Landscape and renewables: a possible coexistence

Opportunities and challenges for sustainable territorial development

Executive summary

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Landscape and renewables: a possible coexistence.

Opportunities and challenges for sustainable territorial development

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It is understood that responsibility for the content, assessments and arguments expressed lies solely with the Author.

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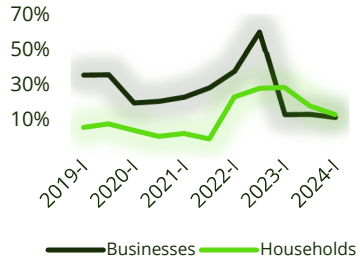
WHY THE TRANSITION

The energy transition benefits Italy and aligns with the country's territorial and productive vocations for several reasons.

Environment. Beyond reducing the carbon footprint of the electricity sector, shifting towards renewable energy sources (RES) allows for the generation of energy without local emissions. This decreases pollution related to fossil fuels used in thermal power plants, which are progressively reducing their production activities and being decommissioned. Using solar and wind energy also reduces the water footprint.

Competitiveness. In terms of electricity costs for consumers, Italy faces a significant gap from other European countries due to its gas-based generation mix. In recent years, the pandemic and conflicts have made its price particularly volatile, threatening the entire system. Renewables are today the most cost-effective sources for producing electricity and are an opportunity to reduce these expenses and improve the country's competitiveness, considering also the costs required for their integration into the electricity system, such as storage and grid infrastructure.

Italy vs. EU-27. How much more is spent on electricity?*



*Taxes and levies included

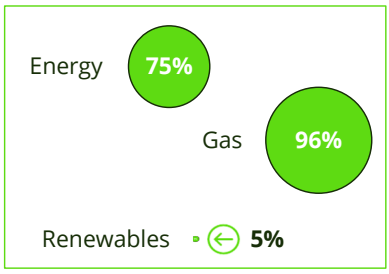
Source: elaborations on Eurostat

Energy security. Italy possesses few fossil energy resources. To meet its electricity needs, it has relied from the beginning on water with hydroelectric power and underground energies, exploited with geothermal energy. For both sectors, our industry has been considered pioneering globally.

After World War II, the growing demand for energy, driven by industrialization, was met by fossil fuels, including coal, oil and natural gas. This created a strong dependency on imports, which still disadvantages the country today.

Thanks to renewables, it is possible to reduce this dependency, allowing price stabilization and ensuring long-term supply.

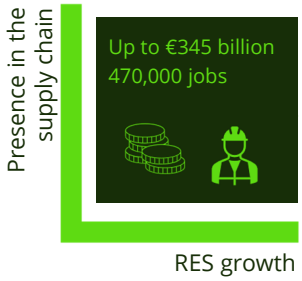
Italy. Dependence on foreign supplies in 2023



Source: elaborations on MASE

Production chain. The Italian renewable energy industry has a centuries-old history, establishing itself today as the second largest in Europe for production capacity and as the sixth largest exporter worldwide. Competencies in manufacturing advanced components for generation plants and grid infrastructures join a network of internationally active companies capable of developing and realizing projects. While the leadership in basic technologies is held by non-European countries, investments in renewables generate significant benefits for the national economy.

