Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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Launch of T.T.# 4 activities on City Innovation Platform and information services (Gothenburg)

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Disclaimer

Executive Summary

This Deliverable describes the development and launch of the demonstrators performed in IRIS Task 7.6, Demonstrating Transition Track #4: City Innovation Platform. Within this task, two demonstrators have been developed: 1) The City Information Model, a pilot that facilitates city management and planning by including building information, infrastructure, geodata and planning data and in 2) The Energy Cloud, a system that provides easy access to structured energy data to promote and support reduction of energy consumption in buildings, initially on the campus of Chalmers University of Technology.

The two demonstrators are linked inasmuch as they both address the potential for using open as well as proprietary data (infrastructure data, BIM data, energy consumption data, etc) to achieve greater efficiency in planning, developing and operating districts and buildings. Furthermore, there is a direct link between the two, as BIM data from the CIM could also be incorporated in the Energy Cloud.

Demonstrator	In a nutshell
#1 CIM Pilot	Brief summary: Gothenburg is in the middle of a major transformation in the City's central areas, and many large construction projects take place at the same time. Such big changes within urban areas will affect many people's lives and force a higher degree of coordination between many actors and organizations. It also requires better information and communication. To meet the challenge, the City of Gothenburg wish to establish a CIM (City Information Model), an information model where City information is stored and can easily be accessed. To test the concept of CIM, the City of Gothenburg in the IRIS project demonstrates a pilot of CIM (City Information Model). One objective for the CIM pilot is to demonstrate the value of automating the process of collecting BIM data from building projects for different phases in the building process. A project using BIM creates a lot of valuable information from the analysis phase through to the design, construction and finishing phases. The idea is that when the collection of this data is automated, and the BIM data is saved in a structured and well-defined way, the data can easier be used to get citizens engaged in projects. It can also easier be used by current and future city building projects in the close by area. They could reuse the data already produced by another project for instance to check for collisions or to find results from earlier investigations etcetera. In the CIM pilot the idea is to provide BIM data from reference project as open or shared data in combination with other geospatial City data. This data could then be downloaded and consumed in applications for visualization or in project design tools. The tool will be demonstrated to upload, validate and save BIM data. Also, it will be demonstrated

Demonstrator	In a nutshell
	Expected impact: In Gothenburg City, the CIM pilot is expected to contribute to improved planning management, control and maintenance for better energy and transport services for citizens and businesses. It should also contribute to Citizen engagement in urban development and growth. The CIM pilot is expected to contribute to the creation of the real CIM for Gothenburg and to contribute to the development of third-party applications. The CIM pilot is also expected to save resources by reusage of data, which would contribute to increased sustainability.
#2 Energy Cloud	Brief summary: The Energy Cloud will collect, structure, store and share energy data from buildings on the Chalmers University of Technology campus in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants using the RealEstateCore ontology.
	Expected impact: The overall ambition with the Energy Cloud is to reduce energy consumption in buildings - first at Chalmers Campus of Johanneberg and Gothenburg city, then Sweden and Europe. This will be achieved by targeting one of biggest bottlenecks for data driven energy savings - access to structured energy data. With the Energy Cloud and its standardized energy data structure, property owners will be able to quickly scale local energy efficiency projects to their entire portfolio. Digital energy services and applications such as visualizing to tenants, building energy management systems (BEMS), energy optimization service and advanced energy research projects can also use the Energy Cloud to replicate and scale faster and at lower cost.

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List of Abbreviations and Acronyms

Abbreviation	Definition
API	Application Program Interface
BEMS	Building Energy Management Systems
BIM	Building Information Model
CIM	City Information Model
CIP	City Innovation Platform
CityGML	An open data model and XML-based format for the storage and exchange of virtual 3D city models
DoA	Description of Action
DWG	Exchange format for CAD drawings, DWG is short for Drawing
EN	European Norm
EU	European Union
EV	Electric Vehicle
FC	Follower City
FDIS	First Draft International Standard (ISO)
FIWARE	A curated framework of open source platform components to accelerate the development of smart solutions
FME	Feature Manipulation Engine
FTP	File Transfer Protocol
GIS	Geographical Information Systems
GOT	Gothenburg
HMI	Human Machine Interface
HTTPS	Hypertext Transfer Protocol Secure
ICT	Information and Communication Technology
IFC	Industry Foundation Classes, Exchange format for CAD drawings
IoT	Internet of Things
IS	IRIS Solution
KPI	Key Performance Indicator
LH	Lighthouse
LHCSM	Lighthouse City Site Manager
MaaS	Mobility as a Service
OMA	Open Mobile Alliance
POC	Proof of Concept
PoR	Programme of Specification
PM3	A governance model and a framework for efficient governance of the intersection between IT and business operations

POC	Proof of Concept
PoR	Programme of Specification
PV	Photovoltaic
REC	RealEstateCore
REHVA	The Federation of European Heating, Ventilation and Air Conditioning associations
RES	Renewable Energy Sources
REST	Representational State Transfer
SaaS	Software as a Service
SFTP	SSH File Transfer Protocol
SMTP	Simple Mail Transfer Protocol
SS	Swedish Standard
SS-ISO	International Standard accepted as Swedish Standard
SSH	Secure Shell
SSN	Semantic Sensor Network Ontology
STA	Swedish Transport Administration
TT	Transition Track(s)
TYR	Tyréns (IRIS Partner)
UTA	Urban Transport Authority
WoT	Web of Things
WFS	Web Feature Service
WMS	Web Map Service
WP	Work Package
XACML	eXtensible Access Control Markup Language

1. Introduction

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The purpose of this Deliverable is to describe the demonstration activities undertaken in Gothenburg concerning IRIS Transition Track #4: City Information Platform and Information Services. The Deliverable reports on the launch of activities for the following two demonstrators. It is intended to provide sufficient level of detail to enable the reader to learn about the main features of each demonstrator and to serve as an inroad to the replication process.

- The City Information Platform
- The Energy Cloud

1.1. Scope, objectives and expected impact

1.1.1. City Information Model pilot

Gothenburg is in the middle of a major transformation in the City's central areas. This is due to a large infrastructure project (The West Swedish package) as well as an increase in property development and urbanization. This is particularly noticeable on the North and South banks of the River as well as in areas around the City.

Such big changes within urban areas will affect many people's lives and force a higher degree of coordination between many actors and organizations. It also requires better information and communication. This could easily be perceived to be a problem but can also be an opportunity to take the next evolutionary step in adopting and using new technology in digitalization (primarily in the visualization area) and thus achieve an improved citizen engagement and a more effective planning process. Today, it is not obvious or easy to access the digital information the City has, either internally or externally.

To meet the above challenge, the City of Gothenburg wish to establish a CIM (City Information Model) and use digitalization (and primarily geospatial data) as a driving force. Building Information Model (BIM) is the existing well-established approach that most design and construction companies use to model, build and visualize buildings, bridges and streets. CIM, in its simplest form can be explained as an extension of BIM (Building Information Model) to encompass an entire city to support management and usage.

The objectives of CIM is to facilitate citizen engagement and political involvement by reducing bureaucracy and paperwork for new projects, but also to increase transparency, facilitate innovation and make BIM a central part of urban planning.

In the IRIS project a pilot of CIM is developed. The objectives with the pilot are to take the first steps to build the CIM. In the pilot the intention is to take advantage of BIM and the BIM data already delivered to the City, and create a tool to collect, validate, and save the data. The next step in establishing CIM will be to link other types of geospatial data to the collected BIM data. This data should be accessible to people with the correct access rights, and some of it should be provided openly. An innovation challenge will be held to stimulate development of applications based on the open CIM data in the pilot.

1.1.1. Energy Cloud

The objective of the Energy Cloud demonstrator is to showcase the value of easy access to structured energy data to promote and support reduction of energy consumption in buildings – initially at Chalmers Campus and in the Gothenburg City and eventually in Sweden and Europe. The objective includes demonstrating how efficient building management and development and replication of innovative energy services can be accelerated by the application of standardized data semantics across the real estate industry. Energy Cloud will collect energy data from buildings in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants and the data will be categorized according to a unified semantic, RealEstateCore (REC), that enables easy sharing of data between stakeholders in the building sector and the smart city as well as fast replication of data-driven energy efficiency services. The demonstrator will identify and focus on typical use case scenarios identified by property owners and application developers including easy sharing and transferring of data between stakeholders, replication of data driven energy services as well as aggregation and analysis of energy data from complex and constantly changing building portfolios. The demonstrator is expected to contribute to a faster implementation of standardized energy data semantics across the real estate industry which will accelerate successful replication and application of new innovative and efficient energy services and solutions across the industry. The final replication phase will include national and international (within IRIS network) outreach and promotion events to promote experience and results to the Swedish and European real estate industry as well as a potential hackathon event to promote development of new and adaption of existing digital energy service applications compatible with the RealEstateCore ontology.

Due to a re-start of the Energy Cloud demonstrator including a partially new project consortium and updated project objectives (as outlined above) the project KPI:s has been update in close collaboration with WP9 and are based on already existing IRIS KPI:s and has also been coordinated with selected KPI:s for the CIM-pilot. The new selected KPIs for the Energy Cloud demonstrator are thus “Quality of Open Data” and “Open Data Based Solution”.

1.2. Contributions of partners

1.2.1. City Information Model pilot

The demonstrator primarily includes contributions from the Urban Transport Authority at City of Gothenburg and Tyréns as primary partners. City of Gothenburg direct the work and are responsible for the requirements and demands. City of Gothenburg will also provide the platform for sharing the CIM data and to make sure data is shared in the pilot. Tyréns are responsible for the software to collect, filter and validate BIM data and to make it accessible through the platform provided by the City of Gothenburg. Also see chapter 4 for description of each party’s responsibility.

1.2.2. Energy Cloud

The demonstrator will include contributions from IRIS partners Akademiska Hus and Metry as primary partners and other real estate companies such as IRIS Partners and Riksbyggen. HSB and Chalmers Fastigheter will be invited to contribute as well as a selected number of digital energy service providers. This project consortium will capture a wide spectrum of user requirements and use case scenarios, from advanced energy research to commercial facility and property management.

1.3. Relation to other activities

1.3.1. City Information Model pilot

The activities and implementation of the CIM pilot are highly related to the activities and deliverables in WP4 City Innovation Platform. The City Innovation Platform include components necessary for the CIM pilot. Some of the CIM pilot components are also CIP components and the CIM pilot will be demonstrated as an integrated part of a test version of a Gothenburg CIP. To produce this deliverable input has been used from especially D4.2 and D4.4. Also, the work producing D4.1 have proven very useful, e.g. the lessons learned from the FIWARE POC, is included in chapter 5 in this deliverable.

The monitoring descriptions in chapter 7 of this deliverable was produced as a result of the work done in cooperation with WP 9. To describe the ethics requirement in chapter 8 deliverables from WP 12 have been studied.

Also, se chapter 9.1.1 how the CIM pilot links to other work packages.

1.3.2. Energy Cloud

The Energy CloudEnergy Cloud demonstrator will be directly linked to several other IRIS WP7 demonstrator activities in transition track #1, #2, #3 and #5 through collection of energy data from the corresponding and relevant demonstrators and buildings. An additional link will be established with the project FED- Fossil-free Energy Districts (UIA Programme) that will contribute demand specifications from an advanced energy service application perspective.

1.4. Structure of the deliverable

General notice: This Deliverable describes the two demonstrators that are implemented within IRIS Transition Track #4 in Gothenburg, the City Information Model and the Energy Cloud, respectively. Chapters 5 and 6 describe each of these demonstrators in detail. In all other chapters, information concerning each of the demonstrators will be grouped under the subheadings “City Information Model pilot” and “Energy Cloud”, respectively.

This Deliverable is structured according to the following:

1. Chapter 1 provides an introduction and overview of the purpose, content and scope of the Deliverable
2. Chapter 2 describes the framework of the demonstrators in the Deliverable, including a description of the demonstration area, integration of demonstrators to solutions and ambitions for the Transition Track as a whole
3. Chapter 3 describes the baseline of the demonstrators along with the drivers and barriers affecting each demonstrator
4. Chapter 4 treats the organization of work within the Transition Track, including roles and responsibilities of the partners
5. Chapter 5 describes the demonstrator “City Information Model pilot”
6. Chapter 6 describes the demonstrator “Energy Cloud”
7. Chapter 7 deals with monitoring KPI’s on an aggregated level, i. e. Transition Track or City level
8. Chapter 8 gives an account of how ethics requirements have been handled by the project.
9. Chapter 9 provides information concerning how resources and information from other Work Packages are being incorporated in the current work.
10. Chapter 10 compares the results so far with the objectives set in the Description of Work and outlines future activities to mitigate and deviations
11. Chapter 11 lists any references that have been included to support the main text
12. Chapter 12 contains the Annexes

2. Demonstration in a nutshell

In general, the two demonstrations in Deliverable aim to improve and strengthen the structure of data processing and management in Gothenburg. The following sections will cover the detailed properties of each demonstrator.

2.1. Ambitions for TT#4

2.1.1. City Information Model pilot

The ambitions for CIM from [2] Grant_Agreement-774199-IRIS-DEF, chapter 1.4, "Ambition" are the following:

"Gothenburg's ambition is to take the next step and integrate building data with infrastructure data and urban planning data to realise the City Innovation Model (CIM). CIM will be a platform for greatly enhancing the efficiency of city management and planning, both saving money and reducing the environmental impact."

"In District Johanneberg, the City aims to test the concept of CIM (City Innovation Modelling). CIM takes the concept of BIM (Building Information Modelling) to the next level by incorporating city data in the model. CIM is the perfect data platform for the smart city as it includes building data as well as infrastructural, geographical and urban planning information."

The City of Gothenburg will test the concept of CIM through a pilot. One objective for the CIM pilot is to demonstrate the value of automating the process of collecting BIM data from building projects for different phases in the building process. A project using BIM creates a lot of valuable information from the analysis phase through to the design, construction and finishing phases. The idea is to automate the collection of this data and save the BIM data in a structured and well-defined way, to share with stakeholders via the City Innovation Platform. The citizens could then use the data more easily and get engaged in projects. Current and future city building projects in the close by area could reuse the data already produced by another project for instance to check for collisions or to find results from already done investigations etcetera. In the CIM pilot the idea is to provide BIM data from reference projects as open or shared data in combination with other geospatial City data. This data could then be downloaded or used in for example apps for visualization or in project design tools. The City of Gothenburg and Tyréns will demonstrate the tool to upload, validate and save BIM data. The CIM pilot will also demonstrate the sharing of data through a catalogue function, and as searchable and downloadable data from a map-based tool. Tyréns will also demonstrate an example of a simple visualization app where the data could be visualized with other data. The City of Gothenburg will hold an innovation challenge to stimulate new applications built on the CIM pilot data.

The original ambition was to demonstrate this in Johanneberg, but since there are no BIM data from infrastructure projects available in the Johanneberg district, other areas must be used. See the following chapter 2.2.1.

2.1.2. Energy Cloud

The ultimate objective of the Energy CloudEnergy Cloud demonstrator is to showcase the value of easy access to structured energy data to promote and support reduction of energy consumption in buildings – initially at Chalmers Campus and in the Gothenburg City and eventually in Sweden, Europe and the rest of the World. The objective includes demonstrating how efficient building management and development and replication of innovative energy services can be accelerated by the application of standardized data semantics across the real estate industry. Energy Cloud will collect energy data from buildings in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants and the data will be categorized according to a unified semantic, RealEstateCore, that enables easy sharing of data between stakeholders in the building sector and the smart city as well as fast replication of data-driven energy efficiency services. The demonstrator will identify and focus on typical use case scenarios identified by property owners and application developers including easy sharing and transferring of data between stakeholders, replication of data driven energy services as well as aggregation and analysis of energy data from complex and constantly changing building portfolios.

2.2. Demonstration area

2.2.1. City Information Model pilot

The ambition is to demonstrate the City Information Model pilot for the areas around three reference projects, within infrastructure, that provide or will provide BIM data in the pilot. Johanneberg was the original area where the pilot was to be demonstrated, but for this area there will not be any data from infrastructure BIM, so the main focus are the areas around reference projects. See map in Fig. 3 below. Johanneberg is also visible in the map.

2.2.2 Energy Cloud

The primary demonstration area for the Energy CloudEnergy Cloud demonstrator will be the Chalmers University Johanneberg campus that includes buildings such as HSB Living Lab representing the high end of the building spectrum when it comes to advanced digitalization and comprehensive sensor and energy data acquisition systems. The demonstrator will also include more standard and generic low-end data acquisition solutions in older office and student housing buildings also on the Chalmers campus as well as some new and ongoing housing development projects in downtown Gothenburg representing the present standard set up for modern commercial building projects including on site electricity micro production, EV charging solutions etc. Figure 1, Figure 2 and Figure 3 show the demonstration area.

Figure 1 A map depiction of the Chalmers Campus Johanneberg. The location of AWL, one of the buildings in the Energy Cloud demonstrator also part of the transition track #2 demonstrator is marked in red

Figure 2 Johanneberg Campus area, where the core of Energy CloudEnergy Cloud demonstrator will be implemented including campus buildings managed by Akademiska Hus, Riksbyggen, HSB and Chalmers Fastigheter

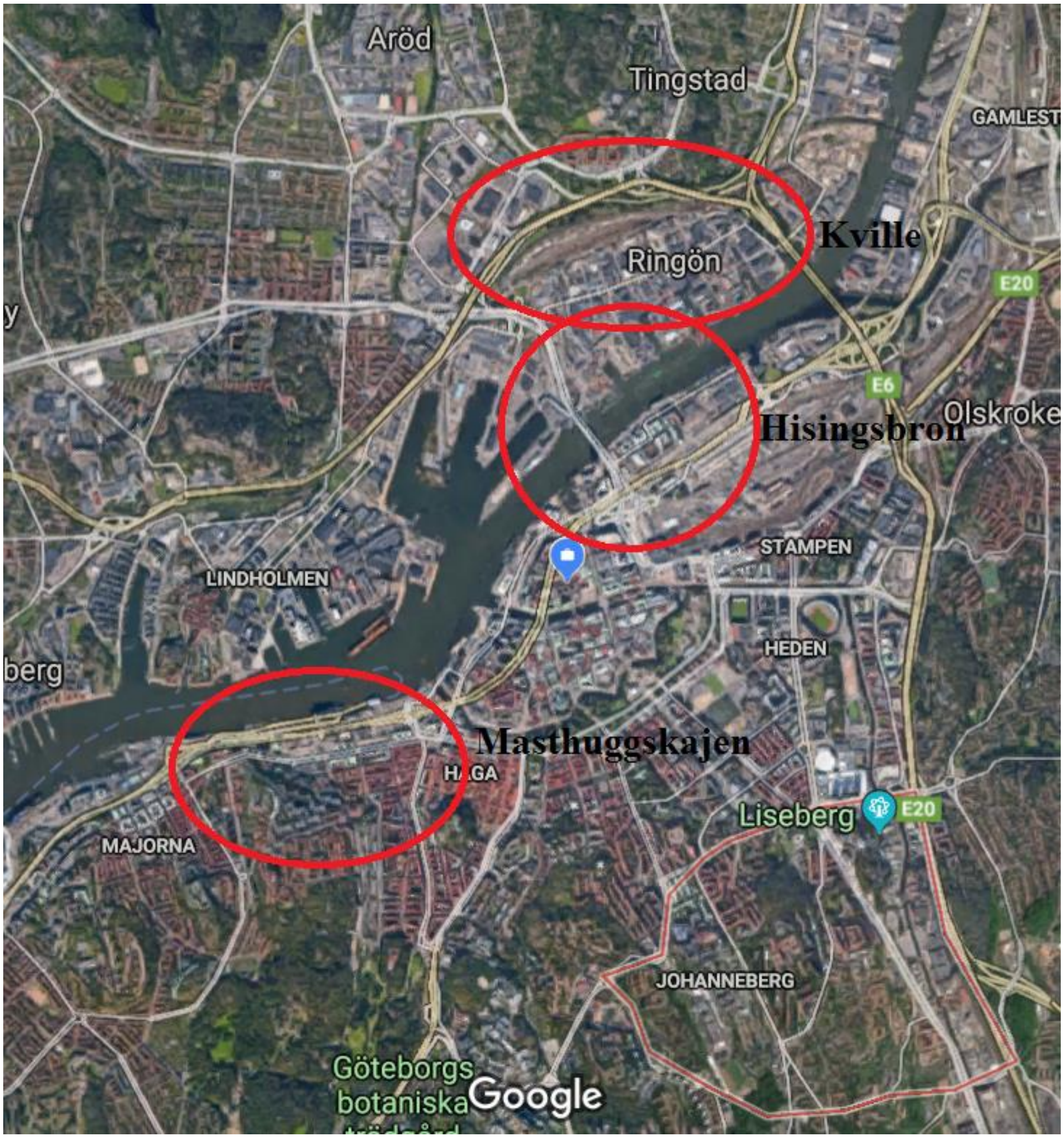

Figure 3: Map over areas for CIM pilot demonstration

2.3. Integrated Solutions in TT#4

2.3.1. City Information Model pilot

The CIM pilot is a demonstrator in the integrated solution IS-4.2 Services for City Management and Planning in Transition Track #4, City Innovation Platform.

