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Documents

User's Guide
The SEEM-model Version 2.0

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1. Introduction*

The Sectoral European Energy Model, abbreviated SEEM, calculates future demand for fossil fuels and electricity in the following five sectors: households, industry, service, electricity generation, and transport in each of thirteen Western European countries[1]. The model is programmed in the Portable Troll software[2], and is an efficient and user friendly tool in order to study energy demand in the continously changing Western Europe.

This document is a user's guide for extrapolating and simulating the implemented SEEM-model version 2.0 by means of the Portable Troll software. The purpose of the user's guide is to make the user familiar with the model as it is implemented in Troll, and to make her able to extrapolate and simulate the model according to various scenarios.

In this user´s guide, the model user is guided through the extrapolation and simulation routine in the cases of the reference scenario, the integration scenario, and the fragmentation scenario for Germany as illustrative examples. These scenarios have been defined by the project «Energy scenarios for a changing Europe», which was jointly carried out by the Netherlands Energy Research Foundation (ECN) and Statistics Norway in 1994 and 1995[3]. The present document also guides the model user through a summation routine which summarises simulated energy demand for each country, and for the total of a group of countries. Moreover, the user´s guide explains the calculation routine for CO_2-emissions as it is implemented in a separate submodel of the SEEM-model.

The user´s guide is organised as follows. Chapter 2 gives an overview of how the SEEM-model is organised in directories and files on the personal computer. Chapter 3 provides an outline of how the SEEM-model for Germany is implemented in the Portable Troll software. Chapter 4 is concerned with the procedure for extrapolating and simulating the model for Germany in the scenarios refered to above. Chapter 5 describes and presents the summation routine of energy demand and the calculation routine of CO_2-emissions. Finally, chapter 6 ends this user´s guide by giving some concluding remarks.

If you as a model user have any questions regarding parts of the user´s guide, spot type errors or find things missing, please do not hesitate to contact the author:

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* Chapter 5 is written by Dag Kolsrud, Statistics Norway, Research Department. The author is indebted to Morten Aaserud. Leif Brubakk, and Snorre Kverndokk for useful comments and suggestions.

[1] For further information about the SEEM-model, consult the model documentation by Brubakk et. al (1995).

[2] c.f. Hollinger and Sivatovsky (1993).

[3] This project was partly funded by Statoil and the Dutch Ministry of Planning. A detailed description of the refered scenarios is given in Aaserud et. al. (1995).

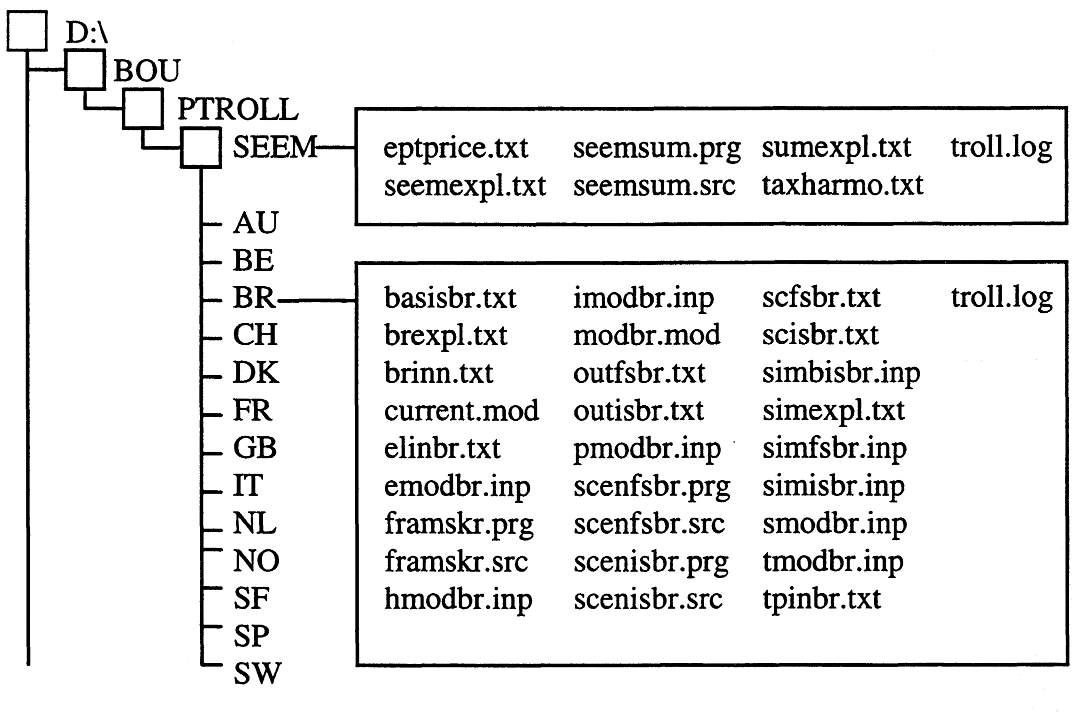
2 Overview of files and directories

This chapter gives an overview of how the implemented SEEM-model is organised in directories and files on a personal computer. The chapter is organised as follows: First, the organisation of files and directories are illustrated and described by means of a figure. Second, an overview of all SEEM related files and their content is given.

2.1 Directories

As can be seen from figure 1, the main subdirectory for the implemented SEEM-model is labelled SEEM and contains non-country specific data files, textfiles, and one Troll macro. This subdirectory is located under the PTROLL subdirectory which contains the Portable Troll software. The PTROLL subdirectory is organised under the BOU subdirectory which is located on the D drive. Finally, a subdirectory for each of the thirteen countries comprised by SEEM is located under the SEEM subdirectory. These directories, as opposed to the SEEM subdirectory, contain country specific data files, textfiles, model files, and Troll macros necessary for simulating the SEEM-model for a certain country. To summarise, the implemented SEEM-model is located on D:\BOU\PTROLL\SEEM and each of the thirteen countries is organised in country specific subdirectories under the SEEM subdirectory,
e.g. D:\ BOU\PTROLL\SEEM\BR.

Figure 1



Note the following abbreviations: AU (Austria), BE (Belgium), BR (Germany), CH (Switzerland), DK (Denmark), FR (France), GB (Great Britain), IT (Italy), NL (Netherlands), NO (Norway), SF (Finland), SP (Spain), and SW (Sweden).

Figure 1 also displays an overview of files which exist on the SEEM directory and files which exist on the country subdirectories. However, such files are shown for Germany only since each other subdirectory contains the same files as the br subdirectory. The only difference is an other country letter code than br in the file names. For further information on files located on the SEEM-directory and files located on each country subdirectory, consult the textfiles seemexpl.txt and brexpl.txt respectively.

2.2 Files for SEEM

The textfile seemexpl.txt

This textfile, called seemexpl.txt, provides an overview of files and their content which exist on the SEEM subdirectory, i.e. on d:\bou\ptroll\seem. Below these files are listed in alphabetic order as they are listed on the SEEM subdirectory.

1) eptprice.txt

An ASCII textfile in the Troll format «formdata» and contains values of fuel import prices, margins, energy taxes, and value added taxes for all fuels, sectors, and countries comprised in the SEEM-model. Since the data are valid for all countries, the file is located directly on the SEEM directory, and not under each country subdirectory. For information on the data sources, consult Brubakk et. al. (1995).

2) seemexpl.txt

A textfile which provides an overview of files and their content existing on the SEEM directory, i.e. on d:\bou\ptroll\seem.

3) seemsum.prg

A compiled version of the Troll macro file seemsum.src. The extension .prg denotes a Troll programme and the file is thus an executable version of seemsum.src.

4) seemsum.src

A Troll macro which summarises simulated fuel demand across sectors and/or countries. Additionally, the macro also calculates CO_2-emissions by fuel, sector, and country based on simulated fuel demand and CO_2-coefficients. Since the macro is general for all countries, the file is located directly on the SEEM directory, and not under each country subdirectory. The macro is programmed by Dag Kolsrud, Statistics Norway.

5) sumexpl.txt

A textfile which explains how to use the macro seemsum.src. In addition, sumexpl.txt provides comments and explanations to each command in the Troll macro.

6) taxharmo.txt

An ASCII textfile in the Troll format «formdata» and contains harmonisation projections of fuel taxes for all fuels, sectors, and countries comprised by the SEEM-model. Since the data are common for all countries, the file is located directly on the SEEM directory, and not under each country subdirectory. This file is relevant for the reference scenario and the integration scenario, since these scenarios assume harmonisation of energy taxes in the period from 2000 to 2010.

7) troll.log

A Troll file which logs the latest simulation results from running a Troll macro or simulating a model. This file also contains any errors or warning messages made by Troll during a simulation.

2.3 Country Files: Germany

The textfile brexpl.txt

This textfile, called brexpl.txt, provides an overview of files and their content which exist on the German (br) directory, i.e. on d:\bou\ptroll\seem\br. Below these files are listed in alphabetic order as they are listed on the br subdirectory. Generally speaking, all the other country subdirectories contain the same files as the br subdirectory.

1) basisbr.txt

An ASCII textfile in the Troll format «formdata» and contains historical and simulated data on all variables and parameters in the SEEM-model from 1960 to 2020 for the reference scenario (basis scenario) for Germany. This datafile may serve as input when simulating the SEEM-model in the case of other scenarios.

2) brexpl.txt
A textfile which provides an overview of files and their content existing on the German (br) directory, i.e. on d:\bou\ptroll\seem\br.

3) brinn.txt
An ASCII textfile in the Troll format «formdata» and contains all data needed for extrapolation of input variables and simulation of the household, the industry, and the service sector models for Germany in the base year 1991.

4) current.mod
The latest version of the Troll model used for simulation of Germany.

5) elinbr.txt
An ASCII textfile in the Troll format «formdata» and contains all data needed for extrapolation of input variables and simulation of the electricity generating sector model for Germany in the base year 1991.

6) emodbr.inp
A Troll input file which defines and establishes the model for the electricity generating sector in Germany. The file includes all equations and provides comments and descriptions to these. The electricity generating model is programmed by Wilma Pellekaan, ECN Netherlands.

7) framskr.prg
A compiled version of the Troll macro file framskr.src. The extension .prg denotes a Troll programme and the file is thus an executable version of framskr.src.

8) framskr.src
A Troll macro which translates the commands in the scenfsbr.src and the scenisbr.src (see below) macros into Troll syntax. The macro is programmed by Rune Johansen, Statistics Norway.

9) hmodbr.inp
A Troll input file which defines and establishes the model for the household sector in Germany. The file includes all equations and provides comments and descriptions to these. The household model is programmed by Leif Brubakk, Statistics Norway.

10) imodbr.inp
A Troll input file which defines and establishes the model for the industry sector in Germany. The file includes all equations and provides comments and descriptions to these. The industry model is programmed by Leif Brubakk, Statistics Norway.

11) modbr.mod
The compiled SEEM-model for Germany, including the household model, the industry model, the service model, the electricity generating model, the transport model, and the price model

12) outfsbr.txt
An ASCII textfile in the Troll format «formdata» and contains simulation results from the fragmentation scenario for Germany.

13) outisbr.txt
An ASCII textfile in the Troll format «formdata» and contains simulation results from the integration scenario for Germany.

14) pmodbr.inp
A Troll input file which defines and establishes the fuel end user price model in Germany. The file includes all equations and provides comments and descriptions of these. The price model is programmed by Morten Aaserud, Statistics Norway and Wilma Pellekaan, ECN Netherlands.

15) scenfsbr.prg
A compiled version of scenfsbr.src. The extension .prg denotes a Troll programme and the file is thus an executable version of scenfsbr.src.

16) scenfsbr.src
A Troll macro which consists of Troll commands extrapolating input variables according to the fragmentation scenario assumptions for Germany. This macro is called upon from the simfsbr.inp file, and the macro works together with the framskr.prg macro.

17) scenisbr.prg
A compiled version of scenisbr.src. The extension .prg denotes a Troll programme and the file is thus an executable version of scenisbr.src.

18) scenisbr.src
A Troll macro which consists of Troll commands extrapolating input variables according to the integration scenario assumptions for Germany. This macro is called upon from the simisbr.inp file, and the macro works together with the framskr.prg macro. Note that the is scenario is based on the same input assumptions as the reference scenario assumptions.

19) scfsbr.txt
An ASCII textfile in the Troll format «formdata» and contains the input extrapolated according to the fragmentation scenario assumptions for Germany. This file is a result of the scenfsbr.src macro.

20) scisbr.txt
An ASCII textfile in the Troll format «formdata» and contains the input extrapolated according to the integration scenario assumptions for Germany. This file is a result of the scenisbr.src macro.

21) simbisbr.inp
A Troll input file which gives access and search lists to all data needed for simulating the SEEM-model for the reference (basis) scenario in Germany. The file also defines and establishes the model by starting the input files hmodbr.inp, imodbr.inp, smodbr.inp, tmodbr.inp, emodbr.inp, and pmodbr.inp. Finally, the file simulates the SEEM-model for Germany and saves the scenario results.

22) simexpl.txt
A textfile which explains the procedure of making a simulation of the SEEM-model.

23) simfsbr.inp
A Troll input file which gives access and search lists to all data needed for simulating the SEEM model for the fragmentation scenario in Germany. The file also defines and establishes the model by starting the input files hmodbr.inp, imodbr.inp, smodbr.inp, tmodbr.inp, emodbr.inp, and pmodbr.inp. Finally, the file simulates the SEEM-model for Germany and saves the scenario results.

24) simisbr.inp
A Troll input file which gives access and search lists to all data needed for simulating the SEEM model for the integration scenario in Germany. The file also defines and establishes the model by starting the input files hmodbr.inp, imodbr.inp, smodbr.inp, tmodbr.inp, emodbr.inp, and pmodbr.inp. Finally, the file simulates the SEEM-model for Germany and saves the scenario results. Note that the integration scenario is identical to the reference (basis) scenario.

25) smodbr.inp
A Troll input file which defines and establishes the model for the service sector in Germany. The file includes all equations and provides comments and descriptions to these. The service model is programmed by Leif Brubakk, Statistics Norway.

26) tmodbr.inp
A Troll input file which defines and establishes the model for the transport sector in Germany. The file includes all equations and provides comments and descriptions to these. The transport model is programmed by Wilma Pellekaan, ECN Netherlands.

27) tpinbr.txt
An ASCII textfile in the Troll format «formdata» and contains all data needed for extrapolation of input variables and simulation of the transport sector model for Germany in the base year 1991.

28) troll.log
A Troll file which logs the latest simulation results from running a Troll macro or simulating a model. This file also contains any errors or warning messages made by Troll during a simulation.

3. The Implemented SEEM-model

This chapter provides an outline of how the SEEM-model for Germany is implemented in the Portable Troll software. The reason for the choice of the implemented model for Germany as an illustrative example, lies in the fact that this model is the most general one compared to other country models. All the other country models are special cases of the more general German model specification. The differences relate to the existing structure of fossil fuel demand in each country. The present chapter presents and describes each sector model and the end user fuel price model for Germany as they are implemented in Troll input files. For a more comprehensive and detailed theoretical explanation on each model, consult Brubakk et. al. (1995).

It is worthwhile to notice in the Troll input files presented below, that the Troll syntax for a comment begins with a «/*». Note also that the Troll commands in each input file are emphasised with italic letters.

3.1 The Household Model

/* **The Troll Input File hmodbr.inp**
/* This Troll input file, called hmodbr.inp, defines and establishes the model for the
/* household sector (ho) in Germany (br). The hmodbr.inp file also provides
/* descriptions and comments to this sector model. For easy references the equation
/* numbers in the brackets below correspond to the equation numbers in the appendix in
/* Brubakk et. al. (1995). As far as variable names and parameter names used in the
/* household model are concerned, consult the appendix to this user´s guide. The other
/* sector models for Germany, namely for the industry sector (in), the service sector
/* (se), the electricity generating sector (el), and the transport sector (tp) are established
/* and described in the files with corresponding names imodbr.inp, smodbr.inp,
/* emodbr.inp, and tmodbr.inp respectively. The end user fuel price calculation routine
/* is implemented in the file named pmodbr.inp.

/* **The Household Sector**
/* ---
/* The following model calculates fuel demand and aggregate fuel price indices in the
/* household sector. First, the aggregate fuel price indices are determined. Second, the
/* demand for the electricity aggregate and the fossil fuel aggregate (consisting of all
/* three fossil fuels) are calculated at the upper level. Third, the fossil fuel aggregate is
/* divided into a subaggregate (consisting of two fuels) and the remaining fuel at the
/* intermediate level. Finally, demand for each of the two fuels constituting the
/* subaggregate is determined at the lower level. In countries where only two types of
/* fossil fuels are used, the lower level is omitted in the model. Similarly, only the upper

/* level applies to countries where only one type of fossil fuel is demanded.

/* **Troll Commands**
/* --
/* This Troll command specifies the endogenous variables in the household model.

addsym endogenous
ocprihobr
cogprihobr
/* start part 1
/* Note that the electricity consumption (eleconhobr) is set to be exogenous here due to
/* the fact that it is set to be endogenous in the electricity generation part of the SEEM-
/* model, named emodbr.inp.
/* eleconhobr
cogconhobr
occonhobr
ngsconhobr
oilconhobr
coaconhobr
/* end part 1
/* When recalibrating the model for the household sector, the endogenous variables
/* above should be specified as exogenous and the calibration parameters below should
/* be specified as endogenous.
/* start part 2
/* a0elehobr
/* a0coghobr
/* a0ochobr
/* a0oilhobr
/* a0coahobr
/* a0ngshobr
/* end part 2
;

/* This Troll command adds equations to the household model.

addeq bottom

/* **Calculation of Aggregate Fuel Price Indices**
/* --
/* Equation 1 and 2 calculates the oil-coal aggregate price index (ocpri) and the coal-oil-
/* gas aggregate price index (cogpri) respectively, based on CES-functions.

/* Equation 1 (A2.4)
*ocprihobr=(a3dochobr*oilprihobr**(1-a1sochobr)+(1-a3dochobr)**
*coaprihobr**(1-a1sochobr))**(1/(1-a1sochobr))*

/* Equation 2 (A2.4)
*cogprihobr=(a3dcoghobr*ngsprihobr**(1-a1scoghobr)+(1-a3dcoghobr)**
*ocprihobr**(1-a1scoghobr))**(1/(1-a1scoghobr))*

,
/* **Calculation of Fuel Demand at the Upper Level**
/* --
/* Equation 3 and 4 calculates the aggregate demand for electricity (elecon) and the
/* aggregate demand for fossil fuels (cogcon) respectively, based on Cobb-Douglas
/* functions. The fossil fuel aggregate consists of coal, oil, and natural gas, named cog.

/* Equation 3 (A2.5)

```
eleconhobr=a0elehobr*eleprihobr**a1elehobr*cogprihobr**a1cogelehobr*
            conhobr**a2elehobr*eleconhobr(-1)**a3lelehobr
```

/* Equation 4 (A2.5)

```
cogconhobr=a0coghobr*cogprihobr**a3coghobr*eleprihobr**a3elecoghobr*
            conhobr**a2coghobr*cogconhobr(-1)**a3lcoghobr
,
```

/* **Calculation of Fuel Demand at the Intermediate Level**
/* ---
/* Equation 5 and 6 calculates the subaggregate demand for fossil fuel (occon) and the
/* demand for natural gas (ngscon) respectively, based on CES-functions. The
/* subaggregate consists of oil and coal, named oc.

/* Equation 5 (A2.6)

```
occonhobr=a0ochobr*cogconhobr*(1-a3dcoghobr)*((1-a3dcoghobr)+
           a3dcoghobr*((ngsprihobr/ocprihobr)**(1-a3lagcoghobr)*
           (((ngsconhobr(-1)/occonhobr(-1))+cogrehobr)/
           (a3dcoghobr/(1-a3dcoghobr)))**((-1)*(a3lagcoghobr/a1scoghobr)))**
           (1-a1scoghobr))**(a1scoghobr/(1-a1scoghobr))
,
```

/* Equation 6 (A2.6)

```
ngsconhobr=a0ngshobr*cogconhobr*a3dcoghobr*(a3dcoghobr+
           (1-a3dcoghobr)*((ngsprihobr/ocPRIhobr)**((-1)*(1-a3lagcoghobr))*
           (((ngsconhobr(-1)/occonhobr(-1))+cogrehobr)/
           (a3dcoghobr/(1-a3dcoghobr)))**(a3lagcoghobr/a1scoghobr))**
           (1-a1scoghobr))**(a1scoghobr/(1-a1scoghobr))
,
```

/* **Calculation of Fuel Demand at the Lower Level**
/* ---
/* Equation 7 and 8 calculates the demand for oil (oilcon) and coal (coacon)
/* respectively, based on CES-functions.

/* Equation 7 (A2.6)

```
oilconhobr=a0oilhobr*occonhobr*a3dochobr*(a3dochobr+
           (1-a3dochobr)*((oilprihobr/coaprihobr)**((-1)*(1-a3lagochobr))*
           (((oilconhobr(-1)/coaconhobr(-1))+ocrehobr)/
           (a3dochobr/(1-a3dochobr)))**(a3lagochobr/a1sochobr))**
           (1-a1sochobr))**(a1sochobr/(1-a1sochobr))
,
```

/* Equation 8 (A2.6)

```
coaconhobr=a0coahobr*occonhobr*(1-a3dochobr)*((1-a3dochobr)+
           a3dochobr*((oilprihobr/coaprihobr)**(1-a3lagochobr)*
           (((oilconhobr(-1)/coaconhobr(-1))+ocrehobr)/
           (a3dochobr/(1-a3dochobr)))**((-1)*(a3lagochobr/a1sochobr)))**
           (1-a1sochobr))**(a1sochobr/(1-a1sochobr))
;
```

/* End of the household model.

3.2 The Industry Model

/* **The Troll Input File imodbr.inp**
/* This Troll input file, called imodbr.inp, defines and establishes the model for the
/* industry sector (in) in Germany (br). The file imodbr.inp also provides descriptions
/* and comments to this sector model. For easy references the equation numbers in the

/* brackets below correspond to the equation numbers in the appendix in Brubakk et. al.
/* (1995). As far as variable names and parameter names used in the industry model are
/* concerned, consult the appendix to this user`s guide. The other sector models for
/* Germany, namely for the household sector (ho), the service sector (se), the electricity
/* generating sector (el), and the transport sector (tp), are established and described in
/* the files with corresponding names hmodbr.inp, smodbr.inp, emodbr.inp, and
/* tmodbr.inp respectively. The end user fuel price calculation routine is implemented in
/* the file named pmodbr.inp.

/* **The Industry Sector**
/* --
/* The following model calculates the energy price index and the desired and realised
/* fuel consumption in the industry sector. In the first part of the model the energy price
/* index is determined. In the second and third part of the model desired and realised
/* consumption of each of the fuel carriers is calculated.

/* **Troll Commands**
/* --
/* This Troll command specifies the endogenous variables in the industry model.

addsym endogenous

eenrpriinbr
ecoaconinbr
eoilconinbr
engsconinbr
eeleconinbr
/* start part 1
coaconinbr
oilconinbr
ngsconinbr
/* Note that the electricity consumption (eleconinbr) is set to be exogenous here due to
/* the fact that it is set to be endogenous in the electricity generation part of the SEEM-
/* model, named emodbr.inp.
/* eleconinbr
/* end part 1
/* When recalibrating the model for the industry sector, the endogenous variables above
/* should be specified as exogenous and the calibration parameters below should be
/* specified as endogenous.
/* end part 2
/* a0coainbr
/* a0oilinbr
/* a0ngsinbr
/* a0eleinbr
/* slutt del 2
;

/* This Troll command adds equations to the industry model.

addeq bottom

/* **Calculation of the Energy Price Index**
/* --
/* Equation 1 calculates the energy price index (eenrpri), based on a Cobb-Douglas
/* function.

/* Equation 1 (A2.1)
*eenrpriinbr=coapriinbr**a1coainbr*oilpriinbr**a1oilinbr*
ngspriinbr**a1ngsinbr*elepriinbr**a1eleinbr*

,
/* **Calculation of Desired Fuel Consumption**
/* --
/* Equation 2, 3, 4, and 5 calculates desired consumption of coal (ecoacon), oil
/* (eoilcon), natural gas (engscon), and electricity (eelecon) respectively, based on
/* Cobb-Douglas functions.

/* Equation 2 (A2.2)
*ecoaconinbr=proinbr**a2proinbr*cappriinbr**a1capinbr*labpriinbr**
a1waginbr*eenrpriinbr**a1enrinbr*coapriinbr**(-1)*
coapriinbr**a1coainbr*oilpriinbr**a1oilinbr*ngspriinbr**
a1ngsinbr*elepriinbr**a1eleinbr*

,
/* Equation 3 (A2.2)
*eoilconinbr=proinbr**a2proinbr*cappriinbr**a1capinbr*labpriinbr**
a1waginbr*eenrpriinbr**a1enrinbr*oilpriinbr**(-1)*
coapriinbr**a1coainbr*oilpriinbr**a1oilinbr*ngspriinbr**
a1ngsinbr*elepriinbr**a1eleinbr*

,
/* Equation 4 (A2.2)
*engsconinbr=proinbr**a2proinbr*cappriinbr**a1capinbr*labpriinbr**
a1waginbr*eenrpriinbr**a1enrinbr*ngspriinbr**(-1)*
coapriinbr**a1coainbr*oilpriinbr**a1oilinbr*ngspriinbr**
a1ngsinbr*elepriinbr**a1eleinbr*

,
/* Equation 5 (A2.2)
*eeleconinbr=proinbr**a2proinbr*cappriinbr**a1capinbr*labpriinbr**
a1waginbr*eenrpriinbr**a1enrinbr*elepriinbr**(-1)*
coapriinbr**a1coainbr*oilpriinbr**a1oilinbr*ngspriinbr**
a1ngsinbr*elepriinbr**a1eleinbr*

,
/* **Calculation of Realised Consumption**
/* --
/* Equation 6, 7, 8, and 9 calculates realised consumption of coal (coacon), oil (oilcon),
/* natural gas (ngscon), and electricity (elecon) respectively, based on Cobb-Douglas
/* functions.

/* Equation 6 (A2.3)
coaconinbr=a0coainbr(ecoaconinbr)**(1-a3laginbr)*
(coaconinbr(-1)-rcoainbr)**a3laginbr*

,
/* Equation 7 (A2.3)
oilconinbr=a0oilinbr(eoilconinbr)**(1-a3laginbr)*
(oilconinbr(-1)-roilinbr)**a3laginbr*

,
/* Equation 8 (A2.3)
ngsconinbr=a0ngsinbr(engsconinbr)**(1-a3laginbr)*
(ngsconinbr(-1)-rngsinbr)**a3laginbr*

,
/* Equation 9 (A2.3)
eleconinbr=a0eleinbr(eeleconinbr)**(1-a3laginbr)*
(eleconinbr(-1)-releinbr)**a3laginbr*

;
/* End of the industry model.

3.3 The Service Model

/* **The Troll Input File smodbr.inp**
/* This Troll input file, called smodbr.inp, defines and establishes the model for the
/* service sector (se) in Germany (br). The file smodbr.inp also provides descriptions
/* and comments to this sector model. For easy references the equation numbers in the
/* brackets below correspond to the equation numbers in the appendix in Brubakk et. al.
/* (1995). As far as variable names and parameter names used in the service model are
/* concerned, consult the appendix to this user´s guide. The other sector models for
/* Germany, namely for the household sector (ho), the industry sector (in), the
/* electricity generating sector (el), and the transport sector (tp) are established and
/* described in the files with corresponding names hmodbr.inp, imodbr.inp, emodbr.inp,
/* and tmodbr.inp respectively. The end user fuel price calculation routine is
/* implemented in the file named pmodbr.inp.

/* **The Service Sector**
/* ---
/* The following model calculates fuel demand and aggregate fuel price indices in the
/* service sector. First, the aggregate fuel price indices are determined. Second, the
/* demand for the electricity aggregate and the fossil fuel aggregate (consisting of all
/* three fossil fuels) are calculated at the upper level. Third, the fossil fuel aggregate is
/* divided into a subaggregate (consisting of two fuels) and the remaining fuel at the
/* intermediate level. Finally, demand for each of the two fuels constituting the
/* subaggregate is determined at the lower level. In countries where only two types of
/* fossil fuels are used, the lower level is omitted in the model. Similarly, only the upper
/* level applies to countries where only one type of fossil fuel is demanded.

/* **Troll Commands**
/* ---
/* This Troll command specifies the endogenous variables in the service model.

addsym endogenous

ogprisebr
cogprisebr
/* start part 1
cogconsebr
/* Note that the electricity consumption (eleconsebr) is set to be exogenous here due to
/* the fact that it is set to be endogenous in the electricity generation part of the SEEM-
/* model, named emodbr.inp.
/* eleconsebr
ogconsebr
oilconsebr
ngsconsebr
coaconsebr
/* end part 1
/* When recalibrating the model for the service sector the endogenous variables above
/* should be specified as exogenous and the calibration parameters below should be
/* specified as endogenous.
/* end part 2
/* a0cogsebr
/* a0elesebr
/* a0ogsebr

/* a0coasebr
/* a0oilsebr
/* a0ngssebr
/* slutt del 2
;
/* This Troll command adds equations to the service model.

addeq bottom

/* **Calculation of Aggregate Fuel Price Indices**
/* ---
/* Equation 1 and 2 calculates the oil-gas aggregate price index (ogpri) and the coal-oil-
/* gas aggregate price index (cogpri) respectively, based on CES-functions.

/* Equation 1 (A2.7)

```
ogprisebr=(a3dogsebr*ngsprisebr**(1-a1sogsebr)+(1-a3dogsebr)*
          oilprisebr**(1-a1sogsebr))**(1/(1-a1sogsebr))
,
```

/* Equation 2 (A2.7)

```
cogprisebr=(a3dcogsebr*coaprisebr**(1-a1scogsebr)+(1-a3dcogsebr)*
           ogprisebr**(1-a1scogsebr))**(1/(1-a1scogsebr))
,
```

/* **Calculation of Fuel Demand at the Upper Level**
/* ---
/* Equation 3 and 4 calculates the aggregate demand for electricity (elecon) and the
/* aggregate demand for fossil fuel (cogcon) respectively, based on Cobb-Douglas
/* functions. The fossil fuel aggregate consists of coal, oil, and natural gas, named cog.

/* Equation 3 (A2.8)

```
eleconsebr=a0elesebr*prosebr**a2elesebr*
           capprisebr**a1capelesebr*labprisebr**a1labelesebr*
           cogprisebr**a1cogelesebr*eleprisebr**a1elesebr*
           eleconsebr(-1)**a3lelesebr
,
```

/* Equation 4 (A2.8)

```
cogconsebr=a0cogsebr*prosebr**a2cogsebr*
           capprisebr**a1capcogsebr*labprisebr**a1labcogsebr*
           cogprisebr**a1cogsebr*eleprisebr**a1elecogsebr*
           cogconsebr(-1)**a3lcogsebr
,
```

/* **Calculation of Fuel Demand at the Intermediate Level**
/* ---
/* Equation 5 and 6 calculates the subaggregate demand for fossil fuel (ogcon) and the
/* demand for coal (coacon) respectively, based on CES-functions. The subaggregate
/* consists of oil and natural gas, named og.

/* Equation 5 (A2.9)

```
ogconsebr=a0ogsebr*cogconsebr*(1-a3dcogsebr)*((1-a3dcogsebr)+
          a3dcogsebr*((ogprisebr/coaprisebr)**((-1)*(1-a3lagcogsebr))*
          (((ogconsebr(-1)/coaconsebr(-1))+cogresebr)/
          ((1-a3dcogsebr)/a3dcogsebr))**(a3lagcogsebr/a1scogsebr))**
          (1-a1scogsebr))**(a1scogsebr/(1-a1scogsebr))
```

,
/* Equation 6 (A2.9)
*coaconsebr=a0coasebr*cogconsebr*a3dcogsebr*(a3dcogsebr+*
(1-a3dcogsebr)((ogprisebr/coaprisebr)**(1-a3lagcogsebr)**
(((ogconsebr(-1)/coaconsebr(-1))+cogresebr)/
*((1-a3dcogsebr)/a3dcogsebr))**((-1)*(a3lagcogsebr/alscogsebr)))***
*(1-alscogsebr))**(alscogsebr/(1-alscogsebr))*

,

/* **Calculation of Fuel Demand at the Lower Level**
/* --
/* Equation 7 and 8 calculates the demand for oil (oilcon) and natural gas (ngscon)
/* respectively, based on CES-functions.
/* Equation 7 (A2.9)
*oilconsebr=a0oilsebr*ogconsebr*(1-a3dogsebr)*((1-a3dogsebr)+*
a3dogsebr((oilprisebr/ngsprisebr)**((-1)*(1-a3lagogsebr))**
(((oilconsebr(-1)/ngsconsebr(-1))+ogresebr)/
*((1-a3dogsebr)/a3dogsebr))**(a3lagogsebr/alsogsebr))***
*(1-alsogsebr))**(alsogsebr/(1-alsogsebr))*

,
/* Equation 8 (A2.9)
*ngsconsebr=a0ngssebr*ogconsebr*a3dogsebr*(a3dogsebr+*
(1-a3dogsebr)((oilprisebr/ngsprisebr)**(1-a3lagogsebr)**
(((oilconsebr(-1)/ngsconsebr(-1))+ogresebr)/
*((1-a3dogsebr)/a3dogsebr))**((-1)*(a3lagogsebr/alsogsebr)))***
*(1-alsogsebr))**(alsogsebr/(1-alsogsebr))*

;
/* End of the service model.