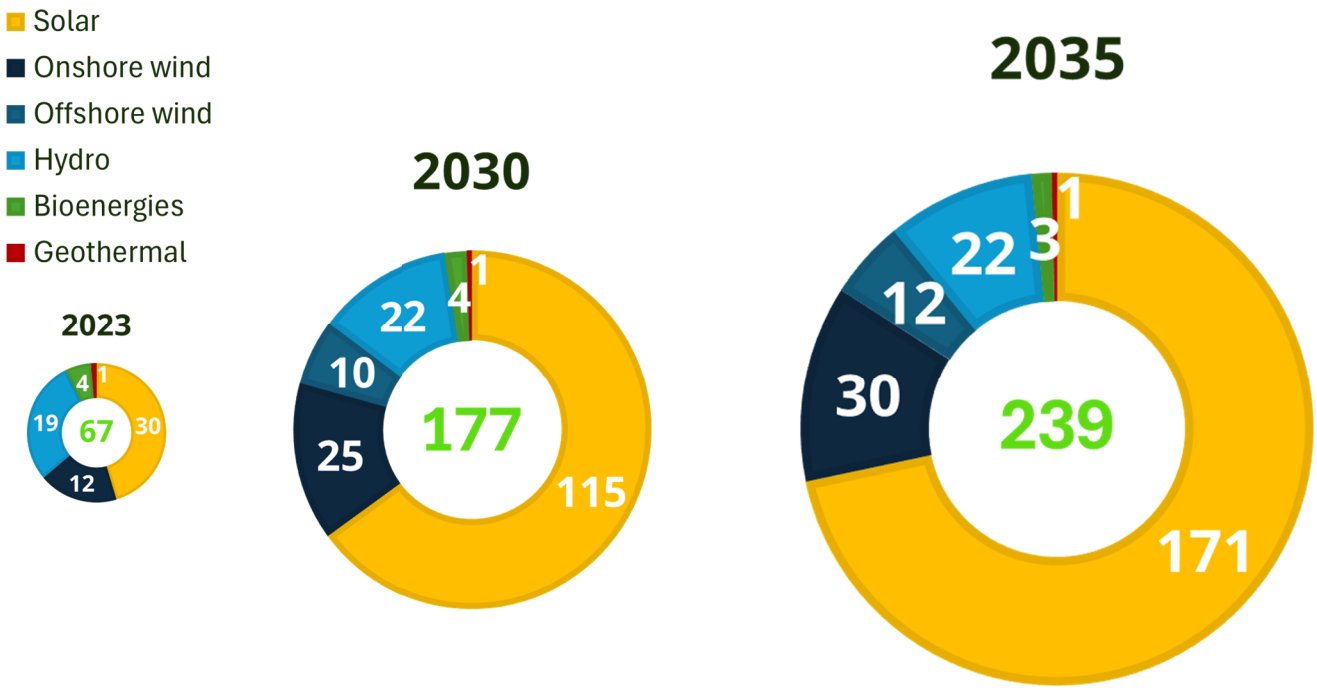
Benefits from RES for Italy in 2030



Source: Enel Foundation, Althesys, Elettricità Futura

Italy, with its rich biodiversity, is particularly vulnerable to climate change. Extreme events are becoming increasingly frequent, threatening agriculture (droughts in the North in 2022 and Sicily in 2024), industrial activities (floods in the Po Valley in 2023 and 2024) and forests (storm «Vaia» in 2018), with growing economic damage estimates over the years.

The national mitigation strategy aims to reduce emissions by 53% by 2030 compared to 2005 levels (NECP 2024). Actions are necessary across all emission fronts, prioritizing sectors with low marginal costs for abatement. For the energy sector, primarily the thermoelectric, responsible for 23% of total national greenhouse gas emissions, efforts are focused on reducing them to a little over 50 million tons per year by 2030, lowering their share to 15% of the total.



Italy – Growth of renewable capacity in the zero-emissions scenario (GW)

The transition in Italy is at an advanced stage and, up to the 2020 targets, is in line with the roadmap agreed upon with other EU partner countries. Looking beyond 2030 allows for exploring the path towards a net-zero emissions economy.

The scenario by 2035 imagines a completely decarbonized electricity sector, relying on solar energy, wind and water movement, aiming for a balance between human activities, the biosphere and the atmosphere, supported by smart grids and flexible resources such as storage, hydrogen and demand management. This is a high-tech energy system utilizing cutting-edge technologies.

Through energy efficiency, for which Italy is traditionally oriented, the final consumption of electricity will not exceed 390 TWh (+30% compared to 2023) despite new uses related to electrification. Demand will be met by a mix of domestic production, primarily photovoltaic and wind and imports (around 60 TWh). The other RES, having already been extensively used, will have limited development but will remain an essential component of the electricity mix.

THE SYNERGY BETWEEN RENEWABLES, LANDSCAPE AND ENVIRONMENT

Is there really a conflict between renewables, landscape and the environment?

