X-tendo

TOOLS AND IT-COMPONENTS OF THE PROPOSED CALCULATION AND DATA HANDLING PROCEDURES TESTED IN X-TENDO

EPC DATABASES

JUNE 2022

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eXTENDing the energy performance assessment and certification schemes via a mOdular approach

D4.6

Tools, IT-components and related documentation of the proposed calculation and data handling procedures to be tested in WP5

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https://x-tendo.eu/wp-content/uploads/2022/08/X-tendo-D4.6_rev_RDA_with-cover.pdf

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EXECUTIVE SUMMARY

The X-tendo project is developing a framework of ten "next-generation EPC features", aiming to improve compliance, usability and reliability of the EPC. These features are divided in two categories, respectively, innovative indicators and innovative data handling.

This report describes the tools and IT-components of the proposed calculation and data handling procedures to be tested in WP5. For the feature **EPC databases** this document provides a summary of the quality control methodology for EPCs in the Database, an explanation of the programming algorithm in Python language, that implements this methodology and the explanation to the repository link. For the feature **enhanced recommendations** this document provides the explanation to the calculation spread sheets and guidelines. For the feature **building logbook** this document provides the technical specifications for linking the national logbook with the EPC data (or even EPC database). In the **building logbook** chapter, country specific solutions for Portugal, Estonia and Greece are presented.

This report builds on past project's activities. Moreover, upcoming project activities include the testing of these tools and data-handling concepts in the implementing partners (foreseen in the project phase for "**testing and developing guidelines**"). Below, the series of previous project reports are listed that present complementary information to the present report:

1. Introductory reports of the 10 innovative EPC features (Deliverable 2.3)
2. Development of assessment methods of next-generation EPC – features 1-5 (Deliverable (3.2)
3. Beta version of algorithms and calculation tools for assessment of next-generation EPC – features 1-5 (Deliverable 3.3)
4. Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user of EPC data – features 6 to 10 (Deliverable 4.2)
5. Summary of implementing partners' user needs and detailed technical specifications – features 6 to 10 (Deliverable 4.3)
6. Description of methodologies and concepts for the technical implementation of each feature regarding improved handling and use of EPC data in selected implementing countries– features 6 to 10 (Toolbox – area per each feature)
7. Tools, concepts and guidelines for features: building logbook, enhanced recommendations and EPC databases (Toolbox – area per each feature)
8. Recommendations and replicability potential (Toolbox – area per each feature)

The complete material is online accessible in the X-tendo Toolbox (https://x-tendo.eu/toolbox/).

This document is the revised version of the report completed in April 2021.

INTRODUCTION

EPCs are the most widely available information documents on building energy performance across Europe. They have the potential to be used as more than just an informative document for example through providing relevant information to assess, benchmark and improve the building's energy performance. Besides the information included in each document, the usage of these information and data handling are becoming more and more important. The recent Renovation Wave Communication published by the European Commission in October 2020 reinforced the importance of the existing EPC frameworks to improve the data gathering, storage and overall quality of EPCs. Besides that, the EPDB review is an activity going on recently and could an important opportunity to include insights and learning outputs from the X-tendo project.

In this context, the five X-tendo EPC features **EPC databases, building logbooks, enhanced recommendations, financing options and one-stop shops** play a relevant role, targeting to improve the way EPC data is being handled and used for different objectives and targeted stakeholders. For the features **EPC databases, building logbooks and enhanced recommendations**, the X-tendo project deep dived on the technical aspects of the implementation of feature, getting closer to the praxis. This was done by developing tools and technical concepts based on lessons learned from the current practice in the X-tendo expert countries (Table 1). For the features **financing options and one-stop shops** embracing concepts were explored. The complete material will be online accessible in the X-tendo Toolbox (https://x-tendo.eu/toolbox/).

The Figure 1 below summarizes the main objectives of each feature. Because of the focus on the technical components, the present document covers the features EPC databases, logbook and enhanced recommendations.

