

## 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/kt

**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: m<sup>3</sup>/(ha\*Year)

**maximum stock per area=**

GET DIRECT CONSTANTS( 'Forests/forests\_Spain.xlsx' , 'forests\_info' ,  
'MAXIMUM\_STOCK\_BIOMASS'\ )

Units: m<sup>3</sup>/ha

**roundwood extracted=**

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

Units: m<sup>3</sup>/Year

**roundwood sustainable volume from forests=**

forest stock increment\*OUTTURN OF WOOD EXTRACTION

Units: m<sup>3</sup>/Year

**demand of roundwood=**

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

Units: m<sup>3</sup>/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: m<sup>3</sup>/Year

**increase of forest stock=**

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

Units: m<sup>3</sup>/Year

**forest stock increment=**

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

Units: m<sup>3</sup>/Year

**stock of forests loss from deforestation=**

forest area lost\*forest volume stock per unit area

Units: m<sup>3</sup>/Year

**HISTORICAL ROUNDWOOD HARVESTED:INTERPOLATE::=**

GET DIRECT DATA( 'Forests/forests\_Spain.xlsx', 'forests\_info',  
'HISTORICAL\_TIME','HISTORICAL\_ROUNDWOOD\_PRODUCTION\_SPAIN'\)

Units: m<sup>3</sup>/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/m<sup>3</sup>

**forestry planetary boundary volume=**

roundwood sustainable volume from forests

Units: m<sup>3</sup>/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: m<sup>3</sup>/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