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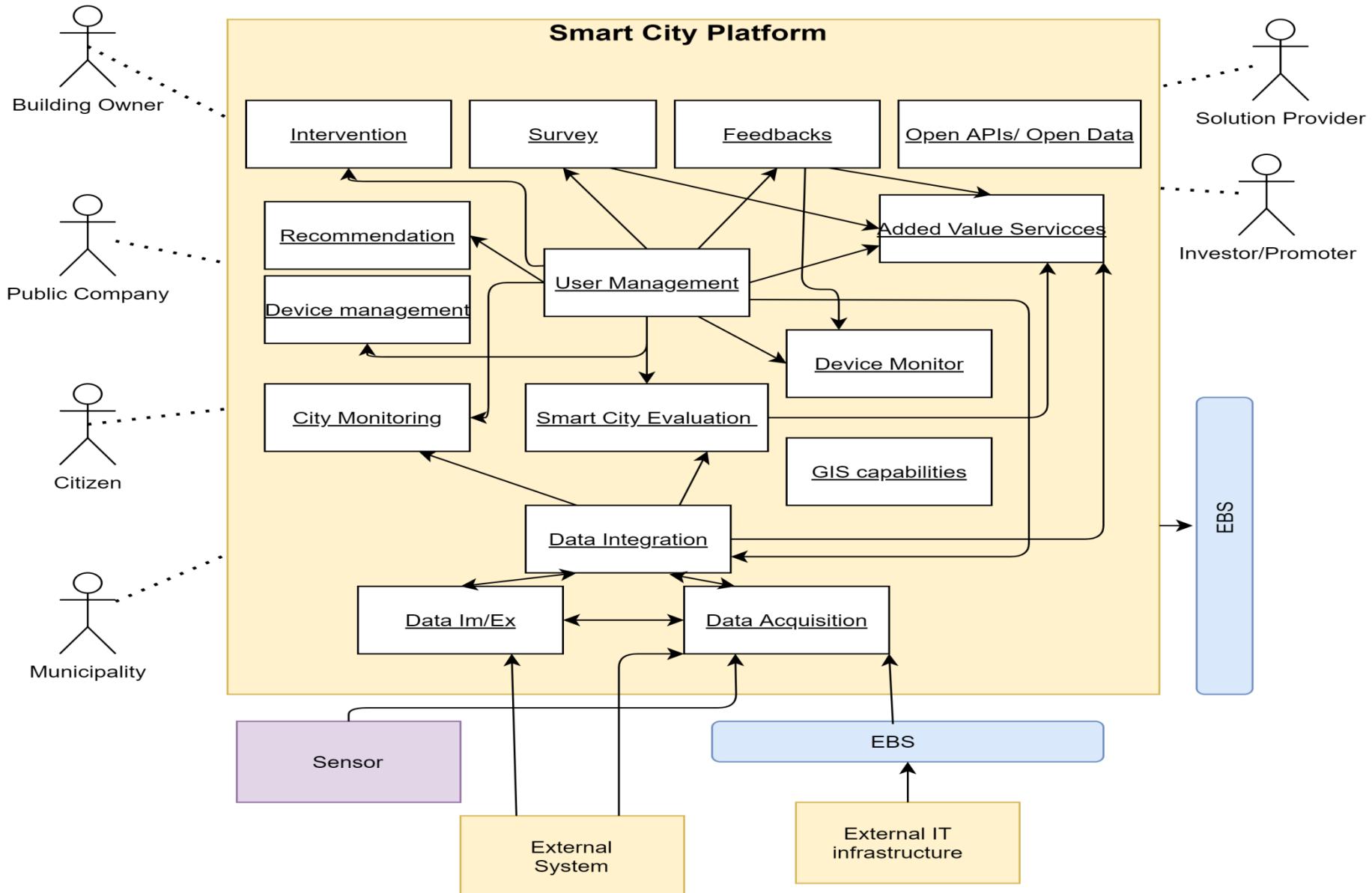
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# Project Vision

