



the
abdus salam
international centre for theoretical physics

40th anniversary
1964
2004

SMR 1585 - 5

WORKSHOP ON DESIGNING SUSTAINABLE ENERGY SYSTEMS
18 October - 5 November 2004

PREPARATION OF MODEL OUTPUT TABLES

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These are preliminary lecture notes, intended only for distribution to participants.

Preparation of model output tables

A.Galinis

Output files of MESSAGE

- ***MPS file***: standardized matrix format, describing linear program – results of MXG
- ***Technology chain file***: description of energy chain
- ***Technology dictionary file***: MXG encoded names of all technologies
- ***Solution file***: results of optimization
- ***Sensitivity file***: information for sensitivity analysis
- ***Tabular output file***: results in the form of tables
- ***Table of contents file***: table of contents for the tabular output file

Extracting the final model results

In the interactive mode

Through cin file

Extracting the final model results

In the Interactive Mode

- **It provides a flexible framework to choose certain parts of the model's solution results in form of tables and graphs;**
- **It allows the user to get the micro-level results on four major component of the model i.e. technologies, resources, constraints/relations and energy forms.**

Interactive mode (1)

The screenshot displays the 'Interactive results' software interface. The main window has a menu bar with 'Load/wS', 'Load/nS', 'Save', and 'Quit'. Below the menu bar are buttons for 'Take balance', 'Take curve', 'Clear', 'Graph', 'Table', and 'Units'. The interface is divided into several sections:

- Graph definitions:** Includes fields for 'title:', 'file:', 'year:' (set to 'annual'), 'graph:' (set to 'cumulative'), 'fill:' (set to 'yes'), and 'type:' (set to 'histogramm').
- Case/scenario selection:** Includes 'case:' (set to 'CHP_IAEA'), 'scen:' (set to 'adb'), 'sort:' (set to 'no'), and 'unit:' (set to 'M/Wyr').
- Curve selection (click 'Take curve' to select):** Includes 'type:' (set to 'Technologies'), 'item:' (set to 'From_ssh_to_wd'), 'aspect:' (set to 'output'), and 'fuel:' (set to 'dummy').
- Balance selection (click 'Take balance' to select):** Includes 'lev:' (set to 'Final'), 'fuel:' (set to 'electricity'), 'pr/con:' (set to 'producers'), and 'tec:' (set to 'electr_td').

Below the main configuration area is a table labeled 'Selected curves'. Below this table are five vertical lists of options, each with a red arrow pointing to a specific selection in the configuration area:

- Final:** Intermediate, Secondary, primary. (Arrow points to 'lev:')
- From_ssh_to_wd:** From_stor_ssh, From_stor_wd, From_wd_to_ssh, Stbypass, To_stor_ssh, To_stor_wd, backpresure, backpresure[2.], boiler, condensing, condensing[2.]. (Arrow points to 'item:')
- electricity:** heat. (Arrow points to 'fuel:' in the balance selection)
- output:** input, new inst, total inst cap, shadow price act, shadow price inst, max output, min output, max input, min input, max inst, min inst. (Arrow points to 'aspect:')
- producer:** consumers, activity, shadow price, slack. (Arrow points to 'pr/con:')

On the left side of the interface, there are three vertical lists of categories:

- Top list: 'annual', 'all', '2001', '2002', '2003', '2004', '2005'. (Arrow points to 'year:')
- Middle list: 'wor', 'miniex', 'CHP_IAEA'. (Arrow points to 'case:')
- Bottom list: 'Relations1', 'Relations2', 'Relationsc', 'Relationsp', 'Technologies', 'Storages', 'Resources'. (Arrow points to 'type:' in the curve selection)

Interactive mode (2)

Options for output of results:

In form of tables;

In form of graphs;

For one or several cases;

For one or several scenarios;

**Output can be saved in form of ggi files that can
be used for other model runs;**

**Can be exported to Microsoft Excel for further
processing;**

Extracting the final model results

Through cin File

- **The user prepares an input file giving names of the model's variables generated by the program to extract the results;**
- **It allows the user to formulate some algebraic relations between variables to calculate some new variables from the results.**

Purpose of the cin file

To give user more freedom to prepare results in format defined by user and for variables selected by user;

To facilitate user to define an algebraic relation to compute some new variables for extracting results.

