SIMULATION OF THE EFFECTS OF POSSIBLE REGULATIONS FOR THE LOCATION OF WIND AND PHOTOVOLTAIC POWER PLANTS IN THE LAZIO REGIONAL ADMINISTRATION (ITALY)

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ABSTRACT:

The need to make electricity production increasingly sustainable requires careful planning of production plants, mainly for wind and photovoltaic energy conversion. Planning areas correctly, while respecting existing environmental constraints, is not an easy task and requires the collaboration of a panel of experts with different skills. The need to search for new sites to be allocated to renewable energy generation plants is demanded by the most pressing current events: it's just in such a context that the Italian national legislation is undergoing a revision, which has entrusted the regional administrations with the task of identifying the territorial criteria. By simulations in GIS environments, it's possible to study the effect of defining certain criteria on the territory, in order to assess in advance which and how many areas could have greater or lesser suitability. Based on this consideration, we proceeded to experiment with the effects of the most common constraints by developing a real simulation on the territory of the Lazio Region. The experimentation used the well-known open environment QGIS 3.22, which made it possible to exploit the possibilities offered by the open territorial databases of the Lazio Region. The first results show that the remaining areas after eliminating all those that are certainly unsuitable are a limited part of the Region itself. The analysis was extended to individual municipalities by comparing average yields per conceivable plant area, then comparing them with inhabitants for an initial estimate of energy needs at least for domestic use.

1. INTRODUCTION

Spatial planning to locate certain types of facilities consists always of complex multi-criteria analyses, widely used in territorial studies when parameters of different kinds and nature and with different types of weight must be taken into account to deduce the greater or lesser suitability of different areas of a territory for a specific use or application; just to give a few examples, such analyses have been applied to fire management (Costantino et al. 2020), cultural heritage management (Pepe et al. 2020), studies on the influence of man on urban microclimates (Baiocchi et al. 2017), the management and analysis of historical cartography (Geri et al. 2019; Gobbi et al. 2019) or to the estimation and management of noise pollution (Dardanelli et al. 2017) or the effect of a seismic event (Baiocchi et al. 2012) . Even if some facilities or infrastructures are of utmost public utility and everyone agrees on their necessity, local fears and misgivings may give rise to the resistance popularly referred to as the 'NIMBY syndrome' (Not In My BackYard). Such psychological resistance is mainly felt for the location of large transport infrastructures (Coppens et al., 2018) and waste disposal areas and facilities (Baiocchi et al., 2015), but also for energy production facilities from alternative sources, such as energy from wind turbines (Walker et al., 2018; Rand et al., 2017) and even the less impactful photovoltaic facilities (Tidwell et al., 2018). On the othe hand, the recent socio-economic developments resulting from the pandemic and related to the current war situation push towards new renewable energy plants. The only way to propose locations that can be accepted by the population as a whole is to determine the areas to be used for plants through the application of objective spatial criteria, such as those ones determined by the constraints now mostly freely available online pursuant to the European Inspire Directive (EC, 2022). The first step for a correct land classification must therefore start with a careful analysis of the relevant legislative indications and restrictions.
The following is a quick description of the regulatory path that has led to the need to identify special-purpose areas for photovoltaic wind turbine installations at a regional level in Italy.

1.1 Guidelines for the development of alternative energies at the national level: the PNRR

Driven by the country's political and economic contingencies, the project goal is to identify suitable areas for the installation of large-scale photovoltaic and wind power plants. Funds for such accomplishments are available under the European Next Generation EU (NGEU) five-year economic plan of about 750 billion, which in Italy has been named the National Recovery and Resilience Plan (PNRR) of about 248 billion to be used from 2021 to 2026. The purpose of this plan is to limit the socio-economic effects of the pandemic and to steer the country towards a decisive step forward also about other structural and technological backwardness problems. Among the 6 missions that compose the Plan, the most important is the third one,

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called 'Green Revolution and Ecological Transition', worth some 68.8 billion euros, to improve the sustainability and resilience of the economic system and ensure a fair and inclusive environmental transition. Objectives include: increasing waste recycling, reducing the loss of drinking water on water networks, energy efficiency in 50,000 private and public buildings per year for a total of 20 million square metres, and developing research and support for the use of hydrogen in industry and transport. Already included in the Plan is the proposal to create innovative plants, with a significant emphasis on the introduction of off-shore (i.e. the installation of wind farms in the sea, several miles from the coast). Such kind of proposals have become more urgent and necessary due to the Russian-Ukrainian conflict in recent months, which have highlighted Europe and Italy's already well-known dependence on foreign gas and energy supplies in general. Italy, for example, imports about 74% of the energy it needs. In terms of domestic production and meets its electricity needs in 2019-2020 using 57.6% non-renewable thermoelectric, 17.6% hydroelectric, and the remaining 24.7% wind, geothermal, photovoltaic and bioenergy sources (Mise, 2022; Terna, 2022).

