Towards a net-zero electric system for Lanzarote: solar and hydrogen at the core.

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Summary.

Reliant on an ageing, highly polluting power plant that is also vulnerable to rising sea levels, Lanzarote's transition to a cleaner and more resilient electricity system cannot be postponed. While public authorities have devised a decarbonisation strategy, it entails extensive land use, potentially altering the island's distinctive landscape. This report proposes an alternative: a low-impact, decentralised, and flexible system based on rooftop solar generation, battery storage, and locally produced green hydrogen. This approach would enable a clean, self-sufficient, and resilient electricity system, ensuring energy independence and minimising environmental impact, and positioning Lanzarote as a potential benchmark for net-zero energy transitions in other regions worldwide, particularly islands and isolated areas.

1. Introduction.

Lanzarote's current electric system relies heavily on the Punta Grande thermal power plant, which burns oil-derivatives — mainly diesel — to supply power across the island. This is an old, highly polluting plant vulnerable to rising sea levels. In fact, projections suggest that by 2050, parts of the facility could be severely affected by coastal flooding[1].

A small portion of Lanzarote's electricity comes from wind turbines, while solar photovoltaic (PV) panels contribute very little. While current energy plans aim to expand wind and solar capacity, the strategy is largely based on the development of large-scale energy farms. However, this approach would have significant impact on the island, consuming significant amount of land in an island where 40% of the surface is under environmental protection. In addition, it would alter the island's scenery and further endanger avian fauna. Similar concerns would be raised by offshore wind farms, which is another option being considered by national authorities.

Lanzarote enjoys a stable, sunny climate year-round, offering an immense potential for solar energy development. Yet, solar contribution to the island's electric generation is marginal. However, with the right strategy, solar power could provide a significant and sustainable source of electricity.

Solar energy, while clean, is intermittent, and production varies throughout the day and with weather conditions. To overcome this, excess solar power can be stored for use during nights or cloudy periods. Advanced high-capacity batteries and green hydrogen, generated through electrolysis using surplus solar energy, offer promising pathways to ensure a reliable supply.

This report proposes an electricity system for Lanzarote centred on widespread deployment of PV panels across existing rooftops. These would meet daily power demand, with excess stored in high-capacity batteries and converted into green hydrogen. During daylight hours, the island would operate mainly on solar energy, while batteries and hydrogen would meet demand at night or in periods with unfavourable weather conditions.

The proposed system is robust, flexible, and decentralised, aligning with climate goals while minimising the impact on the island's landscape and biodiversity. Furthermore, its development could create new job opportunities in emerging sectors, thereby supporting the island's economic diversification.

Similar models have been trialled successfully elsewhere. For example, in Orkney (Scotland), excess wind and tidal energy is used to produce hydrogen for heating, transport, and storage[2]. Another example is the island of Lolland (Denmark) that generates 50% more energy from renewable sources than it consumes, storing the surplus as compressed hydrogen[3]. And on a larger scale, Esbjerg (Denmark) is using offshore wind power to produce green hydrogen for industrial use and export[4]. Though Lanzarote's scale is smaller, the underlying principles are the same — converting renewable energy surplus into green hydrogen.

2. Existing infrastructure and current electricity demand.

The main electricity generation site in Lanzarote is the Punta Grande thermal power plant, located between Arrecife and the tourist hub of Costa Teguise (fig. 1). Operational since 1986, this ageing

[1] Based on Climate Central projections.
[2] Surf 'n' Turf initiative, BIG HIT schema.
[3] Lolland Hydrogen Community
[4] HØST PtX Esbjerg

facility is the island's largest pollution source, accounting for around 60% of total CO_2 emissions[5]. Furthermore, by 2031 all but one of its generators will have reached the end of their operational lifespan[6].

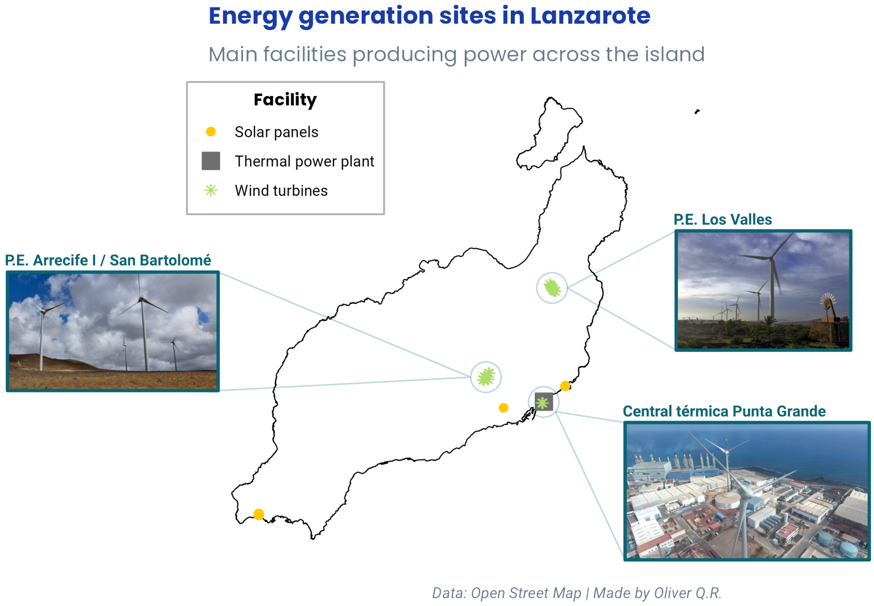

Figure 1. Main energy generation sites in Lanzarote. Pictures from *Consorcio del Agua de Lanzarote*.

