
PROGRAM FOR RENEWAL OF INEFFICIENT ENERGY CONSUMPTION EQUIPMENT. PHASE II.

Project No. 1 Replacement of Refrigerators and
Project No. 2 Replacement of Air-Conditioners focused to the Province of Galapagos

SUMMARY REPORT

Background

The Ministry of Electricity and Renewable Energy (Ministerio de Electricidad y Energía Renovable – MEER), in accordance with the established in the Article 258 of the Constitution of the Republic of Ecuador, promotes the development of Galapagos, "...in function to a strict fulfilling to the natural patrimony conservancy principles of the State and of the good living..." and the National Initiative of Zero Fossil Fuels in Galapagos.

By means of the implementation of the Program of Refrigerators Renewal – RENOVA – which was performed in a first phase (2012 – 2016) at national level, 95.645 units were replaced, processing in consequence 6.012,72 tons of scrap metal and recovering 2.733 kg of refrigerant gases (2.557,945 kg of CFC12 and 175,1 kg of R134a)¹.

The goal in Galápagos was the replacement of 1.109 refrigerators, mainly in Santa Cruz Island, considering that in the year 2015 the total of subscribers was about 8.630 in the residential sector², reaching a saving of approximately 430 MWh/year.

This Secretary of the Government has considered that for the next phase (2017 – 2019) of the Program the impulse to the replacement of inefficient equipment must continue in Galapagos, because the use of fossil fuels remains in almost 90% and also due this is an isolated system having reduced electrical generation from renewable sources, which results in a subsidy provided from the Government for the provision of the service.

In addition, it had been established that the sectors registering the greater electricity consumption are the residential and commercial ones, where it is important to strengthen the energy efficiency policy, emphasizing in the main uses of the energy in the province: refrigeration and acclimatization.

Justification of Phase II

✓ *Offer and demand of electrical power consumption*

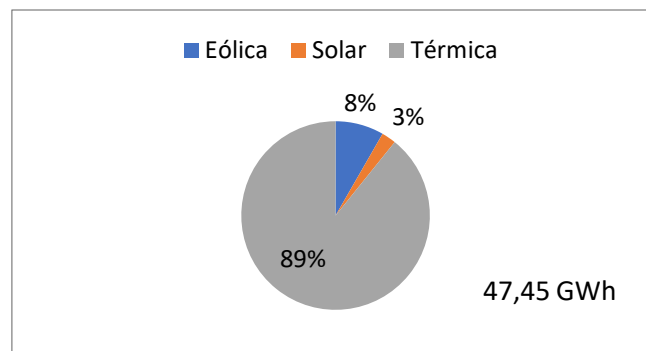
The electricity offer according the Energy Balance of the Province of Galapagos 2015 was 47,45 GWh³, with 89% representing thermal generation and the remaining representing wind and solar generation. See Graphic No. 1.

Graphic No. 1 Percentage structure of electrical generation in 2014

1 RENOVA report of first phase, January 2017. Ministerio de Electricidad y Energía Renovable.

2 Annual and Multi-annual Statistics, Table No.19, Report of Agencia de Regulación y Control de Electricidad - ARCONEL 2015, The Empresa Eléctrica Galápagos has records of 10.788 subscribers, about 80% of them are in residential sector, while 15% remaining are in commercial sector.

3 Base year 2014.

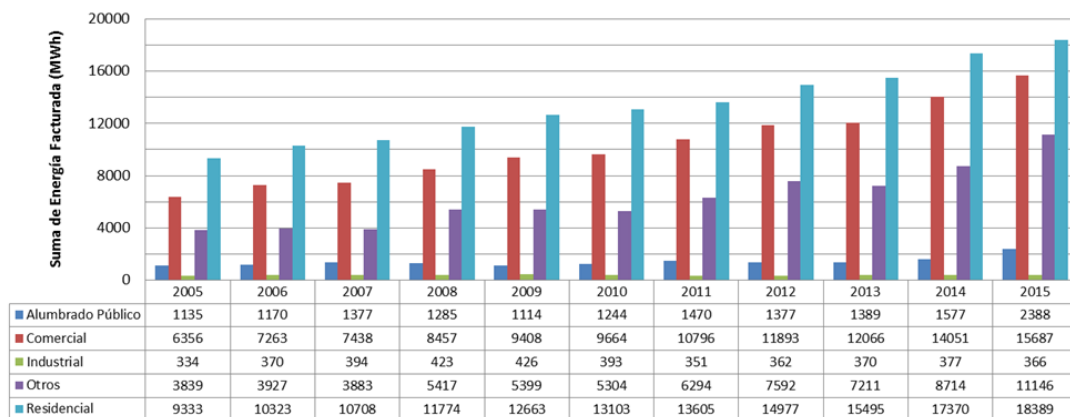


Source: Ministerio de Electricidad y Energía Renovable (MEER).

