

ANEXO I

Informe Escenario de simulación 1: Hibridación.

Variante CAPEX 25%, Spreads 143%.

MHOGA software. Report

Project: Opt.Inc25.4000.mho. Sensitivity analysis # 4. Solution # 1

Sensitivity analysis # 4 (Rad.1: 6,16kWh/m² Load1: 0GWh/day (I-g)1: 7%-3% Inf.F.1:Base Pr4: x1 x1 x0,25 x1). DC

Voltage: 1 kV. AC: 20 kV.

COMPONENTS:

PV gen. PV10_mod_bif, 6x10 MWp. P total = 60 MWp_dc (100% PV#1)

Batt. Bat5MW_2h, 1x4x10 kAh. E total = 0,04 GWh (0 d.aut)

Without Wind Turbines

Without Hydro Turbine

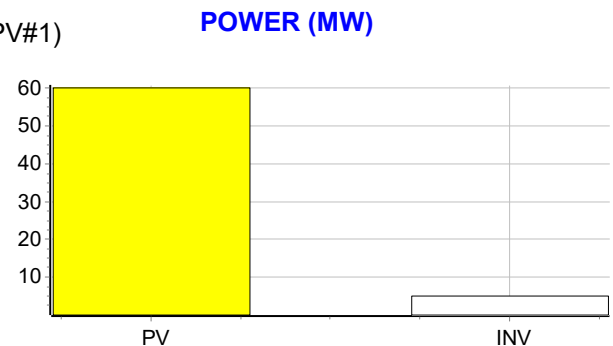
Without AC Generator

Without Fuel Cell

Without Electrolyzer

Inverter Inv-Ch5MW, 5MW

Land use: 180,4 ha.



CONTROL STRATEGY:

THERE IS NO LOAD CONSUMPTION -> NO CONTROL STRATEGIES RELATED TO THE LOAD CONSUMPTION SUPPLY

SOC min. batteries = 10 %

CONTROL STRATEGY FOR CHARGE/DICHARGE (load + injecting to the grid) OF GRID-CONNECTED BATTERIES:

X1=0,05272 €/kWh; X2=20 %; X3=40 %

ECONOMIC CALCULATIONS:

Initial Investment: 51,597 M€. Loan: 100 %, int. 7% in 25 years, annual quota: 4,428 M€/yr. 1st. year net incomes (incomes of sell minus cost of O&M + fuel + purchase): 9,71 M€/yr.

NPV OF THE SYSTEM (25 years lifetime) (Incomes +, expenses -):

Total Net Present Value (NPV): 96,819 M€. Internal Rate of Return (IRR): 21,45 %. LCOE : 0,0351 €/kWh. Payback: 6,28 years

Distribution of NPV:

PV Generator (NPV): -40,682 M€

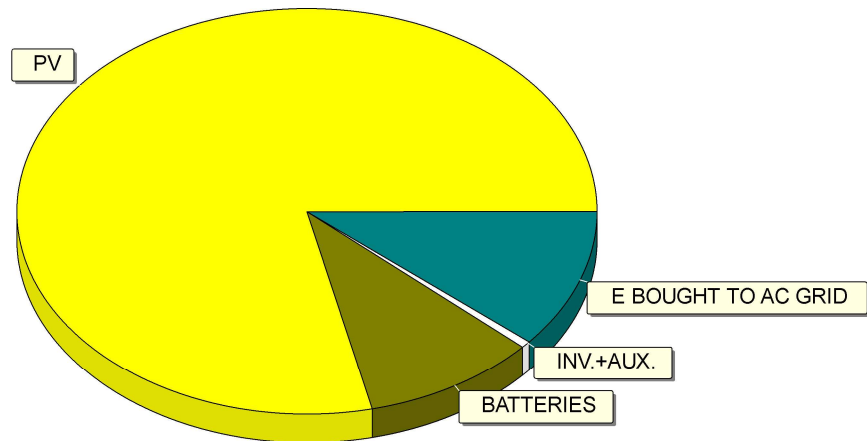
Battery bank (NPV): -5,135 M€. Battery LCOS: -0,027 €/kWh

Inverter (NPV): -0,287 M€

Buy/Sell. Bought Energy (NPV): -5,683 M€ (included 0 M€ due emssions of bought E.). Sold Energy: Electrical E. (NPV): 166,658 M€ (FCR 0%). H2 (NPV): 0 M€.

