



THE COUNCIL OF EUROPEAN GEODETIC SURVEYORS
COMITÉ DE LIAISON DES GÉOMÈTRES EUROPÉENS

Cadastral energy estimation using open-source GIS solutions

Presented by:

Mohammad Hosseingholizadeh

06 October 2022

Introduction

Methodology

Summary

Future development

References

Problem statement

Why should energy efficiency be estimated?

- Increasing energy efficiency and reducing CO₂ emissions are key tasks to confront **climate change**
- European's Climate Action Law: a virtually **climate-neutral** building stock by **2050**
- Roughly **65 percent** of heating systems are fueled by gas and oil

So, Is it essential to evaluate the energy-efficiency factor for each building?

If **yes, how to estimate the energy-efficiency factor at the district level for the entire community?**

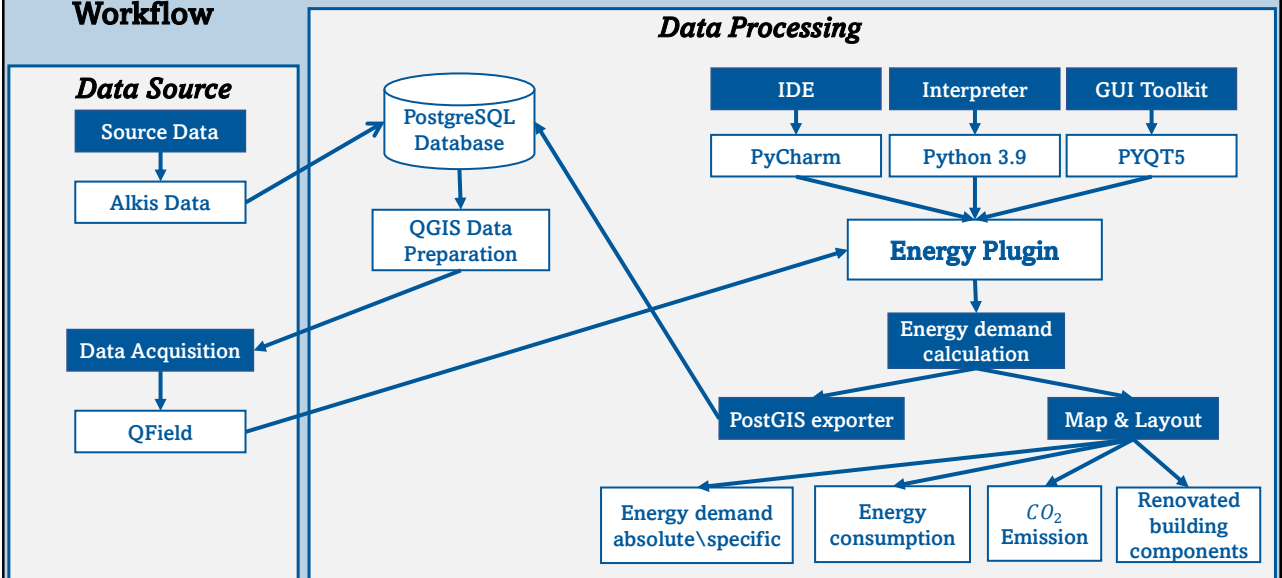


Objectives

- Developing an open-source QGIS plugin to estimate energy demand, energy consumption, and CO₂ emissions
- Enhancing 2D data by field data capturing
- Automating all the processes such as calculations, map generation, and data extraction for cadastral energy projects



Workflow



Energy demand

Calculation

- + Heat demand for domestic hot water (Q_w)
- + Heat losses through the transmission (Q_{tr})
- + Heat losses through ventilation (Q_{ve})
- + Heat gains through solar radiation (Q_{sol})
- + Heat gains through internal heat sources (Q_{int})

Parameters

Construction

- Building age classes
- Floors height, socket height [m].
- Roof shape, roof angle [°].
- Number of floors

