The Green Energy Scenario

from EU-wide (big) numbers …
… to local actions with local real data

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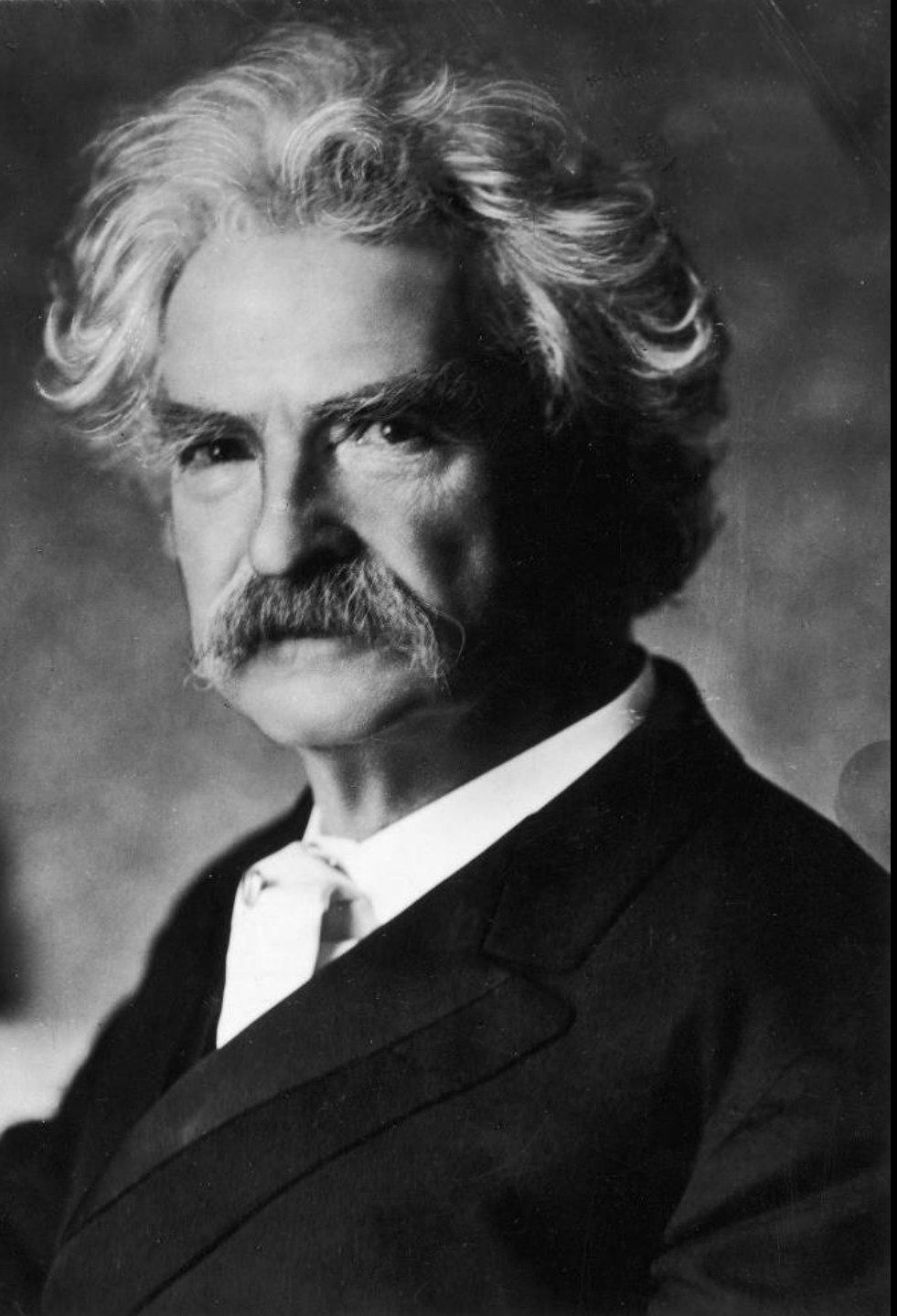
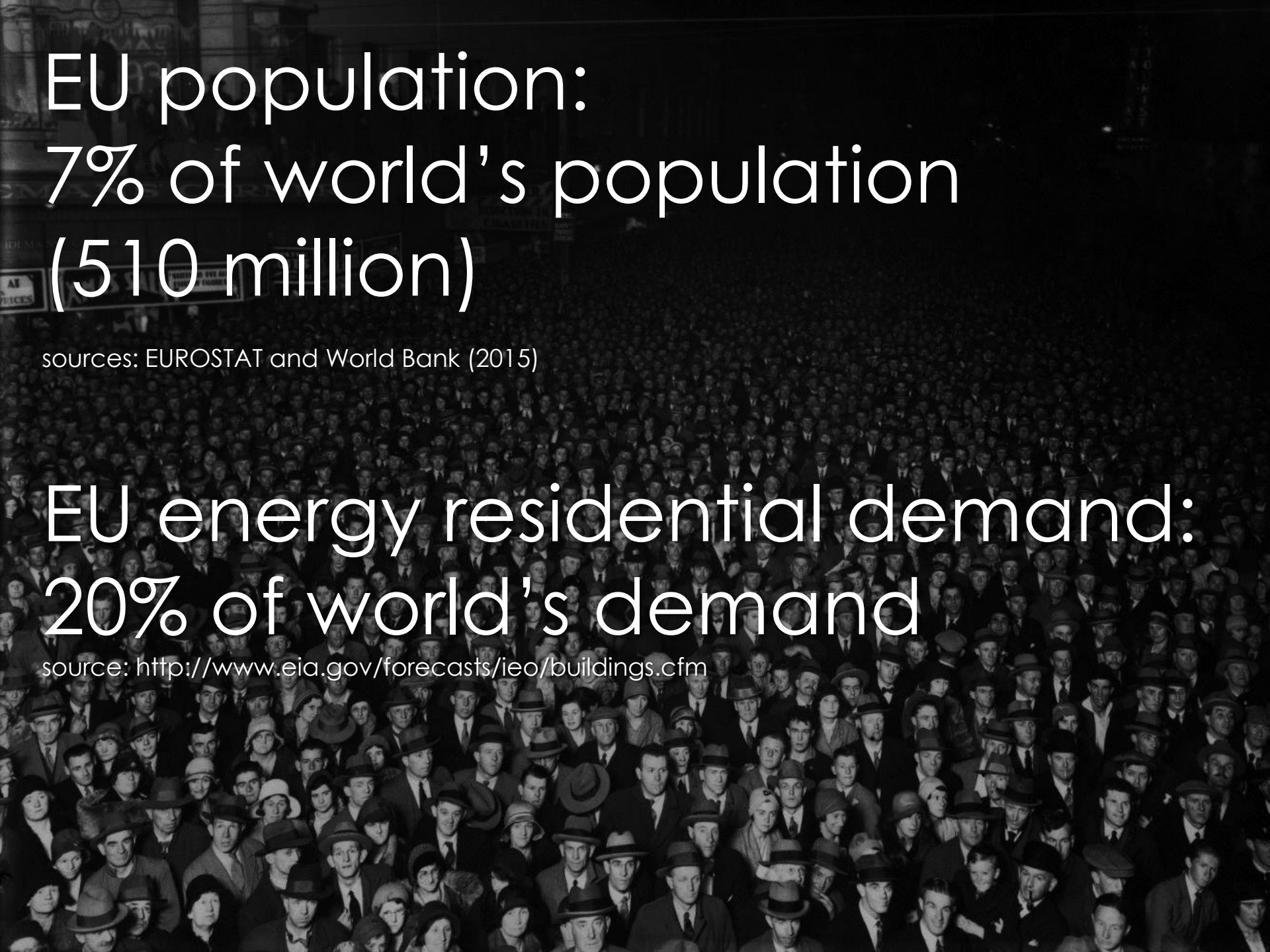


There are three kinds of lies: lies, damned lies, and statistics

Mark Twain

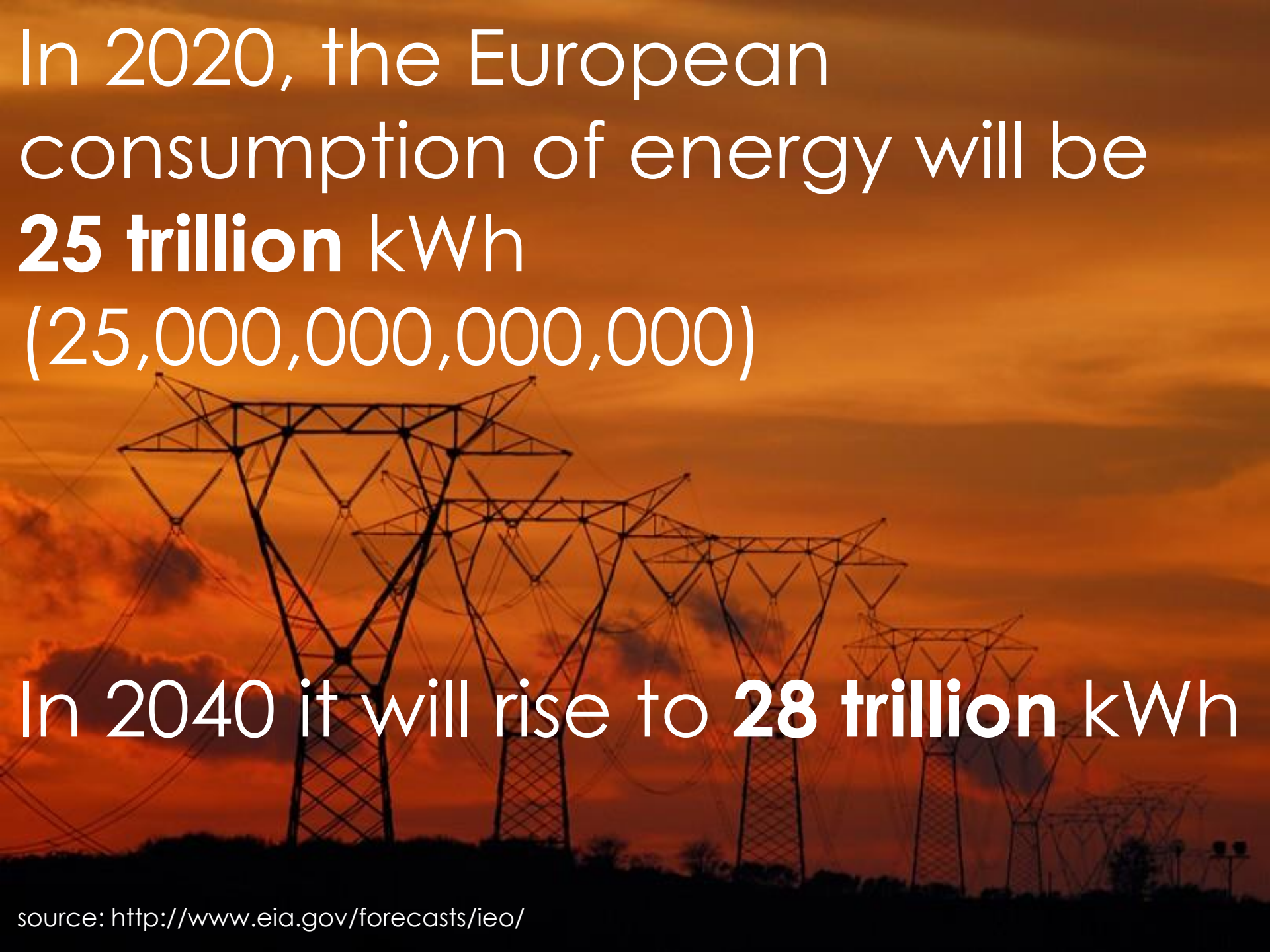


EU population:
7% of world's population (510 million)

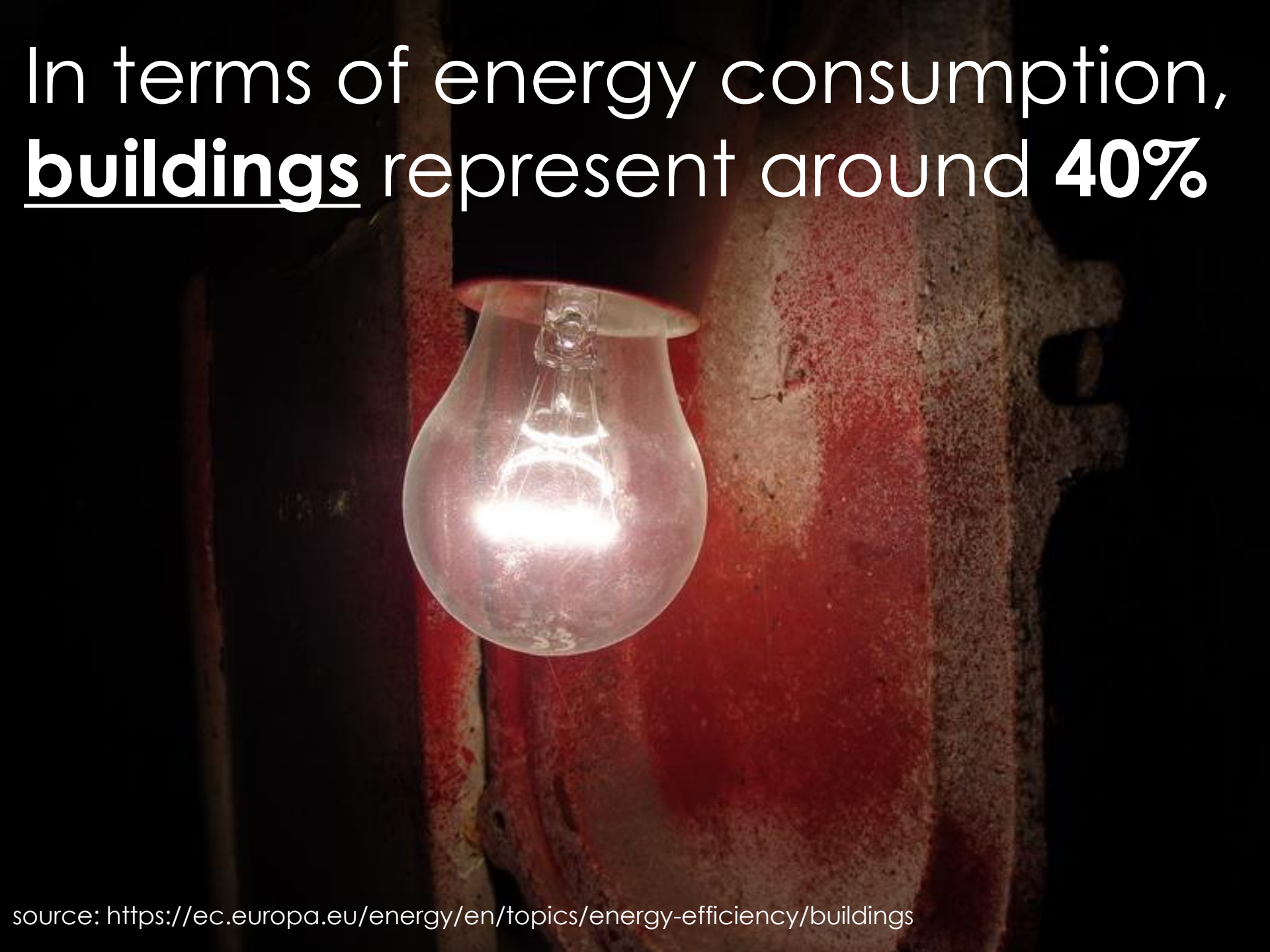
sources: EUROSTAT and World Bank (2015)