Beyond this plant, a small number of wind turbines are installed in three areas: along the central corridor between Arrecife and Teguise (P.E. Arrecife I / P.E. San Bartolomé), in Los Valles (P.E. Los Valles), and a pair located in Punta Grande. Photovoltaic solar capacity is limited to very small clusters, like those in CC Argana, at the airport, Playa Blanca, and Costa Teguise, along with scattered panels on private homes and buildings.

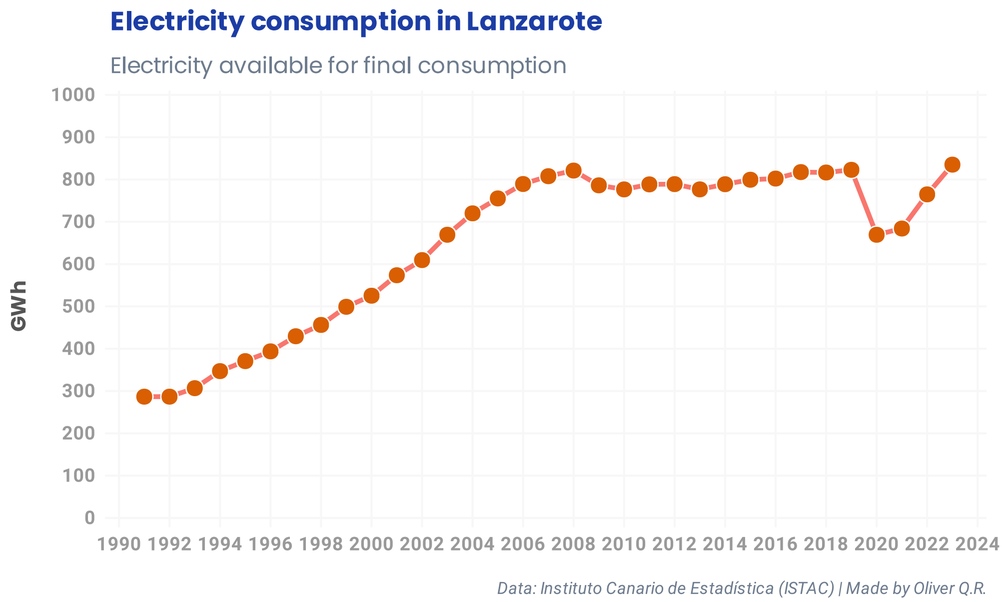

Figure 2. Annual electricity consumption in Lanzarote.

Over the past 30 years, Lanzarote has almost tripled its electricity consumption. This growth can be divided in two phases: one with rapid growth (from 1991 until 2008), followed by a second with

[5]PTECan 2030 & PRTR España.
[6]PTECan 2030.

relatively stable/very slow growth in consumption (from 2008 onwards), likely due to factors like improved energy efficiency (fig. 2).

The services sector, which includes tourism, is by far the island's largest electricity consumer, accounting for over 60% of total demand in recent years (fig. 3). Residential use makes up around one third of the island's demand, while the industrial sector has the lowest share (just 1.24% in 2024).

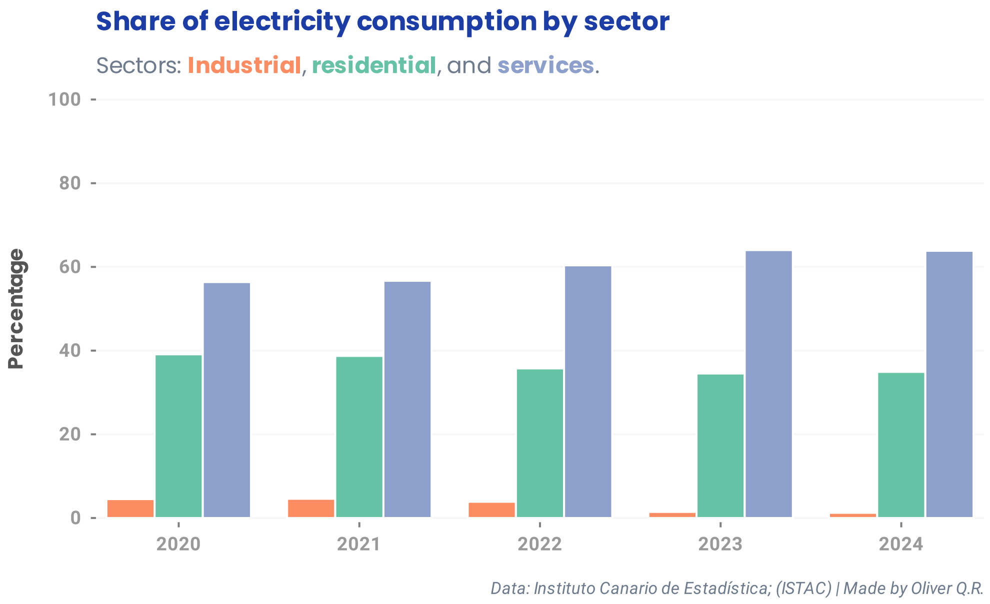

Figure 3. Electricity consumption by main sector.

Despite its abundant sunshine, Lanzarote's electric system heavily relies on fossil fuels. In 2023, 91.26% of the electricity consumed in the island was generated from oil derivatives. Renewables contributed just 8.74%, with solar accounting for only 1.24% (fig. 4).