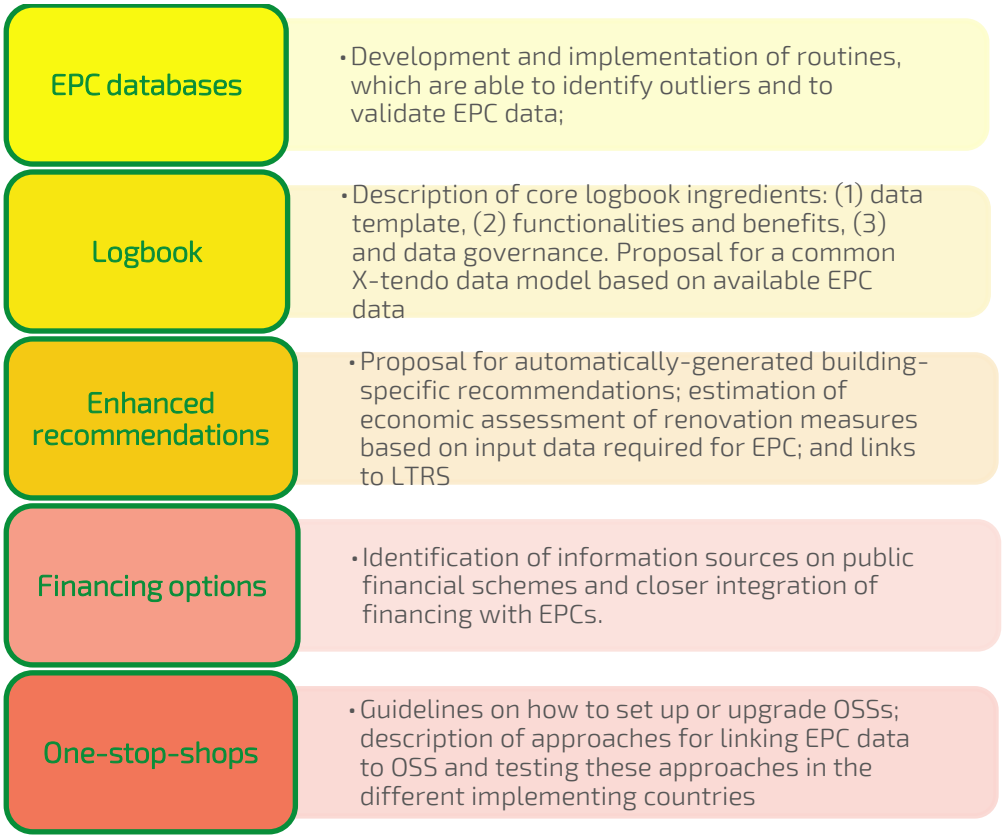

Figure 1: X-tendo methodology for features EPC Databases, Logbook, Enhanced recommendations, Financing options and One-stop-shops

The feature methodologies will be tested in different X-tendo target countries, as showed in the table below:

	 EPC databases	 Building Logbooks	 Enhanced Recommend ations	 Financing Options	 One Stop Shops
Feature lead	*TU Wien*	*BPIE*	*TU Wien*	*ADENE*	*ADENE*
Austria, EAST					
Denmark, DEA	System-test		In-building test	User and system test	User and system test
Estonia, TREA		User and system test			
Greece, CRES	System-test	User and system test			
Italy, ENEA	System-test				
Poland, NAPE			In-building and system test		
Portugal, ADENE		User and system test		User and system test	
Romania, AAECR				User and system test	User and system test
UK, EST			In-building test		User and system test

Table 1: Implementing and expert countries per feature

FEATURE: EPC DATABASE

X-tendo methodology

Figure 2 below shows the proposed quality control method developed by the X-tendo project for EPC databases. In some cases, especially if there is an exchange between EPC database manager and EPC software developer (as it is the case in Denmark), step 1 is basically a verification of EPC input data, and can also be performed directly during the EPC issuing process. In the context of the project, steps 1 to 3 described below are performed after the EPC has been issued, and have logged the Database. Step 4 consists of describing how a post-verification analysis can be done[1]:

1) *First threshold value verification* requires all EPCs in the database to be automatically verified. At this stage, a **"broad" threshold value check** (broad range) is performed for a series of EPC parameters, for example whether U-values fulfil the requirement to be greater than (>) 0.
2) *Second threshold value verification*. In this second stage, a more **"narrow" threshold value check** (narrow range) is performed for previously defined building archetypes. The verification rules are set for different building *archetypes* that are defined by clustering different parameters and their sub-groups (building type, building construction year, climate zone etc.). Also this step is being done automatically. The narrow range needs to be defined separately for each archetype and can result from an EPC database analysis, that identifies where specific parameter values lie with respect to the corresponding parameter values in the already issued EPCs
3) *EPC flagging* according to the identified faults, notification of the inconsistencies and indication of EPCs that will require manual checks. The EPC is flagged according to the severity and number of inconsistencies, and receives a final scoring. The flagging contributes to a targeted selection of the EPCs that have to be manually audited. However, the manual check is not part of X-tendo's methodology.
4) *EPC database post-analysis*: the methodology will deal with how to analyse the results from the EPC database quality control routine. The results from an EPC database quality control process can also serve as feedback loop, on how to improve education programs for energy auditors and other professionals responsible for issuing EPCs. The main objective is to prevent that commonly made mistakes are repeated, and that fewer faulty EPCs are logged in the database.

[1] This methodology is explained in details in the project report - Description of methodologies and concepts for the technical implementation of each feature regarding improved handling and use of EPC data in selected implementing countries– features 6 to 10

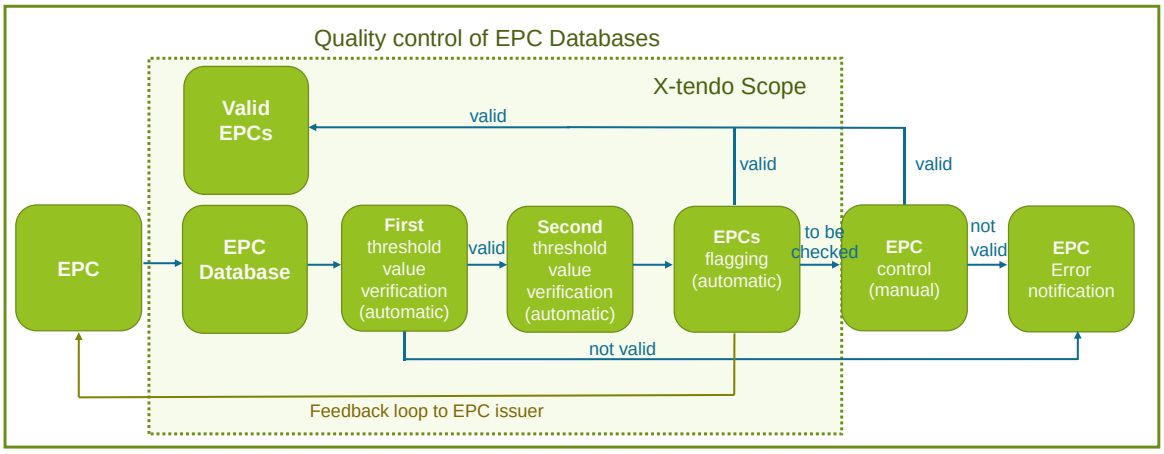

Figure 2: Outline of the proposed quality assurance method

The X-tendo programming algorithm in Python language implements until now the first two steps described below. Further development of the code consists of implementing the *EPC flagging*, step 3.

X-tendo tool

Introduction

The X-tendo EPC Database methodology aims to develop a concept that performs constraint checks on building properties. Furthermore, it generates reports of these checks' results to grant insight to buildings with erroneous data in the database. The constraints can be expressed in terms of static values and values of existing fields that are unknown before runtime. Also, the user can join them with logical operators to allow the creation and execution of more complex, non-atomic Boolean expressions.

An essential aim of the software is to find the balance between providing the users with the possibility to declare complex, potentially interdependent constraints in terms of the field values of the EPCs, and at the same time to make the declaration of these rules as intuitive as possible.

The tool performs checks on two levels: on the first level (*First threshold value verification)*, only the sanity of the field values gets checked, i.e., whether they are in an expected range or have a specific value. On the second level (*Second threshold value verification)*, a more complex, cluster-based check is performed.

Programme code information

The two primary responsibilities of the code are: first, to represent the sourced EPC data in a uniform data structure, and second, to perform the operations. The checks are performed using custom constraints. Each custom constraint inherits from an abstract base class and overrides default functionality to provide custom features.

