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Deliverable Report on

D.3.2: Methodology for resource consumption forecasting (WP3)

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Date: *September 2013*

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Introduction

One of the basic steps of the RE-SEEties project is the **in depth analyses of energy use and waste production patterns** (data collection) and to **make forecast** estimation at the level of the eight participating municipalities in the project (Work Package 3).
The main purpose of this activity is to gain insight into consumer patterns, their potential socio-economic impacts and based on this insight; give an appropriate **strategic planning tool** in the hand of cities involved in the project serving to find possible solution scenarios as a basis for the local strategies and action plans of Work Package 4. Furthermore, the methodology for forecasting is to be useful for other SEE cities and beyond.

The **EU State of the art report** investigated the methodological frames applied to different consumption patterns and needs and various city level characteristics. In line with the basic methodology of the project, not only energy, but also the waste forecasting has been studied in an integrated manner. Based on the lessons learnt from this report and based on the investigation done by the Assessment Support Group of the project, the most suitable approach has been chosen to be applied on a city level tailor made to the project needs. The selected methodology takes into account the **geographical level** of application (city level) and the **particular characteristics of involved cities**. In addition the **problem of the availability of data** is also deeply investigated, level of data is assessed, based on which possible solutions are built- in to the selected data collection and forecasting methods.

The above considerations, in- depth discussions and investigations resulted in the conclusion that none of the currently available tools cover the overall needs of partners to achieve sustainability targets in terms of resource efficiency (waste and energy focus), to examine multidisciplinary features, related benefits and also accompanying measures. As a result, a **combination of already existing tools** has been found as a solution, together with the **development of one additional tool**.

In case of waste data collection forecasting the LCA-IWM* prognosis model and the CO2ZW tool is to be used as the latter is more up- to- date. For energy aspect the free of charge tool of ICLEI was selected to be used as the basis of energy consumption reporting

for future years. This tool is to be streamlined with a series of customized calculation spreadsheets that will enable the estimation of future energy needs as well. The energy consumption figures will be fed in to the ICLEI tool in order to calculate emissions. The tools listed above and described in more details in the present methodology will be interlinked to one another forming the **RE-SEEties Integrated Toolkit**.

Methodology- available data and the tools for data collection and forecasting within RE-SEEties

Supporting the cities' efforts towards a highly efficient and sustainable resource efficient future needs a special focus on technical issues, in particular on energy and waste.

In particular, finding out suited pathways towards more sustainable energy systems and analysing their pros and cons in technical, economic and environmental terms cannot be pursued without a detailed description of the present energy and waste management systems.

Starting from a careful examination of data, methods and tools currently used by RE-SEEties' city partners in their planning activities, CNR-IMAA and CRES carried out an extensive research on internationally recognized methods and tools delivered by previous projects of research and cooperation.

The main idea was to take benefit from previous experiences and techniques selecting those tools suitable for the project in terms of objectives and average expertise of the partnership on engineering models and technical issues. In order to assure the full application of these tools by municipal actors some additional calculation tools had to be developed in some cases.

The full set of tools which set up the RE-SEEties integrated technical toolkit are fully described in the following sections. They constitute the technical component of the RE-SEEties integrated toolkit and can be generally applicable in all European cities to support the definition of sustainable energy and waste management strategies with a long term perspective.

The following sections provides an overview of the main efforts done and related considerations in implementing the most suited technical component of the RE-SEEties integrated toolkit.

Energy forecasting

In the latest decades, energy analysis and forecasting has became increasingly important as planning and policy tool. As an example of the complexity of energy forecasting, future energy consumption for heating in households (generally expressed in kWh/m2) will depend on a number of exogenously defined variables that can represent current trends and

possible policies such as expansion of networks (e.g. natural gas and DH) insulation improvements, use of alternative fuels-technologies (e.g. heat pumps).

