$TITLE CLIMSINK

SETS T time periods /0\*12/

\*5 years are aggregated to one time period

SET I COUNTRIES

/AT Austria

BE Belgium

BG Bulgaria

CY Cyprus

CZ Czech

DE Germany

DK Denmark

EE Estonia

ES Spain

FI Finland

FR France

GR Greece

HU Hungary

IE Ireland

IT Italy

LT Lithuania

LU Luxembourg

LV Latvia

MT Malta

NL Netherlands

PL Poland

PT Portugal

RO Romania

SE Sweden

SK Slovakia

SI Slovakia

UK United Kingdom/

SET IBOR(I) /SE,FI/

SET IMED(I) /CY,MT,GR,FR,IT,PT,ES/

SET J FOSSIL FUEL TYPES

/HAC Hardcoal and derivatives

LIG Lignite and derivatives

NAG Natural and derived gases

LFO Light fuel oil and heating oil

HFO Heavy fuel oil

JEF Jet fuel/

SET P Forest products /BIODOWN,BIOUP,TIMDOWN,TIMUP/

SET BIOS(P) Bioenergy /BIODOWN,BIOUP/

SET TIMS(P) Timber /TIMDOWN,TIMUP/

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\*FUEL COST FUNCTION PARAMETERS

TABLE C0(I,J) p'x' div by e(1+e) - p' div by (2e) - p'x'

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HAC | LIG | NAG | LFO | HFO | JEF |
| AT | 540.9171 | 30.75244 | 2434.402 | 442.04 | 219.3333 | 3172.5 |
| BE | 588.675 | 31.73 | 4160.743 | 299.6825 | 260 | 5305.5 |
| BG | 310.6483 | 591.7178 | 346.5517 | 113.1 | 100.3625 | 918 |
| CY | 4.98306 | 0 | 0 | 5.4902 | 38.90196 | 1386 |
| CZ | 665.1031 | 2240.697 | 1530.385 | 96.25 | 61.6 | 1575 |
| DE | 5264.333 | 5128.953 | 19623.2 | 3412.414 | 1060.862 | 39343.5 |
| DK | 671.3154 | 0 | 1150.333 | 512.234 | 192.4255 | 4135.5 |
| EE | 3.67966 | 312.2051 | 63.09483 | 4.7125 | 0 | 144 |
| ES | 2170.722 | 188.8492 | 7472.5 | 3422.578 | 2218.767 | 25105.5 |
| FI | 646.981 | 318.3078 | 891.6328 | 506.7931 | 406.3879 | 2767.5 |
| FR | 2227.419 | 0 | 7775.833 | 2151.731 | 1815.952 | 31837.5 |
| GR | 38.38306 | 1088.598 | 415.6091 | 1148.167 | 532.5882 | 5827.5 |
| HU | 102.0398 | 241.5839 | 1285.966 | 158.4938 | 69.8 | 1224 |
| IE | 171.9851 | 54.33731 | 1071 | 152.2931 | 238.9655 | 3915 |
| IT | 2844.169 | 0.39762 | 17744.78 | 4883.864 | 2586.159 | 17914.5 |
| LT | 19.24746 | 0.42458 | 228.819 | 110.95 | 48.05 | 238.5 |
| LU | 22.33625 | 0.62625 | 322.1622 | 3.92857 | 0 | 1822.5 |
| LV | 5.09492 | 0.14153 | 141.931 | 2.4375 | 7.94375 | 301.5 |
| MT | 0 | 0 | 0 | 9.01136 | 0 | 346.5 |
| NL | 1075.957 | 0 | 9892.727 | 5459.762 | 244.1667 | 16663.5 |
| PL | 4558.807 | 1842.713 | 2132 | 857.093 | 443.7674 | 1930.5 |
| PT | 483.714 | 0 | 1034.28 | 94.13793 | 429.6552 | 4158 |
| RO | 226.0161 | 983.3186 | 1611.724 | 318.825 | 156.7438 | 625.5 |
| SE | 348.3143 | 57.97286 | 587.7451 | 1126.366 | 563.5714 | 3915 |
| SI | 39.91017 | 175.35 | 137.9741 | 14.8 | 16.8625 | 193.5 |
| SK | 336.1229 | 105.2949 | 624.0517 | 202.3 | 49.275 | 117 |
| UK | 5255.749 | 0 | 20854.64 | 2577.09 | 1387.026 | 58464 |

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TABLE C1(I,J) p'(1+e) div by e

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HAC | LIG | NAG | LFO | HFO | JEF |
| AT | 0.574 | 0.574 | 1.428 | 2.484 | 1.128 | 9.504 |
| BE | 0.585 | 0.585 | 1.296 | 1.527 | 0.724 | 9.504 |
| BG | 0.45 | 0.45 | 0.545 | 1.17 | 0.698 | 9.504 |
| CY | 0.436 | 0.436 | 0.592 | 2.369 | 0.918 | 9.504 |
| CZ | 0.508 | 0.508 | 1.069 | 1.76 | 0.747 | 9.504 |
| DE | 0.441 | 0.441 | 1.466 | 1.743 | 0.817 | 9.504 |
| DK | 0.413 | 0.413 | 1.353 | 3.347 | 2.127 | 9.504 |
| EE | 0.45 | 0.45 | 0.354 | 1.305 | 0.855 | 9.504 |
| ES | 0.445 | 0.445 | 0.998 | 2.062 | 1.192 | 9.504 |
| FI | 0.455 | 0.455 | 0.692 | 1.88 | 1.28 | 9.504 |
| FR | 0.618 | 0.618 | 1.517 | 1.958 | 0.965 | 9.504 |
| GR | 0.436 | 0.436 | 0.592 | 2.457 | 1.066 | 9.504 |
| HU | 0.45 | 0.45 | 0.844 | 2.408 | 0.72 | 9.504 |
| IE | 0.416 | 0.416 | 1.212 | 1.989 | 1.144 | 9.504 |
| IT | 0.565 | 0.565 | 1.259 | 3.796 | 1.244 | 9.504 |
| LT | 0.45 | 0.45 | 0.518 | 1.26 | 0.698 | 9.504 |
| LU | 0.585 | 0.585 | 1.185 | 1.423 | 0.802 | 9.504 |
| LV | 0.45 | 0.45 | 0.436 | 1.463 | 0.698 | 9.504 |
| MT | 0.565 | 0.565 | 0.778 | 1.996 | 1.015 | 9.504 |
| NL | 0.508 | 0.508 | 1.612 | 3.11 | 1.183 | 9.504 |
| PL | 0.46 | 0.46 | 0.944 | 2.162 | 0.964 | 9.504 |
| PT | 0.46 | 0.46 | 1.08 | 1.907 | 1.09 | 9.504 |
| RO | 0.45 | 0.45 | 0.654 | 1.17 | 0.698 | 9.504 |
| SE | 0.644 | 0.644 | 1.628 | 2.981 | 2.229 | 9.504 |
| SI | 0.45 | 0.45 | 0.899 | 1.44 | 0.855 | 9.504 |
| SK | 0.45 | 0.45 | 0.817 | 1.53 | 0.608 | 9.504 |
| UK | 0.455 | 0.455 | 1.609 | 2.103 | 1.533 | 9.504 |