1.2 National regulatory constraints

In Italy, the renewable energy sector is currently regulated by Legislative Decree No. 199 of 8 November 2021 'Implementation of the EU Directive of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable funds', better known as the ‘Decreto Rinnovabili’ (Renewable energies Decree). One of its main goals is to spread large ground-mounted systems, giving priority for their installation to unproductive areas, not intended for other uses, such as areas that cannot be used for agricultural purposes, or to be built on contaminated sites, landfills, and areas along the infrastructure system.

With reference to photovoltaic plants, according to the definition of the inter-ministerial decree of the Ministry of Economic Development, in agreement with the Ministry of the Environment and Protection of the Land and Sea of 5 May 2011 and annexes, "small plants" as those that are built on buildings with power up to 1 MW and those ones built on the ground or on greenhouses, canopies, and pergolas up to 200 kW, while "large plants" are those that exceed these parameters and concentration plants.

The ‘Renewables Decree’ reiterates in Article 3 'national targets' the goals to be achieved: a 30% overall share of energy produced from renewable sources in gross final consumption and a 55% reduction in greenhouse gas production compared to 1990 by 2030. To reach these goals, the note in Article 1 states that the Regions and Autonomous Provinces must identify suitable areas for their planting within 6 months from the entry into force of the following decree (8 November 2021), and so that the deadline expired just a few months ago. Article 2 defines the concept of 'suitable area', i.e., 'area with high potential to host the installation of plants to produce electricity from renewable sources', and Article 20 better defines the areas, stating that in the choice of these areas, preference must be given to the use of 'areas of built structures, such as industrial sheds and car parks'. It is understood that the identification of these areas must respect the constraints and regulations set by the various planning instruments of the territory. The same bodies (or one identified by them) are entrusted with the task of issuing the “Autorizzazione unica” (Single Authorisation), which constitutes the title to build and operate, as enshrined in Article 12 of Legislative Decree no. 387 of 2003.

1.3 Regional transposition of constraints

The Latium Region has decided to delegate to the individual municipalities the identification of suitable areas for the construction of plants for the production of energy from renewable sources, and since they have not yet expressed an opinion on the matter, the only indications available regarding their location are dictated by the Regional Territorial Landscape Plan (PTPR), in the document called "Guidelines for the evaluation of interventions relating to the exploitation of renewable energy sources" dated 2021, which is in the nature of a guideline. The document defines the compatibility of the various possible works with the different landscapes identified by the plan on the regional territory. For large-scale ground-mounted photovoltaic systems with production greater than 20kW, the only acronyms that appear are the "CL" (compatibility with limitations) in landscapes identified as "Agricultural Landscape of Continuity", "Urban Settlement Landscape", "Evolving Settlement Landscape" and "Networks, Infrastructures and Services".

Compatibility is calculated based on the negative impacts that Renewable Energy Sources (RES) may have on the landscape in relation to two indicators: infrastructure visibility and land consumption. The overall impact of large-scale photovoltaics would result in a value catalogued as 7, i.e. 'high', the result of the sum of 3 as 'visual impact' and 4 as 'land consumption'.

