D2.2

Good practice district stimulator

Refinement of Local Master Plans for Smart Energy Cities transition: the experience of Bolzano and Innsbruck

SINFONIA

"Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy"

CONTRACT NUMBER	**609019**	**INSTRUMENT**	**COLLABORATIVE PROJECT**
START DATE	**2014-06-01**	**DURATION**	**60 MONTHS**

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 609019

List of abbreviations

CO_2 – Carbon Dioxide

DTM – Digital Terrain model

EPA – Environmental Protection Agency

GDP – Gross domestic product

GHG – Greenhouse Gases

GIS – Geographic Information System

IEP – Innsbruck Energy Development Plan

IPCC – International Panel for Climate Change

ISO - International Organization for Standardization

LCA – Life Cycle Assessment

RH – Row houses

SEAP – Sustainable Energy Action Plan

SEC – Smart Energy City

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SWOT – Strength, weaknesses, Opportunities, Threats

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Executive Summary

This report aims to contribute to the debate on the development of site-specific solutions for the transition of cities to the Smart Energy City (SEC) concept. Each city is a unique combination of economic, social, environmental, and institutional conditions, which results in various needs, priorities, and capacities for SEC development. Starting from the description of the complex process behind the transition to SEC and its stakeholders, the report focuses in particular on the construction of a baseline of local knowledge that can support the definition of site-specific innovative solutions, stimulating the adoption of best practices through the refinement of local Master Plans.

The SEC development is a site-specific continuous transition towards sustainability, self-sufficiency and resilience of energy systems, while ensuring accessibility, affordability and adequacy of energy services, through optimized integration of energy conservation, energy efficiency and local renewable energy sources. It is characterised by a combination of energy technologies with information and communication technologies that enables integration of multiple domains and enforces collaboration of multiple stakeholders, while ensuring sustainability of its measures.

The refinement of Local Master Plans can also be described as a continuous flow of information among the relevant stakeholders and between them and the city. The setup of such “sharing information system” can be considered as one of the preconditions for a successful implementation of a Smart Energy City Transition.

Bolzano and Innsbruck are chosen as demo cases for the test of the proposed methodology to refine the energy Master Plans. The aim of the “Refinement of the local Master Plans” in these pilot cities is twofold. Firstly, as the masterplans of the two cities were established in 2009 and 2007, it is essential to gather detailed inventories of current energy consumptions - based on 2014/2015 data - in order to have an up to date baseline upon which to evaluate the improvements of the Sinfonia demonstration measures. Secondly, it is essential also to determine the influence of the demonstration measures on the set project goals in the view of the transition to Smart Energy Cities.
For this reason a structure and a list of variables as well as the sources available to gather the information are given.

In order to obtain a sound baseline, the following data should be considered in the calculation:

1) Energy consumption data

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2) Energy production data
3) Boundaries and general context data
4) System components data
5) Framework data
6) Data for monitoring
7) Meteorological data
8) Data about renewable energy potential production
9) Data about energy saving potential#
10) Additional data on the evolution of framework conditions

Of course, these are the ideal theoretical input data for calculating a baseline in urban environment or, as in the demo cities, at district level. However, the process highlighted that the access to the data is a very complex task. For example, in Bolzano and Innsbruck the experience shown that some of the data is simply unavailable and some cannot be retrieved due to data protection laws. Therefore, the theoretical perfect baseline is hard to achieve. This does not mean that the results are unreliable but rather that it is hard to obtain all the data needed in a short time-frame.

The method is structured and explained in a way that Early Adopter Cities and all European Cities could learn and replicate it to create baselines able to promote the transition to smart Energy Urban environments and able to stimulate the adoption of site-specific best practices.

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INTRODUCTION

GOOD PRACTICES FOR SMART ENERGY CITY TRANSITION

Good processes for a Smart Energy City transition

Complexity in the urban contexts, (number of involved stakeholder's, complexity of financial instrument, etc.) can heavily slow down the transition processes from traditional cities to Smart Energy Cities limiting, for example, the adoption of innovative technologies. Currently the panorama of available methodologies to support and speed up the process for the transition toward the Smart Energy City concept is still weak. The traditional cities Master Plans such as Energy Plans or Sustainable Energy Actions Plans are showing to be limited in pushing European Cities to transform themselves in Smart Energy Cities. Very often SEAP or traditional Energy Plans focus on general targets such as CO_2 emission reduction rather than on the stimulation of site-specific good and replicable solutions and smooth implementation processes. On the other hand, the transition towards SEC is in clearly site-specific. Each city is a unique combination of economic, social, environmental, and institutional conditions, which results in various needs, priorities, and capacities for SEC development. The identification of site-specific sustainability oriented solutions based on local stakeholder's participation can answer to concrete local social, economic and environmental needs but can also increment the complexity of the implementation process.

Starting from the assumption that one of the main barriers to the implementation of SEC concept is the limited base knowledge on site-specific conditions, this report wants to contribute to solve this issue.

Figure 1 proposes the SEC development as a site-specific continuous transition towards sustainability, self-sufficiency and resilience of energy systems, while ensuring accessibility, affordability and adequacy of energy services, through optimized integration of energy conservation, energy efficiency and local renewable energy sources. It is characterised by a combination of energy technologies with information and communication technologies that enables integration of multiple domains and enforces collaboration of multiple stakeholders, while ensuring sustainability of its measures.

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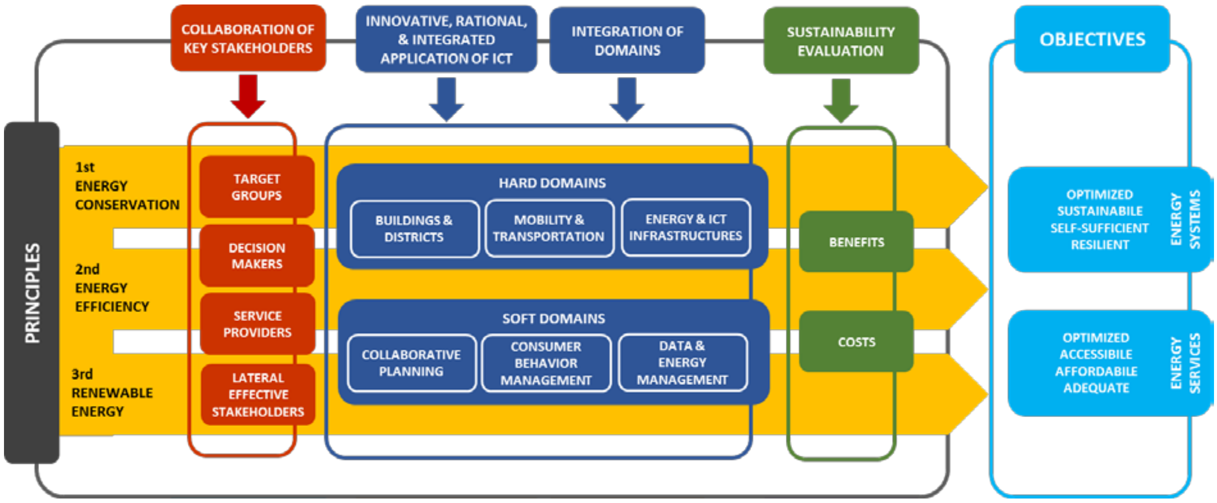

FIGURE 1- SMART ENERGY CITY (SEC) DEVELOPMENT (EURAC): the black outer box passes through sec general principles; three yellow arrows reflect sec energy specific principles pointing to the light blue box showing sec objectives. The red small boxes indicate sec key stakeholder groups, dark blue small boxes indicate sec domains of intervention, and green small boxes reflect SEC sustainability evaluation aspects.
ICT stands for information and communication technology.