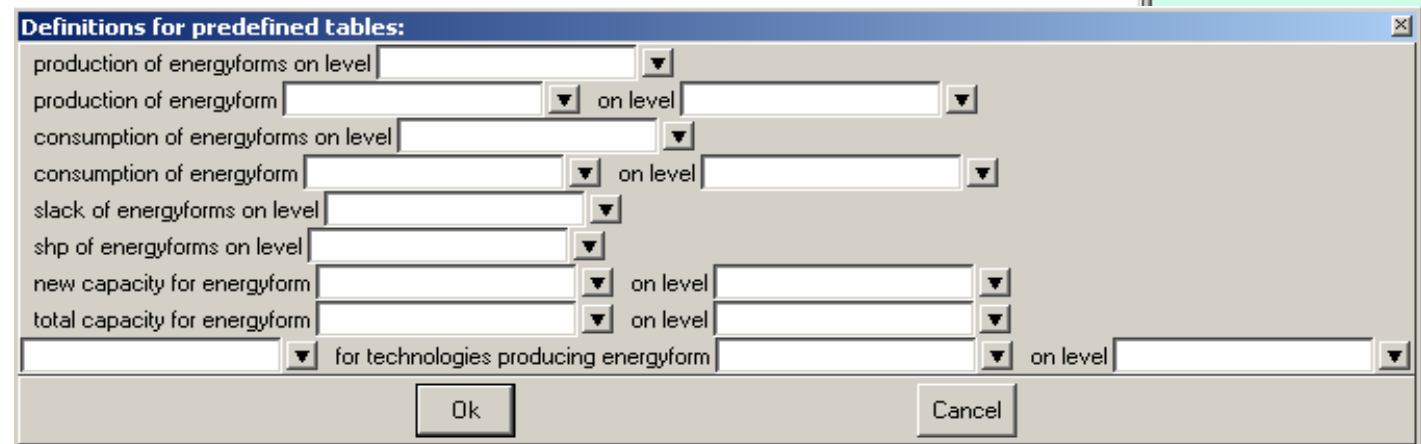
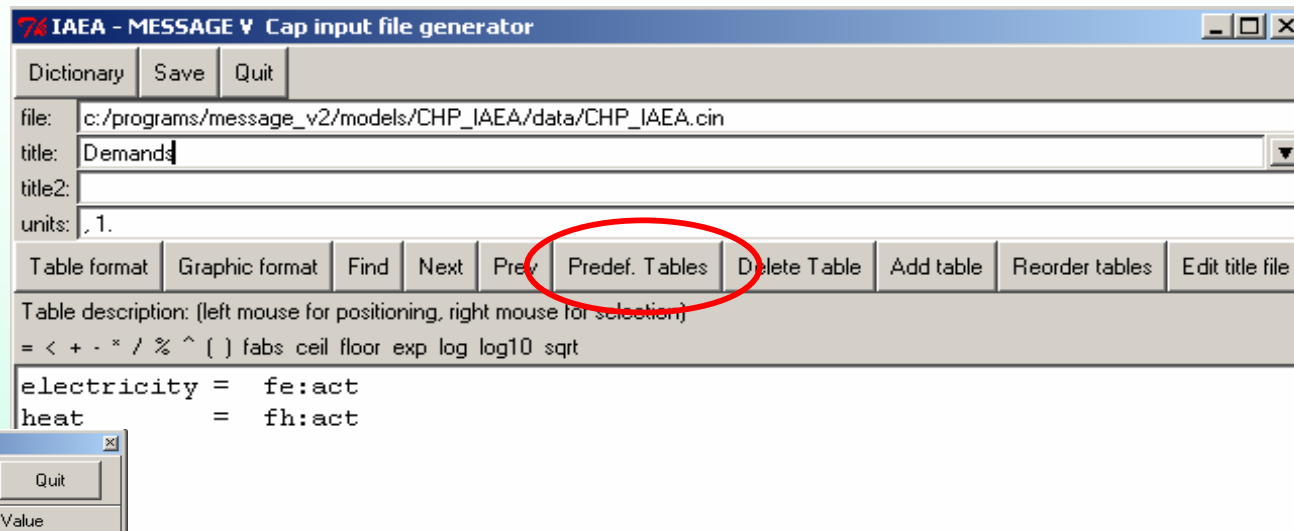
Features of the cin File

It contains detailed instructions on creation of tables and graphs for the program CAP, individually for each tables and graphs;

Each table is specified in two parts:

- General data which are defined in the form of keywords (required and optional),**
- Time series which are defined in the form of equations among variables of the MXG.**

Preparation of pre-selected tables



Preparation of user defined tables (1)