3.4 The Electricity Generating Model

/* **The Troll Input file emodbr.inp**
/* This Troll input file, called emodbr.inp, defines and establishes the model for the
/* electricity generating sector (el) in Germany (br).The file emodbr.inp also provides
/* descriptions and comments to this sector model. For easy references the equation
/* numbers in the brackets below correspond to the equation numbers in the appendix in
/* Brubakk et. al. (1995). As far as variable names and parameter names used in the
/* electricity generating model are concerned, consult the appendix to this user´s guide.
/* The other sector models for Germany, namely for the household sector (ho), the
/* industry sector (in), the service sector (se), and the transport sector (tp) are
/* established and described in the files with corresponding names hmodbr.inp,
/* imodbr.inp, smodbr.inp, and tmodbr.inp respectively. The end user fuel price
/* calculation routine is implemented in the file named pmodbr.inp.

/* **The Electricity Generating Sector**
/* --
/* The following model calculates fuel demand in the electricity generating sector. In
/* the first part of the model the shares of the old, new, and best available technologies
/* (bat) technologies are calculated, using a linear penetration path. Based on these
/* shares the average production costs and efficiencies for each type of production (coal,
/* gas, oil, nuclear and renewable) are determined. These production costs and
/* efficiencies serve in turn as input in the Cobb-Douglas functions which calculate the
/* overall shares of electricity production for each type of fuel based production. These
/* shares multiplied with their respective efficiencies and the total average production
/* cost of electricity yield the fuel demand in the electricity generating sector.

/* **Troll Commands**
/* --
/* This Troll command specifies the endogenous variables in the electricity generating
/* model.

addsym endogenous
coasha0belbr
ngssha0belbr
oilsha0belbr
nucsha0belbr
rensha0belbr
coashanelbr
coashafelbr
coashabelbr
coashaoelbr
ngsshanelbr
ngsshabelbr
ngsshaoelbr
oilshanelbr
oilshabelbr
oilshaoelbr
nucshanelbr
nucshabelbr
nucshaoelbr
renshanelbr
renshabelbr
renshaoelbr
coacstelbr
ngscstelbr
oilcstelbr
nuccstelbr
rencstelbr
coaeffelbr
ngseffelbr
oileffelbr
nuceffelbr
reneffelbr
coasha1elbr
ngssha1elbr
oilsha1elbr
nucsha1elbr
rensha1elbr
coashaelbr
ngsshaelbr
oilshaelbr
nucshaelbr
renshaelbr
coaconelbr
ngsconelbr
oilconelbr
nucconelbr
renconelbr
/* Note that the electricity generating price (elegenpribr) is set to be exogenous here due
/* to the fact that it is set to be endogenous in the end user fuel price model, named
/* pmodbr.inp.

/* elegenpribr
totdemelbr
eleconhobr
eleconsebr
eleconinbr
railcontotbr
;

/* This Troll command adds equations to the electricity generating model.

addeq bottom

/* **Calculation of Shares of Old, New, and Bat Technology**

/* Equation 1 to 16 calculates the share of old, new, and bat technology based on a
/* linear penetration path. Note that the share of future technology is calculated for coal-
/* technology only.

/* The different shares of bat fuel technology are set equal to zero in the base year.

coasha0belbr=0

,

ngssha0belbr=0

,

oilsha0belbr=0

,

nucsha0belbr=0

,

rensha0belbr=0

,

/* ---

/* Equation 1, 2, 3, and 4 calculates the share of new, future, bat, and old coal
/* technology respectively.

/* ---

/* Equation 1
*coashanelbr=(if time > 15 then dumnbr*coasha1nelbr*
*else coasha0nelbr+((dumnbr*coasha1nelbr-coasha0nelbr)/15)*time)*

,

/* Equation 2
*coashafelbr=(if time > 15 then dumnbr*coasha1felbr*
*else coasha0felbr+((dumnbr*coasha1felbr-coasha0felbr)/15)*time)*

,

/* Equation 3
*coashabelbr=(if time > 15 then dumbbr*coasha1belbr*
*else coasha0belbr+((dumbbr*coasha1belbr-coasha0belbr)/15)*time)*

,

/* Equation 4
coashaoelbr=1-coashanelbr-coashafelbr-coashabelbr

,

```
/* ----------------------------------------------------------------------------------------------------------
/* Equation 5, 6, and 7 calculates the share of new, bat, and old natural gas technology
/* respectively.
/* ----------------------------------------------------------------------------------------------------------

/* Equation 5
ngsshanelbr=(if time > 15 then dumnbr*ngssha1nelbr
            else ngssha0nelbr+((dumnbr*ngssha1nelbr-ngssha0nelbr)/15)*time)
,
/* Equation 6
ngsshabelbr=(if time > 15 then dumbbr*ngssha1belbr
            else ngssha0belbr+((dumbbr*ngssha1belbr-ngssha0belbr)/15)*time)
,
/* Equation 7
ngsshaoelbr=1-ngsshanelbr-ngsshabelbr
,

/* ----------------------------------------------------------------------------------------------------------
/* Equation 8, 9, and 10 calculates the share of new, bat, and old oil technology
/* respectively.
/* ----------------------------------------------------------------------------------------------------------

/* Equation 8
oilshanelbr=(if time > 15 then dumnbr*oilsha1nelbr
            else oilsha0nelbr+((dumnbr*oilsha1nelbr-oilsha0nelbr)/15)*time)
,
/* Equation 9
oilshabelbr=(if time > 15 then dumbbr*oilsha1belbr
            else oilsha0belbr+((dumbbr*oilsha1belbr-oilsha0belbr)/15)*time)
,
/* Equation 10
oilshaoelbr=1-oilshanelbr-oilshabelbr
,

/* ----------------------------------------------------------------------------------------------------------
/* Equation 11, 12, and 13 calculates the share of new, bat, and old nuclear technology
/* respectively.
/* ----------------------------------------------------------------------------------------------------------

/* Equation 11
nucshanelbr=(if time > 15 then dumnbr*nucsha1nelbr
            else nucsha0nelbr+((dumnbr*nucsha1nelbr-nucsha0nelbr)/15)*time)
,

/* Equation 12
nucshabelbr=(if time > 15 then dumbbr*nucsha1belbr
            else nucsha0belbr+((dumbbr*nucsha1belbr-nucsha0belbr)/15)*time)
,
/* Equation 13
nucshaoelbr=1-nucshanelbr-nucshabelbr
,

/* ----------------------------------------------------------------------------------------------------------
/* Equation 14, 15, and 16 calculates the share of new, bat, and old renewable
/* technology respectively.
/* ----------------------------------------------------------------------------------------------------------
```

/* Equation 14
*renshanelbr=(if time > 15 then dumnbr*rensha1nelbr*
*else rensha0nelbr+((dumnbr*rensha1nelbr-rensha0nelbr)/15)*time)*

,

/* Equation 15
*renshabelbr=(if time > 15 then dumbbr*rensha1belbr*
*else rensha0belbr+((dumbbr*rensha1belbr-rensha0belbr)/15)*time)*

,

/* Equation 16
renshaoelbr=1-renshanelbr-renshabelbr

,

/* **Determination of Average Production Costs of Electricity**
/* ---
/* Equation 17, 18, 19, 20, and 21 determines the average production costs of electricity
/* when using coal, gas, oil, nuclear, and renewable as input respectively. These
/* calculations are based on the foregoing share calculations.

/* Equation 17 (A5.4)
coacstelbr=coashaoelbr(coaprcstoelbr+coaprielbr/coaeffoelbr)*
+coashanelbr(coaprcstnelbr+coaprielbr/coaeffnelbr)*
+coashafelbr(coaprcstfelbr+coaprielbr/coaefffelbr)*
+coashabelbr(coaprcstbelbr+coaprielbr/coaeffbelbr)*

,

/* Equation 18 (A5.4)
ngscstelbr=ngsshaoelbr(ngsprcstoelbr+ngsprielbr/ngseffoelbr)*
+ngsshanelbr(ngsprcstnelbr+ngsprielbr/ngseffnelbr)*
+ngsshabelbr(ngsprcstbelbr+ngsprielbr/ngseffbelbr)*

,

/* Equation 19 (A5.4)
oilcstelbr=oilshaoelbr(oilprcstoelbr+oilprielbr/oileffoelbr)*
+oilshanelbr(oilprcstnelbr+oilprielbr/oileffnelbr)*
+oilshabelbr(oilprcstbelbr+oilprielbr/oileffbelbr)*

,

/* Equation 20 (A5.4)
nuccstelbr=nucshaoelbr(nucprcstoelbr+nucprielbr/nuceffoelbr)*
+nucshanelbr(nucprcstnelbr+nucprielbr/nuceffnelbr)*
+nucshabelbr(nucprcstbelbr+nucprielbr/nuceffbelbr)*

,

/* Equation 21 (A5.4)
rencstelbr=renshaoelbr(renprcstoelbr+renprielbr/reneffoelbr)*
+renshanelbr(renprcstnelbr+renprielbr/reneffnelbr)*
+renshabelbr(renprcstbelbr+renprielbr/reneffbelbr)*

,

/* **Determination of Average Efficiency in Electricity Production**
/* ---
/* Equation 22, 23, 24, 25, and 26 determines the average efficiency per unit coal,
/* natural gas, oil, nuclear, and renewable as input respectively, when producing
/* electricity. These calculations are based on the foregoing share calculations.

/* Equation 22 (A5.1)
*coaeffelbr=coashaoelbr*coaeffoelbr+coashanelbr*coaeffnelbr*
*+coashafelbr*coaefffelbr+coashabelbr*coaeffbelbr*

,

/* Equation 23 (A5.1)

*ngseffelbr=ngsshaoelbr*ngseffoelbr+ngsshanelbr*ngseffnelbr*
*+ngsshabelbr*ngseffbelbr*

,

/* Equation 24 (A5.1)

*oileffelbr=oilshaoelbr*oileffoelbr+oilshanelbr*oileffnelbr*
*+oilshabelbr*oileffbelbr*

/* Equation 25 (A5.1)

*nuceffelbr=nucshaoelbr*nuceffoelbr+nucshanelbr*nuceffnelbr*
*+nucshabelbr*nuceffbelbr*

,

/* Equation 26 (A5.1)

*reneffelbr=renshaoelbr*reneffoelbr+renshanelbr*reneffnelbr*
*+renshabelbr*reneffbelbr*

,

/* **Calculation of Overall Fuel Based Shares of Electricity Production**

/* ---

/* Equation 27, 28, 29, 30, and 31 calculates the coal, natural gas, oil, nuclear, and
/* renewable based production shares of total electricity produced respectively. These
/* share calculations are based on Cobb-Douglas functions.

/* Equation 27 (A2.20)

coashal elbr=a0coaconelbr(coacstelbr)**(-1)*(coacstelbr)**(alcoaconelbr)**
*(ngscstelbr)**(alngsconelbr)*(oilcstelbr)**(aloilconelbr)**
*(nuccstelbr)**(alnucconelbr)*(rencstelbr)**(alrenconelbr)*

,

/* Equation 28 (A2.20)

ngsshal elbr=a0ngsconelbr(ngscstelbr)**(-1)*(coacstelbr)**(alcoaconelbr)**
*(ngscstelbr)**(alngsconelbr)*(oilcstelbr)**(aloilconelbr)**
*(nuccstelbr)**(alnucconelbr)*(rencstelbr)**(alrenconelbr)*

,

/* Equation 29 (A2.20)

oilshal elbr=a0oilconelbr(oilcstelbr)**(-1)*(coacstelbr)**(alcoaconelbr)**
*(ngscstelbr)**(alngsconelbr)*(oilcstelbr)**(aloilconelbr)**
*(nuccstelbr)**(alnucconelbr)*(rencstelbr)**(alrenconelbr)*

,

/* Equation 30 (A2.20)

nucshal elbr=a0nucconelbr(nuccstelbr)**(-1)*(coacstelbr)**(alcoaconelbr)**
*(ngscstelbr)**(alngsconelbr)*(oilcstelbr)**(aloilconelbr)**
*(nuccstelbr)**(alnucconelbr)*(rencstelbr)**(alrenconelbr)*

,

/* Equation 31 (A2.20)

renshal elbr=a0renconelbr(rencstelbr)**(-1)*(coacstelbr)**(alcoaconelbr)**
*(ngscstelbr)**(alngsconelbr)*(oilcstelbr)**(aloilconelbr)**
*(nuccstelbr)**(alnucconelbr)*(rencstelbr)**(alrenconelbr)*

,

/* **Calculation of Normalized Fuel Based Shares of Electricity Production**

/* ---

/* Equation 32, 33, 34, 35, and 36 calculates the normalized coal, natural gas, oil,
/* nuclear, and renewable based production shares of total electricity produced
/* respectively.

/* Equation 32 (A2.21)
coashaelbr=coashalelbr/(coashalelbr+ngsshalelbr+oilshalelbr+nucshalelbr +renshalelbr)

,
/* Equation 33 (A2.21)
ngsshaelbr=ngsshalelbr/(coashalelbr+ngsshalelbr+oilshalelbr+nucshalelbr +renshalelbr)

,

/* Equation 34 (A2.21)
oilshaelbr=oilshalelbr/(coashalelbr+ngsshalelbr+oilshalelbr+nucshalelbr +renshalelbr)

,
/* Equation 35 (A2.21)
nucshaelbr=nucshalelbr/(coashalelbr+ngsshalelbr+oilshalelbr+nucshalelbr +renshalelbr)

,
/* Equation 36 (A2.21)
renshaelbr=renshalelbr/(coashalelbr+ngsshalelbr+oilshalelbr+nucshalelbr +renshalelbr)

,

/* **Calculation of Total Average Production Costs (i.e. price) of Electricity**
/* --
/* Equation 37 calculates the electricity generation price based on foregoing calculation
/* of normalized fuel based production shares and average production costs. Note that
/* the divisor 1.66 at the end of the equation, is the exchange rate in the base year.

/* Equation 37 (A2.23)
*elegenpribr=(coashaelbr*coacstelbr+ngsshaelbr*ngscstelbr+oilshaelbr*oilcstelbr +nucshaelbr*nuccstelbr+renshaelbr*rencstelbr)/1.66*

,

/* **Calculation of Total Domestic Electricity Production**
/* --
/* Equation 38 calculates total requirement of electricity production based on calculated
/* electricity consumption in the other sectors, net electricity export, and the distribution
/* losses of electricity.

/* Equation 38 (A2.19)
totdemelbr=(eleconhobr+eleconsebr+eleconinbr+railcontotbr+eleconexbr) (1+elelossbr/100)*

,

/* **Calculation of Fuel Demand**
/* --
/* Equation 39, 40, 41, 42, and 43 calculates demand for coal, natural gas, oil, nuclear,
/* and renewable respectively in the electricity generating sector.

/* Equation 39 (A2.22)
*coaconelbr=coashaelbr*totdemelbr*(1/coaeffelbr)*a3coacalelbr*

,
/* Equation 40 (A2.22)
*ngsconelbr=ngsshaelbr*totdemelbr*(1/ngseffelbr)*a3ngscalelbr*

,

/* Equation 41 (A2.22)
*oilconelbr=oilshaelbr*totdemelbr*(1/oileffelbr)*a3oilcalelbr*

,

/* Equation 42 (A2.22)
*nucconelbr=nucshaelbr*totdemelbr*(1/nuceffelbr)*a3nuccalelbr*

,

/* Equation 43 (A2.22)
*renconelbr=renshaelbr*totdemelbr*(1/reneffelbr)*a3rencalelbr*

;

/* End of the electricity generating model.

3.5 The Transport Model

/* **The Troll Input File tmodbr.inp**
/* This Troll input file, called tmodbr.inp, defines and establishes the model for the
/* transport sector (tp) in Germany (br). The file tmodbr.inp also provides descriptions
/* and comments to this sector model. For easy references the equation numbers in the
/* brackets below correspond to the equation numbers in the appendix in Brubakk et. al.
/* (1995). As far as variable names and parameter names used in the transport model are
/* concerned, consult the appendix to this user´s guide. The other sector models for
/* Germany, namely for the household sector (ho), the industry sector (in), the service
/* sector (se), and the electricity generating sector (el) are established and described in
/* the files with the corresponding names hmodbr.inp, imodbr.inp, smodbr.inp, and
/* emodbr.inp respectively. The end user fuel price calculation routine is implemented
/* in the file named pmodbr.inp.

/* **The Transport Sector**
/* ---
/* In general, the transport sector is divided into passenger, transport, freight transport,
/* and air transport as subsectors. The following model calculates separately fuel
/* demand in each of these subsectors.

/* Passenger Transport
/* When it comes to passenger transport the shares of old, new, and bat technologies are
/* calculated using a linear penetration path. Based on these shares the average prices
/* and efficiencies for each type of transport mode options (i.e. gasoline car, diesel car,
/* lpg car, electricity train, diesel train, and diesel bus) are determined. These average
/* prices and efficiencies serve in turn as input in the Cobb-Douglas functions which
/* calculate the optimal share for each type of transport mode option. Finally, these
/* optimal shares multiplied with their respective efficiencies and the total demand for
/* passenger kilometers yield the total fuel demand in the passenger transport sector.

/* Freight Transport
/* The freight transport sector is modelled in a similar way as the passenger transport
/* sector. However, the optimal share of each type of transport mode option (i.e. road,
/* rail, and water) are assumed exogenously given in the freight transport sector as
/* opposed to the passenger transport sector. Based on the level of domestic production,
/* total demand for tonkilometers are determined. Given total demand for tonkilometers
/* and the share for each type of transport mode, the optimal distribution of total freight
/* transport on the three modes is calculated. This in turn determines the final demand
/* for the different fuels in the freight transport sector given some efficiency parameters.

/* Air Transport
/* The air transport sector is modelled somewhat simplier than both the passanger and
/* the freight transport sector. The submodel for air transport abstracts from substitution
/* possibilities between air and other transport modes. Additionally, the model does not
/* distinguish between passenger transport and freight transport. Hence, demand for air
/* fuel is determined directly as a function of the price of kerosene and the activity level
/* (GDP). Finally, total demand for the different fuels is computed in the transport
/* model.

/* **Troll Commands**
/* --
/* This Troll command specifies the endogenous variables in the transport model.

addsym endogenous

totdemindtpbr
totdemtpbr
goshantpbr
goshabtpbr
goshaotpbr
dishantpbr
dishabtpbr
dishaotpbr
gashantpbr
gashabtpbr
gashaotpbr
reshantpbr
reshabtpbr
reshaotpbr
rdshantpbr
rdshabtpbr
rdshaotpbr
bdshantpbr
bdshabtpbr
bdshaotpbr
gocsttpbr
dicsttpbr
gacsttpbr
recsttpbr
rdcsttpbr
bdcsttpbr
goefftpbr
diefftpbr
gaefftpbr
reefftpbr
rdefftpbr
bdefftpbr
goshaltpbr
dishaltpbr
gashaltpbr
reshaltpbr
rdshaltpbr
bdshaltpbr
goshatpbr
dishatpbr
gashatpbr

reshatpbr
rdshatpbr
bdshatpbr
gocontpbr
dicontpbr
gacontpbr
recontpbr
rdcontpbr
bdcontpbr
tppribr
totdemindtfbr
totdemtfbr
rotkmbr
ratkmbr
watkmbr
dicontfbr
elcontfbr
oilcontfbr
oilconindfabr
oilconfabr
aircontotbr
roadcontotbr
/* Note that the total electricity consumption in the transport sector (railcontotbr) is set
/* to be exogenous here due to the fact that it is set to be endogenous in the electricity
/* generation part of the SEEM-model, named emodbr.inp.
/* railcontotbr
railcondiebr
watcontotbr
nsharotfbr
nsharatfbr
nshawatfbr
;
/* This Troll command adds equations to the transport model.

addeq bottom

/* **The Passenger Transport Sector**
/* --

/* **Calculation of shares of New, Bat, and Old Technology**
/* --
/* Equation 1 to 18 calculates the share of new, bat, and old technology for the different
/* transport modes (car, train, and bus) based on a linear penetration path.

/* Equation 1, 2, and 3 calculates the share of new, bat, and old technology respectively
/* for gasoline cars.

<u>/* Equation 1</u>
goshantpbr=dumntpbr(gosha0ntpbr+((1-gosha0ntpbr)/29)*time)*
,
<u>/* Equation 2</u>
goshabtpbr=dumbtpbr(gosha0btpbr+((1-gosha0btpbr)/29)*time)*
,
<u>/* Equation 3</u>
goshaotpbr=1-goshantpbr-goshabtpbr
,

/* Equation 4, 5, and 6 calculates the share of new, bat, and old technology respectively
/* for diesel cars.

/* Equation 4
dishantpbr=dumntpbr(disha0ntpbr+((1-disha0ntpbr)/29)*time)*

,
/* Equation 5
dishabtpbr=dumbtpbr(disha0btpbr+((1-disha0btpbr)/29)*time)*

,
/* Equation 6
dishaotpbr=1-dishantpbr-dishabtpbr

,
/* Equation 7, 8, and 9 calculates the share of new, bat, and old technology respectively
/* for gas cars.

/* Equation 7
gashantpbr=dumntpbr(gasha0ntpbr+((1-gasha0ntpbr)/29)*time)*

,
/* Equation 8
gashabtpbr=dumbtpbr(gasha0btpbr+((1-gasha0btpbr)/29)*time)*

,
/* Equation 9
gashaotpbr=1-gashantpbr-gashabtpbr

,
/* Equation 10, 11, and 12 calculates the share of new, bat, and old technology
/* respectively for electricity trains.

/* Equation 10
reshantpbr=dumntpbr(resha0ntpbr+((1-resha0ntpbr)/29)*time)*

,
/* Equation 11
reshabtpbr=dumbtpbr(resha0btpbr+((1-resha0btpbr)/29)*time)*

,
/* Equation 12
reshaotpbr=1-reshantpbr-reshabtpbr

,
/* Equation 13, 14, and 15 calculates the share of new, bat, and old technology
/* respectively for diesel trains.

/* Equation 13
rdshantpbr=dumntpbr(rdsha0ntpbr+((1-rdsha0ntpbr)/29)*time)*

,

/* Equation 14
rdshabtpbr=dumbtpbr(rdsha0btpbr+((1-rdsha0btpbr)/29)*time)*

,
/* Equation 15
rdshaotpbr=1-rdshantpbr-rdshabtpbr

,
/* Equation 16, 17, and 18 calculates the share of new, bat, and old technology
/* respectively for diesel buses.

/* Equation 16
bdshantpbr=dumntpbr(bdsha0ntpbr+((1-bdsha0ntpbr)/29)*time)*

,

/* Equation 17

bdshabtpbr=dumbtpbr(bdsha0btpbr+((1-bdsha0btpbr)/29)*time)*

,

/* Equation 18

bdshaotpbr=1-bdshantpbr-bdshabtpbr

,

/* **Determination of Average Price (or cost) of Transport Mode**

/* ---

/* Equation 19 to 24 determines the average price per person kilometre (pkm) of
/* transport mode gasoline car, diesel car, gas car, electricity train, diesel train, and
/* diesel bus respectively. These calculations are based on the foregoing share
/* calculations.

/* Equation 19 (A5.3)

gocsttpbr=goshaotpbr(goprcstotpbr+gopritpbr/goeffotpbr)*
+goshantpbr(goprcstntpbr+gopritpbr/goeffntpbr)*
+goshabtpbr(goprcstbtpbr+gopritpbr/goeffbtpbr)*

,

/* Equation 20 (A5.3)

dicsttpbr=dishaotpbr(diprcstotpbr+dipritpbr/dieffotpbr)*
+dishantpbr(diprcstntpbr+dipritpbr/dieffntpbr)*
+dishabtpbr(diprcstbtpbr+dipritpbr/dieffbtpbr)*

,

/* Equation 21 (A5.3)

gacsttpbr=gashaotpbr(gaprcstotpbr+gapritpbr/gaeffotpbr)*
+gashantpbr(gaprcstntpbr+gapritpbr/gaeffntpbr)*
+gashabtpbr(gaprcstbtpbr+gapritpbr/gaeffbtpbr)*

,

/* Equation 22 (A5.3)

recsttpbr=reshaotpbr(reprcstotpbr+repritpbr/reeffotpbr)*
+reshantpbr(reprcstntpbr+repritpbr/reeffntpbr)*
+reshabtpbr(reprcstbtpbr+repritpbr/reeffbtpbr)*

,

/* Equation 23 (A5.3)

rdcsttpbr=rdshaotpbr(rdprcstotpbr+rdpritpbr/rdeffotpbr)*
+rdshantpbr(rdprcstntpbr+rdpritpbr/rdeffntpbr)*
+rdshabtpbr(rdprcstbtpbr+rdpritpbr/rdeffbtpbr)*

,

/* Equation 24 (A5.3)

bdcsttpbr=bdshaotpbr(bdprcstotpbr+bdpritpbr/bdeffotpbr)*
+bdshantpbr(bdprcstntpbr+bdpritpbr/bdeffntpbr)*
+bdshabtpbr(bdprcstbtpbr+bdpritpbr/bdeffbtpbr)*

,

/* **Determination of Average Efficiency of Transport Mode**

/* ---

/* Equation 25 to 30 determines the average efficiency per unit of gasoline (car), diesel
/* (car), gas (car), electricity (train), diesel (train), and diesel (bus) respectively. These
/* calculations are based on the foregoing share calculations.

/* Equation 25 (A5.1)

*goefftpbr=goshaotpbr*goeffotpbr+goshantpbr*goeffntpbr*
*+goshabtpbr*goeffbtpbr*

,
/* Equation 26 (A5.1)
```
diefftpbr=dishaotpbr*dieffotpbr+dishantpbr*dieffntpbr
          +dishabtpbr*dieffbtpbr
```
,
/* Equation 27 (A5.1)
```
gaefftpbr=gashaotpbr*gaeffotpbr+gashantpbr*gaeffntpbr
          +gashabtpbr*gaeffbtpbr
```
,
/* Equation 28 (A5.1)
```
reefftpbr=reshaotpbr*reeffotpbr+reshantpbr*reeffntpbr
          +reshabtpbr*reeffbtpbr
```
,
/* Equation 29 (A5.1)
```
rdefftpbr=rdshaotpbr*rdeffotpbr+rdshantpbr*rdeffntpbr
          +rdshabtpbr*rdeffbtpbr
```
,
/* Equation 30 (A5.1)
```
bdefftpbr=bdshaotpbr*bdeffotpbr+bdshantpbr*bdeffntpbr
          +bdshabtpbr*bdeffbtpbr
```
,

/* **Calculation of Optimal Share of Transport Mode**
/* --
/* Equation 31 to 36 calculates the optimal share of transport mode gasoline car, diesel
/* car, gas car, electricity train, diesel train, and diesel bus respectively. These share
/* calculations are based on Cobb-Douglas functions.

/* Equation 31 (A2.12)
```
gosha1tpbr=a0gocontpbr*(gocsttpbr)**(-1)*(gocsttpbr)**(a1gocontpbr)*
           (dicsttpbr)**(a1dicontpbr)*(gacsttpbr)**(a1gacontpbr)*
           (recsttpbr)**(a1recontpbr)*(rdcsttpbr)**(a1rdcontpbr)*
           (bdcsttpbr)**(a1bdcontpbr)
```
,
/* Equation 32 (A2.12)
```
disha1tpbr=a0dicontpbr*(dicsttpbr)**(-1)*(gocsttpbr)**(a1gocontpbr)*
           (dicsttpbr)**(a1dicontpbr)*(gacsttpbr)**(a1gacontpbr)*
           (recsttpbr)**(a1recontpbr)*(rdcsttpbr)**(a1rdcontpbr)*
           (bdcsttpbr)**(a1bdcontpbr)
```
,
/* Equation 33 (A2.12)
```
gasha1tpbr=a0gacontpbr*(gacsttpbr)**(-1)*(gocsttpbr)**(a1gocontpbr)*
           (dicsttpbr)**(a1dicontpbr)*(gacsttpbr)**(a1gacontpbr)*
           (recsttpbr)**(a1recontpbr)*(rdcsttpbr)**(a1rdcontpbr)*
           (bdcsttpbr)**(a1bdcontpbr)
```
,
/* Equation 34 (A2.12)
```
resha1tpbr=a0recontpbr*(recsttpbr)**(-1)*(gocsttpbr)**(a1gocontpbr)*
           (dicsttpbr)**(a1dicontpbr)*(gacsttpbr)**(a1gacontpbr)*
           (recsttpbr)**(a1recontpbr)*(rdcsttpbr)**(a1rdcontpbr)*
           (bdcsttpbr)**(a1bdcontpbr)
```
,
/* Equation 35 (A2.12)
```
rdsha1tpbr=a0rdcontpbr*(rdcsttpbr)**(-1)*(gocsttpbr)**(a1gocontpbr)*
           (dicsttpbr)**(a1dicontpbr)*(gacsttpbr)**(a1gacontpbr)*
           (recsttpbr)**(a1recontpbr)*(rdcsttpbr)**(a1rdcontpbr)*
```

*(bdcsttpbr)**(albdcontpbr)*

,

/* Equation 36 (A2.12)

bdshaltpbr=a0bdcontpbr(bdcsttpbr)**(-1)*(gocsttpbr)**(algocontpbr)*
(dicsttpbr)**(aldicontpbr)*(gacsttpbr)**(algacontpbr)*(recsttpbr)**
(alrecontpbr)*(rdcsttpbr)**(alrdcontpbr)*(bdcsttpbr)**(albdcontpbr)*

,

/* **Calculation of Normalized Share of Transport Mode**

/* ---

/* Equation 37 to 42 calculates the normalized share of transport mode gasoline car,
/* diesel car, gas car, electricity train, diesel train, and diesel bus respectively.

/* Equation 37 (A2.13)

*goshatpbr=goshaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* Equation 38 (A2.13)

*dishatpbr=dishaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* Equation 39 (A2.13)

*gashatpbr=gashaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* Equation 40 (A2.13)

*reshatpbr=reshaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* Equation 41 (A2.13)

*rdshatpbr=rdshaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* Equation 42 (A2.13)

*bdshatpbr=bdshaltpbr/(goshaltpbr+dishaltpbr+gashaltpbr+reshaltpbr
+rdshaltpbr+bdshaltpbr)*

,

/* **Calculation of the Price Index (cost) per Passenger Kilometer**

/* ---

/* Equation 43 calculates the price index per passenger kilometer based on foregoing
/* calculations of average price of each transport mode. The underlying function is of a
/* Cobb-Douglas spesification. Note that tppri91br denotes a calibration constant in the
/* base year 1991.

/* Equation 43 (A2.10)

*tppribr=((gocsttpbr)**(algocontpbr)*(dicsttpbr)**(aldicontpbr)*(gacsttpbr)**
(algacontpbr)*(recsttpbr)**(alrecontpbr)*(rdcsttpbr)**(alrdcontpbr)*
(bdcsttpbr)**(albdcontpbr))/tppri91br*

,

/* **Calculation of Total Demand for Passenger Kilometres**

/* ---

/* Equation 44 calculates total demand for passenger kilometres based on foregoing
/* calculation of the price index per passenger kilometres as well as the consumer
/* expenditure (income). The underlying function is of a Cobb-Douglas spesification.

/* Equation 45 is equation 44 multiplied with a calibration constant in the base year
/* 1991(totdemtp91br).

/* Equation 44 (A2.11)
*totdemindtpbr=incomebr**b1pkmbr*tppribr**b2pkmbr*
,
/* Equation 45 (A2.11)
*totdemtpbr=totdemindtpbr*totdemtp91br*
,

/* **Calculation of Fuel Demand in Passenger Transport**
/* --
/* Equation 46 to 51 calculates demand (ktoe) for gasoline (car), diesel (car), gas (car),
/* electricity (train), diesel (train), and diesel (bus) respectively in the passenger
/* transport sector. Note that each equation is multiplied with a calibration constant
/* labelled a0calpkmbr

/* Equation 46 (A2.14)
gocontpbr=1000(a0calpkmbr*goshatpbr*totdemtpbr*(1/goefftpbr))*
,
/* Equation 47 (A2.14)
dicontpbr=1000(a0calpkmbr*dishatpbr*totdemtpbr*(1/diefftpbr))*
,
/* Equation 48 (A2.14)
gacontpbr=1000(a0calpkmbr*gashatpbr*totdemtpbr*(1/gaefftpbr))*
,
/* Equation 49 (A2.14)
recontpbr=1000(a0calrelbr*reshatpbr*totdemtpbr*(1/reefftpbr))*
,
/* Equation 50 (A2.14)
rdcontpbr=1000(a0calrdibr*rdshatpbr*totdemtpbr*(1/rdefftpbr))*
,
/* Equation 51 (A2.14)
bdcontpbr=1000(a0calpkmbr*bdshatpbr*totdemtpbr*(1/bdefftpbr))*
,

/* **The Freight Transport Sector**
/* --

/* **Calculation of Total Demand for Tonkilometers**
/* --
/* Equation 52 calculates total demand for tonkilometers in the freight transport sector
/* based on the level of domestic production (GDP). Equation 53 is equation 52
/* multiplied with a calibration constant in the base year 1991 (totdemtf91br).

/* Equation 52 (A2.15)
*totdemindtfbr=gdpindbr**(dumitfbr*b1itkmbr+dumftfbr*b1ftkmbr)*
,
/* Equation 53 (A2.15)
*totdemtfbr=totdemindtfbr*totdemtf91br*
,

/* **Distribution of Total Freight Transport Demand on Modes**
/* --
/* Equation 54, 55, and 56 calculates the normalised road mode share, the rail mode
/* share, and the water mode share respectively of total demand for tonkilometers. Note

/* that the calculated shares are exogenously determined in the model. Equation 57, 58,
/* and 59 multiplies these shares with the total demand for tonkilometers to obtain the
/* distribution of total freight transport in tonkilometers on the three modes road, rail,
/* and water resepctively.