EU energy residential demand:
20% of world's demand

source: http://www.eia.gov/forecasts/ieo/buildings.cfm


In 2020, the European consumption of energy will be **25 trillion** kWh (25,000,000,000,000)
In 2040 it will rise to **28 trillion** kWh
source: http://www.eia.gov/forecasts/ieo/

In terms of energy consumption, **buildings** represent around **40%**

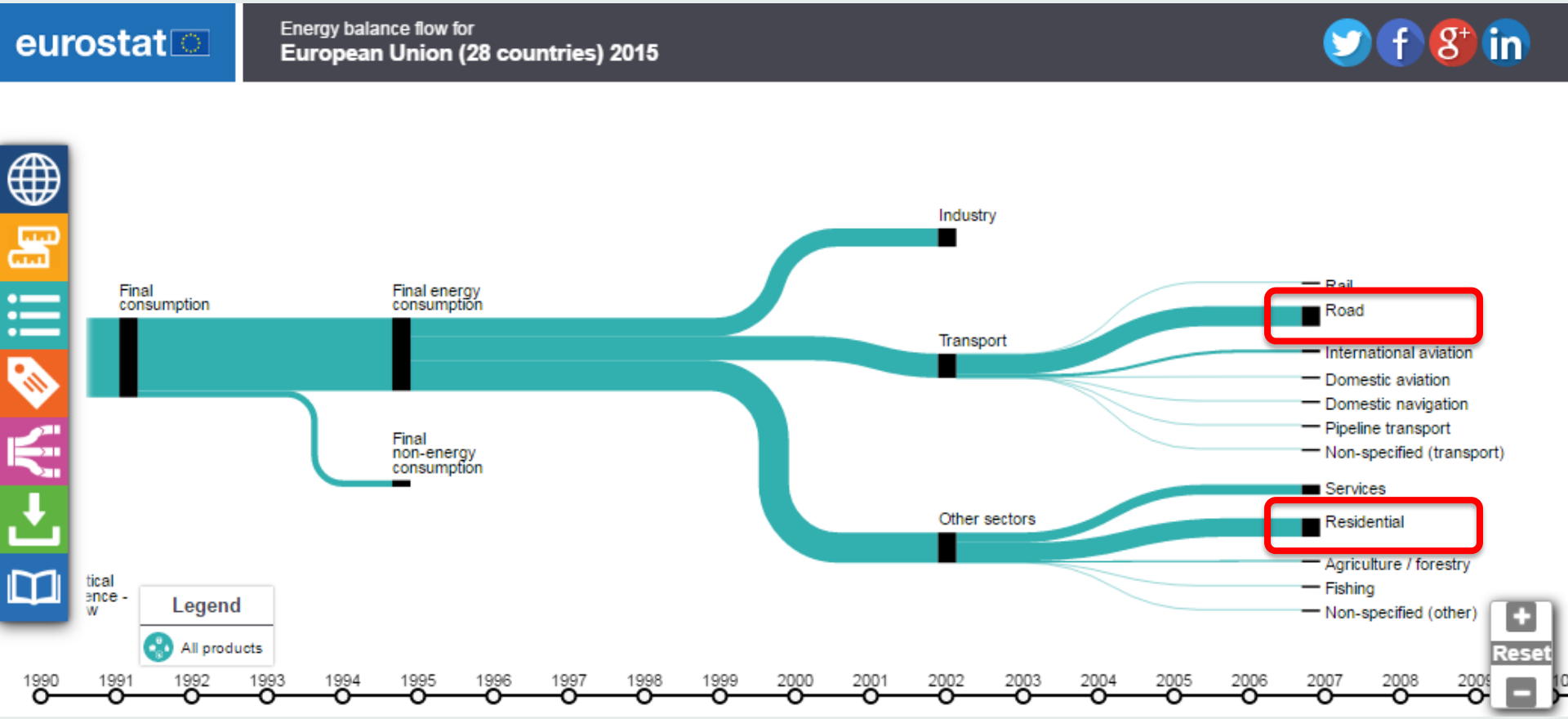


source: https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

… and **transport** is another **33%**

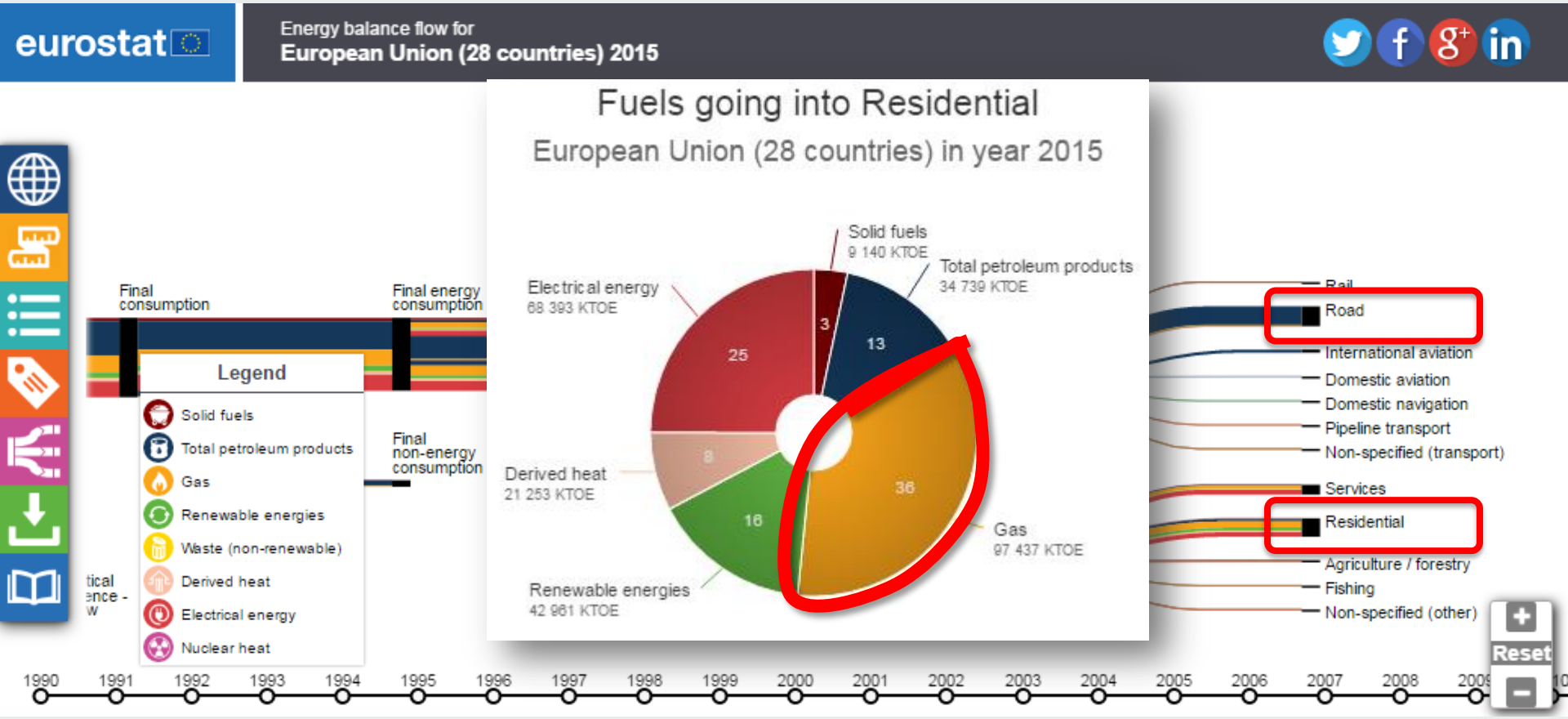
source: https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

Green Energy Context



source: http://ec.europa.eu/eurostat

Green Energy Context



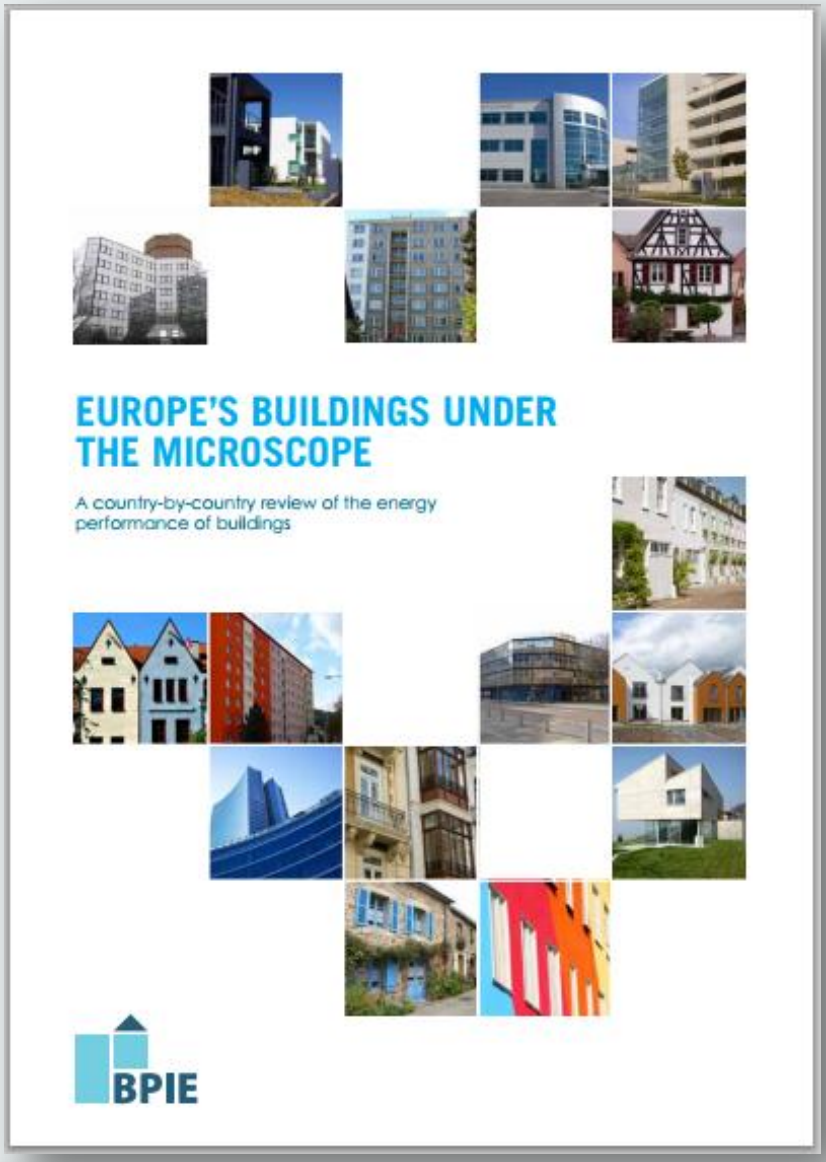
source: http://ec.europa.eu/eurostat

Green Energy Context

European **households** are responsible for **68%** of the total final energy use in **building sector**:

- heating (**70%**)
- cooling
- hot water
- cooking
- appliances

The most used fuel is gas.



