Il Gigante Fotovoltaico: Luci e Ombre della Pianificazione Energetica in Puglia

The Photovoltaic Giant: Lights and Shadows of Energy Planning in Apulia

Edoardo Altavilla[1]

La regione Puglia si è dotata nel 2007 di un nuovo e ambizioso piano energetico. Lo scopo di questo paper è di esplorare e riportare alcune incoerenze nel processo decisionale e di valutare due obiettivi di piano selezionati. La ricerca è stata condotta con una metodologia quantitativa. I risultati della ricerca mostrano che 1) durante il decision-making c'è stata una mancanza di razionalità nel tradurre le opzioni tecnologiche emerse nella fase di brainstorming in obiettivi di piano; 2) la micro-generazione da fotovoltaico rappresenta un obiettivo fallito; e 3) che l'obiettivo di aumentare incrementare la quota di fotovoltaico sul totale dell'elettricità prodotta è stato ampiamente raggiunto ma ha prodotto una evidente conseguenza negativa: l'estensiva copertura di suolo agricolo.

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Italian region Apulia provided itself with a new and ambitious energy plan in 2007. The aim of this paper is to explore and report some suspected inconsistencies in the decision process and to assess two plan objectives. The methodology used was mainly a quantitative one. The findings show that 1) during the decision-making there had been a lack of rationality in translating the advice of the actors' network into plan objectives; 2) the micro-generation of photovoltaic power was an unmet objective; and 3) the enhanced share of photovoltaic power over the total regional electricity generation in 2013 had been widely over-achieved and produced one major consequence – the extensive coverage of mainly agricultural, regional land.

Keywords: Apulia, energy planning, decision-making.

JEL classification: R10; R50; O20.

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1. INTRODUCTION

Climate change (CC) represents a compelling challenge and ranks among the top issues in the policy agenda of contemporary democracies (IPCC, 2013); energy renewal lies at the core of the progressive adaptation to CC.

In the wake of the progressive demand for power, local polities in the western European Union (EU) are gaining entitlement for the design of public policies on a number of country-specific issues. In Italy, the historic reform of the fifth Title of the Constitution in 2001 placed the 'production, transport and distribution of energy' among the subjects in concurrent legislation. It means that the Italian *regioni* are now planning their own energy development with the only constraint of not contradicting the guidelines of the national state (see article 117, Italian Constitution).[2]

Apulia, one of the major energy-producing and energy-consuming regions in Italy (6.2% of total electric demand in Italy and 12% of production come from Apulia[3]), approved the Regional Plan for Energy and Environment (PEAR) in 2007, which raised a lot of national interest among policymakers and commentators for producing significant results in the renewable electric energy sector (primarily photovoltaic [PV] and wind power).

The renewable energy landscape in Italy had been traditionally dominated by hydroelectric power, featuring solar energy only in recent times;[4] in 2006, PV power was almost inexistent compared to all the other energy sources but reached 17.700 MW of installed power in 2013 (Legambiente, 2013, p. 56). As discussed later, its significant share goes to Apulia's credit.

To inform the energy plan in the best way, the regional government, through the Agency for Technology and Innovation (ARTI) – active in fields such as human resources renewal, regional innovation policies and business service – and several actors from the corporate and academic realms, embarked on an *ex-ante* evaluation process aimed at

[2]Reform no. 3, 18 October 2001, reorganises the system of legislative competencies between the central state and the local administrations. The new system is characterised by subjects at *national*, *regional* or *concurrent* competence levels. 'Concurrent competence' means that the legislative power is formally regional, except for the expression of fundamental principles, up to the national state.

[3] TERNA (2012).

[4]The first system of incentives for solar production of electricity dates back to 2005 when the first *conto energia* (the Italian name for the feed-in tariff) had been launched.

assessing a wide array of technological options for the region's future energy profile: the so-called 'technology assessment', a praxis believed (ARTI, 2008) to be a vital tool for forecasting the effects of a given technology's large-scale implementation.

This paper has a twofold aim, first, to show that despite this well-informed and inclusive governance effort where technical, entrepreneurial and political realms came together to define major policy priorities, the Apulian energy plan failed to embed at least one crucial advice that in the first place found diffused agreement among different planning levels (namely, the reconversion of the built environment and thus, the related micro-generation from PV power). General inconsistencies between the technical brainstorming organised by the regional planning apparatus and the final public choice itself (such as the not entirely justified choice of hydrogen) are also raised. Second, this study intends to corroborate the hypotheses of the existence of unexpected outcomes and unmet objectives of this energy policy, such as the extensive coverage of agricultural land for large PV plant installations and the failed achievement of micro-generation, respectively.

No acknowledged and comprehensive evaluation of the PEAR has been produced so far although the plan itself provides the tools for monitoring the objectives across the years.