The role of stakeholders in the information flow for a Smart Energy City transition

The refinement of Local Master Plans can also be described as a continuous flow of information among the relevant stakeholders and between them and the city. The setup of such "sharing information system" can be considered one of the preconditions for a successful implementation of a Smart Energy City Transition. Figure 2 presents Smart Energy City stakeholders optimal interactions for information and data sharing; each box encloses one stakeholder group, and the arrows imply the interaction between stakeholders.

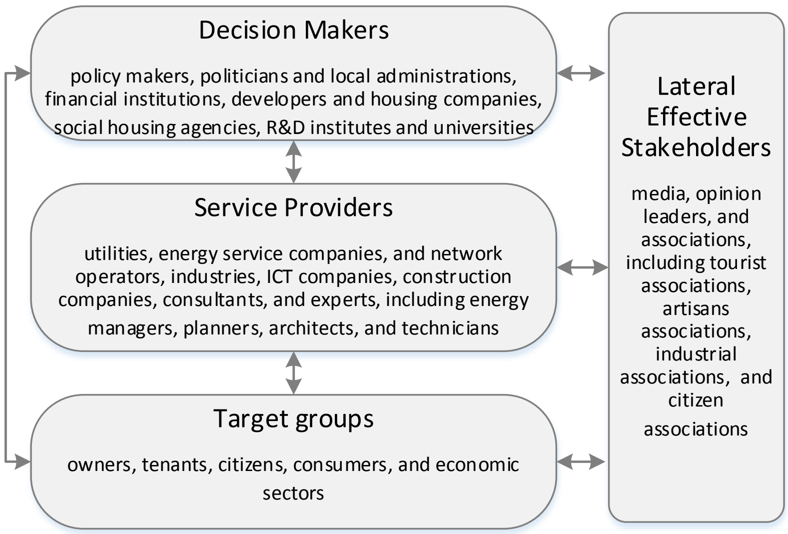

FIGURE 2- SMART ENERGY CITY STAKEHOLDERS OPTIMAL INTERACTIONS FOR INFORMATION AND DATA SHARING (EURAC)

In Task 2.1 the barriers to the implementation of Smart Energy Cities and Districts have been analysed from an holistic perspective with the support of the SWOT analysis tool.

In this Task instead, the second aspect is analysed: the refinement of the local (energy) Master Plans to support the Smart Energy City transformation using a site-specific approach to geo-localize the needs for good practices and stimulate their adoption. In this framework the refinement of the local Master Plans and the creation of an updated districts baseline are the keys to validate the influence of the site –specific innovative sustainability-oriented solutions for the cities' energy systems as well as to create scenarios for future implementation measures based on the results gained in Sinfonia.

REFINEMENT OF LOCAL MASTERPLANS IN BOLZANO AND INNSBRUCK DISTRICTS

The demonstrative cities of Bolzano and Innsbruck have both elaborated environmental action plans in 2009 and 2007 respectively. Bolzano developed the "Action Plan for Bolzano CO_2 neutral" while Innsbruck established the "Innsbruck Energy Development Plan (IEP)" with the aim of creating more energy efficient and CO_2 neutral cities in the future. Both actions lead to cities with a higher quality of life but more importantly to environmental friendly cities, which is even more significant being both surrounded by an alpine environment which is highly vulnerable to climatic changes.

The aim of the "Refinement of the local Master Plans" in these pilot cities is twofold. Firstly, as the masterplans of the two cities were established in 2009 and 2007, it is essential to gather detailed inventories of current energy consumptions - based on 2014/2015 - in order to have an up to date baseline upon which to evaluate the improvements of the Sinfonia demonstration measures. Secondly, it is essential also to determine the influence of the demonstration measures on the set project goals in the view of the transition to Smart Energy Cities.

These scenarios, that are developed in WP3 using the results of the baseline produced in this Task, will provide information about how the energy consumption will evolve under current policies, what would be the impact of the projected actions and what would the recommendations be based on the calculations prepared in Deliverable 2.2.. Scenario elaboration can be an essential decision-support tool and of course, this will be used to draw recommendations for the Early Adopter cities and any other city, which is going to replicate parts of the measures implanted in Sinfonia.

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Calculation of a useful baseline needs time for obtaining the needed input data because of multiple sources, stakeholders and different views around open-data and data protection. For example, one of the lessons learnt was to start early enough to meet all the data protection and/or data exchange laws. In Innsbruck, these discussions took quite some time, as data protection laws are rather strict and contracts have to be elaborated with all the involved parties in order to meet all legal requirements. In Bolzano instead, thanks to recent the elaboration of the SEAP, many data sources and stakeholders were already active and in favour to deliver data to the Municipality.

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ENERGY DATA FOR A BETTER ENERGY PLANNING

COMMON DATASETS AND PARAMETERS NEEDED FOR CREATING AN ENERGY BASELINE

The purpose of this chapter is to present a description of the datasets and the parameters needed for the elaboration of an energy baseline that can stimulate good practices adoption for the Smart Energy City transition. In the last years, various projects at European[1] level have promoted, directly or indirectly, the production of energy plans at different territorial scales. This has led to the elaboration of numerous, well-structured and sound guidelines that provide indications for energy baselines or emission inventories on which action plans have to be based. Unfortunately, the link between the proposed energy baselines calculation methodologies and the Smart Energy City transition is still weak.

The goal of this chapter is therefore to briefly summarize and classify the main elements that have to be considered in the elaboration of an energy baseline for a Smart Energy City transition.

The chapter contains a definition of energy baseline and the description of its purpose, the activities that have to be carried out for its completion and a brief description of the different elements that constitute it. From this general description, which represents the common dataset, almost an ideal wish list of data that could be collected, follows a checklist that can be used for the evaluation of the available data. The chapter concludes with a description of the elements used for the extended district baseline of the two cities. The tests of the proposed method on the two Pilot Cities Bolzano and Innsbruck are described in the Annexes.

