Energy [R]evolution
for the Canary Islands

Energy design for sustainable islands

EXECUTIVE SUMMARY

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INTRODUCTION

The energy model that we adopt as a society is intrinsically linked to climate change. 97% of the scientific community points to human action as responsible for climate change[1]. The main greenhouse gas is carbon dioxide (CO_2), generated by the usage of fossil fuels to produce energy. According to the Intergovernmental Panel on Climate Change[2] (IPCC), humanity cannot emit more than 1,000 Gigatonnes of CO_2 from this point on if we want to avoid the world's average temperature rising by more than 1.5C or 2C. If we project the current pace of consumption, we will have emitted all that carbon by 2040.

That is why it is indispensable to change the current energy model and make it sustainable to avoid the worst consequences of climate change. This implies eradicating the most polluting and dangerous sources of energy, as well as putting an end to energy wastage. However, we need to know if this can be done, if there are solutions that satisfy our energy needs within the sustainability limits of the planet we inhabit, if we are able to get these solutions under way as urgently as needed and what would be the cost of doing it and of not doing it. This is the series of **Greenpeace reports Energy [R]evolution** first published in 2005:

- **Renewable 2050**[3], whose main conclusion is that we have so much renewable potential that it could supply over 56 times the electricity demand in peninsular Spain by 2050.

- **Renewable 100%**[4] shows how an electric system completely based on renewables is technically possible and economically affordable, with a guaranteed supply at all times.

- **The Energy 3.0 study**[5] addresses how to satisfy all the electricity needs

1 Quantifying the consensus on anthropogenic global warming in the scientific literature
2 https://www.ipcc.ch/home_languages_main_spanish.shtml
3 Greenpeace, July 2005 Renovables 2050
4 Greenpeace, October 2006.
5 Greenpeace, September 2011

in all sectors exclusively with renewable energies, and how to achieve this in an easier, quicker, more sustainable and affordable way thanks to energy efficiency and intelligence in the Peninsula.

This series of reports was elaborated taking mainland Spain as a base, since it is the largest electric system in the country. But the relevance of the archipelago made us undertake an analysis on the feasibility of a model based 100% on renewable energies for the islands.

Moreover, the intense mobilisation of the bulk of Canary Island society against oil exploration in deep waters off the coasts of the archipelago in recent years, has led to a wide social debate on the Canary energy model. This debate has highlighted that the search for hydrocarbons does not solve the essential problem of the current energy system in the Canary Islands, characterised for being unsustainable both environmentally and economically.

A key part of this debate requires the data on the possible energy scenarios in the Canary Islands and their costs. Adding this to the broad potential of the Canaries in being a precursor to a change of energy model (that could be exported to other extra-peninsula regions) makes this the ideal moment to launch an analysis on the feasibility of covering the Canary Islands energy needs exclusively with renewable energies.

Greenpeace has researched and presented different Energy [R]evolution scenarios at an international level since 2005, and more recently based on the reports made by the Department of Systems Analysis and Technology Assessment from the German Aerospace Center (DLR, by its initials in German). This executive summary is based on research by DLR, specially commissioned by Greenpeace for the Canary Islands.

The analysis in this report examines how to configure an energy system for the Canary Islands that maintains the use of resources and the deployment of infrastructures within the limits that allow us to follow a sustainable path, so the Canary Islands can have a development model exportable to the rest of the planet and, therefore, with the potential to be a precursor and have an impact on the global issues we face.

EXECUTIVE SUMMARY

CANARY ISLANDS: FROM OIL TO RENEWABLES WITHOUT THE NEED FOR GAS

The Canaries' energy system contains a high potential for change. With only € 257 million of added annual investment over the actual trend, the Canary Islands could save about € 42 billion in the energy bill up to 2050, as well as being an emissions-free energy system and a hundred per cent renewable. This is one of the main results of the Energy [R]evolution report on the Canary Islands. In contrast to a scenario that follows conventional policies, the report sets out a scenario where the archipelago could manage without gas in the transition from oil to renewable energies.

THE ENERGY [R]EVOLUTION IN THE CANARY ISLANDS' MAIN POINTS ARE:

- A 37% **reduction in demand** with respect to current consumption, due to the implementation of efficiency policies.

- The **electrification of most of the demand**, presently supplied by fossil fuels, and coverage with a 100% renewable system by 2050.

- The substitution of **oil power plants by renewables**, without going through gas-fired plants.

- The **reduction of €0.09/kWh** in generation costs, with respect to the costs in the reference scenario where conventional sources prevail.

- An investment of € 20 billion that will lead, at the end of the period, **to total**

savings of € 42 billion in fossil fuels.

- A sub-scenario (**Grid+**) based on **higher investment in electric connections between the islands**, which would improve the efficiency of investments considerably.

- A **rapid penetration of electric vehicles**, already suitable for the islands' distances.

- A **reduction in emissions** from 14 million tCO_2/year to 0.02 million tCO_2/year by 2050, excluding extra-insular transportation.

1] METHODOLOGY

The present report is based on a study by the Institute of Technical Thermodynamics' Department of Systems Analysis and Technology Assessment, from the German Aerospace Center (DLR, by its initials in German) commissioned by Greenpeace. In order to calculate the supply scenarios, the MESAP/PlaNet simulation model was used, as applied earlier in the previous Energy [R]evolution[6] studies.

Efficiency developments are based on Utrecht University (Netherlands), energy demand projections on the potential of energy efficiency measures developed for previous Energy [R]evolution studies.

In 2009, the German Biomass Research Centre calculated the biomass potential following the Greenpeace sustainability principles. In addition, it has been reduced further by the application of the precautionary principle.

Additional studies on local renewable energy potential were considered for the Canary Islands[7]. Future development of automotive technologies is based on a special report elaborated by the DLR Institute of Vehicle Concepts for Greenpeace International in 2012.

For the energy sector sub-scenarios, DLR used a new methodology that integrates standard energy system modelling with MESAP/PlaNet simulation modelling and with high resolution optimisation modelling with REMix.