The average growing of the electricity demand is approximately 9%, where the residential and commercial sectors are those sectors taking advantage of the 70% of the total resource.

See Graphic No. 2

Graphic No. 2 Trends of Annual Growing of the Energy Consumption in the Province of Galapagos – Years 2005–2015

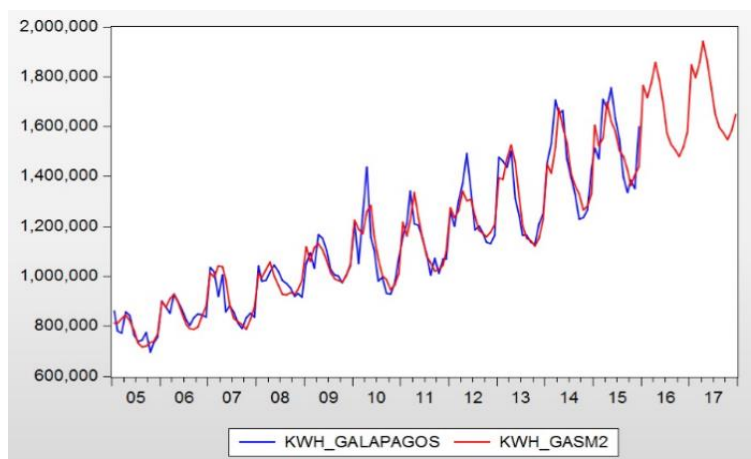


Source: Agencia de regulacion y control de electricidad (ARCONEL). Trends of annual growing of energy consumption in Galapagos, 2015

✓ **Projection of energy consumption**

The projections performed in the residential sector notice that the annual average consumption of energy for year 2017 will be approximately 20 GWh, which in comparison to the year 2014 represents an increment of 3 GWh. While, into the commercial sector this represents an increment of 4 GWh. Graphic No. 3 shows the historical values of energy consumption in the province of Galapagos identifying several peaks in the curve, as consequence of a predominant energy consumption due air-conditioning and refrigeration equipment product of the warm season between the months of January to June in the insular region.

Graphic No. 3 Energy Projection at year 2017 in residential sector

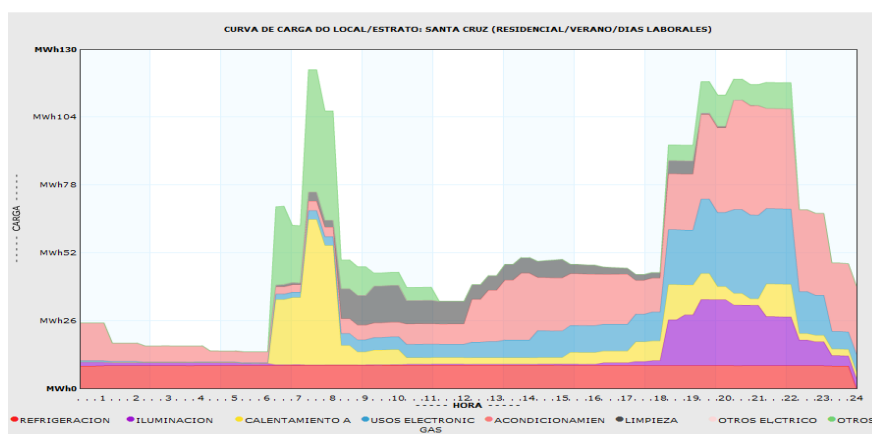


Source: Ministerio de Electricidad y Energía Renovable (MEER).

✓ **Study of final uses of energy**

With the purpose to corroborate the energy consumption at the residential and commercial sectors, MEER performed a Study of Demand and Final Uses of Energy for the Santa Cruz, San Cristobal and Isabela Islands with a total of 500 surveyed people. It was registered that the equipment with greater energy consumption at residential level during the hot season are *refrigeration units with 18,74% and air-conditioning units with 33.26%*. See Graphic No. 4.

