This project has received funding from the European Union's Horizon Europe Programme

RESEARCH PROJECT EASA.2020.FC07

USER MANUAL

Market-based Measures

D11.3: AERO-MS User Manual

An Agency of the European Union

Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Union Aviation Safety Agency (EASA). Neither the European Union nor EASA can be held responsible for them.

DELIVERABLE NUMBER AND TITLE:	D11.3: AERO-MS User Manual
CONTRACT NUMBER:	EASA.2020.FC07 – SC03
CONTRACTOR / AUTHOR:	NLR, / NLR
IPR OWNER:	European Union Aviation Safety Agency
DISTRIBUTION:	Public

APPROVED BY:	AUTHOR	REVIEWER	MANAGING DEPARTMENT
O Pfeifle (NLR)	J. Middel (NLR)		
W. Sigl (EASA)			

DATE: 25 March 2024

SUMMARY

Problem area

The mission of the European Union Aviation Safety Agency (EASA) is to promote the highest common standards of safety and environmental protection in civil aviation. In performing this role, EASA is committed to the European strategy of 'Better Regulation' in order to improve the development, implementation and evaluation of these regulatory standards. An essential element of this strategy is the Regulatory Impact Assessment, which provides information on the consequences of taking regulatory action, and thus aids the decision-making process.

Impact assessments form an integral part of any decision-making process. The assessed impacts can cover, amongst others, environment, safety, economy, and society. The capability within the EU to assess the economic impacts of regulations is critical in identifying the optimal method to achieve future environmental objectives via various policy measures such as technology stringencies, operational restrictions, and financial measures.

In 2009, EASA took over the intellectual property rights associated with the aviation economic model 'AERO-MS' from the Dutch Government. AERO-MS is a tool that can examine the impacts of different policies intended to reduce international and domestic aviation greenhouse-gas emissions. The model is able to assess the effects of a wide range of policy measures aimed at reducing aviation emissions, including technological, operational and market-based measures.

The objective of the EASA Framework Contract EASA.2020.FC07 is to build on AERO-MS and further enhance the European modelling capability for future policy assessments in the next decade.

Description of work

This document is the AERO-MS user manual updated to the latest, 2019 version of AERO-MS.

Results and Application

This document is the AERO-MS user manual adapted to include the work achieved in the deliverables D1 up to and including D10. The updated AERO-MS has been demonstrated in a Final Event at the end of the EASA Framework Contract EASA.2020.FC07. This event included a training of the updated AERO-MS to EASA, EC and Member States' staff.

CONTENTS

ABBREVIATIONS

ACRONYM	DESCRIPTION
AERO-MS	Aviation Emissions and Evaluation of Reduction Options Modelling System
ATEC	Aircraft Technology Model
ATK	Available Tonnes-kilometre
ATM	Air Traffic Management
CSV	Comma Separated Value
D	Deliverable
EASA	European Union Aviation Safety Agency
EEA	European Economic Area
ERF	Emission Reduction Factor
ETS	Emission Trading System
EU	European Union
FLEM	Flights and Emissions Model
GNP	Gross National Product
GVA	Gross Value Added
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
LCC	Low-cost Carrier
LTO	Landing and Take-off
MTOW	Maximum Take-off Weight
NLR	Stichting Koninklijk Nederlands Lucht- en Ruimtevaartcentrum (Royal NLR – Netherlands Aerospace Centre)
nvPM	Non-volatile Particulate Matter
O-D	Origin-Destination
PM	Particulate Matter
RPK	Revenue Passenger Kilometres
RTK	Revenue Tonnes-kilometre
SAF	Sustainable Aviation Fuels
SC	Specific Contract
SQL	Structured Query Language
TAKS	Transport Analysis and Knowledge Systems
TFS	Traffic by Flight Stage

1. Introduction

1.1 General

This report is the user manual of the updated version of the AERO-MS (Base Year 2019). The AERO-MS contains a software-shell, which facilitates the communication and interaction of the user with the AERO models and the internal communication and interaction between the models.
Chapter 2 of this report provides a general description of AERO-MS. Hereby attention is paid to:

- an overview of the complete modelling system, including a short description of the individual models and their interactions;
- the analysis approach in the AERO-project, which is essential for the general set-up of the modelling system;
- the functions of the AERO-MS software-shell.

Chapters 3 till 6 of this report are dealing with the interface and the user possibilities of AERO-MS. These chapters can be regarded as the actual user manual for the modelling system as a whole. The chapters follow the main user-facilities of the interface, being:

- main screen;
- specification of cases;
- analysis of cases;
- evaluation of cases.

Furthermore three appendices are included in this report. Appendix A provides an overview of the unit conventions in AERO-MS. Appendix B gives an overview of the dimensions used in AERO-MS. Finally, appendix C provides a complete overview of the assumption-, scenario and policy-variables available in the AERO-MS.

2. General description of AERO-MS

2.1 Overview of the information and modelling system

The complete information and modelling system covers a sequence of steps from the description/generation of aviation demand to the assessment of the aviation emissions. The objective of the system is to analyse a wide range of autonomous (economic, technical, political) developments and a great variety of measures (such as: regulation, taxation, operational and technical measures) which may reduce the adverse effects of aviation.
Moreover, the modelling system includes the assessment of the direct global and regional socio-economic impacts on the aviation industry of such developments and measures.
The updated version of the information and modelling system consists of the following 5 models:

ATEC Aircraft technology model

ACOS Aviation operating cost model

ADEM Air transport demand and traffic model

DECI Direct economic impacts model

FLEM Flights and emission model

These 5 models are integrated in AERO-MS. A complete overview of the information and modelling system is presented in figure 1. As can be seen in figure 1, the starting point of AERO-MS is the Unified Database, which is a computerised description of the volume and pattern of global aviation activity in the base year in AERO-MS (2019). The primary spatial concept in the Unified Database is each flight stage (airport pairs) for which there are direct aircraft movements. In consequence, all forecasting can be carried out at this level of spatial detail, which facilitates the representation of emissions on a fine grid. For each flight stage, the Unified Database contains data for the number of aircraft movements and the volume of passengers and cargo carried.

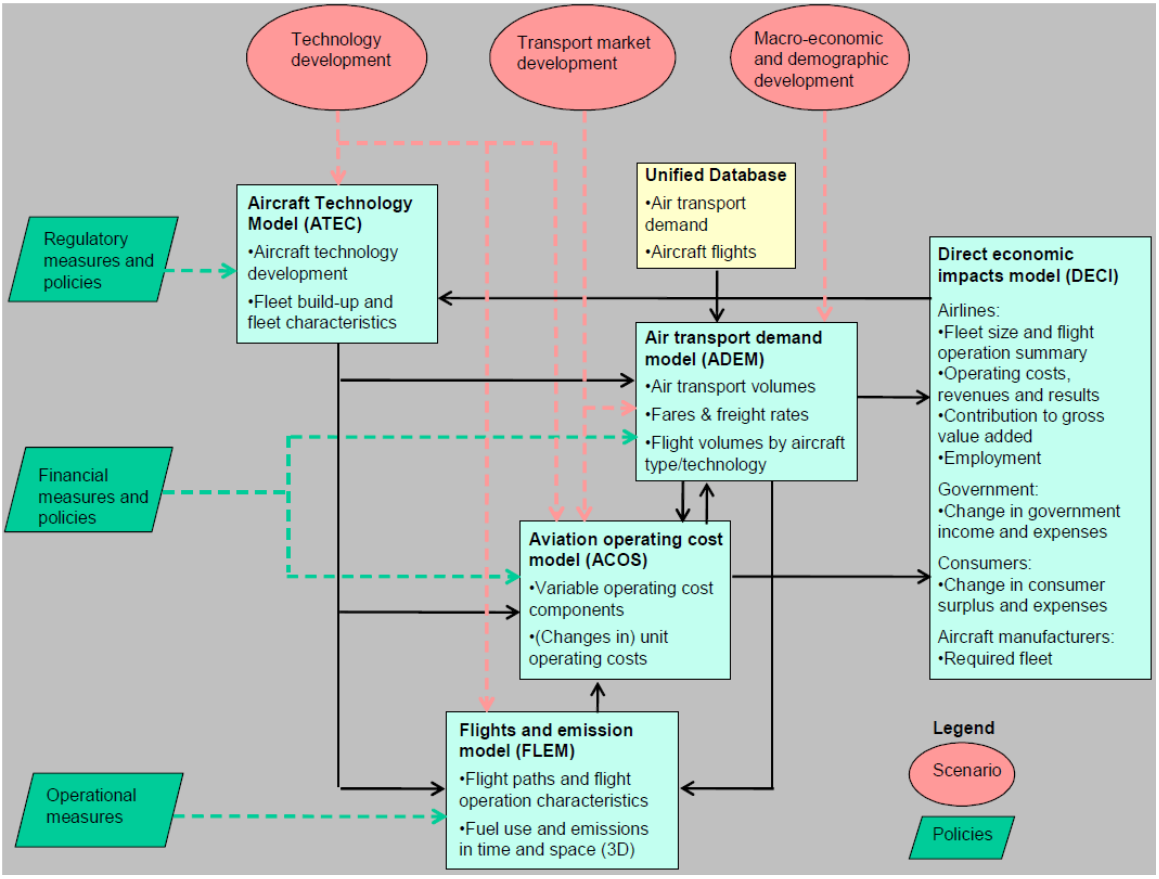


Figure 1 Overview of models in AERO-MS

The first model to run in the modelling system is ATEC. In ATEC fleet aircraft characteristics on fuel use and emissions, and prices of new aircraft are computed.
ACOS computes direct cost consequences for aviation based on airport and airline operation costs. ACOS explicitly takes into account policy-induced cost-changes (charges and/or subsidies). The main output that is computed is a change of aviation operating costs.
ADEM computes aviation transport demand and aircraft movements by region, route group and aircraft type.
Based on ACOS and ADEM results, DECI computes world wide direct socio-economic impacts for the airline industry like operating revenues, operating costs, operating result and employment.
Furthermore the impacts of measures to various actors (airline industry, government, consumers) are computed.
In FLEM flight profiles of the aircraft movements ('delivered' by ADEM) are computed based on aircraft and engine technology and operational conditions. On the basis of flight profiles, FLEM computes global fuel-use and resulting emissions on a three- dimensional grid.

2.2 Analysis approach

The AERO-MS is based on a policy analysis approach. In this analysis approach a clear distinction is made between the effects of autonomous developments on the one hand and the effects of policies/measures on the other hand. Following the policy analysis approach, in the AERO-MS a distinction is made between three types of runs:

- Base run: computation of the Base year (2019) situation based on a set of assumptions.
- Datum run: computation of a future situation for a target year, based on a scenario.
- Forecast run: computation of a 'modified' future situation due to the effects of a policy.

Figure 2 provides a schematic presentation of the analysis approach. Datum and Forecast refer to the same future year, and can be regarded as two alternative futures: one without and one with measures. By comparing datum and forecast results the effects of measures can be assessed.

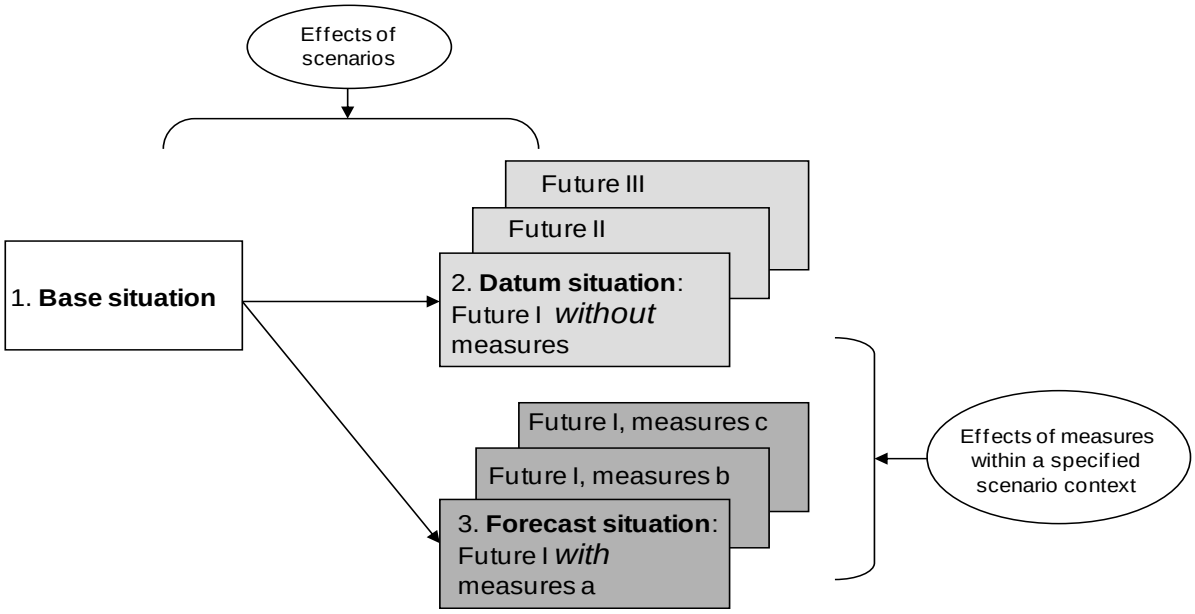


Figure 2 Analysis approach

2.3 Functions of the AERO-MS software-shell

The whole information and modelling system is integrated in the AERO-MS software-shell. The software-shell encompasses all models and data. The main functions of the software-shell are:

- to facilitate the communication and interactions between the various models;
- to facilitate the communication and interaction between the user and the various models.

The technicalities with respect to the communication and interactions between the various models are described in volume I of the main report resulting from the AERO project and the general reports of the individual models. The user facilities of AERO-MS are described in the next chapters of this report. The following user facilities are distinguished:

- Specification of cases:
  - a base case: base year data and assumptions;
  - a datum case: the autonomous future development based on a scenario;
  - a forecast case: the future development including measures.
- Computation of cases:
  - defining which cases to run;
  - defining which models to run;
  - running the models.
- Analysis of an individual case:
  - select a case to analyse;

- make a report;
- show specific case results.

- Evaluating cases:
  - select cases to evaluate;
  - make a scorecard of cases;
  - compare cases.

3. Main screen

When the AERO-MS user interface is started for the very first time, the Figure 3 appears on the screen displaying a panel for the license key. After copying a valid license key int the white [New license] panel, and clicking the [Install] button, AERO-MS will start and the main screen will show. Figure 4 shows the main screen of the AERO-MS-user-interface. The user-interface consists of the menu bar at the top and the tabs at the left end of the main screen.

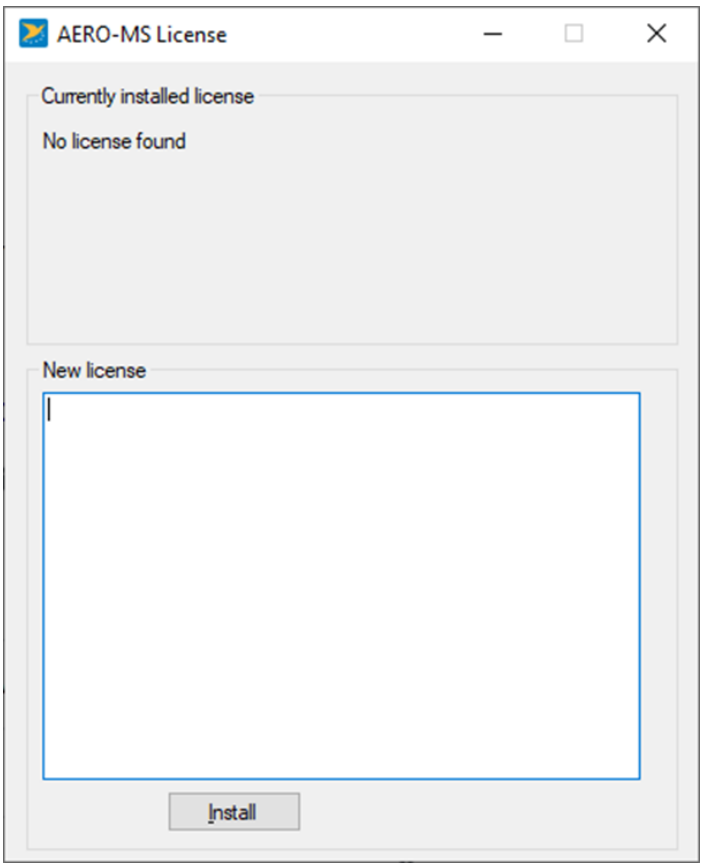


Figure 3: License key panel

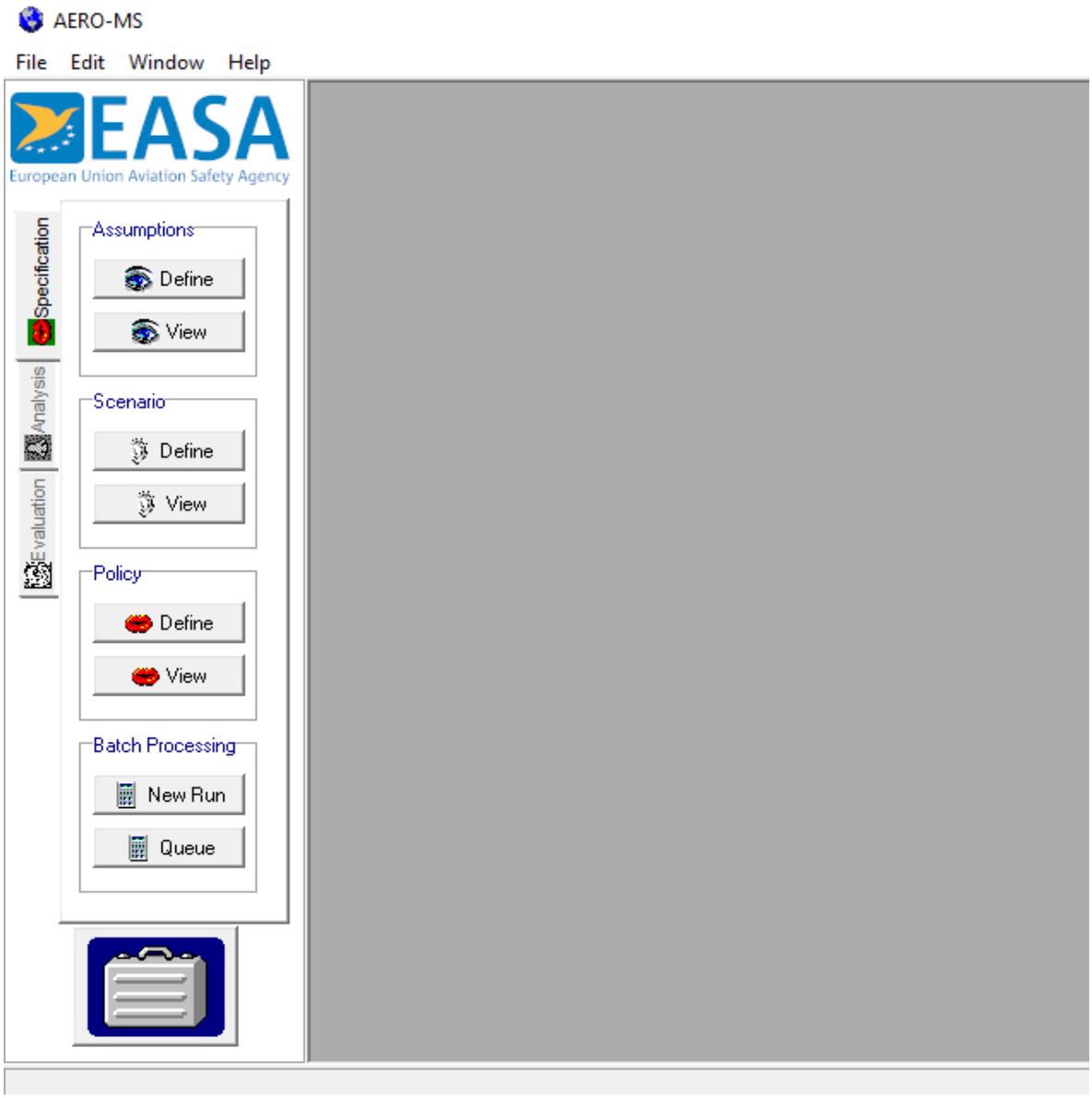


Figure 4 Main panel AERO-MS user interface

3.1 The menu bar

The menu bar consists of the following commands:

- **File**;
- **Edit**;
- **Window** (not active);
- **Help**.

File

When the user chooses the **File** command in the menu bar, a pull down menu appears, which lists additional commands. The “File-Export” option will export a variable selected in the Data-Inspector.

Edit

When the user chooses the **edit** command in the menu bar, a pull-down menu appears, with copy and paste options. When the user is inspecting data and wants to use the results in other documents the user can copy the values of a variable with this command. The values of the variable that are shown on screen including row and column dimensions will be copied. This means the user can choose the way the values will be copied by changing row and column dimensions or the dimensions of the variable.

Help

The versions of the models are shown. For the updated AERO- MS, resulting from this project, version number are as shown in figure 5.

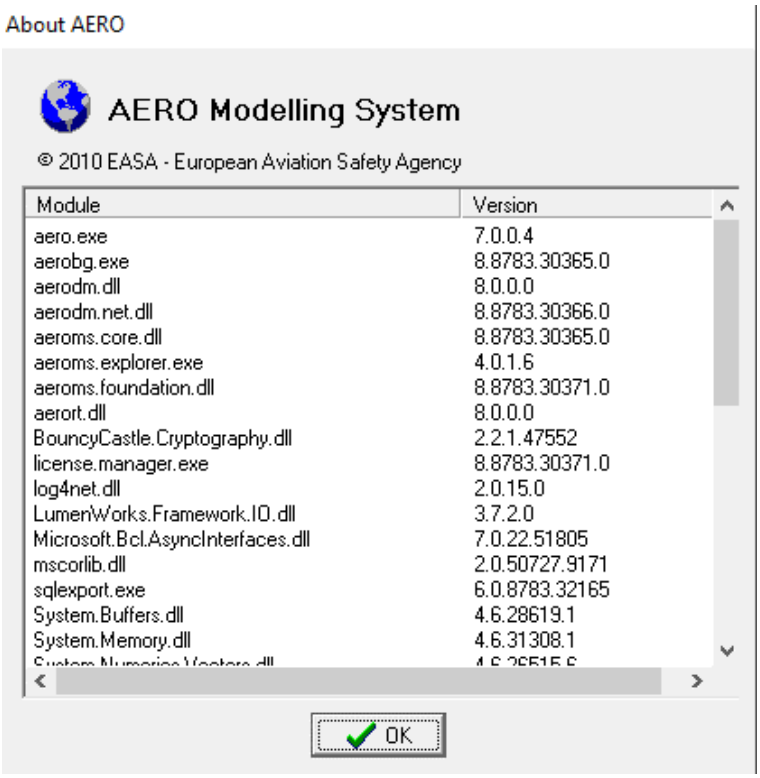


Figure 5 Versions of AERO-MS models

3.2 The tabs

At the left end of the main screen the main structure of the user- interface is visible (in the form of tabs, aligned vertically), consisting of:

Specification (including computation) – this part of AERO-MS deals with the definition of cases and executing computations (Chapter 4).

Analysis – this part relates to the interpretation of computation results (Chapter 5).

Evaluation – this part relates also to the interpretation of computed results (Chapter 6).

Case selector – if the user wants to make the Analysis and/or Evaluation option accessible the so-called case selector has to be selected. The case selector can be found left down in the main screen. The case selector will be further dealt with in chapter 5, as the case selector prepares the analysis and evaluation of cases.

4. Specification of cases

4.1 General

Figure 6 shows the specification tab and the features belonging to this tab.

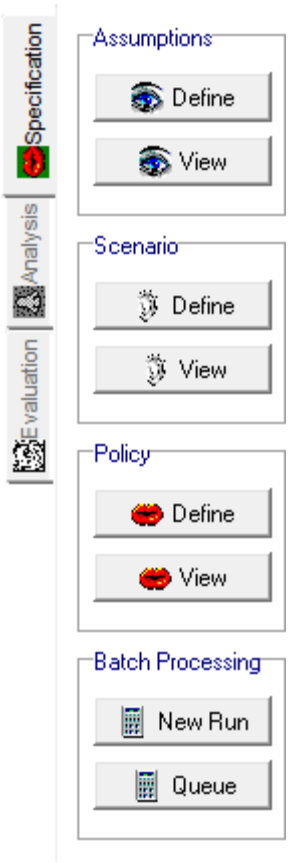


Figure 6 Case specification main menu

The following buttons are available to the user with respect to specification of cases and computation (see Fig 6):

Assumptions

Define	Define a new set of assumptions.

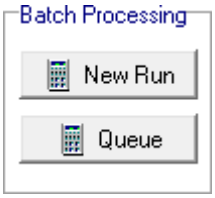
View	View previously defined sets of assumptions.

Scenario

Define	Define a new scenario.
View	View previously defined scenarios.

Policy

Define	Define a new policy.
View	View previously defined policy.



Batch processing

New run	Start a new run as a background process.
Queue	Show the queue of runs waiting to be executed.

The next paragraphs of this chapter will subsequently deal with the specification of assumption-, scenario- and policy-variables in AERO-MS, and the batch processing (computation) facility. A set of assumption variables is defined for the computation of a base case. A scenario is defined for a datum case, and a policy is defined for the computation of a forecast case.

4.2 Assumptions

After pressing the 'Assumptions-**Define'** button in the main screen, the user enters the assumption wizard (see figure 7).