A future realization of the CIM pilot functionality is expected to contribute to the objectives for IS-4.2 Services for City Management and Planning in the following way:

- The CIM pilot is, among other things, about creating prerequisites for planned, ongoing and finished projects to be visualized together and with other city data. This contributes to facilitation of citizen and political involvement in the development of the city. This also contributes to increase of transparency internally and externally.
- In the CIM pilot the data as of above will be provided through open Application Programming Interfaces (APIs) which contributes to facilitating innovation and external transparency.
- The CIM pilot will demonstrate how BIM data from projects in different phases can automatically get filtered, sorted and stored to be provided openly for the future use of other projects. This in a future real implementation would diminish the administration work that have to be done by the City personnel. Before the IRIS project, the City of Gothenburg normally only required drawings from infrastructure projects to be provided in 2D. The personnel at the City do a lot of manual work in administrating this data, putting it into several systems. Also, when a new project is going to start, and it requires knowledge about previous projects and other data relevant for the project, the City personnel must put in a lot of effort to find and provide the required data. In this perspective the CIM pilot will also contribute to facilitate for data to be reused. For example, if one project has done measurements in one area, another project could use that data, without needing to do their own measurements. That will possibly save resources and contribute to increased sustainability.
- The CIM pilot will demonstrate how external projects could collect data from the City that will be importable into their systems. This contributes to the objective of diminishing external administration work, since it will facilitate for external consultants and design teams in retrieving the data from previous and ongoing projects. Also, they will not have to redraw 2D data into 3D which is a nowadays normally required since drawings from the City is provided in 2D.
- Facilitating for consultants and design teams to retrieve data about other projects the way planned in the CIM pilot, will contribute to reducing the time needed to start up new projects, as less time will be spent on searching for data or doing double work since the data could not be found. The structured data in a future CIM will make it possible to do large scale GIS analysis beforehand, facilitating for new projects. It will also contribute to reduction of risk for errors since the design teams can find out things electronically before they build in the real world.
- Within Transition Track #4, CIM is closest related to the integrated solutions IS-4.1 Services for Urban Monitoring and IS-4.3 Services for Mobility.

IS-4.1 Services for Urban Monitoring: Monitoring the City activities through connected objects. In an ideal future version of CIM all city assets are part, also the connected IoT objects. Through visualization of the connected IoT objects the City can for instance see which assets that need maintenance or replacements.

IS-4.3 Services for Mobility. To create good Services for mobility it is necessary to have correct and updated information about the city infrastructure and buildings, both the current situation, what is currently under construction and what is planned. The ambition for CIM is to provide this information in 3D.

2.3.2. Energy Cloud

The Energy Cloud is a demonstrator in the integrated solution IS-4.4 Energy Management in Transition Track #4, Digital Transformation and Services. Depending on the final specification of the demonstrator there might also be links to all the other integrated solutions IS-4.1, IS-4.2 and IS-4.3 in transition track #4 based on the final data that will be collected, stored and shared through the Energy Cloud.

2.4. Integration of demonstrators

The CIM pilot will contain building related data which may in a later phase also include consumption data as supplied by the Energy Cloud, thus further enhancing the usefulness and impact of both demonstrators.

The final specification of the Energy Cloud demonstrator will be finalized during Q4, 2019. This will determine and define all links to other demonstrators. This includes potential links to T7.3 Demonstrating Smart renewables and closed-loop energy positive districts, T7.4 Demonstrating Smart energy management and storage for flexibility, T7.5 Demonstrating Smart E-mobility and T7.6.1 City Information Model.

2.5. Deviation from grant agreement

2.5.1. City Information Model pilot

The CIM pilot has deviated from the original wording of the Grant Agreement regarding location of demonstration area: The CIM pilot was originally planned to use building information from the Campus Johanneberg area, but since BIM data from that area turned out to be unavailable, the location was moved to encompass three other sites in the City (See Fig. 3). These locations are still tentative since discussions are ongoing concerning availability of open BIM data in these areas.

1.1.2 Energy Cloud

The main deviation in the Energy CloudEnergy Cloud demonstrator is a switch of project partner and stakeholder from Chalmers University to real estate company Akademiska Hus. This has shifted focus from issues, problems and opportunities linked to access to energy data for primarily research purpose to access to energy data for efficient building and energy management. This has increased the general relevance of the demonstrator with respect to the overall objectives of the IRIS project *"To create intelligent user- & demand driven city infrastructure & services"*

3. Baseline / Drivers and Barriers

3.1. Baseline

3.1.1. City Information Model pilot

CIM has different meanings to different people. To some people CIM is the data model that would be used to store and connect city data so that it can be easily visualized. To some it is the city data itself stored in such a way it can be visualized. To others it is the actual visualization of the city and the city data. To some it is all three. This chapter describes the baseline in terms of these different views. The view for the pilot is that CIM data could be built up by BIM data from projects and made accessible as open and shared data, thus some baseline description of BIM data collection in the City and how data is made available today.

CIM data model:

A data model is the description of how the data will be stored in a database. No such agreed upon CIM data model exists in Gothenburg today.

City data:

To connect the data in a future digital twin of a city, the data need to have a location in space and preferably even in time. E.g. it needs to have at least 2D, preferably 3D or even 4D or be connected in space in some other way, e.g. connected to another geospatial object.

A lot of Geodata in 2D exist today in Gothenburg, but almost no City data has 3D coordinates or is connected in space. There is a lot of City data which is not georeferenced at all.

CIM visualization:

For the citizens and politicians, the current CityPlanner or "Min Stad" (Figure 4) is a way to visualize city projects. It uses an interactive 3D map where you can see Gothenburg through a helicopter perspective, and it includes some information about larger City development projects on a higher level.

Today there is no automatic process to retrieve the BIM data from projects and make it automatically available for visualization in apps such apps. To visualize the projects in these apps, manual work is required.

Figure 4: CityPlanner rendition of the "West Link" infrastructure project in Gothenburg

BIM and data from building projects:

The main scope of the IRIS CIM pilot is to collect and save BIM data from building projects in a structured way, to build up the data base of City Data in a way that it can be visualized for citizens and used in planning and management.

One important aspect of BIM is the geometry. Today most geometry data from projects is supplied in 2D to the City of Gothenburg. It is not supplied or stored in such a way that it is easy to connect the data in a City 3D model. Very few projects supply 3D data, since this has not been a requirement. For the UTA, Urban Transport Authority, at the City of Gothenburg, only some independent projects provide 3D models for single parts of the project. The data in those files is hard to reuse since there are no unified requirements on the content or the version of the 3D models. The City does not have the software or knowledge to open or use the 3D model data.

Apart from geometry, other important BIM data includes structural, economic and environmental attributes. This data is not collected in a way that makes this data easily accessible, externally or internally. It is not easy for contracted design teams to get hold of data from previous projects. To retrieve such data, they need to request a manual archive search from the administration, and in general no 3D data can be provided.

Tools to find data

In GotMapDemo: https://gotmapdemo.tkgbg.se/provided by the Urban Transport Authority (Figure 5), GIS data can be found and viewed. GIS data can be retrieved as WMS or WFS. The tool (Figure 6) is provided both as an external service where the user will not need to login, and as an internal service where the user needs to login. The internal service provides more data, data which is not allowed for external users to see or use.

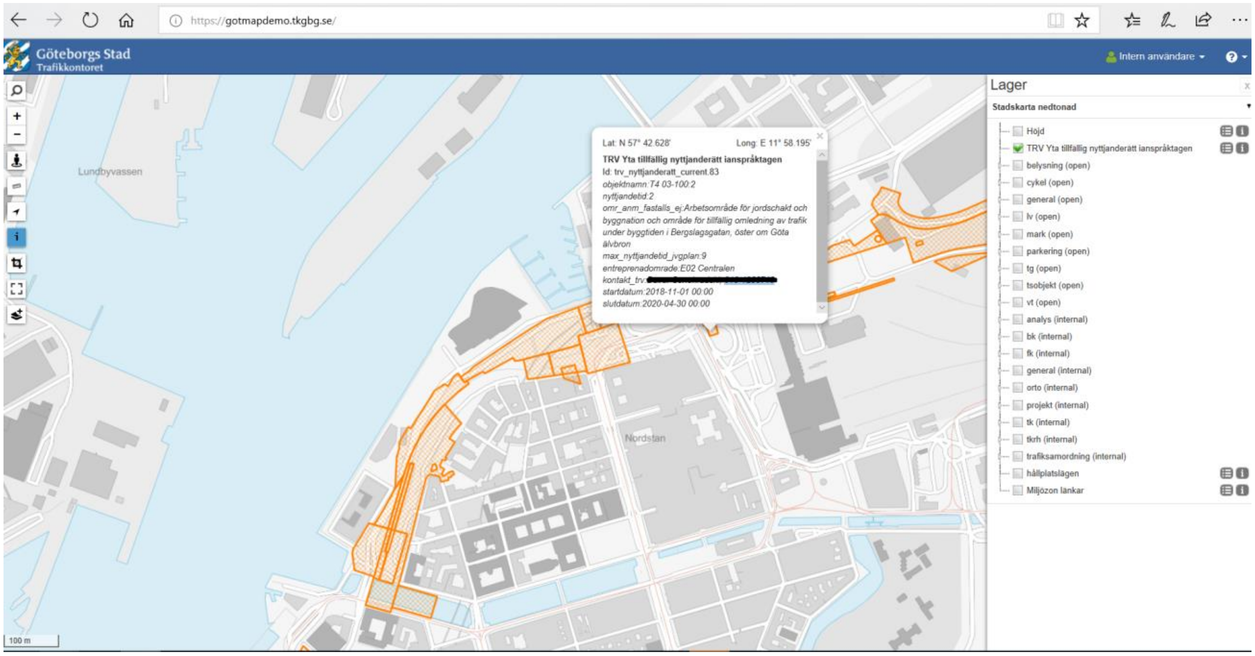

Figure 5: GotMapDemo showing where land is going to be used for project

The internal tool GOkart that is provided by the Gothenburg City Planning Authority, is similar to the GotMapDemo tool. The GOkart tool is only for internal use within the City.

Figure 6: The GOkart Tool

In the City of Gothenburg's open data portal, see [14] Homepage of GOT "Open Data", a limited number of APIs are listed. Some of the data in these APIs could qualify as CIM data.

Energy Cloud

The building sector is presently going through a rapid digitalization process. Ever increasing amounts of data are generated by and within buildings. A multitude of different systems exist to control climate, lighting, access control, etc., not to mention all the new data sources that emerge from IoT devices, all of which generate data.

This enables application of new more efficient and sustainable building technologies and building management practices. However, a major market barrier for introducing and scaling new building and energy service applications is the lack of standardization and common data semantics across the national and international real estate industry and its suppliers of digital solutions. These large amounts of heterogeneous data need to be organized if they are to contribute to cost-efficient and environmentally friendly real estate management. Although there are several ongoing initiative and efforts in this domain including RealEstateCore, Fi2XML and Fastmarket the process is slow. In order to speed up progress in this important domain the IRIS project will implement and evaluate a full-scale Energy CloudEnergy Cloud demonstrator based on the most progressed initiatives to establish a common digital language to enable control over buildings and development of new energy services. The core of the demonstrator will include the practical application of the RealEstateCore ontology.

The demonstrator will be implemented on the Metry platform [10], which is a cloud-based infrastructure specialized in collecting and sharing energy data that includes an API connected to the platform allowing users to give and refuse access to data [11] The Metry platform does not presently support any advanced and standardized data structure semantics nor does the data management tools utilized by participating real estate companies or application and energy service providers. This reflects the general status in the industry.

3.2. Drivers and Barriers

3.2.1. City Information Model pilot

Below are the identified drivers and barriers.

3.2.1.1. Political

Barriers

There is sometimes a reluctance from politicians to open up access to data for fear of abuse.

Drivers

There is a general political trend towards making more data open.

The interest in building a digital twin is currently high, which supports projects going in that direction.

3.2.1.2. Economical

Barriers

It will take a lot of investment to have a fully implemented CIM. These types of sums are hard to find and motivate for a municipality, since it will take a long time before the benefits will be visible.

Drivers

The City Information Model could potentially save huge sums for the City thanks to improved quality of planning with the help of comprehensive data from a district. Also see the business model in chapter 5.2.2.

3.2.1.3. Sociological

No sociological drivers or barriers have been identified.

3.2.1.4. Technological

Barriers

There is a lack of standards. One standard that has been identified and will be tested in the project is CoClass. See chapter 5.5.6.4 for a more detailed description of CoClass.

Not many projects deliver BIM data today. Also, se the risks described in chapter 5.5.5.

The BIM data produced by projects for the City does not follow any set down requirements and might vary a lot in structure and format. It will take a lot of effort to come to a standardized delivery. Also see the description in chapter on how the first steps towards describing the requirements have been taken.

Drivers

There is a general trend towards working with BIM. The fact that the State Road Administration in Sweden is going that way, is a huge driver for the Urban Transport Authority, as these two authorities have many common interests and challenges and cooperate a lot. Also, see chapter 5.5.6.3 where this is described a bit more.

3.2.1.5. Legal

Barriers

Due to public procurement and the laws regulating that some BIM data cannot be shared due to that the infrastructure project is in a certain phase in the procurement process. Also see the risk with secrecy and security issues in chapter 5.5.5 and the description in chapter 5.5.6.8.

Drivers

Increase the degree of innovation and increase transparency.

Parameters can be measured and monitored and provide support for different types of events and decisions in the City planning process.

3.2.1.6. Environmental

Barriers

No environmental barriers have been identified.

Drivers

The implementation of a City Information Model promises huge environmental benefits thanks to improved planning and greater efficiency in execution, for instance improved logistics when building new houses or infrastructure.

3.2.1.7. Organisational

Barriers

The information that will build the CIM for the entire city in the end is owned by different administrative units of the City of Gothenburg. These administrative units are governed by different political boards and have different budgets.

Insecurities about secrecy and security issues prohibits projects from providing their data to be available as open/shared data. Also see the risks described in chapter 5.5.5 and see the description of secrecy and security issues in chapter 5.5.6.8.

Georeferencing is not a natural part of the process today, this is a new way of working.

Getting everyone to deliver into the model, and keeping the data correct and updated with the ability to update it in an easy way will be a challenge.

Drivers

Logistic and economic: The urban development plans concerning traffic and buildings in Gothenburg are huge and intense which demand new solutions such as a City Information Model to increase logistic as well as economic aspects.

Co-workers at the Urban Transport Authority with the role to administrate data from projects are requesting new systems and a structured way of working with geospatial city information and data delivered from projects.

3.2.2. Energy Cloud

3.2.2.1. Political

Barriers

There is sometimes a reluctance from politicians to open up access to data for fear of abuse

Drivers

There is a general political drift towards making more data open in sectors where this can promote more efficient competition and markets. This has for example been manifested in new EU open data regulation for the financial industry in the new “Open Banking” or PSD2 directive.

3.2.2.2. Economical

Barriers

Market barriers: A major market barrier for introducing and scaling new energy service applications is the lack of standardization and common energy data semantics across the national and international real estate industry. Although there are several ongoing initiative and efforts in this domain including RealEstateCore, Fi2XML and Fastmarket the process is slow due to different needs among different types of real estate and property owners.

Drivers

Market drivers: One of the most significant and important drivers include an increasing use of smart digital solutions by the real estate industry to optimize energy use in the building stock. Efficient building energy management is also growing more and more complex with the introduction of distributed micro energy production, energy storage and integration of buildings with the transport system through EV-charging solutions. This generates more energy related data as well opportunities and challenges to use this data for optimization on individual buildings, blocks of buildings, districts and city level. The optimization objectives and cases include both real-time operation as well as in the planning and strategy phase.

3.2.2.3. Sociological

Barriers

Behavioural barriers: Defining standards are many times easy compared to making organization and humans to adopt them. When it come to the energy data standards in the real estate industry you will typically be challenged by the behavioural resistance by local technician and property management staff responsible for the practical implementation of data standards and structure.

Drivers

Broad acceptance with property owners. Primarily, structure and semantics must fit the needs of real estate owners, but it is also important to reach out and create a critical mass of affiliated real estate companies.

3.2.2.4. Technological

Barriers

- There is a lack of standards
- There is a multitude of proprietary solutions

Drivers

The digitalization process and increasing amount of digital data generated by the real estate industry creates a huge demand for efficient solutions to collect, structure, manage and share this data. (see Figure 7).