Based on the findings of the State of the Art on Resource Forecasting report (V. Papandreou et al., 2013) and the discussions held among the partners a simple energy forecasting method is widely needed by cities to support their planning analysis on a medium-long term time horizon. Unfortunately, in scientific literature are not available easy-to-use energy forecasting models or tools. Therefore it was proposed to use the ICLEI Europe Basic Climate Toolkit (indicated in the following as the "ICLEI tool") as the basis of energy consumption reporting for future years coupled with a series of customized calculation spreadsheets that will enable the estimation of future energy needs.

In this respect the provided toolkit will allow users to estimate energy consumption in various sectors (municipal and community buildings, transport etc) by using as input projections and estimates of primary parameters. The energy consumption figures will then be fed in to the ICLEI tool in order to calculate emissions. If necessary for longer term projections correction of emission factors may also be provided.

The LCA-IWM waste prognosis model

Forecasting of generation of municipal solid waste (MSW) in developing countries is often a challenging task due to the lack of data and selection of suitable forecasting method (Rimaityte et al., 2012).

Unfortunately, an extensive literature research outlined that no simple waste prognosis tool is currently available, particularly if the focus is on South East Europe countries.

As extensively reported in (V. Papandreou et al., 2013) the only exception is represented by the waste prognosis model developed under the FP5 LCA-IWM project and based on the identification of significant indicators for the generation of municipal solid waste. The investigation covered 44 European countries and 91 European cities. Furthermore, it was implemented a software tool providing quantitative parameters for the estimation of waste streams to be used for the assessment of waste management systems. The LCA-IWM waste prognosis model is freely available (http://www.iwar.tu-darmstadt.de/lca-iwm/lca_iwm/project_results/results/index.en.jsp) and presents a very user friendly interface.

It has to be pointed out that although the RE-SEEties target regions fits very well to the regions that were investigated in the LCA-IWM project the main limitation depends on the fact that this tool could not be updated since the end of the project in year 2005. Therefore the prognostic model is based on outdated socio-economic forecasts with a base year of 2004 or 2005 and that the historic data as starting points ended at about year 2002.

Email exchanges with the main developer of this software pointed out that updating the model would at least require to gather current socio-economic data of the countries to be included in the analyses as well as current forecast data of socio-economic indicators used in the model.

Carrying out these further activities in this project was considered unfeasible. Thus it was agreed on the common decision to use the LCA-IWM waste prognosis model as a reference for waste forecasting at municipal scale is but with a clear idea of the above mentioned warnings on its use.

The CO2ZW waste management tool

CO2ZW provides a means of calculating the greenhouse gas (GHG) emissions (in carbon dioxide equivalents) emanating from the waste operations of European municipalities.

The tool in this version is an Excel-based calculator which receive as an input data on municipality-specific waste (or national data as a default) allowing the user to obtain a municipality-level carbon footprint of waste treatments (infrastructures are not included). The tool is available online and it can be downloaded free of charge at http://co2zw.eu.sostenipra.cat/

The user will be able to use this calculator to support GHG monitoring and reporting initiatives as well as to provide an estimation of potential GHG reductions (or additions) associated with management and technological changes in local waste operations, as represented in Figure 3.1.

