Running Standard Scenarios with the SAPP and WAPP MESSAGE models

Introduction

The WAPP and SAPP models are organised in a similar way and contains the following components:

- The MESSAGE model archive file (MAIN_date.zip for SAPP and MAINWAPP_date for WAPP)
- Demand_all_SAPP_xxx.xlsx: future demand data
- Load_Calibration_all_SAPP.xlsm: load data
- Transmission Data_xx.xlsx: transmission data
- SADC_supply_reference_xx.xlsm: power plant and RE potential data
- 0REF_vxx_nocostreductions.xlsm: detailed results file for the reference scenario
- 2RE_vxx_highcostreduction.xlsm detailed results file for the renewable scenario
- 3RE_vxx_highcostreduction_no-Inga.xlsm: detailed results file for the renewable scenario without Inga case
- Summary_SAPP_v13.xlsx: summary result file

Running a new scenario is performed in the following 3 steps:

1. Upload input data relevant to the wanted scenario using the power plant and RE potential data (SADC_supply_reference_xx.xlsm). This is done via the excel workbook using a macro that writes the data in the spreadsheet to the MESSAGE model adb file.
2. Running the MESSAGE model using the MESSAGE interface.
3. Extracting the results once the run is complete. Using a combination of the MESSAGE interface and the results excel workbooks (e.g. 2RE_v13_highcostreductions.xlsm)

The rest of the document provides some detailed guidance on each of those steps.

Getting started and the file system setup

- The MESSAGE software should be installed in the standard folder: "C:\Programs\MESSAGE_INT"
- If you are starting from the model archive file (MAIN_date.zip for SAPP and MAINWAPP_date for WAPP) then use the "cases->restore" in the MESSAGE main menu to extract the model files to their working folders: "C:\Programs\MESSAGE_INT\models\SADC" and "C:\Programs\MESSAGE_INT\models\WAPP".
- If you are already working with a version of these models, then it is probably a good idea to make a backup at this point, if you are about to make some changes using the excel macros in case something goes wrong during the update. Do this using the MESSSAGE "cases->backup" option.
- For backup use the "rename" option and then tick the date option.
- For restore use the "replace" option.

1. Uploading power plant and fuel data into the MESSAGE model via the Excel data file macros

Organisation of the Supply workbooks (SADC_Supply_Reference_xx.xlsm and WAPP_Supply_yy_template)

Both templates are organised in a similar way as follows:

- *NameConv*: General Data including naming conventions and RE potential by country
- Sheets that relate to Raw data from source documents:
  - **SAPP/WAPP Hydro Existing and SAPP/WAPP Thermal Existing**: contain raw data from source documents on existing hydro and thermal power plants
  - **SiteSpecific_data**: contains raw data on projects that have been identified in source documents
  - **Gen_Param**: contains raw data on generic technologies with assumptions chosen by IRENA. 3 different scenarios are preloaded for exogenous technology learning (in terms of overnight investment costs) which is controlled in cell C2. This sheet also contains calculations of LCOE, which can be reviewed for the 3 different scenarios for RE investment cost reductions.
  - **MSG_Fuel data**: contains raw data on fuel price assumptions.
- Sheets that prepare power plant data for the MESSAGE model
  - **MSG_Exist, MSG_SiteSpecific, and MSG_Generic:** sheets reorganise the raw input data into a format and units that follow the ones used in MESSAGE, for existing plants, site specific projects, and generic technologies, respectively. The data is organised by country. In order to keep the model to a reasonable size (not too many technologies), existing plants/units that have similar properties (in terms of fuels, and efficiencies) have been regrouped into a smaller set of technologies.
  - **adb_exist(2), adb_sitespec(2), adb_generic(2), and adb_fuel(2)** sheets convert the tables from the MSG_xxx sheets to a format that is matched to the format required for the .adb input text files for MESSAGE. This is done in two steps, with the final step done in adb_xxx2 sheets. The data in these sheets can be pasted directly into adb text files, taking care that it goes in the right place in the text file. The data in adb_xxx(2) shows the data for one country at a time. The country is selected in cell A2, which is currently linked to adb_all.
  - **adb_all** combines all the .adb formatted text files in one place for the selected country. The selection is specified in cell B1, by specifying the 3-letter country code, or via cell C1, by specifying the country number. The country number and code tables are in "NameConvs" sheet. It is from the sheet that data is written to MESSAGE adb files using a VBA macro – activated by the buttons on the sheet. This process is described in detail belo.
- Sheets that link in from other input data workbooks, that get passed to adb/ldb files:
  - **OtherData**: gets the demand data including annual demand and load shape from "Load_Calibration.xlsx" and "Demand_All.xlsx".
- Sheets that link out to output data workbooks:
  - **TechCosts**: has all the cost parameters for all the technologies, drawing from the MSG_xxx sheets (power plants and fuel supply techs). This information is needed in the output workbook for calculations of detailed system costs needed for electricity costs (which can be taken as a close proxy for price).