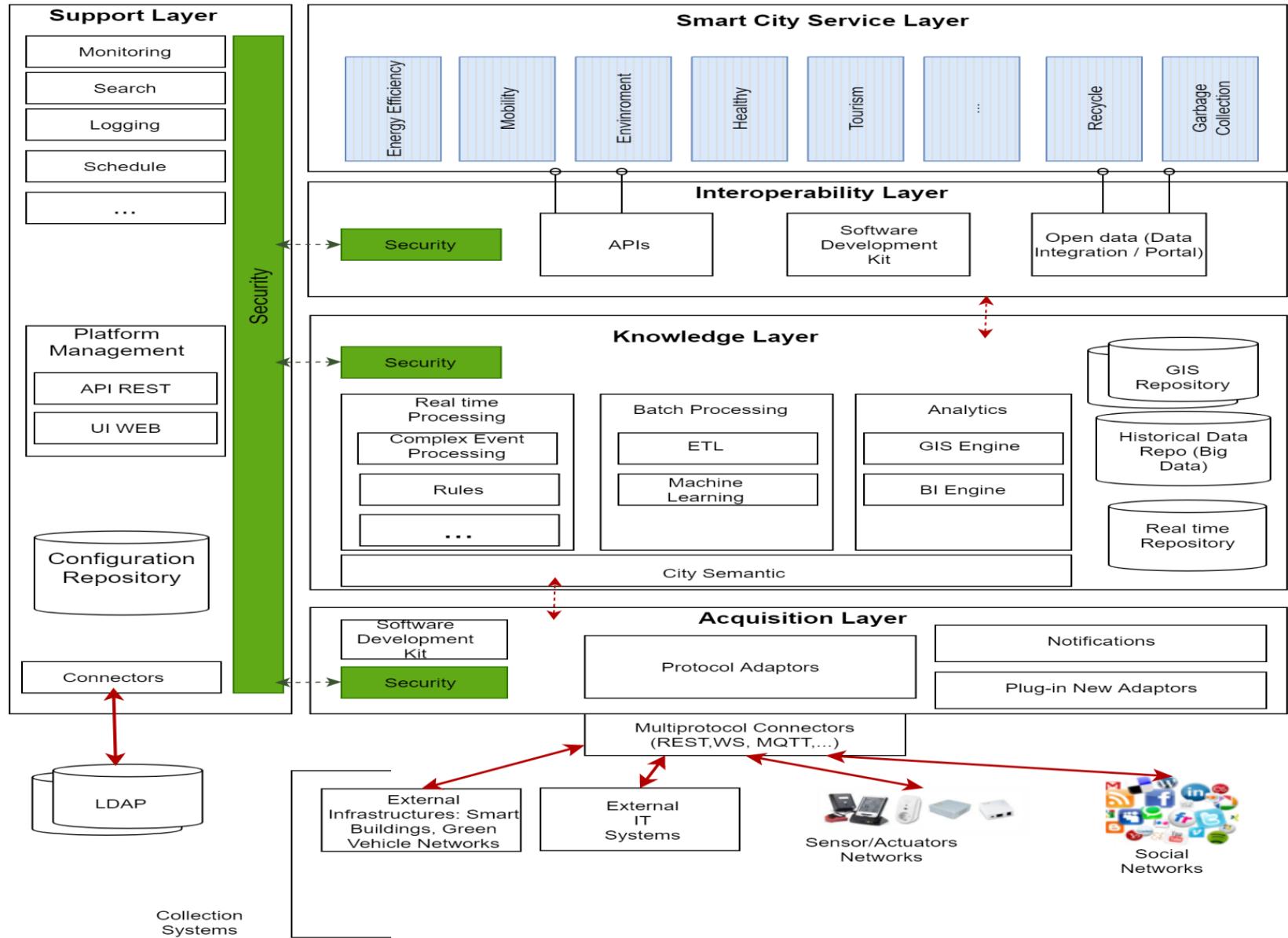
- Create a system that maintains a fundamental database for a smart city.
- A platform to provide services and utilities related to smart city to citizens
- Provide implementations to get involved of citizens (citizen engagement) on making decisions and policies related to smart city operations

