D8.4 - The SECONOMICS Toolkit

Andreas Schmitz (ISST), Jan Jürjens (ISST), Julian Williams (UDUR), Emilio Lopez (URJC), Javier Cano (URJC), Matthew Collinson (ABDN), Woohyun Shim (UNTN), Elisa Chiarani (UNTN), Fabio Massacci (UNTN), Uğur Turhan (ANADOLU), Birsen Acikel (ANADOLU), Alessandra Tedeschi (DBL), Raminder Rupai (NGRID), Greg Cramer (NGRID), Michael Pellot Garcia (TMB), Ricard Munne Caldes (ATOS)

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1	UNIVERSITÀ DEGLI STUDI DI TRENTO	Università Degli Studi di Trento (UNITN) 38100 Trento, Italy http://www.unitn.it	Project Manager: Prof. Fabio Massacci fabio.massacci@unitn.it
2	DEEPBLUE	DEEP BLUE Srl (DBL) 00193 Roma, Italy http://www.dblue.it	Contact: Alessandra Tedeschi alessandra.tedeschi@dblue.it
3	Fraunhofer ISST	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Hansastr. 27c, 80686 Munich, Germany http://www.isst.fraunhofer.de/en/	Contact: Prof. Jan Jürjens jan.juerjens@isst.fraunhofer.de
4	Universidad Rey Juan Carlos	UNIVERSIDAD REY JUAN CARLOS, Calle Tulipán s/n, 28933, Móstoles (Madrid), Spain. http://www.urjc.es	Contact: Prof. David Ríos Insua david.rios@urjc.es
5	UNIVERSITY OF ABERDEEN	THE UNIVERSITY COURT OF THE UNIVERSITY OF ABERDEEN, a Scottish charity (No. SC013683). King's College Regent Walk, AB24 3FX, Aberdeen, United Kingdom http://www.abdn.ac.uk/	Contact: Dr Matthew Collinson matthew.collinson@abdn.ac.uk
6	TMB Transports Metropolitans de Barcelona	FERROCARRIL METROPOLITA DE BARCELONA SA, Carrer 60 Zona Franca, 21-23, 08040, Barcelona, Spain http://www.tmb.cat/ca/home	Contact: Michael Pellot mpellot@tmb.cat
7	AtoS	ATOS ORIGIN SOCIEDAD ANONIMA ESPANOLA, Calle Albarracin, 25, 28037, Madrid, Spain http://es.atos.net/es-es/	Contact: Alicia Garcia Medina alicia.garcia@atos.net
8	SECURENOK	SECURE-NOK AS, Professor Olav Hanssensvei, 7A, 4021, Stavanger , Norway Postadress: P.O. Box 8034, 4068, Stavanger, Norway http://www.securenok.com/	Contact: Siv Houmb sivhoumb@securenok.com
9	SOÚ Institute of Sociology AS CR	INSTITUTE OF SOCIOLOGY OF THE ACADEMY OF SCIENCES OF THE CZECH REPUBLIC PUBLIC RESEARCH INSTITUTION, Jilska 1, 11000, Praha 1, Czech Republic http://www.soc.cas.cz/	Contact: Dr. Zdenka Mansfeldová zdenka.mansfeldova@soc.cas.cz
10	nationalgrid THE POWER OF ACTION	NATIONAL GRID ELECTRICITY TRANSMISSION PLC, The Strand, 1-3, WC2N 5EH, London, United Kingdom http://www.nationalgrid.com/uk/	Contact: Dr. Ruprai Raminder raminder.ruprai@uk.ngrid.com
11	ANADOLU ÜNİVERSİTESİ	ANADOLU UNIVERSITY, SCHOOL OF CIVIL AVIATION Iki Eylul Kampusu, 26470, Eskisehir, Turkey http://www.anadolu.edu.tr/akademik/yo_svlhvc/	Contact: Nalan Ergun nergun@anadolu.edu.tr
12	Durham University	The Palatine Centre, Stockton Road, Durham, DH1 3LE, UK https://www.dur.ac.uk/	Contact: Prof. Julian Williams julian.williams@abdn.ac.uk

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Executive summary

To analyze security aspects the SECONOMICS project models scenarios for each case study. These scenarios are mathematically modeled with different approaches. These models must be implemented with values from scenarios to analyze them efficiently. In this project Matlab is used for model implementation tasks. These model implementations need to be integrated into one big SECONOMICS TOOL with an easy handling, an integrated look and model background information, help, result visualization, and explanation. In this deliverable we explain the SECONOMICS TOOL, its structure and all components. It consists of the Matlab model implementations and the tool framework, which is based on the Eclipse framework and consists of the Analyses Plugin Provider, the Selector, the Parameter Input and Output View.