ENERGY BASELINE DEFINITION AND CONTENTS

Definition of the energy baseline for a Smart Energy City transition

For managing and planning the transition of urban energy systems towards Smart Energy Cities, it is necessary to have a clear picture of their situation not only in terms of energy consumption and production, but also in terms of the components and aspects that can affect those attributes. This can be achieved by collecting and elaborating energy balances and their accessory information; it helps assessing the energy use and production situation and its potential evolution.

[1] For instance: Covenant of Mayors initiative, Intelligent Energy Europe, LIFE which lead respectively to the production of the Guideline for the elaboration of Sustainable Energy Action Plan, Tools and concepts for Local Energy Planning (project easy) and LAKS (local accountability for Kyoto goals).

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Establishing a baseline means collecting the relevant data in a specific time-frame in order to use them as a reference for further comparison.

For the purpose of this deliverable, we define "energy baseline" as the quantification, for a certain time frame during the past, of the energy consumption of a specific territory. It has however to be strongly remarked that such an assessment should, when possible, always be accompanied by the collection, organisation and analysis of accessory information. For this reason, the description of the elements of this document which constitute an energy baseline contains also the description of accessory information. This form of extended energy baseline is defined as "energy assessment".
This definition resembles the one given by the ISO 50001 on Energy Management System, where "energy baseline" is defined as: "quantitative reference(s) providing a basis for comparison of energy performance".

The choice of using a past time frame is in line with the expression "baseline year" used in developing the Sustainable Energy Action Plan within the "Covenant of Mayors" initiative. As an alternative, some definitions of energy baseline refer to future scenarios and not to current or past situations. For instance, in Reichl and Kollmann (2011), energy baseline refers to the future energy consumption that would occur in case of no undertaking of direct measures to influence the development of energy consumption.

Our description of an energy assessment includes also quantitative and qualitative data describing the energy system components and framework. For the sake of completeness, we also report the data and information necessary for evaluating the local energy production potential from renewables and the potential for consumption's reduction.. These sets of data are relevant for the assessment of future development scenarios. The energy assessment should include also relevant "accessory" information pertaining to legislative, social, economic and environmental aspects.

Furthermore, energy baseline and assessments are preparatory for, and often associated with, CO_2/GHG emission inventories. Carbon-dioxide and greenhouse gas emission inventories can therefore be part of an "energy assessment" as well.

As stated before, energy baselines are necessary for supporting the optimized management and planning of sustainable transitions of energy systems. They serve also other purposes, which are briefly descripted as:

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▪ *Knowledge acquiring purposes*

They provide a picture of the state of knowledge of the energy system of the analysed territory.

▪ *Evaluation and comparison purposes. They allow to:*

- evaluate the criticality of the territory;
- compare the situation of the object of the analysis with other territories;
- evaluate the effectiveness of plans or projects;
- compare energy performances in different years.

▪ *Information purposes* Represent a tool for stakeholders with regards to the energy situation.

▪ *Support to planning purposes*

By modelling the energy system of a specific territory, they are preparatory to the elaboration and evaluation of the evolution scenarios and therefore, for the planning of changes. This can be a starting point to move towards relevant objective-settings, elaboration of action plans and monitoring actions.

Preliminary activities and considerations for elaborating an energy baseline and assessment for a Smart Energy City transition

Before starting the collection and elaboration of data and information, many aspects have to be taken into consideration. The following is a list of the most common ones:

- *The boundaries of the target system*

The geographical limit of the area of interest has to be decided.

- *The year to which the data collection refers*

The choice of the year is often dictated by the availability of data and refers to the first year for which a good set of data is available. When possible, an analysis of intermediate years is collected as well in order to evaluate trends.

- *Approaches to be used in the collection of data and in the analysis*

Data can be collected with a bottom up or a top down approach. The first refers to data collected directly, while the second refers to data collected indirectly disaggregating at a local level data coming from higher geographical or administrative scales. With reference to emission inventories, one must consider territorial vs causal approaches, as well as approaches to use in the choice of emission factors (i.e. LCA vs IPCC). While elaborating emission inventories a choice has to be made also on the type of emission to be considered i.e. whether referred to CO_2 only, or to other greenhouse gases, as well as other local pollutants.

- The categories in which to subdivide the collection of data

Categories differ depending on the type of analysis conducted and its scope. The Covenant of Mayors, for instance, places a great importance on the activity of the Municipality itself. For this reason a special place is reserved among other categories to the consumption of Municipal buildings and equipment/facilities and to Municipal transport. Regional or national energy balances focus instead mainly on the classical economic categorisation (primary, secondary and tertiary sector). High attention is set also on assessing consumption for buildings, as it is for the study cases of Innsbruck and Bolzano.

- List of data providers

Organising beforehand the list of potential data providers facilitates the collection of information.

- Clarifying privacy issues

Privacy or data protection reason should be clarified beforehand.

Energy baseline and assessment data

The data to be collected for the elaboration of the baseline of an energy system can be divided in three main categories:

- Data describing the energy flows and stocks that affect the system;
- Data describing the components of the system, the system itself, and its framework;
- Data for the elaboration of scenarios.

Level of detail and geo-referencing of the data

The level of detail of the data collection depends on the objectives of the analysis. While, for assessing the situation of a region from energy consumption and production point of view, aggregate data could be sufficient, for sound planning and management the increasing of the level of detail is crucial. In the case of buildings, for instance, the difference could be between knowing what is the total consumption of the all buildings of a city, or knowing for each building or for certain area of the analysed city what is the average consumption per square meter. In this case again, the geo-referentiation of the data carries a further level of information that enhance the planning and managing capacity. On the other hand geo-referentiated data are essential for the sound evaluation of renewable energy potential such as hydroelectric or biomass at regional scale.

These types of data can be collected at different levels of detail according to the objective of the baseline.

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Energy flows and stock data

Energy flows and stock data are fundamental for analysing and describing an energy system. Considering them alone, it is possible to derive energy balances and emission inventories. They can be classified in two categories:

1) Energy consumption data
2) Energy production data

1) Energy consumption data

Energy consumption data are understandably the most important data to be collected for the elaboration of an energy baseline. Consumption data alone provide already useful information on the energy situation of a city or territory. Combined at an increasing level of complexity with other information, they contribute to an enhanced understanding of an energy system and to the capacity of optimizing its management and changes.

Consumption data are collected for specific energy vectors (i.e. type of fuel) and in relation to specific sectors (residential buildings, tertiary sectors), according to the type of analysis conducted.

