

Multi-Model uncertainty analysis

Introduction

This project was started in the context of the multi-model project. The goal of this project was to see if there are ways of easily performing an uncertainty analysis on multi-model runs.

To this end, in this project I have explored the two main building blocks of the multi-model structure (airflow and the Energy System Description Language (ESDL)), and the Exploratory modelling and analysis (EMA) workbench, to find opportunities of connecting the three.

The result of this exploration is this GitHub repository, that contains a fully functional uncertainty analysis tool.

Method

The general structure of the uncertainty analysis tool is as follows.

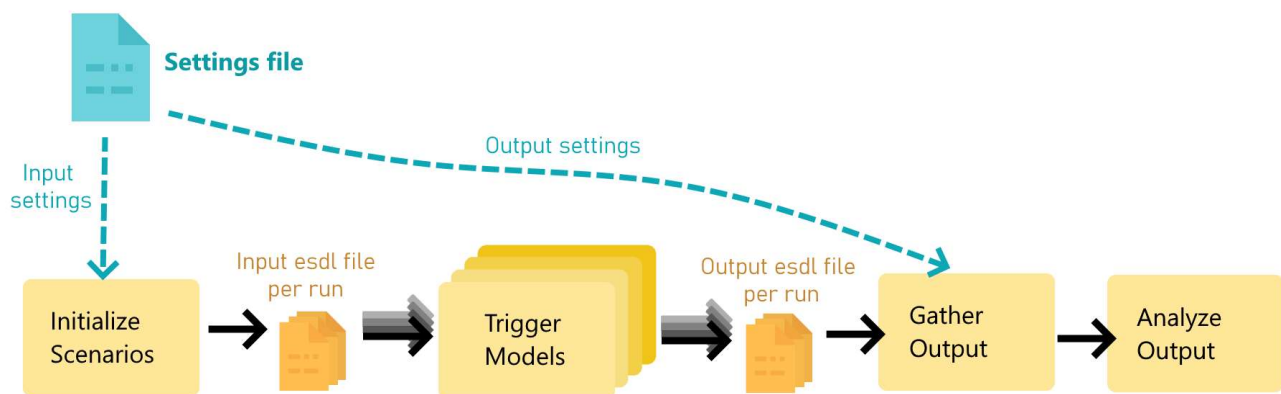


Figure 1: uncertainty analysis tool structure

The user inputs information about the system into a settings file. This information includes which uncertainties to include in the generation of scenarios, as well as which outcomes to consider.

This information is used by the tool to create scenarios, based on tools from the EMA workbench. These scenarios are then transferred to the input of the model; ESDL files. With these ESDL files per scenario, the model is run once for every scenario. Next, the outcomes (as specified in the settings file) are collected from the different model runs and are analysed using tools from the EMA workbench.

While this process sounds simple enough, there were a lot of challenges along the way, and the workflow of the resultant tool does not look nearly as clean as the general idea presented above.

A more rigorous explanation of the workflow is provided in the readme document.

Results

Using the setup described above, a mock-up example was created to show the functionality of the tool. To this end, the meso case esdl file was used, and a couple of input and output parameters were

chosen. A dummy model function was used to create output data based on the input data that was given by the workflow. All in all, this resulted in the following pair plot.