/* Equation 54
nsharotfbr=sharotfbr/(sharotfbr+sharatfbr+shawatfbr)

,

/* Equation 55
nsharatfbr=sharatfbr/(sharotfbr+sharatfbr+shawatfbr)

,

/* Equation 56
nshawatfbr=shawatfbr/(sharotfbr+sharatfbr+shawatfbr)

,

/* Equation 57 (A2.16)
*rotkmbr=nsharotfbr*totdemtfbr*

,

/* Equation 58 (A2.16)
ratkmbr=(nsharatfbr(1-sharaditfbr)+nsharatfbr*sharaditfbr)*totdemtfbr*

,

/* Equation 59 (A2.16)
*watkmbr=nshawatfbr*totdemtfbr*

,

/* **Calculation of Fuel Demand in Freight Transport**
/* --
/* Equation 60, 61, and 62 calculates demand (ktoe) for diesel (road), electricity (rail),
/* and oil (water) respectively in the freight transport sector. These calculations are
/* based on foregoing distribution of total freight transport demand on modes.

/* Equation 60 (A2.17)
*dicontfbr=a0calpkmbr*1000*(rotkmbr/roefftfbr)*exp(a3ditftbr*time)*

,

/* Equation 61 (A2.17)
*elcontfbr=a0calrelbr*1000*((ratkmbr*(1-sharaditfbr))/raefftfbr)*exp(a3eletftbr*time)*

,

/* Equation 62 (A2.17)
*oilcontfbr=a0calwkmbr*1000*(watkmbr/waefftfbr)*exp(a3oiltftbr*time)*

,

/* **The Air Transport Sector**
/* --
/* Equation 63 calculates demand for air fuel (kerosene) in the air transport sector based
/* on a Cobb-Douglas function in which the price of kerosene and the activity measure
/* (GDP) are arguments in the function. Equation 64 is equation 63 multiplied with a
/* calibration constant in the base year 1991 (oilconfa91br).

/* Equation 63 (A2.18)
*oilconindfabr=gdpindbr**b1tabr*oilpritabr**b2tabr*exp(a3oiltfabr*time)*

,

/* Equation 64 (A2.18)
*oilconfabr=oilconindfabr*oilconfa91br*

,

/* **Calculation of Total Fuel Demand in the Transport Sector**
/* --
/* Equation 65, 66, 67, 68, and 69 calculates total demand for air fuel (kerosene), road
/* fuel (sum of gasoline car, diesel car, gas car, diesel bus, and diesel rail freight),
/* electricity (sum of rail passenger and rail freight transport), rail fuel (diesel train
/* passenger transport), and oil (freight transport) respectively.

<u>/* Equation 65</u>
aircontotbr=oilconfabr

,
<u>/* Equation 66</u>
roadcontotbr=gocontpbr+dicontpbr+gacontpbr+bdcontpbr+dicontfbr

,
<u>/* Equation 67</u>
railcontotbr=recontpbr+elcontfbr

,
<u>/* Equation 68</u>
*railcondiebr=rdcontpbr+a0calrdibr*1000*((ratkmbr*sharaditfbr)/raefftfbr)*

,
<u>/* Equation 69</u>
watcontotbr=oilcontfbr

;

/* End of the transport model.

3.6 The Price Model

/* **The Troll Input File pmodbr.inp**
/* This Troll input file, called pmodbr.inp, defines and establishes the model for the end
/* user prices in each sector in Germany. The file pmodbr.inp also provides descriptions
/* and comments to this price model. For easy references the equation numbers in the
/* brackets below correspond to the equation numbers in the appendix in Brubakk et. al.
/* (1995). As far as variable names and parameter names used in the price model are
/* concerned, consult the appendix to this user´s guide. The sector models for Germany,
/* namely for the household sector (ho), the industry sector (in), the service sector (se),
/* the electricity generating sector (el), and the transport sector (tp) are established and
/* described in the files with the corresponding names hmodbr.inp, imodbr.inp,
/* smodbr.inp, emodbr.inp, and tmodbr.inp respectively.

/* **The Price Model**
/* --
/* The following model calculates the fuel end user prices to be used in the SEEM-
/* model simulation. For each fuel the calculations consist of two equations. In the first
/* equation end user prices in USD per toe is computed, based on exogenous inputs for
/* import prices, margins and taxes. In the second equation the end user price in USD
/* per toe for each fuel is multiplied with a coefficient. This coefficient consists of i) the
/* base year value of the end user price used when calibrating the SEEM-model and ii)
/* the base year value of the end user price in USD per toe. Note that the figures
/* constituting the coefficient have to be inserted by hand in the price equations below.

/* **Troll Commands**
/* --
/* This Troll command specifies the endogenous variables in the price model.

addsym endogenous

elegenpribr
coaprisinbr
coapriinbr
coaprissebr
coaprisebr
coaprishobr
coaprihobr
coapriselbr
coaprielbr
oilprisinbr
oilpriinbr
oilprissebr
oilprisebr
oilprishobr
oilprihobr
oilpriselbr
oilprielbr
ngsprisinbr
ngspriinbr
ngsprissebr
ngsprisebr
ngsprishobr
ngsprihobr
ngspriselbr
ngsprielbr
eleprisinbr
elepriinbr
eleprissebr
eleprisebr
eleprishobr
eleprihobr
gopristpbr
gopritpbr
dipristpbr
dipritpbr
rdpritpbr
bdpritpbr
gapritpbr
repritpbr
oilpritabr
;

/* This Troll command adds equations to the price model.

addeq bottom

/* **End User Fuel Prices in the Stationary Sectors**
/* ---
/* Equation 1 to 30 calculates end user fuel prices in the stationary sectors, i.e. in the
/* industry sector, the service sector, the household sector, and the electricity generating
/* sector.

/* **Coal End User Prices**
/* ---
/* Equation 1 to 8 calculates coal end user price in the industry sector, the service
/* sector, the household sector, and the electricity generating sector respectively.

/* Equation 1 (2.43)
coaprisinbr=(coaimppribr+coamrginbr+coataxinbr+cco2taxinbr)*(1+coavatinbr)
,
/* Equation 2
coapriinbr=coaprisinbr*(1/253.1)
,
/* Equation 3 (2.43)
coaprissebr=(coaimppribr+coamrgsebr+coataxsebr)*(1+coavatsebr)
,
/* Equation 4
coaprisebr=coaprissebr*(1021.11/515.40)
,
/* Equation 5 (2.43)
coaprishobr=(coaimppribr+coamrghobr+coataxhobr+cco2taxhobr)*(1+coavathobr)
,
/* Equation 6
coaprihobr=coaprishobr*(1102.01/587.45)
,
/* Equation 7 (2.43)
coapriselbr=(coaimppribr+coamrgelbr+coataxelbr)*(1+coavatelbr)
,
/* Equation 8
coaprielbr=coapriselbr*(358.04/215.8)
,

/* **Oil End User Prices**
/* ---
/* Equation 9 to 16 calculates the oil end user price in the industry sector, the service
/* sector, the household sector, and the electricity generating sector respectively.

/* Equation 9 (2.43)
oilprisinbr=(oilimppribr+oilmrginbr+oiltaxinbr+oco2taxinbr)*(1+oilvatinbr)
,

/* Equation 10
oilpriinbr=oilprisinbr*(1/140.4)
,
/* Equation 11 (2.43)
oilprissebr=(oilimppribr+oilmrgsebr+oiltaxsebr+oco2taxsebr)*(1+oilvatsebr)
,
/* Equation 12
oilprisebr=oilprissebr*(518.32/312.46)
,
/* Equation 13 (2.43)
oilprishobr=(oilimppribr+oilmrghobr+oiltaxhobr+oco2taxhobr)*(1+oilvathobr)
,
/* Equation 14
oilprihobr=oilprishobr*(590.89/356.2)
,
/* Equation 15 (2.43)
oilpriselbr=(oilimppribr+oilmrgelbr+oiltaxelbr)*(1+oilvatelbr)
,
/* Equation 16
oilprielbr=oilpriselbr*(247.55/149.2)
,

/* **Natural Gas End User Prices**

/* ---

/* Equation 17 to 24 calculates the natural gas end user price in the industry sector, the
/* service sector, the household sector, and the electricity generating sector respectively.

<u>/* Equation 17 (2.43)</u>

ngsprisinbr=(ngsimppribr+ngsmrginbr+ngstaxinbr+nco2taxinbr)(1+ngsvatinbr)*

,

<u>/* Equation 18</u>

ngspriinbr=ngsprisinbr(1/223.5)*

,

<u>/* Equation 19 (2.43)</u>

ngsprissebr=(ngsimppribr+ngsmrgsebr+ngstaxsebr+nco2taxsebr)(1+ngsvatsebr)*

,

<u>/* Equation 20</u>

ngsprisebr=ngsprissebr(686.55/413.86)*

,

<u>/* Equation 21 (2.43)</u>

ngsprishobr=(ngsimppribr+ngsmrghobr+ngstaxhobr+nco2taxhobr)(1+ngsvathobr)*

,

<u>/* Equation 22</u>

ngsprihobr=ngsprishobr(782.67/471.8)*

,

<u>/* Equation 23 (2.43)</u>

ngspriselbr=(ngsimppribr+ngsmrgelbr+ngstaxelbr+nco2taxelbr)(1+ngsvatelbr)*

,

<u>/* Equation 24</u>

ngsprielbr=ngspriselbr(305.44/184.1)*

,

/* **Electricity End User Prices**

/* ---

/* Equation 25 to 30 calculates the electricity end user price in the industry sector, the
/* service sector, and the household sector respectively.

<u>/* Equation 25 (2.43)</u>

eleprisinbr=(elegenpribr+elemrginbr+eletaxinbr)(1+elevatinbr)*

,

<u>/* Equation 26</u>

elepriinbr=eleprisinbr(1/1019.7)*

,

<u>/* Equation 27 (2.43)</u>

eleprissebr=(elegenpribr+elemrgsebr+eletaxsebr)(1+elevatsebr)*

,

<u>/* Equation 28</u>

eleprisebr=eleprissebr(2694.61/1624.2)*

,

<u>/* Equation 29 (2.43)</u>

eleprishobr=(elegenpribr+elemrghobr+eletaxhobr)(1+elevathobr)*

,

<u>/* Equation 30</u>

eleprihobr=eleprishobr(3071.86/1851.6)*

,

/* **End User Fuel Prices in the Transport Sector**

/* ---

/* Equation 31 to 39 calculates the end user price for gasoline (car), diesel (car), diesel
/* (rail), diesel (bus), gas (car), electricity (rail), and oil (air) respectively.

/* Equation 31 (2.43)
gopristpbr=(goimppribr+gomrgtpbr+gotaxtpbr+goco2taxtpbr)(1+govattpbr)*
,

/* Equation 32
gopritpbr=gopristpbr(1783.5/1074.4)*
,

/* Equation 33 (2.43)
dipristpbr=(diimppribr+dimrgtpbr+ditaxtpbr+dico2taxtpbr)(1+divattpbr)*
,

/* Equation 34
dipritpbr=dipristpbr(1261/759.6)*
,

/* Equation 35
rdpritpbr=dipritpbr/(1+divattpbr)
,

/* Equation 36
bdpritpbr=dipritpbr/(1+divattpbr)
,

/* Equation 37
gapritpbr=dipritpbr(1070/1261)*
,

/* Equation 38
repritpbr=eleprissebr
,

/* Equation 39
oilpritabr=oilprishobr(1/356.2)*
;

/* End of the price model.

4. Extrapolation and Simulation

This chapter is concerned with the procedure for extrapolating and simulating the implemented SEEM-model in Troll. The chapter is organised as follows: Part one presents and describes macros neccessary for extrapolating input variables. Part two presents and describes input files neccessary for simulating the SEEM-model. Part three gives an overview of files and their linkages when extrapolating and simulating the SEEM-model. Finally, the fourth part of this chapter explains the procedure of making a scenario specific simulation of the SEEM-model.

The following scenarios with related Troll files are considered in this chapter: The reference scenario, the integration scenario (is) which is the same scenario as the reference scenario, and the fragmentation scenario (fs). For further information on these scenarios and their underlying assumptions, consult Aaserud et. al. (1995).

It is worthwhile to notice in the Troll macros and input files presented below that the Troll syntax for a comment begins with «/*». Note also that the Troll commands in each macro and input file are emphasised with italic letters.

4.1 Troll Macros for Extrapolation

4.1.1 The Reference and IS Scenario

/* **The Troll Macro File scenisbr.src**
/* This macro file, called scenisbr.src, consists of Troll commands which extrapolate
/* input variables according to the reference and the is scenario assumptions for
/* Germany. In what follows, a description of how to use this macro is given. Note
/* that scenario assumptions on the growth rates for input variables have to be inserted
/* manually. The file is divided into two parts. Part A consists of dummy variable
/* extrapolations and part B consists of growth rates assumptions on input variables
/* according to the reference and is scenario.

addfun main;
procedure main()
begin;

/* **Part A: Dummy Variable Extrapolations**
/* ---
/* Dummy variables in the electricity generating sector

*>>dofile dumnbr=1+dumnbr*0;*
*>>dofile dumbbr=dumbbr*0;*

/* Dummy variables in the transport sector

*>>dofile dumntpbr=1+dumntpbr*0;*
*>>dofile dumbtpbr=dumbtpbr*0;*

/* Dummy variables in the freight transport

*>>dofile dumitfbr=dumitfbr*0;*
*>>dofile dumftfbr=1+dumftfbr*0;*

/* **Part B: Growth Rates Assumptions**
/* ---
/* The following consists of sequences like

/* &framskr;
/* >>variabel name start year growth factor start year (for next growth period)
/* growth factor ... *.

/* The model user might change the variable names, years, and growth factors. Note that
/* the growth rate sequence must end with «*».

/* Example:
/* >>conhobr 1991A 1.020 2000A 1.030 2010A 1.000 * means that the variable
/* conhobr grows by 2.0 per cent annually from 1991 to 2000, then by 3.0 per cent
/* annually from 2000 to 2010 and finally by 0 per cent the rest of the simulation period.

/* **Part B1: Growth Rates Assumptions on some Exogenous Fuel Use Variables**
/* --
/* The term «x» in the variable names below is used because these variables represent
/* «help» variables in the sector models for some countries. These variables are however
/* endogenous in the SEEM-model, and the extrapolations will thus be overwritten by
/* the model simulations.

&framskr;
*>>coaconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coaconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxinbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **

/* **Part B2: Growth Rates Assumptions for other Variables**
/* --
/* The following equations expand the scenario-dependent variables for the household /* sector.

&framskr;
*>>conhobr 1991A 1.022 2000A 1.025 2010A 1.025 **
&framskr;
*>>a0elehobr 1991A 0.996 2000A 0.996 2010A 0.996 **
&framskr;
*>>a0coghobr 1991A 0.996 2000A 0.996 2010A 0.996 **
/&framskr;*
/ >>ngsimppribr 1991A 0.979 2000A 0.998 2010A 1.024 **
&framskr;
*>>ngsmrghobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngstaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>nco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsvathobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;

*>>elemrghobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>eletaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>eco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>elevathobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coamrghobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coataxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>cco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coavathobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilmrghobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oiltaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilvathobr 1991A 1.000 2000A 1.000 2010A 1.000 **

/* The following equations expand the scenario-dependent variables for the service
/* sector.

&framskr;
*>>prosebr 1991A 1.023 2000A 1.026 2010A 1.023 **
&framskr;
*>>a0elesebr 1991A 0.9974 2000A 0.9974 2010A 0.9974 **
&framskr;
*>>a0cogsebr 1991A 0.9976 2000A 0.9976 2010A 0.9976 **

&framskr;
*>>capprisebr 1991A 1.002 2000A 1.002 2010A 1.002 **
&framskr;
*>>labprisebr 1991A 1.016 2000A 1.016 2010A 1.016 **
&framskr;
*>>ngsmrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngstaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>nco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsvatsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>elemrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>eletaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>eco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>elevatsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;

```
>>oilmrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oiltaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilvatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coamrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coataxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>cco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coavatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* The following equations expand the scenario-dependent variables for the industry
/* sector.

&framskr;
>>proinbr 1991A 1.022 2000A 1.025 2010A 1.022 *
&framskr;
>>a0eleinbr 1991A 0.9988 2000A 0.9988 2010A 0.9988 *
&framskr;
>>a0coainbr 1991A 0.9988 2000A 0.9988 2010A 0.9988 *
&framskr;
>>a0oilinbr 1991A 0.9988 2000A 0.9988 2010A 0.9988 *

&framskr;
>>a0ngsinbr 1991A 0.9988 2000A 0.9988 2010A 0.9988 *
&framskr;
>>cappriinbr 1991A 1.002 2000A 1.002 2010A 1.002 *
&framskr;
>>labpriinbr 1991A 1.016 2000A 1.016 2010A 1.016 *
&framskr;
>>ngsmrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngstaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngsvatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elemrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eletaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elevatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
/*&framskr;
/* >>oilimppribr 1991A 0.983 2000A 0.975 2010A 1.000 *
&framskr;
>>oilmrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
```

```
>>oiltaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilvatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coaimppribr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coamrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coataxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>cco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coavatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
```

/* The following equations expand the scenario-dependent variables for the transport
/* sector.

```
&framskr;
>>incomebr 1991A 1.022 2000A 1.025 2010A 1.025 *

&framskr;
>>gdpindbr 1991A 1.022 2000A 1.025 2010A 1.022 *
&framskr;
>>goimppribr 1991A 0.966 2000A 1.002 2010A 1.001 *
&framskr;
>>gomrgtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>gotaxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>goco2taxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>govattpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>diimppribr 1991A 0.966 2000A 1.002 2010A 1.001 *
&framskr;
>>dimrgtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ditaxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>dico2taxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>divattpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>dumntpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>dumbtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>a3ditftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>a3eletftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>a3oiltftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
```

```
>>a3oiltfabr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* Constant: ?
/* &framskr;
/*  >>b1tkmbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* Endogenous: ?
&framskr;
 >>sharotfbr 1991A 1.000 2000A 1.003 2010A 1.003 *
&framskr;
 >>sharatfbr 1991A 1.050 2000A 1.018 2010A 0.980 *
&framskr;
 >>shawatfbr 1991A 0.990 2000A 0.985 2010A 1.000 *
&framskr;
 >>roefftfbr 1991A 1.005 2000A 1.005 2010A 1.005 *

&framskr;
 >>raefftfbr 1991A 1.010 2000A 1.010 2010A 1.010 *
&framskr;
 >>waefftfbr 1991A 1.010 2000A 1.010 2010A 1.010 *

/* The following equations expand the scenario-dependent variables for the electricity
/* generating sector.

&framskr;
 >>ngsmrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngstaxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>nco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngsvatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilmrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oiltaxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilvatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coamrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coataxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>cco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coavatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
/*&framskr;
/* >>nucprielbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>renprielbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* &framskr;
/*  >>dumnbr 1991A 1.000 2000A 1.000 2010A 1.000 *
```

/* &framskr;
/* >>dumbbr 1991A 1.000 2000A 1.000 2010A 1.000 *

&framskr;
*>>coashalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coashalfelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coashalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 **

&framskr;
*>>ngsshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>nucshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>nucshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>renshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>renshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 **

&framskr;
*>>ngsimppribr 1991A 0.939 1995A 0.991 2000A 0.963 2005A 1.035 2010A 1.021 2015A 1.027 **
&framskr;
*>>oilimppribr 1991A 0.973 1995A 1.021 2000A 0.966 2005A 0.985 2010A 1.000 2015A 1.000 **

end;

4.1.2 The FS Scenario
/* **The Troll Macro File scenfsbr.src**
/* This macro file, called scenfsbr.src, consists of Troll commands which extrapolate
/* input variables according to the fs scenario assumptions for Germany. In what
/* follows, a description of how to use this macro is given. Note that scenario
/* assumptions on the growth rates for input variables have to be inserted manually. The
/* file is divided into two parts. Part A consists of dummy variable extrapolations and
/* part B consists of growth rates assumptions on input variables according to the fs
/* scenario.

addfun main;
procedure main()
begin;

/* **Part A: Dummy Variable Extrapolations**
/* --
/* Dummy variables in the electricity generating sector

*>>dofile dumnbr=1+dumnbr*0;*
*>>dofile dumbbr=dumbbr*0;*

/* Dummy variables in the transport sector

*>>dofile dumntpbr=1+dumntpbr*0;*
*>>dofile dumbtpbr=dumbtpbr*0;*

/* Dummy variables in the freight transport

*>>dofile dumitfbr=dumitfbr*0;*
*>>dofile dumftfbr=1+dumftfbr*0;*

/* **Part B: Growth Rates Assumptions**
/* --
/* The following consists of sequences like
/* &framskr;
/* >>variabel name start year growth factor start year (for next growth period)
/* growth factor... *.

/* The model user might change the variable names, years, and growth factors. Note that
/* the growth rate sequence must end with «*».

/* Example:
/* >>conhobr 1991A 1.020 2000A 1.030 2010A 1.000 * means that the variable
/* conhobr grows by 2.0 per cent annually from 1991 to 2000, then by 3.0 per cent
/* annually from 2000 to 2010 and finally by 0 per cent the rest of the simulation period.

/* **Part B1: Growth Rates Assumptions on some Exogenous Fuel Use Variables**
/* --
/* The term «x» in the variable names below is used because these variables represent
/* «help» variables in the sector models for some countries. These variables are however
/* endogenous in the SEEM-model, and the extrapolations will thus be overwritten by
/* the model simulations.

&framskr;
*>>coaconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>coaconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>oilconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxinbr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxsebr 1991A 1.000 2000A 1.000 2010A 1.000 **
&framskr;
*>>ngsconxhobr 1991A 1.000 2000A 1.000 2010A 1.000 **

/* **Part B2: Growth Rates Assumptions for other Variables**
/* --
/* The following equations expand the scenario-dependent variables for the household /* sector.

&framskr;
*>>conhobr 1991A 1.020 2000A 1.020 2010A 1.020 **

```
&framskr;
 >>a0elehobr 1991A 0.998 2000A 0.998 2010A 0.998 *
&framskr;
 >>a0coghobr 1991A 0.998 2000A 0.998 2010A 0.998 *
/*&framskr;
/* >>ngsimppribr 1991A 0.985 2000A 1.038 2010A 1.006 *
&framskr;
 >>ngsmrghobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngstaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>nco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngsvathobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>elemrghobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>eletaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>eco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>elevathobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coamrghobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coataxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>cco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coavathobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilmrghobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oiltaxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oco2taxhobr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilvathobr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* The following equations expand the scenario-dependent variables for the service
/* sector.

&framskr;
 >>prosebr 1991A 1.022 2000A 1.022 2010A 1.022 *
&framskr;
 >>a0elesebr 1991A 0.9987 2000A 0.9987 2010A 0.9987 *
&framskr;
 >>a0cogsebr 1991A 0.9988 2000A 0.9988 2010A 0.9988 *
&framskr;
 >>capprisebr 1991A 1.002 2000A 1.002 2010A 1.002 *
&framskr;
 >>labprisebr 1991A 1.016 2000A 1.016 2010A 1.016 *
&framskr;
 >>ngsmrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
```

```
>>ngstaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngsvatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elemrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eletaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elevatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilmrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oiltaxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilvatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coamrgsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coataxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>cco2taxsebr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coavatsebr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* The following equations expands the scenario-dependent variables for the industry
/* sector.

&framskr;
>>proinbr 1991A 1.021 2000A 1.021 2010A 1.021 *

&framskr;
>>a0eleinbr 1991A 0.9994 2000A 0.9994 2010A 0.9994 *
&framskr;
>>a0coainbr 1991A 0.9994 2000A 0.9994 2010A 0.9994 *
&framskr;
>>a0oilinbr 1991A 0.9994 2000A 0.9994 2010A 0.9994 *
&framskr;
>>a0ngsinbr 1991A 0.9994 2000A 0.9994 2010A 0.9994 *
&framskr;
>>cappriinbr 1991A 1.002 2000A 1.002 2010A 1.002 *
&framskr;
>>labpriinbr 1991A 1.016 2000A 1.016 2010A 1.016 *
&framskr;
>>ngsmrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngstaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
```

```
>>ngsvatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elemrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eletaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>eco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>elevatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
/*&framskr;
/* >>oilimppribr 1991A 0.989 2000A 1.027 2010A 1.000 *
&framskr;
>>oilmrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oiltaxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilvatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coaimppribr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coamrginbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coataxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>cco2taxinbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coavatinbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* The following equations expand the scenario-dependent variables for the transport
/* sector.

&framskr;
>>incomebr 1991A 1.020 2000A 1.020 2010A 1.020 *
&framskr;
>>gdpindbr 1991A 1.021 2000A 1.021 2010A 1.021 *
&framskr;
>>goimppribr 1991A 0.982 2000A 1.045 2010A 1.021 *
&framskr;
>>gomrgtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>gotaxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>goco2taxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>govattpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>diimppribr 1991A 0.979 2000A 1.044 2010A 1.021 *
&framskr;
>>dimrgtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ditaxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>dico2taxtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
```

```
&framskr;
 >>divattpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>dumntpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>dumbtpbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>a3ditftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>a3eletftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>a3oiltftbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>a3oiltfabr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* Constant: ?
/* &framskr;
/*  >>b1tkmbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* Endogenous: ?
&framskr;
 >>sharotfbr 1991A 1.001 2000A 1.005 2010A 1.005 *
&framskr;
 >>sharatfbr 1991A 1.029 2000A 0.972 2010A 1.000 *
&framskr;
 >>shawatfbr 1991A 1.009 2000A 0.985 2010A 0.977 *
&framskr;
 >>roefftfbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>raefftfbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>waefftfbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* The following equations expands the scenario-dependent variables for the electricity
/* generating sector.

&framskr;
 >>ngsmrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngstaxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>nco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>ngsvatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilmrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oiltaxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>oilvatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
 >>coamrgelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
```

```
>>coataxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>cco2taxelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coavatelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nucprielbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>renprielbr 1991A 1.000 2000A 1.000 2010A 1.000 *

/* &framskr;
/* >>dumnbr 1991A 1.000 2000A 1.000 2010A 1.000 *
/* &framskr;
/* >>dumbbr 1991A 1.000 2000A 1.000 2010A 1.000 *

&framskr;
>>coashalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 *

&framskr;
>>coashalfelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>coashalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngsshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>ngsshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>oilshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nucshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>nucshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>renshalnelbr 1991A 1.000 2000A 1.000 2010A 1.000 *
&framskr;
>>renshalbelbr 1991A 1.000 2000A 1.000 2010A 1.000 *

&framskr;
>>ngsimppribr 1991A 0.913 1995A 1.026 2000A 1.053 2005A 1.023 2010A 1.012 2015A 1.000 *
&framskr;
>>oilimppribr 1991A 0.946 1995A 1.057 2000A 1.039 2005A 1.015 2010A 1.000 2015A 1.000 *

end;
```

4.1.3 A Translation Macro

```
/* The Troll Macro File framskr.src
/* The macro, called framskr.src, translates the commands in the scenisbr.src and the
/* scenfsbr.src files presented and described above into Troll syntax. Hence, the macro
/* works together with the two mentioned Troll macros for extrapolating input variables
/* according to the integration (and reference) and fragmentation scenario respectively.
/* The framskr.src macro is written in the Troll programming language by Rune
/* Johansen, The Research Department, Statistics Norway, email: rjo@ssb.no. Latest
```

/* updated 28. November 1994. In what follows, a description on how this macro works
/* and how to use it is given.

/* **How to use this macro**:
/* ---
/* A call to this macro is done in the following way:

/* &framskr;
/* >>series year1 fac1 year2 fac2 .....*

/* The parameter «series» is the name of the time series to be extrapolated. The
/* parameters «year» and «fac» always occur pairwise. «year» specifies the starting year
/* of a extrapolation and the «fac» represents the extrapolation factor or the growth rate
/* of the time series. WARNING: Due to the general design of the «autocum»-function
/* in Troll, it starts the extrapolation in year number «year+1», in the sense that the
/* value in «year» is not changed, and the value in «year+1» is set equal to the value in
/* «year» multiplied with the factor «fac». The model user may specify as many pairs
/* «year-fac» as wanted, but the parameter sequence must always end with a «*».

```
addfun main;
procedure main()
addsym fac, p1, series, year, num;
begin;
>>do;delcore all;
get series «name of time series to be extrapolated:»;
```

/* The variable «num» decides how far beyond the end date of the original series the
/* model user wants to extrapolate. If the model user does not want to extrapolate
/* beyond the end date of the original series, «num» may be set equal to zero.

```
num = 0;
```

/* The parameter «temp» is a temporary time series where subsequent extrapolated parts
/* of the original series are stored. First the model user creates «temp» as an extension
/* of the original series decided by the variable «num».

```
on warning nomsg;
on error nomsg;
>>docore temp = reshape(seq(&(num)+1)*0,enddate(&(series)));
on warning nomsg;
on error nomsg;
>>docore temp = overlay(&(series), temp);
get p1 "first year (or '*' if finished)";
```

/* The macro is running in a loop until the parameter is a «*».

```
while(p1 <> "*")
begin;
year = p1;
get number fac"extrapolating factor";
on warning nomsg;
on error nomsg;
```

..

/* The extrapolation is done by the «autocum»-function

```
>>docore temp = autocum(temp,0,&(year),0,&(fac));
on error nomsg;
get p1 "next year (or '*')";
end;
```

/* The extrapolation is completed and the temporary series is copied to a new series
/* with the same name as the original series, but belonging to a database specified by the
/* search-statement

```
on error nomsg;
>>dofile &(series) = temp;
>>delcore all;

end;
```

4.2 Troll Input Files for Simulation

4.2.1 The Reference Scenario

/* **The Troll Input File simbisbr.inp**
/* The Troll input file, called simbisbr.inp, contains a collection of Troll commands
/* which extrapolates input variables according to the reference scenario assumptions,
/* and establishes and simulates the SEEM-model for Germany. The file simbisbr.inp
/* makes simulation results for the reference scenario on basis of the is scenario, and the
/* simulation results is saved in a data output file named basisbr.txt. This data file
/* includes historical and simulated data on all variables and parameters for all energy
/* using sectors from 1960 to 2020, and may serve as input when simulating the SEEM-
/* model for other scenarios. In what follows, some comments and explanations
/* connected to each Troll command are given. The file is divided into two parts. Part A
/* consists of Troll commands for implementation of scenario assumptions for input
/* variables and part B consists of Troll commands for establishing, simulating and
/* filing the SEEM-model.

/* **Part A: Troll Commands for Implementation of Scenario Assumptions**
/* --

/* **Access and Search Lists Commands**
/* --
/* The two Troll commands below delete all existing accesses and search lists to data
/* files in Troll in order to clear old search paths no longer relevant.

```
delaccess all;
delsearch all;
```

/* **Access Commands**
/* --
/* The Troll commands below provide access to all data for input variables to be
/* extrapolated in the reference scenario. The access commands are as follows: «access»
/* «alias name of data file» «type» «data file type» «id» «data file name» «mode»
/* «mode type». «access» is a single Troll command. «alias name of data file» is an
/* abbreviated name, made by the model user, of the data file which is accessed. «type»
/* is a Troll command. «data file type» spesifies the type of the datafile to be accessed.
/* In the case of a textfile with extension .txt, «data file type» is Troll´s readable format
/* formdata. «id» is a Troll command. «data file name» represents the entire name of the
/* data file to be accessed. Note that the data file name has to be indicated by the whole

/* path on which the file exists in addition to the data file name itself if the data file
/* exists on another directory than this Troll input file does (simbisbr.inp). The
/* extension in the data file name is .txt. «mode» is a Troll command. Finally, «mode
/* type» specifies the type of mode of the datafile to be accesed, and could be either r
/* (i.e. read) or create.

/* The three commands below provide access to the input data files for each sector in
/* the SEEM-model, that is for the household sector, the industry sector, and the service
/* sector with alias name his, the transport sector with alias name tp, and the electricity
/* generating sector with alias name el.

access his type formdata id brinn.txt mode r;
access tp type formdata id tpinbr.txt mode r;
access el type formdata id elinbr.txt mode r;

/* The command below provides access to the input data file consisting of data for fuel
/* prices, margins and energy taxes.

access pinnbr type formdata id d:\bou\ptroll\seem\eptprice.txt mode r;

/* The command below provides access to the output data for the input extrapolations to
/* be created.

access scinnbr type formdata id scisbr.txt mode create;

/* **Search Lists Commands**
/* ---
/* The commands below provide search lists for the data which have been accessed
/* above. The order of the search list is important. If a variable exists in two data files,
/* but with different values, first search should be on the file with the right value of the
/* variable. The search syntax for input data files is as follows: «search data» «alias
/* name of data file», where «search data» is a Troll command and «alias name of data
/* file» is an abbreviated name, made by the model user, for the data file to be searched.
/* The search syntax for output data files is as follows: «search data» «alias name of
/* data file» «w» where «w» denotes write.

/* The five commands below provide a search list for all data files, both the data input
/* files and the data output file, accessed above.

search data his;
search data tp;
search data el;
search data pinnbr;
search data scinnbr w;

/* **Command for Extrapolation of Input Variables**
/* ---
/* The command below starts the programme called scenisbr.prg for extrapolating the
/* input variables with annual growth rates according to the reference scenario
/* assumptions. Note that the growth rates have to be inserted manually in the file
/* scenisbr.src. This file has to be compiled in Troll in order to make the programme
/* executable. For further information on this, consult the textfile simexpl.txt which
/* explains the procedure of making a simulation with the SEEM-model.

&scenisbr;

/* **Output from Extrapolation of Input Variables**
/* ---
/* The extrapolations of input variables are saved under the data file name indicated in
/* the above access command line ending by create, i.e. under the data file scisbr.txt.
/* This output data file consisting of scenario assumptions on input variables may then
/* be used as an input data file in the simulation initiated by the commands below.

