

ANEXO TFG_02518

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Simulation Control Parameters

FINAL TIME = 2080

- ~ Year
- ~ The final time for the simulation.

INITIAL TIME = 2000

- ~ Year
- ~ The initial time for the simulation.

SAVEPER = TIME STEP = 0.25

- ~ The frequency with which output is stored.

TIME STEP = 0.25

- ~ The time step for the simulation.

VARIABLES DECLARED

energy from natural gas needed=

(toe natural gas*CONVERSION KTOE to TOE*CONVERSION toe to KJ)/CALORIFIC VALUE OF BIOMASS

Units: tonnes/Year

CONVERSION KTOE to TOE=

GET DIRECT CONSTANTS ('Forests/forests_Spain.xlsx' , 'forests_info' , 'CONVERSION_KTOE_TOE'\)

Units: toe/ktoe

increment consume heating added=

IF THEN ELSE(SWITCH SCENARIO HEATING CONSUME=0, 0,IF THEN ELSE(Time>=2020:AND:SWITCH SCENARIO HEATING CONSUME\=1 , volume biomass equivalent natural gas/(FINAL TIME-2020), IF THEN ELSE(Time>=2020:AND:SWITCH SCENARIO HEATING CONSUME=2, volume biomass equivalent diesel\/(FINAL TIME-2020), IF THEN ELSE(Time>=2020:AND:SWITCH SCENARIO HEATING CONSUME=3, (volume biomass

equivalent diesel\ +volume biomass equivalent natural gas)/(FINAL TIME-2020, 0))))

Units: m3/Year

toe natural gas=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'scenarios', 'CONSTANT_GAS_CONSUMPTION'\)

Units: ktoe/Year

energy from diesel needed=

(toe diesel*CONVERSION KTOE to TOE*CONVERSION toe to KJ)/CALORIFIC VALUE OF BIOMASS

Units: tonnes/Year

roundwood exports=

IF THEN ELSE(variation of roundwood exports>0, variation of roundwood exports, 0)

Units: m3/Year

variation of roundwood exports=

IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=0,CONSTANT EXPORTS,IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS\=1, CONSTANT EXPORTS, IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=2, GROWING EXPORTS\, IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=3, GROWING EXPORTS, CONSTANT EXPORTS))\))

Units: m3/Year

variation of consumption=

IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=0,CONSTANT CONSUMPTION,IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS\=1, GROWING CONSUMPTION, IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=2, CONSTANT CONSUMPTION\, IF THEN ELSE(SWITCH SCENARIO FUTURE TRENDS=3, GROWING CONSUMPTION, CONSTANT CONSUMPTION\))))

Units: m3/Year

GROWING EXPORTS=

IF THEN ELSE(Time<2020, HISTORICAL ROUNDWOOD EXPORTS(Time),
2.35572e+06+119155 *(Time\ -2020))

Units: m3/Year

CONSTANT CONSUMPTION=

IF THEN ELSE(Time<2020, HISTORICAL ROUNDWOOD CONSUMPTION(Time),
1.5e+07)

Units: m3/Year

CONSTANT EXPORTS=

IF THEN ELSE(Time<2020, HISTORICAL ROUNDWOOD EXPORTS(Time),
2.35572e+06)

Units: m3/Year

roundwood imports=

IF THEN ELSE(variation roundwood imports>0, variation roundwood imports,
0)

Units: m3/Year

SWITCH SCENARIO FUTURE TRENDS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'scenarios' ,
'SWITCH_SCENARIO_SP1'\)

Units: Dmnl

0--> Scenario not applied

1--> Scenario applied. Growing consumption, constant exports.

2--> Scenario applied. Growing exports, constant consumption.

3--> Scenario applied. Growing consumption and exports.

GROWING CONSUMPTION=

IF THEN ELSE(Time<2020, HISTORICAL ROUNDWOOD CONSUMPTION(Time),
1.45779e+07+278776*(\Time-2020))

Units:m3/Year

SWITCH SCENARIO HEATING CONSUME=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'scenarios' ,
'SWITCH_SCENARIO_SP2'\)

Units: Dmnl

0-->not applied this scenario

1-->include natural gas

2-->include diesel

3-->include diesel-natural gas

HISTORICAL ROUNDWOOD EXPORTS=

GET DIRECT LOOKUPS('Forests/forests_Spain.xlsx', 'forests_info',
'HISTORICAL_TIME',\ 'HISTORICAL_ROUNDWOOD_EXPORTS_SPAIN')

