TeMA

Journal of
Land Use, Mobility and Environment

print ISSN 1970-9889 e-ISSN 1970-9870
FedOA press - University of Naples Federico II

DOAJ
Rivista scientifica di classe A - 08/F1
Scopus
WEB OF SCIENCE

NEW CHALLENGES FOR XXI CENTURY CITIES

Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

Vol.18 n.2
August 2025

TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2025 volume of TeMA Journal propose articles that deal with the effects of Global warming, reduction of energy consumption, immigration flows, optimization of land use, analysis and evaluation of civil protection plans in areas especially vulnerable to natural disasters and multilevel governance approach to adaptation.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. The articles are included in main scientific database as Scopus (from 2023), Web of Science (from 2015) and the Directory of Open Access Journals (DOAJ). It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

TeMA

Journal of
Land Use, Mobility and Environment

NEW CHALLENGES FOR XXI CENTURY CITIES:

Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

2 (2025)

Published by
Laboratory of Land Use, Mobility and Environment
DICEA - Department of Civil, Building and Environmental Engineering
University of Naples Federico II, Italy

TeMA is realized by CAB - Center for Libraries at University of Naples Federico II using Open Journal System

Editor-in-Chief: Rocco Papa
print ISSN 1970-9889 | online ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n°6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use, Mobility and Environment
DICEA - Department of Civil, Building and Environmental Engineering
University of Naples Federico II
Piazzale Tecchio, 80
80125 Naples (Italy)

https://serena.sharepress.it/index.php/tema
e-mail: redazione.tema@unina.it

The cover image was created using an AI tool, taking into account the thematic content of the articles included in this issue.

TeMA - Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

With ANVUR resolution of April 2020, TeMA Journal and the articles published from 2016 are included in A category of scientific journals. The articles published on TeMA are included in main international scientific database as Scopus (from 2023), Web of Science (from 2015) and the *Directory of Open Access Journals* (DOAJ). TeMA Journal has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe). TeMA is published under a Creative Commons Attribution 4.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA

Journal of
Land Use, Mobility and Environment

NEW CHALLENGES FOR XXI CENTURY CITIES:
Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

2 (2025)

Contents

REVIEW NOTES

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 2 (2025) 203-218
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6093/1970-9870/11145
Received 5th September 2024, Accepted 23rd June 2025, Available online 31st August 2025

The role of renewable energies in landscape transformation. Methodological proposal and application to the Valdagno case study

Elena Mazzola

Department of Civil, Architectural and Environmental
Engineering (DICEA)
University of Padua, 35131 Padova, Italy
e-mail: elena.mazzola@unipd.it
ORCID: https://orcid.org/0000-0002-1433-8630

Abstract

Energy has consistently exerted a profound impact on the landscape and human settlements, and it continues to serve as a pivotal force in the formation of our environment. The current era is characterised by an energy transition, driven by an increasing necessity to transition from fossil fuels to renewable energy sources. In evaluating the adoption of these new energy sources in a specific area, it is essential to consider not only the technical aspects but also the landscape and social factors. This paper examines the significance of harmonising energy requirements with landscape conservation, emphasising the imperative for strategic and methodological approaches to integrating renewable energies into landscape and social contexts. The main renewable energy sources are reviewed, their impacts analyzed, and recommendations for better integration into the context are identified. The objective is to propose an analytical methodology that ensures a balance between energy efficiency and landscape conservation, thereby fostering careful design and conscious integration in order to minimise visual and environmental impacts while contributing to energy sustainability. The methodology is then applied to the case study of the Municipality of Valdagno in Italy.

Keywords

Renewable sources; Landscape; Valdagno

How to cite item in APA format

Mazzola, E. (2024). Energy transformations while respecting the landscape. Methodological proposal and application to the Valdagno case study. *TeMA - Journal of Land Use, Mobility and Environment*, *18* (2), 203-218. https://doi.org/10.6093/1970-9870/11145

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) and the subsequent Kyoto Protocol, adopted in 1997, marked the beginning of a shift in global awareness towards the urgent need to address climate change. This has led to the development of national and supranational energy policies, which have become a central aspect of strategies to tackle this global challenge. These policies are officially guided by a number of objectives, including security of energy supply, environmental concerns, the development of export technologies, and rural development. This has resulted in a significant increase in the use of renewable energy, with state support in most developed and many developing countries (Nadai & van der Horst, 2010). This new policy responds to our continuous dependence on electricity and its continuous increase in demand, which has led to a deterioration in the environment, increasing global warming, the production of radioactive waste, deforestation, and so on. The initial focus was on the development of more efficient technologies that could be used in conjunction with fossil fuels, rather than on a complete transition to renewable energies (Pasqualetti, 2011).

In his book (Brown, 2015), Lester Brown advocates for the "solar revolution" through the use of photovoltaics and solar thermal energy, presents the "wind age" with wind power, and discusses the potential for harnessing the Earth's heat with geothermal energy. These arguments highlight the growing recognition of the necessity for renewable energy sources (Schiermeier et al., 2008; Balletto et al., 2023). On a global scale, the proportion of electricity generated from renewable sources reached and exceeded 30% this year, largely due to an increase in solar and wind power (Wiatros-Motyka et al., 2024). At the European level, the figure is in excess of 40%, with prospects for continued improvement as electricity production becomes increasingly environmentally friendly on an annual basis. The objective is to achieve climate neutrality by 2050 (Consiglio dell'Unione europea, 2024).

The potential benefits of utilising renewable energy sources in lieu of fossil fuels include a reduction in external energy dependency, local availability, sustainability with low or no emissions, and a diminished environmental impact for electricity production and processing. Additionally, renewable energy sources do not require cooling water, which is a significant advantage over nuclear power. Furthermore, the deployment of renewable energy sources can stimulate local or regional manufacturing industries, promote regional engineering and consulting services specialising in the use of renewables, and boost research and development. This can, in turn, lead to an increase in the level of services available to rural populations, the creation of jobs, and other economic benefits (Miguez et al., 2006; Hepbasli, 2008).

Conversely, the advent of these novel sources can give rise to a number of challenges, such as:

- Technical, pertaining to temporal and spatial variability, which, in contrast to fossil sources, introduce complexity into the energy system and raise questions about the stability of an energy network. The presence or absence of sunny days, constant wind or water, for example, complicates the need for continuous energy production. Evidence of this can be observed in the production graphs of renewable energy plants, which demonstrate significant variations even within the same day. This necessitates the implementation of effective balancing mechanisms and meticulous planning strategies that take into account the spatial and temporal dynamics of each energy carrier, specifically the alignment between the sources' production capabilities and the prevailing demand. A preliminary, albeit restricted, practical response to this issue is underway, manifesting in the implementation of novel demand-response mechanisms. These mechanisms adapt energy consumption patterns in accordance with the fluctuations in supply, with the objective of optimising energy utilisation and mitigating peak loads (Guida, 2023). A notable illustration of this approach is evidenced in the utilisation of such systems within renewable energy communities (RECs), which are founded on the principle of maximising the utilisation and sharing of energy produced within the community itself. A similar approach is employed by Positive Energy

Districts (PEDs), wherein the primary objective is to achieve a net energy surplus within the district beyond the level of internal consumption (Gaglione, 2023; Volpatti et al., 2024);

- Territorial, with a low density due to both geographic variations and energy supply and demand (Blaschke et al., 2013); additionally, they typically have a considerably lower production capacity per unit area than fossil fuel plants, necessitating significantly larger spaces (Magoni, 2013);
- Landscape, with the increasing debate over the placement of renewable energy facilities in visually sensitive landscapes. Such areas may be of significant national importance due to their qualities, as exemplified by national parks. Alternatively, they may be of local importance, generating resistance to significant changes to their character, such as rural or historical environments in close proximity to human settlements. Furthermore, the accelerated pace of energy development presents an unprecedented potential for environmental change (Apostol et al., 2017).