2. MATERIALS AND METHODS

The experimentation used the well-known open environment QGIS 3.22 (QGIS, 2022), which made it possible to exploit the possibilities offered by the open territorial databases of the Lazio Region. It should be noted that the Lazio Region (like most Italian regions) made many spatial data available in open format in recent years. The European directive called "Inspire" gave a boost to the use, standardisation, and free dissemination of spatial data. The implementation of the open data in QGIS 3.12 made possible to identify topological inaccuracies in the files provided and shared on the Lazio Region site, allowing the needed corrective action on some polygons that presented errors, such as their overlapping or imperfect closure (the correction of the latter case was suggested by QGIS itself, through the "reopen geometries" function). The correct georeferentiation has been checked using previously tested procedures (Baiocchi et al., 2013; Baiocchi et al. 2017) A possible inaccuracy was also found in the "lowland species" and "mountain species" files of the Regional Ecological Network, which seems to show an error in the transcription of the relative geodetic datum on the website, where it is reported as WGS84, UTM33N and resulting from verifications and overlapping more likely ED50. Uncategorised areas also emerged in the file called "PTPR Regione Lazio (Tav. A - Tav. B)" which were however excluded from those ones considered to be unsuitable since a more detailed analysis revealed the area of the Parco della Caffarella in Rome, which is hardly conceivable as the site for a wind farm or large-scale photovoltaic plant. Reference system errors and data inconsistencies were reported to the respective managing bodies, for their correction in the spirit of the 'open source' approach to geospatial data. Extraterritorial areas within the Region's territory belonging to the Vatican State were also added as "unsuitable". The precise identification

of the landscapes can be found in the "Report" of the PTPR. For the realisation of the various maps that follow, recourse was made to the files "PTPR - Tables A" and "PTPR - Tables B" present on the Regional web site, containing the perimeters of the Plan in shapefile format. Tables A, 42 in total, "Landscape Systems and Areas", represent the typological classification of landscape areas ordered by relevance and integrity of landscape values. Tables A have a prescriptive nature exclusively for areas subject to constraints pursuant to Article 134, paragraph 1, letters a), b) and c), of the Code and contain the territorial identification of the landscape areas, the buffer strips of landscape assets, panoramic routes, and viewpoints. Tables B, also 42, 'Landscape Assets', represent the areas and properties subject to landscape constraints. Tables B have a prescriptive nature and contain the description of the landscape assets referred to in Article 134, paragraph 1, letters a), b) and c), of the Code, through their cartographic identification with a regional identifier, and define the parts of the territory in which the PTPR regulations have a prescriptive nature. All the tables were drafted by the Regional Directorate for Housing Policies and Territorial, Landscape and Wide Area Planning, specifically, by the working group for the drafting and design of the PTPR. The scale of each of them is 1:25,000 and the year of edition is 2021.

2.1 Large-scale photovoltaic plants regulatory definitions

For large-scale photovoltaic plants, the landscapes considered compatible with limitations are the following: 'Continuity Agricultural Landscape', 'Urban Settlement Landscape', 'Evolving Settlement Landscape' and 'Networks, Infrastructure and Services'. For each of these, the plan provides a definition and landscape quality objectives.

The areas belonging to these landscapes also include facilities and services such as cemeteries and airports, which present additional planning difficulties as locations for large-scale installations, hence the introduction of these among the compatible but restricted landscapes. The remaining part of the landscapes are not compatible for the installation of large-scale PV power plants. It is important at this point to emphasise that our work should be understood more as an exclusion than as an indication of areas to install the plants because, as in previous classification experiences reported in the literature (Baiocchi et al., 2014), it can be determined that some areas are certainly unsuitable, but the remainder are not with certainty suitable (fig. 1).

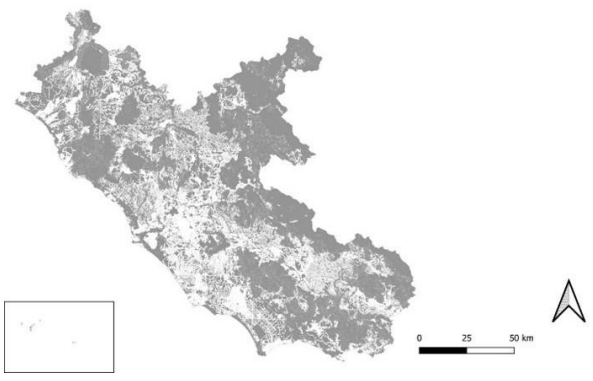

Figure 1. Compatible landscapes with limitations for large-scale photovoltaic installations (in exerpt Latium islands).