Installation + financing + extra cash (NPV): -18,052M€

NPC / NPV (M€)



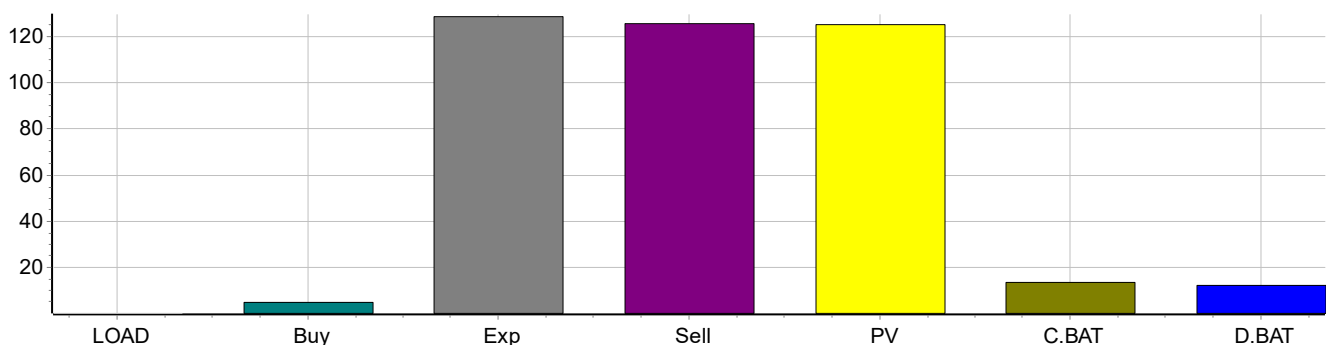
ENERGY BALANCE DURING 1 YEAR (GWh/year):

Overall Load Energy: 0 GWh/yr.
 Unmet load: 0 GWh/yr (0 % load)
 E. Purchased from AC grid: 4,583 GWh/yr
 Export Energy: 128,676 GWh/yr
 E. sold to AC grid: 125,729 GWh/yr. Unexported E. = 2,29 %
 Renewable Capacity Factor (sold_energy/(renew_peak_power*8760)): 23,92 %; Renew. fraction: 100 %
 Energy delivered by PV generator: 125,215 GWh/yr
 Energy delivered by Wind Turbines: 0 GWh/yr
 E. delivered by Hydro Turbine: 0 GWh/yr. Pumped 0 GWh/yr
 Energy delivered by AC Generator: 0 GWh/yr
 Energy delivered by Fuel Cell: 0 GWh/yr
 Energy at Electrolyzer: 0 GWh/yr
 Energy charged by Batteries: 13,247 GWh/yr
 Energy discharged by Batteries: 12,222 GWh/yr

OTHER RESULTS:

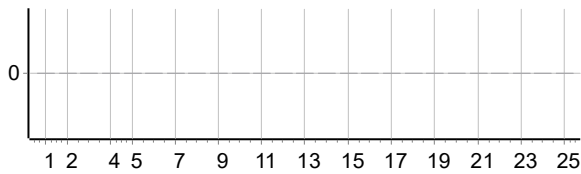
Batteries Lifetime: 9,25 years
 Hours eq. of AC Generator operation (all units): 0 h/yr. Number of starts (all units): 0
 Hours of Electrolyzer operation: 0 h/yr. Number of starts: 0
 Hours of Fuel Cell operation: 0 h/yr. Number of starts: 0
 Hours of Hydro Turb.: 0 h/yr; starts: 0. Hours of Pump: 0 h/yr; starts: 0
 Total CO2 emissions: 3,99ktCO2/yr
 H2 sold in one year: 0 t H2/yr

ENERGY BALANCE DURING 1 YEAR (GWh/year)

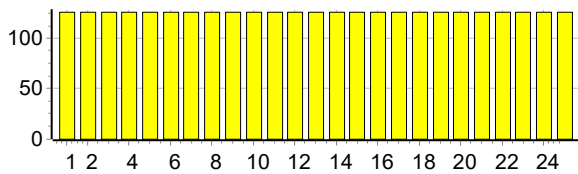


NO MULTI-PERIOD SIMULATION -> ALL THE YEARS SAME ENERGY VALUES (GWh/yr).

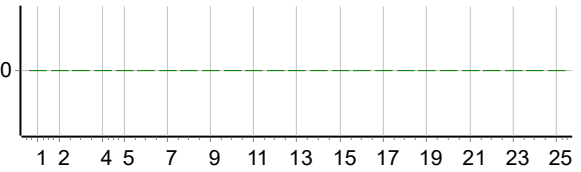
TOTAL LOAD:



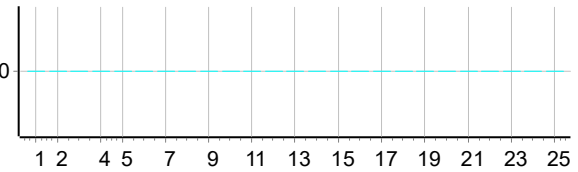
PV GENERATOR:



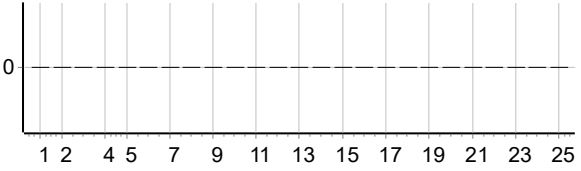
WIND TURBINES:



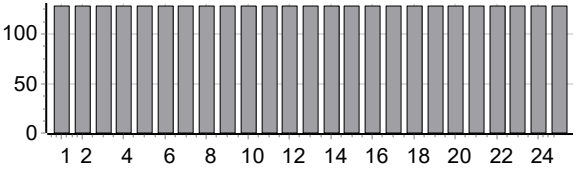
HYDRO TURBINE:



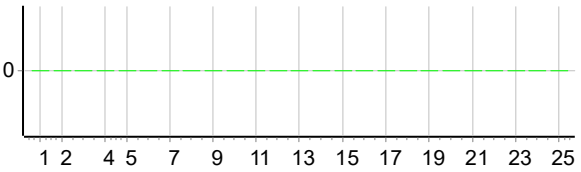
AC GENERATOR:



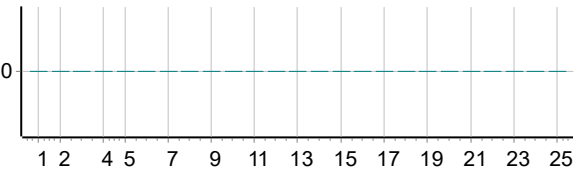
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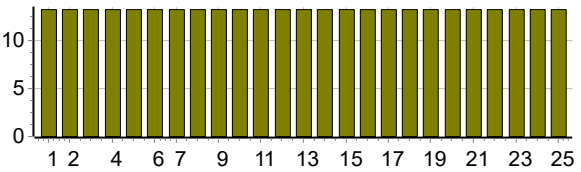
FUEL CELL:



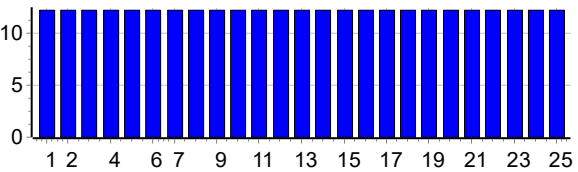
ELECTROLYZER:



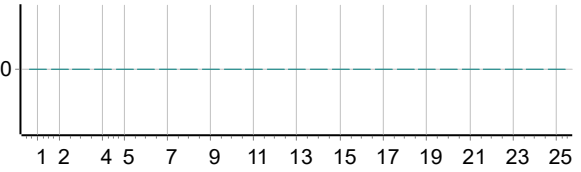
BATTERY BANK CHARGE:



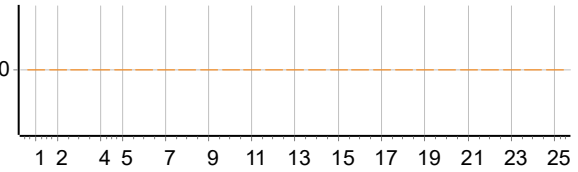
BATTERY BANK DISCHARGE:



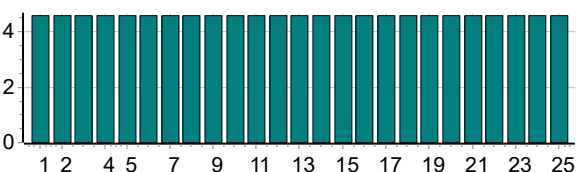
HYDROGEN TANK CAP. OR H2 SOLD (t):



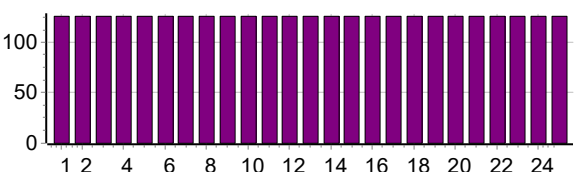
UNMET LOAD:



PURCHASED FROM AC GRID:



SOLD TO AC GRID:



ANEXO II

Informe Escenario de simulación 2: Stand Alone.

Variante CAPEX 25%, Spreads 143%.

MHOGA software. Report

Project: SA.25.4000.mho. Sensitivity analysis # 4. Solution # 1

Sensitivity analysis # 4 (Load1: 0GWh/day (I-g)1: 7%-3% Inf.F.1:Base Pr4: x1 x1 x0,25 x1). DC Voltage: 1 kV. AC: 20 kV.

COMPONENTS:

Without PV

Batt. Bat5MW_2h, 1x3x10 kAh. E total = 0,03 GWh (0 d.aut)

Without Wind Turbines

Without Hydro Turbine

Without AC Generator

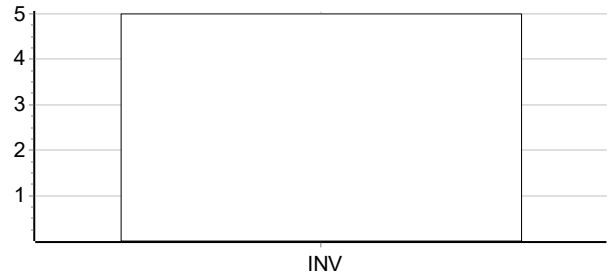
Without Fuel Cell

Without Electrolyzer

Inverter Inv-Ch5MW, 5MW

Land use: 0,3 ha.

