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The ambition for an actual transition

EXPLANATORY NOTE

#1 - May 2022

Accompanying transitions in the SUD PACA region: from a prospective vision to local solar experimentation through the landscape

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The recent contribution made by the WGIII working group to the IPCC report (IPPC-WGIII, 2022) underlines that the energy production sector largely contributes to total net emissions of greenhouse gases (GHG), with around 34% in 2019 (20 GtCO2-eq[1]). The report also stipulates that solar power has the best potential to reduce GHG by 2030, just before wind power, carbon sequestration through agriculture, and reduced land take (IPPC-WGIII, 2022 - figure SPM.7, page 50). In France, 13.2[2] GWp photovoltaic power was installed in 2021 and, according to the PPE (220), by 2028 the figure will be 35 GWp, possibly 45 GWp, corresponding to 9% to 12% of final electricity consumption. According to the prospective study by RTE for the future of energy in 2050 (RTE, 2022), depending on the scenario studied, the power installed will amount to 70 to 208 GWp, for respectively 13% to 36% of final electricity consumption. These ambitious objectives for France are broken down by region. The SUD PACA region, which has high potential for renewable resources, especially solar, has redefined its energy targets in its regional plan for sustainable resources and equality (SRADDET, 2020) and is aiming at carbon neutrality by 2050. To achieve this, it anticipates strong growth of photovoltaic from 1.6 GWp in 2021 to 46.8 GWp in 2050, of which 34 GWp on rooftops, combined with reduced energy consumption.

The achievement of these targets raises several questions. For example: where will installations to capture solar energy be developed? Close to territories that consume high levels of energy, or in areas with high potential? What energy mix should accompany the development of renewable energy sources? At what pace should technologies be deployed? To answer these questions, the application of a prospective approach employing modeling tools is crucial. Such an approach can be used to explore the evolution of the energy system over the long term through different possible evolution scenarios, following imposed constraints that reflect the conditions to be

1. GtCO2-eq (gigatons of CO2 equivalent) designates the quantity of carbon dioxide, expressed here in gigatons, that would provoke the same cumulative radiative forcing over a given period.
2. GWp (gigawatt peak) designates the instant power in GW (gigawatt) of a certain surface of photovoltaic modules when they are at a temperature of 25°C and receive, at normal incidence, solar irradiance of 1,000 W/m2.

respected or avoided. Prospective modeling can also be used to define choices and determine policies aimed at directing energy systems towards the desired trajectory. A prospective approach does not therefore attempt to predict or anticipate the future, but rather to envisage possible futures in order to build them. As defined by Berger (1960), prospective is a "reflection on the future that attempts to describe the most general structures and to identify the elements of a method that can be applied to our fast-moving world [...] Taking a prospective attitude means getting prepared."

In this context, and to explore the possible avenues for decarbonization and for transition towards a circular economy for the energy system of the SUD PACA region, Andrade (2021) has built a prospective model: the TIMES[3] SUD PACA model. This model integrates in detail the technical-economic characteristics of the regional energy system, and the potential of energy resources and different technologies that can be developed on the territory. Through the analysis of different scenarios, Andrade (2021) observes that the efforts that the region needs to make to reach its decarbonization targets are very high: the region must imperatively allocate and manage its resources in an efficient, reasoned, and pertinent manner, according to the different sectors and geographic areas of consumption. Solar resources are key in regional decarbonization, but their exploitation will need to be accompanied by the deployment of hydrogen and battery industries. In addition, the application of a circular economy will lead to a deeper decarbonization of the energy system by recuperating resources that would otherwise have been thrown away, and through a shift towards more energy-saving behavior. To reach these objectives, the region should promote solidarity between territories, which would lead to more efficient exploitation of its local energy resources. Lastly, the scale of local authorities is crucial to reach national and international decarbonization targets.

3. TIMES: The Integrated MarkAl-EFOM System (MarkAl: "Market Allocation", EFOM: "Energy Flow Optimization Model") developed as part of the "Energy Technology Systems Analysis Program" (ETSAP) run by the International Energy Agency (IEA). It is a bottom-up prospective tool based on a partial equilibrium and following a linear optimization paradigm.