6 'Energy [R]evolution: A Sustainable World Energy Outlook', Greenpeace International, 2007, 2008 , 2010, 2012 and 2015

7 J. Schallenberg-Rodriguez et al.: Evaluation of on-shore wind techno-economical potential in regions and islands, Applied Energy 124 (2014) 117–129
A.C. Martin Mederos et al.: An offshore wind atlas for the Canary Islands, Renewable and Sustainable Energy Reviews 15 (2011) 612–620
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D. Stetter: Enhancement of the REMix energy system model: Global renewable energy potentials, optimized power plant siting and scenario validation. Tésis, Stuttgart University, 2014
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Spanish Institute for Energy Diversification and Saving: Assessment of geothermal energy potential, Technical Study, 2011
Hydrological plans for the Canary Islands: http://www.gobiernodecanarias.org/agricultura/aguas/hidrologico/index.html

2] STRUCTURE OF THIS STUDY

This document is based on the development of two different scenarios, according to the energy policy options assumed, but under the same general conditions of population growth, GDP, changes in the costs of the different generation technologies, etc. The scenarios are necessary because they depict the distinct evolutions, allowing the decision makers to have an overview of the situation while at the same time indicating the extent of their influence over the future energy system. The report uses two different scenarios to illustrate the distinct possible energy supply systems.

REFERENCE SCENARIO

This scenario maintains **current policies** and trends, mainly focused on fossil fuels, oil and gas. This scenario follows an exploratory focus that, for the case of the Canary Islands, is based on Government forecasts, statistical trends, current projects for new thermal plants as well as formally proposed or planned network expansion[8], including information on the main local energy suppliers, REE and ENDESA. In addition, the archipelago's general evolving trends were taken into account. Therefore, the Reference scenario is related to the European Union's "Current Policy scenario" included in the World Energy Outlook (AIE 2013) report[9].

ENERGY [R]EVOLUTION

Policies are changed to achieve emissions reductions close to zero by 2050, focusing on **efficiency and renewable energies.** Additionally, long distance transport to the Peninsula and other countries is adjusted and the objective of a 50% reduction in CO_2 emissions is established. To achieve this goal, major efforts are undertaken to exploit the huge potential of energy efficiency, using the best practices available in current technology. At the same time, all cost-effective renewable sources of energy are used to generate heat and electricity, as well as biofuel production.

8 Spanish Secretary of State for Energy (2014). Energy Planning - Development Plan for the electric energy network 2015-2020.
9 International Energy Agency, 'World Energy Outlook 2013', 2013

3] PRELIMINARY HYPOTHESES

The general parameters applied to both scenarios stem from very different forecast analyses, and are the following:

- Canary Island **population growth** of **4.8%** from now to 2050, reaching up to 2.2 million inhabitants.

- A **100%** increase **in the number of tourists**[10] by overnight stay, from the current 200,000 to 400,000;

- **GDP growth** of **1.6%;**

- Changes in oil and gas prices. The study opts for the International Energy Agency projections, which (with all the cautions, due to the high volatility of those markets) places the **oil barrel price at $ 126** and the **gas Gigajoule** between **$ 20** and **$ 25** by the end of the considered period;

- **CO_2 emissions costs,** even more uncertain than the fossil fuel emissions, are **$62 tCO_2.**

- **Energy technology investment costs** and the change in their efficiency; **in the case of the conventional technologies their trajectory is very short**. According to the data included in the International Energy Agency (IEA) *World Energy Outlook*, the cost of an oil power plant, that is presently € 732/kW, could be reduced to € 618/kW, while a combined cycle gas turbine plant would be maintained at € 700/kW, although both would increase their maximum efficiency from the current 46% to 58% by 2050.

In the **projection of renewable technology costs for electricity generation**, a notable decrease is expected, as is happening now with wind and photovoltaic energy. It is more difficult to make a forecast for the energies

10 This hypothesis does not imply that Greenpeace supports such growth in the number of tourists, but it serves to illustrate the feasibility of the analysed energy model, even under this increased tourist hypothesis, with strong implications on the energy demand.

not yet on the market, such as biomass gasification or the diverse varieties of marine energy (wave, tidal, etc.). In any case, this study considers the following investment costs:

Table 1 Investment costs

	(CURRENT COST) €/KW	2050 €/KW	IMPROVEMENT%
Photovoltaic	2,270	720	68.28
Thermal solar	8,670	1,700	69.89
Wind	1,180	900	23.72
Wind - Offshore	4,780	1,800	62.34
Biomass	2,520	1,100	56.34
Geothermal	11,161	7,720	35.31
Hydro	4,000	4,000	=

There are two indispensable considerations to address when comparing the technology investment costs in conventional and in renewable energies. The first is that **renewables have no cost for energy resources (with the exception of biomass)**, while the cost for fossil fuels can be expected to rocket, beyond official forecasts. The second refers to the lack of accountancy of the environmental costs implied by the use of conventional energies, that, added together with the acknowledged costs, would make these energies still less competitive.

This study also advances in the projection of **heating and cooling generation** costs with **renewable technologies**, such as solar collectors, deep geothermal applications, heat pumps or biomass applications, also with important reductions.

4] CANARY ISLANDS: SPECIFIC CONDITIONS

The structure of energy demand in the Canary Islands shows relevant differences with respect to the Peninsula or European Union countries, and it is particularly defined by the following features:

- **Mildness of the climate**, that implies reduced needs regarding heating and refrigeration. This demand comes mainly from premises linked to the tourism sector.

- Influence of the transport sector. This includes maritime, air as well as terrestrial components, in which the Canary Islands have a **vehicle per capita ratio 20% over the national average**, in spite of the short distances, and an ageing fleet.

- The **perception of cheap fuel** and dependence on the private vehicle for any trip is akin to the islands' population. The floating tourist population worsens the situation since they are attracted by cheaper fuel than in their countries of origin to rent a car and drive more kilometres.

- The **need for drinking water production,** through sea water desalination.

- The **low degree of industrialisation**.

- The influence of a **tourism and services sector** with consumption **levels well over the national average.**

- A **per capita energy consumption far below the national average,** which implies a double effort: increase the comfort conditions and incorporate efficient technologies in the new fleet of equipment.

- **Energy demand in the residential sector is inferior to the national average**, not only due to the mild climate, but also to the inadequate coverage of heating and cooling needs. In fact, only 30% have air conditioning systems, and out of household energy demand **only 3% corresponds to climate control (heating/cooling)**. This 3% would rise to 10% with a desirable incorporation level. These values are well below the peninsular average, which is around 40%.