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TABLE C2(I,J) p' div by (2eX')

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HAC | LIG | NAG | LFO | HFO | JEF |
| AT | 7.67E-05 | 1.35E-03 | 9.83E-05 | 1.66E-03 | 6.90E-04 | 6.38E-03 |
| BE | 7.40E-05 | 1.37E-03 | 5.38E-05 | 7.32E-04 | 1.90E-04 | 3.82E-03 |
| BG | 6.45E-05 | 3.38E-05 | 8.58E-05 | 9.34E-04 | 3.74E-04 | 2.21E-02 |
| CY | 3.64E-03 | 1.00E+09 | 1.00E+09 | 1.12E-01 | 2.37E-03 | 1.46E-02 |
| CZ | 4.37E-05 | 1.30E-05 | 9.67E-05 | 3.14E-03 | 8.84E-04 | 1.29E-02 |
| DE | 3.56E-06 | 3.65E-06 | 1.50E-05 | 8.92E-05 | 6.30E-05 | 5.15E-04 |
| DK | 2.25E-05 | 1.00E+09 | 1.89E-04 | 2.53E-03 | 2.72E-03 | 4.90E-03 |
| EE | 5.44E-03 | 6.42E-05 | 1.99E-04 | 2.79E-02 | 1.00E+09 | 1.41E-01 |
| ES | 8.92E-06 | 1.03E-04 | 1.41E-05 | 1.48E-04 | 7.62E-05 | 8.07E-04 |
| FI | 3.20E-05 | 6.51E-05 | 4.99E-05 | 6.98E-04 | 4.04E-04 | 7.32E-03 |
| FR | 2.29E-05 | 1.00E+09 | 4.38E-05 | 1.93E-04 | 5.54E-05 | 6.36E-04 |
| GR | 4.73E-04 | 1.67E-05 | 8.77E-05 | 5.77E-04 | 2.34E-04 | 3.47E-03 |
| HU | 1.96E-04 | 8.29E-05 | 5.55E-05 | 2.82E-03 | 5.73E-04 | 1.65E-02 |
| IE | 9.03E-05 | 2.86E-04 | 1.47E-04 | 2.60E-03 | 5.49E-04 | 5.17E-03 |
| IT | 1.39E-05 | 9.94E-02 | 1.19E-05 | 3.56E-04 | 7.21E-05 | 1.13E-03 |
| LT | 1.04E-03 | 4.72E-02 | 1.17E-04 | 1.10E-03 | 7.81E-04 | 8.49E-02 |
| LU | 1.95E-03 | 6.96E-02 | 5.80E-04 | 4.85E-02 | 1.00E+09 | 1.11E-02 |
| LV | 3.93E-03 | 1.42E-01 | 1.34E-04 | 6.77E-02 | 4.73E-03 | 6.72E-02 |
| MT | 1.00E+09 | 1.00E+09 | 1.00E+09 | 5.33E-02 | 1.00E+09 | 5.84E-02 |
| NL | 2.70E-05 | 1.00E+09 | 3.71E-05 | 2.20E-04 | 7.11E-04 | 1.22E-03 |
| PL | 4.71E-06 | 1.16E-05 | 5.49E-05 | 6.67E-04 | 2.56E-04 | 1.05E-02 |
| PT | 4.44E-05 | 1.00E+09 | 1.25E-04 | 3.87E-03 | 2.77E-04 | 4.87E-03 |
| RO | 8.86E-05 | 2.04E-05 | 2.66E-05 | 3.31E-04 | 2.39E-04 | 3.24E-02 |
| SE | 1.63E-04 | 9.82E-04 | 4.95E-04 | 8.10E-04 | 9.05E-04 | 5.17E-03 |
| SI | 5.02E-04 | 1.14E-04 | 5.87E-04 | 1.08E-02 | 3.35E-03 | 1.05E-01 |
| SK | 5.96E-05 | 1.90E-04 | 1.07E-04 | 8.93E-04 | 5.78E-04 | 1.73E-01 |
| UK | 3.94E-06 | 1.00E+08 | 1.78E-05 | 2.22E-04 | 2.19E-04 | 3.46E-04 |

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TABLE C3 p'

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HAC | LIG | NAG | LFO | HFO | JEF |
| AT | 0.167 | 0.167 | 0.45 | 0.771 | 0.35 | 0.504 |
| BE | 0.167 | 0.167 | 0.35 | 0.59 | 0.28 | 0.504 |
| BG | 0.167 | 0.167 | 0.2 | 0.52 | 0.31 | 0.504 |
| CY | 0.167 | 0.167 | 0.21 | 0.8 | 0.31 | 0.504 |
| CZ | 0.167 | 0.167 | 0.3 | 0.66 | 0.28 | 0.504 |
| DE | 0.167 | 0.167 | 0.38 | 0.64 | 0.3 | 0.504 |
| DK | 0.167 | 0.167 | 0.42 | 1.07 | 0.68 | 0.504 |
| EE | 0.167 | 0.167 | 0.13 | 0.58 | 0.38 | 0.504 |
| ES | 0.167 | 0.167 | 0.35 | 0.64 | 0.37 | 0.504 |
| FI | 0.167 | 0.167 | 0.27 | 0.69 | 0.47 | 0.504 |
| FR | 0.167 | 0.167 | 0.35 | 0.67 | 0.33 | 0.504 |
| GR | 0.167 | 0.167 | 0.21 | 0.83 | 0.36 | 0.504 |
| HU | 0.167 | 0.167 | 0.31 | 1.07 | 0.32 | 0.504 |
| IE | 0.167 | 0.167 | 0.42 | 0.73 | 0.42 | 0.504 |
| IT | 0.167 | 0.167 | 0.34 | 1.16 | 0.38 | 0.504 |
| LT | 0.167 | 0.167 | 0.19 | 0.56 | 0.31 | 0.504 |
| LU | 0.167 | 0.167 | 0.32 | 0.55 | 0.31 | 0.504 |
| LV | 0.167 | 0.167 | 0.16 | 0.65 | 0.31 | 0.504 |
| MT | 0.167 | 0.167 | 0.21 | 0.61 | 0.31 | 0.504 |
| NL | 0.167 | 0.167 | 0.4 | 0.92 | 0.35 | 0.504 |
| PL | 0.167 | 0.167 | 0.26 | 0.65 | 0.29 | 0.504 |
| PT | 0.167 | 0.167 | 0.36 | 0.7 | 0.4 | 0.504 |
| RO | 0.167 | 0.167 | 0.24 | 0.52 | 0.31 | 0.504 |
| SE | 0.167 | 0.167 | 0.55 | 1.07 | 0.8 | 0.504 |
| SI | 0.167 | 0.167 | 0.33 | 0.64 | 0.38 | 0.504 |
| SK | 0.167 | 0.167 | 0.3 | 0.68 | 0.27 | 0.504 |
| UK | 0.167 | 0.167 | 0.39 | 0.59 | 0.43 | 0.504 |