Procedure uploading input data to model

- It is useful here, especially for initial trials with this tool to check that the data items - at least for a small sample - that were updated using the MESSAGE interface. Note that in this approach, the MESSAGE scenario is not used. All scenarios are run via the adb file. It is up to the user to keep track of input data for the different scenarios. This could be changed in the future if needed.
- The input data is uploaded to the model in the Supply workbook from the sheet: "adb_all"
- This sheet contains most of the control parameters for the scenarios that were generated for the IRENA SAPP and WAPP 2013 reports, namely:
    o CO_2 price: set in row 9 (WAPP), row 7 (SAPP) with values from 2015 onward interpolated from the 2030 value (orange cell)
    o Cost trajectory for RE (N10)
    o Fuel Price escalation (N12)
    o Domestic share: row 8 (WAPP), row 9 (SAPP). Note that the value there is a function of the transmission losses.
    o Dry year (N14)
    o Grand Inga (N15) for SAPP. Grand Inga in WAPP is controlled directly via the MESSAGE model by constraining technology: ELNUIngDRcNGw in the MAINWAPP region (with an upper limit on abda)
- The input data is uploaded via a macro activated by clicking on the "Write all" button.
    o The macro writes data to country data files, namely, "XXr/w.adb", one country at a time.
    o It is important to ensure that the Excel calculation option is set to "automatic" otherwise the data for the last country will be written to all countries.
    o It is also possible to upload data to a single country by selecting the country in cell C1, and by clicking on "Write single".
    o Note that only parameters relating to technologies are uploaded, with these two buttons.
    o There is a button for uploading demand data, but this is to be used carefully as there are some possible bugs that still need to be dealt with. If demand is to be changed, at this point it is better to use the MESSAGE interface.
    o The same applies to adding new technologies/constraints. This feature is not working properly yet, and so new technologies/constraints must added manually via the MESSAGE interface.
    o Once this new technology/constraint has been added then the data relating to this technology/constraint must be added to the existing tables in the spreadsheet, otherwise this data will be lost next time a data upload is done.

2. Running the MESSAGE model using the MESSAGE interface

Running a Multi-region model run is done using the following steps:

1. Open model: The run is initiated from the "MAIN" region of the multi-region models (SAPP: SADC->MAIN), (WAPP: WAPP->MAINWAPP), which first needs to be opened via Cases->open, if not already open.
2. Select Scenario: the scenario to be run is then selected with Select->Scenario->adb_Default_scenario->Ok.
3. Run MXG: generates the LP matrix for the solver via Run->mxg, when this step is complete, the message "Done: mxg" should appear on the MESSAGE main interface.
   Problems could occur here triggered by inconsistencies in the input data. Some clues are normally given as to where the problem might be.
4. Run Opt: runs the solver. If cplex is to be used, a valid license is required. Alternatively one can use the license that is packaged with the MESSAGE software, but which expired in 2008 or 2009. The way around the license issue to change the system date to a day in 2008, before initiating the optimization via Run->opt. The message "Done: optimization" should appear on the MESSAGE main interface.
   Problems could occur here triggered by infeasibilities or unbounded problems. There are normally some clues reported here as well although, identifying the true cause of the problem is much harder here. If one gets stuck it is often better to go back to a previous version of the model and make one change at a time until the infeasibility is again triggered.
5. Run Cap: runs the report generator based on what's in the cin file. This done once via Run->cap, and the message "Done: cap" should appear.