The latter issue is linked to the concept of landscape, which does not simply refer to the contest, but to the world as perceived by people. This perception creates connections between people, between people and places, and between society and its environment (Forman, 1995; Naveh, 2000). The importance of local identity, collective perception and historical memory in relation to the landscape underscores the fact that it is also a reflection of everyday practices and the emotional bond that people form with their territory. The concept of landscape is not static; rather, it is a dynamic and evolving phenomenon that is shaped by a multitude of factors, including technological, economic, cultural, and social developments (Romani, 1994).

At the European and Italian levels, the concept of landscape is defined in the Treaty of the European Landscape Convention, held in Florence in 2000, and adopted as law in Italy in 2006. In this document, landscape is defined as a certain part of the territory, as perceived by populations, whose character derives from the action of natural and human factors and their interrelationships (Council of Europe Landscape Convention, 2000). Landscape is a powerful, diverse and dynamic cultural heritage, a resource for humanity. It is an integral part of our culture, comparable to other forms of cultural expression such as literature, art and language. If the environment is the inevitable physical aspect of our existence, then the landscape, whether urban or rural, provides the concept of 'place' that is linked to community. Furthermore, it has the capacity to transform perceptions of the world through psychological boundaries, lifestyles and identities (Blaschke et al., 2013).

Energy has the potential to influence the landscape in a number of ways. Firstly, it can be observed directly through the presence of artefacts, installations and related activities. Secondly, it can be perceived indirectly through the characteristics of human settlements, which in cold climates are characterised by compact and enclosed buildings, while in warmer territories they are more open to the elements. Thirdly, energy can be considered as an inherent component of the landscape, whether embedded in the construction of artefacts or in the natural environment itself (Magoni, 2013).

The preservation of landscape resources with respect to new renewables may present a number of challenges, including:

- The potential impact of large-scale energy production systems (e.g. wind or concentrated solar power systems) on the landscape;
- The risk of damaging the visual quality of the seascape near the coast, where the lack of topography, vegetation or other mitigating visual factors could result in significant negative effects on the landscape;
- The dynamic visual qualities of renewable energy. The rotation of the blades, the switching on and off of lights, the movement of wave buoys, and the changing intensity and direction of solar glare as the sun crosses the sky all present challenges to the conventional approaches to visualising and measuring impacts, including technology simulation;
- The lack of meaningful mitigation measures, which are sometimes very complex or expensive to implement;

- The difficulty of finding relevant energy’s landscape perception studies, such as visual preference assessment surveys and the extent to which people judge renewable energy through, instead, their energy policy biases (clean = good, global warming = hoax);
- The absence of an integrated policy framework;
- The visual impact of the night sky, such as that caused by wind turbines and solar towers, must be considered. These structures are often lit day and night to assist pilots in avoiding potential collisions. The prevalence of dark, starry skies in remote locations, including deserts and previously undeveloped grasslands, is at risk of being compromised by the proliferation of thousands of flashing lights that can be seen from afar. This represents a novel challenge in the field of scenic resource management, with the assessment of impacts on night skies representing a particularly difficult task (Apostol et al., 2017).

In addition, the issue of landscape is, above all, a social issue. Indeed, the utilisation of renewable energy sources serves to illustrate that our energy is derived from a specific source, thereby raising awareness of the impacts and consequences of our energy demand. This, in turn, gives rise to a recomposition of the socio-technical links between landscape and energy. However, it also gives rise to various protests against their application, as people expect 'permanence' in their landscapes. This belief has developed in conjunction with an understanding of the slow workings of nature since the time of the first humans. As a consequence of the increasing distance between humans and the environment, the advent of technology and the development of urban living, there has been a growing insulation from the direct environmental costs of energy. This has led to a corresponding reduction in awareness and tolerance of the encroachment of energy development on personal space. Indeed, on a perceptual level, the less overt the technological landscape, the more likely it is to be appreciated by the general public (Thayer, 1993). It would appear that the general public is in favour of not being aware of the sources of the energy they use, thereby avoiding any sense of responsibility for the source of their energy. This perception is abruptly challenged when there is a sudden and fundamental change in the landscape (Pasqualetti, 2011).

In light of the energy challenges that we are currently facing and will continue to face in the future, it is imperative that we reassess the concept of the energy landscape. This is also necessary because the landscape cannot be preserved in its current state, regardless of whether or not it is transformed by renewables. Indeed, if the demand for electricity is not curtailed, and if climate change is not adequately addressed, even remote wilderness areas will be transformed into unrecognisable environments. Many forests will be stressed due to plant diseases that will spread, and fires will increase in size and intensity. Additionally, glaciers will continue to shrink, and rivers may dry up. Indeed, failure to pursue this energy revolution could result in one or more of the following scenarios: a greater reliance on nuclear energy, increased use of "clean coal," a more rapid growth in greenhouse gas emissions, greater dependence on imported energy, greater pressure for mandatory restrictions on consumption, and/or a more significant shift towards environmentally burdensome resources such as oil shale and tar sands (Pasqualetti & Schwartz, 2011).

In order to surmount the technical, territorial and landscape difficulties associated with the introduction of renewable energy sources, which have just been outlined and are usually assessed individually in the literature, it is therefore necessary to prepare an interdisciplinary model of integrated analysis to be made available to the decision-maker or planner. This model will allow the advantages and disadvantages of the technology to be correlated and assessed. To this end, this contribution examines the intimate connection between landscape and energy, tracing its evolution and examining the various renewable energy sources currently in use. Subsequently, the points that require attention for more effective integration of these new sources within each landscape context are identified, and a territorial analysis methodology is proposed for assessing both the technical issues and the landscape, spatial, social, geographical and historical aspects of energy. The objective of this analysis is to propose a methodology that could be adopted by public administrations or technicians when dealing with the installation of large-scale renewable energy sources. This methodology would guarantee a balance between the energy transition that is now necessary and the preservation of the landscape, favouring an integrated design. In conclusion, the case study of the Municipality of Valdagno is presented, together with an evaluation of the strengths and potential improvements to its urban and energy plans, in accordance with the methodology previously outlined.

1.2 The interconnection between the landscape and energy

Energy has consistently influenced the configuration of our landscape. The historical trajectory of human settlement appears to be shaped by the dynamic interplay between energy demand and the fluctuating availability of energy sources. In the early stages of European history, wood was the primary fuel source, resulting in immediate and localised environmental consequences. Pollution from the burning of wood enveloped cities, and the forests that once defined landscapes were cut down at a faster rate than they could be replenished, leading to the replacement of forests with grasslands. As ever more extensive areas of forest were felled, the urgency of identifying alternative fuels intensified.

This resulted in a shift towards coal, which gave rise to significant alterations in the spatial configuration of energy impacts. There was a transition from a relatively uniform and dispersed utilisation of wood to a concentrated and intensified use of coal, which was employed in a limited number of locations.

