved productive

In the regime of climate change scenarios, it is necessary to produce levels of quality "beyond performance" in order to aim for a "performative level"; this means working for scenarios of climate adaptation and/or mitigation and calling on the capacity of regenerative design to provide pathways that can be activated as responses to states of impact for emerging phenomena. Such an approach is based, also according to the latest IPCC reports (2013 to 2022), on the concepts of impact and vulnerability and thus risk, referring to the "global warming level" (GWL), described as "the increase in global mean near-surface air temperature relative to the pre-industrial period (properly the period prior to 1750, often approximated by conditions in the period 1850-1900)" [6].

The IPCC identifies as key risks for Europe, which are susceptible to their level of impact with reference to increased global warming (since the 1.5° of COP 25 has been largely compromised). Already with a 2° C rise in temperature, the risks become more serious and partly irreversible. The IPCC shows the path to be traced, with reference to past emission scenarios (from 2000) up to 2100, a period in which, in addition to the first challenges of 'climate neutrality' in 2030, 2050, the results of climate mitigation policies carried out in the productive sectors of industry, energy, residential, transport, tertiary, land consumption, etc. should be recorded (Fig.1).

Figure 1. IPCC 6th Assessment Report, Climate Change 2022: Mitigation of Climate Change



Under the climate change regime, even advanced hybrid building design processes must be conducted according to a new approach to innovation and sustainability. Therefore, in the field of frontier research, there is a need for applied experimentation in innovation-led design in transition scenarios, through the expression of more advanced spatial and functional configurations, contributing to the discussion on sustainability in its most radical version, with a building design that projects its goals beyond green and efficient performance, towards climate neutrality, going beyond the concept of “zero carbon” and through regenerative type systems of positive and hybrid response. It should be argued that, to address the design and management of hybrid buildings under climate change, regenerative type design is the most complex but also

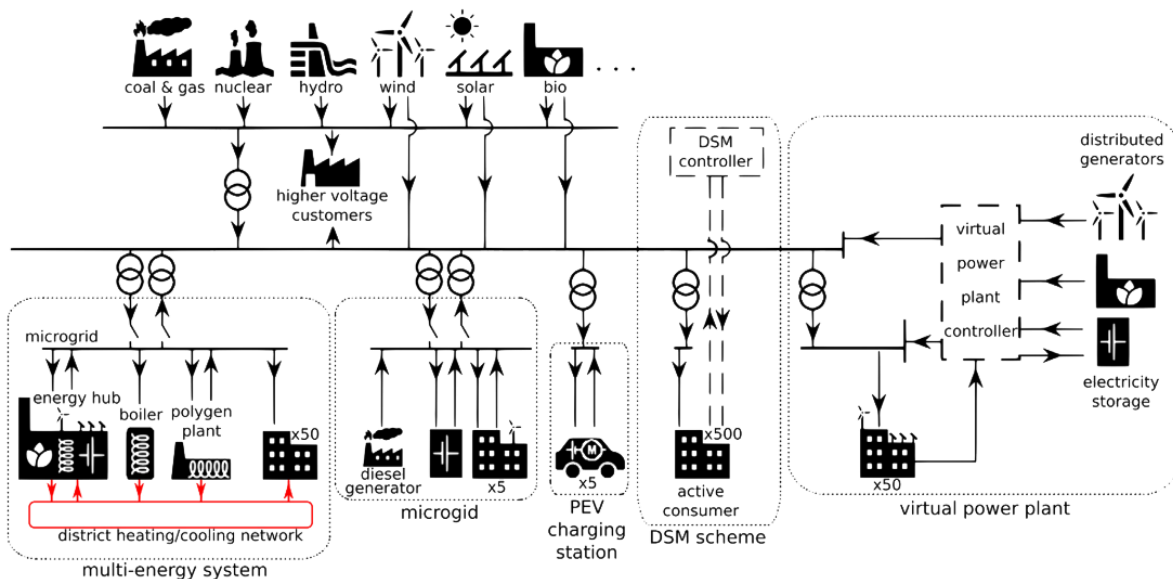
the most performing translation of advanced sustainable design. What is experimented to realize "the resilience of buildings in the built environment", in fact changes the very concept of the hybrid building, in the architecture of its possible forms and materials and context spaces, in its functions as an urban device, as an ecological and technological device, or even as a regenerative device for "living" or "carrying out activities" [7].

All regenerative systems are themselves 'hybrids', since in order to produce performance with a "positive/productive balance", they must be able to function on both high levels of efficiency and effectiveness. Thus, for example, the passive-active behaviors of any technological system designed for a level of thermo-hygrometric wellbeing, is the result of the integration of the physical-environmental devices of the technical elements and the digital ones, of regulation and control of the natural/passive behaviors [8].

In this model of regenerative design, the innovative character emerges that F. Tucci [9] entrusts to the possible interaction between "Self-reliant approach (whose reference principles are: reflexivity, self-organization and inclusivity)", "Error-friendliness approach" (whose reference principles are: robustness, flexibility and adaptability) and "Dynamic-responsive approach" (whose reference principles are: integration, connectivity and responsiveness).

