A quick overview of METIS v1.2.1
SYSTEM MODULE FOR GAS AND POWER
POWER MARKET MODULE
SUMMARY

1. METIS windows
2. Options of generic data visualization window
3. Actions
4. METIS workflow
5. METIS maintenance
Advanced model of EU power and gas systems
  - Multiple scenarios

Minimization of asset variable costs under asset technical constraints
  - For hourly supply demand-equilibrium
  - On multiple zones

Data analysis and visualization
  - Maps, Key primary indicators (tables, charts, on a map)
  - Cumulatives, detailed results

Scenario modification and aggregation
  - Geographical zone selection and aggregation
  - Modification of parameters
Advanced model of power markets
  - Day-ahead, intra-day, balancing

Forecasted values at h-1, h-2, … h-24 included in database
  - For demand and variable renewables

Reserve sizing and unplanned outages
  - Unplanned outages random generator for thermal units
  - Reserve sizing module with different options (hourly, cooperation ...)

Bidding strategies module
  - Simulation of several bidding behaviors
Double-click to open a study

Use the buttons to manage the studies
Selecting contexts and map navigation

- Click and drag the mouse to move around the map
- Switch between different contexts
- Zoom by using the mouse scroll wheel
Open the long term study window
Handling contexts of the study

Timeline: all the contexts are ordered regarding to the year they refer to.

Select the contexts you want to work with, they will appear in blue here. You can then select them in the upper bar in the map view.

Right-click on a context to open the context management window.
To visualize KPIs on the map...
Select the corresponding decorator. Decorators show their associated KPI for each zone.
Decorators options

- Click on an item to open the pull-down menu
- Select the view type:
  - Circle
  - Square
  - Pie chart
  - Bar chart
- Check the pie icon to add this property to the data used into pie/bar chart
- Check this option to stop synchronizing options between different decorators (cross filtering)
- Reset default options
To compare the production of two contexts, select the decorator of your choice and turn on the ‘context comparison mode’.

Select the two contexts to compare in the top banner. The reference context is colored purple.
To visualize KPIs on a graph or in a table, open the KPI window.
KPI : key performance indicators

KPI search: type a part of the KPI name, select the KPI in the list, type Enter

Selection of the KPI

View window (see ‘Generic Data Visualization’ slides for further details on options)
KPIs are computed one by one if you select them in the KPI view. To compute a group of KPIs, open the compute KPI view:

Select KPIs by clicking on them.

Filter the KPIs.

Compute the selected KPIs.
To select the KPIs you want to compare and export:

1. **Select KPIs by clicking on them**
2. **Compare the selected KPIs** (see next slide to export them afterward)
3. **Compare KPIs view**
4. **Filter the KPIs**
To export KPIs in the compare KPIs view:

Choose the « table » graph type

Configure files: in this example,
- One file for each context and scope (« Y » option)
- One line for each other value

Export to excel
Create a pivot table

To avoid refreshing the view while configuring, hold « Ctrl »
To visualize the distribution and the quantiles of a given KPI

Select distribution chart as graph type

Select the number of distribution classes

Bar chart or line chart for the distribution

Statistical indicators
To open the zone window to access zone data (e.g. cumulative generation curves)

Double-click on a zone to open the zone window
... or open zone window from another decorator view

From any other decorator, double-click on a chart to open the associated zone window
Visualize the energy mix, the cumulative generation, net demand, marginal prices and stocks
To visualize the parameters or the results of a specific asset, open the asset window from the map view.

Double-click on an asset to open the asset window.

Use the search button to open a specific asset or a model object such as market parameters.
Select the view: parameters or detailed asset view

Select scopes

Click on parameters or results to see them on the graph

Visualization window (see 'Generic Data Visualization slide')
Detailed analysis: production view, stocks, transmissions, contracts (choose in top banner)
Modelled bidding strategies:

- Marginal costs strategy (reference)
- Competitive strategy
- Fixed-operating costs strategy
- Oligopoly strategy

Results analysis:

- Dedicated KPI: *Production revenue (with strategic bidding) by assets*
- *Bid prices* visualization over time in zone-associated results window

Assumptions:

- Available on a power system simulation without reserve modelling
Oligopoly bidding strategy depends on ownership distribution and its order

- Bidding strategy differs with different ownership percentages
- Bidding strategy differs if, for a given technology, an operator comes after another in the merit order specific to this technology (real marginal costs differ slightly between operators)

METIS users can specify their own assumptions on ownership distribution and its order

- Search for « Ownership distribution » model object in the search window
- The distribution parameter gives the percentages of ownership
- The distribution order parameter gives the merit order of operators
- For each technology, the order starts with 1 (0 corresponds to operators with no ownership in the technology)
Modifying the ownership distribution:

1. Double click on the parameter
2. Import data from a CSV file

→ CSV file format with

- ‘asset,operator’ in A1
- One column per operator
- One line per asset
- Ownership distribution must be specified in %
- Example below:

<table>
<thead>
<tr>
<th>asset,operator</th>
<th>edf</th>
<th>enbw</th>
<th>engie</th>
<th>eon</th>
<th>rwe</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCGT_medium_BE</td>
<td>0</td>
<td>70</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>CCGT_medium_CH</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>43</td>
<td>23</td>
</tr>
<tr>
<td>CCGT_medium_DE</td>
<td>0</td>
<td>14</td>
<td>85</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CCGT_medium_GB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
OPTIONS OF GENERIC DATA VISUALIZATION WINDOW

It is shared by:

– The asset window
– The zone window
– The KPI window
**View tab**

Add your own configuration (save the current state of all view parameters)

Change the configuration:
- Default: last known change
- METIS: factory settings

Table view: Data values

Chart view:
- Zoom-in: click + drag to the right
- Zoom-out: click + drag to the left
Graph options tab: various settings to change the aspect of a graph

Graph type:
- **Bar Chart** + **Stacked Chart**
- **Pie Chart**
- **Temporal**
Time tab: how to time-aggregate data (not for kpis)

Duration of the desired aggregation: Monthly + Mean

Operator used to aggregate:
- None
- Hourly
- Daily
- Weekly
- Monthly
- Yearly
- All
- Hour of day

Aggregation:
- None
- Mean
- Sum
- Subtract
- Multiply
- Divide
- Minimum
- Maximum
Indexes tab

<table>
<thead>
<tr>
<th>View</th>
<th>Indexes</th>
<th>Groups</th>
<th>Graph options</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>All</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Zones</td>
<td>All</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Test cases</td>
<td>All</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

To avoid refreshing the view while configuring, hold « Ctrl »

- Refresh the selection
- Create a new group including the selected items
- Item selection for the given property
- Aggregation of selected items
- Data organisation and graph property tools
### Indexes tab – data organisation and graph properties

<table>
<thead>
<tr>
<th>View validity</th>
<th>General function</th>
<th>Specific function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Table and charts" /></td>
<td>Order the items</td>
<td>Alphabetical order</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table and charts" /></td>
<td></td>
<td>Inverse alphabetical order</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table and charts" /></td>
<td></td>
<td>Default order</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Charts" /></td>
<td>Give different colours to the different item lines</td>
<td>One colour</td>
<td>Only works when &quot;Line&quot; is selected</td>
</tr>
<tr>
<td><img src="image.png" alt="Charts" /></td>
<td></td>
<td>Different colours</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table and charts" /></td>
<td>view the data for all items and the aggregation, or only the aggregation</td>
<td>Items + aggregation</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table and charts" /></td>
<td></td>
<td>Aggregation only</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table" /></td>
<td>switch between horizontal and vertical display</td>
<td>vertical</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Table" /></td>
<td></td>
<td>horizontal</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Line" /></td>
<td>Change the way items are displayed</td>
<td>each item is represented by a different line (or bar, depending on the settings)</td>
<td>The aspect of the line or the point representing each item may vary regarding graph settings</td>
</tr>
<tr>
<td><img src="image.png" alt="Line" /></td>
<td></td>
<td>A new graph is created for each item, ordered horizontally</td>
<td></td>
</tr>
<tr>
<td><img src="image.png" alt="Line" /></td>
<td></td>
<td>A new graph is created for each item, ordered vertically</td>
<td>With &quot;line&quot;, the name of the item is not printed on the X label</td>
</tr>
<tr>
<td><img src="image.png" alt="Line" /></td>
<td></td>
<td>each item is represented by a new point on the X axis, in one graph</td>
<td>If there is only one item in the selection, all the choices are equivalent, but “X” or “Y” remove undesired information on the X axis</td>
</tr>
</tbody>
</table>
Indexes tab – data organisation and graph properties - Colours

Detailed production with:
- 3 zones (ES, FR, PT)
- 3 technos (CCGT, solar, wind onshore)

- Graph type: bar chart
Indexes tab – data organisation and graph properties - Aggregation

Detailed production with:
- 3 zones (ES, FR, PT)
- 3 technos (CCGT, solar, wind onshore)

- Graph type: bar chart
Indexes tab – data organisation and graph properties – Bar chart structure

Detailed production with:
- 3 zones (ES, FR, PT)
- 3 technos (CCGT, solar, wind onshore)

- Graph type: bar chart
Indexes tab – data organisation and graph properties – Graphs layout

Detailed production with:
- 3 zones (ES, FR, PT)
- 3 technos (CCGT, solar, wind onshore)

- Graph type: bar chart
Modify your context by:

– Changing parameters of an asset or a model object
– Computing new results
– Launching action scripts

Create new contexts
To modify an asset parameter... open the asset view by double-clicking on the asset on the map.