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TABLE FOSSILQ(I,J) Fossil fuel consumption kton toe 2006

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HAC | LIG | NAG | LFO | HFO | JEF |
| AT | 2.66E+03 | 1.51E+02 | 4977 | 516 | 564 | 705 |
| BE | 2.82E+03 | 1.52E+02 | 8797 | 640 | 1170 | 1179 |
| BG | 2.20E+03 | 4.18E+03 | 2010 | 348 | 518 | 204 |
| CY | 3.70E+01 | 0.00E+00 | 0 | 7 | 128 | 308 |
| CZ | 3.90E+03 | 1.31E+04 | 3979 | 175 | 264 | 350 |
| DE | 3.85E+04 | 3.75E+04 | 36148 | 6185 | 4102 | 8743 |
| DK | 5.47E+03 | 0.00E+00 | 2465 | 450 | 266 | 919 |
| EE | 26 | 2.21E+03 | 563 | 13 | 0 | 32 |
| ES | 1.56E+04 | 1.36E+03 | 23058 | 4813 | 5397 | 5579 |
| FI | 4.49E+03 | 2.21E+03 | 4227 | 852 | 1003 | 615 |
| FR | 9.87E+03 | 0.00E+00 | 13330 | 3340 | 5723 | 7075 |
| GR | 2.85E+02 | 8.08E+03 | 2177 | 1411 | 1509 | 1295 |
| HU | 7.21E+02 | 1.71E+03 | 4812 | 237 | 349 | 272 |
| IE | 1.38E+03 | 4.36E+02 | 2703 | 242 | 660 | 870 |
| IT | 1.43E+04 | 2.00E+00 | 38621 | 3705 | 5989 | 3981 |
| LT | 1.36E+02 | 3.00E+00 | 1397 | 317 | 248 | 53 |
| LU | 107 | 3.00E+00 | 745 | 9 | 0 | 405 |
| LV | 3.60E+01 | 1.00E+00 | 1029 | 6 | 41 | 67 |
| MT | 0 | 0.00E+00 | 0 | 13 | 0 | 77 |
| NL | 6.31E+03 | 0.00E+00 | 16323 | 4985 | 586 | 3703 |
| PL | 3.11E+04 | 1.26E+04 | 6232 | 1134 | 1316 | 429 |
| PT | 3.30E+03 | 0.00E+00 | 2873 | 156 | 1246 | 924 |
| RO | 1.60E+03 | 6.95E+03 | 7790 | 981 | 809 | 139 |
| SE | 1.46E+03 | 2.43E+02 | 1090 | 1179 | 789 | 870 |
| SI | 2.82E+02 | 1.24E+03 | 485 | 37 | 71 | 43 |
| SK | 2.38E+03 | 7.44E+02 | 2413 | 476 | 292 | 26 |
| UK | 3.65E+04 | 0.00E+00 | 34223 | 3407 | 2516 | 12992 |

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PARAMETER ECOEFF(J) Emission coefficient fossil fuels ktons CO2 per kton toe

/HAC 3.961, LIG 4.237, NAG 2.349, LFO 3.019, HFO 3.279, JEF 2.994/;

\*+++++++++++FOREST DATA++++++++++++

PARAMETER FORLAND(I) Forest land 1000 ha in 2010

/AT 3991, BE 706, BG 3927, CY 387, CZ 2657, DE 11076, DK 635, EE 2337,

ES 28214, FI 23116, FR 17572, GR 6539, HU 2039, IE 788, IT 10916, LT 2249,

LU 88, LV 3467, MT 0.0001, NL 365, PL 9319, PT 3611, RO 6733, SE 30625,

SI 1274, SK 1938, UK 2901/

PARAMETER FORSTO(I) Forest growing stock m3 per ha in 2010

/AT 286, BE 238, BG 167, CY 27, CZ 290, DE 315, DK 180, EE 191, ES 32, FI 96,

FR 148, GR 31, HU 174, IE 95, IT 133, LT 214, LU 295, LV 183, MT 0.0000001, NL 192,

PL 247, PT 52, RO 207, SE 106, SI 327, SK 265, UK 131/

PARAMETER FORFELL(I) Forest fellings 20O5 m3 per ha

/AT 5.3, BE 7.2, BG 2, CY 0.2, CZ 7.2, DE 5.1, DK 4.6, EE 3.6, ES 1.1, FI 2.6,

FR 3.7, GR 0.3, HU 3.3, IE 5.7, IT 1, LT 3.8, LU 3.2, LV 4, MT 0, NL 3.7, PL 4.2,

PT 5.3, RO 2.5, SE 3.5, SI 2.5, SK 5.4, UK 4/

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\*Special adjustment for Portugal and Ireland to avoid negative stock at end

\*time period

FORFELL("PT")= .5\* FORFELL("PT");

FORFELL("IE")= .95\* FORFELL("IE");

\*to avoid forest stock in Portugal below zero in final time periods Portugese

\*forstock is also doubled

\*small impact on aggregate outcome as Portugal has 1.58% of total forest stock

\*in initial time preiod

FORSTO("pt") = 2\*FORSTO("pt");