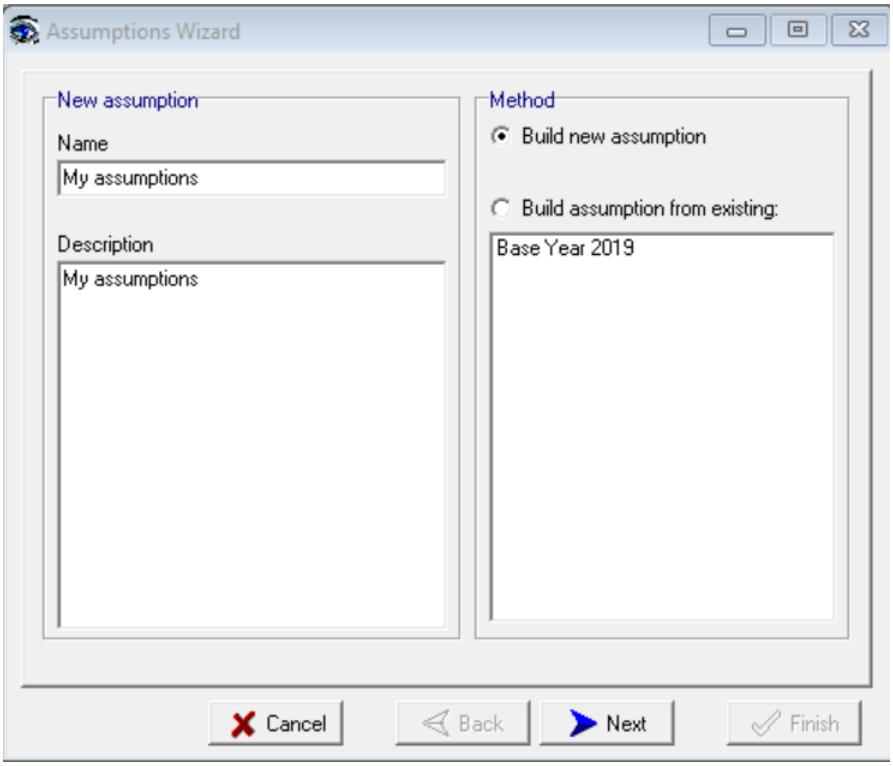


Figure 7 Assumption **wizzard**, first step

As is illustrated in figure 7, there are two options to specify a set of assumptions:

- Build new assumption: build a new set of assumptions from scratch.
- Build assumption from existing: create a new set of assumptions by modifying an existing set of assumptions.

For both options, the user has to specify a name (maximum 32 characters), and a description of the assumption-set. The user can only take the next step (defining the actual set of assumptions) if a name and description is specified. With respect to the option 'Build assumption from existing ', before going on, the user has to select an existing set to be modified. The existing sets of assumptions are listed in the right window of the assumption wizard. The user-interface indicates that the next step can be taken when the 'Next' button lights up.

The next step in specifying a new set of assumptions in AERO-MS is illustrated in figure 8.

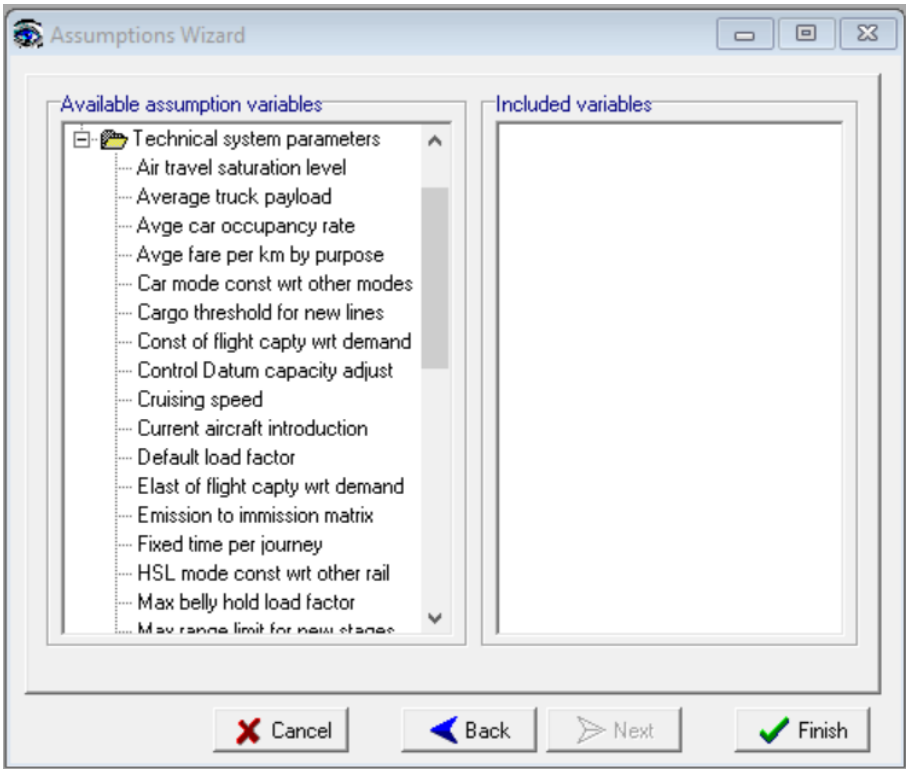


Figure 8 Assumption wizard, second step

In the left window all the available assumption-variables in the modelling system are listed. The assumption-variables have been categorised in the following categories:

- Economic system parameters;
- Other;
- Schematisation parameters;
- Technical system parameters.

A complete list of the assumption-variables in AERO-MS is presented in Appendix C1.

In the left window the user has to open a category to have the available assumption-variables in that category listed by clicking the "+" sign. An assumption variable can be included in the new set of assumptions by dragging and dropping it to the right window. When a variable is dropped in the right window, the user directly enters the variable editor. For a description of the variable editor reference is made to paragraph 4.5.

In case the user is modifying an existing set of assumptions, the variables included in the existing set are already listed in the right window. By clicking the right mouse-button, the user can enter the variable editor and the values of an assumption-variable can be edited. The assumption-variables that are not included in a new set remain their default values.

Further, the following buttons are available in the assumption wizard (see figure 7):

Cancel	To cancel the operation (set of assumptions will not be saved).
Back	To go back to previous screen.
Next	To go to the next screen.
Finish	To save the set of assumptions under the name specified.

After pressing the „Assumption-View" button in the main screen the user enters the View Assumptions screen (see figure 9). An assumption can be selected by clicking on the desired assumption with the left mouse button two times or by dragging and dropping it to the right window.

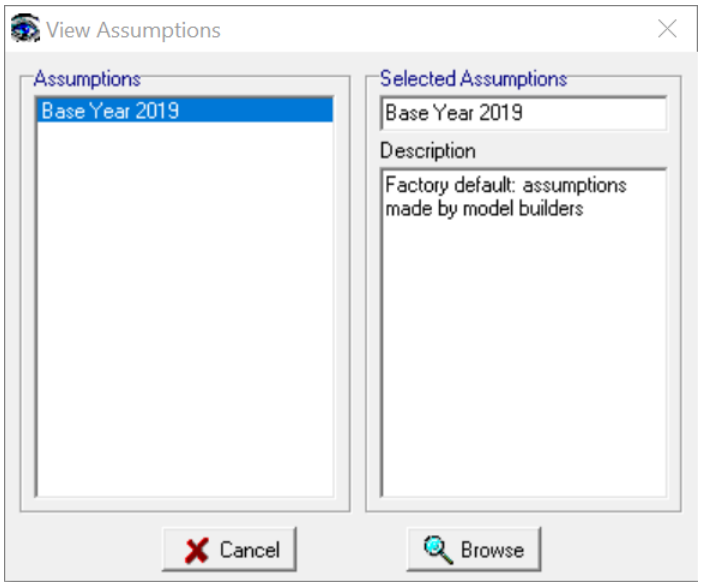


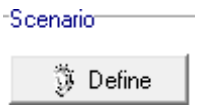
Figure 9 View assumptions

The following buttons are available in the View assumption wizard:

To cancel the operation.

After pressing this button the user enters the data inspector. For a description of the data inspector is referred to paragraph 5.5

4.3 Scenarios



After pressing the 'Scenario-Define' button in the main screen, the user enters the scenario wizard (see figure 10).

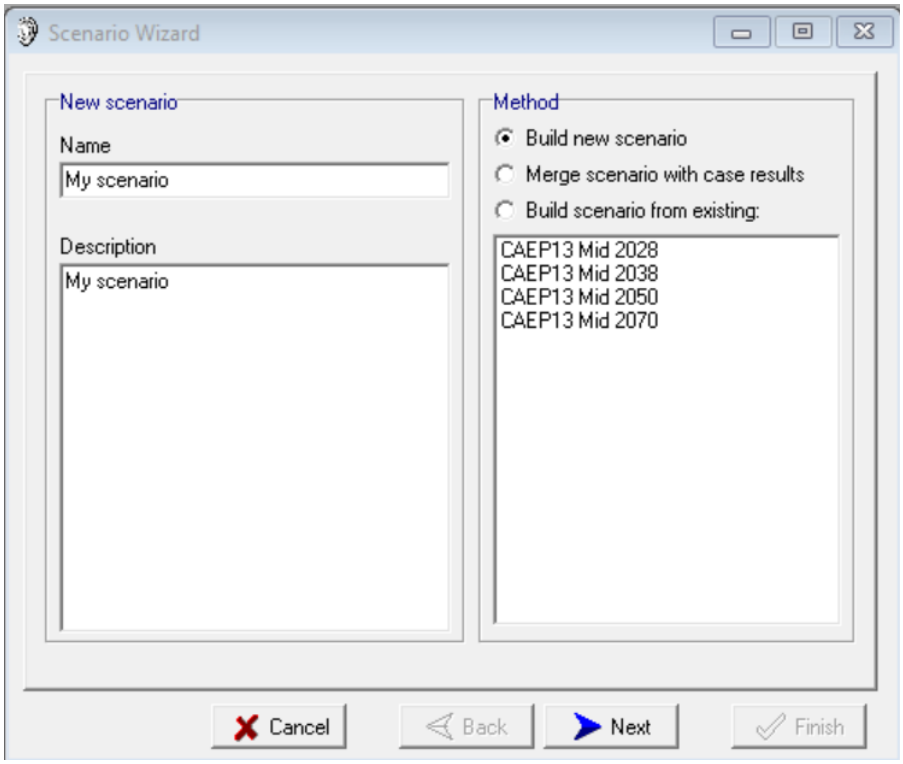


Figure 10 Scenario wizard, first step

Figure 10 further illustrates that there are three options to specify a new scenario:

- Build new scenario: build a new scenario from scratch using categories as building blocks.
- Merge scenario with case results: create a new scenario by using the results of the calculation for some variables.
- Build scenario from existing: create a new scenario by modifying an existing scenario.

As in the assumption wizard, all options require the user to specify a name (maximum 32 characters), and a description of the scenario. The user can only take the next step (defining the actual scenario) if a name and description is specified. With respect to the options „Merge scenario with case results" and „Build scenario from existing", and before taking the next step, the user has to select an existing scenario. The existing scenarios are listed in the right window of the scenario wizard. By clicking with the right mouse button on the scenario the properties window is shown (see Figure 11). In this window the user can see when the scenario is created and/or modified, the name of the scenario and short description.

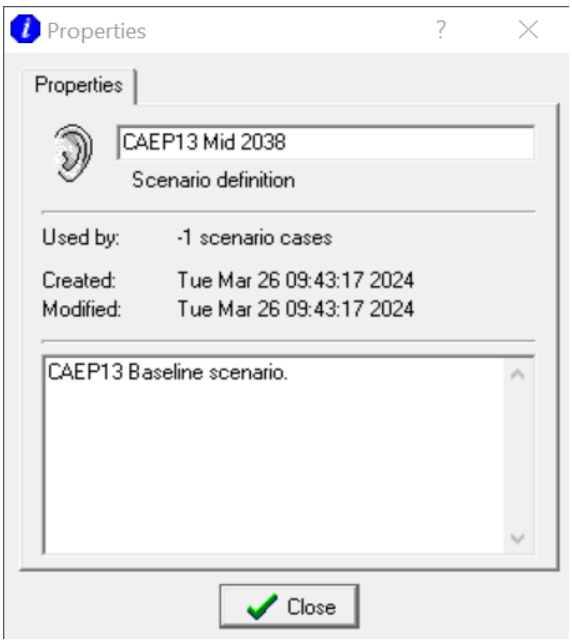


Figure 11 Scenario properties

Further the following buttons are available in the scenario wizard (see Figure 10):

Cancel	To cancel the operation (the scenario will not be saved).
Back	To go back to previous screen.
Next	To go to the next screen.
Finish	To save the scenario under the name specified.

The user-interface indicates that the next step can be taken when the 'Next' button lights up.

4.4 Build a new scenario

In case the user wants to build a scenario using categories as building blocks, the user enters a screen as presented in figure 12.

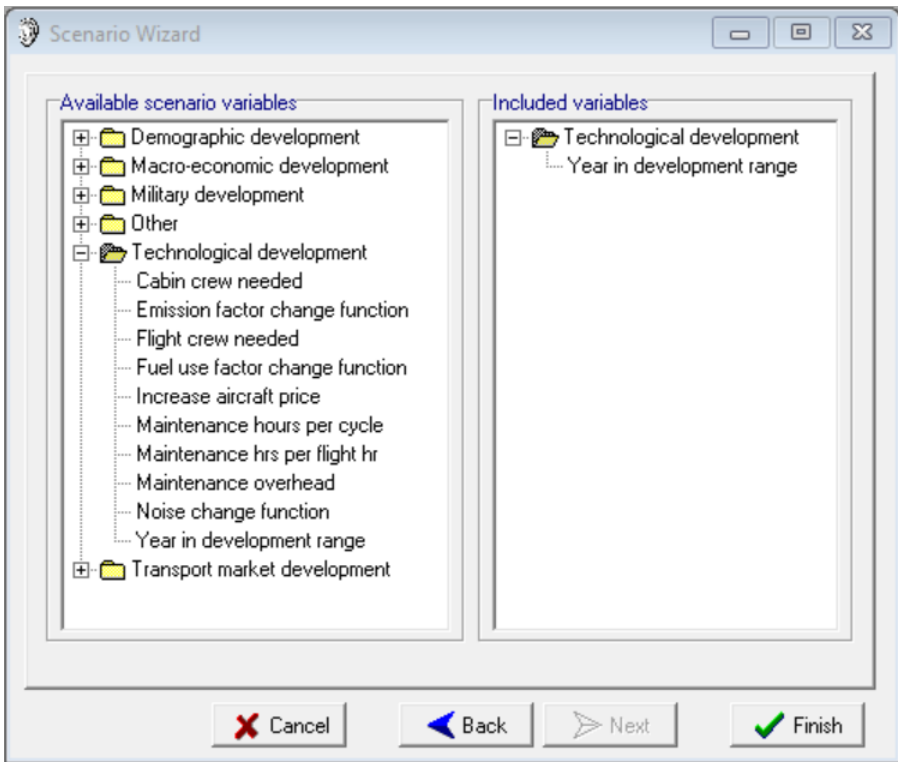


Figure 12 Scenario wizard, build scenario from components

In the left window all the available scenario categories are listed. The user can open a category by clicking the "+" sign, so that the variables in that category will be listed. There are 7 scenario-categories with the following pre-defined variables:

- Demographic development:
  - CPB annual population growth rate;
- Macro-economic development:
  - Autonomous cargo growth; Autonomous passenger growth; Cargo freight rate;
  - Charter passenger fare;
  - CPB annual export growth rate; CPB annual GNP growth rate; Crude oil price;
  - Finance charge interest rate; General aviation growth; Scheduled passenger fare.
- Military development (no underlying data is present in the current AERO-MS version):
  - Military traffic factor
- Other:
  - Elasticity of flight freq wrt demand;
  - Flag allowing existence of NLAS; Iterative datum variables;
  - Reference emission factor change;
  - Reference fuel factor change;
  - Volume costs per region pair.
- Scenario year:
  - Scenario year.
- Technological development:

- Cabin crew needed;
- Emission factor change function;
- Flight crew needed;
- Fuel use factor change function;
- Increase aircraft price
- Maintenance hours per cycle;
- Maintenance hours per flight hours;
- Maintenance overhead.

- Transport market development:
  - Adjustment for Cargo Aircraft fleet size;
  - Aircraft scrap age
  - Aircraft scrap function
  - Amsterdam demand target;
  - Amsterdam transfer proportion;
  - Annual aircraft utilisation;
  - Average age change;
  - Cabin crew salary;
  - Carrier adjustment factor;
  - Detour factor;
  - Factor to adjust profitability;
  - Flight crew salary;
  - Landing charges;
  - Landing slot costs;
  - Life span in scrap function
  - Maintenance costs per maintenance hour;
  - Route charges;
  - Route slot costs;
  - User defined surface comp. level.

For each category one of the available scenario variables can be selected by dragging and dropping it to the right window (see figure 12). Scenario variables for which no selection is made, remain their default values.

During the development of the AERO-MS, procedures have been developed to enable the user for the creation a scenario in terms of a coherent set of scenario variables. A scenario should satisfy the following requirements.

- Each scenario should be consistent in itself. Developments in different fields are sometimes interdependent, which implies the need to link the predictions on individual variables in each scenario.
- The set of scenarios that is used should cover as much as possible the total range of potential future developments of relevance for the air transport sector.Each scenario description must be formulated in

such a way that it can be made operational by means of the available AERO scenario variables.

In practice, the following steps should be taken by the user in order to specify a complete and consistent scenario:

1. Define a scenario year (scenario variable MV_ADEM_ScenarioYear). Any year can be specified for the period between the Base Year 2019 and the future year 2070.
2. Define values for other scenario variables which reflect the ideas of the user with respect to the exogenous future developments for the year specified in step 1.
3. Match costs and revenues by adjusting values for the variables related to cost development trends and variables related to passenger fares and freight rates. Hereby values can be specified in such a way that there is a reasonable profitability for the airline industry in the scenario year defined (for example a profitability level of 3% of operating revenues). Through this step it is assured that cost and revenue trends in the without measure situation are attuned to each other.
4. Ensure that the fleet growth (capacity growth) is consistent with the traffic volume growth. This is done by an iterative approach whereby the results of a first scenario run with respect to the fleet size are fed back into the AERO-MS for the second, final, scenario run. For this use can be made of the option „Merge scenario with case results", as described in par 4.3.2. below.

It is noted that procedures have been developed to construct a set of scenarios over time. For a number of the main scenario variable values can be specified for all years between the base year 2019 and the year 2070. The sets of time-dependent values for scenario variables can be included in one scenario specification file. Once such a specification is available, the user only has to specify a specific scenario year (between 2019 and 2070), and a computation can be made for the year chosen. The time-dependent scenario development procedure ensures that scenarios for different years are consistent. However, not for all scenario variables there is the option to specify time-dependent values. This implies that apart from changing the scenario year other adjustments are required to define a complete scenario for another scenario year.

4.4.1 Merge scenario with case results

Scenario variables in the AERO-MS represent exogenous quantities. There are a few exceptions where the quantity is determined both by processes outside the scope of the modelling system and influenced by the outcome of the AERO-MS computation. An example is the fleet: it must be consistent with the flight information in AERO-MS. The user then specifies the development as expected from external drives, and AERO-MS presents the corrected (i.e., consistent) quantity as an output variable. As a consequence, the first model(s) have used incorrect values for the quantity as the required correction can only be made by making a second computation.

To make the results more accurate, AERO-MS facilitates a second datum run. The user has to specify a new scenario, identical to the scenario used in the first run, except that selected results from the first run are turned into scenario variables. E.g., when fleet size iteration is selected, the fleet as calculated by the first datum run is used to set up the fleet size scenario variable. Other scenario variables are copied from the original specification without modification.

In the case that the merge scenario with case results option is selected, the user enters the screen as shown in the Figure 13.

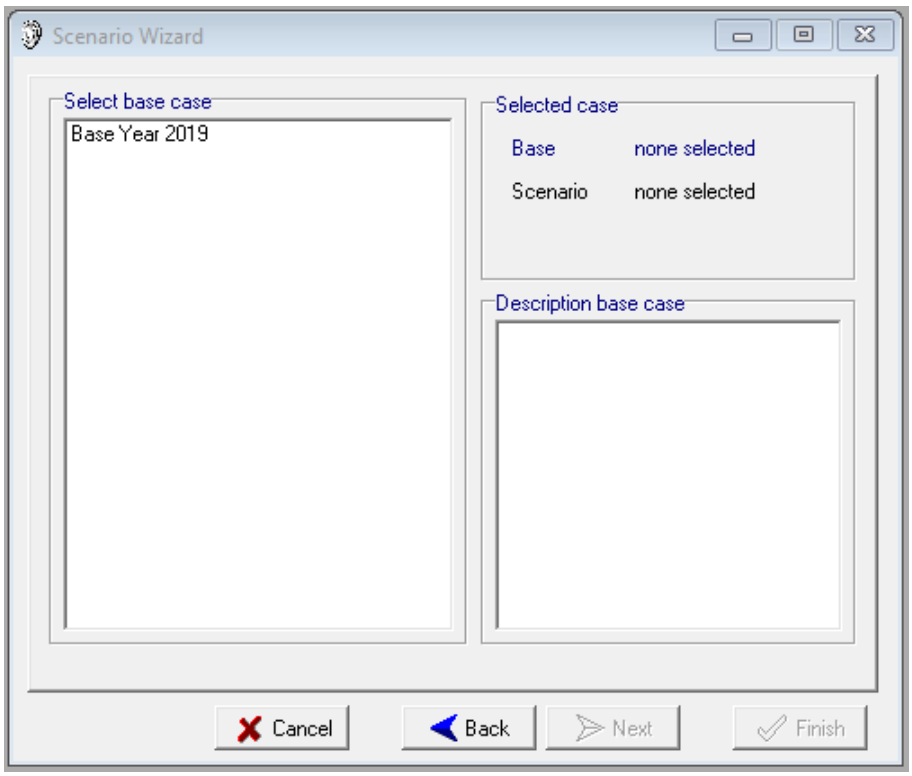


Figure 13 Scenario wizard - Merge with case results

At the left side of the wizard the user can select the base database. The selected database appears then at the right side of the wizard. The short description of selected database is shown in the right window. By pressing the Next button the user enters the next screen (see Figure 14) where the scenario database has to be selected.

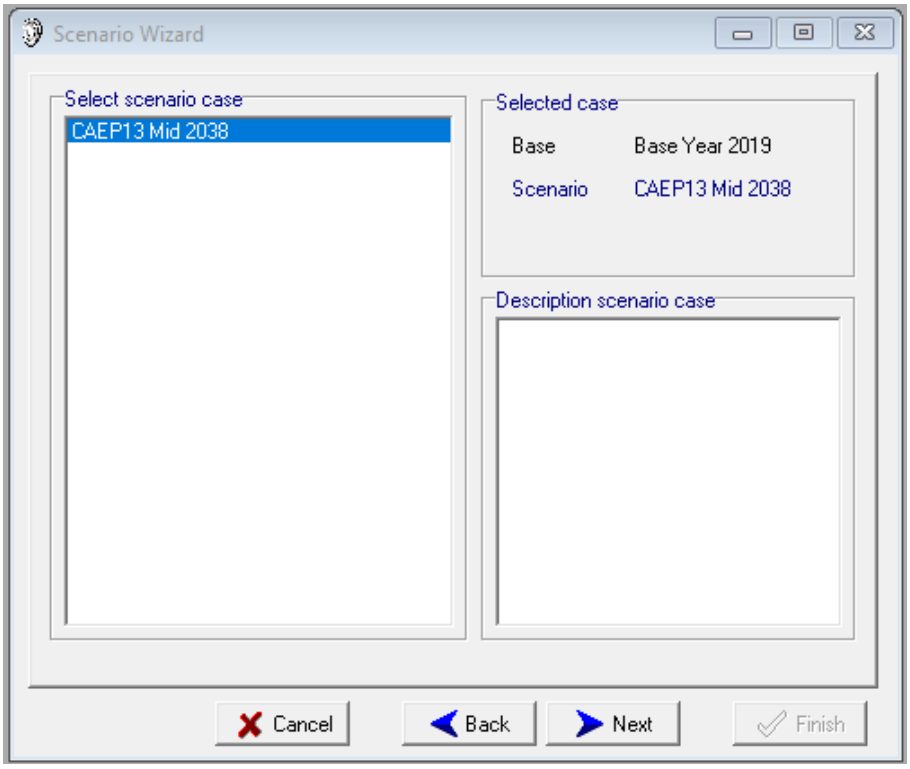


Figure 14 Scenario wizard – Merge with case results

After this scenario database is selected the user has to select a variable in the next screen (see Figure 15).