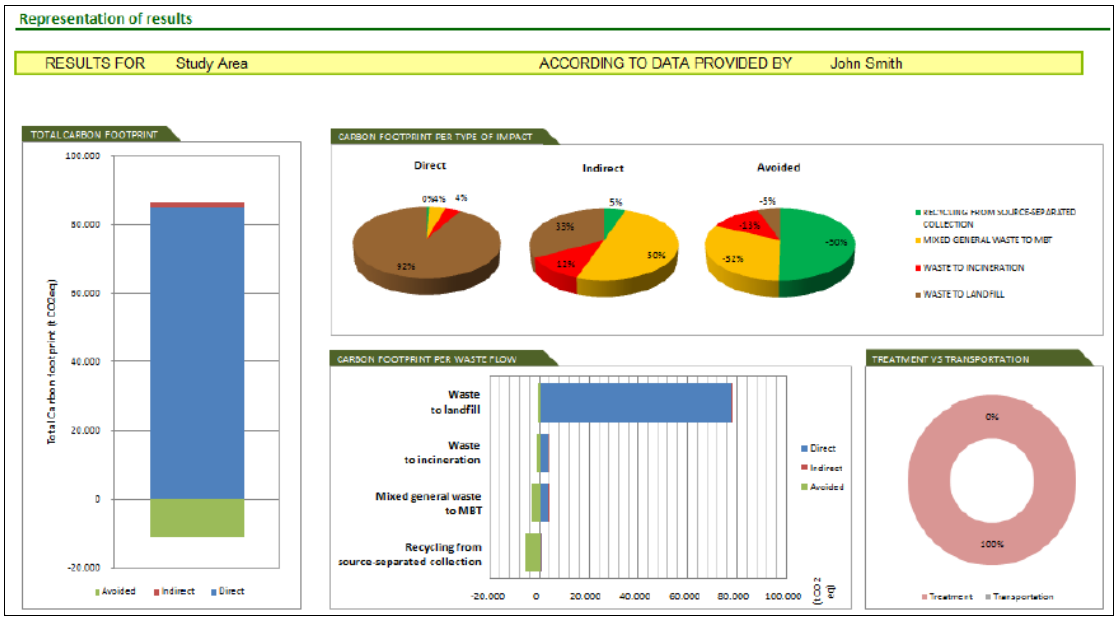


Figure 3.1: An example of results obtained with the CO2ZW tool

The ICLEI tool

The ICLEI Europe's Basic Climate Toolkit was implemented within the context of ICLEI's GreenClimateCities Initiative and is offered as support for Local Governments engaging in local climate action. It is comprised of a Greenhouse Gas Inventory Manual (PART A) and a Basic Greenhouse Gas Inventory Tool (PART B).

The toolkit has been prepared for ICLEI members and participants in ICLEI's climate change mitigation initiatives and projects. It is free of charge for these target groups and was made freely available also for RE-SEEties partners.

The ICLEI tool is based on Excel spreadsheets and provides Baseline Emissions Inventories (BEI) in a SEAP format (CoM_BEI), supporting city partners in adhering or renovating their commitments to the Covenant of Mayors, which is one of the main aim of the RE-SEEties project and is a common need for many municipalities all around Europe.

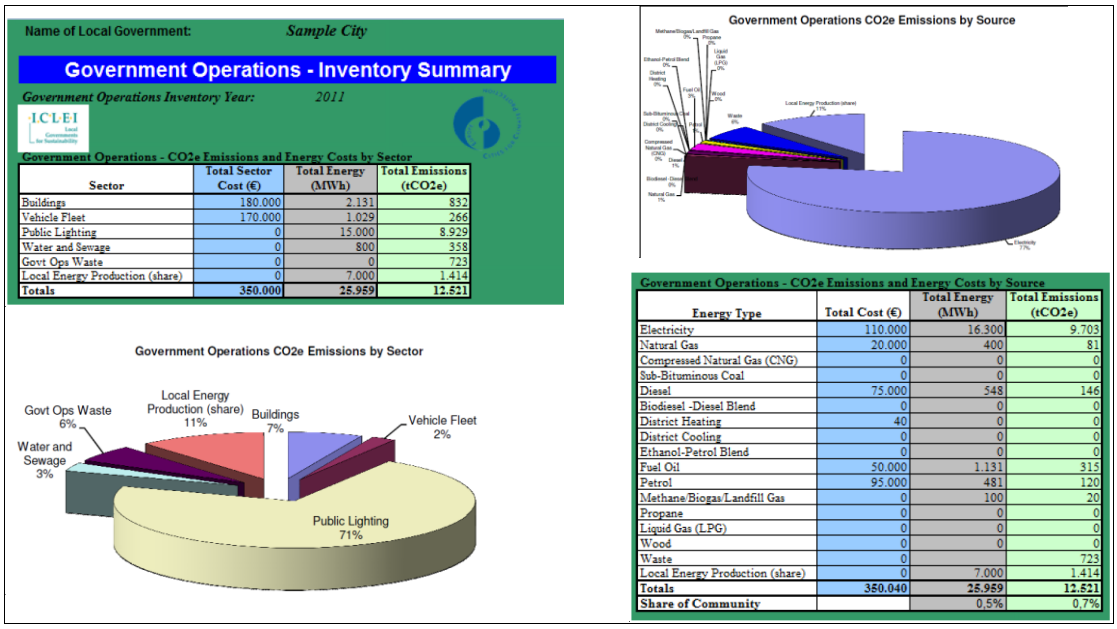
In operating terms, running the GHG inventory tool (calculator) Local Governments (LGs) are requested to complete the:

- Government Operations Emissions Inventory, and
- Community Emissions Inventory.

Together, these inventories provide municipalities with valuable baseline information to help them understand where emissions are released and develop a strategic approach to reducing GHG emissions.

These baselines will help identify key priority areas and activities that address the largest emissions sources, and provide reference points from which the local government can measure achievements as emissions reduction actions are implemented.

Inventory results can be used to inform the City Council and report to others, as shown in Figure 3.2.



Sector	Total Sector Cost (€)	Total Energy (MWh)	Total Emissions (tCO2e)
Buildings	180.000	2.131	832
Vehicle Fleet	170.000	1.029	266
Public Lighting	0	15.000	8.929
Water and Sewage	0	800	358
Govt Ops Waste	0	0	723
Local Energy Production (share)	0	7.000	1.414
Totals	**350.000**	**25.959**	**12.521**

Energy Type	Total Cost (€)	Total Energy (MWh)	Total Emissions (tCO2e)
Electricity	110.000	16.300	9.703
Natural Gas	20.000	400	81
Compressed Natural Gas (CNG)	0	0	0
Sub-Bituminous Coal	0	0	0
Diesel	75.000	548	146
Biodiesel -Diesel Blend	0	0	0
District Heating	40	0	0
District Cooling	0	0	0
Ethanol-Petrol Blend	0	0	0
Fuel Oil	50.000	1.131	315
Petrol	95.000	481	120
Methane/Biogas/Landfill Gas	0	100	20
Propane	0	0	0
Liquid Gas (LPG)	0	0	0
Wood	0	0	0
Waste	0		723
Local Energy Production (share)	0	7.000	1.414
Totals	**350.040**	**25.959**	**12.521**
Share of Community		0,5%	0,7%

Figure 3.2: Exemplificative results that can be obtained using the ICLEI tool

A possible limitation of this tool, from the RE-SEEties point of view but also from more general perspective, is that it does not address forecasting issues as well as planning issues, i.e. calculation of efficiency and emissions after certain investments or actions.

Moreover, although it addresses adequately the calculation process for the "Local Government Operations" the data input concerning the "Community" side requires very specific data that, in our experience, are not commonly available at city level, as outlined in Table 3.1.

Category	Sector	Spreadsheet	Data input structure based on commonly available data
Local Government Operations	Buildings	Govt-Buildings	Yes
	Vehicle Fleet	Govt-Vehicle Fleet	Yes
	Public Lighting	Govt-Public Lighting	Yes
	Water and Sewage	Govt-Water & Sewage	Yes
	Waste	Govt-Waste	Yes
	Local Energy Production	Local Energy Production	Yes
Community inventory	Residential	Com-Residential	No
	Commercial	Com-Commercial	No
	Industrial & Other GHGs	Com-Industrial	No
	Transportation	Com-Transportation	No
	Community Waste	Com-Waste	Yes (only landfill and incinerator)
	Agriculture	Agriculture	Yes

Table 3.1: Summary of the main sectors included in the ICLEI tool

Therefore a joint effort was carried out mainly by CRES and CNR-IMAA to develop an "add-in" tool for ICLEI (as described in Section 4.2) which will become an integral part of the "RE-SEEties Integrated Toolkit" aimed to obtain simplified urban energy system models based on data commonly available at city level.

