INTERNATIONAL CONFERENCE ON RENEWABLE ENERGIES AND POWER QUALITY (ICREPQ'15)

Renewable Energy in Islands. An Integrated Proposal for Electricity Generation and Transports

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ISEL
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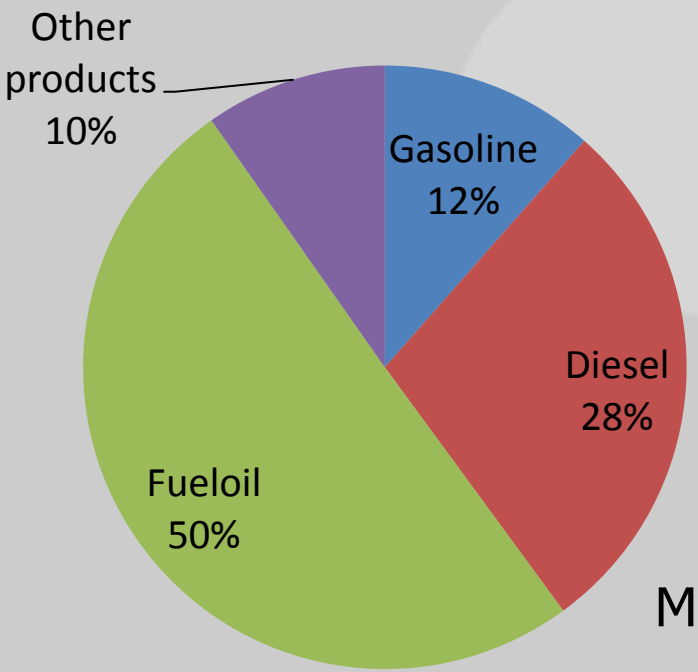
Introduction

Madeira Island has about 55 km length and 24 km width, a total area of 740 km^2 and Terceira has about 29 km length and 18 km width, a total area of 400 km^2. This is suited for an electric vehicle (EV) use because the majority of daily trips are expected to be less than 100 km, so the range limitation problem almost no exists in this Island.

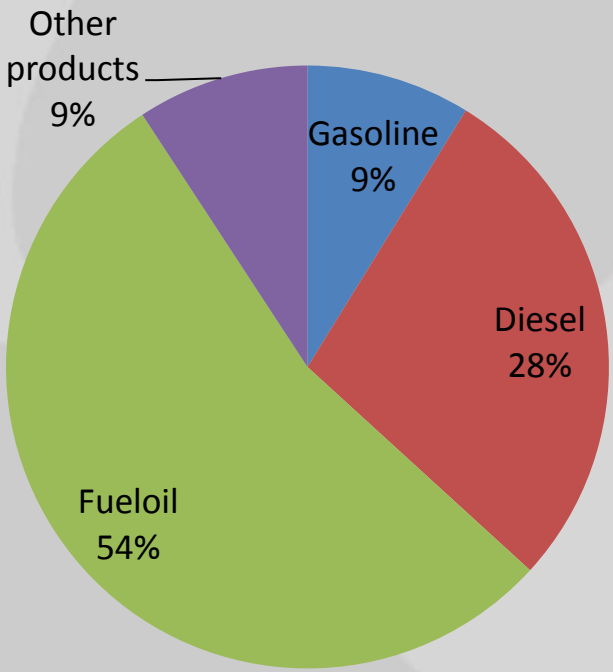
Introduction

Distribution of oil products' consumption in 2013 in Madeira and Terceira among the final products