POWER (MW)



CONTROL STRATEGY:

THERE IS NO LOAD CONSUMPTION -> NO CONTROL STRATEGIES RELATED TO THE LOAD CONSUMPTION SUPPLY

SOC min. batteries = 10 %

CONTROL STRATEGY FOR CHARGE/DICHARGE (load + injecting to the grid) OF GRID-CONNECTED BATTERIES:

X1=0,05272 €/kWh; X2=20 %; X3=40 %

ECONOMIC CALCULATIONS:

Initial Investment: 2,776 M€. Loan: 100 %, int. 7% in 25 years, annual quota: 0,238 M€/yr. 1st. year net incomes (incomes of sell minus cost of O&M + fuel + purchase): 0,389 M€/yr.

NPV OF THE SYSTEM (25 years lifetime) (Incomes +, expenses -):

Total Net Present Value (NPV): 2,557 M€. Internal Rate of Return (IRR): 14,69 %. LCOE : 0,1309 €/kWh. Payback: 10,53 years

Distribution of NPV:

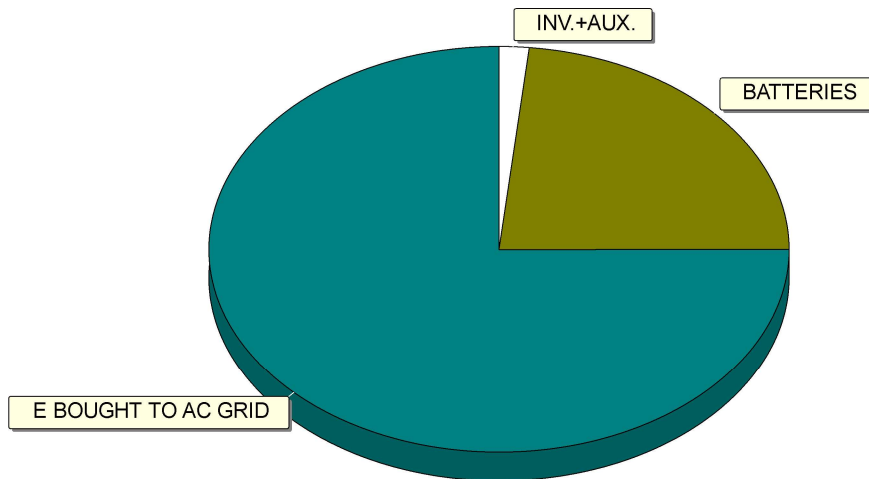
Battery bank (NPV): -3,961 M€. Battery LCOS: -0,024 €/kWh

Inverter (NPV): -0,287 M€

Buy/Sell. Bought Energy (NPV): -12,71 M€ (included 0 M€ due emssions of bought E.). Sold Energy: Electrical E. (NPV): 20,486 M€ (FCR 0%). H2 (NPV): 0 M€.

Installation + financing + extra cash (NPV): -0,971M€

NPC / NPV (M€)



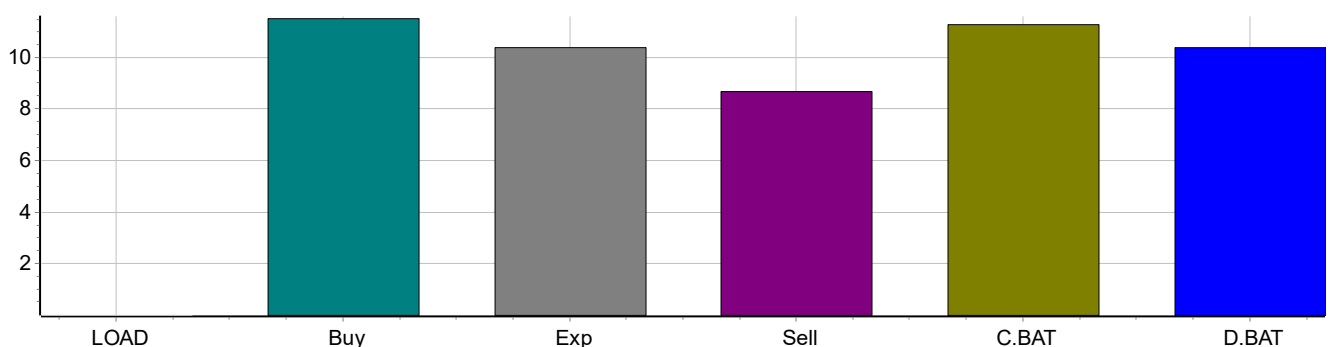
ENERGY BALANCE DURING 1 YEAR (GWh/year):

Overall Load Energy: 0 GWh/yr.
 Unmet load: 0 GWh/yr (0 % load)
 E. Purchased from AC grid: 11,503 GWh/yr
 Export Energy: 10,397 GWh/yr
 E. sold to AC grid: 8,658 GWh/yr. Unexported E. = 16,72 %
 Renewable Capacity Factor (sold_energy/(renew_peak_power*8760)): 0,1 %; Renew. fraction: 100 %
 Energy delivered by PV generator: 0 GWh/yr
 Energy delivered by Wind Turbines: 0 GWh/yr
 E. delivered by Hydro Turbine: 0 GWh/yr. Pumped 0 GWh/yr
 Energy delivered by AC Generator: 0 GWh/yr
 Energy delivered by Fuel Cell: 0 GWh/yr
 Energy at Electrolyzer: 0 GWh/yr
 Energy charged by Batteries: 11,273 GWh/yr
 Energy discharged by Batteries: 10,397 GWh/yr