PARAMETER SOILC0(I) Soil carbon stock 2010 ton CO2 per ha

/AT 220, BE 139, BG 220, CY 48, CZ 220, DE 220, DK 180, EE 180, ES 48, FI 180,

FR 220, GR 48, HU 220, IE 139, IT 48, LT 180, LU 139, LV 180, MT 48, NL 139,

PL 220, PT 48, RO 220, SE 180, SI 220, SK 220, UK 139/

SCALAR HV Harvest to biomass - area to volume ratio /0.6/

PARAMETER LITTER(I) Litter ratio - CO2 to soil from biomass (ki times bi in table)

\*calibrated with climsoil calib also with soil c losses from harvest

/AT 0.00523404, BE 0.00666920, BG 0.00645267, CY 0.00536170

CZ 0.00668239, DE 0.00425532, DK 0.00865249, EE 0.00613680

ES 0.01742021, FI 0.01789931, FR 0.01349622, GR 0.00577745

HU 0.00923567, IE 0.03335239, IT 0.00109799, LT 0.00530976

LU 0.00240000, LV 0.00803604, NL 0.00563404, PL 0.00573688

PT 0.03042553, RO 0.00503701, SE 0.01957043, SK 0.00233437

SI 0.00602463, UK 0.01232837/

\*LITTER calibrated to zero soil carbon losses at the time of forest harvest

\*/AT 0.00068071, BE 0.00095209, BG 0.00116575, CY 0.00114263

\*CZ 0.00067131, DE 0.00061803, DK 0.00049645, EE 0.00046786

\*ES 0.00096409, FI 0.00097222, FR 0.00131541, GR 0.00099519

\*HU 0.00111886, IE 0.00238522, IT 0.00023197, LT 0.00041757

\*LU 0.00076812, LV 0.00048831, MT 3.085106E+2, NL 0.00118019

\*PL 0.00078818, PT 0.00059329, RO 0.00094049, SE 0.00088051

\*SK 0.00073465, SI 0.00059535, UK 0.00172974/

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PARAMETER DECOMP(I) Soil decomposition rate

/AT 4.94E-13, BE 6.07E-13, BG 4.94E-13, CY 7.80E-13, CZ 4.94E-13, DE 5.43E-13,

DK 4.99E-13, EE 4.98E-13, ES 9.24E-13, FI 2.46E-13, FR 6.53E-13, GR 9.16E-13,

HU 4.94E-13, IE 5.80E-13, IT 7.80E-13, LT 4.98E-13, LU 6.07E-13, LV 4.98E-13,

MT 7.80E-13, NL 5.90E-13, PL 5.43E-13, PT 9.39E-13, RO 4.94E-13, SE 2.95E-13,

SI 4.94E-13, SK 4.94E-13, UK 5.43E-13/

SCALAR SOILCH Rate of soil carbon loss at time of harvest /0.5/;

\*SOILCH=0;

\*++++FOREST GROWTH FUNCTION PARAMETERS++++++++++++++

PARAMETER GROINT(I) Intercept forest growth function m3 per ha

/AT 0, BE 0, BG 0, CY -0.96340, CZ 0, DE 0, DK 0, EE 0, ES -0.96340,

FI -1.32664, FR -0.96340, GR -0.96340, HU 0, IE 0, IT -0.96340, LT 0, LU 0,

LV 0, MT 0, NL 0,PL 0, PT -0.96340, RO 0, SE -1.32664, SI 0, SK 0, UK 0/

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PARAMETER GROLIN(I) Linear coeff forest growth function m3 per ha;

GROLIN(I) = 0.05881;

GROLIN("MT") = 0;

PARAMETER GROQUAD(I) Quadratic coeff forest growth function m3 per ha;

GROQUAD(I) = -0.00011044;

GROQUAD("MT") = 0;

PARAMETER INITGRO(I) Initial growth m3 per ha;

INITGRO(I) = GROINT(I) + GROLIN(I)\*FORSTO(I) + GROQUAD(I)\*FORSTO(I)\*\*2;

PARAMETER FORGROP(I) Percent growth intially;

FORGROP(I) = INITGRO(I)/FORSTO(I);

\*++++++++++++++++++++++++++++++++++++++++++++++++

TABLE FPROD0(I,P) Forest production 1000 m3 2010

|  |  |  |
| --- | --- | --- |
|  | BIODOWN | TIMDOWN |
| AT | 5500 | 15653 |
| BE | 762 | 4321 |
| BG | 3690 | 4160 |
| CY | 32 | 46 |
| CZ | 2300 | 16800 |
| DE | 10200 | 46300 |
| DK | 1170 | 1750 |
| EE | 2270 | 6140 |
| ES | 9930 | 21100 |
| FI | 6010 | 54100 |
| FR | 30600 | 34500 |
| GR | 1330 | 628 |
| HU | 3500 | 3230 |
| IE | 314 | 4180 |
| IT | 7210 | 3710 |
| LT | 2310 | 6240 |
| LU | 17 | 265 |
| LV | 2500 | 11400 |
| MT | 0 | 0 |
| NL | 365 | 986 |
| PL | 4700 | 34400 |
| PT | 1150 | 18000 |
| RO | 3370 | 13500 |
| SE | 8580 | 98600 |
| SI | 1180 | 2010 |
| SK | 523 | 9940 |
| UK | 1630 | 9980 |

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TABLE FELLSHARE(I,P) Percentage share of biomass and timber 2010

|  |  |  |
| --- | --- | --- |
|  | BIODOWN | TIMDOWN |
| AT | 0.26 | 0.74 |
| BE | 0.15 | 0.85 |
| BG | 0.47 | 0.53 |
| CY | 0.41 | 0.59 |
| CZ | 0.12 | 0.88 |
| DE | 0.18 | 0.82 |
| DK | 0.40 | 0.60 |
| EE | 0.27 | 0.73 |
| ES | 0.32 | 0.68 |
| FI | 0.10 | 0.90 |
| FR | 0.47 | 0.53 |
| GR | 0.68 | 0.32 |
| HU | 0.52 | 0.48 |
| IE | 0.07 | 0.93 |
| IT | 0.66 | 0.34 |
| LT | 0.27 | 0.73 |
| LU | 0.06 | 0.94 |
| LV | 0.18 | 0.82 |
| MT | 0.00 | 0.00 |
| NL | 0.27 | 0.73 |
| PL | 0.12 | 0.88 |
| PT | 0.06 | 0.94 |
| RO | 0.20 | 0.80 |
| SE | 0.08 | 0.92 |
| SI | 0.37 | 0.63 |
| SK | 0.05 | 0.95 |
| UK | 0.14 | 0.86 |