The main workflow with the tool is that users set the base configurations such as the username of the database user and the corresponding password, edit the constraints as desired, and then use a command-line interface to run the tool.

How is the code structured?

The tool has a modular approach. The core module provides the functionality described above, and country-specific module provide the implementation for accessing the EPCs for the corresponding data source. Both modules are connected. The country-specific module has an interface between programming code and national EPC database though a DAO (data access object). The DAO allows the transformation of the national data format into the code readable data format. This interface enables the communication with any national database format, which is an advantage of this code.

The actual constraints used for the EPC verifications are also declared in the country-specific modules. The current version of the tool supports the handling of Greek and Italian EPC data. Figure 3 and Figure 4 display a higher level as well as a more fine-grained overview of the code's structure.

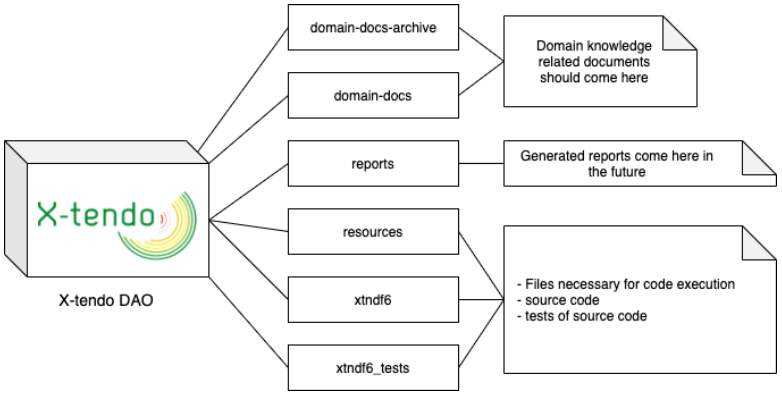

Figure 3: High-level overview of the tool's code structure

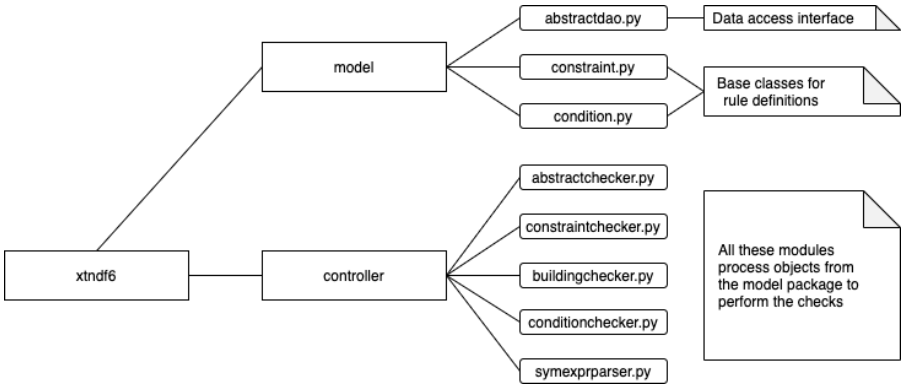

Figure 4: Lower-level overview of the core module's code structure

What computations are performed?

The performed computations include database and file access in order to load the subject EPCs into memory. As soon as they reside in the primary memory, a pre-defined set of Boolean operations are performed on the values of specific fields of the EPCs. The user

defines these operations in a declarative style in the form of constraint objects before running the program. The user can use the specified constraints or define new ones.

How to run the code?

The code can be run using a command-line interface. The available arguments differ by the country-specific implementation that can be observed in detail by visiting the links listed in the next section.

Where is the code hosted?

The permanent repository for the code presented here may be found at:

https://eeg.tuwien.ac.at/gitlab/paul/x-tendo-f6-dao/

Detailed description of the core, Italian and Greek version of tool can be found at:

https://eeg.tuwien.ac.at/gitlab/paul/x-tendo-f6-dao/-/blob/v2_core/README.md

https://eeg.tuwien.ac.at/gitlab/paul/x-tendo-f6-dao/-/blob/v2_italy/README.md

https://eeg.tuwien.ac.at/gitlab/paul/x-tendo-f6-dao/-/blob/v2_greece/README.md

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