/* **Part B: Troll Commands for Establishing and Simulating the SEEM-model**
/* ---

/* **Access and Search Lists Commands**
/* ---
/* The two commands below delete all existing accesses and search lists to data files in
/* order to clear any old search paths no longer valid.

delaccess all;
delsearch all;

/* **Access Commands**
/* ---
/* The commands below provide access to all data files required for simulation of the
/* SEEM-model in the case of the reference scenario. The access commands are as
/* follows: «access» «alias name of data file» «type» «data file type» «id» «data file
/* name» «mode» «mode type». «access» is a single Troll command. «alias name of
/* data file» is an abbreviated name, made by the model user, of the data file which is
/* accessed. «type» is a Troll command. «data file type» spesifies the type of the datafile
/* to be accessed. In the case of a textfile with extension .txt, «data file type» is Troll´s
/* readable format formdata. «id» is a Troll command. «data file name» represents the
/* entire name of the data file to be accessed. Note that the data file name has to be
/* indicated by the whole path on which the file exists in addition to the data file name
/* itself if the data file exists on another directory than this Troll input file does
/* (simbisbr.inp). The extension in the data file name is .txt. «mode» is a Troll
/* command. Finally, «mode type» specifies the type of mode of the datafile to be
/* accesed, and could be either r (i.e. read) or create.

/* The Troll command below provides access to a reference scenario specific data file.
/* In this case the scenario specific data file, called taxharmo.txt, is a file with
/* harmonisation of energy taxes in the period from 2000 to 2010. Note that the data file
/* has been established in advance and made executable for Troll in a Fame routine.

access taxbr type formdata id d:\bou\ptroll\seem\taxharmo.txt mode r;

/* The command below provides access to the data file which contains extrapolations of
/* the input variables. This data file was created under part A.

access scinnbr type formdata id scisbr.txt mode r;

/* The four commands below provide access to all other input data (also start values for
/* the endogenous variables) required for simulation of the different sector models as
/* well as the price model.

access his type formdata id brinn.txt mode r;
access tp type formdata id tpinbr.txt mode r;
access el type formdata id elinbr.txt mode r;
access pinnbr type formdata id d:\bou\ptroll\seem\eptprice.txt mode r;

/* The command below provides access to the scenario output data to be created. In this
/* case the alias name of the data file is just called «filename». Hence the alias name
/* will be the same name as the data file which it is provided access to (basisbr.txt).

access filename type formdata id basisbr.txt mode create;

/* **Search Lists Commands**
/* ---
/* The commands below provide search lists for the data which have been accessed
/* above. The order of the search list is important. If a variable exists in two data files,
/* but with different values, first search should be on the file with the right value of the
/* variable. The search syntax for input data files is as follows: «search data» «alias
/* name of data file», where «search data» is a command and «alias name of data file»
/* is an abbreviated, made by the model user, for the data file to be searched. The search
/* syntax for output data files is as follows: «search data» «alias name of data file» «w»
/* where «w» denotes write.

search data taxbr;
search data scinnbr;
search data his;
search data tp;
search data el;
search data pinnbr;
search data filename w;

/* **Commands for Establishing the SEEM-model**
/* ---
/* In this Troll sequence the SEEM model for Germany is established. That is, all five
/* sector models as well as the price model for Germany are added to and linked
/* together in the modbr model by this sequence. The Troll syntax for establishing the
/* model is as follows:

/* usemod «model name»; (without the extension .mod)
/* modedit «model name»; (edits the model)
/* input «input model file name»; (sector and price models without extension .inp)
/* filemod; (files the model)

/* Note that the sector model input files have to be specified in a certain order due to the
/* link structure between the sector models and the price model for some of the
/* variables. The order should be as follows: First, the fuel end user price model
/* (pmodbr). Then, the electricity generating model (emodbr). Finally, the household,
/* the industry, and the service models (hmodbr, imodbr, and smodbr respectively), and
/* the transport model (tmodbr).

usemod modbr;
modedit modbr;
input pmodbr;
input emodbr;
input hmodbr;
input imodbr;
input smodbr;
input tmodbr;
filemod;

/* Note also that if the model already exists, the model user may do one of the following

/* two alternatives before simulating the SEEM-model: i) Skip the commands above by
/* means of a text string represented by «/*» at the beginning of each command or ii)
/* delete the existing models named modbr.mod and current.mod under the br directory,
/* i.e. under d:\bou\ptroll\seem\br, for instance in MS-DOS .

/* **Commands for Simulating and Filing the SEEM-model**
/* --
/* Now, the model user may simulate and file the established SEEM-model by means of
/* the Troll commands below. First, a command telling which model to use.

usemod modbr;

/* **Simulation Commands**
/* --
/* The following sequence of Troll commands simulates the SEEM-model from 1960 to
/* 2020 anually for Germany in the case of the reference scenario.

simulate;
simstart 1991a from 1960a;
dotil 2020a;
simstart;

/* If the model user does not want to include historical variable values before 1991 in
/* the simulation period, the command «simstart 1991a from 1960a» may be substituted
/* with the command «simstart 1991a».

/* **Filing Commands**
/* --
/* The Troll command below files the output data file containing the simulation results
/* from the reference scenario.

filesim filename;

/* Here all simulated variables and parameters for all energy using sectors are specified
/* to be included in the output data file. Note that the output will be saved under the data
/* file name indicated after the «filesim» command. In this case «basisbr.txt» with alias
/* name «filename» is the name of the output file, which was created under the access
/* command above. If nothing else is commanded the output file is saved under the
/* same directory as the model user is running this input file from. Thus, the
/* output data file in this case will be saved on the following subdirectory:
/* d:\bou\ptroll\seem\br.

/* Furthermore, if only some special variables are to be included in the output
/* data file, the model user may specify the «filesim» command with the following
/* syntax: «filesim» «filename» : «variable name» «variable name»; «filename»
/* represents the alias name of the output data file and «variable name» represents the
/* particular variable the model user wants to include in the output data file.

<u>/* Example:</u>
/* filesim filename : ngsconhobr oilconhobr coaconhobr eleconhobr;

/* If only endogenous variables are to be included in the output data file, the
/* model user may write as follows: filesim filename : endogenous;

/* **Command for Leaving Troll**
/* ---
/* Now, the simulation of the reference scenario for Germany is accomplished. The
/* model user may want to use the output file for instance in a spreadsheet programme
/* for further analysis of the output data.

/* The two commands below delete all existing accesses and search lists to data
/* files in Troll in order to clear old search paths no longer relevant.

delsearch all;
delaccess all;

/* This final Troll command leaves Troll.

trexit

4.2.2 The IS Scenario
/* **The Troll Input File simisbr.inp**
/* The input file, called simisbr.inp, contains a collection of Troll commands
/* which extrapolate input variables according to the integration scenario assumptions,
/* and establish and simulate the SEEM-model for Germany. Since the integration
/* scenario is the reference scenario, simisbr.inp will make identical simulation results
/* as the simbisbr.inp file. In what follows, some comments and explanations connected
/* to each Troll command are given. The file is divided into two parts. Part A consists of
/* Troll commands for implementation of scenario assumptions for input variables and
/* part B consists of Troll commands for establishing, simulating and filing the SEEM-
/* model.

/* **Part A: Troll Commands for Implementation of Scenario Assumptions**
/* ---

/* **Access and Search Lists Commands**
/* ---
/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear search paths no longer relevant.

delaccess all;
delsearch all;

/* **Access Commands**
/* ---
/* The Troll commands below provide access to all data for input variables to be
/* extrapolated in the integration scenario. The access commands are as follows:
/* «access» «alias name of data file» «type» «data file type» «id» «data file name»
/* «mode» «mode type». «access» is a single Troll command. «alias name of data file»
/* is an abbreviated name, made by the model user, for the data file which is accessed.
/* «type» is a Troll command. «data file type» spesifies the type of the datafile to be
/* accessed. In the case of a textfile with extension .txt, «data file type» is Troll´s
/* readable format formdata. «id» is a Troll command. «data file name» represents the
/* entire name of the data file to be accessed. Note that the data file name has to be
/* indicated by the whole path on which the file exists in addition to the data file name
/* itself if the data file exists on another directory than this Troll input file does
/* (simisbr.inp).The extension in the data file name is .txt. «mode» is a Troll command.
/* Finally, «mode type» specifies the type of mode of the datafile to be accesed, and
/* could be either r (i.e. read) or create.

/* The command below provides access to the input data file basisbr.txt, with alias
/* name innbr, which consists of energy demand and fuel prices for all energy using
/* sectors in the SEEM-model. Note that this input data file has been created in the
/* reference scenario which is based on the is scenario (c.f. simbisbr.inp).

access innbr type formdata id basisbr.txt mode r;

/* The Troll command below provides access to the output data for the input
/* extrapolations to be created.

access scinnbr type formdata id scisbr.txt mode create;

/* **Search Lists Commands**
/* --
/* The Troll commands below provide search lists for the data which have been
/* accessed above. The order of the search list is important. If a variable
/* exists in two data files, but with different values, first search should be on the file
/* with the right value of the variable. The search syntax for input data files is as
/* follows: «search data» «alias name of data file», where «search data» is a Troll
/* command and «alias name of data file» is an abbreviated name, made by the model
/* user, for the data file to be searched. The search syntax for output data files is as
/* follows: «search data» «alias name of data file» «w», where «w» denotes write.

/* The two Troll commands below provide search list for all data files, both the data
/* input file and the data output file, which are accessed above.

search data innbr;
search data scinnbr w;

/* **Command for Extrapolation of Input Variables**
/* --
/* The command below starts the programme called scenisbr.prg for extrapolating the
/* input variables with annual growth rates according to the integration scenario
/* assumptions. Note that the growth rates have to be inserted manually in the file
/* scenisbr.src. This file has to be compiled in Troll in order to make the programme
/* executable. For further information on this, consult the textfile simexpl.txt which
/* explains the procedure of making a simulation with the SEEM-model.

&scenisbr;

/* **Output from Extrapolation of Input Variables**
/* --
/* The output from extrapolations of input variables is saved under the data file name
/* indicated in the above access command line ending by create, i.e. under the data file
/* scisbr.txt. This output data file consisting of scenario assumptions on input variables
/* may then be used as an input data file in the simulation initiated by the commands
/* below.

/* **Part B: Troll Commands for Establishing and Simulating the SEEM-model**
/* --

/* **Access and Search Lists Commands**
/* --
/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear any search lists no longer valid.

delaccess all;
delsearch all;

/* **Access Commands**
/* ---
/* The Troll commands below provide access to all data files required for simulation of
/* the SEEM-model in the case of the integration scenario. The access commands are as
/* follows: «access» «alias name of data file» «type» «data file type» «id» «data file
/* name» «mode» «mode type». «access» is a single Troll command. «alias name of
/* data file» is an abbreviated name, made by the model user, for the data file which is
/* accessed. «type» is a Troll command. «data file type» spesifies the type of the datafile
/* to be accessed. In the case of a textfile with extension .txt, «data file type» is Troll´s
/* readable format formdata. «id» is a Troll command. «data file name» represents the
/* entire name of the data file to be accessed. Note that the data file name has to be
/* indicated by the whole path on which the file exists in addition to the data file name
/* itself if the data file exists on another directory than this Troll input file does
/* (simisbr.inp). The extension in the data file name is .txt. «mode» is a Troll command.
/* Finally, «mode type» specifies the type of mode of the datafile to be accesed, and
/* could be either r (i.e. read) or create.

/* The Troll command below provides access to a integration scenario specific data file.
/* In this case the scenario specific data file, called taxharmo.txt, is a file with
/* harmonisation of energy taxes in the period from 2000 to 2010. Note that the data file
/* has been established in advance and made executable for Troll in a Fame routine.

access taxbr type formdata id d:\bou\ptroll\seem\taxharmo.txt mode r;

/* The Troll command below provides access to the data file which contains
/* extrapolations of the input variables. This data file was created under part A.

access scinnbr type formdata id scisbr.txt mode r;

/* The Troll command below provides access to all other input data (also start values for
/* the endogenous variables) required for simulation of the different sector models as
/* well as the price model.

access innbr type formdata id basisbr.txt mode r;

/* The Troll command below provides access to the scenario output data to be created.
/* In this case the alias name of the data file is just called «filename». Hence the alias
/* name will be the same name as the data file which is accessed (outisbr.txt).

access filename type formdata id outisbr.txt mode create;

/* **Search Lists Commands**
/* ---
/* The Troll commands below provide search lists for the data which have been
/* accessed above. The order of the search list is important. If a variable
/* exists in two data files, but with different values, first search should be on the file
/* with the right value of the variable. The search syntax for input data files is as
/* follows: «search data» «alias name of data file», where «search data» is a Troll
/* command and «alias name of data file» is an abbreviated, made by the model user,
/* for the data file to be searched. The search syntax for output data files is as follows:
/* «search data» «alias name of data file» «w», where «w» denotes write.

search data taxbr;
search data scinnbr;
search data innbr;
search data filename w;

/* **Commands for Establishing the SEEM-model**
/* ---
/* In this Troll sequence the SEEM model for Germany is established. That is, all five
/* sector models as well as the price model for Germany are added to and linked
/* together in the modbr model by this sequence. The Troll syntax for establishing the
/* model is as follows:

/* usemod «model name»; (without the extension .mod)
/* modedit «model name»; (edits the model)
/* input «input model file name»; (sector and price models without extension .inp)
/* filemod; (files the model)

/* Note that the sector model input files have to be specified in a certain order due to the
/* link structure between the sector models and the price model for some of the
/* variables. The order should be as follows: First, the fuel end user price model
/* (pmodbr). Then, the electricity generating model (emodbr). Finally, the household,
/* the industry, and the service models (hmodbr, imodbr, and smodbr respectively), and
/* the transport model (tmodbr).

/* usemod modbr;
/* modedit modbr;
/* input pmodbr;
/* input emodbr;
/* input hmodbr;
/* input imodbr;
/* input smodbr;
/* input tmodbr;
/* filemod;

/* Note also that if the model already exists, the model user may do one of the following
/* two alternatives before simulating the SEEM-model: i) Skip the Troll commands
/* above by means of a text string represented by «/*» at the beginning of each
/* command or ii) delete the existing models named modbr.mod and current.mod under
/* the br directory, i.e. under d:\bou\ptroll\seem\br, for instance in MS-DOS. In this case
/* text strings are used, since the model already exists from the reference scenario(c.f.
/* simbisbr.inp).

/* **Commands for Simulating and Filing the SEEM-model**
/* ---
/* Now, the model user may simulate and file the established SEEM-model by means of
/* the Troll commands below. First, a command telling which model to use.

usemod modbr;

/* **Simulation Commands**
/* ---
/* The following sequence of Troll commands simulates the SEEM-model from 1991 to
/* 2020 anually for Germany in the case of the integration scenario.

simulate;

simstart 1991a;
dotil 2020a;
simstart;

/* If the model user wants to include historical variable values before 1991 in the
/* simulation period, the command «simstart 1991a» may be substituted with the
/* command «simstart 1991a from 1960a».

/* **Filing Commands**
/* ---
/* The Troll command below files the output data file containing the simulation results
/* from the integration scenario.

filesim filename;

/* Here all simulated variables and parameters for all energy using sectors are specified
/* to be included in the output data file. Note that the output will be saved under the data
/* file name indicated after the «filesim» command. In this case «outisbr.txt» with alias
/* name «filename» is the name of the output file, which was created under the access
/* command above. If nothing else is commanded the output file is saved under the
/* same directory as the model user is running this Troll input file from. Thus, the
/* output data file in this case will be saved on the following subdirectory:
/* d:\bou\ptroll\seem\br.

/* Furthermore, if only some special variables are to be included in the output
/* data file, the model user may specify the «filesim» command with the following
/* syntax: «filesim» «filename» : «variable name1» «variable name 2»; «filename»
/* represents the alias name of the output data file and «variable name» represents the
/* particular variable the model user wants to include in the output data file.

/* Example:
/* filesim filename : ngsconhobr oilconhobr coaconhobr eleconhobr;

/* If only endogenous variables are wanted to be included in the output data file, the
/* model user may write as follows: filesim filename : endogenous;

/* **Command for Leaving Troll**
/* ---
/* Now, the simulation of the integration scenario for Germany is accomplished and the
/* model user may use the data output file for instance in a spreadsheet programme for
/* further analysis of the output data.

/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear any serach lists no longer valid.

delsearch all;
delaccess all;

/* This final Troll command leaves Troll.

trexit

4.2.3 The FS Scenario

/* **The Troll Input File simfsbr.inp**

/* The input file, called simfsbr.inp, contains a collection of Troll commands which
/* extrapolate input variables according to the fragmentation scenario assumptions, and
/* establishes and simulates the SEEM-model for Germany. In what follows, some
/* comments and explanations connected to each Troll command are given. The file is
/* divided into two parts. Part A consists of Troll commands for implementation of
/* scenario assumptions for input variables and part B consists of Troll commands for
/* establishing, simulating and filing the SEEM-model.

/* **Part A: Troll Commands for Implementation of Scenario Assumptions**
/* ---

/* **Access and Search Lists Commands**
/* ---
/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear search paths no longer relevant.

delaccess all;
delsearch all;

/* **Access Commands**
/* ---
/* The Troll commands below provide access to all data for input variables to be
/* extrapolated in the fragmentation scenario. The access commands are as follows:
/* «access» «alias name of data file» «type» «data file type» «id» «data file name»
/* «mode» «mode type». «access» is a single Troll command. «alias name of data file»
/* is an abbreviated name, made by the model user, of the data file which is accessed.
/* «type» is a Troll command. «data file type» spesifies the type of the datafile to be
/* accessed. In the case of a textfile with extension .txt, «data file type» is Troll´s
/* readable format formdata. «id» is a Troll command. «data file name» represents the
/* entire name of the data file to be accessed. Note that the data file name has to be
/* indicated by the whole path on which the file exists in addition to the data file name
/* itself if the data file exists on another directory than this Troll input file does
/* (simfsbr.inp). The extension in the data file name is .txt. «mode» is a Troll command.
/* Finally, «mode type» specifies the type of mode of the datafile to be accesed, and
/* could be either r (i.e. read) or create.

/* The command below provides access to the input data file basisbr.txt, with alias
/* name innbr, which consists of energy demand and fuel prices for all energy using
/* sectors in the SEEM-model. Note that this input data file has been created in the
/* reference scenario which is based on the is scenario (c.f. simbisbr.inp).

access innbr type formdata id basisbr.txt mode r;

/* The Troll command below provides access to the output data for the input
/* extrapolations to be created

access scinnbr type formdata id scfsbr.txt mode create;

/* **Search Lists Commands**
/* ---
/* The Troll commands below provide search lists for the data which have been
/* accessed above. The order of the search list is important. If a variable

/* exists in two data files, but with different values, first search should be on the file
/* with the right value of the variable. The search syntax for input data files is as
/* follows: «search data» «alias name of data file» where «search data» is a Troll
/* command and «alias name of data file» is an abbreviated name, made by the model
/* user, of the data file to be searched. The search syntax for output data files is as
/* follows: «search data» «alias name of data file» «w» where «w» denotes write.

/* The two Troll commands below provide search list for all data files, both the data
/* input file and the data output file, which are accessed above.

search data innbr;
search data scinnbr w;

/* **Command for Extrapolation of Input Variables**
/* ---
/* The command below starts the programme called scenfsbr.prg for extrapolating the
/* input variables with annual growth rates according to the fragmentation scenario
/* assumptions. Note that the growth rates have to be inserted manually in the file
/* scenfsbr.src. This file has to be compiled in Troll in order to make the programme
/* executable. For further information on this, consult the textfile simexpl.txt which
/* explains the procedure of making a simulation with the SEEM-model.

&scenfsbr;

/* **Output from Extrapolation of Input Variables**
/* ---
/* The output from extrapolations of input variables is saved under the data file name
/* indicated in the above access command line ending by create, i.e. under the data file
/* scfsbr.txt. This output data file consisting of scenario assumptions on input variables
/* may then be used as an input data file in the simulation initiated by the commands
/* below.

/* **Part B: Troll Commands for Establishing and Simulating the SEEM-model**
/* ---

/* **Access and Search Lists Commands**
/* ---
/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear any search lists no longer valid.

delaccess all;
delsearch all;

/* **Access Commands**
/* ---
/* The Troll commands below provide access to all data files required for simulation of
/* the SEEM-model in the case of the fragmentation scenario. The access commands are
/* as follows: «access» «alias name of data file» «type» «data file type» «id» «data file
/* name» «mode» «mode type». «access» is a single Troll command. «alias name of
/* data file» is an abbreviated name, made by the model user, for the data file which is
/* accessed. «type» is a Troll command. «data file type» spesifies the type of the datafile
/* to be accessed. In the case of a textfile with extension .txt, «data file type» is Troll´s
/* readable format formdata. «id» is a Troll command. «data file name» represents the
/* entire name of the data file to be accessed. Note that the data file name has to be

/* indicated by the whole path on which the file exists in addition to the data file name
/* itself if the data file exists on another directory than this Troll input file does
/* (simfsbr.inp). The extension in the data file name is .txt. «mode» is a Troll command.
/* Finally, «mode type» specifies the type of mode of the datafile to be accessed, and
/* could be either r (i.e. read) or create.

/* As in the reference scenario and the integration scenario, fragmentation scenario
/* specific data files could be provided access to in this section of the Troll input file.
/* However, no such scenario specific data files are established in the fragmentation
/* case, and thus no Troll commands for accessing such files are required here.

/* The Troll command below provides access to the data file which contains
/* extrapolations of the input variables. This data file was created under part A.

access scinnbr type formdata id scfsbr.txt mode r;

/* The Troll command below provides access to all other input data (also start values for
/* endogenous variables) required for simulation of the different sector models as well
/* as the price model.

access innbr type formdata id basisbr.txt mode r;

/* The Troll command below provides access to the scenario output data to be created.
/* In this case the alias name of the data file is just called «filename». Hence the alias
/* name will be the same name as the data file which is accessed (outfsbr.txt).

access filename type formdata id outfsbr.txt mode create;

/* **Search Lists Commands**
/* ---
/* The Troll commands below provide search lists for the data which have been
/* accessed above. The order of the search list is important. If a variable
/* exists in two data files, but with different values, first search should be on the file
/* with the right value of the variable. The search syntax for input data files is as
/* follows: «search data» «alias name of data file» where «search data» is a Troll
/* command and «alias name of data file» is an abbreviated, made by the model user, of
/* the data file to be searched for. The search syntax for output data files is as follows:
/* «search data» «alias name of data file» «w» where «w» denotes write.

search data scinnbr;
search data innbr;
search data filename w;

/* **Commands for Establishing the SEEM-model**
/* ---
/* In this Troll sequence the SEEM model for Germany is established. That is, all five
/* sector models as well as the price model for Germany are added to and linked
/* together in the modbr model by this sequence. The Troll syntax for establishing the
/* model is as follows:

/* «usemod» «model name»; (without the extension .mod)
/* «modedit» «model name»; (edits the model)
/* «input» «input model file name»; (sector and price models without extension .inp)
/* «filemod»; (files the model)

/* Note that the sector model input files have to be specified in a certain order due to the
/* link structure between the sector models and the price model for some of the
/* variables. The order should be as follows: First, the fuel end user price model
/* (pmodbr). Then, the electricity generating model (emodbr). Finally, the household,
/* the industry, and the service models (hmodbr, imodbr, and smodbr respectively), and
/* the transport model (tmodbr).

/* usemod modbr;
/* modedit modbr;
/* input pmodbr;
/* input emodbr;
/* input hmodbr;
/* input imodbr;
/* input smodbr;
/* input tmodbr;
/* filemod;

/* Note also that if the model already exists, the model user may do one of the following
/* two alternatives before simulating the SEEM-model: i) Skip the Troll commands
/* above by means of a text string represented by «/*» at the beginning of each
/* command or ii) delete the existing models named modbr.mod and current.mod under
/* the br directory, i.e. under d:\bou\ptroll\seem\br, for instance in MS-DOS. In this case
/* text strings are used, since the model already exists from the reference scenario(c.f.
/* simbisbr.inp).

/* **Commands for Simulating and Filing the SEEM-model**
/* ---
/* Now, the model user may simulate and file the established SEEM-model by means of
/* the Troll commands below. First, a command telling which model to use.

usemod modbr;

/* **Simulation Commands**
/* ---
/* The following sequence of Troll commands simulates the SEEM-model from 1991 to
/* 2020 anually for Germany in the case of the fragmentation scenario.

simulate;
simstart 1991a;
dotil 2020a;
simstart;

/* If the model user wants to include historical variable values before 1991 in the
/* simulation period, the command «simstart 1991a» may be substituted with the
/* command «simstart 1991a from 1960a».

/* **Filing Commands**
/* ---
/* The Troll command below files the output data file containing the simulation results
/* from the fragmentation scenario.

filesim filename;

/* Here all simulated variables and parameters for all energy using sectors are specified
/* to be included in the output data file. Note that the output will be saved under the data

/* file name indicated after the «filesim» command. In this case «outfsbr.txt» with alias
/* name «filename» is the name of the output file, which was created under the access
/* command above. If nothing else is commanded the output file is saved under the
/* same directory as the model user is running this Troll input file from. Thus, the
/* output data file in this case will be saved on the following subdirectory:
/* d:\bou\ptroll\seem\br.

/* Furthermore, if only some special variables are to be included in the output
/* data file, the model user may specify the «filesim» command with the following
/* syntax: «filesim» «filename» : «variable name 1» «variable name 2»; «filename»
/* represents the alias name of the output data file and «variable name» represents the
/* particular variable the model user wants to include in the output data file.

<u>/* Example:</u>
/* filesim filename : ngsconhobr oilconhobr coaconhobr eleconhobr;

/* If only endogenous variables are wanted to be included in the output data file, the
/* model user may write as follows: filesim filename : endogenous;

/* **Command for Leaving Troll**
/* --
/* Now, the simulation of the fragmentation scenario for Germany is accomplished and
/* the model user may use the data output file for instance in a spreadsheet programme
/* for further analysis of the output data.

/* The two Troll commands below delete all existing accesses and search lists to data
/* files in order to clear any search lists no longer valid.

delsearch all;
delaccess all;

/* This final Troll command leaves Troll.

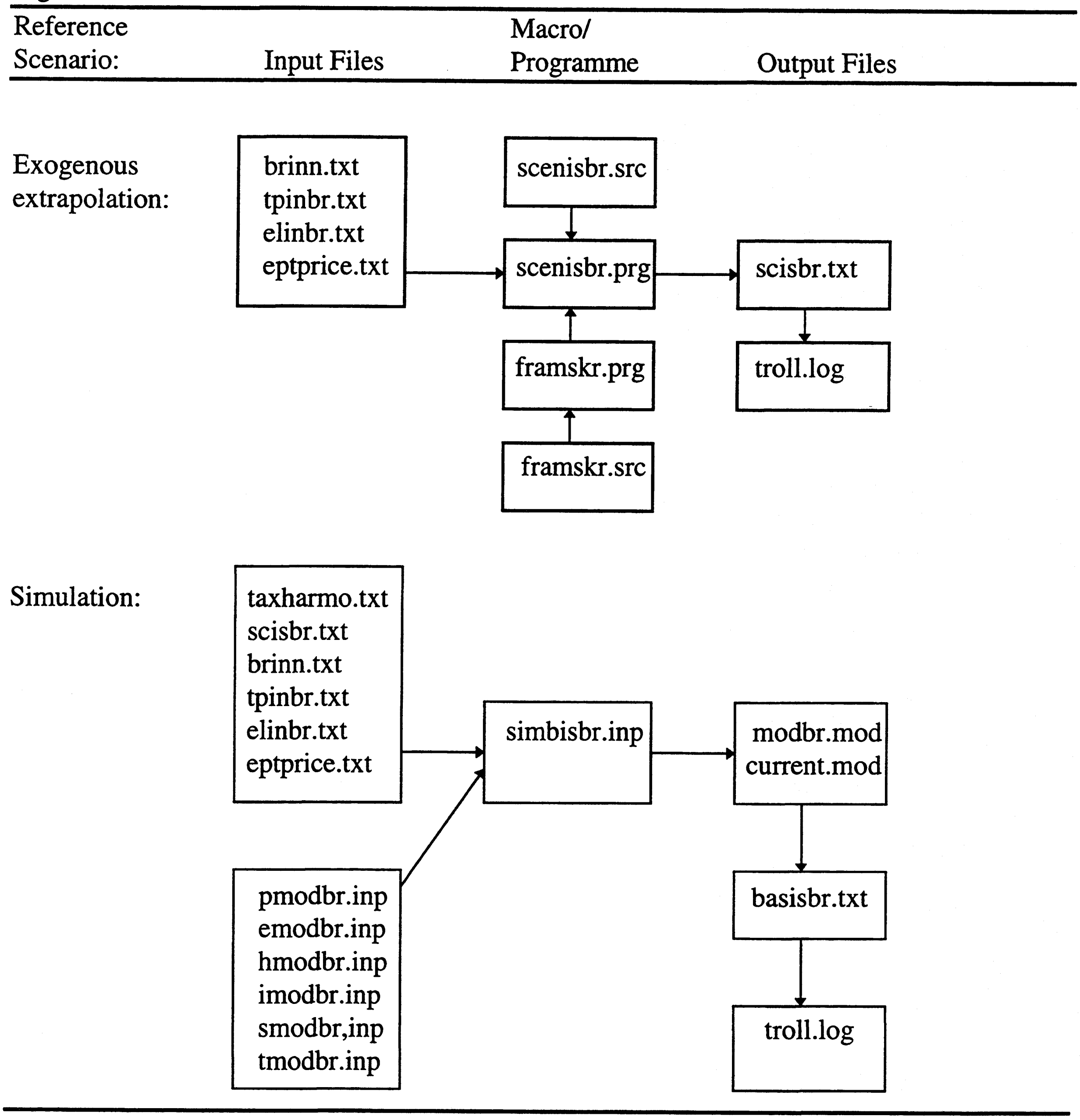
trexit

4.3 A Summary of Files and Their Linkages

4.3.1 The Reference Scenario

Figure 2 depicts an overview of files in terms of input files and Troll macro/programmes neccessary for extrapolating input variables as well as simulating the SEEM-model according to the reference scenario. Additionally, figure 2 provides an overview of output files created from both the extrapolation and the simulation routines. The arrows indicate a link between these files. Below a brief description of the figure is given. For further information of the files and their content, consult the textfile brexpl.txt.

Figure 2:



<u>Exogenous extrapolation</u>

Based on the input files containing historical data for all energy using sectors as well as end user fuel prices, exogenous variables are extrapolated and saved in the output file scisbr.txt by means of the programme scenisbr.prg. This programme works together with the executable framskr. prg, and is called upon from the simulation programme simbisbr.inp (not shown in the figure). Any errors or warning messages made by Troll during the extrapolations are saved in the file troll.log.

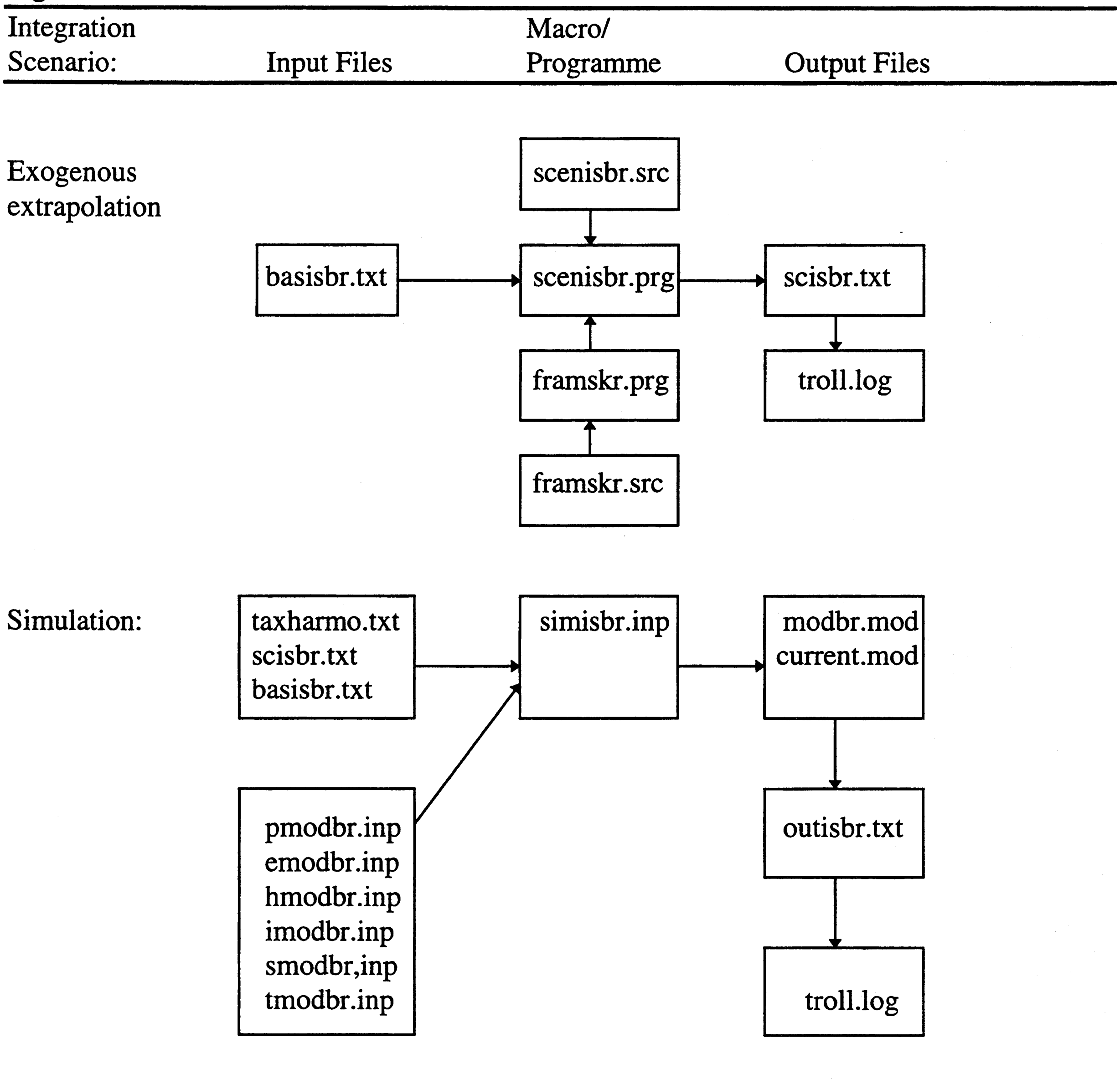
<u>Simulation:</u>

The programme simbisbr.inp establishes and simulates the SEEM-model based on all input files required for simulation in the case of the reference scenario. The established model is saved in modbr.mod as well as in current.mod, and the output of the simulation is saved in basisbr.txt. Any errors or warning messages made by Troll during the establishing and simulation of the model are saved in the file troll.log.

