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Balmorel: Getting Started

To be used with Balmorel Version 2.12 Alpha (July 2005)

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Contents

1 Introduction

This paper describes how to get started using the Balmorel model. The document is part of a series that together documents the Balmorel model:

> Balmorel: A Model for Analyses of the Electricity and CHP Markets in the Baltic Sea Region (Main Report)
>
> The Balmorel Model: Theoretical Background
>
> The Balmorel Model Structure
>
> Balmorel: Data and Calibration
>
> Balmorel: Getting Started (this document)

These documents and further information may be found at the Balmorel homepage: www.Balmorel.com.

1.1 This version

The description given here is for version 2.12 Alpha (July 2005) of the model.

It is intended for use with the document 'The Balmorel Model Structure' for the same version, so please get that document from the Balmorel homepage.

2 Getting the Model

The model may be downloaded from the homepage www.Balmorel.com. There may be different versions, make sure that you take the latest version and in particular that there is consistency between the model version and the documentation version.

The model comes in a zipped version. Unzip it and place it in a convenient directory on your computer.

Now the file structure described in 'The Balmorel Model Structure' should appear, please consult that document and verify that the necessary files are present and properly located.

The model is written in the GAMS modeling language, see Section 3.

3 The GAMS Modeling System

GAMS is the acronym for General Algebraic Modeling System. The system is suitable for formulation, documentation and solution of large mathematical models.

The user must have GAMS installed at the computer, and it is assumed that the reader is sufficiently familiar with the GAMS language and the operation of the GAMS system. Conditions for acquiring GAMS, a User's Guide, a Tutorial, and other relevant information about the GAMS modeling system may be found at GAMS homepage www.gams.com.

Version 2.12 Alpha (July 2005) of the Balmorel model may be used with GAMS version 2.25 or later.

'The Balmorel Model Structure' contains a short description of GAMS. If you are not familiar with GAMS you may find a tutorial and other relevant introductory material at the GAMS homepage.

The basic GAMS system is file-oriented, and any word processor or editor that operates on text files may be used.

User interface facilities using Excel is under development for the Balmorel model, however it is not necessary to use this.

4 The Solver

In order to use the model, a solver is required. The Balmorel model is a linear model and therefore a linear programming solver is required. The solver must have an interface with the GAMS system, see the GAMS User's Guide and the GAMS homepage www.gams.com.

5 The Computer

The GAMS system including solvers with interface to GAMS may be used on a wide variety of computers. Consult www.gams.com.

The time needed to run the model will depend on the model, the solver and the computer. The model, in particular its size, may to some extent be chosen according to circumstances, however, you will probably soon like to run a large model, and therefore you will also want a powerful computer.

The standard user interface operates on text files, so an editor to handle this is necessary. User interface facilities using Excel is under development. It is not necessary to use it, if you want to, you must have Excel of course.

6 Running the Model

Once the model, the GAMS system and the solver are installed on your computer it should be possible to run the model.

There are various ways to operate the GAMS system, cf. www.gams.com, use any.

In the following it will be assumed that you can run the installed model, and that you can do so without getting any error messages.

The description in this section is aimed at working with the text files. In Section 7 the Excel files will be described.

The model comes in a small version where e.g. only one country, one year and one time segment per year are represented, where limited information is printed out, and otherwise. In Section 6.2.5 it will be described how to extend the model and the output to full capabilities.

6.1 First Experiments

6.1.1 The output

In 'The Balmorel Model Structure' you may find a general description of the output produced by a successful run of the Balmorel model. In particular note the distinction between the output automatically generated by GAMS and the output originating specifically from the Balmorel model. In the sequel only the latter type will be dealt with.

6.1.2 Log and Error files

Run the model. It is assumed that this occurs without any problems being reported by the GAMS system.

However, this does not necessarily mean that the output from the model was meaningful or as expected. Therefore the Balmorel model comes with additional features that serves to identify if the input, the model and the solution were reasonable.

Open the file 'logfile.out' in the directory 'logerror'. Here you will find an indication if suspicious things were discovered. If this is the case, the contents of the file will instruct you on how find more details. Observe that the mentioned file may not be updated if the GAMS system reported errors, therefore always check the date and time in the file.