High cost of electricity generation due to the high dependence on fossil fuels. The costs of electricity generation in the Canary Islands, 237 € / MWh (according to latest data from the National Commission of markets and competition, CNMC) are among the highest in the European electricity markets. To prevent the Canarian electric bill to be higher than the rest of the state, these extra costs are shared on the bill of all customers in the country. Only variable costs, € 174.4 / MWh of thermal generation in the Canary Islands (amount of fossil fuels) represent more than double the retribution perceived for MWh by wind power producers (85.2 € / MWh). These costs can be drastically reduced with greater integration of renewable energy, and thus contribute to a reduction in electricity bills throughout the Spanish state.

5] THE NEW ENERGY SCENARIO FOR CANARY ISLANDS

5A] THE OBJECTIVES

The two objectives of the policies set out here are to **eliminate the dependence on oil and prevent the introduction of gas in the medium and long term, and to reduce emissions to practically zero**. Today, fossil fuels provide over 80% of global energy. But in the case of the Canary Islands dependence is even higher: oil supplies more than 98% of the **energy demand in the archipelago.** Oil dominates the transport, energy and heating sectors. This **almost complete dependence on oil contrasts with the abundance of renewable energy resources**, mild climate and adequate territorial extension to rapidly introduce electric mobility, among other conditions on the islands.

"98% of energy comes from oil in the Canaries Islands, this dependency is as big as it is unsustainable."

The following conclusions of the **Energy [R]Evolution for the Canary Islands** will serve to **limit carbon emissions**, nearly to zero, which is **essential in the fight against climate change.**

Likewise, these results show that it **is technologically and economically viable to prevent gas as a substitute for oil** in a theoretical transition, one of whose consequences could be the perpetuation of fossil fuel dependence with costly investments in infrastructures unnecessary for the Canary Islands. It is not only economically viable: it will imply important savings for the archipelago once the fossil fuel bill has disappeared.

The efficiency policies (with a wide margin for improvement), especially in the archipelago, and the renewable resources available (abundant in all the islands, as already demonstrated by El Hierro island) make it possible to **categorically dismiss the introduction of gas in the short, medium and long term.**

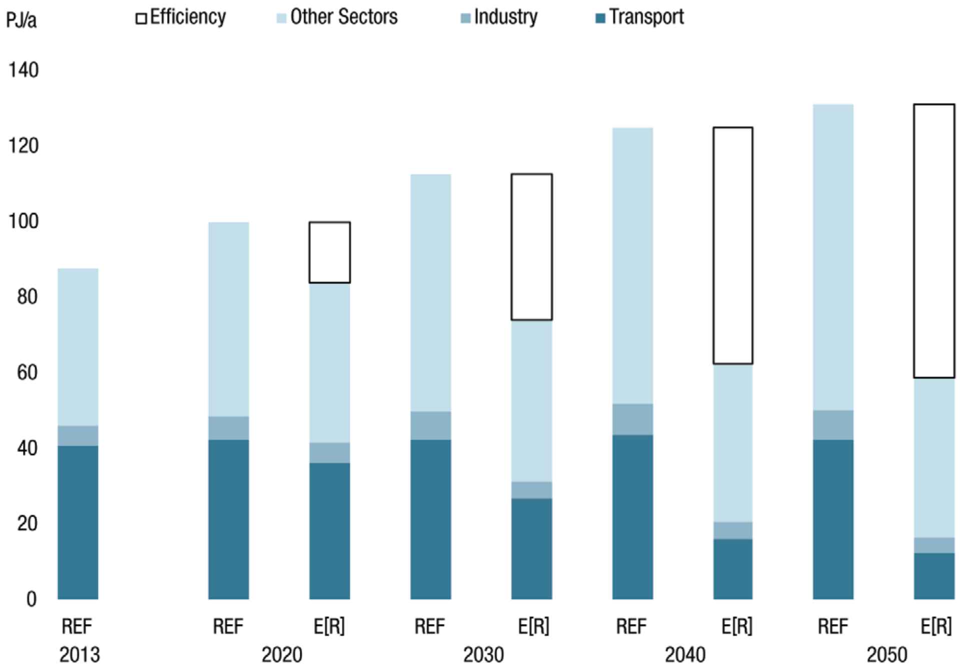
5B] CHANGES IN DEMAND

While in the reference scenario the final energy demand would increase by 42%, in the **Energy [R]Evolution** scenario it is expected to **decrease by 37%** with respect to current demand, thanks to efficiency policies that would enable the **same level of comfort and energy services**.

"The energy efficiency measures could allow to reduce energy demand by 37%"

The electrification of the demand, especially transport but also the rest of the sectors, will lead to an **increase of 33% in the total electricity demand, from the current 9 TW/year up to 12TW/year.**

The greatest fall in demand, nearly half, is reached thanks to efficiency, while the **reduction in the transport sector is over 50% compared to current use**.

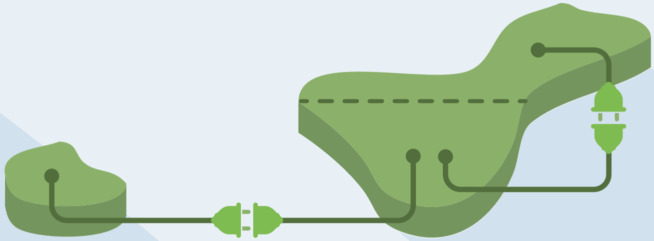


Graph. 1 Demand structure by sector 2012-2050. Reference scenario/Energy [R]Evolution

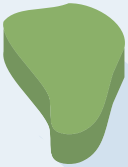
CANARY 100% RENEWABLE TO 2050

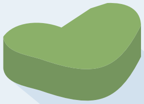
Investment: Energy [R]evolution it would be necessary an investment of € 20 billion between here at the 2050, that to say € 500 million per year, that will lead to total savings of € 42 billion in fossil fuels.