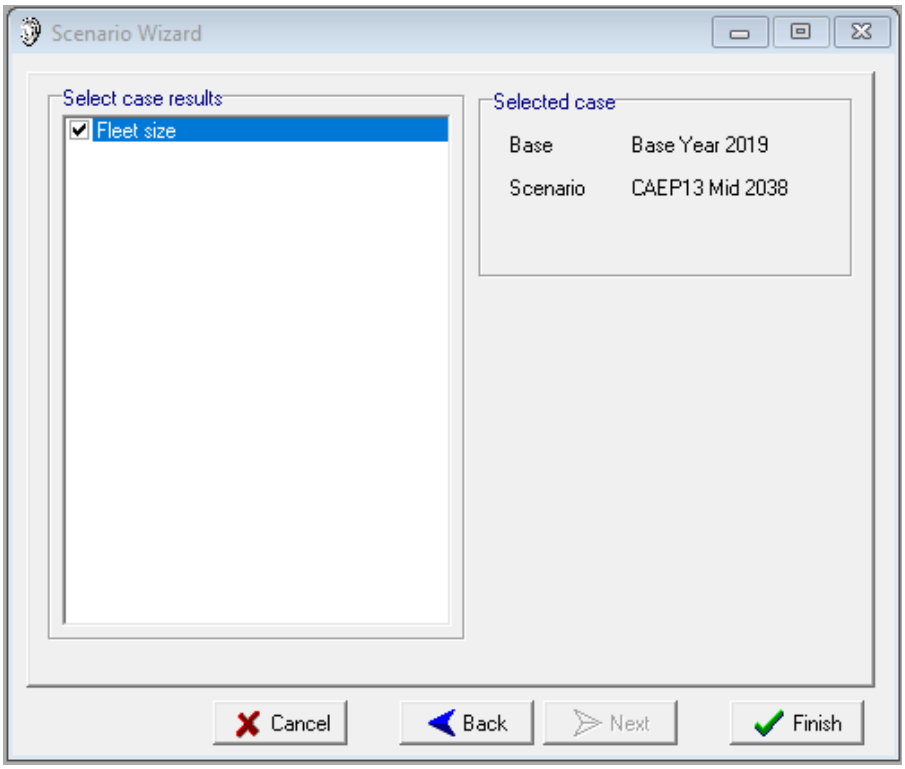


Figure 15 Scenario wizard – Merge with case results

When all databases and variables are selected the user has to press the Finish button (this button is not enabled if no databases or variables are selected).

4.4.2 Build scenario from existing

In case the user wants to build a scenario from existing , the user enters the screen as presented in figure 16.

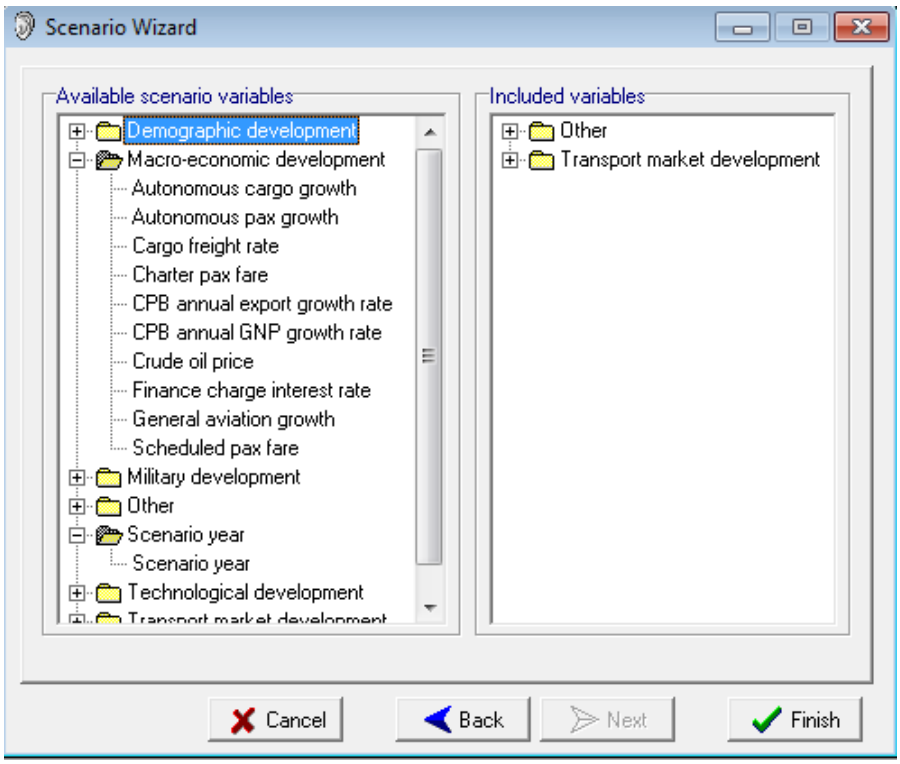


Figure 16 Scenario wizard, modify existing scenario

In the left window the categories with the available scenario variables are listed. In the right window the scenario variables included in the existing scenario are listed. A scenario variable can be included in the new scenario by dragging and dropping it to the right window. When a variable is dropped in the right window, the user directly enters the variable editor. For entering the variable editor for a variable already included in a scenario, the user can click the right mouse-button. All variables that are not edited retain to have the values as in the selected existing scenario.

For a description of use of the variable editor please refer to paragraph 4.5. A complete list of the scenario variables is presented in Appendix C2.

After pressing the „Scenario-View" button in the main screen the user enters the View Scenario screen (see figure 17). A scenario can be selected by dragging and dropping it to the right window.

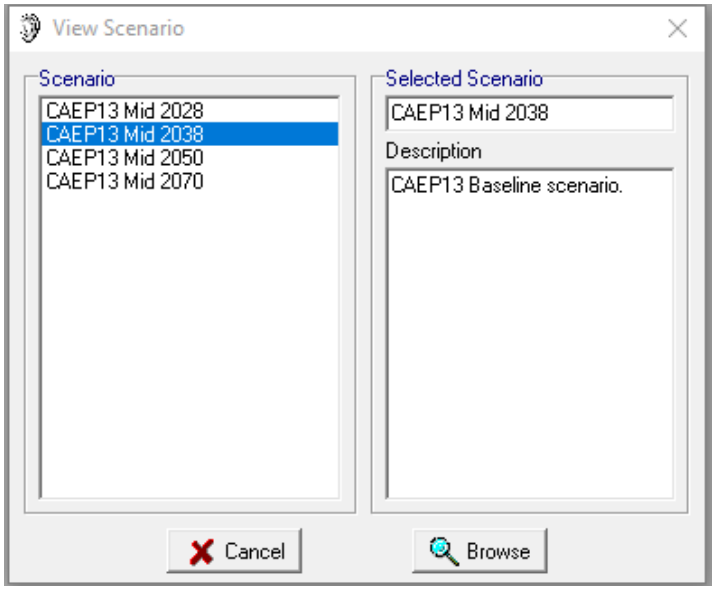


Figure 17 View Scenario

The following buttons are available in the View assumptions wizard:

To cancel the operation.

After pressing this button the user enters the data inspector. For a description of the data inspector is referred to paragraph 5.5

4.5 Policies

After pressing the 'Policy-Define' button in the main screen, the user enters the policy wizard (see figure 18).

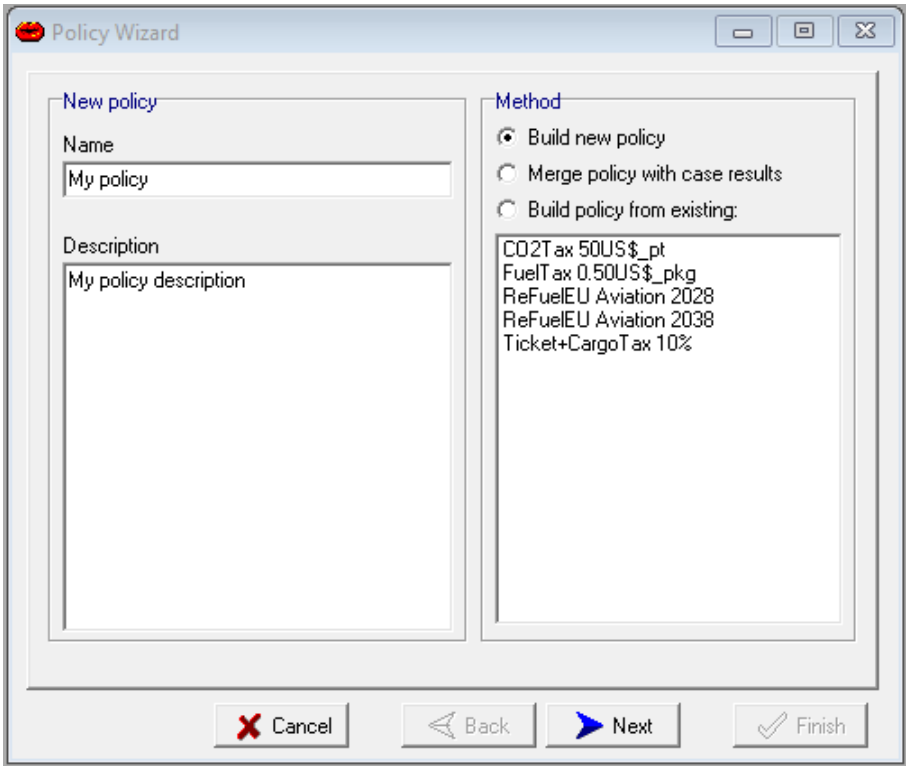


Figure 18 Policy wizard, fist step

Figure 18 illustrates that there are three options to specify a policy:

- Build new policy: build a new policy from scratch using measures as building blocks.
- Merge policy with case results: create the new policy by using the calculation results.
- Build policy from existing: create a new policy by modifying an existing policy.

As in the assumption wizard, all options require the user to specify a name (maximum 32 characters), and a description of the policy. The user can only take the next step (defining the actual policy) if a name and description is specified. With respect to the options

„Merge policy with case results" and „Build policy from existing", before going on, the user has to select an existing policy. The existing policies are listed in the right window of the policy wizard.

The following buttons are available in Policy-Define wizard:

To cancel the operation (the policy will not be saved).

To go back to previous screen.

The user interface indicates that the next step can be taken if this button lights up.

To save the policy under the name specified.

If the „Next" button is pressed a new policy wizard screen is shown.

4.5.1 Build new policy

In case the user wants to build a new policy, the user enters the screen as presented in figure 19.

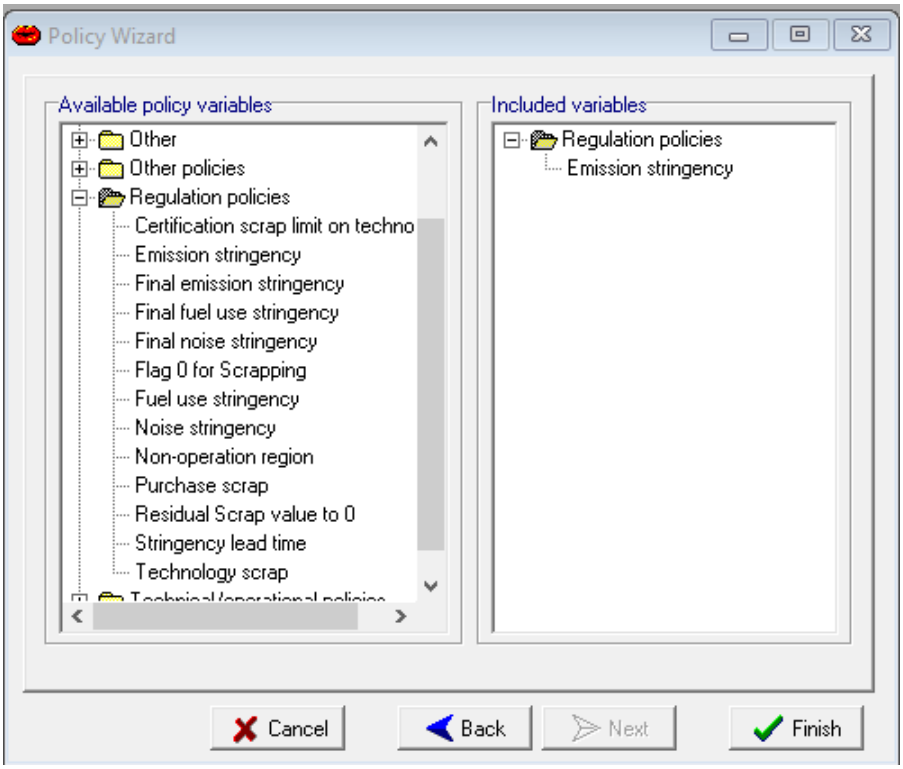


Figure 19 Policy wizard, build policy from measures

In the left window the available policy categories are listed. The user can open a category, and select a measure. The user can include a measure in a policy by dragging and dropping it to the right window. When a variable is dropped in the right window, the user directly enters the Variable editor as shown in figure 20. For more details about Variable editor see paragraph 4.5.

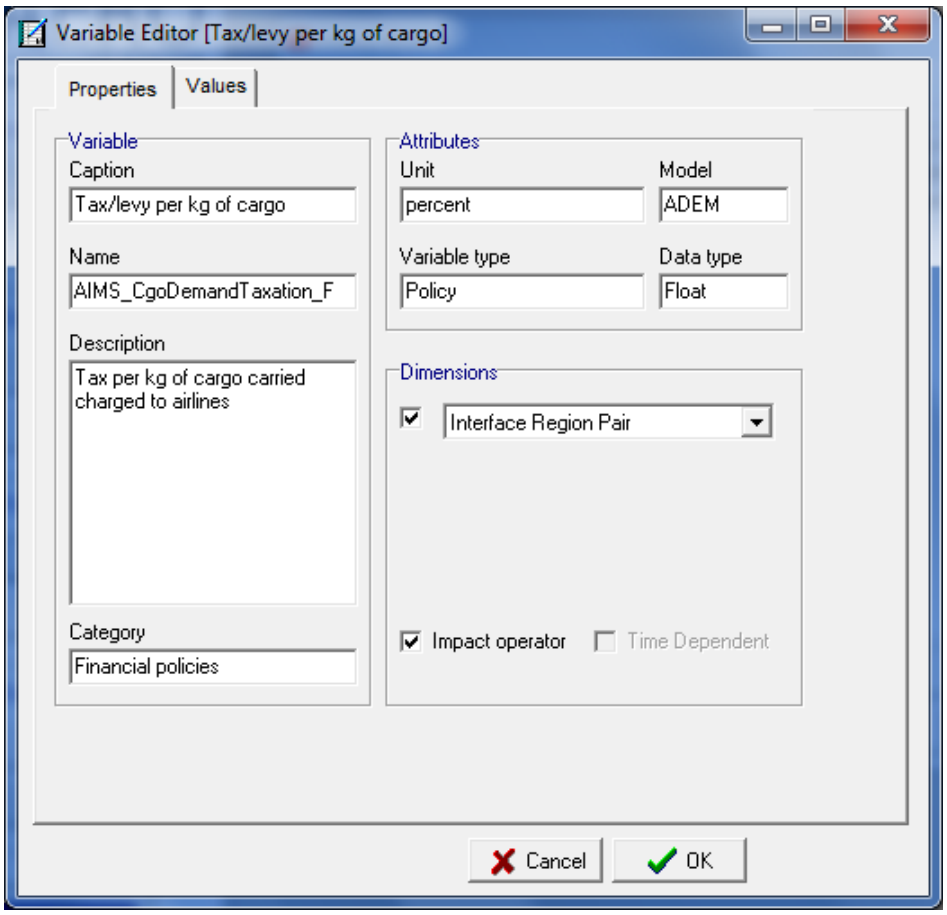


Figure 20 Policy wizard, enter measures

4.5.2 Merge policy with case results

In principle, a policy variable is an input to a forecast run. A few variables represent quantities that are output as well - their value is not independent of the settings of other policy variables or should be consistent with results as calculated in AERO-MS. The value as specified by the user is then interpreted as a first approximation, which is corrected by the models.

To make the results more accurate, AERO-MS facilitates a second forecast run. The user has to specify a new policy, identical to the one used in the first run, except that the first run is used to obtain better approximations to selected policy variables. Other policy variables are copied from the original specification without modification.

When the user wants to create a policy with the Merge policy with case results option, the user enters the screen as shown in Figure 21.

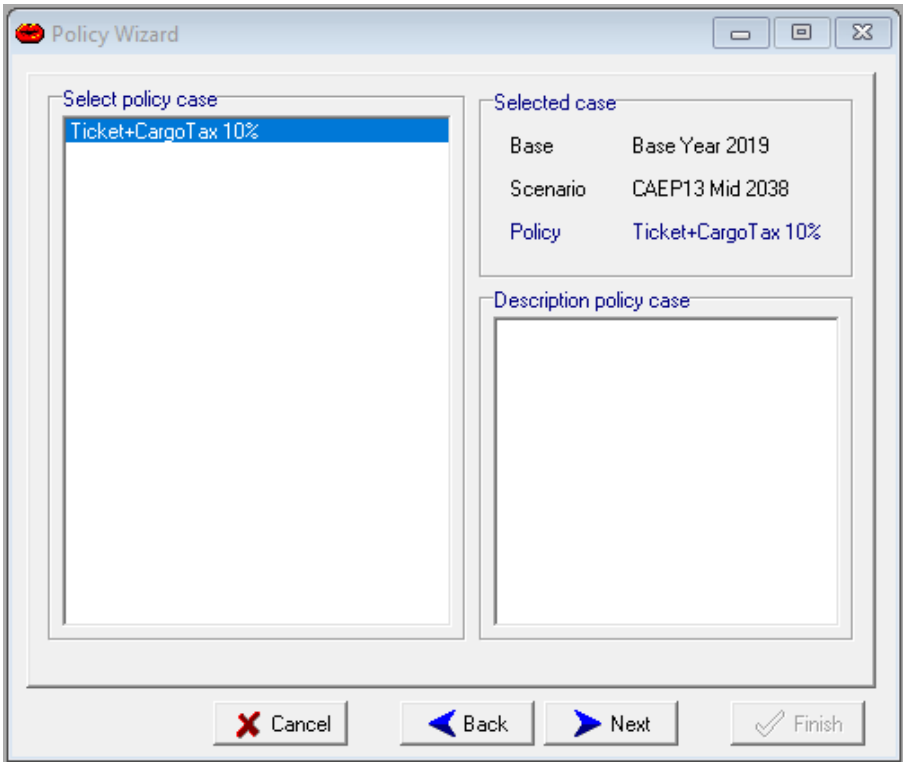


Figure 21 Policy wizard, merge policy with case results

The user has to select the base case, scenario and the policy databases and the variables. The existing databases are shown at the left side of the window and the selected databases with short description are visible at the right side of the window. The user is guided through these screens with the buttons. When the Finish button is enabled, then all databases and variables are selected and the new policy is created.

4.5.3 Build policy from existing

In case the user wants to build policy from existing, the user enters the screen as presented in figure 22.

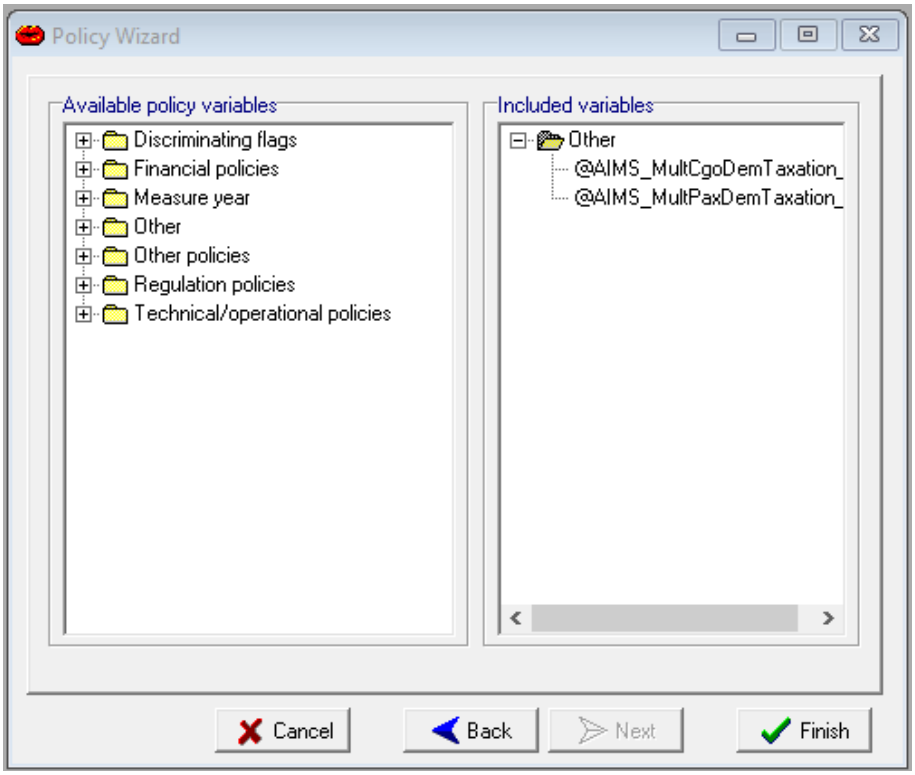


Figure 22 Policy wizard, modify existing policy

In the left window the available policy-variables are listed. In the right window the policy variables included in the existing policy are listed. A policy-variable can be included in the new policy by dragging and dropping it to the right window. When a variable is dropped in the right window, the user directly enters the variable editor. For entering the variable editor for a variable already included in a policy, the user clicks the right mouse-button. For a description of the variable editor please refer to paragraph 4.5. A complete list of the policy-variables is presented in Appendix C3.

After pressing the „Policy-View" button in the main screen the user enters the View Policy screen (see figure 23). A policy can be selected by dragging and dropping it to the right window.

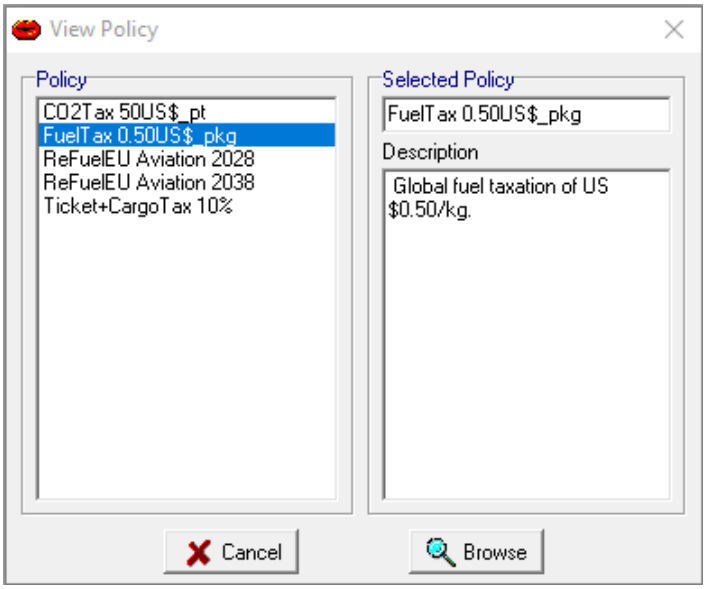


Figure 23 View Policy

The following buttons are available in the View policy wizard:

Cancel	To cancel the operation.
Browse	After pressing this button the user enters the data inspector. For a description of the data inspector is referred to paragraph 5.5

4.6 Variable editor

The variable editor works according to the same principle for assumption-, scenario- and policy-variables.

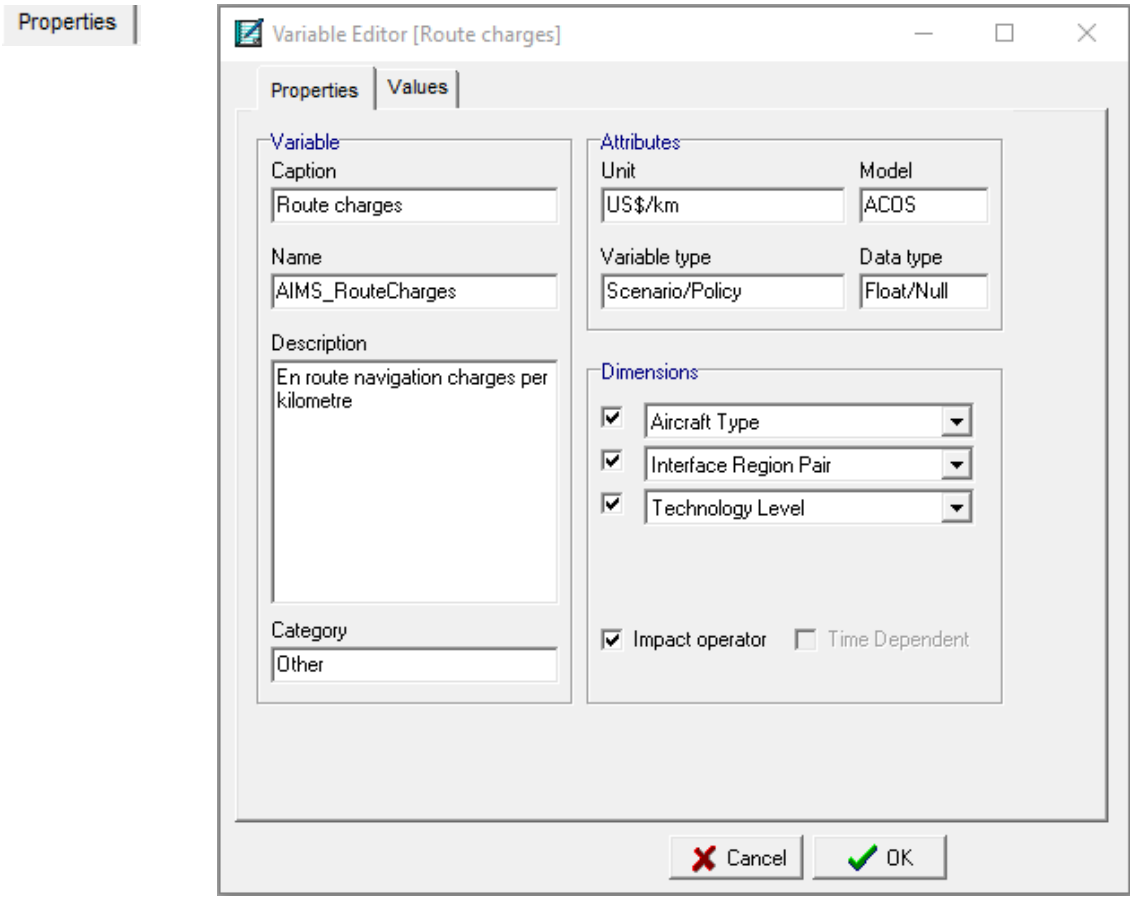


Figure 24 Variable editor, properties

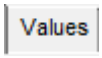
As can be seen in figure 24, in the first screen of the variable editor the following properties of a variable are presented:

- Caption of variable name of variable;
- Description of variable;
- Unit;
- Model;
- Variable type;
- Data type;
- Dimensions;
- Category;
- Impact operator;
- Time dependent.