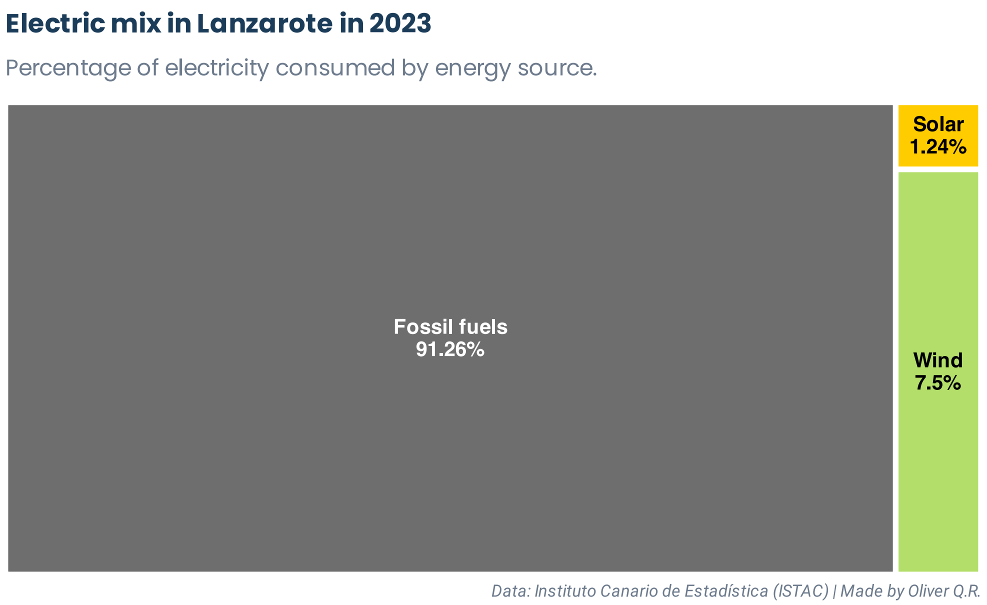

Figure 4. Electric mix in Lanzarote in 2023

This fossil fuel dependency has persisted for years, with at least 90-95% of the electricity consumed being generated from fossil fuels (fig. 5). Renewable sources had a modest increase in their share between 2018 and 2021 (up to 10%), although progress slowed in 2022 and 2023. Nevertheless, local and regional authorities have committed to accelerating energy transition, setting a target of net-zero emissions by 2040.

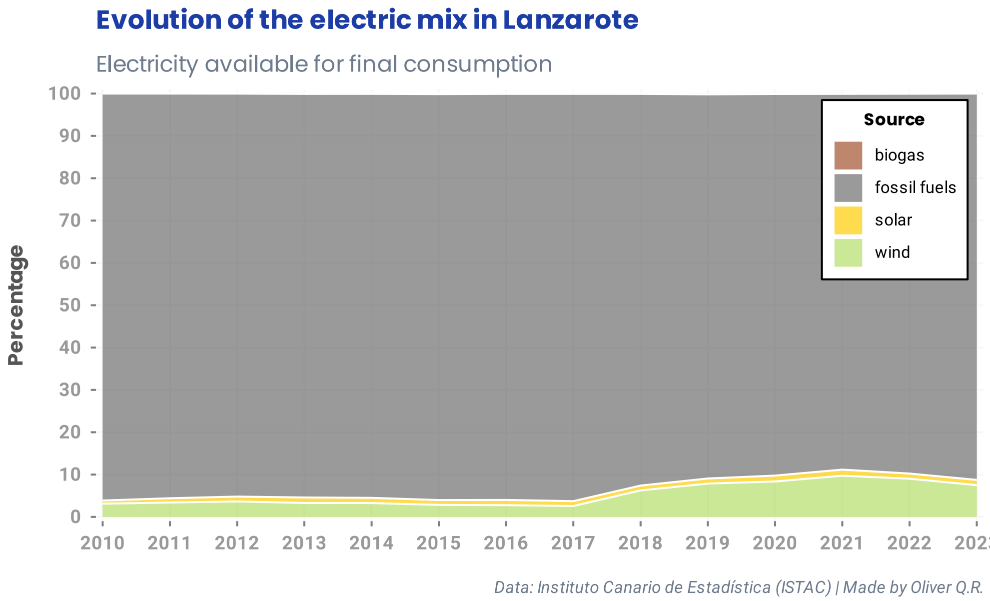

Figure 5. Evolution of the electric mix in Lanzarote.

3. Planned strategies.

The main framework guiding the Canary Islands' energy transition is the *Plan de Transición Energética de Canarias* (PTECan 2030), which also applies to Lanzarote. The plan prioritises the large-scale deployment of solar and wind energy, and it designates specific areas for their development (fig. 6).

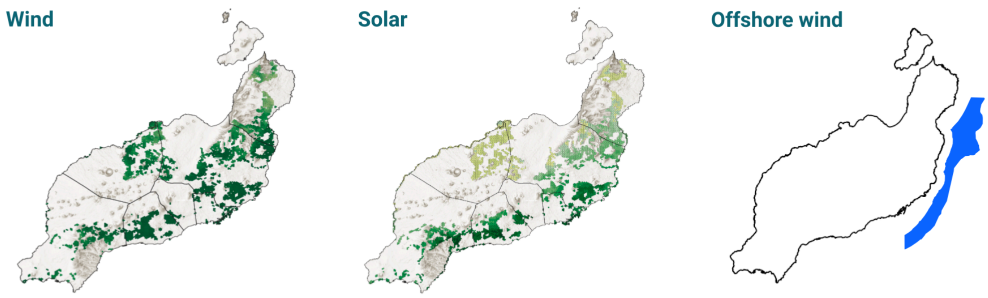

Figure 6. Areas for the development of wind (left), solar (centre), and offshore wind (right) facilities. For the left and centre panels, the colour indicates priority, with darker shades (green) denoting higher priority. For offshore wind (right panel), blue marks the designated area. Sources: PTECan 2030 & INFOMAR.