TENERIFE-N	MW
Biomass	8.91
Solar Thermal	0
Geothermal	50
Run-of-river hydro power	2
Photovoltaic	1438
Wave energy	12
Wind Onshore	524
Hydrogen (Fuel cells + CCGT)	1.61



LA PALMA	MW
Biomass	1.11
Solar Thermal	0
Geothermal	0
Run-of-river hydro power	1.2
Photovoltaic	224
Wave energy	9
Wind Onshore	287
Hydrogen (Fuel cells + CCGT)	27.73

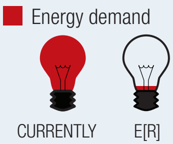




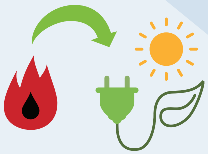
EL HIERRO	MW
Biomass	0.14
Solar Thermal	0
Geothermal	0
Run-of-river hydro power	0
Photovoltaic	39
Wave energy	3
Wind Onshore	36
Hydrogen (Fuel cells + CCGT)	3.30

LA GOMERA	MW
Biomass	0.29
Solar Thermal	0
Geothermal	0
Run-of-river hydro power	0
Photovoltaic	67
Wave energy	0
Wind Onshore	560
Hydrogen (Fuel cells + CCGT)	65.54

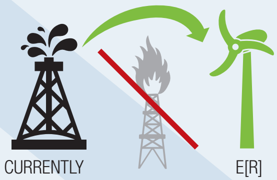
TENERIFE-S	MW
Biomass	3.51
Solar Thermal	0
Geothermal	50
Run-of-river hydro power	0.3
Photovoltaic	1438
Wave energy	0
Wind Onshore	1706
Hydrogen (Fuel cells + CCGT)	197.75



A 37% **reduction in demand** with respect to current consumption, due to the implementation of efficiency policies.

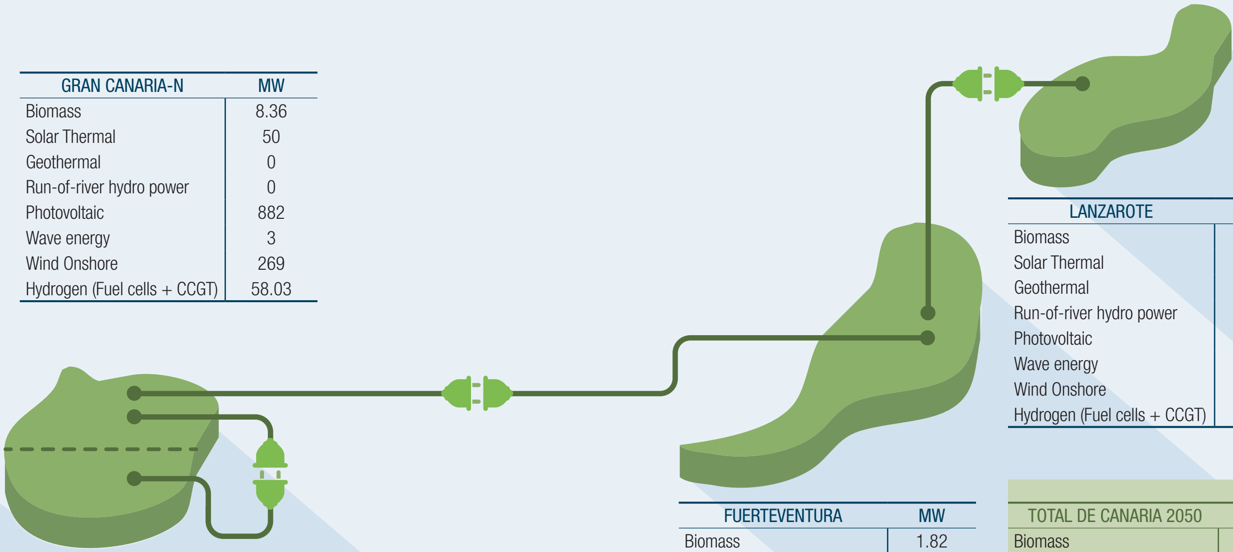


The electrification of most of the demand, presently supplied by fossil fuels, and coverage with a **100% renewable system by 2050.**



The substitution of **oil power plants by renewables,** without going through gas-fired plants.

The **reduction of €0.09/kWh** in generation costs, with respect to the costs in the reference scenario where conventional sources prevail.



GRAN CANARIA-N	MW
Biomass	8.36
Solar Thermal	50
Geothermal	0
Run-of-river hydro power	0
Photovoltaic	882
Wave energy	3
Wind Onshore	269
Hydrogen (Fuel cells + CCGT)	58.03

LANZAROTE	MW
Biomass	2.31
Solar Thermal	144
Geothermal	0
Run-of-river hydro power	0
Photovoltaic	160
Wave energy	16
Wind Onshore	311
Hydrogen (Fuel cells + CCGT)	61.95

FUERTEVENTURA	MW
Biomass	1.82
Solar Thermal	440
Geothermal	0
Run-of-river hydro power	0
Photovoltaic	477
Wave energy	19
Wind Onshore	506
Hydrogen (Fuel cells + CCGT)	89.43

GRAN CANARIA-S	MW
Biomass	3.34
Solar Thermal	136
Geothermal	100
Run-of-river hydro power	0
Photovoltaic	1323
Wave energy	0
Wind Onshore	627
Hydrogen (Fuel cells + CCGT)	80.83

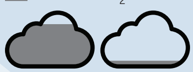
TOTAL DE CANARIA 2050	MW
Biomass	29.79
Solar Thermal	770
Geothermal	200.00
Run-of-river hydro power	3.50
Photovoltaic	6050
Wave energy	60
Wind Onshore	6050
Hydrogen (Fuel cells + CCGT)	586.17

E[R] scenario

The installed power install would be 12 GW (11.944 MW)

12 GW

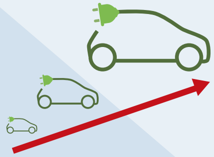
Tons of CO_2



CURRENTLY E[R]

A **reduction in emissions from** 14 million tCO2/year to 0.02 million tCO2/year by 2050, excluding extra-insular transportation.

An investment of € 20 billion that will lead, at the end of the period, **to total savings of € 42 billion** in fossil fuels.



A **rapid penetration of electric vehicles,** already suitable for the islands' distances.

* Because of the rounds,not shown hydraulic

* The situation of the islands is indicative and is just for informatives purpose, does not correspond to the situation on a map.