Madeira

265 000 tons



Terceira

77 208 tons

Introduction

Transportation

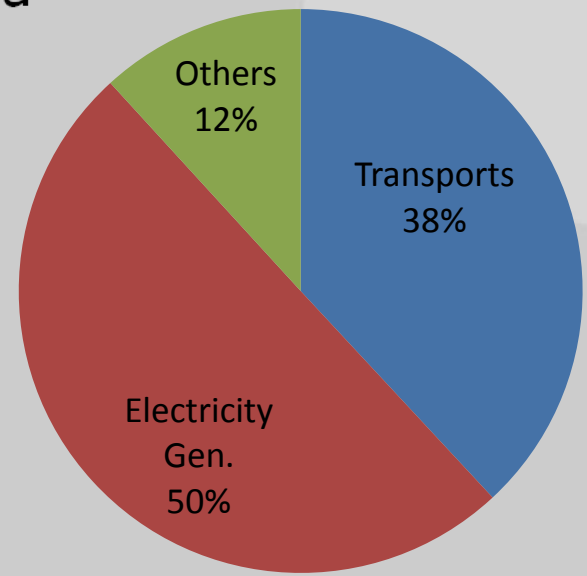
Electricity production

→

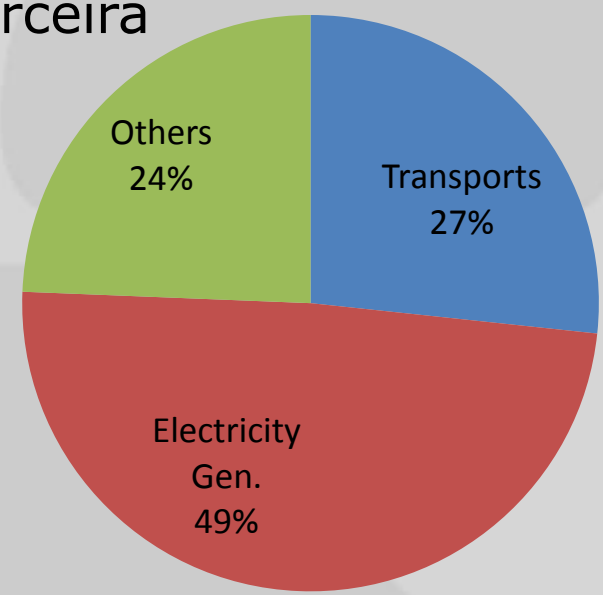
Fossil Fuels use

CO_2 emissions

Madeira

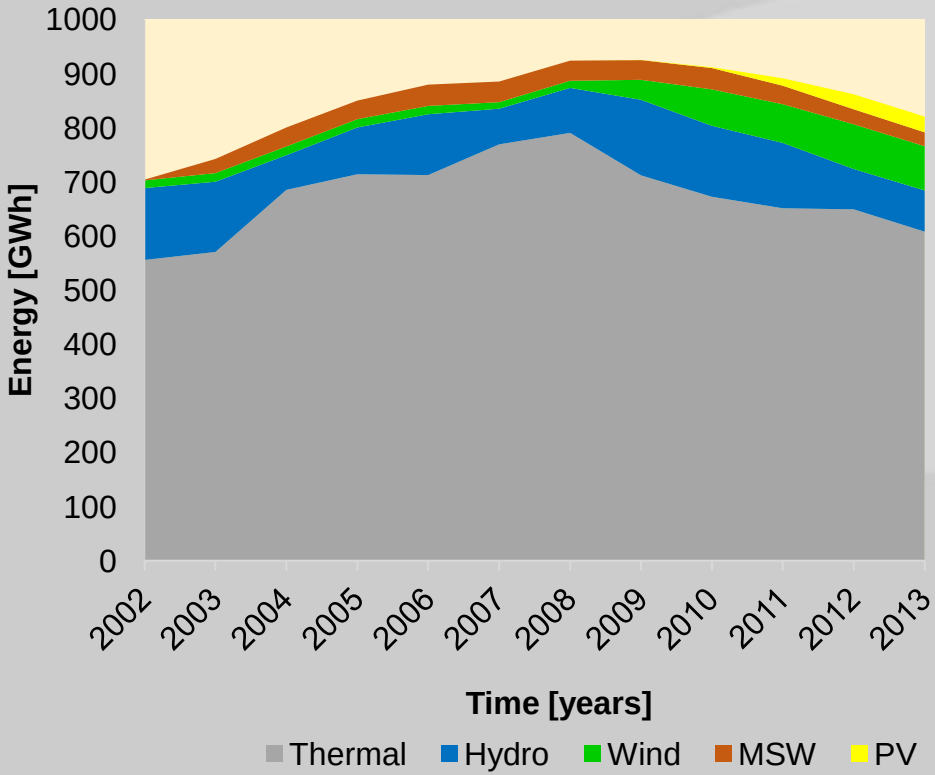


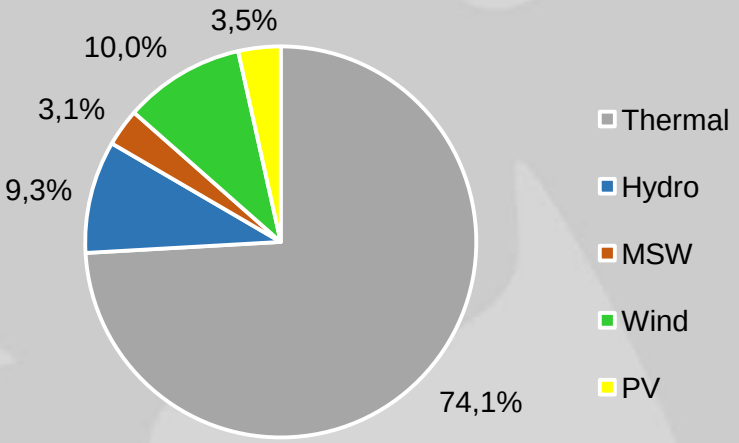
Terceira



The Islands Electric System characterization

Evolution of electricity generation in Madeira

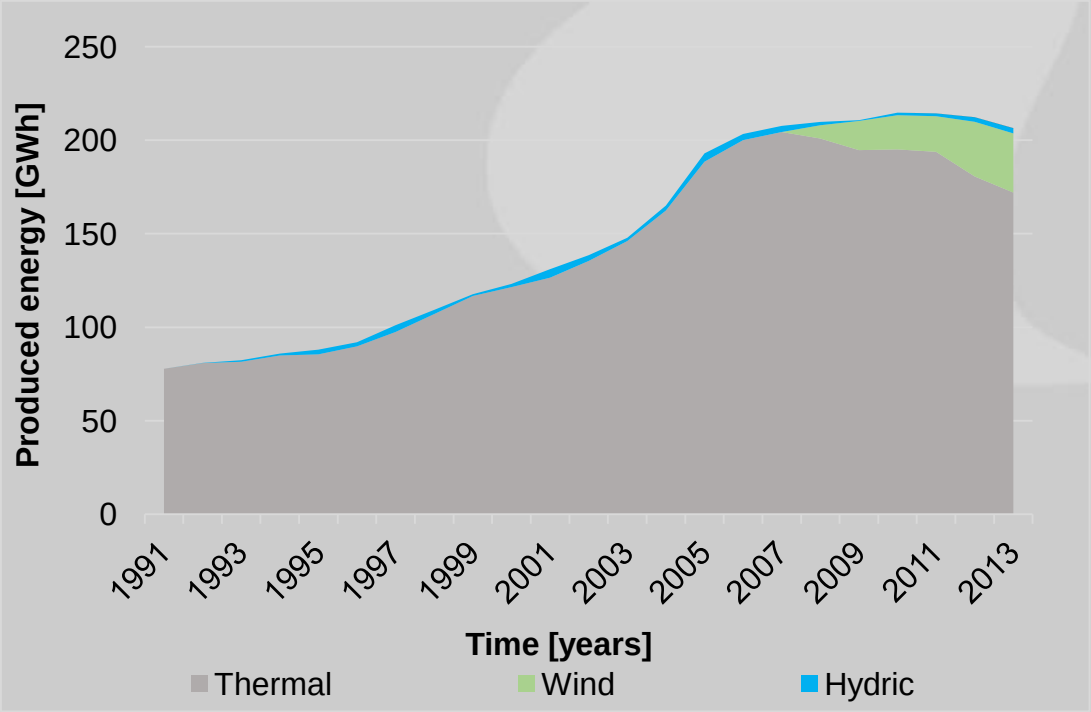


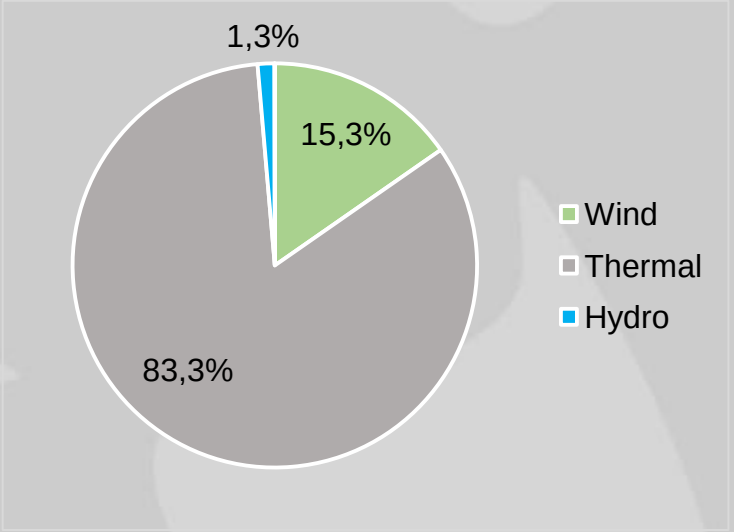