3. Extracting the results once the run is complete

Procedure for extracting results
Results of a multi-region model run are accessed as follows:

1. If results for a run that was just performed is sought then the results are directly accessed via Results->edit tables->adb_default_scenario->ok. If results of a previous run, i.e. model was closed and re-opened after the most recent run, then one has to first select the scenario via select-scenario->adb_default_scenario->ok before going to Results->edit tables->adb_default_scenario->ok.
2. Once this is done then the default edit is opened (MS Editor or MS Wordpad). If MS Wordpad is used then it is better to have the "no wrap" option activated. This is done via View->Word wrap->no wrap, in the MS Wordpad menu.
3. Select all the text in the window via 'Ctrl-A'
4. Copy to clipboard via 'Ctrl-C'
5. Open a result workbook (e.g. 2RE_vxx_highcostreductions.xlsm)
6. Go to the left-hand-most sheet called "RawAll"
7. Place the cursor (make active) cell C11, which is in orange
8. Paste from clipboard via 'Ctrl-V'
9. Press 'Ctrl' key and select 'Use Text Import Wizard' then click on 'Finish' and finally 'Ok' to replace all contents of cells. The results have now been pasted into Excel, and ready to be propagated[1] in the rest of the workbook.
10. This is done by clicking the "Refresh" button that appears in the top-left-hand corner of the sheet. This procedure runs a bit faster if calculation is set to "manual" in excel. This is done via Formulas->Manual. It must be turned back to "automatic" after the "Refresh" button is pressed to update all the tables and charts in the workbook.

Organisation of the Results workbooks (e.g. 2RE_vxx_highcostreductions.xlsm)
The Workbook is a template that can be replicated, one for each scenario. The other sheets in the workbook can be described as follows:

-   **TechCosts:** Links the Results workbook to the Supply workbook, and transfers all the cost and other parameters needed for the costs calculations. Note that this link is also "frozen" to make the operation of the workbook faster. The links are refreshed by clicking on the "Refresh" button in the top-left-hand corner of the workbook.
    NB: it is important to "Refresh" this link if this workbook gets used to analyse results from a run where cost parameters have been changed, since the last refresh.
-   **OtherParams:** is currently not used yet. It is a placeholder for further calculations such as % RE resource that is used, etc…
-   **Single:** Shows detailed results for one country at a time. The country whose results are to be shown is selected in cell B4, where 1..12 is Angola..Zimbabwe (1..15, Benin..Togo in WAPP).
-   **REProd:** has detailed RE Production results by year and by country as well as some totals.

---

[1] The reason why this procedure is used is that if all the results in the rest of the workbook were linked with 'live' links to RawAll, the workbook would be even slower than it already is. This propagation procedure simply refreshes the links and then freezes them with "paste-values", as there is no real need for these links to be 'live'.

- **RENewCap:** has detailed RE New Capacity results by year and by country as well as some totals.
- **DemandsPrices:** has final energy demand and marginal, also the split between distributed and grid.
- **Sum:** Is a replica of "Single" except that values are summed/aggregated over all the countries in the region.
- **ByCountry:** Is a replica of "Single" except that values are shown for all countries but only for one year, selected in cell: B4 (linked to Map!O3)
- **ByProject:** gives a list of projects that are actually implemented by year and by country. The country is selected in cell: C4, and the range of years for which projects are shown are elected in cells: J9 and K9.
- **Map:** Shows the trade flows between countries in the region. The table shows it for all years, and the map only for the years selected in O3, selected with the arrow buttons.
- **TransRaw:** has the rawdata (linked to RawAll) and calculations relating to transmission.
- **RawYyy:** has the rawdata (linked to RawAll) for country Y.