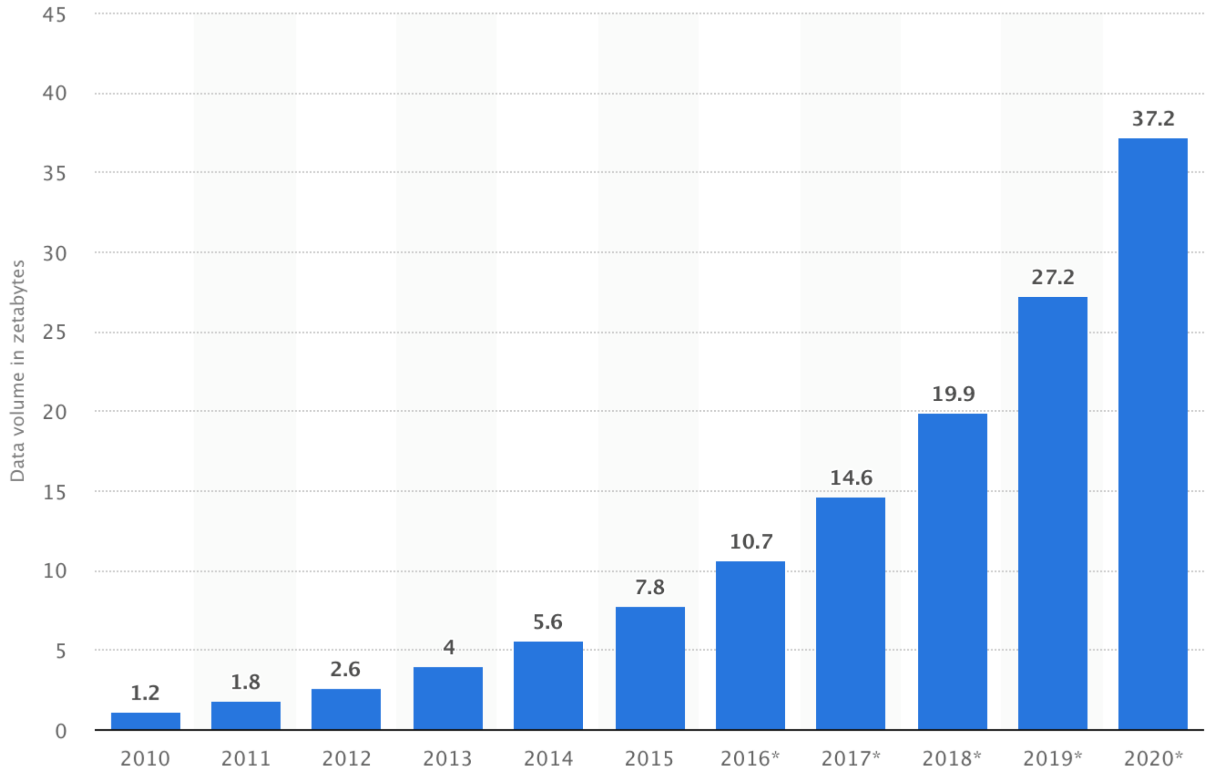

Figure 7 The graph shows the amount of data (in zeta bytes) collected from smart buildings around the world between 2010-2020 (2020 is estimated figures based on a sustained trend). Source: Statista

3.2.2.5. Legal

Barriers

Data privacy: The new GDPR regulation has put more pressure on the importance of data privacy. Uncertainty and lack of competence among real estate industry on the legal implications of the new data privacy rules has created GDPR anxiety although energy data in most cases are not subject to data privacy regulation.

Regulatory barriers: Another related regulatory barrier is that ownership of energy data in many cases is distributed on multiple stakeholders (tenants and energy users) in one single building and not only the building owner.

Drivers

Legal requirements to perform regular energy audits on commercial buildings has generated a demand for cost efficient ways to comply including access to relevant data.

3.2.2.6. Environmental

Barriers

No environmental barriers have been identified

Drivers

Energy Cloud: Inherently, Energy Cloud increases awareness and transparency of the energy usage of companies, buildings and residents and thus provides the foundation for energy savings.

3.2.2.7. Organisational

Barriers

Ownership of data and responsibility for collection is split on different stakeholders, even in the same building. Real estate companies many times lack a homogenous approach across different geographic regions and organisational units how to collect, structure and store energy data.

Drivers

Introduction of centralized sustainability and energy management functions in most real estate companies are promoting and demanding standards and coherent data management across entire company groups and organizations.

4. Organisation of work

4.1. City Information Model pilot

The CIM pilot is done in close cooperation between the Urban Transport Authority at the City of Gothenburg (GOT) and IRIS Partner Tyréns (TYR). The City of Gothenburg directs the functionality of the CIM pilot to be in line with the City's requirements. The City is also responsible for setting up the platform for the pilot. Tyréns have the BIM competence and are responsible for developing most of the core functionality of the CIM pilot. For details about what party is responsible for what part of the pilot see chapter 5.1.4.

The organization chart below (Figure 8) is an illustration of how the CIM pilot work is organized. The boxes in the diagram are explained in more detail in the chapters below. The people involved are described in Annex 1: CIM pilot organization: Names, roles and responsibilities.

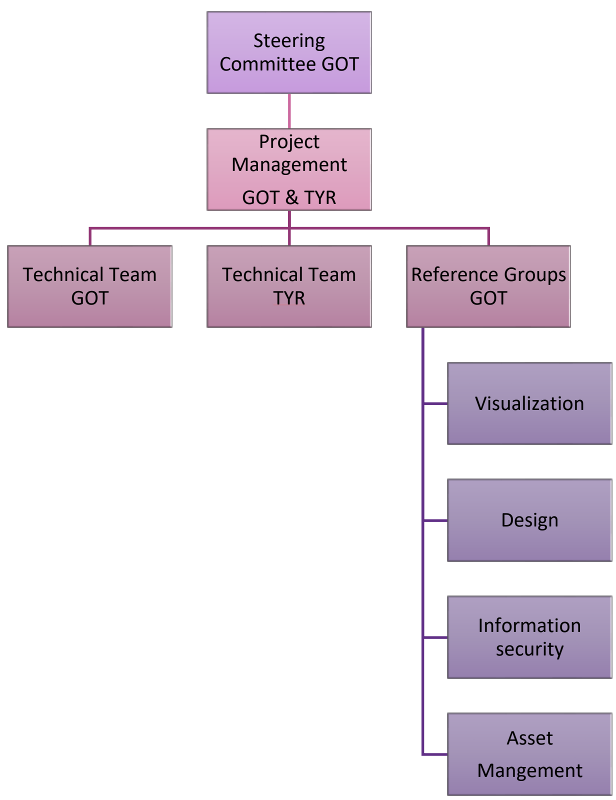

Figure 8 Organisation of CIM pilot project

4.1.1. Steering Committee

The work is directed by a Steering Committee consisting of managers from the Urban Transport Authority at the City of Gothenburg. Their main responsibility is to direct the project to be in line with the City´s requirements and to secure budget and resources within the project.

The Steering Committee is chaired by the IT manager. Other participants are the manager for the department that handles large infrastructure projects, one manager from the asset management department, and the manger from the department for Development and International relations.

The steering committee meets before every important gate in the project. Rapporteur in the meetings is the assistant project owner from Gothenburg together with the subtask leader IRIS task 7.6, subtask 1, from the project management chapter below.

4.1.2. Project management

The work in the CIM pilot is managed by the Project management team. Their main responsibility is to manage the project according to IRIS Grant Agreement and directives from the Steering Committee. Project management consists of the assistant project owner, the project manager from Urban Transport Authority/subtask leader 7.6 subtask 1, and the project manager from Tyréns.

Project management meets on a regular basis to handle the work ahead and current tasks. The Project Manager from Urban Transport Authority and the Project Manager from Tyréns also have joint meetings with the technical teams from each party.

4.1.3. Technical team Gothenburg

The technical team from the City of Gothenburg is managed by the project manager from the Urban Transport Authority. This team is responsible for the technical set up and development of the pilot that the City of Gothenburg is responsible for according to description in chapter 5.

4.1.4. Technical team Tyréns

The technical team from Tyréns is managed by the project manager from Tyréns. This team is responsible for the technical set up and development of the pilot that Tyréns is responsible for according to description in chapter 6.

4.1.5. Reference groups/persons

The CIM pilot project needs to have a broad input; thus, it has many reference groups and people involved. Upon need for various types of input in different stages of the project, reference group meetings are organized with the groups or people below. References are also requested for input by mail.

4.1.5.1. Reference group: Design

The CIM pilot is first tested with three reference projects: Hisingsbron, Masthuggskajen and Kville, which are all major infrastructure projects in the City of Gothenburg. These projects will contribute with their BIM data for the CIM pilot. The design reference group consists of representatives from these projects. The group also have input on the need of data from the design perspective of infrastructure projects: What information should be saved and made accessible for future design teams and what other types of information that is desired.

4.1.5.2. Reference group: Visualization

To help finding the right functionality regarding visualization for citizens and politicians the project have a reference group Visualization.

4.1.5.3. Reference group: Information security

To make sure to handle the questions regarding GDPR and information security the project has a reference group Information security.

4.1.5.4. Reference: Asset management, technical information

At Urban Transport Authority there are employees responsible for technical information about the assets owned and managed by the authority e.g. streets, bridges, etcetera. They receive output data from infrastructure projects and are responsible for the management of that data for the future. Often, they are contacted by design teams or others to provide information about the assets and thus, they are important stakeholders for the CIM pilot project. To make sure to handle the interests from them, the project has a reference person to collect input from.

4.2. Energy Cloud demonstrator

The Energy Cloud demonstrator will be carried out in close collaboration between Metry and Akademiska Hus with a potential contribution from HSB, Riksbyggen and a number of third-party real estate companies and application providers depending on the final specification of demonstrator.

4.2.1. Organization of Energy Cloud pilot work

See the organization chart below (Figure 9):

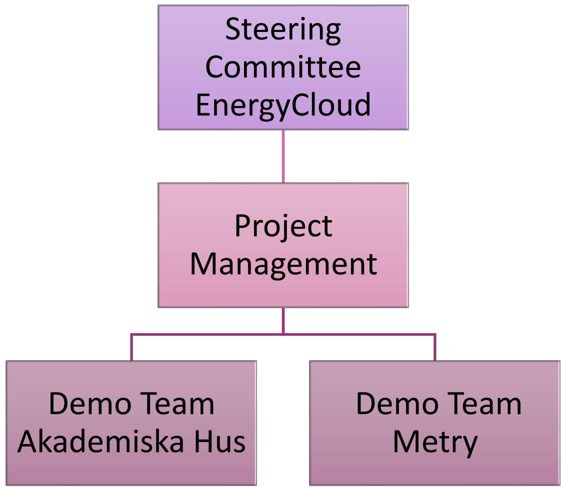

Figure 9: Organisation of Energy Cloud pilot project

4.2.2. Steering Committee

The work is led by a steering committee consisting of relevant managers from the two main project contributors Metry AB and Akademiska Hus (Table 1. Steering Committee of the Energy CloudEnergy Cloud demonstrator) and It is chaired by the CEO of Metry. Other participants might include representatives from third party contributors such as Riksbyggen and HSB depending on the final specification of the demonstrator.

Table 1. Steering Committee of the Energy CloudEnergy Cloud demonstrator

Role	Name	Organisation
CEO	Magnus Hornef	Metry AB
IT Manager	Per Brantsing-Karlsson	Akademiska Hus

4.2.3. Project management

Project management consists of a senior project manager from Metry AB complemented by a representative from Akademiska Hus and Metry demo teams receptively (Table 2. Project Management).

Table 2. Project Management

Role	Name	Organisation
Project manager	Hanna Bjärvik	Metry AB
Metry Demo Team leader	Anna Wannberg	Metry AB
Akademiska Hus Demo Team leader	Per Löveryd	Akademiska Hus

4.2.3.1. Metry Demo Team

The Metry Technical Team (Table 3) is made up of senior Metry associates.

Table 3. Metry Demo team

Role	Name	Organisation
Head of infrastructure	Adam Ringhede	Metry AB
Content Specialist	Julia Sjöwall	Metry AB
Head of Product Management	Anna Wannberg	Metry AB

4.2.3.2. Akademiska Hus Demo Team

The Demo Team from Akademiska Hus is listed in Table 4.

Table 4 Demo Team Akademiska Hus

Role	Name	Organisation
Energy engineer	Per Löveryd	Akademiska Hus
Head of Energy portal	Torbjörn Persson	Akademiska Hus
Energy engineer	René Frydensbjerg	Akademiska Hus

5. Demonstration of a City Information Model

Responsible: City of Gothenburg, Urban Transport Authority and Tyréns.

Description from Grant Agreement: "In a digital model of the city, decisions, documents and plans can be connected to geographic locations, and forecasts, taking benefit of the visualization and planning application innovations provided by combining GIS (Geographical Information Systems) data with BIM (Building Information Model) data and 3D data in a way that captures both existing and planned structures to support the Urban area with analyses and maps. An innovation challenge will be held to stimulate the development of new applications making use of the CIM data."

5.1. Specifications

Gothenburg wish to establish a CIM (City Information Model) and use digitalization (and primarily geospatial data) as a driving force. BIM is the existing well-established approach that most construction companies use to model, build and visualize buildings, bridges and streets. CIM, in its simplest form can be explained as an extension of BIM (Building Information Model) to encompass an entire city.

The City of Gothenburg will test the concept of CIM through a limited pilot. The pilot will contribute to the real CIM implementation for the entire City of Gothenburg. In the pilot the intention is to take advantage of BIM and the BIM data already delivered to the City, and create a tool to collect, validate, and save the data. The next step establishing CIM will be to link other types of geospatial data to the collected BIM data. This data should be accessible to people with the correct access rights, and some of it should be provided openly.

The data should be accessible and possible to visualize in a visualization tool and also be possible to use in design tools used by design teams. The pilot is developed to support the following use-cases:

5.1.1. Use Case: Visualize your city

The main objective is to give citizens and users an easier way to access/acknowledge projects and means to influence the planning process to achieve better and smarter planning through participatory design. Furthermore, the City of Gothenburg and the Urban Transport Authority need to ensure the improvement of city operation performance while improving the citizens' life.

To achieve such objectives, the Urban Transport Authority must share information and give the citizens a chance to co create and be a part of the decision-making process. The citizens should be able to report issues and give feedback that improves the City. By sharing data and information it is expected that the efficiency for the city planners will increase. During planning, contracting and building the quality increases by using co reviewing and collision controls. It may also increase engagement for all parts as it will be easier to be a part of decisions.

5.1.1.1. User story

Before building the planned bridge to Hisingen Island the City officials would like to have feedback from their citizens. They make sure the plans are shown in the City's relevant application and ask the citizens to give feedback.

The citizens want good mobility in their neighbourhood. They check out the plans in the City's tool for ongoing and future infrastructure constructions to see what the City's plans are.

A citizen discovers that the planned bridge to Hisingen island does not have satisfactory road signs and comments that. The project administration receives the comment and determines that the comment is relevant and decides to make an amendment. The drawings and BIM (Building Information Model) data are updated accordingly and resubmitted to the CIP (City Innovation Plattform). The citizen can look at the changed plan for the bridge via the City's application that visualizes data from the CIP. The project brings the comment into the lessons learned during its retrospective for future constructions to consider.

To support the use case, a CIM (City Information Model) data API needs to be developed, where current or new visualization tools easily can access the outcomes of ongoing infrastructure projects in combination with existing geodata and other data. There is also a need for a tool where the BIM providers can submit their BIM-data in a standardized way.

5.1.2. Use-Case: Kickstart you project

Today there is no unified service where a design team can utilize the benefits of having access to all necessary data from one platform or source. This leads to an ineffective way of searching, collecting and validating information which is also not standardized.

The prerequisite for being able to retrieve the correct basis for design is that information from previous projects has been collected and delivered according to standardized requirements.

This leads to better and quicker decision making in the design process. Some parts of the BIM-information can even be reused. The City of Gothenburg and the Urban Transport Authority will get a better and more cost-effective end-product.

5.1.2.1. User story

Before designing the planned bridge to Hisingen Island the design team and decision makers would like to find out subsurface conditions (geotechnical aspects, piping and easements). These conditions might limit and give prerequisites to the design.

The design manager inquiries existing data in a spatial context in the City's tool and find in the datasets two objects that affects the design.

- One main water supply pipe, which is not feasible to move and requires a design change.
- One existing geotechnical rock surface model, that with a few auxiliary soundings can be updated for the bridge project

The design manager now discovers the benefits of reusing BIM-data. The new geotechnical data is submitted to the CIP in the standardized format.

5.1.3. Hardware

The CIM pilot will be an integrated solution in the City Innovation Platform and a test version of a CIP has been set up. Se the illustration in chapter 5.1.4.5 for a better view of how the CIM pilot and the CIP integrates.

The test version of the CIP platform is configured on a virtual server provided by the City of Gothenburg, Intraservice Management. The virtual server can be considered an example of a cloud service from the user perspective. Each standard virtual server in its current configuration provides 4 CPU's and 8 GB of RAM and is effectuated as a WMware server running a Linux operating system (RedHat 7.6). This actual solution is assumed to be vendor agnostic and should be easy to replace by other services.

5.1.4. Software

For the pilot the focus is on developing the components described in the Table 5.

Table 5 Software components in CIM pilot

Component	Functionality	Responsible partner
BIM Data Collection Tool	A component for uploading, storing and versioning of project BIM data including Human Machine Interface (HMI) and API for data exchange to CIM	TYR
CIM Data Catalogue	A catalogue with APIs to stored BIM data and to other geocoded city data	GOT
CIM Data Retrieval Tool	A tool for design teams to find/retrieve available data when starting a new project	GOT
CIM Visualization Tool	A simple visualization tool to visualize the data available in the CIM data catalogue	TYR
Test CIP	A simplified test version of CIP based on the reference architecture described in D4.2 and the technical solution reference architecture described in D4.4	GOT

Figure 10 below shows how different components relate and will interact in the demo. The following chapters will describe the most important components in more detail.

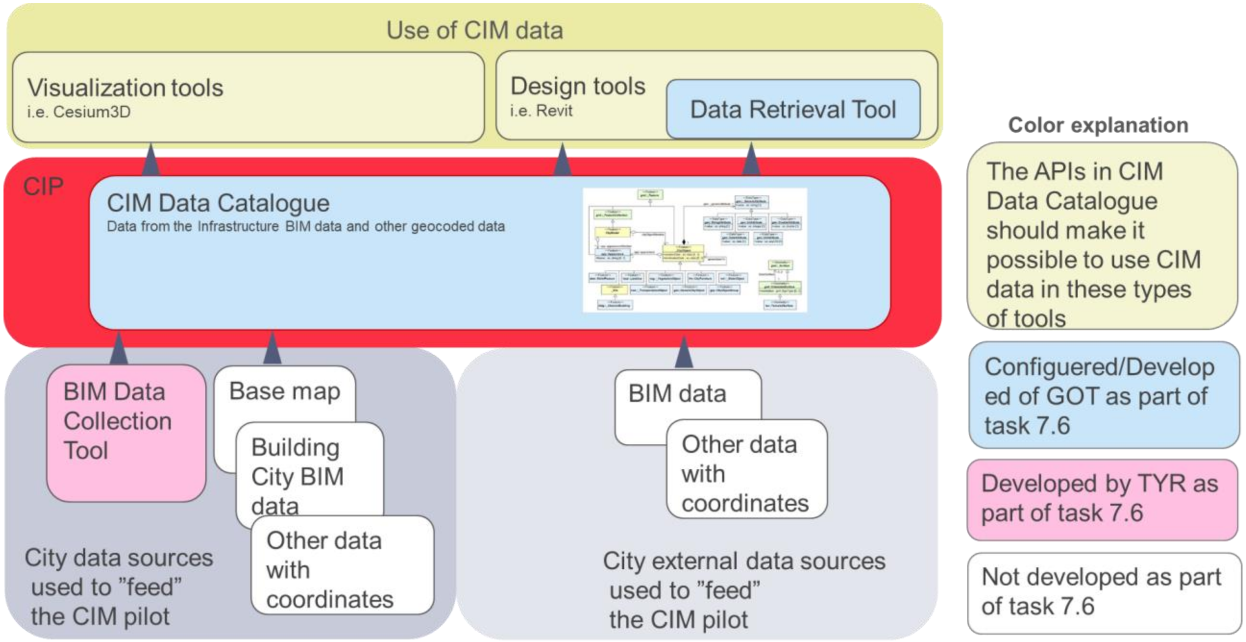

Figure 10 CIM pilot components

5.1.4.1. BIM Data Collection Tool

Purpose: Uploading, validation and storing of BIM data from projects

Responsible: Tyrens

See Figure 11 below for a schematic picture of the component:

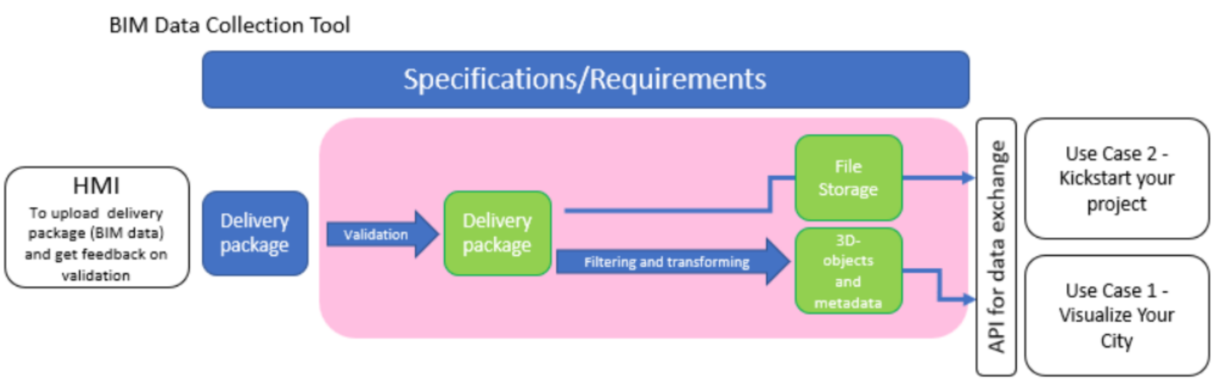

Figure 11 BIM Data Collection Tool

5.1.4.1.1. HMI

The functional requirements of the HMI are:

- Through a web-based HMI for design teams, it should be possible to upload delivery package (BIM Data) from infrastructure projects to the City
- Only permitted users should have the possibility to upload delivery package (BIM data)

5.1.4.1.2. Validation and storing

The functional requirements of the validation and storing component are:

- Delivery packages are uploaded and validated against the specified BIM requirements
- If the delivery package does not pass the validation, the user will get detailed feedback
- Validated and passed delivery packages will be stored and versioned
- Data from approved packages will be made accessible via an API

5.1.4.1.3. Filtering and transforming

The functional requirements of the filtering and transforming component are:

- BIM data is filtered and transformed into simple 3D objects as basis for visualization
- Specified metadata is stored separately

5.1.4.1.4. API for data exchange – Simple 3D Objects

The functional requirements of the API for data exchange – Simple 3D Objects are:

- The filtered and transformed data from 3.1.3 will be made available through an API that can be accessed and published via the CIP
- It should be possible to query the API in regard to geography, timespan, type of data and status
- It should be possible to connect and visualize data via the API, for example using Cesium 3D

5.1.4.1.5. API for data exchange – File Storage

The functional requirements of the API for data exchange – File Storage are:

- Files from the validated delivery package will be made available through an API that can be accessed and published via the CIP
- Access rights will ensure what data in the delivery package that can be accessed by whom
- It should be possible to query the API in regard to geography, timespan, type of data and status
- Data accessed via the API should have a standard format so that it can be reused in design tools
- Data available is:
    - Object divided geometries for geotechnics, road and bridge according to certain levels of detail defined in the BIM requirements
    - Virtual objects such as contracts/agreements, easements and rights of way

5.1.4.2. CIM Data Catalogue

Purpose: A catalogue that will make the CIM data accessible for external applications

Responsible: Gothenburg City

The ambition is that the following data (at least for the pilot areas around Hisingsbron, Kville, Masthuggskajen and Johanneberg) should be made accessible through the catalogue to start with:

- Data from the APIs to the BIM Data collection Tool
- Basemap (to use as background)
- Primary map
- Cables and pipes information through the owners (via Ledningskollen)

- Historical Geotechnical Investigations

5.1.4.3. CIM Data Retrieval Tool

Purpose: An HMI for design teams to retrieve data from the CIM data catalogue

Responsible: City of Gothenburg

The functional requirements for the CIM Data Retrieval Tool are:

- The user interface should be map based at least 2D, possibly 3D
- The available data is visualized in the HMI
- Available data is according to the data that exist in the CIM Data Catalogue
- By drawing a polygon, the user can select an area from where to retrieve data
- What data the user can access is dependent on the user rights
- The user shall be able to select what datasets to retrieve
- The user shall have the possibility to select where to download the data on the local fileserver
- The ambition is that it should be possible to select data from status (preliminary, current, planned etc.)
- The ambition is that the user should be able to subscribe to updates on a specific area and receive notifications if data is updated.

5.1.4.4. CIM Visualization Tool

Purpose: A simple test tool intended for citizens, to show visualization possibilities

Responsible: Tyrens

The functional requirements on the CIM Visualization Tool are:

- The tool should visualize CIM data for the four selected areas in 3D
- It should be possible to view future city scenarios using a time slider
- The visualization should be done in a visualization app such as Cesium3D

5.1.4.5. CIP- City Innovation Platform

Purpose: The purpose of CIP is to be a platform for collecting, managing and exchanging data for the development of new applications and services. For the pilot the City of Gothenburg is implementing a first test version of a CIP as the pilot is dependent of some of the CIP functionality to implement the CIM pilot.

Responsible: City of Gothenburg

The test CIP is implemented incrementally as a set of FIWARE containers in a Docker platform. See Figure 12, below. For the readers' understanding: FIWARE is a curated framework of open source platform components to accelerate the development of smart solutions, see [15] FIWARE homepage. Docker is a tool designed to make it easier to create, deploy, and run applications by using containers. Containers allow deployment of an application as one package with all necessary parts, such as libraries and other dependencies. In this way the developer can rest assured that the application will run on any other machine regardless of any customized settings that machine might have that could differ from the machine used for writing and testing the code.

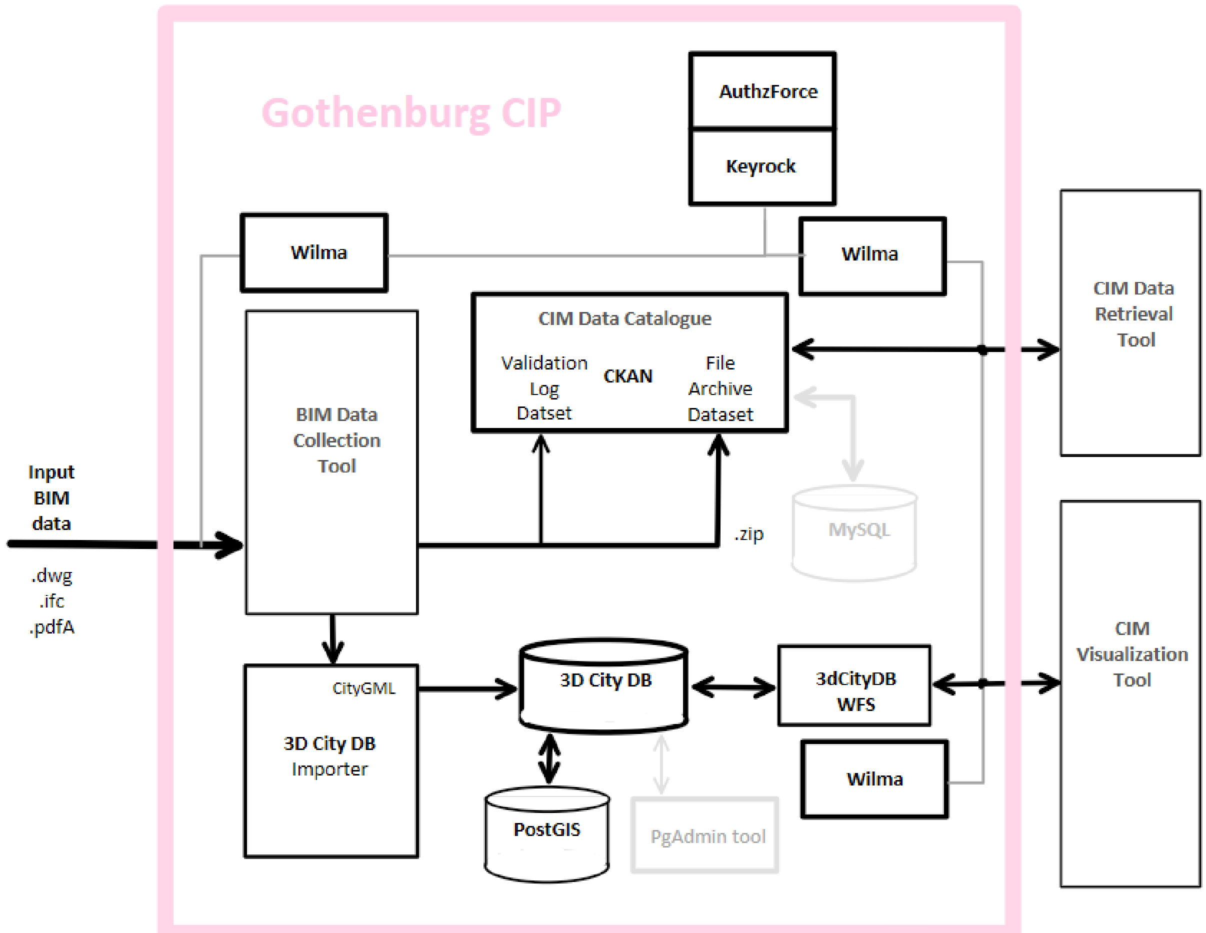

Figure 12 Test CIP with FIWARE containers

The functionality of the BIM Data Collection tool is described in more detail in chapter 5.1.4.1 above.

The results of the filtering and transforming in the BIM Data collection tool (the FME transformation) are of three different types.

- CityGML
- Original input file package
- Log files associated with the FME transformation

The CityGML files are imported to the 3DCityDB by a custom-made container that wraps the GitHub provided tool for import/export to/from the 3DCityDB. The original input file packages are stored in a separate dataset via CKAN and log files associated with the FME transformation process are stored in Validation log dataset.

The 3DCityDB holds all extracted geometries for separate building parts and serves as a WFS via the container made by the company virtualcitySYSTEMS and currently supports the Simple WFS conformance class.

Access control and security are provided by the containers called Wilma, Keyrock and Authzforce. Wilma intercepts all incoming requests to the CIP and, together with Keyrock and Authzforce, adds authentication and authorization to the system. Keyrock is the identity manager to use for easy account creation and it complies with existing standards for user authentication and it can provide access information to services acting as a Single Sign-On platform. Authzforce make authorization decisions based on requests from Wilma and policies set up according to a standard format XACML.

5.1.5. Procurement of equipment and services

Tyréns have a budget of 40 kEUR for equipment. It will be spent on renting a cloud-based development environment 2019-2022. None of this was spent during 2017 or 2018.

From IRIS the City of Gothenburg has a total budget of 75 kEUR for subcontracting for CIM. None of this was spent during 2017 or 2018. During 2019 the City of Gothenburg estimate that 100 kEUR will be spent on subcontractors/services. The budget will be used/was used in the following way:

- Purchase of a solution architect and one IT-developer/FIWARE specialist that will:
    - Set up the test City Innovation Platform so that it can be used for the CIM pilot. The City of Gothenburg foresee a need for a budget of 30 k€ from IRIS, for this part.
    - Produce and configure the CIM data catalogue on the City Innovation Platform
    - Do necessary technical investigation
    - Produce technical documentation of the CIM pilot set up
- Purchase of development of CIM data retrieval tool

The City of Gothenburg will provide some extra budget for subcontracting, as the total cost is not covered by IRIS.

The procurement of solution architect and the IT-developer/FIWARE specialist has been done through the City’s frame agreements for IT services and development. The development of CIM data retrieval tool will also be purchased this way.

The remaining budget for services will be used for updates and technical documentation during 2020 - 2022.

5.2. Societal, user and business aspects:

5.2.1. Citizen engagement

The CIM pilot has defined two use cases. One of the use-cases, Visualize your city (see chapter 5.1.1), is created with the purpose to enable and encourage citizen engagement. The CIM pilot, only provides software and data to help getting citizens engaged. No special activities for citizens are planned.

How the CIM pilot software and data will contribute in citizens engagement is in the following way: The CIM pilot will create the prerequisites to spread data about current, future and planned infrastructure projects before they are built through open APIs. The requirement is that these projects can be visualized together with current City data in externally or internally developed applications. This will give the possibility to create applications or tools in which you can visualize infrastructure before it is built. Visualization of future projects is one important key to get citizens engaged, since it is much easier to have opinions on something you can see. A tool that could be created based upon the CIM API data is for example a tool that visualizes the future projects and allows for citizens to send their feedback digitally to the City.

In the CIM pilot demonstration Tyréns will demonstrate a simple test application called the CIM Visualization Tool, described in chapter 5.1.4.4. This application will be an example tool to demonstrate how the APIs could be used to create tools intended for visualization for both citizens but also for decisionmakers inside the City.

The data from the CIM pilot open APIs shall be in such a format that the data can be shown in for instance the application “Min Stad”. One of the purposes of “Min Stad” is to collect feedback from citizens.

5.2.2. Business model

Based upon the Business Model Canvas template the business model of the functionality in the CIM pilot can be described. The CIM pilot has used the tool CurateFX, see [16] CurateFX homepage, and the module Business Model Canvas to describe the Business model, see Figure 13 below.

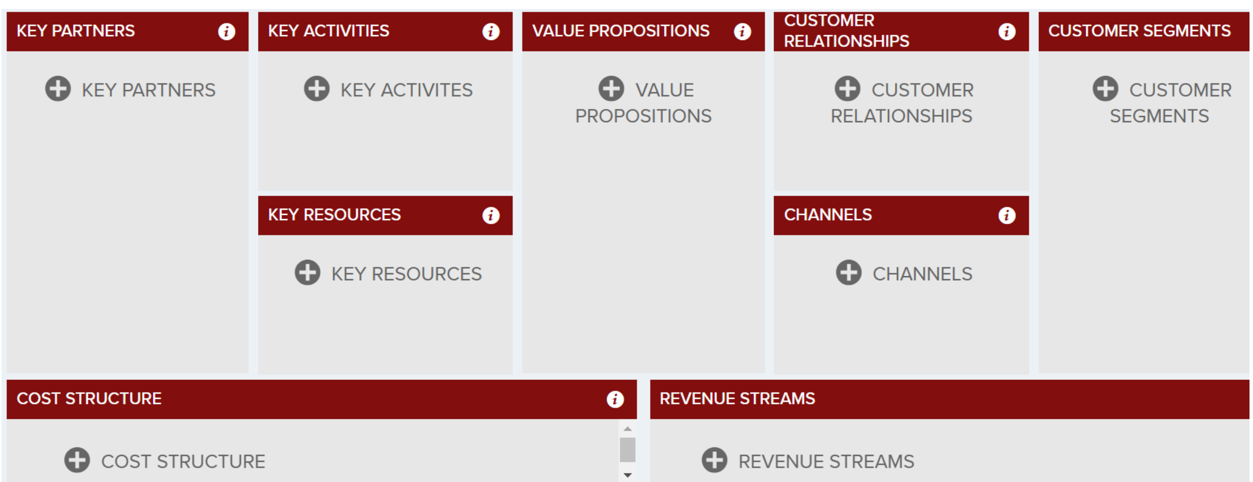

Figure 13 Business Model Canvas template from the tool CurateFX

The headlines from the canvas are listed below in the order which they are normally presented, with the input from the CIM pilot project.

Value propositions

These are the identified values for the CIM pilot functionality:

- Data about current and planned infrastructure that can be visualized
- Data about current and planned infrastructure that can reused in design of the City

Customer segments

The customer segments for the CIM pilot functionality are the following:

- Citizens
- Design teams

Channels

The channels are:

- City Information Platform or other City platform for open/shared data
- Visualization apps
- Design tools

Customer relationships

This is the City's relationship to the customers in the terms of the CIM pilot functionality and how the customer will be interested in using the data form the City:

- Hold consultations with the citizens, listen and respond to input and questions. Communicate what is planned and how and when they can give input.
- Contractual relationship with design teams. Listen to input on what data they need to do succeed in their job

Revenue streams

The City do not charge for the data that they provide, but if the CIM pilot functionality is fully implemented it has potential for:

- Reduced cost for administration
- Reduced cost for errors in the building process

Key resources

These are the key resources for the CIM pilot functionality

- City Innovation Platform or other City platform for open/shared data
- Current GIS data
- BIM data from projects
- Current computer systems
- Tools for collecting and providing BIM data
- Apps for visualization

Key activities

These are the key activities for the City for CIM pilot functionality to work

- Collect BIM data from projects
- Build necessary computer systems
- Make data available

Key partners

These are the Key partners to the City for the CIM pilot functionality

- Provider of BIM data collection tool
- Providers of BIM data
- Provider of City Innovation Platform or other City platform for open /shared data

Cost structure

These are the main costs connected to the CIM pilot:

- Costs for collecting data from projects, requiring BIM data
- Costs for building computer systems
- Costs for maintenance of computer systems

5.2.3. Governance

The Urban Transport Authority of Gothenburg is responsible for the CIM pilot in the IRIS project. The CIM pilot will be governed by the CIM pilot project organization as described in chapter 4.1, as long as it is just a pilot.

In the City of Gothenburg, different administrative units in the City of Gothenburg are governed by different political committees assigned by the City Council. The Urban Transport Authority is governed by the Traffic Committee. Other important partners in a realization of a future CIM are the City Planning Authority, governed by the Planning and Building Committee and Intraservice, governed by the Committee for Intraservice. The fact that important City partners in the work of implementation of CIM are governed by different political committees, is a barrier for the work towards a future all city production version of CIM. Also see organization barriers in chapter 3.2.1.7. What committee that should govern a future CIM remains to be decided.

Should any CIM pilot components become released in a production environment at the Urban Transport Authority in the future, the components will be governed according the governance model used by Urban Transport Authority, see Figure 14 below.