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FPROD0(I,P) = FELLSHARE(I,P)\*FORFELL(I)\*FORLAND(I);

FPROD0(I,"BIOUP")=FPROD0(I,"BIODOWN");

FPROD0(I,"TIMUP")=FPROD0(I,"TIMDOWN");

SCALAR FEMISS Emission coefficient kton CO2 per 1000 m3 biomass /.8/;

PARAMETER BEF(I) Biomass expansion factor overground biomass;

BEF(I)=1.175;

BEF(IBOR)=1.125;

\*++++++FOREST COST FUNCTION PARAMETERS++++++++++++++++++++++++++++++

TABLE CP0(I,P) Forest product cost function parameter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BIODOWN | BIOUP | TIMDOWN | TIMUP |
| AT | 113.33 | 113.33 | 2595.78 | 2595.78 |
| BE | 15.71 | 15.71 | 748.88 | 748.88 |
| BG | 76.06 | 76.06 | 735.28 | 735.28 |
| CY | 0.65 | 0.65 | 8.35 | 8.35 |
| CZ | 47.30 | 47.30 | 2837.55 | 2837.55 |
| DE | 209.52 | 209.52 | 7970.52 | 7970.52 |
| DK | 24.08 | 24.08 | 319.96 | 319.96 |
| EE | 33.04 | 33.04 | 692.29 | 692.29 |
| ES | 204.65 | 204.65 | 3339.49 | 3339.49 |
| FI | 128.45 | 128.45 | 6476.80 | 6476.80 |
| FR | 629.67 | 629.67 | 6012.17 | 6012.17 |
| GR | 27.49 | 27.49 | 114.79 | 114.79 |
| HU | 72.10 | 72.10 | 590.59 | 590.59 |
| IE | 6.15 | 6.15 | 725.26 | 725.26 |
| IT | 148.46 | 148.46 | 656.94 | 656.94 |
| LT | 39.44 | 39.44 | 672.89 | 672.89 |
| LU | 0.35 | 0.35 | 48.40 | 48.40 |
| LV | 36.31 | 36.31 | 1367.32 | 1367.32 |
| MT | 36.31 | 36.31 | 1367.32 | 1367.32 |
| NL | 7.51 | 7.51 | 169.65 | 169.65 |
| PL | 68.32 | 68.32 | 3995.99 | 3995.99 |
| PT | 11.83 | 11.83 | 1271.28 | 1271.28 |
| RO | 69.37 | 69.37 | 2462.35 | 2462.35 |
| SE | 183.27 | 183.27 | 12163.56 | 12163.56 |
| SI | 24.28 | 24.28 | 328.37 | 328.37 |
| SK | 10.78 | 10.78 | 1777.56 | 1777.56 |
| UK | 33.48 | 33.48 | 1772.73 | 1772.73 |

;

TABLE CP1(I,P) Forest product change cost function parameter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BIODOWN | BIOUP | TIMDOWN | TIMUP |
| AT | -0.0412 | -0.0412 | -0.3317 | -0.3317 |
| BE | -0.0412 | -0.0412 | -0.3466 | -0.3466 |
| BG | -0.0412 | -0.0412 | -0.3533 | -0.3533 |
| CY | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| CZ | -0.0412 | -0.0412 | -0.3371 | -0.3371 |
| DE | -0.0412 | -0.0412 | -0.3442 | -0.3442 |
| DK | -0.0412 | -0.0412 | -0.3651 | -0.3651 |
| EE | -0.0291 | -0.0291 | -0.2254 | -0.2254 |
| ES | -0.0412 | -0.0412 | -0.3165 | -0.3165 |
| FI | -0.0427 | -0.0427 | -0.2395 | -0.2395 |
| FR | -0.0412 | -0.0412 | -0.3489 | -0.3489 |
| GR | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| HU | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| IE | -0.0412 | -0.0412 | -0.3655 | -0.3655 |
| IT | -0.0412 | -0.0412 | -0.3540 | -0.3540 |
| LT | -0.0342 | -0.0342 | -0.2157 | -0.2157 |
| LU | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| LV | -0.0291 | -0.0291 | -0.2405 | -0.2405 |
| MT | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| NL | -0.0412 | -0.0412 | -0.3442 | -0.3442 |
| PL | -0.0291 | -0.0291 | -0.2320 | -0.2320 |
| PT | -0.0412 | -0.0412 | -0.2827 | -0.2827 |
| RO | -0.0412 | -0.0412 | -0.3657 | -0.3657 |
| SE | -0.0427 | -0.0427 | -0.2467 | -0.2467 |
| SI | -0.0412 | -0.0412 | -0.3273 | -0.3273 |
| SK | -0.0412 | -0.0412 | -0.3576 | -0.3576 |
| UK | -0.0412 | -0.0412 | -0.3553 | -0.3553 |

;

TABLE CP2(I,P) Bioenergy cost function parameter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BIODOWN | BIOUP | TIMDOWN | TIMUP |
| AT | 3.7468E-06 | 3.7468E-06 | 1.0595E-05 | 1.0595E-05 |
| BE | 2.7025E-05 | 2.7025E-05 | 4.0114E-05 | 4.0114E-05 |
| BG | 5.5822E-06 | 5.5822E-06 | 4.2435E-05 | 4.2435E-05 |
| CY | 6.4934E-04 | 6.4934E-04 | 4.0042E-03 | 4.0042E-03 |
| CZ | 8.9761E-06 | 8.9761E-06 | 1.0012E-05 | 1.0012E-05 |
| DE | 2.0266E-06 | 2.0266E-06 | 3.7149E-06 | 3.7149E-06 |
| DK | 1.7636E-05 | 1.7636E-05 | 1.0417E-04 | 1.0417E-04 |
| EE | 6.4033E-06 | 6.4033E-06 | 1.8354E-05 | 1.8354E-05 |
| ES | 2.0749E-06 | 2.0749E-06 | 7.4980E-06 | 7.4980E-06 |
| FI | 3.5560E-06 | 3.5560E-06 | 2.2136E-06 | 2.2136E-06 |
| FR | 6.7433E-07 | 6.7433E-07 | 5.0633E-06 | 5.0633E-06 |
| GR | 1.5447E-05 | 1.5447E-05 | 2.9129E-04 | 2.9129E-04 |
| HU | 5.8893E-06 | 5.8893E-06 | 5.6616E-05 | 5.6616E-05 |
| IE | 6.8988E-05 | 6.8988E-05 | 4.6055E-05 | 4.6055E-05 |
| IT | 2.8601E-06 | 2.8601E-06 | 4.7692E-05 | 4.7692E-05 |
| LT | 7.4068E-06 | 7.4068E-06 | 1.7288E-05 | 1.7288E-05 |
| LU | 1.2196E-03 | 1.2196E-03 | 6.9080E-04 | 6.9080E-04 |
| LV | 5.8269E-06 | 5.8269E-06 | 1.0573E-05 | 1.0573E-05 |
| MT | 5.8269E-06 | 5.8269E-06 | 1.0573E-05 | 1.0573E-05 |
| NL | 5.6511E-05 | 5.6511E-05 | 1.7455E-04 | 1.7455E-04 |
| PL | 3.0969E-06 | 3.0969E-06 | 3.3684E-06 | 3.3684E-06 |
| PT | 3.5890E-05 | 3.5890E-05 | 1.5712E-05 | 1.5712E-05 |
| RO | 6.1209E-06 | 6.1209E-06 | 1.3579E-05 | 1.3579E-05 |
| SE | 2.4924E-06 | 2.4924E-06 | 1.2508E-06 | 1.2508E-06 |
| SI | 1.7486E-05 | 1.7486E-05 | 8.1558E-05 | 8.1558E-05 |
| SK | 3.9380E-05 | 3.9380E-05 | 1.7984E-05 | 1.7984E-05 |
| UK | 1.2684E-05 | 1.2684E-05 | 1.7800E-05 | 1.7800E-05 |