2013 - 820GWh

The Islands Electric System characterization

Evolution of electricity generation in Terceira

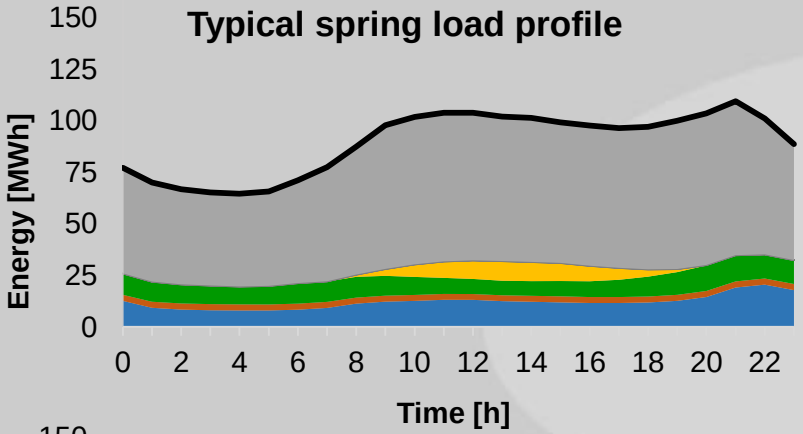


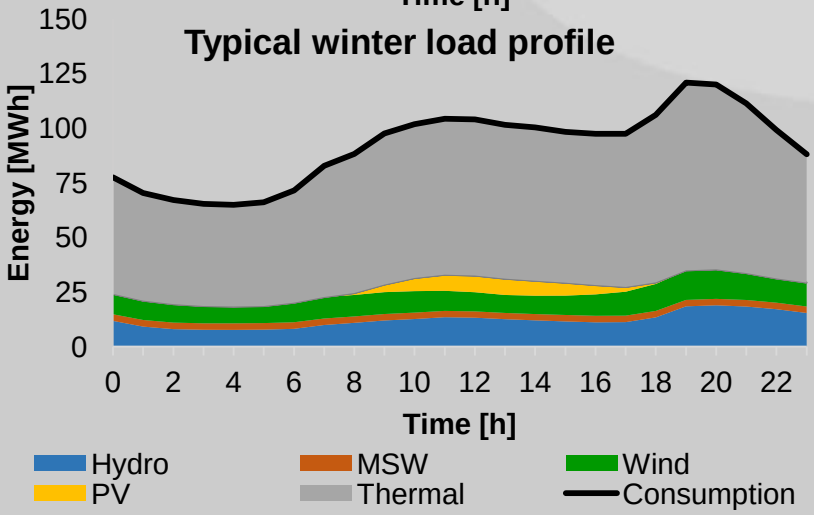


2013 - 206GWh

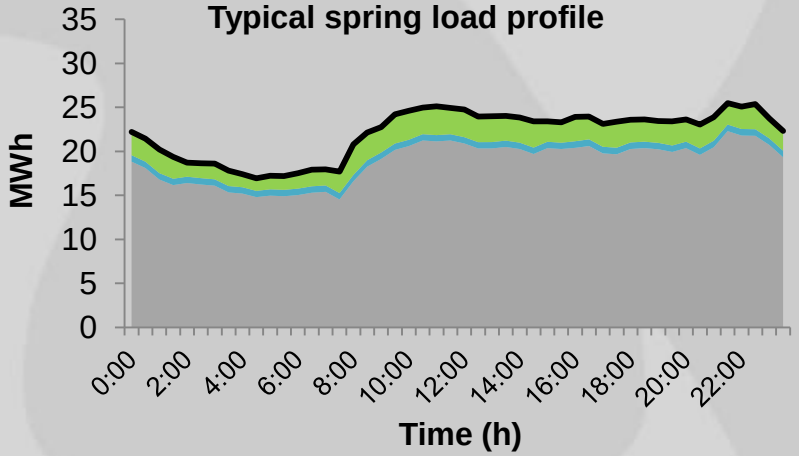
The Islands Electric System characterization

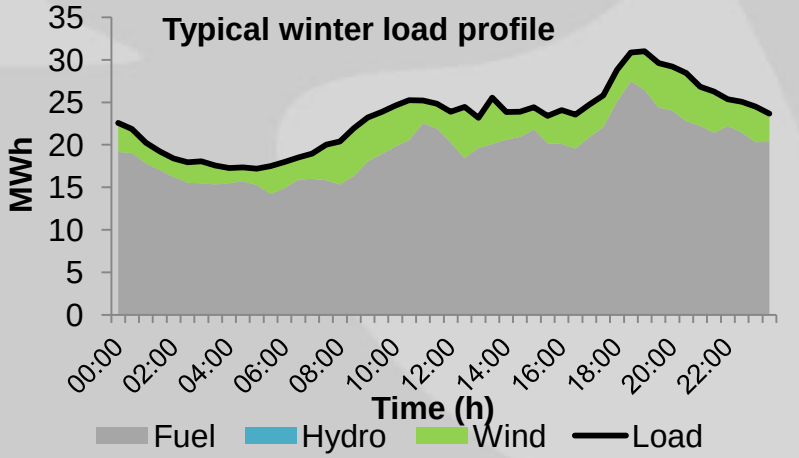
Madeira Island





Terceira Island





The Islands Electric System characterization

Installed capacity and potential of renewable sources

Madeira:

Source	Power [MW]
Fuel	218.7
Hydro	50.9
Wind	45.1
PV	17.9
MSW	8.0
Total	340.6

Source	2030
Wind (more)	60 MW
PV	20 MW

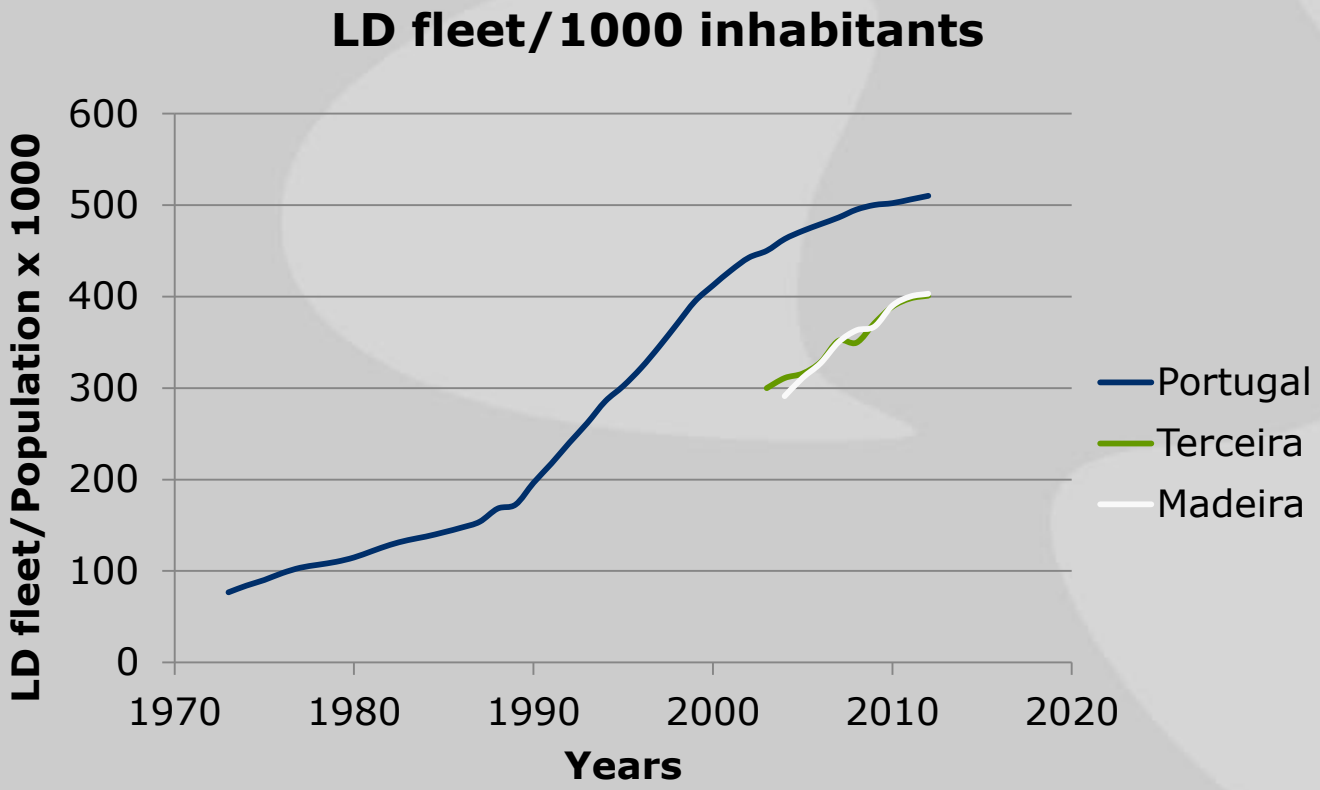
Terceira:

Source	Power [MW]
Fuel	61.2
Hydro	1.4
Wind	12.6
Total	75.2

Source	2030
Geothermal	12 MW
Wind	16.2 MW
PV	4.2 MW
Biomass	3.1MW

The Islands LD Fleet evolution and characterization

Evolution of the light duty fleet/1000 inhabitants in Portugal, Madeira and Terceira

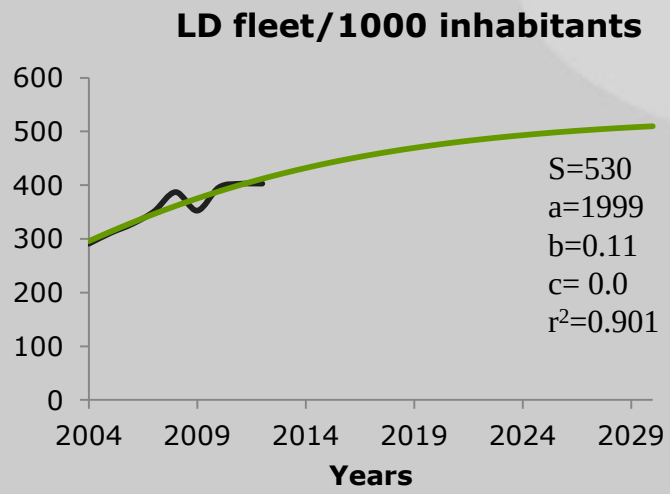


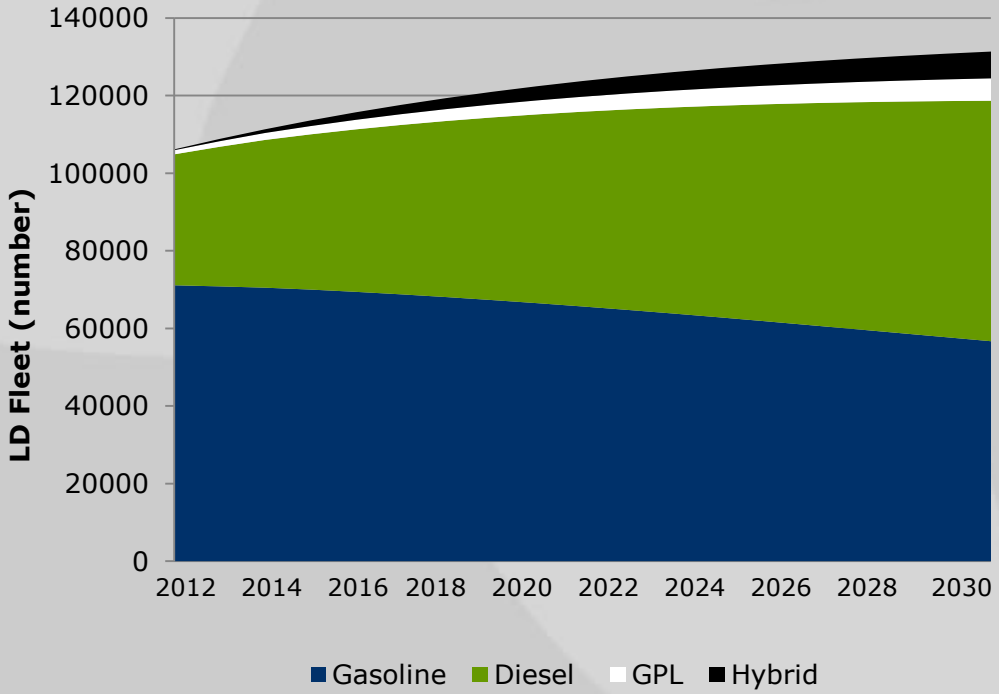
Electric Vehicle penetration and Recharging Scenarios