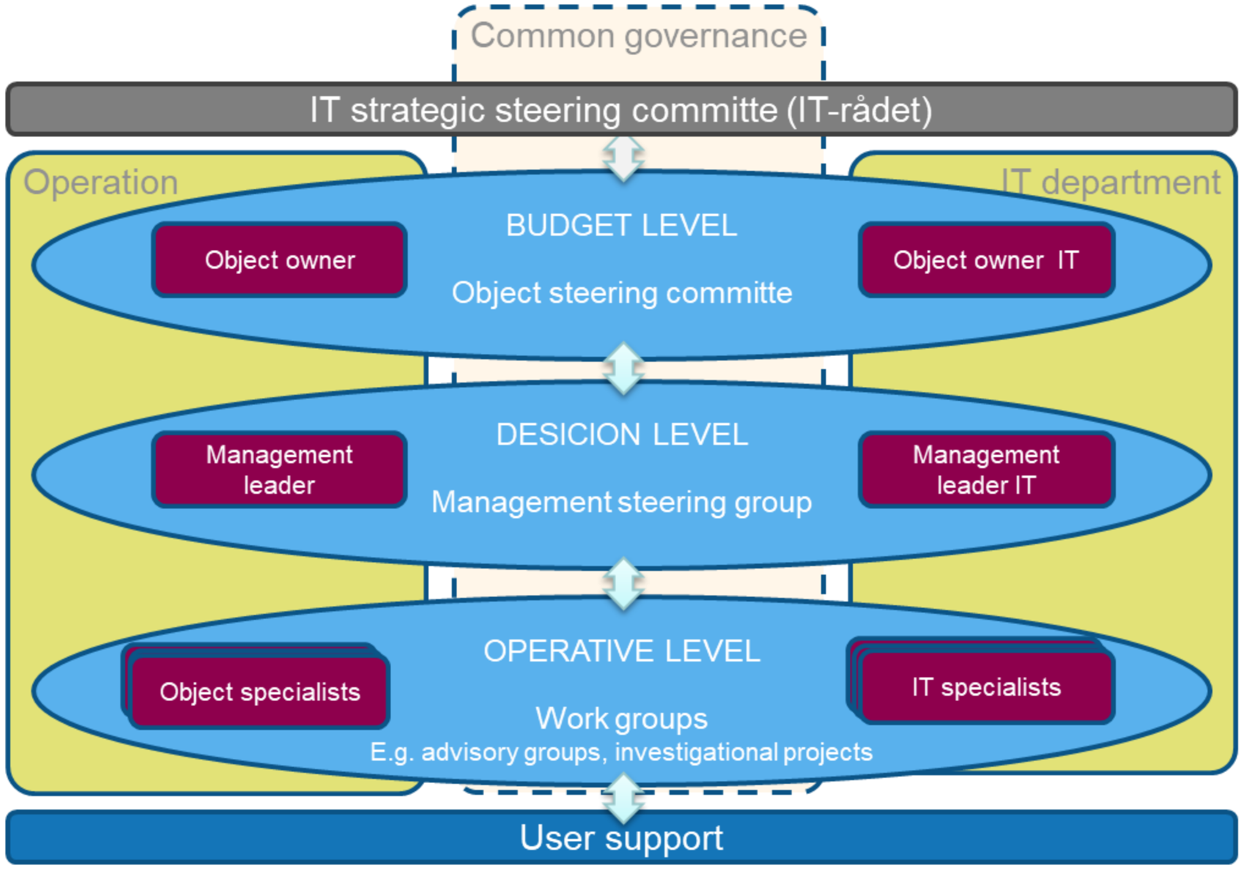

Figure 14 Governance model Urban Transport Authority

The model is based on the governance model PM3. In PM3, the governance object, called the object, is central. It is the object to be maintained and consists of e.g. processes, manuals, drawings and IT-components, such as systems and apps. The defined objects at UTA are based on core activities, supporting activities and Information and Communication (ICT) activities at UTA. Examples of objects for core activities are "Parking" and "Traffic Information", one example of an object for a supporting activity is "Human Recourses" and another example of an object for an ICT activity is "Geographical Information Systems". It has not been defined in what object a future CIM would fit in or if it would be an object of its own.

The different roles from Operation and IT Department, in the model, are described Table 6 and Table 7 below.

Operation

Table 6 Governance roles, Operation

Role	Description
Object owner	Has the overall responsibility for the operational management work within the object.
Management leader	Leads operational related management work within the object and makes sure the objectives

	of the management plan are reached, and that management products give expected value.
Object Specialists	Is the management organization contact area for the users of the object. Catch and formulate requirements from an operational perspective. Write and update user manuals.

IT Department

Table 7 Governance roles, IT Department

Role	Description
Object owner IT	Has the overall responsibility for the IT near management work within the object.
Management leader	Leads IT related management work within the object and makes sure the objectives of the management plan are reached, and that management products give expected value.
System Specialists	Co-workers that work with the object from a technical perspective. E.g. handling of requirements, interactional design, test management, technical documentation, operation and system development.

5.3. Impact Assessment

5.3.1. Expected impact

The CIM pilot will contribute in the following way to the IRIS strategic impacts:

Expected impact 1, Gothenburg City:

Improved planning management, control and maintenance for better energy and transport services for citizens and businesses:

Contribution by CIM pilot: By making data from current and future infrastructure projects available in a more accessible way as tested in the CIM pilot, planning management should be easier.

Expected impact 2, Gothenburg City:

Citizen engagement in urban development and growth.

Contribution by CIM pilot: By. making data from projects more accessible, citizens have greater opportunities to review and give input.

Expected impact 3, Participating Company, Tyréns:

Increase in value due to knowledge generation and development of business. Contribution by CIM pilot:

Tyréns will acquire knowledge about the information needs of governmental organizations. With this knowledge the city will be able to prevent the waste of information that is now taking place. The most sustainable production is to avoid new production by re-using existing products. This also applies to information products. With the CIM, Tyréns hope to find systematic methods to collect quality assured information from all parts of the City building process and make it available for re-use.

Expected impact 4, Participating Company, Tyréns:

Edge over competition due to early access to technical solutions and citizens´ needs. Contribution by CIM pilot:

By early adoption Tyréns will be able to replicate the CIM setup for major cities in Sweden and Europe. With early access to technical solutions and citizens´ needs Tyréns will strengthen the position as expert advisors within the field of smart cities.

Quantified impact 1: City Information Model implemented. The CIM pilot implementation will be one steppingstone towards a real implementation of CIM in Gothenburg.

Quantified impact 2: >10 applications developed and launched by 3rd parties. The CIM pilot implementation will hold an innovation challenge to stimulate new applications based on the CIM pilot data. The target for the CIM pilot is that more than five applications should be developed, so the CIM pilot has the target to contribute with more than five of the total number of applications developed by third parties.

5.3.2. KPIs

In Table 9 below the KPIs selected for the CIM pilot are listed. A more detailed description of each parameter is provided in Annex 2: CIM KPI parameters.

Table 9 KPIs for CIM

KPI	Parameter(s)	Baseline	Target (as described in DoW or declared)
Ease of use for end users of the solution	Ratings on the Likert scale, of “Ease of use for end users”, provided by users [integer, Likert]	N/A – The CIM pilot is new	The ambition is that the calculated average rating given by the users should be 4 or more on the Likert scale 1-5, where 5 is very Easy, and 1 is very difficult. (Not in DoW)
	Total number of users that have provided a rating of “Ease of use for end users” [integer]		
	Ratings on the Likert scale, of “Advantages for end-users”,	N/A – The CIM pilot is new	The ambition is that the calculated average

Advantages for end-users	provided by users [integer, Likert]		rating given by the users should be 4 or more on the Likert scale 1-5, where 5 is very high advantage, and 1 is no advantage. (Not in DoW)
	Total number of users that have provided a rating of "Advantages for end-users" [integer]		
Quality of open Data	Number of datasets that are DCAT compliant in CIM pilot [integer]	0.There is no CIM Pilot and there are no Datasets in the CIM pilot.	100% of DataSets in CIM pilot are DCAT compliant. (Not in DoW)
	Total number of datasets in CIM pilot [integer]		
Open data-based solutions	Number of applications using the API in the CIM pilot [integer]	0.There is no CIM Pilot API and therefore there are no applications using it.	Number of applications using the API are more than 5.
Usage of open source software	Number of full purchased solutions from one single company used [integer]	0.There is no CIM Pilot and therefor there are no solutions built with or without open source software.	No full purchased solution from one single company is used in the CIM pilot. (Not in DoW)

5.3.3. Monitoring plan

The monitoring of the CIM pilot will be done in M32-M33 and M45-M46. In Table 8 below, the monitoring plan for the CIM pilot KPIs is described.

Table 8 Monitoring plan for CIM KPIs

KPI	When monitor	How	Who is responsible	How is baseline established
Ease of use for end users of the solution	Twice, M32-M33 and M45-M46	1:st time, in workshop with users responsible for new projects and users responsible for administration of data from projects. 2:nd time, through questionnaire given to third party	Gothenburg City	N/A – The CIM pilot is new

		developers that participate in the Innovation Challenge		
Advantages for end-users	Twice, M32-M33 and M45-M46	1:st time, in workshop with users responsible for new projects and users responsible for administration of data from projects. 2:nd time, through questionnaire given to third party developers that participate in the Innovation Challenge	Gothenburg City	N/A – The CIM pilot is new
Quality of open Data	Once, M45-M46	Manual check	Gothenburg City	By concluding that there is no CIM pilot, there are no CIM pilot datasets.
Open data-based solutions	Once, M45-M46	Manual check, how many applications exist after Innovation Challenge	Gothenburg City	By concluding that there is no CIM pilot. There are no open data based solutions based on an API from a non-existing CIM.
Usage of open source software	Once, M45-M46	Manual check	Gothenburg City will collect the information. Tyréns will provide information on their part of the solution.	By concluding that there is no CIM pilot. There is no software used (open source or not) in a non-existing CIM.

5.4. Commissioning Plan

The purpose of commissioning is to verify and record that equipment and/or systems comply with the design specification and that construction is done accordingly. This process considers all the process steps from design till completion. The next table, Table 9, shows the high-level commissioning plan for the CIM pilot.

Table 9 Commissioning Plan

Phase	Activity	Parties involved	Responsibility	Relevant standard
1 Design	Identifying BIM requirements suitable for UTA Identification of use cases and creation of functional requirements	City of Gothenburg Tyréns City of Gothenburg Tyréns City of Gothenburg, Tyréns	Provide input on BIM requirements Create draft BIM data requirements Collect input from reference groups Assist in collecting input Write functional requirements with use cases Assist in writing functional requirements	
2 Engineering	Identify need for development	City of Gothenburg, Project management Tyréns Project management	Identify need for development from the City Identify need for development from Tyréns	
3 Contracting	Contracting technicians, software developers	City of Gothenburg Project management	Make sure to have contract with relevant technicians, software developers	
4 Realization	Set up test CIP	City of Gothenburg, server architect City of Gothenburg software developers	Set up docker environment Configure relevant CIP/FIWARE components	

	Set up CIM data Catalogue and CIM data retrieval tool Build BIM data collection tool Build Visualisation App Deploy solution	City of Gothenburg software developers Tyréns software developers Tyréns software developers Tyréns software developers City of Gothenburg software developers	Configure CKAN Build BIM data collection tool Build Visualisation App Create a deploy package. Deploy solution on City of Gothenburg test CIP Assist Tyréns	DCAT
5 Testing	Unit testing User evaluation	Tyréns software developers City of Gothenburg software developers Tyréns software developers City of Gothenburg project managers	Test that BIM data from projects can be uploaded and validated in BIM data Collection tool Test that successfully uploaded BIM data is shown and can be accessed in CIM data catalogue/ CIM data collection tool Test that visualisation app can show successfully uploaded BIM data Test the usability of BIM data collection tool Test the usability of CIM data retrieval tool/CIM data catalogue for planned projects Test the usability of CIM data retrieval	

	Test-CIP evaluation	App developers City of Gothenburg server architects	tool/CIM data catalogue for app development Evaluate the test CIP as a platform	DCAT
6 Completion	Approve the CIM pilot implementation	Steering Committee, CIM pilot, UTA Tyréns project Management	Approve the CIM pilot implementation from City of Gothenburg Approve the CIM pilot implementation from Tyréns	

Please note that at Gothenburg Urban Transport Authority, commissioning is normally done by a delivery of project results to the Commissioning & Support Department. Since the CIM pilot is a pilot it will not be delivered to the Commissioning and support department.

5.5. Implementation plan

The plan is divided into two parts. One describes the plan for the work done until implementation of the pilot and the other one is an overview of the milestones after pilot implementation.

5.5.1. Time plan for the work up until pilot implementation

Figure 15 below is an overview of the time plan up until the pilot is implemented. The implementation of the CIM pilot has been postponed and was planned to be ready for demonstration at the end of December 2019 instead of September 2019. Due to the need to prioritize other projects at UTA, this date, had to be postponed one more time until February 2020. The last change of date does not show in the time plan in Figure 15, but in Figure 16.

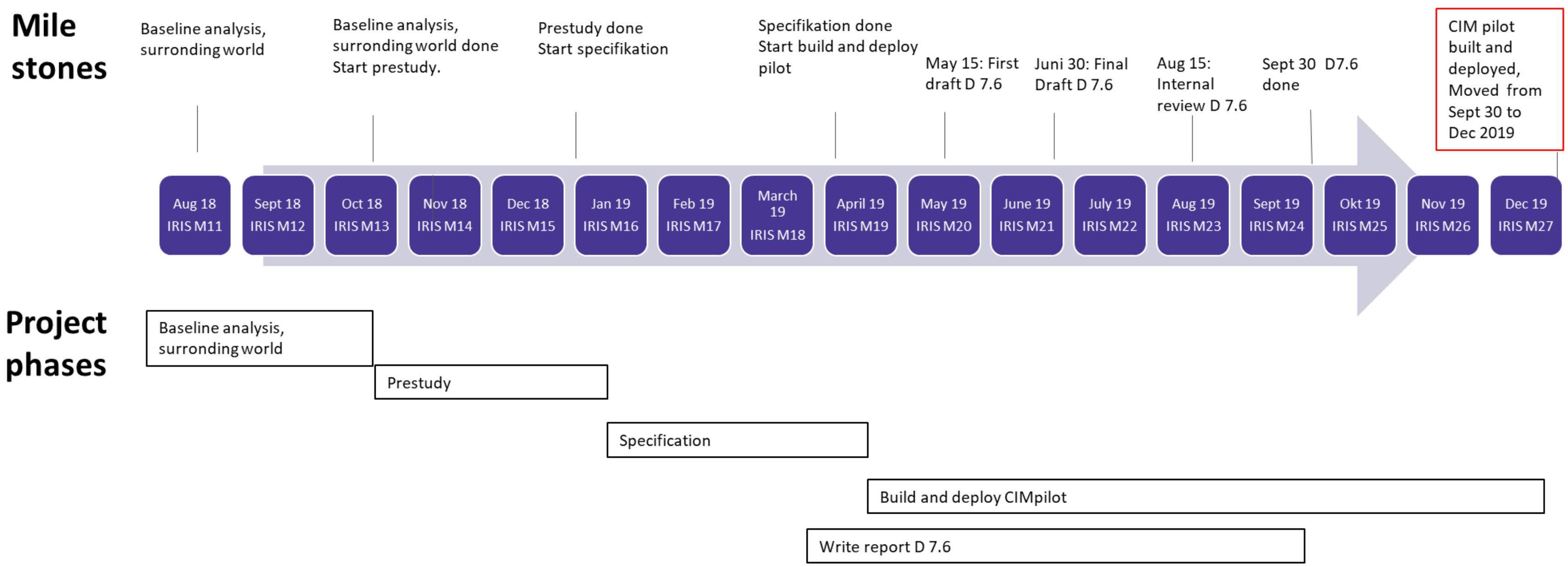

Figure 15 Time plan CIM pilot M11-M27

5.5.2. Overview milestones after CIM pilot implementation

See the Time plan in Figure 16 below for the major milestones for the CIM pilot after first implementation. Depending on the secrecy and security issues described in chapter 5.5.6.8, there are uncertainties about the possibility to proceed with the innovation challenge as planned. During the autumn 2020, the UTA need to make sure to have at least some BIM data to share if it should be possible to proceed with the innovation challenge.

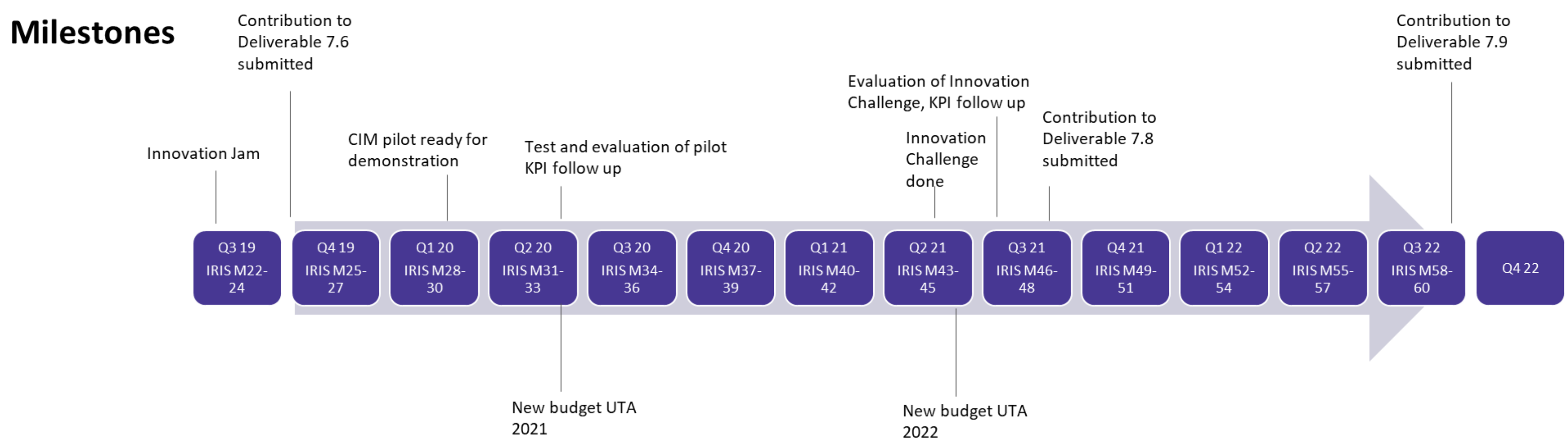

Figure 16 Overview milestones after CIM pilot implementation

Depending on the results of the CIM pilot evaluation and the new budgets for UTA, the UTA will decide if the CIM pilot will be developed further and how.

5.5.3. Planning of activities

5.5.3.1. Pilot implementation

In the Gantt chart in Figure 17 below are the planned activities for the pilot to be completed before January 2020.

Aktivitet	Start	Slut
D 7.6 Report Creation Activities	**fr 19-03-01**	**må 19-09-30**
Create initial Report	fr 19-03-01	fr 19-04-12
First Draft	fr 19-04-12	on 19-05-15
Input from Steering Committee UTA GOT	on 19-06-12	fr 19-06-21
Final Draft	on 19-06-12	sö 19-06-30
Internal Review IRIS	to 19-08-01	to 19-08-15
Update report after Internal review	to 19-08-15	må 19-09-30
D 7.6 ready	må 19-09-3(	må 19-09-30
Pilot implementation phase	**on 19-04-03**	**ti 19-12-31**
Purchase/decide on supplier of CIM Data Retreival Tool	to 19-04-04	fr 19-06-28
Set up of necessary CIP componets for CIM demo	fr 19-03-01	sö 19-09-01
Development BIM Data Collection tool	fr 19-03-01	lö 19-08-31
Development of BIM Data Retreival APIs	on 19-04-03	lö 19-08-31
Plan and organize Innovation jam	on 19-04-03	to 19-09-05
Innovation Jam	to 19-09-05	to 19-09-05
Configuration and development of CIM Data Catalogue	on 19-05-01	må 19-09-30
Development of CIM visualization tool	on 19-05-01	fr 19-11-15
Development of CIM Data Retreival Tool	to 19-08-15	fr 19-11-15
Deploy Pilot	fr 19-11-15	sö 19-12-15
Pilot ready for demonstration	ti 19-12-31	ti 19-12-31
Describe evaluation criteria and plan how to evaluate	ti 19-10-01	ti 19-12-31
Document technical solution	on 19-04-03	ti 19-12-31

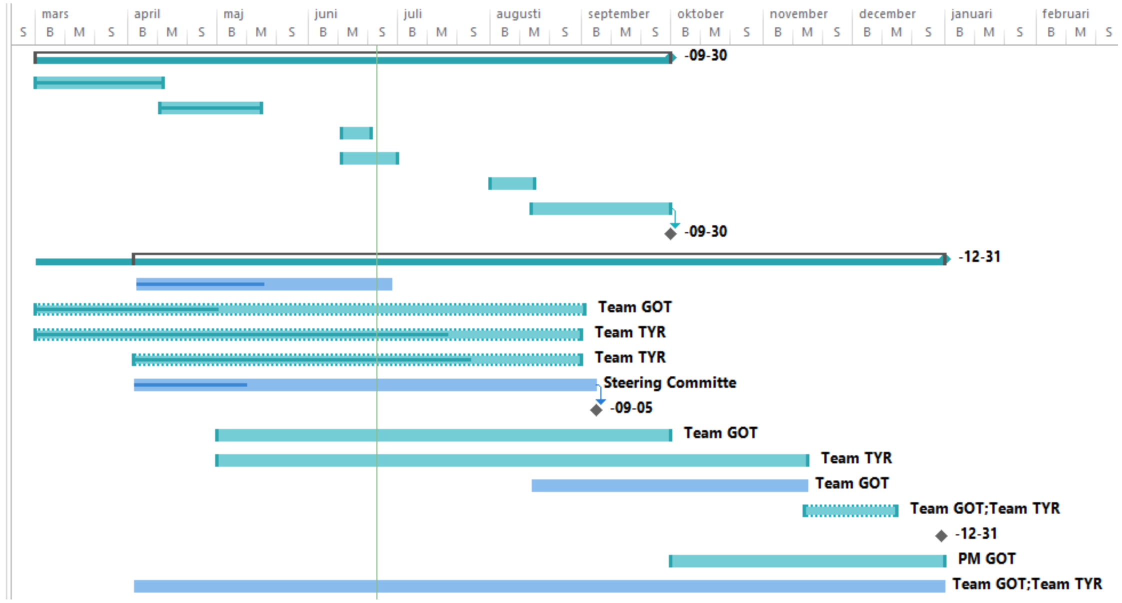

Figure 17 Activities until CIM pilot implemented

5.5.3.2. Evaluation and development of pilot during the rest of the IRIS project

The Gantt chart in Figure 18 below shows the foreseen activities for the rest of the IRIS project period, from the date when the first version of the pilot is ready until the IRIS project ends. These activities might increase if the pilot proves to be successful and the Urban Transport Authority provide or receive complementary budget.