Among the unsuitable landscapes the areas belonging to the Vatican City State and the Caffarella Park have been included by means of a specially created layer because these two areas, beyond the classification that the plan may assign them, cannot in any case be considered suitable for the installation of plants. All the layers superimposed in the various mappings were produced and made available by the Lazio Region on the regional web site (Geoportale) between 3/10/2021 and 8/2/2022 as provided for by the implementation of the Inspire regulation (EC, 2022) with the unique reference system EPSG 25833 (EPSG, 2022). The reference system used by us is, instead, EPSG 6708, (RDN2008 / UTM zone 33N (N-E)), as per specific national regulations (PCM, 2011). To this basic layer more 5 layers, all belonging to Tables A of the plan called "Respect 5 constraints", "Points 5 constraints", "Implementation plans with landscape value", "Protected areas by ministerial decree (DM)" and "Visual areas", must be added. The "Respect 5 constraints" and "Points 5 constraints" layers identify the "areas and points of view" and the "areas of landscape restoration and enhancement", areas considered to be protected because they are part of wider visual routes of landscape importance. The following areas are identified with the "implementation plans with landscape value" layer. The areas in the 'DM protected areas' layer are identified directly following the relevant ministerial guidelines. In the phase preceding the adoption of the PTPR, the viewpoints and scenic routes and view areas already identified by the PTP were identified in the "View Areas" layer. The 42 Tables B of the PTPR called "Landscape Assets", represent the areas and properties subject to landscape constraints. They contain the delimitation and representation of those assets of Lazio's natural, cultural and landscape heritage that are subject to landscape constraints for which the Plan regulations have a prescriptive character. A total of 29 layers were then added to the work previously carried out to definitively delineate the areas that are not unsuitable. These layers were divided into thematically related groups. The first group called 'Natural Boundaries' sees the proper natural areas placed under landscape constraints. We find, in fact, protected mountains for the part exceeding 1. 200 metres of height for the Apennine chain and islands ("1200 altimetry" layer), national or regional parks and reserves, as well as the territories of external protection of parks ("PTPR protected natural areas"), the territories covered by forests and woods, even if they are affected or damaged by fire, and those subject to reforestation constraints, as defined by Article 2, paragraphs 2 and 6, of Legislative Decree 18 May 2001, no. 227 ('Woods') and the wetlands included in the list provided for by Presidential Decree (DPR) no. 448 of 13 March 1976 ('Wetlands'). Protection over these areas is in Article 134 paragraph 1 letters a,b and c of the Code. The second set of layers called "Hydrological constraints" has been grouped according to the theme of water, so that we find within it the coastal territories included within a strip of the depth of 300 metres from the shoreline, even for land elevated above the sea ("sea coast"), and their banks or the foot of their banks for a strip of 150 metres each, and the canals of agricultural reclamations and their respect area ('acque pubbliche', 'acque pubbliche rispetto' and 'canali bonifiche'). The third group "Archaeological constraints" is related to archaeological assets, within which there are the areas of archaeological interest ("archaeological areas"), point and linear assets bearing witness to archaeological and historical identity features and the relevant buffer zone ("archaeological points", "respect archaeological points", "archaeological lines", "respect archaeological lines", "respect typified archaeological points", "respect typified archaeological lines") and those protected by the previous archaeological decrees of 1986, 1995, 1997, 1998,

1999 and 2001 ("archaeological decrees"). The fourth group "Geomorphological constraints" focuses on geomorphological assets, in fact, here we find the vegetational, geomorphological and karst-hypogean identity features and the relevant buffer zone ("typified geomorphological" and "geomorphological constraints"). The fifth group "Urban landscape constraints" relating to urban aspects subject to protection, contains the areas subject to protection of the historic urban settlements and relative respect areas ("historic centres", "historic centres with respect to 150"). They are historic urban settlements that include urban organisms of ancient formation and centres that gave rise to contemporary cities as well as founding cities and centres built in the 20th century ("identity villages"). The sixth group "Constraints agrarian landscapes" focuses on the Region's agricultural heritage, there we find protected, therefore, the villages of rural architecture, the individual assets of rural architecture and its buffer zone ("rural identity", "rural respect"). The seventh group called "1939 Constraints" (from 1939 n. 1497 environmental legislation) includes the "ex 1497 ab" and "ex 1497 cd", i.e. the areas constrained in due to their important public interest. The eighth group 'Agricultural University Constraints' consists of the areas belonging to agricultural in civic use ('civic use'). There is an interesting reflection to be made on these, as they are areas intended for the use of all citizens, who can exploit them in a variety of ways (including getting wood from them), they could be areas for the installation of renewable energy (of any kind) to meet the energy needs of neighbouring communities. To these eight groups were added more layers concerning the constraints posed by other regulations such as “Natura 2000” Network, European Directive 92/43 for the conservation of natural habitats of wild fauna and flora. The acronyms SPA and SAC stand for 'Special Protection Area' and 'Site of Community Importance' respectively and indicate areas included in the wider European protection network. The layers "Ecological Network Connection Areas" and "Ecological Network Central Areas", which were entirely provided by the Latium Region about the Region's Ecological Network, were also added by the first Italian PEAR (Renewable energies location plan) Plan, that of the Lombardy Region of 21 April 2021. The final map that emerges from this progressive overlapping is reported in figure 2.