All human activities have impacts on the environment in which they occur.
The criticism sometimes directed at renewables for impacting the landscape must be compared to possible alternatives, primarily energy production from fossil sources.

While less impactful than fossil fuel infrastructure - like drilling platforms, pipelines, refineries, LNG terminals and thermal power plants - wind and solar farms require installations and interventions that can alter the visual and environmental balance of a territory.

However, the difference is substantial: the construction of renewable energy facilities is reversible and their presence does not cause soil pollution or contamination.
Therefore, their impact, if properly planned, can be contained and managed.

What is meant by "landscape"?

> ***"Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." – European Landscape Convention (art. 1a)***

The landscape is a cultural and identity value, representing the relationship between nature and human presence and conveying the historical memory of a place. In Italy, sensitivity towards the landscape is deep and recognized as an aesthetic, moral and collective value.

The difference between a natural panorama and an industrial structure, such as a cooling tower of a thermal power plant, lies in the perception of harmony and beauty - elements intertwined with emotions and cultural identity. Preserving the landscape means safeguarding this heritage as a living testimony of local history and culture and the nation.

Who should protect the landscape?

In Italy, the protection of the landscape is guaranteed by Article 9 of the Constitution, which mandates the protection of the environment and cultural heritage. Since the 2020s, laws regarding renewables have been adjusted to balance the energy transition and environmental protection.

The State, Regions and local authorities collaborate in the evaluation of renewable projects, considering territorial specificities and promoting sustainable development. This integrated approach aims to respect the collective right to environmental preservation, implementing projects that respond to the climate urgency without compromising the quality of the landscape.

Why renewables cannot and should not be a threat to the landscape

Renewables should not detract from the landscape because they can be installed in low-impact areas, such as abandoned industrial sites, rooftops, parking lots and disused quarries. Some renewable installations, like photovoltaic panels, can integrate into the territory without occupying vast areas, while other technologies can be designed to minimize visual impact.

The acceptance of renewables, similar to other infrastructures, depends on landscape planning and the active participation of specialists and local communities seeking harmonious solutions.

This consideration must always weigh the lower impact compared to alternatives like fossil-fuel-powered plants, such as coal power plants or refineries, which permanently scar the landscape much more invasively.

Photo credits - RaiNews24

Thermoelectric plant in Piombino (LI).
The chimneys of the Enel power plant «Tor del Sale» have been recently demolished. The entire area will be converted and will have a tourist-oriented vocation with recreational structures. In the background, there is a wind power plant.

Transition from fossil fuels to RES and transformation of the landscape

An opposition that does not exist

The opposition between landscape protection and renewable development is often artificial. When considering the need to meet local energy demand with clean sources, renewables become an opportunity rather than a threat. The real question is what solutions exist to harmonize renewables with the landscape.

Through thoughtful planning, widespread distribution and respectful design, renewables can be integrated into the territory in a sustainable and beneficial way, enhancing both the environment and the local quality of life by reducing harmful emissions.

TERRITORY FOR RENEWABLES

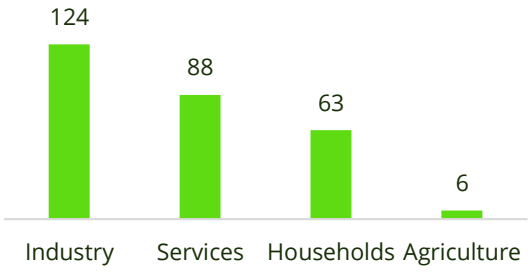
Renewable sources must integrate into the territory, using local resources such as sun, wind, water and soil. The territorial impact of these technologies is often used as a pretext against their development. In reality, estimates show that the necessary renewable electricity to achieve decarbonization targets would occupy modest portions of Italian agricultural land, even less compared to the entire national territory. Currently, the footprint of ground-based solar and wind uses only 0.15% of the Used Agricultural Surface (SAU) nationally and 0.11% of the Total Agricultural Surface (SAT), which includes unused land.

The impact can be further reduced by integrating installations into already urbanized areas, utilizing existing buildings and infrastructure to minimize the use of new land.