In appendix C an overview is given of assumption-, scenario- and policy-variables whereby the variable caption, name, description, unit, dimensions, model and categories are indicated. With respect to units, the unit conventions in AERO-MS are presented in appendix A. For dimensions, a complete list is provided in appendix B.

Furthermore in the 'properties-screen' of the variable editor the dimensions can be selected by which the user wants to specify a variable. Beside that the user can choose to use an impact operator. By using an impact operator the default values of variables can be manipulated by using a multiplicative (multiplying default values)

or/and an additive (adding a value to the default values). In case no impact operator is selected the values of variables will be directly edited.



By pressing the tab 'Values' at the top of the Variable Editor, the user will actually be able to specify values (see figure 25).
Furthermore the user can change the format of the screen, by selecting a different row- or column-dimensions. Only the dimensions selected in the 'properties-screen' are available, whereby (if selected) an impact operator is regarded as an extra dimension.

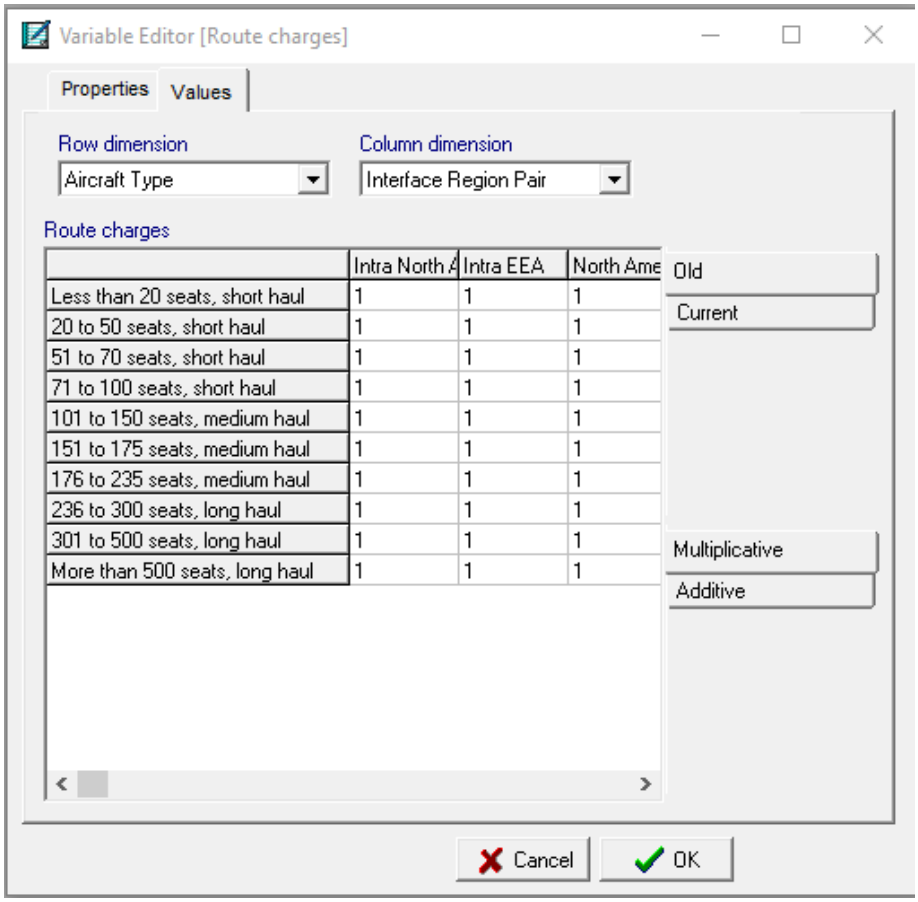


Figure 25 Variable editor-Values

In case of an impact operator the initial values for the multiplicative is '1'. For the additive it is '0'. With these initial values the default values of a variable remain unchanged.

4.7 Computation of cases

As indicated in paragraph 4.1, with respect to computation the following buttons are available in the main screen of AERO-MS:
New run: starts a new run as a background process.

Queue: shows the queue of runs waiting to be executed.

After pressing the ‘New-run’ button the user enters the run wizard (see figure 26).

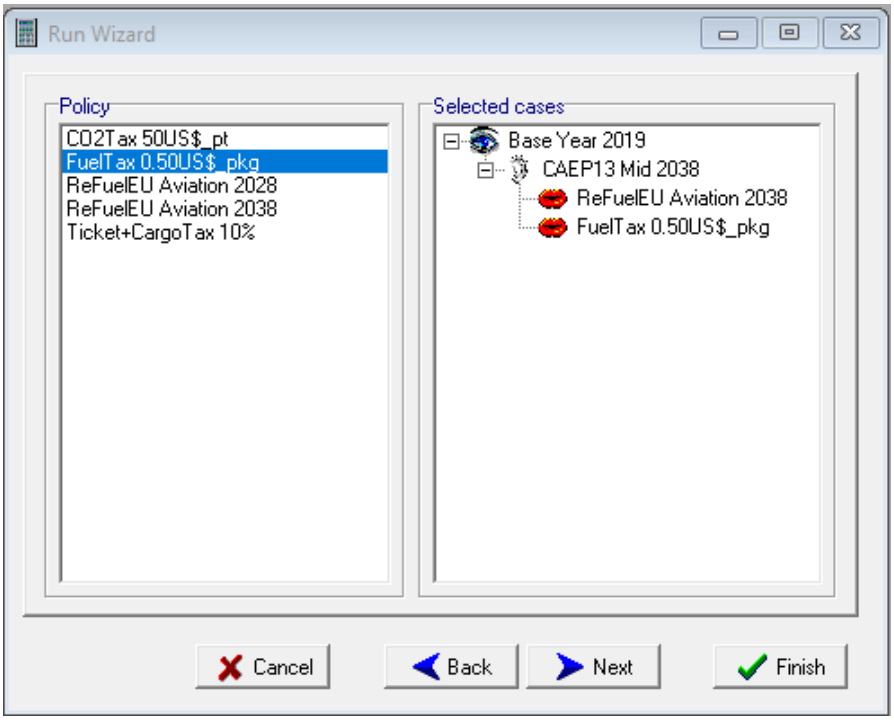


Figure 26 Run wizard

In the run wizard the user can subsequently select one or more:

- assumption sets (base cases);
- scenarios (datum cases);
- policies (forecast cases).

In the left window the available cases are listed. A case can be selected by dragging and dropping a case from the left to the right window. After one or more base cases are selected, the user can press the 'Next' button, and will be able to select scenarios. After the selection of scenarios, policies can be selected.

After the selection of policies (by pressing the 'Next' button) the user can specify which models are to be run.

The user will enter the screen as presented in figure 27. Here the user can specify the run objectives.

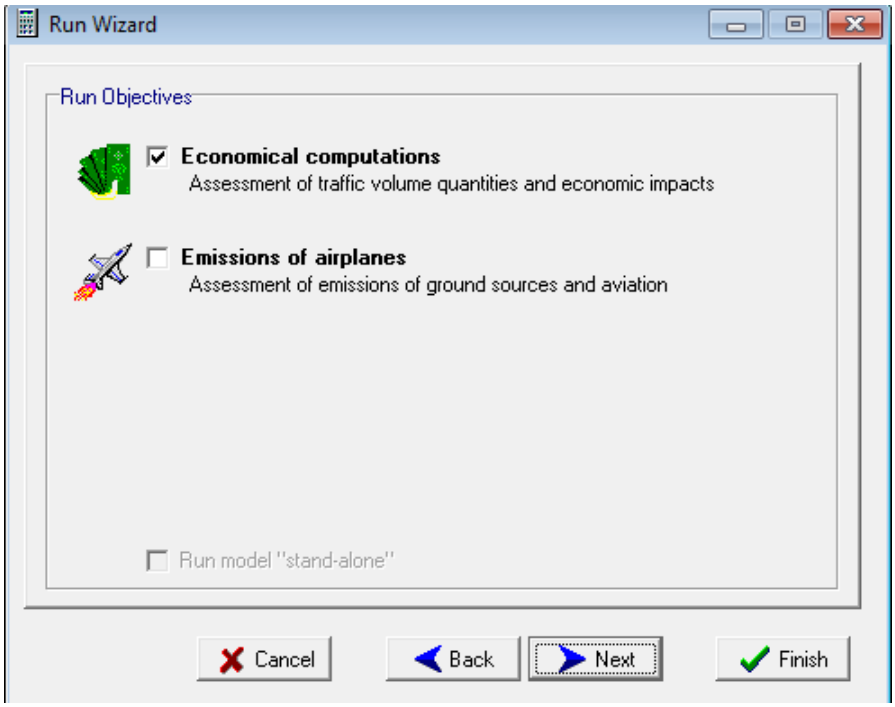


Figure 27 Run wizard, included run objectives

For specifying which models to run, the user will enter the screen as presented in figure 28.

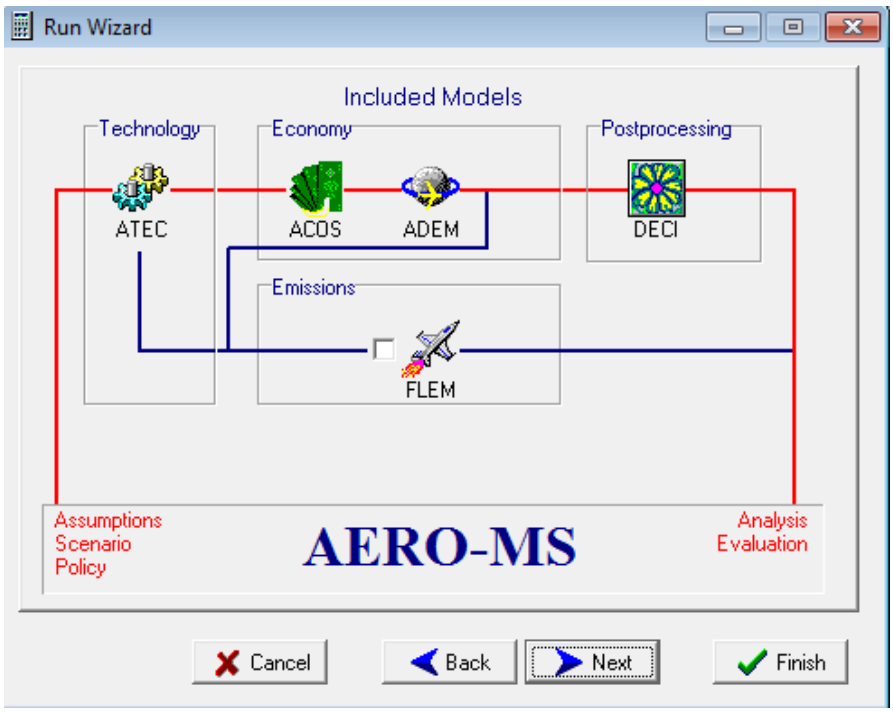


Figure 28 Run wizard, included models

In figure 28 the complete modelling system is presented in a highly schematic form. The figure illustrates that the following models are always included in a run:

- ATEC;

- ACOS;
- ADEM;
- DECI.

Running the model FLEM is optional. It is noted however that if the user want to test the effects of policies (Forecast run), this is best done relative to a Datum (scenario) run whereby FLEM has also been run.

The user will enter first the screen as presented in figure 27 and then the screen as presented in figure 28.

After the specification of the run objectives and/or the models to run, the user can press the 'Next' button (see the screen in figure 27 and 28), and enter the job-queue (see figure 29).

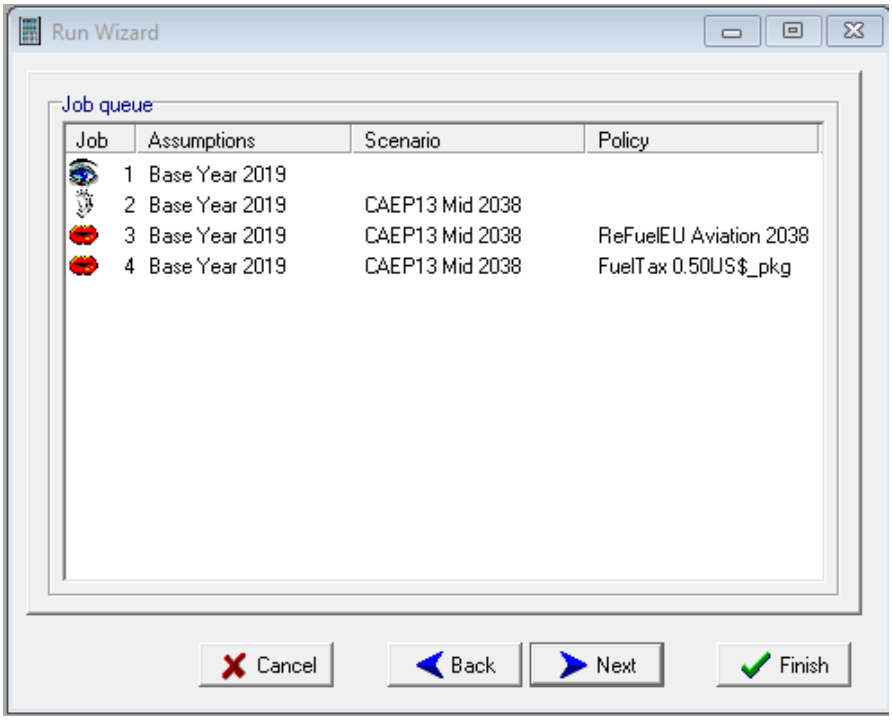


Figure 29 Run wizard, job queue

Within the job queue dragging and dropping a case to another place in the queue can change the sequence of the runs.

In the final step the user can indicate whether results should be exported to SQL format. The user can select an SQL specification file. These files contain a list of variables to be exported to SQL. The files are stored in the folder ../imports/sqlexport, and can be modified by the user by removing or adding variable names to be exported.

When a run is made, with the selection of an SQL specification file, the SQL database will be placed in the folder ../sql. If no file is selected none of the AERO-MS data will be exported to SQL.

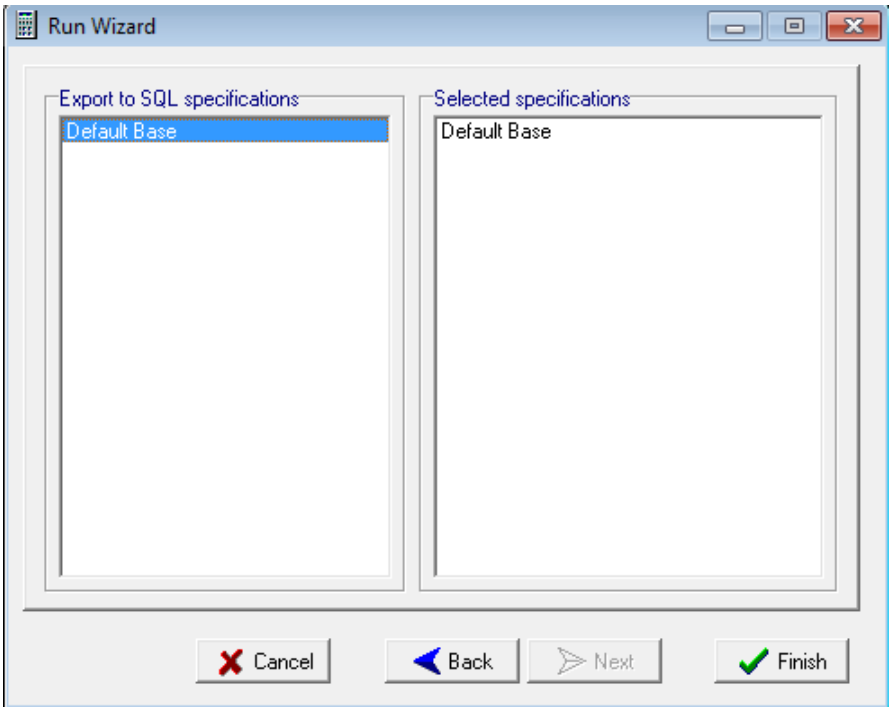


Figure 30 Selection of SQL export

To execute the job queue the user has to press the 'Finish' button in the run wizard.

The cases will then be run in a background process (see figure 31). This means that while the cases are running, AERO-MS can still be used for preparing new runs or analysis tasks.

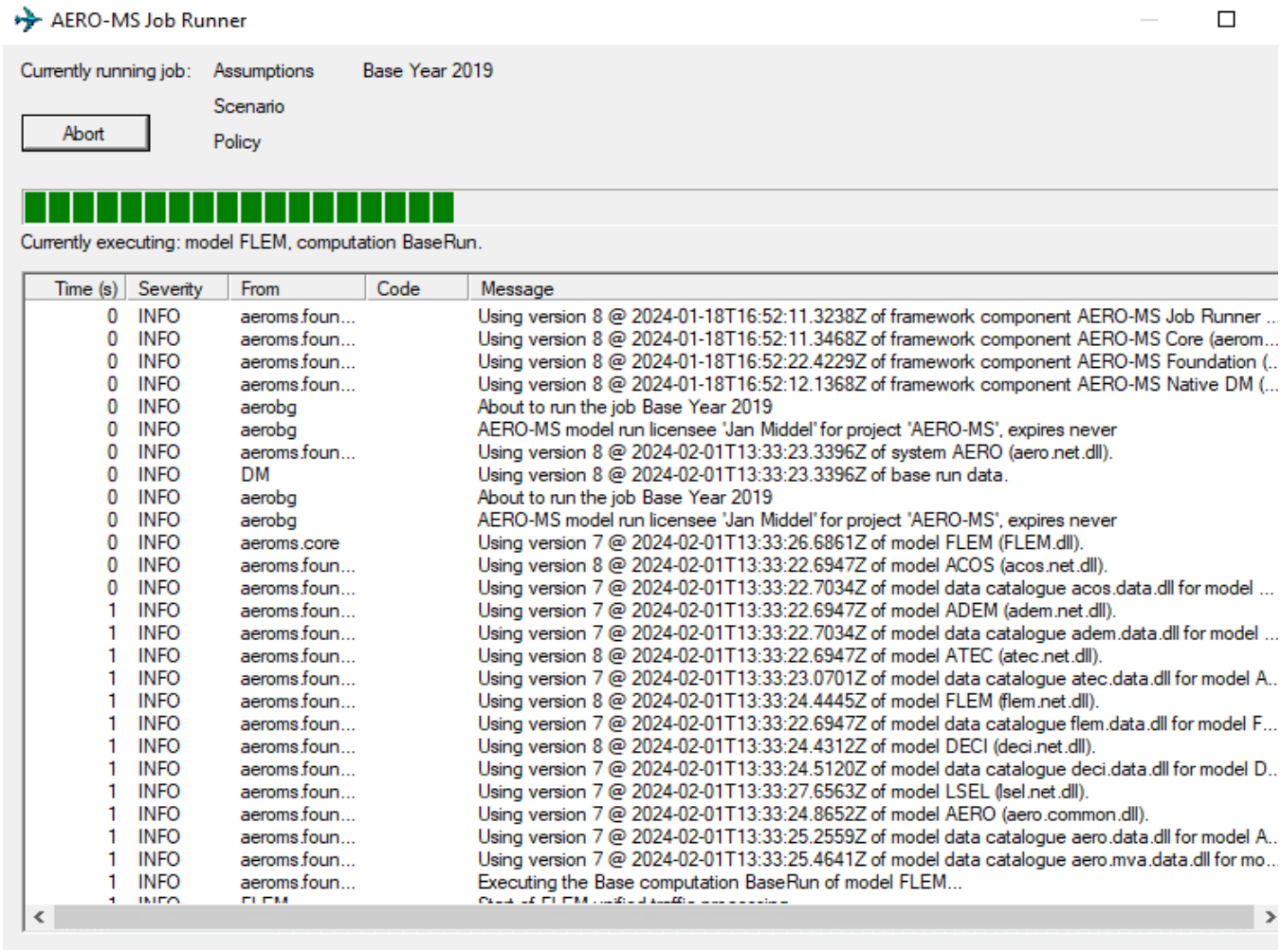


Figure 31 AERO-MS Background Job

As can be seen in figure 31, in the screen of the AERO-MS Background Job, the following properties of the job information are presented:

- name of assumption, scenario, and/or policy that is running;
- a progress bar (green by default, in case of warnings the color will turn orange, and red in case of errors;
- job control with information on the (sub) model currently running;

After pressing the „Queue" button the user enters the View queue wizard (see Figure 32). wizard the user can see which runs are going to be executed and what is the status of the job. The status can be running, waiting and/or failed. The user can select a job and delete the job.

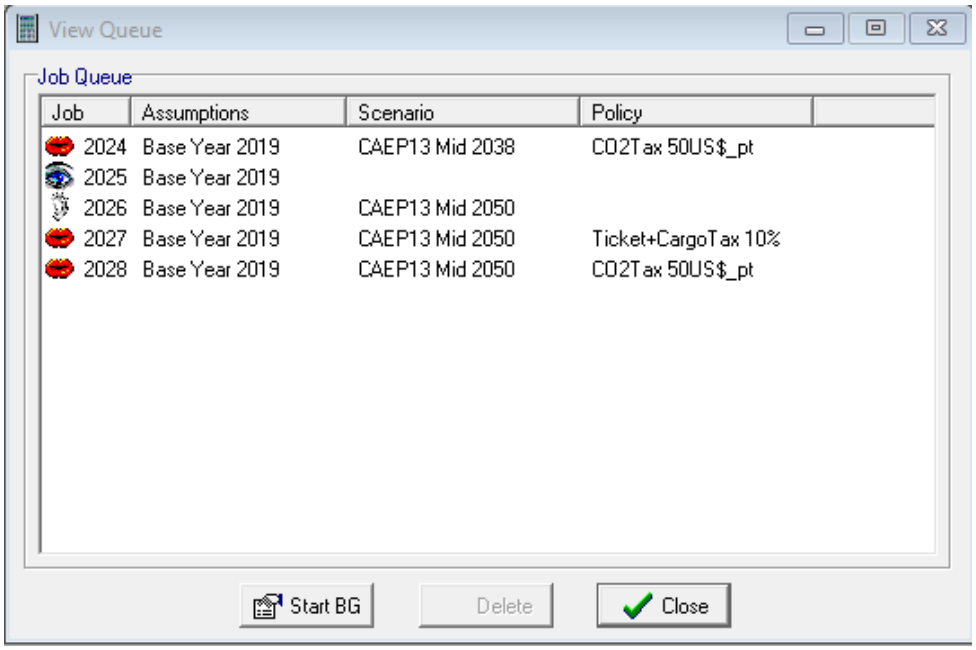


Figure 32 View queue wizard

The following buttons are available in this wizard:

Delete	By pressing on this button the user can delete a selected job.
Close	To close View queue wizard.

5. Analysis of cases

Before the analysis and evaluation of cases can start, the user has to select one or more cases. The selection of the cases is done with the case selector (see 5.1 Case selector). Analysis relates to the interpretation of results of one particular case. Evaluation relates to a comparison of the results of various cases.

5.1 Case selector

For selecting (computed) baseline, scenario and/or policy cases, the user has to open the case selector that can be found left down in the main screen. In the case selector all cases, which have been run, are presented and can be selected.

When opening the case selector the user enters the screen as presented in figure 33.

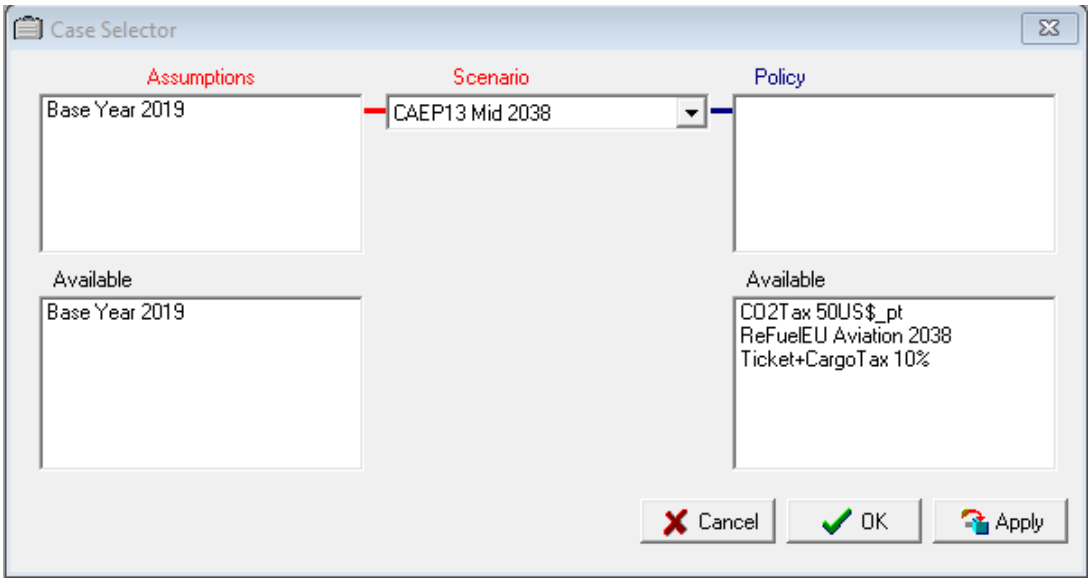
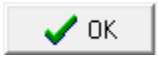


Figure 33 Case selector

The user can select base case only or base and datum cases or subsequently base, datum and forecast cases. To list the available cases the user clicks on the assumption-, scenario- or policy window. To select a case, the user has to drag and drop a case to the upper window.

The following buttons are available in this wizard:

To cancel the selection of cases.