The ICLEI "add-in" tool

Based on the above considerations, the ICLEI tool was considered strategic in the RE-SEEties project. On the other hand, to make it fully exploitable it was necessary to develop an additional calculation tool to help city partners in filling in the "Community" spreadsheets.

In operating terms this meant the development of a set of spreadsheets (the so-called ICLEI "add-in" tool) that will facilitate calculation of the input parameters of ICLEI tool based on primary information and using proxy variables where no data exist and is also a fundamental input to any forecasting method (Figure 3.3).

The proposed set of spreadsheet will constitute a simplified bottom-up model of the most crucial sectors (i.e. community-residential, community-transport, community-industrial, community-commercial), as described in the following.

The ICLEI add-in tool has been implemented by CRES and CNR-IMAA. A key issue is the expected level of accuracy of the forecasting tools which obviously influences directly the required efforts from developers and city partners.

A prerequisite of any efficient forecasting methodology is the development of a reliable baseline, which represents adequately the present situation. However, this is not an easily achievable target since municipalities usually suffer of data unavailability. For this reason it has been adopted a back-up strategy in order to provide the users an "add-in" tool with indications about the required data. These indications originate from various public databases and are provided at a national level of detail. Thus, in case municipalities fail to collect the required data due to their unavailability they could easily base the data

computation on the basis of national values and either adopt or better adjust their estimations, as described sector by sector in the following sections.

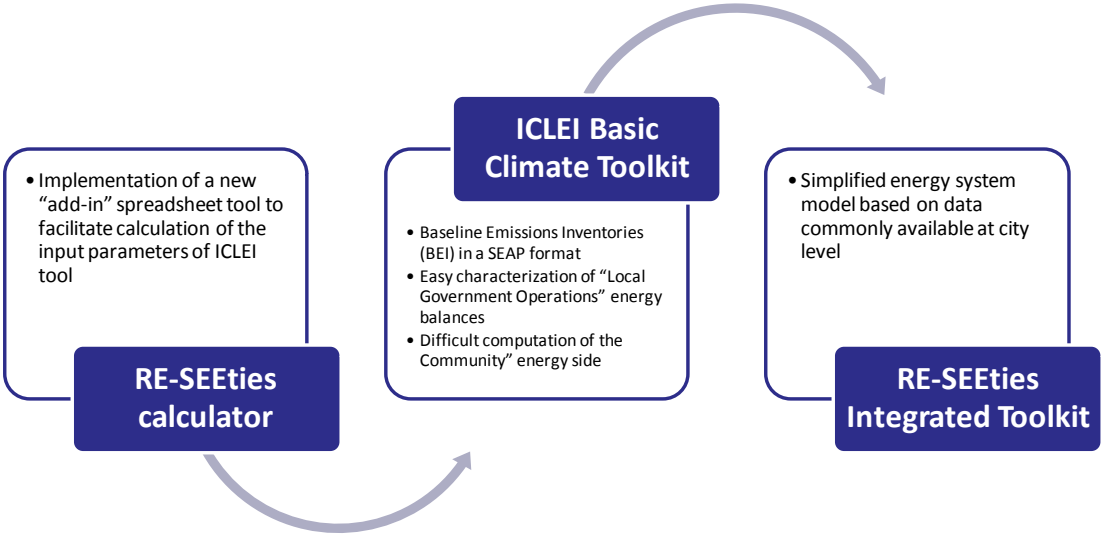


Figure 3.3: Role of the "add-in" ICLEI tool in the overall process

The integrated technical tool

The integrated technical toolkit, which is a key component of the RE-SEEties step-by-step methodology is represented in Figure 4.4.

In particular, city partners will use:

- the "amended" ICLEI tool, which is the "traditional" ICLEI software completed with the new "add-in" tool developed by CRES and CNR-IMAA and which contain a very simplified module focusing on waste
- the energy forecasting equations

In addition to that, city partners focusing on waste issues in their case studies will use also:

- the LCA-IWM waste prognosis model
- the CO2ZW waste management tool

introducing the final results into the ICLEI tool. This will allow a soft-linking among these two models and also a first step towards the integration of energy and waste flows in urban energy systems.

