THEMATIC CHAPTER 3

The Long-Term Strategy: Co-Evolution of Solutions

This thematic document arises from and also complements the publication *Elements for a Long-Term Low-Carbon Strategy*, produced by UNICEN.

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FUNDACIÓN AMBIENTE Y RECURSOS NATURALES

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INTRODUCTION

The publication *Elements for a Long-Term Low-Carbon Strategy*, prepared by UNICEN (2020), proposes as a long-term goal in Argentina to eliminate greenhouse gas (GHG) emissions and increase immissions through nature-based solutions (NBS) and through sustainable practices for the land use and land-use change sector (LULUCF) In this paper we will try to answer whether it is possible to manage the carbon cycle in such a way as to increase its absorption in the period 2020-2050, while replacing fossils and having forests recovered.

HOW TO MANAGE THE ENERGY SURPLUS TOWARDS 2050

Currently, most of the use of agricultural land is explained by the indicator referring to the foreign trade balance and not by the domestic food sovereignty. Therefore, it is appropriate to analyze the energy surplus that could be exported by 2050.

In order to do so, we will start from the three low carbon energy scenarios modeled for 2050 in the UNICEN document, which are based on three alternatives: 1 (electric), 2 (hydrogen) and 3 (biofuel).

Before starting, it is worth explaining the analysis supporting that if today we wanted to export energy, the market for biological bunker fuels for international transport would be available, as is the market for biofuels in general.

The greatest long-term export potential is presented by the low-carbon 2 scenario, based on increased production and use of hydrogen. According to global economic models such as those of Teske, Breyer, and others - and not just physical models, such as UNICENs' - Argentina qualifies as a world-class hydrogen export center.

Wind or wind and solar power plant factors for hydrogen electrolysis higher than 60%, located from Bahía Blanca to the south, allow for favorable seasonality with higher local hydrogen consumption in winter and higher export in spring-summer. The transport of hydrogen or electrons to the north to cover the gaps in the energy supply, especially in winter, modifies the evaluation of the need for power reserves, since there will always be excess fluid for the local system, which would be coupled to the variable hydrogen synthesis. Liquefaction and marine transport of hydrogen are revealed as a problem of greater significance than the cost of electricity generation and electrolysis.

To avoid this, the production of bunker biofuels (fuels for the bunker market of biological origin) has in the transition the chance to contribute carbon to the synthesis of fuels from biorefineries co-fed with non-fossil hydrogen, with local advantages over other sites in the world. End uses that are difficult to replace with electricity will persist for a long time; for that reason local electrification can coexist at a lower rate, along with the export of fuels identical to hydrocarbons in the off-season with respect to the northern hemisphere. In this way, local consumption of fossil fuels could be replaced more quickly, through investments whose financing would essentially be based on the international competitiveness of bunker energy production

In the case of prioritizing scenario 1, of electrification, both storage and a high level of electrical interconnection with neighboring countries are required. Concentrated solar power generation with storage, as well as photovoltaic with batteries, present seasonality of the exportable surplus compared to a scenario where wind power with storage predominates. For all the possible combinations, it is required to determine the temporal variation of these variable renewable resources. Geographic complementation is necessary to establish a regional transport system that minimizes the need for reserves and increases the availability of electricity for exchange over very long periods. The capacity factors in the wind and solar hubs will be, in this case, also very high, as well as the infrastructure costs. Unless a very favorable pattern of fluid exchange with neighboring countries is achieved, it is likely that it will be more convenient to decentralize geographically and thus accept lower capacity factors to take advantage of the greater stability provided by the dispersion of resources.

Scenario 3, intensive in bioenergy with storage of combustible fluids, is more autonomous, requires less new infrastructure and allows early incorporation of hydrogen. Compared to the current situation, this option implies more territory, more water or both for the provision of carbon-based compounds for export or domestic consumption. In the long term, it is possible to incorporate both desalination and seaweed cultivation in the marine environment, which would decrease competition for both resources. The technologies involved are known, but the environmental impacts and their economic viability at the required scale are uncertain.

HOW TO ATTUNE THE TERRITORIAL GOALS OF THE LONG-TERM STRATEGY WITH INCREASED CARBON REMOVAL

The return of the territory to ecosystems proposed in the strategy requires the restoration and regeneration of forest ecosystems. This is a long-term process (20 to 50 years, or more) that must take into account preserving biodiversity and optimizing carbon capture, with the aim of solving their future non-permanence in the soil and biomass. On the contrary, fossil fuel substitution must be done essentially in the next two decades; consequently, the volumes to be mitigated are much more significant than the immissions expected in natural forests or in forestation. For this reason, the planning foreseen in the current Forestry Law must take into account the management of these environments to be restored and regenerated, whose evolution allows for multiple uses, including extractions for energy, food and material supply purposes. The condition that must be demanded in this transition is that, at the end of the period, the restoration of ecosystem functions takes place, considering as much as possible the original biodiversity.

Outside the forested area, identical criteria could be met with other ecosystems to be recovered. In the case of agro-productive systems, it would be desirable to start with the degraded areas and take into account the synergy with climate change adaptation measures. In the long term, part of this area under agricultural use could be returned to the original ecosystem, while in the transition regulated carbon extraction can be allowed for various purposes that contribute to mitigation.