In addition, the *Plan de Ordenación del Espacio Marítimo* (POEM), Spain's maritime spatial planning framework, designates a high-priority offshore wind development zone off Lanzarote's eastern coast (fig. 6). Covering nearly 100 square kilometres and situated less than 2 km from shore, this zone raises concerns due to the visual and ecological impact that large offshore turbines could have.

At present, a number of wind and photovoltaic projects for Lanzarote are awaiting approval, all concentrated in the southwestern part of the island (fig. 7). While contributing to increase the renewable capacity of the island, these projects will require considerable land use and could significantly alter the landscape, particularly in the case of wind farms.

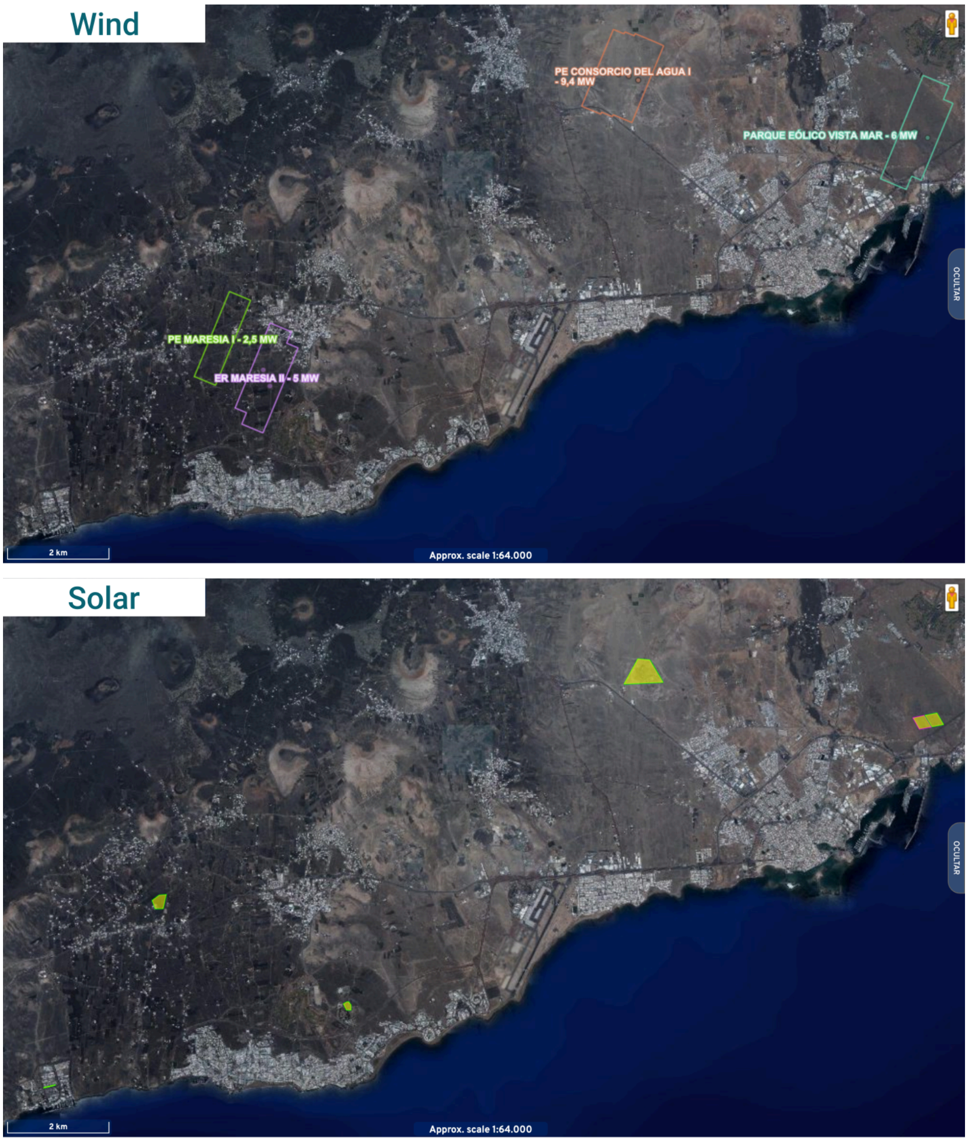

Figure 7. Projects pending approval. Upper panel: wind farms. Lower panel: solar photovoltaic farms. Modified from GRAFCAN.

These strategies present several challenges. With around 40% of its land under environmental protection, space availability in Lanzarote is limited. Large-scale renewable installations would consume land and would have a significant visual impact on the island's unique volcanic scenery, especially in the case of wind farms. Additionally, they also pose risks to the island's biodiversity, potentially affecting both local and migratory bird populations.

For these reasons, an alternative model, based on decentralised solar generation, supported by high-capacity batteries and green hydrogen, could offer a more balanced, locally integrated solution towards a net zero future, while preserving the island's landscape and biodiversity.

4. A rooftop solar and green hydrogen model for Lanzarote.

Instead of pursuing large-scale solar and wind farms, whether onshore or offshore, this plan proposes a decentralised model build around rooftop solar that would generate surplus energy. This excess would then be stored in high-capacity batteries and used to produce green hydrogen that would cover demand during periods of low or no solar output.