Therefore, part of this paper describes the cognitive process put in place by the regional government as a preliminary phase to the redaction of the PEAR to identify the feasible options in terms of technology, as well as tests the hypotheses cited above.

The rest of this article is structured as follows. The first section (chapter 2) explains the research methodology. Secondly (chapter 3), the context and case of Apulia are introduced. The third part (chapter 4) presents the findings, and the fourth section (chapter 5) discusses such results. Finally, the conclusions are drawn.

2. METHODOLOGY AND POLICY DOCUMENTS REVIEW

This research was conducted by using mostly quantitative data; in this respect, it included a mix of secondary and primary sources.

Deskwork design comprised two elements: one that involved the revision and analysis of relevant policy documents and programmes and the other, a press review. This was done

to isolate the salient passages of the Apulian energy planning experience and to help formulate the research questions more accurately.

The documents reviewed in this phase were the 1) Regional Plan for Energy and Environment (PEAR, 2007), 2) ARTI notebook no. 14 (ARTI, 2008), and 3) the 2006 feasibility study coordinated by the then ARTI president, Prof Luigi Nicolais (Nicolais, Rosatelli, Annunziato, Campanile, & Gasperi, 2006).

The PEAR and the national act provided the legislative and planning settings of the context, such as plan objectives, timelines, action strategies and the like; on the other hand, the notebooks issued by the ARTI gave accounts of the preliminary phase of Apulian energy planning, where the wide array of technological options had been assessed and sorted out. Since the specific documents that could have given a better picture of some steps of the decision process (such as the multi-criteria analysis records or the questionnaires distributed to stakeholders and experts in the corporate and academic sectors) were quite difficult to access, the ARTI's summarising work had been an alternative and trustworthy source of secondary information although not in the ideal detail.

At the end of this stage, it became clear which were the most ambitious perspectives designed for Apulia and what objectives found in the plan were worth verifying.

Another important focus had been operated subsequently; according to the availability of secondary data, it was considered appropriate to narrow the investigation to the PV sector of renewable energy sources as the target of this research.

The data mining bibliography ranged from annual (and sometimes monthly) data collections of the Italian national manager of electric infrastructures (TERNA) and statistical annual reports of the Energy Services Manager (*Gestore Servizi Energetici* [GSE]) to periodic reports of environmentalist associations, such as *Legambiente* (which provided valuable PV data at the municipal level). The GSE website was also consulted for its geographic information system (GIS) service on the Italian PV power named *Atlasole*, an important tool for the geographic referencing of PV deployment. Another valuable GIS source was the open data of the *Regione Apulia* website named *SIT Apulia*.

To a much lesser extent, some primary data had been produced, concerning information about the PV plants' land coverage comparisons among selected Italian regions, for which the data were all original elaborations.
The results of this stage's work are presented in the results section.

3. ELEMENTS OF CONTEXT

This section describes all the contextual factors useful for framing the case study of Apulia. It is divided into four subsections. Subsection 3.1 shows the normative panorama starting from the Europe 2020 strategy and progressively zooming into the regional Apulian scale. Subsection 3.2 introduces the regional agency ARTI, which animated the cognitive process underpinning the final plan decisions. Subsection 3.3 reconstructs the decision process itself. Subsection 3.4 shows the quantitative data on PV regional development.

3.1 The region taking on the burden: Europe 2020 and political turn in Apulia

The *Europe 2020* strategy is a set of nationally articulated objectives aimed to be achieved by 2020 in Europe as a whole. It appoints Italy with three main environmental targets: 13% reduction of greenhouse gases (GHGs) with respect to 2005, 17% share of renewable energy sources over total energy consumption and 20% of overall energy efficiency. This strategy ought to be embedded in the national normative systems through the so-called National Action Plans;[5] in the same way, other nations have to establish regionally tailored targets.[6]
This *burden-sharing* process institutionalised the regional objectives with the Ministerial Decree of 15 March 2012, which, for Apulia, provides 14.2% of consumption (electric plus thermic) from renewable energy sources.
However, the season of regional sustainability began even earlier for Apulia. With the first, clamorous electoral victory of Nichi Vendola in 2005, Apulia emerged from a long-

[5] *Piano d'Azione Nazionale* (PAN) in Italian.

[6] For a comprehensive picture of the regionalisation of Europe 2020 strategy objectives and a summary of the criteria used to diversify the national targets for regions, see chapter 6 of Borganello, Brignoli, Benini, and Gelmini (2010) and for the sake of this study, Borganello et al. (pp. 72-74).

lasting, centre-right government and was considered – likewise, the whole Italian *Mezzogiorno* at that time – impervious to left-wing political penetration. The coalition managed to unite the fragmented galaxy of the Italian leftism and is now on its second mandate. The political proposal was markedly based on the idea of environmental sustainability as a key driver for regional economic development, which represents until today a prototype of the European green, left political discourse. The regional cabinet had been elected with a programme that was strongly inspired by ecological reconversion, something that called for an implicit but deep change in the energy offer as expected by the public sector and not the least, by the renewal of the demand from both civil society and firms and industries.