OTHER RESULTS:

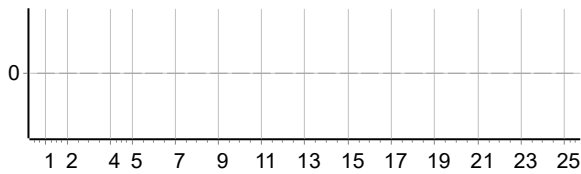
Batteries Lifetime: 8,36 years
 Hours eq. of AC Generator operation (all units): 0 h/yr. Number of starts (all units): 0
 Hours of Electrolyzer operation: 0 h/yr. Number of starts: 0
 Hours of Fuel Cell operation: 0 h/yr. Number of starts: 0
 Hours of Hydro Turb.: 0 h/yr; starts: 0. Hours of Pump: 0 h/yr; starts: 0
 Total CO2 emissions: 4,8ktCO2/yr
 H2 sold in one year: 0 t H2/yr

ENERGY BALANCE DURING 1 YEAR (GWh/year)

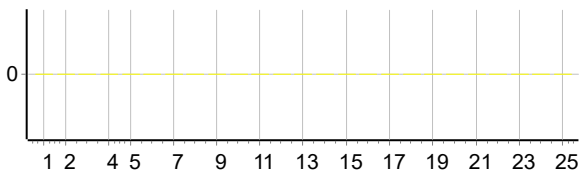


NO MULTI-PERIOD SIMULATION -> ALL THE YEARS SAME ENERGY VALUES (GWh/yr).

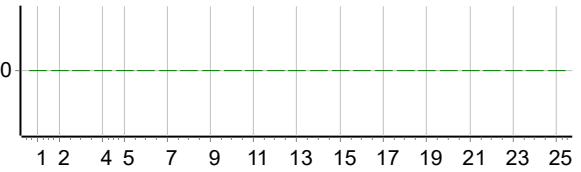
TOTAL LOAD:



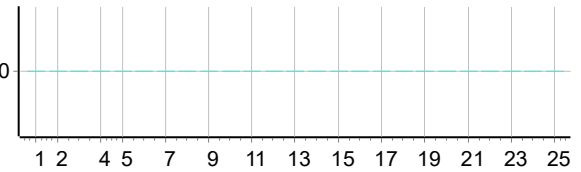
PV GENERATOR:



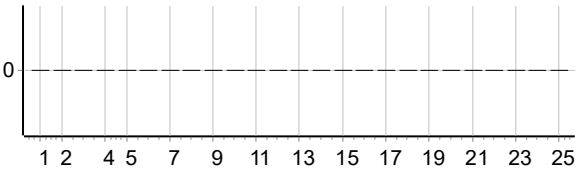
WIND TURBINES:



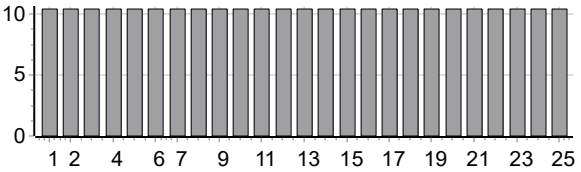
HYDRO TURBINE:



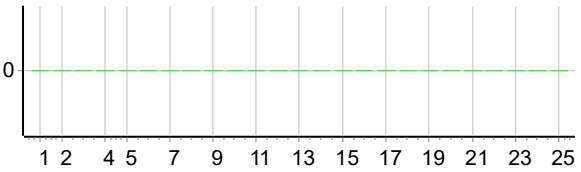
AC GENERATOR:



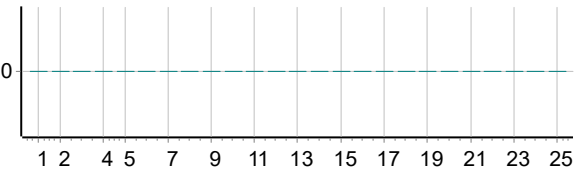
EXPORT:



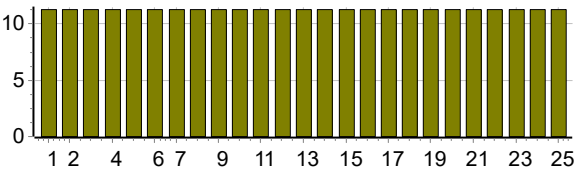
FUEL CELL:



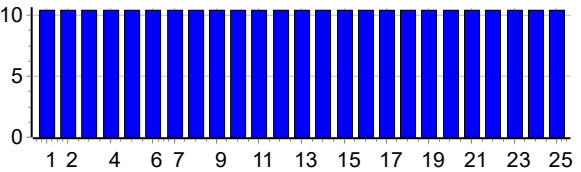
ELECTROLYZER:



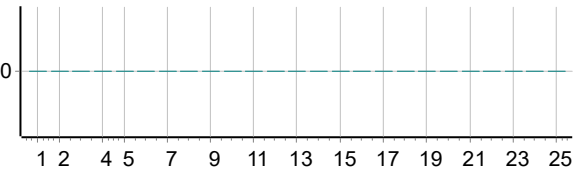
BATTERY BANK CHARGE:



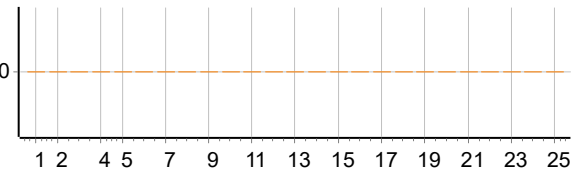
BATTERY BANK DISCHARGE:



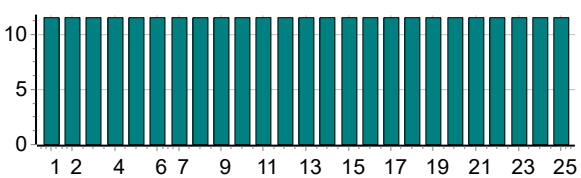
HYDROGEN TANK CAP. OR H2 SOLD (t):



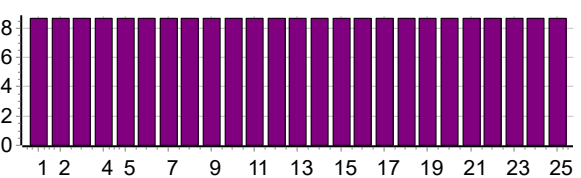
UNMET LOAD:



PURCHASED FROM AC GRID:



SOLD TO AC GRID:



ANEXO III

Informe Escenario de simulación 3: Hibridación con
sobredimensionamiento PV.

Variante CAPEX 25%, Spreads 143%.

MHOGA software. Report

Project: SDPV.Inc25.4000.mho. Sensitivity analysis # 4. Solution # 1

Sensitivity analysis # 4 (Rad.1: 6,16kWh/m² Load1: 0GWh/day (I-g)1: 7%-3% Inf.F.1:Base Pr4: x1 x1 x0,25 x1). DC Voltage: 1 kV. AC: 20 kV.

COMPONENTS:

PV gen. PV10_mod_bif, 9x10 MWp. P total = 90 MWp_dc (100% PV#1)

Batt. Bat5MW_4h, 1x2x20 kAh. E total = 0,04 GWh (0 d.aut)

Without Wind Turbines

Without Hydro Turbine

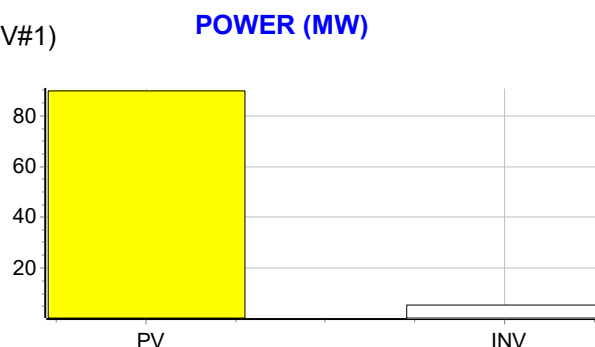
Without AC Generator

Without Fuel Cell

Without Electrolyzer

Inverter Inv-Ch5MW, 5MW

Land use: 270,4 ha.



CONTROL STRATEGY:

THERE IS NO LOAD CONSUMPTION -> NO CONTROL STRATEGIES RELATED TO THE LOAD CONSUMPTION SUPPLY

SOC min. batteries = 10 %

CONTROL STRATEGY FOR CHARGE/DICHARGE (load + injecting to the grid) OF GRID-CONNECTED BATTERIES:

X1=0,05272 €/kWh; X2=40 %; X3=60 %

ECONOMIC CALCULATIONS:

Initial Investment: 75,35 M€. Loan: 100 %, int. 7% in 25 years, annual quota: 6,466 M€/yr. 1st. year net incomes (incomes of sell minus cost of O&M + fuel + purchase): 12,875 M€/yr.

NPV OF THE SYSTEM (25 years lifetime) (Incomes +, expenses -):

Total Net Present Value (NPV): 121,433 M€. Internal Rate of Return (IRR): 19,6 %. LCOE : 0,0383 €/kWh. Payback: 7,07 years

Distribution of NPV:

PV Generator (NPV): -61,024 M€

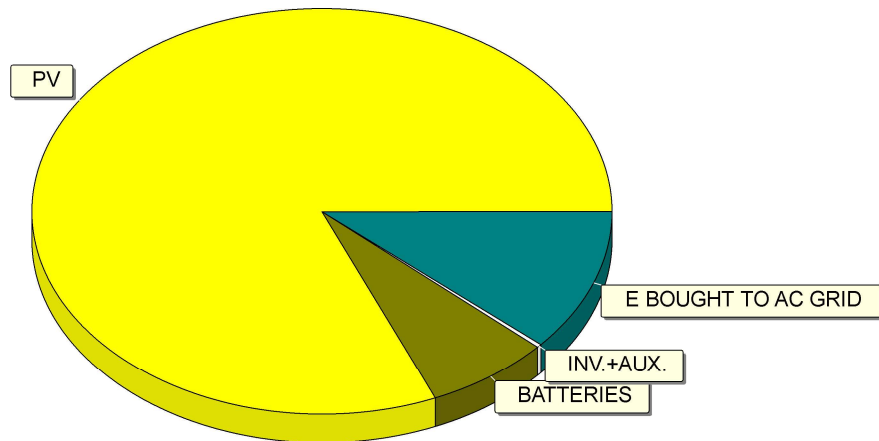
Battery bank (NPV): -5,034 M€. Battery LCOS: -0,02 €/kWh

Inverter (NPV): -0,287 M€

Buy/Sell. Bought Energy (NPV): -8,522 M€ (included 0 M€ due emssions of bought E.). Sold Energy: Electrical E. (NPV): 222,66 M€ (FCR 0%). H2 (NPV): 0 M€.

Installation + financing + extra cash (NPV): -26,36M€

NPC / NPV (M€)



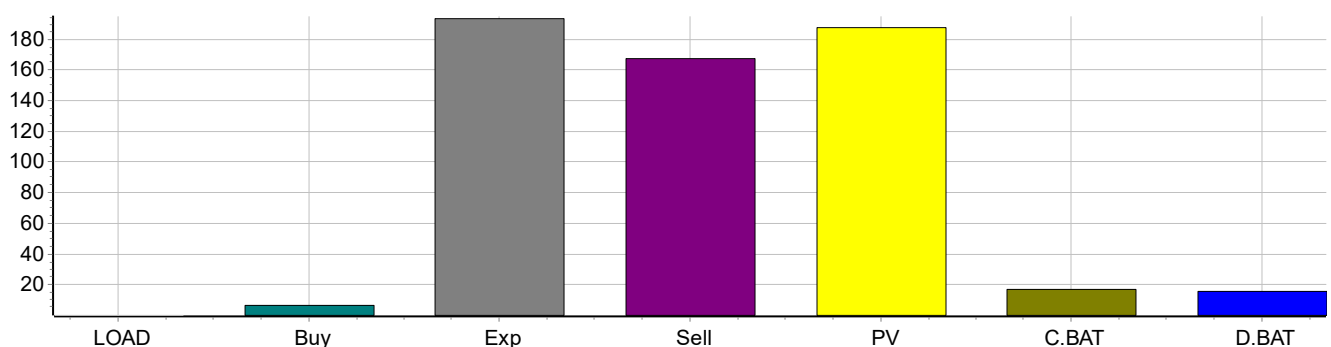
ENERGY BALANCE DURING 1 YEAR (GWh/year):

Overall Load Energy: 0 GWh/yr.
 Unmet load: 0 GWh/yr (0 % load)
 E. Purchased from AC grid: 6,678 GWh/yr
 Export Energy: 193,413 GWh/yr
 E. sold to AC grid: 167,308 GWh/yr. Unexported E. = 13,5 %
 Renewable Capacity Factor (sold_energy/(renew_peak_power*8760)): 21,22 %; Renew. fraction: 100 %
 Energy delivered by PV generator: 187,823 GWh/yr
 Energy delivered by Wind Turbines: 0 GWh/yr
 E. delivered by Hydro Turbine: 0 GWh/yr. Pumped 0 GWh/yr
 Energy delivered by AC Generator: 0 GWh/yr
 Energy delivered by Fuel Cell: 0 GWh/yr
 Energy at Electrolyzer: 0 GWh/yr
 Energy charged by Batteries: 16,939 GWh/yr
 Energy discharged by Batteries: 15,618 GWh/yr

OTHER RESULTS:

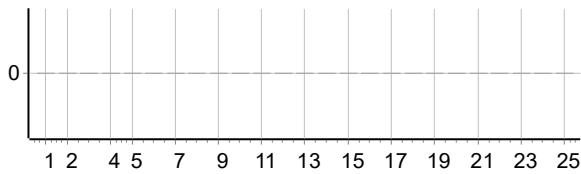
Batteries Lifetime: 7,83 years
 Hours eq. of AC Generator operation (all units): 0 h/yr. Number of starts (all units): 0
 Hours of Electrolyzer operation: 0 h/yr. Number of starts: 0
 Hours of Fuel Cell operation: 0 h/yr. Number of starts: 0
 Hours of Hydro Turb.: 0 h/yr; starts: 0. Hours of Pump: 0 h/yr; starts: 0
 Total CO2 emissions: 5,83ktCO2/yr
 H2 sold in one year: 0 t H2/yr

ENERGY BALANCE DURING 1 YEAR (GWh/year)

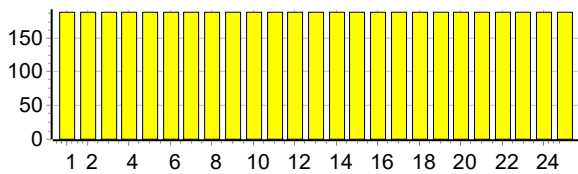


NO MULTI-PERIOD SIMULATION -> ALL THE YEARS SAME ENERGY VALUES (GWh/yr).