According to OpenStreetMap data, the total rooftop surface area in Lanzarote is approximately 11,054,760 m². Covering 40% of this area with solar panels would yield an installed capacity of around 997.94 MW (nearly 1 GW), with an estimated annual generation potential of 1,532.02 GWh per year[7]. For context, the island's total electricity consumption in 2023, the highest on record, was 835.13 GWh. This means that rooftop solar alone could generate more than enough to meet Lanzarote's energy needs.

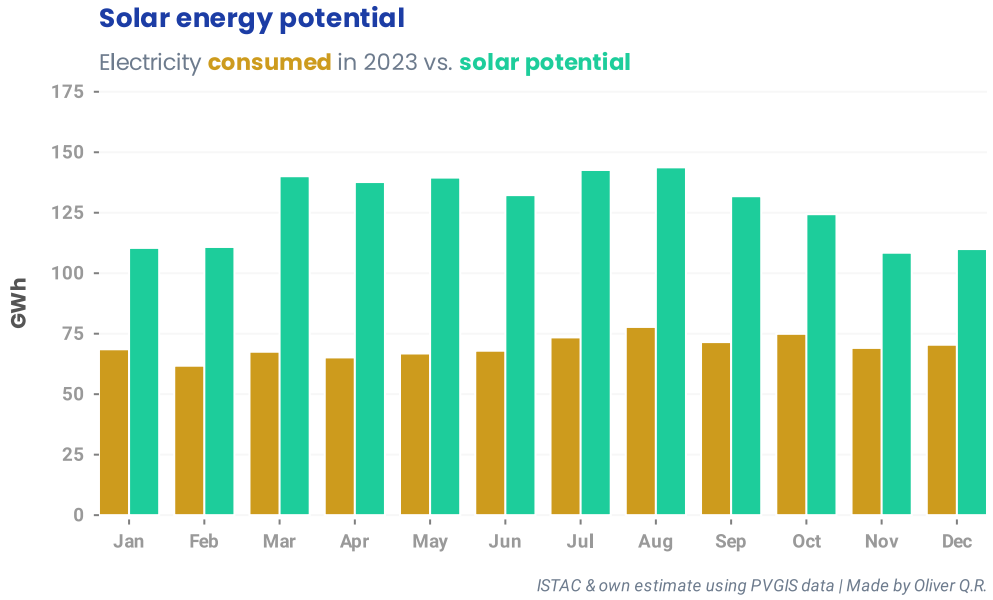

Figure 8. Mean electric energy consumed in 2023 vs. potential solar energy generation per month.

By following this approach, estimates show monthly solar generation would largely exceed consumption throughout the year (fig. 8), highlighting the island's untapped solar potential. In this proposal, rooftop solar would serve as the foundation of the system: covering 40% of the island's rooftops with PV panels would provide the primary source of clean electricity, generating enough to meet the island's annual demand.

However, solar power is intermittent, limited to daylight hours, and affected by weather conditions. Thus, to ensure reliability, the system needs complementary storage, which would be structured in two layers. The first one would be high-capacity batteries, like those deployed in California. Distributed across the island, batteries with a total capacity of around 607 MW, could meet around 40% of the island's night-time demand[8].

The second layer involves green hydrogen. Surplus solar energy would power electrolysis to produce hydrogen, which would then be stored for later use at night, during cloudy periods, or when demand peaks. This approach, inspired by systems in places like Orkney (Scotland), Lolland (Denmark) and Esbjerg (Denmark), would make Lanzarote's electric system flexible and resilient (fig. 9).

In essence, the daytime solar output would serve immediate consumption needs, charge batteries, and power hydrogen production. At night, batteries and hydrogen would jointly supply electricity. Surplus hydrogen could also be stored as a long-term backup, powering the island for several days, or creating potential for export (fig. 9 and Figure 10).

[7]Estimated using the EU's Photovoltaic Geographical Information System (PVGIS).
[8]In California, with a total battery capacity of 10,379 MW, batteries have covered up to 32% of the demand (California ISO).