The *smart growth* concept launched by the EU as a sort of 'umbrella term' became one of the key conceptual weapons of the political discourse of the newly established ruling class. Initially, the governor's office managed to create an original declination of sustainable development among applied policy objectives such as labour (ecological reconversion as an opportunity for skills and labour training renewal), tourism (ecotourism as a consequence of landscape preservation), economic development (new entrepreneurship around information and communication technologies [ICTs], renewable-related tools manufacturing and so on) and urban policy (smart cities, mostly characterised by electric transport, energy efficiency of buildings and diffused electricity generation).

Discussing all these factors is beyond this paper's scope; nonetheless, it is important to appreciate the ARTI's pivotal role in this innovation-based, regional development strategy.

3.2 The Agency for Technology and Innovation: in quest of the 'triple helix'

As soon as the new regional government took over in 2005, it put into function the agency ARTI that had been only hypothetical during the last period of the previous administration.[7]

Appointed with other tasks that include allocation of regional and European funds for start-ups, the agency has been primarily active in gathering, distilling and disseminating scientific and technical knowledge for regional policies. It has also been involved in conducting research on public and corporate innovation to renew the regional human capital, giving advice on appropriate demand-side policies for economic development and ultimately, orchestrating the regional innovation system inspired by the so-called *triple helix* (understood as the fertile cooperation between universities, public sector and corporate sector[8]). Overall, for its capacity to mobilise local cognitive capital, bring together different actors and views, and coordinate the technical substrate on behalf of rational and thought-out public choice, the ARTI can be reasonably considered some kind of a 'regional *animateur*' (Morgan, 1997, 1998) for Apulian economic development.[9]
Substantial technical efforts had been produced over the 2006–2008 period by the regional energy planning apparatus, during which the agency coordinated the technology assessment (Matalucci & Rubino, 2008), an analysis methodology to evaluate the consequences of the large-scale application of an energy technology (European Commission, 2013).

3.3 Energy decision-making process: a historical reconstruction

Apulia had taken into consideration the European planning level during the brainstorming phase prior to the redaction of the energy plan – it has been argued lately by the governor himself – as Italy has been unable so far to give itself a clear and sound, national energy

[7]The agency ARTI had been established by regional law no. 1 in 2004 but had been formally operative (with tasks and a formal statute) following the deliberations of regional assembly no. 1172 dated 06 August 2005 and no. 1297 dated 20 September 2005.

[8]For details on the 'triple helix model', see Etzkowitz (2008).

[9]This is with the due differences with respect to much more *political* regional agencies that had been discussed widely in the literature (such as QUANGOs, including the Welsh Development Agency – until its demise in 2006 – to which it had been referred earlier) and were able to directly invest money in the territories and generally had much wider responsibilities.

strategy (D'Amico, February 2014). The regional decision-making process on energy-related matters had been in a way favoured by this national negligence and began to work on the preliminary part of its energy policy, reviewing European planning and foreign (Scandinavian and German in general, with their well-consolidated practices of *ex-ante* evaluation of technology options) governance praxes (ARTI, 2008, p. 19).

Undertaken in May 2006, the first step was the selection of the most promising technological alternatives for Apulia through the analysis of international orientations and the vocational study of the Apulian territory. In the preliminary hearings, notable advice had been collected,[10] and with the support of the Ministry of Economy's evaluation unit for public investments (*Unità di Valutazione degli Investimenti Pubblici - UVAL*), the ARTI managed to explore and verify the economic feasibility of broadly selected technologies. The document produced from this round (the Nicolais Document) constituted the first layer of the 'evaluation of coherence' pictured in Table 1.

In 2007, besides the previous recognition across the supranational planning system, another round of hearings was put forward by informally interviewing 35 of the most relevant entrepreneurs in Apulia (*grandi attori*), asking for their advice on technology options and key technical interventions. On the other hand, the questionnaire – distributed mostly among 700, medium-sized firms – highlighted the wind offshore source, biomass reconversion, solar energy (particularly thermodynamic and solar cooling), bio-architecture and energy reconversion of the built environment as the most viable technology options[11].

[10]The work for the identification of the best alternative energy technologies for Apulia availed itself of the contribution of three universities and research units (Polytechnic of Milan, Department of Energy; University of Insubria, for the parts regarding wind power and biofuel; and CRA-VIV of Pescia (Potenza, Basilicata). The technological consulting activity of ARTI also supported the aforementioned outsourced studies. This complex work of identification of technology options for Apulia had been launched, following the regional Department for Economic Planning's assignment to ARTI to draft a feasibility study.