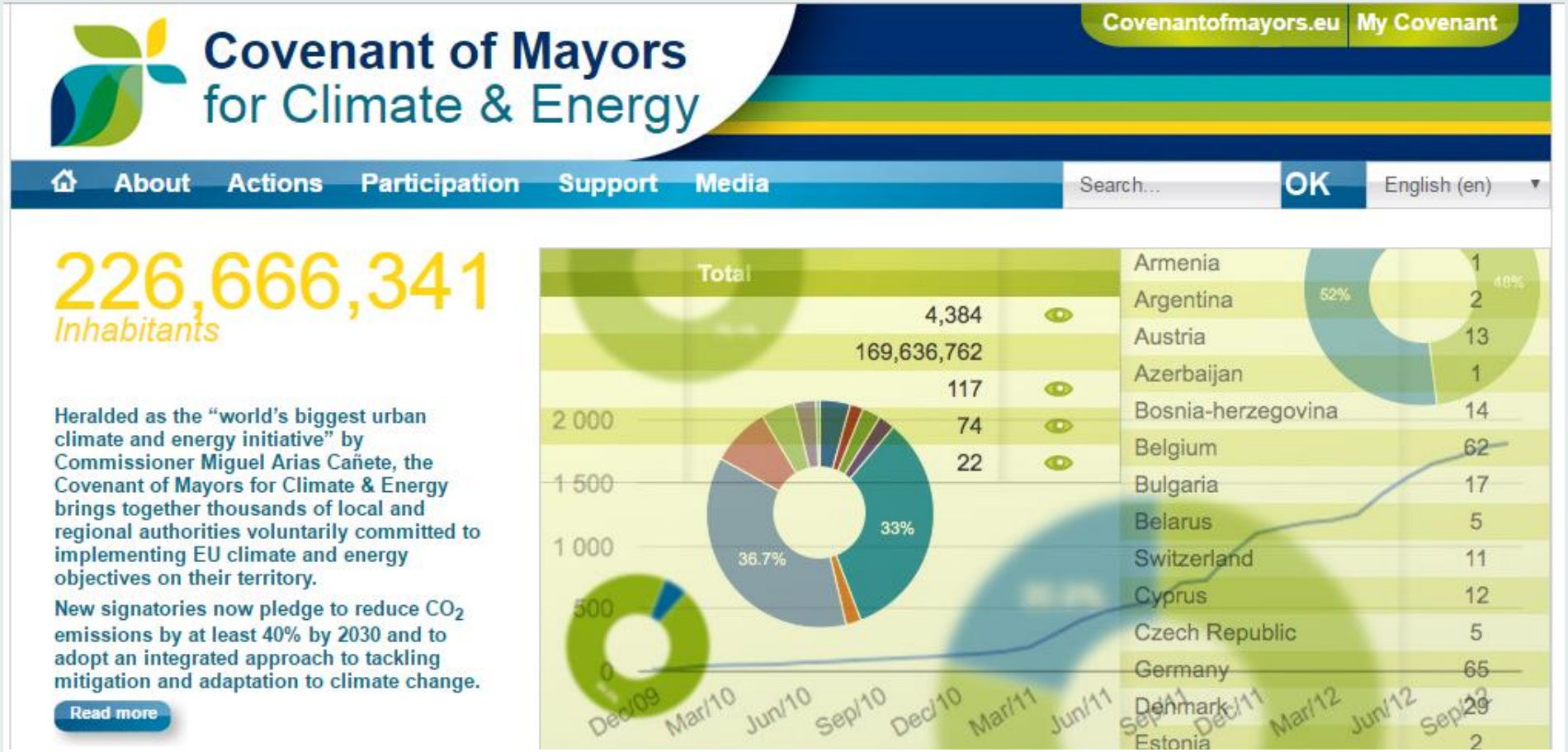
source: http://bpie.eu/publication/europes-buildings-under-the-microscope/

Well … we have a lot of statistics, but we need actual data

preferably open and harmonized

local and detailed data

Green Energy Context



Covenant of Mayors is the policy '*with highest impact on climate change mitigation*'

(Source: Economist, 2014)

http://www.covenantofmayors.eu/index_en.html

Green Energy Context

Energy strategy:

- ❑ **20%** reduction in EU **greenhouse** gas from 1990
- ❑ **20%** of energy from **renewable sources**
- ❑ **20%** improvement of **energy efficiency**

- ❑ **40%** reduction in EU GHG
- ❑ **27%** of energy from renewable sources
- ❑ **27%** improvement of energy efficiency

- ❑ **85-90%** reduction in EU GHG
- ❑ About **2/3** of energy from renewable sources

Source: http://ec.europa.eu/energy/en/topics/energy-strategy

Green Energy pilots

Use Cases

and

Requirements

... local actions with local real data

Green Energy Pilots

5 pilot cities involved in this scenario

- Reggio Emilia (Italy)
- Maroussi (Greece)
- Oeiras (Portugal)
- Turku (Finland)
- Girona (Spain)

13 Use Cases collected

59 requirements (functional, non-functional, generic)

Reggio Emilia (Italy)

Use cases

- Publication of energy performance of municipal buildings
- Publication of energy performance of other buildings

General objectives

- Integrate geodata and energy data for strategic purposes
- Provide integrated open geodata

Main requirements

- Estimate energy performance and CO2 emissions
- Energy maps and reports, interoperable access to data

Marousi (Greece)

Use cases

- Data collection via field survey and crowdsourcing
- Energy map creation
- Data publication

General objectives

- Enable citizens and SMEs to make valuable comments and enhance their energy consumption behavior

Main requirements

- Mobile app for editing buildings' properties
- Searching capabilities for buildings
- Provide open geodata through the hub

Oeiras (Portugal)

Use cases

- Urban sustainable planning tool
- Zero-balance calculation
- Calculation of energy performance of buildings

General objectives

- Monitor energy consumption in public buildings
- Achieve a balance between various urban areas

Main requirements

- Calculate solar potential and electric balance
- Reports, statistics

Turku (Finland)

Use cases

- Selecting green route
- Green driving
- Green parking

General objectives

- Shift from private to public transport in commuter traffic
- Acquire real-life information to be used for planning

Main requirements

- Bike routing, bus timetables, paths for commuters
- Estimation of fuel consumption, collect stats

Girona (Spain)

Use cases

- *I want to ride my bicycle, I want to ride it where I like*
- Find healthy bike route

General objectives

- Encourage alternative/light transportation
- Involve city users and stakeholders in data integration

Main requirements

- Provide updates to OpenStreetMap
- Estimate pollution, calculate bike routing

Green Energy Specialized Services (standard Geo-ICT services)

Specialized Services

… Geo-ICT services for Buildings

- Buildings "on-site" data quality check
- Estimation of Energy Performance of buildings
- Buildings CO_2 emissions estimation
- Heat consumption dashboard
- Upload of "future "buildings
- Solar potential calculation
- Zero-balance layer
- Linked open data

Specialized Services

… Geo-ICT services for Transport

- Multi-lingual Address Geocoding
- Green preferences and routing
- Next departure time
- Drive to park

Examples – Buildings

- Some pilots (e.g. Reggio-Emilia, Maroussi, Oeiras) are requesting processing services, as the estimation at individual building level of:
  - energy performance
  - CO_2 emissions
  - solar potential

A (WPS) "specialized" service in brief

- E.g. for the "**Estimation of Energy Performance**" this is a (complex) process that:
  - Considers the characteristics of buildings (e.g. age of construction, size, usage, …) as well as climatic zones
  - Calculates vertical surfaces (envelope)
  - Apply TABULA project typologies for households (U-values for roof, floor, envelope, … degree-days of the location, …) to existing buildings
  - Generates the EP value in annual kWh (per m2 or m3, according to location and legislation)

A (WPS) "specialized" service in brief

Building Type | Construction Year | Country | Climatic Zone

Typical climatic parameters	
Heating season lenght	183 days
Average outdoor temperature during the heating season	12° C
Indoor design temperature	20° C

Facade element	Typical U-value [W/m²·K]	Typical % of facade
Walls	full/semi-full bricks 1,08	60%
Roof	bricks and concrete 0,95	10%
Floor	bricks and concrete 0,92	10%
Windows	thermal break frames + low-emission glass 2,63	20%

Typical building shape parameters	
Heated volume (**V**)	1234 m_S^3
Shape factor (**S/V**)	0.66 m_S^{-1}
Useful floor area (**A**)	353 m_S^2

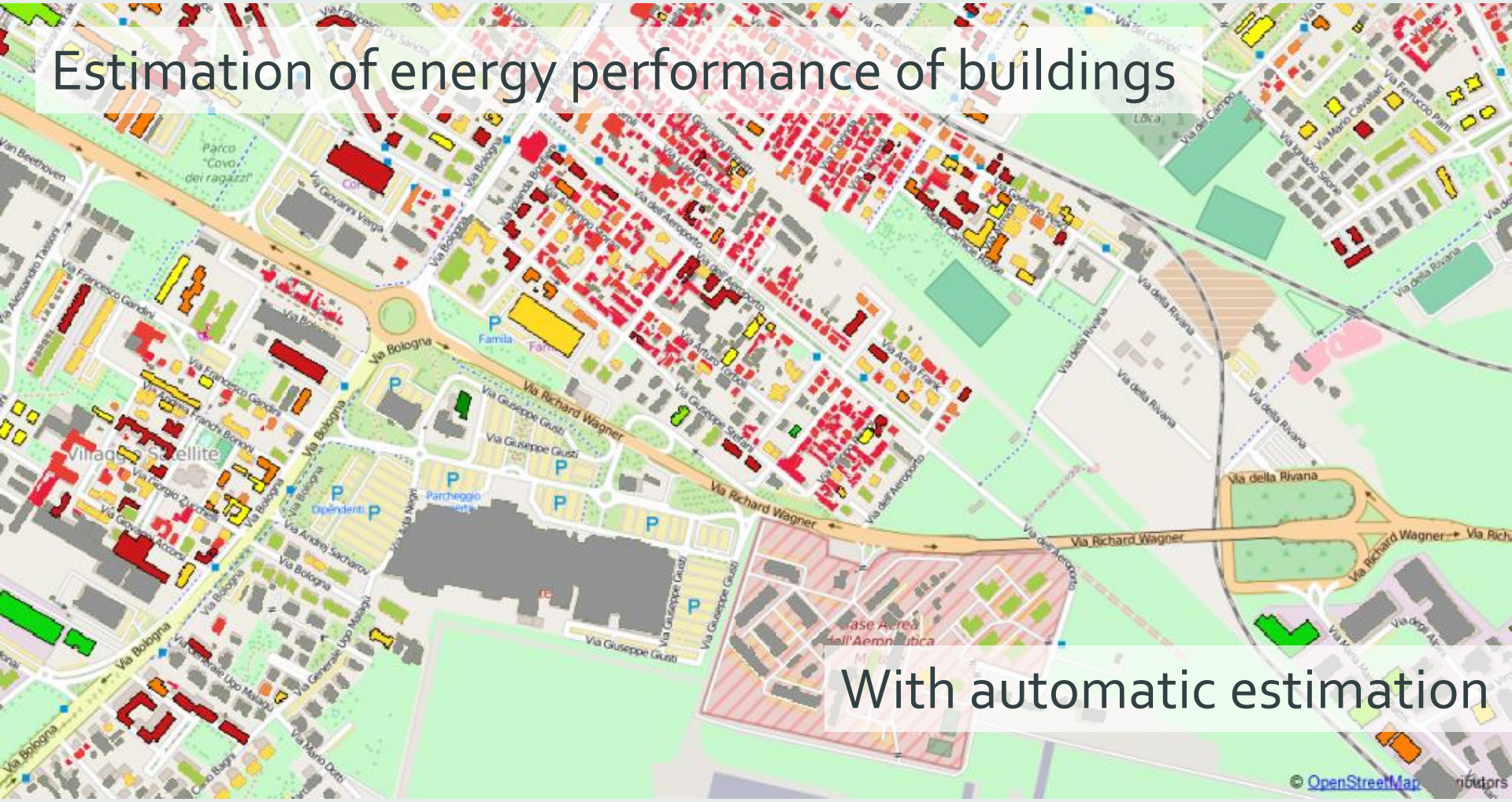
Typical Degree Days
DD_t [days/K·year]

Typical heath transmission coefficient for building envelope
HT [$W/m_S^2 \cdot K$]

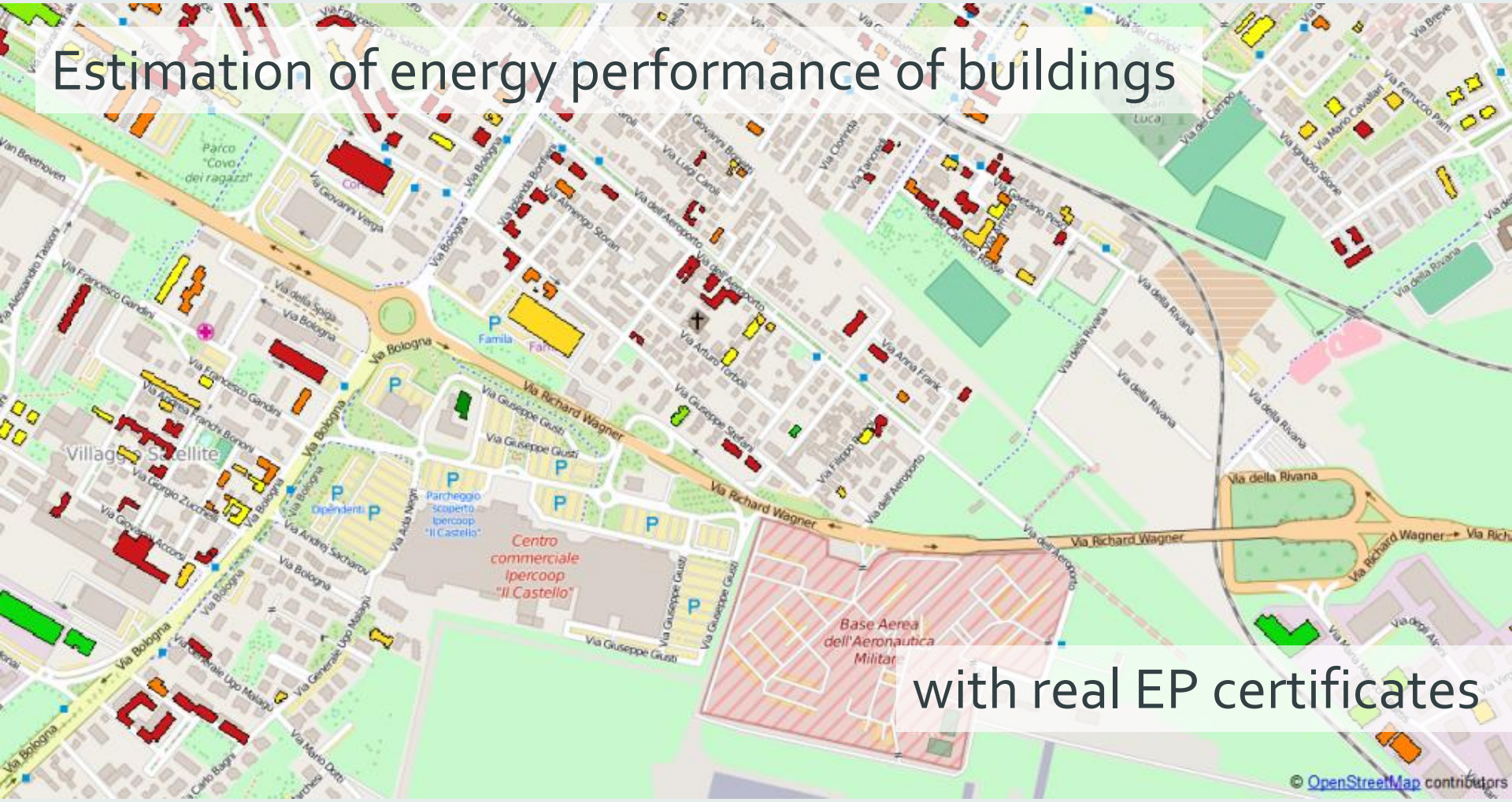
$$Q_t = 10^{-3} \cdot HT \cdot 24 \cdot DD \cdot V \cdot S/V \cdot A$$
$$[kWh/m_A^2 \cdot year] = [kW/m_S^2 \cdot K] \cdot [h/K \cdot year] \cdot [m_S^2/m_A^2]$$

Typical Consumption
Q_t [$kWh/m_A^2 \cdot year$]

A (WPS) "specialized" service in brief



… without any "specialized" service



A (WFS-T) "specialized" service in brief

- In order to calculate the energy performance we need data with **good level of accuracy and detail**.
- If not yet available in existing datasets, or if the quality has to be validated, we need to consider the possibility to involve local communities to **collect or correct data "on site"**.