# City Information Open Platform (General architecture)

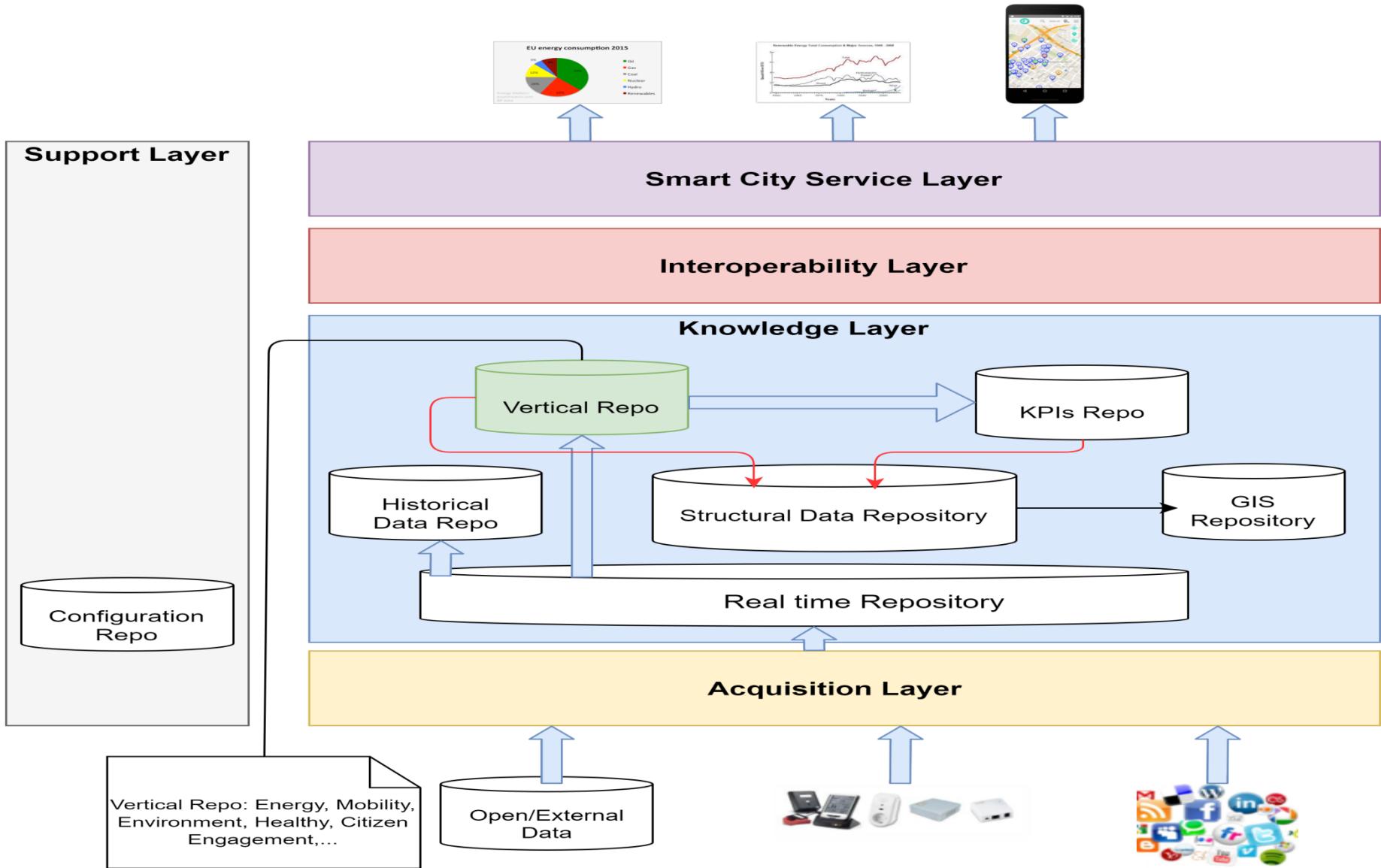
# A Context View



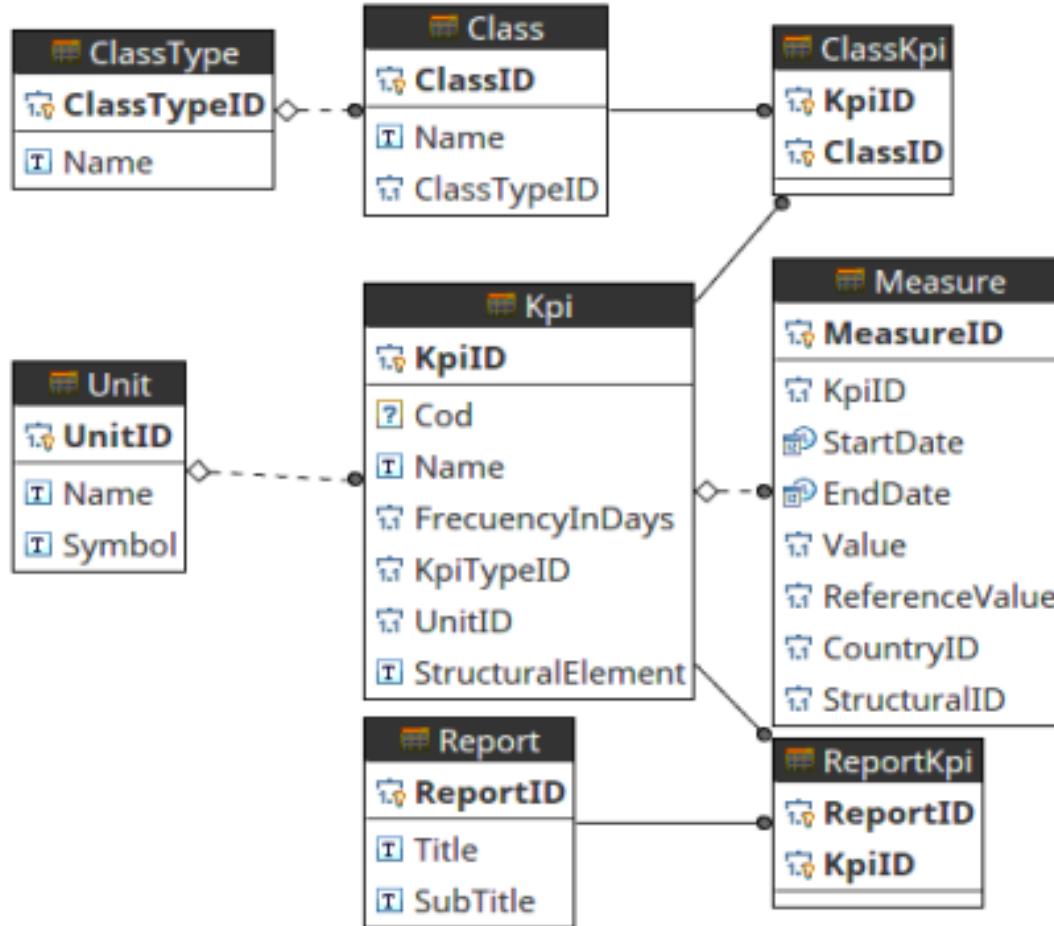
# Architecture Reference



# Data Work Flow



# More about KPIs



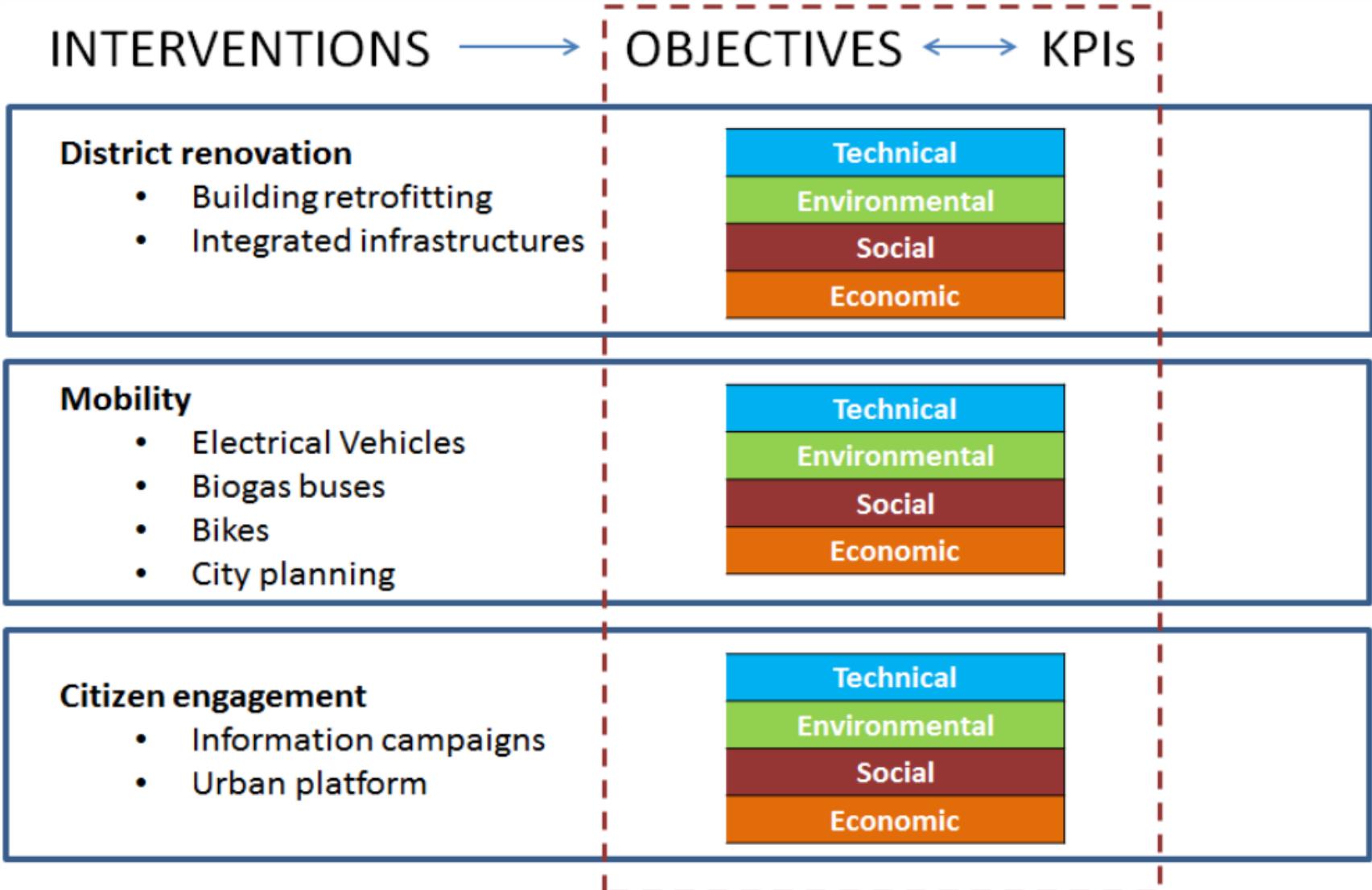
# City Information Open Platform (Examples of implementation)

# Smart City Data

Table 1: Information that could be potentially retrieved about cities.

Data Category	Owner (Data Publisher)	Data Description	Sampling
Transport	Traffic Authority	Maps of Cities (Roads, Street Names, POIs, subway and bus stations, etc.) <sup>3</sup>	Static
	Municipality	Public Transport Schedules <sup>4</sup>	Semi-Dynamic
	Traffic Authority	Transport Authority Updates (Roadwork, traffic status, etc.) <sup>5</sup>	Dynamic
Air Quality	Env. Agency	Particle concentration <sup>6</sup>	Dynamic
Traffic	Traffic Authority	Number of vehicles passing between two points, speed <sup>7</sup>	Dynamic
City Events	Cultural Groups	Entertainment (movie/theater plays)	Semi-Dynamic
Municipal Services	Municipality	Library Data <sup>8</sup>	Dynamic
	Private Company	Waste Collection Data <sup>9</sup>	Dynamic
Citizen data	Private Individuals	Parking Meters <sup>10</sup>	Dynamic
	Private Individuals	Social Media Information: Tweets, Status updates and blog posts, popular places ("check-ins")	Semi-Dynamic
		Household Energy Consumption	Semi-Dynamic
Health data	Private and Public	Relevant information about potential or confirmed sources of health threats	Dynamic

# Evaluation of smart city objectives



# 1. Description of the objectives

Type of intervention	Technical objectives	Environmental objectives	Social objectives	Economic objectives			