4.3.2 The IS Scenario

Figure 3 depicts an overview of files in terms of input files and Troll macro/programmes neccessary for extrapolating exogenous variables as well as simulating the SEEM-model according to the integration scenario.

Figure 3:



Additionally, figure 3 provides an overview of output files created from both the extrapolation and the simulation routines. The arrows indicate a link between these files. Below a brief description of the figure is given. For further information of the files and their content, consult the textfile brexpl.txt.

<u>Exogenous extrapolation:</u>

Based on the input file containing historical data for all energy using sectors as well as end user fuel prices, exogenous variables are extrapolated and saved in the output file scisbr.txt by means of programme scenisbr.prg. This programme works together with the executable framskr. prg, and is called upon from the simulation programme simisbr.inp (not shown in the figure). Any errors or warning messages made by Troll during the extrapolations are saved in the file troll.log.

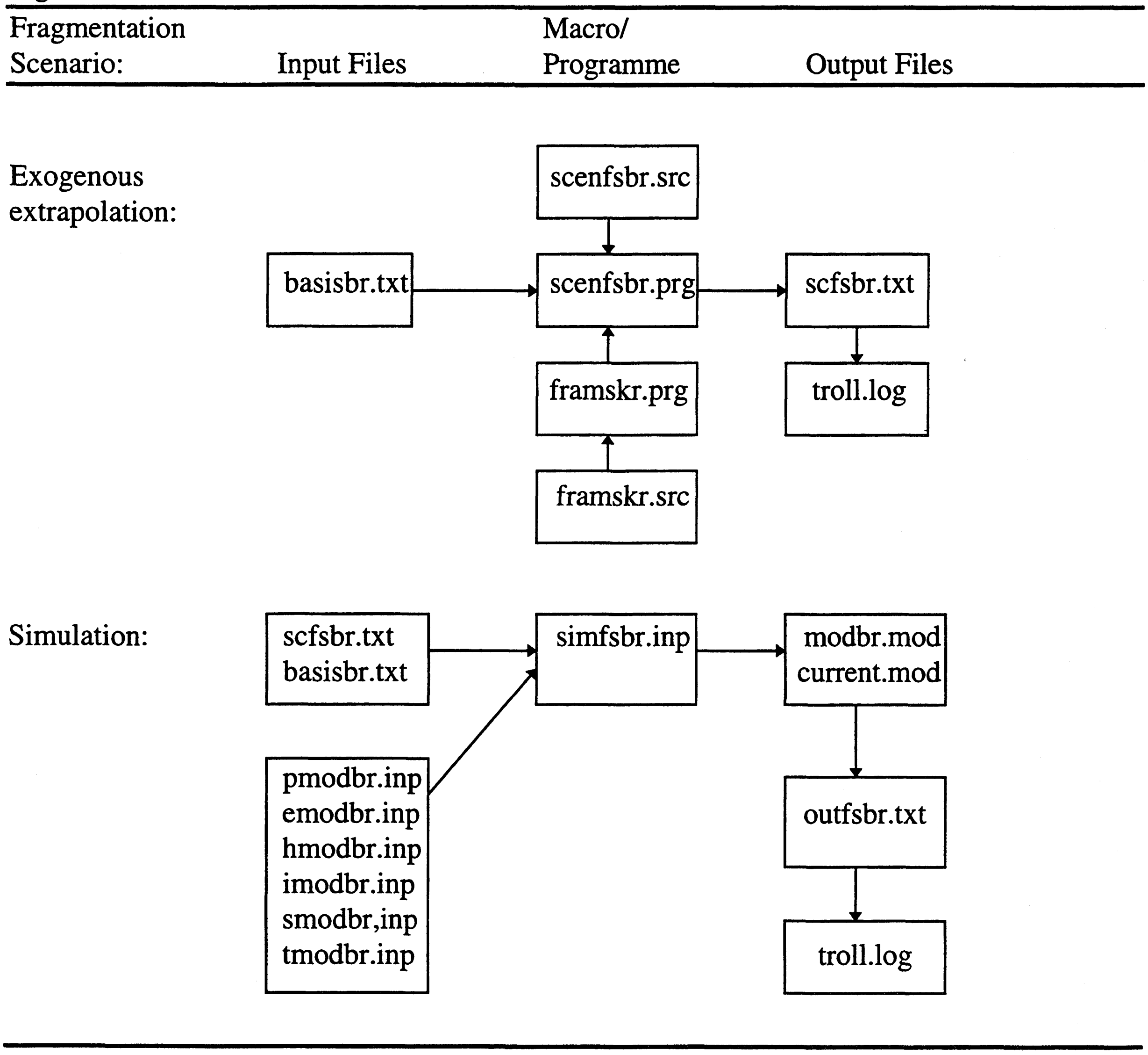
Simulation:
The programme simisbr.inp establishes and simulates the SEEM-model based on all input files required for simulation in the case of the integration scenario. The established model is saved in modbr.mod as well as in current.mod, and the output of the simulation is saved in outisbr.txt. Any errors or warning messages made by Troll during the establishing and simulation of the model are saved in the file troll.log.

4.3.3 The FS Scenario
Figure 4 depicts an overview of files in terms of input files and macro/programmes neccessary for extrapolating exogenous variables as well as simulating the SEEM-model according to the fragmentation scenario. Additionally, figure 4 provides an overview of output files created from both the extrapolation and the simulation routines. The arrows indicate a link between these files. Below a brief description of the figure is given. For further information of the files and their content, consult the textfile brexpl.txt.

Exogenous extrapolation:
Based on the input file containing historical data for all energy using sectors as well as end user fuel prices, exogenous variables are extrapolated and saved in the output file scfsbr.txt by means of the programme scenfsbr.prg. This programme works together with the executable framskr. prg, and is called upon from the simulation programme simfsbr.inp (not shown in the figure). Any errors or warning messages made by Troll during the extrapolations are saved in the file troll.log.

Simulation:
The programme simfsbr.inp establishes and simulates the SEEM-model based on all input files required for simulation in the case of the fragmentation scenario. The established model is saved in modbr.mod as well as in current.mod, and the output of the simulation is saved in outfsbr.txt. Any errors or warning messages made by Troll during the establishing and simulation of the model are saved in the file troll.log.

Figure 4:



4.4 The Procedure for Simulation

The Textfile simexpl.txt

The textfile, called simexpl.txt, explains the procedure of making a simulation with the SEEM-model for a given scenario and country. In what follows, the simulation procedure for the fragmentation scenario for Germany is used as an example.

General Information

Generally speaking, the model user needs the following in order to accomplish a simulation: a compiled SEEM-model and a data file with scenario spesific data necessary for simulation. However, before any simulation can be accomplished, the model user has to make sure that no output files of any kind already exist, that is no data output file with extension .txt and no model file with extension .mod should already exist before simulation. In the fs scenario case such output files include the following:

outfsbr.txt, scfsbr.txt, modbr.mod, and current.mod

A Simulation Example

This is an example of the simulation procedure for the fragmentation scenario for Germany. The fragmentation scenario has the identification letters «fs», and is based on the reference scenario which is represented by the datafile basisbr.txt. The fs scenario differs from the reference scenario only when it comes to assumed growth rates in GDP, private consumption, sectoral production, and import fuel prices among others.

Simulation Procedure

1) Go to the br country subdirectory under the SEEM-directory in MS-DOS, i.e. d:\bou\ptroll\seem\br.

2) Copy scenisbr.src to scenfsbr.src, and start editing scenfsbr.src. In scenfsbr.src, change the annual growth rates manually according to the fs scenario input assumptions. That is, insert the new growth rates for the following variables and save the file scenfsbr.src:

<u>The Household Sector:</u>
conhobr
a0elehobr
a0coghobr
ngsimppribr

<u>The Service Sector:</u>
prosebr
a0elesebr
a0cogsebr

<u>The Industry Sector</u>
proinbr
a0eleinbr
a0coainbr
a0oilinbr
a0ngsinbr
oilimppribr

<u>The Transport Sector:</u>
incomebr
gdpindbr
goimppribr
diimppribr
sharotfbr
sharatfbr
shawatfbr
roefftfbr
raefftfbr
waefftfbr

<u>The Electricity Generating Sector:</u>
ngsimppribr
oilimppribr

3) Start Troll by writing troll from the br subdirectory

d:\bou\ptroll\seem\br\troll

and Troll command will be shown on the screen. PC-Troll is now ready for commands. Then, compile the scenfsbr.src file and the framskr.src file by writing

Troll command: *compile scenfsbr*
Troll command: *compile framskr*

Note that no file extension is neccessary. The compiled or executable version of the scenfsbr.src file and the framskr.src file are now made, and they are called scenfsbr.prg and framskr.prg respectively. The extension .prg denotes a programme. Leave Troll by writing

Troll command: *trexit*

4) Copy the Troll input file for simulation, simisbr.inp to simfsbr.inp, and start editing simfsbr.inp. Simfsbr.inp contains a set of Troll commands which starts scenfsbr.prg, establishes the SEEM-model for Germany (if the model does not exist already), and simulates the model. Since simfsbr.inp is a copy of simisbr.inp, it has to be edited and adjusted to the fs scenario before simulation. In principle all «is» in the file names referred to in simisbr.inp should be changed to «fs» in order to avoid any overwriting of old scenario results. That is the model user has to specify the name of the output files which keep the extrapolations of the input variables as well as the simulation results of the fs scenario. Furthermore, the model user should check that only the data input files relevant for the fs scenario is accessed to and searched for. Additionally, the model user has to make sure that none of the output files (or eventually models) which will be created by running simfsbr.inp, exist already. If such files do exist already, the model user has to delete those files before starting the chosen scenario simulation. When simfsbr.inp has been edited, save the file.

5) Start Troll again (see item 3) from the br subdirectory and write

Troll command: *input simfsbr*

Note that no file extension is necessary. With this Troll command the file simulates the model, saves the output file with simulation results, and leaves Troll.

6) Check if the simulation has succeeded by looking at the file list under the br subdirectory.The output file should be in the br subdirectory, with the right name, the right size (compare with other output files), and it should have been established at the right time. To check the simulation results further, the model user should make a hard copy of values and annual growth rates for main input and output variables (for instance by means of a spreadsheet table).

If something has gone wrong when running the simulation input file simfsbr.inp, the model user may read and check the troll.log text file. This file contains any warnings or error messages made by Troll during the simulation. A list of all possible Troll errors or warning messages with explanations is attached to this user´s guide. Note that the troll.log file is overwritten when running the next Troll input or macro file.

7) The fs scenario simulation for Germany is accomplished

5. Aggregate Energy Demand and CO_2-emission

This chapter describs and presents the summation routine for summarising simulated energy demand from the different scenarios for each country, or for a total of a group of countries. Moreover, the chapter presents the calculation routine of CO_2-emissions as it is implemented in a submodel of the SEEM-model.

It is worthwhile to notice in the Troll macro presented below that the Troll syntax for a comment begins with a «/*».

5.1 Description of the Troll Macro seemsum

The textfile, called sumexpl.txt, explains how to use the Troll macro seemsum.src. In addition, the textfile provides comments and explanations related to each Troll command in the Troll macro just mentioned.

The SEEM-model outputs disaggregated energy consumption figures. For each single fuel f in each single sector s within each single country c, the SEEM model outputs a simulated time series of energy consumption figures $x_{c,s,f}(t)$. The seemsum.src macro does either

(i) aggregate the energy consumption figures over the three dimensions of fuel, sector and/or country, that is calculate the different aggregates

$$X_{s,c}(t)=\sum_f x_{c,s,f}(t),\qquad X_{f,c}(t)=\sum_s x_{c,s,f}(t),\qquad X_{f,s}(t)=\sum_c x_{c,s,f}(t),$$
$$X_c(t)=\sum_s\sum_f x_{c,s,f}(t),\qquad X_s(t)=\sum_c\sum_f x_{c,s,f}(t),\qquad X_f(t)=\sum_c\sum_s x_{c,s,f}(t),$$
$$X(t)=\sum_c\sum_s\sum_f x_{c,s,f}(t),$$

and in addition a few special category aggregates over subsets of the fuels and subsets of the sectors,

or

(ii) calculate disaggregated CO_2 emissions: $e_{c,s,f}(t) = x_{c,s,f}(t)\ \alpha_f$, where α_f is a CO_2 emission coefficient specific to the fuel f, before calculateing the corresponding aggregates

$$E_{s,c}(t)=\sum_f e_{c,s,f}(t),\qquad E_{f,c}(t)=\sum_s e_{c,s,f}(t),\qquad E_{f,s}(t)=\sum_c e_{c,s,f}(t),$$
$$E_c(t)=\sum_s\sum_f e_{c,s,f}(t),\qquad E_s(t)=\sum_c\sum_f e_{c,s,f}(t),\qquad E_f(t)=\sum_c\sum_s e_{c,s,f}(t),$$
$$E(t)=\sum_c\sum_s\sum_f e_{c,s,f}(t).$$

In addition come the few special category aggregates over subsets of the fuels and subsets of the sectors.

The SEEM model contains 13 countries, 7 sectors and 14 fuels, which imply that the `seemsum` macro either calculates more than 400 aggregated energy series or about 600 disaggregated and aggregated emission series. Consult the documentation of the SEEM model for more details on the countries, sectors and fuels, or read the comments to the macro code on the following pages.

The tasks (i) and (ii) are performed by the same macro by multiplying each disaggregated energy consumption figure output from SEEM by either 1 or a fuel specific CO_2 emission coefficient before aggregation. In the latter case (ii) the calculated disaggregated emission figures are also saved to disk along with the aggregates.

The macro performs the calculations in nested loops. It runs through all fuels within all sectors within all countries, initializing and updating aggregation variables, and storing them on disk after final update. To make the macro readable and understandable we name each variable according to its content. But, amounting to more than half a thousand in number motivates a scheme of automatic naming of the individual variables. The names are constructed by concatenating the *contents* of a few variables. Let us say that the variables named *oil, sector* and *country* at a certain stage contain the names "oil", "in" (short for industry) and "nor" (short for Norway). By concatenating (the content of) the three variables and an explicit text string, like *name* = *fuel* || "co2" || *sector* || *country,* we get *name* = "oilco2innor". In TROLL the construct *&name* returns the content of the variable *name*. Hence the macro command >>*DOFILE &name* = ... here equals the TROLL command "DOFILE oilco2innor = ...", which files the right hand side of the equation as the disaggregated CO_2 emission from oil consumption in Norwegian industries in a disk variable named "oilco2innor". The alternative of an indexed variable (e.g. $emission_{c,s,f}$) would not reveal its content, thus yielding an incomprehensible code. This would hamper or effectively block code maintenace. Besides, it would create a problem of naming the disk variable.

The macro is extensively commented, to such an extent that we only sketch an outline:

1. User interface and initialization,
2. For c = first_country to last_country
   for s = first_sector to last_sector
     for f = first_fuel_within_sector to last_fuel_within_sector
       update relevant variables;
       if final update store variables;
3. Store rest of the variables.