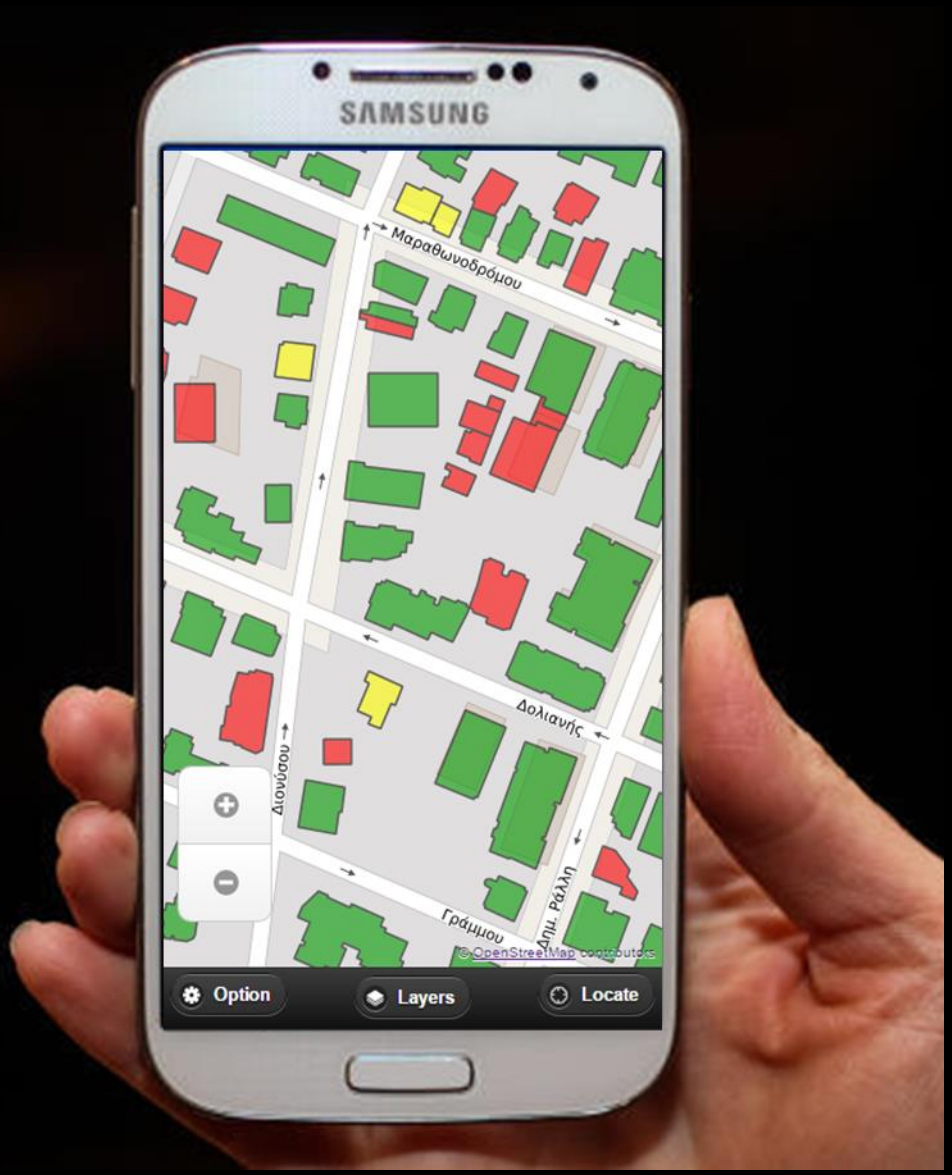
A (WFS-T) "specialized" service in brief

https://play.google.com/store/apps/details?id=it.sinergis.geosmartcity.map4data

In **Marousi(GR)** buildings' data have been collected, but some **attributes are still missing** or need to be checked (e.g. "age of construction, age of renovation, uses, …").

An ***on-site* campaign** has been organized by the **EPSILON International**, involving the local School of Architecture.

People involved used smartphones and tablets to edit attributes via **WFS-T** service, and updates data on PostGIS database.

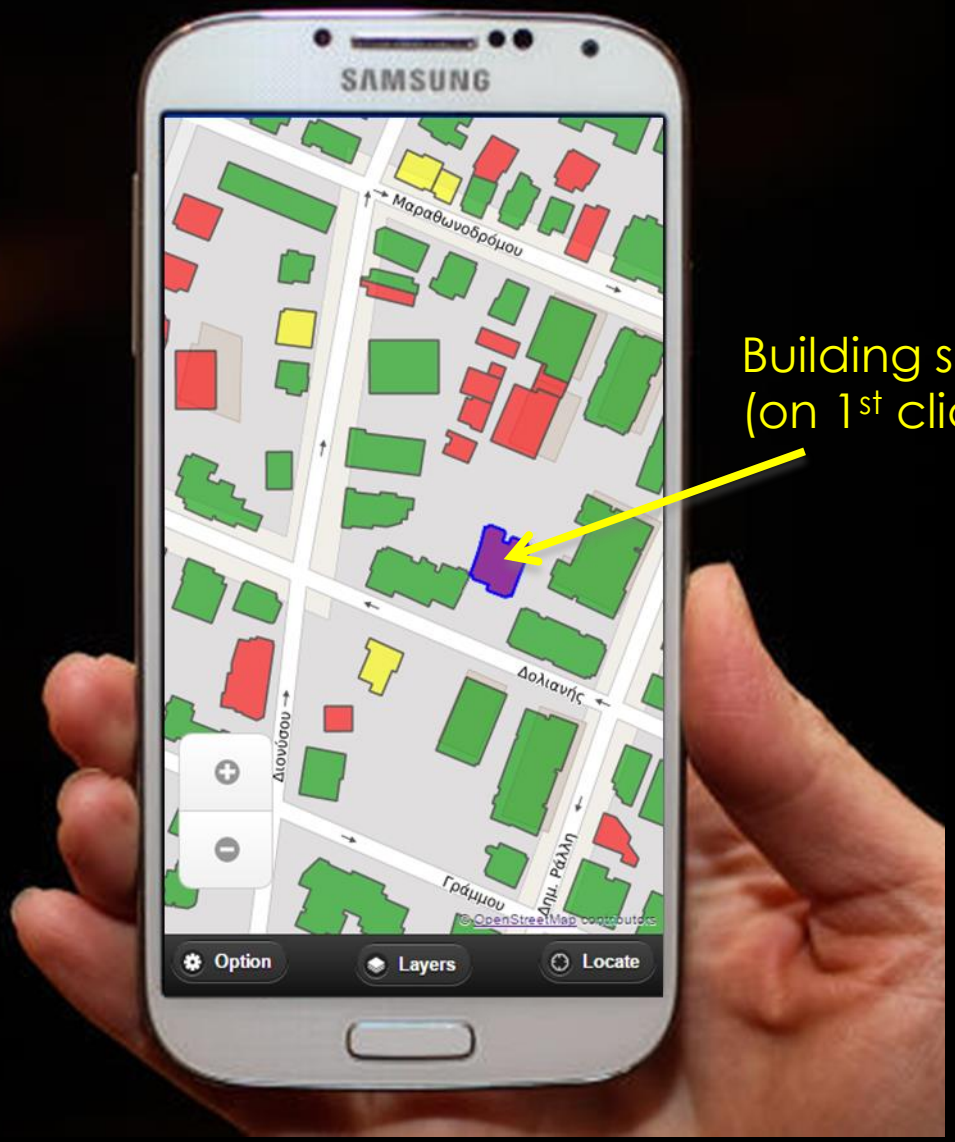


Buildings properties missing, on-site to be performed

Some buildings properties still missing, on-site already done

Buildings properties available, on-site check suggested

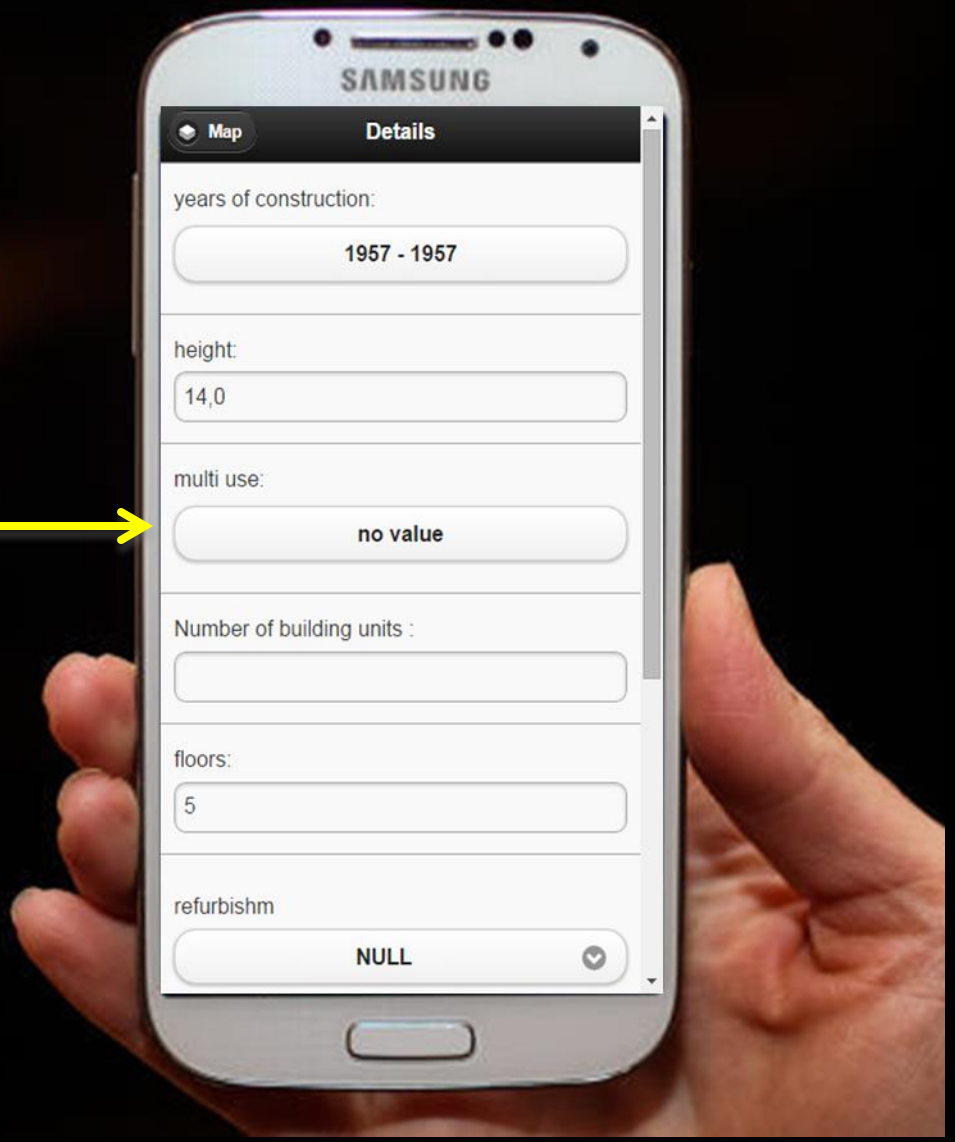
Buildings properties available and on-site check performed

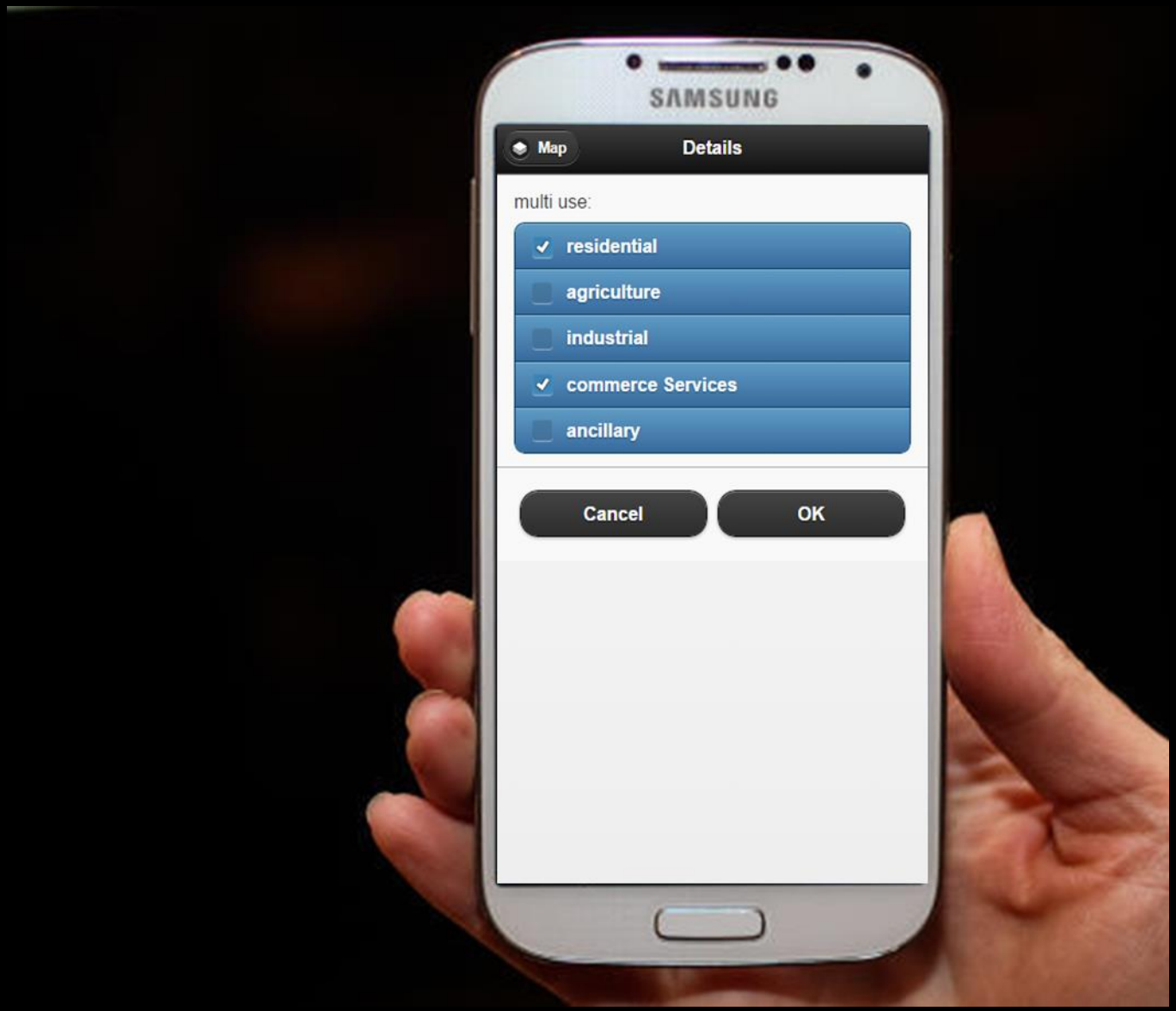


Building selection (on 1st click)