Real configurations of energy landscapes in smart grids (Fig.2), recognize energy communities and their distribution technologies with reference to the use of renewable resources, realized in a single urban energy system.

Figure 2. Emerging energy landscape on smart grid and urban energy system concepts. Source: Applied Energy, 2018

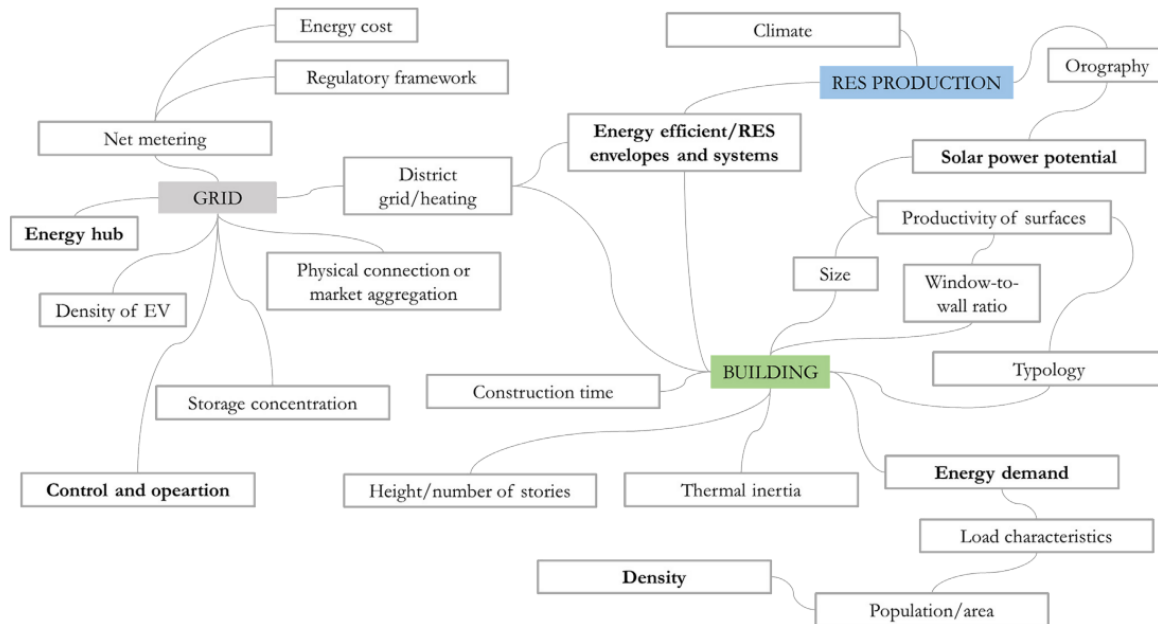


In these scenarios, where technologies powered by renewable energy sources are of relevant importance, the building takes on the definition of a 'building cluster'. "(...) The building cluster scale, also known as 'building block or neighborhood', represents an intermediate level between the individual building and the neighborhood or urban scale. It can be defined by several criteria, such as energy system, archetypes, location, building size, density (low, medium, high), function (residential, office, mixed), number of floors (low, high), year of construction, geographical boundary and so on.

Consequently, a building cluster is considered as a group of buildings systematically interconnected to the same energy infrastructure, so that a change in the energy performance of a single building affects both the energy infrastructure and the other buildings in the cluster. synergistically or disruptively' [10]. A true productive energy landscape (Fig.3), whose cluster efficiency is influenced by many factors, at different scales, that can be ascribed as "impact parameters"; these can be divided into four categories: geometry (form), construction (fabric), systems (equipment) and operation (program).

It is in this organizational dimension that policies and strategies referring to SDG7 (targets and indicators) and the role that innovative and emerging technologies play through the configuration of advanced energy communities can be implemented.

Figure 3. Outline of the main parameters influencing the energy characteristics of a building cluster.
Source: Applied Energy, 2018



It is therefore necessary to redefine the inter-scalar relationship between functioning models and expected impacts, to define the quality of space in terms of functions and well-being, and thus to adopt a regenerative approach with high performances, for which sustainable design is not limited to the reduction of impacts, but produces positive environmental and social performance [11].