1. Introduction

The SECONOMICS project analyses security aspects from economical, sociological and political points of view in three different industrial case studies: air traffic, critical national infrastructure and urban transport. In each of these case studies we consider security threat scenarios from different perspectives with varying mathematical approaches. For example, we consider Public Policy models, that incorporate mandatory and risk-based security investments, or Adversarial Risk Analysis models, which simulate the decisions of an attacker and hence compute the most effective defense strategy. The mathematical models are complex and scenario specific in a way that users could need to much knowledge about the model ideas and model mechanics to adapt them to complete new scenarios. This implies that if the aspired scenarios are quite different from the existing ones, only specialized consultants can handle the adaption.

In this paper we present the SECONOMICS TOOL, which has been developed within the project. We have created an integrated toolkit, that can assist a consultant in specific security threat scenarios. The tool can support a policy maker in different types of essential decisions:

1. How much money should be invested in Security?

2. What investment distribution will be the most promising one?

This paper is organized as follows. In Section 2 we present the architecture of the tool framework with deeper look at the different components. In Section 3 we will present an overview of the integrated models in general and have a detailed look at one specific model. Section 4 sums up the main ideas of this document.

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2. Tool Architecture

The tool is architecturally divided into two separated parts: (1) the integrated tool framework, that is implemented in Java by WP8; (2) its conforming models from the modelling work packages, which are realized in Matlab. The model mechanics and mathematics were developed by WP5 and WP6. The wrapping and some additional adaptations were done by WP8. The tool framework is separated into self-contained components displayed in Figure 1.
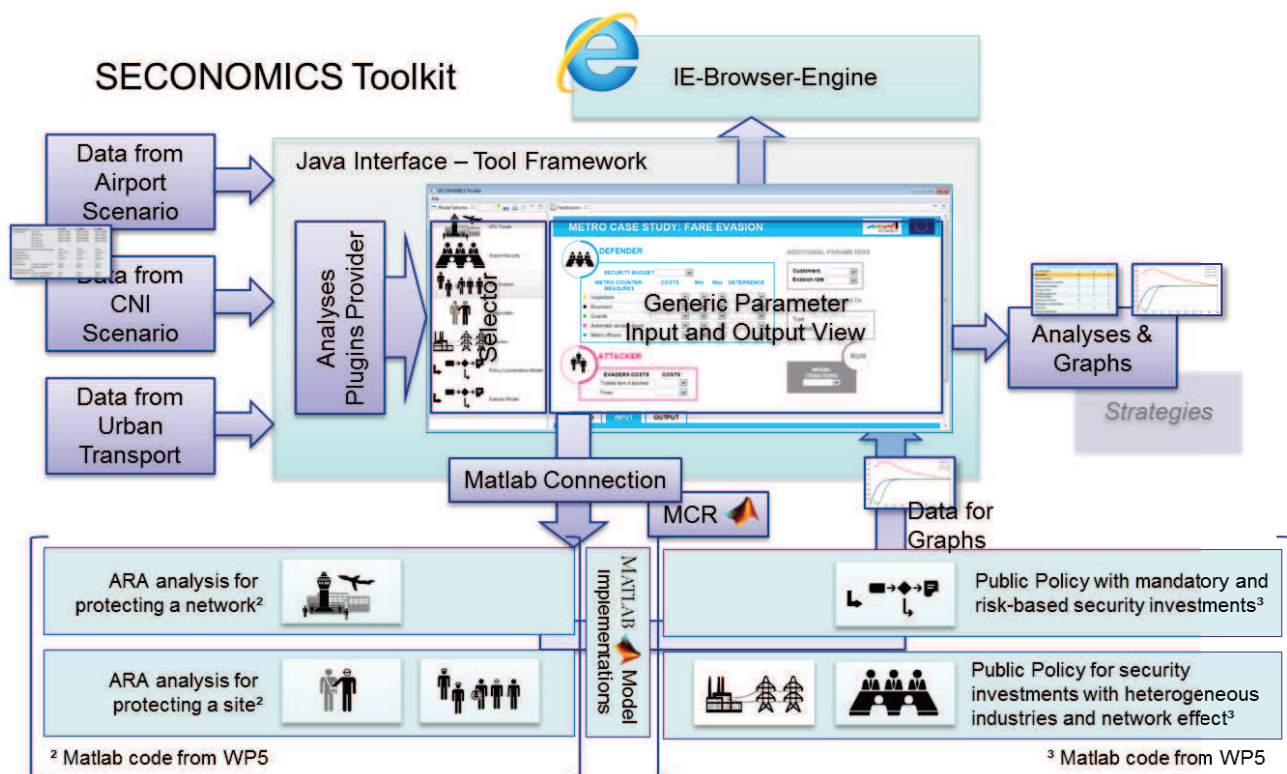