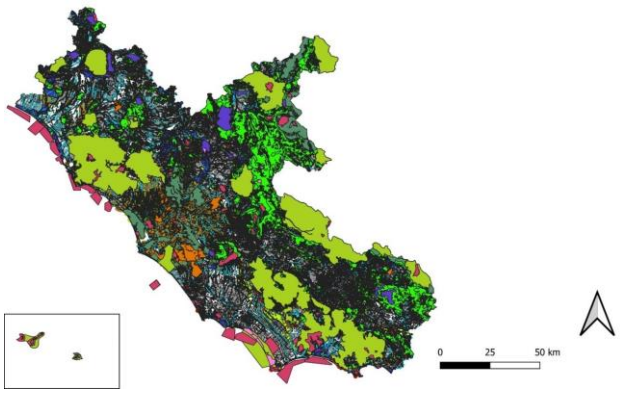

Figure 2. Large photovoltaic map with the constraints of tables A and B; in white the not unsiuitable areas with remaining constraints (in exerpt Latium islands).

Following the indications provided by the document "Guidelines for the evaluation of interventions relating to the exploitation of renewable energy sources", superimposing all the constraints provided for by the PTPR with prescriptive nature and the areas protected by the various conventions (Ramsar and 2000 network) and adding the indications of the aforementioned PEAR, Italian regional energy plan, of the Lombardy Region regarding protection on the areas of the Ecological Network, it can soon be seen that more than 90% are unsuitable areas and the same white areas on the map are 'compatible with limitations' as previously written. Some limitations couldoccur, for example, in the landscape areas categorised as 'Networks, infrastructures and services', which also include airport areas, which seem unlikely to be suitable for installations due to flight safety constraints. A second map was prepared following the indications provided by the National Integrated Energy and Climate Plan (PNIEC), which explicitly suggests locating new renewable energy plants in areas that are already degraded, compromised, and contaminated, such as landfills. In addition to these, also suggested by the Lazio Region's own file in which we find the areas of landfills and quarries identified and demarcated together, there is also the possibility of including among the places promoted as suitable also areas where mining activities such as quarries and mines have been done (fig. 3).

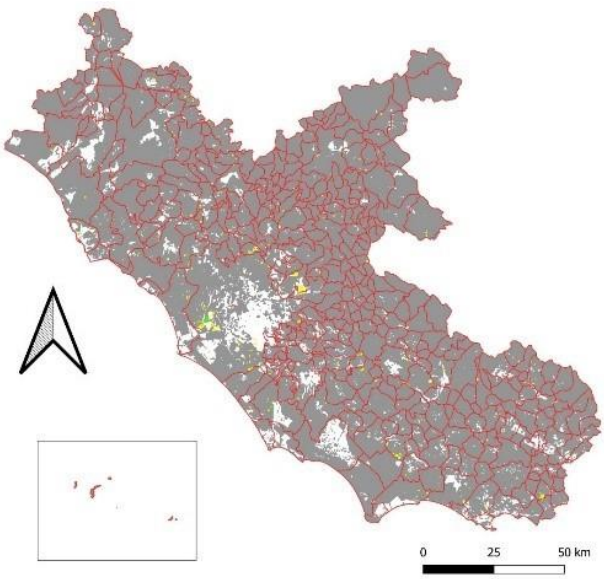

Figure 3. Map with 'Landfills’ (green) and ‘Quarries' (yellow), in grey all unsuitable areas; red lines are municipalities borders.

2.2 Large Wind Turbines plants

For large-scale wind energy, i.e. for plants with production greater than or equal to 60kw, the "Guidelines for the assessment of interventions relating to the exploitation of renewable energy sources" identify as "compatible landscapes with limitations" the same landscapes tracked down for large-scale photovoltaic, "agricultural landscape of continuity", "landscape of urban settlements", "landscape of evolving settlements" and "networks, infrastructures and services", to which, however, are added 'natural landscape of continuity', 'agricultural landscape of significant value' and 'valuable agrarian landscape'.