DISTRICT RENOVATION: Building retrofitting Integrated infrastructures	<ul style="list-style-type: none"> <li>Reduce energy demand of buildings</li> <li>Reduce home thermal energy consumptions with desired comfort at dwelling level</li> <li>Improve the energy efficiency of district</li> <li>Maximizing the use of RES and the self-sufficient energy consumption in the district</li> </ul>	<ul style="list-style-type: none"> <li>Reduce the CO<sub>2</sub> emissions generated from the district</li> <li>Reduce the environmental impact of the district intervention</li> </ul>	<ul style="list-style-type: none"> <li>Improve the quality of life of residents (thermal comfort)</li> <li>Improve the acceptance of the project by residents</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of the energy costs of residents</li> <li>Decrease the payback of investment intervention</li> </ul>			
SUSTAINABLE MOBILITY  Electrical Vehicles Biogas buses Bikes sharing City mobility planning	<ul style="list-style-type: none"> <li>Reduce the traffic congestion</li> <li>Improve the efficiency of urban transport systems</li> <li>Decrease energy consumption in urban transport</li> </ul>	<ul style="list-style-type: none"> <li>Reduce the CO<sub>2</sub> emissions associated to urban transport</li> </ul>	<ul style="list-style-type: none"> <li>Improve the quality of life and the acceptance of the project by drivers</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of the energy costs of drivers</li> <li>Decrease the payback of investment intervention</li> </ul>			
CITIZEN ENGAGEMENT STRATEGY  Information campaigns Urban platform	<ul style="list-style-type: none"> <li>Achieve the engagement of citizens</li> <li>Improve the current urban infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Increase the environmental awareness of residents, drivers and citizens</li> </ul>	<ul style="list-style-type: none"> <li>Improve the acceptance of the project by citizens</li> </ul>	<ul style="list-style-type: none"> <li>Contribute to the reduction of the energy costs of the citizens</li> </ul>			