Aktivitet	Start	Slut
Evaluation and development of Pilot 2020	**on 20-01-01**	**to 20-12-31**
Technical Evaluation	on 20-01-01	to 20-04-30
User Evaluation	må 20-03-16	fr 20-05-29
1:st KPI Follow up	fr 20-05-01	ti 20-06-30
Plan Innovation Challenge	må 20-08-17	to 20-12-31
Technichal Update for Innovation Challenge	to 20-10-01	to 20-12-31
Evaluation and development of Pilot 2021	**fr 21-01-01**	**fr 21-12-31**
Preparation Innovation Challenge	fr 21-01-01	on 21-03-31
Innovation Challenge	to 21-04-01	fr 21-05-28
Evaluation Innovation Challenge	må 21-05-31	on 21-06-30
Evaluation Thirdparty developers	to 21-04-01	on 21-06-30
2:nd KPI follow up	må 21-05-03	on 21-06-30
Contribute to deliverable 7.8	to 21-04-01	to 21-09-30
Evaluation and development of pilot 2022	**må 22-01-03**	**fr 22-09-30**
Contribute to deliverable 7.9	fr 22-04-01	fr 22-09-30
Unpurchased/ unwanted pilot components are remove	må 22-08-01	fr 22-09-30

Figure 18 Activities 2020-2022

5.5.4. Planning of costs and (equipment) investments

The budgets for the Urban Transport Authority are decided one year at a time, thus it is not certain that budget will be provided according the cost plan. The following tables shows the cost plans for the CIM pilot.

Table 10 Summarized cost plan for the CIM pilot during entire IRIS project 2017-2022

	GOT			Tyrens			Total
Year	Personnel	Subcontractors	Travel	Personnel	Investments	Travel	
2017-2018	75 000,00 EUR	0,00 EUR	0,00 EUR	70 000,00 EUR		3 000,00 EUR	
2019	125 000,00 EUR	100 000,00 EUR	2 000,00 EUR	250 000,00 EUR	10 000,00 EUR	3 000,00 EUR	
2020	73 000,00 EUR	40 000,00 EUR	2 000,00 EUR	55 000,00 EUR		2 000,00 EUR	
2021-2022	40 000,00 EUR	35 000,00 EUR	4 000,00 EUR	55 000,00 EUR		3 000,00 EUR	
Total	**313 000,00 EUR**	**175 000,00 EUR**	**8 000,00 EUR**	**430 000,00 EUR**	**10 000,00 EUR**	**11 000,00 EUR**	**947 000,00 EUR**
Finaced by IRIS	130 000,00 EUR	105 000,00 EUR	2 000,00 EUR	217 000,00 EUR	10 000,00 EUR	11 000,00 EUR	**475 000,00 EUR**
Financed by GOT	183 000,00 EUR	70 000,00 EUR	6 000,00 EUR				**259 000,00 EUR**
Financed by TYR	0,00 EUR	0,00 EUR	0,00 EUR	213 000,00 EUR	0,00 EUR	0,00 EUR	**213 000,00 EUR**

Table 11 Cost plan for the CIM pilot 2017-2018

	GOT			Tyrens		Total
2017-2018	**Personnel**	**Subcontractors**	**Travel**	**Personnel**	**Travel**	
Planning, baseline, analyses	30 000,00 EUR	0,00 EUR	0,00 EUR	30 000,00 EUR		
Prestudy inc POC BIM and reference work	30 000,00 EUR	0,00 EUR	0,00 EUR	25 000,00 EUR		
Steering and Project management	15 000,00 EUR	0,00 EUR	0,00 EUR	15 000,00 EUR	3 000,00 EUR	
Total 2017-2018	**75 000,00 EUR**	**0,00 EUR**	**0,00 EUR**	**70 000,00 EUR**	**3 000,00 EUR**	**148 000,00 EUR**
Finaced by IRIS	30 000,00 EUR	0,00 EUR	0,00 EUR	37 000,00 EUR	3 000,00 EUR	**70 000,00 EUR**
Financed by GOT	45 000,00 EUR	0,00 EUR	0,00 EUR		0,00 EUR	**45 000,00 EUR**
Financed by TYR	0,00 EUR	0,00 EUR	0,00 EUR	33 000,00 EUR		**33 000,00 EUR**

Table 12 Predicted costs for the CIM pilot 2019

	GOT			Tyrens			Total
2019	**Personnel**	**Subcontractors**	**Travel**	**Personnel**	**Investments**	**Travel**	
Specifikation	20 000,00 EUR	5 000,00 EUR		10 000,00 EUR			
Reportwriting activities	15 000,00 EUR			5 000,00 EUR			
Setting up test CIP components		30 000,00 EUR		30 000,00 EUR	10 000,00 EUR		
Building/purchasing/deploying pilot components		35 000,00 EUR		160 000,00 EUR			
Planning Evaluation	15 000,00 EUR						
Steering and Project management	20 000,00 EUR			10 000,00 EUR			
Technical documentation and investigations		20 000,00 EUR		10 000,00 EUR			
Reference work	20 000,00 EUR						
Unforseen	30 000,00 EUR	10 000,00 EUR		25 000,00 EUR			
Travel	5 000,00 EUR		2 000,00 EUR			3 000,00 EUR	
Total 2019	**125 000,00 EUR**	**100 000,00 EUR**	**2 000,00 EUR**	**250 000,00 EUR**	**10 000,00 EUR**	**3 000,00 EUR**	**490 000,00 EUR**
Finaced by IRIS	75 000,00 EUR	80 000,00 EUR	2 000,00 EUR	125 000,00 EUR	10 000,00 EUR	3 000,00 EUR	**295 000,00 EUR**
Financed by GOT	50 000,00 EUR	20 000,00 EUR	0,00 EUR				**70 000,00 EUR**
Financed by TYR	0,00 EUR	0,00 EUR	0,00 EUR	125 000,00 EUR			**125 000,00 EUR**

Table 13 Predicted costs for the CIM pilot 2020

	GOT			Tyrens		Total
2020	**Personnel**	**Subcontractors**	**Travel**	**Personnel**	**Travel**	
Evaluation, KPI follow up	13 000,00 EUR	10 000,00 EUR		15 000,00 EUR		
Innovation Challenge	15 000,00 EUR	5 000,00 EUR		5 000,00 EUR		
Updating of pilot components				10 000,00 EUR		
Steering and Project management	20 000,00 EUR					
Technical documentation and investigations		5 000,00 EUR		15 000,00 EUR		
Reference work	10 000,00 EUR					
Unforseen	10 000,00 EUR	10 000,00 EUR		10 000,00 EUR		
Travel	5 000,00 EUR		2 000,00 EUR		2 000,00 EUR	
Maintenace		10 000,00 EUR				
Total 2020	**73 000,00 EUR**	**40 000,00 EUR**	**2 000,00 EUR**	**55 000,00 EUR**	**2 000,00 EUR**	**172 000,00 EUR**
Finaced by IRIS	25 000,00 EUR	25 000,00 EUR	0,00 EUR	25 000,00 EUR	2 000,00 EUR	**77 000,00 EUR**
Financed by GOT	48 000,00 EUR	15 000,00 EUR	2 000,00 EUR			**65 000,00 EUR**
Financed by TYR	0,00 EUR	0,00 EUR		30 000,00 EUR		**30 000,00 EUR**

Table 14 Predicted costs for the CIM pilot 2021-2022

	GOT			Tyrens		Total
2021-2022	**Personnel**	**Subcontractors**	**Travel**	**Personnel**	**Travel**	
Evaluation, KPI follow up	5 000,00 EUR	10 000,00 EUR		15 000,00 EUR		
Reportwriting activities	10 000,00 EUR			5 000,00 EUR		
Updating of pilot components				10 000,00 EUR		
Steering and Project management	10 000,00 EUR					
Technical documentation and investigations				15 000,00 EUR		
Reference work	5 000,00 EUR					
Unforseen	5 000,00 EUR	5 000,00 EUR		10 000,00 EUR		
Travel	5 000,00 EUR		4 000,00 EUR		3 000,00 EUR	
Maintenance		20 000,00 EUR				
Total 2021-2022	**40 000,00 EUR**	**35 000,00 EUR**	**4 000,00 EUR**	**55 000,00 EUR**	**3 000,00 EUR**	**137 000,00 EUR**
Finaced by IRIS	0,00 EUR	0,00 EUR	0,00 EUR	30 000,00 EUR	3 000,00 EUR	**33 000,00 EUR**
Financed by GOT	40 000,00 EUR	35 000,00 EUR	4 000,00 EUR			**79 000,00 EUR**
Financed by TYR	0,00 EUR	0,00 EUR		25 000,00 EUR		**25 000,00 EUR**

5.5.5. Risk management

Risks are continuously monitored and handled in the project. Risks constitute a mandatory agenda item at the Steering Committee meetings at the Urban Transport Authority. Figure 15 below shows the highest open risks for the moment.

Table 15 Risk overview working document

Risk type	Risk description	Mitigating action	Contingent action	Progress on actions	Status	Probabilit	Impact
Management	BIM data cannot be shared due to uncertanities about secrecy and security classification. If data cannot be shared it will be hard to get app developers to develop interesting apps based on data that we cannot give access to.	Clarify what can be shared or not openly. Start work to classify BIM data. Steering Committee at UTA is to investigate possible consequenses of sharing of the BIM data further.	Treat it as a valuable finding. Have innovation challenge as a closed happening	Steering Committe at UTA see the sharing of data as a security risk, and do not want to allow the sharing until further investigation has been done by them. The Innovation challenge is postponed.	Pending	High	High
Management	The budget from EU and UTA will not cover all the future forseen costs in 2022. We might not be able to do everything as promised in GA	Agree on ambition level at UTA. Rise to project management of IRIS and see if we could get more budget. If not the UTA will have to add more budget or resourses before 2022		Budget and activites have been looked over. Some work is still needed for 2022, to make sure we have budget for that period also.	Pending	High	High
Management	Lack of input from other departments on UTA than IT. The risk is that the solution will not be usable/valuable for real.	Get other departments at UTA involved Raise to Steering Committee at UTA	Try to adopt afterwards and provide the findings/lessons learned to future implementations	A specified request for input from other departments of UTA has been raised to the steering committe at UTA New person from department for management of constructions is	Pending	High	High

5.5.6. Progress achieved up to M24

The following chapters describes the progress, results and lessons learned in the project so far.

5.5.6.1. Analysis of digitalization of the building sector

To understand more about BIM, the project started with an analysis of how the close by surrounding world are working with BIM and digitalization of the building sector and what are the benefits of using BIM. The following are some conclusions:

Digitalization of the building sector has led to a new way of working using 3D models and digitalization of the construction process i.e. BIM. BIM is more than just a 3D model; it is an object based working method where all production aspects are integrated.

Instead of making mistakes in the physical environment, the focus is to detect as many problems as possible in the early phases with the help of BIM. In BIM, both function- and collision control can be done as well as common reviews of models etcetera. It means a transfer of working hours from the physical to the virtual world where problems can be discovered early in the process, and solutions are developed. In addition, there are several possibilities with visualization. These digital documents are perceived to have great value both now and in the future.

EU has identified the value of BIM and produced a handbook on how to use BIM in the public sector. See [6] Handbook for the introduction of Building Information Modelling by the European Public Sector. The introduction of the handbook points out that there are up to 25% savings by using BIM. The handbook is very focused on helping the public sector getting started with BIM and to be a better client with the help of the policies and processes.

Swedish Transport Administration- STA

BIM was primarily intended for buildings, but, within the last few years, BIM has been developed to also cover infrastructure. In 2013, the Swedish Transport Administration developed a BIM strategy with the aim of urging a new way of working.

STA has discovered several challenges mostly in standardization, due to BIM being relatively new and lack a standard for information exchange. The transport administration has developed requirements where BIM information (i.e. 3D models etc.) should be delivered both in its original format and in a de facto standard format i.e. IFC. Through BIM Alliance, a general Swedish BIM organisation, STA and others can raise development issues and have a dialogue with suppliers about BIM. See [3] BIM Alliance homepage.

STAs ambition is that all larger projects should be coded according to CoClass, which is the new Swedish digital classification system for all built environment, see chapter 5.5.6.4.

Even though the Swedish Transport Administration have been working with BIM for several years, they have not had time to reach all the way through their construction process. Specifically, the benefits of BIM have not come into the operation and maintenance process. The cause for that has primarily to do with need for skills enhancement and new ways of working to manage the models. The question of who should manage the model is not really responded yet.

The Swedish Association of Local Authorities and Regions

The Swedish Association of Local Authorities and Regions have produced a report on the situation with BIM within the municipalities and county councils, [4] BIM – digitalisering av byggnadsinformation i OFFENTLIGA FASTIGHETSORGANISATIONER.

In this report, an analysis of the public sector in Sweden is done, and among other things, it is noted that there is almost no BIM competence on the client side in most organizations. There would be a substantial gain to increase the degree of digitalization in working methods and to establish clear guidelines for the management and archiving of digital data and models. However, it is a big challenge to establish new ways of working within many organizations that are already strained.

Smart Built Environment

The City of Gothenburg and Tyréns are part of the strategic innovation program “Smart Built Environment”. See [5] Smart Built Environment homepage. The program outlines how the built environment sector can contribute to Sweden’s journey to the global forefront of the new opportunities of digitalization, so that intelligent, sustainable cities can be achieved, the City’s resources can be managed more efficiently and carbon emissions can be reduced. The program points out that unbroken information flow with business-driven applications within BIM, GIS and industrial processes creates benefits for companies, users and society and increases the potential to utilize all the possibilities of digitalization.

Identified benefits of using BIM are:

- A reduction in the number of 2D drawings when everyone works in a 3D model
- All project members work in the same model
- Reduce costs for visualization since everyone is working in one model
- It is easier to make revisions
- One modification in the model will modify all the related information
- Fewer documents to keep track of
- Common review, function control and collision control between different actors become easier
- Quantity management and quality assurance become more efficient since it can be created straight from the model
- Modification and supplementary work are facilitated because changes can be made straight in the model and from it all drawings can be created. Quality control is done via the model
- Increased citizen dialogue during project planning (Visualization)
- Increased understanding for politicians (Visualization)
- Increased connection between projects
- Reduction of costs due to collisions, misconceptions or miscalculations.
- Reduction of the number of necessary modifications through visualization in all phases.
- Less expensive and quicker start-up for projects.

For the CIM pilot project the UTA have decided to focus on the benefits of visualization and the fact that BIM use will simplify common review and collision control in and between different projects. These benefits where the most important when the BIM requirements below was specified.

5.5.6.2. Proof of Concept Experience

FIWARE Proof of Concept at the Urban Transport Authority

FIWARE is a curated framework of open source platform components to accelerate the development of smart solutions, see [15] FIWARE homepage. Early in the IRIS project the Urban Transport Authority, started investigating the FIWARE tools and components since they are major building blocks of the City Innovation Platform. The Urban Transport Authority did a simple Proof of Concept (POC) to evaluate if FIWARE, and the FIWARE tools, could be used by the Urban Transport Authority for their needs. This POC was also an important step to learn more about FIWARE. The POC was done using parking data specifically and data from traffic signals to verify the real time event mechanisms.

The findings in that test were:

- The FIWARE platform has potential to cover the needs of the Urban Transport Authority as a platform for shared data.
- Prerequisites exist to share data in a structured way
- Urban Transport Authority could minimize their own development
- By using a combination of FIWARE extended CKAN, FIWARE Orion Context Broker and FIWARE Keyrock Identity Manager administration could be simplified when it comes to shared data and access rights.
- Regarding Parking Data specifically, the CKAN/DATEX II data model in FIWARE can be used to publish parking data. The data model is different and not as complete as the UTAs own data model, but it is relatively easy to add data outside of the data model

- The FIWARE Geoserver can be used for open Geodata and in combination with other FIWARE components it will likely reduce the need for the UTA to do development on their own.
- The tool FIWARE Orion Context Broker is a good tool for publishing real time events

The remaining questions after the pilot were:

- How can a small city, as Gothenburg affect the established models and standards for example within CKAN?
- How does the City of Gothenburg establish their own FIWARE environment?

Based on the outcome of this POC the City of Gothenburg decided to continue to evaluate FIWARE and is a FIWARE frontrunner city.

Proof of Concept BIM and CIP

To understand how the CIM pilot technically would be set up and be connected to a future City Innovation Platform the CIM pilot project did another Proof of Concept in cooperation with CIVITY. The POC tested to Collect, structure, validate and communicate BIM data via a very simple test version of CIP provided by CIVITY. The idea was to test the entire chain from import of BIM data, validation, filtering, storing and visualization, for a simple Data Set.

Figure 19 below is a schematic picture of how the POC was set up.