Local energy production and consumption offer significant opportunities; self-consumption from photovoltaics has grown by 45% in the last two years, surpassing the growth rate of solar production (+20%).

However, these possibilities alone are not enough to allow Italy to meet its full energy demand, requiring also the use of non-industrial areas to produce energy.

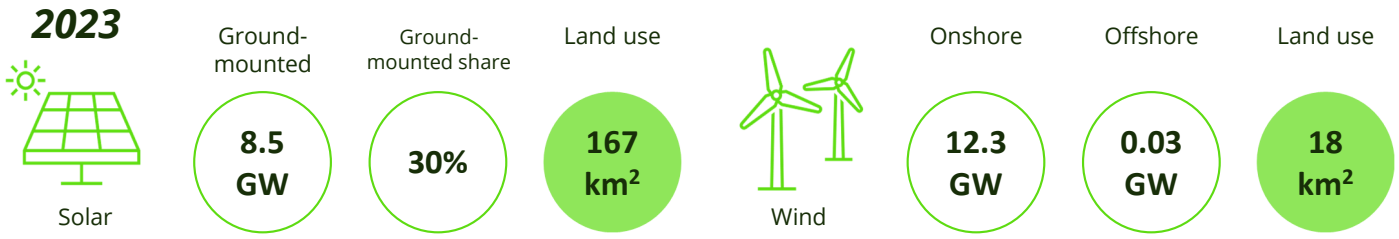
National sectoral electricity consumption in 2023 (TWh)



Source: Terna

The distribution of renewable potential reflects the degree of urbanization: urban hubs and metropolitan areas contribute less compared to rural areas, where the greatest availability of space for photovoltaics and wind exists.

For solar, these areas offer higher energy density, with a potential production per unit of surface area 2.7 times greater than in suburban areas and 8.3 times greater than in cities.



Source: elaborations on Terna, GSE, ISTAT

Beyond land use, it is essential to consider the integration of renewables into the landscape and environment. Design must respect the local context: while a wind turbine may enhance the appearance of an industrial area, in a natural landscape, careful considerations are needed to minimize visual and environmental impacts.

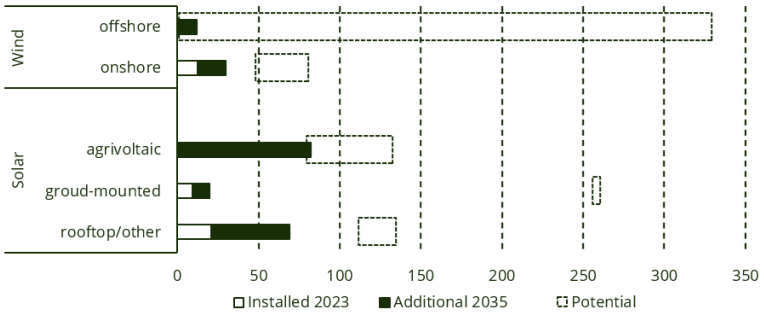
Landscape planning must ensure a balance between transition and protection, using tools like Strategic Environmental Assessment (VAS) and updated landscape plans.

The tool of «suitable» and «acceleration» areas, if properly planned and implemented, is a key step to reconcile the growth of renewables with territorial protection.

The **potential** of renewables can be distinguished between technical and economic ones. The technical potential refers to what is theoretically exploitable, while the economic potential includes solutions that are currently sustainable from an economic standpoint.

The latter is sufficient to reach the 2035 targets, with significant growth expected for rooftop photovoltaics and agrivoltaics, which will become the primary solar configuration due to their ability to reduce land use.