		Energy Saving (kWh/y)	CO <sub>2</sub> Emission Reduction (T/year)
Wuppertal	<ul style="list-style-type: none"> <li>Building Retrofitting</li> <li>Integrated Infrastructures</li> <li>Sustainable Mobility</li> <li>ICTs</li> </ul>	<ul style="list-style-type: none"> <li>750 dwellings / 80.000m<sup>2</sup> Envelope insulation (façade &amp; roof) Connection to the district heating</li> <li>New biomass (wood chips) district heating network Integrated electrical and thermal network energy management systems, at home, building and district level (HEMS/BEMS/DEMS)</li> <li>Giving EVs acquisition (taxis and private cars) Extending the recharge network Electric last mile logistic</li> <li>Urban Management System (UMS)</li> </ul>	
Turin	<ul style="list-style-type: none"> <li>Building Retrofitting</li> <li>Integrated Infrastructures</li> <li>Sustainable Mobility</li> <li>ICTs</li> </ul>	<ul style="list-style-type: none"> <li>900 dwellings / 39.000m<sup>2</sup> Envelope insulation (façade &amp; roof) New low energy windows and doors PV panels in the South façade Connection to the district heating and removing old electric boilers Heat recovery ventilation system</li> <li>Integrating heating and cooling in the current DH through a new heat-pump Smart public lighting</li> <li>Giving EVs acquisition for rental services Giving the EVs acquisition (taxis and private cars) Bikeshare Buses Reuse of EVs batteries as storage system for PV panels Urban Management System (UMS), including public transportation</li> <li>Urban Management System (UMS), including public transportation</li> </ul>	<ul style="list-style-type: none"> <li>7.584.425</li> <li>2.476</li> <li>14.828.325</li> <li>12.594</li> </ul>
Södertälje	<ul style="list-style-type: none"> <li>Building Retrofitting</li> <li>Integrated Infrastructures</li> <li>Sustainable Mobility</li> <li>ICTs</li> </ul>	<ul style="list-style-type: none"> <li>844 dwellings / 66.181m<sup>2</sup> Envelope insulation (façade &amp; roof) New low energy windows and doors LED outdoor lamps Lighting control PV panels</li> <li>New high efficiency heat pump Integration with geothermal, solar and biomass RES Electrical supply from a dedicated wind park</li> <li>Buses Giving the EVs acquisition (taxis and private cars) Extending the recharge network</li> <li>Urban Management System (UMS)</li> </ul>	<ul style="list-style-type: none"> <li>7.017.788</li> <li>3551</li> <li>29.430.538</li> <li>18.623</li> </ul>

## 2. Design action programs

- Mobility interventions (Tartu city)
  - introducing sustainable vehicles (e.g. electric cars, last mile logistic EV services, electric bikes or biogas buses) for public and private use
  - deploying public and private EV charging infrastructures
  - providing bike sharing system
  - re-using EV batteries which allow to storing and using renewable energy
- District renovation interventions (Sonderborg city)
  - building envelope insulation, new energy efficient windows and doors
  - installation of ventilation systems with heat recovery
  - upgrading of district heating and cooling networks
  - introducing solar panels and street lighting with intelligent controlling systems.

### 3. Definition of Key Performance Indicators

Technical indicators	Implementation of ICT solutions and RES	Improve the energy efficiency of district	Efficiency indicators- Control of energy systems	Use of information generated by end consumers				
				Degree of energetic self-supply				
Environmental indicators	Implementation of energy performance measures, RES and ICT solutions in district	Maximizing the use of RES and the self-energy consumption in the district	Efficiency indicators- Reliability system	Share of renewable energy				
				Ratio of power interruptions avoided in a year				
Social indicators	Implementation of energy performance measures, RES and ICT solutions in district	Reduce the CO <sub>2</sub> emissions	Emission indicators	CO <sub>2</sub> emissions				
				Cumulative energy demand				
	Implementation of energy performance measures and RES in district	Reduce the environmental impact of the district intervention in the environment	LCA index	Climate change				
				Ecotoxicity				
	Implementation of energy performance solutions, RES and ICT solutions in district	Improve the life quality of residents & social acceptance of residents	Statistical indicators-Demographic resident data	Human toxicity				
				Fossil depletion				
				Ecological footprint				
				Age of inhabitants				
				Highest level of completed education of inhabitants				
				Nationality				
				Number of people living in the house				
				Number of households without employment				
				Number of households receiving housing subsidies				
				Net monthly income of the households				
				Size of the household				
					</			