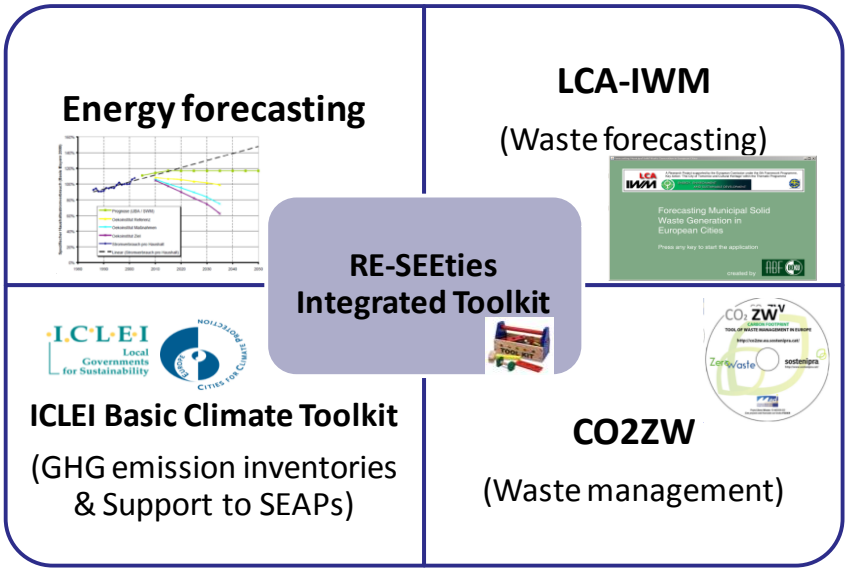


Figure 3.4: The main components of the RE-SEEties integrated tool

The problem of data availability and the solutions found

Once the final configuration of the integrated technical tool was set up, the next step dealt with the preparation of Excel tables which contain the data input necessary to run the selected tools.

According to these spreadsheets, city partners were, first, requested to collect data on:

- Energy forecasting based on customized data collection templates
- The LCA-IWM waste prognosis model
- The CO2ZW waste management tool
- The ICLEI tool (only the GOV spreadsheet)

In the Skopje plenary event (September 2013) city partners reported their feedbacks on data collection in terms of data availability, problems encountered and doubts and questions, in general. This served also to exchange experiences and suggestions among them and the ASG groups as well as to learn from each other about successes and challenges.

The next steps deal with the completion of data gathering as concerns the remaining spreadsheets of the ICLEI tool (CONS, TRANS, AGR, PROD), as described in detail in section 4.2.

Finally, once all the input data are available at city level, cities will be ready to run the selected models, according to their specific objectives:

- The ICLEI tool (All)
- Energy forecasting (All)
- The LCA-IWM waste prognosis model (only the case studies focusing on waste)
- The CO_2ZW waste management tool (only the case studies focusing on waste)

Main references

M. Salvia, H. Maras, C. Nakos, S. Panevski, Z. Tarevska, L. Csanaky, F. Pietrapertosa and S. Di Leo. South East Europe RE-SEEties Project "Towards resource efficient urban communities in SEE", D.4.2: Step-by step methodology with initial criteria for assessment (WP4). September 2013.

V. Papandreou, C. Nakos, S. Papagianni, M. Salvia, H. Maras, S. Panevshki. South East Europe RE-SEEties Project "Towards resource efficient urban communities in SEE", D.3.1: Deliverable Report on "EU state of the art on resources consumption forecasting (WP3)". March 2013.

M. Salvia, S. Di Leo, F. Pietrapertosa, V. Papandreau, S. Papagianni, H. Maras, S. Panevski, Z. Tarevska. South East Europe RE-SEEties Project "Towards resource efficient urban communities in SEE", D.4.1: Deliverable Report on EU state-of-art on resource efficiency (WP4). March 2013. Available at: http://www.re-seeties.eu/eu-state-art-resource-efficiency