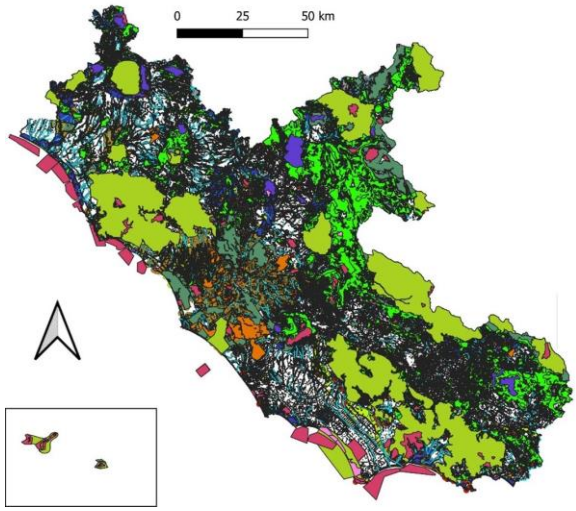

Figure 4. Complete map of all constraints for large wind turbine plants; in white all not unsuitable areas.

Compatibility is also limited for that wind farm as its overall impact is around value 7 (high impact), resulting from the sum of the visual impact categorised as value 4 and the land consumption categorised as value 3. For the final representation, the compatible landscapes with constraints added to those of the photovoltaic system were then superimposed on the layers of tables B with the landscape constraints.

As can be seen in the case of large wind farms, the unsuitable areas are much larger (fig. 4). However, even here compatibility is always restricted and, as with photovoltaics, it must be emphasised that airport areas are decidedly unsuitable for the installation of a wind farm, so the areas must definitely be reduced. A second map was also created for wind power, highlighting the areas that the PNIEC encourages to be used as planting sites for renewable energy. Here is the map showing the areas in the Lazio Region where there are landfills and quarries within compatible landscapes with limitations for large-scale wind power plants (fig. 5).

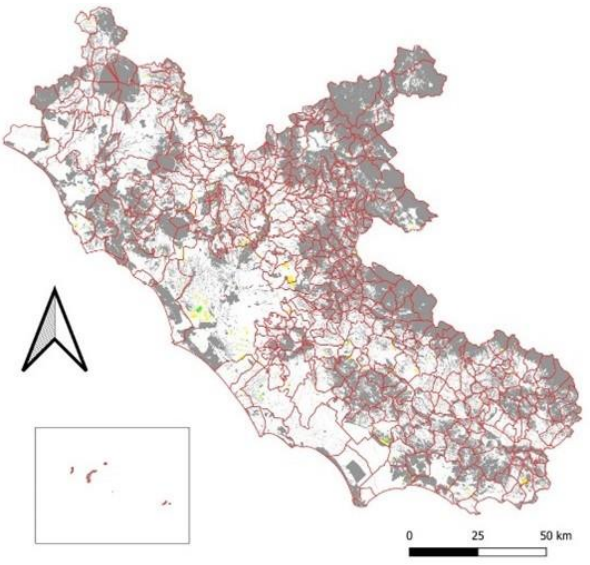

Figure 5. Map with 'Landfills' (green) and 'Quarries' (yellow), in grey all unsuitable areas; red lines are municipalities borders.