This constituted a shift from a centuries-old pattern, resulting from the transition from low-value and widely available resources such as wood to a more spatially concentrated resource like coal. A further shift occurred with the advent of oil in the early decades of the 20th century, which was more readily and economically transported over longer distances. In the final third of the 20th century, uranium became a significant source of electricity generation. However, declining reserves and the emergence of hitherto unidentified and insidious risks prompted a decline in interest in this form of energy production. In the present era, with population growth and the transition to renewable energy sources, the discrepancies between supply and demand are once again diminishing. Additionally, a novel phenomenon is emerging: while the consequences of coal, such as air pollution and mercury deposition, are often imperceptible and confined to specific regions, those of renewable energy are conspicuous and localised, reminiscent of the impacts of wood utilisation in the past. From a spatial perspective, we are witnessing a clear return to historical practices.

In general, energy is not a directly visible element. However, it is capable of generating visible structures in the territory due to the ways in which it is produced (Pasqualetti, 2011) The various energy infrastructures are material and visible elements within the space. However, since the landscape is the set of technical, cultural, economic, social and political elements that have given rise to a given morphology of the territory, they also generate immaterial and not directly observable elements. This is in addition to the numerous 'physical' factors that contribute to the determination of the landscape's energy needs and consumption, including the shape and size, the density and dispersion of residents, climatic conditions, the type of building, and the way these factors are managed. Indeed, it has been demonstrated that urban density, building orientation, and the finishing materials of facades and ground surfaces can enhance solar energy production (Lobaccaro et al., 2017).

It can thus be proposed that if each morphological element is in fact associated with a set of invisible, relational elements, which are expressed by the term 'territoriality', then the energy landscape can also be defined as a set of visible morphological elements and invisible relations. These relations are intangible and not directly perceivable, yet they produce the landscape.

A detailed examination of the development of renewable energy sources from a landscape perspective reveals the following impacts:

- Geothermal energy: this source has a significant landscape impact, as it must be developed close to the resource, regardless of topography or land use. Every stage of the process, from exploration to the drilling of wells (which can lead to the emission of unpleasant odours), from construction to the operation of the power plant and the re-injection of fluids, takes place at the site where the resource is available. At each stage, the activity must adapt to the existing landscape, whether flat or mountainous. Furthermore, geothermal resources have a lower energy density than other fuels, which means that larger areas must be disturbed to produce equivalent amounts of electricity. Taken together, these characteristics result in a relatively large, unavoidable and permanent landscape footprint;

- Wind turbines: the visual impact of turbines is evident due to their physical presence, warning lights and the movement of the blades (Fistola et al., 2023). Such structures have the potential to generate noise and pose a threat to avifauna. However, from an environmental standpoint, they require no cooling water, produce no emissions, are easily assembled and disassembled, and can be rapidly installed in a multitude of locations. Despite the numerous advantages and growing popularity of wind energy, it continues to encounter social difficulties. These difficulties can be divided into two main categories: general barriers, such as the obvious and unavoidable presence of turbines in the landscape, and site-specific barriers. The latter vary according to local natural and cultural sensitivities, but the greatest concern remains the visual disruption that turbines create in the landscape (Pasqualetti et al., 2002);
- Solar: the installation of these plants can alter both the natural and man-made environment. In the former case, the utilisation of extensive land for energy production represents a significant concern, with the potential for adverse impacts on local fauna and flora. Nevertheless, this technology is lauded for its capacity to furnish clean and limitless energy, with no greenhouse gas emissions or long-term waste production, no necessity for cooling water and no noise;
- Hydroelectricity: this is one of the oldest and most widespread renewable sources globally, although production has declined in recent years due to major droughts (International Energy Agency - IEA, 2023). This source has a minimal environmental impact and high efficiency and can also be employed as a storage system for photovoltaic energy production through pumped storage plants. From a landscape perspective, the incorporation of hydropower infrastructure can both alter and intensify existing landscape features, thereby revealing their original character (Selvafolta, 1998). This process can also create new scenarios. However, the process of landscape and hydroelectric infrastructure heritability, to which new cultural values are attributed, should also be considered, as evidenced by the increasing tourist flow (Fontana, 1998);
- Biomass: this source requires a considerable amount of space for energy production. However, it is capable of functioning in environments where other renewable sources are less effective due to its resilience to the topography of the land (the presence or absence of shade or low solar factors) and weather conditions (the presence of wind or sun). However, in contrast to other renewable energy sources, the combustion of biomass releases gases and dust into the atmosphere, contributing to the pollution of the environment.

A synopsis of the aforementioned information can be found in Tab.1, which permits a comparison of the assorted renewable energy sources in relation to the disparate issues discussed. The diagram enables a comparison of the specific advantages, disadvantages and impacts of each energy source.

Preserving the landscape does not imply opposing renewable energy or hindering its development by exaggerating its visual impact. Conversely, it is foundamental:

- Optimise technologies to enhance their efficiency, potency, aerodynamics, minimalism, security and dependability;
- Evaluate energy integration in landscapes in order to gain insight into the interrelationship between energy and its sources with the territory. This can be achieved by conducting research on existing themes that link energy and landscape, as well as through an analysis of the symbolic perception of installed technologies;

- Identify and protect the most significant landscapes, taking into account not only their boundaries but also the areas of visibility or visual influence. In essence, it is of paramount importance to determine suitable and unsuitable locations for renewable energy development, promoting construction only in suitable areas and utilising design and mitigation measures to reduce visual impacts wherever facilities are located;
- Reduce visual impact by designing them in a way that better integrates them with their surroundings. This can be achieved by limiting the number of installations in a given area or by adapting aesthetic expectations to accommodate renewable energy as a new cultural feature (Selman, 2010; Sheppard, 2012);
- Integrate systems into individual landscapes with due consideration of the relevant factors, including scale, design symmetry, road construction, site preparation and equipment maintenance (Nielsen, 1996);
- Raise awareness of the impact of modern conveniences and lifestyles, making them aware of the associated costs, which should not be hidden or ignored. Social barriers, which are often underestimated, can impede or even obstruct the implementation of projects (Pasqualetti, 2011);
- Develop non-standardised plans, adapted to the local specificities of the energy transition, and that the needs and social conflicts encountered be taken into account (Koelman et al., 2018).

Source	Efficiency	Continuity	Clean Energy	Landscape	Other elements
Geothermal	10-20%			need for large areas	need proximity between producer and consumer
Wind	35%	depends on the winds		evident landscape change	noise and danger to birds
Solar	15-30%	depends on the sun		especially for possible developments on land	
Hydroelectric	70-90%	depends on the flow and availability of water		creation of new landscapes	usable as a photovoltaic battery
Biomass	20-35%		gas and dust emissions	need for large areas	

Tab.1 schematisation of technical and landscape information related to renewable energy sources. The efficiency was derived from the literature (Blaschke et al., 2013)

2. Methodological proposal

In order to address the spatial, social, geographical and historical aspects of energy in a balanced and integrated manner, it is necessary to identify a tool that can assess these elements jointly (Castiglioni et al., 2015). The objective of this tool is to explore the spatial dimension of energy, thereby making it visible and aware of its fundamental role for the city and the territory. Furthermore, in light of the multitude of conflicts that define the contemporary energy transition, it is imperative that spatial and landscape awareness be promoted in energy policies, thereby rendering them more effective and inclusive, and compelling them to consider spatial, temporal, and social aspects that are frequently overlooked (Nadai & van der Horst, 2010).