[11]For the justifications of the experts' advice, see ARTI (2008, pp. 73-74).

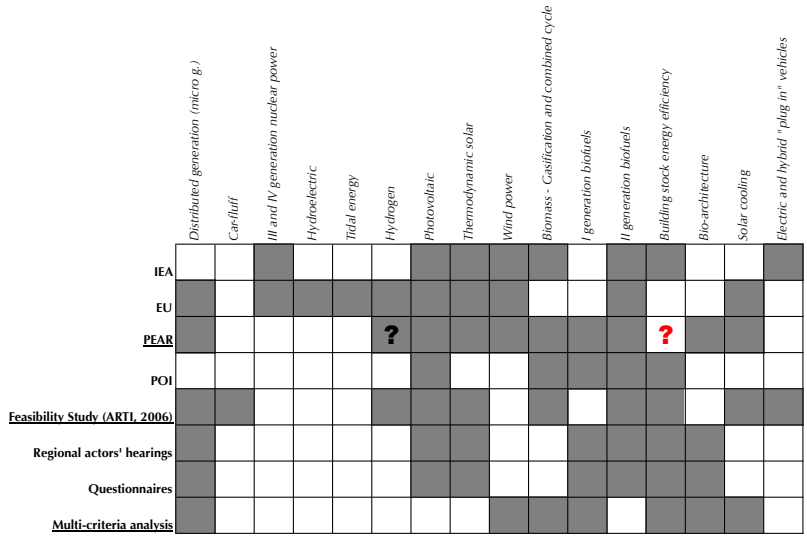

Table 1 Overview of plan choices and experts' advice

After the interviews and questionnaires and significantly after the approval of the regional plan, the new European programming period started. The region's Programming Department also asked the ARTI to conduct a specific multi-criteria analysis that served in this phase to establish order among the different options that emerged from the previous planning recognition. The research group then agreed on seven criteria.[12] This multi-criteria analysis (the final summary is on the last row of Table 1) made it possible to rank the array of the different options in an effort to isolate the most suitable one by using the ELECTRE III method.[13] The result, a matrix that sorted all the options according to a value ranging from 0 to 1, identified the following six technologies (values above 0.60 were considered satisfactory)[14]:

[12] These are consistent with the objectives of the Strategic National Framework 2007-13: regional normative, transferability of commercial applications from other territorial contexts, commercial opportunities, market niches useful for the initial development of the technology, impact of the local research network and specific vocation of the regional productive fabric.

[13] The chosen simulation called ELECTRE is a particular method of decision support for public choices designed to rank different alternatives according to the criteria of coherence, non-excludability and outranking among them. In so doing, thanks to the admission of incomparability among the alternatives and above all, because of its adoption of the *bounded rationality paradigm* (Bobbio, 1996; La Spina & Espa, 2011) the method is deemed one of the most consistent with the reality of decision-making and particularly suitable for energy planning (Beccali, Cellura, & Mistretta, 2003, p. 2086). For fundamental literature on the method, see Roy (1991).

[14] Note that the PV option did not obtain the necessary score to be considered appropriate.

1. *energetic renovation of existing buildings (0.80),*
2. *production of biomasses (0.74),*
3. solar cooling (0.71),
4. small wind power (0.69),
5. bio-climatic architectural techniques (0.69) and
6. offshore wind power (0.63).

The options in italics are the only ones that (according to the ELECTRE method jargon) are not 'outranked' by any other option but outrank all the others.

Table 1 summarises the rounds of hearings, comparing all the opinions of the planning bodies and main actors. The chart groups both technologies and usage modalities; it describes to what extent regional choices on energy planning have been consistent with the advice of the bodies and players involved and to what extent subsequent option assessments have been confirming the plan choices. Highlighted are the choices of the regional plan, the scarcely advised option of hydrogen is represented by the black question mark, and the red question mark identifies the missed tick on the building stock's efficiency option – a highly shared priority. These notations will be clearer in the discussion section.

3.4 The new regional profile: the rise of a photovoltaic giant

Let alone the fact that they partly contradict subsequent options advised, the strategic objectives set by the PEAR for Apulia are indeed far reaching: investments on the economy of hydrogen,[15] complete substitution of carbon with natural gas[16] and overproduction of electricity according to a 'principle of solidarity' towards neighbouring regions. However, apart from some cases, such objectives are hardly verifiable because of

[15]Apulia was one of the first regions in Europe to hypothesise the use of hydrogen for the widest applications, featuring the sponsorship of Jeremy Rifkin (Rifkin, 2002), one of the most famous theorists of the so-called 'third industrial revolution': from public transport to smart grids (see project INGRID for details on the use of hydrogen to improve the efficiency of the electricity grid towards micro-generation).