The research conducted by G. Mangano and C. Nava, as described in some of the results already produced and illustrated in the following paragraphs, moves from these premises and finds in the methodological investigation referred to the general thematic objectives the theoretical and applicative conditions for the two outputs sought: *output 1 - Sustainability Assessment - Monitoring of SDG7, related SDGs and technological performances* - *output 2 Sustainability Assessment - Prioritization of policies and public funds to create a REC*.

the Report provides valuable thematic and analytical insights at both the regional and socio-demographic levels. Acknowledging the inherent complexity of sustainable development, the Report also presents an analysis of the interconnections between targets, sub-targets, indicators and statistical measures, included in a set of 55 national indicators, defined by the National Table for Sustainable Development. This ongoing effort fits with the progress in the production of statistical measures within the National Statistical System and the expansion of the 'mapping' of indicators proposed by the UN-IAEG-SDGs. For the purposes of investigating the territorialization of the 2030 Agenda at regional, metropolitan and municipal scales, it is also useful to mention the role played by the Alliance for Sustainable Development - AsviS, with its "ASviS Report. Italy and the Sustainable Development Goals" [16], which analyses the state of progress of our country with respect to the implementation of the 17 SDGs, on the basis of the evaluation of "composite indicators" (Istat, Ispra, UN, indicators of other bodies...) and illustrates an organic framework of proposals, pointing out the areas where action is needed to ensure the economic, social and environmental sustainability of territories.

2.3 Methodologies developed to support SDG7 in academic field

SDG 7 is a critical component of achieving all SDGs. The primary objective of SDG 7 is to ensure universal access to energy, particularly for disadvantaged populations, while simultaneously promoting a global shift towards utilizing low-carbon energy sources. Energy, which is the capacity to perform work, plays a fundamental role in transforming materials in economic activities to enhance the overall well-being of society.

Several studies in the scientific literature have highlighted the need to develop effective methodologies for monitoring and evaluating the achievement of the SDG7 targets, defined as (7.1) ensuring universal access to affordable, reliable and modern energy services, (7.2) increasing the share of renewable energy, (7.3) doubling the global rate of energy efficiency improvement, (7.a) strengthening international cooperation on clean energy research and technology, and (7.b) expanding infrastructure and developing technologies.

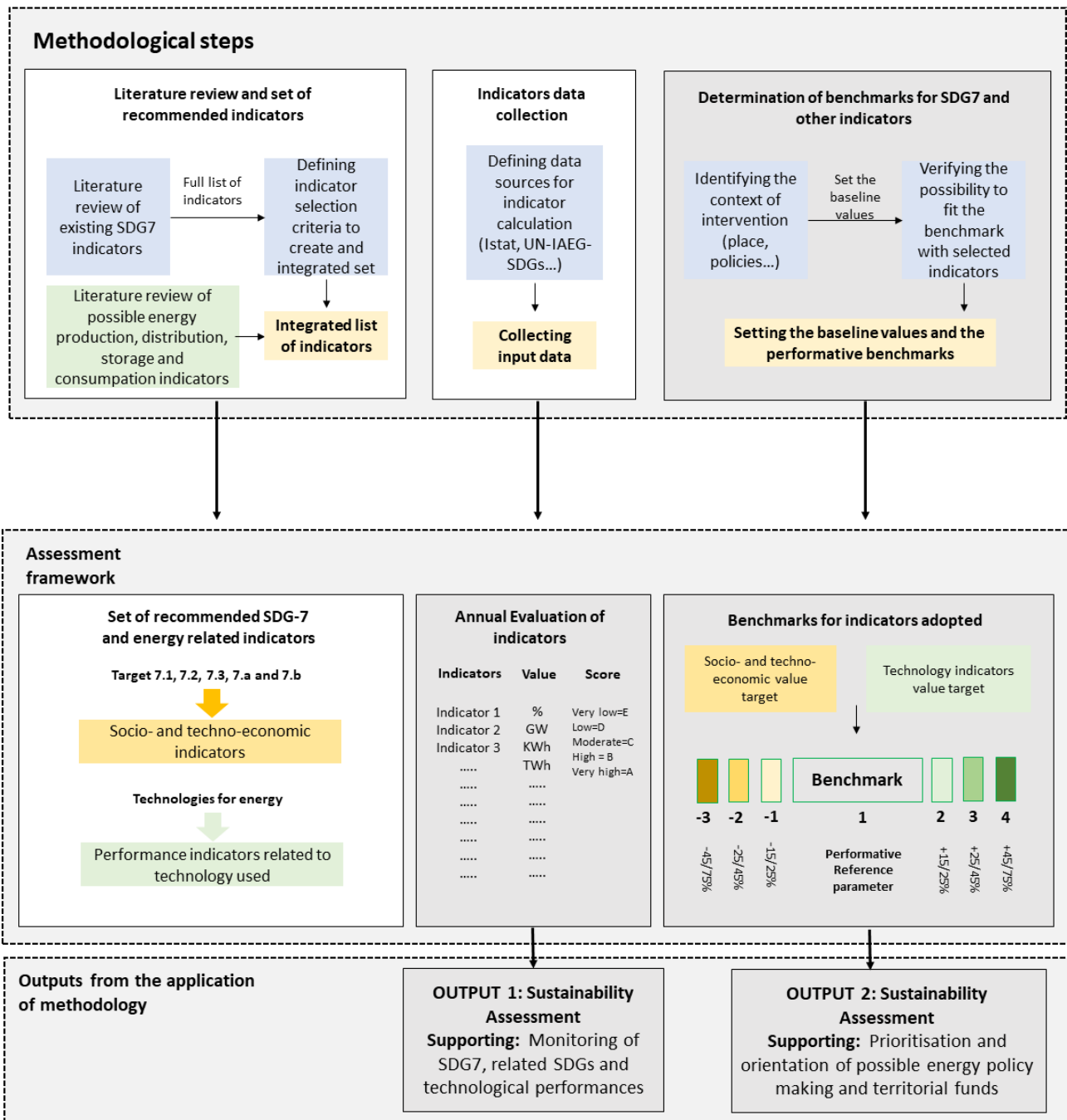
According to Matthew J. Burke and Rigo Melgar [17], the goals outlined in SDG7 strongly emphasize the use of technological solutions, particularly energy efficiency and renewable energy. The authors developed a methodology to compare how SDG7 places a significant emphasis on the adoption of advanced technologies to promote energy efficiency and renewable energy sources, while at the same time predicting a significant reduction in the correlation between economic growth and energy consumption. These goals combine the sustainable expansion of energy systems with an equitable distribution and effective allocation of energy resources and services, being more effective and beneficial if implemented as an integrated policy framework, rather than being treated as separate measures.