;

\*+++++++++FOREST PRODUCT EMISSIONS++++++++

PARAMETER LIFE(I) Life lenght of timber products in years

\*http://www.efi.int/files/attachments/publications/ir\_09.pdf

/AT 11, BE 9, BG 7, CY 9, CZ 9, DE 11, DK 10, EE 9, ES 7, FI 6, FR 9, GR 9,

HU 6, IE 6, IT 7, LT 9, LU 9, LV 9, MT 9, NL 10, PL 9, PT 7, RO 14, SE 6,

SI 9, SK 7, UK 9/;

\*aggr LIFE(I) to 5 year time period

LIFE(I) = .2\*LIFE(I);

\*round off LIFE(I):

LIFE(I) = round(LIFE(I));

PARAMETER FPRODSUB(P) Substitution effect of forest products kton CO2 fossil

\*fuel replaced per kton CO2 in forest products

/BIODOWN 0.25, BIOUP 0.25, TIMDOWN 0, TIMUP 0/

;

\*++++++calculation of target emissions++++++++++++++++++++++

PARAMETER TEMISST(I,T) Total emissions at time t from foss fuels in kton CO2;

TEMISST(I,T)= SUM(J,ECOEFF(J)\*FOSSILQ(I,J));

PARAMETER EMTARG(T) Emission target at time t kton CO2;

EMTARG(T)= POWER(0.976848545,ORD(T))\*SUM(I,TEMISST(I,T));

\*aggr to 5 year time period

EMTARG(T)= POWER(0.976848545\*\*5,ORD(T))\*SUM(I,TEMISST(I,T));

EMTARG(T)$(ord(t) gt 9) = EMTARG("8");

SCALAR FREESINK Sink at start kton CO2;

FREESINK = SUM{I,FEMISS\*FORLAND(I)\*[GROINT(I) + GROLIN(I)\*FORSTO(I)

+ GROQUAD(I)\*FORSTO(I)\*\*2 - FORFELL(I)]};

SCALAR FPRO Forest prod emissions at initial time period kton CO2;

FPRO = SUM(I, - FPRODSUB("TIMDOWN")\*FEMISS\*FPROD0(I,"TIMDOWN") +

FPRODSUB("BIODOWN")\*FEMISS\*FPROD0(I,"TIMDOWN")

+ FPRODSUB("BIODOWN")\*FEMISS\*FPROD0(I,"BIODOWN"));

PARAMETER SOILEQUIV(T) Soil sequestration kton baseline

/1 30070,2 46643,3 61717,4 76999, 5 92469,6 107987,7 123330,8 138426/

;

SOILEQUIV(T)$(ord(t) gt 9) = SOILEQUIV("8");

PARAMETER FOREQUIV(T) Forest biomass sequestration kton baseline

/1 209695,2 235284,3 248433,4 258957,5 266322,6 270083,7 270040,8 266603/

;

FOREQUIV(T)$(ord(t) gt 9) = FOREQUIV("8");

\*EMTARG must be changed for alternative scenarios so that target only

\*includes sinks considered in the scenario

PARAMETER TARGNEW(T);

TARGNEW(T) = EMTARG(T) - SOILEQUIV(T) - FOREQUIV(T) + FPRO;;

DISPLAY TARGNEW;

PARAMETER TARGET(T) Target emissions kton CO2;

TARGET(T) = TARGNEW(T);

\*+++++++DISCOUNTING+++++++++

SCALAR RFAC Discount factor;

RFAC=1/(1+.03);

\*aggrege to 5 year periods

RFAC=(RFAC\*\*5);

PARAMETER DF(T) Discount factor at time t;

DF(T) = RFAC\*\*ORD(T);

VARIABLES

TC Total discounted cost in MEUR

TCIT(I,T) Total cost in country i at time t in MEUR

FOSSQ(I,J,T) Fossil fuel consumption at time t in kton

FORSTOCK(I,T) Forest stock m3 per ha

FORGRO(I,T) Forest growth m3 per ha

FPROD(I,P,T) Forest product 1000 m3

HARVEST(I,T) Forest harvest m3 per ha

SINK(I,T) Forest sink kton CO2

SOILC(I,T) Soil CO2 stock ton CO2 per ha

SOILSINK(I,T) Soil CO2 sink kton CO2

FPROEM(I,T) Forest product emissions kton CO2

;

POSITIVE VARIABLES TCIT, FORSTOCK, FOSSQ, FPROD, HARVEST, SOILC;

\*+++++restrictions on variables++++++++++++

FOSSQ.LO(i,j,t)=0.05\*fossilq(i,j);

FOSSQ.UP(i,j,t)=fossilq(i,j);

FOSSQ.FX(i,j,t)$(fossilq(i,j) eq 0)=0;

FORSTOCK.LO(i,t) = 0.0001\*forsto(i);

FORSTOCK.UP(i,t) = 15\*forsto(i);

FORSTOCK.FX(i,"0") = forsto(i);

FORGRO.LO(I,T) = -2;

FORGRO.UP(I,T) = 15;

FORGRO.FX(I,"0")=initgro(i);

SOILC.UP(I,T) = 350;