Time series definition

Time series are defined in the form of usual mathematical equation where each line contains one equation with its time series name:

$$\text{coal_costs} = \text{pcec:act} * \text{pcec:vom}$$

Name of variable

Descriptor

*coal _cost is the name of the time series , is obtained by multiplying (character *) the annual activity (pcec:act) and the respective variable operation and maintenance costs (pcec:vom) of the technology called pcec in MXG*

Preparation of user defined tables (2)

*Descriptors from the
solution file*

act	activity (input)
inp	activity (input)
sla	slack activity
lol	lower limit
upl	upper limit
shp	shadow price
obx	objective function value x
ony	objective function value y
lev	levellized cost
atu	1 if at upper limit
atl	1 if at lower limit
tot	total output
out	activity (output)
use	use of fuel f on level 1 If:use
prd	production of fuel f on level 1 If:prd
tic	total installed capacity
prc	average fuel prices calculated from chain
sin	sum over inputs to a technology
spr	sum over products from a technology
cic	cumulative installed capacity

Preparation of user defined tables (3)

*Descriptors from the
input file*

inv	investment costs
fom	fix O&M costs
vom	variable O&M costs
prl	period length
lev	levellized costs
tot	lev + input costs
cst	costs of add. rows or resource
rem	remaining resources
vol	initial volume of resource
ei.	energy input .
eo.	energy output .
ci.	construction input .
co.	Construction output .
eff	main efficiency
plf	plant factor
pll	plant life
hia	historic activity
lr.	length of load region lr .
fr.	Fraction of lr .

Preparation of user defined tables (4)

Mathematical operators and functions in CAP

Mathematical Operators

+	addition
-	subtraction
*	multiplication
/	division
^	power
%	integer division

Functions

fabs()	absolute value
ceil()	ceiling
floor()	floor
exp()	exponential
log()	natural logarithm
log10()	logarithm base 10
sqrt()	square root

Preparation of user defined tables (5)

The screenshot displays the IAEA MESSAGE V Cap input file generator interface. The main window shows a table definition for 'Demands' with columns for 'electricity', 'heat', and 'gas'. A context menu is open over the table, with 'insert' selected, leading to a sub-menu where 'Technology' is chosen. A secondary dialog box, 'IAEA - MESSAGE V CHP_IAEA', is open, showing a list of technologies and aspects. The 'main input amount' aspect is selected for the 'boiler' technology. The 'adb' scenario is selected at the bottom.

IAEA - MESSAGE V Cap input file generator

Dictionary Save Quit

file: c:/programs/message_v2/models/CHP_IAEA/data/CHP_IAEA.cin
title: Demands
title2:
units: , 1.

Table format Graphic format Find Next Prev Predef. Tables Delete Table Add table Reord

Table description: (left mouse for positioning, right mouse for selection)
= < + - * / % ^ () fabs ceil floor exp log log10 sqrt

```
electricity = fe:act  
heat       = fh:act  
gas        =
```

copy
paste
cut
delete
insert ▶ Technology
conversion ▶
name

Storage
Resource
Relations ▶
Demand
Energyforms
Aspects

IAEA - MESSAGE V CHP_IAEA

Select technology Select aspect

Select technology	Select aspect
boiler	main input amount
From_ssh_to_wd	main input amount
From_stor_ssh	main output amont
From_stor_wd	by inputs
From_wd_to_ssh	by outputs
Stbypass	new capacity
To_stor_ssh	entries in group1
To_stor_wd	entries in group2
backpressure	entries in storage
backpressure[2.]	activity
boiler	investment cost
condensing	fix O&M cost cost
condensing[2.]	variable O&M cost cost
condensing[3.]	efficiency
condensing[4.]	plant factor
electr_td	plant life
gas_imp	historic activity
heat_td	activity slack value
oil_imp	investment slack value
power_plant	activity lower limit
xxx	investment lower limit
xxx[2.]	activity upper limit
	investment upper limit
	activity shadow price
	investment shadow price
	activity ojective function value
	investment ojective function value
	levelized cost
	at lower limit
	at upper limit
	total cost
	total installed capacity
	sum over inputs for technology
	sum over outputs for technology
	cumulative installed capacity