Andrea A. Eras-Almeida and Miguel A. Egado-Aguilera [18], emphasize the importance of achieving SDG7 particularly for the most vulnerable regions such as small islands and rural areas in developing countries. Both small islands and rural areas face numerous difficulties, including limited access to essential goods and services such as energy, isolation from markets, scarcity of human resources, difficulty in achieving economies of scale, and other obstacles to development. In their research work, they developed a methodology to study the role of off-grid energy systems for fragile contexts, based on an extensive literature review and the construction of a set of indicator tables to assess access to household electricity supply, overall renewable energy capacity, categorization of off-grid applications and consumption of hybrid business models in vulnerable contexts.

Maria Canepa, Adriano Magliocco and Nicola Pisani [19] developed an analytical platform that uses artificial intelligence, geo-referenced data and automated analysis to define the characteristics of urban contexts and identify parameters and solutions to respond to the effects of climate change in the urban environment, considering risk levels and settlement types. The methodology is based on a data-driven approach, starting with the choice of essential indicators for the metropolitan city of Genoa, taking into account development trajectories and key sectors (derived, for example, from SWOT analyses provided by the municipalities). This methodology makes it possible to identify trends associating validated indicators with different macro-level objectives, as the SDGs are correlated with KPIs that could describe different scenarios and be associated to define a trend.

The methodologies described above contribute to understand the connection existing between the need to associate performance indicators referable to the technologies employed, to the impacts from a socio-

Figure 4. Construction of methodology framework. Source: elaboration by G.Mangano (2023)



these indicators takes place with "annual period" and will allow to populate each individual indicator both quantitatively (value on units, e.g. %, GW, KWh, etc...) and qualitatively by assigning a score relative to the relative weight that the individual indicator has on the whole set (Very low=E, Low=D, Moderate=C, High=B, Very high=A). The assessment process at the methodological level, concludes with the determination of benchmarks for the SDG7 indicators: at this stage, first of all, it turns out to be necessary to identify the context of intervention (place, policies, etc.), as each context may establish (from the point of view of the regulatory instruments in place, for example), different benchmarks; then, the basic benchmark values are set and the possibility of "populating" these benchmarks with the selected indicators is checked. This process becomes important for defining baseline values and performance benchmarks (e.g., expected installed PV power, amount of energy from PV, CO2 emission reduction relative to context, and so on.). The benchmarks for the adopted indicators will also constitute the "target values" for socio-technical and economic indicators and for technological indicators. In order to provide a comprehensive assessment of whether the benchmark is met (or not), a score is established for the level of contribution that the case study/project investigated are able to make to the specific indicator, according to a numeric scale, related to incremental or decreasing percentage of matching the indicator itself. The benchmark level is fixed as "1", the incremental levels from 1 to 3, while decreasing from -1 to -3, according to scale of percentage.

The application of this assessment methodology, in the case of Renewable Energy Communities, allows for two outputs:

- *Output 1*) Sustainability Assessment for supporting monitoring of SDG7, related interconnected SDGs (e.g. SDG9, SDG11, SDG13) and technological performances. This output narrowly defines the contribution of RECs to the achievement of the SDG7 targets of Agenda2030 and the interconnected SDGs, among which certainly to be identified in the targets related to technological innovation, research, infrastructure and combating climate change. Each of the Sustainable Development Goals is inherently interconnected, forming a cohesive and interrelated set of global priorities and objectives. Recognizing the diverse spectrum of both favorable and unfavorable interactions between these SDGs is essential to fully harnessing their potential on a global scale. It ensures that advancements in certain areas do not come at the detriment of progress in other domains. The dynamics of these interactions, including their nature, strengths, and potential impacts, heavily rely on the specific context in which they are applied.
- *Output 2*) Sustainability Assessment for Supporting prioritization and orientation of possible energy policy making and territorial funds (RFF, ORP 21-27, Horizon Europe, etc.). The chosen policy options and strategies pursued play a critical role in shaping the outcomes and implications of these interactions.