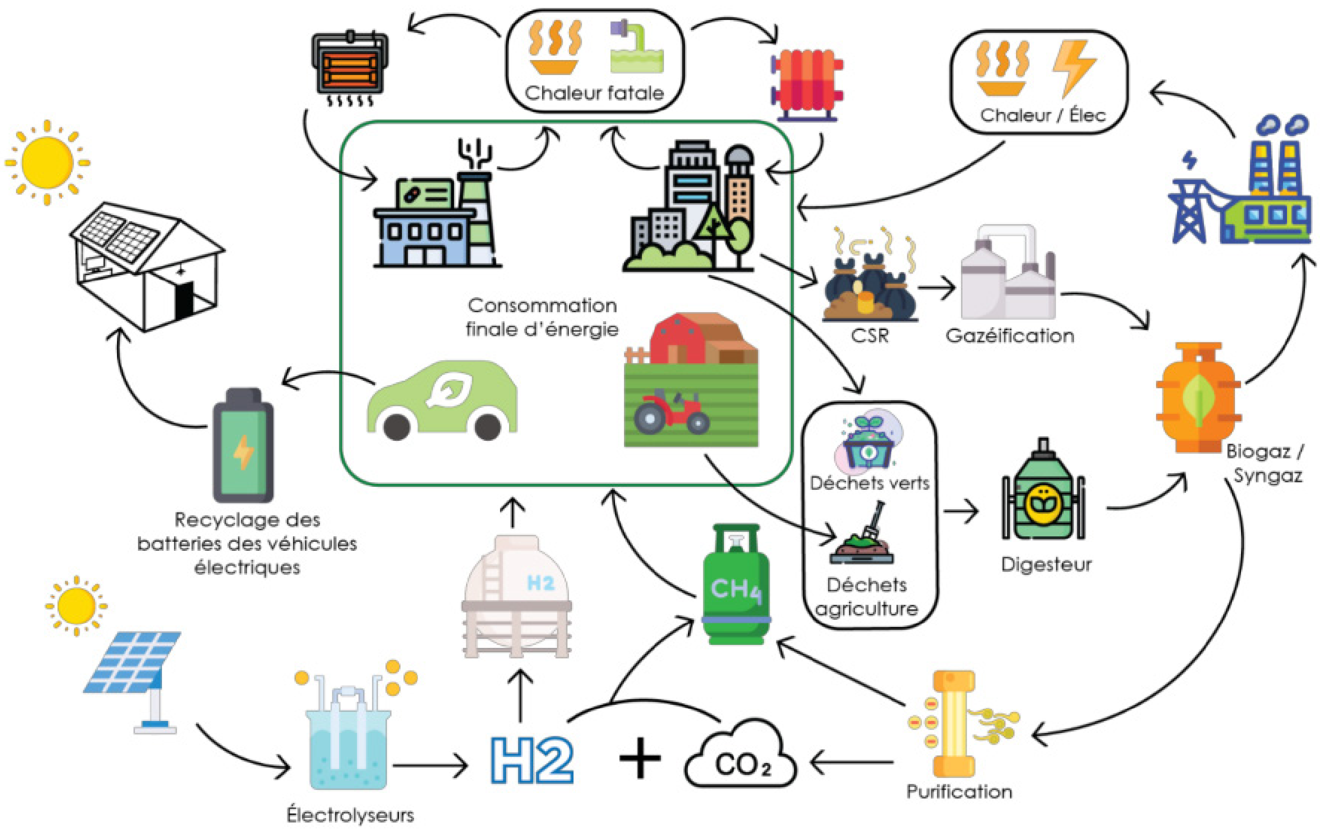

Figure 1: Vision of a circular energy system for the SUD PACA region (Andrade, 2021).

To go beyond "getting prepared" to define and act for the region's decarbonization and sustainable development, in particular benefiting from its abundant solar resources, the next engineering step should involve refining the characterization of territorial situations. This consists in crossing a mapping of the solar resources with other information and geographic issues, such as sloping land, buildings, roads, the distance to electric networks, biodiversity-sensitive zones (wetlands, Natura 2000, forests, etc.), and human issues such as relating to agriculture, heritage, tourism and landscape.