5C] ELECTRICITY GENERATION

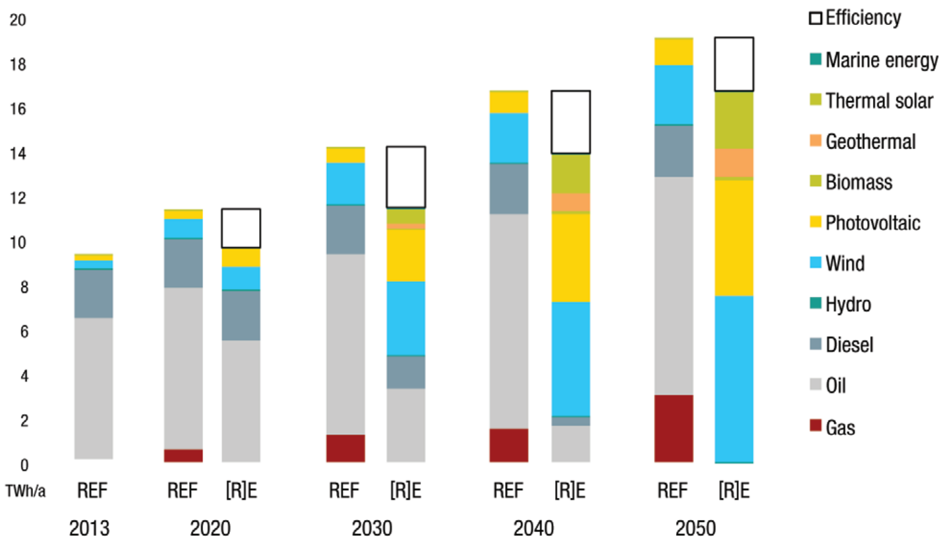
"The Canary Islands could have around 12,000 MW of renewable installed capacity "

By **2050, 100% of electricity generated in the Canary Islands will be from renewable sources**, with intermediate goals of 20% by 2020 and 58% by 2030.

To make this possible, the **Energy [R]Evolution** is expected to go from the current 338 MW of **installed renewable power generation to 11,944 MW** by the middle of this century, with intermediate goals of 1,011 MW by 2020, 3,254 MW by 2030 and 6,933 MW by 2040. In the reference scenario renewable power generation in 2050 would be only 2,759 MW.

In this regard, attention should be drawn to the paralysis in the current development of renewable energies on the islands, and especially wind power which has less than half the generation costs with respect to polluting power plants that today account for over 90% of electricity demand.

The following graph shows the transition change by decade of the current mix of electricity generation to a mix one hundred per cent renewable.



Graph 2. Change in electricity generation 2012-2050 by technology. Scenarios REF and E[R]

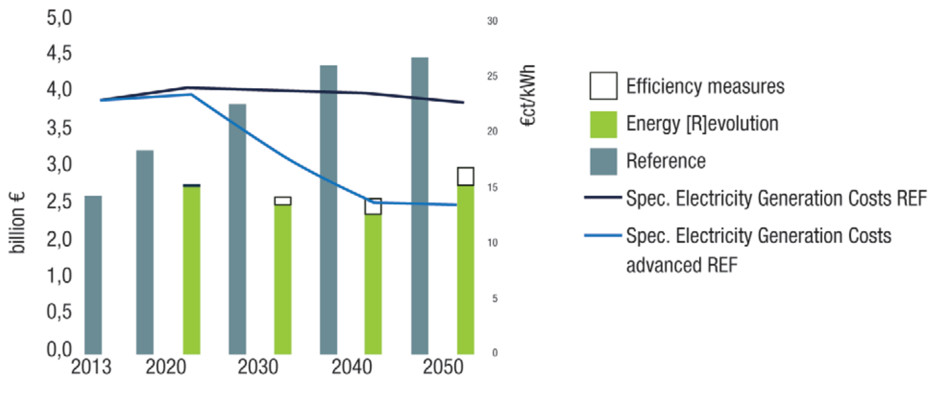
En MW		2012	2020	2030	2040	2050
Hydro	REF	0.5	1.2	1.4	1.7	2.0
	E[R]	0.5	1.2	1.7	2.3	3.5
Biomass	REF	3.8	2.5	2.6	2.7	2.8
	E[R]	3.8	4.4	12	24	30
Wind	REF	154	327	680	1,009	1,570
	E[R]	154	392	1,264	2,379	4,824
Geothermal	REF	0	0	0	0	0
	E[R]	0	0	31	124	200
Photovoltaic	REF	177	267	430	669	1,184
	E[R]	177	515	1,434	2,834	6,050
Thermal solar	REF	0	0	0	0	0
	E[R]	0	12	280	603	775
Marine energy	REF	0	0	0	0	0
	E[R]	0	0	11	39	62
Total	REF	335	597	1,114	1,682	2,759
	E[R]	335	925	3,034	6,007	11,944

Table 2 Canary Islands: projection of renewable electricity generation capacity under the Reference and the Energy [R]evolution scenario

5D] GENERATION COSTS

The **Energy [R]Evolution** commitment not only achieves a decrease in emissions, **but a very important reduction in electricity generation costs, € 0.09 kWh** below the costs in the reference scenario, **€ 0.14 kWh** instead of **€ 0.23 kWh.**

“The costs of renewable electricity generation could come down from the 14 cents expected to a 9 cents per kWh”



Graph 3. Changes in the electricity supply costs 2012-2050. Trend scenario / Energy [R]Evolution (HABRÍA QUE ADAPTAR LOS COLORES DEL GRÁFICO)

“In addition to cost savings, this will also save considerable CO2 emissions.”

As you can see in this graph, in the reference scenario, **total electricity supply costs rise from € 2bn a year to over € 4bn**, as a result of the increase in demand along with fossil fuel prices and CO_2 emissions. Meanwhile, in the **Energy [R]evolution** scenario the costs would be maintained even with the increase in electricity demand and offers **the enormous benefit of saving on the fossil fuel import bill.**

These figures are conclusive and dismiss the cliché about the high cost of renewable energies, the excuse perpetrated by the public administrations to put off the indispensable commitment to renewables, “even though acknowledging their environmental virtue”. As well as the data on investment costs, this model also adds social and economic benefits, especially in terms of employment, but also in other aspects, like the better distribution of the wealth created.

5E] NECESSARY INVESTMENTS

“ The Canary Islands produces its electricity primarily with oil, with a model 100% renewable, they would stop importing oil worth € 42 billion “

In order to make the **Energy [R]Evolution** a reality, an **investment of € 20bn is needed, from the study start date to 2050**, or just over € 500 million a year. In the Reference Scenario this investment would be € 11bn, but the fossil fuel import bill would remain. This means that the **Energy [R]Evolution would save € 42bn.**

That is to say, with an **added cost** of € 9bn (the difference between investments in both scenarios) **or € 257m a year, annual savings of € 1.1bn would be achieved**. These savings would increase from 2050 on, since the renewable installations would keep operating and oil would be almost totally abandoned.

The **Energy [R]Evolution** scenario **does not consider any investment in new gas-fired plants**. It does consider temporary maintenance for the current oil infrastructures that will be needed in the transition towards a 100% renewable energies model.