Units: m3/Year

HISTORICAL ROUNDWOOD CONSUMPTION=

GET DIRECT LOOKUPS('Forests/forests_Spain.xlsx', 'forests_info',
'HISTORICAL_CONSUMPTION_YEARS'\,'HISTORICAL_ROUNDWOOD_CONSUMPTION_ SPAIN')

Units:m3/Year

HISTORICAL ROUNDWOOD IMPORTS=

GET DIRECT LOOKUPS('Forests/forests_Spain.xlsx', 'forests_info',
'HISTORICAL_TIME',\ 'HISTORICAL_ROUNDWOOD_IMPORTS')

Units: m3/Year

variation roundwood imports=

IF THEN ELSE(Time<2020, HISTORICAL ROUNDWOOD IMPORTS(Time),
1e+06)

Units:m3/Year

added consume heating=

INTEG (increment consume heating added,0)

Units: m3

CALORIFIC VALUE OF BIOMASS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'CALORIFIC_VALUE_OF_BIOMASS'\)

Units: KJ/tonnes

CONVERSION toe to KJ=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'CONVERSION_TOE_KJ'\)

Units: KJ/toe

toe diesel=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'scenarios',
'CONSTANT_DIESEL_CONSUMPTION'\)

Units: ktoe/Year

volume biomass equivalent natural gas=

energy from natural gas needed/WOOD DENSITY

Units: m3/Year

volume biomass equivalent diesel=

energy from diesel needed/WOOD DENSITY

Units:m3/Year

k1= constant that determines de annual growth rate of forest stocks by calibration

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'CONSTANT_GROWTH'\)

Units: Dmnl

ratio annual growth=

forest stock increment/total forest area

Units: m³/(ha*Year)

maximum stock per area=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'MAXIMUM_STOCK_BIOMASS'\)

Units: m³/ha

roundwood extracted=

IF THEN ELSE(Time<=2020, HISTORICAL ROUNDWOOD HARVESTED ,
demand of roundwood+added consume heating\+added consume industrial
sector)

Units: m³/Year

roundwood sustainable volume from forests=

forest stock increment*OUTTURN OF WOOD EXTRACTION

Units: m³/Year

demand of roundwood=

IF THEN ELSE(Time<=2020, HISTORICAL ROUNDWOOD HARVESTED,
roundwood imports+roundwood exports\+variation of consumption)

Units: m³/Year

annual growth rate of forest stock=

forest volume stock per unit area*k1*(1-forest volume stock per unit
area/maximum stock per area\)

Units: Dmnl/Year

forest volume stock changes=

IF THEN ELSE(Time<=2020, HISTORICAL FOREST STOCK CHANGE(Time),
forest stock increment\ -roundwood extracted from forest volume -stock of forests
loss from deforestation)

Units: m3/Year

increase of forest stock=

IF THEN ELSE(forest volume stock changes>0,forest volume stock changes ,
0)

Units: m3/Year

forest stock increment=

IF THEN ELSE(total forest volume stock>=0, total forest volume
stock*annual growth rate of forest stock\, 0)

Units: m3/Year

stock of forests loss from deforestation=

forest area lost*forest volume stock per unit area

Units: m3/Year

HISTORICAL ROUNDWOOD HARVESTED:INTERPOLATE::=

GET DIRECT DATA('Forests/forests_Spain.xlsx', 'forests_info',
'HISTORICAL_TIME','HISTORICAL_ROUNDWOOD_PRODUCTION_SPAIN'\)

Units: m3/Year

roundwood sustainable available weight=

roundwood sustainable volume from forests*WOOD DENSITY

Units: tonnes/Year

WOOD DENSITY=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'WOOD_DENSITY_SPAIN'\)

Units: tonnes/m3

forestry planetary boundary volume=

roundwood sustainable volume from forests

Units: m³/Year

forest planetary boundary weight=

roundwood sustainable available weight

Units: tonnes/Year

OUTTURN OF WOOD EXTRACTION=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx' , 'forests_info' ,
'OUTTURN_PERCENTAGE'\)

Units: Dmnl

total forest area:INTERPOLATE::=

GET DIRECT DATA('Forests/forests_Spain.xlsx' , 'land_uses',
'HISTORICAL_YEARS','TOTAL_FOREST_AREA'\)

Units: ha

roundwood extracted from forest volume=

(roundwood extracted/OUTTURN OF WOOD EXTRACTION)

Units: m³/Year

forest area lost=

0

Units: ha/Year

variation of forest above ground biomass stock=

forest volume stock changes*WBS PLUS BIOMASS EXANSION FACTOR
FOREST

Units: tonnes/Year

forest volume stock per unit area=

ZIDZ(total forest volume stock, total forest area)