They are often represented in the following categories:

- Electricity consumption;
- Thermal energy consumption;
- Transport related consumption (transport data are not considered in the SINFONIA analysis).

The data, however, are not directly available in an aggregated form and have to be derived from separate collections of other data (i.e. thermal consumption data are generally divided per energy vector).

Within such a representation, the local energy production - not only the one deriving from renewables- is missing and the level of information is limited. However, the consumption statistics related to the three above categories allows by itself to display the general energy scenario of a city or territory in a synthetic manner and also to compare different energy systems.

The collection of data for that representation should be considered almost the minimum target to be achieved in analysing an urban or regional energy system.

In cases in which consumption data were not directly available, the energy demand could be estimated trough the calculation or through the downscaling and disaggregating (by means of proxies) of other data, aggregated at a higher scale. In particular, for the extended district baseline in Innsbruck, and similarly for Bolzano (as explained in detail in chapter 4 and 5), buildings consumption data were measured or calculated from geometrical data and based on buildings age and type and were adopted by "service factors" that adjusted the calculated demand by the statistical elaboration of actual measured consumptions.

2) Energy production data

To complete the information on the energy flows within the system, energy production data should be collected. This data, together with the consumption one, allows for the elaboration of energy balances. Data related to storage systems, if presents, should be collected in association with production data. Since all the energy flows within a system are meant to satisfy a demand, it can be observed that the consumption data covers already all those flows (except eventual exports) and would already be sufficient to describe the system. However, in order to understand what part of the consumption is covered by local energy and by renewable sources and at what efficiency it is produced, it is necessary to collect the respective production data. Local production data is also necessary for the evaluation of the local electrical energy mix and for the calculation of the GHG emissions related to electricity consumption (see box on local electric production mix). Energy production data are typically divided in electrical and thermal referred to the energy carrier used for their production (i.e. type of fuel) or the renewable sources from which they originates and may be visualized in this aggregated form or with a greater level of detail.

Main output of the energy flows and stock data

The main output of energy flows and stock data are energy balances and emission inventories

Energy balances

Consumption and production data allow to generate energy balances and, as illustrated in the next paragraph, to calculate the associated GHG emissions.

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As expressed by Eurostat, energy balances "allow to see the relative importance of the different fuels in their contribution to the economy" and are "also the starting point for the construction of various indicators as well as analyses of energy efficiency"[2].

Generally, they are organized in matrices displaying the different energy vectors in the columns and the classification categories in the rows.

They are useful and relevant in providing with an overview on the situation of an energy system over a certain period of time. Yet, they are missing dynamic and spatial information as well as information on the characteristics of the components of the energy system. Furthermore, they are not efficient in displaying the energy flows direction, and connections and the interactions between the different sectors of the system. For those reasons, they are often elaborated and displayed in other forms i.e. Sankey diagrams, GIS maps and others. If information on temporal dimensions is available, it can be represented in time data series to be displayed by means of graphs or tables. The temporal dimension might be used for the evaluation of consumption patterns and for managing the energy demand and the energy grid. Spatial information, on the other hand, can be used for the optimal planning of actions on the territory.

Local electricity emission factor

Electric consumption produce indirectly, through its generation, GHG emissions. Since it is not possible to differentiate where an "electron" comes from, for assessing the quantity of emissions a general emission factor is calculated. This is based on the total emission of the national generation plants mix divided by the total electricity production. In order to consider the effect of the local production a local emission factor is calculated. The latter is calculated with the same approach. The only difference is that, to the electricity that is not produced locally, which is needed to cover the local consumption, the national emission factor is assigned (or the one administrative one above). The local emission factors becomes therefore a weighted average of the two emission factors: the first related to the local production and the second to the imported electricity.

Emission Inventories

Emission inventories[3] are realised by simply converting energy consumption data, aggregated per energy vector, into emissions by means of emission factors. The latter, as

[2] http://ec.europa.eu/eurostat/web/energy/data/energy-balances

[3] A comprehensive guideline on elaborating emission inventories is "How to develop a Sustainable Energy Action Plan" elaborated by the Join Research Centre (JRC) of the European Union, 2010.

mentioned above can be of different types, and are given for each type of fuel or source both fossil and renewable.

In order to estimate the emission factors for electricity, one must first assess the local electricity production mix emission factor.

For the elaboration of emissions, inventories classification related to the type of source could be introduced i.e. point, diffuse or linear sources. They are, however, not dealt with in this document since they are more relevant for pollutants with local effects, such as NOx, SOx, PM10 etc.

Energy system components and framework data

To further increase the understanding of the urban and regional energy systems and their functioning, and to enhance the capacity of managing it and planning its, if considered, sustainable transition, further information on the characteristics of its component and the framework conditions are required. The main categories, which have been individuated, are:

3) Boundaries and general context data
4) System components data
5) Framework data
6) Data for monitoring
7) Meteorological data

3) Boundaries and general context data

The choice of the general context information that has to be collected depends upon the level of detail of the analysis that is performed, its objective, and main focus. The essential information refers to the area of interest, its surface, and its visual representation. The number of inhabitants is fundamental as well as it allows to derive per-capita indexes, which are useful for comparing the results of different energy systems and monitoring evolution trends.

Further general information can refer, for instance, to the GDP of the area considered or to the number of employees per economy sectors. Geomorphological aspects and environmental information could be included as well. At an increasing level of detail, context data fall into categories of data for energy system components, which are dealt with in next paragraph.

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4) System components data

System components data are crucial in understanding the performance and behaviour of the energy system. They provide information on the sensitive parameters and variables that determine the consumption and production patterns. Together with the energy flows data, they enable a comprehensive analysis of the energy system and the elaboration of data and indices for their management and planning. They allow also to evaluate the potential for energy saving and improvement of the system.

System components data can be highly various and complex and present a wide range of details. The main categories to which they may refer are here briefly illustrated.

- Consumption and production units' information

This type of data describes the characteristics of the consumption or production unit. It can be divided into geometrical (and eventually spatial) (i.e. size of the building, position of the plant) physical (i.e. transmittance of the envelope) and technical (i.e. efficiency of the plant). Time-related information, such as the year of construction of a component, is relevant too. Geometrical data allows to calculate indices and indicators for the evaluation of the system`s performance and/or to monitor its trends. This can be done by calculating the ratio between consumption and surface, as in the case of the kWh/m^2y parameter. Physical and technological data allow to benchmark the characteristics of the components against reference values and to enhance the planning and managing capacity.

- Behaviours of end-users

The behaviour of end-users can affect energy consumption more than the characteristics of the component itself can do. Data and information related to these aspects are therefore relevant for evaluating the room for improvement through awareness raising and educational activities. The collection of information and data on this topic can be supported by questionnaires and surveys. Indirectly the extent to which behaviour affects the consumption can be estimated by comparing real consumption results with expected ones.