Building properties (on 2nd click)

Editing of multi-value attribute



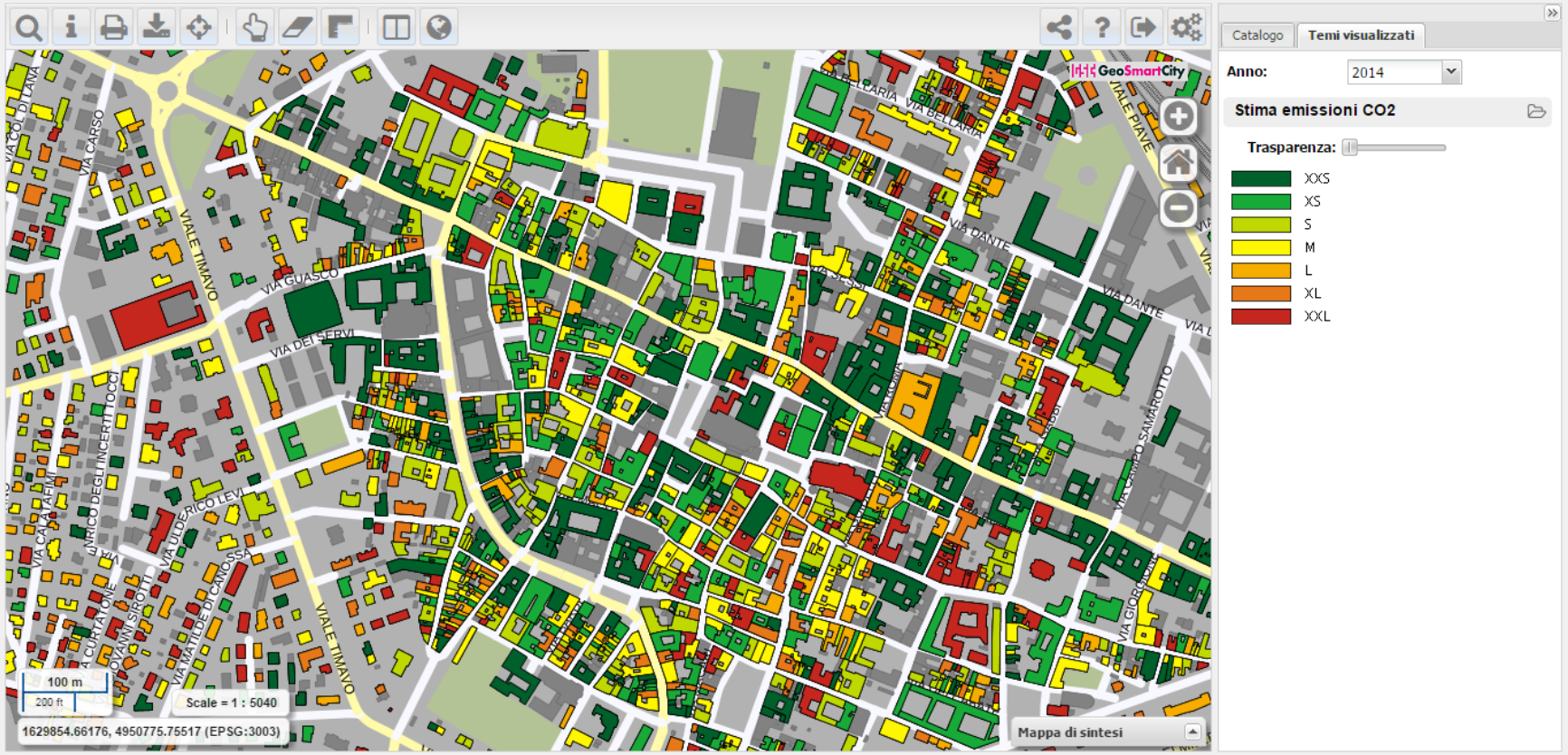

SAMSUNG
Map
Details
multi use:
residential
agriculture
industrial
commerce Services
ancillary
Cancel
OK

Another (WPS) "specialized" service in brief

- E.g. similarly to the estimation of the energy performance, the **estimation of the CO2 emissions** is based on an algorithm that uses in input spatial feature (buildings) with attributes containing data about real energy consumption, by type of fuel (gas, electricity, LPG, DH, …)

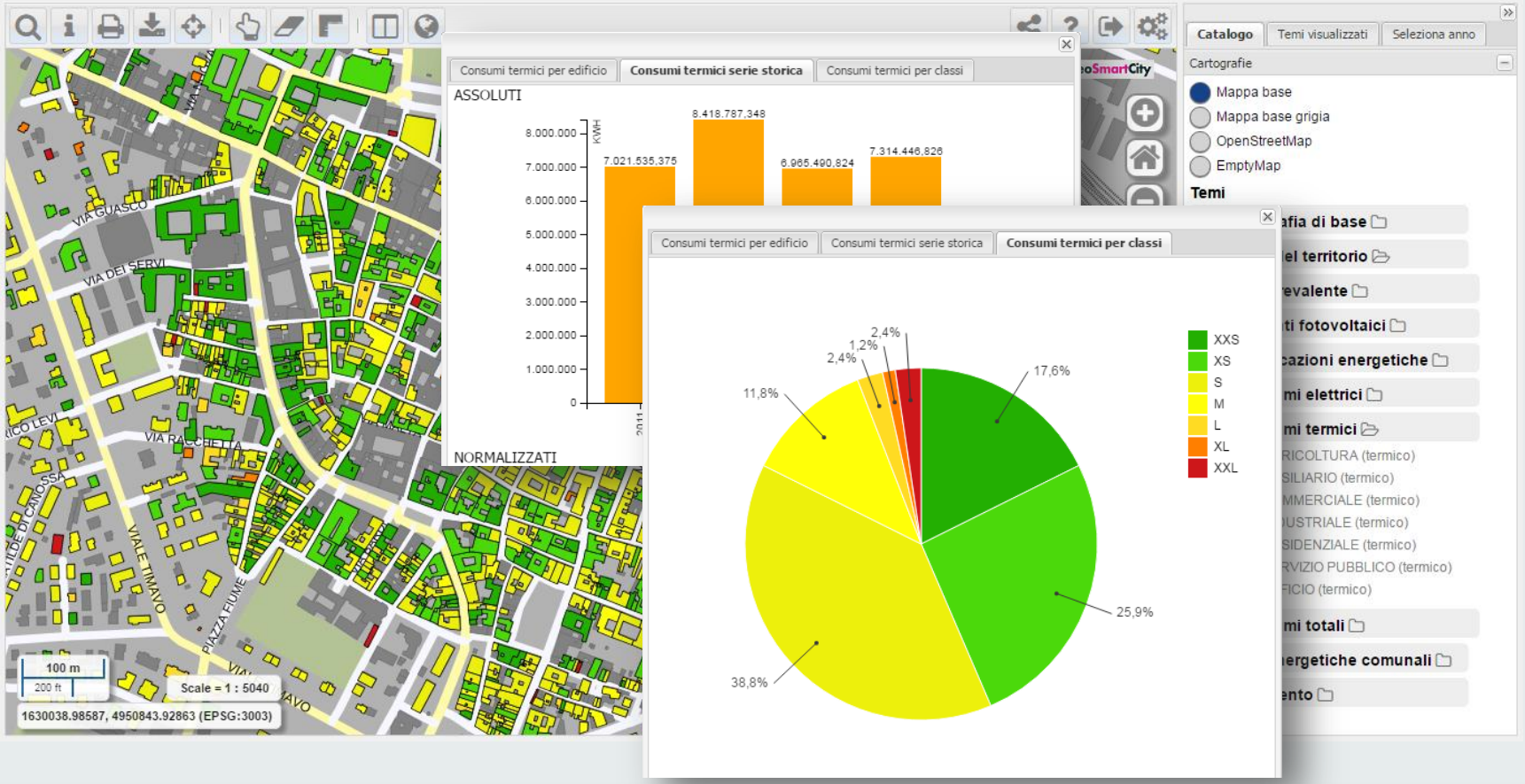
Another (WPS) "specialized" service in brief

CO_2 emissions estimation



A (RESTful) "specialized" service in brief

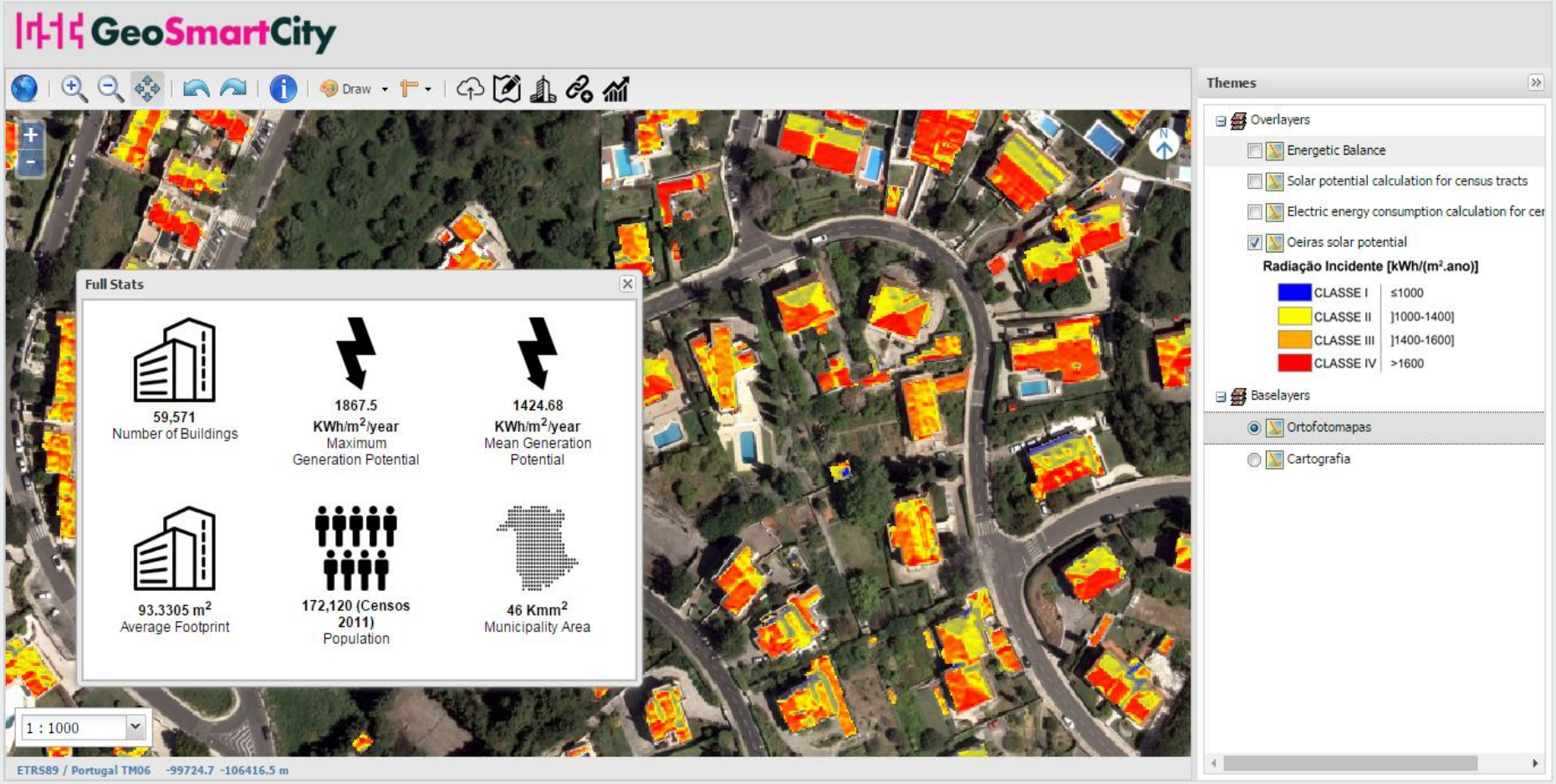
Heat Consumption dashboard



Another (WPS) "specialized" service …

- The "**Solar potential**" in brief:
  - Routing calculation based on green preferences (avoid most crowded routes, use public transportation, minimize fuel consumption).
  - This service provides routes calculated for different types of vehicles (depending on user preference for maximum distances) so to let users to select "zero emission" instead of bus or private car. CO2 equivalent emissions will be based on available data and statistics provided by the European Environmental Agency (EEA, 2015).