# Functional Requirements (1)

Req_ID	Category	Description
FR_EA_01	Energy efficiency	Monitoring of most relevant KPIs (Key Performance Indicators) at different levels household, building and city. There are two types of KPIs as Indoor KPIs (e.g. temperature, humidity, energy) and Outdoors KPIs (e.g. street lights, temperature, speed of wind, humidity, waste collection)
FR_EA_02	Energy efficiency	The system should provide means of identifying energy consumption patterns
FR_EA_03	Energy efficiency	The system should provide means of detecting buildings in city with poor energy performance
FR_EA_04	Energy efficiency	The system should support decision making capabilities to guide stakeholders on the implementation of energy efficiency measures (e.g. Identification of priorities for intervention)
FR_EA_05	Energy efficiency	The system should support an integrated electrical and thermal network energy management
FR_EA_06	Energy efficiency	The system should have access to specific information from dwellings and buildings through sensors or meters to be installed (e.g. temperature, humidity, electricity consumption, gas, water), through a weather forecast station (exterior temperature, wind speed, sunshine)
FR_EA_07	Energy efficiency	The system should provide an energy use forecast at dwelling and city level by means of incorporating weather forecasts. A set of recommendations could be emitted to the end-users and ESCOs with the aim at managing the energy use in an efficient way
FR_MB_01	Mobility	The system should provide services that allow the optimization of public transportation routes and the last mile logistic
FR_MB_02	Mobility	The system should provide services that inform the users about the availability of shared green vehicles
FR_MB_03	Mobility	The system should provide services that allow the management of EVs recharging network and the availability of EVs recharging points

## Functional Requirements (2)

FR_MB_04	Mobility	The system should provide analysis results of CO2 emissions based on the efficient use of mobility resources
FR_MB_05	Mobility	The system should have access to specific information from vehicles through meters to be installed (e.g. distances travelled, geo-location) or provided by vehicle users (e.g. costs, investment, operation costs)
FR_MB_06	Mobility	The system should provide citizens with resources to calculate the total cost of ownership of EV
	Healthy	
	Environment	
FR_CE_01	Citizen Engagement	The system should provide citizens with information about smart city policies and implementation programs
FR_CE_02	Citizen Engagement	The system should provide information about schedules and routes of public transportation
FR_CE_03	Citizen Engagement	The system should enable the citizens to provide feedback about failures in the services (e.g. EVs charging points, public transportation, bike sharing)
FR_CE_04	Citizen Engagement	The system should allow launching surveys in the district about the smart city policies and implementation programs
FR_CE_05	Citizen Engagement	The system should enable the answering of questions from comments regarding the smart city implementation programs (technical, regulatory, process, funding, etc.)
FR_CE_06	Citizen Engagement	The system should have suitable data to offer citizens and a direct connection among platform and building owners for energy domains or platform user for other domains
FR_CE_07	Citizen Engagement	The system should allow to broadcast any type of information to the residents in the form of a digital TV channel
FR_DM_01	Device management	The system should provide a way to manage connected devices. Management activities include adding and removing devices, managing ownership and hierarchy, relations to other assets
FR_DM_02	Device management	The system should provide means of defining and reusing the data model profiles for various devices

## Functional Requirements (3)

FR_DM_02	Device management	The system should provide means of defining and reusing the data model profiles for various devices
FR_DM_03	Device management	Devices should be able to advertise which services they provide (service discovery)
FR UM_01	User management	The system should enable several users to access the system using their own username and password.
FR UM_02	User management	Based on authorization level, existing users can add new user
FR UM_03	User management	Users only have access to data of their own assets and to assets they have been given permissions to
FR DE_01	Decision Engine	The system should provide a way to apply automatic business rules (for example turn on a light when motion in the room is detected). This may be either internal to the platform or using external callbacks
FR RA_01	Remote Actions	The system should allow for certain actions to be triggered remotely, sending commands to the devices
FR DA_01	Data Analysis	The system should provide a way to gather historical device measurements data
FR DA_02	Data Analysis	The platform should support storing all communication with any device or component in an external data analytics platform
FR DA_03	Data Analysis	The system should provide varying charts for visualize statistics data collected from vertical domain data
FR DA_03	Data Analysis	It should be possible to export the data to be analyzed
FR GEO_01	Geo-location	The system should enable storing the physical coordinates of devices
FR GEO_02	Geo-location	The system should provide means of querying for devices by their coordinates
FR GEO_03	Geo-location	The system should provide GIS capabilities for visualization of added value services

# Non-Functional Requirements (1)

Req_ID	Category	Description
NFR_SEC_01	Security	User data should be protected from unauthorized access from many services deployed and accessed remotely
NFR_SEC_02	Security	The security and privacy mechanism should sufficient to be trustworthy for the clients
NFR_SEC_03	Security	The system should make it difficult to spy on messages communicated in the system (for example, use HTTPS)
NFR_SEC_04	Security	The system should provide a secure environment protected from common attack vectors
NFR_SEC_05	Security	The system components should be updateable to protect against known vulnerabilities
NFR_PRI_01	Privacy	The system should respect user's privacy, preventing unauthorized access
NFR_PRI_02	Privacy	Users without applicable permissions should not be able to track what other users are doing in the system
NFR_PRI_03	Privacy	It is ok to publicly share aggregated user data (data combined for a number of users for some prolonged period of time)
NFR_PRI_04	Privacy	The physical location of users should not be made accessible to other parties without the required permissions
NFR_PRI_05	Privacy	The system should prevent tracking of devices by unauthorized entities
NFR_PRI_06	Privacy	The system should not be configured to collect more data than it needs
NFR_PRI_07	Privacy	When relocating existing devices, the new owner should not be able to view the history of previous device owner
NFR_PRI_08	Privacy	In case of aggregated data, it should not be determinable exactly from whom was this data gathered from
NFR_NET_01	Networking	The platform should be able to operate over different networks (wired and wireless internet, GSM)
NFR_NET_02	Networking	It's a benefit if the system uses standard HTTP communication, not requiring special firewall configurations
NFR_NET_03	Networking	The system should be able to handle heterogeneous networks such as wireless internet and data over mobile networks