Remember:

- After any model run which was somehow declared successful by GAMS, check the file 'logfile.out'.

6.1.3 Other output files

Output describing the energy system results of a simulation will appear in various files in the directory 'printout'.

Open one file with the extension 'out' in the directory 'printout' and study the contents. You may also study the contents of other files with the extension 'out' in the same directory.

See the description of the various output files in a document located in the 'documentation' directory.

Observe that the output files are overwritten each time the model is run. Therefore you will have to move or rename the files after each run if you want to save them for later use.

6.1.4 The input

In 'The Balmorel Model Structure' you may find a description of the file structure of the model, the input to the model, and where this is located in the different files.

In the following you will be directed to make elementary changes in the input that is found in some of the files that are included into the main file 'balmorel.gms'.

6.1.5 Change demand

Open the file 'de.inc' in the directory 'model'. For the country and the year simulated (search one or more of the output files, cf. Section 6.1.3, to identify this) change the electricity demand in one of the regions (see 'The Balmorel Model Structure' for the definition of region). Rerun the model and study the consequences for the output in various files (Section 6.1.3).

Remember that the output files are overwritten each time the model is run, Section 6.1.3.

You may similarly change heat demand in the file 'dh.inc' for one heat area in the country and year simulated and study the consequences (see 'The Balmorel Model Structure' for the definition of area). Do not forget the advice given in Section 6.1.2!

You may experiment with other changes of numerical input data found in e.g. 'geogr.inc' or 'fuelp.inc'.

Make sure that after these experiments you reenter the original numerical values.

Do not change anything in the file 'balmorel.gms', and be very careful if you make changes in 'sets.inc'!

6.2 Carrying On

6.2.1 The inputout file

The file 'inputout.out' in the directory 'printout' contains a summary of the input to the model that is simulated. The file is useful for getting an overview of the model and data, for error finding and otherwise.

The simulated model need not represent all the countries and all the years that are indicated in the include files (eg. 'de.inc', cf. Section 6.1.5). See also the description on the difference between data structure and simulation in 'The Balmorel Model Structure' .

The following section illustrates how the simulated model is specified, see also Section 6.2.5.

6.2.2 Countries

The countries in the data structure are specified in SET CCC which is defined in the file 'sets.inc'. Open this file, find CCC and study the definition.

The countries in the simulation are specified in SET C(CCC) (which is a subset of SET CCC), also in the file 'sets.inc'. Find C(CCC) and study the definition. Observe in particular that an asterix (*) in the first position of a line turns that line into a comment. Only one country from the set CCC is selected for inclusion in C(CCC), since all other countries have an asterix in the first position of the line.

Include one more country. Run the model. Study the consequences (Section 6.1.3, Section 6.2.1).

You end this section by redefining SET C(CCC) to contain only one country (the one originally included or any other).

6.2.3 The years

The years in the data structure are given as SET YYY and the years simulated are given in SET Y(YYY), both located in the file 'sets.inc'.

Find YYY and study the definition. Observe that a notation like "/1995*2030/" means that all years from 1995 to 2030 are included, and "/2000*2000/" hence means that only 2000 is selected. Find Y(YYY) and change it to contain two consecutive years, rerun the model and study the consequences.

You end this section by redefining SET Y(YYY) to contain only one year.

6.2.4 Time segments within the year

The simulated year may be subdivided into time segments (S,T), cf. 'The Balmorel Model Structure' .

The seasons (e.g. months of the year, or summer/winter) in the data structure are given as SET SSS and the seasons simulated are given in SET S(SSS), both located in the file 'sets.inc'.

The subdivision of the seasons (e.g., 4-hours intervals) are given in the data structure by SET TTT and the ones simulated are given in SET T(TTT), both located in the file 'sets.inc'.

Change S(SSS) and T(TTT) to contain two labels each, rerun the model and study the consequences.

You may experiment with various selections of time segments by changing the definitions of S(SSS) and T(TTT). Observe how the solution and the solution time depend on this. You will probably find that the number of time segments per year is a crucial determinant for the results as well as for the solution time. Intuitively, one would prefer many time segments to obtain more accuracy, however, this implies a more heavy computational burden.