This type of approach by geographic information system (GIS) in the SUD PACA region can also draw from the atlas[4] of solar resources in the SUD PACA region at a resolution of 200 m (Blanc et al., 2011). Moreover, to accompany the development of solar roof panels in urban areas, solar maps with metric resolution –

4. www.atlas-solaire.fr

or solar cadasters – have been developed (Callegari et al., 2017) and extended to take into account the temporal variability of solar radiation in order to make a detailed characterization of the potential for self-consumption from roof solar panels and shelters (Blanc and Ménard, 2021). Ultimately, this expertise can be combined with engineering tools to detect, through characterization, the relations that interweave territorial situations in order to effectively deploy our power to act (civil engineering/human engineering) with regard to the complexity of pre-existing human and non-human environments.

It is particularly difficult to apply the ambitions formulated by national, regional and local policies in order to implement the energy transition. This confirms the calling into question of planning and technological approaches that are only top-down, which are increasingly contested by inhabitants (Labussiere and Nadaï, 2018).

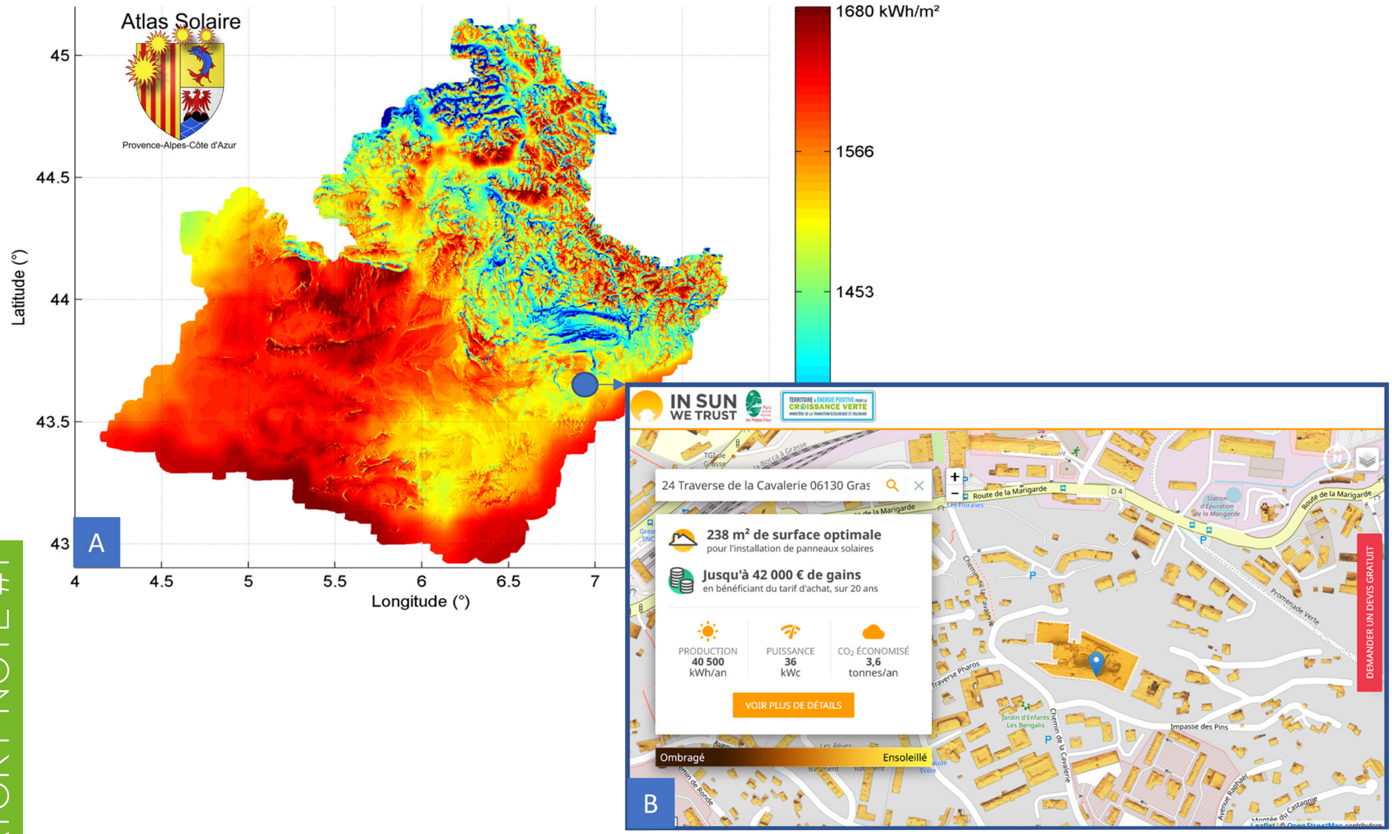

Figure 2: A. Map of the multi-annual average of overall annual irradiance on a horizontal plane taken from the atlas of solar reserves in the SUD PACA region (Blanc et al. 2011). B. Example of the solar cadaster of the Pré-Alpes d'Azur regional park in a neighborhood of the city of Grasse (06) taken from (Callegari et al., 2017).

The question therefore involves reconciliating with the expression of a two-fold challenge: our capacity to take the rationale of centralized engineering and successfully foster locally led experiments that consider the complexity of territorial situations. The results of prospective scenarios, methods and models for engineering the planning and capturing of resources, such as solar, constitute real levers of ecological action by revealing the transition potentials. Nevertheless, without local communities capable of taking hold of these data and solutions produced by engineering to operate planning that deals with the spatial and temporal interweaving of inherited landscape situations, they remain limited and even disconnected. In some cases, these solutions even lead to justifying pressures that see certain territories undergoing energy changes featuring opportunist projects with no additional value for the territories and sites involved.

These are the questions raised by the thesis currently being worked on by Joris Masafont, co-financed by ADEME and the Caisse des Dépôts, jointly supervised by the Ecole Nationale Supérieure de Paysage de Versailles-Marseille and MINES Paris – PSL, and situated in the "Landscapes of Energies" research field (Nadaï and van der Host, 2010). The problem that this work tackles is the following: How can a landscape perspective take us beyond simply looking at land use through a process of engineering abstraction that can involve neglecting the complexity of landscape situations? How can solar installations maintain, repair, enrich, and energize landscapes by becoming a part of the web of signifying relationships that they deploy? How could the introduction of these installations refocus our attention on the sharing of energies and the pooling of resources such as water?