## Non-Functional Requirements (2)

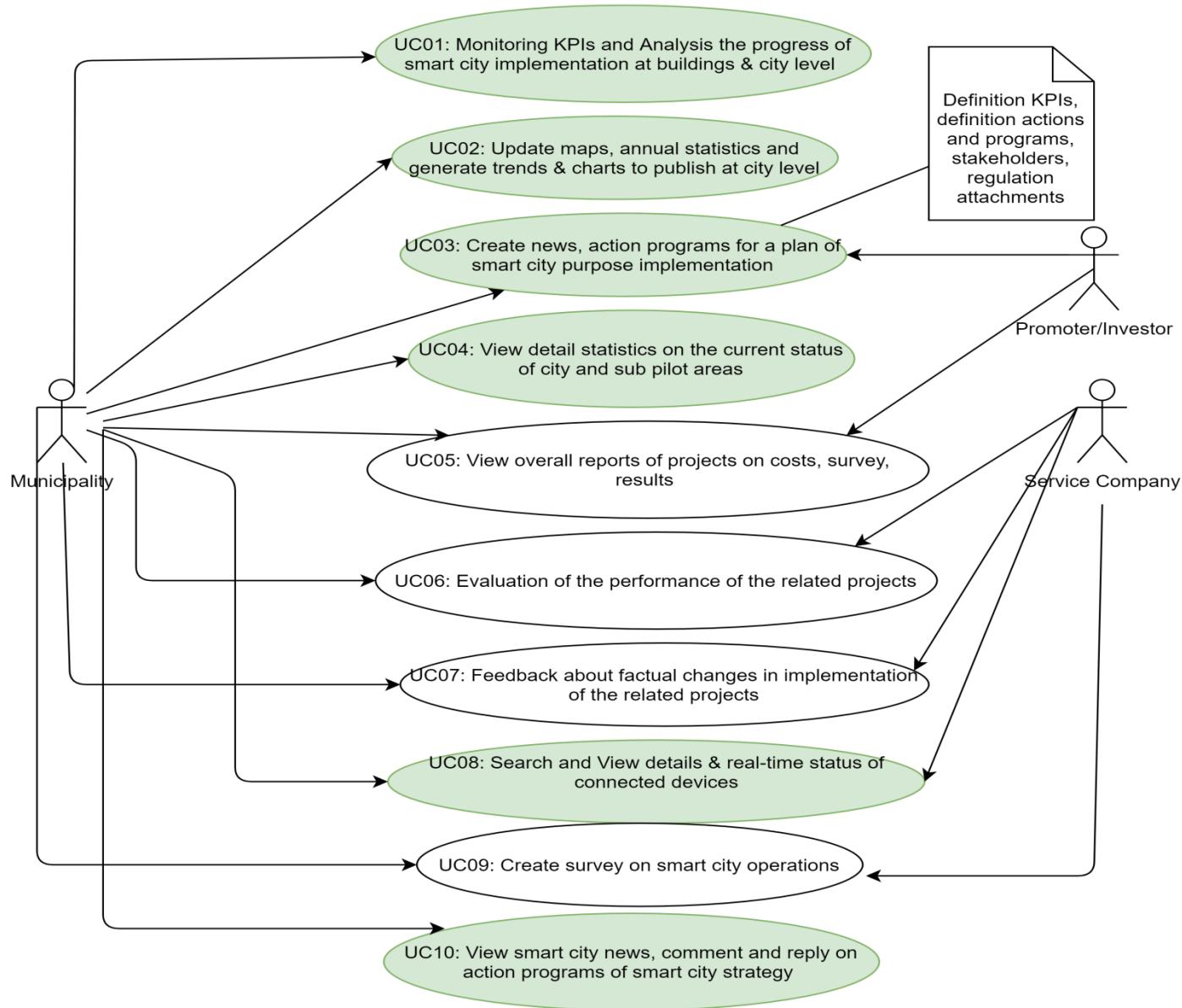
NFR_NET_04	Networking	The system should be able to run on distributed networks and operate over VPN if required
NFR_NET_05	Networking	When using networks such as mobile network, the system should be able to gracefully handle roaming services
NFR_NET_06	Networking	Support for IPv6 is a benefit
NFR_AUD_01	Auditing	All changes made to the system should leave an automatic and permanent audit trail showing who and when made which changes
NFR_BAC_01	Backup	The system should provide means or ways to back up the data periodically
NFR_BAC_02	Backup	The system should provide means to restore to a backed up version
NFR_HOS_01	Hosting	The data stored and generated in the system should belong to the clients and operators and be subject to laws of the deployed country
NFR_HOS_02	Hosting	It's a benefit if it's possible to host the platform on the operator's infrastructure
NFR_EXT_01	Extensibility	The system should be extensible with new functionality either through modifying its source code or by utilizing the API interfaces to build external 3 <sup>rd</sup> party modules
NFR_AVA_01	Availability	The system should take measures to provide high availability
NFR_AVA_02	Availability	The system should provide high Quality of Service
NFR_SCA_01	Scalability	The system requirements meet a large number of users access concurrently and the number of users will increase unexpectedly in the future
NFR_INT_01	Interoperability	The system should provide ways for different external 3rd party systems to communicate with the platform
NFR_INT_02	Interoperability	If the system has its own administration interface, the provided API should allow performing all the same functions by 3rd party application given sufficient privileges
NFR_FAU_01	Fault tolerance	The system should be able to handle faulty or compromised devices sending invalid data or at high rates
NFR_FAU_02	Fault tolerance	The system should be able to detect and notify about devices not reporting expected data