Expected evolution for the LD fleet in Madeira in a BAU scenario

Best fit for Gompertz logistic function

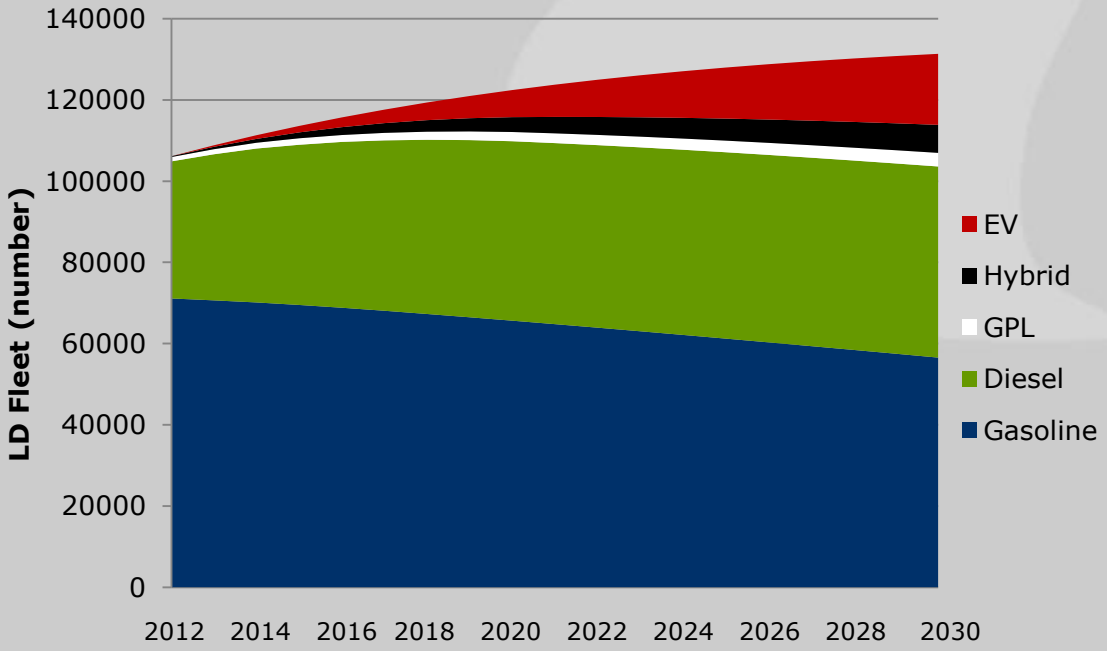
$$VD(t) = c + (S - c) \cdot e^{-e^{-b(t-a)}}$$



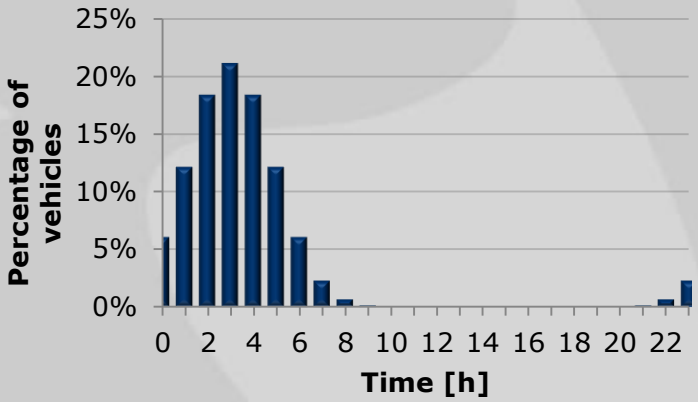


Electric Vehicle penetration and Recharging Scenarios

Considering the % of EV sales increases till 50% - 17500 EVs in 2030 (14% LD Fleet)



Gaussian distribution for off-peak charging mean at 3h and std of 2h.

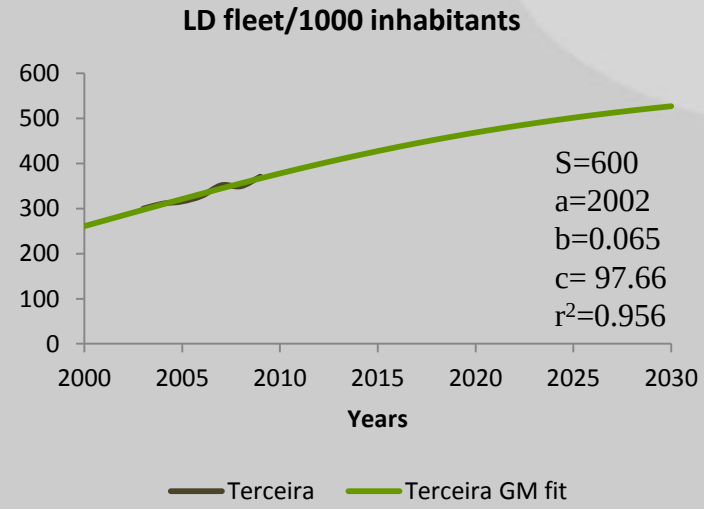


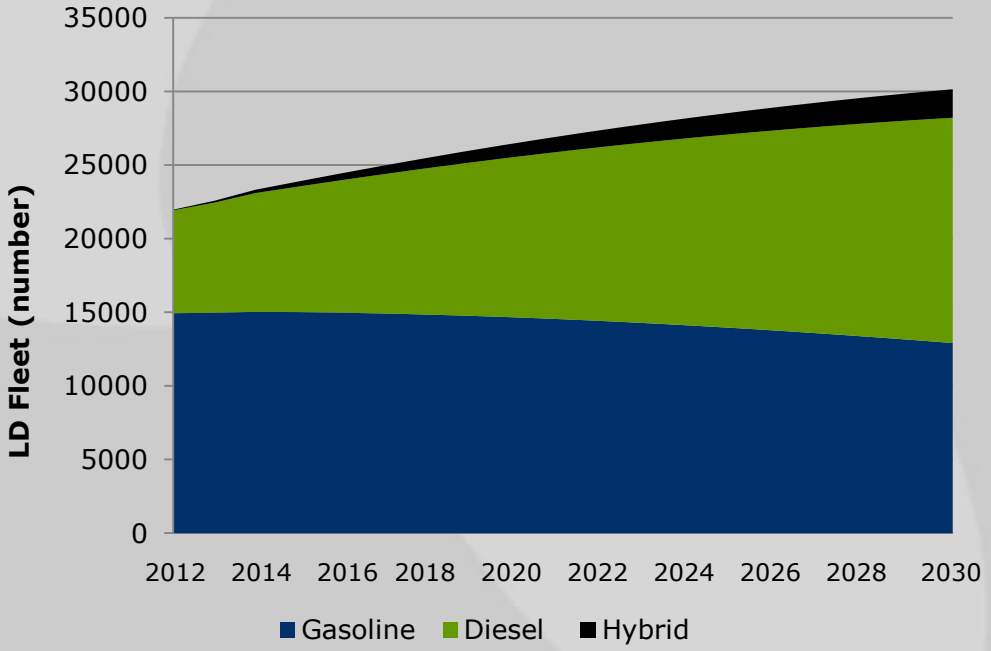
Electric Vehicle penetration and Recharging Scenarios