In order to achieve this objective, Nadai and van der Horst (Nadai & van der Horst, 2010) put forth two parallel lines of research: a reading of energy through the landscape, with the aim of making energy projects more sensitive to the needs of the landscape itself; and a reading of the landscape through energy, with the goal of understanding the relationship between energy and the landscape. This approach enables the landscape to "speak", elucidating how interactions with energy have influenced its evolution over time. It also emphasises the ways in which the relationship between society and energy has manifested itself even in apparently unrelated elements, such as the shape of settlements, agricultural structures, agronomic dynamics, road or tourist infrastructures and vegetative dynamics. From a social perspective, this novel approach to planning can facilitate discourse on the future of the territory and act as a conduit between society and the energy transition, addressing the intricate challenges it presents. In this context, the term 'landscape' should be understood not merely as a means of simplifying technical knowledge, but rather as a key element in the reinvention of the territory. This transformation should be such that the landscape is no longer perceived as a mere obstacle to the energy transition, but rather as a tool to facilitate the democratic territorialisation of the territory in question (Castiglioni et al., 2015). It is therefore imperative to consider both the technical aspects and the perception of risk, interference with established lifestyles, altered landscapes and the potential violation of new projects on the local sense of fairness and injustice. In this context, it is necessary to re-evaluate project evaluation processes, with a particular focus on social considerations and the integration of social factors. Early and thorough engagement in understanding the human landscape and the people involved is essential for them to perceive and receive significant benefits from proposed projects for the landscapes they value (Pasqualetti, 2011)

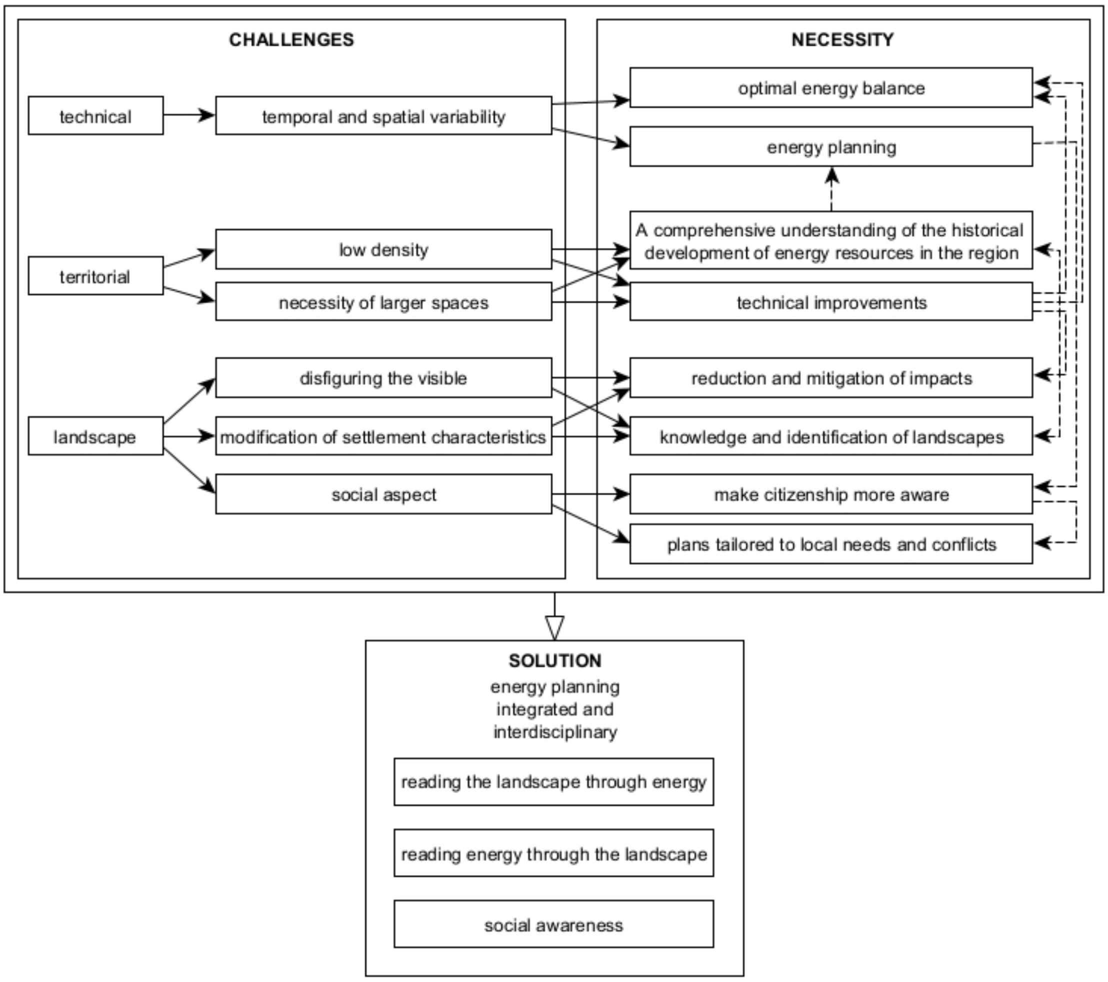

Fig.1 The proposed methodology, divided into potential disadvantages, identifying necessary requirements and suggesting solutions to address. The continuous arrows indicate direct relationships between the three themes, whereas the dashed arrows represent indirect and internal relationships between the needs alone

In terms of scale, the energy transition should be preceded by strategic spatial planning. While landscape transformations are primarily perceived at the local level, they reflect socio-spatial evolutions involving significantly larger spatial dimensions. This is exemplified by the typical relations between mountains and plains in the context of hydropower. Such transformations can thus also be analysed at a higher scale (Castiglioni et al., 2015).

In conclusion, a methodology is proposed (Fig.1) that aims to resolve, at least in part, the issue of the link between landscape and energy. This is to be achieved through the systematic integration of the aforementioned elements. Commencing with the enumeration of the various disadvantages associated with the utilisation of renewable energy sources, as outlined in the introduction, the technological, territorial and landscape requirements, as articulated in the preceding paragraph and derived from extant literature, are catalogued and correlated. These requirements can be addressed through integrated and interdisciplinary energy planning, which is not distinct from other plans, but becomes an integral and indispensable component of them. The proposed planning will be carried out through the following readings of landscape through energy, energy through landscape and social awareness, which have just been defined.

The limitations of this methodology are contingent upon the availability and quality of the documentation pertaining to the territorial analysis, both in terms of landscape and energy. In particular, the lack or incompleteness of tools such as Land Use Plans or updated Intervention Plans, which identify areas of special interest, can constitute a significant obstacle. Furthermore, the absence of a comprehensive energy balance or delineated actions within the Sustainable Energy (and Climate) Action Plan may impede the capacity to conduct a comprehensive and precise analysis.

Once the proposed method has been applied, it will be possible to obtain comprehensive energy and territorial considerations capable of assessing, for each specific territory, the relative merits and shortcomings associated with new installations of renewable sources. This approach will facilitate the integration of the gathered information with the technical, territorial and landscape issues encountered. In order to achieve this, the diagram in Fig.2 is proposed, which relates the technical information presented in the previous paragraph with the main drawbacks usually associated with each renewable source.