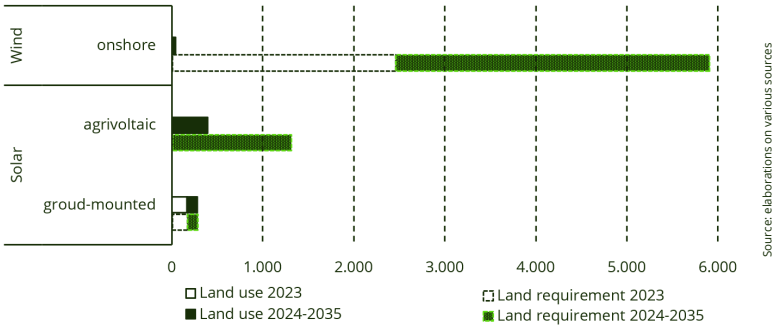
Existing capacity and 2035 target vs. installation potential (GW)



Source: Terna, elaborations on various sources

Wind energy will expand both onshore, particularly on mountainous ridges with a 1.4-fold increase, and offshore, which will provide a significant contribution from a minimal base. Its potential varies based on constraints like distance from the coast, maritime traffic and environmental limitations. However, even a limited development can cover a substantial part of renewable needs. New technologies, such as floating photovoltaics and marine energies, will offer additional possibilities, expanding the potential.

Land use and land requirement (km^2)



Source: elaborations on various sources

Land requirement. Solar on the ground has a minimal impact on agricultural land even by 2035, with agrivoltaics further reducing the footprint by integrating energy production with agriculture, saving at least 70% of the land.

Onshore wind continues to have minimal land coverage but requires significantly more space due to the large distances necessary between turbines.

Land use. Even by 2035, the land use of renewables remains negligible compared to current agricultural surfaces. Agrivoltaics significantly reduce the impact compared to traditional solar and wind shows almost irrelevant land values.

However, the development of renewables will require investments in grids and storage, which in turn necessitate additional space. For large-scale batteries, despite their power of 36 GW for 144 GWh of capacity, land use is expected to remain very minimal.

Land use and agricultural surfaces

2035		**Land use compared to:**		
		SAU	**SANU**	**SAT**
Solar	Ground-mounted	0,23%	8,9%	0,17%
	agrivoltaic	0,31%	8,4%	0,24%
Wind	onshore	0,03%	1,4%	0,03%
Batteries	Ground-mounted	0,004%	0,15%	0,003%

SAU/SANU: Agriculturally Used (Non-Used) Area - SAT: Total Agricultural Area

Source: elaborations on various sources

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RENEWABLES FOR THE TERRITORY

The adoption of renewable energy sources is a remarkable opportunity for regions, offering economic, environmental and social benefits that contribute to improving the quality of life in local communities and stimulating economic development.

Benefits of self-consumption. One of the main benefits of RES is the ability to reduce energy costs for households, through self-production, which helps to lower electricity bills. An investment in rooftop photovoltaic systems pays off over time, providing lasting economic benefits to residential consumers.

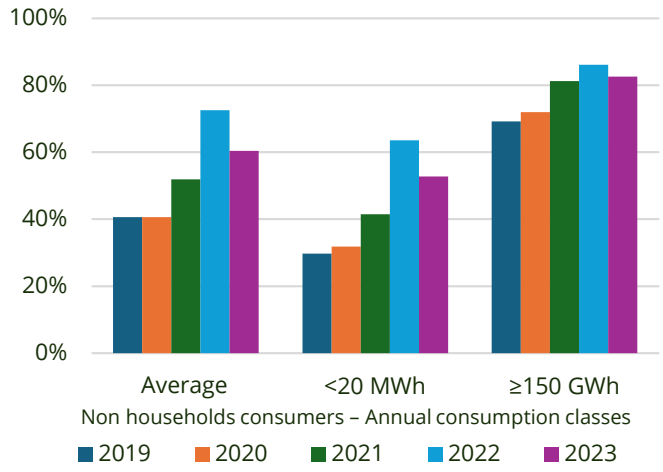
Renewable energy communities, which facilitate self-consumption, are an innovative model for sharing locally produced energy, enhancing acceptance from citizens.

Energy cost reduction. The economy benefits significantly from renewables. Businesses can use self-produced energy, improving competitiveness through savings on transportation costs and system charges, and shielding themselves from market fluctuations in energy costs. Even through long-term renewable energy supply contracts (PPAs), companies can benefit from fixed prices and savings, ensuring greater cost stability.

On a systemic level, the widespread adoption of renewable energy will provide additional benefits to all consumers.