Expected evolution for the LD fleet in Terceira in a BAU scenario

Best fit for Gompertz logistic function

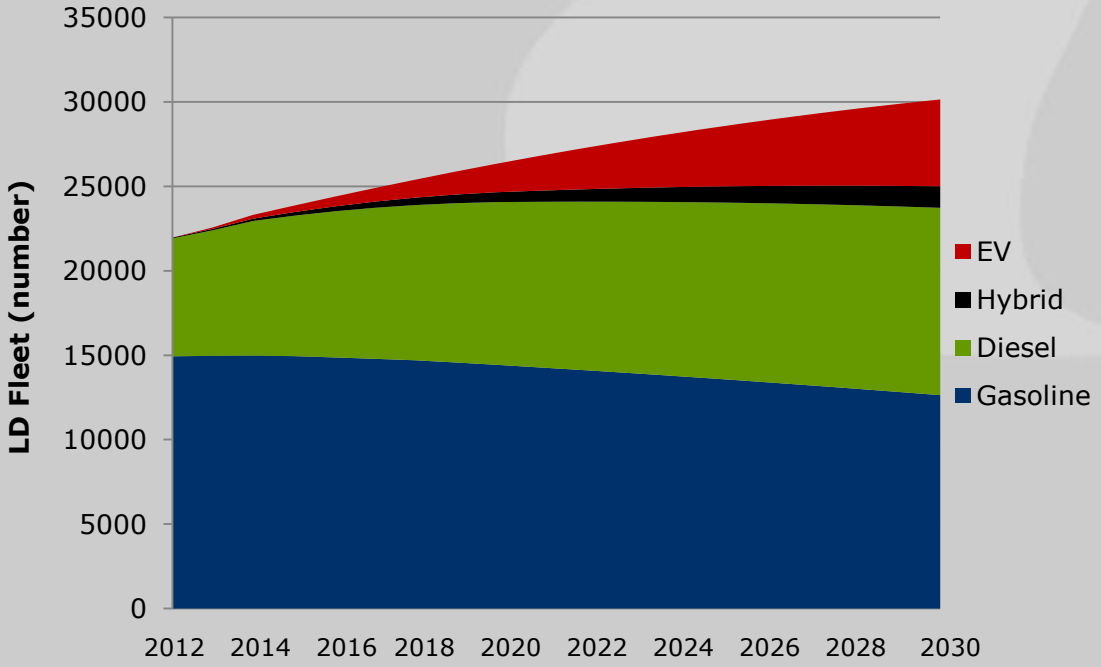
$$VD(t) = c + (S - c) \cdot e^{-e^{-b(t-a)}}$$



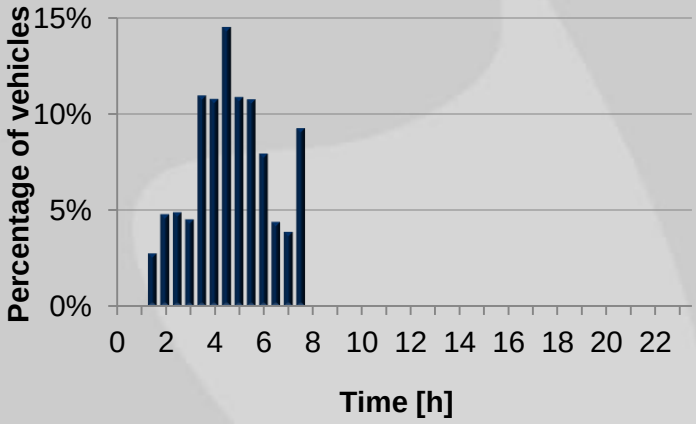


Electric Vehicle penetration and Recharging Scenarios

Considering the % of EV sales increases till 50% - 5140 EVs in 2030 (14% LD Fleet)



Profile of controlled off-peak charging with 14% EV in spring season

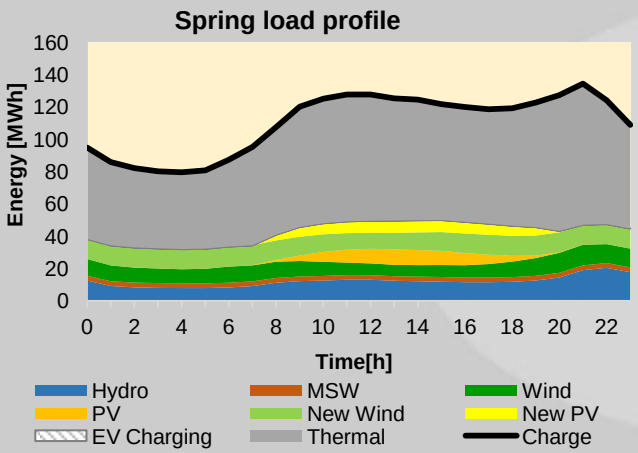


Case Studies

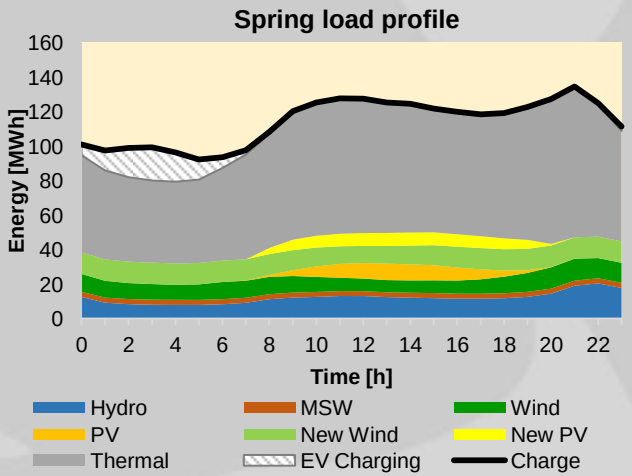
SIMULATION RESULTS:

Scenario of 1% increase of electricity demand and 60 MW of wind power and 20 MW of PV by 2030