5.2 Presentation of the Troll Macro seemsum

```
/* The Portable TROLL macro: SEEMSUM.                                                                                    */

/* Programmed by: Dag Kolsrud, SRM, Research Department, Statistics Norway                                              */
/* Updates: Version 1 in December 1994 by Dag Kolsrud                                                                   */

/* Purpose: Either to (1) sum up energy consumption figures or (2) calculate and sum up CO2-emission figures for        */
/* several European countries. A third task of calculating and summing up fuel expenditure can be implemented the same  */
/* way as the CO2-emission.                                                                                             */

/* Short description: This macro does the following:                                                                    */
/* - decides whether to calculate (1) consumption or (2) emmision figures from user's choice input,                     */
/* - reads from a TROLL FORMDATA file disaggregated energy consumption figures for various fuel-sector-country,         */
/* - initializes and updates aggregates with disaggregates in single and nested loops through fuels, sectors and countries, */
/* - stores the aggregates in an ouput FORMDATA file after final updates.                                               */

/* Details: The calculations are performed by traversing the 3 "dimensions" of country-, sector- and fuel specific energy */
/* consumption figures, calculating disaggregated and/or aggregated figures. The structure of the calculations are the same */
/* in both cases (1) and (2), hence the two tasks of aggregating energy consumption figures and calculating and aggregating */
/* emission figures can be gathered into one single macro. The macro prompts the user to choose between the two tasks   */
/* (1) and (2), which are independent of each other. The user also has to provide a number for the scenario for which the */
/* consumption or emission aggregates are to be calculated.                                                             */
/*                                                                                                                      */
/* The SEEM model has 13 countries:AUstria, BElgium, BundesRepublik, Canton Helvetica, DenmarK, FRance, Great Britain,  */
/* ITaly, NetherLands, NOrway, Suomi Finland, SPain and SWeden: (AU, BE, BR, CH, DK, FR, GB, IT, NL, NO, SF, SP, SW).   */
/* There are 4 STationary sectors: ELectricity, HOseholds, INdustry and SErvices: (EL, HO, IN, SE), and 3 MObile sectors: */
/* Transport Passengers, Transport Freigth and Freight Air: (TP, TF, FA). The stationary sectors use 6 fuels: NUClear power, */
```

```
/* RENewables, COAl, OIL, Natural GaS and ELEctricity: (NEC, REN, COA, OIL, NGS, ELE), while the mobile sectors use      */
/* 8 fuels: Bus Diesel, GAs, GasOline, Rail Electricity, Rail Diesel, DIesel, ELectricity and OIl: (BD, GA, GO, RE, RD, BD, DI,  */
/* EL, OI). TROLL FORMDATA files output from the SEEM model contain disaggregated country-sector-fuel specific energy      */
/* consumption data in the form of time series. Some series may be equal to zero. Not all fuels and sectors combine, e.g.   */
/* there is no use of ELEctricity in the production of ELEctricity, and some fuels are transport specific, e.g. Rail Diesel in the */
/* sector Transport Passengers.                                                                                            */
/*                                                                                                                         */
/* For the STationary sources this macro calculates (2) disaggregated CO2-emissions from each of                           */
/*       1: #countries x 4 x 3 = #countries x 12 <= 156 country-sector-fuel combinations, contained in the TROLL variables  */
/*          fuel_CO2_sector_country (see below for explanations of the composition of names),                              */
/* and/or (2 or 1) it sums up disaggregated energy consumption figures or the calculated emission figures for              */
/*       2: #countries x 4 <= 52 totals for the country-sector combinations (aggregating over all STationary fuels), named  */
/*          ENR_{CON or CO2}_sector_country,                                                                               */
/*       3: #countries x (6 or 3) <= 78 or 39 totals for the country-fuel combinations (aggregating over ST sectors), named */
/*          fuel_{CON or CO2}_ST_country,      (= fuel_{CON or CO2}_TO_country (except for NGS, cf 31), which is omitted)  */
/*       4: (5 or 3) + 3 x (4 or 3) = (17 or 12)  totals for the fuel in sector combinations (aggregating over all countries), named */
/*          fuel_{CON or CO2}_sector_EU     (or country-aggregate codes - C#countries, e.g. C3 - if a subset of countries), */
/*       5: #countries <= 13 totals for the countries (aggregating over all STationary fuels and sectors), named            */
/*          ENR_{CON or CO2}_ST_country,                                                                                   */
/*       6: 4 totals for the sectors (aggregating over all STationary fuels and all countries), named                      */
/*          ENR_{CON or CO2}_sector_EU,                                                                                    */
/*       7: 6 or 3 totals for the fuels (aggregating over all STationary sectors and all countries), named                 */
/*          fuel_{CON or CO2}_ST_EU,              (= fuel_{CON or CO2}_TO_EU (except for NGS, cf 32), which is omitted)    */
/*       8: 1 total for the STationary sources (aggregating over all STationary country-sector-fuel combinations), named   */
/*          ENR_{CON or CO2}_ST_EU,                                                                                        */
/* where 4 or 3 refers to 4 CONsumption or 3 CO2 aggregates, since the fuel ELE emits no CO2. The numbering corresponds    */
/* to the numbered TROLL code statements in the macro. This sums up to (1) #countries x 11 + 28 <= 171 consumption         */
/* aggregates or (2) #countries x 12 <= 156 disaggregated and #countries x 8 + 20 <= 124 aggregated emissions in the       */
/* STationary sectors.                                                                                                     */
/*                                                                                                                         */
/* For the MObile sources this macro calculates (2) disaggregated CO2-emissions from each of                               */
/*       9: #countries x (5 + 2 + 1) = #countries x 8 <= 104 country-fuel in sector combinations, named                    */
/*          fuel_{CON or CO2}_sector_country,                                                                              */
/* and/or (2 or 1) it sums up disaggregated energy consumption figures or the calculated emission figures for              */
/*       10: #countries x 2 <= 26 totals for the country-sector (TP and TF only, since FA sector uses only one single fuel) */
/*           combinations (aggregating over all MObile fuels), named ENR_{CON or CO2}_sector_country,                      */
/*       11: #countries x 2 <= 26 totals for the country-fuel (DI and OI only, since the other MObile sectors each uses only */
/*           one single fuel) combinations (aggregating over all MObile sectors),                                          */
/*           named fuel_{CON or CO2}_MO_country,               (= fuel_{CON or CO2}_TO_country, which is omitted)          */
/*       12: (6 or 5) + (3 or 2) + 1= (10 or 8) totals for each fuel-sector combination (aggregating over all countries), named */
/*           fuel_{CON or CO2}_sector_EU,                                                                                  */
/*       13: #countries <= 13 totals for the countries (aggregating over all MObile fuels and sectors), named              */
/*           ENR_{CON or CO2}_MO_country,                                                                                  */
/*       14: 2 totals for sectors TP and TF (FA uses only OI, aggregating over all MObile fuels and all countries), named  */
/*           ENR_{CON or CO2}_sector_EU,                                                                                   */
/*       15: 2 totals for the fuels DI and OI, cf. 11 (aggregating over all MObile sectors and all countries), named       */
/*           fuel_{CON or CO2}_MO_EU,                            (= fuel_{CON or CO2}_TO_EU, which is omitted)             */
/*       16: 1 total for the MObile sources (aggregating over all MObile country-sector-fuel combinations), named          */
/*           ENR_{CON or CO2}_MO_EU.                                                                                       */
/* This sums up to (1) #countries x 5 + 15 <= 80 consumption aggregates or (2)  #countries x 8 <= 104 disaggregated        */
/* and #countries x 5 + 13 <= 78 aggregated emissions in the MObile sectors.                                               */
/*                                                                                                                         */
/* The STationary and the MObile sectors together are summed up by the following:                                          */
/*       17: #countries totals for each country (the sum of STationary total and MObile total in each country), named      */
/*           ENR_{CON or CO2}_TO_country,                                                                                  */
/*       18: 1 total for all STationary and MObile sources (aggregating over everything), named                            */
/*           ENR_{CON or CO2}_TO_EU,                                                                                       */
/* This sums up to #countries + 1 <= 14 consumption or emission aggregates. Since each fuel is specific to the STationary  */
/* and the MObile sectors there is no fuel TOtal (which would equal the ST and MO total).                                  */
```

```
/*                                                                                                              */
/* In addition come some special aggregates. First, the sector aggregate called Final Consumption = TOtal - ELctricity     */
/* producing STationary sector yields the extra aggregates:                                                     */
/*        19: #countries x (3 or 2) <= (39 or 26) FC totals for the country-fuel combinations (aggregating over the fuels   */
/*             COA, NGS (and ELE if not CO2 calculations) in ST sectors HO, IN and SE. The FC total for OIL containing oil   */
/*             fuels in MO sectors is calculated in 25), named fuel_{CON or CO2}_FC_country,                  */
/*        20: 3 or 2 FC totals for the fuels (aggregating over the fuels COA, NGS (and ELE if not CO2 calculations) in ST    */
/*             sectors HO, IN and SE. The FC total for OIL containing oil fuels in MO sectors is calculated in 28), named   */
/*             fuel_{CON or CO2}_FC_EU,                                                                          */
/*        21: #countries <= 13 FC totals for the countries (aggregating over all ST fuels and FC sectors), named       */
/*             ENR_{CON or CO2}_FC_country,     (= ENR_{CON or CO2}_TO_country - ENR_{CON or CO2}_EL_country),   */
/*        22: 1 total for the FC sectors (aggregating over all country-FC sector-ST fuel combinations), named           */
/*             ENR_{CON or CO2}_FC_EU,       (= ENR_{CON or CO2}_TO_EU - ENR_{CON or CO2}_EL_EU).               */
/* This sums up to #countries x 4 + 4 <= 56 consumption or #countries x 3 + 3 <= 42 emission aggregates.         */
/*                                                                                                              */
/* Second, the fuel aggregates OIL = BD+GO+RD+DI+OI in MO sectors (not RE and EL in MO sectors) plus OIL in       */
/* ST sectors. This yields the extra aggregates:                                                                */
/*        23: #countries x 2 <= 26 OIL totals for the country-TP and -TF sector specific combinations, named      */
/*             OIL_{CON or CO2}_{TP and TF}_country,                                                             */
/*        24: #countries <= 13 OIL totals for the country-MO sectors specific combinations, named                */
/*             OIL_{CON or CO2}_MO_country,                                                                      */
/*        25: #countries x 2 <= 26 OIL totals for the country-FC and -TO sector specific combinations, named      */
/*             OIL_{CON or CO2}_{FC and TO}_country,                                                             */
/*        26: 2 OIL totals for the TP and TF sectors (aggregating over all countries), named                     */
/*             OIL_{CON or CO2}_{TP and TF}_EU,                                                                  */
/*        27: 1 OIL totals for the MObile sectors (aggregating over all countries), named                        */
/*             OIL_{CON or CO2}_MO_EU,                                                                           */
/*        28: 2 totals for the FC and TO sectors (aggregating over all countries), named                         */
/*             OIL_{CON or CO2}_{FC and TO}_EU.                                                                  */
/* This sums up to #countries x 5 + 5 <= 70 consumption or emission aggregates. Since FA sector uses only one OIL product */
/* OI, it is not included in the fuel-sector aggregates (i.e. in 23 and 26).                                    */


/* Third, the fuel consumption aggregate ELE = RE+EL in MO sectors and ELE in ST sectors, yielding the extra aggregates: */
/*        29: #countries x 2 <= 26 OIL totals for the country-MO and -TO sector specific combinations, named      */
/*             ELE_CON_{MO and TO}_country,                                                                      */
/*        30: 2 ELE totals for the MO and TO sectors, (aggregating over all countries), named                    */
/*             ELE_CON_{MO and TO}_EU.                                                                           */
/* This sums up to #countries x 2 + 2 <= 28 consumption aggregates. There is no calculation of ELEctricity aggregate if  */
/* CO2 emissions are calculated, since ELEctricity emits no CO2.                                                 */
/*                                                                                                              */
/* Fourth, the fuel aggregate NGS = GA in MO sectors and NGS in ST sectors, yielding the extra aggregates:       */
/*        31: #countries  <= 13 gas totals for the country (aggregating over all ST sectors and TP sectors), named   */
/*             NGS_{CON or CO2}_TO_country,                                                                      */
/*        32: 1 NGS total (aggregating over all countries) named                                                 */
/*             NGS_{CON or CO2}_TO_EU.                                                                           */
/* This sums up to #countries + 1 <= 14 consumption or CO2 aggregates.                                          */
/*                                                                                                              */
/* The total number of calculated new series are (1) #countries x 29 + 56 <= 433 consumption aggregates or      */
/* (2) #countries x 43 + 43 <= 602 emission variables.                                                          */

/* Macro programming: The macro uses local variables to hold both scalar constants and strings that are letter codes for */
/* the fuels, sectors and countries. Looping through the fuels, sectors and countries the letter codes are concatenated  */
/* into names of temporary TROLL variables. These memory (not disk) variables are initialized to zero and then updated with */
/* disaggregated figures in (nested) loops. The disaggregated figures are read from FORMDATA output files from simulations */
/* of the SEEM model. In the case of calculating emmision figures, the consumption disaggregates are first multiplied with */
/* emission coefficients. (Fuel expenditurs can be calculated the same way, by multiplying consumption figures with fuel */
/* prices (and exchange rates)). After final updates the temporary TROLL variables are written into an output FORMDATA   */
/* file. The number of the input scenario is used for naming both the input files and the single output file.    */
```

```
/*                                                                                                                   */
/* Names of the aggregate energy consumption or CO2-emission variables written to the output FORMDATA file          */
/* are all concatenations of 4 components:                                                                           */
/*      1: a disaggregated fuel code or the all fuels aggregated code ENR,                                           */
/*      2: the energy consumption code CON or the CO2-emission code CO2,                                             */
/*      3: a single sector code or one of the sector aggregation codes ST, MO, FC or TO,                             */
/*      4: a single country code or the code for the number of countries included in the summation C# or EU.        */
/* A disaggregated output variable may e.g. be named OIL_CO2_HO_NO, while a most aggregated variable may be          */
/* named ENR_CON_TO_EU, where the _ separating the different components of the names is dropped when storing         */
/* the files in the FORMDATA file on disk.                                                                           */


ADDFUN MAIN;
PROCEDURE MAIN()
BEGIN;

/* ------------------------------------------------------ USER INTERFACE AND INITIALIZING ------------------------------------------------------ */

   /* First the user decides whether the macro should calculate emission figures or only sum up the energy consumption   */
   /* figures already simulated. Later, the, boolean variables will decide whether energy consumption figures have to be */
   /* multipied with CO2-emission coefficients:                                                                          */

   GET FROM TERMINAL NUMBER task "\n Answer 1 for summing energy consumption or 2 for \n for calculating and
summing CO2-emission figures. \n Any other answer terminates the macro: ";
   co2_emission = task == 2;                   /* TRUE implies calculating CO2-emissions and all their aggregates */
   energy_summation = task == 1;               /* TRUE implies calculating all aggregates of energy consumptions */

   /* Electricity, nuclear power and renewables count when summing up energy consumption, but not when calculating     */
   /* CO2-emission. Hence the difference in (the numbers of) STationary fuels in the two cases. For the STationary     */
   /* sectors we have that                                                                                           */
   /*   EL sector uses              NUC, REN, COA, OIL, NGS,     i.e. fuel no. 1 to 5, while emitting from COA, OIL NGS, */
   /*   HO, SE and IN sector uses         COA, OIL, NGS, ELE,    i.e. fuel no. 3 to 6, while emitting from COA, OIL NGS, */

   /* Rail Electricity and ELectricity count when summing up energy consumption, but not when calculating CO2-emmision. */
   /* For the MObile sectors we have that                                                                            */
   /*   TP sector uses BD, GA, GO, RE, RD, DI,          i.e. fuel no. 1 to 6, while emitting from all but RE,           */
   /*   TF sector uses                      DI, EL, OI, i.e. fuel no. 6 to 8, while emitting from DI and OI,            */
   /*   FA sector uses and emits from            OI, i.e. fuel no. 8.                                                   */

   IF (energy_summation) THEN BEGIN;            /* The consumption of hydroelectric energy (ELE and RE and EL) counts */
      summ          = "CON";                     /* Name postfix reflecting summation of energy consumption figures */
      ST_fuel       = COMBINE("NUC", "REN", "COA", "OIL", "NGS", "ELE");
      final_ST_fuel = 6;
      MO_fuel       = COMBINE("BD", "GA", "GO", "RE", "RD", "DI", "EL", "OI");
      final_MO_fuel = 8;
      final_TP_fuel = 6;                                                               /* TP uses the first 6 fuels */
   END; /* IF energy_consumption */
   ELSE IF (co2_emission) THEN BEGIN;                 /* Hydroelectric energy does not contribute to any CO2-emission */
      summ          = "CO2";                     /* Name postfix reflecting calculation of emmision consumption figures */
      coef_NGS      = 0.0024;                            /* Amount of CO2-emission pr energy unit of the various fuels */
      coef_GA       = 0.0024;
      coef_OIL      = 0.0031;
      coef_BD       = 0.0031;
      coef_GO       = 0.0031;
      coef_RD       = 0.0031;
      coef_DI       = 0.0031;
      coef_COA      = 0.0039;
      ST_coef       = COMBINE(coef_COA, coef_OIL, coef_NGS);            /* Array corresponding to the array ST_fuel */
      ST_fuel       = COMBINE("COA", "OIL", "NGS");       /* NUC, REN and ELE is ommited due to zero CO2 emission */
```

```
        final_ST_fuel   = 3;
        MO_coef         = COMBINE(coef_BD, coef_GA, coef_GO, coef_RD, coef_DI, coef_OIL);
        MO_fuel         = COMBINE("BD", "GA", "GO", "RD", "DI", "OI");  /* RE and EL is ommited due to zero CO2 emission */
        final_MO_fuel   = 6;
        final_TP_fuel   = 5;                                 /* TP uses the first 5 fuels (which all emit CO2) */
    END; /* IF CO2_emission */
    ELSE BEGIN; PRINT("\n Wrong answer, ending macro! "); EXIT(); END;                /* Error message and exit */

    /* The user then decides whether to sum up for a single country, a few countries or for all 13 countries:      */

    GET FROM TERMINAL choice "\n Decide what countries to sum up. Answer the letter S \n for a singel country, the letter M
for many (or a few) countries \n or the letter A for all 13 countries. \n Any other answer terminates the macro: ";
    choice = UPPER(choice);                                                  /* User's choice = S, M or A */
    single_country = choice == "S";
    many_countries = choice == "M";
    all_countries = choice == "A";

    IF (single_country) THEN BEGIN;                                    /* Construct a single entry array */
        GET FROM TERMINAL answer "\n Give ONE SINGLE country code from the following: AU, BE, \n BR, CH, DK, FR,
GB, IT, NL, NO, SF, SP or SW: ";
        all_country = COMBINE(UPPER(answer));                                   /* Single country code */
        final_country = 1;
        geo = "C1";                                                     /* Code for country aggregation */
    END; /* IF single_country */

    ELSE IF (many_countries) THEN BEGIN;              /* Construct an array with user's country codes as entries */
        all_country = COMBINE();                                          /* Empty array of zero length */
        final_country = 0;                                                             /* Initializing */
        GET FROM TERMINAL answer "\n List countries by the following codes: \n AU, BE, BR, CH, DK, FR, GB, IT, NL, NO,
SF, SP or SW \n separated by blanks and terminated bya blank and \n a semicolon (e.g. like NO SF SW ;): ";
        WHILE (answer <> ";") BEGIN;                                          /* Not finnished country input */
            all_country = COMBINE(all_country, UPPER(answer));           /* Adding next country to the array */
            final_country = final_country + 1;
            GET FROM TERMINAL answer;
        END; /* WHILE answer */
        geo = "C" || CONVERT(final_country);                       /* CONVERT changes number to string */
        IF (final_country == 0) THEN BEGIN; PRINT("\n Wrong option, ending macro! "); EXIT(); END;  /* Error message, exit */
    END; /* IF many_countries */

    ELSE IF (all_countries) THEN BEGIN;
        all_country = COMBINE("AU", "BE", "BR", "CH", "DK", "FR", "GB", "IT", "NL", "NO", "SF", "SP", "SW");
        final_country = 13;
        geo = "EU";                                                     /* Code for country aggregation */
    END; /* IF all_countries */
    ELSE BEGIN; PRINT("\n Wrong option, ending macro! "); EXIT(); END;                 /* Error message and exit */

    /* Then the SEEM simulation scenario on which to base the calculations have to be input. Later the scenario number goes */
    /* into the name of the FORMDATA or FAME file containing the individual TROLL files (variables). The user chooses     */
    /* between storing the output in a FORMDATA or FAME database:                                                          */

    GET FROM TERMINAL scenario "\n Give the name code (is or fs) of the scenario which data to calculate/summarize: ";
    GET FROM TERMINAL format "\n Write FORM for FORMDATA output or FAME for FAMEDATA output: ";

    /* ---------------------------------------------- CALCULATING, UPDATING AND STORING ------------------------------------------------ */

    /* Putting sector codes into vectors. The sectors are the same no matter what the user answers:                       */

    ST_sector           = COMBINE("EL", "HO", "IN", "SE");
    final_ST_sector     = 4;
```

```
MO_sector          = COMBINE("TP", "TF", "FA");                              /* Vital order of MO sectors */
final_MO_sector    = 3;

/* The calculated TROLL DATA files will be written into one single FORMDATA or FAME file (for all countries), containing   */
/* disaggregated and aggregated emissions or aggregated energy use. The filename is converted to lowercase letters,        */
/* being common in the UNIX environment:                                                                                    */

IF (UPPER(format) == "FAME" ) THEN                  /* The (name of the) FORMDATA file to be written does already exist */
    out_file = LOWER("sum" || scenario || summ || ".db");            /* Concatenating name of FAMEDATA file to write */
ELSE
    out_file = LOWER("sum" || scenario || summ);                     /* Concatenating name of FORMDATA file to write */
IF (HOSTEXIST(out_file)) THEN BEGIN;                /* The (name of the) FORMDATA file to be written does already exist */
    PRINT("Deleting existing formdata file: ", out_file);                                /* Informing user of macro */
    >> HOST "rm -f &out_file";                              /* Unix command to delete any existing file by the same name */
END;

>> ACCESS outfile TYPE &(format)DATA ID &(out_file) MODE CREATE;          /* Creating new FORM- or FAMEDATA file */
>> SEARCH DATA outfile W;                                           /* Set up to write results to the accessed outputfile */

/* Main loop through the 13 countries. Both the STationary and the MObile sources are dealt with in this loop:            */

FOR (i = 1; i <= final_country; i = i + 1) BEGIN;                                        /* Looping through the countries */
    first_country = i == 1;                                                                         /* =TRUE or FALSE */
    last_country = i == final_country;                                                              /* =TRUE or FALSE */
    country = all_country[i];                                                       /* Getting country name from vector */

    /* The TROLL DATA files containing the simulation results for the specified scenario are read from a single            */
    /* FORMDATA file for each country. All disaggregated energy consumption figures are read from this file:               */

    informfile = LOWER(country || "/" || country || "out" || scenario || ".txt");          /* Name of FORMDATA file to read */
    IF (NOT HOSTEXIST(informfile)) THEN BEGIN; PRINT("Does not find the formdata file: ", informfile); EXIT(); END;
    >> ACCESS infile TYPE FORMDATA ID &informfile MODE R;
    >> SEARCH FIRST DATA infile;                                             /* Ready to read energy use in current country */

    /* -------------------------------------------------------- STATIONARY SOURCES ---------------------------------------------------------- */

    /* For each country looping through 4 or 3 fuels within 4 sectors calculating all CO2-emissions or energy-use          */
    /* aggregates for the STationary sources:                                                                               */

    FOR (j = 1; j <= final_ST_sector; j = j + 1) BEGIN;                   /* Looping through 4 sectors: EL, HO, IN and SE */
        first_ST_sector = j == 1;                                                                   /* =TRUE or FALSE */
        second_ST_sector = j == 2;                               /* =TRUE if first Final Consumption sector else FALSE */
        last_ST_sector = j == final_ST_sector;                                                    /* = FALSE or TRUE */
        sector = ST_sector[j];                                                       /* Getting sector name from vector */

        /* Deciding which fuels to scan depending on type of calculation (CO2 or not) and current sector. Then scan:        */

        first = 1;                                                                                /* Default start index */
        last = final_ST_fuel;                                                                       /* Default end index */
        IF (energy_summation) THEN              /* only first or last has to be altered (ELSE first and last are correct) */
            IF (sector == "EL") THEN           /* If calculating CO2-emission no emission from NUC, REN and ELE fuel */
                last = 5;                                                /* last = 5 since EL sector uses no ELE fuel */
            ELSE first = 3;                                           /* first = 3 since NUC and REN only in EL sector */

        FOR (k = first; k <= last; k = k + 1) BEGIN; /* Looping through 3 fuels: COA, OIL, NGS (and ELE), with ELE only... */
            first_ST_fuel = k == first;
            last_ST_fuel = k == last;                                                                 /* = FALSE or TRUE */
            fuel = ST_fuel[k];                                                      /* Getting country name from vector */
            variable = fuel || "CON" || sector || country;                                       /* Concatenating filename */
```

```
/* 1: Calculating and storing #countries x 4 x 3 = #countries x 12 <= 156 country-sector-fuel specific emission */
/* disaggregates or just reading country-sector-fuel specific energy consumptions: */

IF (co2_emission) THEN BEGIN;                                   /* Calculating disaggregated CO2-emission */
    co2_coef = ST_coef[k];                                      /* Getting the right emission coeffisient */
    >> DOCORE fuel_use = GETDATA("&variable", -1);              /* Reading consumption from file */
    >> DOCORE disaggregate = &(co2_coef) * fuel_use;            /* CO2-emission in fuel-sector-country */
    name = fuel || "CO2" || sector || country;                  /* Concatenating name of FORMDATA file variable */
    >> DO PUTDATA(disaggregate, "&name", -1);                   /* Write emission to disk file variable */
END; /* IF co2_emission */
ELSE >> DOCORE disaggregate = GETDATA("&variable", -1);         /* Only energy consumptions */

/* 3: Initializing, updating and/or storing #countries x (6 or 3) <= (78 or 39) totals for the country-fuel */
/* combinations (aggregating over all ST sectors): */

variable = fuel || "_" || summ || "_ST_" || country;            /* Name of local variable */
IF (first_ST_sector) THEN                                       /* EL sector */
    >> DOCORE &variable = disaggregate;                         /* Initializing */
ELSE BEGIN;                                                     /* Not EL sector */
    IF (second_ST_sector AND fuel == "ELE") THEN
        >> DOCORE &variable = disaggregate;                     /* Initializing ELE_CON_ST_country */
    ELSE >> DOCORE &variable = &variable + disaggregate;        /* Updating with sector's emission/usage */

    /* 19: In addition: #countries x (3 or 2) <= (39 or 26) Final Consumption totals = ST total - fuel in EL sector. */
    /* The variable OIL_&summ_FC_&country is not stored after final update since OIL_&summ_MO_&country */
    /* has to be added before storing it on disk. */

    xtra_variable = fuel || "_" || summ || "_FC_" || country;   /* Name of an extra local variable */
    IF (second_ST_sector) THEN
        >> DOCORE &xtra_variable = disaggregate;                /* Initializing FC total for fuel or... */
    ELSE >> DOCORE &xtra_variable = &xtra_variable + disaggregate;    /* ...updating */

    IF (last_ST_sector) THEN BEGIN;                             /* Final sector hence store... */
        IF (fuel <> "OIL") THEN                                 /* ...non OIL fuel in a... */
            >> DO PUTDATA(&xtra_variable, "&(fuel)&(summ)FC&country", -1);   /* ...fuel-country FC-total */
        >> DO PUTDATA(&variable, "&(fuel)&(summ)ST&country", -1);   /* ...ST-total from fuel-country */

        /* 7: Last sector in country: the country total can be added to the ST total (aggregating over all ST */
        /* sectors and all countries to get 6 or 3 totals). Note that 'variable' contains the country's ST total. */
        /* 20: In parallel with 7: initializing, updating and storing 3 or 2 fuel-FC totals. The variable */
        /* OIL_&summ_FC_&geo needs updating with the MObile total before storing (hence it is not stored) */
        IF (first_country) THEN BEGIN;
            >> DOCORE &(fuel)_&(summ)_FC_&geo = &xtra_variable;     /* Initializing FC total */
            >> DOCORE &(fuel)_&(summ)_ST_&geo = &variable;          /* Initializing ST total */
        END; /* IF first country */
        ELSE BEGIN;                                                 /* Updating and storing */
            >> DOCORE &(fuel)_&(summ)_FC_&geo = &(fuel)_&(summ)_FC_&geo + &xtra_variable;
            >> DOCORE &(fuel)_&(summ)_ST_&geo = &(fuel)_&(summ)_ST_&geo + &variable;
            IF (last_country) THEN BEGIN;                           /* Final country for fuel hence storing */
                IF (fuel <> "OIL") THEN
                    >> DO PUTDATA(&(fuel)_&(summ)_FC_&geo, "&(fuel)&(summ)FC&geo", -1);  /* Non OIL */
                >> DO PUTDATA(&(fuel)_&(summ)_ST_&geo, "&(fuel)&(summ)ST&geo", -1);
            END; /* IF last country */
        END; /* ELSE not first country */
    END; /* IF last ST sector */
END; /* ELSE not first ST sector */

/* 4: Initializing, updating and/or storing (5 or 3) + 3 x (4 or 3) =(17 or 12) totals for the fuel in sector */
/* combinations (aggregating over all countries): */
```

```
        variable = fuel || "_" || summ || "_" || sector || "_" || geo;                    /* Name of local variable */
        IF (first_country) THEN
            >> DOCORE &variable = disaggregate;                                            /* Initializing or... */
        ELSE BEGIN;
            >> DOCORE &variable = &variable + disaggregate;              /* ...updating with country's emission/fuel */
            IF (last_country) THEN                                                        /* Final country: store... */
                >> DO PUTDATA(&variable, "&(fuel)&(summ)&(sector)&geo", -1);         /* ...total from fuel in sector */
        END; /* ELSE not first country */

        /* 2: Initializing or updating (and storing immediately after the fuel-loop) #countries x 4 <= 52 totals for the   */
        /* country-sector combinations (aggregating over all STationary fuels):                                            */

        variable = "ENR_" || summ || "_" || sector || "_" || country;                    /* Name of local variable  */
        IF (first_ST_fuel) THEN
            >> DOCORE &variable = disaggregate;                                            /* Initializing or... */
        ELSE >> DOCORE &variable = &variable + disaggregate;         /* ...updating with fuel emission/consumption */
    END; /* fuel-loop */
    >> DO PUTDATA(&variable, "ENR&(summ)&(sector)&country", -1);              /* Storing total from sector-country */

    /* 6: Initializing, updating and/or storing 4 totals for the sectors (aggregating over all STationary fuels and all   */
    /* countries). Note that variable = ENR_&(summ)_&(sector)_&country from above:                                        */

    xtra_variable = "ENR_" || summ || "_" || sector || "_" || geo;                        /* Name of local variable */
    IF (first_country) THEN
        >> DOCORE &xtra_variable = &variable;                  /* Initializing with first country's sector total or... */
    ELSE BEGIN;
        >> DOCORE &xtra_variable = &xtra_variable + &variable;                                    /* ... updating with it */
        IF (last_country) THEN                                                             /* Final country for sector... */
            >> DO PUTDATA(&xtra_variable, "ENR&(summ)&(sector)&geo", -1);                   /* ...storing total from sector */
    END; /* ELSE not first country */
    /* 5: Initializing or updating (and storing immediately after the sector-loop) #countries <= 13 totals for the countries */
    /* (aggregating over all STationary fuels and sectors). Note that from above we have                                     */
    /* variable = ENR_&(summ)_&(sector)_&country:                                                                            */

    xtra_variable =  "ENR_" || summ || "_ST_" || country;                                     /* Name of local variable */
    IF (first_ST_sector) THEN
        >> DOCORE &xtra_variable = &variable;                  /* Initializing with first country's sector total or... */
    ELSE >> DOCORE &xtra_variable = &xtra_variable + &variable;                                  /* ...or updating with it */
END; /* sector-loop */
>> DO PUTDATA(&xtra_variable, "ENR&(summ)ST&country", -1);                                  /* Storing total ST-country */

/* 8: Initializing and updating (and storing after the country-loop) 1 total for from STationary sources (aggregating      */
/* over all STationary country-sector-fuel combinations). Update ST total with country-ST total. Note that we have         */
/* xtra_variable = ENR_&(summ)_ST_&country from above:                                                                     */

variable =  "ENR_" || summ || "_ST_" || geo;                                                   /* Name of local variable */
IF (first_country) THEN
    >> DOCORE &variable = &xtra_variable;                                                        /*  Initializing total ST */
ELSE>> DOCORE &variable = &variable + &xtra_variable;                                     /* updating total ST with country */

/* ------------------------------------------------------- MOBILE SOURCES ------------------------------------------------------- */

/* For each country looping through different fuel subset within the 3 sectors TP, TF and FA calculating all              */
/* CO2-emissions or energy-use aggregates for the MObile sources:                                                          */

FOR (j = 1; j <= final_MO_sector; j = j + 1) BEGIN;                /* Looping through 3 MObile sectors: TP and TF and FA */
    first_MO_sector = j == 1;                                                                       /* = TRUE or FALSE */
    last_MO_sector = j == final_MO_sector;                                                          /* = FALSE or TRUE */
    sector = MO_sector[j];
```

```
/* Deciding which fuels to loop through for the current sector, as different MObile sectors use different fuels:          */

IF (sector == "TP") THEN BEGIN;                          /* TP uses the 5/6 first fuels BD, GA, GO, (RE), RD and DI*/
    first_fuel = 1;
    last_fuel = final_TP_fuel;                                                                          /* = 6 or 5 */
END; /* IF TP-sector */
ELSE IF (sector == "TF") THEN BEGIN;                     /* TF uses the 3/2 next fuels DI, (EL) and the oil product OI */
    first_fuel = final_TP_fuel;                                                     /* = 6 if CONsumption or 5 if CO2 */
    last_fuel = final_MO_fuel;                                                      /* = 8 if CONsumption or 6 if CO2 */
END; /* IF TF-sector */
ELSE BEGIN;                                                                  /* FA sector uses only the oil product OI */
    first_fuel = final_MO_fuel;                                                     /* = 8 if CONsumption or 6 if CO2 */
    last_fuel = first_fuel;
END; /* IF FA-sector */

/* For each sector in each country loop through a subset of BD, GA, GO, (RE,) RD, DI, (EL) and OI:                      */

FOR (k = first_fuel; k <= last_fuel; k = k + 1) BEGIN;      /* Looping through 6 or 5 and 3 or 2 and finally just 1 fuel */
    first_sector_fuel = k == first_fuel;                                                         /* = TRUE or FALSE */
    last_sector_fuel = k == last_fuel;                                                           /* = FALSE or TRUE */
    first_MO_fuel = k == 1;                                                                      /* = TRUE or FALSE */
    last_MO_fuel = k == final_MO_fuel;                                                           /* = FALSE or TRUE */
    fuel = MO_fuel[k];                                                                /* Getting fuel name from vector */
    IF (fuel == "OI") THEN
        SEEM_fuel = "OIL";            /* SEEM output fuel name = OIL different from macro output fuel name = OI */
    ELSE SEEM_fuel = fuel;                                          /* SEEM output fuel name = macro output fuel name */
    variable = SEEM_fuel || "CON" || sector || country;               /* Concatenating name of SEEM output variable */


    /* 9: Calculating #countries x 8 <= 104 emissions or reading energy disaggregates in sector-country:                */

    IF (co2_emission) THEN BEGIN;                                                /* Calculating disaggregated CO2-emission */
        co2_coef = MO_coef[k];                                                     /* Getting the right emission coeffisient */
        >> DOCORE fuel_use = GETDATA("&variable", -1);                                /* Reading consumption from file */
        >> DOCORE disaggregate = &(co2_coef) * fuel_use;                            /* CO2-emission in fuel-sector-country */
        name = fuel || "CO2" || sector || country;                        /* Concatenating name of FORMDATA file variable */
        >> DO PUTDATA(disaggregate, "&name", -1);                                 /* Writing emission to disk file variable */
    END; /* IF co2_emission */
    ELSE BEGIN;                                                                                 /* Energy consumption is... */
        >> DOCORE disaggregate = GETDATA("&variable", -1);                                 /*... fuel-sector-country specific */

        /* 29: If fuel is electricity, calculating #countries x 2 <= 26 ELE-CON totals for MO and TOT country. The 2 */
        /* ELE fuels in the MO sectors are visited once, hence we do the storing once in the fuel-sector loop:          */

        IF (fuel == "RE") THEN                                                                   /* El-consumption in TP sector */
            >> DOCORE ELE_CON_MO_&country = disaggregate;                          /* initializing El aggregate for country */
        ELSE IF (fuel == "EL") THEN BEGIN;                                                       /* El-consumption in TF sector */
            variable = "ELE_CON_MO";                             /* Updating El aggregate for country with consumption in ... */
            >> DOCORE &(variable)_&country = &(variable)_&country + disaggregate;                            /* ...TF sector */
            >> DO PUTDATA(&(variable)_&country, "ELECONMO&country", -1);                              /* ...and storing total */
            xtra_variable = "ELE_CON_TOT";                                                     /* Total ELEctricity consumption */
            >> DOCORE &(xtra_variable)_&country = &(variable)_&country + ELE_CON_ST_&country;
            >> DO PUTDATA(&(xtra_variable)_&country, "ELECONTOT&country", -1);                                /* ...and storing */

            /* 30: Initializing and updating 2 ELEctricity consumption MO and TOT total:                                 */

            IF (first_country) THEN                                                  /*Initializing total MObile ELE-consumption */
                >> DOCORE &(variable)_&geo = &(variable)_&country;                    /* ...with consumption in country... */
            ELSE BEGIN;                                                                                        /* ...or updating... */
```

```
        >> DOCORE &(variable)_&geo = &(variable)_&geo + &(variable)_&country;              /* ...with it */
          IF (last_country) THEN BEGIN;
            >> DO PUTDATA(&(variable)_&geo, "ELECONMO&geo", -1);          /* ...and storing total MO */
            >> DOCORE &(xtra_variable)_&geo = &(variable)_&geo + ELE_CON_ST_&geo;
            >> DO PUTDATA(&(xtra_variable)_&geo , "ELECONTOT&geo", -1);            /* ...and storing */
          END; /* IF last country */
        END; /* ELSE IF not first country */
      END; /* ELSE IF last electricity fuel in MObile sectors */
    END; /* ELSE energy consumption */
    IF (fuel == "GA") THEN                              /* Saving disaggregate for operation 31 below */
      >> DOCORE GA_&(summ)_TP_&country = disaggregate;

    /* 11: Initializing updating and/or storing #countries x 2 <= 26 totals for those-fuel combinations that     */
    /* are different from the disaggregates. When a MObile sectoris the only one using the current fuel the     */
    /* aggregate &(fuel)&(summ)MO&country = disaggregate is not stored.                                         */
    /* 15: Aggregating the fuel-country combinations over all countries for the MObile fuels DI and OI, which are */
    /* used in two MO sectors:                                                                                  */

    IF (fuel == "DI") THEN                                                     /* DI in TP and TF sector */
      IF (sector == "TP") THEN                                                            /* Sector = TP */
        >> DOCORE DI_var = disaggregate;                      /* Remembering DI fuel to add to TF's DI series */
      ELSE BEGIN;                                                                         /* Sector = TF */
        >> DOCORE DI_var = DI_var + disaggregate;                       /* Adding DI fuel  to TP's DI series */
        >> DO PUTDATA(DI_var, "DI&(summ)MO&country", -1);               /* ...and storing as DI-country total */
        variable = "DI_" II summ II "_MO_" II geo;                                /* Name of local variable */
        IF (first_country) THEN                                                          /* Total DI fuel*/
          >> DOCORE &variable = DI_var;                                               /*  Initializing or.... */
        ELSE BEGIN;
          >> DOCORE &variable = &variable + DI_var;                                         /* ...updating */
          IF (last_country) THEN                                                 /* Final country for fuel... */
            >> DO PUTDATA(&variable, "DI&(summ)MO&geo", -1);                        /* ...storing fuel total */
        END; /* ELSE not first country */
      END; /* ELSE TF sector */
    ELSE IF (fuel == "OI") THEN                                                /* OI in TF and FA sector */
      IF (sector == "TF") THEN                                                            /* Sector = TP */
        >> DOCORE OI_var = disaggregate;                      /* Remembering OI fuel to add to FA's OI series */
      ELSE BEGIN;                                                                         /* Sector = FA */
        >> DOCORE OI_var = OI_var + disaggregate;                       /* Adding OI fuel  to TF's OI series */
        >> DO PUTDATA(OI_var, "OI&(summ)MO&country", -1);                       /* Storing OI-country total */
        variable = "OI_" II summ II "_MO_" II geo;                                /* Name of local variable */
        IF (first_country) THEN                                                          /* Total OI fuel*/
          >> DOCORE &variable = OI_var;                                               /*  Initializing or.... */
        ELSE BEGIN;
          >> DOCORE &variable = &variable + OI_var;                                         /* ...updating */
          IF (last_country) THEN                                                 /* Final country for fuel... */
            >> DO PUTDATA(&variable, "OI&(summ)MO&geo", -1);                        /* ...storing fuel total */
        END; /* ELSE not first country */
      END; /* ELSE FA sector */

    /* 12: Initialize, update and/or store (6 or 5) + (3 or 2) + 1 = (10 or 8) totals for each fuel-sector combination  */
    /* (aggregating over all countries)                                                                          */

    variable = fuel II "_" II summ II "_" II sector II "_" II geo;                         /* Name of local variable */
    IF (first_country) THEN
      >> DOCORE &variable = disaggregate;                          /* Initialize with value for the first country */
    ELSE BEGIN;                                                                  /* Updating fuel in sector... */
      >> DOCORE &variable = &variable + disaggregate;            /* ...with country's emission/consumption */
      IF (last_country) THEN                                                               /* Final country... */
        >> DO PUTDATA(&variable, "&(fuel)&(summ)&(sector)&geo", -1);        /* ...storing total fuel in sector */
```

```
END; /* ELSE not first country */

/* 23: TP and TF sectors use several oil products, hence initializing, updating and storing the #countries x 2    */
/* <= 26 oil aggregates in TP and TF sector. FA sector is not included since it uses only OI:                      */

IF (fuel <> "GA" AND fuel <> "RE" AND fuel <> "EL") THEN BEGIN;                          /* OIL fuel in sector */
    IF (sector <> "FA") THEN BEGIN;                                                        /* TF or TP sector */
        variable = "OIL_" II summ II "_" II sector II "_" II country;                   /* Name of local variable */
        IF (first_sector_fuel) THEN                            /* Initializing oil aggregate for sector in country... */
            >> DOCORE &variable = disaggregate;                              /* ...with fuel consumption/emission */
        ELSE BEGIN;                                               /* Updating oil aggregate for sector in country... */
            >> DOCORE &variable = &variable + disaggregate;                  /* ...with fuel consumption/emission */
            IF (last_sector_fuel) THEN BEGIN;                                              /* Final update hence... */
                >> DO PUTDATA(&variable, "OIL&(summ)&(sector)&country", -1);                      /* ...storing total */

                /* 26: Updating 2 OIL aggregates in TP and TF sector                                               */

                xtra_variable = "OIL_" II summ II "_" II sector II "_" II geo;             /* Name of local variable */
                IF (first_country) THEN
                    >> DOCORE &(xtra_variable) = &variable;               /* Initializing oil aggregate for sector */
                ELSE BEGIN;
                    >> DOCORE &(xtra_variable) = &(xtra_variable) + &variable;/* Updating sector aggregate */
                    IF (last_country) THEN
                        >> DO PUTDATA(&(xtra_variable), "OIL&(summ)&(sector)&geo", -1); /* ...storing total */
                END; /* ELSE not first country */
            END; /* IF last sector fuel */
        END; /* ELSE not first sector fuel */
    END; /* IF not FA sector */

    /* 24: Initializing, updating and/or storing #countries <= 13 total OIL aggregates in MO sectors in country:  */

    variable = "OIL_" II summ II "_MO_" II country;
    IF (first_MO_sector AND first_MO_fuel) THEN                /* Initializing oil aggregate for MO in country... */
        >> DOCORE &variable = disaggregate;                           /* ...with consumption/emission in sector */
    ELSE BEGIN;                                                    /* Updating oil aggregate for MO in country... */
        >> DOCORE &variable = &variable + disaggregate;               /* ...with consumption/emission in sector */
        IF (last_MO_sector AND last_MO_fuel)  THEN BEGIN;                                /* Final sector update... */
            >> DO PUTDATA(&variable, "OIL&(summ)MO&country", -1);          /* storing total OIL in MO-country */
            >> DOFILE OIL&(summ)FC&country = OIL_&(summ)_FC_&country + &variable;  /* FC i ST + MO */

            /* 27: Initializing, updating and/or storing 1 total OIL consumption/emission in all MObile sectors:   */

            xtra_variable =  "OIL_" II summ II "_MO_" II geo;                              /* Name of local variable */
            IF (first_country) THEN
                >> DOCORE &(xtra_variable) = &variable;                    /* Initializing total oil in MO sectors */
            ELSE BEGIN;
                >> DOCORE &(xtra_variable) = &(xtra_variable) + &variable;                 /* Updating total oil... */
                IF (last_country) THEN BEGIN;
                    >> DO PUTDATA(&(xtra_variable), "OIL&(summ)MO&geo", -1);   /* Storing total in sector */
                    >> DOFILE OIL&(summ)FC&geo = OIL_&(summ)_FC_&geo + &(xtra_variable);
                END; /* IF last country */
            END; /* ELSE not first country */
        END; /* IF last.... */
    END; /* ELSE not first MO sector */
END; /* IF OIL fuel */

/* 10: Updating and storing #countries x 2 <= 26 totals for the country-sector combination (aggregating over   */
/* all MObile fuels). Since FA uses the single OI fuel, only TP and TF are included:                            */
```

```
            variable = "ENR_" II summ II "_" II sector II "_" II country;                    /* Name of local variable */
            IF (sector <> "FA") THEN                                                             /* TP or TF sector */
                IF (first_sector_fuel) THEN                                              /* Initializing fuel total with ... */
                    >> DOCORE &variable = disaggregate;                     /* ...sector's first fuel's emission/consumption */
                ELSE BEGIN;                                                                /* Updating fuel total with ... */
                    >> DOCORE &variable = &variable + disaggregate;             /* ...with fuel's emission/consumption */
                    IF (last_sector_fuel) THEN
                    >> DO PUTDATA(&variable, "ENR&(summ)&(sector)&country", -1);      /* Storingsector-country total */
                END; /* ELSE not first fuel in sector */
            ELSE >> DOCORE &variable = disaggregate;                              /* variable = OI_&(summ)_FA_&country */
        END; /* fuel-loop */

        /* 14: Initializing, updating and storing 2 totals for the sectors TP and TF (aggregating over all MObile fuels and all: */
        /* countries). Since sector FA uses only one fuel OI, there is no fuel aggregation (ENR = OI):                            */

        IF (sector <> "FA") THEN BEGIN;
            xtra_variable = "ENR_" II summ II "_" II sector II "_" II geo;                       /* Name of local variable */
            IF (first_country) THEN
                >> DOCORE &xtra_variable = &variable;                       /* Initializing with first country's sector total */
            ELSE BEGIN;
                >> DOCORE &xtra_variable = &xtra_variable + &variable;            /* Updating with country's sector total */
                IF (last_country) THEN
                    >> DO PUTDATA(&xtra_variable, "ENR&(summ)&(sector)&geo", -1);        /* Storing total from sector */
            END; /* ELSE not first country */
        END; /* IF sector not FA */

        /* 13: Initializing and updating (but storing immediately after the sector-loop) #countries <= 13 totals for all MObile  */
        /* sectors in the country, aggregating over all MObile fuels and sectors:                                                 */

        xtra_variable =  "ENR_" II summ II "_MO_" II country;                                  /* Name of local variable */
        IF (first_MO_sector) THEN
            >> DOCORE &xtra_variable = &variable;                           /* Initializing with first country's sector total */
        ELSE >> DOCORE &xtra_variable = &xtra_variable + &variable;                                       /* Updating with it */
    END; /* sector-loop */
    >> DO PUTDATA(&xtra_variable, "ENR&(summ)MO&country", -1);                    /* Storing total in MO sectors in country */

    /* 16: Initializing and updating (but storing after the country-loop) 1 total for MObile sources (aggregating over all    */
    /* MObile sector-fuel combinations in all countries) with country's MO total. Note that we have xtra_variable holding     */
    /* the string ENR_&(summ)_MO_&country from above, while variable is given a new string:                                    */

    variable =  "ENR_" II summ II "_MO_" II geo;                                                 /* Name of local variable */
    IF (first_country) THEN
        >> DOCORE &variable = &xtra_variable;                                                          /*  Initializing or */
    ELSE >> DOCORE &variable = &variable + &xtra_variable;                                           /* Updating with country */

    /* 17: Adding MObile sector totals to Stationary sector totals and storing as #countries <= 13 country-TOtals:             */

    >> DOCORE ENR_&(summ)_TOT_&country = ENR_&(summ)_ST_&country + ENR_&(summ)_MO_&country;
    >> DO PUTDATA(ENR_&(summ)_TOT_&country, "ENR&(summ)TOT&country", -1);

    /* 21: Storing #countries <= 13 totals for FC sectors, aggregated over all fuels and sectors but EL:                        */

    >> DOFILE ENR&(summ)FC&country = ENR_&(summ)_TOT_&country - ENR_&(summ)_EL_&country;

    /* 25: Calculating #countries x 2 <= 26 TOtal and Final Consumptions or CO2-emissions from oil products in each          */
    /* country, aggregated over all fuels and all sectors and FC = all sectors but EL:                                         */

    >> DOCORE OIL_&(summ)_TOT_&country = OIL_&(summ)_ST_&country + OIL_&(summ)_MO_&country;
    >> DO PUTDATA(OIL_&(summ)_TOT_&country, "OIL&(summ)TOT&country", -1);
```

```
        >> DOFILE OIL&(summ)FC&country = OIL_&(summ)_FC_&country + OIL_&(summ)_MO_&country;

        /* 31: Calculating #countries <= 13 TOtals for aggregated gas consumption or CO2-emission:                */

        >> DOFILE GAS&(summ)TOT&country = NGS_&(summ)_ST_&country + GA_&(summ)_TP_&country;

        /* Delete search path and access to current country input file that is now done with, so that a new input file can   */
        /* be accessed and searched by the alias file name infile:                                                 */

        >> DELSEARCH infile;
        >> DELACCESS infile;

    END; /* main loop through the single country, the given countries or all 13 countries */

    /* 8: Storing 1 total for all STationary sectors, aggregated over all fuels, all ST sectors and all countries:      */

    >> DO PUTDATA(ENR_&(summ)_ST_&geo, "ENR&(summ)ST&geo", -1);

    /* 16: Storing 1 total for all MObile sectors, aggregated over all fuels, all MO sectors and all countries:         */

    >> DO PUTDATA(ENR_&(summ)_MO_&geo, "ENR&(summ)MO&geo", -1);

    /* 18: Storing 1 TOtal energy consumption or CO2 emission, aggregated over all fuels, all sectors and all countries:  */

    >> DOFILE ENR&(summ)TOT&geo = ENR_&(summ)_ST_&geo + ENR_&(summ)_MO_&geo;

    /* 22: Storing 1 total for FC sectors (= all sectors but EL), aggregated over all fuels, all sectors but EL and all countries:   */

    >> DOFILE ENR&(summ)FC&geo = ENR_&(summ)_ST_&geo + ENR_&(summ)_MO_&geo - ENR_&(summ)_EL_&geo;

    /* 28: Calculating 2 TOtals and Final Consumptions or CO2-emissions from oil products, aggregated over all fuels, all   */
    /* sectors - with FC = all sectors but EL - and all countries:                                                 */
    >> DOCORE OIL_&(summ)_TOT_&geo = OIL_&(summ)_ST_&geo + OIL_&(summ)_MO_&geo;
    >> DO PUTDATA(OIL_&(summ)_TOT_&geo, "OIL&(summ)TOT&geo", -1);
    >> DOFILE OIL&(summ)FC&geo = OIL_&(summ)_TOT_&geo - OIL_&(summ)_EL_&geo;

    /* 32: Calculating TOtal aggregated gas consumptions or CO2-emissions:                                         */

    >> DOFILE GAS&(summ)TOT&geo = NGS_&(summ)_ST_&geo + GA_&(summ)_TP_&geo;

    /* Some special fuel aggregates used by ECN, summed across countries:                                           */

    IF (final_country > 1) THEN BEGIN;
        >> DOFILE AIR&(summ)TOT&geo = OI_&(summ)_FA_&geo;
        >> DOFILE ROAD&(summ)TOT&geo = OIL_&(summ)_MO_&geo - OI_&(summ)_FA_&geo -  RD_&(summ)_TP_&geo;
        >> DOFILE RAIL&(summ)DIE&geo = RD_&(summ)_TP_&geo;
        >> DOFILE WAT&(summ)TOT&geo = OI_&(summ)_TF_&geo;
        IF (energy_summation) THEN
            >> DOFILE RAILCONTOT&geo = ELE_CON_MO_&geo;
    END;

    /* Deleting TROLL's local variables, search paths and access to output database:                                */

    >> DELCORE ALL;
    >> DELSEARCH ALL;
    >> DELACCESS ALL;
END; /* macro */
```

6. Concluding Remarks

This user´s guide has fully documented the implemented SEEM-model version 2.0 and how a model user can extrapolate and simulate the model by means of the Portable Troll software. The model user is guided through various SEEM related Troll macros and input files necessary for extrapolating and simulating the model according to certain scenarios for Germany as an illustrative example. These scenarios include the so called reference scenario, the integration scenario, and the fragmentation scenario defined by the project «Energy scenarios for a changing Europe».