Energetic

- Windows
- Outer walls
- Roof
- Building entrance door

The energy demand for building heating (Q_{ht})
CO₂ emission



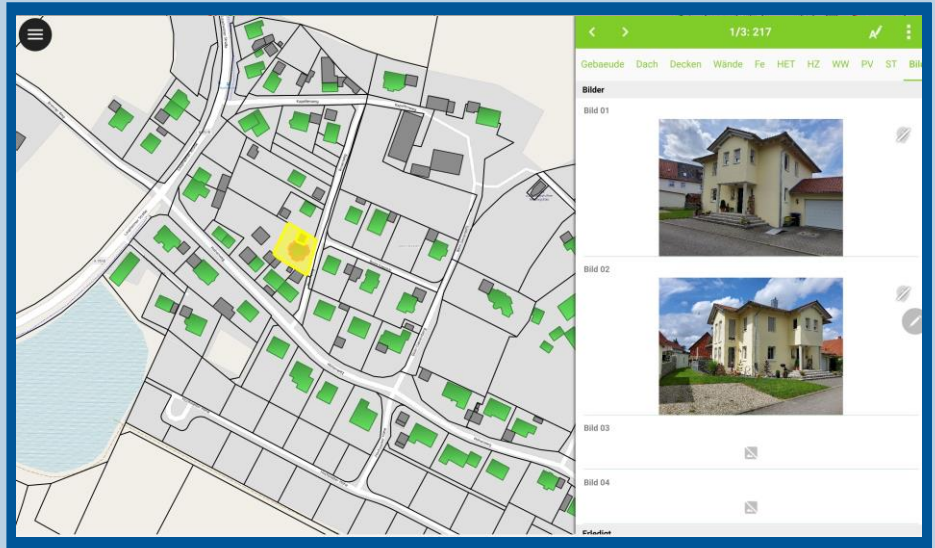
Data preparation

- ALKIS Data
- Attribute form
- Export to QField



Data acquisition

- Surveyed buildings
- Attribute form categories in Qfield
- Finalizing survey by capturing building images



Data acquisition

- More than **70 parameters** are needed to estimate energy demand with **2D data**
- A **developmental solution** is required to calculate all these parameters in a couple of seconds if any data or formula needs to be updated
- Besides all calculations, the maps and layouts should be **reproduced again** with any changes

How?

QGIS Plug-in Based on OOP



Introduction

Methodology

Summary

Future development

References

Plug-in stucture

- Import raw data
- Import field data, calculation, and database connection
- Generating layers with their own symbology
- Generating automatically pdf maps
- Logger

Laden der Rohdaten

Laden der Flurstücke

Laden der Gebäude

Laden der Straßennamen

Laden der Hausnummer

Laden der Flurstücknummer

Abgrenzung

Eingabe der Gebäude mit Felddaten

Gebäude-Shapefile oder Geopackage ...

Exportoptionen

Verbindungsname

Rechner

Anschluss

Datenbank

Benutzername

Kennwort

Verbinden

Beginn der Kalkulation

0%

Ebenen Ersteller

Beginn der Erzeugung

Erstellung der Karten und Layouts (PDF)

Projekt-Informationen

Stadt

Stadtname

Projektnummer

Energiebedarf

Solar Potential

Bauteile saniert

Heizung

Alle Kategorien

Erstellen aller Karten und Layouts

0%

Logger

OK

Cancel

Introduction

Methodology

Summary

Future development

References

Import raw data

Laden der Rohdaten

Laden der Flurstücke

Laden der Gebäude

Laden der Straßennamen

Laden der Hausnummer

Laden der Flurstücknummer

Abgrenzung

Eingabe der Gebäude mit Felddaten

Gebäude-Shapefile oder Geopackage ...

Exportoptionen

Verbindungsname

Rechner

Anschluss

Datenbank

Benutzername

Kennwort

Verbinden

Beginn der Kalkulation

0%

Ebenen Ersteller

Beginn der Erzeugung

Erstellung der Karten und Layouts (PDF)