5F] THREE POSSIBILITIES FOR THE NEW ENERGY SCENARIO

The **Energy [R]Evolution** scenario is divided in turn in three sub-scenarios to go deeper into the possible consequences of the integration of renewable capacity in different combinations:

- Basic. Only the planned insular interconnections are implemented.
- **DSM-**. Excluding demand-side management.
- **Grid+**. Grid expansion connecting all the islands.

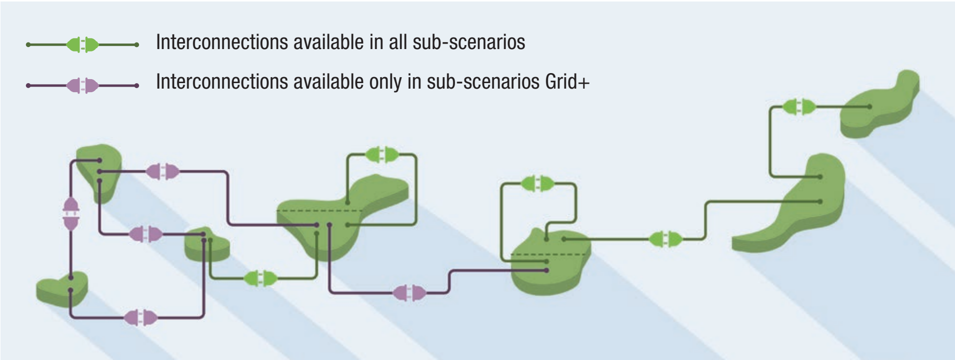


Diagram 1. Interconnections by sub-scenario

Total electricity generation only varies slightly between the sub-scenarios, but there are relevant differences in the generation structure and the installed capacity required in each case. The study reveals that under the Grid+ scenario (which implies a sharp increase in the interconnections) the **generation cost is € 0.03 kWh cheaper than in the other two scenarios**. In this case, importation and exportation among the 9 regions of the Canary Islands (one region for each island, except Gran Canaria and Tenerife with two regions each) would mean around 5,6 TWh per year. The main characteristic is that the huge potential of renewable energy in Fuerteventura would be exploited.

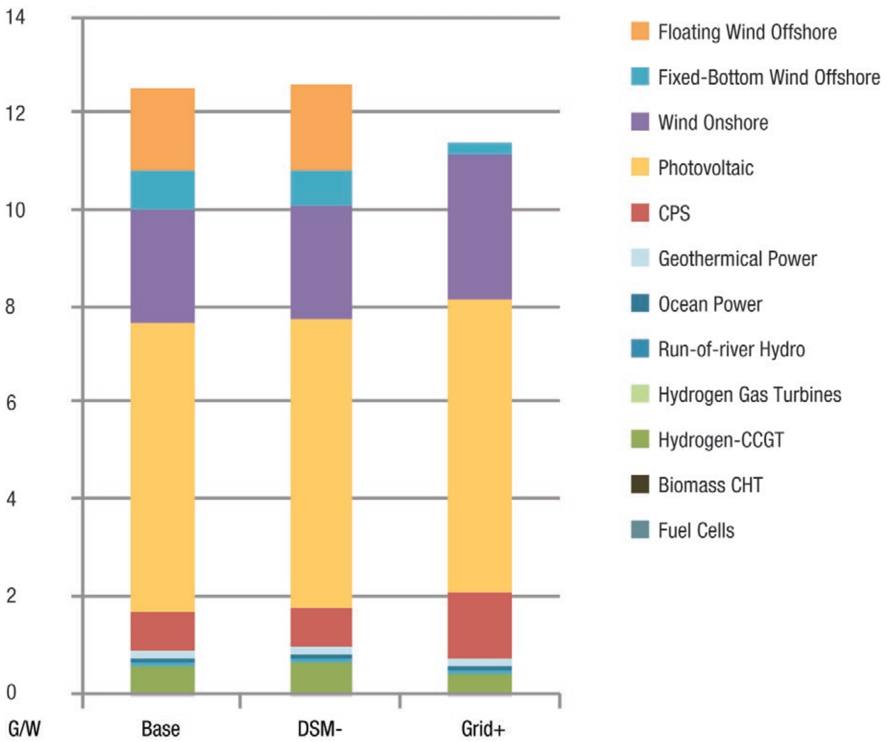
"An intelligent grid could connect all the islands for better electricity distribution and exchange "

5G] STRUCTURE OF THE INSTALLED CAPACITY AND GENERATION

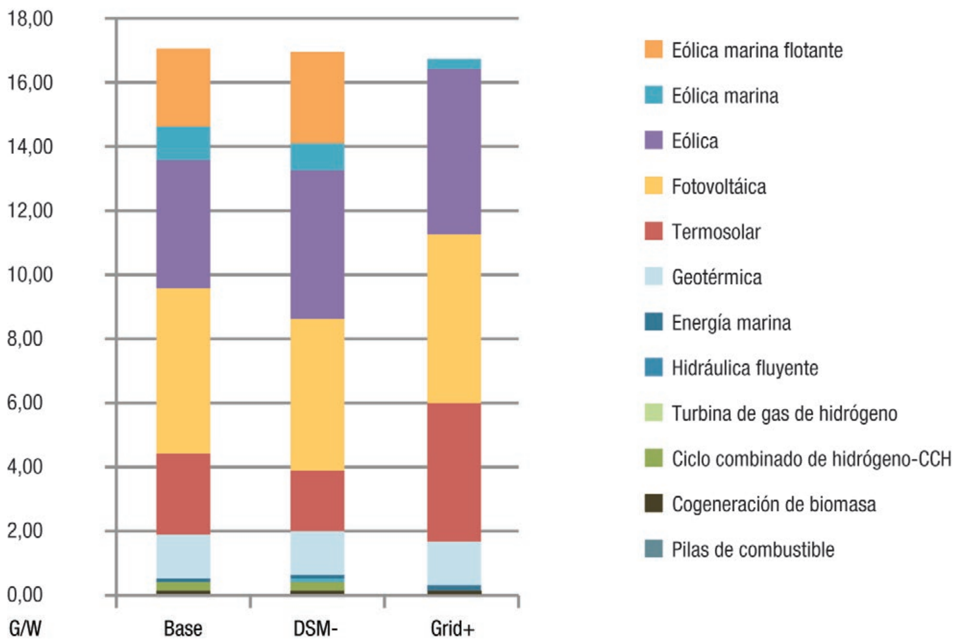
The installed generation capacity and the share of demand covered varies from one sub-scenario to the other. Regarding the **installed capacity** in the three cases, **photovoltaic is the technology with highest levels of implementation** and the main difference between the first two and the third scenario is the role of offshore wind and floating marine energy.