3.2 Methodology application on three study cases

Below, we present the results of the application of the above methodology, in order to evaluate its effectiveness, on no.3 case studies in inner areas:

- no.2 national case studies for output 1, with the RECs "Energy City Hall", Magliano Alpi (Ita) and "Berchidda Energy 4.0" (Ita);

- no.1 local case study for output 2, with the ongoing experimentation for the activation of a Living Lab in the Grecanica Area, within the project-research Tech4You (see acknowledgements).

The case studies and applied assessment methodology are presented in the form of fact sheets with original information structure by the authors.

3.2.1 Study cases application for output 1- Sustainability Assessment - Monitoring of SDG7, related SDGs and technological performances

Case Study 1. REC “Energy City Hall” (Magliano Alpi, Cuneo, Ita)



IDENTIFICATION SECTION

Location: Magliano Alpi (Cuneo, Italy)

Year: 2020

Population: 2166 inhabitants (up to date 31-12-2020)

Management model: Energy Community made up of Municipality of Magliano Alpi, the Public Library, the gym, the school and n.4 residents

TECHNOLOGY USED

- 20Kwp photovoltaic plant on the roofs of the Town Hall
- Connection PODs for energy sharing
- Electric Vehicles (EV) recharging stations
- IoT platform for real time energy management and monitoring (Energy4Com support)

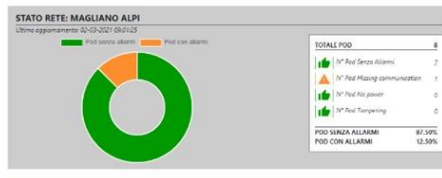
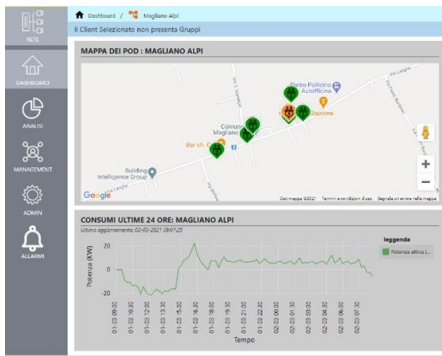
PERFORMATIVE INDICATORS **Benchmark**

Energy Production: 24 MWh by photovoltaic system **1,5**

Energy demand coverage: 7 households of which three municipal 3 households and 1 small handicraft enterprise **1,5**

SOCIO-, TECHNO-ECONOMIC IMPACTS

- Building retrofit **2**
- Processes of local development **2**
- Local short supply chains with a strong cognitive and technological value **1**
- Free services for residents (EV charge, energy sharing) **2**



SDG7 – CONTRIBUTIONS ON INDICATORS		Score	
7.1.1	Proportion of population with access to electricity	C	
7.1.2	Proportion of population with primary reliance on clean fuels and technology	C	
7.2.1	Renewable energy share in the total final energy consumption	C	
7.3.1	Energy intensity measured in terms of primary energy and GDP	B	
7.b.1	Installed renewable energy generating capacity in developing countries (in Watts per capita)	N.a.	
Level of Contribution on other SDGs			
SDG9	C	SDG11 B	SDG13 B

Figures above: PV plant and energy monitoring platform. Source: <https://cermaglianoalpi.it>

Case Study 2. REC “Berchidda 4.0” (Magliano Alpi, Cuneo, Ita)



IDENTIFICATION SECTION

Location: Berchidda (Sassari, Italy)

Year: 2019

Population: 2688 inhabitants (up to date 31-08-2020)

Management model: Energy Community made up citizens, Sardegna Region, Department of Engineering and Electronic University of Cagliari

TECHNOLOGY USED

- 200 photovoltaic plants with >1500 kWp of power
- Storage systems with a capacity of 50 kW/50kWh
- Smart Home Systems (smart box) for energy monitoring

PERFORMATIVE INDICATORS

Benchmark

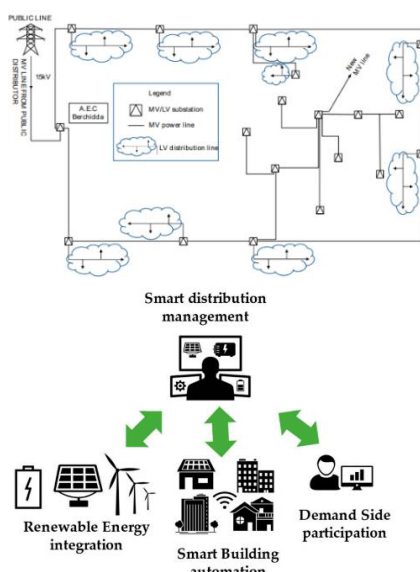
Energy Production: - solar energy production of about 3 GWh/year