Another (WPS) "specialized" service …



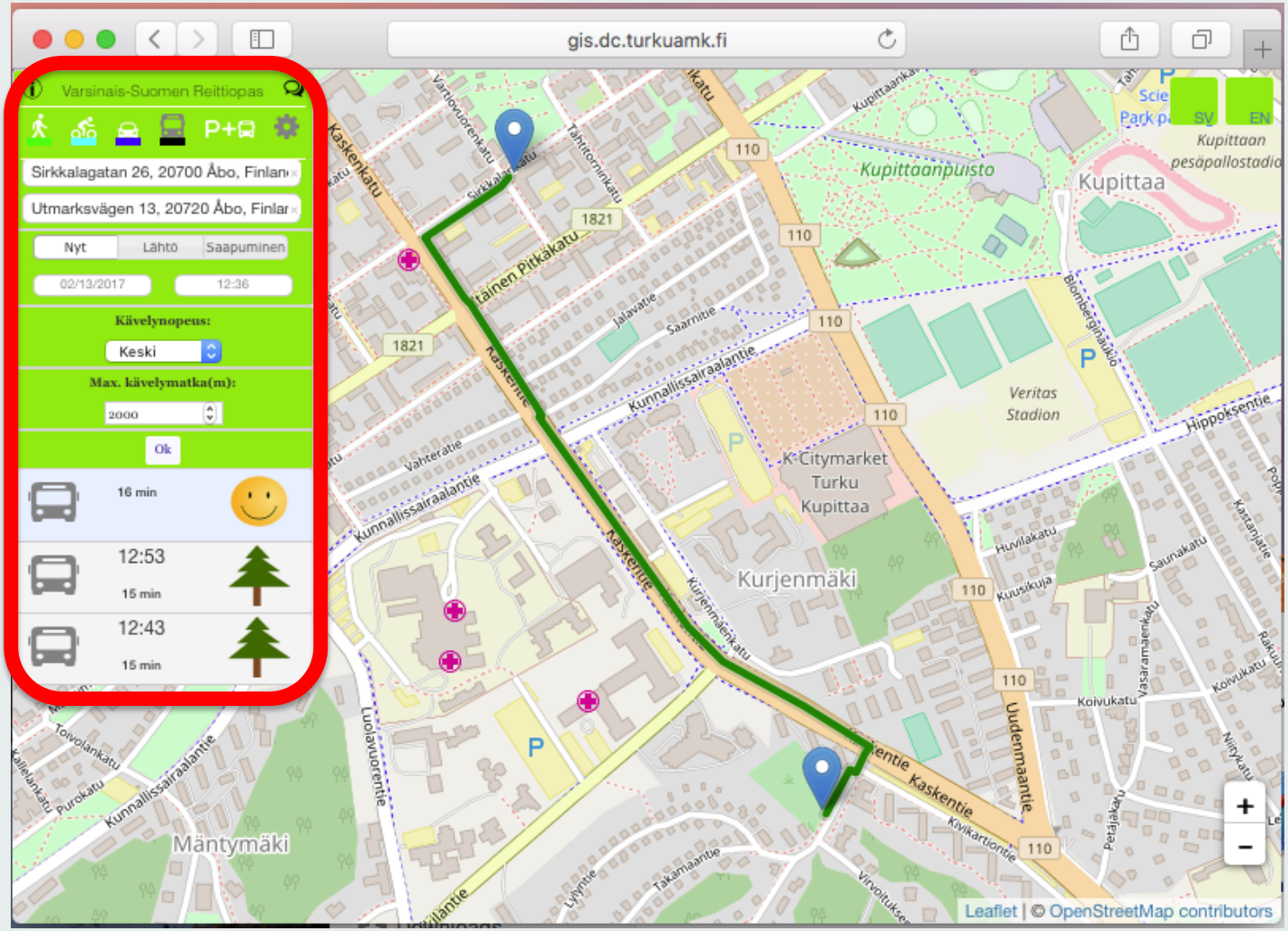
Example – Transport

- Some other pilots (e.g. Turku) require processing services as "green" route calculation based on green preferences (avoid most crowded routes, use public transportation, minimize fuel consumption).

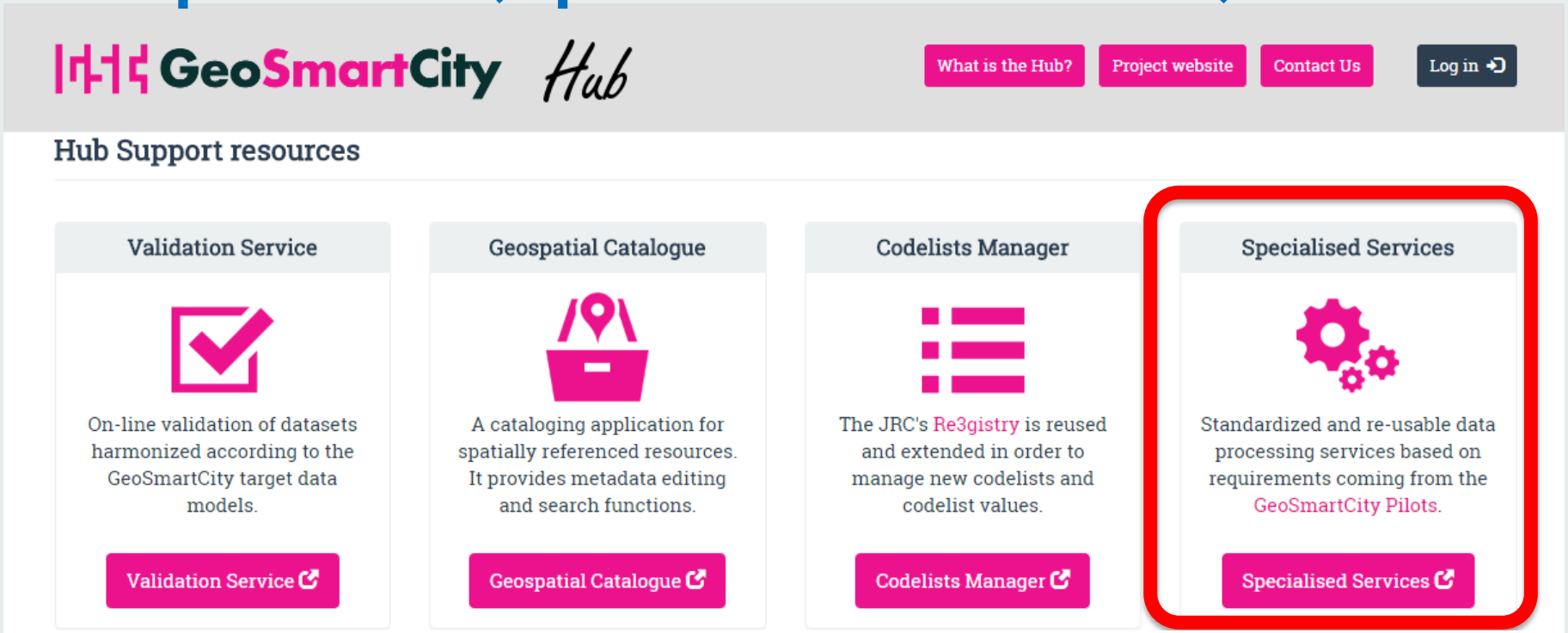
A (RESTful) "green routing" service in brief

- The "**Green preferences**" service provides routes calculation for different types of vehicles (depending on user preference for maximum distances) so to let users to choose "zero emission" instead of bus or private car.
- CO2 equivalent emissions are based on data provided by the European Environmental Agency (EEA, 2015).

Green routing service in brief …



Components (Specialized Services)



Specialized services are "**pilot-driven**" services tightly coupled to the detailed requirements coming from pilot partners in terms of **data processing** and user engagement.

The overarching objective of the specialized services is to provide **common re-usable functionalities** among the "Green Energy" and "Underground" scenarios.

If You Can't Measure It, You Can't Improve It

William Thomson, Lord Kelvin

The GeoSmartCity Hub

Piergiorgio Cipriano
Business Analyst – Public Sector & Utilities

The idea

Imagine that, in few years, all European cities will share geographic information being really interoperable, with the same semantic, encoding and licenses.

We started with the idea of a "hub" where to provide data related to "energy" and "underground" being interoperable as open&harmonized data.

The Hub concept

GeoSmartCity "Hub" is a software and hardware platform to **catalogue**, **store**, and make **data available** through standard APIs and protocols.

The software **components** (open source) expose interfaces for **integrating**, **visualizing**, **analyzing** and **processing** spatial and non-spatial data sources, allowing users to upload or connect their data sources, configure maps and publish data through a web based user interface.

GeoSmartCity Hub

What is the Hub? | Project website | Contact Us | Log in

The list of installed basic applications is:

- Apache 2.4.7 (Web server)
- Tomcat 7.0.62 (applications server that cointains applications packed as war)
- PostgreSQL 9.5.2 (Database server)PostGIS 2.2.1 (Spatial and Geographic objects for PostgreSQL extension)
- pgRouting 2.1 (Routing library for Postgis)
- OpenTripPlanner (Multimodal trip planning & analysis application)
- Virtuoso 07.20.3212 (database engine for RDF)
- SOLR 5.2.1 (indexer and search engine)
- CKAN 2.4 (Open-source data portal platform)
- GeoServer 2.7.1.1 (Map Server)
- Geonetwork 3.0.3.0 (Geospatial catalog)
- Geowebcache (Geoserver extension that create cache for layers)
- Re3gistry 1.0 (INSPIRE registry of codelists, codelist values and feature concepts)
- Python 2.7.6 (Programming language)

> The GeoSmartCity HUB is distributed as a SaaS service or as virtual machines based on Ubuntu Linux available for download, in order to allow the reuse of all the software components developed for the project.

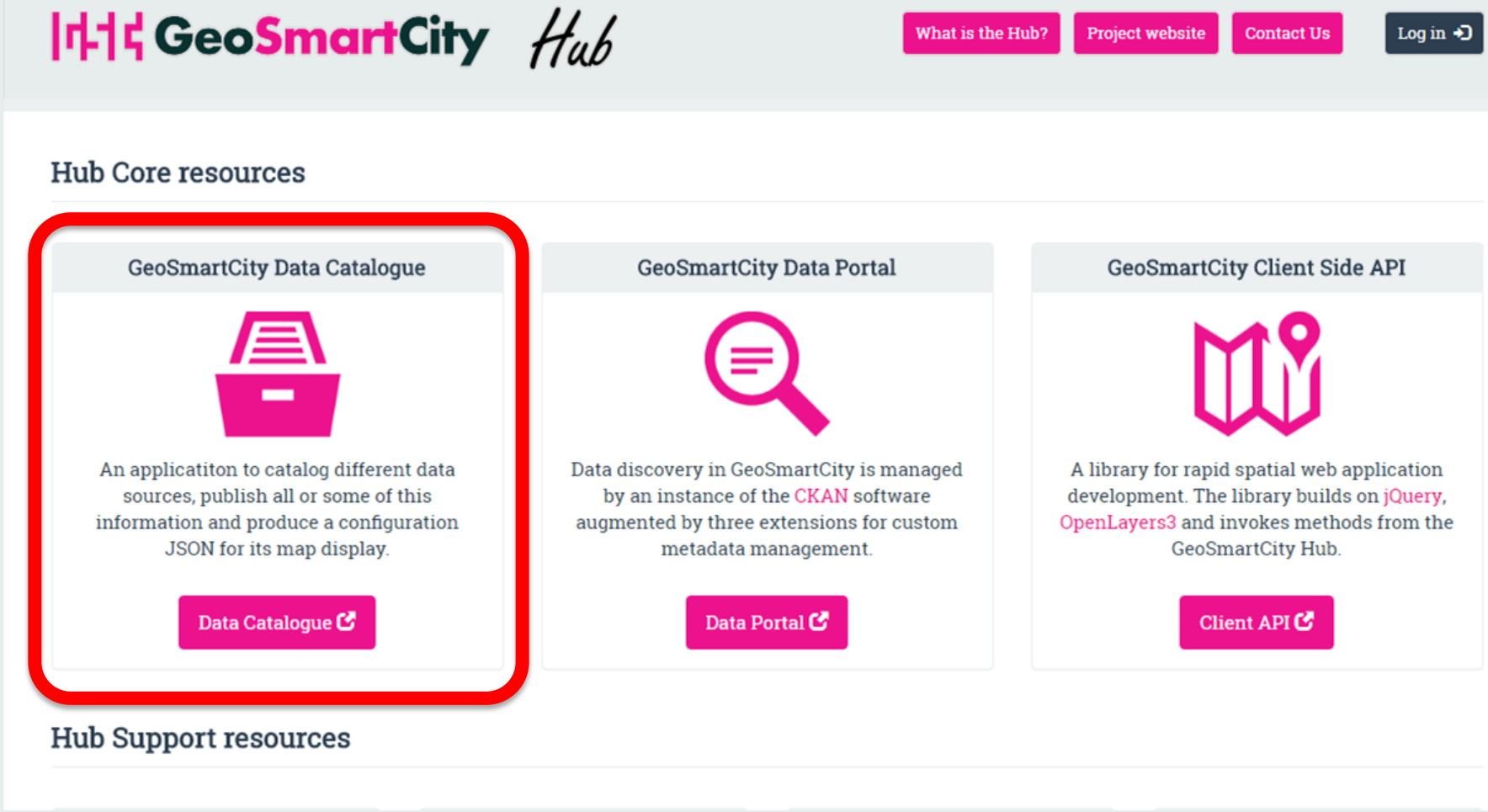
The benefit of the Hub lies simultaneously in:

- its innovative approach to bridging and bringing together public sector data infrastructures
- its extensive use of well-known open standards;
- its simplicity of implementation