- Energy infrastructure conditions

Energy infrastructure conditions refer to the capacity of the energy network infrastructure (electricity grid in the first place) to manage diffuse energy production from renewable energy sources.

- Cost of technologies and of energy vectors

These data are relevant for the assessment of the costs related to operating and maintaining the system as well as to evaluate optimized management or development options.

5) Framework data and information

Framework data are data that allow to contextualize energy consumption and production activities in a territory by providing information on the elements and aspects that can indirectly influence them. They are therefore very important for supporting the elaboration of plans. Framework data can be various and complex, and therefore we choose to illustrate them briefly for the sake of completeness without entering into details.

The most relevant categories can be summarised as follows:

- Legislative framework and plans in place

These types of information are required in the elaboration phase of a plan in order to assess legislative barriers and drivers that can affect the actions and/or strategies to be defined.

- Economic aspects and presence of incentives or financial schemes for actions implementation

The evaluation of financing opportunities is also an important instrument for the identification of actions or strategies or the optimisation of an energy system at territorial level.

- Information on stakeholders;

The involvement of the local stakeholders in the elaboration process of a plan through a participatory approach is one of the critical elements to be considered for the successful implementation of the plan or project.

- Social and cultural aspects

Socio-cultural aspects are important for their influence on end users` behaviour. Some of these aspects could be synthesized, for example, with attitudes to energy saving and efficiency, information and knowledge, composition of residential settlements and others.

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6) Monitoring data

If already available, energy consumption and production monitoring data could be used for the elaboration of an energy baseline and assessment and for the evaluation of performance components. These data however are usually available only when a specific monitoring plan or campaign is ongoing and not prior to the planning stage. Monitoring data can be acquired through specific sensors, which can directly measure consumption and/or production of energy flows, or which can measure other relevant parameters (i.e. temperature, solar radiance etc.). On the other hand, monitoring data can refer also to explicit indicators that help assessing the performance or the implementation level of a certain action. As such, monitoring plays a crucial role in the management and realisation of plans, giving the possibility to introduce corrective and preventive measures towards their realisation.

7) Meteorological and climate data

Climate conditions affect the energy consumption and production of an urban system and should therefore be taken into consideration when comparing different cities or regions or the performance of a territory over different years.

Specific meteorological data are also used for the estimation of the production potential of certain renewable energy source (these are analysed in another paragraph). Part of these types of data (i.e. solar radiation) could affect the energy production of the same source. Nonetheless, if not for research reasons, they are not explicitly collected for evaluation. Their use for monitoring purposes is however relevant.

Main outputs of the energy system components and framework data

System components and framework data combined with energy flow data allow for the elaboration of different types of analysis and outputs. These can include for instance: reports, maps, feasibility studies, energy saving potential analysis, optimised-managing plans. The choice of which outputs to elaborate depends on the information available, the scope and focus of the analysis and the targeted stakeholders. A classification of these outputs is however excluded from this deliverable. Nonetheless, it has been considered to describe the category “key indicators” given its relevance in facilitating the production of many of the outputs cited above.

Key indicators

Cities and regions need Key Performance Indicators (KPIs) to measure and steer their performance. KPIs define a set of quantifiable and qualitative measures, agreed on beforehand, that is used to gauge or compare performance, progress and impact of a project, program or organization of strategic meetings and operational goals (Painesis Michalis (2011); EPA, Fiksel J., Eason T., Frederickson H., (2011)). Carefully developed KPIs provide set parameters or metrics against which a city can monitor its progress towards its sustainable energy planning goals. Energy KPIs will be useful for monitoring progress towards sustainability and for communicating energy related issues to the policy-makers and the public in order to facilitate institutional dialogue. KPIs can be used to track and monitor progress on a city energy performance.

Data for the elaboration of scenarios

In elaborating scenarios for possible future developments of a territory, the following types of data must be collected or derived from previous ones:

8) Data about renewable energy potential production
9) Data about energy saving potential
10) Additional data on the evolution of framework conditions

8) Data about renewable energy potential production

Data about potential production from renewable energy can in some cases be partially derived from previous data (i.e. a rough estimation of the PV potential can be calculated considering the surface of the building in a certain area); if not, they have to be calculated through specific data collections. The collection of such data can be very complex since several types of them are required in order to correctly assess the potential of a certain energy source. For instance, in the case of biomass, more than 10 different types of data have to be collected and analysed while for the potential of hydroelectric up to almost 20. The level of data complexity in most cases, is further increased by the necessity of geo-referencing.

9) Data about energy saving potential Estimation of the energy saving potential would not per se require an extra category of data, since it can be derived by just analysing the data described previous paragraphs. This category however has been introduced in order to explicate the relevance of estimating the saving potential for the development of different scenarios. Nonetheless, benchmark values (in many cases key indicators) should be used, and hence collected if unavailable, for comparing the performance of the system`s components with reference ones.

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10) Additional data on the evolution of framework conditions

The evolution of framework conditions- meaning those aspects that can indirectly influence consumption and production - is understandably relevant for the elaboration of scenarios. This involves, for instance, evaluating population`s changes over the years, estimating the variation of discount rates or the prices of certain technologies as well as predicting the evolution of their efficiency. Cultural and social trends also play an important role and, if possible, should be taken into consideration. The same applies for the effects of climate change, which should also be considered in the elaboration of long term scenarios.

Scenarios

Possible scenarios should be built upon the collected data for the energy baseline and assessment elaboration, the different sets of hypotheses on energy consumption and production trends, the type and share of renewable sources, etc. These scenarios can give information about how energy consumption would evolve under current or different policies and what the impact of the projected actions would be. What would be the most convenient exploitation of renewable energy and which kind of sustainable sources would be better to use? Etc. Scenarios elaboration can be an essential decision-support tool because it allows evaluating ex-ante the likely result of the planned actions.

CHECKLIST FOR THE ELABORATION OF A BASELINE

This paragraph contains a checklist of data that should be collected for the elaboration of a general baseline as defined in this deliverable. These data are copious and complex and, by increasing the level of detail and the type of analysis carried out (i.e. data for building performance certification), their list could become very extended. For this reason, in this deliverable we focused on providing an overview of the general type of data that should be collected. Consumption and production data have been described a bit more in detail, while for the other categories the listing is more general and referring to categories rather than to specific data. For contextualising the different sections of the checklist, please refer also to the above paragraphs.

Considering that the district baselines of both Innsbruck and Bolzano are focused on buildings, the example provided refers mainly to that sector.

Data describing the energy flows and stocks affecting the system

1) Energy consumption data

Consumption data are here represented with a categorisation that has been used in the Alpine Space project Alpstar. This categorisation reflects the classical economic classification with the adding of the building, transport and illumination sectors.