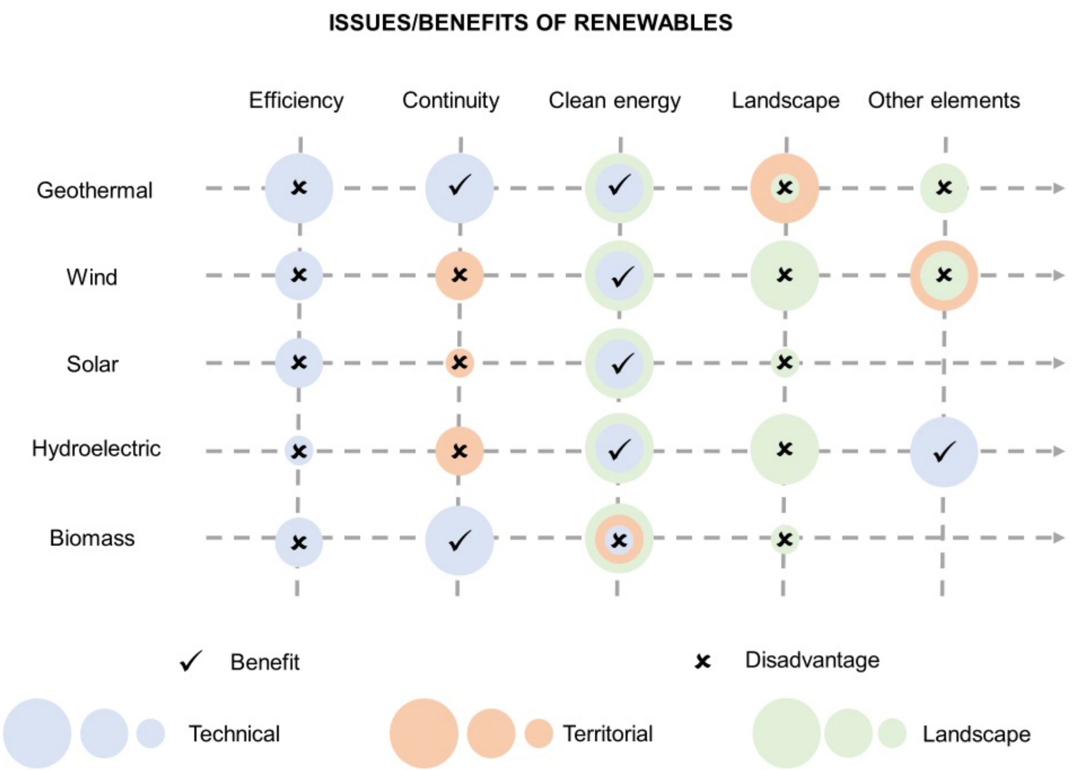

Fig.2 The system of technical and landscape information on renewable energy sources in Tab.1 in relation to the benefits (✓) or disadvantages (×) identified in the introduction. The technical aspects are indicated by blue circles, the territorial aspects by orange circles, and the landscape aspects by green circles. The dimensions of the coloured circles indicate the degree of significance of the disadvantage or benefit in question

The proposed methodology is employed for the analysis of the current situation in the Municipality of Valdagno, which serves as a case study in this paper. In this manner, it will be feasible to observe how the application of the method will result in the alteration of the relative merits and demerits of individual source technologies within a specified geographical area, thereby furnishing the decision-maker with a more comprehensive perspective on the potential transition scenarios. Indeed, this approach allows for a comprehensive examination of the municipality's particular energy and territorial characteristics, evaluating the impact of renewable energy installations and identifying potential solutions to reconcile energy needs with the preservation of the landscape and local social dynamics.

3. The Valdagno case study

The municipality of Valdagno, situated within the province of Vicenza, encompasses an area of approximately 50 km², exhibiting a considerable altimetrical variability. The altitude of the municipality ranges from 214 to 1,340 metres above sea level. The territory is encircled by a distinctive natural amphitheatre, delineated by the Lessini Mountains on one side and the Little Dolomites on the other. The principal settlement is situated in the valley, while the surrounding slopes and hillsides are home to a number of rural agglomerations with a predominantly agricultural character. The naturalistic context of Valdagno is characterised by a rich and diverse array of habitats, with woodlands occupying the pre-alpine belt and alternating with cultivable land and pastures in the hilly areas. The valley bottom is where human activity is most evident, due to the abundance of water resources in this area.

Valdagno represents a significant case study in urban planning, exemplifying the concept of a 'social city' in Italy, which was developed between the 19th and 20th centuries. The driving force behind this development was the Manifattura Lane Gaetano Marzotto & Figli, Italy's largest wool company, which had already become a leader in the sector by the 1930s. This was achieved through the exploitation of hydraulic power for textile production. The company was established in 1836 and rapidly established itself on the international market, distinguishing itself in the production of combed yarns and fabrics for men (Roverato, 1983). The area was selected for its proximity to waterways, which were crucial for both transport and production; the availability of local raw materials; and the presence of established manufacturing activities and expertise. The planner in charge was able to exert control over the urban scale, from the quality of public spaces to places for collective entertainment and recreation, to the updating of housing solutions in accordance with the hygienic and sanitary standards of the time (Del Monaco, 2016).

The current urban planning of the Municipality is comprised of three key elements: a Municipal Regulatory Plan (P.R.C.), articulated in an Inter-municipal Territorial Layout Plan (P.A.T.I.) developed in collaboration with the Municipality of Schio, and a Plan of Interventions (P.I.). Furthermore, in 2016, the municipality joined the Covenant of Mayors in collaboration with the municipalities of Brogliano, Castelgomberto, Cornedo Vicentino, Recoaro Terme and Trissino. This resulted in the formulation of a Sustainable Energy and Climate Action Plan (SECAP) at the valley level.

The data obtained from the diverse urban planning and energy tools can be subjected to analysis using the aforementioned methodology.

Indeed, as illustrated in Fig.1, the solution section provides a framework for subdividing the information on the use of renewable energy sources in the territory according to the three main themes of the reading of the landscape through the lens of energy, the reading of energy through the lens of the landscape, and social awareness.

In particular, Tab.2 illustrates the data of interest, organised according to the plan to which they refer, thus allowing for an integrated comparison between the landscape, energy and social aspects that characterise the municipal territory. This scheme enables the identification of areas of conflict or synergy, thereby facilitating more informed and conscious planning.