This user´s guide has also offered one chapter on the procedure for summarising simulated energy demand for each country, and for the total of a group of countries. Moreover, the user´s guide has explained the calculation routine for CO_2-emissions as it is implemented in a separate submodel of the SEEM-model.

Finally, the author would like to emphasise that this document may be used as a guideline for extrapolating and simulating scenarios other than the above mentioned ones when the aim is to study energy demand in Western Europe.

Appendix

A1 Troll Errors and Warning Messages

Recall from section 4.4, «The Procedure for Simulation», that the «troll.log» file contains errors or warning messages when something goes wrong during a simulation of the SEEM-model. All possible errors or warnings are listed below as the model user may meet them in the «troll.log» file. This list may also be found in the «troll.err» file located on the following subdirectory: d:\bou\ptroll.

Portable TROLL error messages

#00002 System file missing or corrupted.
#00101 Not a command:
#00102 Internal program error: invalid subtask.
#00160 Internal program error -- report to TROLL maintenance staff.
#00161 Command or option not available:
#00193 HOST command processor returned a non-zero code:
#00500 Not an option:
#00501 Incorrect input:
#00502 Name not found:
#00700 Not enough memory.
#01000 Invalid date.

#01001 Parser error.
#01004 Evaluating error.
#01006 Parser redefinition.

#02047 OLS Message.
#02048 Ols statistics message.
#02049 Ols statistics message.
#02050 Datamatrix is extremely ill-conditioned.
#02051 SCC Message.
#02052 REGOPT message
#02053 TSLS Message.
#02054 NLS Message.
#02055 Gremlin Message.

*** Gremlin messages ***

#02056 There are no coefficients in the current model.
#02057 There are no equations in the current model.
#02058 The number of equations does not match the number of endogenous variables.
#02059 Negative subscript
#02060 SFILLIN_XFILLIN error.
#02222 Evaluating error.

#03001 Input/output - error.
#03102 The string to be changed was not found.
#03106 Invalid equation position:
#03202 DEFINITION variable used before it is defined:
#03203 ENDOGENOUS or DEFINITION variable has a lead:
#03204 A lag or subscript cannot be calculated in equation:
#03205 Subscripts are nested, or a symbol has more than one subscript, in eqn:
#03206 Nested SUMs or PRODUCTs were found in equation:

#03207 The incidence matrix cannot be created due to problems with lags.
#03208 Symbol not used in any equation (it will be ignored):
#03209 The number of equations does not equal the number of variables.
#03210 Some variables cannot be assigned to any equation:
#03211 There are no assignable variables in some equations:
#03212 The model cannot be block-ordered due to problems with the incidence matrix.
#03213 It was not possible to normalize all equations.
#03214 The CURRENT model has no equations.
#03302 Not a symboltype:
#03303 Not a symbolname, symboltype or suffix:
#03304 Equation label already used:
#03308 Suffixes may not be declared; ignoring:
#03309 Wrong symboltype:
#03333 Compile Error:
#03401 Not a symbolname in the model:
#03403 Missing comma before new symboltype:
#03405 Symbol(s) used in equations cannot be deleted:
#03503 The current model has no name, so you must give a name in this case.
#03504 Not a valid model name:
#03507 No CURRENT model can be found.
#03599 GETXREF problem:

#04005 Run-Time error.

#05000 Problem trying to write data file:
#05001 Problem trying to read data file:
#05002 Problem trying to read program file:
#05003 Problem trying to write program file:
#05004 Problem trying to open file:
#05005 Problem trying to close file:
#05006 Disk file has incorrect contents:
#05010 Search error:

#06000 Invalid argument(s) to a function.
#06001 NA(s) returned where operand values did not allow an operation.
#06010 Regression error.
#06011 DLAG command error.

#07001 Input/Output Error.
#07010 Modedit error

#08000 Macro error

#09002 No simulation dates are possible with the available data.
#09003 No data was found for:
#09010 The periodicity did not match that of the previous data for:
#09012 The available data did not cover the lead/lag horizons for:
#09013 Variables must be scalar or scalar timeseries; space dimension found for:
#09016 Non-numeric data was found for:
#09017 Timeseries data was found for constant symbol(s):
#09018 Function(s) not supported in SIMULATE:
#09019 Initial constant subscript not 1 (will be treated as 1) for:
#09020 NEWVALS assumes date-range is ALL for constant symbols:

#15000 The current model cannot be simulated (check identities, lags, SUMs etc).

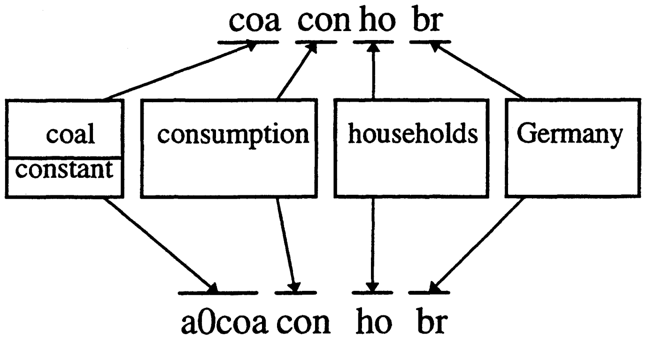
#15005 You must issue SIMSTART first.
#15007 Not a date:
#15008 An 'NA' was encountered:
#15010 Date too early or late:
#15011 Divergence occured:
#15030 These variables were not on the DROP list:
#15041 'FROM' option ignored in SIMRESID
#15042 No simulation output to store. Use SIMSTART, then DOSIM or DOTIL.
#15045 Iteration limit has been reached at iteration:
#15046 Expression cannot be evaluated.
#15049 You have already simulated the model through this date:
#15050 The Jacobian matrix is singular or extremely ill-conditioned:
#15070 Date has wrong periodicity:
#15081 'STACK' not specified for Forward-Looking simulation -- 'NOFL' assumed.
#15082 'STACK' is only intended for forward-looking models.
#15083 STACKing only 1 time period has no effect.
#15084 The number of periods you simulate must be a multiple of the number you STACKed.

#24204 Input format error in bounds:
#24207 Regression bounds have not yet been set.

A2 List of Variables and Parameters

This appendix presents a complete list of variable names and parameter names used in the sector models as well as the price model for Germany (c.f. chapter 3). Since the names are constructed according to a general pattern of codes, the list may be applied as an illustrative example for other countries as well. This general pattern of names is illustrated by means of figure 5.

Figure 5



As can be seen from the figure, the variable «coaconhobr» denotes coal consumption in the household sector in Germany. The parameter «a0coaconhobr» likewise denotes a calibration constant for the coal consumption in the household sector in Germany. Hence, the names of the variables and the parameters consist of four separate letter/figure codes.

The first part of the names indicates the «type» of variable or parameter. Some of these «types» include the following: *coa* = coal, *oil* = oil, *ngs* = natural gas, *ele* = electricity, cog = coal-oil-gas aggregate, *cap* = capital, *lab* = labour. The first two symbols in the parameter names indicate whether the parameter is a calibration constant (*a0*), a price or a substitution elasticity (*a1*), an income elasticity (*a2*) or other parameters such as a lag parameter and a technological progress parameter (*a3*).

The second part indicates a consumption (*con*), a price (*pri*), or a cost (*cst*) variable or parameter. Finally, the third and fourth part of the names indicates the sector and the country, respectively, in which the variable or the parameter belongs to. The sector codes are as follows: *ho* = the household sector, *in* = the industry sector, *se* = the service sector, *el* = the electricity generating sector, and *tp* = the transport sector. The country codes are as follows: *au* = Austria, *be* = Belgium, *br* = Germany, *ch* = Switzerland, *dk* = Denmark, *fr* = France, *gb* = Great Britain, *it* = Italy, *nl* = Netherlands, *no* = Norway, *sf* = Finland, *sp* = Spain, and *sw* = Sweden.

Applying this general pattern of codes for the variable oil consumption in the service sector in Germany, we obtain the following variable name: oilconsebr. Similarly, by changing *con* with *pri* we get the variable *oilprisebr*, which is the end user oil price in the service sector in Germany.

In the tables below, the numbers in the first column correspond to the equation numbers in the models presented in chapter 3 and the equation numbers in Brubakk et.al. (1995).

Table 1: The Household Model

Variable/ Parameter		
eq. #	name	description
1 (A2.4)	ocprihobr	end user aggregate price index of oil and coal
	a3dochobr	distribution parameter
	oilprihobr	end user price of oil
	a1sochobr	elasticity of substitution between oil and coal
	coaprihobr	end user price of coal
2 (A2.4)	cogprihobr	end user aggregate price index of oil, coal and natural gas
	a3dcoghobr	distribution parameter
	ngsprihobr	end user price of natural gas
	a1scoghobr	elasticity of substitution between coal, oil and natural gas
	ocprihobr	end user aggregate price index of oil and coal
3 (A2.5)	eleconhobr	electricity consumption
	a0elehobr	calibration constant
	eleprihobr	end user price of electricity
	a1elehobr	direct price elasticity of electrisity
	cogprihobr	end user aggregate price index of oil, coal and natural gas
	a1cogelehobr	the elasticity of electr. w.r.t. the aggregate price of coal-oil-gas
	conhobr	consumption expenditure
	a2elehobr	income elasticity
	eleconhobr(-1)	electrisity consumption lagged
	a3lelehobr	lag/adjustment coefficient
4 (A2.5)	cogconhobr	aggregate consumption of coal, oil and natural gas
	a0coghobr	calibration constant
	cogprihobr	end user aggregate price index of coal, oil and natural gas
	a3coghobr	direct price elasticity of the aggregate coal, oil and natural gas
	eleprihobr	end user price of electricity
	a3elecoghobr	the elasticity of the aggregate coal-oil-gas w.r.t. electricity
	conhobr	consumption expenditure
	a2coghobr	income elasticity
	cogconhobr(-1)	aggregate consumption of coal, oil and natural gas lagged
	a3lcoghobr	lag/adjustment coefficient
5 (A2.6)	occonhobr	aggregate consumption of oil and coal
	a0ochobr	calibration constant
	cogconhobr	aggregate consumption of coal, oil and natural gas
	a3dcoghobr	distribution parameter
	ngsprihobr	end user price of natural gas
	ocprihobr	end user aggregate price index of oil and coal
	a3lagcoghobr	lag/adjustment coefficient
	ngsconhobr(-1)	natural gas consumption lagged
	occonhobr(-1)	aggregate consumption of oil and coal lagged
	cogrehobr	residual term coal-oil-gas
	a1scoghobr	elasticity of substitution between coal, oil and natural gas

Table 1 (continued)

Variable/ Parameter		
eq. #	name	description
6 (A2.6)	ngsconhobr	natural gas consumption
	a0ngshobr	calibration constant
	cogconhobr	aggregate consumption of coal, oil and natural gas
	a3dcoghobr	distribution parameter
	ngsprihobr	end user price of natural gas
	ocprihobr	end user aggregate price index of oil and coal
	a3lagcoghobr	lag/adjustment coefficient
	ngsconhobr(-1)	natural gas consumption lagged
	occonhobr(-1)	aggregate consumption of oil and coal lagged
	cogrehobr	residual term coal-oil-gas
	a1scoghobr	elasticity of substitution between coal, oil and natural gas
7 (A2.6)	oilconhobr	oil concumption
	a0oilhobr	calibration constant
	occonhobr	aggregate consumption of oil and coal
	a3dochobr	distribution parameter
	oilprihobr	end user price of oil
	coaprihobr	end user price of coal
	a3lagochobr	lag/adjustment coefficient
	oilconhobr(-1)	oil concumption lagged
	coaconhobr(-1)	coal concumption lagged
	ocrehobr	residual term oil-coal
	a1sochobr	elasticity of substitution between oil and coal
8 (A2.6)	coaconhobr	coal concumption
	a0coahobr	calibration constant
	occonhobr	aggregate consumption of oil and coal
	a3dochobr	distribution parameter
	oilprihobr	end user price of oil
	coaprihobr	end user price of coal
	a3lagochobr	lag/adjustment coefficient
	oilconhobr(-1)	oil concumption lagged
	coaconhobr(-1)	coal concumption lagged
	ocrehobr	residual term oil-coal
	a1sochobr	elasticity of substitution between oil and coal

Table 2: The Industry Model

Variable/	Parameter	
eq. #	name	description
1 (A2.1)	eenrpriinbr	end user price index of energy
	coapriinbr	end user price of coal
	a1coainbr	cost-share coal
	oilpriinbr	end user price of oil
	a1oilinbr	cost-share oil
	ngspriinbr	end user price of natural gas
	a1ngsinbr	cost-share natural gas
	elepriinbr	end user price of electricity
	a1eleinbr	cost-share electricity
2 (A2.2)	ecoaconinbr	desired coal consumption
	proinbr	production/activity level
	a2proinbr	elasticity of energy w.r.t. industry production
	capriinbr	price of capital
	a1capinbr	cross price elasticity of energy w.r.t. capital price
	labpriinbr	price of labour
	a1waginbr	cross price elasticity of energy w.r.t. labour price
	eenrpriinbr	end user price index of energy
	a1enrinbr	price elasticity of energy w.r.t. energy price
	coapriinbr	end user price of coal
	a1coainbr	cost-share coal
	oilpriinbr	end user price of oil
	a1oilinbr	cost-share oil
	ngspriinbr	end user price of natural gas
	a1ngsinbr	cost-share natural gas
	elepriinbr	end user price of electricity
	a1eleinbr	cost-share electricity
3 (A2.2)	eoilconinbr	desired oil consumption
	proinbr	production/activity level
	a2proinbr	elasticity of energy w.r.t. industry production
	capriinbr	price of capital
	a1capinbr	cross price elasticity of energy w.r.t. capital price
	labpriinbr	price of labour
	a1waginbr	cross price elasticity of energy w.r.t. labour price
	eenrpriinbr	end user price index of energy
	a1enrinbr	price elasticity of energy w.r.t. energy price
	coapriinbr	end user price of coal
	a1coainbr	cost-share coal
	oilpriinbr	end user price of oil
	a1oilinbr	cost-share oil
	ngspriinbr	end user price of natural gas
	a1ngsinbr	cost-share natural gas
	elepriinbr	end user price of electricity
	a1eleinbr	cost-share electricity

Table 2 (continued)

Variable/	Parameter	
eq. #	name	description
4 (A2.2)	engsconinbr	desired natural gas consumption
	proinbr	production/activity level
	a2proinbr	income elasticity
	capriinbr	price of capital
	a1capinbr	cross price elasticity of energy w.r.t. capital price
	labpriinbr	price of labour
	a1waginbr	cross price elasticity of energy w.r.t. labour price
	eenrpriinbr	end user price index of energy
	a1enrinbr	price elasticity of energy w.r.t. energy price
	coapriinbr	end user price of coal
	a1coainbr	cost-share coal
	oilpriinbr	end user price of oil
	a1oilinbr	cost-share oil
	ngspriinbr	end user price of natural gas
	a1ngsinbr	cost-share natural gas
	elepriinbr	end user price of natural gas
	a1eleinbr	cost-share electricity
5 (A2.2)	eeleconinbr	desired electricity consumption
	proinbr	production/activity level
	a2proinbr	income elasticity
	capriinbr	price of capital
	a1capinbr	cross price elasticity of energy w.r.t. capital price
	labpriinbr	price of labour
	a1waginbr	cross price elasticity of energy w.r.t. labour price
	eenrpriinbr	end user price index of energy
	a1enrinbr	price elasticity of energy w.r.t. energy price
	coapriinbr	end user price of coal
	a1coainbr	cost-share coal
	oilpriinbr	end user price of oil
	a1oilinbr	cost-share oil
	ngspriinbr	end user price of natural gas
	a1ngsinbr	cost-share natural gas
	elepriinbr	end user price of electricity
	a1eleinbr	cost-share electricity
6 (A2.3)	coaconinbr	realised coal consumption
	a0coainbr	calibration constant
	ecoaconinbr	desired coal consumption
	a3laginbr	lag/adjustment coefficient
	coanoninbr(-1)	realised coal consumption lagged
	rcoainbr	residual term coal
7 (A2.3)	oilconinbr	realised oil consumption
	a0oilinbr	calibration constant
	eoilconinbr	desired oil consumption
	a3laginbr	lag/adjustment coefficient
	oilconinbr(-1)	realised oil consumption lagged
	roilinbr	residual term oil

Table 2 (continued)

Variable/ eq. #	Parameter name	description
8 (A2.3)	ngsconinbr	realised natural gas consumption
	a0ngsinbr	calibration constant
	engsconinbr	desired natural gas consumption
	a3laginbr	lag/adjustment coefficient
	ngsconinbr(-1)	realised natural gas consumption lagged
	rngsinbr	residual term natural gas
9 (A2.3)	eleconinbr	realised electricity consumption
	a0eleinbr	calibration constant
	eeleconinbr	desired electricity consumption
	a3laginbr	lag/adjustment coefficient
	eleconinbr(-1)	realised electrisity consumption lagged
	releinbr	residual term electrisity

Table 3: The Service Model

Variable/ eq. #	Parameter name	description
1 (A2.7)	ogprisebr	end user aggregate price index of oil and natural gas
	a3dogsebr	distribution parameter oil-gas
	ngsprisebr	end user price of natural gas
	a1sogsebr	elasticity of substitution between oil and natural gas
	oilprisebr	end user price of oil
2 (A2.7)	cogprisebr	end user aggregate price index of coal, oil and natural gas
	a3dcogsebr	distribution parameter coal-oil-gas
	coaprisebr	end user price of coal
	a1scogsebr	elasticity of substitution between coal, oil and natural gas
	ogprisebr	end user aggregate price index of oil and natural gas
3 (A2.8)	eleconsebr	electricity consumption
	a0elesebr	calibration constant
	prosebr	production/activity level
	a2elesebr	income elasticity
	capprisebr	price of capital
	a1capelesebr	capital factor elasticity
	labprisebr	price of labour
	a1labelesebr	labour factor elasticity
	cogprisebr	end user aggregate price index of coal, oil and natural gas
	a1cogelesebr	the elasticity of electricity w.r.t. the aggr. price of coal-oil-gas
	eleprisebr	end user price of electricity
	a1elesebr	direct price elasticity of electrisity
	eleconsebr(-1)	electrisity consumption lagged
	a3lelesebr	lag/adjustment coefficient

Table 3 (continued)

Variable/	Parameter	
eq. #	name	description
4 (A2.8)	cogconsebr	aggregate consumption of coal,oil and gas
	a0cogsebr	calibration constant
	prosebr	production/activity level
	a2cogsebr	income elasticity
	capprisebr	price of capital
	a1capcogsebr	capital factor elasticity
	labprisebr	price of labour
	a1labcogsebr	labour factor elasticity
	cogprisebr	end user aggregate price index of coal, oil and natural gas
	a1cogsebr	direct price elasticity of the aggregate coal-oil-gas
	eleprisebr	end user price of electricity
	a1elecogsebr	elasticity of the aggr. coal, oil and natural gas w.r.t electricity
	cogconsebr(-1)	aggregate consumption of coal,oil and gas lagged
	a3lcogsebr	lag/adjustment coefficient
5 (A2.9)	ogconsebr	aggregate consumption of oil and natural gas
	a0ogsebr	calibration constant
	cogconsebr	aggregate consumption of coal,oil and gas
	a3dcogsebr	distribution parameter
	ogprisebr	end user aggregate price index of oil and natural gas
	coaprisebr	end user price of coal
	a3lagcogsebr	lag/adjustment coefficient
	ogconsebr(-1)	aggregate consumption of oil and natural gas lagged
	coaconsebr(-1)	coal consumption lagged
	cogresebr	residual term coal-oil-gas
	a1scogsebr	elasticity of substitution between coal, oil and natural gas
6 (A2.9)	coaconsebr	coal consumption
	a0coasebr	calibration constant
	cogconsebr	aggregate consumption of coal, oil and gas
	a3dcogsebr	distribution parameter
	ogprisebr	end user aggregate price index of oil and natural gas
	coaprisebr	end user price of coal
	a3lagcogsebr	lag/adjustment coefficient
	ogconsebr(-1)	aggregate consumption of oil and natural gas lagged
	coaconsebr(-1)	coal consumption lagged
	cogresebr	residual term coal-oil-gas
	a1scogsebr	elasticity of substitution between coal, oil and natural gas

Table 3 (continued)

Variable/ eq. #	Parameter name	description
7 (A2.9)	oilconsebr	oil consumption
	a0oilsebr	calibration constant
	ogconsebr	aggregate consumption of oil and natural gas
	a3dogsebr	distribution parameter
	oilprisebr	end user price of oil
	ngsprisebr	end user price of natural gas
	a3lagogsebr	lag/adjustment coefficient
	oilconsebr(-1)	oil consumption lagged
	ngsconsebr(-1)	natural gas consumption lagged
	ogresebr	residual term oil-gas
	a1sogsebr	elasticity of substitution between oil and natural gas
8 (A2.9)	ngsconsebr	natural gas consumption
	a0ngssebr	calibration constant
	ogconsebr	aggregate consumption of oil and natural gas
	a3dogsebr	distribution parameter
	oilprisebr	end user price of oil
	ngsprisebr	end user price of natural gas
	a3lagogsebr	lag/adjustment coefficient
	oilconsebr(-1)	oil consumption lagged
	ngsconsebr(-1)	natural gas consumption lagged
	ogresebr	residual term oil-gas
	a1sogsebr	elasticity of substitution between oil and natural gas

Table 4: The Electrisity Generating Model

Variable/ eq. #	Parameter name	description
1	coashanelbr	share of new coal technology
	dumnbr	dummy variable new technology
	coasha1nelbr	share of new coal technology later than the base year
	coasha0nelbr	share of new coal technology in the base year
2	coashafelbr	share of future coal technology
	dumnbr	dummy variable new technology
	coasha1felbr	share of future coal technology later than the base year
	coasha0felbr	share of future coal technology in the base year
3	coashabelbr	share of bat coal technology
	dumbbr	dummy variable bat technology
	coasha1belbr	share of bat coal technology later than the base year
	coasha0belbr	share of bat coal technology in the base year
4	coashaoelbr	share of old coal technology
	coashanelbr	share of new coal technology
	coashafelbr	share of future coal technology
	coashabelbr	share of bat coal technology

Table 4 (continued)

Variable/	Parameter	
eq. #	name	description
5	ngsshanelbr	share of new natural gas technology
	dumnbr	dummy variable new technology
	ngssha1nelbr	share of new natural gas technology later than the base year
	ngssha0nelbr	share of new nat.gas technology in the base year
6	ngsshabelbr	share of bat natural gas technology
	dumbbr	dummy variable bat technology
	ngssha1belbr	share of bat natural gas technology later than the base year
	ngssha0belbr	share of bat nat.gas technology in the base year
7	ngsshaoelbr	share of old natural gas technology
	ngsshanelbr	share of new natural gas technology
	ngsshabelbr	share of bat natural gas technology
8	oilshanelbr	share of new oil technology
	dumnbr	dummy variable new technology
	oilsha1nelbr	share of new oil technology later than the base year
	oilsha0nelbr	share of new oil technology in the base year
9	oilshabelbr	share of bat oil technology
	dumbbr	dummy variable bat technology
	oilsha1belbr	share of bat oil technology later than the base year
	oilsha0belbr	share of bat oil technology in the base year
10	oilshaoelbr	share of old oil technology
	oilshanelbr	share of new oil technology
	oilshabelbr	share of bat oil technology
11	nucshanelbr	share of new nuclear technology
	dumnbr	dummy variable new technology
	nucsha1nelbr	share of new neuclear technology later than the base year
	nucsha0nelbr	share of new nucl. technology in the base year
12	nucshabelbr	share of bat nuclear technology
	dumbbr	dummy variable bat technology
	nucsha1belbr	share of bat neuclear technology later than the base year
	nucsha0belbr	share of bat nucl. technology in the base year
13	nucshaoelbr	share of old nuclear technology
	nucshanelbr	share of new nuclear technology
	nucshabelbr	share of bat nuclear technology
14	renshanelbr	share of new renewables technology
	dumnbr	dummy variable new technology
	rensha1nelbr	share of new renewables technology later than the base year
	rensha0nelbr	share of new renew. technology in the base year

Table 4 (continued)

Variable/ eq. #	Parameter name	description
15	renshabelbr	share of bat renewables technology
	dumbbr	dummy variable bat technology
	rensha1belbr	share of bat renewables technology later than the base year
	rensha0belbr	share of bat renew. technology in the base year
16	renshaoelbr	share of old renewables technology
	renshanelbr	share of new renewables technology
	renshabelbr	share of bat renewables technology
17 (A5.4)	coacstelbr	average production cost of electricity using coal
	coashaoelbr	share of old coal technology
	coaprcstoelbr	fixed production cost using old coal technology
	coaprielbr	end user price of coal
	coaeffoelbr	efficiency per unit of coal old technology
	coashanelbr	share of new coal technology
	coaprcstnelbr	fixed production cost using new coal technology
	coaeffnelbr	efficiency per unit of coal new technology
	coashafelbr	share of future coal technology
	coaprcstfelbr	fixed production cost using future coal technology
	coaefffelbr	efficiency per unit of coal future technology
	coashabelbr	share of bat coal technology
	coaprcstbelbr	fixed production cost using bat coal technology
	coaeffbelbr	efficiency per unit of coal bat technology
18 (A5.4)	ngscstelbr	average production cost of electricity using gas
	ngsshaoelbr	share of old gas technology
	ngsprcstoelbr	fixed production cost using old gas technology
	ngsprielbr	end user price of natural gas
	ngseffoelbr	efficiency per unit of gas old technology
	ngsshanelbr	share of new gas technology
	ngsprcstnelbr	fixed production cost using new gas technology
	ngseffnelbr	efficiency per unit of gas new technology
	ngsshabelbr	share of bat gas technology
	ngsprcstbelbr	fixed production cost using bat gas technology
	ngseffbelbr	efficiency per unit of gas bat technology
19 (A5.4)	oilcstelbr	average production cost of electricity using oil
	oilshaoelbr	share of old oil technology
	oilprcstoelbr	fixed production cost using old oil technology
	oilprielbr	end user price of oil
	oileffoelbr	efficiency per unit of oil old technology
	oilshanelbr	share of new oil technology
	oilprcstnelbr	fixed production cost using new oil technology
	oileffnelbr	efficiency per unit of oil new technology
	oilshabelbr	share of bat oil technology
	oilprcstbelbr	fixed production cost using bat oil technology
	oileffbelbr	efficiency per unit of oil bat technology

Table 4 (continued)

Variable/	Parameter	
eq. #	name	description
20 (A5.4)	nuccstelbr	average production cost of electricity using nuclear
	nucshaoelbr	share of old nuclear technology
	nucprcstoelbr	fixed production cost using old nuclear technology
	nucprielbr	end user price of nuclear
	nuceffoelbr	efficiency per unit of nuclear old technology
	nucshanelbr	share of new nuclear technology
	nucprcstnelbr	fixed production cost using new nuclear technology
	nuceffnelbr	efficiency per unit of nuclear new technology
	nucshabelbr	share of bat nuclear technology
	nucprcstbelbr	fixed production cost using bat nuclear technology
	nuceffbelbr	efficiency per unit of nuclear bat technology
21 (A5.4)	rencstelbr	average production cost of electricity using renewables
	renshaoelbr	share of old renewables technology
	renprcstoelbr	fixed production cost using old renewables technology
	renprielbr	end user price of renewables
	reneffoelbr	efficiency per unit of renewables old technology
	renshanelbr	share of new renewables technology
	renprcstnelbr	fixed production cost using new renewables technology
	reneffnelbr	efficiency per unit of renewables new technology
	renshabelbr	share of bat renewables technology
	renprcstbelbr	fixed production cost using bat renewables technology
	reneffbelbr	efficiency per unit of renewables bat technology
22 (A5.1)	coaeffelbr	average efficiency of coal
	coashaoelbr	share of old coal technology
	coaeffoelbr	efficiency per unit of coal old technology
	coashanelbr	share of new coal technology
	coaeffnelbr	efficiency per unit of coal new technology
	coashafelbr	share of future coal technology
	coaefffelbr	efficiency per unit of coal future technology
	coashabelbr	share of bat coal technology
	coaeffbelbr	efficiency per unit of coal bat technology
23 (A5.1)	ngseffelbr	average efficiency of natural gas
	ngsshaoelbr	share of old gas technology
	ngseffoelbr	efficiency per unit of gas old technology
	ngsshanelbr	share of new gas technology
	ngseffnelbr	efficiency per unit of gas new technology
	ngsshabelbr	share of bat gas technology
	ngseffbelbr	efficiency per unit of gas bat technology
24 (A5.1)	oileffelbr	average efficiency of oil
	oilshaoelbr	share of old oil technology
	oileffoelbr	efficiency per unit of oil old technology
	oilshanelbr	share of new oil technology
	oileffnelbr	efficiency per unit of oil new technology
	oilshabelbr	share of bat oil technology
	oileffbelbr	efficiency per unit of oil bat technology

Table 4 (continued)

Variable/	Parameter	
eq. #	name	description
25 (A5.1)	nuceffelbr	average efficiency of nuclear
	nucshaoelbr	share of old nuclear technology
	nuceffoelbr	efficiency per unit of nuclear old technology
	nucshanelbr	share of new nuclear technology
	nuceffnelbr	efficiency per unit of nuclear new technology
	nucshabelbr	share of bat nuclear technology
	nuceffbelbr	efficiency per unit of nuclear bat technology
26 (A5.1)	reneffelbr	average efficiency of renewables
	renshaoelbr	share of old renewables technology
	reneffoelbr	efficiency per unit of renewables old technology
	renshanelbr	share of new renewables technology
	reneffnelbr	efficiency per unit of renewables new technology
	renshabelbr	share of bat renewables technology
	reneffbelbr	efficiency per unit of renewables bat technology
27 (A2.20)	coashalelbr	share of electicity produced using coal
	a0coaconelbr	calibration constant
	coacstelbr	average production cost of electricity using coal
	alcoaconelbr	cost share of coal consumption
	ngscstelbr	average production cost of electricity using gas
	alngsconelbr	cost share of gas consumption
	oilcstelbr	average production cost of electricity using oil
	aloilconelbr	cost share of oil consumption
	nuccstelbr	average production cost of electricity using nuclear
	alnucconelbr	cost share of nuclear consumption
	rencstelbr	average production cost of electricity using renewables
	alrenconelbr	cost share of renewables consumption
28 (A2.20)	ngsshalelbr	share of electricity produced using gas
	a0ngsconelbr	calibration constant.
	ngscstelbr	average production cost of electricity using gas
	coacstelbr	average production cost of electricity using coal
	alcoaconelbr	cost share of coal consumption
	alngsconelbr	cost share of gas consumption
	oilcstelbr	average production cost of electricity using oil
	aloilconelbr	cost share of oil consumption
	nuccstelbr	average production cost of electricity using nuclear
	alnucconelbr	cost share of nuclear consumption
	rencstelbr	average production cost of electricity using renewables
	alrenconelbr	cost share of renewables consumption

Table 4 (continued)