Double-click on its value:
- Type in a new constant value
- Select a new time series
To modify a model object parameter...
Search for it by name in the research view (on the map), click on it and the parameters view will open.

- Double-click on its value:
  - Change boolean
  - Open the matrix editor
  - Edit matrix values

Click « OK » to validate changes.
Cluster commitment plan
- Coal and lignite running capacities are committed on day-ahead (boolean)

Exchange auction
- Specify if transmission reservation is explicit or implicit (boolean per country pair)
- If explicit, number of hours before actual usage must be specified (number of hours per country pair)

National reserve symmetry requirements
- Activate symmetry requirements (boolean): assets must procure up and down reserve in equal amounts. Can only be used if there is no reserve procurement regional cooperation (see below).
- Requirement per zone (boolean by zone): specify for which zones this requirement applies

Europe regional cooperation
- Cooperation for reserve procurement. Can only be used if the reserve is hourly
- Enable regional cooperation (boolean)
- Regions definition (region number by zone): zones in the same cooperation region have the same number

Reserve sizing
- Reserve is annual / hourly (boolean)
- Forecast horizon (in hours)

Ownership distribution
- Distribution among operators and their merit order for each individual asset (for bidding module)

Balancing parameters
- Balancing activation fee (€/MWh)
To create new assets or delete others (warning: results are deleted upon such operations)

Right-click on the map to open the asset management window
To compute results, open the Simulation Window
Select the desired test cases and start the simulation

Select the test cases in the right scope and the right context

Run the simulation

Choose the number of processors for simulation
Right-click on the context in the top banner of the map to open the Context actions window.

Add an action:
- Name your action
- Choose between available action scripts
- The action will link the current context and the chosen linked context.

Launch the action script.
**Imbalances generation**
- Creates imbalances according to context demand and renewable capacities
- Imbalances files are stocked in database
- No linked context

**Outages generation**
- Generates outages and puts them in the « Outages » parameter of each thermal asset
- If imbalances have been generated, creates new imbalances files including outages
- No linked context

**Reserve sizing**
- Reads imbalances in database
- Computes the sizing according to user options in the model objects: see slide 45
- Sets the reserve parameters in all Reserve assets:
  - Total requirement
  - National procurement minimum (if cooperation)
- Generates reserve activation to be used by the balancing (in database)
- No linked context
Save long term storage
- Set linked context to current context
- Long term storage levels for hydro reservoir and pumped storage assets are saved to be used in market simulation
- To be called after a system simulation and before the market simulation

TransferForAfrBalancing
- Set linked context to aFRR balancing context
- All data and results will be transferred from current (market) context to targeted balancing context

TransferForMfrBalancing
- Set linked context to mFRR balancing context
- All data and results will be transferred from current (market) context to targeted balancing context
To create a new study, choose « New study » in the Study menu.

After creating a study, a window to create a context will appear : close it without creating a context and see the next slide.
To create new contexts (without duplicating others), open the scripting console.
Import scripts are available to the user to create new contexts

Open a script from a Python file

Run the currently opened script

After the script has finished running, select the new context in the top banner of the map
Free memory.py

- This script can be used to clear the data in cache memory after importing contexts with other import scripts.
- Use it only after importing all your scripts as data can be used in several import scripts.

For all the following scripts, open them in the console and change their parameters according to comments in the script.

In all scripts, countries can be filtered or aggregated.

**Import_power_system_template.py**

- Use this script to create a system simulation without markets

**Import power market template.py**

- Use this script to create a market simulation

**Import_balancing.py**

- Use this script to create a balancing simulation
Import-MDI_1b.py

Import-MDI_1c.py

Import-MDI_2.py

- Import scripts to recreate contexts from the MDI IA, from options 1b, 1c and 2.
- Import scripts are based on import_power_market_template.py where parameters have been set according to the various MDI options.
importGas_ENTSOG2030GREY.py
importGas_ENTSOG2030GREEN.py
- Import scripts to create gas system contexts based on ENTSO-G’s 2015 GREY and GREEN scenario

Import_S5.py
- Import script to recreate contexts from METIS S5 study (PCI).

ImportGas_NUTS2.py
- Import script to create a context of gas infrastructure at the NUTS2 geographical level

Import_Nordstream2-Usecase.py
- Import script to recreate demo context: assessment of Nordstream2 interconnector project
How to create a context with several test cases

Open an import script in the scripting console
Choose several climatic years in database by setting a list in the temporalRealizations parameter.

To replace values with other stochastic values, open the parameters window for the corresponding Demand and Renewable assets (Availibility).
Note : the imbalances generation module will use the original test cases imported from database and can not be used with data from other sources.
WORKFLOW
WORKFLOW AROUND THE VARIOUS WINDOWS

Data Management
- Study management window
- Import script console
- Long term study window

Main window
- Opening and map view

Results Analysis
- KPI window
- Zone window

Asset window

Action window

Simulation window
System simulation : data and results analysis

A system simulation has a unique set of results:
- Scope « Simulation » : system simulation results
- All other scopes do not contain any results

In all analysis views, results are indexed by their scope. Select one or several scopes:
- Map view : Indicator options
- KPI window / Detailed asset production window / Zone window : indexes tab
- Asset or model object parameters : scopes list
Power or Gas System simulation: new system context – method 1

To create a new system simulation:

- Create a new study in Study menu
- In the long term study window, duplicate a system context from the reference study
- Modify asset parameters or market options
- If reserve is modelled, launch imbalances generation, then launch reserve sizing in action window
- Compute the «Simulation» scope
- If reserve is modelled and outages should be considered in reserve sizing, launch outages generation, then re-launch full reserve sizing in action window and recompute the «Simulation» scope
- Analyse results
To create a completely new system simulation from a METIS Database scenario:

- Create a new study in Study menu
- Open the import script `import_power_system_template.py` in the scripting console
- Specify options of your choosing and launch the script
- In the newly created context, modify asset parameters
- If reserve is modelled, launch imbalances generation, then launch reserve sizing in action window
- Compute the « Simulation » scope
- If reserve is modelled and outages should be considered in reserve sizing, launch outages generation, then re-launch full reserve sizing in action window and recompute the « Simulation » scope
- Analyse results
Assuming you already have a reference context created in your study

1. Otherwise, see earlier slides

Three-step process:

1. In the long-term window, duplicate the reference context
2. Modify the parameters of the infrastructure asset
3. Run your ‘System’ simulation

You are ready to analyze your results
Market simulation: data and results analysis

- A market simulation has several sets of results or « scopes »:
  - « Simulation »: system simulation
  - « Day-ahead »: simulation on day-ahead market
  - « Intraday »: simulation on intraday market
  - « Balancing »: simulation on balancing market
  - 1 Market context (1h steps)
  - 2 Balancing contexts (5 min steps)

- In all analysis views, results are indexed by their scope. Select one or several scopes:
  - Map view: Indicator options
  - KPI window / Detailed asset production window / Zone window: indexes tab
  - Asset or model object parameters: scopes list
To create a new market simulation:

1. Create a new study in Study menu
2. In the long term study window, duplicate a market context from the reference study
3. Modify asset parameters or market options
4. Launch imbalances generation, then launch reserve sizing in action window
5. Compute the « Simulation » scope
6. If outages should be considered in reserve sizing, launch outages generation, then re-launch full reserve sizing in action window
7. Launch « Save long term storage » in the action window
8. Compute the « Intra-day » scope (day-ahead will be computed automatically)
9. Analyse results
Market simulation: new market context – method 2

To create a completely new market simulation:

- Create a new study in Study menu
- Open the import script *import_power_market_template.py* in the scripting console
- Specify options of your choosing and launch the script
- In the newly created context, modify asset parameters
- Launch imbalances generation, then launch reserve sizing in action window
- Compute the « Simulation » scope
- If outages should be considered in reserve sizing, launch outages generation, then re-launch full reserve sizing in action window
- Launch « Save long term storage » in the action window
- Compute the « Intra-day » scope (day-ahead will be computed automatically)
- Analyse results
Market simulation: new balancing context

1 Create new contexts in scripting menu

2 Action window

Map view

3 Simulation window

4 Results analysis windows

To complete your new market simulation on balancing market:

1. Open « import_balancing.py » in the scripting console and check the zones you want to import. Two new contexts will be created.
2. In your market context, launch « TransferForAfrrBalancing » on the aFRR context and « TransferForMfrrBalancing » on the mFRR context from the action window.
3. Compute the “Balancing” scope in the two balancing contexts.
4. Analyse results. In these contexts, only balancing results are available.
REPORTING BUGS OR MAKING SUGGESTIONS
Go to: redmine.artelys.com

Create an account and send us an email at metis.contact@artelys.com to add you to the ‘METIS – European Commission’ project
HOW TO REPORT A BUG OR A FEATURE

- Report a new bug for each issue
- Title uniquely identifies problem
- In the description
  - Identify if you can reproduce the bug at will, occasionally, or never
  - Specify precise steps to reproduce bug
  - Describe observed results
  - Explain expected results
- Add supporting documents
  - Screen shots
  - A copy of the command window
- Create ticket