[16]Regarding the natural gas supply, the region includes in its programme – coherent with its economic and commercial relationship strategy with the Balkan area – the participation in the trans-Adriatic pipeline (TAP) that is supposed to bring in natural gas from Azerbaijan to Italy via Apulia Greece and Albania in the future. However, the project has been much criticised because the pipeline will pass by one of the finest coastal areas in southern Italy (Melendugno marina), which is one of the fastest growing tourist attractions over the last decade.

the way they are expressed, the lack of quantitative indicators or the absence of up-to-date data about some of the indicators that the PEAR itself provides in the strategic environmental assessment (PEAR, 2007, pp. 454-471).

Nevertheless, this part of the study focuses on the deployment of PV technology in Apulia; in this regard, it deals with two dimensions of the phenomenon: the actual magnitude of regional PV technology as of 2014 and to what extent PV micro-generation had been achieved.

To define the tendency scenarios for each sector and energy source and to justify resorting to renewable energy sources, the PEAR working group produced a detailed reconstruction of the consumption and production patterns over the 1990–2004 period. This time span had been confirming the progressive configuration of the regional society as a slowly developing one; overall energy consumption had increased by 19% since 1990 (22% Italian average), and consumption levels per capita rose from 1.87 tonnes of oil equivalent (toe) to 2.21 toe in 2004, again less than the Italian average over the same period. The most energy-consuming sectors were industry (18% in relation to other consumption sectors, higher than the national average – with the prominent contribution of the Taranto productive area) and transportation (accounting for 27% with respect to the other sectors). In this same percentage comparison, civil use had been considerably minor relative to the Italian case as a whole (18% and 33%, respectively).

The primary tool used to achieve the PV targets had been the feed-in tariff (*conto energia*[17]), a national policy that aimed at stimulating PV installations in the Italian territory through a massive incentive system. However, the local output of such technology (for example, the size of the installations) had been for years heavily dependent on the regulation policy (permit systems) that each region decided to adopt.[18] In this respect, Puglia aimed at incentivising mostly large-sized installations through a

[17]The feed-in tariff (*conto energia*) in Italy has had five editions (the fifth being the current one); Apulia built its fortune on the full exploitation of the first three (first phase). The difference has been made by the high premium put on large-sized PV panel parks, drawing attention and criticism on the unscrupulous management of the national incentives for renewable energy sources.

[18]Until the Ministerial Decree 28/2011, with which the national legislator aimed to standardise the authorisation systems.

particular, regional authorisation regime. Such a system required only a simple communication to the municipality (*Denuncia Inizio Attività – DIA*) for PV installation, each up to 1 MW of power.[19]

This national incentive policy, coupled with a clear regional strategy oriented to favour large-sized PV installations, brought about the results summarised in Figures 1 and 2. Nearly 15% of Italian PV installations (in terms of power) are located in Apulia; this percentage had been achieved through the peculiar management (the tailored permit system described above) of the feed-in tariff, through which Apulia rapidly jumped to the top of the Italian 'green' regions table.

The second part of Figure 2 shows the specifications of the two most responsible provinces for installed power, Brindisi and Lecce. Moreover, Brindisi includes some of the most PV-covered municipalities in Italy, with peaks (such as in Cellino San Marco, Brindisi) of over 42,000 kW per plant, covering about 125 ha of agricultural land.

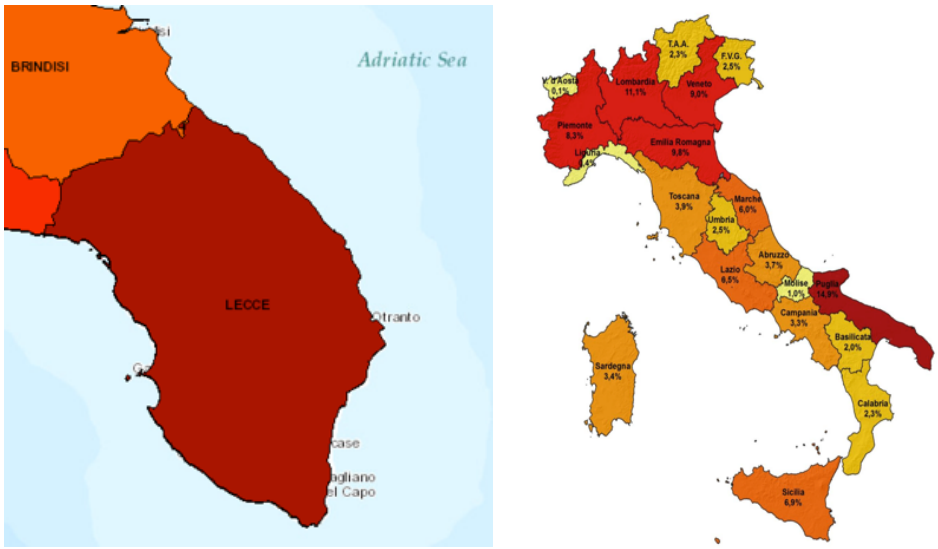

Figure 1 Regional PV-installed power in Italy in 2012(%) - colour shades from yellow (low effect of PV) to red (high effect of PV)

[19]To give an idea of the usually applied classification, plants with power up to 20 kW are 'small', between 20 and 50 kW are 'medium' and higher than 50 kW are 'large' (II *Conto Energia* taxonomy).