After pressing on this button, the Case selector wizard is closed and the analysis and evaluation can be started.

The analysis and evaluation can be started and the Case selector wizard is not closed.

The user-interface indicates that the analysis and evaluation can be started by lighting up the 'Analysis'- and 'Evaluation'-buttons at the left end of the main screen.

5.2 Main screen analysis

The analysis option refers to the interpretation of computational results of one particular case. Pressing the (lightened) „Analysis" -button starts the analysis.

The user enters the following screen (see figure 34).

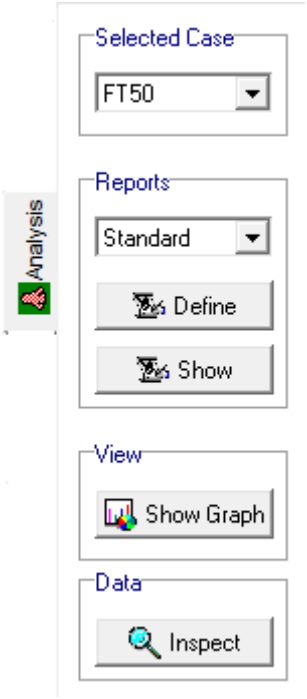
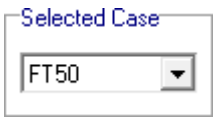


Figure 34 Main screen analysis

The following buttons are available for the analysis of cases.



Selected Case

„Window" Select a single case to analyse.

Reports

„Window" Select the report layout.

Define Define a new report format

Show Show a report of the currently selected case.

View

Show Graph

By clicking on this button the user can display a graphical presentation of the selected variable on the screen.

Data

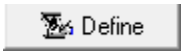
Inspect

Inspect the raw data of the selected case.

5.3 Reports

Before reporting, the user can select a report layout. In the present version of AERO-MS several standard type of reports are available. The user can also create one or more reports using Define report button. The standard report contains information with respect to:

- aviation activity; passenger activity; capacity and demand; scheduled capacity;
- cost and economic information



The user designs own report layout by pressing this button (see Figure 35). On the top the user can give the name of the report. By default is the report name New report. By clicking on this default name the user can give any name to the report.

At the left side of the wizard all buttons related to the design of the report are shown. At the right side of the wizard the user can see the name of the report and two rows of the different tabs. In the first row the user can select the different pages (sheets) of the report to design and/or to see them. In the second row the user can click on the Definition tab to make a report design or on the Preview tab to see the report layout.

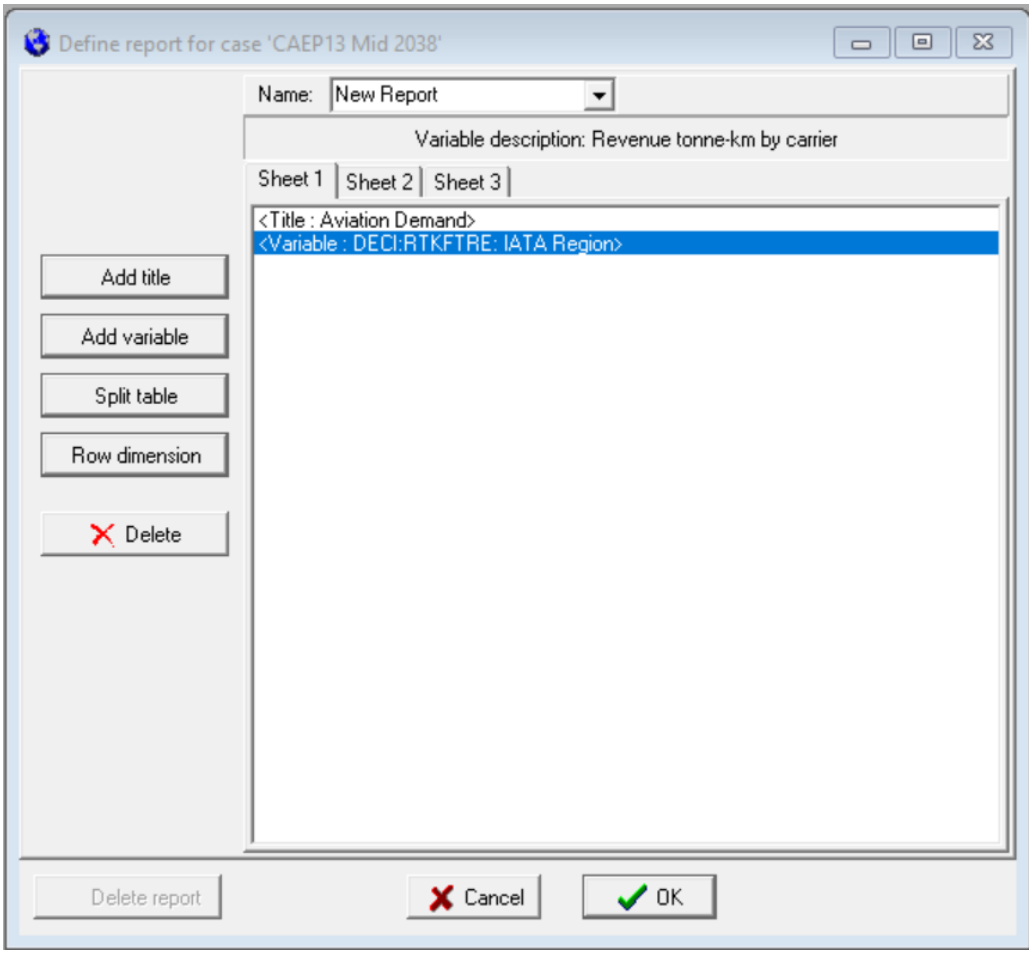


Figure 35 Define report wizard

The following buttons are available in this wizard:

Add title	To add a title to the report.
Add variable	To select a variable included in the report. By clicking on this button, the user enters the screen as shown in Figure36. When the variable is selected and the Next button is pressed a new wizard appears on the screen (see Figure 37). The user has to select the dimension and the type of the aggregation of the variable in this wizard.
Split table	To split the table. If the user uses this button between the variables, the result are shown in two different tables. If this command is not used, the results are shown in the same table in separate columns (for same dimensions).

Row dimension	A user can choose the row dimension with the help of this button.
Delete	The user can delete one or more selected rows in the report with this button.
Delete report	To delete the report. The user selects the report at the left side in Reports window, then click on the Define button . The selected report is shown on the screen. The user can delete this report clicking on this button. Before the report is deleted, the user has to click on Yes button in Confirm dialog.
Cancel	To cancel the operation.
OK	To close the window. Before the window is closed, the user enters Confirm dialog with the question 'Save changes to report "Report name"?'. The user can choose between Yes, No or Cancel.

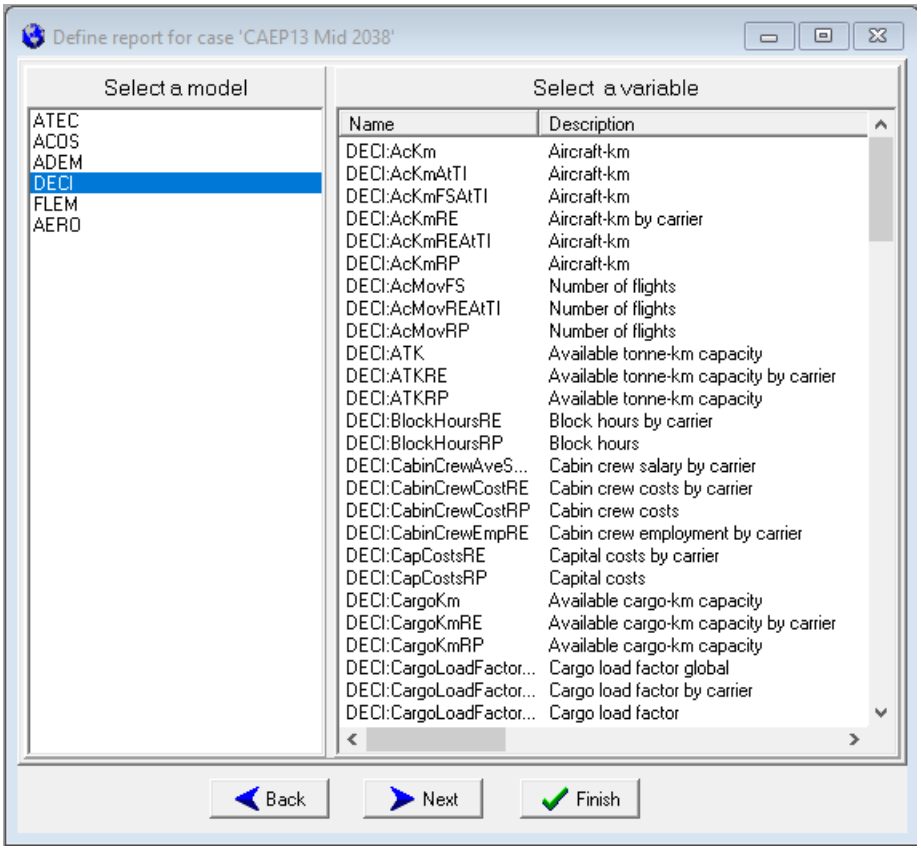


Figure 36 Define report – Add a variable

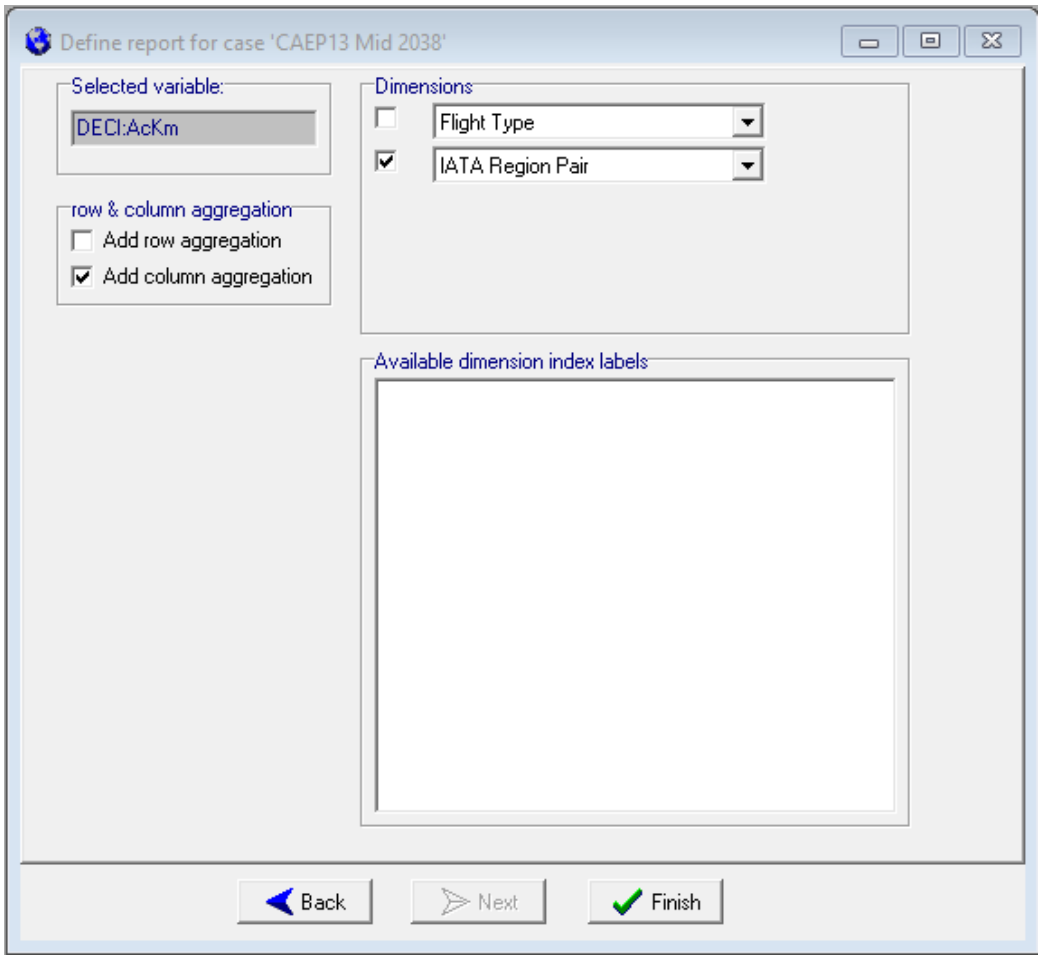
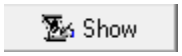


Figure 37 Define report – Choose dimension and aggregation



The user can produce a report (for the case selected) by pressing the'Report-Show' button. The report will be directly shown to the user. The Standard report goes straight to Excel (see Figure 38), the reports made by user go via screen as shown in Figure 39.

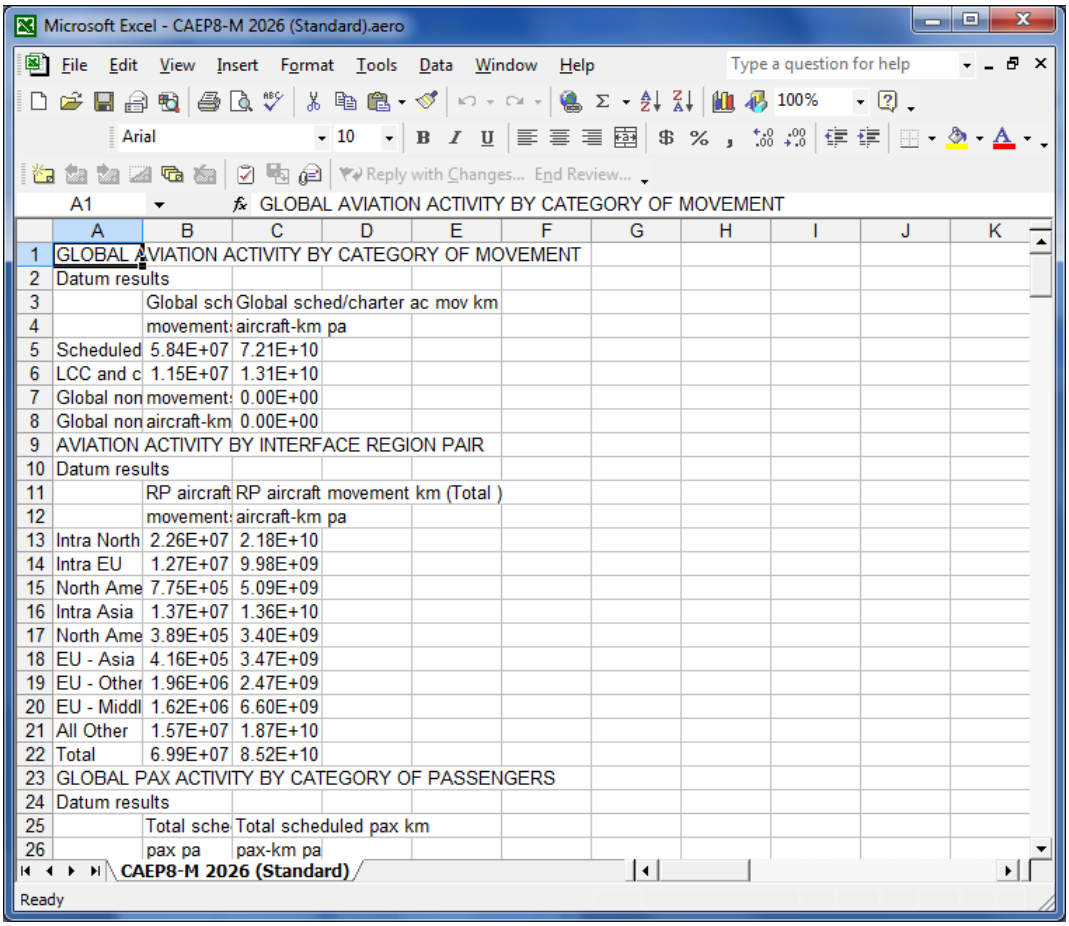


Figure 38 Standard Report

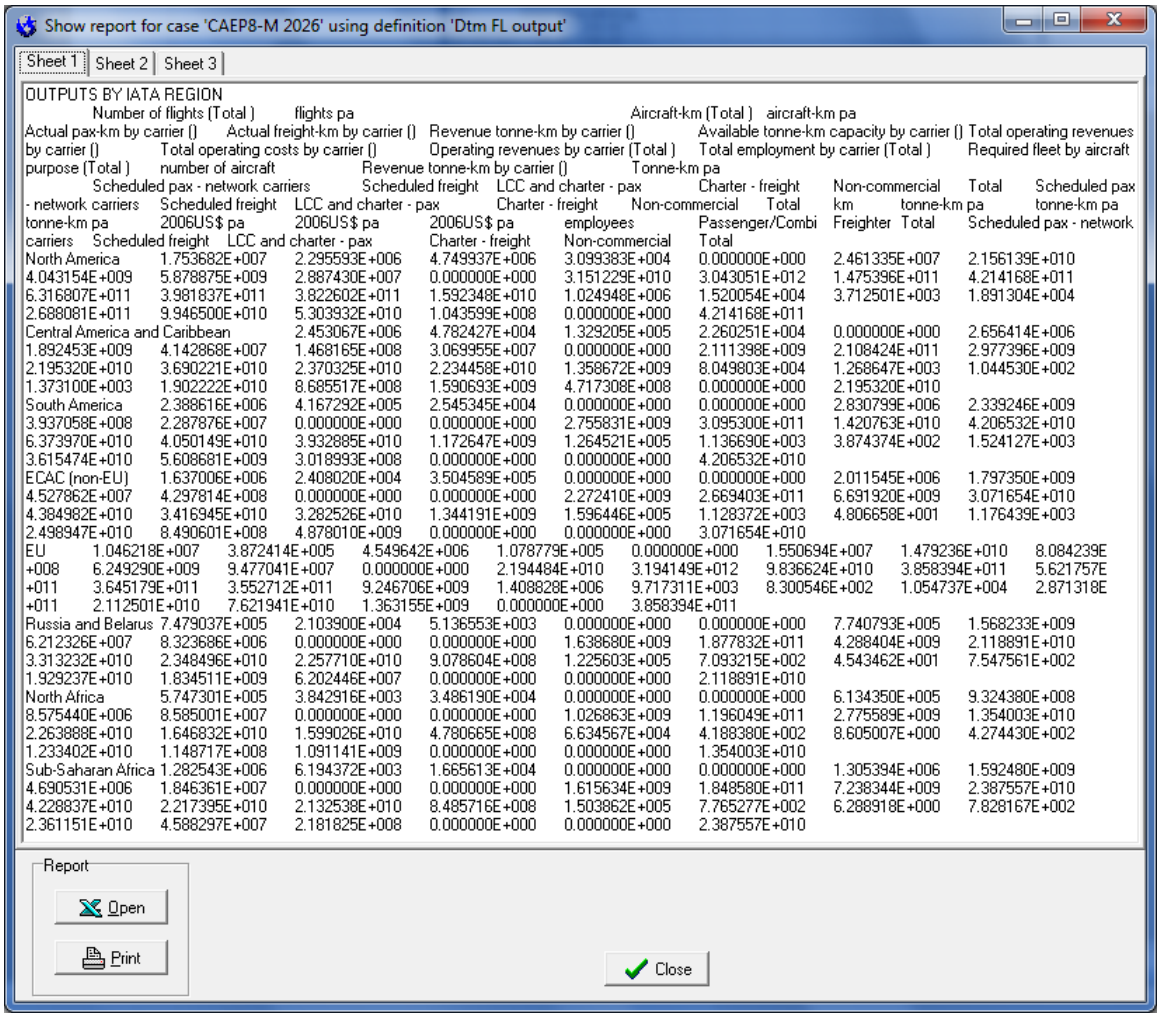


Figure 39 Show Reports designed by user

The user can change layout of the standard report using all EXCEL facilities. In the case that the report designed by user is selected, a screen as shown in Figure 39 appears. The user can select different sheets at the top of the report to open or to print them. In addition the following buttons are available:

Open the report in EXCEL (the report can then be edited using all EXCEL facilities).

Print one or more pages of the report.

Close the report and go back to the main screen.

5.4 View

In case the user wants to have a geographical look at the results the„View-Show Graph " option can be used. After pressing the „View-Show Graph" button the user enters the screen Select a Variable (see figure 40).

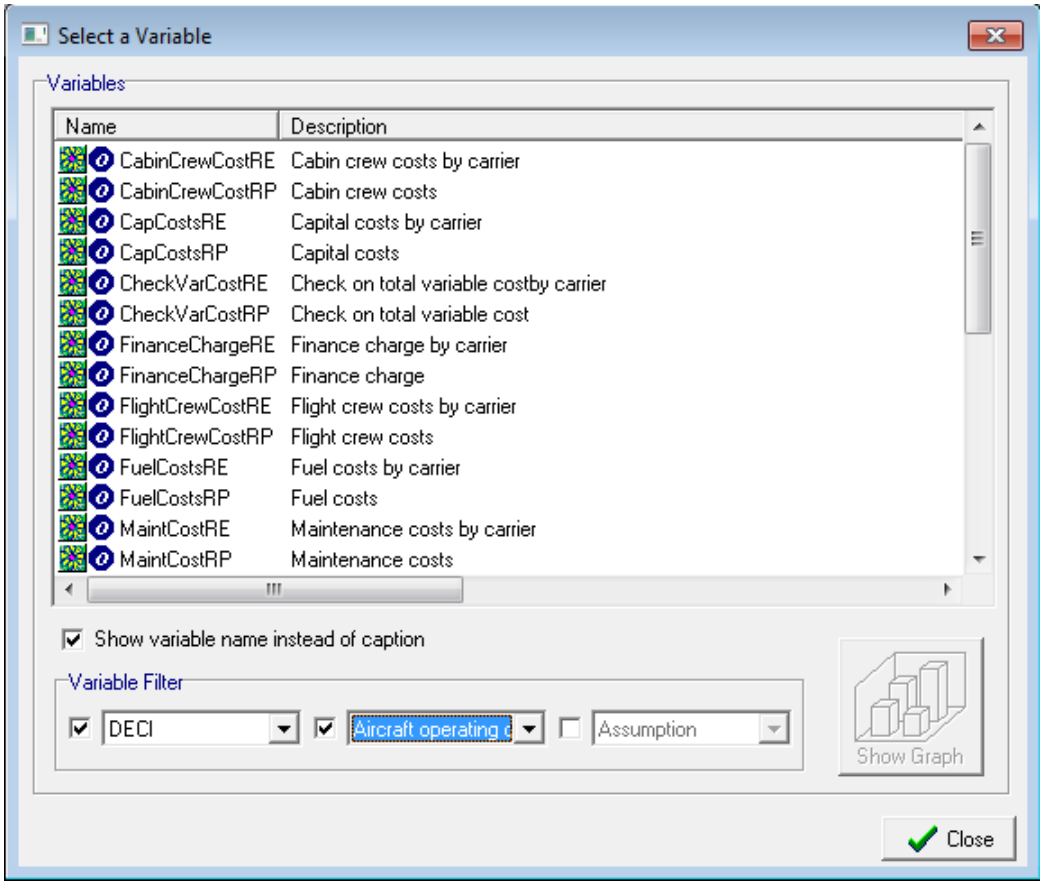


Figure 40 Select a Variable

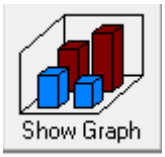
In this screen, the user can select the variable to have a closer look at it. As can be seen in figure 40, in the 'Select a Variable' screen the following properties of the variables are available:

- Name of variables;
- Description of variables;
- Variable filter that gives the following information:
  - Model;
  - View category;
  - Type of the variable.

Another option that is available is the „Show variable name instead of caption". With this option the variables are listed by variable ID* instead of variable name (see Appendix C).

Note: In the technical documentation of the individual models the variable ID is called „variable name" and the variable name is called „caption

The following buttons are available in this wizard:



After pressing this button the user enters the graph generator (see figure 41).

Close Close the View by variables wizard and go back to the main screen.

After pressing the „Show Graph" button the user enters the Graph Generator screen as shown in Figure 41.

