

MARKAL¹ Version 5.9a-f Enhancements and Updates

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1.0 Background

ETSAP and other key institutions that use MARKAL continue to provide support for and enhancements to the MARKAL model generator and report writer. This short Information Note describes these latest facilities.

2.0 Overview of Updates

A new model variant option to allow the modeling of Lumpy Retirement of Capacity was added to the MARKAL code. The GAMS coding for this enhancement was carried out by Dr. Ken Noble of Noble-Soft Systems, with specifications provided by Dr. Ken Stocks of Intelligent Energy Systems, Sydney. For full details of the Lumpy Retirement facility, see the Word document “Modeling Lumpy Retirements in ANSWER-MARKAL.doc” that is distributed with the ANSWERv6-MARKAL version 6.3.01 update.

In addition the following minor adjustments and corrections have been made to the MARKAL code since the release of Version 5.8a.

1. The ETRANINV/OM charges are no longer included (automatically) for LNK grid technologies, users should use INVCOST/FIXOM on the link technology when desired instead.
2. Facilitate comparing results from a MARKAL run against those of an associated TIMES version, for those trying to "migrate" (most of) an existing MARKAL model to a similar TIMES model by:
 - a. Providing new GDX2VEDA dump specification files that use the TIMES VD structure/parameters to produce more compatible sets of model results to enable both MARKAL/TIMES results to reside in the same TIMES VEBA-BE database. [MARKAL/RMARKAL_TIM.VDD]
 - b. Preparing a small GAMS routine which can be added to the end of the GEN file (at run time, via \$BATINCLUDE M2TKILL.GMS) to remove

¹ See *Documentation for the MARKAL Family of Models*, Volume I - III, International Energy Agency - Energy Technology Systems Analysis Programme, October 2004.

- some MARKAL parameters for which there is no "direct" TIMES equivalent.
3. Add
 - a. Dump of ETL calculated investment costs in each period to VEDA-BE.
 - b. Output the Total Discounted System cost for MED runs to T01.
 - c. Undiscounted annual cost reporting for MED.
 - d. R_GTRD added to user constrains (ADRATIOs).
 - e. Various additional information dumped to VBE (e.g., stochastics results, producer/consumer surplus)
 4. Made the following "fixes"
 - a. Add full pathing for the GDX for MARKAL-MACRO Restart.
 - b. Permit the user to request the setting of an Upper Bound equal to GROWTH_TID (and r) "seed" for a growth constraint.
 - c. Adjust the dumping of MED_OBJ/CPSUR to VEDA-BE.
 - d. Don't put out Expenditure on Fuel if LNK technology to VEDA-BE.
 - e. Adjust the hard-wired 6-timeslice reference in the multi-region code so that properly handles the open TD(ZY) now supported.
 - f. Exports were not getting out to VEDA-BE.
 - g. Stochastics was missing setting the Fixed emissions bound and the BOUND(BD)O for CONs, adjusted to handle case names >8 characters, and correct a couple of other minor issues
 - h. Tax/Sub was putting all timeslice variables in for baseload plants.
 - i.
 5. Pending "fixes"
 - a. The reporting of IMP(ENT)P was removed from RMARKAL.VDD owing to inclusion of ELCx VAR_Fin, reinstate.

3.0 GAMS Tidbits

1. GAMS CPLEX/XPRESS support for parallel processing, and more

As of version 23.3 of GAMS, released November 1, 2010, full support of parallel processing is provided with the base CPLEX/XPRESS distributed with GAMS. This means that the user can automatically request that CPLEX/XPRESS exploit dual and quad (or more) computers, assuming there is ample memory.

In addition, some other useful switches request Interior Point/Barrier be the default algorithm, and that same is employed during the 1st step of the MIP run.

The CPLEX.OPT file distributed in the GAMS_SrcPRD folder has the switches necessary to activate these and some other worthwhile features for CPLEX. See the XPRESS manual or its equivalent.

2. Checking model scaling

A longtime issue with many (most all) MARKAL/TIMES models is poor scaling. A series of scripts and procedures have been prepared to enable the iterative diagnosis and improving of the model scaling. These are documented in the CONVERT.OPT file distributed in the GAMS_SrcPRD folder and shown below. A (slightly difficult to read – suggest zooming to 150%) snapshot of the components and results for looking at the scaling of a model is shown in the PowerPoint slide that follows.