Graphic No. 4 Load Curves by final uses in Santa Cruz island – Residential



Source: Ministerio de Electricidad y Energía Renovable (MEER).

✓ **Offer and Demand of Fuel for electrical power generation**

For the electrical power production in the insular region, the diesel is recognized as the dominant fuel with approximately 3.081,3 thousands of gallons burned during 2014, existing additionally a minimum contribution in burning of jatropha vegetal oil.

✓ **Offer and Demand of power**

The effective power at 2014 was 18,93 MW, where the thermal plant MCI type (engine of internal combustion) with 12,71 MW is predominant. Similarly there is a discrete contribution of the wind and solar plants with power generations of 4,65 MW and 1,57 MW, respectively. In addition, there is a maximum monthly power demand which is shown below.

Table No. 1 Maximum monthly power demand in the Residential Sector

MAXIMUM POWER 2015 (kW)												
MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec*

Demand	7.350	8.350	8.710	8.541	8.403	8.322	6.979	6.803	6.677	8.384	8.464	9.785
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*Maximum year demand 9.785 kW

✓ **Tariff Deficit**

The Agencia de Regulación y Control – ARCONEL for year 2015 has records that the “Tariff Deficit”⁴ is about 1,54 MM USD. To this cost other subsidies, compensations or incentives must be added, which are supported directly by the Ecuadorian Government.

In this sense, it is necessary the implementation of Energy Efficiency measures which allow to the Government, to optimize the fossil fuel consumption for electrical power generation in the islands, by means of effective and economical practices to mitigate the climatic change and the negative effects currently affecting its ecosystem.

Objective of the Program for Renewal of Inefficient Energy Consumption Equipment Second Phase.

Optimize the electrical energy consumption in the acclimatization and refrigeration areas BY MEANS OF the replacement of 3.225 units in the residential and hotel-commercial sectors of the Province of Galapagos with the purpose to reduce the amounts invested by the Government in the electrical generation of that intervention zone.

Baseline

✓ **Refrigeration Equipment**

The national market began the commercialization of refrigeration and acclimatization equipment of domestic use with a best efficient level, with average saving ranges between 250 and 450 kWh/year, corresponding to the A, B and C types, regarding the Ecuadorian Technical Regulation - RTE 035-2009.

✓ **Air-conditioning Equipment**

Recent referential data provided by national suppliers report the sales distribution of air-conditioning units in the insular region, with 53% of units of 12.000 BTU/h of Split type. Additionally, there are 25% of window type units, and the remaining units are Split type for the total of the surveyed sample for the two sectors.

Offer and Demand Analysis of Efficient Equipment

✓ **Offer**

Below are specified the models of the equipment and their percentage distribution for the phase II of the Program:

Table No. 2 Models and percentage of welcome for the equipment

REFRIGERACIÓN		CLIMATIZACIÓN	
Modelo	% distribución	Modelo	% distribución
INDURAMA IR 365	40%	SPLIT INVERTER 9.000 BTU	20%
INDURAMA IR 400	38%	SPLIT INVERTER 12.000 BTU	80%
INDURAMA IR 460	22%	-	-
Total	100%	Total	100%

Source: Own elaboration, March 2017.

✓ **Demand**

It is focused in the quantity of potential and effective subscribers of the residential and hotel sectors in Galapagos, who are looking for a reduction and/or optimization of their monthly energy consumption by the replacement of inefficient equipment.

⁴ Reforma de la Ley del Régimen del Sector Eléctrico, Mandato Constituyente Nro. 15, Regulación Nro. 006708 “Aplicación del Mandato Constituyente Nro.15 y finalmente la Ley Orgánica del Servicio Público de Energía Eléctrica.

Table No. 3 Demand per subscribers in residential and commercial sectors

DEMANDA	ABONADOS POSIBLES			ABONADOS OBJETIVO		
	SECTOR RESIDENCIAL	SECTOR COMERCIAL	TOTAL	SECTOR RESIDENCIAL	SECTOR COMERCIAL	TOTAL
REFRIGERACIÓN	3.000	0	3.000	1.891	0	1.891
CLIMATIZACIÓN	1.751	1.583	3.334	701	633	1.334
TOTAL	4.751	1.583	6.334	2.592	633	3.225

Source: Own elaboration, February 2017.

Period of Execution required by the Program of replacement of Equipment in Galapagos, Phase II

The estimated execution time will be 72 months, which include 36 months of portfolio recovery.