Projekt-Informationen

Stadt

Stadtname

Projektnummer

Energiebedarf

Solar Potential

Bauteile saniert

Heizung

Alle Kategorien

Erstellen aller Karten und Layouts

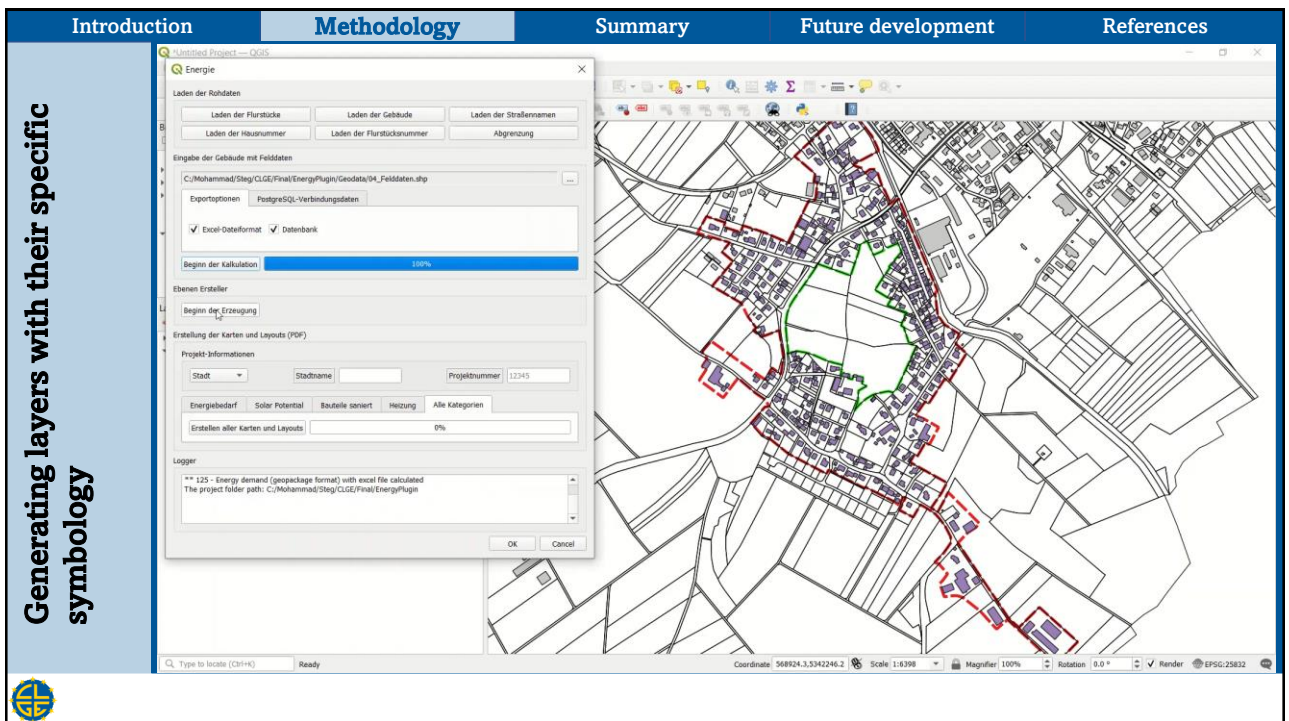
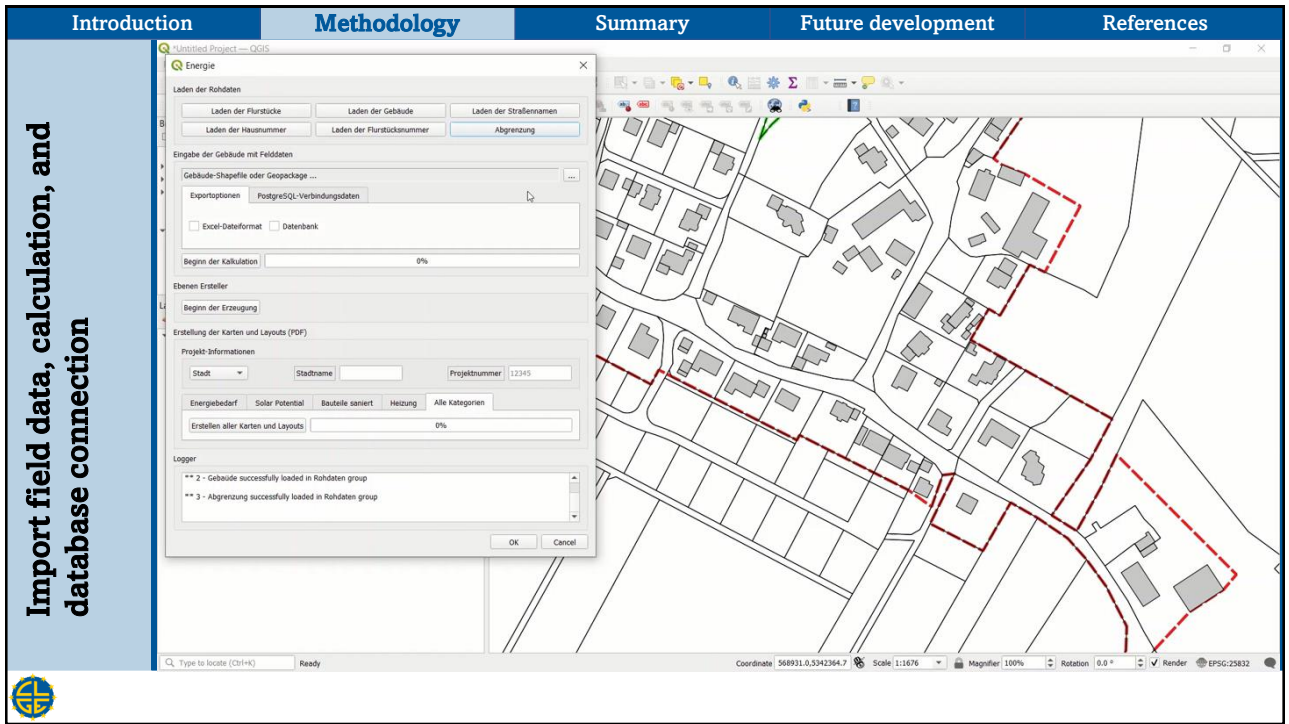
0%