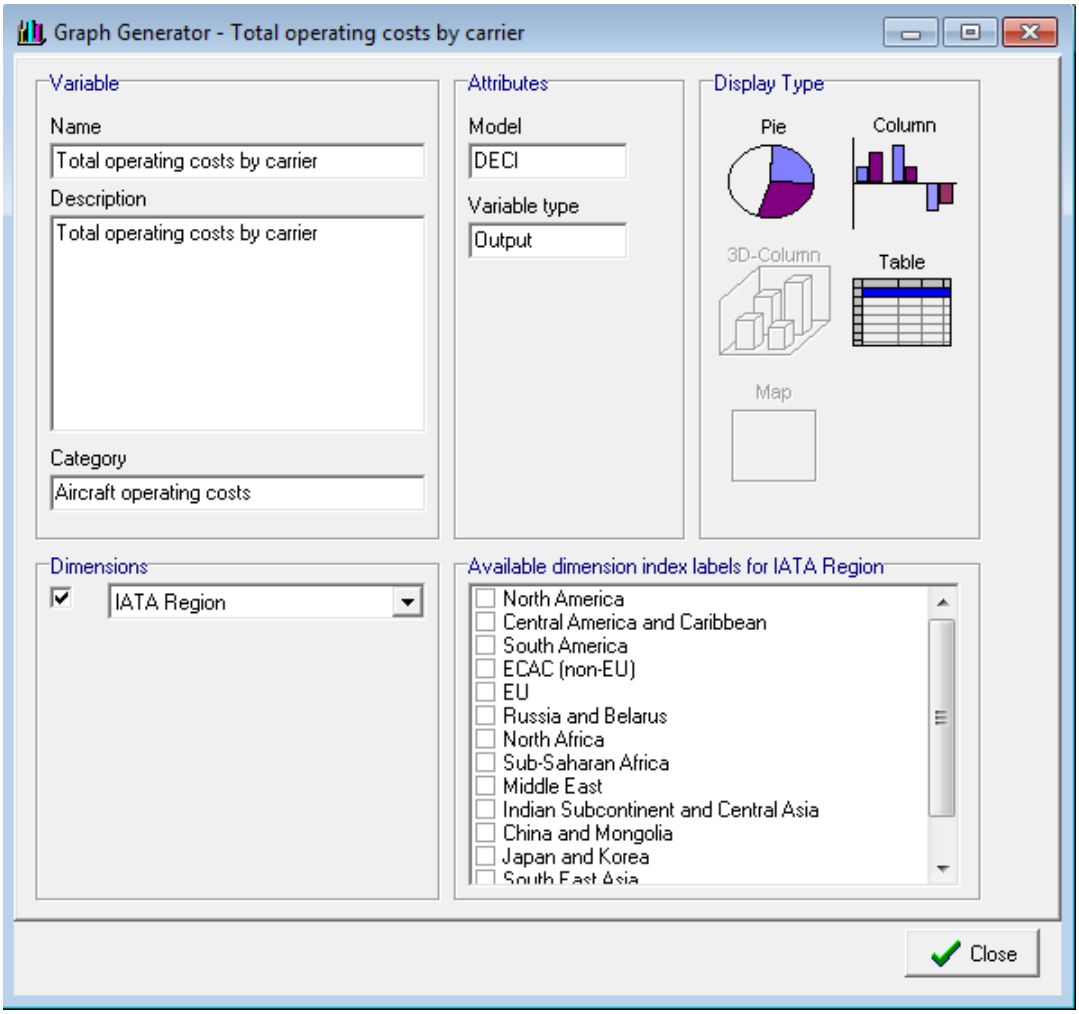


Figure 41 Graph Generator

The following properties of the variable are presented:

- Variable:
  - Name of variable;
  - Description of variable;
  - Category ;
- Attributes:
  - Model;
  - Variable type;
- Dimensions:

- Here the view dimension can be chosen, and special results can be selected out of the available results;

- Display type:
  - Pie (see Figure 42); Column (see Figure 43);
  - 3D-Column (see Figure 44);
  - Table (see Figure 45).

The display types that are available for the selected variable are displayed in colour; the display types that are not available stay grey.

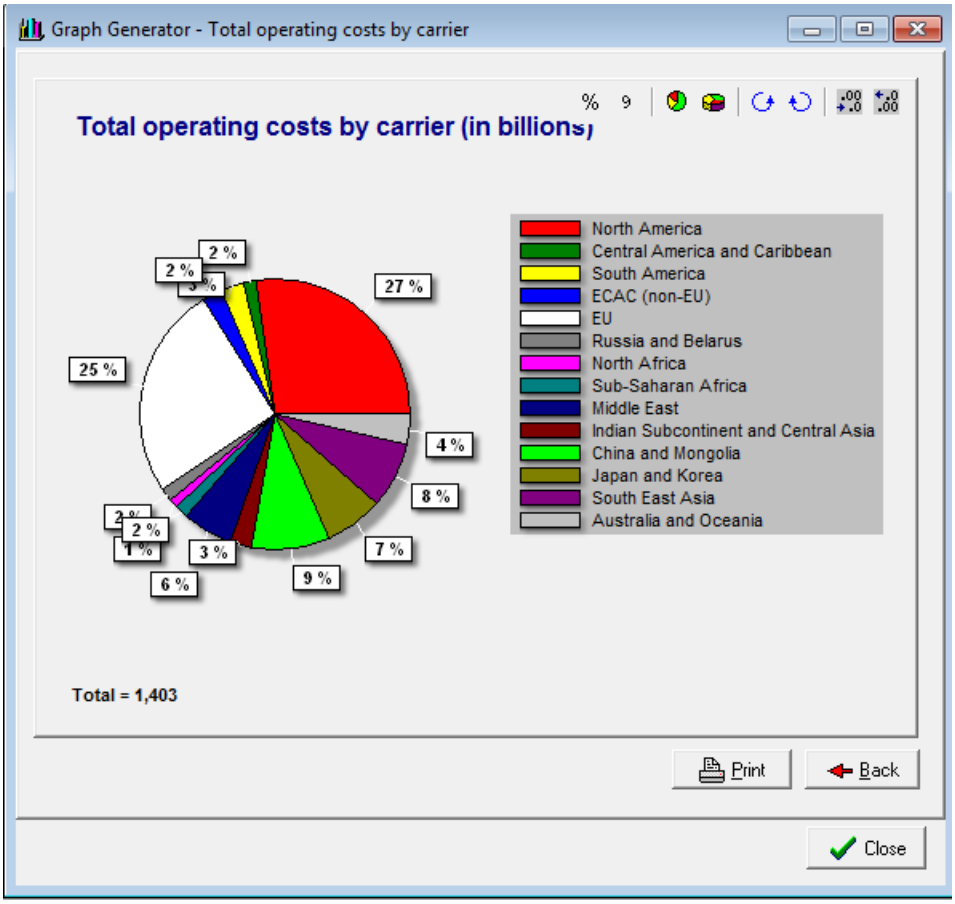


Figure 42 Pie graph

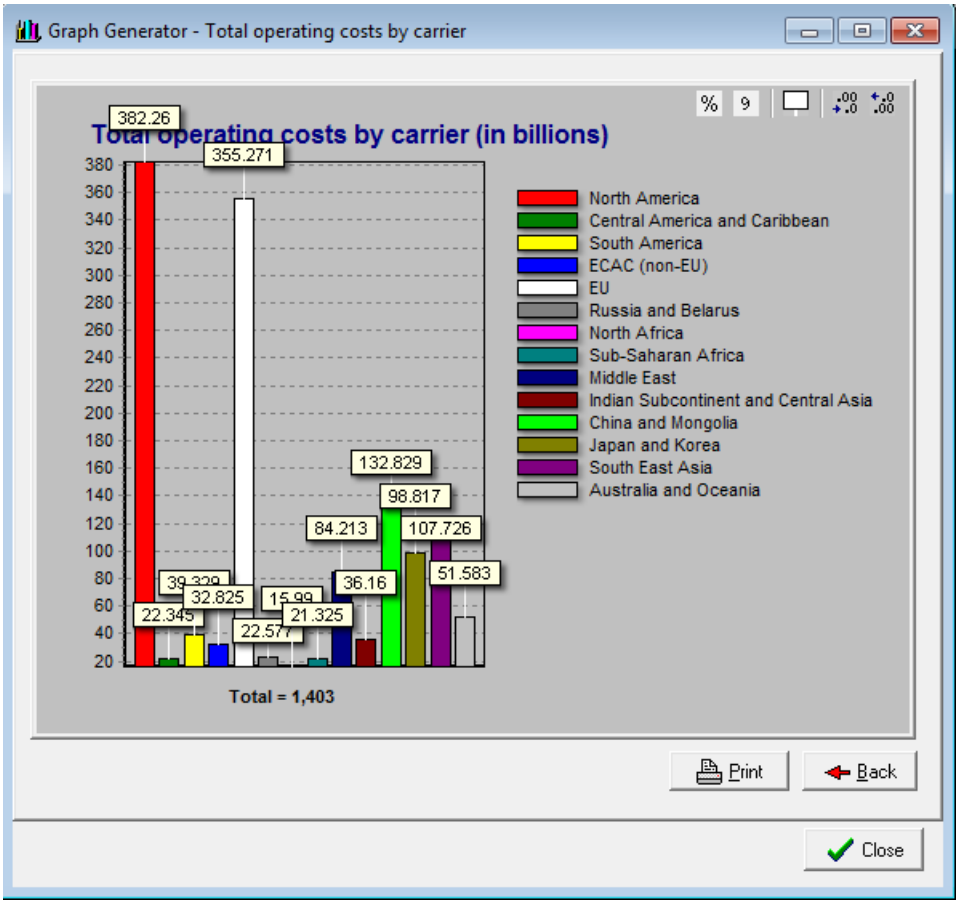


Figure 43 Column graph

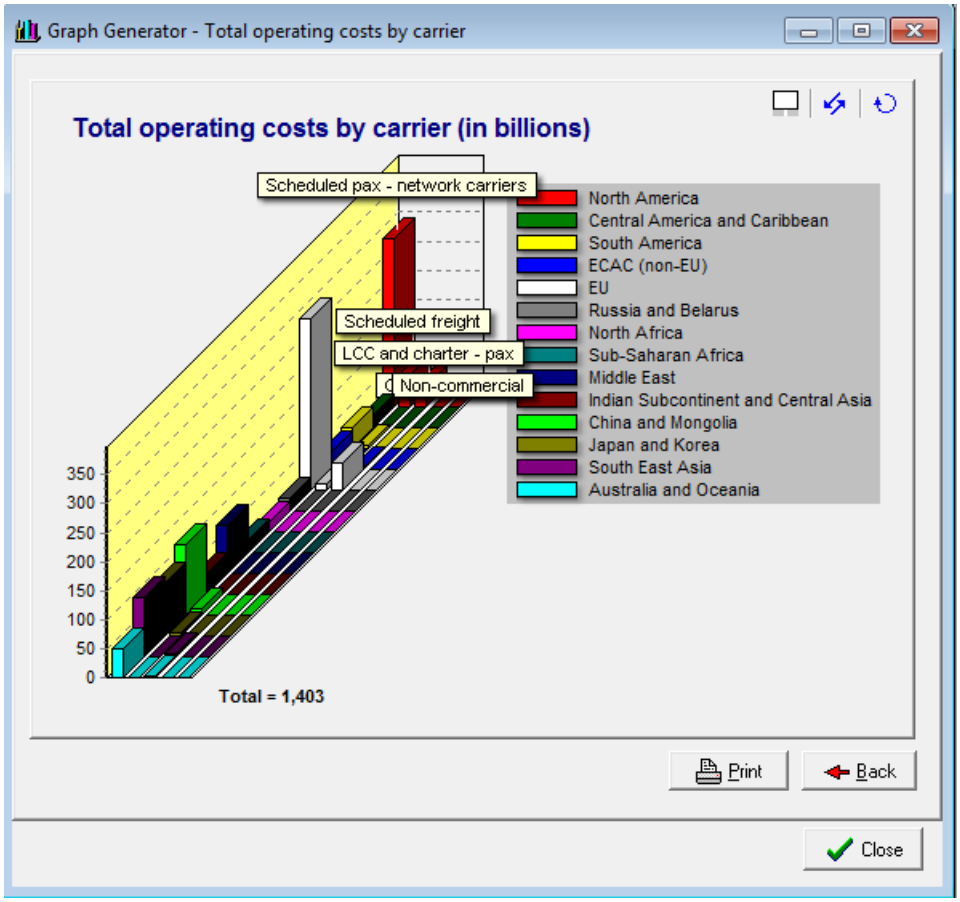


Figure 44 3D column graph

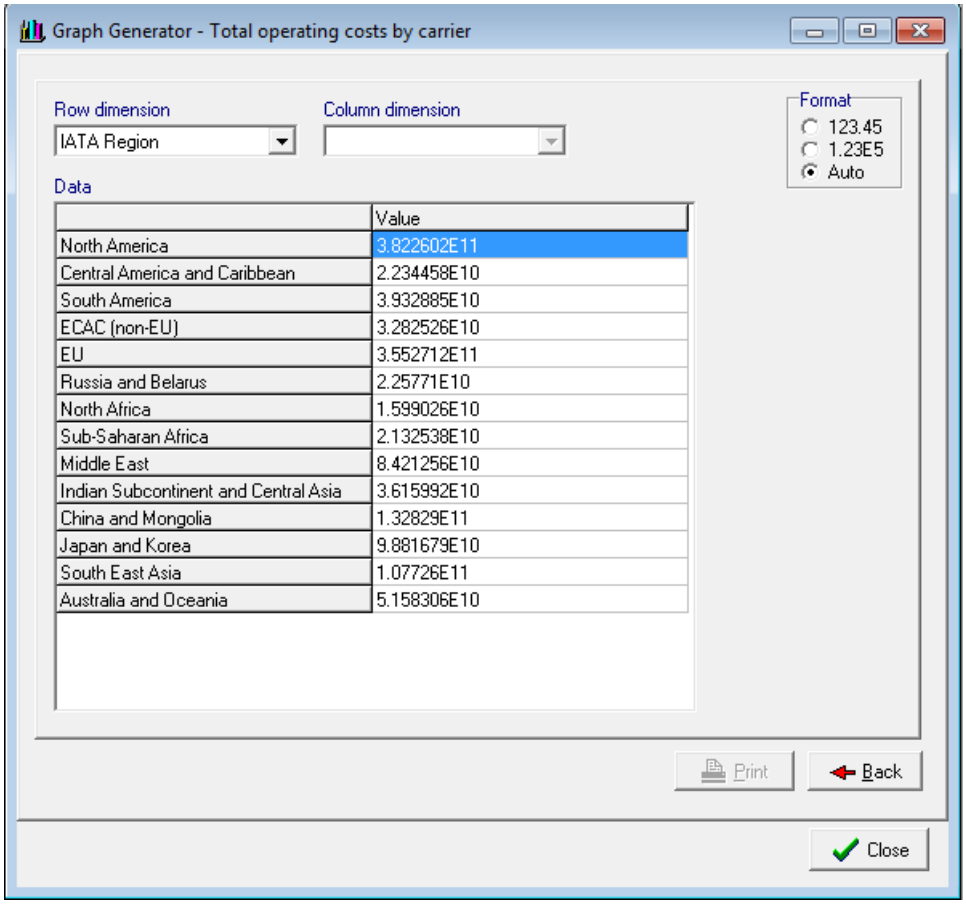


Figure 45 Table

In figure 42, 43, 44 and 45 an example of a pie graph, a column graph, 3D-column graph, table and map graphs are given. The following options are available to edit the layout in the graph generator:

%	Show as percentage;
9	Show as value;
	2D Pie;
	3D Pie;
	Rotate counter-clockwise;
	Rotate clockwise;
.00 .0	Reduce precision;
.0 .00	Increase precision;
	Marks on/off;
	Permute series.

The following buttons are available in these graphs:

Print	To print the graph.
Back	To go back to the previous screen.
Close	To close the Graph Generator.

5.5 Data inspect

The "Data-Inspect' option enables the user to have a more detailed look at the results

Inspect

After pressing the „Data-Inspect" button the user enters the data inspector (see figure 46). In the first screen of the data inspector select one of the databases by clicking its radio button. There are the following options:

- Assumptions (base run database),
- Scenario (datum run database)
- and Policy (forecast run results).

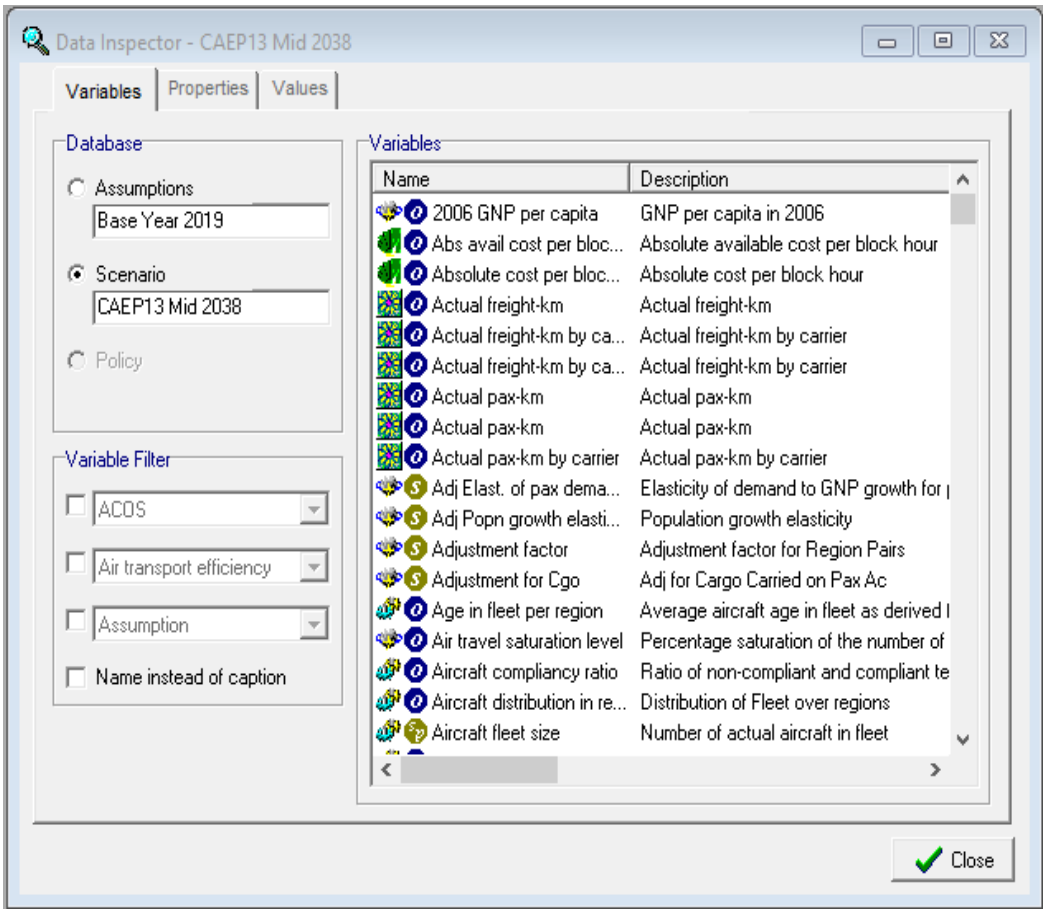


Figure 46 Data inspection

Select the check box in the Variable Filter to show the variables by:

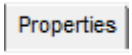
- Model (ACOS, ADEM, ATEC, DECI, FLEM);
- Category (Aircraft characteristics, Cargo demand, Fuel consumption etc.);
- Type(Input, Output, Scenario, Policy etc).

Another option is the „Name instead of caption" check box. With this option the variables are listed by variable ID* instead of variable name (see Appendix C).

A list of the variables is shown at the right side of the wizard. The user can see two icons at the left side, the name and the description of the variable.

At the left side of the variable two icons are shown. The first icon represents a model and the second icon the type of the variable (for example: input, output, update etc.).

After selecting a variable at the right side of the wizard the user can inspect the properties of that variable (see figure 47) and the values of the variable (see figure 48).



As can be seen in figure 47, in the second screen of the data inspector the following properties of a variable are presented:

- Caption;
- Name of variable;
- Description of variable;
- Unit;
- Model;
- Variable type;
- Data type;
- Dimensions;
- Category

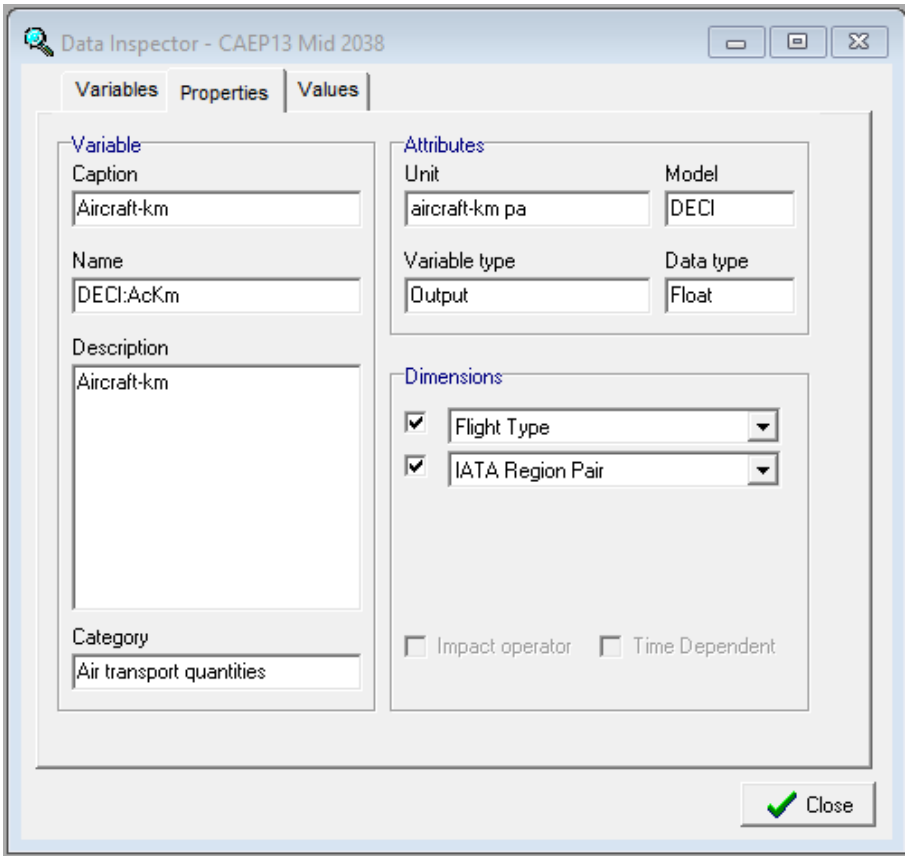


Figure 47 Data inspector, Properties

In the 'properties-screen' of the Data Inspector, it is possible to choose an aggregation of a variable‟s dimension (mapping mechanism). The values for this dimension are then summed to the aggregation dimension, and the resulting data are shown (see Figure 51). In this case the dimension Flight Type is aggregated into the dimension Movement Type and the dimension Region Pair into Interface Region Pair. All variables are then summed for the dimension Movement Type. In the table 5.5.1 some of possible dimension mappings are presented. In the first column is the dimension(s) of the original, disaggregated AERO- MS variable; the dimension used in the aggregated variable is in the second column.

Table 1 Some dimension mappings examples

From dimension(s)	Aggregated dimensions
Flight Type	Load Type
Flight Type	Movement Type
Region Pair	Interface Region Pair
Flight Stage	Region Pair
Flight Stage	Interface Region Pair

Values

By pressing the button 'Values' at the right top end of the DataInspector, the user will actually be able to inspect values (see figure 48). Further the user can change the format of the screen, by selecting a different row- or column-dimensions. Only the dimensions selected in the 'properties-screen' are available.

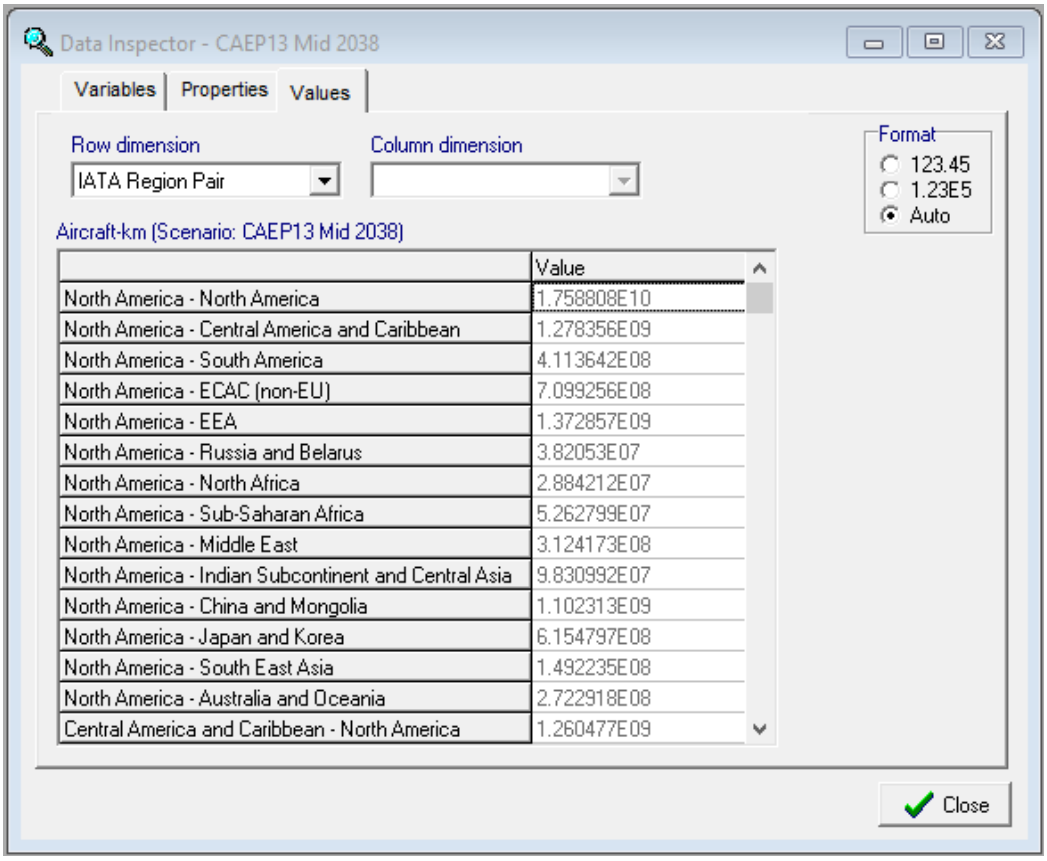


Figure 48 Data inspector, values

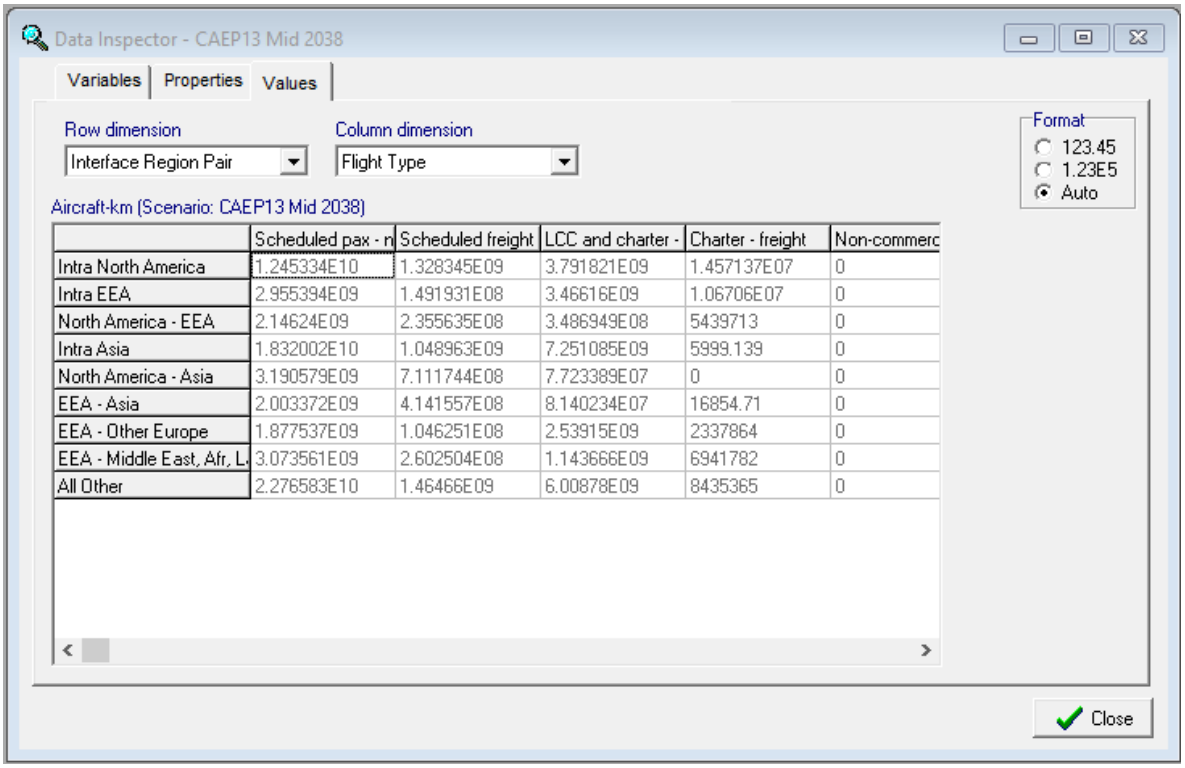


Figure 49 Data Inspector Values after mapping

6. Evaluation of cases

6.1 Main screen evaluation

The evaluation option refers to the comparison of computational results of the various selected cases. Pressing the (highlightened) „Evaluation" -button starts the evaluation.