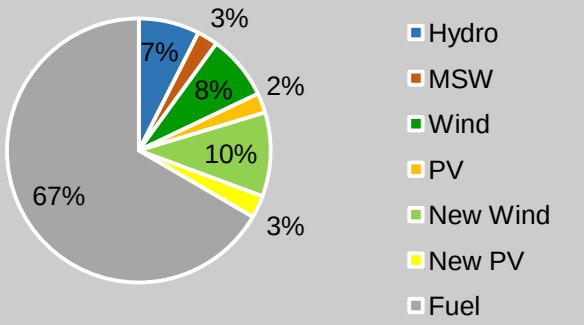
Madeira



14% EV penetration

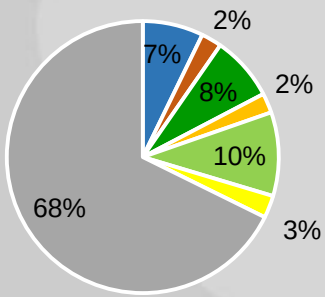


1012 GWh/yr



1047 GWh/yr

EVs
+35 GWh/yr



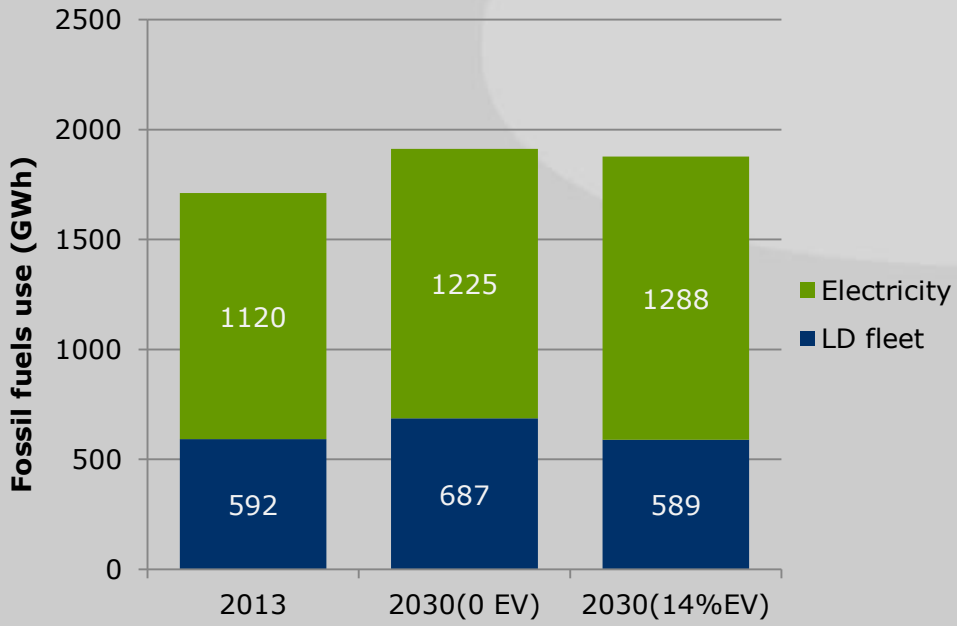
Case Studies

SIMULATION RESULTS:

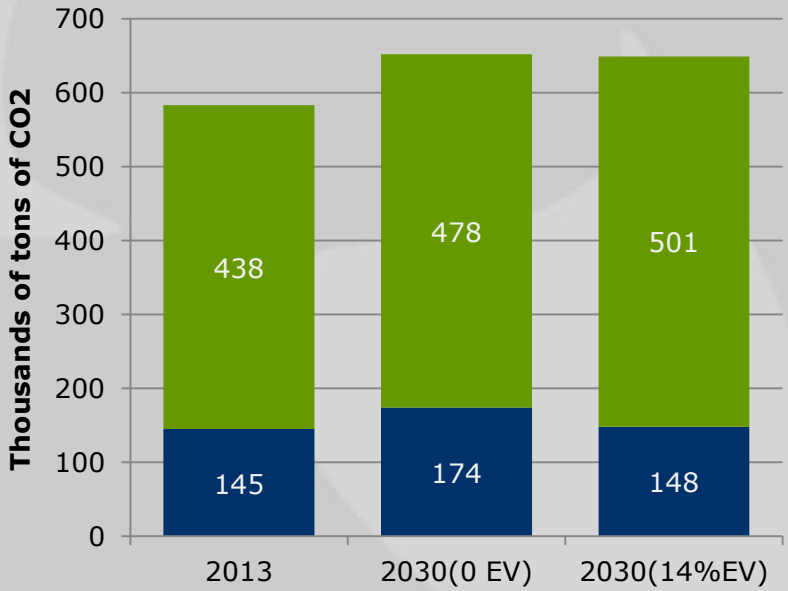
In Madeira Island it is expected that EV will be charged with fuel oil power plants although there are some benefits in the whole.

Madeira

Fossil fuels use (primary energy in GWh/year)



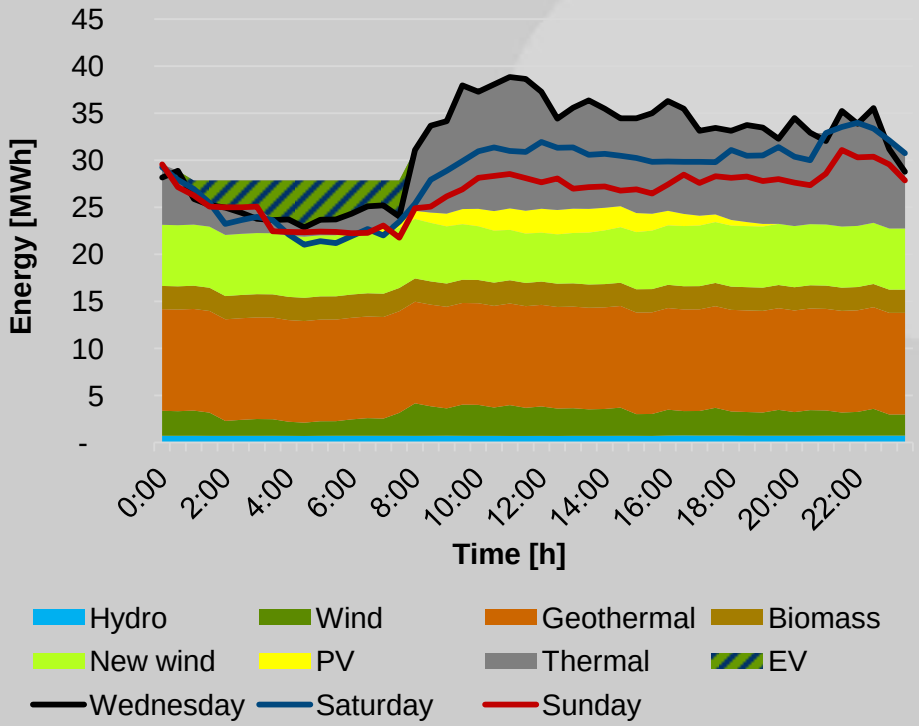
Emissions in thousand tons of CO_2



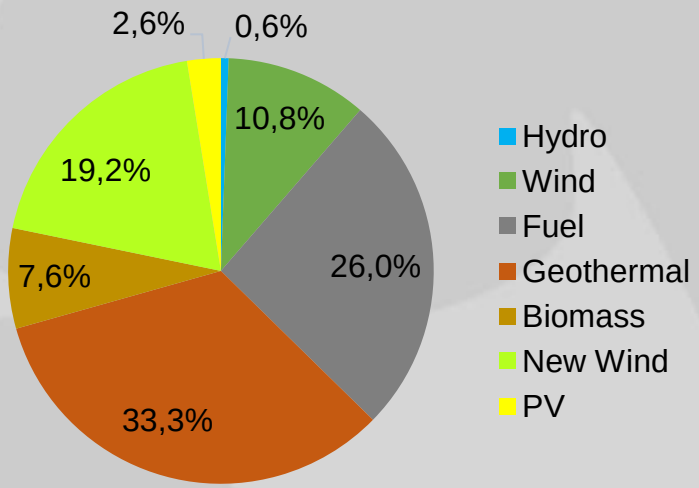
Case Studies

SIMULATION RESULTS:

Scenario of 14% EV penetration, 1% increase of electricity demand and 12 MW Geothermal power, 16.2 MW of Wind power, 4.2 MW PV and 3.1MW in Biomass by 2030



Terceira



285 GWh/year

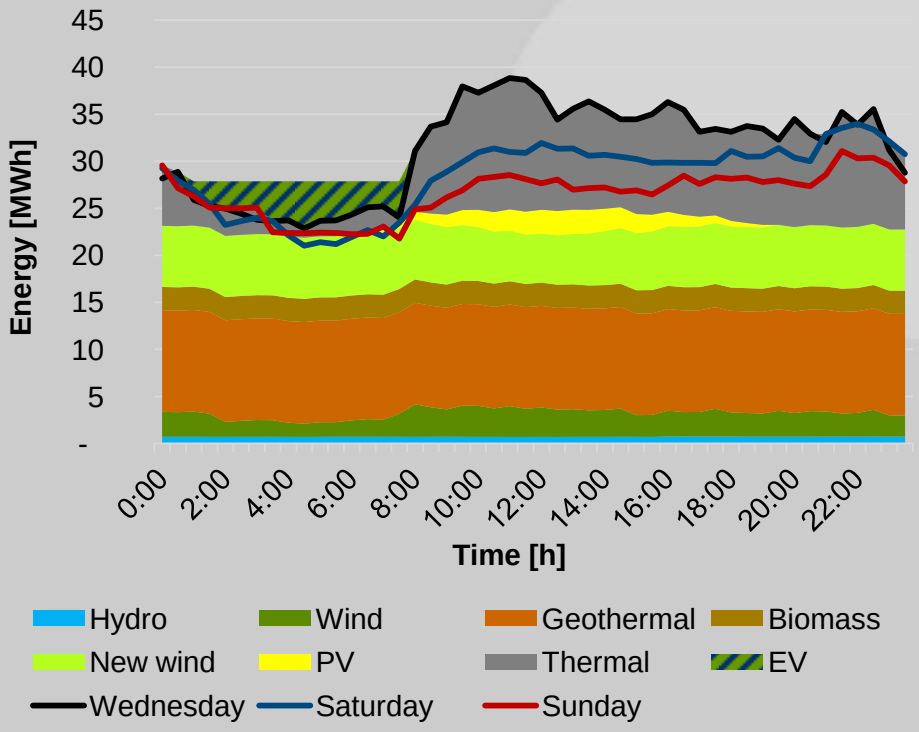
Load - 276 GWh

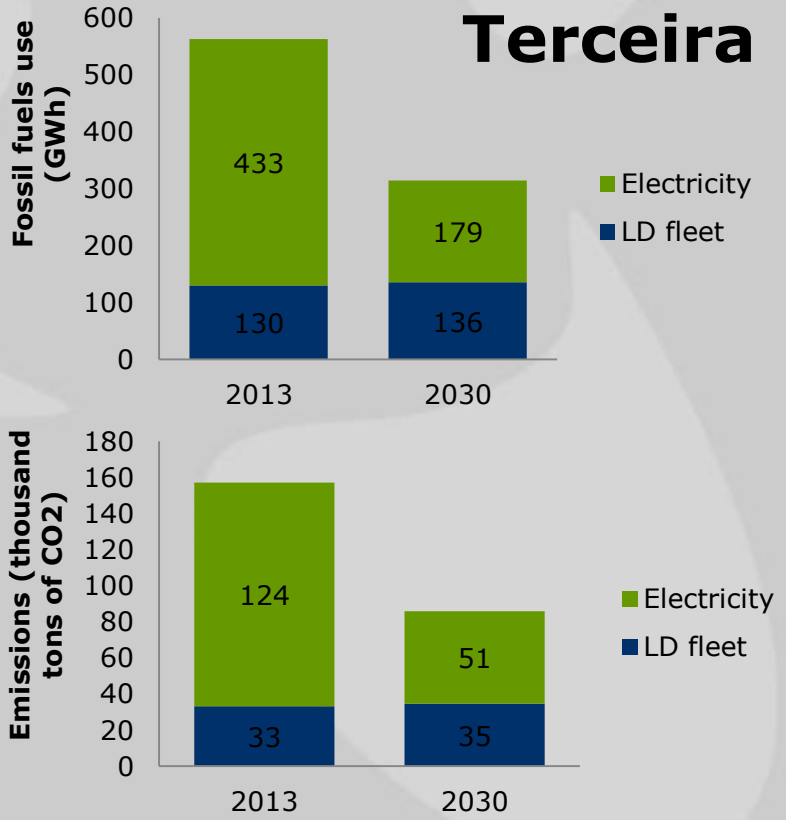
EV - 9 GWh

Case Studies

SIMULATION RESULTS:

Scenario of 14% EV penetration, 1% increase of electricity demand and 12 MW Geothermal power, 16.2 MW of Wind power, 4.2 MW PV and 3.1MW in Biomass by 2030





Conclusions

Electrifying the car sector has the potential to

- Reduce CO_2 emissions,
- Use locally produced electricity increased by renewable sources
- Decrease energy unit costs and oil imports.

If there is not enough demand to fill the valley hours in order to incorporate more renewable production, there are only small advantages in the electric vehicle, as the oil products imports saved for the cars are replaced by fuel oil for the thermal power plants and the CO_2 emissions are transferred from the tail pipes to the power plants chimneys.

Conclusions

- The impact of EVs could be disastrous in a scenario of strong penetration if uncontrollable charging is allowed.
- The charging of EVs should be done during off-peak hours and if possible controlled by the electric utility as a dispatchable or scheduled load.
- The cost of EVs energy may be less than ¼ of ICEVs
- V2G and other systems of energy storage should also be considered in islands in order to increase renewable penetration and energy security of supply in the region.

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Electric Vehicle penetration and Recharging Scenarios

Considering the % of EV and HEV sales increases till 100% - 30200 EVs in 2030 (23% LD Fleet)