Lecce (665,000 kW) as a whole accounts for half of the installed kW of regions such as Lombardy, Veneto or Emilia-Romagna. Figure 2 shows the pie chart summarising the provincial percentages per classes of PV power.

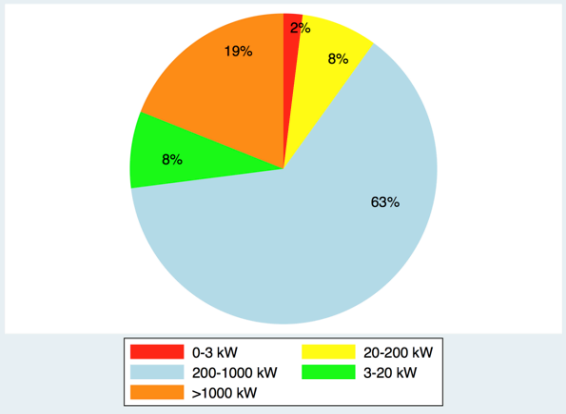

Figure 2 Share of classes of PV power in the province of Lecce

Figure 2 is the result of the first phase of the Apulian PV policy, oriented to offer side efforts towards the differentiation of energy sources.

4. RESULTS

The results presented in this section reflect the data mining done with respect to two objectives of the PEAR. These assessed objectives are the 1) micro-generation and initiatives towards electricity production from PV plants and 2) installation by 2016 of at least 150 MW more from PV plants in comparison to 2004.

1. To verify the hypothesis of micro-generation as an unmet objective, three kinds of data are used: the number of PV plants, land coverage and roofs' coverage.

Apulia is fifth among Italian regions in the number of plants (38,214) (Atlasole), and the large share of power comes from larger-sized (mostly grounded) installations.

Another explicit datum confirms this previous statement: 432 of the total PV plants in Apulia (1.13% of 38,214) had been employed to cover harmful[20] asbestos roofs, whose disposal had been recently incentivised (GSE, 2012).

[20]In Italy, the *eternit* roofs' coverage has been proven responsible for hundreds of deaths from exposure to asbestos.

According to the study of the US governmental body National Renewable Energy Laboratory (NREL) (Ong, Campbell, Denholm, Margolis, & Heat, 2013), the land needed to produce 1 MW of PV power is calculated to be between 3 and 4 ha (3.5 ha on average). For this research, this value has been computed with the installed (grounded) PV power in Apulia to obtain the percentage of gross regional surface covered by PV units; around 8.75 ha of the regional land are employed for PV plant installations (around 0.0004% of the total gross regional area).

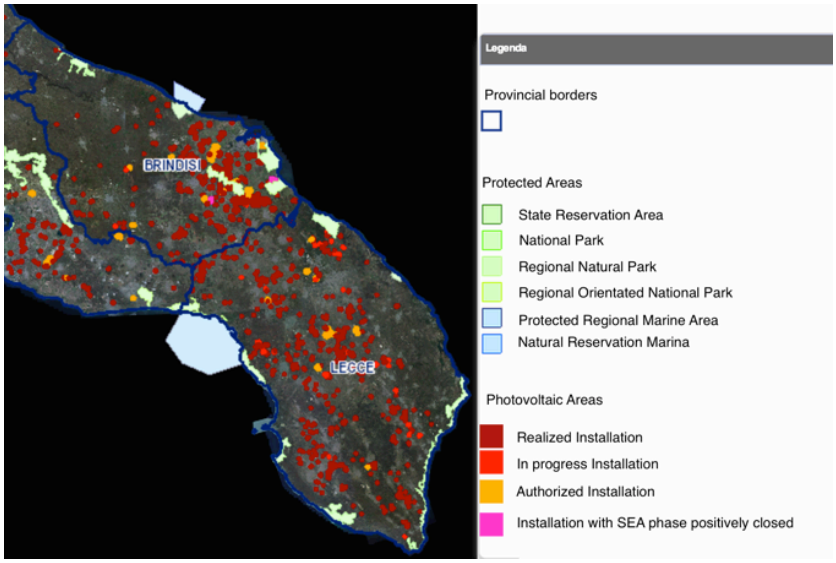

Figure 3 Localisation of PV plants in the provinces of Lecce and Brindisi ("SIT Puglia," 2014).