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* GAMS/CONVERT Directives File for Analyzing Scaling

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jacobian
dict

=====

* GAMS procedure for deciphering the extremes impacting model scaling

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- * 0 - Put the ScaleCk.CMD, RCLookUp.CMD and this CONVERT.OPT file in your MARKAL/TIMES run folder, likely GAMS_Wrk<Run>.
- * 1 - Run with OPTION LP=CONVERT; in the MARKAL/TIMES <case>.GEN/RUN file, with this CONVERT.OPT in your GAMS_Wrk<Run> folder
- * {Ignore the error message at the end of the run.}
- * 2 - Then analyze the GDX file jacobian.gdx. For example, from a CommandPrompt window (opened through the IDE!!!) type
- * ScaleCk {row}
- * This gives you ScaleCk/OBJ/Row files with the matrix elements sorted from abs(smallest) to abs(largest) coefficient).
- * 3 - Use a text editor to examine the ScaleCk/OBJ/Row.TXT file to identify the candidate rows/columns to be examined.
- * 4 - With the help of dict.txt you can identify the original row and column name by running RCLookUp <row> <col>
- * 5 - The key thing to examine and improve is the range within any single equation.
- *
- * MARKAL/TIMES models employing "ZZZMY" backstop options will result in particularly poor scaling in the objective function,
- * and any "shadow" equation (e.g., EQ_PRICER in MARKAL) owing to the high value assigned to these infeasibility avoidance
- * modeling trick. Bringing this value more in range (e.g., VAROM = 500 rather than 10,000) can help, but the analyst will
- * need to check the solution to ensure no backstops slipped in. Or alternatively, and perhaps better, isolate all the
- * ZZZMY backstop options in a scenario that would be omitted from productions runs, running the risk that an INFESibility
- * could sneak in, in which case one would need to rerun. {Discuss with Amit/Ken a convention that would **suppress** all
- * such ZZZMY technologies (e.g., if ZZZMY is an input commodity) at runtime via a user setting.}
- *
- * {There are other tools such as Examiner, Gamschk, and so on; but they are also not always intuitively usable.}
- *
- * [NOTE: you must have a C:\TMP file created in order for the GSORT call to work!]

Results for Checking Scaling in MARKAL/TIMES Models



The screenshot displays a Windows desktop environment with several open windows:

- C:\GAMS23.3**: A command prompt window showing the execution of the `scaleck` command. The output provides scaling statistics:
 - Objective Scale Range: Smallest coefficient is 0.000139810247194014 at 'e1'.x31575', Largest is 9922.60173300526 at 'e1'.x23198'.
 - Matrix Scale Range: Smallest coefficient is 0.0001 at 'e237'.x8550', Largest is 10079.55649508 at 'e27729'.x24969'.
 - e237 Row Scale Range: Smallest coefficient is 0.0001 at 'e237'.x8550', Largest is 0.9999 at 'e237'.x8554'.
- tstscld1 - WordPad**: A window titled "SOLVE SUMMARY" showing:

MODEL	MRK	OBJECTIVE	objz
TYPE	MIP	DIRECTION	MINIMIZE
SOLVER	CPLEX	FROM LINE	6905
**** SOLVER STATUS 1 Normal Completion			
**** MODEL STATUS 1 Optimal			
**** OBJECTIVE VALUE 35302871.4401			
RESOURCE USAGE, LIMIT		78.703	50000.000
ITERATION COUNT, LIMIT		11280	200000
- TSTSCLO2 - WordPad**: A window titled "SOLVE SUMMARY" showing:

MODEL	MRK	OBJECTIVE	objz
TYPE	MIP	DIRECTION	MINIMIZE
SOLVER	CPLEX	FROM LINE	6942
**** SOLVER STATUS 1 Normal Completion			
**** MODEL STATUS 1 Optimal			
**** OBJECTIVE VALUE 35302871.4385			
RESOURCE USAGE, LIMIT		85.562	50000.000
ITERATION COUNT, LIMIT		6298	200000
- j_noZZDMY - Notepad** and **j_zZDMY - Notepad**: Windows displaying lists of row and column names with their corresponding scaling factors. For example, row 7703 has scaling factors like 'x8332', 'x8333', 'x8334', etc.
- ScaleCk.cmd**: A batch file containing GAMS directives for scaling analysis, including `convert opt`, `mmeqopt inc`, `mmeqf inc`, `mmequa inc`, `model mtk`, `RCLookUp cmd`, and `ScaleCk cmd`.
- dict.txt**: A text file providing instructions on how to use the scaling analysis results to identify and improve model scaling. It includes steps like "Put the ScaleCk.CMD, RCLookUp.CMD and this CONVERT.OPT file in your MARKAL/TIMES run folder" and "Use a text editor to examine the ScaleCk/Obj/Row.TXT file to identify the candidate rows/columns".

6.0 GAMS Runtime License

GAMS provides a 50% discount for those non-academic institutions looking to use GAMS only to run TIMES models by means of an ETSAP Runtime license. The table below reflects the savings. Note that existing Outreach licenses may continue to be used, or migrated to a Runtime license cutting the annual maintenance fee by around 50%.

A Runtime license does **NOT** allow the user to make any changes to the TIMES model definition (equations and variables), or run any other GAMS model.

Contact ETSAP Liaison Officer (Gary Goldstein, DecisionWare.NY@gmail.com) for more information on the ETSAP GAMS Runtime license.

	Standard	Runtime
Modeling Language		
GAMS	\$3,200	\$1,600
GAMS Runtime	\$3,200	\$1,600
Solvers		
Power LP/MIP	\$9,600	\$4,800
NLP	\$3,200	\$1,600