The growing use of carbon in the economy - from the cascades of various agricultural and forestry chains - provides materials for the replacement of steel, aluminum and cement, such as wood and fibers, and inputs for the production of synthetic compounds such as polymers, which today are obtained from fossil carbon out of hydrocarbon refineries. The life cycle of this carbon can be very long depending on the regulatory framework in force, resulting in an effective and early form of removal of atmospheric carbon fixed in products with a long half-life. In any case, a significant decrease in energy demand in the benefited sectors, as well as in their carbon footprint, is expected.

HOW TO OPTIMIZE THE POTENTIAL OF BIOENERGY IN AGROPRODUCTIVE SYSTEMS

The transition supported by first generation biofuels shares all the limitations of the practices that these compounds entail. For that reason they would compete unfavorably with agricultural production for other purposes on the available land and should be eliminated. Two alternative pathways are underway, which are developed below.

ECO-INTENSIFICATION FOR THE PRODUCTION OF SUBSTRATES AS A SOURCE OF CARBON

Whereas in some cases competition for land surface area for other purposes is inevitable, in the period of use until its return it is possible to increase productivity and the extraction of carbon compounds, while improving sustainability parameters in the soil, such as organic matter content. Integrated water management, including irrigation and the advanced agro-ecological approach, is shared with all agricultural production and allows for optimal use of its waste. The result will be a cautious transition; a land-use planning that allows simultaneous improvements in food and energy sovereignty and guarantees soil conservation in good conditions for when the change of use is decided. Intensive energy crops appropriate for advanced technologies target high-productivity gramineae, such as energy sugar cane, which requires five times less surface area than the current Argentine average based on this work.

As an example for family production, it has been suggested that native plants such as *Acrocomya totai* would allow for agroforestry production with multiple objectives (food and energy) that are not competitive on the same land, in the same way that agro-photovoltaic production would do in all fruit and vegetable belt areas.

TRANSFORMATION TECHNOLOGIES MORE ADVANCED THAN THOSE OF FIRST GENERATION

Biogas

Biomethane is a fuel that is spreading worldwide and local studies show that it has a much higher potential than first-generation liquids. According to several studies (FAO, 2019; CADER, 2020), the inherited extensive natural gas infrastructure - including the extensive pipeline network, industrial and transport uses, and electrical generation - would be a great advantage for Argentina. The flexibility in the use of substrates such as agricultural waste and energy crops provides opportunities for regional development and brings social and economic benefits, with current technologies for biodigestion (INTA, 2019) and future possibilities for methanization and incorporation of hydrogen in biorefineries (IEA Bioenergy, 2020; IRENA, 2019). The synthesis of methane from non-fossil carbon dioxide and hydrogen is in a pre-commercial stage and can be based on the combustion or biodigestion of biomasses. The residue from biodigestion allows the nutrient cycle to be closed at the production site. And, unlike the case of food, what is exported from the territory is carbon and hydrogen, which are obtained from air and water.

Biorefineries

From biomasses, biorefineries produce a diverse palette of liquid fuels such as methanol and dimethyl ether, designer fuels such as biodiesel; inputs for chemical synthesis such as polymers and, in general, the entire supply of petrochemicals; charcoal or biochar; gases such as methane and other hydrocarbons. As in the case of hydrocarbon refineries, hydrogenation allows the incorporation of hydrogen to obtain molecules with a higher proportion of hydrogen.

The expansion should consider a prompt substitution of fossil fuels before 2040 and a withdrawal consistent with the return of territories and food sovereignty in the second half of the century. These dynamics must be taken into account to define both the expected maximum as well as the research agenda and the required investments.

CONCLUSIONS

The long-term strategy has 2050 as its horizon and 2030 as its checkpoint, which is the target year for the nationally determined contribution. The scenarios show the stark need to “pick the winners”: there is no room to get back on track. “Lock-in effects”, as well as fixed assets, are likely in the fossil paradigm, but may also be a consequence of the technological path adopted to break with it. This is the case of the infrastructure for transporting and distributing fossil-fueled fluids when bioenergetic fluids that could replace them are excluded, as is the case in scenarios 1 and 2.

The prospective and the technological assessment show the convenience for Argentina of combining technologies to meet sustainability indicators. The technological learning curves are very favorable for this co-evolution. The irreducible and inevitable uncertainties in the long term can be better addressed with more diverse systems. Climate and biodiversity goals are achievable with transformational changes in society, which would also satisfy most of the strategy’s indicators. Agricultural productivity, carbon extraction for bioenergy generation, removal of atmospheric carbon, incorporation of carbon into sinks, and the expansion of the restored and regenerated area all need to be increased at the same time.

A probable consequence is the reduction of the area allocated to livestock and, perhaps, a decrease in absolute terms of this activity displaced by plant production. This would not threaten the population’s ability to make food choices, although it could have an impact on exports. Electrification also has limits on the negative impact on the relief due to the extraction of some key metals such as copper; analysis of the aggregate footprint would require taking the change in consumption and production patterns as a whole and not in isolation. Domestic demand would need to be much lower than assumed for 2050 under climate constraints if sufficiency, and not just efficiency, criteria were applied. To this end, the corresponding satisfiers and forms of end use should be defined, instead of projecting a growth in energy demand that is neither in line with the change in consumption and production patterns nor with the proposed equity criteria. This implies an abandonment of consumerism and, more generally, assuming the necessary transformations for the transition from the current path of development.

This post-normal situation, that is, with radical uncertainties, conflicts of values, urgency in the decision making process and lots at stake, can only be addressed with the extended participation of peers for the collective construction of the scenarios, roadmaps and research agenda that this transformation requires.

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