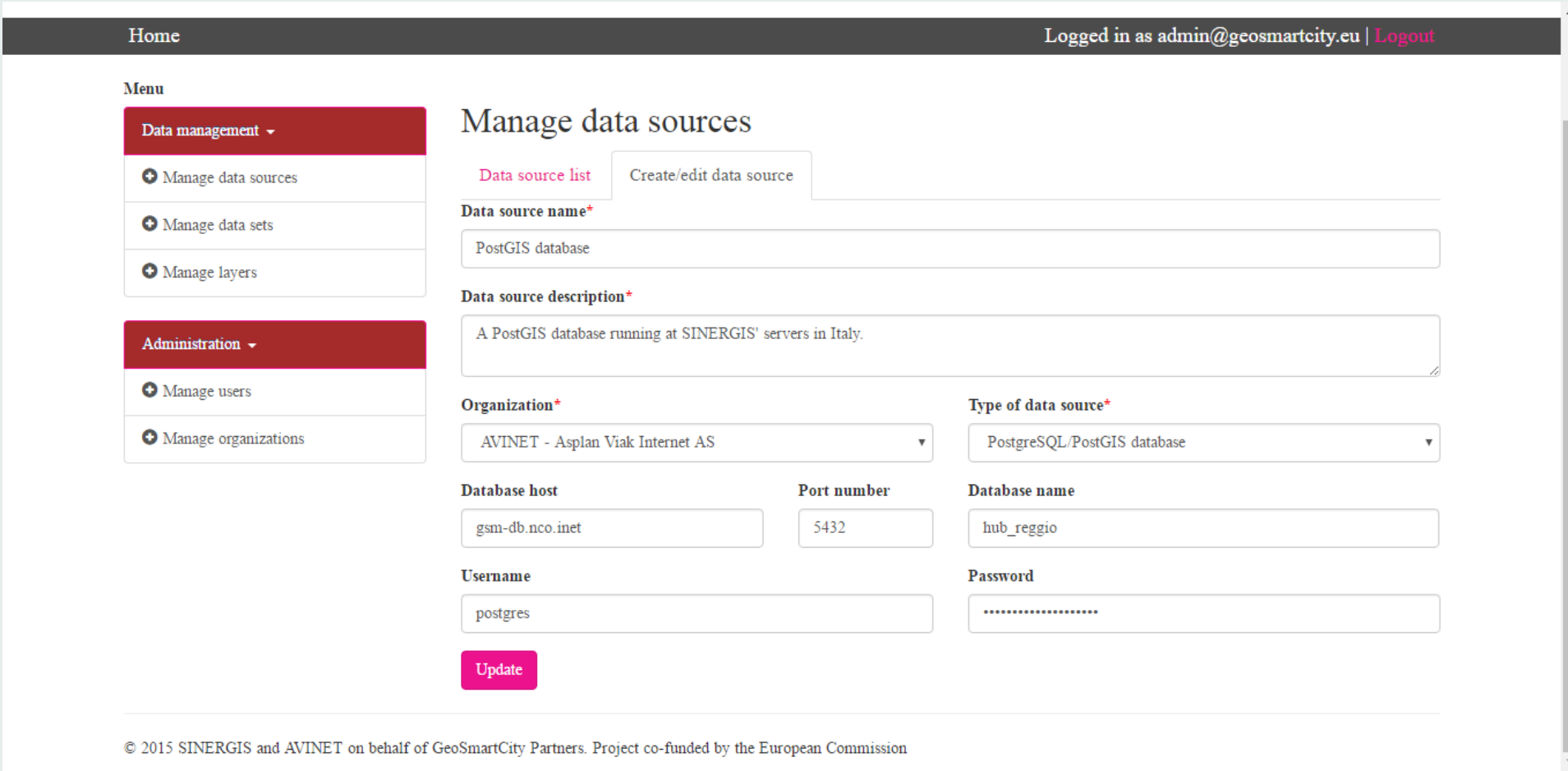
Design of scenario data service

- Standard-based open services
  - OGC & INSPIRE (CSW, WMS, WFS, WCS, WPS, SOS)
  - INSPIRE Data Specifications (extended)
  - Well-documented APIs for open data and geospatial
- Reuse of INSPIRE reference platform
  - INSPIRE Registry
- Based on outcomes of other projects, e.g.
  - eENVplus - http://www.eenvplus.eu/
  - Sunshine - http://www.sunshineproject.eu/

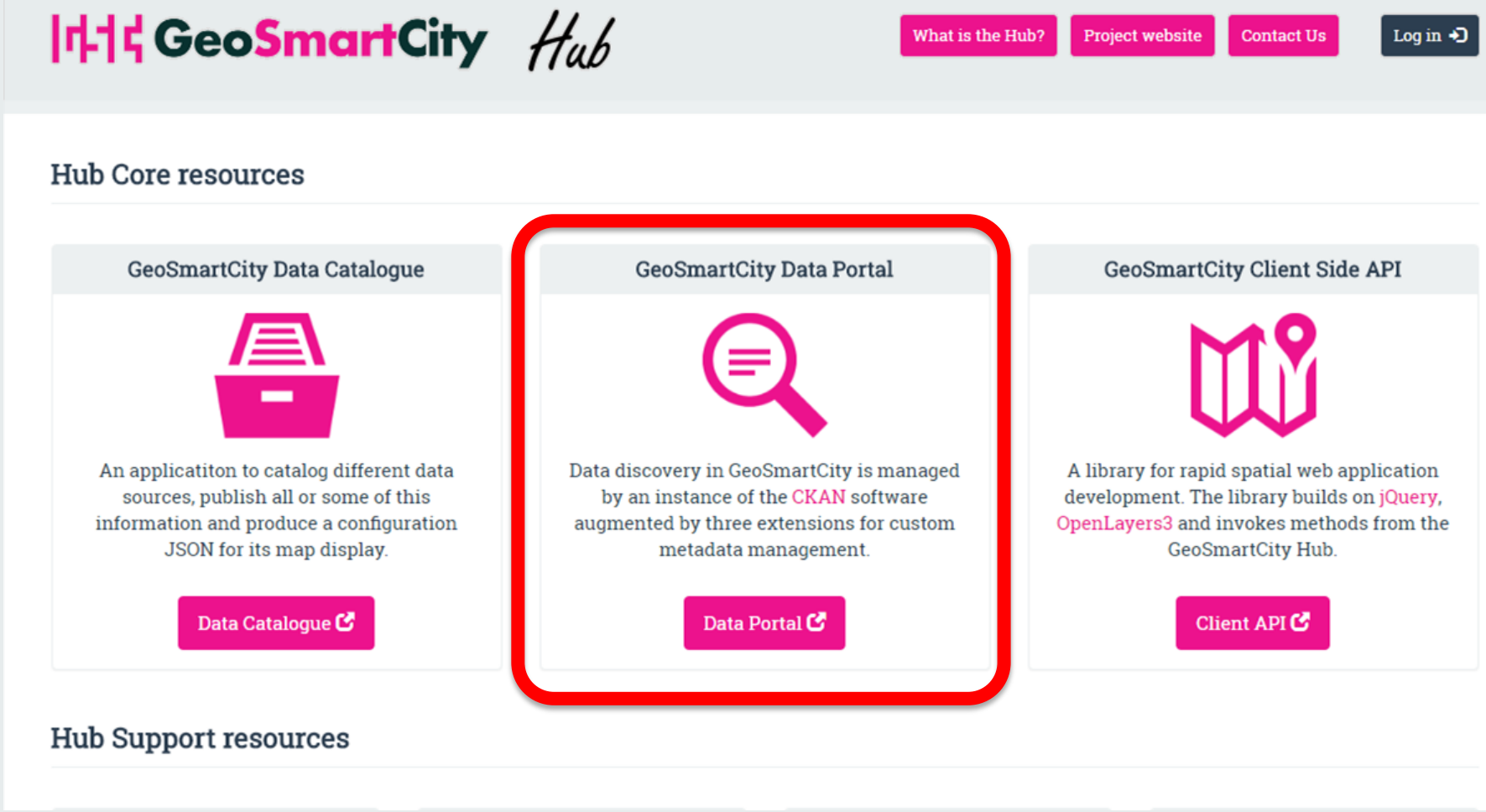
Components


GeoSmartCity Hub
What is the Hub?
Project website
Contact Us
Log in
Hub Core resources
GeoSmartCity Data Catalogue
An applicatiton to catalog different data sources, publish all or some of this information and produce a configuration JSON for its map display.
Data Catalogue
GeoSmartCity Data Portal
Data discovery in GeoSmartCity is managed by an instance of the CKAN software augmented by three extensions for custom metadata management.
Data Portal
GeoSmartCity Client Side API
A library for rapid spatial web application development. The library builds on jQuery, OpenLayers3 and invokes methods from the GeoSmartCity Hub.
Client API
Hub Support resources

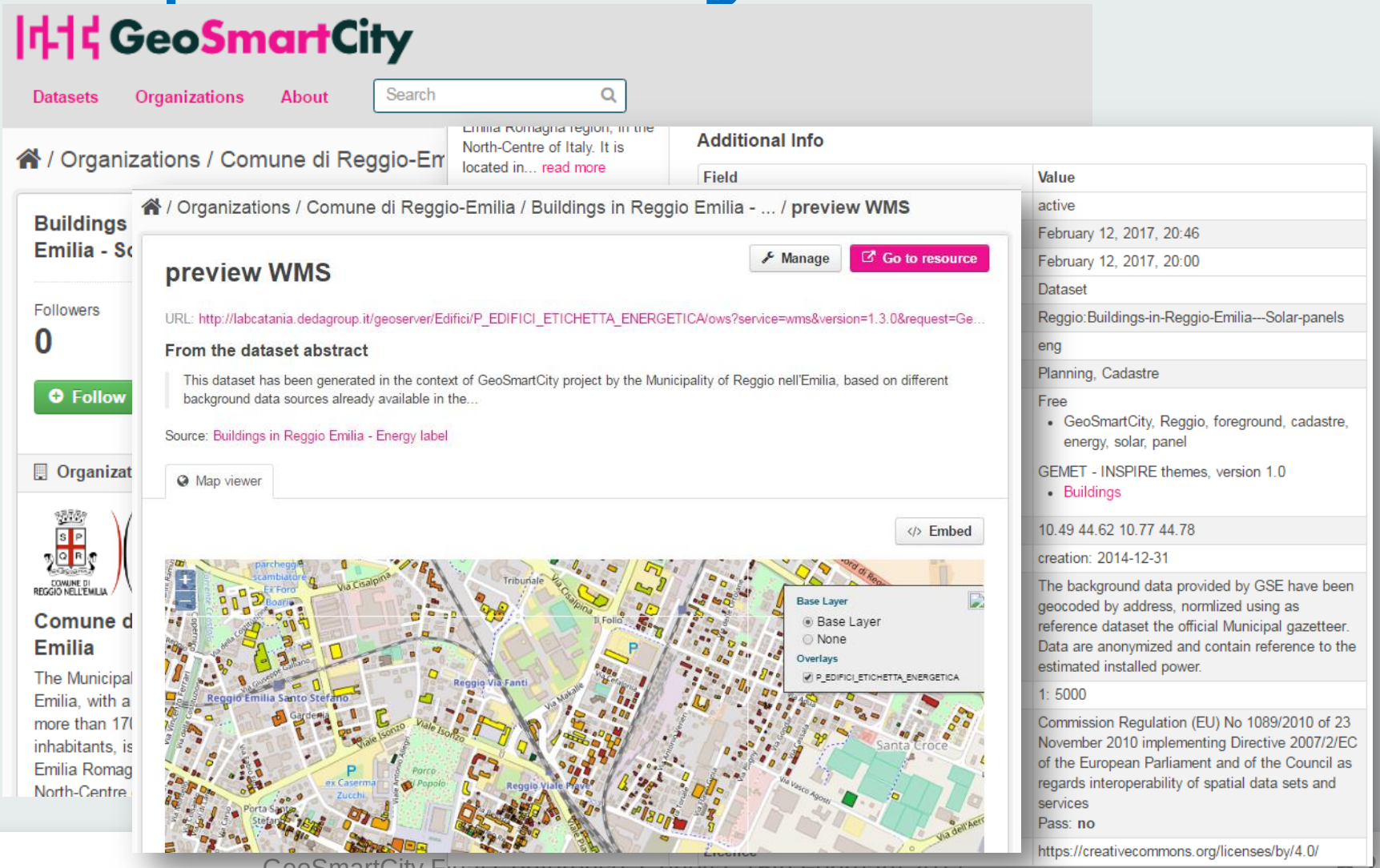
Components (Data Catalogue)



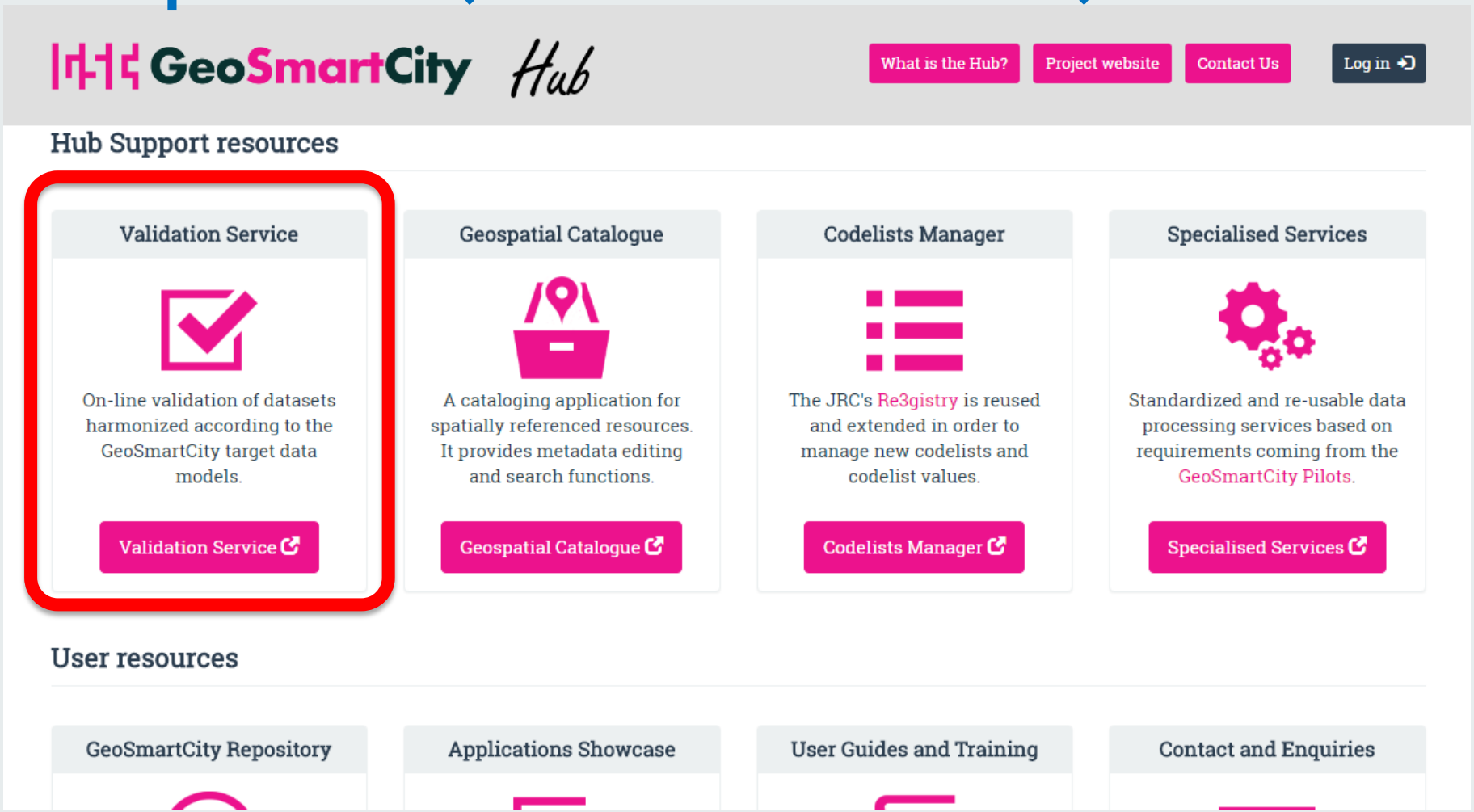
Components (Data Portal)