Wind power, photovoltaic and solar thermal are the three technologies with the highest level of **generation** in all scenarios, but especially in **Grid+**: it favours the connection between islands and can do without the majority of offshore wind and floating offshore wind energy.

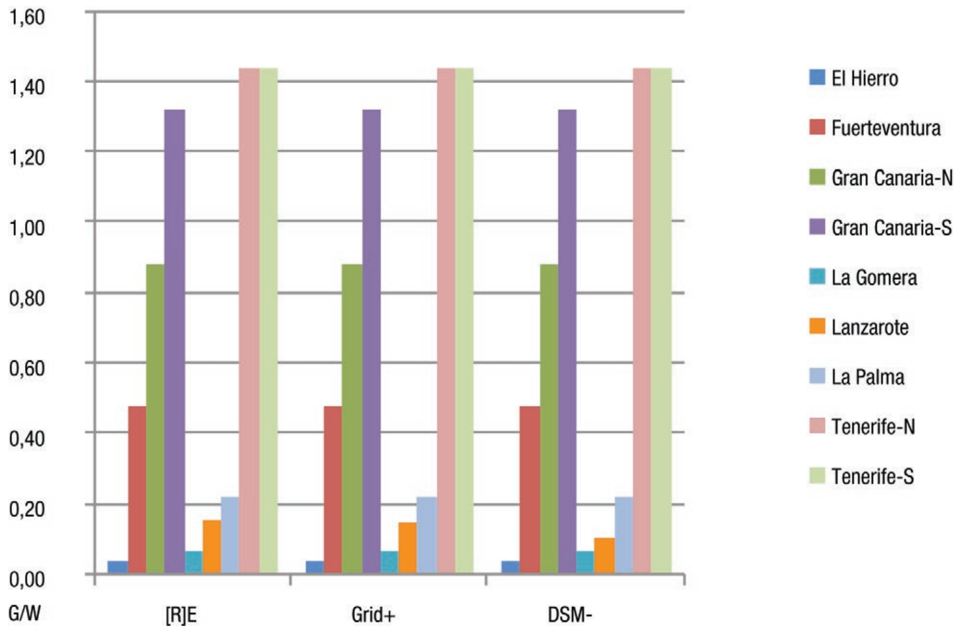
Graph 4. Capacity installed by 2050 by technology and by sub-scenario.



Solar thermal energy and the introduction of geothermal heat pumps could cover 99% of the heat demand of the islands".

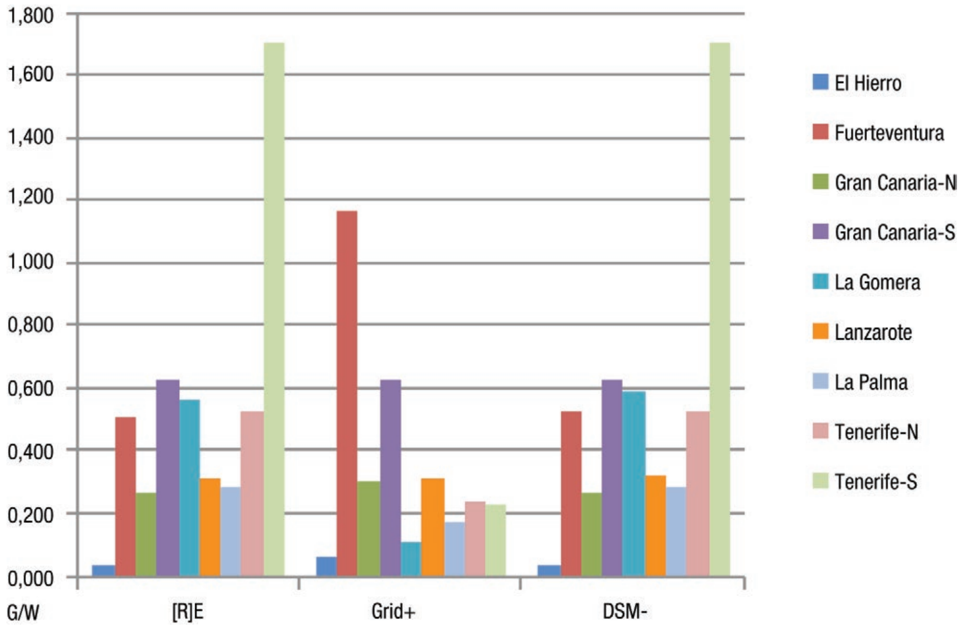


Graph 5. Generation by 2050 by technology and by sub-scenario.



Graph 6. Installed photovoltaic capacity by island and by sub-scenario.

Graph 7. Installed wind capacity by 2050 by sub-scenario.



With photovoltaic, the introduction of new capacity is similar in the three scenarios. But in the case of wind, the two regions of Tenerife would require a consolidated implantation in the two first scenarios; in the third, however, **Grid+** would make the most of the wind resource on Fuerteventura thanks to the interconnections planned.

5H] HEAT SUPPLY

"Hybrids and electric cars would be all over the islands"

Currently **renewable energies only meet 2% of heating demand**; in the **reference scenario they would only go from the current 90 MW of solar thermal to a total of 406 MW**; in the meantime, the **Energy [R]evolution scenario would reach 1,925 MW**. With the introduction of geothermal energy and heat pumps, the goal is for **renewable energies to cover 30% of the total of this demand in 2030 and in 2050 about 99%**. Thanks to the **efficiency measures this demand could be reduced in 2050 by 42%** with respect to the Reference Scenario.

5I] TRANSPORTATION

One key element in the **Energy [R]evolution** is to bring about **transport electrification** by the **swift introduction of electric vehicles**. This would enable a reduction in demand from the current 42 PJ/year to 12 PJ/year with a **71% saving** with respect to the reference scenario.

The key elements to reach this objective are the implementation of a highly efficient propulsion technology, with hybrid motorisation, plug-in hybrid and battery-powered electric.