SOILC.FX(i,"0") = soilc0(i);

FPROD.LO(i,"biodown",t) = 0.45\*fprod0(i,"biodown");

FPROD.UP(i,"biodown",t) = fprod0(i,"biodown");

FPROD.LO(i,"timdown",t) = 0.79\*fprod0(i,"timdown");

FPROD.UP(i,"timdown",t) = fprod0(i,"timdown");

FPROD.LO(i,"bioup",t) = fprod0(i,"bioup");

FPROD.UP(i,"bioup",t) = 1.75\*fprod0(i,"bioup");

FPROD.LO(i,"timup",t) = fprod0(i,"timup");

FPROD.UP(i,"timup",t) = 1.75\*fprod0(i,"timup");

FPROD.FX(i,p,t)$(fprod0(i,p) eq 0) = 0;

HARVEST.LO(I,T) = 0.001\*forfell(i);

HARVEST.UP(I,T) = 6\*forfell(i);

HARVEST.FX(I,"0")=forfell(i);

\*for scenario where forest and forest prod management are constant i.e. BAU scenario

\*FPROD.FX(I,"timdown",T) = fprod0(i,"timdown");

\*FPROD.FX(I,"timup",T) = fprod0(i,"timup");

\*FPROD.FX(I,"biodown",T) = fprod0(i,"biodown");

\*FPROD.FX(I,"bioup",T) = fprod0(i,"bioup");

\*+++++++++++initial values for variables+++++++++++

FOSSQ.L(I,J,T) = fossilq(i,j);

FORSTOCK.L(I,T) = forsto(i);

FORGRO.L(I,T) = initgro(i);

SOILC.L(I,T) = soilc0(i);

FPROD.L(I,P,T) = fprod0(i,p);

HARVEST.L(I,T) = forfell(i);

FPROEM.L(I,T) = - fprodsub("timdown")\*femiss\*fprod0(i,"timdown") +

fprodsub("biodown")\*femiss\*FPROD0(i,"timdown")

+ fprodsub("biodown")\*femiss\*fprod0(i,"biodown");

EQUATIONS

OBJ Total minimized cost MEUR

ICOST(i,t) Total cost in MEUR country i at time t

ONLYB(i,t,bios) Bioenergy can only change either up or down

ONLYT(i,t,tims) Timber can only change either up or down

EREST(t) Emission restriction total annual kton CO2

FORDYN(I,T) Forest stock dynamics m3 per hectar

FORGROWTH(I,T) Forest growth m3 per hectar

SINKEQ(I,T) Forest carbon sink kton CO2

SOILDYN(I,T) Soil CO2 stock dynamics ton per hectar

SOILSINKEQ(I,T) Soil CO2 sink kton CO2

FORMARK(I,T) Forest market balance 1000 m3

FORPROEM(I,T) Forest product emissions kton CO2

;

OBJ.. TC =E= SUM((i,t)$(ord(t) gt 1),df(t)\*TCIT(i,t));

ICOST(i,t)$(ord(t) gt 1)..

TCIT(i,t) =E= sum[j, c0(i,j)-c1(i,j)\*FOSSQ(i,j,t) +

c2(i,j)\*FOSSQ(i,j,t)\*\*2 + c3(i,j)\*FOSSQ(i,j,t)] +

sum[p, cp0(i,p) + cp1(i,p)\*FPROD(i,p,t) +

cp2(i,p)\*FPROD(i,p,t)\*\*2];

ONLYB(i,t,bios)$(ord(t) gt 1)..

[FPROD(i,"bioup",t) - fprod0(i,"bioup")]\*

[FPROD(i,"biodown",t) - fprod0(i,"biodown")] =E= 0;

ONLYT(i,t,tims)$(ord(t) gt 1)..

[FPROD(i,"timup",t) - fprod0(i,"timup")]\*

[FPROD(i,"timdown",t) - fprod0(i,"timdown")] =E= 0;

EREST(t)$(ord(t) gt 1)..

sum((i,j),ecoeff(j)\*FOSSQ(i,j,t))

- sum(i,SINK(i,t))

- sum(i,SOILSINK(i,t))

+ sum(i,FPROEM(i,t))

=L= target(t);

\*below aggregation to 5 year time period through multiplication with 5

FORDYN(i,t)$(ord(t) gt 1)..

FORSTOCK(i,t) =E= FORSTOCK(i,t-1) + 5\*FORGRO(i,t-1)

- 5\*HARVEST(i,t-1);

FORGROWTH(i,t)$(ord(t) gt 1)..

FORGRO(i,t) =E= GROINT(I) + GROLIN(I)\*FORSTOCK(i,t) +

GROQUAD(I)\*FORSTOCK(i,t)\*\*2;

FORMARK(i,t)..

forland(i) \* HARVEST(i,t) =E=

[-FPROD0(i,"timdown") + FPROD(i,"timup",t)

+ FPROD(i,"timdown",t)] +

[-FPROD0(i,"biodown") + FPROD(i,"bioup",t)

+ FPROD(i,"biodown",t)];

\*below disaggr to 1 year time period through mult w 0.2

SINKEQ(i,t)$(ord(t) gt 1)..

SINK(i,t) =E= bef(i)\*.2\*femiss\*forland(i)\*[FORSTOCK(i,t)

- FORSTOCK(i,t-1)];

\*soil dynamics aggr to 5 year time period through mult w 5

SOILDYN(i,t)$(ord(t) gt 1)..

SOILC(i,t) =E= SOILC(i,t-1)

- 5\*soilch\*SOILC(i,t-1)\*hv\*HARVEST(i,t-1)/FORSTOCK(i,t-1) +

5\*litter(i)\*bef(i)\*femiss\*FORSTOCK(i,t-1)

- 5\*decomp(i)\*SOILC(i,t-1);

\*below disaggr to 1 year time period through mult w 0.2

SOILSINKEQ(i,t)$(ord(t) gt 1)..

SOILSINK(i,t) =E= 0.2\*forland(i)\*[SOILC(i,t) - SOILC(i,t-1)];

FORPROEM(i,t)$(ord(t) gt 1)..