3

Energy demand coverage: Local self-consumption >50%

3

SOCIO-, TECHNO-ECONOMIC IMPACTS



- Activation of 30 pilot projects on existing pv systems for self-consumption promotion and community engagement 2
- 620,000 € savings (-50% public cost of energy) and 30% energy bill reduction 3

SDG7 – CONTRIBUTIONS ON INDICATORS	Score
7.1.1 Proportion of population with access to electricity	B
7.1.2 Proportion of population with primary reliance on clean fuels and technology	B
7.2.1 Renewable energy share in the total final energy consumption	B
7.3.1 Energy intensity measured in terms of primary energy and GDP	B
7.b.1 Installed renewable energy generating capacity in developing countries (in Watts per capita)	N.a.
Level of Contribution on other SDGs	
SDG9 B	SDG11 B
SDG13 A	

Figures above: PV panels for REC on roofs and Smart distribution management of the local energy community resources. Source: web search

3.2.2 Study cases application for output 2-Sustainability Assessment for Prioritisation of policies and public funds to create a REC

For output 2, we will use the illustrated methodology to guide choices in the pre-design phase of a Living Lab for the establishment of a REC. at the Municipality of Bova (Reggio Calabria, Ita), as part of Pilot Project 4.7.1 - "Open platform "phigital space" (physical and digital) of the type "user profiling" for the advanced and dynamic codesign of interventions on the built and ex novo" within the Tech4You research project.

Case Study 3. Experimentation in the Grecanica Area: Living Lab in Bova



IDENTIFICATION SECTION

Location: Bova (Metropolitan City of Reggio Calabria, Calabria, Italy)

Year: 2023-in progress

Population: 400 inhabitants (Istat data 2021)

Surface: 46,94 km²

Population density_ 8,52 inhab./km²

Altitude: 820 m a.s.l.

Inner Areas classification: F-Ultra Peripheral

Management model proposed: Living Lab for the activation of a Renewable Energy Community

TECHNOLOGY TO BE PROPOSED

- Photovoltaic with innovative organic cells (high capacity)
- Eolic turbines
- Biomass



PERFORMATIVE INDICATORS

Benchmark

Production of electricity from solar PV

Production of electricity from wind power

Production of electricity from bioenergy (biomass) n.a.

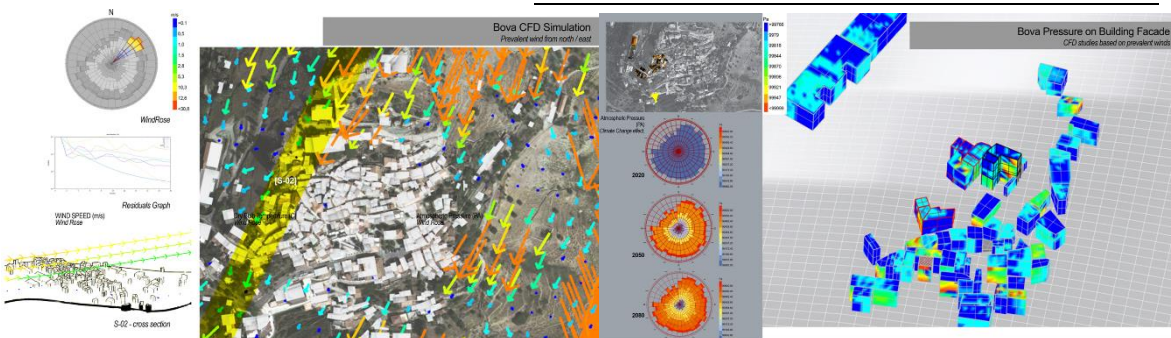
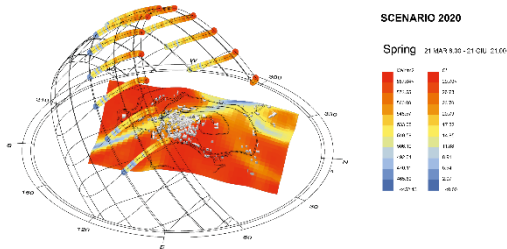
Storage of electricity

Transmission and distribution of electricity

SOCIO-TECHNO-ECONOMIC IMPACTS EXPECTED

- Processes of local development
- Free services for residents (EV charge, energy sharing)
- Process of community awareness on environmental safety
- Challenge of Energy Poverty for public goods
- Public Building retrofit

Radiation Analysis Suolo _ Bova



SDG7 – CONTRIBUTIONS ON INDICATORS	Score
7.1.1 Proportion of population with access to electricity	N.a.
7.1.2 Proportion of population with primary reliance on clean fuels and technology	N.a.
7.2.1 Renewable energy share in the total final energy consumption	N.a.
7.3.1 Energy intensity measured in terms of primary energy and GDP	N.a.
7.b.1 Installed renewable energy generating capacity in developing countries (in Watts per capita)	N.a.
Level of Contribution on other SDGs	
SDG8, SDG9, SDG11, SDG13, SDG17	
Figures above: Mangano G., Draft Paper and ABITAlab elaboration for radiation, sunlight and windflow analysis (Grasshoppers + Ladybug Tools), Action 8, M1, Activities 1 for Spoke 4, PP 4.7, Tech4You, PNRR, march 2023	