The importance of being … 'well described'



Components (Validation Service)



The importance of being … 'harmonized'

SHP, XLS, CSV,
ORACLE, POSTGIS, …

```
        <bu-base:status xlink:href="http://inspire.ec.europa.eu/codelist/HeightStatusValue/estimated"/>
        <bu-base:value uom="meter">8.0</bu-base:value>
      </bu-base:HeightAboveGround>
    </bu-base:heightAboveGround>
    <bu-base:inspireId>
      <base:Identifier>
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    <bu-core2d:geometry2D>
      <bu-base:BuildingGeometry2D>
        <bu-base:geometry>
          <gml:Polygon gml:id="_2cb12b17-5bkd-7b57-720e-8fe04av0c931" srsName="EPSG:3044">
            <gml:exterior>
              <gml:LinearRing>
```

The importance of being … 'harmonized'

- To facilitate pilots to harmonize their own data, a double-step approach has been proposed:
  - 1st transformation into a **pseudo-INSPIRE SQL database** ("Buildings" only), structured for creating target databases on pilots' premises (Reggio, Oeiras, Marousi)
  - 2nd transformation from pseudo-INSPIRE SQL db into GSC (INSPIRE extended) **GML compliant datasets**
- SQL structures are based on extended INSPIRE data model

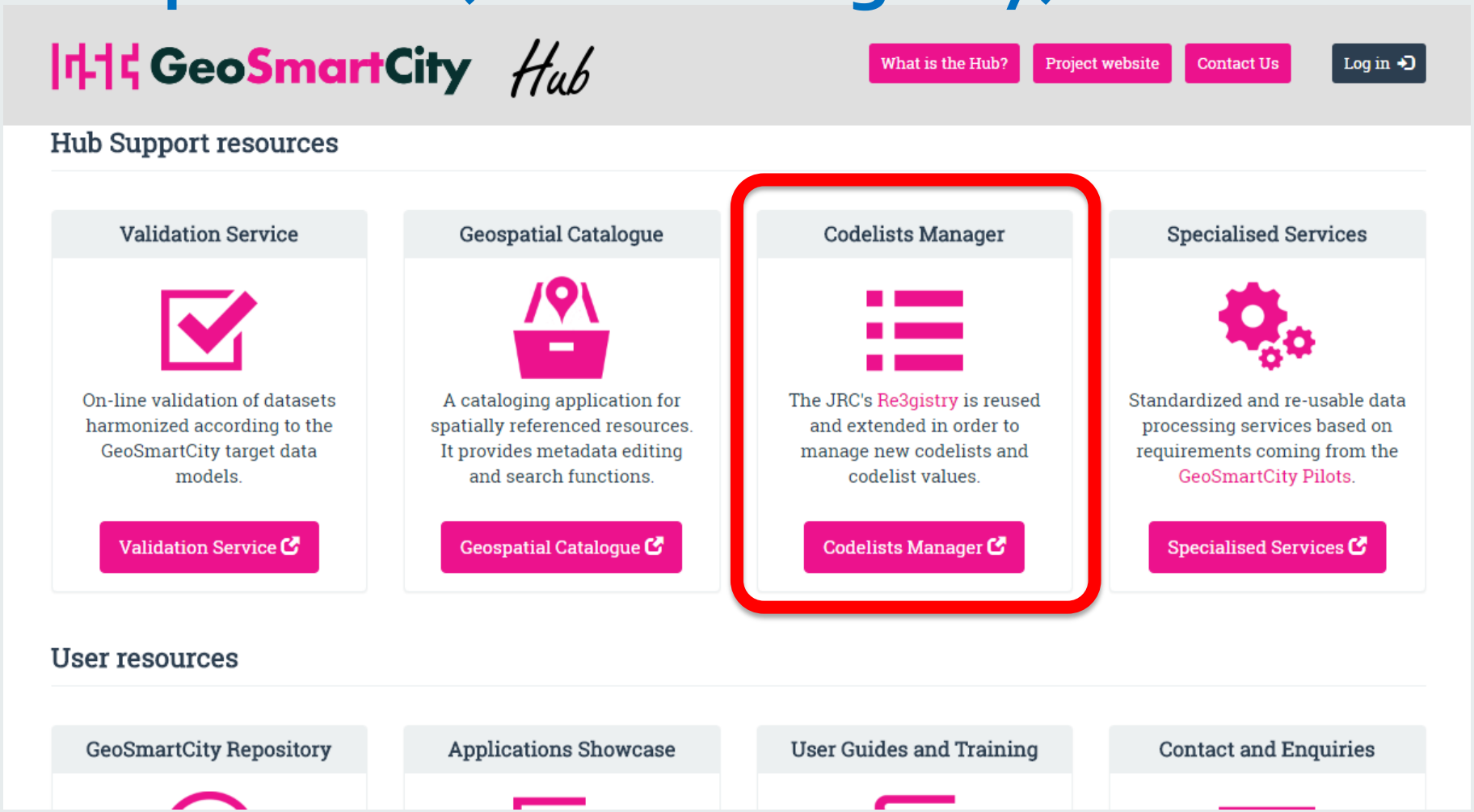
The importance of being … 'harmonized'

```
CREATE TABLE conversion (
      classid  varchar(70) NOT NULL,
      input  varchar(80) NOT NULL,
      location  varchar(80),
      output  varchar(80) NOT NULL,
      value  double precision  NOT NULL,
      year  date
);

--
-- CREATE TABLE: buildings
-- Rappresenta la classe: Buildings - BUILDINGS
--

CREATE TABLE buildings (
      classid  varchar(70) NOT NULL,
      buildingtype  varchar(80),
      condition  varchar(80) NOT NULL,
      connection_electricity  char(1) ,
      connection_gas  char(1) ,
      connection_sewage  char(1) ,
      connection_thermal  char(1) ,
      connection_water  char(1) ,
      date_c_beginning  numeric(15,0) ,
      date_c_end  numeric(15,0) ,
      date_r_beginning  numeric(15,0) ,
      date_r_end  numeric(15,0) ,
      dist_floor  varchar(40) NOT NULL,
      elev_ref  varchar(80),
```

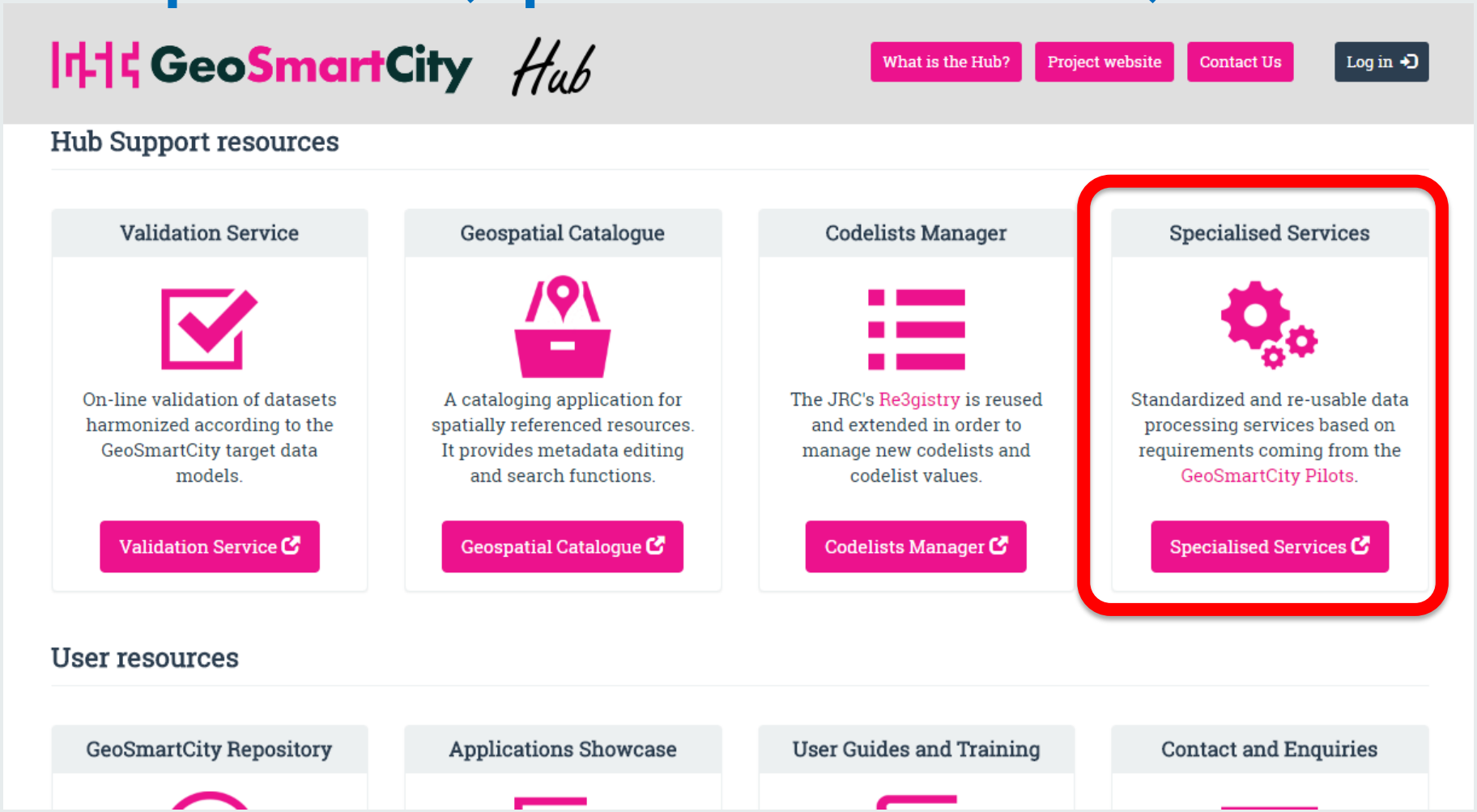
Components (Codelist Registry)



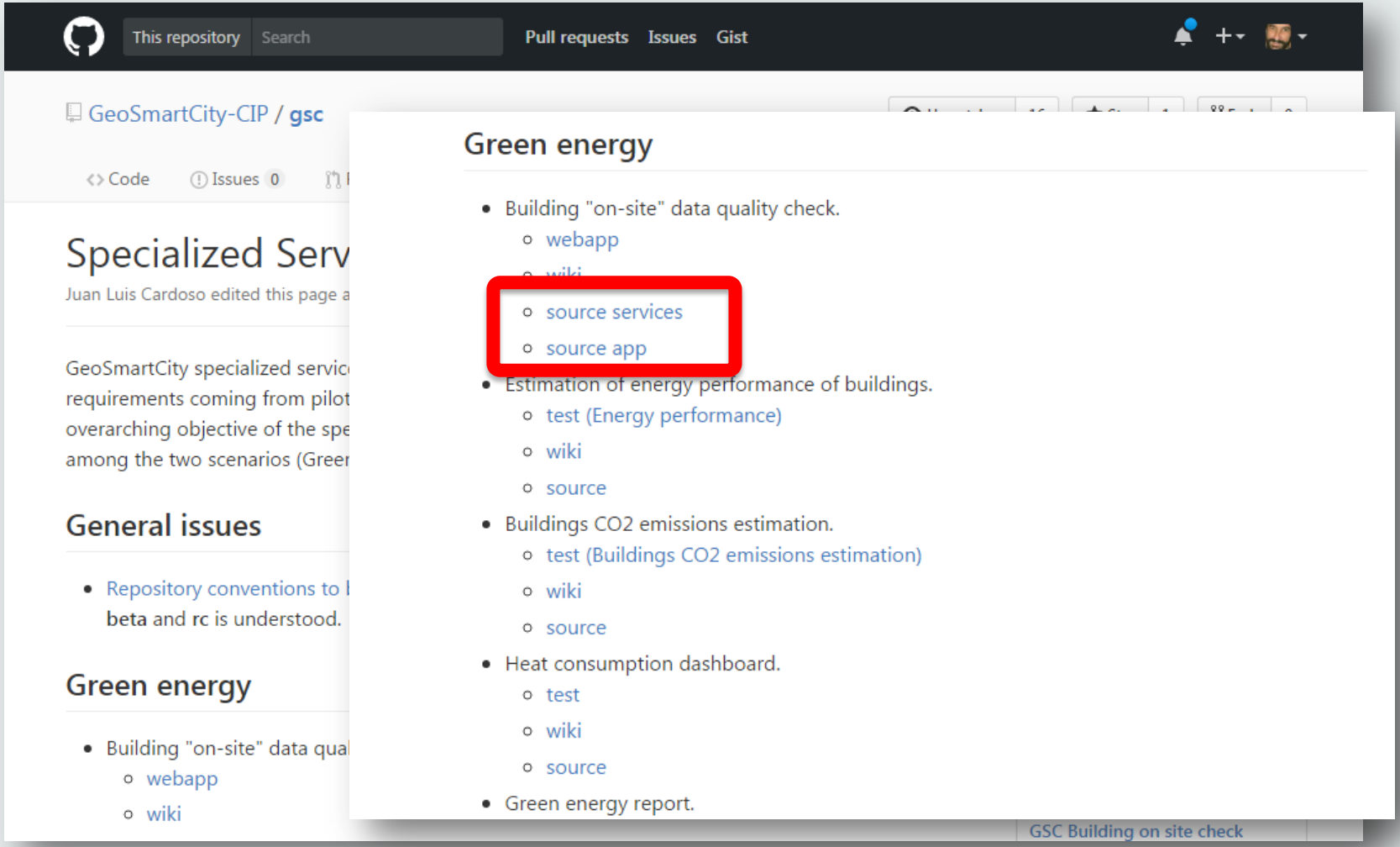
The importance of being … 'INSPIRed'

http://hub.geosmartcity.eu/registry/codelist/CurrentUseValue/publicServices/

Components (Specialized Services)



Specialized services are public on Github



Thanks for your attention

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