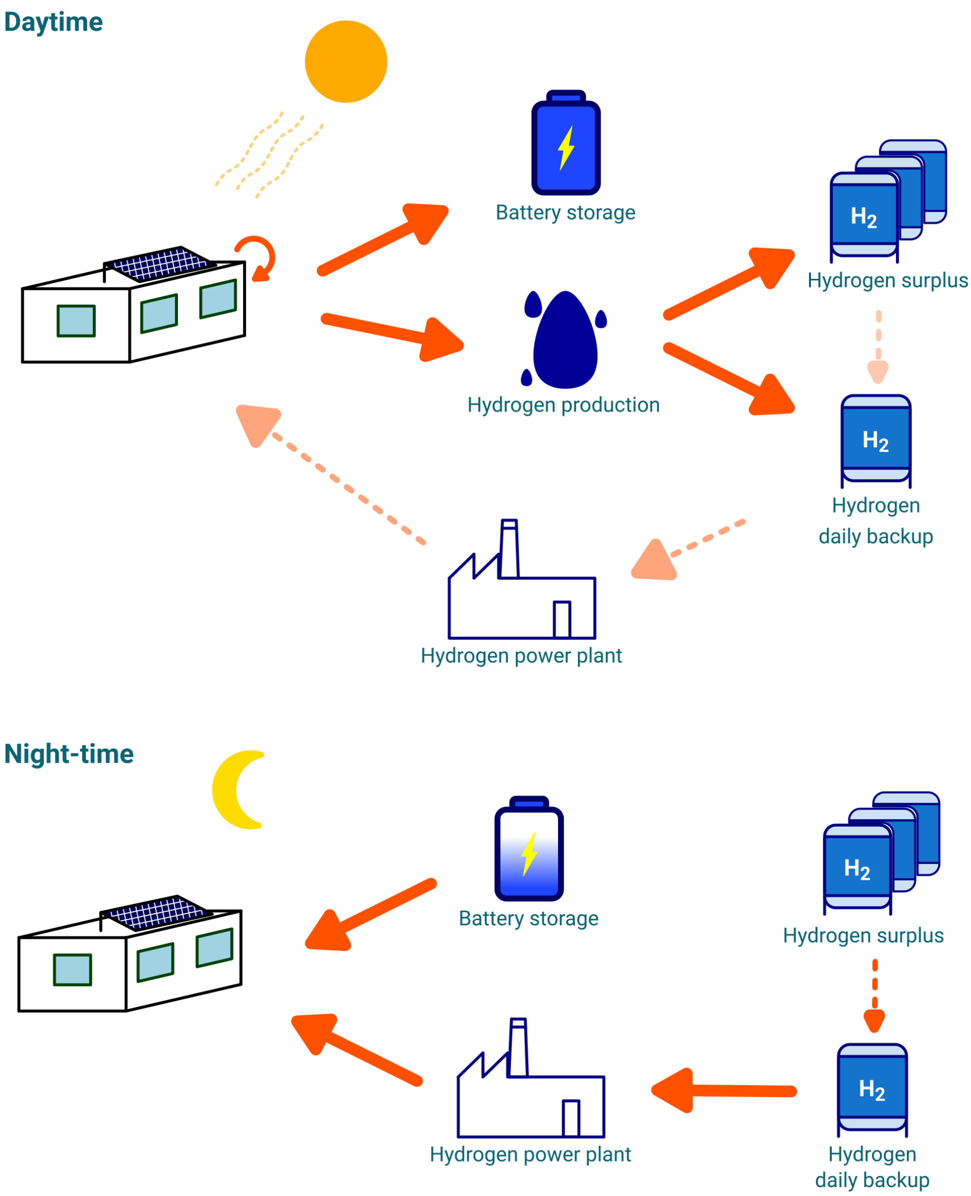

Figure 9. Proposed electric system for Lanzarote and energy flows (orange arrows) during daytime (upper panel) and night-time (lower panel)

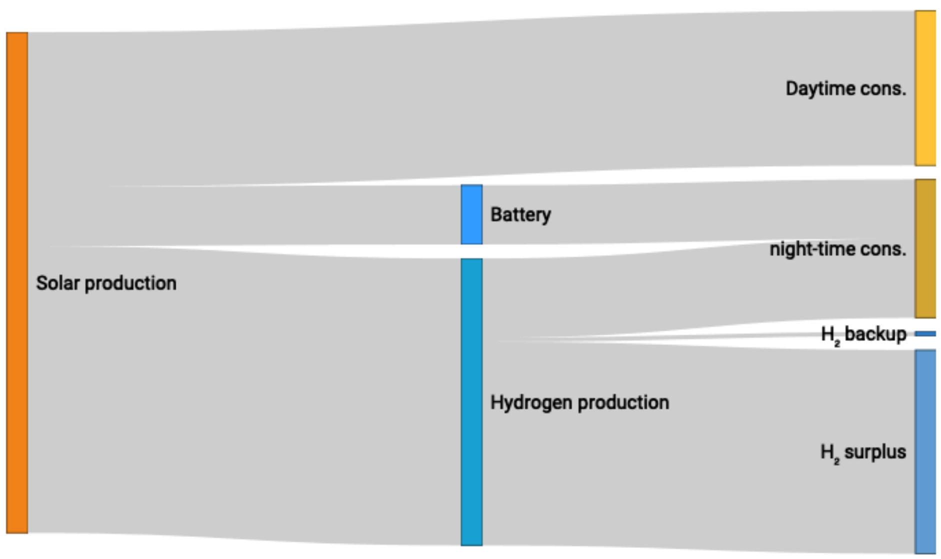

Figure 10. Yearly energy flows for the proposed scenario. Energy losses not depicted.

This decentralised model offers an alternative path towards energy independence without significant land consumption or compromising the island's landscape. Also, by keeping energy generation close to where it will be used, transmission losses would be reduced.

Furthermore, with a hydrogen reserve covering up to five days of full demand, Lanzarote could produce an estimated 3,918.1 tonnes of surplus hydrogen each year. Though modest in global terms, this could open the door to future scaling and strategic energy partnerships for green hydrogen export.

5. Financial outlook.

Implementing this vision would require a long-term strategy supported by substantial capital investment. The main cost drivers include widespread rooftop solar installation, high-capacity batteries, a hydrogen power plant with associated compression and storage facilities, desalinisation and electrolysis infrastructure, and the modernisation and adaptation of Lanzarote's electrical grid.

Altogether, the initial capital expenditure could be estimated at around €2.5-3 billion[9], which is roughly 100-120 millions annually over a 25-year horizon.

Several EU funding programmes could help finance this transition. These include Horizon Europe (especially for pilot projects), Innovation Fund, the LIFE Programme, the Just Transition Mechanism, and the Clean Energy for EU initiative. If strategically leveraged, these sources could substantially reduce the financial burden on local, regional, and national authorities.

Another potential revenue source could be environmental- or tourist-focused taxes. For example, the *Lanzarote Futuro* initiative has proposed a sustainability-focused tax that could generate between €80 and €100 million annually[10], a portion of which could be allocated to financing this plan.