Units: m³/ha

INITIAL FOREST STOCK=

GET DIRECT CONSTANTS('forests/forests_Spain.xlsx' , 'forests_info',
'INITIAL_FOREST_VOLUME_STOCK'\)

m³

HISTORICAL FOREST STOCK CHANGE=

GET DIRECT LOOKUPS('Forests/forests_Spain.xlsx', 'forests_info',
'HISTORICAL_TIME',\ 'HISTORICAL_STOCK_CHANGE'))

Units: m³/Year

decrease of forest stock=

IF THEN ELSE(forest volume stock changes>0, 0, ABS(forest volume stock
changes))

Units: m³/Year

total forest volume stock=

INTEG (increase of forest stock-decrease of forest stock,INITIAL FOREST
STOCK)

Units: m³

total forest plantations:INTERPOLATE::=

GET DIRECT DATA('Forests/forests_Spain.xlsx' , 'land_uses',
'HISTORICAL_YEARS','TOTAL_FOREST_PLANTATIONS'\)

Units: ha/Year

forest CO₂ in above ground biomass flow=

variation of forest carbon in above ground biomass stock*44/12

Units: tonnes/Year

forest CO2 in below ground biomass flow=

variation of forest carbon in below ground biomass stock*44/12

Units: tonnes/Year

forest CO2 total flow=

forest CO2 in above ground biomass flow+forest CO2 in below ground biomass flow

Units: tonnes/Year

forest carbon in above ground biomass stock=

INTEG (variation of forest carbon in above ground biomass stock,INITIAL FOREST CARBON IN ABOVE GROUND BIOMASS)

Units: tonnes

CARBON FRACTION OF DRY MATTER FOREST=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info', 'CARBON_FRACTION_OF_DRY_MATTER_FOREST'\)

Units: Dmnl

INITIAL FOREST BELOW GROUND BIOMASS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info', 'INITIAL_FOREST_BELOW_GROUND_BIOMASS_SPAIN'\)

Units: tonnes

forest above ground biomass stock=

INTEG (variation of forest above ground biomass stock,INITIAL FOREST ABOVE GROUND BIOMASS)

Units: tonnes

INITIAL FOREST CARBON IN BELOW GROUND BIOMASS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info',
'INITIAL_FOREST_CARBON_IN_BELOW_GROUND_BIOMASS'\)

Units: tonnes

WBS PLUS BIOMASS EXANSION FACTOR FOREST=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info',
'WBS_PLUS_BIOMASS_EXANSION_FACTOR_FOREST'\)

Units: tonnes/m³

forest carbon total flow=

variation of forest carbon in above ground biomass stock+variation of forest
carbon in below ground biomass stock

Units: tonnes/Year

variation of forest carbon in above ground biomass stock=

variation of forest above ground biomass stock*CARBON FRACTION OF DRY
MATTER FOREST

Units: tonnes/Year

forest carbon in below ground biomass stock=

INTEG (variation of forest carbon in below ground biomass stock, INITIAL FOREST
CARBON IN BELOW GROUND BIOMASS)

Units: tonnes

variation of forest below ground biomass stock=

variation of forest above ground biomass stock*ROOT TO SHOOT RATIO
FOREST

Units: tonnes/Year

forest carbon total stock=

forest carbon in below ground biomass stock+forest carbon in above ground biomass stock

Units: tonnes

variation of forest carbon in below ground biomass stock=

variation of forest below ground biomass stock*CARBON FRACTION OF DRY MATTER FOREST

Units: tonnes/Year

INITIAL FOREST ABOVE GROUND BIOMASS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info', 'INITIAL_FOREST_ABOVE_GROUND_BIOMASS_SPAIN'\)

Units: tonnes

INITIAL FOREST CARBON IN ABOVE GROUND BIOMASS=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info', 'INITIAL_FOREST_CARBON_IN_ABOVE_GROUND_BIOMASS'\)

Units: tonnes

ROOT TO SHOOT RATIO FOREST=

GET DIRECT CONSTANTS('Forests/forests_Spain.xlsx', 'forests_info', 'ROOT_TO_SHOOT_RATIO_FOREST'\)

Units: Dmnl

proportion of plantations in the forest area=

total forest plantations/total forest area

Units: Dmnl

forest below ground biomass stock=

INTEG (variation of forest below ground biomass stock,INITIAL FOREST BELOW GROUND BIOMASS)

Units: tonnes