Through local experimentation on three territories in the Mediterranean, which, among other things, are characterized by abundant solar resources, the thesis aims to draw out potential transition solutions. Based on an approach combining theoretical, practical, and didactic dimensions, through the lens of landscape and energy, these potential solutions are pursued in a collective approach, in order to respond to both the specific features of territorial situations and to national and global transition objectives. These local experiments were the object of four annual pedagogical workshops, called MIGs[5], which lasted three weeks, as part of the first year of the civil engineering course at MINES Paris – PSL, in partnership with the ENSP Energy and Landscape Chair[6] (MIG SOLAIRE, 2018; 2019; 2020; 2021). The workshops brought together MINES Paris – PSL engineering students to work with landscape architecture students and recent graduates. Each workshop illustrated the rich and inspiring combination of energy and landscaping, and involved a genuine synergy between landscape architects and engineers. This synergy fostered the joint conception of projects whose efficiency criteria included respecting the land and the diversity of the living world in accordance with landscape situations. The dynamics resulting from the ecological and energy transition projects in these local experiments led to devising adaption strategies to tackle climate change, on diverse scales of action, and with a concern for territorial solidarity and the pooling of local resources.

Figure 3: Timeline of the four "MIG SOLAIRE" pedagogical workshops (2018-2021) bringing together engineering students in their first year of the civil engineering course at de MINES Paris – PSL with landscape architecture students and recent graduates via the ENSP "Energy and Landscape" chair.

5. MIG (métiers de l'ingénieur généraliste – general engineering occupations): https://mig.minesparis.psl.eu/ (consulted on 5 April 2022).
6. http://www.ecole-paysage.fr/site/chaire-entreprises-paysage-energie_fr (consulted on 5 April 2022).

Thus, three activities involving research, forecasting, characterization of solar resources, and local experimentation of approaches combining engineering and landscaping, can come together to help design our transitions, at the regional scale for the 2050 horizon, with local and current applicability. In addition, thinking in terms of landscape can lead our engineering students to have “an ecological mindset, in other words an awareness of the close relationships that govern the way that humans act in a finite world,” called for by Travadel and Guarnieri (2021).

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