Additional mechanisms, such as *Climate Resilience Tax*[11] on high-emission vehicles and activities, could further contribute to funding while incentivising behavioural change aligned with the island's sustainability goals.

Institutional commmitment is also essential. By allocating a modest but stable share of the annual public budget to support the plan, local and regional authorities would send a clear sign of political will and prioritisation.

In the long term, the system itself could have potential to become a net contributor to the island's economy. If hydrogen production consistently exceeds domestic consumption, surplus could be exported to other regions. In the proposed system, a surplus of around 3,918.1 tonnes of hydrogen would be available for export each year, which could generate around €24 million annually[12]. Although this would require further investment in infrastructure, such as port upgrades and a hydrogen transport system, it could open up new opportunities for hydrogen export.

[9] Estimated from real-world case data using current and projected prices.

[10] https://www.lanzarotefuturo.com/grupo/1-enfoque-en-personas-y-entornos-naturales/discussion/91b1e153-538c-4ebe-a2f4-6543dc812cb7.

[11] Inspired by the *Climate Resilience Fee* existing in Greece, imposed on hotel rooms and short-term rentals per night.

[12] Based on a price of around €6/kg (Provaris estimates).

6. Timeline.

This proposal envisions a phased transition over a 25- to 30-year horizon, structured around three main stages:

- **Stage 1 (Years 1-8)**:
  - Large-scale deployment of rooftop solar panels and high-capacity batteries across houses/buildings.
  - In parallel, small-scale pilot on La Graciosa. This would involve the temporary installation of a mini hydrogen generator, battery storage, and rooftop solar, simulating the full system in a low risk, real-world environment.
- **Stage 2 (Years 9-16)**:
  - Continue solar and battery rollout.
  - Begin construction of hydrogen-related infrastructure: electrolisers, desalinisation units, storage facilities, and hydrogen fuel cell power plant.
- **Stage 3 (Years 17-25)**:
  - Complete all infrastructure works and fully integrate the system.
  - Performance optimisation and smart grid upgrades implementation.
  - Potential expansion of hydrogen production for export or mobility, if viable.

La Graciosa, a small island located just over 1 km north of Lanzarote, offers a unique opportunity for a proof-of-concept due to its small population and low energy requirements. Insights gained from this trial could guide broader development across Lanzarote.

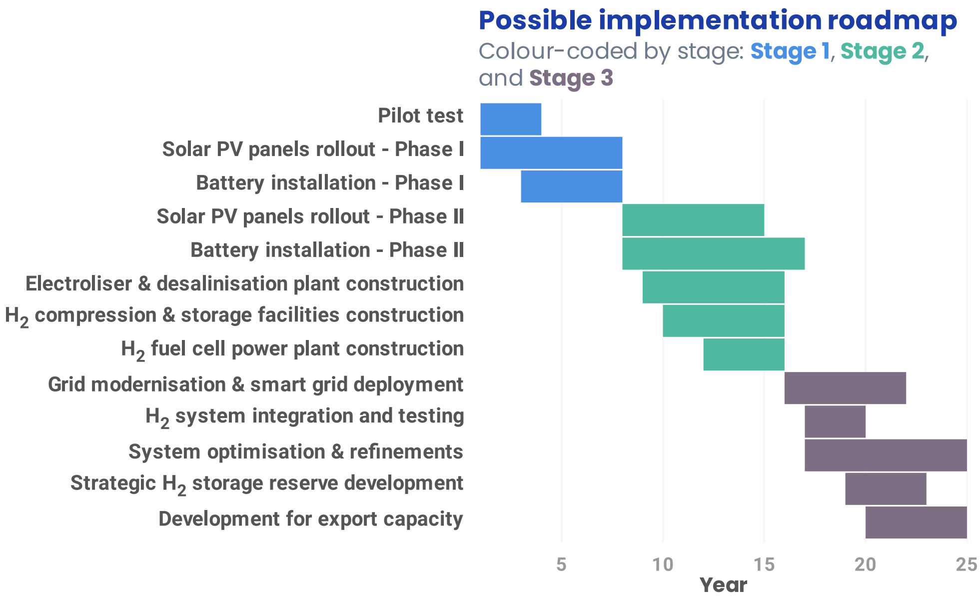

Figure 11. Possible implentation roadmap over a 25-year horizon.

7. Risks and mitigations.

This plan is highly ambitious and entails several potential risks that must be addressed.

- **Financial scale:** The estimated €2.5-3 billion investment, spread over 25-30 years, is substantial but feasible given the multiple funding sources available. Furthermore, long-term cost projections from the IEA and IRENA, among others, anticipate a continued decline in the prices of solar panels, batteries, electrolysers, etc., improving the financial outlook over time.

- **Political commitment:** A project this scale needs strong and long-term political will. Institutional coordination and stable multi-year budgeting, with broad support across administrations, would be critical for success.

- **Operational costs:** Lanzarote's current electric system heavily relies on imported oil derivatives. The proposed system eliminates fuel imports, since solar is highly abundant and hydrogen would be locally produced. The system thus would gain long-term price stability and reduce exposure to fuel markets volatility. Moreover, operational costs are expected to decrease as technology advances[13].

- **Hydrogen power plant scale:** This system would require a hydrogen power plant with a capacity of at least 115-120 MW to meet the island's full energy demand when needed, which could be challenging. Currently, the largest plant of this kind, the Shinincheon Bitdream Hydrogen Fuel Cell Power Plant in South Korea, reaches 79 MW. However, in this proposal, the hydrogen plant would be deployed in Stage 2 or 3 (10-15 years into the transition). By that time, technological advances and increased hydrogen deployment should make this scale achievable.