Expected results due the replacement of equipment

Based on the results obtained for the first phase, it is expected to continue with the energy saving via the replacement of old equipment by other with most efficient technology, and below the data and suppositions considered for the next calculations are detailed:

Table No. 4 Suppositions considered for demand and energy calculations

GENERAL DATA	
Real energy cost in centsUSD/kWh	0,39
Cost of the installed thermal generation (USD/kW installed)	818.49
Electrical service for the user (centsUSD/kWh)	0,10
Displacement of diesel [kWh/diesel gallon]	12,08

Source: Own elaboration, February 2017.

Table No. 5 Annual Distribution of Equipment

EQUIPOS	2017	2018	2019	TOTAL
CLIMATIZACIÓN	266	400	668	1.334
REFRIGERACIÓN	378	567	946	1.891
TOTAL	644	967	1.614	3.225

Source: Own elaboration, February 2017.

Savings by refrigeration and acclimatization in the residential and hotel-commercial sectors

✓ Refrigeration

Table No. 6 Estimated savings due the replacement of refrigerators

Detail	Electricity (kWh)	Installed power (kW)	Diesel (gal)
Estimated saving	1.357.165,50	109,32	121.897,73**
Saving in USD dollars	529.294,54*	89.481,68	

*Generation and distribution cost in Galapagos of 39cents/kWh, includes the cost of subsidized diesel (45cents/kWh not considering the subsidy to diesel)

** Considers 8,5% of technical losses

Source: Own elaboration, February 2017.

✓ Acclimatization

Table No. 7 Estimated savings due the replacement of air-conditioning systems

Detail	Electricity (kWh)	Installed Power (kW)	Diesel (gal)
Estimated Saving	922.336,51	337,56	82.842,31
Saving in USD dollars	359.711,24*	276.292,79	

*Generation and distribution cost in Galapagos of 39cents/kWh, includes the cost of subsidized diesel (45cents/kWh not considering the subsidy to diesel)

** Considers 8,5% of technical losses

Source: Own elaboration, February 2017.

✓ **Power Demand (Benefit to the total load curve of Galapagos)**

Table No. 8 Estimated saving in the load curve

Maximum Power Demand in Galapagos (December 2015) (kW)	Reduction due replacement of Air-Conditioning units (kW)	Reduction due replacement of Refrigerators (kW)	Percentage of Saving in Dmax. (%)
9.785	338	109	5%

✓ **Avoided emissions of greenhouse gases**

Table No. 9 Avoided CO2 emissions due the energy saving

Equipment to replace	Saving in Electricity (MWh)	Avoided Emissions (tonCO2)
Acclimatization	922,3	618,0
Refrigeration	1.357,2	909,3
Total	2.279,5	1.527,3

* Emission Factor for the Electrical System of Galapagos: 0,67tonCO2/MWh, considering the Energy Balance of Galapagos 2015 based on 2014 year.

Indicators of results at 2019

- ✓ It is expected to obtain an energy consumption saving of 2.279 MWh at 2019, which will permit to achieve an economical saving of USD 899.006,00 taking into account the generation and distribution cost for the electrical utility of 39 cents/kWh.
- ✓ After to complete the Project, the total of replaced equipment yearly will generate a saving of 1.341 MWh, which is equivalent to USD 523.180.
- ✓ The savings due the energy consumption represent to avoid the emission of 1.527 tnCO2 to the environment, which is equivalent approximately to the pollution produced by 325 light cars of internal engine combustion⁵.
- ✓ After to complete the project, yearly the total replaced equipment will generate a saving of 899 tnCO2.
- ✓ Regarding the power demand it is estimated to obtain 447 kW (5% respect the maximum demand of 2015), which permits to have an economical saving of USD 365.774,48 considering the cost of 818.49 USD/installed kW for thermal generation.
- ✓ The electrical power generation in the Galapagos Islands based on diesel is approximately 4 million gallons per year, therefore it is expected a saving of 204.740 gallons of diesel in the energy production, equivalent to 5%.
- ✓ The projects represents the 68% of the initiatives implemented on energy efficiency in Galapagos, assessed respect to the Energy Management Systems in the commercial sector, promoting the introduction of electrical vehicles and communication campaigns of energy efficiency.
- ✓ It is expected to recover the 100% of the financial incentives granted to the beneficiaries of the Program at national level up to the year 2022.

⁵ The Consejo de Gobierno de Galápagos indicates that for October 2012 the size of the automotive sector has 2.572 vehicles