## Non-Functional Requirements (3)

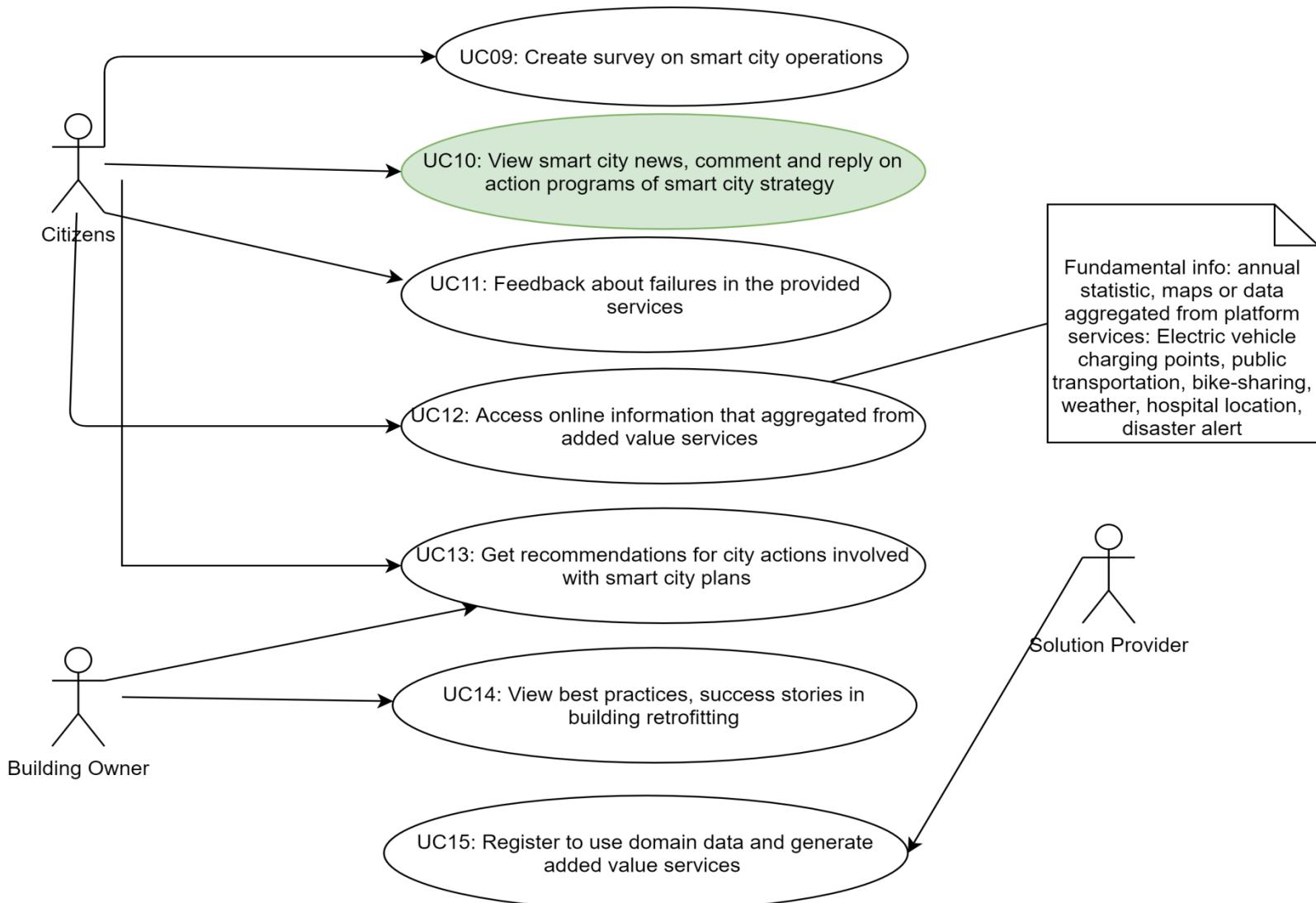
NFR_MAI_01	Maintainability	The system should be designed to be operated and maintained for a prolonged period of time
NFR_MAI_02	Maintainability	The components and dependencies should be updateable
NFR_MAI_03	Maintainability	The system should not lock the client into a certain vendor
NFR_DOC_01	Documentation	The platform and its functions should be sufficiently documented so new people could be included to work on it without dependence on original developers
NFR_DOC_02	Documentation	The public API interface should be extensively documented

# Business Use Cases

# Business Use Case Diagram (1)



# Business Use Case Diagram (2)



# References

1. <https://smartencity.eu/outcomes/public-papers/>
2. <http://www.smart-cities.eu/>
3. KPIs definition: [https://smartencity.eu/news/detail/?rx\\_call=114](https://smartencity.eu/news/detail/?rx_call=114)