Reading the landscape through the lens of energy

The presence of landscape constraints, areas with VINCA applications, and other zones with potential exemption possibilities may restrict the installation of renewable energy sources.
The settlement structure is markedly shaped by the topography of the region, with a discernible delineation between the urban structure and the hamlets. The construction of the civil buildings was undertaken during the entrepreneurial period of the Marzotto family, with the design of the buildings (including their shape, layout and sun exposure) taking place in the 1930s. This included the school complex, the hospital (which has since been renovated), the music school, the recreational clubs and the theatre. In the period following the Second World War, further extensions of the city were undertaken, always in accordance with urban planning projects, with the objective of ensuring compactness and the containment of land use.
The area exhibits a pervasive influence of industrial culture, evident in the presence of early industrial sites, architectural heritage, and industrial archaeology. It thus becomes evident that a conjunction between policies aimed at the industrial sector and those related to education, research, urban quality and landscape is required, with the aim of achieving greater sustainability value.
The invariants of a landscape nature, with the identification of elements with specific and identifying characteristics that distinguish a place and that must be safeguarded. The areas of high value identified are the slope with Castelvecchio meadows and the riverine countryside of Maglio/Menovre.
The invariants of an environmental nature, with the identification of areas of particular ecosystem and biodiversity value to be protected and safeguarded. In particular, the Castiglieri high wooded slope and the Monte Scandolara high wooded slope are reported.
The invariants of a historical-monumental nature.
On a landscape level, the advancing woodland area with brambles, locust trees and hazels is presented as problematic. Historically, the forest was managed for timber and foliage, which were used as animal bedding. In contrast, the forest now exists as scrubland with tangled undergrowth.
POSSIBLE FUTURE DEVELOPMENTS
In regard to quarries, the objective of environmental protection is not the establishment of new sites, but rather the rehabilitation of existing ones. This approach extends beyond the conventional concept of restoration, encompassing the redevelopment and intensification of supervisory activities.
Gradual rehabilitation and valorisation of existing plants producing energy from renewable sources.
One potential avenue for further development is the unification of the territory with other municipalities to achieve economies of scale in the provision of utilities. Additionally, there is scope for experimentation with renewable energy sources, such as the RECs.
The promotion of projects with the objective of utilising renewable energy and energy efficiency.

Reading energy through the lens of landscape

There is considerable potential for the utilisation of both fermentable biomass, derived from livestock manure and FORSU, and ligno-cellulosic biomass, derived from agricultural waste and forest wood.
The municipality exhibits a relatively low level of producibility in comparison to its windiness.
A total of six hydroelectric power stations are present, with a collective nominal power of 6.8 MW. In addition to their function as energy production facilities, these are regarded as landmarks for tourist itineraries.
The production of photovoltaics in this region is below the provincial and regional average. Specifically, it is 0.114 kWp/inhabitant, compared to 0.275 in the Province of Vicenza and 0.330 in the Veneto Region.
POSSIBLE FUTURE DEVELOPMENTS
Provide for the regeneration of the historical heritage through reuse and redevelopment, with a view to enhancing energy and climate performance.
Blighted areas have been identified, with the objective of improving their energy performance and saving energy resources, among other things.
Installation of new photovoltaic systems on public buildings and promote this also in the private residential and tertiary sector (expected percentage change of 31% between the years 2013 and 2030).

Social awareness

The establishment of the 'Punto Risparmio Energetico' (Energy Saving Point) desk at Confartigianato Vicenza as a forum for discussion and consultation on energy-saving interventions and incentives with professionals.
POSSIBLE FUTURE DEVELOPMENTS
Encourage quality building through courses and the dissemination of meaningful project experiences.

Promoting the restoration and use of hydroelectric power stations.
Drawing up a "Valley" energy balance oriented towards a carbon-free policy.
Promoting an Energy City project for the improvement of energy efficiency and the coordination of different individual interventions.
Provide information and awareness campaigns for the installation of photovoltaic systems.

Tab.2 Information gathered from the various urban and energy plans prepared and published by the Municipality of Valdagno. In particular, the data available in the P.A.T.I. (Comune di Valdagno, 2016) are indicated in light blue, those in the P.I. (Comune di Valdagno, 2019) in pink and those in the P.A.E.S.C. (AzzeroCO2 S.r.l. et al., 2016) in green

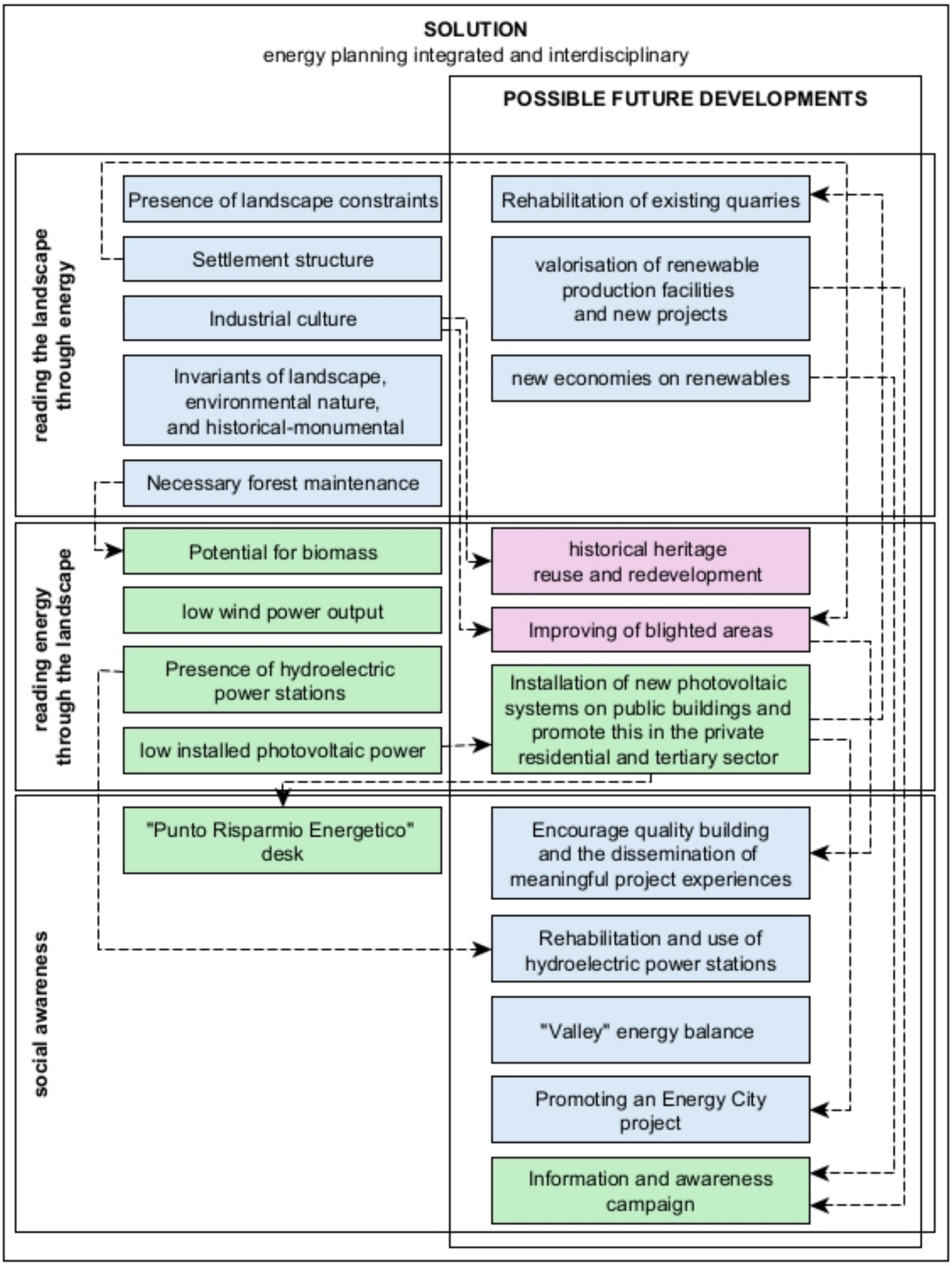

Fig.3 Diagram of the methodology proposed above applied to the case study of the Municipality of Valdagno. The information available in the P.A.T.I. (in light blue), in the P.I. (in pink) and in the P.A.E.S.C. (in green) is shown in the same colours as in the previous tables. The use of dotted arrows indicates the presence of identified relationships