\*carbon displacement of timber

FPROEM(i,t) =E= - fprodsub("timdown")\*femiss\*[-fprod0(i,"timdown")

+ FPROD(i,"timup",t) + FPROD(i,"timdown",t)] +

\*burning of timber after "life" years

fprodsub("biodown")\*femiss\*[-fprod0(i,"timdown") + FPROD(i,"timup",t)

+ FPROD(i,"timdown",t)]$(ord(t) gt life(i)) +

\*burning of timber in intital time period before "life" years

fprodsub("biodown")\*femiss\*fprod0(i,"timdown")$(ord(t) le life(i))

\*burning of bioenergy

+ fprodsub("biodown")\*femiss\*[-FPROD0(i,"biodown")

+ FPROD(i,"bioup",t) + FPROD(i,"biodown",t)];

MODEL INTERDEP dynamic SINK model /OBJ,ICOST,EREST,FORDYN,FORGROWTH,FORMARK,SINKEQ,SOILDYN,SOILSINKEQ, FORPROEM/;

SOLVE INTERDEP USING NLP MINIMIZING TC;

\*++++++++++outputs++++++++++++++++++++

PARAMETER TCAGG Total discounted cost in MEUR when 5 year aggr;

TCAGG = 5\*TC.L;

PARAMETER TCITAGG(I) Total discounted cost in MEUR when 5 year aggr;

TCITAGG(I) = 5 \* SUM(t,df(t)\*TCIT.L(i,t));

PARAMETER FOSSQTOT(T) Fossil fuel consumption at time t in kton;

FOSSQTOT(T) = sum((i,j),FOSSQ.L(I,J,T));

PARAMETER FORSTOCKTOT(T) Forest stock m3 per ha;

FORSTOCKTOT(T)= sum(i, FORSTOCK.L(I,T));

PARAMETER FPRODTOT (P,T) Forest product 1000 m3;

FPRODTOT(P,T) = sum(i, FPROD.L(I,P,T));

PARAMETER HARVTOT(T) Forest harvest 1000 m3;

HARVTOT(T) = SUM(I,forland(i)\*HARVEST.L(I,T));

PARAMETER SINKTOT(T) Forest sink kton CO2;

SINKTOT(T) = SUM(I, SINK.L(I,T));

PARAMETER FPROEMTOT(T) Forest product emissions kton CO2;

FPROEMTOT(T) = SUM(I,FPROEM.L(I,T));

PARAMETER TCAGGP Total discounted cost in MEUR when 5 year aggr;

TCAGGP = 5\*TC.L;

PARAMETER SINKTOTP(T) Forest sink kton CO2;

SINKTOTP(T) = SUM(I, SINK.L(I,T));

PARAMETER FPROEMTOTP(T) Forest product emissions kton CO2;

FPROEMTOTP(T) = SUM(I,FPROEM.L(I,T));

PARAMETER BIOD(\*,T) Forest product bioenergy reduction change 1000 m3;

BIOD("biodown",T) = sum(i, FPROD0(i,"biodown") - FPROD.L(i,"biodown",t));

PARAMETER BIOU(\*,T) Forest product bioenergy increase change 1000 m3;

BIOU("bioup",T) = sum(i, FPROD.L(i,"bioup",t) - FPROD0(i,"bioup"));

PARAMETER BIOP(T) Forest product bioenergy 1000 m3;

BIOP(T) = sum[i,[-FPROD0(i,"biodown") + FPROD.L(i,"bioup",t)

+ FPROD.L(i,"biodown",t)]] ;

PARAMETER TIMD(\*,T) Forest product bioenergy reduction change 1000 m3;

TIMD("timdown",T) = sum(i, FPROD0(i,"timdown") - FPROD.L(i,"timdown",t));

PARAMETER TIMU(\*,T) Forest product bioenergy increase change 1000 m3;

TIMU("timup",T) = sum(i, FPROD.L(i,"timup",t) - FPROD0(i,"timup"));

PARAMETER TIMP(T) Forest product bioenergy 1000 m3;

TIMP(T) = sum(i,[-FPROD0(i,"timdown") + FPROD.L(i,"timup",t)

+ FPROD.L(i,"timdown",t)]);

PARAMETER TCIP(I) Total discounted national cost in MEUR when 5 year aggr;

TCIP(I) = 5\*SUM(t$(ord(t) gt 1 and ord(t) le 9),df(t)\*TCIT.L(i,t));

PARAMETER TCT(T) Total discounted cost in MEUR when 5 year aggr;

TCT(T) = 5\*SUM(i,df(t)\*TCIT.L(i,t));

PARAMETER FPRODCOST(i,p,t);

FPRODCOST(i,p,t)$(FPROD.L(i,p,t) ne fprod0(i,p)) = cp0(i,p)

+ cp1(i,p)\*FPROD.L(i,p,t) + cp2(i,p)\*FPROD.L(i,p,t)\*\*2;

PARAMETER EFOSSQP(T) Fossil fuel emissions kton CO2;

EFOSSQP(T) = sum((i,j),ecoeff(j)\*FOSSQ.L(i,j,t));

PARAMETER FORSTOP(T) Forest stock 1000 m3 total;

FORSTOP(T)= sum(i,forland(i)\*FORSTOCK.L(I,T));

PARAMETER HARVP(T) Forest harvest 1000 m3;

HARVP(T) = sum(i,forland(i)\*HARVEST.L(I,T));

\*calculation of country sink

PARAMETER SINKHA(I,T) Sink per ha kton CO2 per ha;

SINKHA(I,T) = SINK.L(I,T)/FORLAND(I);

PARAMETER SOILSINKTP(T) Soil sink kton CO2;

SOILSINKTP(T) = SUM(I, SOILSINK.L(I,T));

PARAMETER SOILSINKHA(I,T) Sink per ha kton CO2 per ha;

SOILSINKHA(I,T) = SOILSINK.L(I,T)/FORLAND(I);

PARAMETER SOILCP(T) Soil C stock kton CO2 total;

SOILCP(T)= sum(i,forland(i)\*SOILC.L(I,T));

\*PARAMETER FREESINKHA(I) initial sink kton CO2 per ha;

\*FREESINKHA(I) = femiss\*[GROINT(I) + GROLIN(I)\*FORSTO(i)

\*+ GROQUAD(I)\*FORSTO(i)\*\*2 - FORFELL(I)];

\*calculate optimal tax or subsidy:

PARAMETER FOSSTAX(I,J,T) tax on fossil fuels;

fosstax(i,j,t)= (- c1(i,j) + 2\*c2(i,j)\*FOSSQ.L(i,j,t) + c3(i,j))/ecoeff(j);

PARAMETER FPRODTAX(I,P,T) tax on forest prod;

fprodtax(i,p,t)$(FPROD.L(i,p,t) ne fprod0(i,p)) = cp1(i,p)

+ 2\*cp2(i,p)\*FPROD.L(i,p,t);