Figure 1: Architecture of the SECONOMICS TOOL: The Integrated Framework is located in the center. It consists of the Analyses Plugins Provider, the Selector, and the Parameter Input and Output View. The last component uses the IE-Browser-Engine (located on top of the framework). The tool includes the Matlab implementations of the SECONOMICS models by incorporating the Matlab Connection. Data is gained from the case studies Airport, CNI and Urban Transport.

2.1 Integrated Tool Framework (JAVA)

The SECONOMICS TOOL is based on the Eclipse Framework, which is released by the Eclipse Foundation [1]. It provides the whole necessary infrastructure basement for the tool including plugin interfaces, window management, file management. Eclipse applications are developed in Java and can be released as a standalone program (called RCP, rich client platform). Eclipse and most of its tool boxes are open source and free of charge. In the following sections we will describe the main components of the tool framework.

2.1.1 Analyses Plugins Provider

This component is responsible for the background loading and providing analyses that can be performed by our tool. It loads the Matlab analyses together with the associated configuration files, stores the information about the analyses and passes them to other components. It reads all data corresponding to a model out of the associated files, e.g., model name, icon file, Matlab file and function definitions, precise definition of all model parameters, associated Matlab parameters, Matlab result, output and HTML input forms. The input parameters are one of the common types: numerical, text, etc. while the Matlab output further includes diagrams and arrays for plotting. All data is stored in the Analyses Plugins Provider and can be retrieved by other components at any time. The whole component was implemented in a generalizing way so that it was easy to add, remove, and change models.

2.1.2 Selector View

This component gathers the information about the analyses from the Analyses Plugin Provider and presents a list of all models currently included in the tool. They are visualized as icons representing the model together with the model name. By selecting one of them a new instance of the model is created. It also manages saving and loading of models.

2.1.3 Parameter Input and Output View

One central component is the Parameter Input and Output View. It is the user interface for interacting with a model. The user gets information about the model, can enter all necessary data to the model, run the calculation, and see and interpret the results. Each SECONOMICS model has its own interface. So a way to easily create these forms and reuse many parts in all models is needed to reach a good integrated look and feel. This is achieved with HTML and JavaScript. In the last version the IE-Browser library is used to render HTML forms and interacting with them. Tests with Mozilla's Browser Engine called XULRunner revealed, that many needed functionalities were not included in the default integrated version (XULRunner 3 ,from Firefox 3.0) and it was not stable enough. It shall be possible to include XULRunner 24 with high efforts, but the IE-Browser works well on Microsoft Windows machines and are integrated by default. So HTML is used to design the forms for each model seperatly using some general parts and the same Cascading Style Sheets (CSS). JavaScript is used to enable the functionality of the forms and interact with Java and Matlab. A Google diagram library is used to plot the Matlab results, visualize them in a fancy way, and allow the user to interact with them.

2.2 MATLAB

We have chosen Matlab as the mathematical computation engine. It is a very sophisticated software on complex numerical calculations comprising an optimized powerful engine. Although Matlab is proprietary, the implementations can be compiled using the Matlab Builder for Java and used license free within Java applications. It needs a local installation of the Matlab Compiler Runtime Environment (MCR), which can be found for download at the website of Matlab [2]. All mathematical models are implemented in Matlab, which provides a

good runtime and an easier use of specific toolboxes like Monte Carlo Simulation and others.

2.2.1 Matlab Connection

In several cases, we have to perform highly demanding computational analyses. Therefore we make use of Matlab because of its power and excellent performance as a mathematical engine. As our tool is developed within a Java environment, we have to provide a connec-
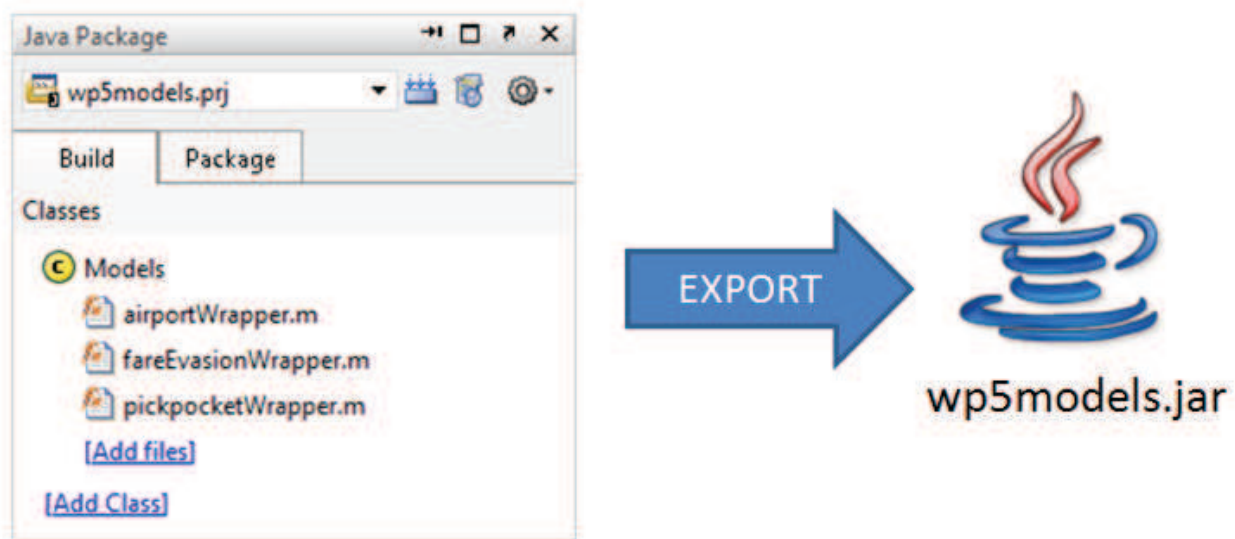

Figure 2: Matlab Builder JA: With the Matlab Builder JA mathematical Matlab implementations can be exported to a Java library, which then can be included and executed from any Java program. It is one optional toolbox purchasable from MathWorks.

tion between Java and Matlab. This is encapsulated in the Matlab Connection Component. It is designed to support several types of parameters and several return values including numbers, arrays of numbers for plots, and graphics. The connection details as, e.g., the name of the compiled Matlab file, the function name, and the parameter association are obtained from the Analyses Plugin Loader. The component is done with the aid of the Matlab Builder JA package. The Builder is shown in Figure 2. With this tool, functions implemented in Matlab code can be deployed as Java classes and exported subsequently as Java libraries. We make use of Java Reflection to include Matlab functions at runtime. The execution of a Matlab driven analysis is processed in the Matlab Compiler Runtime. For the actual Matlab function call, we need to convert all input data for the analysis to one single Java object array. The function is called with this array as an input afterwards: The Matlab execution returns an object array. This has to be converted back to ordinary Java data types. In order to get feasible results for the analysis with the policy model, it is necessary to perform several number of runs in Matlab. The organization of this has to be done inside Matlab, as we want to avoid shifting results from Matlab to Java and back again several times with regard to possible impreciseness. For the underlying policy model, there is a wrapping function in Matlab and we only call this one to perform the execution. The whole scheme of how we integrated the Economic and Policy models into our tool is visualized in Figure 3.
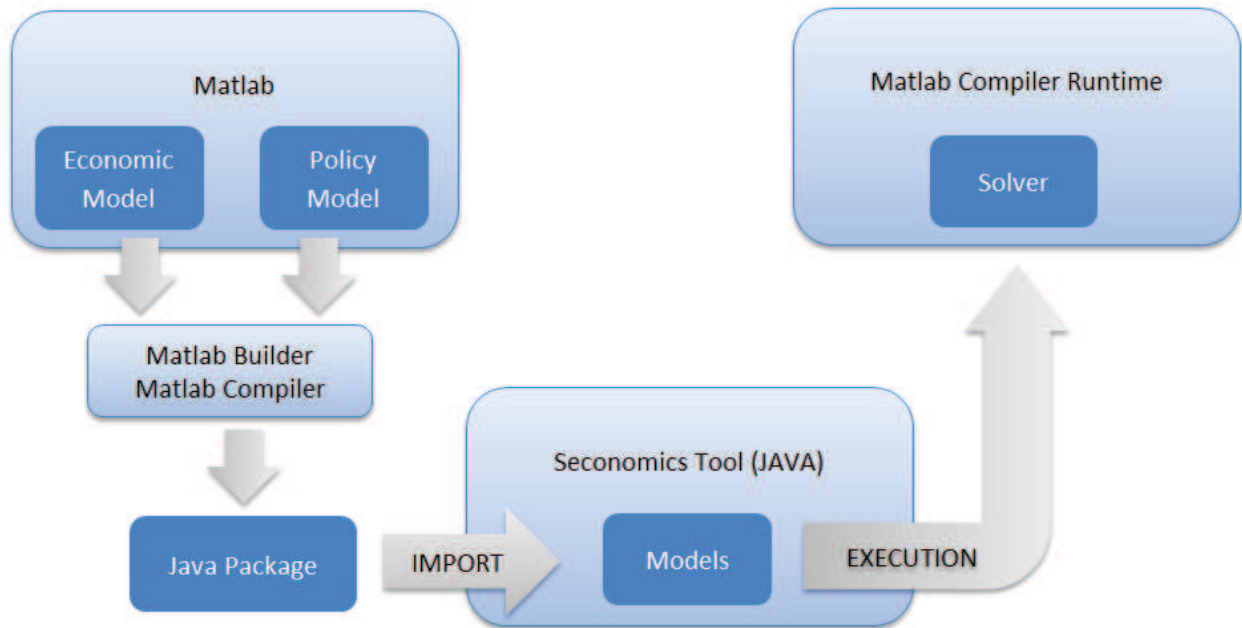
Figure 3: Scheme of the model integration

2.2.2   Matlab Model Implementations

In the scope of SECONOMICS six models were developed and implemented in the tool. They are implemented in Matlab and compiled to Java so they can be integrated in the tool. The model approach as well as the Matlab code of the model was developed by WP5 & WP6, the Matlab-Wrapper and the integration and all frontend implementations were done by WP8. In Figure 1 the models done by WP5 are depicted on the left hand side and the one developed by WP6 are on the right. In the following section the models is discussed in detail with the Policy Coordination Model as a detailed example.

3.   The Policy Coordination Model as Example

In the three industrial case studies of the SECONOMICS project we considered six different security threat scenarios. In the following, we give a brief overview of each of these scenarios: Afterwards we will describe one of the scenarios in detail.

- **Attack to the tower of an airport** is an Adversarial Risk Analysis (ARA) of a scenario in which attackers are trying to get in control of the Air Traffic Control Tower. Therefore we simulate the attacker and compute the attack he will most likely perform. Based on that we find the optimal defense strategy. See [3] for more detailed information.

- **Policy coordination of airport security** is an analysis of the policy makers decision for investments with big airports and small airports. See [4], [5] and [6] for more information about the mathematical concept of this approach.
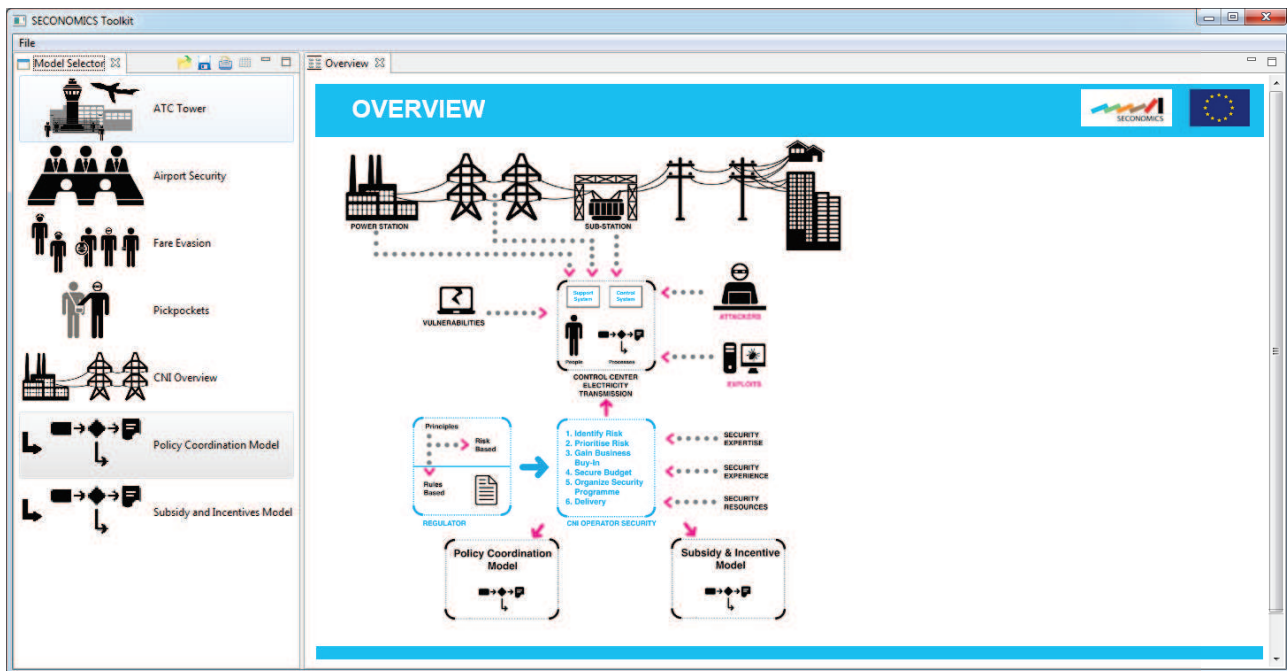
Figure 4: Screenshot of the SECONOMICS TOOL: On the left panel the model selector is located. All available mathematical models from the SECONOMICS project are included. The CNI Overview is opened on the right panel. Here we can select the Policy Coordination Model used in this example.

- **Policy coordination in electricity network** is an analysis of the policy makers decision for investments with heterogeneous industries and network effect. See [5] and [6] for detailed explanation.

- **Subsidy and incentives model** is an analysis about subsidy preferences of the policy makers to reach more risk-based or more rules-based regulation. [7] describes the mathematics and explains the phase diagram shown in the results.

- **Fare evasion in an urban metro** is an Adversarial Risk Analysis about passengers and colluders of passengers trying to avoid paying the transportation fare in an urban metro system. See D5.3 and [8] for further information.

- **Pickpocketing in the metro** is an Adversarial Risk Analysis of securing an urban metro system against pick pocketers. In D5.3 and [8] the approach is explained in more detail.