At this step, the aim is to understand whether such an assessment methodology is useful in guiding working trajectories for capturing public integrated spatial investments that may come from competitive opportunities or funding devices such as the EU Recovery Fund or RePower EU for instruments such as Energy Communities. The fact sheet below is therefore the result of the analytical study phase of those data useful for the construction of the set of indicators and analyses conducted by the ABITAlab research team on the scenarios and climatic and environmental factors, capable of being able to give indications on which renewable energy technologies to adopt.

4. Results and Discussion

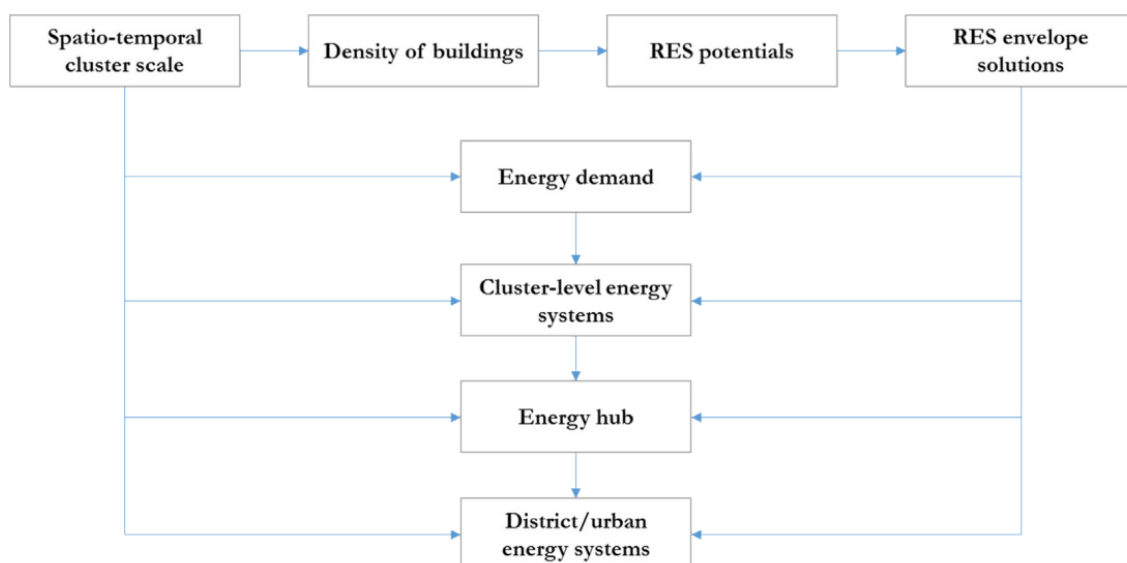
The discussion related to the results at this step, regard the performance effectiveness of energy technologies, suggesting to address the questions related to the time factor and the loss of performance of those technologies defined as "business as standard" in the medium and long term. In fact, following the methodological proposal of evaluating performance indicators of energy technologies, it is necessary to consider the evaluation of regenerative processes in the medium and long term related to technologies using renewable sources: the most popular ones, such as photovoltaics, have a performance in terms of energy production within 20 years. In deed for example, it is known that after 20 years, the efficiency of technologies raises the question of performance and thus, in turn, the ability to generate a positive impact. Nowadays

The most innovative RES solutions must be able to offer potential opportunities for energy savings and improvement of the environmental quality of the interior space, using those distribution technologies that can make the system adaptable and integrable, multi-operational, expandable, in order to combine the complementary beneficial aspects of active and passive technologies in the building envelope (Fig.7). In fact, the high-performance hybrid building with positive building requirements is realized, which will be referred to below. Solar energy and solar heat are usually energy generators for buildings, while energy-efficient solutions help to reduce energy use in the buildings themselves; they, as well as devices, technologies, spaces and infrastructures, become nodes of the energy HUBs of the smart grid. "(...) The energy hub is a node of the urban energy system as a whole, with multiple energy carriers in and out and typically consists of a more elaborate and complex internal arrangement of components. The benefits of this close integration are identified as increased reliability, load flexibility and efficiency gains through synergy effects, which are well suited to building clusters.

The energy hub is also seen as a practical way to offer more services through the sharing and interconnection of domestic devices, thus reducing the impact on carbon emissions. Thus, energy hub is not a single entity that contains all the necessary systems for energy transformation, conversion and storage, but a collection of individual energy consumers and producers distributed over an area (as reported on energy communities).

This allows the variable loads, systems and energy sources of multiple buildings to be taken into account in several alternative pathways" [10] [22].