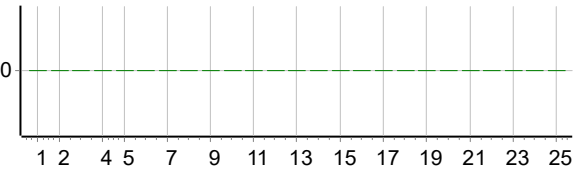
TOTAL LOAD:



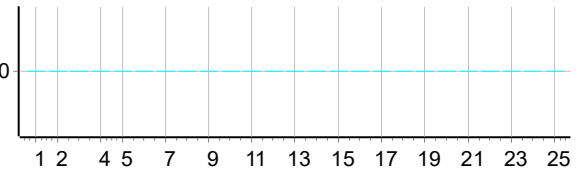
PV GENERATOR:



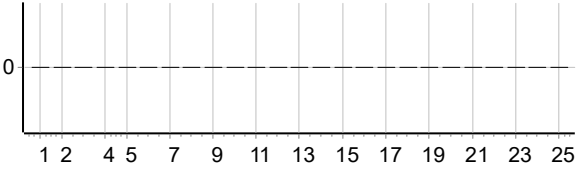
WIND TURBINES:



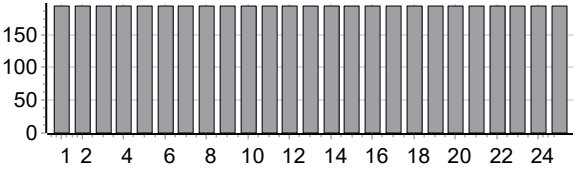
HYDRO TURBINE:



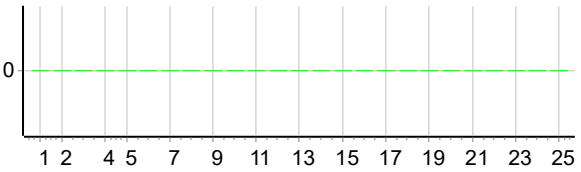
AC GENERATOR:



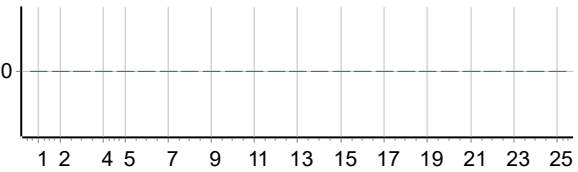
EXPORT:



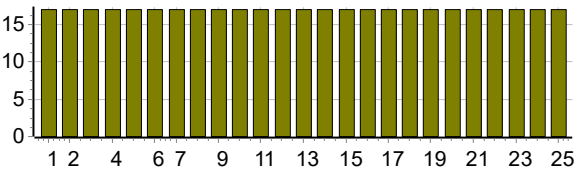
FUEL CELL:



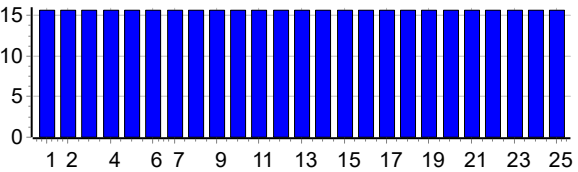
ELECTROLYZER:



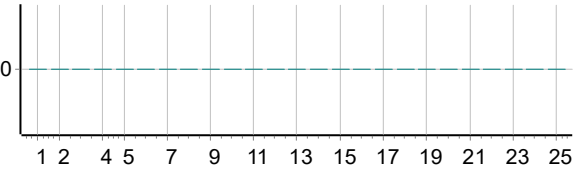
BATTERY BANK CHARGE:



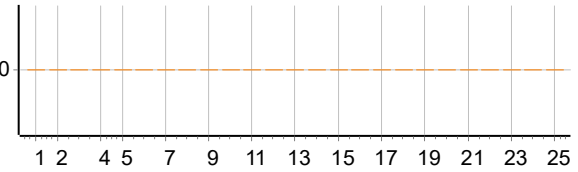
BATTERY BANK DISCHARGE:



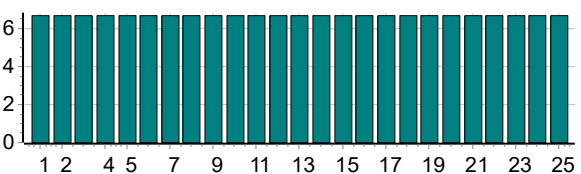
HYDROGEN TANK CAP. OR H2 SOLD (t):



UNMET LOAD:



PURCHASED FROM AC GRID:



SOLD TO AC GRID:

