
# D6.1 NARRATIVE SCENARIOS AND POLICY MODELS

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## EXECUTIVE SUMMARY

In the context of current increasing variety, interconnectivity and alteration, many methods and tools for planning and decision-making such as time series analysis and trend extrapolation do no longer work out. Along the demands for Good Governance and Open Government, policy-makers need concise, reliable and up-to-date information to manage society's problems and affairs in an efficient and effective way. Likewise, stakeholders affected by a particular policy demand transparency, accountability and trustworthiness in political decision-making. Besides the increasing digitisation of the Information Society, citizens are more and more requesting direct involvement in policy making. The implementation of Good Governance principles (see e.g. OECD [23] or the European Commission [7]) becomes predominant in societal evolution.

In this document, a novel approach to policy development through collaborative scenario building via online means to inform formal modelling and simulation of policies is introduced. This document contains interim results of scenarios, CCD models and simulation models. The report at hand documents on the one hand the OCOPOMO methodology for the development of narrative scenarios and policy models and on the other hand on the results received, so far. Different stakeholder groups from three case study areas, namely Slovakia, Italy and England, cooperate with domain experts in the development of narrative scenarios and policy models for their respective region and policy issue:

- Heating in Kosice Self-governing Region (Slovakia)
- Competence centres for knowledge transfer in Campania Region (Italy), and
- London Housing in the Greater London Authority (England)

The process of collaborative scenario building and knowledge elicitation for informing agent-based models implemented in WP6 grounds on the specification devised in WP5.

The narrative scenarios developed with stakeholder participation for the three case studies informed the design and implementation of the Consistent Conceptual Design (CCD) and Agent-Based Models (ABM).

For each of the three use cases OCOPOMO developed narrative scenarios, CCD models and DRAMS models. This report provides an overview of the respective results in each use case. The report, therefore, includes:

- Narrative scenarios developed together with stakeholders for individual pilots
- A common macroeconomic model for all pilots
- Implementation of individual pilot models (i.e. CCD models and DRAMS agent-based models)

The overall OCOPOMO policy development approach as introduced in previous deliverables D 1.1 and 5.1 (see also [35]) adds value to current policy discussions by facilitating the understanding and assessment of specific policy issues, letting stakeholders express their views and concerns on a policy via collaborative scenarios and e-participation tools, and providing means to better understand possible consequences of policy choices through models and simulation results.

# 1. INTRODUCTION

## 1.1. PURPOSE AND ACHIEVEMENTS

This work package lies at the core of the open collaboration and policy modelling processes supported by the OCOPOMO approach: Narrative scenarios for several case studies developed with stakeholder participation inform the design and implementation of agent-based models (ABM). Their evaluation by stakeholders can instigate a revision of the original scenarios, thus starting another iteration of the modelling process. The overall OCOPOMO policy development process as developed in the first period is shown in Figure 1.

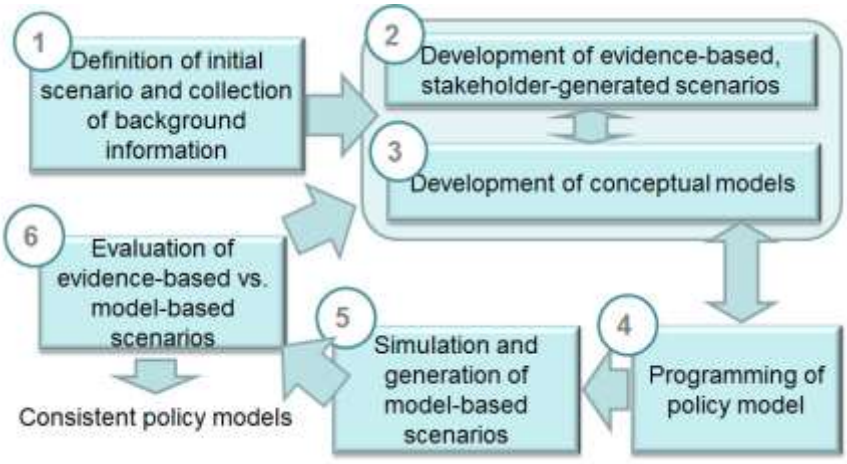



**Figure 1:** OCOPOMO's policy development process (see D5.1 and [35]).

Along the OCOPOMO policy development process, the objectives of work package 6 are:

- Development of narrative scenarios together with stakeholders
- Design and implementation of a common macroeconomic model for all pilots
- Implementation of individual pilot models
- Integrating model and scenario development

The narrative scenarios have been produced by our partners from Warsaw (UW) and Kosice (TUK/IS/KSR) with the support of UKL for the analysis of heating policy in the Kosice Self-governing Region and by UNISOB for knowledge transfer policies relating to heritage and tourism in the Campania Region of Italy.

This work package has not only built directly on the achievements of Work Package 5 (WP5) but it has also produced some very effective and useful developments that were neither planned nor expected at the start of work on this work package.

By the end of WP5, we had decided on a metamodel that involved clear traceability from evidence to simulation model outputs and back. The idea was (and remains) that there should be linkages that would enable a non-specialist user to track the reasons for a particular output from a simulation model back to the evidence that informed the assumptions underlying the model that, in turn, produced the output of interest (see overall OCOPOMO policy development process as described in D5.1 and [35]). These linkages were to depend on two core software components: the CCD (Consistent Conceptual Descriptions – see D3.1 for more details) and the modelling library DRAMS (Declarative, Rule-based, Agent Modelling System - see D5.1, [15] and D3.1 for more details). Both of these components existed in at least rudimentary form as outputs from WP5 and both have been developed into sophisticated and useable software (cf. D3.1) that has been applied to our contracted case studies.

To understand our reasons for choosing this approach, we offer the following context:

The purpose of all formal modelling is to produce statements that are precise – they lack both the richness and the ambiguity of natural language statements. The reason for using both stakeholder-generated and model-generated scenarios in OCOPOMO is to maintain the richness (or expressiveness) of natural language with the stakeholder-generated scenarios and to introduce precision to the analysis with the model-generated scenarios.

Agent-based modelling represents individual stakeholders by "autonomous" computer programs (the agents) within an overarching software system. The agents perceive elements of the system state, the process those perceptions and they "act" by changing the system state in some way. There are several different agent-based modelling paradigms but what is common to them all is the facility to capture social interaction amongst the agents. This facility is an advance over for example, conventional economic modelling in which there is assumed to be either one agent or many agents that do not interact directly. Since this sort of assumption flies in the face of all evidence, and since OCOPOMO is committed by design and by contract to an evidence-based approach, agent-based modelling is the obvious option.

Agent-based models can be procedural or declarative. Procedural models specify in advance (e.g., at compile-time) an order in which computations will be undertaken and, in an agent-based model, these are hard-wired into the agents. Declarative models specify a set of *if-then* conditional actions so that the particular computations and their order are determined at run-time. A declarative modelling approach was chosen for OCOPOMO, and DRAMS was developed for the purpose, because our concern is with possible policy impacts, which are normally intended to have some effect on the behaviour of decision-makers. A procedural approach renders more difficult the modelling of these effects. Different parameters or variable values might enter as inputs to the algorithms determining the decision-making processes of agents but the algorithms themselves are normally fixed. Declarative modelling effectively supports the modification by agents of the algorithms themselves according to circumstance at runtime.

Rule-based, declarative models are easier for the modeller to implement than models where the *if-then* statements are coded in essentially procedural programming languages such as C++ or Java. The key difference here is modularity. From the point of view of the model implementer, each rule is a separate module. Each rule will depend on, and be depended upon by, other rules but those dependencies can be (and in DRAMS are) calculated by the rule engine. In a procedural programming language, the modeller has to specify the order in which the *if-then* statements are executed. Because the OCOPOMO process specifies that scenarios and models will be developed iteratively with stakeholder participation, The greater modularity of a rule-based modelling environment makes it is easier to elaborate the models by adding rules to describe individual decisions by stakeholders that by adding *if-then-else* statements to a model in a procedural programming environment. As models become increasingly elaborated and therefore complicated, the positioning of the *if-then-else* statements in the program code and any consequent debugging will become increasingly difficult. And it may turn out that the position of a statement in the code makes some difference in the output. At least in a rule-based environment, the criteria for positioning are clear and consistent.

It is in the nature of the OCOPOMO process that models and scenarios will become ever more complicated as different stakeholders offer their own unique perspectives on the social processes affected by policies and on which the policies rely. We would not expect any one stakeholder to comprehend all aspects of a complicated model any more that we would expect ourselves to comprehend all aspects of our own social environments. The key question in this regard is how to enable stakeholders to filter the information available to them in order to understand how and why particular phenomena of interest to them came to be observed and also to identify any evidence in favour of the assumptions and specifications of the model that led to those outcomes. Our answer to this question is described in section 6.

Social policies are typically intended to bring about social outcomes though these will depend on the behaviour of individuals. Our partners UNISOB have produced a series of prototype models for the Campania case study incorporating XSLT libraries that produce visual outputs. The latest of these models enables the user to click on a standard numerically based graphic – bar chart, line chart, etc. – to get specific information about outputs from the model relating to individual agents or classes of agents or aggregate output for the modelled system. A virtue of these XML-based visualisations is that they can be linked to other sources of information such as the rules producing the agent behaviour that resulted in the numerical outputs or corresponding narrative passages describing the actions and the reasons for those actions taken by individual agents.

In its final form, the development tools in the OCOPOMO toolkit support links from (1) a narrative scenario to (2) the print statements produced by rules during a simulation run to (3) the rules producing those print statements to (4) the CCD elements corresponding to the rules to (5) the passages in background documents and interview reports, etc. with which the CCD elements have been annotated. Consequently, the fullest provenance of the model structure and simulated social processes are captured by this set of links. The documents can be in ASCII, Unicode, PDF or HTML format. This range of formats makes most online documents available for linking to the CCD, In several of the models reported below, documents from Microsoft Office and from Open Office have been exported as PDF files and linked to the appropriate elements of the CCD.

## 1.2. RELATION TO OTHER TASKS AND WORK PACKAGES

This document reports on parts of the developments taking place and results achieved so far in phase 2 (Implementation includes WP3 and WP6, see Figure 2) out of the five main phases of OCOPOMO's work plan according to the Description of Work. Phase 1 (WP1 and WP2), completed at the end year 1, established the overall concept on which the implementation of collaborative scenario building and policy modelling, as well as the supportive ICT toolbox takes place.

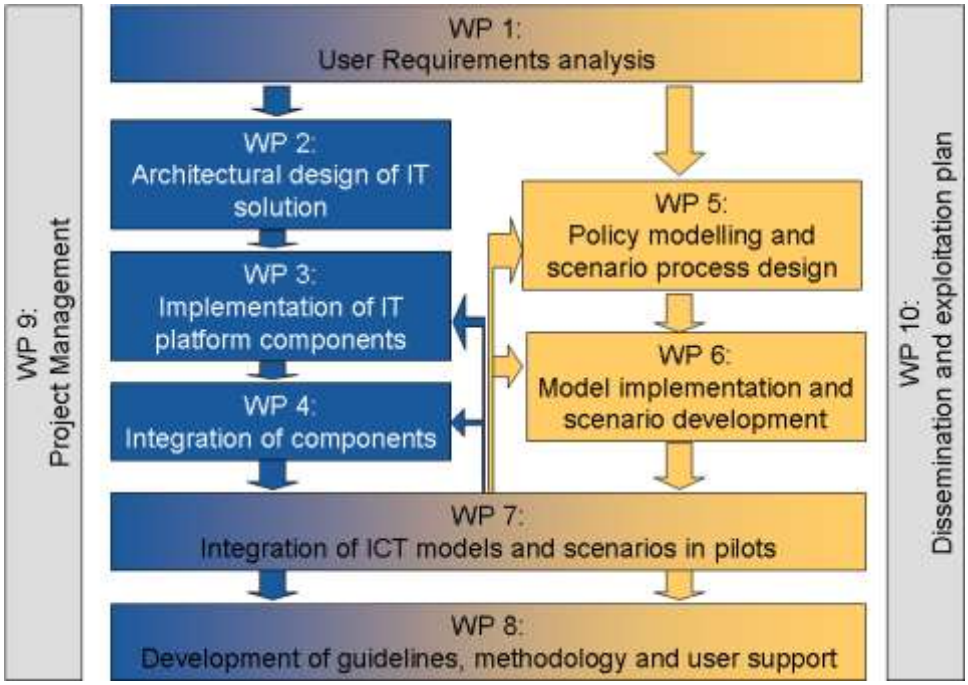



**Figure 2:** OCOPOMO's approach to implement the project [22].

While the IT platform components are implemented based on the specifications made in phase 1, WP6 implements the procedures and model artefacts devised in WP5, i.e. it implements the policy

modelling and scenario process (see section 2). This report focuses on the one hand on T6.1 (i.e. the development of narrative scenarios) and is, therefore, putting a strong emphasis on stakeholder engagement in the definition of narrative scenarios. The results received from scenario building lay the foundation for the development of evidence-driven agent-based models (T6.2-T6.4), which are the second focus of this deliverable. With it, a common macroeconomic model for the two pilots is being developed, as well as pilot models for each case (i.e. Kosice self-governing region and Campania, and initial results from London Housing).

## 2. METHODOLOGY FOR THE DEVELOPMENT OF NARRATIVE SCENARIOS AND POLICY MODELS

The core methodological principle of the OCOPOMO process is that there must be a trail that stakeholders can follow from evidence to model design to model output. The stakeholders must be able to use the integrated OCOPOMO ICT toolkit to explore the consequences of their assumptions and the particular assumptions that lead to simulation outcomes. They must also be able to assess the evidentiary basis of assumptions and implications – both their own and those of other stakeholders.

A second methodological principle is that the process should be, as far as possible, stakeholder driven. We do not want any limitations of our software to restrict the questions and concerns of stakeholders. If stakeholders indicate the importance of some piece of evidence, it should be incorporated into the documents cash and additional information made available by that evidence should be added to the CCD and the policy models.

An immediate consequence of these methodological principles is that the CCD, hence the model designs, and therefore the models themselves can become increasingly complicated. Whilst the complication has benefits for the ability of stakeholders to explore issues relevant to any policy analysis in a wide and free-ranging fashion, it also brings with it the danger, perhaps the likelihood, that the model design and the models themselves are too complicated for the stakeholders usefully to understand. Our developing view is that it is important to be able to filter the visualisations of the model design and model outputs so that the user can choose elements of interest and focus on those without having to comprehend the whole analysis and model all at once from the outset.

For example, the actor-network and activity diagrams produced by the CCD software can become too dense to be useful either to facilitators or stakeholders. Similarly, the data dependency graphs showing upon which facts rules depend, which they produce and how rules depend on one another can become too dense to be useful. In the development of the DRAMS library, the requirements that came to be understood as a consequence of the modelling (WP5 and WP6) involved the creation of different views of the data dependency graph.

The data dependency graph depicted in Figure 3 for the complete macroeconomic model is considerably simplified if we just view the data dependency graph for the household agents as in Figure 4. Since there is rule-driven communication among agents, some of the rules in the Household data dependency graph are in fact rules fired by agents of type Firm who communicate with households. Since the data dependency graphs even of individual agent classes can be quite complicated, we have identified a need for even more specialised views such as those presenting just those elements of a data dependency graph that lead to a particular rule yielding a particular output. This feature will have two benefits. The first is that it will make it possible for a stakeholder to identify the reasons for any individual simulation output of interest by tracing that output back to the DDG representation of the rule that generated it which will in turn be linked back to the corresponding element of the CCD, similarly filtered, and thence, via annotations, back to the evidence describing the behaviour that justifies that rule.

Our problem here has been to square the circle presented by the combination of the necessity for complicated model designs and implementations to capture the different perspectives and interests of different stakeholders and the need for the outputs from these models to be comprehensible to the different stakeholders so that they can form the basis of discussion or, at the least, the identification of the nature of and reasons for key differences of view. Because of the annotation features of the OCOPOMO toolkit, it will also be possible to assess the relevant design features against the available documentary evidence. An important developmental objective for the scenario analysis and modelling is therefore the appropriate means of filtering information to maintain important content without overwhelming the user.

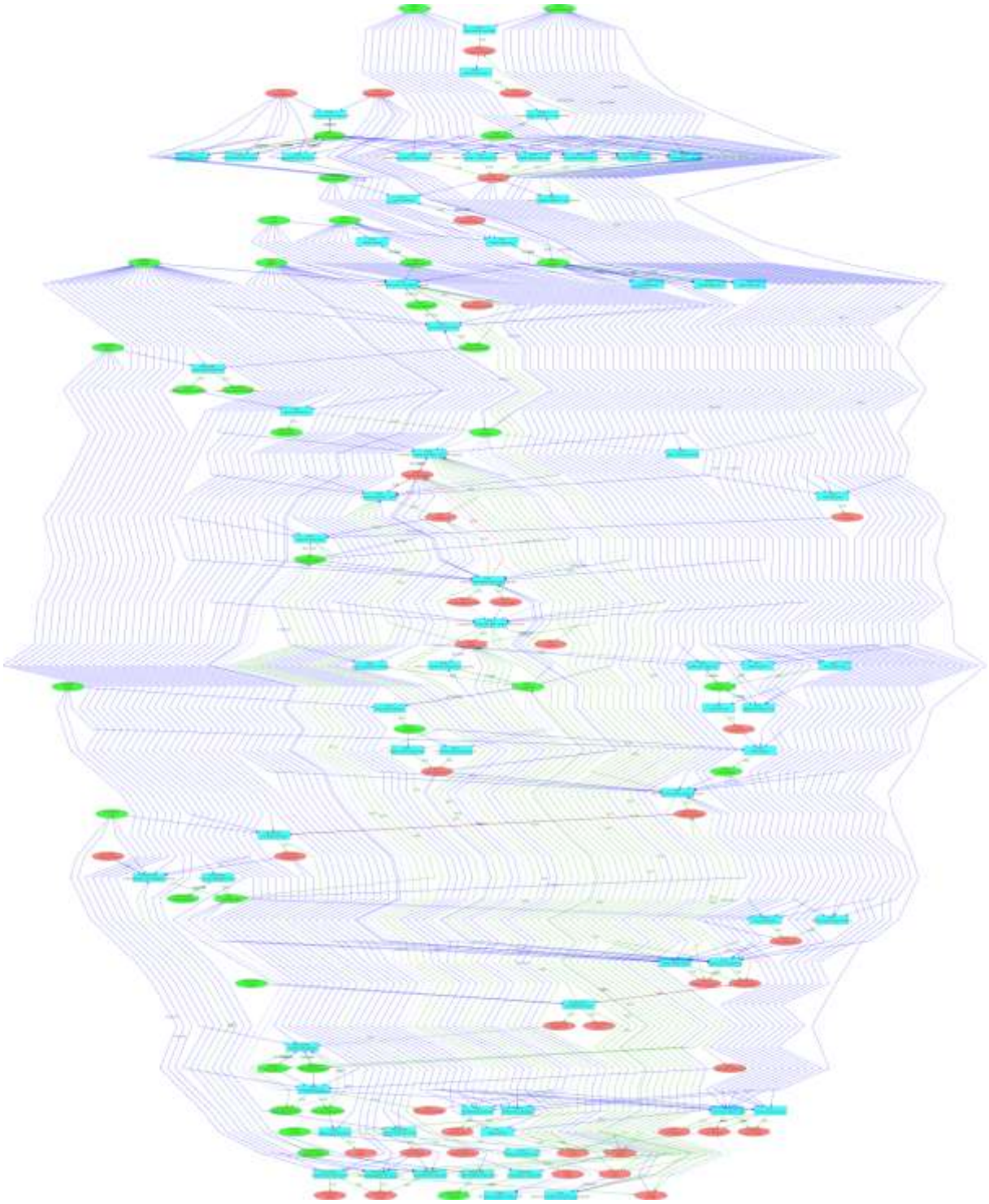


**Figure 3:** Macroeconomic model data dependency graph.

A common view amongst modellers of all stripes is that models should be as simple as possible or, as Einstein is claimed to have said, "everything should be made as simple as possible, but no simpler." In the OCOPOMO process, the simplest possible models are those that capture all of the evidence that stakeholders deem to be relevant and of some importance. This is why they can be "as simple as possible" but still very complicated. Nonetheless, there is no reasonable disagreement between

modellers engaged in the OCOPOMO process and other modellers. Where there is a difference is in the question of "over-fitting". A model is over-fitted if it has so many parameters and equations or other statements that it is always possible to find values that will match any set of evidence. This is a serious problem for forecasters since there is likely to turn out to be evidence that does not conform to the initial and highly specific values of the over-fitted model. However, in the OCOPOMO and other stakeholder-participatory processes, the point is not to forecast but to tell the story that stakeholders want told. The virtue of the model is that in entails precision and lack of ambiguity. Since, in practice, forecasting models do not forecast reliably, we submit that there is no loss from substituting our approach to that of forecasters and other (mainly economic) modellers.

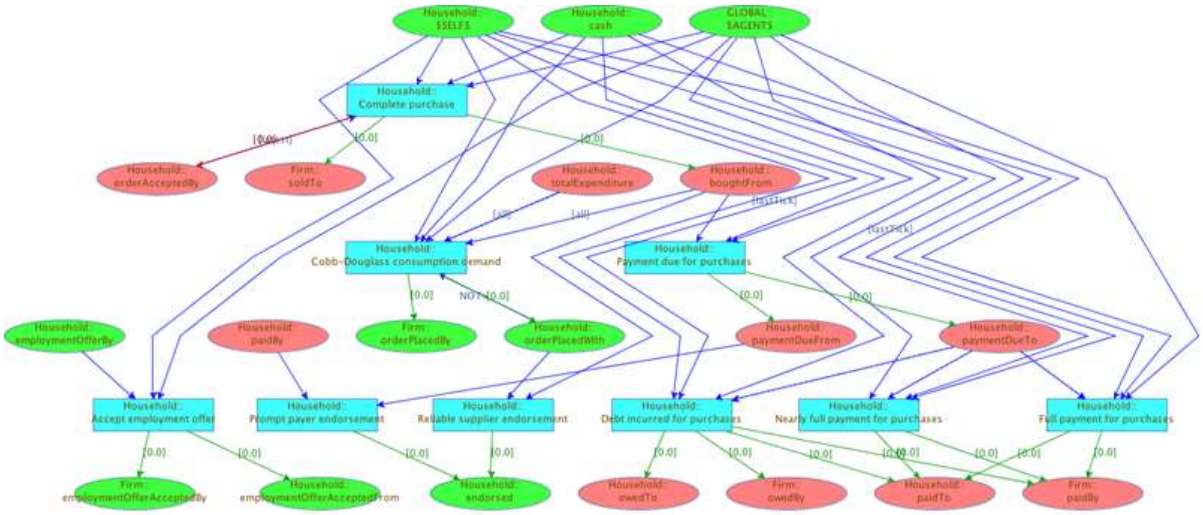



**Figure 4:** Household agents' data dependency graph.

## 2.1. COLLABORATIVE SCENARIO BUILDING IN OCOPOMO

In OCOPOMO, a scenario is a textual description (i.e., narrative, structured text) of a perceived view or understanding of a topic under discussion. A scenario may cover an existing world status or mental model of stakeholders (cf. Piaget and Senge cited in [14] on p. 30 and p.32). Alternative scenarios may exist or are developed to describe different aspects and /or alternatives stakeholders have in mind. Different stakeholder groups may develop different sets of scenarios independently (i.e., reflecting e.g. different mental models in scenario sets of different groups). Some of the scenarios may also be conflicting among different stakeholder groups. Scenarios may be extended and therewith advance an existing scenario (nesting scenarios). Hence, scenarios as narrative texts enable stakeholders to express their views and concerns on potential policy decisions (see [6] for more detailed explanations).

For OCOPOMO, scenario building is applied to identify conditions and circumstances of the policy under investigation in order to allow better handling of complexity and related uncertainty.

In OCOPOMO two different kinds of evidence-based scenarios are developed:

1. Stakeholder-generated scenarios
2. Model-generated scenarios

The stakeholder-generated scenarios subsequently inform simulation models to run alternative policy choices, i.e. to show potential real effects of alternative conditions and courses of action. Therewith, OCOPOMO aims to generate scenarios in order to represent different views of stakeholders in a sensible way, taking into account the goal of the modelling process and its structure, the available information and the computer facilities and available software.

The results of the simulation run will generate scenarios to help better understand potential interferences or conflicts of positions of stakeholders, which help them to reflect their positions.

Collaborative scenario building in OCOPOMO is carried out in phases 1 and 2 (see Figure 1):

- In phase 1, an initial scenario is developed by the policy initiators with respective facilitators to start the discussion.
- In phase 2 scenarios are developed by stakeholders.

Both, face-to-face scenario building workshops and a virtual common workspace for online scenario development are used. The face-to-face scenario building workshops are mainly used in phase 1 and at the beginning of the process in phase 2 to detail the policy issue and the objectives related to the policy issue with initiators of the policy process. The OCOPOMO project encompasses three use cases; hence, the initiators of the policy process are the Campania Region in Italy, the Kosice Self-Governing Region in Slovakia, and the Greater London Authority in UK. Each use case is tackling a specific policy issue:

- heating in Kosice Self-governing Region
- competence centres for knowledge transfer in Campania Region
- housing facilities in London

Figure 5 presents scenario building activities as planned and initiated in OCOPOMO (not involving scenario analysis, i.e. phase 3 of the OCOPOMO policy development process). Before initiating a scenario building process, the collaboration space has to be set up, which enables to share documents and to discuss and commonly develop scenarios via a participatory online platform. In OCOPOMO, the Alfresco content management system is used (cf. D 3.1).


**Figure 5:** Main steps of scenario building (excluding scenario analysis).

The first step in the scenario building is the generation of the policy description and of an initial scenario (covering phase 1 of the overall policy development process of OCOPOMO). The policy description includes text descriptions and official background documents that provide evidence about the as-is situation of the policy domain. The initial scenario(s) may describe a to-be scenario of the policy owners (or key stakeholders). This scenario is to be informative towards the stakeholders in the second phase in order to generate further views and scenarios. The methods to generate the initial scenario(s) are e.g. interviews or joint workshop sessions with the policy owners (or key stakeholders). The scenario(s) is/are described with the support of facilitators. The policy owners (and/or) key stakeholders can also provide background documents which are to be shared with further stakeholders in phase 2. When the initial scenario(s) are agreed among policy owners and facilitators, the facilitators publish them at the collaboration space.

In agreement with the policy owners, external stakeholders are invited to participate in the second phase of the scenario building. These stakeholders are invited to register at the stakeholder participation platform and to develop their own scenarios and upload their evidence documents (background documents) for the policy domain. To start off a scenario generation through

stakeholders, it is advised to organise kick-off workshops with stakeholders to launch the participation phase. Such a workshop shall include the introduction of the policy to be discussed, explanations about the objectives of the stakeholder participation and about the expected outcome and impact of stakeholder participation, and explanations about how to participate through the online platform.

To trigger discussions and to guide stakeholders during the scenario generation, a set of questions is prepared, which is directed towards the specific needs for modelling a policy. The questions are exposed to the stakeholders who are asked to write scenarios. In writing their scenarios, stakeholders should answer questions like:

- the role and the activities of the stakeholders and of other actors in the context of the policy domain,
- their perception of the as-is situation in the policy domain
- their view on what should change, and how, through a revised / new policy in the domain (to-be view)
- their view on expectations and implications of how they would foresee changes in the policy domain

During the scenario generation by stakeholders, facilitators may expose further questions to trigger discussion or to make the stakeholders reflect particular positions and viewpoints on the policy domain.

Stakeholders may agree with facilitators that a scenario is complete. In this case, the scenario can be handed over to the scenario analysis and CCD model generation (phase 3 in the overall OCOPOMO policy development process). This way, phases 2 and 3 run in parallel for a while. During this overlap, stakeholders may generate new scenarios and new discussion items, while those scenarios that have been declared as completed are being frozen for the CCD annotation and CCD artefact generation.

The stakeholder generation phase is recommended to run for approximately 3-4 weeks per iteration. This means that, when an iteration of scenario generation ends, the modification of scenarios will be disabled by facilitators. The stakeholders will receive information about this action. The scenario analysts may take the final scenarios and complete the CCD artefacts that in turn inform the policy modelling (phase 4).

When proper results of the formal simulation model are generated, the scenario generation is reopened (entering into phase 6, see Figure 1). The model-based scenarios and simulation outcomes are added to the stakeholder participation platform and stakeholders are invited to return to the platform and examine / comment the results of the simulation and/or revise their narrative scenarios based on the insights from the simulation outcomes.

Before introducing the model artefacts of the individual pilot cases, the next subsection outlines the development of a common macroeconomic model.

## 2.2. DEVELOPMENT OF CONCEPTUAL AND SIMULATION MODELS

The conceptual and simulation models in practice are typically developed in tandem. The structure of the conceptual model is developed initially from the documentation and scenarios developed collaboratively by the facilitators and stakeholders. The decision-making processes are described by stakeholders but not usually in available public documents. As a result, an initial conceptual description of the steps in different stakeholders' decision-making processes can be produced from initial stakeholders' descriptions but the more detailed accounts required for the more extensive simulation models are developed around rules implemented first in the simulation model

### 2.2.1. The actor-network diagram and model structure

An early (and usually the first) step in building up a policy analysis is to identify the relevant stakeholders. In some cases, individual stakeholders are best represented as abstract agents and in some as agents capturing relevant features of specific stakeholders.

In the London housing case, for example, there are 33 planning authorities (32 London boroughs plus the City of London). Each borough has known characteristics deemed by stakeholders to be relevant to their decisions about planning applications for new housing units. These include indicators of household income levels and indicators of the income distribution, whether the borough is in inner or outer London, the quality of education provision, health-care provision and transportation and the levels of house prices both for private housing sold on a free and open market and affordable housing which is either rented or rented with an equity element at prices agreed by developers and local councils. A key element in the planning decision and the way planning applications are investments in infrastructure by the developers. The planning authorities' requirements for infrastructure investment depend on whether households in the borough are broadly wealthy or poor, on the quality of health, education and transportation provision and whether the borough is in inner or outer London. How these considerations enter into the decision-making processes of both planning authorities and developers is complicated. But the general set of issues and the identification of relevant borough characteristics is relatively straightforward.

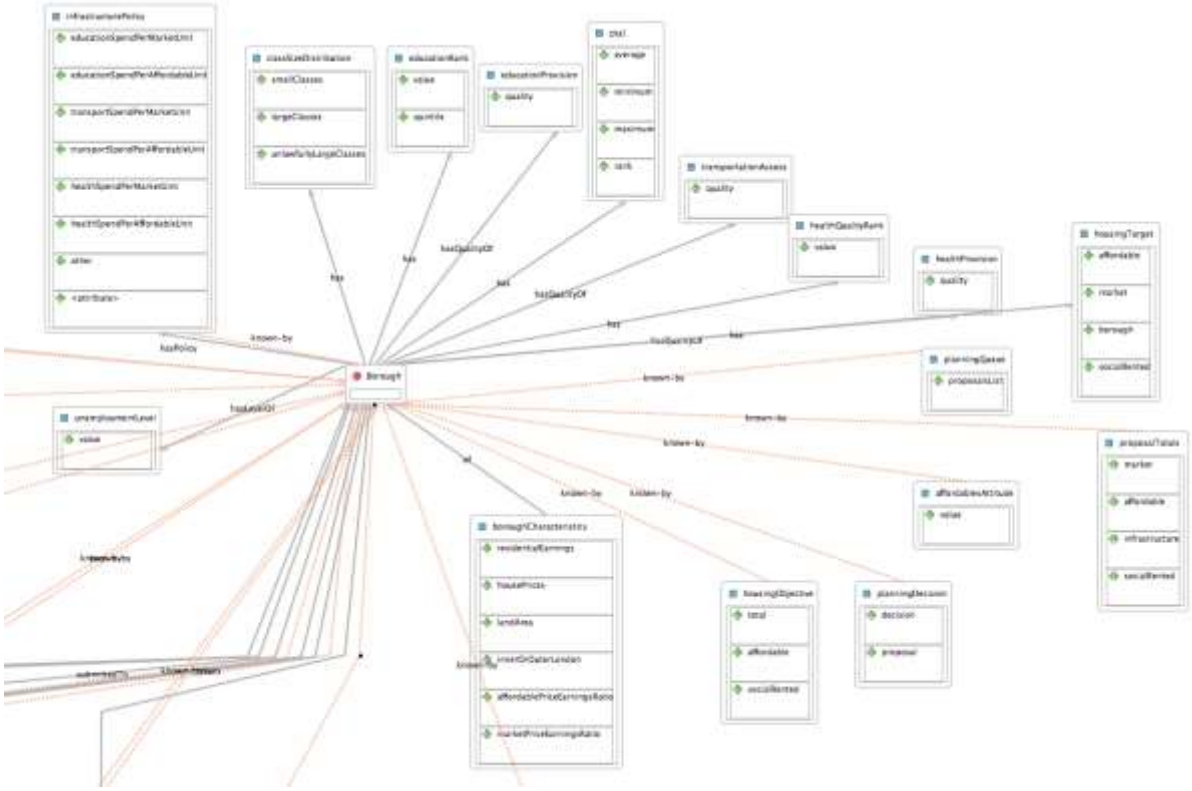


**Figure 6:** Fragment of London Housing CCD actor-network diagram relating to Borough type.

As shown in Figure 6, each of these factors relevant to boroughs and the planning decisions they take are defined as Objects and Attributes of those objects. For example, the object boroughCharacteristics has these attributes: residentialEarning, housePrices, landArea, innerOrOuterLondon, affordablePriceEarningsRatio and marketPriceEarningsRatio. Each of these attributes was indicated to be relevant and important either by a domain expert or in publicly available documents.

Other important types of stakeholder are housing associations which build affordable (including social rented) housing and private developers. We do not have the same detailed information about each actual stakeholder in these categories. We were told that there are about seven major private developers, 15 large housing associations and about 350 housing associations active in London. These were implemented as abstract Actors in the CCD using information about size distribution and some behavioural characteristics that came either from domain experts or publicly available documents.

All three of the OCOPOMO models had this sort of combination of Actors targeting specific stakeholders and abstract Actors in a population with a distribution of empirically suggested distributions of features.

The links between boxes representing Objects in Figure 6 and boxes representing Actors indicate relationships if they are in black and privacy if they are in red. For example, the arrow from the boroughCharacteristics box to the Borough box is labelled "of" indicating that these are the characteristics of the borough. All of the red arrows labelled "known-by" to indicate that the information represented by the Object is known only to the Actor pointed to by the arrow. If there is no "known-by" link, then the information is common knowledge.

The actor-network diagram can be generated graphically of by defining Actors, Objects, Attributes and Relations in a text-based window.

The CCD2DRAMS tool generates all of the necessary Java and DRAMS code of the simulation except for complete rules which will be discussed presently. Every Actor is translated into a Java class. There is also a class for the model which instantiates every instance of each type of Actor. In the London model, this included 33 named instances of Borough, eight instances of Developer, 300 instances of HousingAssociation a generator of land parcels for sale to developers and one named instance of GreaterLondonAuthority. It also created required templates for DRAMS facts as described below.

### 2.2.2. The Action diagram and modelling of social process

Within a given social structure, individual behaviour and social interaction are sensitive to the prevailing context including the behaviour of other individuals and how they interact. In the Kosice case, for example, neighbours influenced one another in the course of deciding whether to change heating technologies and what technologies to choose. In the London case, social interaction was largely through the development and negotiation of planning applications but the precise nature of such interaction was predicated on the experience of planning authorities, developers and finance houses with one another. Similarly developing experience in the Campania case determines who wants to collaborate with whom as well as the outcomes of applications for funding.

In building a model, it is important to understand not just the sequence of steps but how each step is chosen and made concrete and how a whole sequence emerges as a social process. These processes are initially described by stakeholders as stories or scenarios. The Actions in the CCD are essentially labels for the various steps. Each action has pre-conditions and post-conditions. The pre-conditions are statements describing what must be true for the step to be taken and the post-conditions are statements of what will be true as a result of the step being taken.

The two types of Conditions in the CCD correspond to Facts in DRAMS. Facts have a keyword or fact name and an arbitrary number of named slots and values. For example, for each borough there is a fact with the fact name boroughCharacteristics. Such facts correspond in DRAMS to the boroughCharacteristics object described above in section 2.2.1. An example of such a fact is shown in Figure 7.

```
(global::boroughCharacteristics
        (instName BarkingAndDagenham)(residentialEarnings 26586.0)
        (housePrices 171000.0)(landArea 3778.0)(innerOrOuterLondon outer)
        (affordablePriceEarningsRatio 6.61 (marketPriceEarningsRatio 7.044) )
```

**Figure 7:** Example for DRAMS fact.

This fact is known globally in the sense that it can be accessed by all agents and the slots have slot names "instName", "residentialEarnings", and so on. The slot values are sometimes numbers or, if appropriate, verbal tokens such as "inner" or "outer" in the "innerOrOuterLondon" slot.

As a key debugging aid, every fact must conform to a fact template that specifies the scope of the fact (global or known only to specific agent types) and the slot names and the types of slot values (e.g. Double, Integer, String or arrays of these types). It is also possible to define types so that "outer" and "inner" are the possible values of the type "InnerOrOuter". The fact template for the boroughCharacteristics facts is defined in DRAMS as shown in Figure 8.

```
(deftemplate global::boroughCharacteristics
        (uuid:UUID)
        (instName:String)
        (residentialEarnings:Double)
        (housePrices:Double)
        (landArea:Double)
        (innerOrOuterLondon:InnerOrOuter)
        (affordablePriceEarningsRatio:Double)
        (marketPriceEarningsRatio:Double)
)
```

**Figure 8:** Example for DRAMS fact template.

The DRAMS code for the fact templates such as this and the specific facts can be generated by the CCD2DRAMS tool from the CCD Objects and Instances. Moreover, the DRAMS code maintains the links between the CCD element from which the code was generated. Consequently, any annotations linking the CCD elements to documentary evidence can be followed from the generated elements in the DRAMS code.

When the development of DRAMS rules takes the form of filling in the rule stubs generated by the CCD2DRAMS tools from CCD Actions and Conditions, these link back indirectly to the documentary evidence are automatically maintained. However, experience with the toolkit suggests that it is normally best to develop rules within DRAMS because DRAMS has a rule editor that supports testing the rule in given conditions as the rule is developed clause-by-clause.

Each rule has a rule name corresponding to the label on a CCD Action. Each clause of the left hand side (LHS) of the rule must conform to a fact template but with variables allowed in the place of slot values. These variables are unified with values in facts on the appropriate (global or agent) fact base. By running the model until a particular set of conditions is realised in the fact bases, a further step in the decision-making processes of the various agents can be crafted as a rule and tested to see whether the rule will be activated and whether the effect of the rule is what the modeller has intended. The effect of a rule on the conditions prevailing in the model is always to assert new facts corresponding to appropriate fact templates. The new facts are asserted by the right hand side (RHS) of the rule.

Once such a rule has been implemented, the modeller can then go back to the CCD to define an Action with the same label as the name of the DRAMS rule and link Conditions corresponding to the DRAMS facts to the action as either pre-conditions corresponding to the LHS clauses of the rule or

post-conditions corresponding to the RHS clauses of the rule. Running the CCD2DRAMS tool links the newly defined CCD Action to the previously implemented DRAMS rule.

Building up the rulebases of agents is thus seen to be partly the completion of rule stubs generated by the CCD2DRAMS tool from the CCD and partly the definition of CCD Actions defined to cohere with DRAMS rules. Which of the two possibilities is dominant in CCD and simulation model development will depend on the style of the modeller and the degree of relevant complication of the policy context and therefore the CCD and the simulation model.

## 2.3. DEVELOPMENT OF MODEL-BASED SCENARIOS AND SCENARIO ANALYSIS

Based on simulation output policy analyst creates a model-based scenario that links policy descriptions made by stakeholders as well as official background documents to the model outcomes, thereby to provide evidence supporting the model-generated scenarios. The new model-based narration is annotated to the simulation logs using Simulation Analysis Tool (Figure 9). The model-based scenario may refer to individual changes observed in the system (e.g. what stands behind decisions of a single household that changes its energy consumption patterns) or can encapsulate general tendencies at the collective level. It may have structure of the vignette – a set of short narrations that are focused on the chosen moment in the process. In case of contradicting narrations, there might be several parallel scenarios or vignette structures.

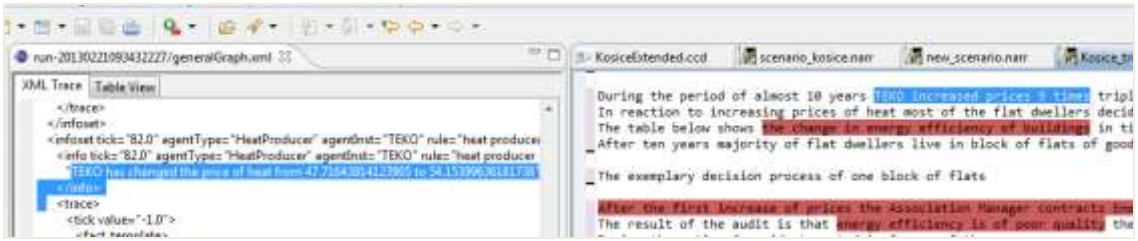



**Figure 9:** Exemplary annotation of model-based scenario allowing traceability back to the logs, CCD as well as stakeholders' input.

The model-based scenarios and other simulation outcomes (like tables, charts) are uploaded to the online collaboration platform. Next stakeholders are invited to comment on the results of the simulation, revise or elaborate on their scenarios, thus starting new round of iteration.

## 2.4. TRACEABILITY

Traces are the means for increasing credibility of simulation results by providing evidence that assertions generated by the simulation models have links to the informal description of the real-world section which is subject of the model. Traceability facilitates navigating from simulation outcomes back to the simulation model back to the conceptual model, and finally back to the empirical basis (i.e. scenarios and background documents). The traces established help stakeholders to better understand simulation models of particular policy perspectives, but are also important auxiliary means for policy modellers, by helping the experts to better understand complex interrelations of policy aspects and how informal data elements feed into a formal model [37].

Starting point and hub of the technical realisation of traces along the phases of the OCOPOMO process is the CCD. On the one hand the annotations of text phases of scenarios and background documents to the conceptual model elements are maintained by the CCD, on the other hand each CCD entity is equipped with an unique uniform identifier (UUID), which can easily be processed by modelling and simulation tools, and passed along the subsequent model and simulation artefacts.

The first step of processing the traces is to attach the link UUID to relevant elements of the formal simulation model. This step is supported by a model-to-text code generation tool (CCD2DRAMS), which generates the code stubs with appropriate link tags from the CCD model (Figure 10).

```
/*Object: HouseholdCharacterstics
 *@link _j2N48MdEEeGILbUlSo0ubw
 */
(deftemplate Household::HouseholdCharacterstics
    (uuid:UUID)
    (instName:String)
)

/* Action: calculate the household heat demand
 *@link _KSe8AK8GEeGItqqK0ME1Yw
 */
(defrule Household::"calculate the household heat demand"
(
    // insert LHS clauses here
=>
    // insert RHS clauses here
)
```

**Figure 10:** Generated DRAMS code with a fact template definition (`deftemplate`) and rule stub (`defrule`) with link UUID annotations (`@link`).

As next step the traces are processed by the simulation tool, i.e. DRAMS. In DRAMS, the creation of the trace information is an ancillary procedure of the forward-chaining rule engine process. A simplified description of this algorithm comprises five steps:

1. At the initial state of the rule engine - no rule has fired - a number of fact templates, partly concrete facts for the templates and rules are present. For subsets of each of these elements (for which CCD elements exist), trace tags are attached.
2. When the rule engine is initiated, it firstly checks which rules might fire with the given set of facts. The LHS's (left-hand-sides, specifying the conditions) of these rules are evaluated, and for each successful evaluation, the RHS (right-hand-side, describing the actions) is triggered.
3. The RHS processing starts with checking, whether at least one of the facts evaluated by the LHS (and, hence, determining the data basis for the RHS execution) is attached with a trace tag. If this is the case, a new trace tag for this particular rule firing at the current simulation time is generated, using the information (link UUID) stored in the rule trace tag, if available. All trace tags for the LHS facts are then incorporated as predecessors of the rule firing trace tag.
4. The rule firing trace tag, or the rule trace tag, according to disposability, is then passed to all RHS clauses.
    a. A clause for asserting a new fact to a fact base generates a new trace tag for this fact with the trace tag delivered by the rule as predecessor.
    b. A clause for writing output data (e.g. a log record) passes the trace tag to the output processing facility.

5. When all rules have fired, the newly created facts constitute the new state of the rule engine, and the processing continues with step 2.

If a rule producing a log record or (numerical) outcome data is either equipped with a trace tag, or when any of the elements that lead to firing this rule have had a trace tag attached, then a "connector" trace tag is available as result of the algorithm. This connector trace tag can be seen as root node of a directed acyclic graph, which covers all the important steps for creating this log or outcome. The DRAMS Model Explorer Plugin [37] can be used to visualise and explore the generated trace graph (Figure 11). After finishing a simulation run, a potentially very large graph data structure is available, holding information about traces for all relevant generated facts and simulation outcomes.

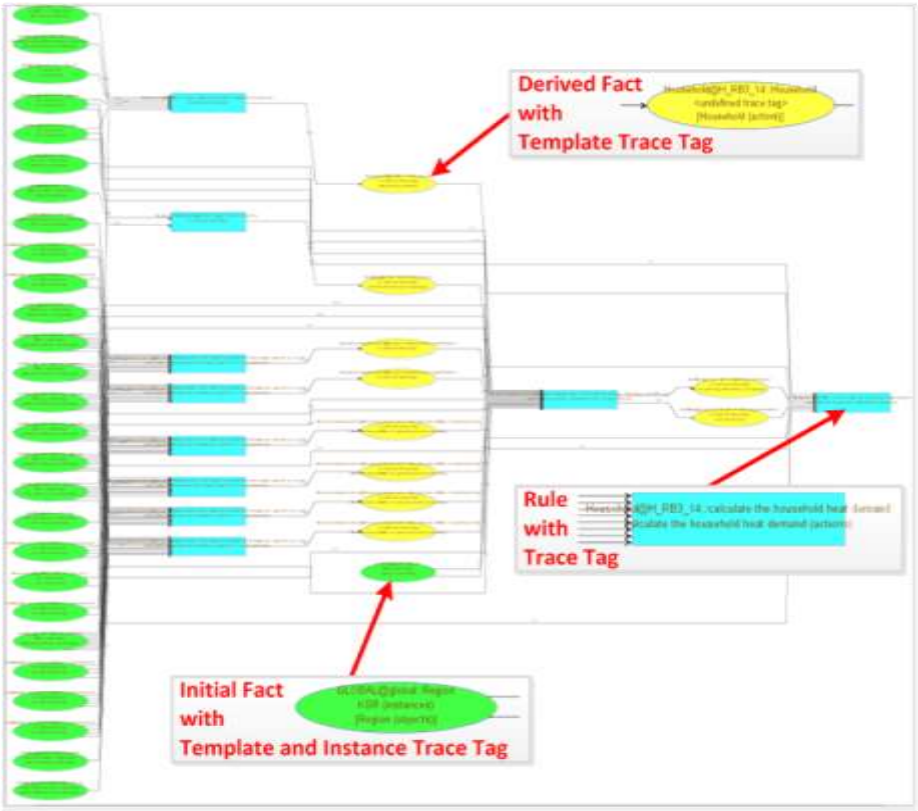



**Figure 11:** Trace graph from a simulation run (root node on the right side).

The trace information stored in the graph is attached to the simulation outcomes. These outcomes are stored in XML files, and in the next processing step used as input for the Simulation Analysis Tool, described in the previous section. The narrative model-based scenarios finally contain the trace information as well, and can be visualised in the collaboration space.

Hence, from the stakeholder perspective the trace information can be used to find the text passages in initial or stakeholder scenarios and background document, which have contributed to a specific simulation outcome. Figure 12 shows one of the so called vignettes, a part of a model-based scenario describing a specific detail of the simulation result. The overall result presentation consists of an overview scenario, linking to a number of such vignettes. For the highlighted text phrases trace information is available. Clicking on the phrase opens an Annotation info box with the related text passages from the documents of the evidence base.

Usually, the model-based scenarios are translated into the stakeholders' language (see Figure 13), and also for the conceptual model a translation can be provided. Figure 14 shows the CCD Explorer

Applet with a part of the translated action diagram displayed. This view is triggered by a link in the Annotations info box, and it is possible to filter the content according to elements which are relevant in the trace information.

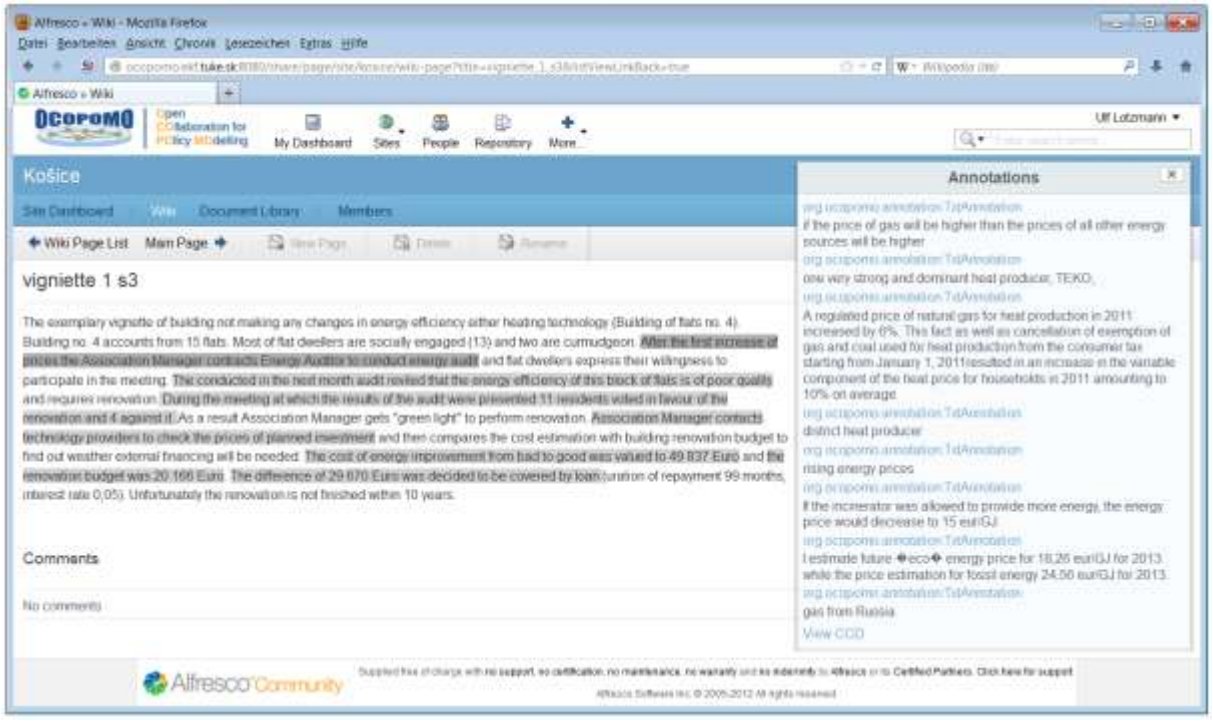



**Figure 12:** Presentation of simulation results to stakeholders: vignette with Annotations info box for the first highlighted text phrase.

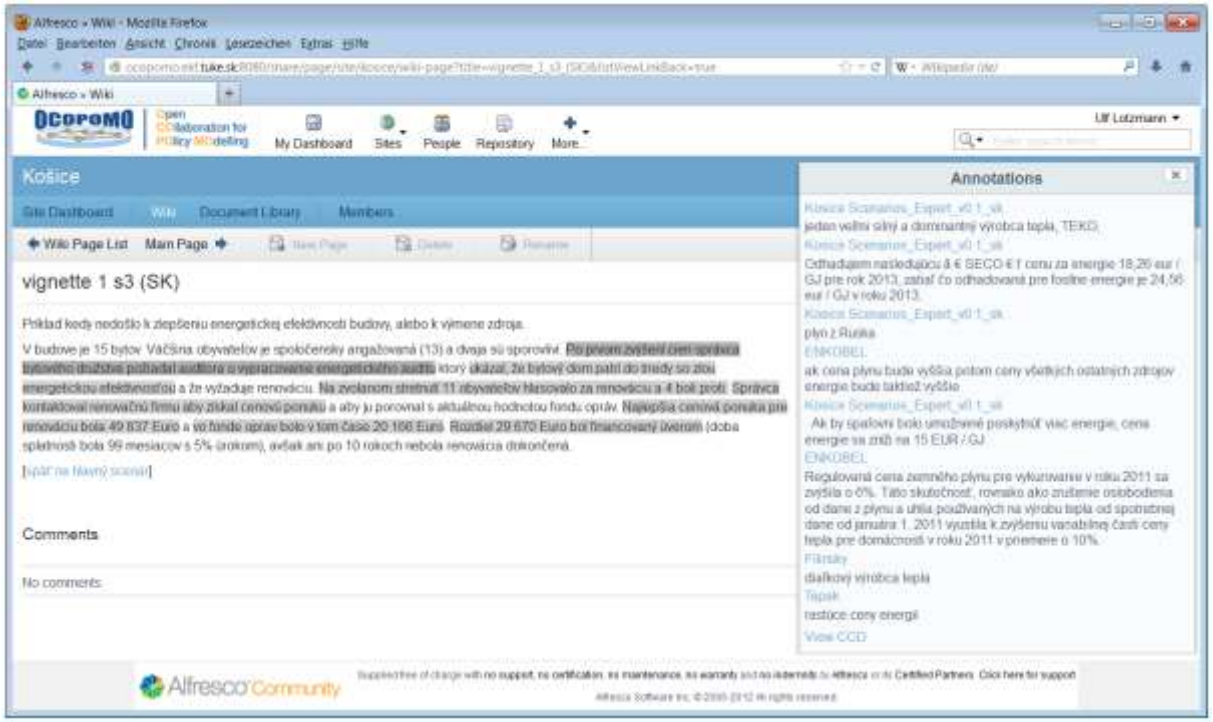



**Figure 13:** Slovak translation of the vignette showed above.

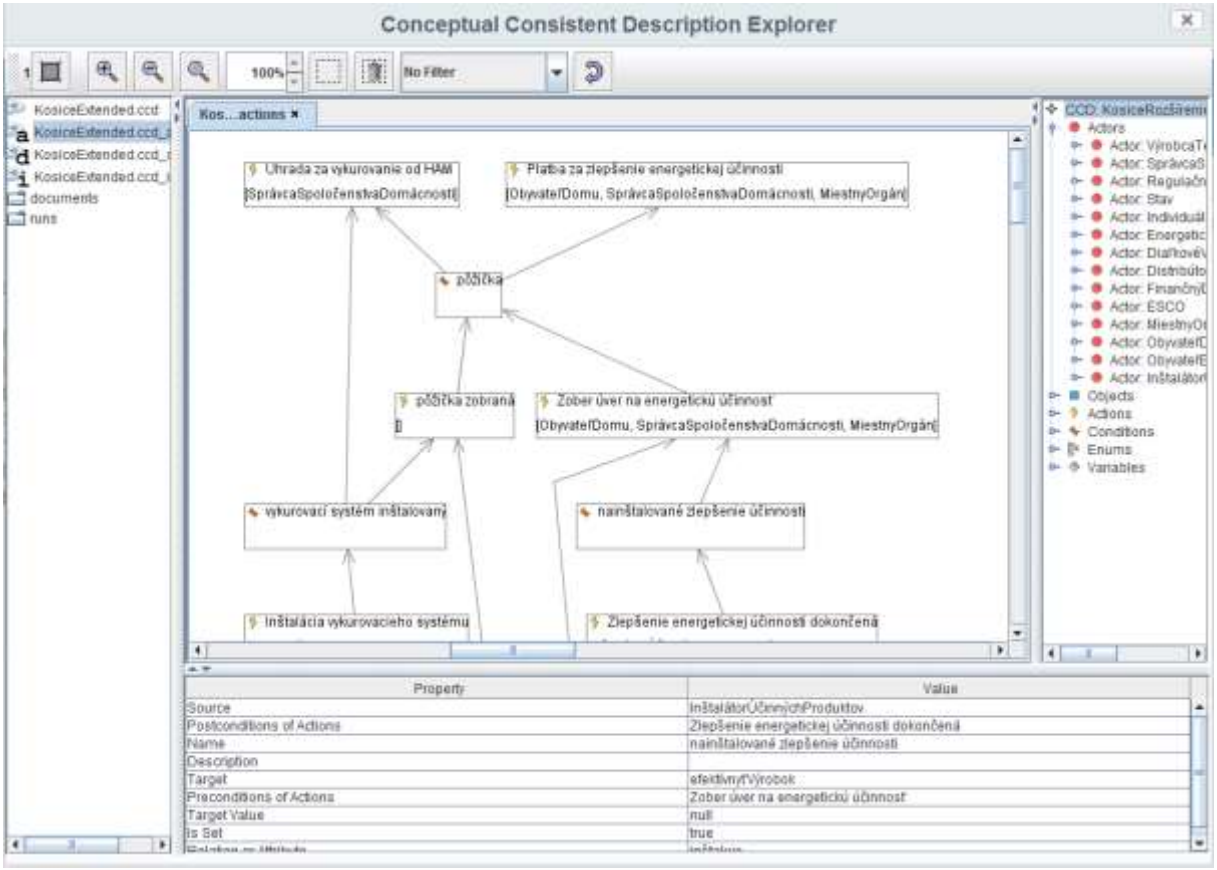



**Figure 14:** Action diagram displayed when clicking on the "View CCD" link in the Annotations info box from the previous screenshot.

## 2.5. THE DEVELOPMENT OF A COMMON MACROECONOMIC MODEL FOR THE PILOTS IN OCOPOMO

The purpose of the macroeconomic model was to generate simulated time-series data that does not lend itself to forecasting with better accuracy than real-world forecasting models. This will be a property of any model generating complexity in the sense of interactions amongst entities that result in macro-level outputs that cannot be explained by, for example, scaling up the behaviour of individuals. In the design of the OCOPOMO project, this was thought to provide a realistic context for the analysis of social policies such as those of interest in our case studies.

By adding the London housing case to the project, the resources available were diverted from the macroeconomic modelling. Also, the three case study models and analyses turned out to be interesting without the complication of introducing the macroeconomic context. A concern explored in section 6 below was the necessity to provide the outputs from relatively complicated models to the stakeholders in a form that they would find both comprehensible and interesting. To add essentially peripheral content at this stage was deemed unnecessary and probably unwise.

Nonetheless, the macroeconomic model as developed in WP5 did provide an application for the development of DRAMS and the CCD prior to the development of the stakeholder scenarios and other information required for the Campania and Kosice models. Consequently, the macroeconomic model provided the basis for an important contribution to the development of the OCOPOMO toolkit, albeit a different contribution to the project than had been anticipated.

## 3. RESULTS FROM KOSICE SELF-GOVERNING REGION

In this section, the scenarios, CCD models, DRAMS agent-based models, and the outputs of the simulation, namely the model-based scenarios from the Kosice Self-Governing Region use case are presented.

### 3.1. SCENARIOS FROM KOSICE SELF-GOVERNING REGION (KSR)

Based on the method of scenario generation introduced in section 2.1, the initial scenario for the KSR pilot was developed on the basis of discussions, interviews and background documents provided by the user partner KSR in the consortium. Additional interviews with three key stakeholders (Energy expert, NGO expert, household representative) resulted in three further scenarios. A kick-off workshop with stakeholders was carried out in early January 2012 to introduce OCOPOMO, the policy development process and the stakeholder participation platform with the possibility to develop scenarios by the stakeholders themselves. During second trial we collected additional scenarios representing perspective of the following groups: main heat producer in Kosice, minor heat producer, housing association manager, technology provider, public buildings administrator. Moreover on the OCOPOMO platform stakeholders commented on existing narrations and uploaded supporting background documents.

The policy to be developed for the Kosice Self-governing Region covers the subject of energy policy (heating). The focus is on three issues, namely energy efficiency, decrease of energy consumption and utilization of renewable energy sources in the KSR. The main aim of the scenarios is to describe the behaviours of key stakeholders and the process of decision making in the energy domain. The scenarios combine interrelations between the local environmental as well as spatial determinants, economic conditions and realistic social dynamics to inform the KSR model, which in the end allows for testing the effectiveness of various government policies under different conditions.

Subsequently, the background of the KSR policy case, the key questions and motivation for the stakeholders to participate in the scenario exercise, a summary and references to the initial scenarios and a brief status of current stakeholder participation in scenario generation are provided.

***Background for Initial scenario of the Kosice Self-Governing Region***

Renewable sources of energy such as solar power  geothermal energy and biomass were identified as essential alternatives to fossil fuels. It is expected that the use of renewable energy reduces the greenhouse gas emissions, diversifies the energy supply and reduces the dependence on unreliable and volatile fossil fuel markets (in particular oil and gas). The growth of renewable energy sources is expected as stimulating employment in Europe, creating new technologies and improving trade balance.

The energy policy has become a key development factor on national as well as regional level. On one hand, the existing structure of energy suppliers in Slovakia deepens dependency on the traditional Russian primary energy resources. On the other hand, it supports functioning of the monopoly producers and distributors. The Kosice Self-Governing Region offers significant future potentials for several kinds of Renewable Energy (RE) sources, which can be exploited in the period of years to come. Of course, significant barriers to wider deployment of RE is the cost factor (reflected in price) and available technologies. In spite of the existence of the current barriers, it seems viable that in the heat sector RE sources can play significant role in the KSR in the near future.

Efficient energy consumption is, therefore, a central policy issue. The view described below envisions the 2020 renewable energy policy of Kosice Self-Governing Region. This scenario shall lay the foundation for the implementation of a regional renewable energy action plan including financing instruments to achieve the 2020 renewable energy policy goals.

There are two possible goals in terms of energy policy:

- Increase energy efficiency/decrease energy consumption (e.g. by insulation).
- Increase renewable energies

***Motivation and key questions for Stakeholders to participate in the scenario generation of KSR***

Since the quality of the policy strongly depends on the interplay of the different stakeholders, we asked stakeholders to provide us with ideas and perceptions towards renewable energy, as well as operational measurements to improve efficient energy consumption. The quality of the policy to be developed strongly depends on stakeholders contributions and scenarios. Therefore, we asked them to build scenarios, i.e. to undertake simple "what if" exercises thereby outlining several possible future developments and anticipating opportunities of different developments. We underlined that their scenarios should be archetypal images of possible behaviour and developments. They were asked to:

- either start participating in and advancing the scenarios provided by us or to build their own scenarios.
- either interpret current realities (i.e., to explain their behaviour based on current circumstances) or find new aspects of the future thereby capturing possible future ideas and anticipating opportunities of different developments

They were advised to write scenarios that are internally consistent, plausible, although mutually different stories. Scenarios could include contrasting perspectives on the future and could support better policy development. Stakeholders were free to change current conditions (i.e. change current facts, but only those that can be changed, e.g. law can change, policy can change. However, they were not allowed to defy the laws of e.g. physics.)

Their task was to provide ideas and perceptions towards renewable energy, as well as operational measurements to improve efficient energy consumption. Since the success of the measurements strongly depends on the acceptance of the people who take action, we wanted them to inform us about promising measurements as well as the pros and cons of measurements that have been established so far. For us it was necessary to know:

- what they think about traditional energy production and consumption?
- what they think about the different alternative renewable sources of energy?
- what instruments would they like the Kosice Self-Government Region to establish for promoting the use of renewable energy
- how will they proceed if they want to trigger a change (e.g. renovate house in which the flat is, in which they live, apply for government grant, etc.) ?
- what is the market for a specific kind of energy?
- what are the barriers hindering a specific kind of energy use for energy generation in Kosice region?

We also asked them to provide simple If-Then argumentation:

- what are the conditions for them to change their energy consumption behaviour
  For instance, "as a house owner I would spend some money to install photovoltaic panels at the top of my roof, if government would subsidise it with at least 50% of the total costs".
- what do they think are the conditions for the remaining stakeholders to change their behaviour
  For instance, "I think that people won't like to install photovoltaic panels because they perceive them as ugly and, therefore, the use of other renewable sources of energy is more promising".

***Initial scenarios of KSR***

In APPENDIX A: Scenario descriptions of KSR are provided. Different views have been generated as mentioned above. The scenarios are available to the stakeholders via the collaborative scenario generation platform under http://ocopomo.ekf.tuke.sk/share/page/site/kosice/dashboard. It is to be noted that the text for stakeholders has been translated and prepared in Slovak language in order to overcome potential problems with English. The facilitators and pilot partners from TUK and KSR subsequently translated the scenarios into English in order then to proceed with the CCD modelling and programming of the simulation models.

***Status of stakeholder consultation***

Table 1 provides an overview of activities towards preparing the initial scenarios for the KSR case. The stakeholder involvement has started on 10th January 2012 with a kick-off workshop. Table 2 provides some facts on stakeholder participation in the KSR case. The collaborative scenario building with stakeholders was open from 10/01/2012 till mid Feb 2012.

**Table 1:** Overview of workshop and interviews performed in KSR case.

| ***What*** | ***Date*** | ***Where*** | ***Participants*** | ***Output*** |
|---|---|---|---|---|
| *Scenario building workshop* | *03/03/2010* | *Kosice / Slovakia* | *Representatives of Kosice Self-Governing Region* | *1 draft of initial scenario* |
| *Scenario building workshop* | *08/12/2010* | *Neaples / Italy* | *Representatives of Kosice Self-Governing Region* | *1 initial scenario* |
| *Individual interviews* | *22-23/06/2011* | *Kosice / Slovakia* | *NGO expert, Energy expert and Representatives of Kosice Self-Governing Region* | *2 initial scenarios* |
| *1st trial workshop* | *10/01/2012* | *Kosice/ Slovakia* | *KSR authorities and invited stakeholders* | *Registration of stakeholders on OCOPOMO platform* |
| *1st trial* | *10/01/2012 – 17/02/2012* | *Kosice/ Slovakia/online collaboration platform* | *KSR authorities and stakeholders* | *Stakeholders scenarios (5),comments and documents* |

**Table 2:** Facts about the first and second iteration of online consultation with stakeholders in KSR.

| | |
|---|---|
| *Duration of online consultation* | 1st iteration:10/01/2012- 17/02/2012,<br>2nd iteration:11/03/2013 – 12/04/2013 |
| *Stakeholder groups* | *energy producers*<br>*energy consumers (i.e., representative of flat associations, households, public building administrator)*<br>*policy makers*<br>*technology experts/providers*<br>*NGOs*<br>*energy distributors* |

| | |
|---|---|
| | *energy auditors/consultants* |
| *No. of stakeholders participating in the kick-off workshop* | *10* |
| *No. of stakeholders participating in 1st iteration* | *18* |
| *No. of stakeholders participating in 2nd iteration* | *11* |
| *No. of initial scenarios provided* | *3* |
| *No. of stakeholders contributing to the initial scenario* | *3 (NGO, energy expert and KSR representative)* |
| *No. of scenarios developed by stakeholders* | *5* |

## 3.2. SCENARIO ANALYSIS TOWARDS POLICY MODELS FOR KSR

The policy model for KSR was developed in two steps: (1) prototype model and (2) final policy model.

The first prototype model was built based on the "expert scenario" that contained the most extensive consideration of the energy situation in Kosice. It enabled to develop boundary values of the biggest energy players (Combined Heat and Power plant (CHP) TEKO, Garbage Incinerator KOSIT, pipeline owner TEKO, company licensing geotherm sources Geotherm Kosice). Then the model was extended by the data extracted from other scenarios (see Appendix C) and documents gathered during the 1st trial.

During the development of the model relevant materials were analysed and phrases related to energy (heating) topic were manually annotated. On this basis CCD indicating actors, relations and their actions was created. Rules depicting actors behaviours were presented in a form of conditions and actions. CDD enable people who are not professional programmers (most of stakeholders) to see the structure of the model and basic dependencies. Hence stakeholders are able to understand links between their input (e.g. stakeholders-based scenarios) and the output (e.g. model-based scenario). In case of KSR pilot distinguished actors, "natural language rules" and CCD were consulted first with KSR use case partners and then published on OCOPOMO platform.

After consultations, the CCD was translated into DRAMS code using the CCD2DRAMS tool. Based on the output of the simulation model, a model-based scenario was developed. This again promotes understanding of the model output among stakeholders as narrative description helps them with the interpretation of results obtained.

## 3.3. CCD MODEL(S)

In the process of conceptual design of the KSR model we have used the CCD toolbox. We started from identifying main actors and objects; then we specified their attributes, which was supplemented by creation of adequate variables and enums. Once we elicited all main actors we identified basic relations between them that are depicted in actor network diagram (see Figure 16) and defined their spectrum of behaviours (see Figure 17) in form of conditions and actions. The identified elements were annotated in the text (scenarios; see Figure 15).

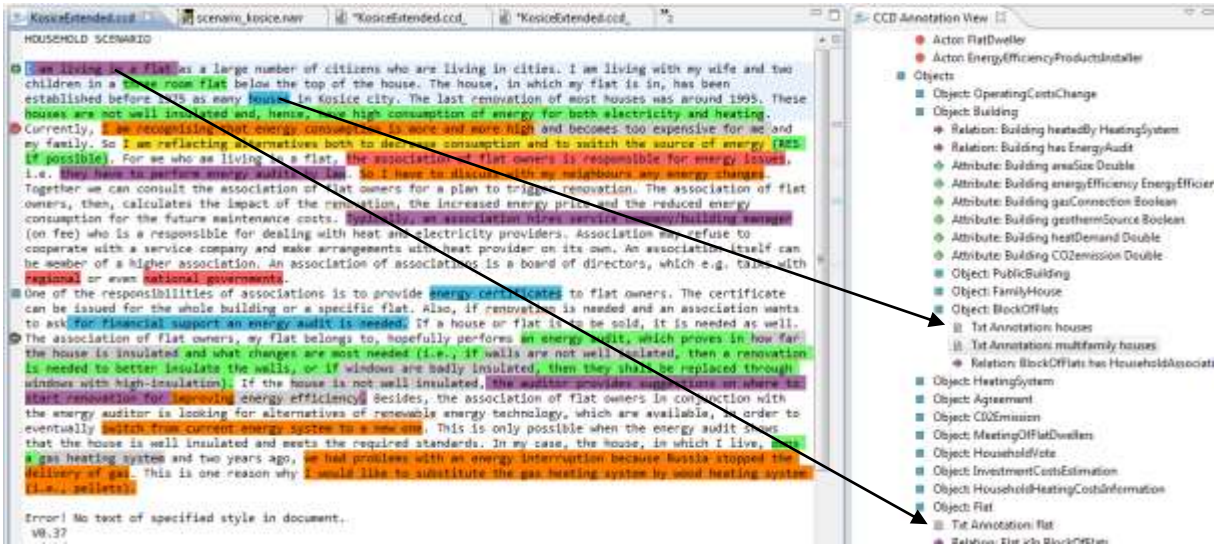



**Figure 15:** Examples of objects and attributes with annotation in CCD.

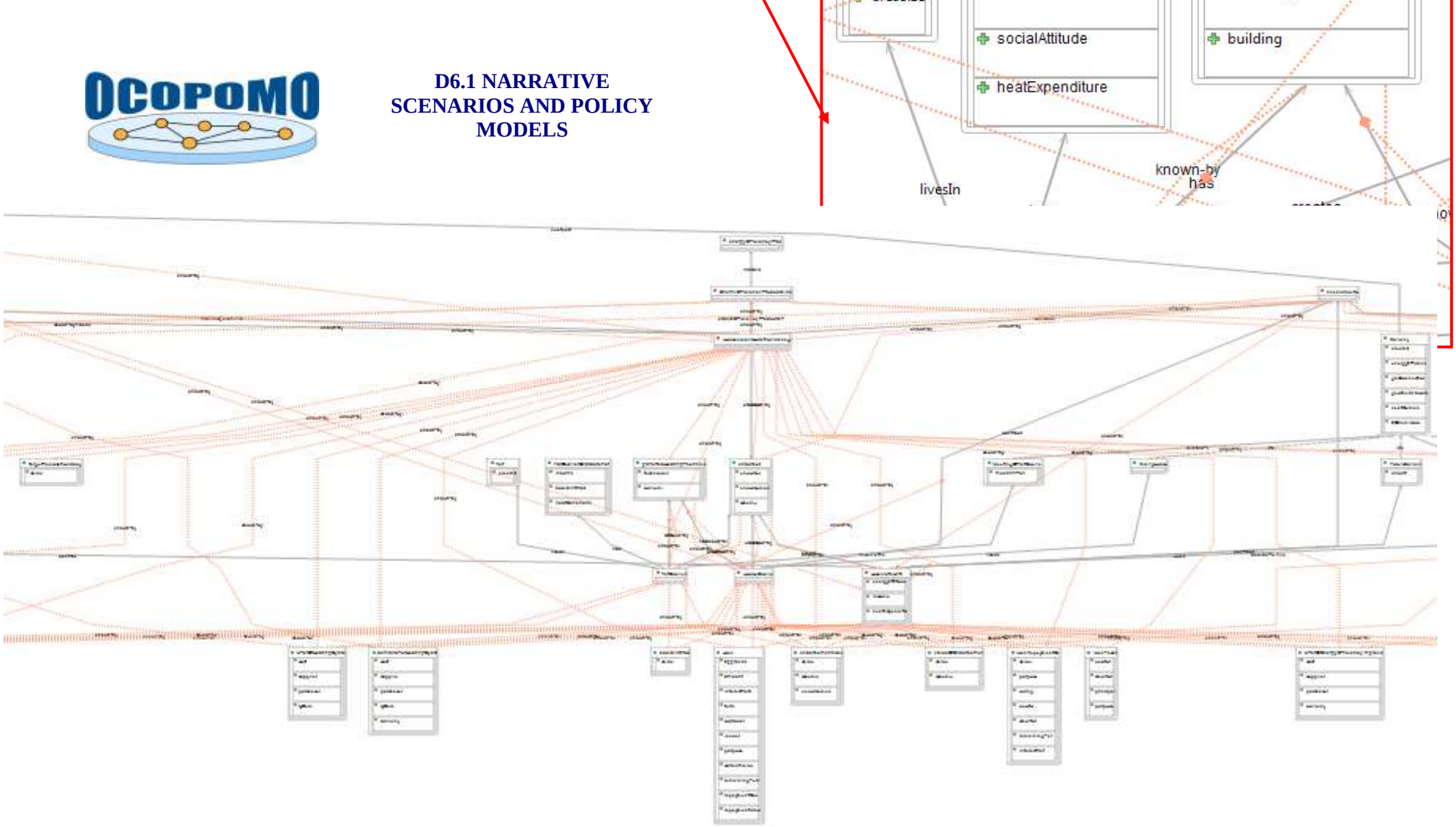



**Figure 16:** Actor Network Diagram for KSR use case with zoom in.

The main groups of actors identified in the prototype model are compiled in Table 3.

**Table 3:** Actors in Kosice model.

| | |
|---|---|
| **Gas distributor** | Gas distributor is engaged in delivering gas to energy producers and households. |
| **Heat producer** | In our prototype model we defined heat producers as companies which provide heat to district heating system. We have distinguished three main heat producers' instances: garbage incinerator KOSIT, CHP (combined heat and power plant) TEKO and Geotherm Kosice.<br>• Garbage incinerator KOSIT produces heat from waste and delivers it to district heating which capacity is 500.000GJ.<br>• CHP TEKO is a dominant heat producer in Kosice city. It produces heat from gas and coal.<br>• Geotherm Kosice is an owner of the license for the utilization of geothermal resources placed near to Kosice. In future geothermal resources could be used for heating, but now it is closed. |
| **Individual heating system provider** | In our model we define heating system provider as company that sells various heating technologies to end heat consumers. |
| **Energy efficiency product installer** | This represents companies that provide renovation services to housing associations, households and public buildings. Services include insulation of building, window exchange which is reflected in the model by upgrade of the heating system efficiency in a building. |
| **Finance house** | Finance house grants credits to heat consumers for renovations of buildings and transformation of heating technologies. |
| **Household association manager** | Household association managers are responsible for managing of blocks of flats, e.g. they call flat dwellers meetings, contract auditors and apply for loan to finance house. |
| **Flat dweller** | Household that is an owner of the flat. He/she makes key decisions regarding renovation of the building or change of the heating technology via voting. |
| **House dweller** | In our model house dweller owns family house and decides about energy efficiency and heating technology in his/her building. |
| **Local authority** | Local government owns public buildings and control them in terms of heating efficiency. |
| **State** | In our model State is responsible for granting subsidies for renovation of buildings. |
| **Regulatory office** | In our model regulatory office is responsible for controling of energy prices. |
| **Slovak Government** | In our model Slovak government agencies are responsible for granting subsidies for renovation of buildings, regulation of energy prices and |

| | |
|---|---|
| **Agencies** | inspection of heat producers. |
| **District heating** | District heating company distributes heat from heat producers to heat consumers. |
| **Energy auditor** | Energy auditor checks energy efficiency of the buildings. |
| **ESCO** | Energy service company, responsible for providing range of comprehensive energy solutions. |

***Objects:***

In our prototype model we have distinguished following objects: operating cost change, building (public building, family house, block of flats), heating system (individual heating system, collective heating system), agreement, CO2 emission, meeting of flat dwellers, household vote, investment cost estimation, household heating cost information, flat, energy source, price change, heat, energy audit, loan, state aid, investment plan, flat dweller characteristics, house dweller characteristics, local authority characteristics, voting result, endorsement value, social attitude, value of endorsements, heating technology characteristics, preferred heating technology, number of votes, energy efficiency product, offer of heating system, offer of energy efficiency improvement, demand for heating system, heating system installation cost, renovation budget, heating system transaction, demand for energy efficiency improvement, energy efficiency improvement cost, efficiency improvement transaction, payment, efficiency improvement installed, loan repayment due, payment requested, target renovation budget, loan taken.

***Actions and conditions:***

We have identified actions that are possible for each actor and associated them conditions (pre- and post-conditions) building the diagram of actions. The multiplicity of relations between actions and conditions is shown in Figure 17. The enlargement of the fragment of the graph (Figure 18) depicts the possible reaction of flat dwellers to increase of energy price driven by change of energy source price or operational costs.

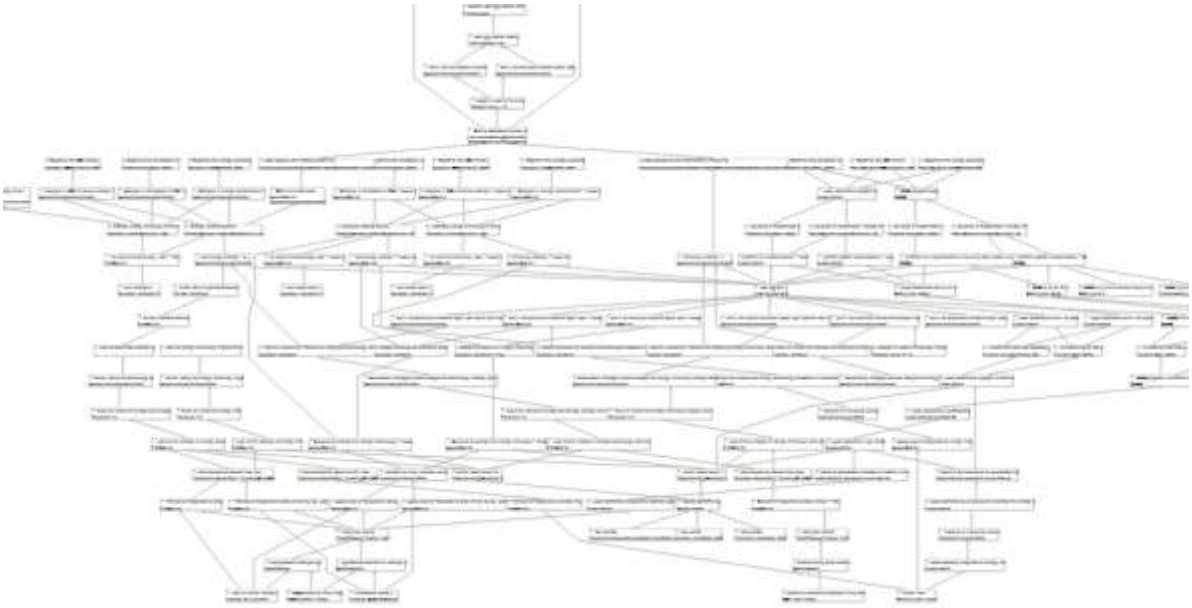


**Figure 17:** Excerpt of the action diagram for Kosice use case.

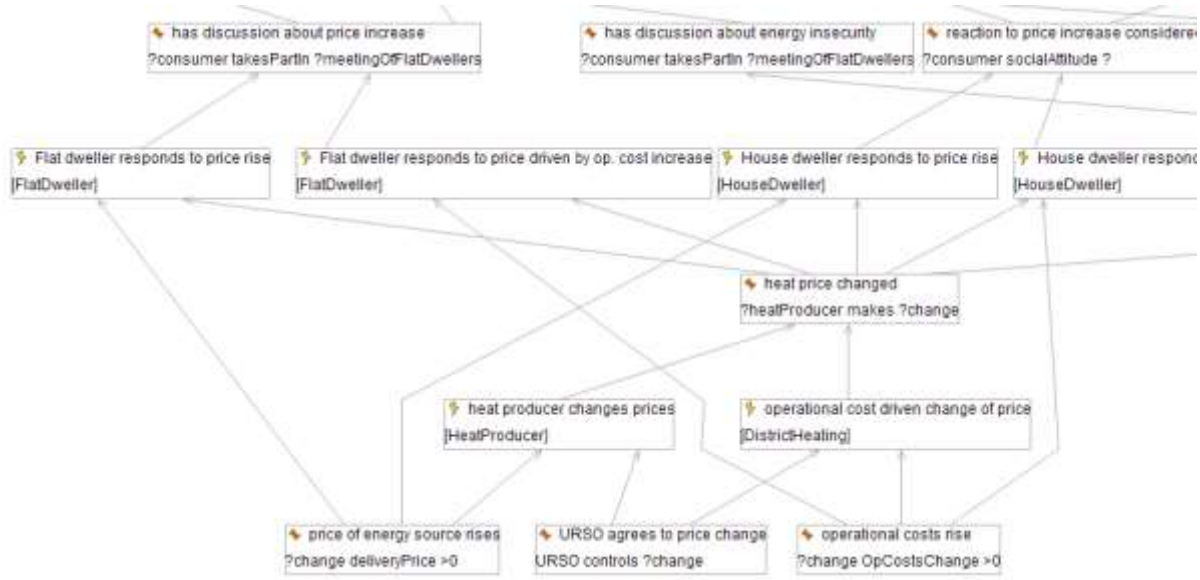



**Figure 18:** Excerpt of the action diagram for Kosice use case – possible reaction of flat dwellers to increase of energy price driven by change of energy source price or operational costs.

### 3.4. DRAMS AGENT-BASED MODEL(S)

The DRAMS simulation model for the Kosice case is partly implemented, with focus on households living in residential blocks (flat dwellers). It is taken care that all important means of interaction among flat dwellers and the different other actors are fully implemented according to the conceptual model. Households living in family houses (house dwellers) are already included and equipped with code for initialisation, so that only rules describing the specific behaviour have to be added. The rules can basically be taken from flat dwellers with minor adaption. Public buildings are not regarded yet.

The simulation environment takes the following important objects into account (defined as fact templates with appropriate initial fact assertions in the code.drams file):

- building, with sub-objects for blocks of flats, family houses and public buildings, together with a flat object;
- heating system of categories "individual" and "collective", with supporting objects like usability characteristics, CO2 emission or installation costs;
- energy source;
- energy efficiency product;
- several other supporting objects.

The (according to CCD) fully implemented agents are equipped with functionality as listed below.

The **FlatDweller** agent has rules for:

- initialisation, i.e. selecting own attitude, creating relations to neighbours or friends, initialising endorsements (Figure 20 shows the DDG of a similar but less complicated initialisation process for HouseDweller agents);
- reacting on price changes of heat producer;
- voting for measures against cost increase for heat energy and environmental pollution (change heating technology or improve energy efficiency);
- endorsing different heating systems under constrains on availability of heating sources (gas, geothermal) and selecting a technology according to the endorsement values;
- (monthly) payments to a shared fund for heating technology or energy efficiency investments (renovation budget for the building), which are transferred to the household association manager.

The **HouseholdAssociationManager** has rules for:

- managing a shared fund (renovation budget) for the managed blocks of flats (e.g. issue budget invoice, note expenditures and revenues);
- initiate contract with energy auditor;
- initiate meetings of residents, conduct polls among them on heating technology change or energy efficiency improvements, analyse results of polls and trigger measures according to the results;
- trigger and accomplish transactions on heating technology change (with IndividualHeatingSystemProvider) or energy efficiency improvements (with EnergyEfficiencyProductsInstaller);
- interaction with finance house (apply for bank loan, carry out repayment).

The **EnergyAuditor** is able to perform an audit, i.e. to issue an energy efficiency audit for a building on request from another agent (HouseholdAssociatemManager). The fact describing the audit result is asserted to the requesting agent's fact base.

The **EnergyEfficiencyProductsInstaller** implements rules for:

- issue an offer to transact on a block of flats;
- complete an energy efficiency improvement;
- updating the energy record for a building;
- requesting a payment from the buyer.

Similarly, the **IndividualHeatingSystemProvider** implements rules for:

- issue an offer to transact on a block of flats;
- install a heating system.

The **FinanceHouse** (see DDG in Figure 19) is able to:

- assess loan application from household association manager;
- handle a loan repayment.

Finally, the **HeatProducer** triggers the process of interaction among the other agents by proposing price changes.

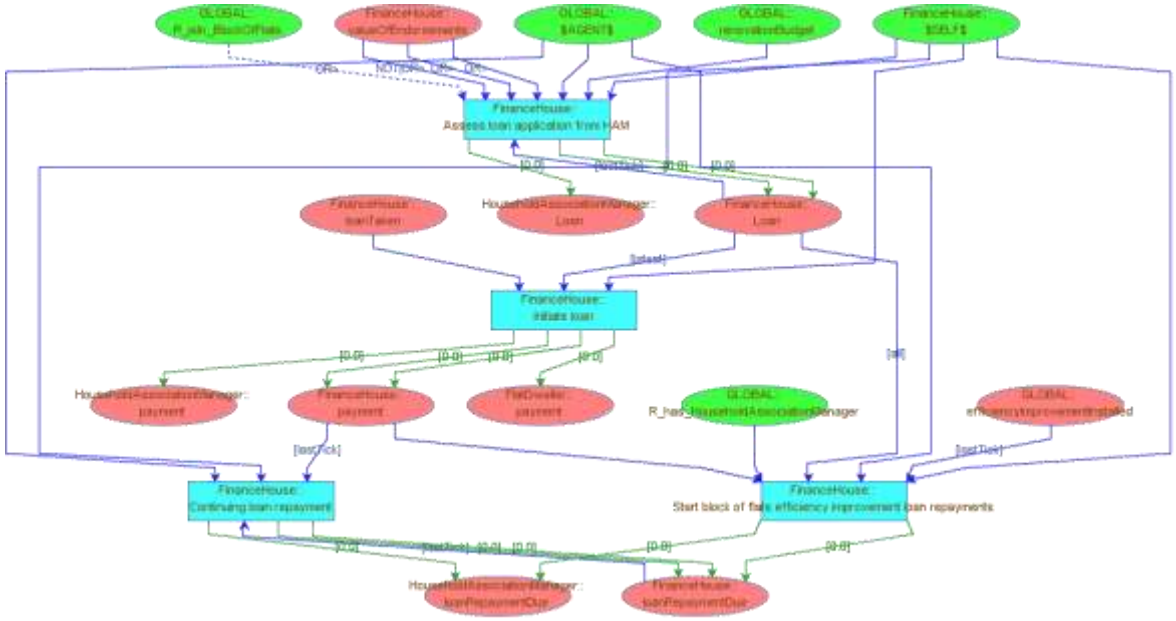


**Figure 19:** DDG of FinanceHouse dynamics.

As mentioned above, the **HouseDweller** agent currently implements only rules for initialisation purposes, i.e. selecting own attitude on environmental protection ("green", not green"), creating relations to neighbours with similar attitudes or friends, and initialising endorsements for heating technologies. As this is a typical example for an initialisation process, the related DDG is shown in Figure 20.

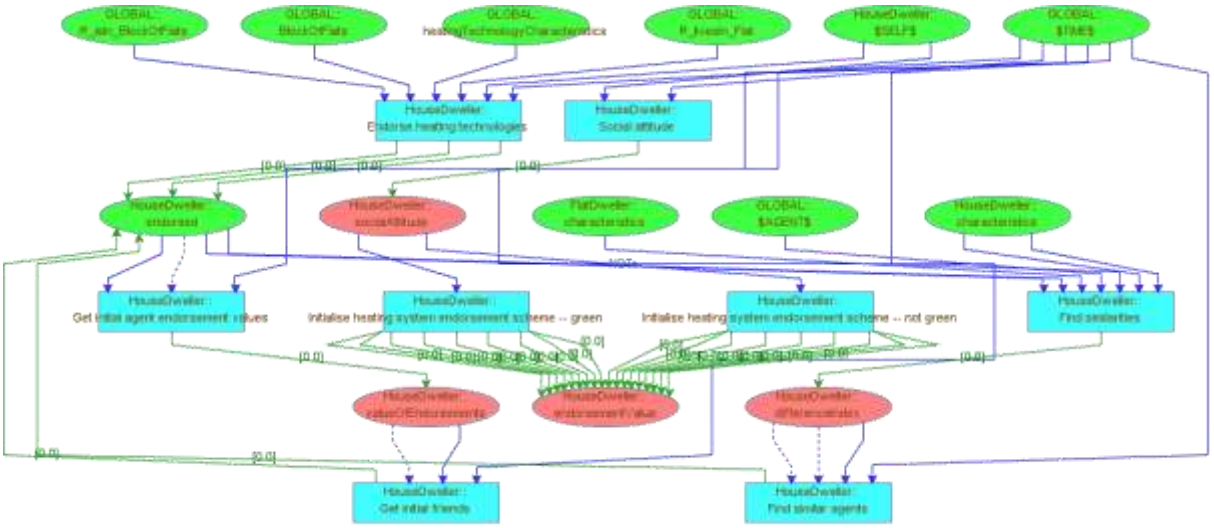


**Figure 20:** DDG describing the initialisation of HouseDweller agents.

The following agents are not implemented at the moment and contain only generated code:

- **DistrictHeating**;
- **ESCO**;
- **GasDistributor** (no actions in CCD) ;
- **LocalAuthority**;
- **RegulatoryOffice**;
- **State**.

Besides printing "utterances" of agents during simulation runs into console windows, making parts of the simulation outcome persistent by writing into files is an essential feature of the DRAMS model in order to allow the creation of model-based scenarios. The related code is implemented in code.drams, from which the important output writer definitions are shown in Figure 21.

```
// definitions of log output writer (to be processed by the Simulation Analysis Tool)
(deflog graph-xml prio <=> 10 19 [no_task, no_sys, no_err, cumulated] "generalGraph")
(deflog graph-xml prio <=> 20 29 [no_task, no_sys, no_err, cumulated] "financialTransactionsGraph")
(deflog graph-xml prio <=> 30 39 [no_task, no_sys, no_err, cumulated] "renovationBudgetPaymentsGraph")

// statistical outcomes (stored in csv files)
(defoutput csv [no_task, no_trace] "flatDwellerStatistics"
        ("heatSys_district":Double) ("heatSys_gas":Double) ("heatSys_bio":Double) ("heatSys_heatPump":Double)
                ("heatSys_dualSolarHeatPump":Double)
        ("utilising_RES":Double)
        ("buildingEff_veryGood":Double) ("buildingEff_good":Double) ("buildingEff_medium":Double)
                        ("buildingEff_poor":Double) ("buildingEff_veryPoor":Double)
        ("attitute_curmudgeon":Double) ("attitute_strongGreen":Double) ("attitute_sociallyEngaged":Double)
        ("change_successful":Double) ("change_unsuccessful":Double)
)
(defoutput csv [no_task, no_trace] "buildingStatistics"
        ("building":String)
        (renovationBudget:Double)
        (loan:Double)
        (loanRepaymentDue:Double)
        (technologyInvestment:Double)
        (efficiencyInvestment:Double)
)
```

**Figure 21:** DRAMS output writer definitions for the Kosice model.

## 3.5. MODEL-BASED SCENARIO(S)

Here we present an exemplary model-based scenario in form of vignette. More model-based scenarios were prepared to stakeholders during the second trial and are shown at the OCOPOMO platform (http://ocopomo.ekf.tuke.sk/share/page/site/kosice/wiki).

***Kosice renewable energy - heating scenario***

Model-generated scenarios of the choice of heating technologies in blocks of flats in Kosice, all indicate that a substantial majority of flats respond to rising energy prices first by improving the energy efficiency of the buildings and then by installing gas-fired furnaces in preference go biomass-fired furnaces.

The changing distribution the number of flats in blocks with different qualities of energy efficiency are shown in Figure 22.

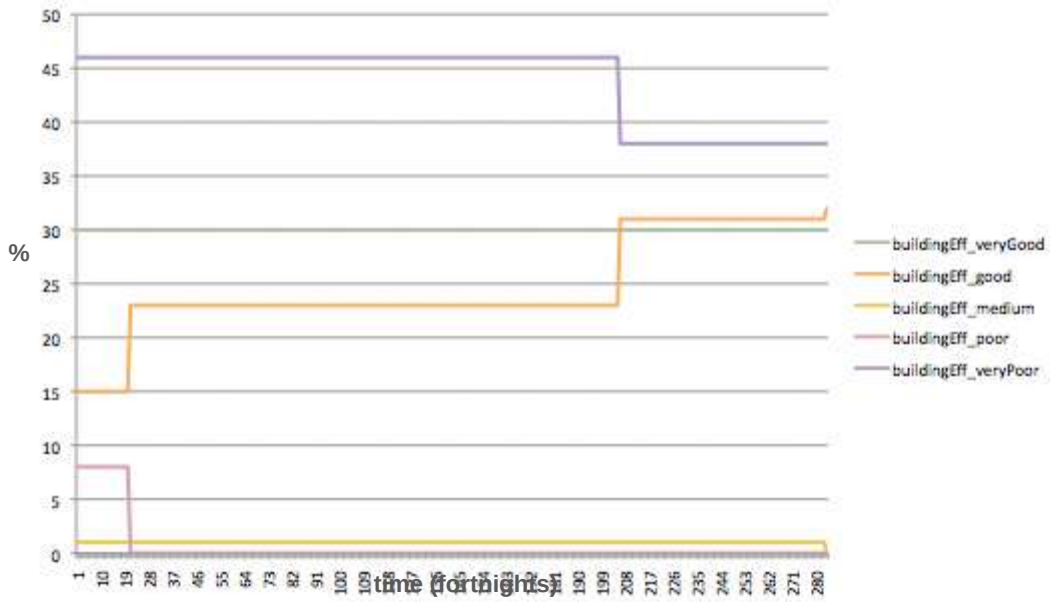



**Figure 22:** Energy efficiency in blocks of flats.

On every occasion when gas prices were increased, the managers of blocks of flats which had medium, poor or very poor energy efficiency as determined by an energy auditor asked the residents of the block to consider paying for an improvement in energy efficiency. An example of such a request and a positive vote for energy efficiency improvement is shown in Vignette 1 (below).

In some cases, a majority of residents of blocks of flats voted against installing energy efficiency improvements. An example of a resident of a block of flats voting against energy efficiency improvements is shown here.

Over the course of the simulation, the percentage of flats in buildings that achieved a good level of energy efficiency was increased by virtue of purchased improvements from 15 percent to 32 percent. The number with a poor level of energy efficiency declined from eight percent to zero early in the simulation but, because of the greater expense and limited finance, the percentage of flats in very

poorly efficient blocks declined from 46 percent only to 38 percent. This was due not only to a reluctance on the part of flat owners but also because finance houses would not provide loans of the size required. This reluctance was due to the requirement for very large loans in relation to the internally generated funds for the block of flats.

A graph of the distribution of different types of heating technology amongst the simulated blocks of flats is shown in Figure 23. As shown in the graph, the number of gas fired furnaces increased over the course of the first 10 years of the simulation.

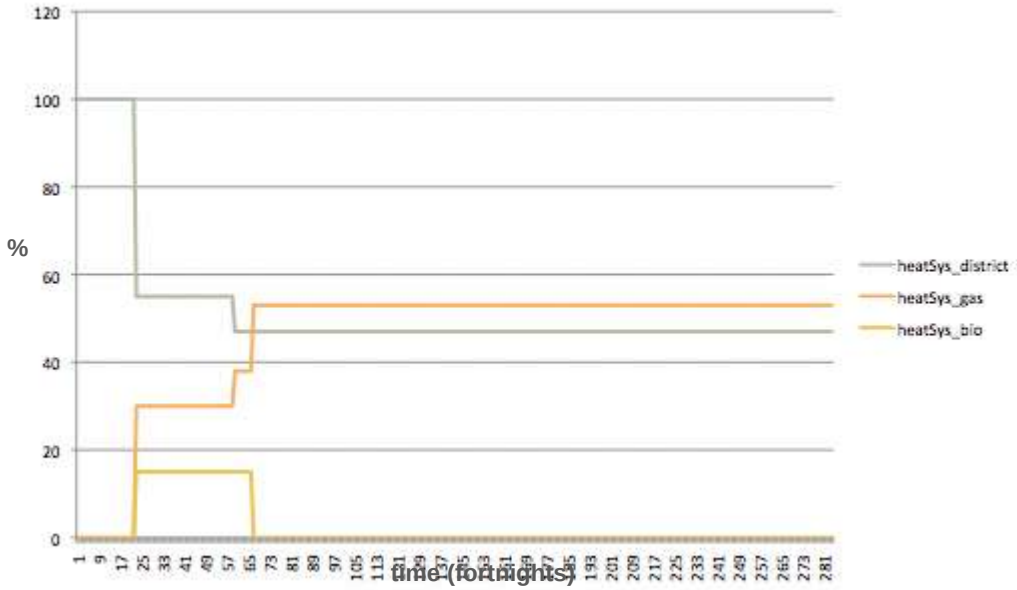



**Figure 23:** Heating technologies in blocks of flats.

***Vignette 1 – GasFurnaceSelectedBOF***

BlockOfFlats-3 went through a process of improving the energy efficiency of the building and, ultimately of replacing its district heating system with a gas-fired furnace. When the price of gas was raised at month 0, the household association manager for BOF-3 placed a contract for an energy audit of the building. The audit showed that the energy efficiency of BOF-3 was very poor. As a result, at a meeting of the flat owners in BOF-3, 11 of the 15 residents voted in favour improving energy efficiency in the building and four voted against. The household association manager approached a firm that installs products to improve energy efficiency and received a quote for improving the energy efficiency of BOF-3 at a cost of 52854 Euros. This process took three months to complete. At the time the quote was received, the renovation budget for the building was just 9700 Euros. Consequently a loan of 41815 Euros was required and applied for at month 5.The loan was approved by a finance house at month 5 for a term of 140 months at an interest rate of 5 per cent. The energy efficiency improvement was completed at month 13 and the installer invoiced the household association manager for 52854 Euros at the same time. By that time, the renovation budget for the building was 11040 Euros. The result of the contract was an improvement of energy efficiency from very poor to good. This improvement was confirmed by an energy auditor at month 26 after another rise in the price of gas. Energy audits confirmed that BOF-3 has a good quality of energy efficiency so that a new and more efficient heating system could be installed at a subsidized price. After yet another increase in the price of gas at month 90, a vote on whether to have a new heating system and the preferred heating technology was held at the six-monthly meeting of residents that same month. The decision to replace

the heating system was approved by a vote of 14-1. The preferred heating system was a gas-fired furnace. An example of the way a resident of the block of flats reached the decision to vote for a gas-fired boiler will be found in Vignette 2.

***Vignette 2 – GasFurnacePreferredByFlatDweller***

FlatDweller-50 voted for the installation of a gas-fired furnace. FD-50 had formed the view that, for purposes of application to large blocks of flats, gas furnaces are environmentally unfriendly, easy to use and easy to install. The only feasible alternative to a gas fired furnace was a biomass fired furnace which FD-50 recognized as being environmentally friendly but also difficult to use. This individual is quite normal in being socially engaged but not very strongly concerned with environmental issues. Evidently, and in common with neighbours in BlockOfFlats-3. The difficulty of installation was more important than environmental friendliness.

# 4. RESULTS FROM CAMPANIA REGION

In this chapter we present the results for the Campania Region use case. This includes the scenarios, scenario analysis, CCD model, Java/DRAMS agent-based models, and the first outputs of the simulation, namely the model-based scenarios.

## 4.1. SCENARIOS FROM CAMPANIA REGION

Similar to the KSR case, the facilitators from UNISOB studied the policy case of Campania and performed a series of interviews and meetings in order to elicit the most appropriate policy domain for the piloting in the OCOPOMO project. The method to develop pilot scenarios for Campania has been based, first of all, on desk research, review of strategic policy documents and relevant literature. This has allowed formulating an initial report identifying the economic, social context, the main actors of the Campania pilot and their interactions. The report has been discussed with internal stakeholders. The summary of background information is available at the stakeholder participation platform[1]. The feedback has been gathered through e-mail interaction and meetings with Campania region and BENECON representatives.

The Importance of face-to-face meetings for building engagement, motivation and commitment, as well as the importance to have the Regional authority as intermediary towards other stakeholders are the main methodological guidelines followed.

Stakeholders have also been enabled to express their views in national language, so to avoid language barriers.

The policy to be developed in the Campania pilot aims at establishing competence centres for knowledge transfer in order to support the development of industrial clusters within the Campania Region (Europe Area Project). The formation of networks between private and public bodies is assumed as the main way to stimulate innovation in SMEs and extend the dissemination of R&D results. The need to create intermediary institutions that were neither business enterprises nor government agencies, but which form an integral part of the local/regional system of innovation, was recognized in Campania. The competence centres represent a networking model with the objective of bringing together in a single pool the research capacities existing in the region in a plurality of institutions such as research bodies, universities, laboratories, etc. that were previously unconnected. In the programming period 2000 - 2006, ten Regional Centres of Competence (CRdC) for different sectors were established. With the consolidation of the public research centres, the first phase of the deployment of this mechanism has already been completed. The second phase, regards opportunities to match the supply and demand for innovation generated by businesses and research centres in the framework of pilot projects. Only in this phase the centres have become legal entities (thus able to sign contracts) they have been able to perform contractual research, and generate income and new spin-off. However, the centres still rely on public funding and are not yet self-sustainable.

Scenarios relate to the third phase of the Europe Area Project, where new and sustainable activities are to be financed. The third phase takes advantage of economic resources and points of scientific and technological excellence to finance new and sustainable activities mainly through a combination of public and private incomes. In the third phase the centre itself looks for potential customers. Also at this stage there are calls for proposals funded by the Structural funds but they require the joint participation of clients companies with their own resources and the centres of the competence. Therefore, the calls for proposals that are being issued are based on 50% public funding and 50% private investment of companies.

[1] http://ocopomo.ekf.tuke.sk/share/page/site/campania/document-details?nodeRef=workspace://SpacesStore/14f58b2f-9db4-4aca-bc0e-c903e9925c92

Subsequently, the invitation letter for stakeholders to participate in the scenario generation of Campania, an overview of the main actors and features of the policy domain, and a status of collaborative scenario generation are documented.

***Invitation letter for Stakeholders to participate in the scenario generation of Campania***

We would like to invite you to take part in an online consultation aimed at shaping Campania policy on technology transfer. This initiative is supported by the Campania region administration and it is conducted within the European research project Open Collaboration in Policy Modelling (OCOPOMO) supported by European Commission in Seventh Framework Programme (www.ocopomo.eu).

This project aims at producing a software supporting decision makers in shaping policies with stakeholders.

The specific objective of the consultation is promoting the self- sustainability of regional centres of competence as an example of effective technology transfer policy

This aim have to be pursued in taking into account needs and expectations of stakeholders involved in and being affected by decisions made in this field. None of them can successfully be met without profound consultations with stakeholders that help to see and understand the issue from different perspectives. Hence the objective of the consultation is to seek interested parties' views on possible solutions and possible new initiatives in this field.

The consultation will take place first through face-to-face meeting, in the form of focus groups and interviews, aimed at scenario generation. After that, online consultation will allow to enrich and refine scenarios.

The interaction with the Regional authority and with BENECON representatives has led to the refinement of the focus of Campania region pilot, identification of the building blocks of the policy model and elaboration of three scenarios, which are reported in APPENDIX B: Scenarios for the Campania Region. Table 4 sums up the main components of the Campania policy domain which will inform the CCD and simulation model.

**Table 4:** Main components of the Campania policy domain feeding the policy model.

| Name of stakeholder | Role | Priorities | Available Actions | Relevant conditions |
|---|---|---|---|---|
| **BENECON** | **R&D Performer**<br>Goal:<br>Become self-sustainable (100% of revenues from the market or from competitive bids). | ▪ Gather adequate skills and equipment<br>▪ Increase reputation among potential clients<br>▪ Enhance customer satisfaction<br>▪ Cultural capital → Increase n° of patents, access to funds for R&D projects, publications<br>▪ Transparency (no mismanagement of public funds) | ▪ Sell services and consultancies<br>▪ Recommend and promote R&D results towards end users and client<br>▪ gather competences and resources (human resources, equipment, overhead) | ▪ Legal framework (reform of the University)<br>▪ Transparency of public authorities<br>▪ Variation in public R&D expenditure<br>▪ Focus on cultural heritage by policy makers<br>▪ Widening market → Growing awareness of cultural heritage as an asset ,propensity to innovate among |

| Name of stakeholder | Role | Priorities | Available Actions | Relevant conditions |
|---|---|---|---|---|
| | | | | BENECON clients |
| **Enterprises** | **Clients** of services/ technologies developed by BENECON | ▪ Increased revenues thanks to innovative services provided to customers<br>▪ Costs Reduction | ▪ Purchase BENECON services<br>▪ Sell innovative products/services to citizens | ▪ limited access to credit/ cultural resistance, small dimensions affect propensity to innovate<br>▪ Widening market |
| **Public authorities**<br><br>**Regional administra-tion** | **Grants providers**<br>Can be also clients | ▪ Improving BENECON Competitiveness[2]<br>▪ Focus on cultural and environmental heritage<br>▪ comply with National/EU regulatory framework | ▪ Recommend and promote R&D results towards end users and clients<br>▪ Promote awareness raising campaigns | ▪ Increased public and private investment (e.g. from national government and enterprise)<br>▪ National/EU regulatory framework changes |
| **Public authorities**<br>**Ministry of cultural heritage** | **Client** | ▪ Promote heritage | ▪ Invest in heritage<br>▪ Purchase BENECON services | ▪ Austerity policy... |
| **Local authorities**<br>Large and small Municipali-ties administra-tions<br>Department administra-tions | **Clients** of services/<br>technologies developed by Regional centre of competence | ▪ Invest in heritage valorisation projects<br>▪ Increased touristic flows<br>▪ Increased employment in tourism and sectors related to heritage valorisation<br>▪ Access to funds for heritage valorisation | ▪ Purchase BENECON services<br>▪ Recommend services to heritage institutions and end-users<br>▪ Contrast decisions from regional authorities (particularly large municipalities) | ▪ Funds available for heritage valorisation<br>▪ Enhanced awareness and demand from citizens |

[2] Promote business oriented approaches in research policy e.g. Campania Innovazione Strategy http://www.campaniainhub.it/;
R&D, innovation and ICT plan (2010) http://www.innovazione.regione.campania.it/

| Name of stakeholder | Role | Priorities | Available Actions | Relevant conditions |
|---|---|---|---|---|
| **Heritage valorisation institutions** (museums, park authorities, other public authorities, in charge of heritage) | **Clients** of services/ technologies developed by BENECON | ▪ Promote heritage<br>▪ Increase number of visitors<br>▪ Access to funds for heritage valorisation | ▪ Purchase BENECON services<br>▪ Recommend services to municipalities and end users<br>▪ Seek public funding from public authorities on heritage valorisation | ▪ Funds available for heritage promotion from the ministry of cultural heritage<br>▪ Enhanced awareness and demand from end users of heritage valorisation services |
| **Interest groups,** NGOs, Religious institutions, associations, | **Clients** of innovative services/technologies in the field of tourism and Heritage promotion | ▪ Better heritage | ▪ Purchase BENECON services<br>▪ use services provided by heritage institutions and municipalities<br>▪ Recommend services to citizens and peers<br>▪ Influence political parties | ▪ Change in investment for heritage promotion |
| **Citizens** (Tourists, Students, professionals etc.) | **Final users / consumers** of innovative services/technologies in the field of tourism and Heritage promotion<br>**Clients** of enterprises and heritage institutions | ▪ User-friendliness and accessibility of services in the field of tourism and Heritage promotion<br>▪ cost reduction | ▪ use services provided by heritage institutions municipalities, and interest groups<br>▪ buy products/services from enterprises and heritage institutions<br>▪ Recommend services to their peers<br>▪ Influence political parties (Particularly during elections) | ▪ Growth of cultural capital and educational attainment of citizens<br>▪ Increased investment in heritage promotion<br>▪ Tourism promotion<br>▪ Services improvement |

## 4.2. SCENARIO ANALYSIS TOWARDS POLICY MODELS FOR CAMPANIA

Table 5 provides a summary of findings relevant for the Campania policy model, which have been derived from the scenarios and the investigations of background documents. In Table 6, a SWOT analysis of the overall conditions and Campania environment for technology transfer at BENECON is provided.

**Table 5:** Summary of findings about key aspects in the Campania policy case.

| | |
|---|---|
| *GOAL(S)* | *Competence centres for knowledge transfer dedicated to competitiveness of Campania Region* |
| *STATUS* | *How efficient is the knowledge transfer in Campania Region?*<br>- *Campania is of a substantial and chronic dependence on state investments. Regional centres of competences continue to exist in the current structural funds programming period (2007-2013), but evolve with the purpose to become self-sustainable.*<br>- *Centres have plenty of space and facilities to experiment new technologies and offer services, testing facilities and technologies on a commercial basis.*<br>- *Regional centres of competence still operate in a context characterized by low rates transfer of innovation and low investment to research and innovation by private industry*<br>- *Attempts to encourage Research have therefore been focused on the only entities having the appropriate human resources and know-how: Universities, which must face at the same time heavy congestions and funding cuts.* |
| *Possible MEANS to achieve goals* | - *Adopting specific measures dedicated to SMEs and knowledge transfer between universities and industries e.g., fostering knowledge transfer between academia and SMEs, and particularly improving and funding networks between universities, research centres and companies, thus addressing the needs of the knowledge economy*<br>- *The purposes of regional centres of competence are:*<br>  - *Promoting research at the highest level of excellence, by bridging the integration and fragmentation of critical mass of expertise needed to create leadership;*<br>  - *Strengthen research cooperation between different operators, by enhancing clusters and knowledge districts, networks of excellences between universities, research centres and companies, thus addressing the needs of the knowledge economy*<br>  - *Promote investment in R&D of industries (particularly SMEs)*<br>  - *Strengthen the coordination of research programs within the region in this area*<br>  - *Promote the dissemination of knowledge and transfer of research results; foster international cooperation;*<br>  - *Focusing on competences and human capital development particularly in relation to high-tech sectors*<br>- *Network of excellence projects- together with the creation of Regional Competence Centres, try to create a local network, forcing the union of strengths, especially in times of investment and resource crisis, with research hubs* |
| *CONSE-QUENCES* | *Since many SME in Campania cannot afford the early stages of development of new technologies, they ask to centres the support services that they cannot develop in house.* |
| *CONDITIONS (PESTEL: hard vs. soft facts)* | *POLITICAL conditions:*<br>- *Research Centres are just a few, and often fostered by a Regional or Ministerial initiative. The link to a political class is, therefore, important throughout lobbying activities, which have often led to episodes of corruption during the past years.*<br>- *The regional administration chose to focus resources on large cities in order to increase the effectiveness of interventions and avoid fragmentation, in accordance with EU regulations*<br>- *Naples role is historically based role and has led to a steady centralization of power and of people aspiring to power* |

| | |
|---|---|
| | - *The Province of Salerno is the largest of Campania, with a strong autonomist vocation while enjoying a certain distance from Naples that has allowed autonomy. It also counts on some weight in the region, with important politicians*<br>- *Chosen sectors are those where tradition is stronger in Campania or where it is possible to tap into thematic European funds. Key fields chosen: Transportation, Tourism and Food Processing. Investments have been concentrated mainly on these fields.*<br>*ECONOMIC conditions*<br>- *Municipalities are attractors of specific funds and often recipients of major infrastructure and retraining interventions*<br>- *Within medium/large size municipalities there is adequate administrative capacity and management structure to manage grants and projects*<br>- *Funds have come from national investments or from European funding destined to research*<br>  - *The distribution of the government spending: Naples absorbs most of it for Research and Innovation, but also for other strategic fields. It is therefore crucial for Companies not to be located far from Naples, where most of decision-making offices are situated.*<br>- *The Province of Salerno has one of the major touristic harbours counting on an airport (Pontecagnano), an important National Park (Cilento), as well as several touristic resorts (Amalfi coast and Cilento)*<br>- *Universities born in Campania in Benevento and Salerno have been conceived to meet specific local needs*<br>- *The Province of Benevento suffers from the distance from Naples. Only in recent years it has been reached by the motorway network, which allows rapid connection to the rest of the region. The transportation network is not well developed*<br>- *The Service sector represents more than 62% while the Industry sector accounts 21,8% of the overall number of active Companies in Campania; The tourism and cultural sector are among the driving forces of the Campania economy thanks to its remarkable artistic, historic and cultural heritage, combined with its internationally acclaimed excellence in terms of wine, food and the natural environment, even though the waste emergency had repercussions on the tourism sector.*<br>- *Death and birth rate:*<br>  - *Positive death and birth rate: The Service sector, the sector of Power, Gas and Water distribution, Restaurants and Hotels, Real Estate, Renting, Computer Science and Services, Research, Financial and Monetary Trade and the Social and Personal Services sector*<br>  - *Stable death and birth rate: Wholesale & Retail sector, Repair of personal and household goods sector, and Agriculture, Hunting and Fishing sector only Fishing increased a little bit.*<br>  - *Negative death and birth rate: the Manufacturing sector and the Education sector (but recovering), the Industry sector*<br>- *Tourism represent a significant share of regional GDP and increases; Naples and Salerno concentrate tourism enterprises (75% of all tourism businesses in the region)*<br>- *Campania attract around 20% of the national demand for cultural heritage sites[3] and is the 3rd Italian region as for the number of visitors in public museums per KM2, as displayed by the following graph.*<br>- *all the great production units are historically located in Naples* |

[3] SCABEC Società Campana Beni Culturali (2006) Rapporto sull'economia dei beni culturali in Campania: offerta, domanda, occupazione, finanziamento, impatto economico (), ed. Einaudi

| | |
|---|---|
| | - *The Companies' size in Campania is mostly small or medium, often managed by families*<br>- *The most advanced sectors bear the difficulty of branching into the wider regional or national market due to logistic issues, as they are often located far from central areas.*<br>- *The Lisbon target of achieving by 2010 a level of total expenditure equal to 3% of GDP (2% target for the only private component), however, is still far away*<br>- *the percentage of innovative enterprises is below the national aggregate figures*<br>*SOCIAL conditions:*<br>- *The Province of Salerno has a good level of quality of life*<br>*TECHNOLOGICAL conditions:*<br>- *Campania serves as a driving force for the development and diffusion of technological innovation among the southern regions, as it is the main centre for research in the South of Italy, featured by the presence of several universities and public research centres.*<br>*ENVIRONMENTAL conditions:*<br>- *High densely populated municipalities (with the exception of the cities of Benevento and Avellino)*<br>- *municipalities often grow very quickly and in an uncontrolled manner, particularly in demographic terms*<br>- *The Province of Salerno has an important natural heritage*<br>- *The Province of Benevento has a low population density in all its municipalities*<br>- *The regional Transportation network*<br>  - *very strong link to Naples thanks to heavy investments in the city, in particular for the regional railway system (Metropolitana)*<br>  - *The only international Airport (Capodichino) is located in Naples; one planned (bigger and less overcrowded) in Grazzanise, Caserta*<br>  - *lack of infrastructures and services for Companies are infrequent and low in quality*<br>- *out of a total of 87 public research centres based in "Convergence Regions" (4 regions in South of Italy, i.e. Apulia, Campania, Sicily and Calabria), as many as 32 are located in Campania*<br>- *Campania is also recognized as the leader in Convergence regions in the south of Italy as far as level of R&D expenditure, share of public investment in R&D, impact of private sector spending in R&D and number of employees in R & D. The main intensity of R&D spending is localized predominantly along the Naples-Salerno and Naples-Caserta axes.*<br>*LEGAL conditions:*<br>- |

| | |
|---|---|
| *ACTIONS* | - *potential customers (companies in the first place, although public bodies such as Museums can also be customer) ask to centres a particular service / technology*<br>  - *Since many SME in Campania can not afford the early stages of development of new technologies, they ask to centres the support services that they cannot develop in house.* |
| *STAKE-HOLDERS* | - *Federico II University*<br>  - *reputation for scientific study (physics, mathematics), engineering and humanities*<br>  - *faculties with many important research centres, i.e. it remains the leader in the field of hard sciences and historically significant research funds have been concentrated on this university*<br>- *University of Naples "Parthenope"*<br>  - *Originally specialized in economic studies, with a special focus on international trade*<br>  - *Includes the Faculty of Economics, Engineering, Law, Science and Technological Sciences*<br>- *Second University of Naples*<br>  - *Established to relieve congestion on the Federico II*<br>  - *It has faculties in the cities of Aversa, Capua, Caserta, Santa Maria Capua Vetere, while it has the Faculty of Medicine in Naples, sharing the premise (a Hospital) with the University Federico II*<br>  - *Main reputation is in the field of medicine*<br>- *University of Naples "L'Orientale"*<br>  - *The oldest university in Europe for Oriental and sinology studies* |

| | |
|---|---|
| | - *Strong tradition on philological and linguistic studies for extra-European areas*<br>- *Includes Faculties of literature and philosophy, foreign languages and literature, Arab-Islamic and Mediterranean Studies, political science (with a focus on international relations).*<br>- *Suor Orsola Benincasa University*<br>- *A higher education pedagogic institute*<br>- *Specialized in social sciences and humanities, with a special emphasis and tradition on education*<br>- *Important centre for communication and Cultural Heritage studies of and also hosts an important School of Journalism.*<br>- *Pontifical Theological Faculty of Southern Italy*<br>- *A reference point for all Southern Italy theology studies*<br>- *Includes INFN (National Institute of Nuclear Physics), several centres of the National Research Council, an important science park (Città della Scienza) and the Italian Institute of Aerospace Research.*<br>- *The University of Salerno, has historically had a major medical school (originating in the thirteenth century), which has tried to reconnect the current important work of the medical faculty and pharmaceutics, an important faculty in the University of Salerno, together with Education and Communication Sciences (site of a major School of Journalism)*<br>- *The University of Sannio based in Benevento*<br>- *Strong specialization as a Polytechnic*<br>- *Includes the Faculty of Economics, Engineering, Mathematics and Physics and law*<br>- *Strong points are mathematical sciences and information technology, especially techniques geology and geo-monitoring technique* |

**Table 6:** SWOT analysis of the overall conditions and Campania environment for technology transfer at BENECON.

| **Strength** | **Weaknesses** |
|---|---|
| • Younger population than national average<br>• 7 Universities and 40 private and public research centres<br>• Concentration of R&D actors in certain areas<br>• Tourism, R&D and sustainable development increasingly acknowledged as assets<br>• Growing demand of cultural tourism<br>• Organisational mechanisms of Regional competence centre in place<br>• High public investment in Regional centres of competences | • Mainly SMEs with little capacity to invest in innovation<br>• Dependence on public funds for innovation<br>• Some key indicators (e.g. number of patents, employment rate and educational attainment) below EU average<br>• Brain drain<br>• Public and private R&D expenditure lower than national average<br>• Entrepreneurial and market oriented approaches often missing in R&D institutions' management<br>• Substantial dependence on public funding of enterprises and research centres |
| **Opportunities** | **Threats** |
| • Stable regulatory and political framework after elections<br>• Increasing number of graduates in Scientific studies<br>• Recent Policies emphasising the market value of R&D (Campania Innovazione strategy) | • Damage to regional competitiveness due to environmental issues<br>• Risk of further brain drain<br>• Budget restraint due to adoption of austerity measures in Campania<br>• Difficulty to create self-sustainable centres of competence |

## 4.3. CCD MODEL

The Campania CCD model describes the strategies implemented by a regional centres of competence (i.e. a consortium of research centres, labelled as "service provider") can become a self-sustainable organization, independent from the automatic funding delivery schemes and able to attract funds from competitive bids or from the market. The service provider is called BENECON and is active in the domain of greening and cultural heritage. It was born thanks to the EU structural funds automatically awarded in "Campania" Region, and according to regional policy it has to become self-sustainable when the initial public funding is over. The model, to a certain extent the model is applicable also to other regional centres of competence.

In this context the Campania CCD model describes the dynamics associated with i) competitive calls for proposals issued by public bodies at European, national and regional level and ii) free-market services sold to promoting agencies or private enterprises.

The **competitive bids sub-model**, focused on strategies implemented by Regional centres of Compentence to maximize participation in competitive bids provided by public R&D funding programmes. In this part of the model Public organizations (such as Campania Region or the Ministry of Education) issue call for proposals, Service providers set themselves up in consortia and submit a proposal to answer the call, promoting agency awards the best proposal, which becomes a financed project. On the basis of awarded projects services providers increase their skills.

The **Service and products delivering sub-model**, focuses on the provision of a set of services and/or products for customers on the market by regional centres of competences (service providers). In this part of the model services are offered by providers. These services are sold to both enterprises and promoting agencies, the latter having a double-sided interaction with the providers (e.g. on both the bids and the market side). The skills of a service provider affect the effectiveness of its services.

Both sub-models generate incomes and endorsement for service providers (i.e. Regional centres of competence like BENECON). In particular:

- Any service provider has the possibility to invest more on the market or on the bids side
- Increasing the skills on the market lowers the focus on the calls (or vice versa)
- During every year of the simulation a service provider can decide whether to spend more effort on the market or on the bids.

First inputs generated in collaboration with stakeholders during the scenario building were imported within the CCD, and then UNISOB proceeded to develop the model based on the annotations defined on these texts. During this phase all the CCD features were adopted: the editing, annotation and graphical modelling features have been used in an integrated manner, and it was possible to test the effectiveness of these tools in shaping and defining the main elements of the conceptual model related to the Campania case. Figure A documents the annotation phase of the texts: in particular, the relations between the annotated text fragments and elements of the model with which they were related are highlighted.

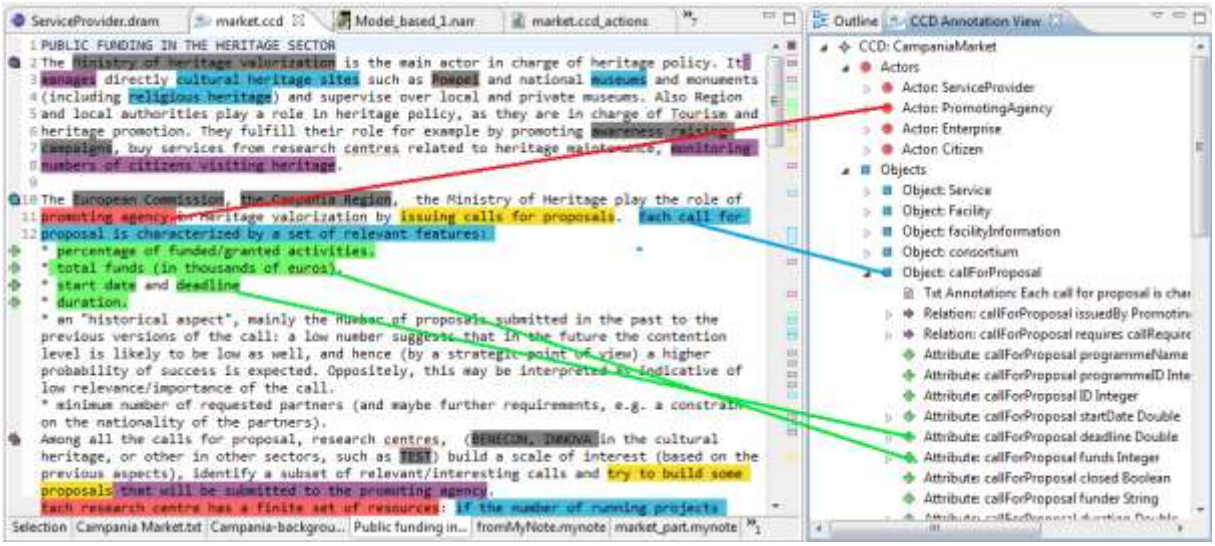
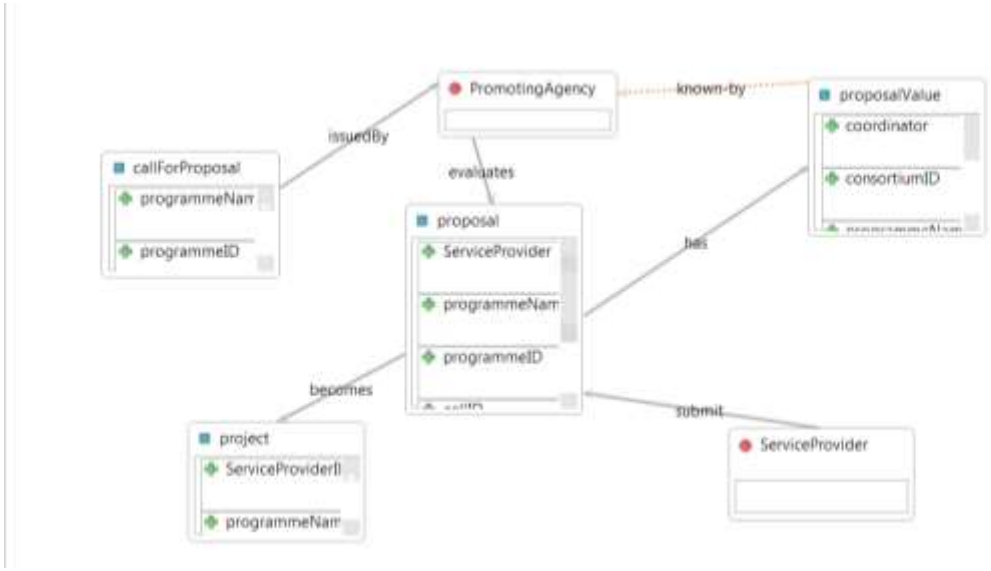



**Figure 24:** Examples of annotation.

The general structure of the model created is shown in next figure, where the main Actors are represented with a red dot, Objects with blue squares and their attributes with green crosses. The solid arrows represent relations between the elements of the model and in particular the red dashed arrow states that "proposalValue" is only known by the Promoting Agency (i.e. not by the Service Providers). Part a) of the model deal with calls for proposal, while part b) deals with services provision on the market.

a) Calls for proposal sub-model




b) Services provision on the market sub-model

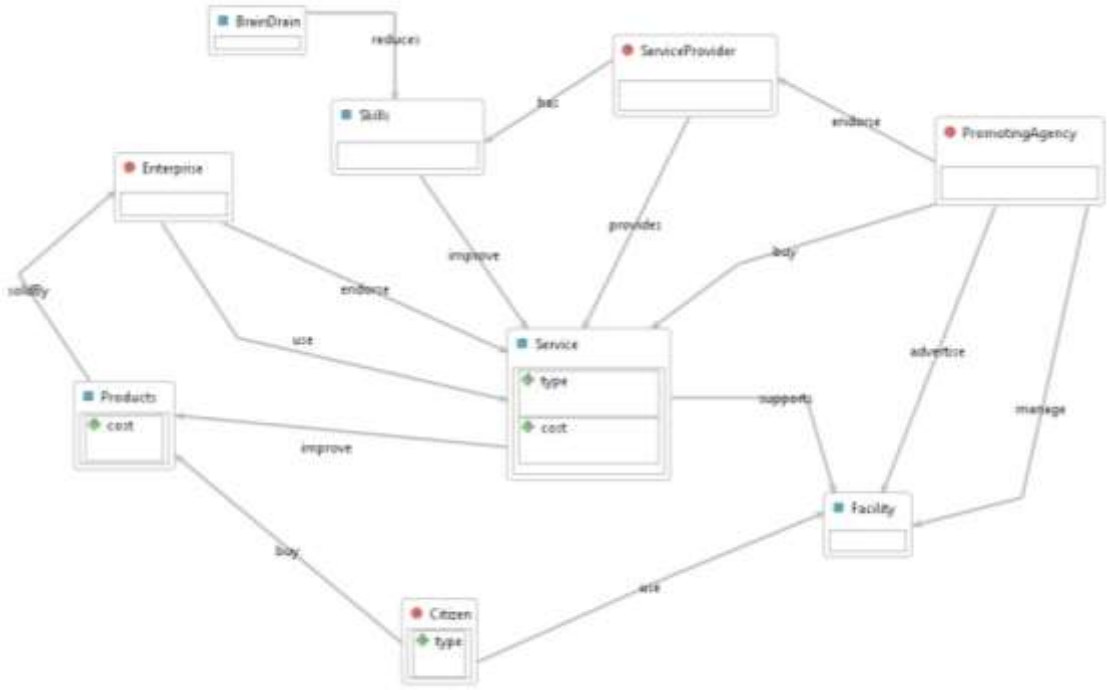



**Figure 25**: Campania case diagram.

The action diagram, i.e. a graphical tool to model the actions that govern the behaviour of actors, turned out to be particularly important. In Figure C a fragment of the Action diagram is presented, showing some of the main aspects of the process of setting up a consortium for a project proposal: Actions are characterized by a yellow lightning, also indicating their actor within squared brackets,

while an orange sign represents a condition i.e. inputs and outputs of actions that allow modelling the behaviours and interactions among the actors.

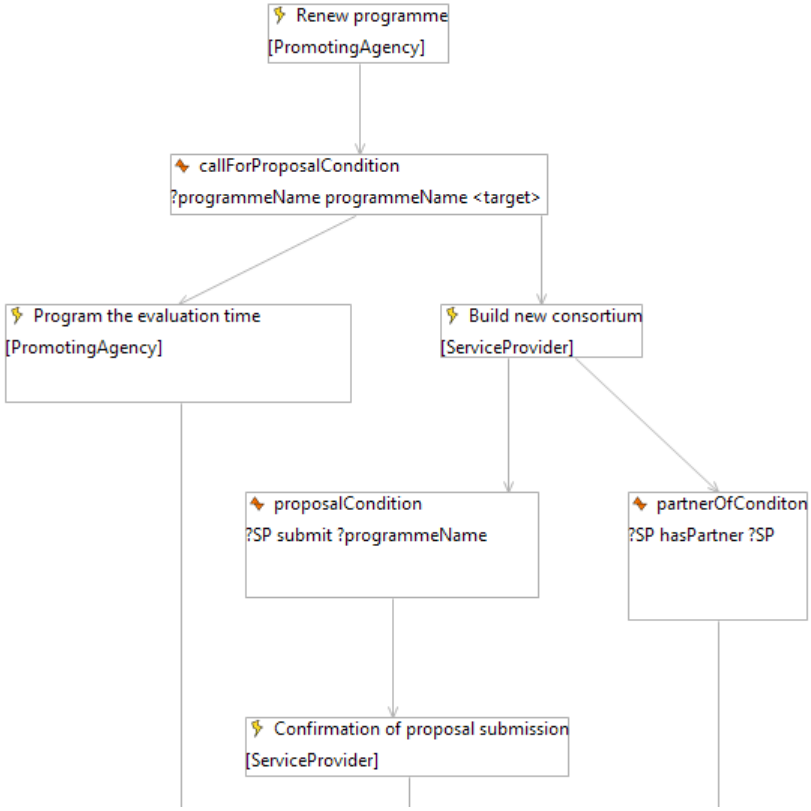



**Figure 26:** Excerpt of the action diagram that shows the main aspects of the consortium building process).

Thanks to the CCD tool, one can model the actions to be codified into rules (i*f-then* clauses) governing the actions of agents.

***Endorsement Scheme***

The model developed makes use of the endorsement, i.e., labels used by actors to describe specific aspects of other actors or objects (e.g. reliable, attractive, convenient, etc.). Within a declarative model they are utilized to provide a representation of a decision model [20].

Some endorsements are static and cannot be re-processed, others are dynamic and may be revoked or replaced in the light of any single agent experience [34].

The endorsement value is obtained by considering all the existing endorsements referring to an endorsee: every endorsement is given a value within the model and their sum allows the agents to choose the favourite agents / objects among the possible endorsee.

In order to describe the mechanisms governing the dynamics of competitive call for proposals and market services, three major endorsement schemes have been defined:

1. **proposalEndorsementScheme**: this endorsement scheme is used by the Promoting Agencies to select successful proposals. The proposal with the highest endorsement value will be awarded. In case of a tie, the successful proposal will be chosen at random from amongst all of the best endorsed proposals.

- *positive endorsements:* nationalityBalanced , goodManagementCapacity, matchesCall, technicalSustainability, socialSustainability, goodMembership, innovative, goodTrackRecord
- *negative endorsement:* badTrackRecord, poorSustainability, lowResources

2. **consortiumPartnerEndorsementScheme:** this endorsement scheme is used by Service Providers with the role of coordinator of a consortium to select partners to submit a proposal or for a potential partner to decide whether to join a consortium.
    - *positive endorsements:* relevantTechnicalSkills, complementaryTechnicalSkills, cheap, goodReputation, previousSuccessefulProject
    - *negative endorsements*: incongruousTechnical-VS-Asset, lowInvestment, badReputation, previousUnsuccessfulProject
3. **skillsEndorsementScheme:** this endorsement scheme is used to sell services on the market. Whenever an Enterprise is willing to buy a service, it will choose the one provided by the most skilled Service Provider.
    - *positive endorsements:* goodSkills, excellentSkills
    - *negative endorsements:* badSkills

## 4.4. DRAMS AGENT-BASED MODEL(S)

In this section the DRAMS agent-based model is depicted that represents the self- sustainability of a Regional centres of competence called BENECON (consortia of research centres) as an example of Campania technology transfer policy

Thanks to the interaction with stakeholders which took place via face-to-face meeting, in the form of focus groups and interviews, it has been possible to clarify and better calibrate the focus of the Campania pilot and collect information supporting the definition of building blocks for the models. Subsequently, the key elements of the Campania pilot and related model are reported:

**Goal:**

A Regional centres of competence called BENECON (a consortium of research centres) become self-sustainable (gathering revenues from the market or from competitive bids).

**Existing (as is) situation**: Mainly revenues from automatic funding (which are reducing due to austerity policy), some revenues from the market, currently few revenues from competitive bids

**To be situation:** Focus on innovative services, cost-effectiveness in management, marketing and customer satisfaction. Increase of funding for R&D projects from competitive bids, and increased capacity to transform R&D results into innovative services.

**Conditions**

Regional centres of competence capacity to sell increase when:

→ Level of innovation of R&D results increase
→ Its capacity to transform R&D results into marketable service increase
→ Its staff increase its skills in technology transfer through training
→ Its staff increase its skills in applying for competitive bids (e.g. EU projects) and in R&D project management
→ n° of collaborative projects with enterprises increase
→ The internationalisation of staff, R&D projects increase, thus widening opportunities
→ Dedicated staff is recruited for sales/marketing
→ University makes available adequate skills and infrastructure
→ BENECON acquires equipment which is unique in the market and allow competitive advantage/ cost-reduction compared to competitors.

→ Administrative and financial management of BENECON is adequate
→ BENECON is able to generate competitive spin-off
→ BENECON existing clients recommend services to new clients
→ BENECON services portfolio increase
→ (…)

CLIENTS propensity to invest increase when:

→ N° of clients increase (positive enterprise birth rate)
→ Enterprises increase their dimension (mergers, acquisitions)
→ BENECON services allow cost reduction and ultimately increase turnover
→ economic conjuncture improve
→ public R&D expenditure increase
→ Political parties change level of attention to cultural heritage (e.g. due to elections)
→ legal framework improve or does not worsen (e.g. due to university reform)
→ Local authorities do not contrast decisions of regional authorities
→ the image of public administrations do not worsen (e.g. due to scandals)
→ Enterprises reduce their dependence on public funding in order to survive
→ Public funds are managed in a transparent and cost-effective way
→ Awareness raising campaigns on cultural heritage are promoted by the region
→ Educational attainment of citizens (i.e. final users) increase
→ (…)

**Services currently provided by BENECON**

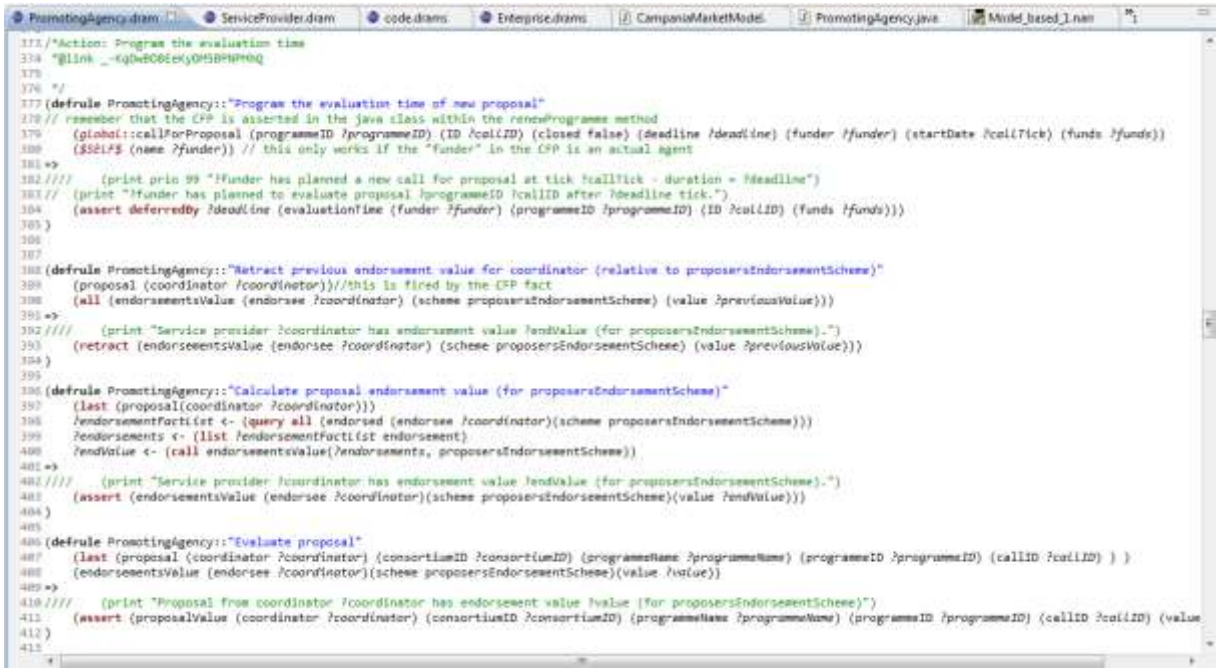
- Multidimensional environmental, territorial analysis (air, water and soil quality analysis, land use analysis) e.g. for monitoring the stability of slopes, the earthquake risks, the environmental impact of human activity, with specific equipments as geo-radars
- Materials and building evaluation and analysis, suited for the national and European markets in the areas of construction, civil engineering, energy, lighting, acoustic, electromagnetic fields
- conservation and promotion of cultural heritage (historical building restoration), territorial planning and recovery
- innovative screening systems, based on the use of natural lighting, for environmental planning
- cataloguing cultural and environmental heritage for territorial planning purpose, supporting public administrations, museums and parks
- Consultancy for touristic planning and eco-planning to public administrations
- Territorial Information Systems, supported by ICT platform able to trace according different criteria all the material and immaterial components of the natural and man-made environments, controlling the impact of development initiatives and activities and planning and utilizing landscape resources
- innovative tourist Information Systems supported by GPS technology, able to provide geo-

| |
|---|
| referenced content and information (these are being developed)<br>• monitoring of compliance with regulations for public buildings (e.g. UNI 10840).<br>• Green certification for enterprises |

The Policy model building blocks resulting from these key elements are as follows:

| | |
|---|---|
| **Agents** | • **Service provider** (i.e. Regional centres of competence like BENECON which has human resources, equipment, infrastructure, administration, has multidisciplinary skills...)<br>• **Enterprises** (mainly SMEs; dependant on public funding, have limited investment capacity, purchase services from Service provider)<br>• **Promoting agency** (public body, issues calls for proposals, can also be client), e.g.:<br>  ○ Ministry of cultural heritage (client, promote heritage, monitor the state of heritage facilities)<br>  ○ Region (grants funding)<br>  ○ Local authorities (client, low and decreasing investment capacity) Heritage valorisation institutions (client, low investment capacity)<br>  ○ Other national and international public authorities (grants funding)<br>• **Citizens** (use heritage, increase visits to cultural heritage on the basis of the state of heritage sites and facilities) |
| **Objects** | • Services<br>• Consortium<br>• Automatic funds<br>• Call for proposals<br>• R&D projects<br>• Heritage site (facility)<br>• R&D Equipment/infrastructure<br>• Multidisciplinary skills<br>• Product |
| **Facts** | • Public funding variation<br>• Capacity to sell services<br>• Propensity to buy services<br>• Capacity to apply for competitive bids<br>• capacity to transform R&D results into marketable services<br>• Level of innovation of R&D results<br>• level of public attention to cultural heritage |
| **Relations** | • BENECON sell services to clients (Enterprises, local authorities, NGOs, Region)<br>• Promoting agency monitor the state of heritage facility and on this basis purchase services from service provider<br>• Citizens use services from heritage institutions, buy products from enterprises<br>• Enterprises buy services from BENECON and on this basis improve their products<br>• (...) |

This information were used to produce a DRAMS Agent-based model, able to simulate the behaviour of the agents over a time period of many years, starting from the situation depicted in the CCD. Code for the generation of simulation output files was included in the model, so that policy modellers could produce model-based scenarios for stakeholders, according to the OCOPOMO methodology.



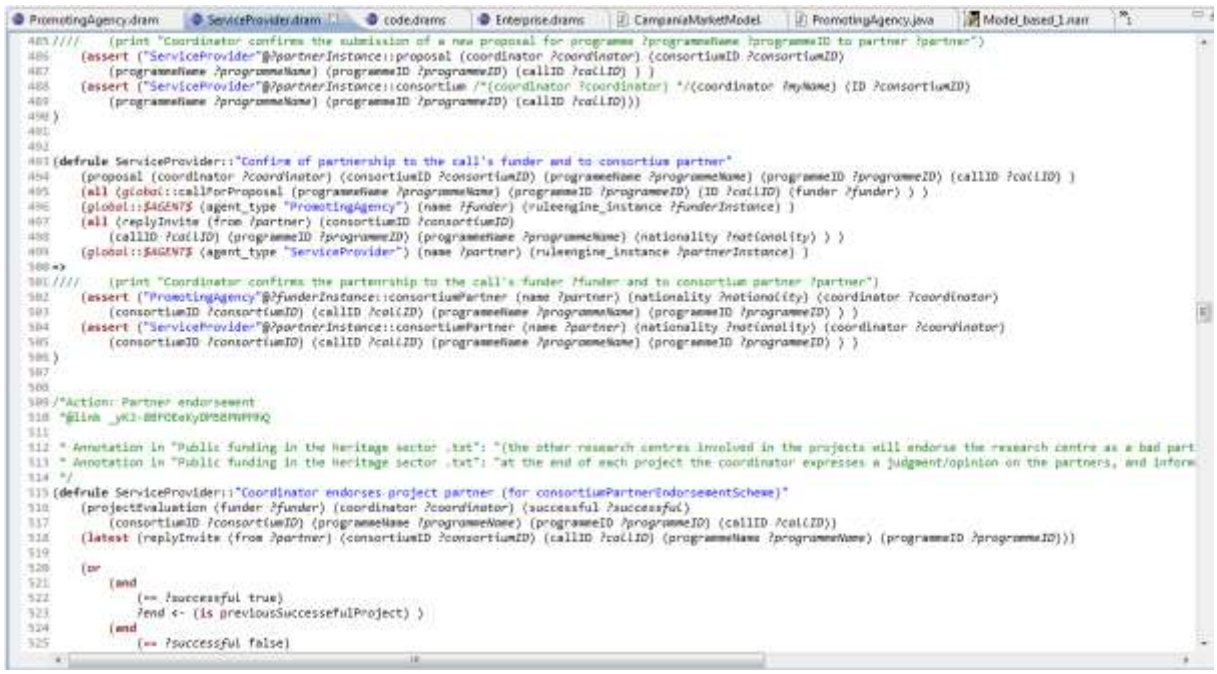




**Figure 27:** Example of rules related to actions presented in previous figures.

### *Supporting library*

A supporting library was developed, providing a common set of features to support the development of models in DRAMS. In particular, this library includes functionalities for defining and managing endorsement schemes, as well as for the management of time and dates (matching between simulation

cycles and dates). It also facilitates the export of most significant data related to simulations into XML formats suitable for storage and subsequent processing (e.g. for displaying the results). As for the endorsement scheme, for example, it is possible for each agent to define new ones, add a new endorsement and define its weight, get the weight of an endorsement or a list of endorsements, request the complete list of endorsements defined etc.

## 4.5. MODEL-BASED SCENARIO(S)

The Campania model contains two main classes of agents: the funding agencies that promote and evaluate calls for proposals and the service providers which setup consortia in order to participate to such call. The entire process has been modelled, including allocation of funds for call, setup of the consortium, development of a proposal, submission and evaluation of results. As a second sub-model, a free-market of services was also modelled: service providers are able to sell market services to either promoting agencies or private enterprises.

According to the pilot objectives, the main results were inferred from the generated simulation output files and model-based scenarios were produced by the modellers.

Here are presented three examples of such scenarios:

*1)*

*In this simulation the outcomes of two research centres operating in Campania Region are presented: these are Innova (RC1) and Benecon (RC2). At the beginning of the simulation Research centres rely mainly on automatic funding which decreases over time. Promoting agencies (regional, national or European) issue calls for proposals, research centers set up consortia so to apply for competitive bids (different from automatic funding). At the same time Research centres attempt to sell services on the market. During the simulation only few proposals are successful and services are sold for RC2, therefore RC2 sustains itself only with automatic funding (awarded regardless of its capability to win bids or sell services) while in the same period Research centre 1 has been able to sell successfully services and attract competitive bids so its turnover increases.*

*Over time RC2 relies mainly on decreasing automatic funding and it is forced to close while RC1 is able to operate thanks to a mix of competitive bids and revenues from the market. Projects funded and services sold allow RC1 to further generate opportunities to increase its revenues over time.*

*2)*

*The starting point is the same as in 1). In this simulation the outcomes of all research centres operating in Campania and the outcomes of other research centres outside the region are presented. At the beginning of the simulation Research centres rely mainly on automatic funding which decreases over time. Promoting agencies (regional, national or European) issue calls for proposals, research centers set up consortia so to apply for competitive bids (different from automatic funding). At the same time Research centres attempt to sell services on the market. Some competitive bids are successful for the 1st year, therefore regional research centres sustain themselves with automatic funding (awarded regardless their capability to win bids or sell services) and competitive bids awarded.*

*Overtime they rely mainly on public funding, and are not able to sell successfully services on the market, their turnover remains steady or slightly decreases but survival is still possible. On the other hand research centres outside Campania are able to both generate incomes from the market and attract grants. From the perspective of the Regional authority, in this simulation the Regional competitiveness (measured as the variation over time of income generated by Campania research centres vs. the total income of all research centres) does not increase.*

*3)*

*In this simulation the financial outcomes of research centres operating in Campania and the outcomes of other research centres outside the region are presented. At the beginning of the simulation there*

*are mainly automatic funds decreasing over time. During the simulation regional research centres apply for public grants and intends to sell services on the market.*

*Over time few bids for publicly awarded grants are successful, but on the other hand Regional research centres are able to sell successfully services on the market and their turnover increases even though automatic funding decrease. Compared to several research centres outside Campania, research centres operating in Campania become self-sustainable over time and do not rely on automatic funding for their survival, but rely mainly on market revenues and competitive bids. On the other hand research centres outside Campania are not equally able to both generate incomes from the market and attract grants.*

*From the perspective of the Regional authority, in this simulation the Regional competitiveness (measured as the variation over time of income generated by Campania research centres vs. the total income of all research centres) increases.*

## 4.6. OFFICIALS' ASSESSMENT OF MODEL BASED SCENARIOS

Interviews and stakeholders validation workshops allow to gather Campania policy officials feedback on model based scenarios.

In particular a stakeholders' validation workshop took place on the 15th of April 2013. It has involved Prof. Guido Trombetti, Regional Counsellor for University and research of Campania Regional administration, Prof. Lucio d'Alessandro rector of Suor Orsola Benincasa University, Dr. Giuseppe Russo, representative of directorate for university and research of Campania Regional administration, Dr. Vincenzo Rinaldi.

Model based scenarios have been considered plausible to different degrees and under several respects. It has been underlined first of all that, although referring specifically to a specific regional centre of competence called BENECON, results can be applicable and can be generalised to several regional centres of competence.

Particularly the second and the third model based scenario are supported by empirical evidences: some regional centres of competence continued to generate funds mainly by providing high-quality services to private enterprises. This is for instance the case of centres working in the transport and ICT sectors. Others has raise funds mainly from the public sector. This is for example the case of Regional centres of competence working in the field of arts and cultural heritage. Also the first scenario can be considered plausible, since of course different regional centres of competences had different outcomes (although none of them has been discontinued).

The key factors, which affected the self-sustainability strategy of Regional centres of competence have been:

- an innovative implementation approach. Full-time project managers, for the ten Regional centres of competence, were chosen on the basis of their experience in the private sector, in order to maximise the chances of the centres becoming financially independent. The region nominated an international evaluation committee to select, and then coach each of the centres.
- Feasibility of the project plan and willingness of partners to contribute to the project was crucial for making the initiative attractive for the partners. Clearly set out and feasible objectives boosted participation and avoided duplication of resources.
- Providing a response to a well-defined need while introducing a degree of innovation is crucial. The Regional centres of competence responded to a clear need while avoiding overlap between their activities and what universities and firms were already doing separately.
- The possibility to access first-class networks was critical, the Regional centres of competence are consortiums and hence allow participants to carry out projects in synergy and share risks. The Regional centres of competence also represented a gateway for setting up collaborations with other international actors e.g. in the framework of European funded projects.

In more general terms the exploitation potential of the OCOPOMO platform as a support of policy making has been underlined: the possibility to open up strategic orientations of Regional administration to stakeholders consultation and the possibility to generate simulations as a result of this participatory process, as well as the "open source" licensing policy have been particularly

appreciated. The Regional Counsellor for University and research of Campania Regional administration expressed its interest in using the results of the project also after its contractual end, for instance in the framework of the evaluation of structural funds expenditure.

***Account of stakeholders' consultation activities***

The following tables provides an overview of activities related to stakeholders consultation for the Campania case, i.e. workshops**,** interviews and online activity all along the project lifecycle. All the material referring to interviews and online consultations, including background documents are available on the dedicated Campania site of the collaboration platform[4].

**Table 7:** Overview of workshops, interviews and online consultations performed in Campania.

| ***What*** | ***Date*** | ***Where*** | ***Stakeholders involved*** | ***Output*** |
|---|---|---|---|---|
| *Scenario building workshop* | *15-16/04/2010* | *Neaples / Italy* | *Representatives of Campania Region* | *1 draft initial scenario* |
| *Scenario building workshop* | *07/12/2010* | *Neaples / Italy* | *Representatives of Campania Region* | *1 initial scenario* |
| *Scenario validation workshop* | *09/05/2011* | *Neaples / Italy* | *Representatives of Campania Region* | *Revised initial scenario* |
| *Study visit to BENECON premises* | *28/07/2011* | *Aversa/Italy* | *Representatives of Campania Region and BENECON* | *Initial scenario enriched with policy model building blocks* |
| *1st trial online consultation* | *March-April 2012* | *Neaples / Italy* | *Representative of Campania Technology transfer agency, public officer from Municipality of Naples, Campania region, University teachers and researchers* | *Stakeholders comments to initial scenarios representing in some cases alternative scenarios on the Alfresco site (4 comments to 1st scenario, 4 to second, 1 to third scenario)* |
| *Interviews* | *March-June 2012* | *Neaples / Italy* | *University teachers and researchers* | *4 Interview reports on Alfresco* |
| *2nd trial online consultation* | *February-April 2013* | *Neaples / Italy* | *University teachers and researchers, policy advisors* | *Stakeholders comments to model based scenarios* |
| *Workshop* | *15 April 2013* | *Neaples / Italy* | *Regional Counsellor for University and research, representative of directorate for university and research, representative of the programming department of* | *Validation of the OCOPOMO policy development process and outputs* |

[4] http://ocopomo.ekf.tuke.sk:8080/share/page/site/campania/dashboard

| | | | | |
|---|---|---|---|---|
| | | | *Campania regional administration*<br>*rector of Suor Orsola Benincasa University*<br>*other researchers from this University* | |

**Table 8:** Facts about the first and second iteration of online consultation with stakeholders in Campania.

| | |
|---|---|
| *Duration of online consultation* | *March April 2012 1st iteration and March April 2013 2nd iteration* |
| *Stakeholder groups* | *Representative of Campania Technology transfer agency, public officer from Municipality of Naples, Campania region, University teachers and researchers* |
| *No. of stakeholders participating in the online consultation, workshops and interviews* | *30 (10 online, 20 face-to-face, either interviews or workshops)* |
| *No. of initial scenarios provided* | *3* |
| *N° of Model based scenarios* | *3* |
| *Contributions from stakeholders (1st and 2nd iteration)* | *15 Online comments (1st and 2nd iteration, 4 interviews, input formulated in several workshops.* |

## 5. RESULTS FROM THE LONDON HOUSING CASE

This section is dedicated to the presentation of scenarios, CCD models, DRAMS agent-based models and model-based scenarios from the London Housing use case.

### 5.1. BACKGROUND

The Mayor of London is required by statute to produce a 25-year housing strategy which is to be updated every five years. The strategy involves the setting of targets for total new housing and specifically affordable new housing. Proposals for the development of new housing are produced by private developers and by housing associations. Private developers are interested primarily in profits whilst housing associations claim in their reports and publicity to be interested in balanced development of housing and supporting infrastructure such as schools, health facilities, employment and transportation. The proposals are assessed, negotiated and ultimately either approved or rejected by the 33 boroughs of London. The boroughs are also the planning authorities and do not report to the Mayor.

Evidence collected for the London housing study indicates that the local authorities in the richer boroughs do not want affordable housing and, in inner London, they do not want any new housing. In the poorer London boroughs, the planning authorities do want housing especially if it is affordable and social rented housing.

A lever held by the planning authorities is the requirement of spending on infrastructure by the developers whether private or housing association. The rich, inner-London boroughs can require sufficiently large infrastructure expenditure by developers to ensure that the private developers would not make sufficient profit to proceed and that housing associations would be unable to finance the full development with infrastructure investment. Even if the housing associations could find sufficient debt finance, evidence shows that they self-limit their gearing (debt-equity ratios) to 0.8.

### 5.2. THE MODEL AND SIMULATION RESULTS

The model incorporated the properties described above together with numerical data such as median residential incomes, income distributions, populations, prices of market and affordable houses, land areas and similar statistics for each borough. These statistics were drawn from public records.

Rules of behaviour driving the various types of agents conformed to the evidence from interviews and public reports about the goals and concerns of the various stakeholders. Incorporating all of the evidence suggested and otherwise acquired for the model design, the simulation results differed in important respects from experience. Figure 28 shows the market, affordable and social rented housing completions over 10 simulated years. Note the large number of boroughs (17 of 33) having no completions during that time. This was not true of any borough. Figure 29 shows the most recent available three-year average (6$^{th}$ April 2009 – 5$^{th}$ April 1012) of affordable and social rented housing completions taken from published data for London together with average completions over ten “years” from a typical run with the simulation model.

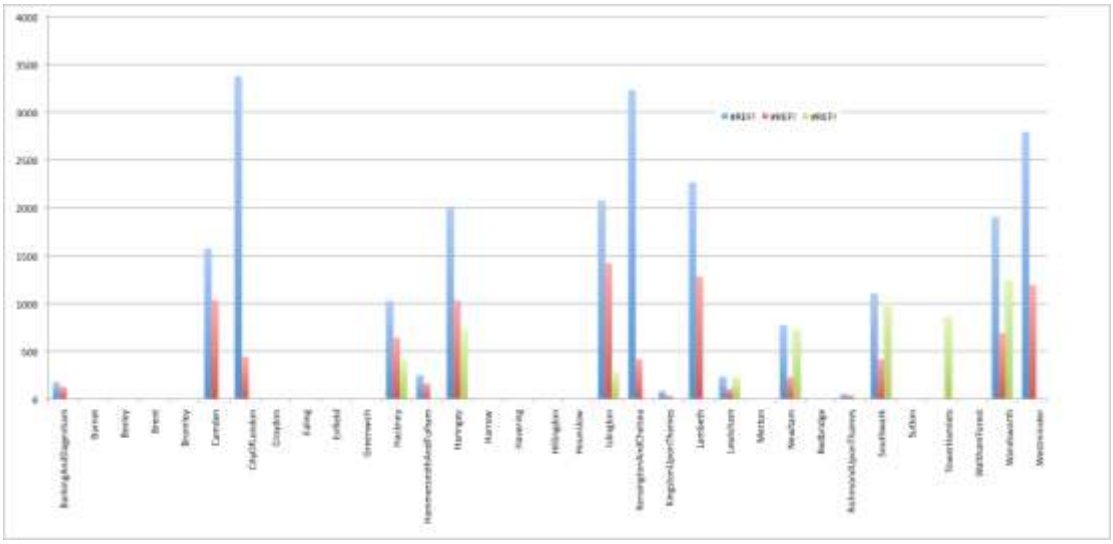


**Figure 28:** Total simulated housing completions after 122 time steps.

The simulated distribution of non-market housing across boroughs for which the simulated outcomes were non-zero is not too bad. The scale of the average, simulated completions is in every case lower than actual averages.

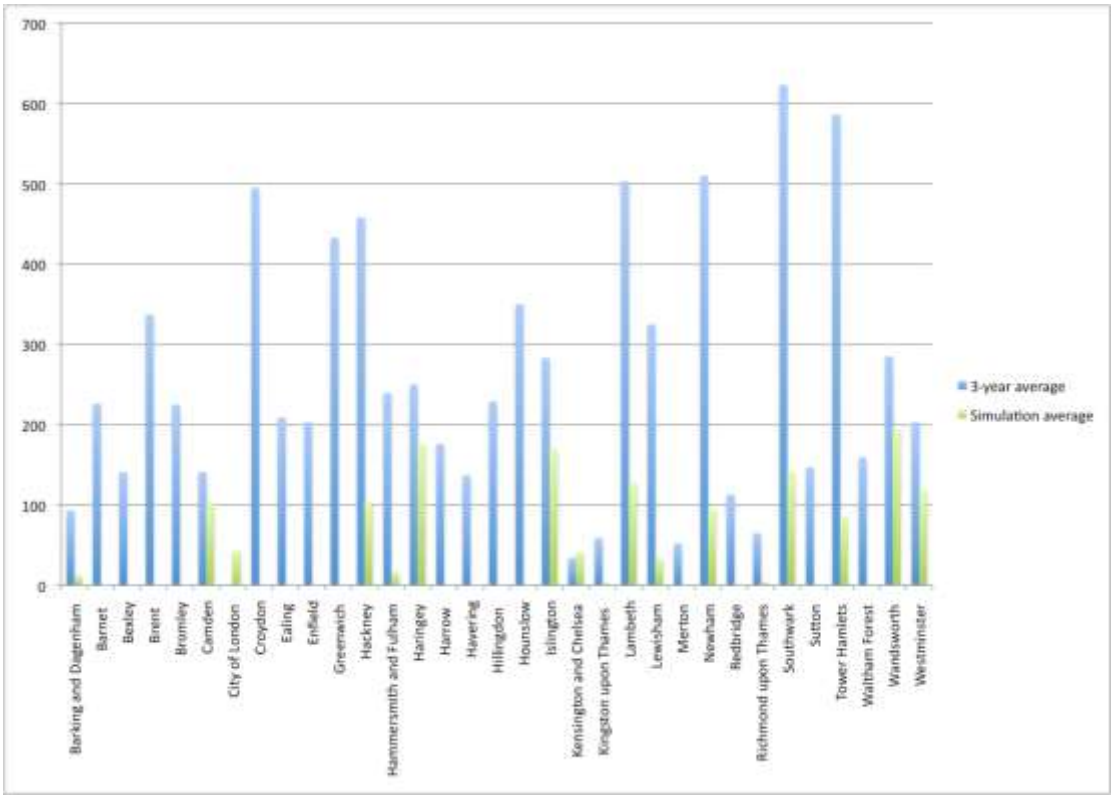



**Figure 29:** Comparison of simulated and actual affordable + social rented completions.

Analysis of the model indicates that the scale and number of zero completions was due largely to rules of behaviour for the source of land parcels for building. The source of land is entirely a modelling

artefact to avoid having to identify why and when landowners sell their properties. An arbitrary initial assumption was that land for sale was generated at random for each borough at each time step (intended to correspond to a calendar month). If the land were not sold within five "months", the land source would reduce the price by up to 15 per cent. If it were not sold within a further five months, the land would be withdrawn from sale. Increasing the lengths of time over which land was on the market and allowing for repeated reductions in price would increase the profitability of the land for private developers and place more land within the financial capacities of the housing associations.

An interesting result of the meeting with GLA officials related specifically to claims by various housing associations that they willingly include substantial investment in infrastructure in their developments. The GLA officials specifically rejected these claims and stated that, like private developers, the housing associations seek to minimise infrastructure investment in their planning proposals. This difference between the documentary evidence from the housing associations and the interview evidence from the GLA officials could be explored by a modification of a small number of rules describing housing association behaviour and running simulations with the original and that modified model. There would certainly be a difference in the simulated planning negotiations between boroughs and housing associations, perhaps lengthening the time required for planning decisions, but it is not clear whether this would have any significant impact on the scale of infrastructure investment by housing associations.

This was the most complicated model produced with the OCOPOMO toolkit and involved the first use of a number of features of the toolkit. It was also produced on Mac workstations and laptops running the OS X operating system which brought additional compatibility issues. As a result, considerable time was required for debugging and stress testing the toolkit and this reduced the time available for model development. Because of the highly modular nature of the OCOPOMO model design and development environment, the time required to introduce these modifications is slight so that the simulation outputs are readily made to conform better to the evidence on completions. Of course, more complete development would acquire and integrate evidence on the distribution of the lengths of intervals between land coming on to the market and eventual sale together with distributions of price change in relation to time on the market.

We have demonstrated that such complications can be developed in a controlled and effective manner. This may be a post-project endeavour in the course of preparing the results for publication.

## 5.3. FROM NARRATIVE TO EVIDENCE

The extra complication of London housing case beyond that of either the Kosice or Campania cases is due in part to the larger number of decisions combined with the larger number of key social interactions.

Each developer, whether private or housing association, must first decide on a price to offer for available development land. If the offer is accepted, then a planning proposal has to be developed involving the choices of numbers of housing units to be produced for the open housing market, the number to be produced as affordable but owned housing and the number for social renting. In addition, the planning proposal will have to include a (possibly zero) specification of infrastructure investment. The number of proposed housing units and the composition in terms of market, affordable-owned or social rented units will depend on expected profitability of the development for private developers and available financing for housing associations. All evidence suggests that private developers will seek to minimise infrastructure spending. Publicity by housing associations suggests that they are concerned to ensure that they support infrastructure appropriate to the scale and composition of the housing development. This will depend on the quality of existing educational, health and transportation provision. GLA officials claimed at our final meeting that the publicity of housing associations is misleading and that they, too, want to minimise infrastructure investment.

The requirements and negotiating stances of the planning authorities (the boroughs) depends on the targets for the different types of housing set out in the GLA's housing strategy, the quality of existing infrastructure and the rate of unemployment in the borough.

An example from the narratives published on the project Alfresco site will serve to indicate the paths from evidence to CCD to DRAMS model to output logs to narrative scenario.

Two rules that were not based on evidence are the strongest candidates for being the source of unrealistic results. The first rule states that, if a land parcel was on the market and unsold for five "months", the price would be reduced by 15-25 percent. The rule definition is shown in Figure 30.

```
(defrule LandSump::"Reduce land price"
    (global::$TIME$ (value ?today))
    ?saleFact <- (global::landForSale (timeStamp ?initDate)(hectares ?area)(offerPrice ?currentPrice)
        (instName ?parcel)(borough ?borough)(landOwner landSump)(listingDate ?listed))
    (> {?today - ?initDate} 3)
    (> {random() * (?today - ?initDate)} 2.0)
    ?reducedPrice<- (is {(0.85 + random() * 0.1) * ?currentPrice})
=>
    (retract ?saleFact)
    (assert (global::landForSale (hectares ?area)(offerPrice ?reducedPrice)(instName ?parcel)(borough ?borough)
        (landOwner landSump)(listingDate ?listed)))
    (print prio 30 "Price of ?parcel reduced from ?currentPrice to ?reducedPrice")
)
```

**Figure 30:** DRAMS code for rule "Reduce land price" of LandSump.

The second rules states that, if the land parcel is unsold for a further five months, it was withdrawn from sale. The rule definition is shown in Figure 31.

```
(defrule LandSump::"Retract unsold for-sale facts"
    (global::$TIME$ (value ?today))
    (all (global::landForSale (listingDate ?ld)(instName ?parcel)(timeStamp ?ts)))
    (< ?ts {?today - 5.0})
    (< ?ld {?ts - 5.0})
    ?forSaleFact <- (all (global::landForSale (instName ?parcel)))
    ?landParcelFact <- (all (global::landParcel (instName ?parcel)))
=>
    (retract ?forSaleFact)
    (retract ?landParcelFact)
)
```

**Figure 31:** DRAMS code for rule "Retract unsold for-sale facts" of LandSump.

Neither of these rules is linked to any CCD Action or, therefore, to any documentary evidence. However, the prices of the land parcels were based on documentary evidence. Here is the DRAMS source code for the following actions:

- offer land in rich inner borough (Figure 32)
- offer land in middling rich inner borough (Figure 33)
- offer land in poor inner borough (Figure 34)
- offer land in poor outer borough (Figure 35)
- offer land in richer outer borough (Figure 36)

```
/* Action: offer land in rich inner borough
 *@link _CCFZ4KllEeGVXo7GeOrp4A

 * Annotation in "borough_land_prices.txt": "For residential earnings above 40k, prices are  drawn from U(100 million, 150 million)."
 * Annotation in "borough_land_prices.txt": " If residential earnings are 30-40k, prices  generated from U(30 million, 50 million)"
 */
(defrule LandSump::"offer land in rich inner borough"
    (global::$TIME$ (value ?today))
    (LandSump (instName ?me))
    (last (global::landParcel (timeStamp {?today - 1})(hectares ?ha)(borough ?borough)(instName ?parcel)(landOwner ?me)))
    (global::boroughCharacteristics (instName ?borough)(innerOrOuterLondon inner)
        (residentialEarnings ?residentialEarnings))
    (> ?residentialEarnings 40000.0)
    ?priceHa <- (is {100000000.0 + random() * 50000000.0})
    ?offerPrice <- (is {?priceHa * ?ha})
=>
    (assert permanent (global::landForSale (instName ?parcel)(offerPrice ?offerPrice)(hectares ?ha)
        (borough ?borough)(landOwner ?me)(listingDate ?today)))
    (print prio 30 "Land parcel ?parcel in ?borough with ?ha ha. is for sale at price ?offerPrice")
)
```

**Figure 32:** DRAMS code for rule "offer land in rich inner borough" of LandSump.

```
/* Action: offer land in middling rich inner borough
 *@link _4yy3cKlyEeGVXo7GeOrp4A

 */
(defrule LandSump::"offer land in middling rich inner borough"
    (LandSump (instName ?me))
    (global::$TIME$ (value ?today))
    (last (global::landParcel (timeStamp {?today - 1})(hectares ?ha)(borough ?borough)(instName ?parcel)(landOwner ?me)))
    (global::boroughCharacteristics (instName ?borough)(innerOrOuterLondon inner)
        (residentialEarnings ?residentialEarnings))
    (<= ?residentialEarnings 40000.0)
    (> ?residentialEarnings 30000.0)
    ?priceHa <- (is {30000000.0 + random() * 50000000.0})
    ?offerPrice <- (is {?priceHa * ?ha})
=>
    (assert permanent (global::landForSale (instName ?parcel)(offerPrice ?offerPrice)(hectares ?ha)
        (borough ?borough)(landOwner ?me)(listingDate ?today)))
    (print prio 30 "Land parcel ?parcel in ?borough with ?ha ha. is for sale at price ?offerPrice")
)
```

**Figure 33:** DRAMS code for rule "offer land in middling rich inner borough" of LandSump.

```
/* Action: offer land in poor inner borough
 *@link _s_edkKl2EeGVXo7GeOrp4A

 * Annotation in "borough_land_prices.txt": "if residential earnings are less than 30000, set  the price per hectare as
the realisation of U(9 million,15 million)"
 */
(defrule LandSump::"offer land in poor inner borough"
    (LandSump (instName ?me))
    (global::$TIME$ (value ?today))
    (last (global::landParcel (timeStamp {?today - 1})(hectares ?ha)(borough ?borough)(instName ?parcel)(landOwner ?me)))
    (global::boroughCharacteristics (instName ?borough)(innerOrOuterLondon inner)
        (residentialEarnings ?residentialEarnings))
    (<= ?residentialEarnings 30000.0)
    ?priceHa <- (is {9000000.0 + random() * 6000000.0})
    ?offerPrice <- (is {?priceHa * ?ha})
=>
    (assert permanent (global::landForSale (instName ?parcel)(offerPrice ?offerPrice)(hectares ?ha)
        (borough ?borough)(landOwner ?me)(listingDate ?today)))
    (print prio 30 "Land parcel ?parcel in ?borough with ?ha ha. is for sale at price ?offerPrice")
)
```

**Figure 34:** DRAMS code for rule "offer land in poor inner borough" of LandSump.

```
/* Action: offer land in poor outer borough
 *@link _duHhcKl4EeGVXo7GeOrp4A

 * Annotation in "borough_land_prices.txt": "up to 30k residential earnings, land prices are U(800k, 2 million)"
 */
(defrule LandSump::"offer land in poor outer borough"
    (LandSump (instName ?me))
    (global::$TIME$ (value ?today))
    (last (global::landParcel (timeStamp {?today - 1})(hectares ?ha)(borough ?borough)(instName ?parcel)(landOwner ?me)))
    (global::boroughCharacteristics (instName ?borough)(innerOrOuterLondon outer)
        (residentialEarnings ?residentialEarnings))
    (<= ?residentialEarnings 30000.0)
    ?priceHa <- (is {800000.0 + random() * 1200000.0})
    ?offerPrice <- (is {?priceHa * ?ha})
=>
    (assert permanent (global::landForSale (instName ?parcel)(offerPrice ?offerPrice)(hectares ?ha)
        (borough ?borough)(landOwner ?me)(listingDate ?today)))
    (print prio 30 "Land parcel ?parcel in ?borough with ?ha ha. is for sale at price ?offerPrice")
)
```

**Figure 35:** DRAMS code for rule "offer land in poor outer borough" of LandSump.

```
/* Action: offer land in richer outer borough
 *@link _bD79sKl5EeGVXo7GeOrp4A

 * Annotation in "borough_land_prices.txt": "above 30k earnings U(5million, 25 million"
 */
(defrule LandSump::"offer land in richer outer borough"
    (LandSump (instName ?me))
    (global::$TIME$ (value ?today))
    (last (global::landParcel (timeStamp {?today - 1})(hectares ?ha)(borough ?borough)(instName ?parcel)(landOwner ?me)))
    (global::boroughCharacteristics (instName ?borough)(innerOrOuterLondon outer)
        (residentialEarnings ?residentialEarnings))
    (> ?residentialEarnings 30000.0)
    ?priceHa <- (is {5000000.0 + random() * 20000000.0})
    ?offerPrice <- (is {?priceHa * ?ha})
=>
    (assert (global::landForSale (instName ?parcel)(offerPrice ?offerPrice)(hectares ?ha)(borough ?borough)
        (landOwner ?me)(listingDate ?today)))
    (print prio 30 "Land parcel ?parcel in ?borough with ?ha ha. is for sale at price ?offerPrice")
)
```

**Figure 36:** DRAMS code for rule "offer land in richer outer borough" of LandSump.

Each of these rules is linked to a CCD Action and all of these Actions are annotated with passages from a document in the text file borough_land_prices.txt. The data and their source are reported in that file (Figure 37).

Land prices in London.
This note is based on http://www.uklanddirectory.org.uk/building-land-plot-sales-london.asp read on 28th May, 2012.
Tower Hamlets; £950,000, 235 sq.m. Outline planning permission for residential development (9 flats).
Westminster; £5,000,000, 5000 sq ft,
Southwark, £1,750,000, 1600 sq.m., currentlhy one Victorian 8-bed house plus garden
Kensington, £230,000, for one basement flat
Newham, £7,000,000, 1.2 acres. 5 units (?)
Tower Hamlets, £1,300,000, 3000 sq. ft.
Barnet, £1,500,000, 0.2 acres/0.115 ha, outline planning permisson for 9 flats
Newham, £310,000, 2900 sq.ft., 2 houses
Westminster/Kensinton&Chelsea, £130,000,000, 2.6 acres, 22 storey tower block
Croydon, £199,950, 0.026ha, 1 four-bed house
Enfield, £400,000, 1 acre, 3 houses
Hillingdon, £8,000,000; 13 acres, greenfield site.
Barnet, £2,500,000, 1620 sq.m., 1 high-end house
Tower Hamlets, £170,000, 1665 sq.ft.
Croydon, £160,000, two semi-detached
Newham, £250,000, 250 sq. m., 4 flats
Lewisham, £375,000, 405 sq. m., 1 house
Waltham Forest, £575,000, 1720 sq. ft./160 sq. m., outline planning permission for 9 flats.

| Borough | Price | Area | hectares | £/ha | inner or outer | res earnings |
|---|---|---|---|---|---|---|
| Newham | £7,000,000 | 1.2acres | 0.485622 | £14,414,503.46 | inner | 26990 |
| Newham | £310,000 | 2900 sq.ft. | 0.026941 | £11,506,249.89 | inner | 26990 |
| Newham | £250,000 | 250 sq. m. | 0.025 | £10,000,000.00 | inner | 26990 |
| Lewisham | £375,000 | 405 sq. m. | 0.0405 | £9,259,259.26 | inner | 29880 |
| Southwark | £1,750,000 | 1600sq.m. | 0.16 | £10,937,500.00 | inner | 33315 |
| Tower Hamlets | £950,000 | 235 sq.m | 0.0235 | £40,425,531.91 | inner | 34362 |
| Tower Hamlets | £1,300,000 | 3000 sq. ft. | 0.027870 | £46,643,615.15 | inner | 34362 |
| Tower Hamlets | £170,000 | 1665 sq.ft. | 0.015468355 | £10,990,179.59 | inner | 34362 |
| Westminster | £5,000,000 | 5000 sq.ft. | 0.046451517 | £107,639,111.89 | inner | 45986 |
| Westminster | £130,000,000 | 2.6 acres | 1.052181 | £123,552,886.81 | inner | 45986 |
| Waltham Forest | £575,000 | 160 sq. m. | 0.016 | £35,937,500.00 | outer | 28843 |
| Enfield | £400,000 | 1 acre | 0.404685 | £988,423.09 | outer | 29342 |
| Hillingdon | £8,000,000 | 13 acres | 5.260905 | £1,520,650.91 | outer | 29837 |
| Barnet | £1,500,000 | 0.2 acres | 0.080937 | £18,532,933.02 | outer | 32209 |
| Barnet | £2,500,000 | 1620 sq.m | 0.162 | £15,432,098.77 | outer | 32209 |
| Croydon | £199,950 | 0.026ha | 0.026 | £7,690,384.62 | outer | 52699 |

**Figure 37:** Partial content of borough_land_prices.txt file.

This data was used to produce the following algorithm reported in the borough_land_prices.txt file. The passages to which the relevant CCD Conditions and Actions are linked are indicated by the highlighting (Figure 38).

The following algorithm for generating prices of land parcels newly on the market seems consistent with the above data:

for an inner London borough, if residential earnings are less than 30000, set the price per hectare as the realisation of U(9 million,15 million). If residential earnings are 30-40k, prices generated from U(30 million, 50 million). For residential earnings above 40k, prices are drawn from U(100 million, 150 million).

For an outer London borough, up to 30k residential earnings, land prices are U(800k, 2 million) and above 30k earnings U(5million, 25 million).

**Figure 38:** Screen shot of marked up passages of borough_land_prices.txt.

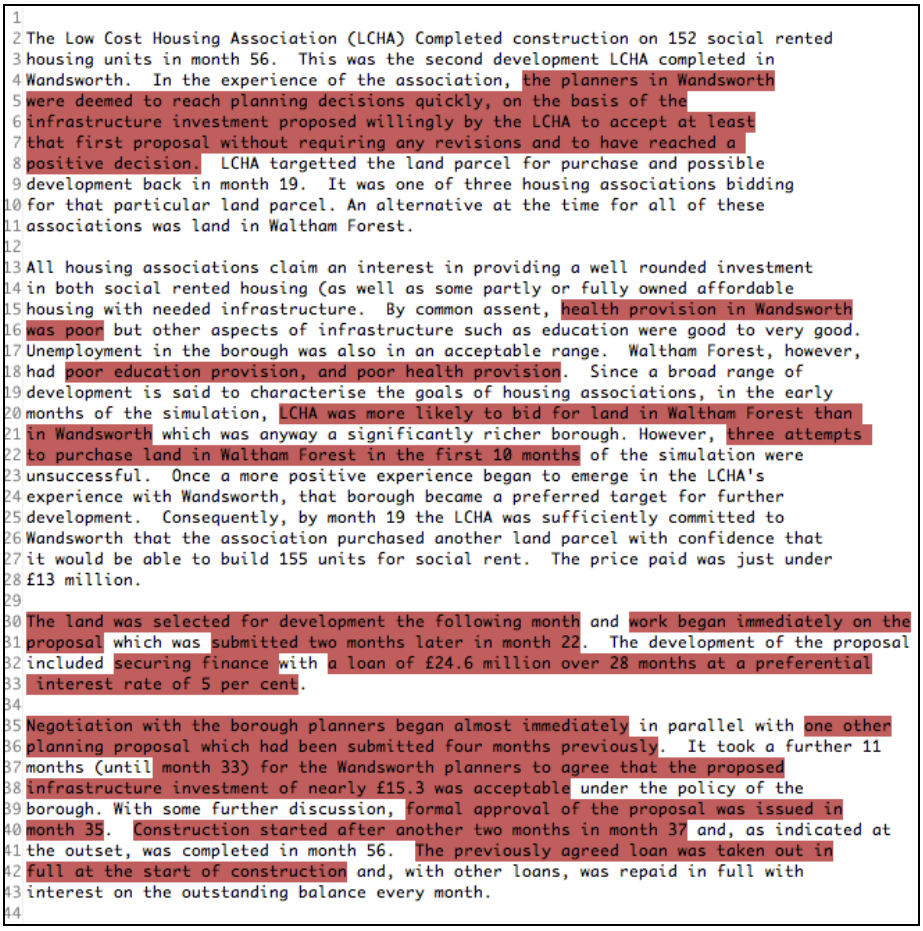
Figure 40 shows a vignette of the decision by a housing association to purchase land in the Borough of Wandsworth and the process of developing a planning application and negotiating with the borough's planning department. The first highlighted passage follows from the print statement of the second of the rules in Figure 39.

```
/*Action: Proposal accepted without revision
 *@link _EC6BMJCbEeKhBL7QFKezyw

 */
(defrule HousingAssociation::"Proposal accepted without revision"
    //submitted planning proposal
    //(HousingAssociation::R_submittedTo_Borough(planningProposal ?proposal) (Borough ?borough))
    //proposal revision issed
    //(HousingAssociation::R_issues_revisedPlanningProposal(Borough ?borough) (revisedPlanningProposal ?proposal))
    (last (revisedPlanningProposal (socialRented ?sr)(affordable ?aff)(market ?mkt)
    (revisedBy ?borough)(instName ?proposal) (landParcel ?parcel) (infrastructure ?inf)))
    (global::planningProposal (instName ?proposal)(borough ?borough)
    (socialRented ?sr)(affordable ?aff)(market ?mkt) (landParcel ?parcel) (infrastructure ?inf))
    (global::$AGENT$ (name ?borough)(ruleengine_instance ?boroughInst))
    ($SELF$ (name ?me))
=>
    (assert ("Borough"@?boroughInst::revisedPlanningProposal (socialRented ?sr) (affordable ?aff)(market ?mkt)
        (revisedBy ?me)(instName ?proposal) (landParcel ?parcel) (infrastructure ?inf)))
    (assert (revisedPlanningProposal (socialRented ?sr)(affordable ?aff)(market ?mkt) (revisedBy ?me)(instName ?proposal)
        (landParcel ?parcel) (infrastructure ?inf)))
)

(defrule HousingAssociation::"Endorse borough for quick, affirmative, no-revision decision"
    (last (revisedPlanningProposal (socialRented ?sr)(affordable ?aff)(market ?mkt)(revisedBy ?borough)
        (instName ?proposal) (landParcel ?parcel) (infrastructure ?inf)))
    (global::$TIME$ (value ?today))
    (global::planningProposal (instName ?proposal)(borough ?borough)
    (> timeStamp {?today - 4.0})(socialRented ?sr)(affordable ?aff)(market ?mkt)
    (landParcel ?parcel) (infrastructure ?inf))
=>
    (assert (endorsed (endorsee ?borough)(endorsement quickDecision)(endorsementScheme boroughEndorsementScheme)))
    (assert (endorsed (endorsee ?borough)(endorsement noRevisionRequested)(endorsementScheme boroughEndorsementScheme)))
    (assert (endorsed (endorsee ?borough)(endorsement acceptedProposal)(endorsementScheme boroughEndorsementScheme)))
    (print prio 40 "?borough endorsted for having accepted a proposal, accepted it without revision and decided quickly")
)
```

**Figure 39:** DRAMS code for rules "Proposal accepted without revision" and "Endorse borough for quick, affirmative, no-revision decision" of agent HousingAssociation.



The Low Cost Housing Association (LCHA) Completed construction on 152 social rented housing units in month 56. This was the second development LCHA completed in Wandsworth. In the experience of the association, the planners in Wandsworth were deemed to reach planning decisions quickly, on the basis of the infrastructure investment proposed willingly by the LCHA to accept at least that first proposal without requiring any revisions and to have reached a positive decision. LCHA targetted the land parcel for purchase and possible development back in month 19. It was one of three housing associations bidding for that particular land parcel. An alternative at the time for all of these associations was land in Waltham Forest.

All housing associations claim an interest in providing a well rounded investment in both social rented housing (as well as some partly or fully owned affordable housing with needed infrastructure. By common assent, health provision in Wandsworth was poor but other aspects of infrastructure such as education were good to very good. Unemployment in the borough was also in an acceptable range. Waltham Forest, however, had poor education provision, and poor health provision. Since a broad range of development is said to characterise the goals of housing associations, in the early months of the simulation, LCHA was more likely to bid for land in Waltham Forest than in Wandsworth which was anyway a significantly richer borough. However, three attempts to purchase land in Waltham Forest in the first 10 months of the simulation were unsuccessful. Once a more positive experience began to emerge in the LCHA's experience with Wandsworth, that borough became a preferred target for further development. Consequently, by month 19 the LCHA was sufficiently committed to Wandsworth that the association purchased another land parcel with confidence that it would be able to build 155 units for social rent. The price paid was just under £13 million.

The land was selected for development the following month and work began immediately on the proposal which was submitted two months later in month 22. The development of the proposal included securing finance with a loan of £24.6 million over 28 months at a preferential interest rate of 5 per cent.

Negotiation with the borough planners began almost immediately in parallel with one other planning proposal which had been submitted four months previously. It took a further 11 months (until month 33) for the Wandsworth planners to agree that the proposed infrastructure investment of nearly £15.3 was acceptable under the policy of the borough. With some further discussion, formal approval of the proposal was issued in month 35. Construction started after another two months in month 37 and, as indicated at the outset, was completed in month 56. The previously agreed loan was taken out in full at the start of construction and, with other loans, was repaid in full with interest on the outstanding balance every month.

**Figure 40:** Screen shot of housing association development vignette.

The RHS of the first rule supports the latest revision of the housing association's planning proposal by the borough planners. Then the second of these rules notes on the LHS that the planning proposal was initially submitted within the past four "months", that the "revision" simply restated the planning proposal which was therefore accepted by the planners. Consequently, the housing association endorsed the borough (in this case Wandsworth) as having made a decision quickly without asking for any revisions and the proposal was accepted. These are deemed to be positive results as a result of which the borough is now viewed more favourably by the housing association.

The next set of highlights in Figure 40 refers to the choice of land purchases to target. The alternatives were Wandsworth and Waltham Forest. The previous positive experience with Wandsworth, recorded by the endorsements asserted in the second of the rules above, induced the housing association to make a strong bid for the Wandsworth property. The bid was made as a result of the rule in Figure 41.

```
/*Action: Initial bid for land parcel
 *@link _pZi1EIgXEeKTou5hmholqg
 */

(defrule HousingAssociation::"Initial bid for land parcel"
    //(HousingAssociation::targetLandToPurchase(seller ?seller))
    //(global::landParcel(borough ?landParcel))
    //(global::boroughCharacteristics(innerOrOuterLondon ?innerOrOuterLondon))
    //(global::boroughCharacteristics(innerOrOuterLondon ?innerOrOuterLondon))
    //(HousingAssociation::unitConstructionCost(value ?ucc))
    //(HousingAssociation::unitConstructionCost(value ?ucc))
    (selectedLandParcel (parcel ?selectedParcel)(borough ?borough))
    (targetLandToPurchase (instName ?selectedParcel)(seller ?owner)(offerPrice ?price)(hectares ?area))
    ($SELF$ (name ?me))
    (latest (global::balanceSheet (instName ?me)(equity ?equity)(cash ?cash)(debt ?debt)(fixedAssets ?assets)))
    ?gearing <- (is {?debt / ?equity})
    (latest (global::gearingRatio (instName ?me)(maxValue ?maxGearing)))
    (global::landForSale (instName ?selectedParcel)(borough ?borough))
    (latest (housingDensity (instName ?parcel)(borough ?borough)(value ?density)))
    (unitConstructionCost (value ?ucc) (borough ?borough) (type affordable))
    ?numUnits <- (is {(int) floor(?density * ?area)})
    (global::housePriceLevel (borough ?borough)(houseType affordable)(value ?mktValue))
    (or
        (and
            (>= ?cash {?price + ?ucc*?numUnits})
            ?bidPrice <- (is ?price)
        )
        (and
            (< ?cash {?price + ?ucc*?numUnits})
            ?requiredDebt  <- (is {?price + ?ucc*?numUnits - ?cash})
            ?maxNewDebt <- (is {(?maxGearing - ?gearing) * ?assets})
            ?maxBidPrice <- (is {(?mktValue - ?ucc)*?numUnits})
            ?maxFinancialPrice <- (is {?maxNewDebt + ?cash - ?ucc*?numUnits})
            ?maxPrice <- (is {min(?maxFinancialPrice, ?maxBidPrice)})
            ?bidPrice <- (is {min(?maxPrice, ?price)})
            (> ?bidPrice 0.0)
        )
    )
    ($SELF$ (name ?me))
    (global::$AGENT$ (name ?owner)(agent_type ?type)(ruleengine_instance ?ownerInst))
=>
    (assert (?type@?ownerInst::purchaseOffer (landParcel ?selectedParcel)(price ?bidPrice)(offerBy ?me)))
    (assert (purchaseOffer (landParcel ?selectedParcel)(price ?bidPrice)(offerBy ?me)))
    (print prio 40 "Placing a bid of ?bidPrice for ?selectedParcel in ?borough for building ?numUnits affordable
        residential units.")
)
```

**Figure 41:** DRAMS code for rule "Initial bid for land parcel" of agent HousingAssociation.

The purpose of this rule is to determine the maximum bid price for the land that the financial position of the housing authority would support. This rule is based on the description in Figure 42 of the financial policies of housing associations provided by Volterra.

Housing Associations:

We took a sample of 4 associations from the g15 group, which currently account for around 25% of new builds in London. From their respective annual reports, we obtained gearing ratios, increase in stock, turnover and surplus. The companies define gearing as [total debt/(grant + reserves)]. All figures are for financial year ending 2012.

L&Q (the most profitable association):

* 53% net gearing
* 2% increase in stock in 2012, 4-5% average increase over five years to 2012.
* £95million surplus on £368million turnover (25.8%)

Hyde Group:

* 67.8% gearing ratio (target <80%)
* 3.6% increase in stock
* £23.8million surplus on £194.3million turnover (12.2%)

Peabody:

* 67% gearing ratio
* 1% increase in stock
* £30.9million surplus on £122.4million turnover (25.2%)
* £19.6million surplus after interest and tax

Catalyst:

* 37% gearing ratio
* 7.8% increase in stock
* £40.7million surplus on £152.1million turnover (26.8%)
* Spend 13p in every pound on reinvestment

From these figures we established the following basic rules:

* Maximum new stock of 1500 units per association per year in London.
* Maximum gearing ratio of 80%, start with an initial distribution weighted towards maximum. Lower gearing ratio allows greater growth capacity.
* Surplus normally distributed around 20% mean, with greater surplus allowing greater growth capacity.

**Figure 42:** Description in of the financial policies of housing associations (Volterra).

The rule uses the DRAMS Fact representing the current state of the balance sheet of the housing association together with facts concerning its unit construction costs of the relevant, affordable housing in Wandsworth. It determines how many housing units could be built after paying for the land and staying within the maximum gearing ratio of the association. In this case, some additional debt was required and this was sought from the one finance house implemented in the model. The decision of the finance house was determined by the rule in Figure 43.

In this case, because the gearing ratio of the housing association was below 0.4, the lower interest rate of five per cent was set and the term of the loan was set at the number of months in would take to pay off the loan if the whole of the average surplus of the association over the preceding "year" were applied to the loan repayment. The conditions relating to gearing were linked to the Volterra document through the relevant CCD preconditions of the corresponding CCD Action. However, we have no evidence regarding interest-rate setting by banks and finance houses so that element of the rule remains a "magic fact" (i.e., one that is just pulled out of a hat).

Other vignettes driven by the model and published on the Alfresco site and relate to the simulation model, the CCD and the documentary evidence in the same ways as described above.

```
(defrule FinanceHouse::"accept loan application including land cost -- new borrower"
    //(global::gearingRatio(value ?gearing))
    //(::infrastructurePolicy(healthSpendPerMarketUnit invalid))
    //HA owes for land
    //(global::R_borrows_loan(HousingAssociation ?housingAssn) (loan ?principal))
    (last (loanApplication (principal ?amount)(borrower ?applicant)(purpose ?site)))
    (not (loanDecision (instName ?site)(borrower ?applicant))) // to stop multiple firings at one tick
    (not (endorsed (endorsee ?applicant)))
    (global::transaction (item ?site)(buyer ?applicant)(price ?landCost)(instName ?transaction))
    (latest (global::loan (borrower ?applicant)(principal ?landCost)(purpose ?transaction)(lender landSump)))
    (last (global::balanceSheet (instName ?applicant)(equity ?eq)(debt ?debt)(cash ?cash)))
    ?gearing <- (is {(?debt) / ?eq})
    (< ?gearing 0.8)
    (global::$TIME$ (value ?today))
    ?incomeFacts <- (query all (global::incomeStatement (instName ?applicant)(> timeStamp {?today - 12.0})))
    ?avgSurplus <- (avg ?incomeFacts surplus)
    (> ?avgSurplus 0.0)
    (or
        (and
            (<= ?gearing 0.4)
            ?r <- (is 0.05)
        )
        (and
            (> ?gearing 0.4)
            ?r <- (is 0.1)
        )
    )
    ?term <- (is {(int) ceil(?amount / ?avgSurplus)})
    ?repayments <- (is {?amount / ?term})
    ($SELF$ (name ?me))
    (global::$AGENT$ (name ?applicant)(agent_type ?type)(ruleengine_instance ?appInst))
=>
    (assert (global::loan (principal ?amount)(term ?term)(interestRate ?r)(repayments ?repayments)(purpose ?site)
        (lender ?me)(borrower ?applicant)))
    (assert (loanDecision (instName ?site)(approved true)(borrower ?applicant)(principal ?amount)))
    (assert (?type@?appInst::loanDecision (instName ?site)(approved true)(borrower ?applicant)(principal ?amount)))
    (print prio 50 "Application by ?applicant for a loan of ?amount to develop ?site is agreed for ?term months at
        an interest rate of ?r")
)
```

**Figure 43**: DRAMS code for rule "accept loan application including land cost -- new borrower" of agent FinanceHouse.

## 5.4. OFFICIALS' ASSESSMENT

The assessment of the GLA officials was that they liked the linking of evidence to simulation outputs but they did not want the detail provided by the complicated model. The possibilities for open consultation and collaboration that the more detailed and therefore complicated makes feasible were not of interest to the officials.

One of the GLA officials at our meeting stated clearly that what they want is simple models that produce clear results that can then be modified to meet their requirements. In the quarter-century experience of the principals of SMA, these requirements can either be a confirmation of preconceptions about a desired policy or simply making the results conform to the officials' views of the limits of plausibility.

It is important to note in this regard that the GLA is not a user-partner and the OCOPOMO toolkit was never intended for use involving the GLA in open (or any other type of) consultation. The London Housing case was used for purposes of testing the features of the OCOPOMO toolkit for both design and implementation of the policy model, the presentation of the results to users on the collaboration website and getting feedback on desirable model properties.

## 5.5. IMPLICATIONS

Both experience and evidence developed in connection with the London housing case suggest that there is no demand by government officials in the UK for models with rich qualitative as well as numerical content and output. However, the capability of the toolkit to link evidence with simulation outputs is a very desirable feature.

Whether officials, politicians and non-government stakeholders could be educated to appreciate the possibilities for collaboration afforded by rich models with extensive qualitative content and output remains an open research question.

For example, at the time of writing here have been several policy announcements by the UK government with direct effects on housing. One is for a tax on occupants of housing where there are more bedrooms that couples or uncoupled individuals. A second is the offer of government guarantees of mortgages issued by banks and similar finance houses where the mortgagors can produce an otherwise unacceptably small deposit. A third policy expected to impact on housing involves restrictions on benefits paid to the poor. All of these policies impact on the level and composition of demand for housing. At the same time, the leading NGO concerned with housing for lower-income families has argued, in part on the basis of econometric models, that subsidising the supply side of the housing market directly would be more effective than subsidising the demand side.

This would seem to be precisely the sort of issue that would benefit from the OCOPOMO toolkit supporting detailed, rich, qualitative modelling integrated with the links to evidence and scope for direct user participation in order to explore the different consequences of the various policy options. However, the usefulness of the toolkit will obviously depend on the willingness of government to justify policy proposals in the kind of detail that the modelling supports *and* to seek meaningful inputs to the policy design from other stakeholders.

It is clear from our experience with the GLA and other officials that, in the UK, the case for both participation and rich, qualitative is yet to be made.

## 6. LESSONS LEARNT AND ASSESSMENT OF REQUIREMENTS MET

The development of the three applications of the OCOPOMO toolkit proceeded in different ways, thereby to provide insights into appropriate ways of using the toolkit and variations on the OCOPOMO process of policy collaboration and analysis.

Initially, and in different ways, SMA and Volterra in the London case and UWAR in the Kosice case developed policy models using both procedural and declarative modelling approaches. For simple models, it is clear that the task of translating from procedural to declarative code holds little difficulty. Essentially, the procedural source code is treated like any other document. It was used to define agents, objects, relations and attributes and the relevant elements of the source code are annotated and linked to these CCD entities.

The experience of UWAR in writing a procedural model and then trying to replicate it directly into declarative code using DRAMS. For the overall OCOPOMO process, procedural modelling was more difficult and less helpful with respect to linking output to CCD to evidence. Starting with a procedural modelling approach by programming entirely in Java was chosen by UWAR as the energy model is complex and the support of a well developed and well documented simulation environment was preferred by the modelling team. UNISOB led the way in applying just the OCOPOMO software (including DRAMS) to the knowledge elicitation, CCD development and modelling process, thereby to demonstrate the promise of the integrated ICT toolkit in supporting the OCOPOMO process of policy analysis with open collaboration. Also, an experiment of a student at UKL in implementing a complimentary model by running through the whole OCOPOMO policy development turned out to be very useful and effective. This showed that the OCOPOMO platform offers flexibility and modularity by enabling variances of the approaches and broad utilization of ICT toolbox in different contexts.

In the latter part of the project, UNISOB developed the evidence and the CCD and implemented the DRAMS model for the Campania case. UNISOB also produced visualisations and linked the narrative scenarios to model outputs which were then automatically linked to the CCD and documentary evidence. Within UNISOB, the CCD and model implementations were undertaken by separate individuals. For the Kosice case, UWAR collected and produced the documentary evidence and created a detailed CCD whilst the model was implemented by SMA with some additions to (but no deletions from) the CCD produced by UWAR. The narrative scenarios based on the verbal outputs from the model were produced both by SMA and UWAR with UWAR ensuring that the appropriate links were created. For the London case, all of the work with the OCOPOMO toolkit was undertaken by a single individual who also produced an entirely new Kosice model.

### 6.1. DEVELOPMENT TOOLS

SMA has found that the basic actor-network diagram of the CCD is best implemented, at least in the first instance, entirely from the evidence base. That is, the different types of stakeholders are identified from the evidence and CCD Actors are created to represent each type. The important non-stakeholder phenomena such as technology-based objects and processes, relevant goods and services and non-cognitive institutional arrangements are best identified from the outset and represented by CCD Objects. The relationships amongst stakeholders and between a stakeholder type and the social items represented by CCD Objects are also best identified and included in the CCD as relations. Both Actors and Objects will have attributes that the evidence indicates to be important and these are naturally included as attributes of the Actors and Objects in the CCD. In the development of the Kosice model, the CCD Actors created by UWAR were all used as transformed by the CCD2DRAMS tool. By no means all of the Objects were used in the model and, therefore, the relationships amongst those Objects and between any Actor and unused Object were also unused. In further development of the model, doubtless those so-far-unused Objects and Relations would be incorporated substantively in the model. There is no doubt, therefore, that the CCD actor-network as implemented by UWAR for the Kosice case and by SMA for the London case provided both a starting point for the structure of the model and a menu of Actors, Objects and Relations to be developed further. The order in which they

are to be developed would depend largely on the views of users though the analysts and modellers might choose to implement particular CCD entities that would improve the plausibility of the model outputs.

The place of the CCD action diagram in the OCOPOMO process is more complicated.

The procedure that was found to be effective for the Kosice and London models was to write a collated verbal description of the decision-making processes of each of the stakeholder types taking account of how different attributes (for example wealth, age, location) of the stakeholder influence the decisions they take. Using the MyNote feature of the OCOPOMO development toolkit, this description can be built up in light of preliminary simulation results. These MyNote descriptions inform the development of DRAMS rules. Then a CCD Action is created for each of these DRAMS rules as well as a set of CCD Conditions corresponding to the clauses of the rules. These Actions and corresponding rules are linked by the CCD2DRAMS tool. The actions and conditions are then annotated with appropriate passages from the MyNote descriptions as well as with passages from the PDF, HTML and text documents from which the information collected in the MyNote descriptions is taken.

In general, the social structure of the context and environment for which the policy is being formulated is readily captured in the CCD on the basis of evidence provided by existing documents and stakeholders' descriptions of the social structure and decision-taking processes. In using the CCD and the model to build up stories that capture the social processes indicated by the evidence, there is more iteration between model implementation and testing on the one hand and CCD development on the other hand. This finding is a result of experience indicating that the relevant social structure can, in practice, be described more clearly and simply by stakeholders and from documentary evidence whilst the processes of decision-making and social interaction are more complicated and subtle.

## 6.2. USERS' INTERFACE

The information provided for the users of the OCOPOMO toolkit is both text-based and numerical and, as a result, more varied and voluminous than conventional policy models. In addition, the models can be quite complicated simply because they capture in arbitrary detail verbal descriptions of social processes as well as structures. In consequence, it was necessary to find ways of presenting the scenarios produced on the basis of verbal and numerical simulation results in a way that would be comprehensible to users.