Buildings, Equipment/Facilities □ Electricity □ Natural Gas □ Liquid Gas □ Heating Oil □ Coal □ Biomass □ Biofuel	*Private and commercial transport*[4] □ Electricity □ Gasoline □ Diesel □ Liquid Gas □ Natural Gas □ Biofuel
Agriculture □ Electricity □ Natural Gas □ Liquid Gas □ Heating oil □ Coal □ Biomass □ Biofuel	*Industries* □ Electricity □ Natural Gas □ Liquid Gas □ Heating oil □ Coal □ Biomass □ Biofuel
Tertiary Sector (without buildings above) □ Electricity □ Natural Gas □ Liquid Gas □ Heating oil □ Coal □ Biomass □ Biofuel	*Public illumination* □ Electricity

The categories above help to collect and organize data in an aggregated form. As it is the case for Innsbruck and Bolzano, the category building has been further subdivided:

[4] The list of data to be collected for transport have been inserted as well although transport issues are not dealt with in SINFONIA.

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TABLE 2. LIST OF BUILDINGS CATEGORIES CONSIDERED IN INNSBRUCK AND BOLZANO

Buildings categories	
Detached houses and duplex	Industrial Buildings
Row houses (RH)	Mixed use
Small multi-family house	Other uses
Medium multi-family house	Public buildings
Large multi-family house	Others
Commercial buildings	

These categories, if necessary, could be further subdivided; for instance, the public buildings could be split into, schools, offices, hospitals and so on and the subcategories derived could undergo the same process. This would serve as example on how the level of disaggregation during data collection can be increased.

2) Energy production data

The collection of energy production data has to be associated with the assessment of the energy consumed for its production in order to establish its efficiency. Both data on consumption and production have to be expressed in a convenient unit of measurement.

- *Electricity production from renewable energy;*

Production(el)	*Consumption*
○ Wind	
○ Photovoltaic	
○ Hydroelectric	
○ Biogas	○ Energy consumed for production from biogas
○ Biomass	○ Energy consumed for production from biomass
○ Other renewables	○ Energy consumed for production from other renewables

- Electricity production from non-renewable energy;

Production(el)	*Consumption*
○ Natural Gas	○ Energy consumed for production from natural gas
○ Liquid Gas	○ Energy consumed for production from liquid gas
○ Heating Oil	○ Energy consumed for production from heating oil
○ Coal	○ Energy consumed for production from coal
○ Other fossil fuel	○ Energy consumed for production from others fossil fuel

- Energy production for district heating with CHP (Combined Heat and Power)

Production	*Consumption*
○ Electricity	○ Energy consumed for their production from natural gas
○ Thermal energy	○ Energy consumed for their production from liquid gas

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○ Energy consumed for their production from heating oil
○ Energy consumed for their production from coal
○ Energy consumed for their production from wood biomass
○ Energy consumed for their production from biofuel
○ Energy consumed for their production from other renewable
○ Energy consumed for their production from waste

- Thermal energy for district heating (no CHP) from renewables

Production	*Consumption*
○ Wood biomass	○ Energy consumed for production from wood biomass
○ Biofuels	○ Energy consumed for production from biofuels
○ Other renewables	○ Energy consumed for production from other renewables

- Thermal energy for district heating (no CHP) from fossil fuels

Production	*Consumption*
○ Natural Gas	○ Energy consumed for production from natural gas
○ Liquid Gas	○ Energy consumed for production from liquid gas
○ Heating Oil	○ Energy consumed for production from heating oil
○ Coal	○ Energy consumed for production from coal
○ Other fossil fuel	○ Energy consumed for production from others fossil fuel

- Thermal energy from heat pumps

Production	*Consumption*
○ Heat pumps	○ Electricity consumed for production

- Solar thermal energy

Production
○ Solar thermal energy

- Other renewable Energies

Data describing the components of the system, the system itself and its framework

3) Boundaries and general context data

The main data that can be collected are:

- Reference year
- Geographic data: boundaries, surface of territory
- Demographic data: number and characteristics of inhabitants
- Economic data: gross domestic product (GDP)
- Number of employees per economic sector

4) System components data

Given the complexity and variety of this type of data only the main categories are reported together with a few example for the building sectors.

- Consumption and production units' information;
- Behaviours of end-users.
- Energy infrastructure conditions
- Cost of technologies and of energy vectors

Example from building sector at wider scale

- Number of construction per typology of buildings
- Gross volume, area and heated surface
- Age of buildings

Example from building sector at building scale

- Type of windows and transmittance
- Heat distribution system
- Efficiency, age and power of the heating plant

5) Framework data

The framework section is the one that contains the widest range and number of data that could possibly be collected. The legislative framework, for instance, could contain all the laws that affect a specific topic. For the building sector, this could range from building codes to planning legislations. For this reason, only the main categories, which have been individuated above, are reported.

- Legislative framework and plans in place
- Economic aspects and presence of incentives or financial schemes for actions implementation
- Information on stakeholders
- Social and cultural aspects

6) Data for monitoring

As explained above , the data used to monitor the level of success in implementing or managing an action plan can refer to direct consumption, to accessory information (i.e. indoor temperature of an house) or to monitoring of performance. . As an example[5], a few indicators that can be used for evaluation are here represented.

- % of households with energetic label A
- Total surface of solar collectors
- Number of companies involved in energy services, energy efficiency and renewable energies business

[5] Examples taken from the guideline "How to develop a Sustainable Energy Action Plan" from the JRC. © European Union, 2010

- Number of companies involved in energy services, energy efficiency and renewable energies business
- Number of citizens attending to energy efficiency/renewable energies events.

7) Meteorological data

The most relevant meteorological data for the analysis and comparison of the energy baseline relative to different regions are degree-days. Other relevant indicators in evaluating the potential of renewable energies (such as rainfall data or solar irradiance) are not listed.

- Degree days

Data for the elaboration of scenarios

8) Data about renewable energy potential production

Data for the calculation of the renewable energy potential are complex and copious and in most of the cases they need to be georeferenced.

The following are only a few example from the hydroelectric potential:

- River Network
- Rainfall data
- Rain-off coefficient
- Discharge
- DTM (Digital terrain model)
- Road Network

9) Data about energy saving potential

The energy saving potential can be calculated by using consumption data and system component data. The results of these calculation should be compared with benchmark data, reported therefore as the only type of data to be collected.

- Benchmark data for different technologies and components of the system

10) Additional data on the evolution of framework conditions

Again, these data are copious and complex and no attempt is made to list them in an exhaustive manner here. A few examples from the one previously mentioned are reported below.