- **Water supply:** Lanzarote faces chronic water scarcity and it has an obsolete water network in which 56% of water production is lost. Hydrogen production at the estimated levels (around 11,676 tonnes a year) would require approximately 128,431.6 m^3 of water. This amount represents 0.41% of Lanzarote's total water production in 2024 (over 31 million cubic metres[14]). A small dedicated desalinisation plant, adjacent to the hydrogen plant, could supply this water without affecting the island's general supply.

- **Weather variability and system resilience:** Lanzarote benefits from over 2,800-3,000 direct sunshine hours each year[15], and long cloudy periods are rare. The system is designed to store enough energy to meet the island's demand for a period of around 47 days[16]. Furthermore, in case of unexpected shortages, hydrogen could temporarily be imported, just like oil-derived fuels are today.

- **Visual impact:** Lanzarote is well known for its unique volcanic landscape, with distinctive small villages of white houses and flat rooftops being part of the island's visual identity. This could be altered by a widespread rooftop solar rollout. However, based on the optimal panel tilt calculated by PVGIS (27-29°), panels would remain relatively low, with minimal or no visibility from street level, thus mitigating this risk. In addition, by prioritising installation in high-demand areas such as Arrecife, Puerto del Carmen, Playa Honda, etc., the impact on smaller villages could be significantly reduced.

- **Social acceptance:** Widespread solar panel deployment on private rooftops may face resistance. A robust public awareness campaign highlighting the environmental and economic benefits of the transition, such as lower electricity costs, better air quality, less visual impact, etc., would be key to ensure social support.

- **System isolation:** Although this report evaluates Lanzarote as an isolated system, it is interconnected with Fuerteventura. Extending a similar solar-hydrogen system to Fuerteventura would add flexibility and backup capacity, thus further improving resilience and robustness. In addition, deploying the system across both islands could further lower the costs per installed MW due to economies of scale.

[13] IEA and IRENA.
[14] *Centro de Datos Lanzarote*.
[15] *Agencia Estatal de Meterología* (AEMET).
[16] Assuming all the estimated hydrogen produced annually is used.

8. Conclusions.

With its main electricity generation facility being an obsolete, highly polluting thermal power plant at serious risk due to rising sea levels, Lanzarote's transition towards a new energy system cannot be delayed.

Current transition plans aim to reach net zero emissions by 2040, focusing primarily on large-scale wind and solar farms, along with local hydrogen production. However, these strategies would require significant land use and would have a considerable visual impact, compromising the island's unique landscape.

This report outlines a potential alternative approach centred on distributed solar energy generation, primarily through rooftop PV installations. This system would generate surplus energy that, stored in high-capacity batteries and converted into green hydrogen, could ensure round-the-clock energy supply, and with the potential of producing excess hydrogen for export.

While the initial capital investment is substantial, various funding mechanisms at EU, national, and local levels could support the project over a 25-30 year period. For context, the Canary Islands Government's current plan (PTECan 2030) estimates a cost of €4.12 billion to full decarbonise Lanzarote by 2040.

The levelised cost of energy (LCOE) from solar PV is already lower than fossil fuels, and is projected to keep falling, potentially reaching €14-30/MWh by 2050. Likewise, the cost of green hydrogen from electrolysis is forecast to drop below €1-2/kg (around €40/MWh)[17], making it one of the cheapest energy sources by mid-century, alongside onshore wind. In comparison, diesel generation is projected to exceed €200/MWh. These trends make solar and hydrogen compelling long-term options, both economically and environmentally.

Beyond domestic supply, hydrogen production also creates offers possibilities for export, potentially generating long-term economic returns and helping offset operational costs (OpEx).

In parallel, the exploration of Lanzarote's low-depth geothermal potential could add a promising new layer to the island's renewable mix. Promising tests have already been carried out[18] and, if successfully harnessed, geothermal energy could significantly enhance system resilience and robustness. Furthermore, it could potentially increase hydrogen export capacity, positioning Lanzarote as a relevant player in the emerging green hydrogen market.

This transformation could also have the potential to generate new job opportunities and stimulate economic diversification. Given Lanzarote's heavy reliance on tourism, this initiative could represent a strategic opportunity towards a more balanced economic model.

The plan would also imply a shift in the island's energy governance, going from a centralised, privately owned model to a more distributed system in which self-generation plays a pivotal role. In doing so, it would reduce reliance on large utility suppliers and could significantly lower energy costs for end users. Similar shifts have already taken place in places like Samsø (Denmark), Orkney (Scotland), and parts of Germany, resulting in reduced emissions and lower energy costs.

In summary, this plan would not only replace fossil fuels entirely, but also has the potential to reshape Lanzarote's electricity system, serving as a model for clean and decentralised energy systems worldwide, particularly for islands and isolated regions.

[17] IRENA, IEA, NESO, Lazard, and others.

[18] Alegría *et al.*, 2025. 400 W facility of geothermal thermoelectric generators from hot dry rocks on the Canary Islands. Sustainable Energy Technologies and Assessments, 78, 104338.

Annex – System assumptions.

Parameter	Value
Solar panel efficiency	20%
Battery round-trip efficiency	80%
Electrolysis efficiency	70%
Hydrogen compression loss	5%
Hydrogen fuel cell efficiency	66.4%
Distribution grid loss	10%
Water consumption per kg H_2	11 L/kg