This is one of the reasons why the model has been constructed with a flexible subdivision of the year. For any problem to be analysed the determination of the necessary and sufficient number of time segments of the year is part of the problem.

You end this section by defining the sets S(SSS) and T(TTT) to contain only one or two elements each.

6.2.5 The full model

The model installed was a small version where e.g. only one country, one year and one time segment per year are represented. In the previous sections some of this has been illustrated, and it has been explained how to extend the model.

A list of the main intended limitations in the supplied model is given below along with an indication of how they are implemented, and hence what should be changed in order to eliminate them.

- Only one country: SET C(CCC), cf. Section 6.2.2.
- One time segment per year: SET T(TTT) and SET S(SSS), cf. Section 6.2.4.
- Only one year: SET Y(YYY), cf. Section 6.2.3.
- Limited output: files 'print1.inc', 'print2.inc', 'prt3-bb1.inc', 'prt4-bb1.inc', cf. Section 6.2.6 and Section 6.2.7.
- No investments in new production capacity: consult 'The Balmorel Model Structure' .
- No investments in new transmission capacity: consult 'The Balmorel Model Structure' .

6.2.6 Print files

The output observed above was produced by instructions written specifically for the Balmorel model. Typically, one file of output was produced by one file containing the printing specifications. These files are located in the subdirectory 'printinc' and have the extension '.inc'. The file 'prt4-bb1.inc' specifies which files that are selected.

In 'prt4-bb1.inc' you may comment in some more print files (provided of course that they exist and are properly located, defined and specified, note in particular 'print1.inc'). Comment in two or three more files, run the model and observe the new files in the subdirectory 'printout'. Open them and study the contents.

Observe that you computer may have a limit on the number of files that may be open at the same time. Therefore be careful not to use too may print files in the same simulation. If you encountered no problems with this, so far, you may proceed, otherwise make a smaller selection of print files that you want to have open by commenting out those that are not necessary. Alternatively you may change the setting of the computer.

See Section 6.2.7 for more on output.

6.2.7 Designing and controlling the output

The output facilities described in Section 6.2.6 were prepared specifically for the Balmorel model. Although there are many print files, you will probably soon like to have more simulation output. You may get this by copying and modifying the print files to suit your purpose.

The mentioned print files rely on the PUT command. You may also use the DISPLAY command which you may find more easy to use. This produces output to the file 'balmorel.lst'.

Place the statement "DISPLAY 'MyOwnChoice: ', Y, C, G, DE, VGE_T.L , 'End MyOwnChoice' ;" at the very end of the file 'balmorel.gms'. Run the model and find the result in 'balmorel.lst' (near the end of the file; you may search for the text string 'MyOwnChoice').

Various options control the type, amount and format of the output in the file 'balmorel.lst'. The options along with a short description is given in the file 'balgams.gms'. See further the GAMS User's Manual (Section 3).

7 Using Excel Interface

The description in Section 6 was based on working with the text file version of the model.

However, it is also possible to work with an Excel interface (presently under development). Basically, this consists of two parts, an input part containing the

model and additional material, and an output part providing graphs based on some of the output files.

The advantage of using a spreadsheet environment like Excel as interface is that it provides convenient facilities for preparation of input. In few cases the input to a model can be taken directly from data sources, in most cases it must in some way be manipulated. Some kinds of such manipulation may conveniently be done in a spreadsheet environment. Further, through graphical presentation and otherwise, easy overview and control of the input is possible. Similarly the output may advantageously be presented and further processed in a spreadsheet environment. Some Excel spreadsheet facilities are provided for this purpose.

The text files described in Section 6 serve as intermediate files. Thus, it will always be possible to observe directly in those files the input to and output from simulation.

Since the Excel user interface is under construction it will not be explained here.

You may get a preliminary version by contacting us as www.Balmorel.com.

7.1 The input system

Awaiting description.

7.2 The output system

Awaiting description.

8 And then

The present document provides a basic introduction on how to get started. To proceed, you will have to experiment yourself. You may benefit from studying other documents mentioned in Section 1, in particular 'The Balmorel Model Structure' .

In case of serious problems you may contact us, see www.Balmorel.com for contact address.

Any comments to this document or any other aspects related to Balmorel are welcome.