The substitution of fossil fuel production with renewables will lead to a reduction in zonal electricity prices. With the reform of the electricity market and the phasing out of the National Single Price (PUN) expected by 2025, this reduction will primarily benefit consumers in regions with higher renewable penetration. In 2023, this component was on average 60% of businesses' electricity costs, after reaching 73% in 2022.

Italy. Energy and supply component (%) of total electricity bill



Source: elaborations on Eurostat

The distribution of any cost related to support measures for renewables, such as the 'FER 2' decree and the future 'FER X', becomes a central issue. If these costs remain within system charges and are uniformly shared, regions with fewer renewables would contribute to supporting those with higher installed capacities. This cross-subsidy could reduce costs for consumers in the South and Islands, promoting industrial development thanks to low-cost energy.

The energy transition, in this sense, balances renewable generation, which has been concentrated in the North due to hydroelectric power, towards the South where solar and wind have the greatest potential. If managed well, this transformation will make the system more equitable and competitive.

Local benefits. Renewable energies generate multiple benefits, including job creation, especially during the construction of plants. The development of a supply chain related to the operation and maintenance of these plants has led to significant local economic growth in some areas.
This impact contributes to local economic development and creates shared value. Renewable energy facilities increase local wages and revenues through taxes, compensation and rents for land use, with positive effects on the income of host communities and public investments.

Regeneration. The transition to renewables can create value in the areas where they are located, not only by reducing local pollution but also by offering new opportunities in urban, industrial, rural contexts, or for marginal or degraded areas.

«There are 70,000 ha of marginal areas in Italy to be utilized for renewables» - CREA

Uncultivated lands present a significant potential. In Italy, 24% of agricultural land is not cultivated, often due to economic non-viability. Installing photovoltaic systems on small portions of these uncultivated lands can transform such areas into productive resources. The revenues generated from energy could fund interventions to restore the remaining land to cultivation, thereby providing a dual benefit: renewable energy production and agricultural recovery. This approach not only avoids taking up cultivable land but even increases the areas effectively used for agriculture.

Abandoned quarries, disused industrial sites, polluted or to-be-remediated lands are other opportunities for the installation of photovoltaic and wind systems. These interventions transform unproductive spaces into energy hubs, accelerating their environmental recovery.

In urban areas, renewable energies contribute to the redevelopment of the urban fabric. Such projects not only reduce emissions but also enhance urban resilience and make neighborhoods more attractive to citizens and investors.

Photovoltaic greenhouse in the Torrigiani Garden in Florence

Photo credits – Elena Lucchi

Renewables can also be integrated into valuable contexts, through careful design that harmonizes their inclusion in built heritage and landscape.

With appropriate solutions, it is possible not only to avoid compromising their beauty but also to enhance it, highlighting their aesthetic and cultural characteristics.

FROM WORDS TO ACTIONS, SOME PROPOSALS

Addressing the energy transition involves not only increasing renewable energy but doing so harmoniously with the territory. The design of installations must minimize impacts and promote community participation, fostering a sense of belonging and collaboration to achieve goals that concern everyone. The ten proposals that follow aim to translate these principles into concrete actions, balancing development, environmental and landscape protection, and social acceptance.

1. Give value to the existing facilities

Renewing wind, solar and hydroelectric installations is a strategic opportunity for Italy, not only to preserve installed capacity but also to improve efficiency. With approximately 28 GW of wind and solar installations reaching 20 years old by 2035, interventions on existing infrastructure are necessary to prevent losing part of the renewable capacity. Technological progress in wind allows for a significant reduction in the number of turbines, minimizing the 'forest effect' and increasing power and heights. For solar, performance improves with module replacements and more efficient use of areas.
To achieve this potential, it is essential to define the regulatory framework. The 'FER X' decree must provide the necessary conditions to extend the lifespan of these installations.

2. Focus on land reuse

To ensure balanced development of renewables, projects should focus on marginal, degraded areas or those that do not affect other activities. The 'suitable areas' decree has begun the regional mapping process necessary for territorial planning. It is now crucial to accelerate implementation to meet the regional goals set for 2030 with burden-sharing and requiring shared responsibility.
An opportunity arises from the Renewable Energy Directive RED III, which mandates the creation of "acceleration areas". The calibration of support instruments for renewables is a key factor for their geographical distribution and for choosing among technological options. In this delicate phase, it is important to balance equity and economic efficiency through coordination with local territories.