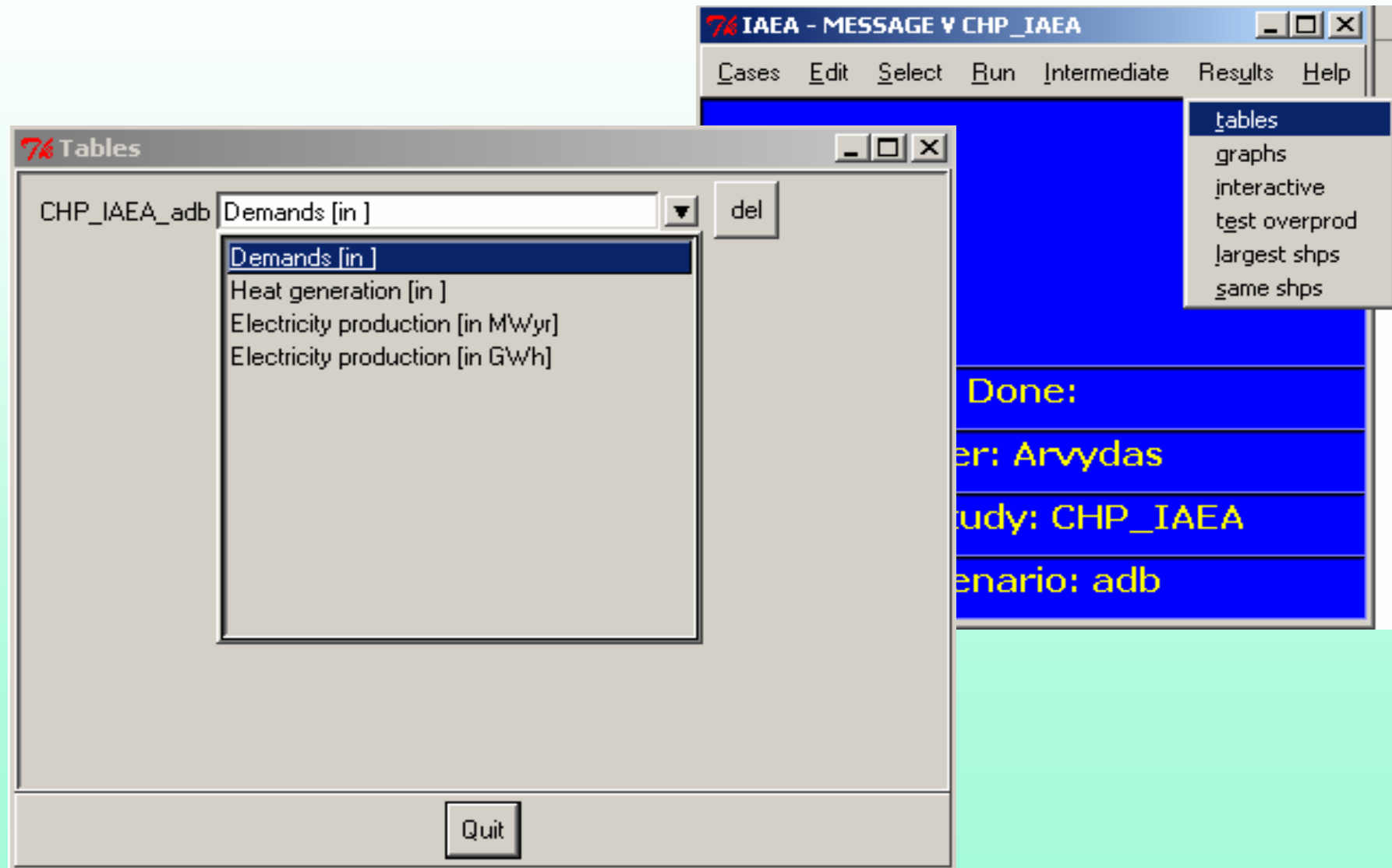
Select scenario adb

Ok Cancel

Characteristics of the cin File

- **The cin file can be prepared before and/or after run the MXG and optimization, i.e. manually and/or using program provided mathematical operators, functions and a set of commands, respectively**
- **The calculation of all variables defined in all the tables in the cin file for the selected scenario can only be made after run the CAP on the base of successful completion of MXG and optimization**
- **The extraction of the results from the cin file can then be viewed on the dropdown menu of the ‘Results’ command – ‘tables’ and ‘graphs’**

View of results



Preparation of the cin File

open cin file from the 'Edit' command



select existing or create new cin file



select scenario



edit cin file (title, units, format of the table/graph)



prepare the tables



save cin file



calculates the tables defined in the cin file (run CAP)



extracting the results at the 'tables' and 'graphs'
from the 'Results' command