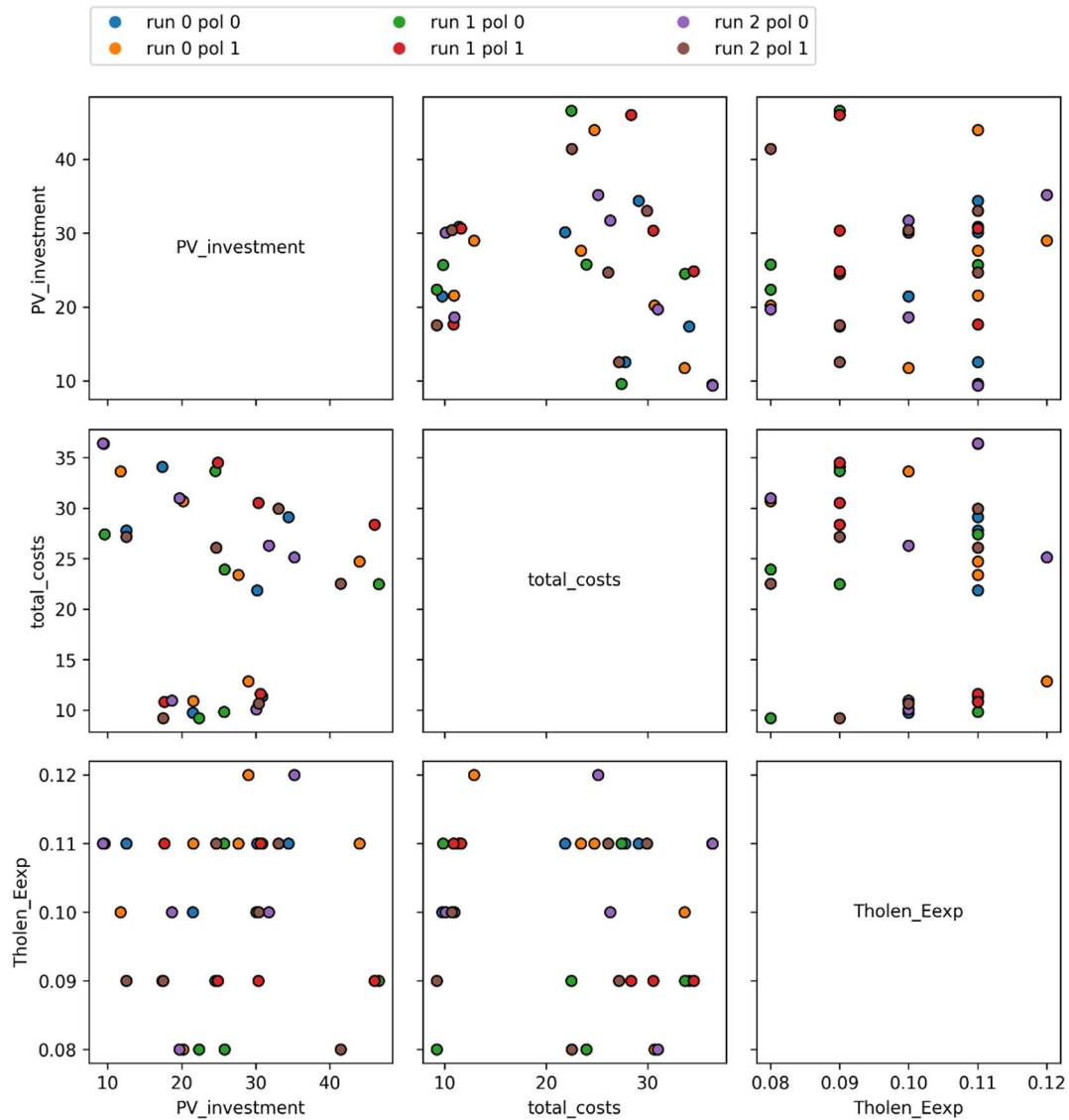


Figure 2: pair plot based on the PV investment (solar panels investment costs), total costs of the system, and the total energy production of the municipality of Tholen. Note that all data in this figure is mock-up data.

Note that while all the data in the pair plot does not give any real information, it shows that the method as described by figure 1 works. Note that the discrete lines in the pair plots connected to the Tholen total energy use are due to rounding used in the dummy model.

Discussion and conclusion

The goal of this project was to create an uncertainty analysis tool that can be used in the multi model context. This has succeeded, though an actual test with a multi-model has yet to take place. This project shows that an uncertainty analysis of a multi-model is possible. Future research should focus on integrating this repository with the existing multi-model workflow and extending this tool where necessary. The specific limitations of the tool that can be extended can be found in the readme file in this repository.