European Commission

Science for Environment Policy

A carbon-free future for the Canary Islands possible by 2050

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The Canary Islands have the potential to become carbon neutral by 2050, a new study indicates. This could be achieved by shifting to a 100% renewable energy supply, improving energy efficiency and building new grid connections between islands. Energy solutions for small island regions, such as the Canaries, could act as role models for larger systems, as well as similar islands, the researchers suggest.

Transferring to a renewable energy supply can be more challenging for islands, as they have small isolated markets for energy and associated technologies. Furthermore, they are often popular with tourists, which makes energy demand very variable and, therefore, harder to provide for with variable renewable supplies. On the other hand, renewable energies represent an excellent opportunity for islands where the cost of energy production is usually much more expensive than on the mainland and where pollution is usually an issue.

This study suggests that it is entirely possible for the popular holiday islands of the Canaries, Spain, to shift over to a near-100% renewable energy system, which is carbon-neutral and cheaper than a fossil-fuel-based system. Currently, the islands import 99% of their energy needs in the form of oil, which is used to generate power, produce heat and for land transport.

The researchers arrived at this conclusion by identifying and modelling the steps needed to meet the goal of a totally renewable energy system in the Canaries by 2050. In their analysis, they took into account not only which energy technologies are available and feasible for the islands, but also how energy savings could be made by various sectors, including industry, transport and the residential sector, and the impact of introducing new energy cables between and across islands.

They assumed that there will be a major shift towards electrical transport; this can be quickly and feasibly introduced, they say, as car journeys are typically short on the Canaries (given each island's small size), and so battery recharging is not as much of an issue as it is on the mainland. The study also assumed continued economic and population growth, and an ongoing increase in tourist numbers.

The study's modelling exercises suggest that the total final energy demand of the Canaries could drop to 58 petajoules (PJ) per year if energy efficiency measures are applied across all sectors considered by the researchers[1]. This compares with around 92 PJ in 2012, and a predicted 131 PJ in 2050, if no measures are taken at all.

This demand could be met by a mixture of renewable energy technologies. With increased sector coupling, power generation becomes more important. A power-generation capacity of between 11.3 and 12.2 gigawatts (GW) would be necessary, depending on how many new energy cables are installed. The overall power generation of this capacity ranges between 16.5 and 18 TWh, equivalent to 60–65 PJ. This is around 70% of the primary energy demand of 86 PJ and equates to 320–350% of annual peak load. Power cables bring benefits through their effects on the overall balance of energy sources: the higher overall grid capacity enables the use of cheaper power-generation technologies. However, the researchers acknowledge that some of the cables they propose are currently difficult to install, due to the deep and rough seabed.

Continued on next page.

Source: Gils, H.C. and Simon, S. (2017). Carbon neutral archipelago – 100% renewable energy supply for the Canary Islands. *Applied Energy*, 188: 342–355. DOI:10.1016/j.apenergy.2016.12.023.

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1. Sectors considered across all models used in the study were: agriculture, commerce, heating, industry, power, residential, service, tourism, land transport and water.

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The least-cost mix of energy sources with the highest potential output of energy would be dominated by solar technologies, which would account for around 37% of primary energy demand, followed by wind (31%), geothermal/ambient heat (29%) and biomass (3%). This shift to renewables could lead to cuts in CO_2 emissions by 48% by 2030 and nearly 100% by 2050.

A combination of energy-storage technologies would be needed to better integrate variable power production from wind and photovoltaic generators: hydrogen storage, hydroelectric storage[2] and battery storage together with a more active demand response. Again, this mix varies with the degree of grid connectivity — very high connectivity reduces the need for battery storage, for instance.

The mix of energy technologies identified could generate electricity at a cost of €0.10–0.13 per kilowatts hour (kWh), the researchers calculate. Costs for storage, grid and demand flexibility amount to additional €0.07 per kWh. The cheaper cost, €0.10, assumes that there is a comprehensive network of grid connections across the islands. The savings achieved by introducing renewable energy would offset the costs of installing initial infrastructure, such as cables; a fossil fuel-based power system would cost around €0.23 per kWh in 2050.

However, the study admits to only focusing on land transport and does not include the energy needs of aviation and shipping (significant for this remote holiday destination), which are likely to continue to depend on imports of either fossil or renewable fuels in future.

2. The researchers say that, given the mountainous surface of most islands and the availability of many water reservoirs, significant potential for an installation of PSH is available in the Canary Islands, concentrated on the islands of Tenerife and Gran Canaria.