Figure 3 is a map obtained by overlapping several layers of geo-referencing land-use restrictions for natural boundaries and cultural properties (all hues of green, grey and pink), together with PV plant installations (red dots). On the other hand, Figure 4 shows the details of the province of Brindisi (southwest of Brindisi town[21]), making it possible to note the agricultural locations of most PV installations.

2. The PEAR also provides a quantitative minimum objective for PV power installation of additional 150 MW by 2016. In 2004, electricity production from the solar source was 0.5

[21]Orthophoto.

MW in power and 0.7 GWh in production; the share of total regional production was slightly above 0% (GSE, 2012). In percentage, the region had set an increase (PEAR, 2007, p. 260) of at least 300% in installed power, and it reached an increase (in production, thus in GWh) of almost 5000%: 0.7 GWh in 2004 against 3438.8 GWh in 2012 (TERNA, 2012).

According to the GSE (2012), Apulia had the highest share of grounded PV modules (78%) on the total regional installations and showed the highest average PV plant size in Italy (74 Kw). Apulia was also ranked last among Italian regions regarding the share of PV power generated by households (5% of total installed MW).

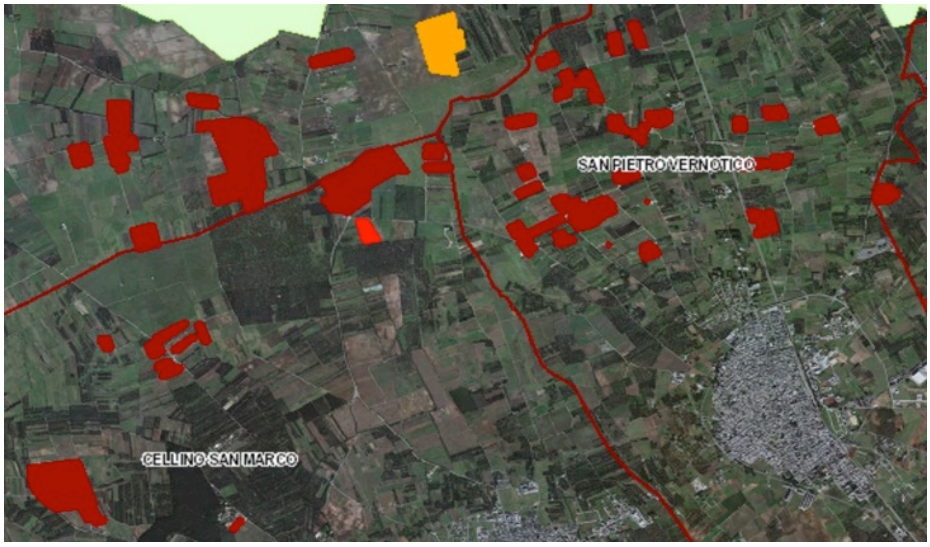

Figure 4 Detail of Brindisi province's PV locations (SIT Puglia, 2014)

5. DISCUSSION

This section uses the data in the previous section to corroborate the two hypotheses linked to points 1 and 2 presented earlier, as well as to judge the decision process reconstructed in subsection 2.3. These three arguments are the following:

1) Micro-generation in Apulia was an unmet target.

2) The plan's targeted PV production increase was hugely *over-achieved* and caused a major unexpected outcome.

3) Despite the inclusive and well-thought technology assessment praxis put in place, it failed to achieve full coherence among the various rounds of advice collected, and some choices of the plan seemed fairly irrational.

I argue that the first two arguments are related to the regional permit regime in force from 2005/2006 to 2011.

Emerging from the empirical survey results, the Apulian energy plan achievements (at least the ones considered in this article, which are quite representative) are rather controversial. If no argument can be proposed towards the outstanding magnitude of renewable electricity (PV in this case), some nuances can be detected on its modalities and the collateral effects brought about by this fast and robust development. As documented earlier, the micro-diffusion of electricity production plants has been hypothesised as a still unmet objective – at least with reference to some other comparable (in terms of installed power) Italian regions. Therefore, although this objective has not been substantiated by a quantifiable indicator, it can reasonably be assessed as a widely unmet target in terms of the data on the number of plants in the region (38,214). Considering that regions with comparable installed power, such as Lombardy and Veneto, hosted twice the plants that Apulia did in 2014 (76,000 and 74,000, respectively), if there is such a thing as micro-generation of PV power, this is not the case for Apulia. Comparing these three regions again, Apulia's poor performance regarding the substitution of asbestos roofs with PV units can be taken as a further proxy for confirming the hypothesis.