The principle adopted in the designing the means of reporting model-based scenarios was based on well established principles of cognitive science. We know that individuals can keep in mind between five and seven mental "objects" at any one time. What constitutes a mental "object" can itself be more or less highly articulated. For example, chess players of almost any level of expertise keep in mind from five to seven elements and implications of the pattern and positions of pieces on the chess board. But the amount of information packed into the elements and implications in the mind of a grandmaster is enormously greater than the amount of information packed into the elements and implications in the mind of a novice.

The implication of this principle is that information should be provided to users in a relatively small number of simple "chunks". Then each "chunk" can be explored also in a small number of simple "chunks". Each users can develop increasingly elaborate understanding of the areas of particular interest and do so at rates they find comfortable.

In order to achieve this incremental and selective learning, we decided to provide the users with a top-level summary of the results from each simulation. The summary in each case is no more than a few hundred words. Each element of the summary – for example, the decisions taken by one set of stakeholders in a particular context – was linked to a more detailed description of an example such a decision. There different decisions were taken by similar stakeholders in similar contexts, then examples of such different decisions were linked from the top-level summary. When decisions were

the result of interactions with other agents – for example, planning negotiations in London or financing applications in Kosice – there are descriptions of simulated interactions leading to a final decision. There are links from descriptions of individual behaviour to the description of the interaction and *vice versa*.

By keeping each description simple and linked to other simple descriptions as well as to summary statements in less detailed accounts, users are able to build up their understanding of the scenarios incrementally. Of course, the point is not for the users to understand the scenarios but, rather, for them to deepen and render more precise their understanding of the conditions in which the policies are to be implemented and the differences in the interests, perspectives and objectives of the various stakeholders.

## 7. CONCLUSIONS AND OUTLOOK

The OCOPOMO process emerged from a combination of engagement with stakeholders and software development taking place in close connection with one another. The software development and modelling teams involved in the creation of the OCOPOMO process have brought diverse skills and modelling perspectives to the project. As a result, every element of the project software has been subject to detailed discussion and testing by the application of different approaches to model design development and use.

We now have a toolkit that supports the development of arbitrarily complicated models and scenarios with facilities for liking each element of a scenario to supporting evidence for the social structures and processes leading to it. We have understood the users' requirements for understanding and using the scenarios and based the presentation of the scenarios and allowed for user participation on Web, and in particular Web 2.0, technology.

The toolkit has all of the features required for evidence-based model design and development and for evidence-based scenarios where the evidence base for each significant element of model outputs can be identified by users. We have recognised and successfully addressed the requirements for users to be able to build their understanding of different stakeholders' positions with accuracy and precision. Our three case studies, taken together, have demonstrated that the OCOPOMO process can accommodate some differences in the approaches of facilitators, modellers and analysts. We have also found from the work of WP5, that a declarative modelling approach fits more easily with the production of verbally rich and evidenced-linked scenarios than does a procedural modelling approach. This result is doubtless due to property of declarative modelling that it necessarily describes process and how process emerges as actions change prevailing conditions and these conditions lead to yet further actions. Procedural modelling is better suited to the implementation of algorithms so that the process is described a priori rather than emerging at runtime.

As indicated in the reports of the three case studies, we have found that at least some officials concerned with social policies have a considerably more restricted view of the role of the model than is inherent in the OCPOMO process and toolkit. However, other officials and stakeholders have participated with enthusiasm in providing evidence and evaluating results. We conjecture that there are cultural differences here: some officials are seeking answers to problems or opportunities that the policies are intended to address and others want support for, and justification of, the policies to which they are already committed in more or less detail. Also, some officials are convinced that they already understand the relevant social processes and have no need to explain them to or convince other stakeholders of their validity. Perhaps others are more open to learning about the relevant social processes.

The outlook for take-up of the OCOPOMO process and toolkit is obviously brighter where those concerned with social policies are open to learning about the relevant social processes and to open collaboration and consultation. Since open collaboration is in line with EU and some member-states' policies, the implementation of these policies can only enhance the outlook for the OCOPOMO process.

## 8. REFERENCES


[1] Banisar, David, Freedom of Information Around the World 2006: A Global Survey of Access to Government Information Laws (September 20, 2006). Privacy International, 2006. Available at SSRN: http://ssrn.com/abstract=1707336

[2] Bicking, M., Wimmer, M.A.: Concept to Integrate Open Collaboration in Technology Roadmapping: Stakeholder Involvement in Strategic E-Government Planning. In: Proceedings of the 44th Annual Hawaii international Conference on System Sciences (44-HICCS). IEEE Press, New York (2011)

[3] Bortz, J., Döring N.: Forschungsmethoden und Evaluation für Sozialwissenschaftler. Springer, Heidelberg (1995)

[4] Bradfield, R., Wright, G., Burt, G., Cairns, G., Van Der Heijden, K.: The origins and evolution of scenario techniques in long range business planning. Futures 37(8), 795–812 (2005)

[5] Carroll, J.M.: Scenario-Based Design: Envisioning Work and Technology in System Development. John Wiley & Sons Inc (1995)

[6] Codagnone, C. and M.A. Wimmer (eds.): Roadmapping eGovernment Research: Visions and Measures towards Innovative Governments in 2020. MY Print snc di Guerinoni Marco & C, Clusone (2007)

[7] Commission of the European Communities: European Governance – A White Paper. COM(2001) 428 final, http://eur-lex.europa.eu/LexUriServ/site/en/com/ 2001/com2001_0428en01.pdf (accessed 23/03/2011)

[8] Flick, U.: Qualitative Sozialforschung. Eine Einführung. Rowohlt Tb. (2002)

[9] Gausemeier, J., Fink, A., Schlake, O.: Szenario-Management: Planen und Führen mit Szenarien. Hanser Publishing, München (1996)

[10] Geschka, H., Hammer, R.: Die Szenario-Technik in der strategischen Unternehmensplanung. Strategische Unternehmensplanung, Heidelberg, Germany (1997)

[11] Geschka, H.: Delphi. In Bruckmann, G.: Langfristige Prognosen: Möglichkeiten und Methoden der Langfristprognostik komplexer Systeme. Physica-Verlag, Würzburg (1978)

[12] Gustavsson, S., Karlsson, C., Persson, T. (eds.): The Illusion of Accountability in the European Union. Routledge, London (2009)

[13] Kahn, H., Weiner, A.J.: The Year 2000: A Framework for Speculations on the Next Thirty-Three Years. The MacMillan Company Publishing (1967)

[14] Kim, D.H.: The link between individual and organizational learning. In Starkey, K., Tempest, S., McKinlay, A. (eds.): How organizations learn: managing the search for knowledge. 2nd ed., Cengage Learning Business Press (2003).

[15] Lotzmann U, Meyer R (2011) DRAMS – A Declarative Rule-based Agent Modelling System. In: Proceedings of ECMS 2011 - 25th European Conference on Modelling and Simulation, Krakow, June 7-10 2011, Poland.

[16] Adolph Lowe, "A Structural Model of Production", 1952, *Social Research*

[17] Michael, J.: The Politics of Secrecy: Confidential Government and the Public's Right to Know. In: REVIEWS. Public Administration, vol. 61, no. 2, pp. 225--236. Wiley (1983)

[18] Möhrle, M., Isenmann, R.: Technologie-Roadmapping – Zukunftsstrategien und Technologieunternehmen. Heidelberg, Springer Verlag, (2008)

[19] Moss, S.: Markets and macroeconomics: macroeconomic implications of rational individual behaviour. B. Blackwell, Oxford, OX; New York, NY, USA (1984)

[20] Moss, S. (1995) Control metaphors in the modelling of decision-making behaviour. Computational Economics. 8. 283-301

[21] Moss, S.: Policy Modelling: Problems and Prospects. (2008) http://www.cfpm.org/papers/

[22] OCOPOMO consortium (2009). Annex I to the Grant Agreement: Description of Work. Internal Document.

[23] OECD: Open Government: Fostering Dialogue with Civil Society. OECD Study, 2003

[24] Radin, B.A. (2000). Beyond Machiavelli: Policy Analysis Comes of Age. Georgetown University Press, Washington, D.C.
[25] Repnik, H.P., Mohs, R.M.: Good Governance, Democracy and Development Paradigms. In: Intereconomics, vol. 27, no. 1, pp. 28--33. Springer (1992)
[26] Richardson, G.P., Andersen, D.F. Teamwork in group model building. In: System Dynamics Review. 11(2): 113–137 (1995) John Wiley & Sons, Ltd.doi: 10.1002/sdr.4260110203
[27] Roberts, A.: Blacked Out. Government Secrecy in the Information Age. Cambridge University Press, Cambridge (2006)
[28] Schelter, B., Winterhalder, M., Timmer, J.: Handbook of Time Series Analysis. Wiley VCH (2006)
[29] Sharpe, B., Van der Heijden, K., *Scenarios for Success – Turning Insights into Action*. John Wiley &Sons, Ltd., England
[30] Smith, S.K., Tayman, J., Swanson, D.A.: Trend Extrapolation Methods. State and Local Population Projections, The Springer Series on Demographic Methods and Population Analysis, 2002, 161-183, doi: 10.1007/0-306-47372-0_8
[31] Piero Sraffa (1960). Production of Commodities by Means of Commodities, Cambridge: Cambridge University Press.
[32] Sträter, D.: Szenarien als Instrument der Vorausschau in der räumlichen Planung. Regionalprognosen. Methoden und ihre Anwendung. Akademie für Raumforschung und Landesplanung: Forschungs- und Sitzungsberichte, Hannover, Germany, vol. 175, pp. 417--440 (1988)
[33] Theoharis, Athan (ed.) (1998). A Culture of Secrecy: The Government versus the People's Right to Know. University Press of Kansas.
[34] Werth, B., Geller, A. and R. Meyer (2007) He endorses me - he endorses me not - he endorses me ... contextualized reasoning in complex systems. Papers from AAAI Fall Symposium: Emergent Agents and Socialities – Social and Organizational Aspects of Intelligence. AAAI Technical Report: FS-07-04
[35] Maria A. Wimmer, Karol Furdik, Melanie Bicking, Marian Mach, Tomas Sabol, Peter Butka: Open Collaboration in Policy Development: Concept and Architecture to integrate scenario development and formal policy modelling. In: Yannis Charalabids, Sotiris Koussouris (eds.): Empowering Open and Collaborative Governance. Springer: Berlin et al, 2012, forthcoming
[36] Wimmer, M.A.; Stadach, M.; Morland, P., "*Glossary*". In (Zechner, A. Hrsg.): E-Government Guide Germany. Strategies, Solutions and Efficiency, Fraunhofer IRB Verlag, Stuttgart, 2007; S. 431-456
[37] U. Lotzmann and M. A. Wimmer, Traceability in Evidence-based Policy Simulation, in *27th European Conference on Modelling and Simulation, ECMS 2013 (accepted)*, Alesund, 2013.

## APPENDIX A: SCENARIO DESCRIPTIONS OF KSR

***Scenario representing the view of Energy Expert***

*I am a Kosice citizen and I am retired director of a power plant in Kosice. I am not a decision maker anymore, so I can express only my opinions how good energy policy could look like.*

*The heat consumption in Kosice city in recent years decreased substantially. In 1987 the demand per year was about 7 000 000 GJ, in 2006 it was 4 400 000 GJ. We can say that this is thanks to new technologies and better insulation of buildings.*

*Currently, we have in Kosice one very strong and dominant heat producer, TEKO, which uses gas from Russia and coal from Ukraine. The proportion of sources is ca. 1:1 coal and gas. This power plant produces heat and electricity. The current technology is working well from the producer's economic point of view. The idea for the whole heating system was that the management of the main power plant would be open for cooperation with other heat producers in Kosice city. But in fact they cover the Kosice energy (heating) demand by 95%, leaving only 5% for the competition.*

*The main competitor in Kosice is the garbage incinerator (KOSIT, belonging to the Italian company) which also produces heat (and is able to produce electricity). The incinerator utilizes communal waste. They byproduct of the utilization is heat. But it cannot fully exploit its capabilities due to an agreement with TEKO. In consequence, 2/3 of its power is wasted. The capacity of KOSIT is 500 000 GJ per year. Due to the agreement, it is allowed to sell the city only 180 000 GJ. If KOSIT could deliver 500 000 GJ energy from incinerator to the pipe system, a CO2 coefficient of 350 kg/MWh would be reached. This is a high coefficient, but it is produced as the waste has to be burned anyway. For comparison, CO2 coefficient for burning Coal is 360 kg/MWh, and for Gas it accounts for 230 kg/MWh. Nowadays, weighted CO2 coefficient for TEKO that uses combination of Gas and Coal accounts for 322 kg/MWh.*

*As stated above, the cooperation between heat producers is based on an agreement between TEKO and its competitors, which does not allow competitors to deliver energy and heat beyond the 5 % of the total needs. This situation does not represent a free market competition. Because of its interest, the main heat producer does not let the incinerator to use the system to a greater extent. Especially when looking at the heating prices, this is not a good situation: the price for energy from power plant is 18 eur/GJ, while from incinerator it is 8 eur/GJ. If the incinerator was allowed to provide more energy, the energy price would decrease to 15 eur/GJ. As a citizen I have to pay 24 eur/GJ only because the main power plant (owner of the heating exchanger) doesn't allow the competitor to sell more.*

*If people are not happy about the energy costs, they start thinking about alternative solutions like heat pumps. For example, low geothermal resources exist around Kosice, which may provide 1 200 000 GJ per year without CO2. Private investors already introduce this technology although on a small scale. Also on the individual level people invest in individual gas furnaces at homes or flats.*

*A concern I have is that heat transfer is associated with losses. Modern gas furnaces are as effective as large heating stoves, so some people install them at home. They utilize fossil fuels, but by avoiding the transmission losses, this contributes to some reduction in CO2 emission.*

*I imagine that there is a possibility in Kosice to have a sustainable utilization of resources with the usage of renewable energy sources. For example if Kosice city introduces geothermal energy, which is located 14 km from Kosice agglomeration, it will generate additional heat - 2 000 000 GJ per year without CO2. The investment will cost about 76,3 million Euro. The problem is, however, that this energy source was bought by a company with Russian and French owners (a gas company), which has stopped any investments in this area because of other interests to sell gas from Russia (contradicting interests).*

*Another particular problem is that in order to utilize the geothermal energy, an existing heating exchangers is needed, which belongs to the main producer (TEKO).*

*If all the possible energy "eco-sources" will be introduced, the TEKO power plant will need to produce only 700 000 GJ to satisfy the remaining city demand. I estimate future "eco" energy price for 18,26 eur/GJ for 2013 while the price estimation for fossil energy 24,56 eur/GJ for 2013. This price is valid only for Košice heating supply and distribution system.*

*This means remarkable savings for citizens: 12 – 16 eur/GJ. Having an average salary in Kosice region of about 700 eur/month, this reduction of costs for heating is a remarkable item. Besides with this solution Kosice would reduce the CO2 emission from 840 000 t per year to 15 600 t.*

*Fuller use of local energy resources will increase energy security of Kosice and Slovakia (even 98 % self-sufficiency!). Unfortunately the State is not interested in implementing this solution (they want to preserve their income from power plant currently supplied by the coal and gas delivering from abroad), nor are the owners of geothermal source (the energy producers – which is Slova Geotherm and is controlled by Slovak Gas industry, which is primary interested to sale the gas). So the status quo, although unfavourable to citizens, is not easy to be changed.*

***Scenario representing the view of NGO***

*I am working in NGO. Our institute is not a typical NGO, it is a little bit like a think tank. Our target is comprehensive and integral region development including climate, economic and social issues. We work with local government and local authorities who ask us for expertise.*

*We describe ecological impact for every city that is interested in the topic. We collaborate with business. Privet companies support us; even big gas companies. They know that our measures are against usage of gas but they know that consumption of gas will decrease and they want to know in which renewable sources of energy they should invest. Insurance companies are also interested in our activity.*

*If some cities are interested in energy efficiency we propose Covenant of Mayors program. This program is for cities to reduce the emission of green house gases. If city agrees on the policy statement it has to prepare action plan for renewable energy. It can than rise the money from different European Commission programs. Four cities in Slovakia have enrolled to the program, but not Kosice. Than our think tank helps city to prepare sustainable energy action plan. It takes about one year because it is very detailed. We can help to find money for the implementation and process implementation.*

*When it comes to energy we deal mainly with energy issues for whole Slovakia, not Kosice Region. Every city in Slovakia has different energy situation/motivation some base on coal or gas, other concentrate on energy efficiency, energy savings. In Slovakia the electricity is produced from nuclear power (50%), coal (25%), hydropower (10-15%), renewable sources of energy.*

*In Slovakia, regions (administrative territory) have zero decisive power in energy issues. Government and parliament have the power – they vote and decide about political instruments (e.g., they can vote for some credit system). Local governments like city council have no power because they cannot decide about credits neither vote for some limits. Still local governments have some possibilities to engage in energy issues, e.g., local government can produce local regulation saying that if private households invest in energy efficiency they will pay lower taxes for buildings. Besides city council can decide about the energy sources in buildings owned by them (school, hospital).*

*The strongest influence on energy issues comes from national level. We have National Council for Energy which evaluates and approves prices for energy, new energy sources (e.g. when company wants to build solar power plant and connect it to the network it needs to be approved by national council for energy).*

*In Slovakia we have system that supports renewable sources of energy, energy efficiency, development of some type of renewable energy technology for households, companies and local authorities. Households, when investing in biomass or solar energy (for heating water), can ask for financial support. Part of your costs is paid back then. But you have to fulfil the criteria regarding efficiency, filters, etc. This is popular strategy for a household as saving is a motivator. At least for people I know. In my opinion most people are practical and only few have ideals to be eco-friendly.*

*Currently the energy issue becomes very important because of oil peak. In near future energy demand will be much higher and Slovakia does not have efficient alternative source of energy to oil. This can cause social and economic problems. Nuclear and renewable energy is not a solution. Nuclear energy is very complicated and expensive (radiator, security issues, etc.). While renewable sources of energy are good for local authorities. However, it is not so efficient and you have unchangeable limits of exploitation like soil (the production of food and biomass stands in contradiction).*

*There are no easy solutions. We need to reduce energy consumption expectations by many per cents and energy efficiency itself cannot help. The tricky think is that energy efficiency can increase energy consumption. It is called Jevons paradox.*

*We need to use systematic approach to fight the problem. I used to work for NGOs that run social campaigns – and to my opinion it does not work. You must create more systematic plan for progress with detailed solution, some concept and programs that can be showed to people who have power.*

*In current situation local authorities work on routine government activities. Separately, you have climate change issues. Local authorities do not care about climate change. They are only interested in dealing with disaster risk management like float. They want to know how to react not how to prevent.*

*I think it is important to invest in prevention and adaptation to climate change. This of course includes energy issues. Investment in renewable sources of energy and energy efficiency will reduce the greenhouse gas emission. We need to invest in energy infrastructure to prepare for impact of climate change as well. The sustainable development is a solution. There is difference between development and growth. Growth is for short time and the main goal is economic one. In sustainable development the goal is quality of life, not GPD. To achieve this, we have to reduce the usage of natural sources, minimise waste and pollution, increase recycling, and reduce our consumptions.*

***Scenario representing the view of household***

*I am living in a flat as a large number of citizens who are living in cities. I am living with my wife and two children in a three room flat below the top of the house. The house, in which my flat is in, has been established before 1975 as many houses in Kosice city. The last renovation of most houses was around 1995. These houses are not well insulated and, hence, have high consumption of energy for both electricity and heating.*

*Currently, I am recognising that energy consumption is more and more high and becomes too expensive for me and my family. So I am reflecting alternatives both to decrease consumption and to switch the source of energy (RES if possible). For me who am living in a flat, the association of flat owners is responsible for energy issues, i.e. they have to perform energy audits by law. So I have to discuss with my neighbours any energy changes. Together we can*

*consult the association of flat owners for a plan to trigger renovation. The association of flat owners, then, calculates the impact of the renovation, the increased energy price and the reduced energy consumption for the future maintenance costs. Typically, an association hires service company/building manager (on fee) who is a responsible for dealing with heat and electricity providers. Association may refuse to cooperate with a service company and make arrangements with heat provider on its own. An association itself can be member of a higher association. An association of associations is a board of directors, which e.g. talks with regional or even national governments.*

*One of the responsibilities of associations is to provide energy certificates to flat owners. The certificate can be issued for the whole building or a specific flat. Also, if renovation is needed and an association wants to ask for financial support an energy audit is needed. If a house or flat is to be sold, it is needed as well.*

*The association of flat owners, my flat belongs to, hopefully performs an energy audit, which proves in how far the house is insulated and what changes are most needed (i.e., if walls are not well isolated, then a renovation is needed to better insulate the walls, or if windows are badly insulated, then they shall be replaced through windows with high-insulation). If the house is not well insulated, the auditor provides suggestions on where to start renovation for improving energy efficiency. Besides, the association of flat owners in conjunction with the energy auditor is looking for alternatives of renewable energy technology, which are available, in order to eventually switch from current energy system to a new one. This is only possible when the energy audit shows that the house is well insulated and meets the required standards. In my case, the house, in which I live, owns a gas heating system and two years ago, we had problems with an energy interruption because Russia stopped the delivery of gas. This is one reason why I would like to substitute the gas heating system by wood heating system (i.e., pellets).*

## APPENDIX B: SCENARIOS FOR THE CAMPANIA REGION

***Scenario 1 representing the view of Campania Region administration***

*Over the next years our administration will continue to invest in key areas for its competiveness, including heritage valorisation and technology transfer. And yet, due to austerity policy and the stability pact, public funding for Regional centres of competences, i.e. the main instrument established by the region in order to foster technology transfer, will be significantly reduced, if not cancelled. There is uncertainty about the amount of funding which will still be available and on the timing for future funding provision, since these aspects depend also on decisions taken at national and European level. Also public funding for universities and research centres of the region will be reduced.*

*Being aware of the constraints due to the economic conjuncture and the socio-economic environment but also of regional assets for competitiveness (see the SWOT analysis reported in our programming documents), we expect that Regional centres of competence such as BENECON:*

- *become fully self-sustainable over the next few years, i.e. are able to sell R&D services and consultancies to the market, in partnership with the universities and research organizations operating on the territory,*
- *sustain their national and international projection, gather R&D funding from competitive bids at national and European level,*
- *enhance their organizational and business model, with an efficient allocation of multidisciplinary human resources (both newly employed young researchers and structured personnel) and cutting edge of scientific and technical equipment*
- *carry out dissemination, demonstration, information activities,*
- *provide office space for innovative spin-offs and for private research laboratories;*
- *act as access points to the entire R&D providers network dislocated throughout the regional territory, operating according to a network logic,*
- *Foster the liaison between enterprises and researchers and offer access to state-of-the-art scientific facilities, thus narrowing the gap between demand and supply of research*

*There are similar expectations for universities and research centres of the region.*

***Scenario 2 Getting knowledge to market: towards BENECON regional centre of competence for cultural heritage, ecology and economy self-sustainability***

*<u>Existing (as is) situation</u>*

*We are one of the ten Regional centres of competence promoted by Campania region in the framework of its technology transfer policy. Thanks to public funding, we have been able to gather together a unique array of multi-disciplinary competences for heritage valorisation, including:*

*Archaeology, topography, art history, Design, environment monitoring, protection and preservation Administration, management of R&D project, engineering for Environmental Sustainability, climate monitoring, Dynamics of the territory in seismic areas, Science education, Biology and ecology, cultural and environmental heritage training and promotion.*

*Thanks to our skills and infrastructures we are able to deliver the following services:*

- *Multidimensional environmental, territorial analysis (air, water and soil quality analysis, land use analysis) e.g. for monitoring the stability of slopes, the earthquake risks, the environmental impact of human activity, with specific equipments as geo-radars*
- *Materials and building evaluation and analysis, suited for the national and European markets in the areas of construction, civil engineering, energy, lighting, acoustic, electromagnetic fields*
- *conservation and promotion of cultural heritage (historical building restauration), territorial*

*planning and recovery*
- *innovative screening systems, based on the use of natural lighting, for environmental planning*
- *cataloguing cultural and environmental heritage for territorial planning purpose, supporting public administrations, museums and parks*
- *Consultancy for touristic planning and eco-planning to public administrations*
- *Territorial Information Systems, supported by ICT platform able to trace according different criteria all the material and immaterial components of the natural and man-made environments, controlling the impact of development initiatives and activities and planning and utilizing landscape resources*
- *innovative tourist Information Systems supported by GPS technology, able to provide geo-referenced content and information (these are being developed)*
- *monitoring of compliance with regulations for public buildings (e.g. UNI 10840).*
- *Green certification for enterprises*

*We currently get revenues from public funding (which are reducing due to austerity policy), some revenues from the market.*

*<u>To be situation.</u>*

*Over the next years we need to focus on the most innovative and value added services on the market, thus capturing the potential demand from customers. We need to promote cost-effectiveness in management, marketing and customer satisfaction. We need to increase the amount of funding for R&D projects from competitive bids (e.g. European R&D projects), and increased capacity to transform R&D results into innovative services.*

*Our capacity to sell increase if:*
- *We are able to attract new customers and N° of clients increase (also thanks to positive enterprise birth rate)*
- *Level of innovation of R&D results increase thus we strengthen our position a unique selling point and our services portfolio increase*
- *Our capacity to transform R&D results into marketable service increase*
- *Our staff increase its skills in technology transfer through training*
- *Our staff increase its skills in applying for competitive bids (e.g. EU projects) and in R&D project management*
- *n° of collaborative projects with enterprises increase*
- *The internationalisation of staff, R&D projects increase, thus widening opportunities*
- *Dedicated staff is recruited for sales/marketing*
- *Universities and research centres of our consortium make available adequate skills and infrastructure*
- *We acquires equipment which is unique in the market and allow competitive advantage/ cost-reduction compared to competitors.*
- *Administrative and financial management of BENECON is adequate*
- *We are able to generate competitive spin-off*
- *existing clients recommend services to new clients*

***Scenario 3: an Ecomuseum buying Benecon services***

*We are a public private partnership which has established an Eco-museum in the regional park of Roccamonfina. The eco-museum can be defined as an initiative aiming to strengthen the valorisation of the territorial heritage by identifying pathways that connect those sites which are already known by tourists and other cultural, environmental assets (tangible and intangible) of the territory. Our mission is:*
- *protection / rediscovery of intangible heritage which forms the identity of a population,*

*(collective memory, local socio-cultural traditions...) and bridge with contemporary history and society*

- *Study, research and dissemination of social, cultural, natural heritage*
- *Promotion of economic development and sustainable tourism,*
- *networking of local resources*
- *promotion of socially responsible business*
- *active citizenship participation in processes of sustainable development of the territory.*

*We understand that technologies have a huge potential in achieving our goals and we have long and established cooperation with universities in the framework of projects dealing with heritage promotion. One of the university teachers with whom we have worked in the past suggest us to contact BENECON; which offer products able to fulfil our mission.*

*We discover that the Centre has very advanced Territorial Information Systems, supported by state of the art ICT platform able to trace according different criteria all the material and immaterial components of the natural and man-made environments.*

*Thanks to BENECON support we are not only able to carry out a comprehensive monitoring of our heritage. We now also provide innovative services to tourists, based on ICT-enabled Tourist Information Systems. Tourists can consults now on their mobile phone a virtual guide which is supported by GPS technology and can provide geo-referenced content, and are able to purchase, integrated tickets or custom their tickets according to specific combinations of service such as transport, accommodation options, museums, tours, etc. on the basis of their wishes).*

*These services have been made available and promoted also towards the local museum, very active in the field of valorisation of cultural heritage.*

*Information on these innovative services has been promoted also by the municipality tourist information office and website, as well as by private tour operators. Particularly highly educated citizens, who have access to internet, have been reached by this awareness raising actions.*

*Tourists experiences and level of satisfaction has increased thanks to the implementation of these innovative services, with benefit on the tourist industry and local development.*

*In our view, the choice to buy BENECON services and consultancies depend on:*

- *the amount of public funds for heritage promotion available*
- *The economic conjuncture (if it improves we are able to gather more resources for innovation, due to more tourism, more revenues taxes...)*
- *Our perception of BENECON services potential in terms of cost reduction of our service provisions toward tourists and better tourists experience*
- *Regional and national authorities change level of attention to heritage valorisation (e.g. due to administration changes)*
- *legal framework improve or does not worsen (e.g. due to university reform)*
- *Public funds are managed in a transparent and cost-effective way*
- *Awareness raising campaigns on cultural heritage are promoted by the region*
- *Educational attainment of citizens (i.e. final users) increases*

## APPENDIX C: CCD MODELS AND DRAMS MODELS OF POLICY CASES

The CCD models and DRAMS simulation models of the three different policy cases are available as software package in the reviewer space.