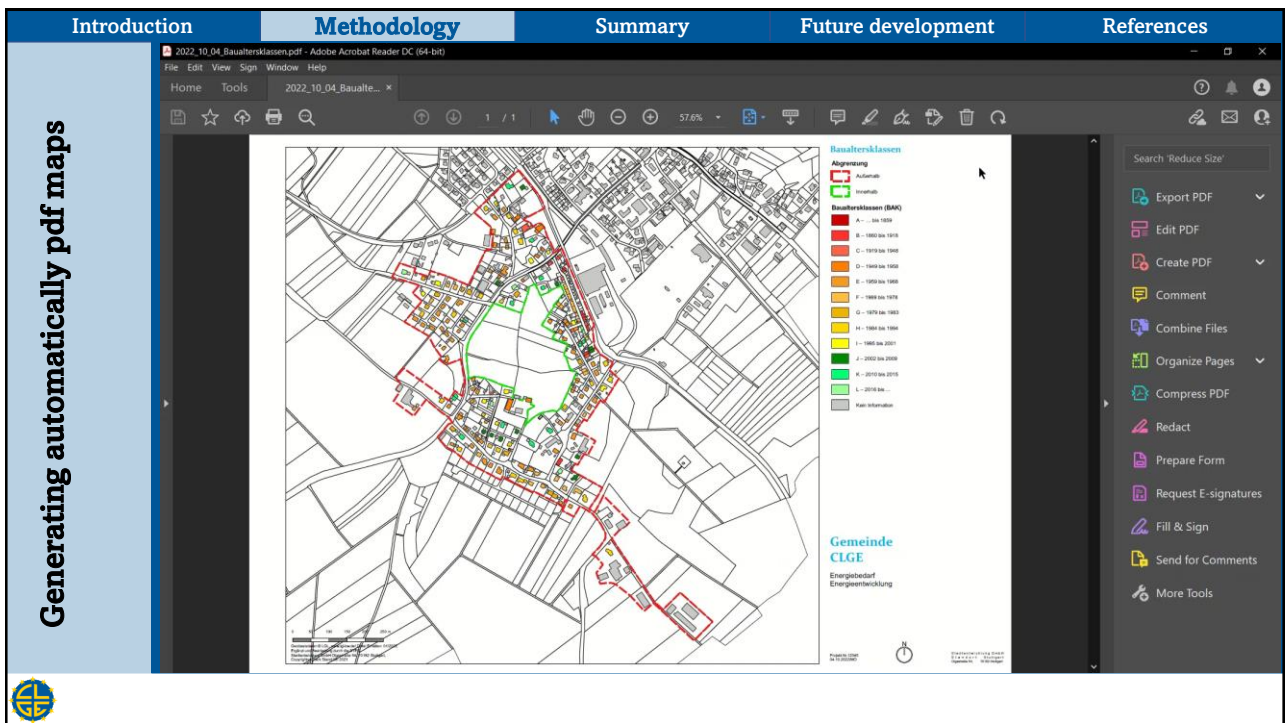
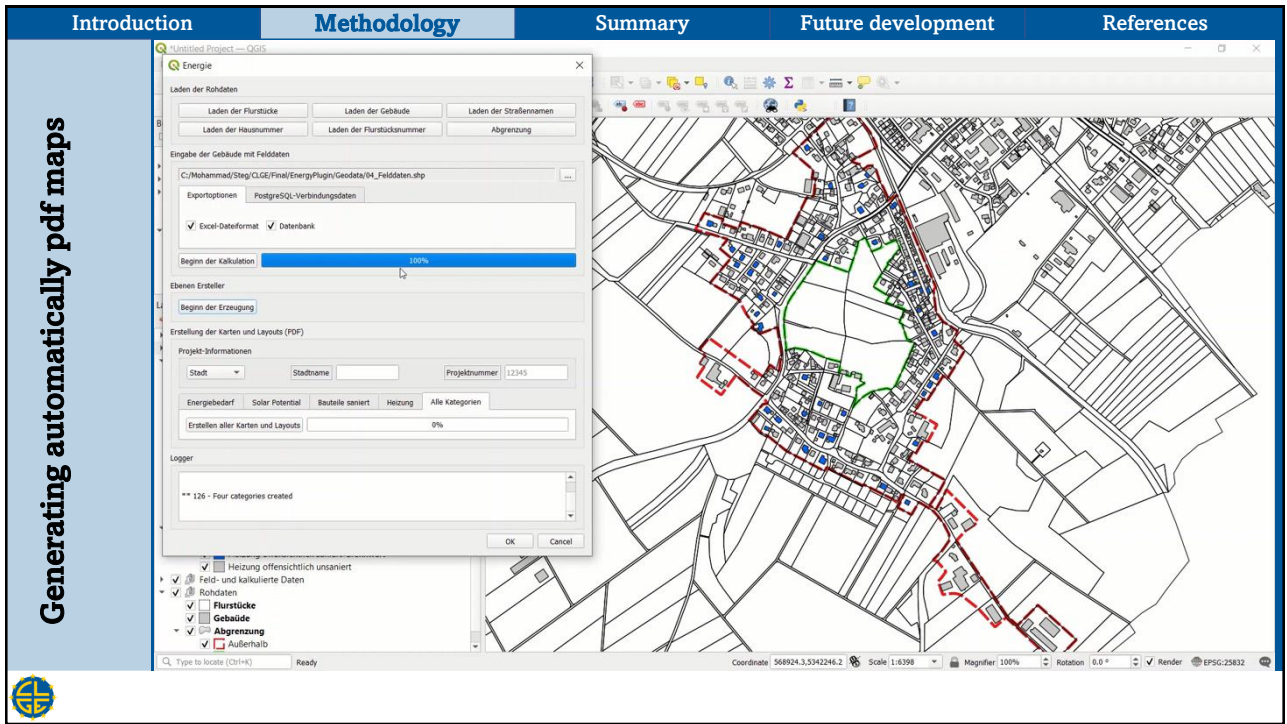
Logger