3. Promote agrivoltaics

Agrivoltaics allows combining agricultural production with renewable generation and is a key element for the success of the transition. This technology can be implemented by designing a new rural landscape. The validation of projects can use voluntary tools resulting from collaboration between the agricultural and energy sectors, ensuring high construction standards and social acceptance.
It is important to differentiate agrivoltaics from other renewable sources in the support measures, introducing dedicated auctions or registers that reflect its specificities.

4. Support distributed generation

Distributed Generation is already favored in permitting due to simplified procedures. The stabilization of tax deductions and the approval of 'FER X' will allow investments to continue to grow, pushing the energy transition in urbanized areas, valuing the built environment and using existing surfaces and infrastructure without the need for new land use.

5. Coordinate grid management

The growth of renewables spread across the territory requires adequate infrastructure development. To avoid possible saturation of networks, selective criteria for projects and priorities based on sustainability and infrastructure compatibility are needed. Better coordination between administrations and grid managers to accelerate approvals and optimize resources is essential.

6. Disseminate energy communities and crowdfunding

It is important to adopt participatory processes that allow residents to have a voice in project choices, including through tools like Renewable Energy Communities. Solutions such as crowdfunding, systems for financing initiatives through citizen fundraising, can support the growth of renewable installations, providing the opportunity to contribute to the energy transition while also benefiting economically.

7. Raise public awareness

To integrate renewables into the landscape and overcome local resistance, it is crucial to raise public awareness about their benefits. Information and transparency regarding positive impacts on the territory, employment and the environment can help create awareness, trust and consensus. Knowledge is the first step to overcoming fears and doubts.

8. Promote participatory processes

The dissemination of clean energy cannot happen without involving local communities.
The culture of renewables must be based on shared decision-making and respect for local concerns, promoting a relationship of trust and collaboration between institutions and citizens. Real, not formal, tools for citizen engagement are necessary. A public discussion about projects should be promoted, rewarding those that are best integrated into the landscape and built heritage.

9. Share economic benefits

To improve the acceptance of projects, territories must directly benefit from investments.
Various forms of compensation can be employed, including resources from environmental funds or from mechanisms such as pollution permit trading (ETS). Host municipalities must manage these resources transparently, making clear the link between the benefits obtained and the installations on their territory. The introduction of targeted training programs will strengthen local entrepreneurship and the job market, creating specialized skills in the renewables sector. Prioritizing access to the grid and quotas for national support mechanisms for renewables should be reserved for projects that provide the greatest benefits to local communities.

10. Monitor projects and results

The monitoring of projects must be focused on evaluating impacts on ecosystems and local socio-economic dynamics. To promote transparency and citizen involvement, dedicated, continuous and verifiable information channels are needed. This will ensure greater efficiency, social acceptability and better integration of works into territories, promoting awareness and active participation.

This document is a summary of the broader study «Renewable Energy Growth and Landscape. Dimensions and Perspectives of a Possible Alliance». This study was conducted with the support of the European Climate Foundation. The information contained in this report comes from open sources. The research is based on information and data released by research institutes, media and institutions.

Althesys in no way guarantees the completeness and correctness of the information, which is presented solely to provide an overview and evolution of the sector under review. In some cases, due to rounding, totals in the tables may not reconcile with the sums of the individual items.

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ALTHESYS Strategic Consultants is an independent professional company specializing in strategic consulting and knowledge development.

It is active in the areas of strategic analysis, extraordinary finance and economic-financial research. It has in-depth knowledge of the environmental, energy, public utility and infrastructure sectors.

The think tanks **IREX** in the energy sector, **NET - New Electricity Trends** in the Italian electricity market, **Top Utility** in the public utility sector, **WAS - Waste Strategy** in the waste management and recycling industry and **Shared Value Institute** on sustainable value creation are points of reference and opportunities for dialogue for operators, institutions and stakeholders.

ALTHESYS conducts studies and research at both national and international levels on behalf of major companies and institutions.

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