5J] LONG DISTANCE TRANSPORTATION

Given the relevance of tourism and its relation with long distance transport, this study separates the energy demand related to these journeys from the goal of one hundred per cent renewable and considers the importation of the required fuels, biofuels and synthetic fuels for air and sea transport (long distance). The criteria used is that 50% of the fuels used in international transport and all the fuels used in journeys at a national level come from Spanish territory and under sustainability criteria, as analysed in Energy 3.0.[11]

11 http://www.greenpeace.org/espana/es/Trabajamos-en/Frenar-el-cambio-climatico/Revolucion-Energetica/Energia-30-/

6] GREENPEACE PROPOSALS

In the light of the German Aerospace Center (DLR) study, Greenpeace proposes the adoption of very specific measures, both in the scope of supply and demand, and to begin working on making the **Energy [R]Evolution** scenario a reality.

6A] PROPOSALS ON DEMAND REDUCTION AND MANAGEMENT

The implementation of programmes must be applied to the overall demand to reduce and manage the demand included in the projections, but, to be more effective, these programmes must be specifically focused on those **sectors with the highest possibilities of intervention.**

6A1] MEASURES ON BUILDINGS APPLIED IN THE TOURISM AND SERVICES SECTOR

- To advance in the application of the aims of **Directive 2010/31/UE: the obligation of nearly zero energy buildings** (NZEB) in all sectors, public and private. Due to the amount of sunshine and the non-extreme climatic characteristics, the Canary Islands are the suitable framework to implement the instruments to rehabilitate all buildings devoted to services following NZEB criteria, which all new buildings must comply with. These measures must apply to hotels, hospitals, public administration buildings, schools, sport centres, shopping centres, etc.

- To incorporate **efficient technologies** in the tourism sector such as heat pumps for cold and sanitary hot water.

- To incorporate systems for an optimum use of solar energy with thermal objectives. Today, renewable energies cover 2% of the heating demand in the Canaries, solar collectors being the most important (traditional biomass use was not considered).

6A2] MEASURES ON THE RESIDENTIAL SECTOR

Due to the structure of energy consumption in Canary Island households, several initiatives need to be implemented:

- **Substitution of household equipment**. The use of appliances triples the national average. So it is vital to launch an **informative campaign to renew small appliances** with incentives for high efficiency equipment and to introduce a new energy culture.

- **Generation plan for consumption of electrical energy.** Due to the layout of the roofs and the high electrification of demand, the houses in the Canaries are ideal to incorporate distributed generation, if possible under the Net Balance criteria. A reversal of Royal Decree 900/2015 regulating auto-consumption is required to bring this about.

- **Building rehabilitation plan**, especially regarding the incorporation of improvements in the building envelopes and passive architecture measures, with priority subsidies for the most vulnerable families facing energy poverty.

- **Awareness-raising plan on energy.** This idea of cheap and abundant energy is rooted in the Canary Islands due to the different tax system and to subsidies with respect to energy products' real cost. It is important to reverse this situation since the main actors to achieve the planned objectives are the islanders themselves.

6A3] EFFICIENCY IN WATER DESALINATION.

Water desalination is one of the main elements in energy consumption. Although its professional and experienced management cannot be improved, it has to **incorporate the best technologies and especially the use of desalination systems, due to their storage capacity as a regulation element of the energy system** and also incorporating renewable energies as the main source of electricity generation.

The adaptation of the islands' electric system must count on the possibilities of water desalination and storage in order not to waste the available energy without any real demand.

6A4] MEASURES IN THE INDUSTRIAL SECTOR

The **electrification of industrial demand in the Canaries** is one of the most important foundations to achieve an efficient substitution of fuels and to eliminate the dependence on fossil fuels.

The characteristics of Canary Island industry (largely reliant on agriculture and food production and the lack of heavy industry) require the implementation of a sectoral plan including the following objectives:

- **audit** development;
- **electrification of demand**;
- **substitution of equipment**;
- protection of **local production** as an element to reduce transport needs and external dependence.

The Canary Islands depend on external supply due to the lack of competition of autoctonous products; this situation is not real when considering the environmental problem and dependence and when transport is taken into account. A new national accounting is required to send adequate signals to transform a dependent economy into a self-sufficient economy.

6A5] ACTION PLAN FOR TERRESTRIAL TRANSPORT

In this area, the measures should include:

- The organisation of smart transport based on the supply of mobility services, backed by a diverse fleet of collective electric vehicles that facilitates the intermodality for different capacity vehicles.
- A network of charging points and hydrogen refuelling stations must be included for interurban mobility.
- The design of **urban mobility plans** to recover a human dimension for the cities, moving towards pedestrianisation, the use of the bicycle, public transport and persuasive measures to avoid the use of private vehicles.
- **An electric vehicle incorporation plan**, through the compulsory rental of electric vehicles in the tourism sector.
- **Substitution of the current fleet**.
- **Promotion of car sharing and car pooling**.
- An active tax policy to stop **subsiding fossil fuels** and promote the development of emissions-free transport.
- **Modification of infrastructure plans**, not to promote the use of private vehicles, but to transform them into elements of interchange to be used as public transportation.
- **New criteria for industry localisation** as well as for goods production and services.
- Promote a **reduction of work-related journeys** and facilitate remote processes with public administrations.

7B] PROPOSALS ON OFFER

The development of renewable energies in the Canary Islands, despite having a much higher energy resource than the Peninsula, has been very limited, mainly due to the lack of administrative procedures that promote their development, both in relation to the political will and to the competences of the different institutions in national, regional and local administrations.

The increasing importance of renewable energies should be based, at least in the first phase, on the profitability of technologies and in the creation of a friendly administrative and economic environment, meaning, in each case, administrative simplification and with no need to subsidise the energy produced.

The energy measures should include:

- The development of the existent wind potential, starting with the implementation of the wind capacity already planned in the Canary Islands Energy Plan (PECAN, by its initials in Spanish).
- The development of a repower plan, including the maximum use of the current locations. The Canary Islands have wind potential but very small size turbines.
- The development of a photovoltaic installation plan, centred in sites close to the demand because of the availability of the resource.
- The development of self-supply, considering that a high percentage of photovoltaic capacity has to be in the consumption.
- The identification of locations for solar thermal electricity production.
- The development of a geothermal energy plan for electricity production.
- The updating of distribution networks to integrate the distributed generation and manage the active storage.

- The development of energy storage based on coordinated desalination management and the maximum use of the surplus, storage systems, development of electric vehicles, analysis of pumping plants' potential.

All of the above must form part of an energy plan for the Canary Islands, integrating measures on demand and on energy production, as well as transport, distribution and storage infrastructures required in the Energy Revolution scenario.

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