Moreover, the mentioned regions have not used so much agricultural land as that of Apulia; thus, it can be demonstrated not only that the PV penetration has been more capillary in these regions but also that a larger share of the plants has been integrated with residential buildings. In Apulia, despite the PEAR mentioning the need to integrate PV

units with housing modules (see point 2), PV power remains a clearly extensive phenomenon.

Concerning the extensive land coverage of PV plants, some original calculations have been done in this study to assess this 'qualitative' target. Notwithstanding the lack of an appropriate quantifiable indicator, in Apulia, 0.0004% of the total gross regional surface is covered by PV plants; in contrast, Veneto, Lombardy and Emilia-Romagna, on average, use half the percentage (0.0002%) of gross land for PV plants.

In the light of the data presented in the previous section (point 2), the +150 MW objective by 2016 (at least) can be checked as *over-achieved* and taken as a measure of the fact that PV deployment in Apulia went somehow out of the hands of regional policy actors. Citing the then third, feed-in tariff period, the plan set very low target values for what had been the policy conducted since then in the PV sector; the oversized (+5000%, as shown) increase in PV plants installed against the 300% planned increase clearly demonstrates this insight. It is noteworthy – apart from this unexpected quantitative result – how the target had been worked out in relation to the intervention tools that the plan provided. The Strategic Environmental Assessment SEA appendix mentions the intention to achieve the objective of installing at least 150 MW more of PV power by resorting to 'small-medium installations that could be integrative of the larger sizes currently favoured by the feed-in tariff' and by 'implementing policies that aim at favouring the integration' of such small-sized modules 'in the buildings' structure according to the incentives for such installation modality acknowledged by the Ministerial Decree 6 Feb. 2006' (PEAR, 2007, p. 340). Indeed, the empirical evidence showed a different scenario, as the PV data on households and average size of plants accredited.

Some remarks must also be made on the decision-making aspects of regional energy planning. Some inconsistencies have been found between the PEAR's choices and the – even well-constructed – technology assessment; to some degree, several options seemed unjustified in the light of the multiple-layered rounds of hearings among experts (namely, the scarcely advised hydrogen option and how the energy efficiency of existing housing stock failed to be included in the agenda). Furthermore, it appears that there had been

some kind of preferential relations among the three planning levels, as highlighted in Table 1, namely, the multi-criteria analysis, the feasibility study and the PEAR itself. In fact, the first two documents represent the most *local* voices as they were elaborated (if not by the ARTI itself, which is an emanation of the regional government) by analysts and specialists chosen directly by the ARTI (Matalucci & Rubino, 2008). Therefore, it can be fairly asserted that most of the PEAR choices on technology implementation have been *scientific* and *technical* rather than strictly political; it is just this latter consideration that makes, for instance, the hydrogen option (but something similar could be said for PV power itself) or the missing 'housing stock renewal' choice more difficult to understand. One could risk saying that these were the circumstances under which the political-lobbying forces had been at work in Apulia. However, this is a matter for further studies since no research has been conducted to deepen such mechanisms.

As a marginal note, recalling the numbers that testimony the over-coverage of regional land with large-sized PV plants, this might have been avoided if the evaluation of coherence (the analytical tool that provides for the consistencies of plan choices with other planning documents) had taken into account the Regional Landscape Protection Plan (PPTR). In fact, when approved, the PPTR brought about resolution no.1947 dated 20 October 2009, which prohibited further installations of grounded plants in agricultural zones.

6. CONCLUSIONS

Regional polities are increasingly crucial for socioeconomic adaptation to a global challenge such as CC. Taking advantage of the newly devolved legislative powers on energy, the Italian region of Apulia inaugurated a season of intense energy planning in 2006. Since then, through the regional agency ARTI, it had been capable of triggering a high-profile, decision-making debate on environmental issues that lasted until 2007.

However, the PEAR's ultimate choices that emerged from this period did not always coherently reflect this multi-layered set of advised technological options for Apulia's future energy profile. Furthermore, according to this study's findings, two crucial

objectives of the plan had not materialised so far, or in some cases, they did but not in the expected magnitude.

On one hand, this paper has discussed the decision-making process developed in Apulia. On the other hand, it has attempted to take stock of two indicative objectives presented in the PEAR and for which the plan itself has provided yearly intermediate objectives up to 2016. These investigated objectives were the achievement of micro-generation from PV plants and the installation of at least 150 MW more of PV power by 2016.

The empirical results showed that 1) micro-generation was a widely failed target, 2) the goal of installing additional 150 MW of PV power had been largely exceeded and caused the extensive coverage of regional agricultural land, and 3) even a well-arranged process of brainstorming policy options – in accordance with the new imperatives of multi-level and inclusive governance – could fail to reach substantial consistency in terms of policy choices.

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