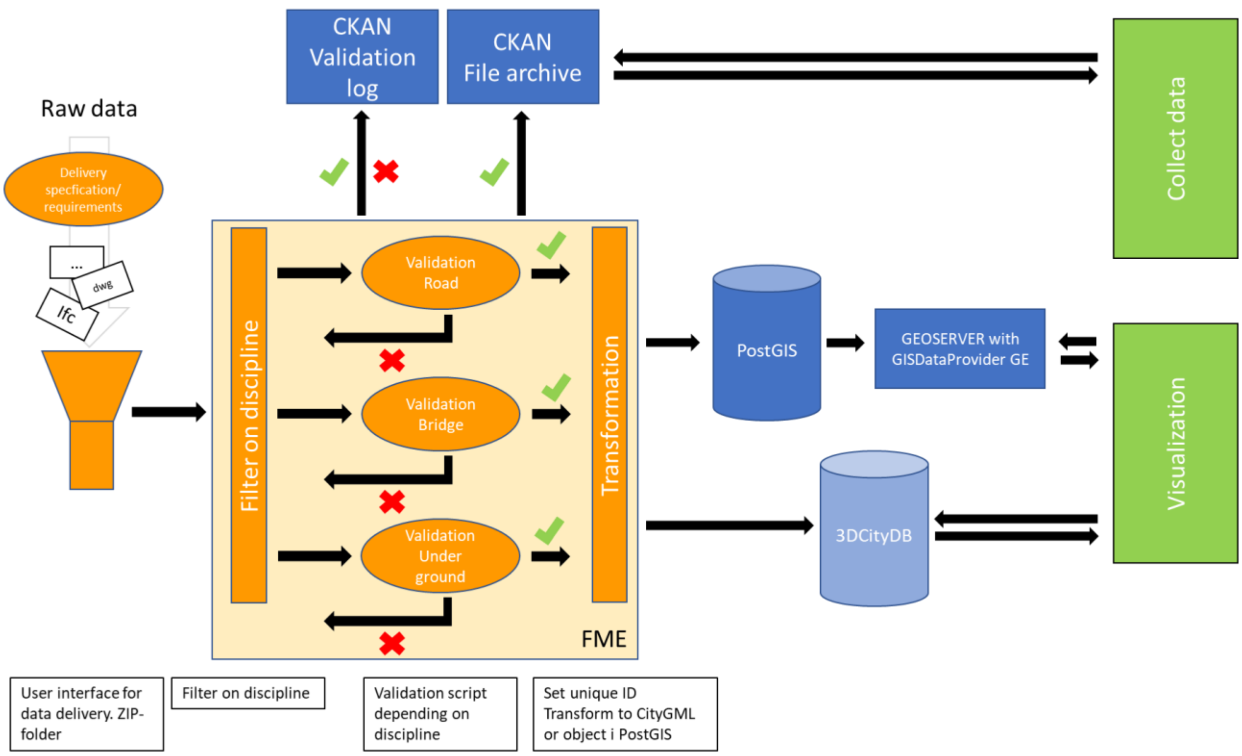

Figure 19 Schematic set-up of POC

The conclusions of lessons learnt in this POC are:

- There is a need for BIM standards. As of now the CIM pilot project has to find their own way of filtering BIM data. There is a need for national standards as well as project standards.
- The validation of data is important, not only from a data integrity perspective but from the user perspective. The validation process needs to provide a thorough and relevant feed-back.
- The georeferencing is a challenge. It is important to provide a secure method for the user to geographically reference the imported models.
- The automated process takes time. Investigations have to be done on how to speed up the process and maybe investigate running parallel processes in the background.
- General presentation attributes such as color and textures need to be further investigated. The visual representation is important.

This way the City of Gothenburg also built valuable knowledge on how to create the test platform which is needed for the CIM pilot.

5.5.6.3. BIM, BIM Requirements and the Technical Manual for infrastructure projects

BIM data is the most essential part of the CIM pilot. Before the IRIS project the Urban Transport Authority did not officially require any BIM data from projects and did not have means for receiving, saving and administrating this type of data. The result is that the Urban Transport Authority initially had very little BIM data as input in the project. Recently some projects have started requiring the use of BIM and 3D modelling due to either their complex nature or that they are done together with the Swedish Transport Administration who requires this. Three of these projects thus became the reference projects in the IRIS CIM pilot. The projects are referred to as: Hisingsbron, Kville and Masthuggskajen.

The contractors working for the Urban Transport Authority are normally obliged to follow the guidelines of the Technical manual, “Teknisk Handbok”, published by the Urban Transport Authority. One of the first things that UTA did was to update the Technical manual to make sure that if a project has requirements on 3D modelling, then the Urban Transport Authority should also receive the resulting 3D model output. The first step, however, only took in to consideration to collect the 3D model in the format specified in the contract and as IFC. This will make it harder to automate the extraction of data and the categorizing of it for archiving.

Since then the CIM pilot project has worked on a more detailed specification of requirements, BIM requirements, that could be used as requirements on the infrastructure projects in terms of data delivery, 3D models and BIM data. These requirements will be tested as part of the CIM pilot to see if they can be used in the Technical Manual to get more structured data from projects that use 3D modelling and BIM, and to see if that could be used to build up the digital information about planned, future and finished infrastructure projects.

The BIM requirements have been specified for each phase in the build process. The phases in the build process, at the Urban Transport Authority are:

- Analyse
- Plan
- Carry out
    - Design
    - Produce

- Finish

The BIM requirements are also specific per information type. The information types are

- Geometry 2D
- Geometry 3D
- Textual document based data
- Survey data

5.5.6.4. The use of CoClass to have a common language in all phases

For the data in the BIM files there is a need to have a “common language”. The CIM pilot projectdecided to use CoClass for this purpose. CoClass is the new Swedish digital classification system for all built environment. Also see [7] CoClass homepage. The purpose of CoClass is to use the concept model of all parties during the entire lifecycle. With CoClass all parties get access to a joint language, i.e. the same concept and terminology in all steps, in all programs and in all information deliveries.

The Swedish Road Administration is in favour of CoClass which is an important reason for the Urban Transport Authority to use the same terminology, since these authorities have a lot in common and do many projects in cooperation. CoClass is administered by Byggtjänst, a company owned by some 30 organizations that represent the entire construction. The mission is to offer products and services that contribute to a more efficient construction process.

CoClass is connected to several international standards:

- ISO 12006-2 grant the general structure
- IEC 81346-1 grant the rules for regulations for reference term
- IEC 81346-2 grant classes for construction elements (components) and for built space
- ISO 81346-12 grant classes for construction elements (systems)

CoClass is also based on the following national and international standards:

- SS-ISO 12006-2:2015, Building construction – Organization of information about construction works – Part 2: Framework for classification
- IEC-EN 81346-1:2009 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules
- IEC FDIS 81346-2:2019 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes
- ISO 81346-12:2018 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 12: Construction works and building services

[1] See[17] Homepage of International Organization for Standardization (ISO), and [18] Homepage of Swedish Institute for Standards (SIS)

for information about the standards.

5.5.6.5. Written and agreed upon functional requirements of the CIM pilot

CIM can mean different things to different people and to clarify exactly what to demonstrate in the pilot the UTA and Tyréns have put together a functional requirements document for the CIM pilot. This document also points out who is responsible for the different CIM pilot components.

The functional requirements are based on the following theory: The Urban Transport Authority believes that collecting BIM data is a key to have an updated digital version of the City. A digital version which will create prerequisites for easier visualization and easier project planning and management. For that reason, creating the prerequisites for collecting, storing and versioning of BIM data is essential for the City. Another important thing, to achieve the benefits, is to make the data available in combination with other City data, for the citizens and the people planning and building the City.

The functional requirements are based on two use-cases which have been put together based on what is most important and achievable within the IRIS project. The CIM pilot project have collected input from the reference groups on the functional requirements so that the pilot demonstrate something which is useable for the City. The functional requirements are the base for chapter 5.1.4 and the use-cases are described in chapter 5.1.1 and 5.1.2.

5.5.6.6. Saving original design model or not as part of the pilot

The original design model is the BIM model used by design projects. During the design phase of the infrastructure project this model is updated frequently by many different people in the project. The model can consist of thousands of files which are versioned, and all linked together. For the pilot we will not collect and save the entire design model. The following is saved:

- The model in the exchange format: IFC or DWG: The theory is that the design project resaves and provides their data in this format according the BIM requirements. This should in theory be done after each phase in the project, also see the description of collection of BIM data in chapter 5.5.6.3.
- The IFC or DWG files that are provided are also saved as CityGML with the purpose of making it possible to visualize the data.
- Textual based documents e.g. investigational data.
- Databases e.g. investigational data.

Even though the CIM pilot project have decided not to save the original design model from an infrastructure project, it could have values:

- Quicker startup for new projects in the same area.
- Gothenburg as a city would be certain to get all data from the project. It is a challenge to establish and decide upon what data should be collected or not.
- Designers prefer to receive the original files and are not used to working with the IFC format.
- In areas where many changes are done on the same time it could be valuable to save, administer and update a design model for the entire area.
- New unknown requirements on desired data, that could appear in the future, would be possible to handle.
- When there is a conflict with the contractor building the infrastructure, it is good to have the original design to prove what has been agreed upon.

Some identified consequences if collecting and saving the original design model are the following:

- An original design model is provided in the format from the design program and version that the design project used. It requires a lot of resources from the City administration to have all these versions of design programs installed and the competence for handling them. Which means that they will not have the possibility to control or access the data.
- It is hard to develop a tool that validates data that could be in an unknown number of different formats, so the data in the original project model is hard to validate automatically.
- The data provided through the original design model could be data which is not owned by the City. It could also be security classified data or personal data. When the City store data and someone request this data, the City must answer to that request. If the administration does not have the tools or the competence to check the data there is a risk that this secret, or security classified information or personal data is provided unintentionally, since the personnel does not have the prerequisites to check everything.
- An original design model would require technical up to date keeping, to make sure the files can be opened in the future.
- Regular screening would be necessary.
- The storing of the original design mode will require a lot of storing capacity.

After identifying all these consequences, the CIM pilot project have decided not to handle the original model in the pilot. The main reason for this is that we do not want to take the risk that secret, or security classified data or personal data is leaked unintentionally due to the pilot project. Probably the reference projects would not provide the original design model either, because of the risk of spreading any information that should not be spread. See also the security and secrecy issues described in chapter 5.5.6.8 below.

5.5.6.7. Implementation of the CIM pilot components and specifications

During specification phase of the CIM pilot, thanks to input from the Proofs of Concept described earlier, the CIM pilot project have identified a very close relationship between the CIM pilot and the City Innovation Platform. The project has identified how the CIM pilot components should relate to the City Innovation platform. This is also described in chapter 5.1.4.5. Thus, it was clear that the City of Gothenburg needed to build a test version of the City Innovation Platform to be able to demonstrate the pilot. During 2019 a test CIP was built based on the technical solution reference architecture for CIP (D 4.4). The test CIP in Gothenburg is not a full-scale CIP but a preliminary version that has been configured with the components necessary to demonstrate the CIM pilot.

The implementation of the other CIM pilot components according to the functional requirements, are been implemented as well, but the time plan on when to be finished with the pilot implementation has been prolonged. The reason for this was that the City have had some problems finding the right technical resources.

Regarding technical specifications and documentation, the project decided not to specify too much in advance. It is hard to specify to much details beforehand as this is new ground to the project participants. The project also wants to work in agile way. The technical specifications will be produced during implementation to document what have been done and make the solution replicable. We have however started creating technical documents for:

- Configuration of components on City Innovation Platform
- APIs
- Architecture

5.5.6.8. Identified secrecy and security issues

Today infrastructure projects at Urban Transport Authority does not have any unified guidelines as of how to classify different types of BIM data when it comes to security or secrecy. This could be data that should not be spread due to the risk for malicious attacks, but it could also be that the project is in a certain phase in the procurement process and cannot spread data in order not to risk the upcoming procurement. Due to this the infrastructure projects follow the principle that it is better not to spread any data at all, rather than risking spreading data which should not be made available. This is a challenge for the CIM pilot project, as an objective is to have several external applications that are built based on the CIM data we are providing. As a result, the project has identified that a classification on level of secrecy should be in the general BIM requirement. Also, this classification must be handled by the system to collect the data, in the pilot named the BIM data Collection tool and by the tool to share the data, the CIM data catalogue. These tools must be able to handle the data that has been classified on different levels of accessibility, which are unknown for us in the CIM pilot project today. For the pilot implementation the ambition is to test some basic classification, but this will need to be investigated further.

One possibility is also to find more or other reference projects, hopefully more open to spreading data.

The issues with secrecy and security might be so challenging that the ambition to have an innovation challenge based on open data, based on BIM data from the reference projects, is not possible or worth the effort.

5.6. Conclusion

Chapter 5 describes the vision for the CIM pilot components and sums up the work done and planned for the CIM pilot task by the City of Gothenburg and Tyréns.

The City of Gothenburg is just in the starting phase of building a digital twin of the City. The IRIS CIM pilot is one stepping stone towards the goal. The core in the IRIS CIM pilot is to implement a structured way of collecting and storing BIM data from projects so that this data can be made accessible together with other necessary City data for project management and planning and for visualization for citizens. The CIM data should be provided through APIs. To test the usability of the APIs and demonstrate how they could be used, two demonstration tools will be built. The tools are built to illustrate the two defined use cases: “Visualize your city” and “Kick start your project”.

The first phase of the project has identified that there are several benefits of requesting and collecting BIM from a city perspective, but the work in terms of collecting BIM data for the City and in other municipalities in Sweden is immature and it is harder than expected to get hold of BIM data from the City of Gothenburg. Uncertainties also remains about how to handle different level of secrecy of the information in the BIM data. One challenge the City has is to decide what data to save and what data to discard. To save all data can be challenging for the personnel that needs to manage it.

The CIM pilot is closely related to the City Innovation Platform, and the pilot is designed in such a way that it is dependent on the components of the City Innovation Platform. Thus, a test version of the City Innovation Platform needs to be built to start implementing the CIM pilot. Close cooperation with the work done in WP 4 have been necessary and will continuously be necessary. The City of Gothenburg have no obligations to implement the CIP and might decide not to. This will affect the way ahead for the CIM pilot components and how they can be used and implemented in a larger perspective.

The CIM pilot is planned to be ready for demonstration in February 2020. In 2021 the City of Gothenburg plan for an innovation challenge, if the uncertainties regarding what data can be shared is solved. The purpose of an innovation challenge is to attract external app developers to develop applications on the new available data. Also, this is a way to connect to application developers and get feedback on the APIs and the usability of the data.

The plan is that the CIM pilot will be evaluated in Q2 2020 and after the Innovation Challenge. Depending on the results of the evaluation the Urban Transport Authority will decide how to proceed with the CIM pilot.

6. Demonstration of an "Energy Cloud" on the Chalmers Campus

6.1. Specifications

Due to the delay of the project caused by a switch in project partners, the detailed specification of the Energy Cloud demonstrator is still to be finalized in the ongoing work in sub-task 7.6.2.3 that will be concluded in Q4-2019. The overall specification of the measure is defined as follows.

The purpose of the Energy Cloud demonstrator is to showcase the value of easy access to structured energy data to promote and support reduction of energy consumption in buildings – initially at Chalmers Campus and in the Gothenburg City and eventually in Sweden, Europe and the rest of the world. The objective includes demonstrating how efficient building management, development and replication of innovative energy services can be accelerated by the application of standardized data semantics across the real estate industry. Energy Cloud will collect energy data from buildings in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants and the data will be categorized according to a unified, semantic RealEstateCore [12] that enables easy sharing of data between stakeholders in the building sector and the smart city as well as fast replication of data-driven energy efficiency services. RealEstateCore is a common language and domain ontology that will enable control over buildings and development of new services and prepare buildings to interact with the Smart City. RealEstateCore is not aiming to be a new standard, but rather bridge existing standards and find the common denominators. RealEstateCore uses and maps such existing standards in a pragmatic manner by adding annotations. RealEstateCore is an as open source initiative and is published under the MIT License to ensure that it is freely accessible for commercial use to property owners, suppliers, integrators, etc.

Property owners can use RealEstateCore to describe the data of interaction within the buildings that they operate (see Figure 20) – as well as the management, storage, and sharing of this data. RealEstateCore covers building structures, ownership, inhabitants, technical systems, and sensors, events, etc. Having the shared language that these data schemas provide enables property owners to connect their buildings with new services on a large scale, and not have to worry about building- or technology-specific implementation details and formats.

RealEstateCore focuses on merging and bridging three domains:

- Digital representation of the building's elements (e.g. BIM and IFC)
- Control and operation of the building (e.g. Haystack= open source initiative to develop naming conventions and taxonomies for building equipment and operational data, REHVA)
- Emerging IoT technologies (e.g. SSN, WoTs and OMA SpecWorks)

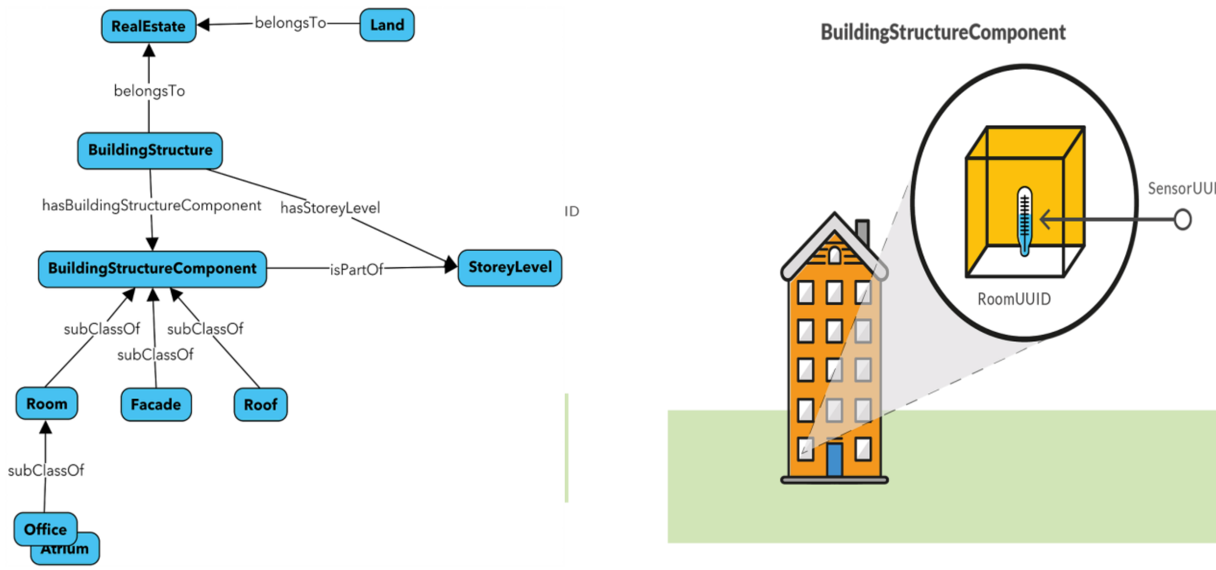

Figure 20. Example of Building Data Model and a sensor in a BuildingStructureComponent (source: REC)

The demonstrator will identify and focus on typical use case scenarios identified by property owners and application developers including easy sharing and transferring of data between stakeholders, replication of data driven energy services as well an aggregation and analysis of energy data from complex and constantly changing building portfolios.

The demonstrator will be implemented on the Metry platform, which is a cloud-based infrastructure specialized in collecting and sharing energy data that includes an API connected to the platform allowing users to give and refuse access to data. On premise installations of the platform are not possible. Clients can interact with the platform using a RESTful HTTP API. Authentication is performed using OAuth 2.0 and transmitted data is encrypted. Using the API [11], it is possible to list metering points and fetch consumption data. Consumption data is added in Metry using integrations with external systems and imports of files. Files with data can be sent to Metry using the protocols FTP, SFTP, SMTP, and HTTP(S). Consumption data can also be exported to external systems using FTP, SFTP, SMTP, and HTTP(S). The Metry platform does presently not support any advanced and standardized data structure semantics nor does the data management tools utilized by participating real estate companies or application and energy service providers. This reflects the general status in the industry.

6.2. Societal, user and business aspects

6.2.1. Citizen engagement

The implementation of the Energy Cloud will provide a platform for rapid replication of energy service applications including services that promote energy consumption awareness among property owners, property managers as well as their tenants and the energy end user. In order to inspire innovation in the field of energy related citizen engagement applications, the intention is to organize a hackathon based on access to Energy Cloud data during the evaluation period.