In this section we describe the handling of the SECONOMICS TOOL on the policy coordination model in electricity network scenario. We start it by selecting the electricity network overview from the model selector. The overview shows a pictographical description of the scenario and leads to the two electricity network models. The overview is depicted in Figure 4. We want to open the policy coordination model and do so by selecting the associated icon on the lower side of the screen. The policy coordination model is opened and also shows a pictographical description of the model, seen in Figure 5 (a). The input of the model specific parameters starts on the second tab, the input tab on the bottom of the window.
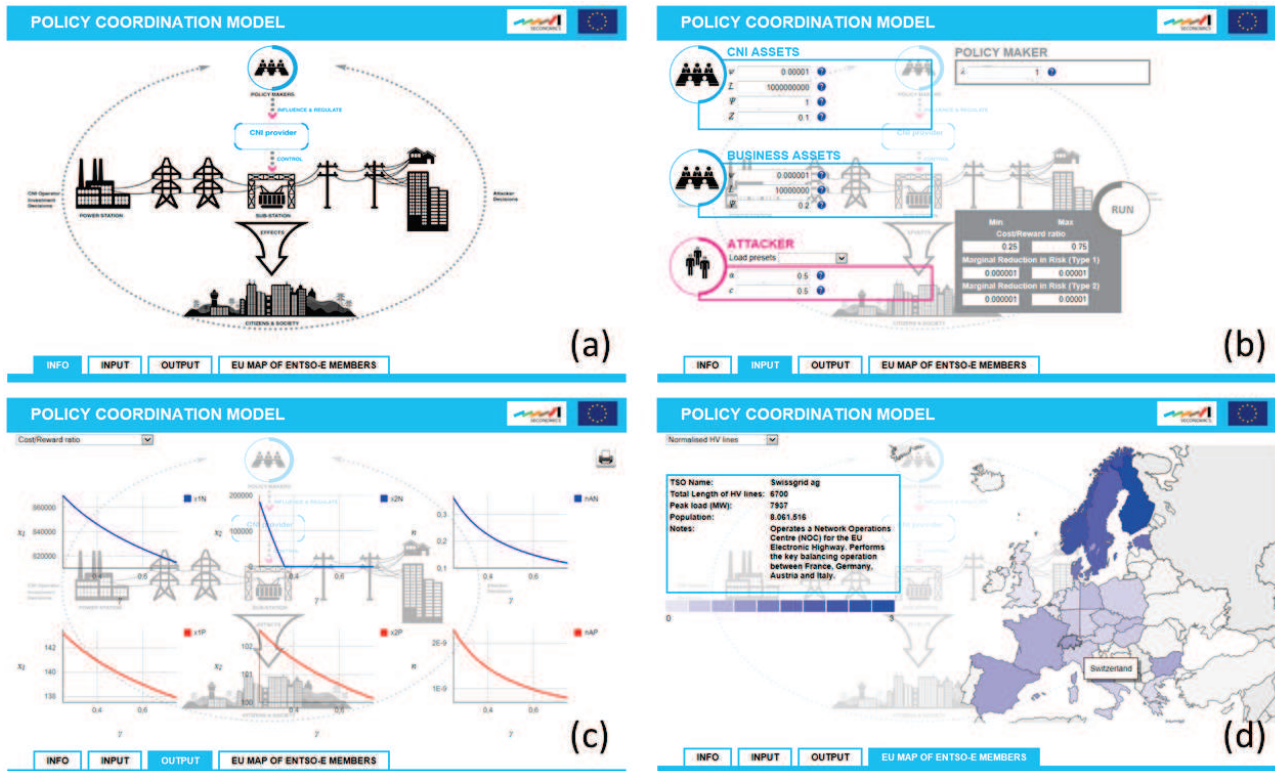
Figure 5: The different tabs of the Policy Coordination Model: (a) shows the info tab, which shows a pictorgraphical description of the model, (b) shows the parameter input form, (c) shows the calculated output and (d) shows the ENTSO-E map.

The input screen is seen in Figure 5 (b). For each parameter we can gather help by hovering the mouse over the accompanying help icon. The input parameters are organized in 4 parts. For the critical national infrastructure (CNI) operator we use the definition of the CNI assets and the business assets. Both consist of the risk reduction rate ψ for a given investment, the instantaneous loss L to a firm associated with a successful attack and the intercept level of risk in absence of investment Ψ. Furthermore, Z is the relative size of the CNI operator to the rest of the economy. This provides an indication of the cost transfer level for risks from the CNI operator to the real economy as a whole. Additionally, we have to define the attacker with a and c, as well as the global discount rate λ of the policy maker. After specifying the scenario we now select ranges of the steering parameters cost/reward ratio and marginal reduction in risk of type 1 and 2. The calculation of the model will be done for these ranges to show graphical diagrams for the steering parameters. After entering all parameters the calculation can start, which will take a few seconds. We can then inspect the resulting diagrams on the output tab depicted in Figure 5 (c). Four diagrams are shown together each time. From the drop down menu on the upper left corner different views can be select. We are able to zoom and scroll in all diagrams. By double clicking on one diagram it maximizes. On the last tab seen on Figure 5 (d) we see a map of Europe containing data of all ENTSO-E members. The map is colorized regarding the normalized high voltage (HV) lines, normalized peak load etc. by selecting the specific one from the drop down menu. For each country we see data about the grid operator in the info box on the left hand side.

4. Summary

In this paper we have presented the SECONOMICS TOOL. The tool framework integrates all mathematical models from the project to a complete tool. As shown with the policy coordination model as one example of the included models, the user can adapt the developed models for similar scenarios by adjusting the model definition parameters and analysing the result by interpreting the diagrams. For all models holds, that adapt the model to a very different scenario, the user has to go deeper in the code of the model, understand the underlying approach and adapt this approach to the new scenario.

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