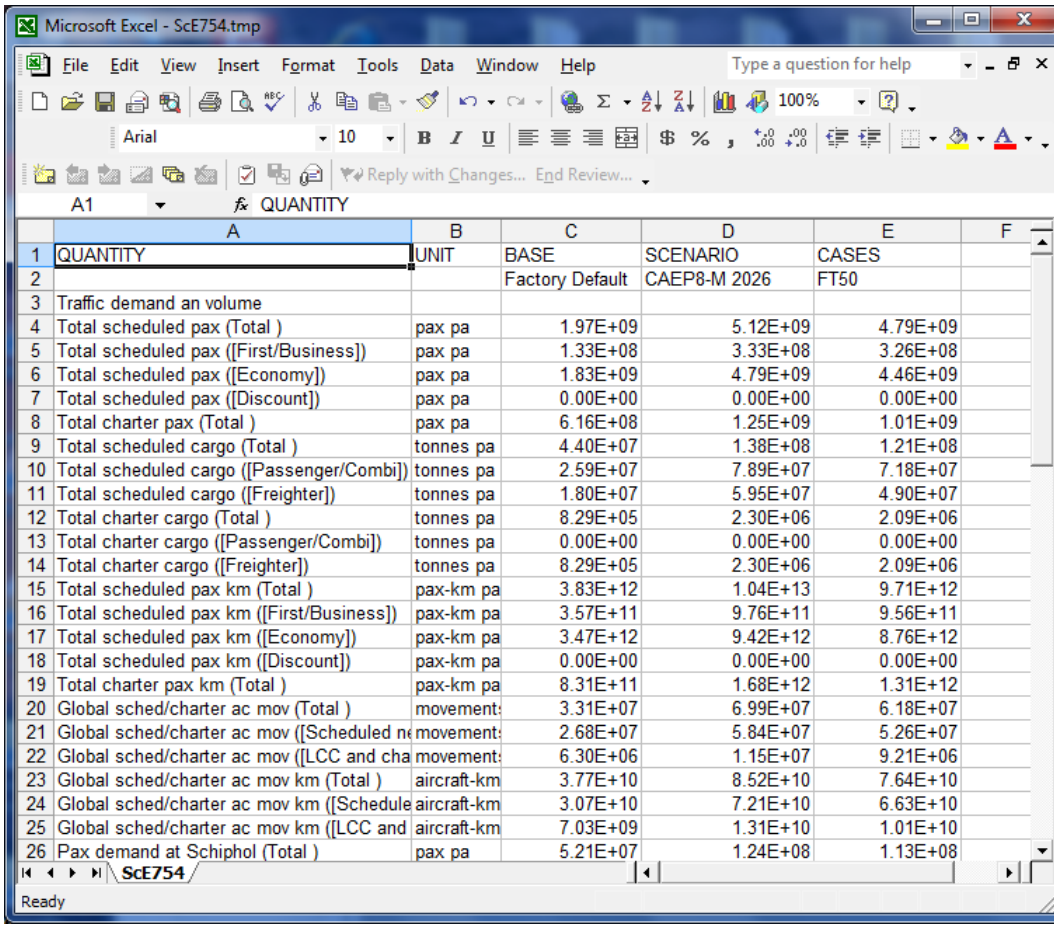
Figure 50 Main screen evaluation

6.2 Scorecards

To produce a scorecard, the user selects the scorecard button. In the present version of AERO-MS one standard scorecard format is available. This “standard” scorecard contains information with respect to:

- Traffic demand and volume;
- Cost and economic information;
- Fuel and emissions aviation

The user can produce a scorecard (for the selected cases) by pressing the 'Scorecard-Show' button. The scorecard will be directly shown to the user. The Standard scorecard goes straight to Excel (see Figure 51).



	A	B	C	D	E	F
1	QUANTITY	UNIT	BASE	SCENARIO	CASES	
2			Factory Default	CAEP8-M 2026	FT50	
3	Traffic demand an volume					
4	Total scheduled pax (Total)	pax pa	1.97E+09	5.12E+09	4.79E+09	
5	Total scheduled pax ([First/Business])	pax pa	1.33E+08	3.33E+08	3.26E+08	
6	Total scheduled pax ([Economy])	pax pa	1.83E+09	4.79E+09	4.46E+09	
7	Total scheduled pax ([Discount])	pax pa	0.00E+00	0.00E+00	0.00E+00	
8	Total charter pax (Total)	pax pa	6.16E+08	1.25E+09	1.01E+09	
9	Total scheduled cargo (Total)	tonnes pa	4.40E+07	1.38E+08	1.21E+08	
10	Total scheduled cargo ([Passenger/Combi])	tonnes pa	2.59E+07	7.89E+07	7.18E+07	
11	Total scheduled cargo ([Freighter])	tonnes pa	1.80E+07	5.95E+07	4.90E+07	
12	Total charter cargo (Total)	tonnes pa	8.29E+05	2.30E+06	2.09E+06	
13	Total charter cargo ([Passenger/Combi])	tonnes pa	0.00E+00	0.00E+00	0.00E+00	
14	Total charter cargo ([Freighter])	tonnes pa	8.29E+05	2.30E+06	2.09E+06	
15	Total scheduled pax km (Total)	pax-km pa	3.83E+12	1.04E+13	9.71E+12	
16	Total scheduled pax km ([First/Business])	pax-km pa	3.57E+11	9.76E+11	9.56E+11	
17	Total scheduled pax km ([Economy])	pax-km pa	3.47E+12	9.42E+12	8.76E+12	
18	Total scheduled pax km ([Discount])	pax-km pa	0.00E+00	0.00E+00	0.00E+00	
19	Total charter pax km (Total)	pax-km pa	8.31E+11	1.68E+12	1.31E+12	
20	Global sched/charter ac mov (Total)	movement	3.31E+07	6.99E+07	6.18E+07	
21	Global sched/charter ac mov ([Scheduled ne	movement	2.68E+07	5.84E+07	5.26E+07	
22	Global sched/charter ac mov ([LCC and cha	movement	6.30E+06	1.15E+07	9.21E+06	
23	Global sched/charter ac mov km (Total)	aircraft-km	3.77E+10	8.52E+10	7.64E+10	
24	Global sched/charter ac mov km ([Schedule	aircraft-km	3.07E+10	7.21E+10	6.63E+10	
25	Global sched/charter ac mov km ([LCC and	aircraft-km	7.03E+09	1.31E+10	1.01E+10	
26	Pax demand at Schiphol (Total)	pax pa	5.21E+07	1.24E+08	1.13E+08	

Figure 51 Standard scorecard

Annex A Unit conventions in AERO-MS

For reasons of internal consistency and clarity to the AERO-MS users it was agreed between all parties involved in the development of AERO-MS to use an unambiguous set of unit conventions. The following general principles underlie these unit conventions:

- The general notion is that the units used are meaningful, clear, complete and consistent.
- The same unit should always be expressed in exactly the same way.
- No capital letters are used to express units, unless the unit represents a given name (such as Newton, Joule, and Watt).
- All volume-related and financial quantities that apply to the annual situation shall be given the addition 'pa' (per annum).
- US$ is generally used as the unit to express monetary values.
- Note that the year 2019 was used as the base year for all cost and price assessments.
- In cases where there is no 'actual' unit, a further indication will be provided in terms of e.g.: proportion, factor, elasticity or index.
- Acronyms will only be used for obvious or frequently occurring situations such as: metre (m), second (s), kilogram (kg), passengers (pax), etc.

This appendix provides an overview of the unit conventions adopted in AERO-MS. Within the list of conventions provided, the following categories, or base types of units were distinguished:

- 'Single' units;
- 'Financial' units;
- Annual quantities;
- Other (composed) units.

'Single' units

percentage	proportion in %
factor	dimensionless growth or scaling factor
proportion	dimensionless proportion
elasticity	relative rate of change, typically between -1 and +1
'-'	no unit or dimensionless constant in formula
index	used for classification identifiers, flags, index numbering, pointers
g	mass unit (gram)
kg	mass unit (kilogram), typically applied for transportation quantities at the flight stage and traffic line dimension
tonnes	mass unit, typically applied for transportation quantities at the region pair dimension and higher
m	metres (unit of length)

km	kilometres (unit of distance)
100 ft	100 feet (unit of flight altitude)
m^2	square metres (unit of surface area)
degrees	degrees latitude/longitude
s	seconds (unit of time)
min	minutes (unit of time)
hours	hours (unit of time)
year	years (unit of time)
years	number of years
rpm	revolutions per minute
1/hour	reciprocal of time unit
1/km	reciprocal of distance unit
1/kg	reciprocate of mass unit
1/kg^2	formula parameter unit
1/kg^3	formula parameter unit
1/kg^4	formula parameter unit
hPa	unit of pressure (hecto Pascal)
mbar	unit of pressure (millibar) (Note: 1 hPa = 1 mbar)
Joule	Joule (unit of energy)
Newton	Newton (unit of force, thrust)
Watt	Watt (unit of power or energy per time unit) Note: 1 Watt = 1 Joule/s
Mach	speed expressed in 'speed of sound' units
employees	unit of labour
persons	unit of population
aircraft	(change of) fleet size, e.g. number of aircraft purchased or scrapped in a given period
pax	number of passengers
carriers	number of carriers (airlines)
stages	number of flight stages
traffic lines	number of traffic lines
sectors	number of sectors
zones	number of zones

Financial' units

US$ pa	US$ per annum
US$/hour	US$ per hour
US$/cycle	US$ per flight cycle
US$/kg	US$ per kg
USc/kg	US$ cent per kg
US$/seat	US$ per seat
US$/km	US$ per km
US$/aircraft	US$ per aircraft

Annual quantities

percentage pa	percentage annual change
hours pa	hours, e.g. block hours or utilisation hours, per annum
kg pa	capacity or transportation quantity in kilograms per annum)
tonnes pa	capacity or transportation quantity in tonnes per annum
seats pa	capacity in seats per annum
aircraft pa	fleet changes, e.g. aircraft purchased or scrapped, per annum
movements pa	transportation quantity in aircraft movements per annum
pax pa	transportation quantity in passengers per annum
aircraft-km pa	transportation quantity in aircraft-km per annum
pax-km pa	transportation quantity in passenger-km per annum
seat-km pa	transportation capacity in
	passenger-km per annum
kg-km pa	transportation quantity or capacity in kilogram-km per annum
tonne-km pa	transportation quantity or capacity in tonne-km per annum
vehicle-km pa	transportation quantity in vehicle-km per annum
factor pa	annual growth/change factor
proportion pa	proportion of annual growth / change

Other (composed) units

m/s	metres per second (unit of speed)
m/s^2	metres per second square (unit of acceleration)

km/hour	kilometres per hour (unit of speed)
kg/s	mass per unit time, e.g. fuel flow
kg/m^2	mass per square metre
kg/km	mass per unit distance
kg/cycle	mass per flight cycle
g/kg	mass per unit mass (emission index)
g/g	mass per unit mass (emission index)
hours/km	hours per unit distance
hours/cycle	(block) hours per flight cycle
pax/aircraft	aircraft occupancy rate
seats/aircraft	aircraft capacity (passengers)
kg/aircraft	aircraft load or capacity (freight)
kg-km	transportation quantity or capacity in kilogram-km
tonne-km	transportation quantity or capacity in tonne-km
kg/pax-km	mass per transportation quantity (emission index)
utility units	unit of spread parameter
utility units/hour	unit of spread parameter
utility units/US$	unit of spread parameter
various	to be applied in case of different units for different elements of the same variable

Additional remarks:

- In some cases, constants in formulas may have more or less complicated and not always meaningful units. If this occurs, appropriate units will be used in line with the above conventions. In this respect, the list of conventions provided in this appendix may not be exhaustive.
- There is no formal convention for using thousands or millions of 'single' units. In general, such units are not often used, but it may occur that 'thousand' or 'million' as a prefix to certain single units (e.g. 'thousand US$' or 'million pax'). The common way to express larger numbers is to use single units in scientific notation (adding the exponent of 10 to the number).

Annex B Overview of dimensions used in AERO-MS

In AERO-MS, in the specification of variable arrays, great many dimensions are used. The present appendix provides an overview and specification of the most common dimensions in use. In addition, a number of dimensions appear in AERO-MS that are very specific for the individual models. The latter types of dimensions are merely listed in this appendix but not further explained. For a full comprehension of the modelling details, reference is made to the system documentation of the individual models.

The more or less 'common' dimensions and the more specific dimensions (the latter by model) are listed below in alphabetical order. For the 'common' dimensions, a standard two-letter abbreviation is proposed. This does not imply that these indices necessarily have been used in the technical model descriptions.

More or less 'common' dimensions

Aircraft Purpose	Aircraft Purpose (ap): 2 purposes, as follows: 0 passenger/combi; 1 freighter.
Aircraft Seatband	Aircraft Seatband (ab): 7 seat bands used for frequency size allocation of aircraft to flight stages: 0 < 20; 1 20 - 100; 2 101 - 150 3 151 - 235; 4 236 - 300; 5 301 - 500; 6 > 500.
Aircraft Type	Aircraft Type (at): 10 types, by seat and range classification: 0 Short haul, less than 20 seats 1 Short haul, 20 to 50 seats 2 Short haul, 51 to 70 seats 3 Short haul, 71 to 100 seats 4 Medium haul, 101 to 150 seats 5 Medium haul, 151 to 175 seats 6 Medium haul, 176 to 235 seats 7 Long haul, 236 to 300 seats 8 Long haul, 301 to 500 seats 9 Long haul, more than 500 seats
Carrier Area	Carrier Area (ca): 4 carrier areas, as follows: 0 EU; 1 origin region; 2 destination region;
Certification Year	Certification Year (cy): year of certification of aircraft: 200 values

Class	Class (cl): 3 passenger (fare) classes: 0 first/business; 1 economy; 2 discount.
CPB Region	CPB Region (cr): For overview of elements: see IATA region
Compliancy Type	Compliancy Type (ct): 2 types of compliancy to certification measures: 0 compliant; 1 non-compliant.
Country	Country (co): 245 countries for airports (also origin/destination country).
Distance Band	Distance Band (db): 6 distance bands used for frequency size allocation of aircraft to stages: 0 < 250 km; 1 250-500 km; 2 500-1000 km; 3 1000-2500 km; 4 2500-4500 km; 5 > 4500 km
Emission	Emission (em): FLEM substances considered in emission computation: 0 H_2O 1 CO_2 2 SO_2 3 C_xH_y 4 CO 5 NO_x 6 PM
Fleet Mix Dim	Fleet Mix Dim (fm): 3 hierarchy levels for fleet mix model: 0 Range; 1 Aircraft Type; 2 Technology.
FLEM Altitudecells	FLEM Altitudecells (fa): 15 equidistant layers (1 km) in vertical direction.
FLEM Latitudecells	FLEM Latitudecells (fl): 36 cells in latitude direction of 5° latitude grid size.
FLEM Longitudecells	FLEM Longitudecells (fo): 72 cells in longitude direction of 5° longitude grid size.
Flight Stage	Flight Stage (fs): 123.026 flight stages based on airport pairs
Flight Type	Flight Type (ft): 5 flight types as follows: 0 Scheduled pax - network carriers 1 Scheduled freight 2 LCC and charter – pax 3 Charter – freight

	4 Non-commercial
IATA Region Pair	IATA Region Pair (rp): 196 IATA region pairs. In the numbering system for IATA region pairs, the origin region is first kept constant. Hence: region pair 0 is intra North America (region 0); region pair 13 is North America (region 0) to Australia and Oceania (region 13); region pair 14 is Central America and Caribbean (region 1) to North America (region 0); region pair 195 is intra Australia and Oceania (region 13).
IATA Route Group	IATA Route Group (rg): 17 (aggregated) IATA route groups, as follows: 0 Between North America and Central America/Caribbean 1 Between and within Central America and the Caribbean 2 Between Canada, Mexico and the United States 3 Between North America/Central America/Caribbean and South America 4 Local South America 5 Local Europe 6 Local Middle East 7 Local Africa 8 Between Europe and Middle East 9 Between Europe/Middle East and Africa 10 North Atlantic 11 Mid-Atlantic 12 South Atlantic 13 Local Asia/Pacific 14 Between Europe/Middle East/Africa and Asia/Pacific 15 North and Mid-Pacific 16 South Pacific
Immission	Immission (im): FLEM substances considered in immission computation (after 'plume' transformation): 0 H_2O 1 CO_2 2 SO_2 3 C_xH_y 4 CO 5 NO_x 6 PM
Impact Operator	Impact Operator (io): two types of operators used in AERO-MS to manipulate user variables: 0 multiplicative; 1 additive.
IATA Region Pair	IATA Region Pair (rp): 196 IATA region pairs. In the numbering system for IATA region pairs, the origin region is first kept constant. Hence: region pair 0 is intra

	North America (region 0); region pair 13 is North America (region 0) to Australia and Oceania (region 13); region pair 14 is Central America and Caribbean (region 1) to North America (region 0); region pair 195 is intra Australia and Oceania (region 13).
IATA Route Group	IATA Route Group (rg): 17 (aggregated) IATA route groups, as follows: 0 Between North America and Central America/Caribbean 1 Between and within Central America and the Caribbean 2 Between Canada, Mexico and the United States 3 Between North America/Central America/Caribbean and South America 4 Local South America 5 Local Europe 6 Local Middle East 7 Local Africa 8 Between Europe and Middle East 9 Between Europe/Middle East and Africa 10 North Atlantic 11 Mid-Atlantic 12 South Atlantic 13 Local Asia/Pacific 14 Between Europe/Middle East/Africa and Asia/Pacific 15 North and Mid-Pacific 16 South Pacific
Immission	Immission (im): FLEM substances considered in immission computation (after 'plume' transformation): 0 H_2O 1 CO_2 2 SO_2 3 C_xH_y 4 CO 5 NO_x 6 PM
Impact Operator	Impact Operator (io): two types of operators used in AERO-MS to manipulate user variables: 0 multiplicative; 1 additive.
Interface Region Pairs	Interface Region Pairs (ip): 9 aggregated IATA region pairs (for output generation), as follows: 0 Intra North America; 1 Intra EU;

	2 North America - EU; 3 Intra Asia; 4 North America - Asia; 5 EU - Asia; 6 EU - Other Europe; 7 EU - Middle East, Africa, Latin America, Oceania; 8 All other.
Mode	Mode (me): 4 transportation modes, as follows: 0 high speed rail; 1 rail; 2 air; 3 car.
Movement Type	Movement Type (mt): 2 types of aircraft movement: 0 Scheduled network carrier operations 1 LCC and charter operations
Passenger Purpose	Passenger Purpose (pp): 2 passenger purposes: 0 business; 1 leisure.
Purchase Year	Purchase Year (py): aircraft age relative to year currently considered (200).
Technology Factor	Technology Factor (tf): 7 technology factors associated with fuel use and emissions: • fuel • H2O • CO2 • SO2 • CxHy • CO • NOx • PM
Technology Level	Technology Level (tl): 2 technology levels used to classify aircraft: 0 old; 1 current
Thrust	Thrust (th): 4 engine power levels as a percentage of maximum engine thrust: 0 7% 1 30% 2 85% 3 100%
Traffic	Traffic (tr): 153.134 traffic lines.

Value	Value (single value, no dimension).
Year	Year (yr): number of years in which time dependent variables may be specified (10).
Zone	Zone (zo): 6104 airports, (also departure and arriving airport).

B.1 More specific dimensions

The following, more specific dimensions used in AERO-MS are merely listed by model. Between parenthesis, the size of the dimension is indicated.