Variable/ Parameter		
eq. #	name	description
29 (A2.20)	oilsha1elbr	share of electricity produced using oil
	a0oilconelbr	calibration constant
	oilcstelbr	average production cost of electricity using oil
	coacstelbr	average production cost of electricity using coal
	a1coaconelbr	cost share of coal consumption
	ngscstelbr	average production cost of electricity using gas
	a1ngsconelbr	cost share of gas consumption
	a1oilconelbr	cost share of oil consumption
	nuccstelbr	average production cost of electricity using nuclear
	a1nucconelbr	cost share of nuclear consumption
	rencstelbr	average production cost of electricity using renewables
	a1renconelbr	cost share of renewables consumption
30 (A2.20)	nucsha1elbr	share of electricity produced using nuclear
	a0nucconelbr	calibration constant.
	nuccstelbr	average production cost of electricity using nuclear
	coacstelbr	average production cost of electricity using coal
	a1coaconelbr	cost share of coal consumption
	ngscstelbr	average production cost of electricity using gas
	a1ngsconelbr	cost share of gas consumption
	oilcstelbr	average production cost of electricity using oil
	a1oilconelbr	cost share of oil consumption
	a1nucconelbr	cost share of nuclear consumption
	rencstelbr	average production cost of electricity using renewables
	a1renconelbr	cost share of renewables consumption
31 (A2.20)	rensha1elbr	share of electricity produced using renewables
	a0renconelbr	calibration constant.
	rencstelbr	average production cost of electricity using renewables
	coacstelbr	average production cost of electricity using coal
	a1coaconelbr	cost share of coal consumption
	ngscstelbr	average production cost of electricity using gas
	a1ngsconelbr	cost share of gas consumption
	oilcstelbr	average production cost of electricity using oil
	a1oilconelbr	cost share of oil consumption
	nuccstelbr	average production cost of electricity using nuclear
	a1nucconelbr	cost share of nuclear consumption
	a1renconelbr	cost share of renewables consumption
32 (A2.21)	coashaelbr	normalised share of electricity produced using coal
	coasha1elbr	share of electricity produced using coal
	ngssha1elbr	share of electricity produced using gas
	oilsha1elbr	share of electricity produced using oil
	nucsha1elbr	share of electricity produced using nuclear
	rensha1elbr	share of electricity produced using renewables

Table 4 (continued)

Variable/ eq. #	Parameter name	description
33 (A2.21)	ngsshaelbr	normalised share of electricity produced using gas
	ngsshalelbr	share of electricity produced using gas
	coashalelbr	share of electricity produced using coal
	oilshalelbr	share of electricity produced using oil
	nucshalelbr	share of electricity produced using nuclear
	renshalelbr	share of electricity produced using renewables
34 (A2.21)	oilshaelbr	normalised share of electricity produced using oil
	oilshalelbr	share of electricity produced using oil
	coashalelbr	share of electricity produced using coal
	ngsshalelbr	share of electricity produced using gas
	nucshalelbr	share of electricity produced using nucl.
	renshalelbr	share of electricity produced using ren.
35 (A2.21)	nucshaelbr	normalised share of electricity produced using nuclear
	nucshalelbr	share of electricity produced using nuclear
	coashalelbr	share of electricity produced using coal
	ngsshalelbr	share of electricity produced using gas
	oilshalelbr	share of electricity produced using oil
	renshalelbr	share of electricity produced using renewables
36 (A2.21)	renshaelbr	normalised share of electricity produced using renewables
	renshalelbr	share of electricity produced using renewables
	coashalelbr	share of electricity produced using coal
	ngsshalelbr	share of electricity produced using gas
	oilshalelbr	share of electricity produced using oil
	nucshalelbr	share of electricity produced using nuclear
37 (A2.23)	elegenpribr	electricity generation price
	coashaelbr	normalised share of electricity produced using coal
	coacstelbr	average production cost of electricity using coal
	ngsshaelbr	normalised share of electricity produced using gas
	ngscstelbr	average production cost of electricity using gas
	oilshaelbr	normalised share of electricity produced using oil
	oilcstelbr	average production cost of electricity using oil
	nucshaelbr	normalised share of electricity produced using nuclear
	nuccstelbr	average production cost of electricity using nuclear
	renshaelbr	normalised share of electricity produced using renewables
	rencstelbr	average production cost of electricity using renewables
38 (A2.19)	totdemelbr	total domestic electricity production
	eleconhobr	electricity consumption in the household sector
	eleconsebr	electricity consumption in the service sector
	eleconinbr	electricity consumption in the industry sector
	railcontotbr	electricity consumption in the rail transport
	eleconexbr	net electricity exports
	elelossbr	distribution loss of electricity

Table 4 (continued)

Variable/	Parameter	
eq. #	name	description
39 (A2.22)	coaconelbr	coal consumption
	coashaelbr	normalised share of electricity produced using coal
	totdemelbr	total domestic electricity production
	coaeffelbr	average efficiency of coal
	a3coacalelbr	calibration constant
40 (A2.22)	ngsconelbr	natural gas consumption
	ngsshaelbr	normalised share of electricity produced using gas
	totdemelbr	total domestic electricity production
	ngseffelbr	average efficiency of natural gas
	a3ngscalelbr	calibration constant
41 (A2.22)	oilconelbr	oil consumption
	oilshaelbr	normalised share of electricity produced using oil
	totdemelbr	total domestic electricity production
	oileffelbr	average efficiency of oil
	a3oilcalelbr	calibration constant
42 (A2.22)	nucconelbr	nuclear consumption
	nucshaelbr	normalised share of electricity produced using nuclear
	totdemelbr	total domestic electricity production
	nuceffelbr	average efficiency of nuclear
	a3nuccalelbr	calibration constant
43 (A2.22)	renconelbr	renewables consumption
	renshaelbr	normalised share of electricity produced using renewables
	totdemelbr	total domestic electricity production
	reneffelbr	average efficiency of renewables
	a3rencalelbr	calibration constant

Table 5: The Transport Model

Variable/	Parameter	
eq. #	name	description
1	goshantpbr	share of new technology for gasoline cars
	dumntpbr	dummy variable for new technology
	gosha0ntpbr	share of new technology for gasoline cars in the base year
2	goshabtpbr	share of bat technology for gasoline cars
	dumbtpbr	dummy variable for bat technology
	gosha0btpbr	share of bat technology for gasoline cars in the base year
3	goshaotpbr	share of old technology for gasoline cars
	goshantpbr	share of new technology for gasoline cars
	goshabtpbr	share of bat technology for gasoline cars

Table 5 (continued)

Variable/	Parameter	
eq. #	name	description
4	dishantpbr	share of new technology for diesel cars
	dumntpbr	dummy variable for new technology
	disha0ntpbr	share of new technology for diesel cars in the base year
5	dishabtpbr	share of bat technology for diesel cars
	dumbtpbr	dummy variable for bat technology
	disha0btpbr	share of bat technology for diesel cars in the base year
6	dishaotpbr	share of old technology for diesel cars
	dishantpbr	share of new technology for diesel cars
	dishabtpbr	share of bat technology for diesel cars
7	gashantpbr	share of new technology for gas cars
	dumntpbr	dummy variable for new technology
	gasha0ntpbr	share of new technology for gas cars in the base year
8	gashabtpbr	share of bat technology for gas cars
	dumbtpbr	dummy variable for bat technology
	gasha0btpbr	share of bat technology for gas cars in the base year
9	gashaotpbr	share of old technology for gas cars
	gashantpbr	share of new technology for gas cars
	gashabtpbr	share of bat technology for gas cars
10	reshantpbr	share of new technology for electricity trains
	dumntpbr	dummy variable for new technology
	resha0ntpbr	share of new technology for electricity trains in the base year
11	reshabtpbr	share of bat technology for electricity trains
	dumbtpbr	dummy variable for bat technology
	resha0btpbr	share of bat technology for electricity trains in the base year
12	reshaotpbr	share of old technology for electricity trains
	reshantpbr	share of new technology for electricity trains
	reshabtpbr	share of bat technology for electricity trains
13	rdshantpbr	share of new technology for diesel trains
	dumntpbr	dummy variable for new technology
	rdsha0ntpbr	share of new technology for diesel trains in the base year
14	rdshabtpbr	share of bat technology for diesel trains
	dumbtpbr	dummy variable for bat technology
	rdsha0btpbr	share of bat technology for diesel trains in the base year
15	rdshaotpbr	share of old technology for diesel trains
	rdshantpbr	share of new technology for diesel trains
	rdshabtpbr	share of bat technology for diesel trains

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
16	bdshantpbr	share of new technology for diesel buses
	dumntpbr	dummy variable for new technology
	bdsha0ntpbr	share of new technology for diesel buses in the base year
17	bdshabtpbr	share of bat technology for diesel buses
	dumbtpbr	dummy variable for bat technology
	bdsha0btpbr	share of bat technology for diesel buses in the base year
18	bdshaotpbr	share of old technology for diesel buses
	bdshantpbr	share of new technology for diesel buses
	bdshabtpbr	share of bat technology for diesel buses
19 (A5.3)	gocsttpbr	average cost of gasoline cars per pkm
	goshaotpbr	share of old technology for gasoline cars
	goprcstotpbr	variable cost of old technology for gasoline cars
	gopritpbr	gasoline price for cars
	goeffotpbr	average efficiency of gasoline cars using old technology
	goshantpbr	share of new technology for gasoline cars
	goprcstntpbr	variable cost of new technology for gasoline cars
	goeffntpbr	average efficiency of gasoline cars using new technology
	goshabtpbr	share of bat technology for gasoline cars
	goprcstbtpbr	variable cost of bat technology for gasoline cars
	goeffbtpbr	average efficiency of gasoline cars using bat technology
20 (A5.3)	dicsttpbr	average cost of diesel cars per pkm
	dishaotpbr	share of old technology for diesel cars
	diprcstotpbr	variable cost of old technology for diesel cars
	dipritpbr	diesel price for cars
	dieffotpbr	average efficiency of diesel cars using old technology
	dishantpbr	share of new technology for diesel cars
	diprcstntpbr	variable cost of new technology for diesel cars
	dieffntpbr	average efficiency of diesel cars using new technology
	dishabtpbr	share of bat technology for diesel cars
	diprcstbtpbr	variable cost of bat technology for diesel cars
	dieffbtpbr	average efficiency of diesel cars using bat technology
21 (A5.3)	gacsttpbr	average cost of gas cars per pkm
	gashaotpbr	share of old technology for gas cars
	gaprcstotpbr	variable cost of old technology for gas cars
	gapritpbr	gas price for cars
	gaeffotpbr	average efficiency of gas cars using old technology
	gashantpbr	share of new technology for gas cars
	gaprcstntpbr	variable cost of new technology for gas cars
	gaeffntpbr	average efficiency of gas cars using new technology
	gashabtpbr	share of bat technology for gas cars
	gaprcstbtpbr	variable cost of bat technology for gas cars
	gaeffbtpbr	average efficiency of gas cars using bat technology

Table 5 (continued)

Variable/	Parameter	
eq. #	name	description
22 (A5.3)	recsttpbr	average cost of electricity train per pkm
	reshaotpbr	share of old technology for electricity train
	reprcstotpbr	variable cost of old technology for electricity train
	repritpbr	electricity price for train
	reeffotpbr	average efficiency of electricity train using old technology
	reshantpbr	share of new technology for electricity train
	reprcstntpbr	variable cost of new technology for electricity train
	reeffntpbr	average efficiency of electricity train using new technology
	reshabtpbr	share of bat technology for electricity train
	reprcstbtpbr	variable cost of bat technology for electricity train
	reeffbtpbr	average efficiency of electricity train using bat technology
23 (A5.3)	rdcsttpbr	average cost of diesel train per pkm
	rdshaotpbr	share of old technology for diesel train
	rdprcstotpbr	variable cost of old technology for diesel train
	rdpritpbr	diesel price for train
	rdeffotpbr	average efficiency of diesel train using old technology
	rdshantpbr	share of new technology for diesel train
	rdprcstntpbr	variable cost of new technology for diesel train
	rdeffntpbr	average efficiency of diesel train using new technology
	rdshabtpbr	share of bat technology for diesel train
	rdprcstbtpbr	variable cost of bat technology for diesel train
	rdeffbtpbr	average efficiency of diesel train using bat technology
24 (A5.3)	bdcsttpbr	average cost of diesel bus per pkm
	bdshaotpbr	share of old technology for diesel bus
	bdprcstotpbr	variable cost of old technology for diesel bus
	bdpritpbr	diesel price for bus
	bdeffotpbr	average efficiency of diesel bus using old technology
	bdshantpbr	share of new technology for diesel bus
	bdprcstntpbr	variable cost of new technology for diesel bus
	bdeffntpbr	average efficiency of diesel bus using new technology
	bdshabtpbr	share of bat technology for diesel bus
	bdprcstbtpbr	variable cost of bat technology for diesel bus
	bdeffbtpbr	average efficiency of diesel bus using bat technology
25 (A5.1)	goefftpbr	average efficiency of gasoline cars
	goshaotpbr	share of old technology for gasoline cars
	goeffotpbr	average efficiency of gasoline cars using old technology
	goshantpbr	share of new technology for gasoline cars
	goeffntpbr	average efficiency of gasoline cars using new technology
	goshabtpbr	share of bat technology for gasoline cars
	goeffbtpbr	average efficiency of gasoline cars using bat technology

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
26 (A5.1)	diefftpbr	average efficiency of diesel cars
	dishaotpbr	share of old technology for diesel cars
	dieffotpbr	average efficiency of diesel cars using old technology
	dishantpbr	share of new technology for diesel cars
	dieffntpbr	average efficiency of diesel cars using new technology
	dishabtpbr	share of bat technology for diesel cars
	dieffbtpbr	average efficiency of diesel cars using bat technology
27 (A5.1)	gaefftpbr	average efficiency of gas cars
	gashaotpbr	share of old technology for gas cars
	gaeffotpbr	average efficiency of gas cars using old technology
	gashantpbr	share of new technology for gas cars
	gaeffntpbr	average efficiency of gas cars using new technology
	gashabtpbr	share of bat technology for gas cars
	gaeffbtpbr	average efficiency of gas cars using bat technology
28 (A5.1)	reefftpbr	average efficiency of electricity train
	reshaotpbr	share of old technology for electricity train
	reeffotpbr	average efficiency of electricity train using old technology
	reshantpbr	share of new technology for electricity train
	reeffntpbr	average efficiency of electricity train using new technology
	reshabtpbr	share of bat technology for electricity train
	reeffbtpbr	average efficiency of electricity train using bat technology
29 (A5.1)	rdefftpbr	average efficiency of diesel train
	rdshaotpbr	share of old technology for diesel train
	rdeffotpbr	average efficiency of diesel train using old technology
	rdshantpbr	share of new technology for diesel train
	rdeffntpbr	average efficiency of diesel train using new technology
	rdshabtpbr	share of bat technology for diesel train
	rdeffbtpbr	average efficiency of diesel train using bat technology
30 (A5.1)	bdefftpbr	average efficiency of diesel bus
	bdshaotpbr	share of old technology for diesel bus
	bdeffotpbr	average efficiency of diesel bus using old technology
	bdshantpbr	share of new technology for diesel bus
	bdeffntpbr	average efficiency of diesel bus using new technology
	bdshabtpbr	share of bat technology for diesel bus
	bdeffbtpbr	average efficiency of diesel bus using bat technology

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
31 (A2.12)	goshaltpbr	optimal share of gasoline cars
	a0gocontpbr	calibration constant
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus
32 (A2.12)	dishaltpbr	optimal share of diesel cars
	a0dicontpbr	calibration constant
	dicsttpbr	average cost of diesel cars per pkm
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus
33 (A2.12)	gashaltpbr	optimal share of gas cars
	a0gacontpbr	calibration constant
	gacsttpbr	average cost of gas cars per pkm
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
34 (A2.12)	reshaltpbr	optimal share of electricity train
	a0recontpbr	calibration constant
	recsttpbr	average cost of electricity train per pkm
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus
35 (A2.12)	rdshaltpbr	optimal share of diesel train
	a0rdcontpbr	calibration constant
	rdcsttpbr	average cost of diesel train per pkm
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus
36 (A2.12)	bdshaltpbr	optimal share of diesel bus
	a0bdcontpbr	calibration constant
	bdcsttpbr	average cost of diesel bus per pkm
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	a1bdcontpbr	cost share of diesel consumption, bus

Table 5 (continued)

Variable/	Parameter	
eq. #	name	description
37 (A2.13)	goshatpbr	normalised share of gasoline cars
	gosha1tpbr	optimal share of gasoline cars
	disha1tpbr	optimal share of diesel cars
	gasha1tpbr	optimal share of gas cars
	resha1tpbr	optimal share of electricity train
	rdsha1tpbr	optimal share of diesel train
	bdsha1tpbr	optimal share of diesel bus
38 (A2.13)	dishatpbr	normalised share of diesel cars
	disha1tpbr	optimal share of diesel cars
	gosha1tpbr	optimal share of gasoline cars
	gasha1tpbr	optimal share of gas cars
	resha1tpbr	optimal share of electricity train
	rdsha1tpbr	optimal share of diesel train
	bdsha1tpbr	optimal share of diesel bus
39 (A2.13)	gashatpbr	normalised share of gas cars
	gasha1tpbr	optimal share of gas cars
	gosha1tpbr	optimal share of gasoline cars
	disha1tpbr	optimal share of diesel cars
	resha1tpbr	optimal share of electricity train
	rdsha1tpbr	optimal share of diesel train
	bdsha1tpbr	optimal share of diesel bus
40 (A2.13)	reshatpbr	normalised share of electricity train
	resha1tpbr	optimal share of electricity train
	gosha1tpbr	optimal share of gasoline cars
	disha1tpbr	optimal share of diesel cars
	gasha1tpbr	optimal share of gas cars
	rdsha1tpbr	optimal share of diesel train
	bdsha1tpbr	optimal share of diesel bus
41 (A2.13)	rdshatpbr	normalised share of diesel train
	rdsha1tpbr	optimal share of diesel train
	gosha1tpbr	optimal share of gasoline cars
	disha1tpbr	optimal share of diesel cars
	gasha1tpbr	optimal share of gas cars
	resha1tpbr	optimal share of electricity train
	bdsha1tpbr	optimal share of diesel bus
42 (A2.13)	bdshatpbr	normalised share of diesel bus
	bdsha1tpbr	optimal share of diesel bus
	gosha1tpbr	optimal share of gasoline cars
	disha1tpbr	optimal share of diesel cars
	gasha1tpbr	optimal share of gas cars
	resha1tpbr	optimal share of electricity train
	rdsha1tpbr	optimal share of diesel train

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
43 (A2.10)	tppribr	price index for passenger transport
	gocsttpbr	average cost of gasoline cars per pkm
	a1gocontpbr	cost share of gasoline consumption, cars
	dicsttpbr	average cost of diesel cars per pkm
	a1dicontpbr	cost share of diesel consumption, cars
	gacsttpbr	average cost of gas cars per pkm
	a1gacontpbr	cost share of gas consumption, cars
	recsttpbr	average cost of electricity train per pkm
	a1recontpbr	cost share of electricity consumption, train
	rdcsttpbr	average cost of diesel train per pkm
	a1rdcontpbr	cost share of diesel consumption, train
	bdcsttpbr	average cost of diesel bus per pkm
	a1bdcontpbr	cost share of diesel consumption, bus
	tppri91br	calibration constant
44 (A2.11)	totdemindtpbr	total demand for passenger transport
	incomebr	consumption expenditure (income)
	b1pkmbr	income elasticity for passenger transport
	tppribr	price index for passenger transport
	b2pkmbr	price elasticity fot passenger transport
45 (A2.11)	totdemtpbr	total demand for passenger transport
	totdemindtpbr	total demand for passenger transport
	totdemtp91br	calibration constant
46 (A2.14)	gocontpbr	demand for gasoline (car) in passenger transport
	a0calpkmbr	calibration constant
	goshatpbr	normalised share of gasoline cars
	totdemtpbr	total demand for passenger transport
	goefftpbr	average efficiency of gasoline cars
47 (A2.14)	dicontpbr	demand for diesel (car) in passenger transport
	a0calpkmbr	calibration constant
	dishatpbr	normalised share of diesel cars
	totdemtpbr	total demand for passenger transport
	diefftpbr	average efficiency of diesel cars
48 (A2.14)	gacontpbr	demand for gas (car) in passenger transport
	a0calpkmbr	calibration constant
	gashatpbr	normalised share of gas cars
	totdemtpbr	total demand for passenger transport
	gaefftpbr	average efficiency of gas cars
49 (A2.14)	recontpbr	demand for electricity (train) in passenger transport
	a0calpkmbr	calibration constant
	reshatpbr	normalised share of electricity train
	totdemtpbr	total demand for passenger transport
	reefftpbr	average efficiency of electricity train

Table 5 (continued)

Variable/	Parameter	
eq. #	name	description
50 (A2.14)	rdcontpbr	demand for diesel (train) in passenger transport
	a0calpkmbr	calibration constant
	rdshatpbr	normalised share of diesel train
	totdemtpbr	total demand for passenger transport
	rdefftpbr	average efficiency of diesel train
51 (A2.14)	bdcontpbr	demand for diesel (bus) in passenger transport
	a0calpkmbr	calibration constant
	bdshatpbr	normalised share of diesel bus
	totdemtpbr	total demand for passenger transport
	bdefftpbr	average efficiency of diesel bus
52 (A2.15)	totdemindtfbr	total demand for freight transport
	gdpindbr	gross domestic production (GDP)
	dumitfbr	dummy variable for the integration scenario
	b1itkmbr	income elasticity in the case of the integration scenario
	dumftfbr	dummy variable for the fragmentation scenario
	b1ftkmbr	income elasticity in the case of the fragmentation scenario
53 (A2.15)	totdemtfbr	total demand for freight transport
	totdemindtfbr	total demand for freight transport
	totdemtf91br	calibration constant
54	nsharotfbr	normalised road transport share
	sharotfbr	road transport share
	sharatfbr	rail transport share
	shawatfbr	water transport share
55	nsharatfbr	normalised rail transport share
	sharatfbr	rail transport share
	sharotfbr	road transport share
	shawatfbr	water transport share
56	nshawatfbr	normalised water transport share
	shawatfbr	water transport share
	sharotfbr	road transport share
	sharatfbr	rail transport share
57 (A2.16)	rotkmbr	demand for road transport
	nsharotfbr	normalised road transport share
	totdemtfbr	total demand for freight transport
58 (A2.16)	ratkmbr	demand for rail transport
	nsharatfbr	normalised rail transport share
	sharaditfbr	dummy variable for the integration scenario
	totdemptfbr	total demand for freight transport

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
59 (A2.16)	watkmbr	demand for water transport
	nshawatfbr	normalised water transport share
	totdemtfbr	total demand for freight transport
60 (A2.17)	dicontfbr	demand for diesel in road transport
	a0calpkmbr	calibration constant
	rotkmbr	demand for road transport
	roefftfbr	average efficiency of diesel used in road transport
	a3ditftbr	coefficient for technological improvement
61 (A2.17)	elcontfbr	demand for electricity in rail transport
	a0calrelbr	calibration constant
	ratkmbr	demand for rail transport
	sharaditfbr	dummy variable for the integration scenario
	raefftfbr	average efficiency of electricity used in rail transport
	a3eletftbr	coefficient for technological improvement
62 (A2.17)	oilcontfbr	demand for oil in water transport
	a0calwkmbr	calibration constant
	watkmbr	demand for water transport
	waefftfbr	average efficiency of oil used in water transport
	a3oiltftbr	coefficient for technological improvement
63 (A2.18)	oilconindfabr	demand for air fuel (kerosene)
	gdpindbr	gross domestic production (GDP)
	b1tabr	income elasticity
	oilpritabr	price of kerosene
	b2tabr	price elasticity
	a3oiltfabr	lag/adjustment coefficient
64 (A2.18)	oilconfabr	demand for air fuel (kerosene)
	oilconindfabr	demand for air fuel (kerosene)
	oilconfa91br	calibration constant
65	aircontotbr	total demand for air fuel (kerosene)
	oilconfabr	demand for air fuel (kerosene)
66	roadcontotbr	total demand for fuel in road transport
	gocontpbr	demand for gasoline (car) in passenger transport
	dicontpbr	demand for diesel (car) in passenger transport
	gacontpbr	demand for gas (car) in passenger transport
	bdcontpbr	demand for diesel (bus) in passenger transport
	dicontfbr	demand for diesel in road transport
67	railcontotbr	total demand for electricity in rail transport
	recontpbr	demand for electricity (train) in passenger transport
	elcontfbr	demand for electricity in rail transport

Table 5 (continued)

Variable/ Parameter		
eq. #	name	description
68	railcondiebr	demand for diesel in rail transport
	rdcontpbr	demand for diesel (train) in passenger transport
	a0calrdibr	calibration constant
	ratkmbr	demand for rail transport
	sharaditfbr	dummy variable for the integration scenario
	raefftfbr	average efficiency of electricity used in rail transport
69	watcontotbr	total demand for fuel in water transport
	oilcontfbr	demand for oil in water transport

Table 6: The Price Model

Variable/ Parameter		
eq. #	name	description
1 (2.43)	coaprisinbr	end user price of coal in the industry sector, USD per toe
	coaimppribr	import price of coal in Germany
	coamrginbr	price margin on coal in the industry sector
	coataxinbr	excise tax on coal in the industry sector
	cco2taxinbr	co2 tax on coal in the industry sector
	coavatinbr	value added tax on coal in the industry sector
2	coapriinbr	end user price of coal in the industry sector
	coaprisinbr	end user price of coal in the industry sector, USD per toe
3 (2.43)	coaprissebr	end user price of coal in the service sector, USD per toe
	coaimppribr	import price of coal in Germany
	coamrgsebr	price margin on coal in the service sector
	coataxsebr	excise tax on coal in the service sector
	coavatsebr	value added tax on coal in the service sector
4	coaprisebr	end user price of coal in the service sector
	coaprissebr	end user price of coal in the service sector, USD per toe
5 (2.43)	coaprishobr	end user price of coal in the household sector, USD per toe
	coaimppribr	import price of coal in Germany
	coamrghobr	price margin on coal in the household sector
	coataxhobr	excise tax on coal in the household sector
	cco2taxhobr	co2 tax on coal in the household sector
	coavathobr	value added tax on coal in the household sector
6	coaprihobr	end user price of coal in the household sector
	coaprishobr	end user price of coal in the household sector, USD per toe

Table 6 (continued)

Variable/ Parameter		
eq. #	name	description
7 (2.43)	coapriselbr	end user price of coal in the electricity sector, USD per toe
	coaimppribr	import price of coal in Germany
	coamrgelbr	price margin on coal in the electricity sector
	coataxelbr	excise tax on coal in the electricity sector
	coavatelbr	value added tax on coal in the electricity sector
8	coaprielbr	end user price of coal in the electricity sector
	coapriselbr	end user price of coal in the electricity sector, USD per toe
9 (2.43)	oilprisinbr	end user price of oil in the industry sector, USD per toe
	oilimppribr	import price of oil in Germany
	oilmrginbr	price margin on oil in the industry sector
	oiltaxinbr	excise tax on oil in the industry sector
	oco2taxinbr	co2 tax on oil in the industry sector
	oilvatinbr	value added tax on oil in the industry sector
10	oilpriinbr	end user price of oil in the industry sector
	oilprisinbr	end user price of oil in the industry sector, USD per toe
11 (2.43)	oilprissebr	end user price of oil in the service sector, USD per toe
	oilimppribr	import price of oil in Germany
	oilmrgsebr	price margin on oil in the service sector
	oiltaxsebr	excise tax on oil in the service sector
	oco2taxsebr	co2 tax on oil in the service sector
	oilvatsebr	value added tax on oil in the service sector
12	oilprisebr	end user price of oil in the service sector
	oilprissebr	end user price of oil in the service sector, USD per toe
13 (2.43)	oilprishobr	end user price of oil in the household sector, USD per toe
	oilimppribr	import price of oil in Germany
	oilmrghobr	price margin on oil in the household sector
	oiltaxhobr	excise tax on oil in the household sector
	oco2taxhobr	co2 tax on oil in the household sector
	oilvathobr	value added tax on oil in the household sector
14	oilprihobr	end user price of oil in the household sector
	oilprishobr	end user price of oil in the household sector, USD per toe
15 (2.43)	oilpriselbr	end user price of oil in the electricity sector, USD per toe
	oilimppribr	import price of oil in Germany
	oilmrgelbr	price margin on oil in the electricity sector
	oiltaxelbr	excise tax on oil in the electricity sector
	oilvatelbr	value added tax on oil in the electricity sector
16	oilprielbr	end user price of oil in the electricity sector
	oilpriselbr	end user price of oil in the electricity sector, USD per toe

Table 6 (continued)

Variable/	Parameter	
eq. #	name	description
17 (2.43)	ngsprisinbr	end user price of gas in the industry sector, USD per toe
	ngsimppribr	import price of gas in Germany
	ngsmrginbr	price margin on gas in the industry sector
	ngstaxinbr	excise tax on gas in the industry sector
	nco2taxinbr	co2 tax on gas in the industry sector
	ngsvatinbr	value added tax on gas in the industry sector
18	ngspriinbr	end user price of gas in the industry sector
	ngsprisinbr	end user price of gas in the industry sector, USD per toe
19 (2.43)	ngsprissebr	end user price of gas in the service sector, USD per toe
	ngsimppribr	import price of gas in Germany
	ngsmrgsebr	price margin on gas in the service sector
	ngstaxsebr	excise tax on gas in the service sector
	nco2taxsebr	co2 tax on gas in the service sector
	ngsvatsebr	value added tax on gas in the service sector
20	ngsprisebr	end user price of gas in the service sector
	ngsprissebr	end user price of gas in the service sector, USD per toe
21 (2.43)	ngsprishobr	end user price of gas in the household sector, USD per toe
	ngsimppribr	import price of gas in Germany
	ngsmrghobr	price margin on gas in the household sector
	ngstaxhobr	excise tax on gas in the household sector
	nco2taxhobr	co2 tax on gas in the household sector
	ngsvathobr	value added tax on gas in the household sector
22	ngsprihobr	end user price of gas in the household sector
	ngsprishobr	end user price of gas in the household sector, USD per toe
23 (2.43)	ngspriselbr	end user price of gas in the electricity sector, USD per toe
	ngsimppribr	import price of gas in Germany
	ngsmrgelbr	price margin on gas in the electricity sector
	ngstaxelbr	excise tax on gas in the electricity sector
	nco2taxelbr	co2 tax on gas in the electricity sector
	ngsvatelbr	value added tax on gas in the electricity sector
24	ngsprielbr	end user price of gas in the electricity sector
	ngspriselbr	end user price of gas in the electricity sector, USD per toe
25 (2.43)	eleprisinbr	end user price of electricity in the industry sector , USD per toe
	elegenpribr	electricity generation price (cost)
	elemrginbr	price margin on electricity in the industry sector
	eletaxinbr	excise tax on electricity in the industry sector
	elevatinbr	value added tax on electricity in the industry sector
26	elepriinbr	end user price of electricity in the industry sector
	eleprisinbr	end user price of electricity in the industry sector , USD per toe

Table 6 (continued)

Variable/ Parameter		
eq. #	name	description
27 (2.43)	eleprissebr	end user price of electricity in the service sector , USD per toe
	elegenpribr	electricity generation price (cost)
	elemrgsebr	price margin on electricity in the service sector
	eletaxsebr	excise tax on electricity in the service sector
	elevatsebr	value added tax on electricity in the service sector
28	eleprisebr	end user price of electricity in the service sector
	eleprissebr	end user price of electricity in the service sector , USD per toe
29 (2.43)	eleprishobr	end user price of electr. in the household sector , USD per toe
	elegenpribr	electricity generation price (cost)
	elemrghobr	price margin on electricity in the household sector
	eletaxhobr	excise tax on electricity in the household sector
	elevathobr	value added tax on electricity in the household sector
30	eleprihobr	end user price of electricity in the household sector
	eleprishobr	end user price of electr. in the household sector, USD per toe
31 (2.43)	gopristpbr	end user price of gasoline in the passenger transp., USD per toe
	goimppribr	import price of gasoline in Germany
	gomrgtpbr	price margin on gasoline in the passenger transport
	gotaxtpbr	excise tax on gasoline in the passenger transport
	goco2taxtpbr	co2 tax on gasoline in the passenger transport
	govattpbr	value added tax on gasoline in the passenger transport
32	gopritpbr	end user price of gasoline in the passenger transport
	gopristpbr	end user price of gasoline in the passenger transp., USD per toe
33 (2.43)	dipristpbr	end user price of diesel in the passenger transport, USD per toe
	diimppribr	import price of diesel in Germany
	dimrgtpbr	price margin on diesel in the passenger transport
	ditaxtpbr	excise tax on diesel in the passenger transport
	dico2taxtpbr	co2 tax on diesel in the passenger transport
	divattpbr	value added tax on diesel in the passenger transport
34	dipritpbr	end user price of diesel in the passenger transport
	dipristpbr	end user price of diesel in the passenger transport, USD per toe
35	rdpritpbr	end user price of diesel in the rail passenger transport
	dipritpbr	end user price of diesel in the passenger transport
	divattpbr	value added tax on diesel in the passenger transport
36	bdpritpbr	end user price of diesel in the bus passenger transport
	dipritpbr	end user price of diesel in the passenger transport
	divattpbr	value added tax on diesel in the passenger transport
37	gapritpbr	end user price of gas in the passenger transport
	dipritpbr	end user price of diesel in the passenger transport

Table 6 (continued)

Variable/ Parameter		
eq. #	name	description
38	repritpbr eleprissebr	end user price of electricity in the rail passenger transport end user price of electricity in the service sector , USD per toe
39	oilpritabr oilprishobr	end user price of oil (kerosene) in the air transport end user price of oil in the household sector, USD per toe

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