Figure 7. Flow chart of the building cluster approach based on RES envelope solutions. Source: Applied Energy, 2018



It is therefore a matter of considering the performative contribution that can be made by so-called “emerging technologies”, defined as “[...] a set of technologies whose areas of development and application are still rapidly expanding, and their technical and value potential is still largely unrealised. Naturally, this leads to a vibrant innovation environment for these technologies” [21].

Among them, *energy storage technologies* are crucial for maintaining a high level of energy storage performance when systems are not in use. Indeed, new energy storage systems have started to be used by people in many sectors. Grid energy storage systems are needed to maximise the introduction of energy efficiency. The electrochemical energy storage system, known as the battery system, has enormous potential for grid energy storage. Energy storage methods can be used in various applications. Energy storage systems are grouped into five main categories: *mechanical, thermal, chemical, electrochemical and electrical energy storage*.

5. Future Trends

From this initial discussion, we can see how the terms of the issues related to production from renewable sources and the use of production technologies change, which, precisely because of their ability to respond "to changes in energy demand" (of other resource flows in general), must be much more open and responsive. Moreover, technologies as devices make all the parameters we have discussed, 'equipment' for production, exchange but also monitoring the efficiency and effectiveness of networks. The availability of processes and products from emerging technologies (sensors, virtuality, etc.), support this new dimension of control and operation, according to targets and performance levels dictated by the global and local demand for climate and hence carbon neutrality [22]. Also among the main aims of CERs is to establish new social innovation enterprises, in which citizens and small groups of producers, structures and knowledge centers participate, mediating and accelerating processes of participation and technology transfer. The sharing of the process and results of these activities transforms energy communities into "communities of place", where citizens can enjoy the co-benefits of their participation, and into "communities of interest", capable of sharing visions that go beyond the benefits themselves and that promote local development [23], also Distribution Technologies: from the cluster to the hybrid building through co-design and co-management practices of processes, projects and programs [2] [24].

Some considerations on future research scenarios can be made regarding the two outputs of the adopted methodology:

- a) The methodology proves useful in understanding the progress of achieving the Sustainable Development Goals (SDG 7 and related) in order to understand the substantial contribution, including through technology push, of Renewable Energy Communities at the building and cluster scale (see output 1 of the methodology). In fact, each of the SDGs is inherently interconnected, forming a cohesive and interrelated set of global priorities and objectives. Recognizing the diverse spectrum of both favorable and unfavorable interactions between these SDGs is essential to fully harnessing their potential on a global scale. It ensures that advancements in certain areas do not come at the detriment of progress in other domains;
- b) the methodology, in monitoring and verifying the traceability of sustainable development goals and the contribution of technologies in achieving carbon neutrality objectives, can provide interesting benchmarks to guide and prioritise integrated territorial investments for the creation of energy communities (RRF, Horizon Europe, etc.). The dynamics of these interactions, including their nature, strengths, and potential impacts, heavily rely on the specific context in which they are applied. The chosen policy options and strategies pursued play a critical role in shaping the outcomes and implications of these interactions. The underlying idea of this approach is that an analysis of interactions between various Sustainable Development Goal domains, informed by science, can greatly enhance decision-making effectiveness and ensure more coherent outcomes, as well as facilitate follow-up and monitoring of progress, which is currently lacking in the current practice.

Recognizing both potential trade-offs and synergistic relationships between different SDGs is of utmost importance in accomplishing lasting sustainable development results. The scoring methodology introduced here aims to foster a deeper science-policy dialogue regarding the significance of such interactions. It serves as a starting point for policymakers, stakeholders and researchers to establish their priorities and implementation strategies in public funds and policy-oriented projects (NRRP, Horizon Europe, ORP 2021-2027, RePower EU, Metro ONP). Furthermore, it encourages the engagement of the policy community in advancing knowledge in this field through continuous development and exploration. The impact of this methodology can certainly help guide action trajectories, which involve communities in decision-making and technology transfer processes, as illustrated in the case of feasibility studies for the start-up of the Living Lab in Bova, as a physical-digital space capable of triggering local development actions, which also leverage

sustainable development objectives and the need/objective of mitigating energy poverty and climate neutrality.

6. Acknowledgement

This contribution is partially supported by the ONP research project "Research and Innovation" 2014-2020, Action IV.6 "Research contracts on green issues", cod. G05, CUP C35F21001290002 and the research project Tech4You - PP 4.7.1 Open platform "phigital space" of the type "user profiling" for the advanced and dynamic codesign of interventions on the built and ex novo – Competitive academic research NGEU, MUR, PNRR - Spoke 4: Unibas, Unical, Unirc, CNR (2022-in progress), with the Scientific Responsibility of Consuelo Nava (dArTe UniRC).

Consuelo Nava is the author of the paragraph 'Introduction'. Giuseppe Mangano is author of the paragraphs "Literature Review" and "Materials and methods". C.Nava and G.Mangano are co-authors of the paragraphs "Results and Discussion" and "Future Trends".

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e ISBN 978-967-26554-1-1