ACOS/ADEM:	ACOS Summary Outputs (4) Country Attributes (3) Density Band (9) Density Limit (11) Distance Limit (8) Length of Haul (3) Route Choice (4) Stage Density (9) Time Constants (5) Transfer Route (3) Travel Route (2)
FLEM:	Cell Coordinate (3) ClAlphaConstants (4) ClCdConstants (4) Engine Power (2) Flight Profile (60) Fuel Constants (6) Height (11) Height Dep Variables (2) Height Segment (2) Mach Dep Variables (6) Mach Number (15) Military Grid Cell (5000) Military Region (32) Military Time Frame (2) Power Setting (20) Table Thrust (15) Thrust Dep Variables (2) Weight (20)

	Weight Dep Variables (2) Weight Step (26)

Annex C Overview of assumption, scenario and policy variables in AERO-MS

Table 2 Assumption-variables in AERO-MS

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
Schematization parameters					
Cell_Altitude_Size	Cell altitude size	Size of the grid cells in altitude direction	m	Value	FLEM
Cell_Latitude_Size	Cell latitude size	Size of the grid cells in latitude direction	degrees	Value	FLEM
Cell-Longitude-Size	Cell longitude size	Size of the grid cells in longitude direction	degrees	Value	FLEM
Cell_Max_Altitude	Cell maximum altitude	Maximum altitude grid coordinate	m	Value	FLEM
Cell_Max_Latitude	Cell maximum latitude	Maximum latitude grid coordinate	degrees	Value	FLEM
Cell_Max_Longitude	Cell maximum longitude	Maximum longitude grid coordinate	degrees	Value	FLEM
Cell_Min_Altitude	Cell minimum altitude	Minimum altitude grid coordinate	m	Value	FLEM
Cell_Min_Latitude	Cell minimum latitude	Minimum latitude grid coordinate	degrees	Value	FLEM
Cell_Min_Longitude	Cell minimum longitude	Minimum longitude grid coordinate	degrees	Value	FLEM
DetourinFlight	Detour in flight	Apply detour factor to flight phases that are enabled for detour	-	Major Flight Phase	FLEM
MaxSalesGrowth	Maximum annual sales growth	Maximum annual sales growth	proportion pa	Aircraft Type, Aircraft Purpose	ATEC
MaxSteppedClimb	Maximum steps in climb	Maximum number of steps to reach cruise flight levels	-	Value	FLEM
RubberisingTolerance	Rubberising tolerance	Tolerance for finding aircraft rubberising factor on flight requirement	factor	Value	FLEM
Stepsize	Flight phase step size	Distance step of the profile segments in the various flight phases	m	Phase	FLEM
Economic system parameters					
AcDeprRate	Aircraft depreciation rate	Real annual aircraft depreciation rate	proportion	Aircraft Type	ACOS

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
AircraftDemandElast	Aircraft demand elasticity	Elasticity of demand for aircraft with respect to capital cost	elasticity	Aircraft Type	ACOS
AveCapElasticity	Capacity elast for NLA	Elasticity of change in supply with respect to change in demand as a control for the introduction of New Large Aircraft	elasticity	IATA Region Pair	ADEM
CapCostSupplyElast	Capital cost supply elasticity	Elasticity of outcome (supply/demand equilibrium) quantity of aircraft to capital cost	elasticity	Aircraft Type, Aircraft Purpose	ACOS
CgoCostElast	Cargo cost elast	Elasticity of cargo demand to change in freight rate	elasticity	IATA Region Pair	ADEM
CgoGNPElast	Cargo GNP elasticity	Elasticity of demand to GNP growth for cargo	elasticity	Value	ADEM
CharterPaxFareElast	Elast of charter demand to fare	Elasticity of charter demand to fare	elasticity	Value	ADEM
DiscountRate	Discount rate	Discount rate used in calculation of capital costs	proportion	Value	ACOS
FleetMixBetas	Fleet mix betas	Spread parameters for flight mix hierarchical logic model	utility units/199US$	Flight Type, Fleet Mix Dim	ACOS
FreqElast	Elast of flight freq wart demand	Elasticity of increase in flight frequency to increase in demand	elasticity	Distance Band, Aircraft Purpose	ADEM
PaxFareElast	Pax fare elast by purpose	Passenger fare elasticity by purpose	elasticity	IATA Region Pair, Passenger Purpose	ADEM
PaxGNPElast	Elast of pax demand wart GNP	Elasticity of demand to GNP growth for passengers	elasticity	Passenger Purpose	ADEM
PaxServeElast	Elast of direct travel to demand	Elasticity of the proportion of passengers seeking to travel direct wart demand growth	elasticity	Value	ADEM
PopElast	Popn growth elasticity	Population growth elasticity	elasticity	Value	ADEM
PurposeFarePerKm	Avg fare per km by purpose	Average fare per kilometre paid by passengers by purpose and mode	US$/km	Passenger purpose, Mode	ADEM
OpPropCapital	OpPropCapital	Proportion of Capital Costs Attributed to Aircraft Operations	proportion	Value	ACOS

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
OpPropCrew	OpPropCrew	Proportion of Crew Costs Attributed to Aircraft Operations	proportion	Value	ACOS
OpPropFuelCons	OpPropFuelCons	Proportion of Fuel Costs Attributed to Aircraft Operation	proportion	Value	ACOS
OpPropMaintenance	OpPropMaintenance	Proportion of Maintenance Costs Attributed to Aircraft Operations	proportion	Value	ACOS
OpPropRouteLanding	OpPropRouteLanding	Proportion of Route and Landing Costs Attributed to Aircraft Operations	proportion	Value	ACOS
SupplyElast	Elasticity of supply wart demand	Elasticity of supply with respect to demand which is used to ensure cost changes are correctly translated into fare changes	elasticity	Aircraft Purpose	ADEM
YearlyAcDeprRate	Yearly Ac depreciation rate	Yearly real annual aircraft depreciation rate		Aircraft Type, Year Band	ACOS
TimeValue	Value of time for purpose	Value of time for purpose	US$/hour	Passenger Purpose	ADEM
Technical system parameters					
CapacityConst	Const of flight capty wrt demand	Constant for estimating flight capacity from demand	constant	Distance Band, Aircraft Purpose	ADEM
CapacityElast	Elast of flight capty wrt demand	Elasticity of increase in flight capacity to increase in demand	elasticity	Distance Band, Aircraft Purpose	
CapacityElastControl	Control Datum capacity adjust	Control for the increase in flight capacity related to increase in demand	elasticity	IATA Region Pair, Aircraft Purpose	ADEM
CargoRealisedShare	Realised share of cargo by truck	Realised market share of cargo demand transported by truck mode	proportion	Value	ADEM
CargoThreshold	Cargo threshold for new lines	Level of demand at which new freighter traffic lines are introduced when demand exceeds capacity which is available in belly hold of passenger aircraft	kg pa	Value	ADEM
CarOccupanceRate	Avg. car occupancy rate	Number of passengers per car, by purpose	pax/car	Passenger Purpose	ADEM
Cruisingspeed	Cruising speed	Average speed for the entire journey,	km/hour	Mode	ADEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
		used in the surface competition model to calculate the variable journey time component by mode			
CurrentIntroduction	Current aircraft introduction	Time period science first current aircraft sold - from year of first production to scenario year	years	Aircraft Type, Aircraft Purpose	ATEC
DefaultLoadFactor	Default load factor	Default load factor for each movement type	proportion	Demand Type	ADEM
Earth_Radius	Mean earth radius	Mean earth radius	km	Value	FLEM
Emis_Immis_Matrix	Emission to immission matrix	Matrix that reproduces the transition of emissions to immissions	-	Emission, Immission	FLEM
FixedPerJourneyTime	Fixed time per journey	Fixed time component of each journey used in the surface competition model	hours	Mode	ADEM
MaxBellyHoldLoadFactor	Max belly hold load factor	Maximum value to which belly hold load factors may be raised before introducing new freighter-only traffic lines	proportion	Value	ADEM
MaxNewStageRange	Max range limit for new stages	Maximum allowable distance for the creation of new fight stages and traffic lines	km	Value	ADEM
OffCruiseFuelFactor	Off-cruise fuel flow corr factor	Off-cruise fuel flow correction factor	factor	Value	FLEM
PurtoClass	Purpose to class mapping	Variable to allow mapping between passenger purpose to class	percentage	Passenger Purpose, Class	ADEM
PurposeFarePerKm	Avge fare per km by purpose	Average fare per km paid by passengers by purpose and mode	US$/km	Passenger purpose, Mode	ADEM
RealisedShare	Realised share of air, rail, car	Realised share of travel by all models	proportion	Passenger purpose	ADEM
RecentOldIntroduction	Recent-old aircraft introduction	Time period since first recent-old aircraft were sold: from year of first production to scenario year	years	Aircraft Type, Aircraft Purpose	ATEC
RelHumidity	Relative humidity	Relative humidity	factor	Value	FLEM
Repr_EmissionFactor	Representative emission factor	Factor on emission index to make specific aircraft type representative for all aircraft with the aircraft class	factor	Aircraft Type, Technology Level, Thrust, Emission	FLEM
Repr_FuelUseFactor	Representative fuel use factor	Factor on fuel flow to make specific aircraft type representative for all	factor	Aircraft Type, Thrust,	FLEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
		aircraft within the aircraft class			
Repr_TimeUseFactor	Representative time use factor	Factor on flight time to make specific aircraft type representative for all aircraft within the aircraft class	factor	Aircraft Type, Technology Level	FLEM
ScrapAge	Aircraft scrapage	Time period of aircraft in served - lifetime of aircraft	years	Aircraft Type, Aircraft Purpose	ATEC
SurfaceAlphaCar	Car mode constant wart other modes	Mode-specific constant for car mode for purpose	utility units	Passenger Purpose	ADEM
SurfaceAlphaHSL	HSL mode constant wart other rail	Mode-specific constant for HSL mode with respect to rail	utility units	Passenger Purpose	ADEM
SurfaceAlphaRail	Rail mode constant wart air	Mode-specific constant for rail mode with respect to air travel	utility units	Passenger Purpose	ADEM
SurfaceAlphaTruck	Mode constant of truck vs air	Mode-specific constant for truck versus air travel in cargo surface competition	utility units	Value	ADEM
SurfaceBetaOne	Spread parameter for car vs other	Spread parameter for mode choice between car and other modes for surface competition	utility units/hour	Passenger Purpose	ADEM
SurfaceBetaThree	Spread parameter for HSL vs rail	Spread parameter for choice between rail and HSL for surface competition	utility units/hour	Passenger Purpose	ADEM
SurfaceBetaTwo	Spread parameter for air vs other	Spread parameter for choice between air mode and rail modes for surface competition	utility units/hour	Passenger Purpose	ADEM
SurfaceBetaZero	Spread parameter for realised travel	Spread parameter for realised market share for travel in surface competition model	utility units/hour	Passenger Purpose	ADEM
TechnPenetr	Technology penetration	Number of years between first introduction of technology and moment all aircraft in fleet are equipped with technology	years	Aircraft Type, Aircraft Purpose	ATEC
TripRateSat	Air travel saturation level	Proportional saturation of the number of trips expected to be made by air (potential damping effect on economic based air travel growth)	percentage pa	Value	ADEM
TimeValue	Value of time for purpose	Value of time for purpose	US$/hour	Passenger Purpose	ADEM
TruckPayload	Average truckpayload	Average number of tonnes of cargo per truck	kg/Truck	Value	ADEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
TruckSurfaceBetaOne	Spread parameter for truck vs air	Spread parameter for the choice between truck and air in surface competition model	utility units/hour	Value	ADEM
TruckSurfaceBetaZero	Spread parameter for cargo market	Spread parameter used to determine realised cargo market in surface competition	utility units/hour	Value	ADEM
Other					
AvgPaxWeight	Average weight pax + baggage	Average weight of one passenger plus baggage	kg	Value	DECI
BlockHoursWorked	Annual block hours worked	Annual number of block hours worked by flight crew and cabin crew staff	hours pa	IATA Region	DECI
MaintLabCostFactor	Prop labour costs in maintenance	Proportion of labour costs in total maintenance costs	proportion	IATA Region pair	DECI
NSPaxRevFactor	Revenue adjustment factor NSpax	Factor to adjust airline revenue computation from non-scheduled pax fares	factor	Value	DECI
SPaxRevFactor	Revenue adjustment factor Spax	Factor to adjust airline revenue computation for scheduled pax fares	factor	Value	DECI
Min_Moves	Minimum moves	Minimum number of annual movements required for processing	movements pa	Value	FLEM
FormatID	Report/scorecard format	Format selector for standard report and scorecard generation	-	Single Value	AERO
SelectAcType	Selected aircraft type	Aircraft type selected for procession unified traffic	index	Value	FLEM
SelectAvType	Selected aviation type	Aviation type selected for processing unified traffic	index	Value	FLEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
SelectCityLTO	Selected cities for LTO results	List of cities selected for the city LTO map	index	City List	FLEM
SelectRegionPairs	Selected region pairs	List of region pairs selected for processing unified traffic	index	IATA Region Pair	FLEM
SelectTrafficLines	Selected traffic lines	List of traffic lines selected for processing unified traffic	index	Traffic List	FLEM
YearRange	Year in development range	Year of certification. Years for which the aircraft technology development is specified. Year range is applied for both FuelUseFactorChgFunc and EmissionFactorChgFunc	year	Year	ATEC

* In the technical documentation of the individual models the variable ID is called 'variable name'.

** In the technical documentation of the individual models the variable name is called 'caption'.

Table 3 Scenario-variables in AERO-MS

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
Demographic Development (DEM)					
CPBPopGrowth	CPB annual popn growth rate	Annual population growth by CPB region	Percentage pa	CPB Region	ADEM
Macro-economic Development (MED)					
CrudeOilPrice	Crude oil price	Crude oil price per IATA (AERO-MS) region	US$/kg	IATA Region	ACOS
InterestRateRegion	Finance charge interest rate	Real interest rate used in calculation of finance charges	Proportion	IATA Region	ACOS
CgoAutoGrowth	Autonomous cargo growth	Autonomous growth in cargo demand	Percentage pa	IATA Region	ADEM
ChPaxFare	Charter pax fare	Charter passenger fare on each flight stage	US$/pax	Flight Stage	ADEM
CPBExpGrowth	CPB annual export growth rate	Per capita annual export growth by CPB region	Percentage pa	CPB Region	ADEM
CPBGNPGrowth	CPB annual GNP growth rate	Per capita annual GNP growth by CPB region	Percentage pa	CPB Region	ADEM
FreightRate	Cargo freight rate	Freight rate per kg on each flight stage	USc/kg	Flight Stage, IATA Region Pair, Interface Region Pair	ADEM
GenAveGrowth	General aviation growth	Growth in general aviation movements	Percentage pa	IATA Region Pair, Interface Region Pair	ADEM
PaxAutoGrowth	Autonomous pax growth	Autonomous growth in passenger demand	Percentage pa	IATA Region, Passenger Purpose	ADEM
PaxFare	Scheduled pax fare	Passenger fare per seat on each flight stage	US$/seat	Flight Stage, Class, Interface Region Pair, IATA Region Pair	ADEM
Military Development (MID)					
MilTrafficFactor	Military traffic factor	Factor on traffic volume in region	Factor	Military Region	FLEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
Technological Development (TED)					
CabinCrewNeeded	Cabin crew needed	Cabin crew needed	Employees	Aircraft Type, Technology Level, Aircraft Purpose, IATA Region	ACOS
FlightCrewNeeded	Flight crew needed	Flight crew needed	Employees	Aircraft Type, Technology Level	ACOS
MaintHoursPerCycle	Maintenance hours per cycle	Maintenance hours per cycle	Hours/cycle	Aircraft Type, Technology Level	ACOS
MaintHoursPerFlHour	Maintenance hrs per flight hr	Hours of maintenance per block hour	Hours/hour	Aircraft Type, Technology Level	ACOS
MaintOhead	Maintenance overhead	Maintenance burden or engineering overhead per aircraft class as a proportion of direct maintenance costs	Proportion	Aircraft Type, Technology Level	ACOS
EmissionFactorChgFunc	Emission factor change function	Emission change over time (function of certification year). Growth relative to previous certification year	Proportion pa	Aircraft Type, Emission, Year	ATEC
FuelUseFactorChgFunc	Fuel use factor change function	Fuel use change over time (function of certification year). Growth relative to previous certification year	Proportion pa	Aircraft Type, Year	ATEC
IncAcPrice	Increase aircraft price	Increase in annual new aircraft price known from base data	proportion pa	Aircraft Type	ATEC
Scenario Year (SCY)					
ScenarioYear	Scenario year	Scenario year	Year	Value	ADEM
Transport Market Development (TMD)					
AcUtil	Annual aircraft utilisation	Average annual aircraft utilisation	Hours pa	Aircraft Type, Aircraft Purpose, Technology Level	ACOS
CabinCrewSal	Cabin crew salary	Cabin crew salaries, subsistence and bonuses per flight hour	US$/hour	IATA Region	ACOS

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
FlightCrewSal	Flight crew salary	Flight crew salaries, subsistence and bonuses per flight hour	US$/hour	IATA Region	ACOS
LandingCharges	Landing charges	Landing charges	US$/cycle	Aircraft Type, Technology Level, IATA Region	ACOS
LandingSlotCosts	Landing slot costs	Landing slot costs	US$/cycle	Aircraft Type, IATA Region	ACOS
MaintCostPerHour	Maintenance costs per maint. hr	Maintenance costs per hour of maintenance	US$/hour	Aircraft Type, Technology Level, IATA Region	ACOS
RouteCharges	Route charges	En route navigation charges per kilometre	US$/km	Aircraft Type, Technology Level, IATA Region Pair, Interface Region Pair	ACOS
RouteSlotCosts	Route slot costs	Route slot costs	US$/cycle	Aircraft Type, IATA Region Pair, Interface Region Pair	ACOS
AMSTargetDemand	Amsterdam demand target	Amsterdam demand target	Various	Load Type, Movement Type	ADEM
AmsterdamTransfer	Amsterdam transfer proportion	Amsterdam transfer proportion	Proportion	Value	ADEM
CarrierAdjust	Carrier adjustment factor	Carrier adjustment factor for region Pairs	Proportion	IATA Region, IATA Region Pair, Interface Region Pair	ADEM
PaxAcCargoAdj	Adjustment for Cgo	Adj for Cargo Carried on Pax Ac	Proportion	Aircraft Type	ADEM
ProfitAdjustFactor	Factor to adjust profitability	Factor to determine what proportion of a cost increase is passed on to passenger fares and cargo freight rates	Proportion	IATA Region Pair, Interface Region Pair	ADEM
SurfaceCompLevel	User defined surface comp level	User defined level of surface competition	Index	Value	ADEM
AverageScrapAge	Aircraft scrap age	Average lifetime of aircraft	years	Aircraft Type, Aircraft Purpose	ATEC

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
AvgAircraftAgeChange	Average age change	Change in average aircraft age reflecting regional developments or measures.	years	IATA Region, Aircraft Type, Aircraft Purpose	ATEC
FleetSize	Aircraft fleet size	Number of aircraft in fleet	Aircraft	Aircraft Type, Aircraft Purpose, Technology Level	ATEC
RetirementFunc	Aircraft scrap function	Proportion of aircraft in service as function of life span (RetirementPeriod)	proportion pa	ScrapFuncValues	ATEC
RetirementPeriod	Life span in scrap function	Life span proportion of maximum scrap age. A sequence of values for which aircraft scrap is specified (RetirementFunc)	proportion	ScrapFuncValues	ATEC
DetourFactor	Detour factor	Distance change factor for IATA Region Pair and Aircraft Type	Factor	Aircraft Type, IATA Region Pair, Interface Region Pair	FLEM
Other (OTH)					
NLAAvailable	Flag allowing existence of NLAs	Flag to switch on mechanism to allow the introduction of New Large Aircraft in the model	Index	Value	ADEM
AcEmisRefChange	Reference emission factor change	Reference emission factor change (default for base year derived from EmissionFactorFunc)	factor	Aircraft Type, Emission	ATEC
AcFuelRefChange	Reference fuel use factor change	Reference emission factor change (default for base year derived from FuelUseFactorFunc)	factor	Aircraft Type	ATEC
DatumIteration	Iterative datum variables	Selected variables for datum run iteration	-	Datum Iteration Varibles	AERO
FreqElast	Elast of flight freq wrt demand	Elasticity of increase in flight frequency to increase in demand	elasticity	Distance Band, Aircraft Purpose	ADEM

Variable ID*	Variable name**	Description	Unit	Dimensions	Model
VolCostScenFacRP	VolCostScenFacRP	-	-	IATA Region Pair, Interface Region Pair	DECI
AveFreighterCap	Avge freighter capacity	Average capacity for freighter aircraft	kg/aircraft	Aircraft Type	ADEM
AveSeats	Avge number of seats	Average number of seats for each aircraft type	-	Aircraft Type	ADEM

* In the technical documentation of the individual models the variable ID is called 'variable name'.
** In the technical documentation of the individual models the variable name is called 'caption'.

Table 4 Policy-variables in AERO-MS

Financial policies (FIP)					
CgoDemandTaxation	Tax/levy per kg of cargo	Tax per kg of cargo carried charged to airlines	US$/kg	IATA Region Pair, Interface Region Pair	ADEM
DepthVintAffect	Vintage depth of ac affected	Depth of vintage of the aircraft type certification year versions affected by sales shift due to a measure	Years	Aircraft Type, Aircraft Purpose	ATEC
DomesticFuelPrice	Domestic Fuel Price by flight stage	Domestic Fuel price in US$ per kilogramme per flight stage	US$/kg	Flight Stage	ACOS
FareChangeFactor	Fare change factor	Factor to override fare change output from C2F mechanism	factor	-	ADEM
FuelPriceRegion	Fuel price per region	Fuel price per IATA (AERO-MS) region	US$/kg	IATA Region	ACOS
FuelTaxFS	Fuel tax by flight stage	Fuel tax by flight stage	US$/kg	Flight Stage	ACOS
FuelTaxRP	Fuel tax for region pairs	Fuel tax applied directly to region pairs	US$/kg	IATA Region Pair	ACOS
IntFuelPriceFS	International Fuel Price by flight stage	International Fuel price in US$ per kilogramme per flight stage	US$/kg		

MultCgoDemandTaxation	% levy per kg of cargo	Percentage tax per kg of cargo carried charged to airlines	percent	IATA Region Pair	ADEM
MultPaxDemandTaxation	% levy per pax	Percentage tax per passenger carried charged to airlines	percent	IATA Region Pair	ADEM
PaxDemandTaxation	Tax/levy per pax seat	Tax per passenger carried charged to airlines	US$/seat	IATA Region Pair, Interface Region Pair, Class	ADEM
RegainShare	Regain share	Proportion of potentially lost market share to be regained by reducing purchase prices of non-eligible aircraft	Proportion	Aircraft Type, Aircraft Purpose	ATEC
SubsidElastic	Subsidy elasticity	Airline response to subsidy elasticity	Elasticity	Aircraft Type, Aircraft Purpose	ATEC
SubsidProp	Subsidy proportion	Subsidy as a proportion of the non subsidised purchase price	Proportion	Aircraft Type	ATEC
Regulation policies (REP)					
CertScrap	Technology scrap	Age of technology at which aircraft are scrapped. Aircraft from older certification years are removed from the fleet	years	Aircraft Type, Aircraft Purpose	ATEC
EmissionStringency	Emission stringency	Stringency level on emission factor - part of the certification measure	Factor	Aircraft Type, Emission	ATEC
FstateEmissionStrin	Final emission stringency	Stabilized stringency level on emission factor after stringency lead time	factor	Aircraft Type, Emission	ATEC
FstateFuelUseStrin	Final fuel use stringency	Stabilized stringency level on fuel use	factor	Aircraft Type	ATEC
FuelUseStringency	Fuel use stringency	Stringency level on fuel use - part of the certification measure	Factor	Aircraft Type	ATEC

NonOperationRP	Non operation policy	Proportion of old aircraft banned from use	Proportion	Aircraft Type, Aircraft Purpose, IATA Region Pair, Interface Region Pair	ACOS
Purchase Scrap	Purchase scrap	Age of purchase for which aircraft are scrapped. Aircraft sold in years before are removed from the fleet	years	Aircraft Type, Aircraft Purpose	ATEC
ResidualScrapFactor	Residual Scrap value to 0	Varies Residual Scrap Value between default and 0	-	Aircraft Type	ACOS
ScrapFlag	Flag 0 for Scrapping	Flag indicating scrapping	-	-	ACOS
StringencyLeadTime	Stringency lead time	Period following measure year leading to stabilized stringency -- part of stringency measure (AKA response period)	years	Aircraft Type	ATEC
Technical/operational policies (TOP)					
AcPriceEmissionRate	Price-emission rate of change	Rate of change between new aircraft price and change in emission factors (relative to the emission factor change in base year)	factor	Aircraft Type, Emission	ATEC
AcPriceFuelUseRate	Price-fuel rate of change	Rate of change between new aircraft price and change in fuel use factors (relative to the fuel use factor change in base year)	factor	Aircraft Type	ATEC
ClimbSpeedFactor	Climb speed factor	Speed factor in climb phase of aircraft flight	Factor	Aircraft Type, Technology Level	FLEM
CruiseMachNrFactor	Cruise Mach number factor	Speed factor in cruise phase of aircraft to calculate the effects of speed restrictions	Factor	Aircraft Type, Technology Level	FLEM
DescFlPathAngleFactor	Descent flight path angle factor	Flight path angle factor in descent phase of aircraft flight	Factor	Aircraft Type, Technology Level	FLEM
FlightLevelLimit	Flight level limit	Maximum flight level for IATA region pair	100 ft	IATA Region Pair, Interface Region Pair	FLEM

SAF lifecycle CO2 reduction factor	SAF_CO2_reductionfactor	SAF lifecycle CO2 emission reduction factor	-	Impact Operator	FLEM
ZeroLiftDragCoefFac	Zerolift drag coefficient factor	Drag coefficient factor on aircraft at zero-lift	Factor	Aircraft Type, Technology Level	FLEM
Measure Year (MEY)					
MeasureYear	Measure Year	Year of introduction of certification, subsidy or scrapping measure	Year	Value	ATEC
Other policies (OTP)					
AvgAircraftAgeChange	Average age change	Change in average aircraft age reflecting regional developments or measures	years	IATA Region, Aircraft Type, Aircraft Purpose	ATEC
BetaAdjustment	Beta adjustment factor	Beta adjustment factor for Aircraft Choice Model	value	Aircraft Type, Aircraft Purpose	ADEM
ChPaxFare	Base pax fare	Charter passenger fare on each flight stage	US$/pax	Flight Stage	ADEM
DetourFactor	Detour factor	Distance change factor for IATA region pair and aircraft type	Factor	Aircraft Type, IATA Region Pair, Interface Region Pair	FLEM
FleetSize	Aircraft fleet size	Number of aircraft in fleet	Aircraft	Aircraft Type, Aircraft Purpose, Technology Level	ATEC
ForecastIteration	Iterative forecast variables	Selected variables for forecast run iteration	-	Forecast Iteration Varibles	AERO
FreightRate	Cargo freight rate	Freight rate per kg on each flight stage	USc/kg	Flight Stage, IATA Region Pair, Interface Region Pair	ADEM
InterestRateRegion	Finance charge interest rate	Real interest rate used in calculation of finance charges	Proportion	IATA Region	ACOS
LandingCharges	Landing charges	Landing charges	US$/cycle	Aircraft Type, Technology Level, IATA Region	ACOS
MeasurePeriod	Years after base of notice	Number of years after base year measure announcement is made	years	-	ADEM
PaxFare	Pax fare	Passenger fare per seat on each flight stage	US$/seat	Flight Stage, Class	ADEM
RouteCharges	Route charges	En route navigation charges per kilometre	US$/km	Aircraft Type, Technology Level, IATA Region Pair ,	ACOS

				Interface Region Pair	
SalesShiftFactor	Sales shift factor	Change in sales proportion after measure for all affected aircraft versions, defined by depth of	Factor	Aircraft Type, Aircraft Purpose	ATEC
		vintage affected parameter			
ShortTerm	Proportion of Transition	Proportional Adjustment of Fleet to Equilibrium	none	-	ADEM
Tankering	Tankering	Tankering options at IATA region pairs	Index	IATA Region Pair , Interface Region Pair	FLEM
TechnPenetrOffs	Technology penetration offset	User proposed change in the technology penetration after a measure	Years	Aircraft Type, Aircraft Purpose	ATEC
Discriminating flags					
AmsterdamOnly	Amsterdam policy changes flag	Flag for policy changes to Amsterdam only	Index	Value	ADEM
EU_Discrimination	EU/global carrier cost chng flag	Flag indicating whether changes in costs affect global (0) or EU carriers only (1)	Index	Value	ADEM
SubsidElastic	Subsidy elasticity	Airline response to subsidy elasticity	Elasticity	Aircraft Type, Aircraft Purpose	ATEC
SubsidProp	Subsidy proportion	Subsidy as a proportion of the non subsidised purchase price	Proportion	Aircraft Type	ATEC

In the tecchnical documentation of the individual models the variable ID is called 'variable name'.

** In the technical documentation of the individual models the variable name is called 'caption'.

European Union Aviation Safety Agency

Konrad-Adenauer-Ufer 3
50668 Cologne
Germany

Mail EASA.research@easa.europa.eu
Web www.easa.europa.eu

An Agency of the European Union