OK

Cancel

5





Introduction	Methodology	Summary	Future development	References
--------------	-------------	---------	--------------------	------------

Code stucture

Using ...

- Object-Oriented programming
- inheritance and composition
- properties, staticmethods, instancemethods, classmethods, and abstractmethods
- design patterns

increases the readability and performance of code

```

('Fe_U_Part', ('Fe_A' / 'A_Bak' + 'Fe_U_Bak')),

('Dbaae_U_Bak',
'''CASE
  WHEN "Da_Bak" = 'A' THEN 2.6 WHEN "Da_Bak" = 'B' THEN 2.6 WHEN "Da_Bak" = 'C' THEN 1.4
  WHEN "Da_Bak" = 'D' THEN 1.4 WHEN "Da_Bak" = 'E' THEN 1.4 WHEN "Da_Bak" = 'F' THEN 0.8
  WHEN "Da_Bak" = 'G' THEN 0.7 WHEN "Da_Bak" = 'H' THEN 0.8 WHEN "Da_Bak" = 'I' THEN 0.2
  WHEN "Da_Bak" = 'J' THEN 0.24 WHEN "Da_Bak" = 'K' THEN 0.24 WHEN "Da_Bak" = 'L' THEN 0.24
  WHEN "Da_Bak" = 'A' THEN 2.6 WHEN "Da_Bak" = 'B' THEN 2.6 WHEN "Da_Bak" = 'C' THEN 1.4
  WHEN "Da_Bak" = 'D' THEN 1.4 WHEN "Da_Bak" = 'E' THEN 1.4 WHEN "Da_Bak" = 'F' THEN 0.8
  WHEN "Da_Bak" = 'G' THEN 0.7 WHEN "Da_Bak" = 'H' THEN 0.8 WHEN "Da_Bak" = 'I' THEN 0.2
  WHEN "Da_Bak" = 'J' THEN 0.24 WHEN "Da_Bak" = 'K' THEN 0.24 WHEN "Da_Bak" = 'L' THEN 0.24
END'''),

('Dbaae_U_Part', ('Dbaae_A' / 'A_Bak' + Dbaae_U_Bak)),

# Create variable for [U_TB] Thermal bridging (possible values could be 0.0, 0.1, 0.15, 0.4 )
# in our Calculation we take 0.1)
('U_Best_Des', 'NO_U_Part' + 'AK_U_Part' + 'Fe_U_Part' + 'Dbaae_U_Part' + 0.10'),
# U_TB = 0.10 ==> future as a variable, link to BAK class

('U15_20', '3780'),

('K2_WW_Best', '10000'),
('K2_WW_Best_f', '0.245'),

('U15', '0.024 * 3 + 222 + 'Ak''),

('U_GL_N', '''CASE
  WHEN "Da_Bak" = 'A' THEN 0.87 WHEN "Da_Bak" = 'B' THEN 0.87 WHEN "Da_Bak" = 'C' THEN 0.87
  WHEN "Da_Bak" = 'D' THEN 0.87 WHEN "Da_Bak" = 'E' THEN 0.79 WHEN "Da_Bak" = 'F' THEN 0.79
  WHEN "Da_Bak" = 'G' THEN 0.79 WHEN "Da_Bak" = 'H' THEN 0.79 WHEN "Da_Bak" = 'I' THEN 0.79
  WHEN "Da_Bak" = 'J' THEN 0.65 WHEN "Da_Bak" = 'K' THEN 0.65 WHEN "Da_Bak" = 'L'
  THEN 0.65 END'''),
('Q15', '0.4 * (1 - 0.3) + 0.9 * "U_GL_N" + (0.25 * "Fe_A" + (271 + 392 + 271 + 1481)'),

('Qve', '0.024 * 0.34 + (0.4 + 0.4) * 'Ak' + 'Dbaae_U_15' + U15_20'),

('QW_Best', '12.5'),

('QW_Best', '"A_Bak" + "U_Best_Des" + 0.024 * 1.2 + "U15_20"'),
('QW_Best_Seq', 'QW_Best' / 'Ak'),
('QW_Best', 'QW_Best' + 'Qve' - 'Q15' - 'Q15'),
('QW_Best_Seq', 'QW_Best' / 'Ak'),
# For 0 to 100, 1.1 changed to 1 because energy consumption should be equal or lower than energy demand
('QW_Con_f', '100 - 1.1 * (QW_Best - QW_Con_Seq) / (QW_Best - QW_Con_Seq)'),
('QW_Con', 'QW_Best' + 'QW_Con_f' - 1)

```

Introduction	Methodology	Summary	Future development	References
--------------	-------------	---------	--------------------	------------

Code stucture

Why OOP?

- Increase the **readability** of code
- More straightforward for further **development**
- Using other python libraries with QGIS functionalities like **ORMs** and **encryption** libraries
- Unit testing**

Why cadastral energy plugin?

- Developing an open-source QGIS plugin based on OOP to calculate energy demand, energy consumption, and CO₂ emission using 2D data for Cadastral Energy
- Compatible with the new area just by changing the QField inputs
- Monitoring users' activity in case of more than one user
- Creating all the maps and layout in a couple of seconds and storing data in the database instead of days of manual work



Energy demand calculation with 3D city models


- Using 3D city models as input data
- Integration between 2D and 3D database
- Developing refurbishment scenarios with the usage of renewable energy



Introduction	Methodology	Summary	Future development	References
--------------	-------------	---------	--------------------	------------

3D visualization

Developing a QGIS plugin using interactive web application for 3D visualization and refurbishment procedure monitoring



Introduction	Methodology	Summary	Future development	References
--------------	-------------	---------	--------------------	------------

- <https://episcopo.eu/building-typology/>
- <https://www.din.de/de/mitwirken/normenausschuesse/nabau/auslegungendinv18599-68632>
- https://docs.qgis.org/3.22/en/docs/pyqgis_developer_cookbook/index.html
- <https://docs.python.org/3/>

Thank you so much for your attention