- Population evolution trends
- Discount rates
- Cost of energy
- Price of technology

ENERGY PLANING INSTRUMENTS AT CITY AND DISTRICT LEVEL

ENERGY PLANNING INSTRUMENTS IN BOLZANO

SEAP, MASTER PLAN

In 2009 the city of Bolzano was appointed "Alpine Town of the Year". It was awarded this recognition thanks largely to its commitment to achieving the neutrality of local carbon dioxide emissions in the near future. The city accepted with great responsibility the undertaking of such an ambitious challenge becoming in 2009 among the first signatories of the Covenant of Mayors (together with other 200 European cities).

The Vision "Action Plan for Bolzano CO_2 neutral" synthesizes effectively the goals towards which the City is directing its efforts, both with specific actions and through the synergies of various instruments of strategic planning and local regulations.

Not only is Bolzano equipped with traditional instruments such as Building Code and Municipal Master Plan, but also with an innovative Strategic Plan interacting with energy issues and urban development.

The Strategic Development Plan of the city of Bolzano "Ideas 2015 - Think the City" examines strengths and weaknesses of the City as well as opportunities for development and population growth. The four major areas of action are: society (family, youth, women, leisure, home, etc.), culture, tourism and entertainment (enhancement of local resources within a framework of European citizenship), economic development and employment (infrastructure, technological innovation, settlements), territory and environment (space and time in the city, mobility).

The aim is to strengthen the existing positive trend looking for solutions to mitigate or reverse the negative trends.

The SEAP of Bolzano positions itself in the framework of the Masterplan directives on issues of energy and reduction of greenhouse gases, to which a large section is devoted, foreseeing possible implementation modalities.

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Formulated according to the SEAP European methodology, the plan resumes and frames ongoing actions started by the city of Bolzano within a strategic vision projected to2020, including also new actions organised in the following macro-groups:

- reduction of energy consumption;
- restoration of pre-existing buildings;
- consumption reduction in mobility;
- production of energy from renewable sources.

European Union data show that 48% of energy consumption, and thus CO_2 emissions, is represented by heat consumption, and that this prevalence is due to the building and services sectors (43% + 13% = 56%).

ENERGY PLANNING INSTRUMENTS IN INNSBRUCK

In 2007 the City of Innsbruck decided to establish the Innsbruck Energy Development Plan (IEP) to contribute to environmental protection and to increase its already high quality of life. The overall goals of the IEP are a decrease of energy consumption and an increase in the share of renewable energies. In 2009, phase 1 of the IEP started with the elaboration of the baseline, which served to develop several future scenarios as well as to discover the potential of the City. To reach the ambitious goals of the IEP - a 20% decrease of heating demand, a 44% decrease of fossil fuels and a 27% increase of renewable energy supply - the Municipality of Innsbruck established an implementation team to carry out the needed measures. In 2013 the incentive “Innsbruck fördert-energetische Sanierung” (“Innsbruck grants funding for energy efficient refurbishment”) was established for high quality energy efficient refurbishment. Measures like the replacement of windows, the integration of PV plants and/or the implementation of a ventilation system received financial funding. Following a mandatory preliminary consultation, it is possible that the Municipality will grant an extra eco- bonus for the realization of more than 3 high quality measures.

A second package of measures consist in the realisation of lighthouse projects, such as SINFONIA, and a third one in increasing public information and awareness.

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ADAPTATION OF THE BASELINE CALCULATION METHOD TO BOLZANO AND INNSBRUCK

CONTENTS OF EXTENDED DISTRICT BASELINE DATASETS IN BOLZANO AND INNSBRUCK

While the above description in Ch. 2 is fairly comprehensive for a general baseline, in this paragraph we anticipate a synthetic description of the contents of the district baselines of Innsbruck and Bolzano (leaving the details to the Annexes).

Both district baselines focus on the building sector and its energy consumption. However, while the case study of Innsbruck considers all the types of buildings (briefly listed in the paragraph below), the one of Bolzano deals only with residential building or buildings that host both dwellings and other activities (offices or shops at the ground floor). On the other hand, the district of Bolzano analysis will be displayed almost at a single building level (some contiguous buildings were merged), while the Innsbruck ones will be graphically displayed in an aggregated form- due to privacy issues. The following section contains a brief description of the dataset structure for the two analyses.

Bolzano

For Bolzano the extended district baseline is based on the collection of data from residential and mixed buildings only. The buildings are classified according to size and year of construction using the following categories, the geometrical characteristics of which are described in the next chapter:

TABLE 2. LIST OF BUILDINGS CATEGORIES CONSIDERED IN BOLZANO

Buildings categories	
Detached houses or duplex	Medium multi-family house
Small multi-family house	Large multi-family house

For Bolzano these main following attributes have been collected to calculate the consumption per square meter of each building.

TABLE 3. ATTRIBUTE CONSIDERED FOR BOLZANO

Attribute for building	
Total Volume	Construction epochs
Area of the building	Natura gas consumption per address

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Innsbruck

As explained above, Innsbruck`s data are not available at a single building level. A 100x100 meter raster has been defined as the minimum requirement for data aggregation, so that no personal inference is possible.

The data for constructing the graphic representation of the spatial dependence are collected for the following building categories:

TABLE 4. LIST OF BUILDINGS CATEGORIES CONSIDERED IN INNSBRUCK

Buildings categories	
Detached houses	Industrial Buildings
Row houses (RH)	Mixed use
Small multi-family house	Other uses
Medium multi-family house	Public buildings
Large multi-family house	Others
Commercial buildings	

For each type of building the following attribute are collected:

TABLE 5. ATTRIBUTE COLLECTED FOR EACH BUILDING IN INNSBRUCK

Attribute for building	
Building Category	Number of Residences
Gross floor area	Fuels distribution for space heating
Useful area	Fuels distribution for domestic hot water
Age of the building	Energy demand

MAIN DIFFERENCES IN THE METHODOLOGIES USED IN BOLZANO AND INNSBRUCK BASELINES CALCULATION

The main differences between the cities are shown in the table below.

The most relevant ones are connected with the availability of data and with restriction in their use (results could be displayed only in an aggregated form). The baseline calculation for the Sinfonia district in Bolzano assesses the heat consumption at building level based on the main characteristics of the residential buildings (e.g. volume, epoch of construction) and real gas consumption data,

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without taking into consideration the electric consumption. The analysis of non-residential buildings and industry was not performed due to the lack of data.

The calculation for Bolzano is performed using and developing a set of open-source tools to statistically analyze the available data, process these spatial data and visualize them at building scale. In Bolzano the data are aggregated at civic/building level, and not single flat level. These data are covering only a fraction of the entire building stock. Furthermore, no information on the level of occupancy of the flat in the buildings were given (I.e. whether all flats are rented or occupied). This led to a higher level of complexity in the data elaboration process and in the statistics assumption to be considered.