3. DISCUSSION AND VERIFICATION OF THE SUSTAINABILITY OF THE HYPHOTESIZED CONSTRAINTS

The constraints assumed and mapped in the first phase of the project may outline a scenario that is either too 'permissive' or too 'restrictive'. In previous studies on similar simulations, it was verified that the assumed constraints were too restrictive, making the project effectively unfeasible (Lupia et al., 2007). The depicted situation is the most likely to be applied and we wanted to assess whether it is sustainable, in particular whether the remaining areas (which, again, we repeat, will not all be suitable) would be able to meet the energy needs of the region and the individual municipalities. In order to verify its real sustainability, a preliminary estimate was made of a possible energy requirement of the entire region and its sustainability completely satisfied with energy produced by large-scale photovoltaic plants. We proceeded by concentrating only on large-scale photovoltaics because it was noted that the Latium region is not among the windiest in Italy, and from the perspective of minimum waste of land and maximum energy production, we preferred to concentrate solely on energy produced by the sun. To estimate this latter value, we used a programme created by the JRC of the European Community called "PHOTOVOLTAIC GEOGRAPHICAL INFORMATION SYSTEM" ver. 5.2 (EC, 2022). It must be emphasised that the estimates produced in this paragraph are approximate and, therefore, certainly need to be refined, the estimates are extremely complex, and the simplifications proposed here are only intended to assess whether the choices are sustainable or largely order of magnitude deficient. The energy productivity calculation focused on the possibility per square metre of a plant to produce energy, the estimated and conservative reference value chosen is 200 Kwh/ m^2 per year for this area. A very simplified calculation, as we have said, which however tried to take into account the conditions possible in this context for its yield, which, let us remember, can vary depending on numerous factors (latitude, inclination of the panel, etc.). At the same time as this calculation, we tried to make an estimate of the possible energy needs of the region. An estimate that turns out to be very quick and approximate for the reasons stated above and for the vicissitudes that have occurred in this last period, which precisely on energy are having considerable repercussions. Data on per capita consumption in Lazio were then sought; these, supplied by Arpa, indicate an annual consumption in 2017 of around 3560 Kwh (Arpa, 2022) per inhabitant including all uses: domestic, public and industrial. It should be borne in mind, however, that this figure is influenced by a drop in industrial use of around 5% compared to the previous year, and on the basis of a similar figure even the industrial data for the following years, i.e. the years of the current pandemic crisis, seem to us to be of little relevance and indicative for this estimate. We therefore concentrated on the figure for domestic consumption alone, which is around 1200 Kwh per person.

To this was added the estimated consumption of a complete electrification of Lazio's car fleet, a probable challenge for the future of our administrations. For this assessment we turned to the data of the Italian car club (ACI, 2022) which informs us of a presence of 0.63 cars per inhabitant of the Region, which travels an average of (ANIA, 2022) 11200 Km/year, so for each inhabitant of Lazio about 7050 km are travelled in a year, which requires about 875 Kwh/year for each inhabitant for motoring, considering an average distance of 6 Km/Kwh, consumption

currently achievable with the electrically driven vehicles currently circulating. To the 1200 Kwh for domestic use, 900 Kwh must therefore be added for travel by private electric car. This estimate, it must be emphasised, does not take into account industrial consumption, nor consumption related to public transport. It is therefore a gross underestimate of the region's energy needs, but at least representative and congruent of part of the region's energy demand. Comparing, therefore, the values obtained, it can be deduced that at least 6 m^2 are required for the energy needs of a Lazio inhabitant for domestic purposes only, but if we also consider the needs for the desirable future electric conversion of motor vehicles, we arrive at at least 10.5 m^2. Combining the data collected on Lazio's per capita consumption, the production per square metre of an average plant and those relating to unsuitable areas available for each municipality with its population, it emerges that energy sustainability and autonomy would be attainable for the majority of municipalities, but there remains the enormous unknown factor of its actual feasibility by the actual compatibility with limitations of the locations identified, the presence among them of areas that are certainly not usable for this purpose and above all an underestimated need. The analysis was performed on each individual municipality by comparing the unsuitable areas with the census population of each individual municipality (ISTAT, 2022) because a critical point is the distance between the production plant and the end user, which in the past has in some cases made installed plants not entirely usable due to grid limitations. In the attached table, it can be seen that in the last column "Difference domestic use plus private electric cars" the values with a positive number are greater and therefore potentially sustainable in terms of energy, subject to the clarifications made earlier.

4. CONCLUSIONS AND FURTHER DEVELOPMENTS

As can be seen, the areas that are not available for two of the most widespread alternative energy sources are a reduced part of the regional territory. On the other hand, our very preliminary assessment has made it possible to ascertain that, at least to a first approximation, the extent of not unsuitable land seems to be sufficient in almost every municipality to ensure domestic and private motor vehicle use. The result is not trivial because, on the contrary, it could be the case that our estimate showed that the remaining areas were already decidedly insufficient, imposing a reconsideration of constraints. Moreover, the central government's request to the individual regions to identify suitable areas perhaps also implies an implicit re-evaluation of the uses of many of the territories on national territory. Investment in alternative energies seems decidedly necessary in this historical period; not to miss an opportunity with substantial funds, incentives, and needs to develop new technologies, protect the environment, and ensure independence from fossil fuels. With more in-depth research conducted by experts in the field, one could work more effectively on the ratio of settled population-energy consumption-m^2 of plant needed to meet the needs of that community. With this type of work, it could be planned and estimated the surface area, in terms of square metres in a more comprehensive manner, to be allocated to the energy production plant to reduce its overall impact and respond effectively to the energy demands of the community's users.

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