In particular, a number of significant observations emerge with regard to the municipality of Valdagno. Biomass, for instance, represents not only a useful renewable source, but also has the potential to actively contribute to the maintenance of the local landscape. In contrast, hydropower has a longstanding presence in the region, constituting a pivotal element of its energy identity. Furthermore, areas that have undergone degradation have been identified as requiring redevelopment, including in terms of energy. Awareness and information initiatives targeting the community on these issues have already been planned.
In consideration of the methodology previously outlined, it is observed that the urban planning instruments adopted by the municipality are significantly interrelated, despite often being presented and evaluated in isolation. This reinforces the notion that energy is inextricably linked to the built environment and the local landscape heritage. The aforementioned synergies are illustrated in Fig.3, in which the last point of the methodology concerning the 'solution' to the energy and landscape problem, dropped on the case study, is presented again.
The information gathered allows for the reformulation of the system proposed in Fig.2, with the aim of adapting it specifically to the Valdagno case study. As illustrated in Fig.4, the benefits and disadvantages associated with different renewable sources are contingent upon the local context. For example, hydropower, which is already integrated into the territory, will result in minimal landscape disadvantages. Similarly, the use of biomass may be perceived less as a social or territorial problem, offering the advantage of contributing to the maintenance of forests, a distinctive element of Valdagno's landscape.

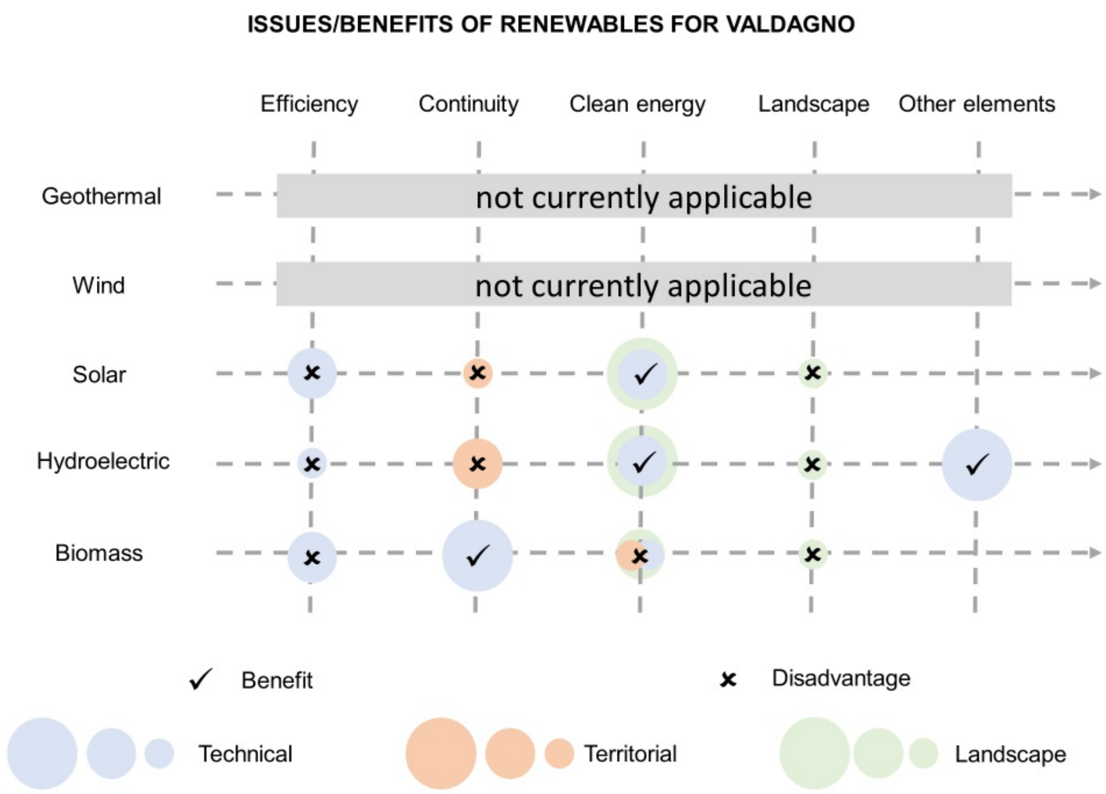

Fig.4 The system of technical and landscape information on renewable energy sources in relation to the benefits (✓) or disadvantages (×) identified for the case study of Valdagno. The technical aspects are indicated by blue circles, the territorial aspects by orange circles, and the landscape aspects by green circles. The dimensions of the coloured circles indicate the degree of significance of the disadvantage or benefit in question

4. Conclusion

If future energy systems are to be characterised by three fundamental qualities - low energy consumption, achieved through the adoption of highly efficient technologies, low carbon emissions, made possible by the phasing out of fossil fuels in favour of renewable energies, and short transport distances, through localised energy production (Schleicher, 2010) - it becomes essential to assess how these transformations will affect the landscape during the current energy transition. This paper examines the historical evolution of the landscape in relation to changes in energy sources and analyses the specific challenges related to the integration of renewable energy sources. In conclusion, a methodology for analysis is proposed that is not limited to technical aspects, such as the assessment of the producibility of specific technologies in a given area or their impact on urban energy budgets, nor to isolated landscape or social considerations. Instead, an integrated approach is proposed that considers both aspects simultaneously, thus enabling the development of balanced and viable solutions. The rationale behind this methodology is that it is not possible to establish a priori which renewable energy source is the most suitable, but rather an interdisciplinary assessment in the context of the situation is necessary. Indeed, all the technologies presented, which are useful for the energy transition, denote problems and advantages that should always be evaluated. Consequently, it becomes evident that established considerations, which are commonly regarded as valid for any given situation and illustrated in Fig.2, may undergo variation when the method is employed in a particular context. For the Municipality of Valdagno, the case study of this contribution, hydroelectric and biomass energy are particularly salient due to their alignment with the local territorial, technical and landscape characteristics. While these results are qualitative in nature, they are derived from a meticulous social and territorial analysis of contemporary urban plans. It is hoped that such analyses will be addressed and materialised through projects and plans in future.

Potential future developments of the research could include:

- The application of the proposed methodology in other municipalities to facilitate a comparison of the quantity and quality of data reported in the different plans, or on a larger territorial scale, such as the Agno Valley, including the entire P.A.E.S.C. This would enable an assessment of the methodology's applicability in different contexts;
- The utilisation of GIS tools for the mapping of information collated from the various plans will facilitate the identification of novel areas conducive to the construction of renewable energy facilities. Furthermore, this approach will enhance the efficacy of information and awareness campaigns.

References

Apostol, D., Palmer, J., Pasqualetti, M., Smardon, R., & Sullivan, R. (2017). The renewable energy landscape. Preserving scenic values in our sustainable future (D. Apostol, J. Palmer, M. Pasqualetti, R. Smardon, & R. Sullivan, Eds.). Routledge.