The baseline calculation for the Sinfonia district in Innsbruck provides the main advantage that the information of the individual utilization units are available. Therefore, the utilization units, which are for example office or dwelling, are considered in the respective usage profile.

The calculation is based on the EnerAlp Tool, which calculates and calibrates the characteristic values afterwards. The unknown units (i.e. further use or industry) have been estimated. This gives the possibility to represent the whole building stock of the district. Compared to the district in Bolzano the whole building stock of the Innsbruck district includes the calculated and calibrated electricity demand.

Due to the reason of data protection and the framework contract with the energy supply company the analysis details in the GIS (Geo Information System) are limited. The calculated and calibrated characteristic values of demand are displayed in a raster of 100 x 100 meter.

Additional to the total gas consumption the total electricity consumption is for the district level in Innsbruck available.

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TABLE 6. METHOLOGICAL DIFFERENCES BETWEEN BOLZANO AND INNSBRUCK BASELINES CALCULATION

Information available	Innsbruck	Bozen
Building information (building level)	yes	yes
Building unit information	yes	no
Step within the methodology		
Pre-processing of input data to standardize and extract buildings characteristics	yes	yes
Compute buildings demands based on buildings characteristics	yes	no
Extract main statistics at building level based on real Consumption data per buildings age and typology	no	yes
Assign the average value to the buildings with missing consumption data	yes	yes
Calculation		
Calculation of the electricity demand	yes	no
Calculation of the space heating demand	yes	no
Calculation of the domestic heat water demand	yes	no
Calibration by real electricity consumption	yes	no
Calibration by real gas consumption	yes	no
Calculation residential buildings	yes	no
Calculation non-residential buildings	yes	no
Estimation industry	yes	no
GIS analysis		
GIS based analysis of building stock	yes	yes
GIS based anylsis of heat consumption on building level	no	yes
GIS based analysis of calculated and calibrated heat demand	yes	no
GIS based analysis of calculated and calibrated eletrictity demand	yes	no
GIS based analysis of demographic data	no	yes
Post-processing		
Aggregation electricity consumption to the district level	yes	yes
Aggregation gas consumption to the district level	yes	yes

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GOOD PRACTICE RECOMMENDATIONS FOR THE BASELINE CALCULATION AND APPROACH LIMITATIONS

A baseline calculation methodology as proposed in the current Task 2.2. is essential to stimulate the transition of existing cities/districts to Smart Energy Cities / districts. As announced by the European Commission the targets for 2030 are

- a 40% cut in greenhouse gas emissions compared to 1990 levels
- at least a 27% share of renewable energy consumption
- at least 27% energy savings compared with the business-as-usual scenario

These targets are similar to the ones in Sinfonia. However, how can it be proved that these targets are met? Current energy demand, share of renewable energies and emissions- or in other words a baseline are essential to determine whether the set targets will be met by 2030.

In Sinfonia we foreseen this baseline to prove that the ambitious targets set at the beginning of the project have been achieved and to prove that the planned demonstration measures carry the same effects in practice as calculated in theory.

In order to obtain a sound baseline following data should be considered in the calculation:

1) Energy consumption data
2) Energy production data
3) Boundaries and general context data
4) System components data
5) Framework data
6) Data for monitoring
7) Meteorological data
8) Data about renewable energy potential production
9) Data about energy saving potential#
10) Additional data on the evolution of framework conditions

Of course, these are the ideal theoretical input data for calculating a baseline in urban environment or, as in the current case, at district level. However, in the last 18 month we realized that obtaining the data is not that easy. Some of the data is simply unavailable and some cannot be retrieved due to data protection laws. Therefore, the theoretical perfect baseline is hard to achieve, as has also been

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experienced in the demonstration cities of Sinfonia- Bolzano and Innsbruck. This does not mean that the results are unreliable but rather that it is hard to obtain all the data mentioned above in a short time-frame. Therefore, it is essential for replication cities to take their time to obtain a minimum set of data in order to calculate a sound baseline.

The experience is that it is impossible to calculate the baseline the same way in Bolzano and Innsbruck. Different countries have different ways of collecting data and therefore the used datasets differ in content and accuracy. Of course, energy demand and energy consumption can be obtained in both cities but neither with the same accuracy nor the same building level. The above-mentioned perfect dataset has to be seen also as a caveat having country- specific standards in mind. Another example is the different way the building stock surveyed over countries.

In these regards, also the different legal framework has to be considered. Its diversity over countries impacts the reading of individual-related data.

The aim of the current baseline calculations is to figure out at the end of the project whether the demo cities have reached their goals or not. Therefore it is also essential to have the same data available at the end of the project, which implies a common data basis in order to apply the same correction values to calibrate the underlying model. Also, the method of calculation has to be the same in order to compare beginning with end results. If the model is changed, also the baseline has to be recalculated to adapt to the new model to avoid contradictory results.

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SINFONIA DELIVERABLE FACT SHEET	
PROJECT START DATE	1st June 2014
PROJECT DURATION	60 months
PROJECT WEBSITE	http://www.sinfonia-smartcities.eu
DOCUMENT	
DELIVERABLE NUMBER:	D 2.2
DELIVERABLE TITLE:	Good practice district stimulator
DUE DATE OF DELIVERABLE:	October 2015
ACTUAL SUBMISSION DATE:	September 2016
EDITORS:	Klaus Kleewein, Wolfgang Streicher, Daniele Vettorato, Roberto Vaccaro
AUTHORS:	Daniel Fischer, Marco Casotti, Valentina D'Alonzo, Simon Grutsch, Stephan Hilber, Klaus Kleewein, Petra Mautner, Roberta Pernetti, Simon Pezzutto, Dominik Pfeifer, Wolfgang Streicher, Roberto Vaccaro, Daniele Vettorato, Pietro Zambelli, Alyona Zuberayeva.
REVIEWERS:	Hakan Perslow, Daniele Vettorato
PARTICIPATING BENEFICIARIES:	Municipalities of: Bolzano, Innsbruck, Boras, La Rochelle, Paphos, Rosenheim, Sevilla
WORK PACKAGE NO.:	2
WORK PACKAGE TITLE:	Design and specifications of scalable/replicable refurbished district templates
WORK PACKAGE LEADER:	EURAC
WORK PACKAGE PARTICIPANTS:	SP, MAGIBK, IKB, NHT, UIBK, SAT, BOZ, EURAC, IPES, SEL, ACC, BORAS, LARO, SEV, PAFOS, G!E, PHI, ROSE, ALF, LIE
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DRAFT/FINAL:	FINAL
NO OF PAGES (INCLUDING COVER):	36
KEYWORDS:	Baseline, GIS, Energy consumption, energy production, renewable energy potentials, spatialization, district, good practices, calculation, data base.