Balletto, G., Sinatra, M., Milesi, A., Ghiani, E., Borruso, G., & Zullo, F. (2023). Spatial regional electricity intensity and equitable well-being to support just transition. *TeMA Journal of Land Use Mobility and Environment*, *16* (3), 609–624. http://dx.doi.org/10.6092/1970-9870/10289

Blaschke, T., Biberacher, M., Gadocha, S., & Schardinger, I. (2013). "Energy landscapes": Meeting energy demands andhuman aspirations. *Biomass and Bioenergy, 55*, 3–16. https://doi.org/10.1016/j.biombioe.2012.11.022

Brown, L. R. (2015). The Great Transition: Shifting from Fossil Fuels to Solar and Wind Energy. W. W. Norton & Company.

Castiglioni, B., Parascandolo, F., & Tanca, M. (2015). Landscape as mediator, landscape as commons. International perspectives on landscape research. Retrieved from: https://www.researchgate.net/publication/288823492

Consiglio dell'Unione europea. (2024). Come viene prodotta e venduta l'energia elettrica dell'UE? Retrieved from: Https://Www.Consilium.Europa.Eu/It/Infographics/How-Is-Eu-Electricity-Produced-and-Sold/#0.

Council of Europe Landscape Convention. (2000). The European Landscape Convention (Florence, 2000). Retrieved from: Https://Www.Coe.Int/En/Web/Landscape/the-European-Landscape-Convention.

Del Monaco, A. I. (2016). La città sociale italiana: la ricerca di un modello. Il Villaggio Leumann di Pietro Fenoglio, Valdagno di Francesco Bonfanti, Torviscosa di Giuseppe de Min, Pujiang di Vittorio Gregotti. L'architettura Delle Città. The Journal of the Scientific Society Ludovico Quaroni, 6, 149–169.

Fistola, R., Gaglione, F., & Zingariello, I. (2023). The small smart city: renewable energy sources in little town of Italy. *TeMA - Journal of Land Use, Mobility and Environment, 16* (1), 183–199. https://doi.org/10.6093/1970-9870/9850

Fontana, V. (1998). Tra il Veneto e il Friuli; l'architettura degli impianti idroelettrici. In *Paesaggi elettrici. Territori, architetture, culture*, 167–184. Marsilio.

Forman, R. T. T. (1995). Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press.

Gaglione, F. (2023). Policies and practices to transition towards Renewable Energy Communities in Positive Energy Districts. *TeMA - Journal of Land Use, Mobility and Environment*, *16* (2), 449–454. https://doi.org/10.6093/1970-9870/10054

Guida, C. (2023). City vs Energy consumptions: Energy Communities in Italy. *TeMA - Journal of Land Use, Mobility and Environment, 16* (2), 443–447. https://doi.org/10.6093/1970-9870/10040

Hepbasli, A. (2008). A key review on exergetic analysis and assessment of renewable energy resources for a sustainable future. Renewable and Sustainable Energy Reviews, 12(3), 593–661. https://doi.org/10.1016/j.rser.2006.10.001

International Energy Agency - IEA. (2023). Hydroelectricity. Retrieved from: Https://Www.Iea.Org/Energy-System/Renewables/Hydroelectricity.

Koelman, M., Hartmann, T., & Spit, T. (2018). Land Use Conflicts in the Energy Transition: Dutch Dilemmas*. TeMA - Journal of Land Use, Mobility and Environment*, *11* (3), 273–284. https://doi.org/https://doi.org/10.6092/1970-9870/5830

Lobaccaro, G., Carlucci, S., Croce, S., Paparella, R., & Finocchiaro, L. (2017). Boosting solar accessibility and potential of urban districts in the Nordic climate: A case study in Trondheim. *Solar Energy*, *149*, 347–369. https://doi.org/10.1016/j.solener.2017.04.015

Magoni, M. (2013). Energia e paesaggio al tempo dei cambiamenti climatici. Proceedings REAL CORP 2013 Tagungsband, 1169–1176. Retrived from: http://www.corp.at

Miguez, J., Lopezgonzalez, L., Sala, J., Porteiro, J., Granada, E., Moran, J., & Juarez, M. (2006). Review of compliance with EU-2010 targets on renewable energy in Galicia (Spain). *Renewable and Sustainable Energy Reviews*, *10* (3), 225–247. https://doi.org/10.1016/j.rser.2004.09.009

Nadai, A., & van der Horst, D. (2010). Introduction: Landscapes of energies. *Landscape Research, 35* (2), 143–155. https://doi.org/10.1080/01426390903557543

Naveh, Z. (2000). What is holistic landscape ecology? A conceptual introduction. *Landscape and Urban Planning*, *50* (1–3), 7–26. https://doi.org/10.1016/S0169-2046(00)00077-3

Nielsen, F. B. (1996). Wind Turbines & the Landscape: Architecture & Aesthetics.

Pasqualetti, M., Gipe, P., & Righter, R. (2002). Wind Energy in View: Landscapes of Power in a Crowded World.

Pasqualetti, M. J. (2011). Social barriers to renewable energy landscapes. *Geographical Review*, *101* (2), 201–223. https://doi.org/10.1111/j.1931-0846.2011.00087.x

Pasqualetti, M., & Schwartz, C. (2011). Siting Solar Power in Arizona: A Public Value Failure? *Renewable Energy and the Public: From NIMBY to Participation*, 167–185.

Romani, V. (1994). Il paesaggio. Teoria e pianificazione. Franco Angeli.

Roverato, G. (1983, April 1). Un archivio industriale: il caso della Marzotto. Rivista Di Storia Contemporanea, 266–275.

Schiermeier, Q., Tollefson, J., Scully, T., Witze, A., & Morton, O. (2008). Energy alternatives: Electricity without carbon. *Nature, 454* (7206), 816–823. https://doi.org/10.1038/454816a

Schleicher, S. P. (2010). Energy systems of the future. New perspectives for efficiency and renewables. *Forum Alpinum* 10, October 6th 2010, Munich, 39-42.

Selman, P. (2010). Learning to Love the Landscapes of Carbon-Neutrality. *Landscape Research*, *35*. https://doi.org/10.1080/01426390903560414

Sheppard, S. R. J. (2012). Visualizing Climate Change. A Guide to Visual Communication of Climate Change and Developing Local Solutions. Routledge. https://doi.org/10.4324/9781849776882

Thayer, R. L. (1993). Gray World, Green Heart: Technology, Nature, and the Sustainable Landscape - Hardcover. Wiley.

Volpatti, M., Mazzola, E., Bottero, M., & Bisello, A. (2024). Toward a certification protocol for Positive Energy Districts (PED). A methodological proposal. *TeMA - Journal of Land Use, Mobility and Environment*, *1*, 137-153. https://doi.org/10.6093/1970-9870/10301

Wiatros-Motyka, M., Fulghum, N., Jones, D., Altieri, K., Black, R., Broadbent, H., Bruce-Lockhart, C., Ewen, M., MacDonald, P., & Rangelova, K. (2024). *Global Electricity Review* 2024.

Image Sources

Figg.1 - 4: Authors' elaboration

Author’s profile

Elena Mazzola

She is currently a researcher in the University IUAV of Venice and an Assistant Professor in the faculty of Engineering in Padua (Italy). She obtained her PhD in Architecture, City and Design from Iuav of Venice University, published a number of papers in preferred journals, and presented various academic as well as research-based papers at national and international conferences. Her research activities are currently twofold: while the first research activity is set to explore the efficiency of buildings, the second major research theme is focused on the develop of sustainable urban cities.