6.2.2. Business model

Since the final and detailed specification for the Energy Cloud demonstrator is still to be defined a detailed analysis and specification of an appropriate and efficient business model is not possible. This task is however included in the coming sub-tasks and in particular sub-task 7.6.2.6 "Live demonstrator launch". The Value Proposition for the demonstrator is however straight forward and predictable and includes to collect, structure, store and support sharing of energy data through a web-based cloud service (e.g. "Dropbox" for energy data). Based on experience from existing cloud based data services, including the business model already applied and proved by Metry for its existing data collection- and management services, it could be assumed that a SaaS-model could be readily applied based on amount of data or data sources managed in the Energy Cloud.

6.2.3. Governance

The governance model for the Energy Cloud demonstrator is split on a project and development phase that is followed by an evaluation and replication phase. During the project phase the applied governance model is based on an equal influence innovation collaboration between a startup/SME and a big corporate organization. This is replaced by governance model influenced by a supplier-buyer relationship during the evaluation/replication phase. The latter to put focus on and optimize value creation for all stake holders and create an efficient platform for further replication and scaling beyond the IRIS-project.

6.3. Impact assessment

6.3.1 Expected impact

The overall ambition with the Energy Cloud is to reduce energy consumption in buildings - first at Chalmers Campus of Johanneberg and Gothenburg city, then Sweden and Europe. This will be achieved by targeting one of biggest bottlenecks for data driven energy savings - access to structured energy data. The Energy Cloud will collect, structure, store and share energy data from buildings in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants using the RealEstateCore ontology.

With the Energy Cloud and its standardized energy data structure, property owners will be able to quickly scale local energy efficiency projects to their entire portfolio. Digital energy services and applications such as visualizing to tenants, building energy management systems (BEMS), energy optimization service and advanced energy research projects can also use the Energy Cloud to replicate and scale faster and at lower cost.

6.3.2 KPIs

Due to a re-start of the Energy Cloud demonstrator including a partially new project consortium and updated project objectives a new set of project KPIs based on existing IRIS KPI:s have been selected and confirmed in close collaboration with WP9. The new IRIS Energy Cloud KPI's are listed in Table 16 below.

Table 16 KPIs for Energy Cloud

KPI	Parameter(s)	Baseline	Target (as described in DoW or declared)
Quality of open Data	Number of datasets that are REC (RealEstateCore) compliant in Energy Cloud demonstrator [integer]	0.There is no Energy Cloud demonstrator and there are no Datasets in the Energy Cloud pilot.	100% of DataSets in Energy Cloud demonstrator are REC compliant.
	Total number of datasets in Energy Cloud [integer]		
Open data-based solutions	Number of applications using the REC compliant datasets in the Energy Cloud demonstrator [integer]	0.There is no Energy Cloud demonstrator and therefore there are no applications using it.	Number of applications using the REC compliant datasets in the Energy Cloud demonstrator are more than 3.

6.3.3 Monitoring plan

Monitoring activities are listed in Table 17.

Table 17. Monitoring activities for Energy Cloud

KPI	When	How
Quality of open Data	During evaluation phase	Manual check
Open data-based solutions	During evaluation phase	Manual check

6.4. Commissioning Plan

Due to the re-configuration of the Energy Cloud demonstrator caused by the withdrawal of Chalmers University of Technology from the project consortium and the introduction of Akademiska Hus the projects suffer from about a 12-month delay. This means that the project now is in the middle of the process of producing a detailed demonstrator specification. Consequently, is has not yet been possible to establish a commissioning plan. According to the updated project plan this is to be established in sub-task 7.6.2.4 in Q1 2020.

6.5. Implementation Plan

The demonstrator will include contributions from IRIS Partners Akademiska Hus (AH) and Metry (METRY) as primary partners but other real estate companies such as Riksbyggen (RB), HSB (HSB) and Chalmers Fastigheter will be invited to contribute as well as a selected number of digital energy service providers. This project consortium will capture a wide spectrum of user requirements and use case scenarios, from advanced energy research to commercial facility and property management.

The demonstrator will be organized and executed in 4 project phases and 9 sub-tasks according to Table 18 and Figure 21.

Table 18 Energy Cloud project phases and sub-tasks

Ongoing
7.6.2.0 Projectmanagement
Pre-study & preparation phase
7.6.2.1 Make Inventory of similar project, initiatives & standards
7.6.2.2 Stakeholder needs and requirement analysis
7.6.2.3 Demonstrator priorities & specification
Implementation phase
7.6.2.4 REC energy data ontology completion (tentative)
7.6.2.5 Implementationof REC compatible energycloud platform & applications
7.6.2.6 Live demonstrator launch
Evaluation phase
7.6.2.7 Use case testing & evaluation
Replication phase
7.6.2.8 Replication roadshow

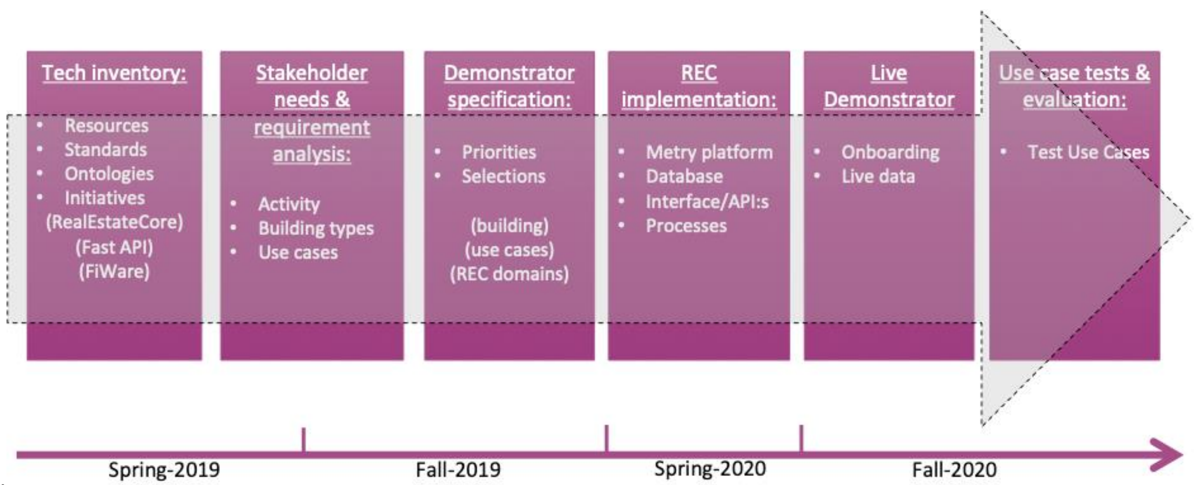

Figure 21. Energy Cloud overview – 6 initial sub-tasks focused on demonstrator implementation

The six initial work packages will be focused on preparation, implementation and evaluation of the demonstrator. These will be complemented with a seventh work package that will focus on dissemination and replication of demonstrator results and solutions.

The demonstrator will include an initial mapping activity of existing and on-going relevant initiatives to establish data standards within the real estate industry and how they relate to the RealEstateCore initiative in particular. This will be followed by a series of workshop with relevant stakeholders such as real estate companies and application developers to identify the most common hurdles and problems for efficient building management and application of energy services related to access and management of structured energy data. The final part of the preparation phase will include defining the detailed specification of the demonstrator including a priority list of the most important problems with relevant use cases to test and evaluate and also decide which concrete buildings that will be included in the demonstrator.

The detailed demonstrator specification will be implemented on the Metry platform including tools for efficient on-boarding of buildings according to the selected data ontology RealEstateCore. The Metry platform [10], which is a cloud-based infrastructure specialized in collecting and sharing energy data, includes an API connected to the platform allowing users to give and refuse access to data [11]. When the technical platform has been established the live demonstrator phase will be initiated by on boarding of all selected buildings, primarily on campus Johanneberg at Chalmers University of Technology but other buildings across participating real estate companies building portfolio will also be included. When the demonstrator is live a series of use case test, including replication/migration of energy service application and exchange and sharing of data between relevant stakeholders, will be performed and evaluated. The primary KPIs used for evaluation of the Energy Cloud demonstrator will be “Quality of Open Data” (e.g. number of REC compliant dataset) and “Open Data Based Solution” (e.g. number of applications using the REC compliant datasets).

The final replication phase will include national and international (within IRIS network) outreach and promotion events to promote experience and results to the Swedish and European real estate industry as well as a potential hackathon event to promote development of new and adaption of existing digital energy service applications compatible with the RealEstateCore ontology.

6.5.1 Planning and timeline of Energy Cloud activities

The Gantt scheme in Table 19 below outlines the timeline and resource allocation for all planned sub-tasks.

Table 19 Gantt Chart for Energy Cloud

EnergyCloud Demonstrator 7.6.2				**2019**				**2020**				**2021**			
Activity	**Metry (time)**	**AH (time)**	**TP* (time)**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Ongoing															
7.6.2.0 Projectmanagement	4	1,5		■	■	■	■	■	■	■	■	■	■	■	■
Pre-study & preparation phase															
7.6.2.1 Make inventory of similar project, initiatives & standards	0,5	0,25			■										
Interviews & research															
Reporting															
7.6.2.2 Stakeholder needs and requirement analysis	1,5	1,75				■									
Workshop 1 - focus real estate owners/managers															
Workshop 2 - focus application developers															
Workshop 3 - summary															
7.6.2.3 Demonstrator priorities & specification	1,5	1					■								
Workshop 4 - focus real estate owners/managers															
Workshop 5 - focus application developers															
Workshop 6 - summary															
Implementation phase															
7.6.2.4 REC energy data ontology completion (tentative)	0,5	0,5					■								
Workshop 7															
7.6.2.5 Implementationof REC compatible energycloud platform & applications	10	1,5						■	■						
Workshop 8 - REC onboarding															
Metry platform including onboarding tools															
AH-applications															
TP applications															
7.6.2.6 Live demonstrator launch	1	1,5								■	■				
Property onboarding															
Evaluation phase															
7.6.2.7 Use case testing & evaluation	1,5	1,5								■	■	■	■		
Workshop 9 - evaluation workshop															
Replication phase															
7.6.2.8 Replication roadshow	1,5	0,5												■	■
IRIS Swedish Energycloud seminar															
IRIS Dutch Energycloud seminar															
IRIS French Energycloud seminar															
IRIS EnergyCloud innovation contest (tentative)															

6.5.2 Planning of costs and (equipment) investments

No significant investments are planned. Costs will consist of personnel costs accumulated during the development and implementation of the demonstrator.

6.5.3 Risk management

Risks are continuously monitored and handled in the project. See below Table 20 for present risk assessment.

Table 20. Risk overview

Risk	Mitigation action	Probability	Impact
Access to relevant expert people in the define phase and stakeholder workshops	Secure Workshop priority through steering group. Early communication of dates and content	medium	high
Weak link with other demonstrators	Active promotion of Energy Cloud including Workshop activities at partner meetings + bilateral contacts	medium	medium
New priorities for project participants (another drop out)	Make sure that the “Stakeholder need” project phase put priority to formal project stakeholders vs. contributing third parties	low	high
Demonstrator will NOT be implemented and evaluated within IRIS overall timeframe	Limit the scope and prioritize execution	medium	medium

6.5.4 Progress achieved up to M24

Due to that Chalmers University pulled out of the Energy Cloud demonstrator during the initial project phase, the recent period (M12-24) has been focused on a re-configuration of the demonstrator consortium. This period has also included the definition of sharper task objective with focus on the demands and issues facing the real estate industry which are now joining the demonstrator primarily represented by Akademiska Hus. Achievements up to this date can be summarized as follows:

- A new demonstrator consortium has been established with real estate company Akademiska Hus substituting Chalmers University and a number of additional third party stakeholders (real estate companies and application developers) are planning to join providing in kind contributions.
- An updated project plan for the demonstrator implementation has been developed including a sharper task objective more focused on the challenges facing the real estate industry rather than the research community.

- The initial demonstrator implementation research & inventory sub-task 7.6.2.1 according to updated project plan has been concluded and has been successfully reported in M32.
- The second demonstrator implementation sub-task 7.6.2.2 “stake holder needs & requirement analysis” has been initiated in M32 and the work with a detailed demonstrator specification is well under way.

6.6. Conclusions

The Energy Cloud demonstrator project has been through a re-boot process due to withdrawal from initial project partner Chalmers University of Technology. The project is however now back on track with a balanced and motivated stakeholder consortium and have clearly defined objectives in line with the overall IRIS objectives as well as the original objectives for the Energy Cloud demonstrator. In fact, due to the introduction of the real estate company Akademiska Hus into the stakeholder consortium, the focus of the demonstrator has become even more relevant for IRIS from a replication point of view. The project also has an updated project plan including an updated timeline that indicates a 12-month delay. It´s however expected that the project demonstrator still will be implemented and evaluated within the time boundaries of the IRIS-project overall time plan.

7. Summary on monitoring of KPIs

7.1. Expected impact

In Gothenburg City, the CIM pilot is expected to contribute to improved planning management, control and maintenance for better energy and transport services for citizens and businesses. It should also contribute to Citizen engagement in urban development and growth. The CIM pilot is expected to contribute to the creation of the real CIM for Gothenburg and to contribute to the development of third-party applications.

For Tyréns as a company the CIM pilot is expected to contribute to an increased value due to knowledge generation and development of business. It should also contribute to edge over competition due to early access to technical solutions and citizens´ needs.

The overall ambition with the Energy Cloud is to reduce energy consumption in buildings - first at Chalmers Campus of Johanneberg and Gothenburg city, then Sweden and Europe. This will be achieved by targeting one of biggest bottlenecks for data driven energy savings - access to structured energy data. The Energy Cloud will collect, structure, store and share energy data from buildings in Gothenburg, including micro-production, EV-charging, building control systems, smart meters and tenants using the RealEstateCore ontology.

7.2. Aggregation of KPI's for Gothenburg

Each LH city has its own set of KPIs that can be related to the IRIS KPI house; the top level of the house containing the IRIS level KPIs (IL) is however the same for all cities. On solution level (STT1-5), the KPIs may vary between the cities since different solutions are implemented in each city and the cities have different objectives, but in many cases the same KPIs can be found in all cities, thus allowing comparison between the Transition Tracks of the cities. For some Transition Tracks the evaluation of integrated solutions cannot be separated and the KPIs are hence calculated at Transition Track level (TT1-5). The KPIs for each transition track and possibilities to aggregate them are presented in Table 21.

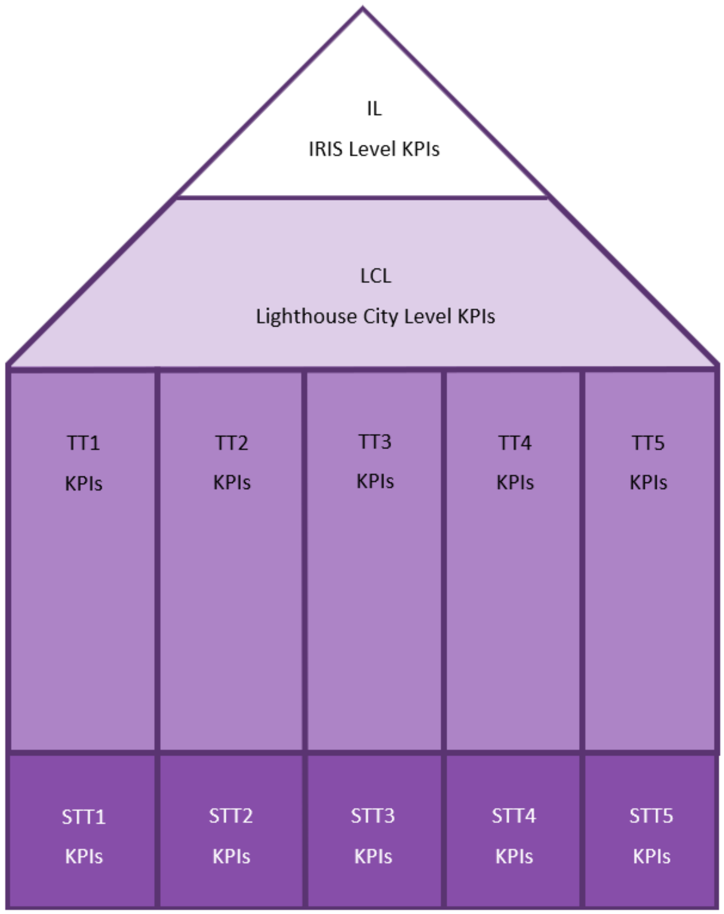

Figure 22 IRIS KPI-house. The KPIs presented in Tables 21-22 are, if possible, aggregated to transition track level (TT1-5) or higher.

Table 21. Aggregated KPI's relevant to GOT TT#4 demonstrators

KPIs	Solution	Position in IRIS KPI House
Carbon dioxide Emission Reduction	At least 200 kWh electricity storage in 2nd life automotive (bus) batteries powered by 140kW local PV Local energy storages Cooling from geo energy without chillers Heating from geo energy with heat pumps (2-300 m deep boreholes) Seasonal energy trading (cooling in summer season) with adjacent office block Energy Management System to integrate PV, DH, grid and storage Demonstration of how Building Integrated Photovoltaics (BIPV) can be used in roof and façade renovation process	STT1-4, TT1-4, LCL, IL

	A 350 V DC building microgrid utilizing 140 kW rooftop PV installations and 200 kWh battery storage A low temperature DH 45/30 system for six buildings in Riksbyggen sub-district A 1700 kWh PCM (Phase Change Material) pilot facility Integration and evaluation of a 200kWh energy storage with 10-14 2nd life Li-Ion batteries EC2B Energy Cloud	
CO2 reduction cost efficiency	At least 200 kWh electricity storage in 2nd life automotive (bus) batteries powered by 140kW local PV Heating from geo energy with heat pumps (2-300 m deep boreholes) Cooling from geo energy without chillers Local energy storages Seasonal energy trading (cooling in summer season) with adjacent office block Energy Management System to integrate PV, DH, grid and storage Demonstration of how Building Integrated Photovoltaics (BIPV) can be used in roof and façade renovation process A 350 V DC building microgrid utilizing 140 kW rooftop PV installations and 200 kWh battery storage A low temperature DH 45/30 system for six buildings in Riksbyggen sub-district A 1700 kWh PCM (Phase Change Material) pilot facility Integration and evaluation of a 200kWh energy storage with 10-14 2nd life Li-Ion batteries Energy Cloud	STT1, STT2, STT4
Open data-based solutions	City Information Model (CIM) Energy Cloud	STT4, TT4, LCL
User engagement	City Information Model (CIM)	STT4, TT4
Quality of open data	City Information Model (CIM) Energy Cloud	STT4, TT4

8. Ethics requirements

The IRIS Ethics Deliverables are consortium confidential documents that provide information on the IRIS ethics approach and are the basis for the ethics requirements described in this chapter.

D12.1 H – Requirements No.1: The scope of this deliverable is to explain how the IRIS consortium will address the identification and recruitment of participation of humans in the demonstration pilot projects and how the consortium will implement informed consent procedures for these human research participants.

D12.2 POPD - Requirement No. 2: The scope of this deliverable is to show how the IRIS consortium will address the ethical, data protection, confidentiality and privacy aspects related to the processing of personal data collected by IRIS consortium partners for the purpose of executing the project tasks.

8.1. GDPR compliance

8.1.1. Overall Lighthouse Approach

A general description of how the City of Gothenburg work in terms of GDPR can be found on [7] Homepage of GOT "How the City of Gothenburg handles personal information". In the City of Gothenburg, it is each administrative unit's responsibility to make sure that any personal data that is collected is processed lawfully, safely and properly according to the Data Protection Regulation (EU) 2016/679 and other applicable laws. Each administrative unit in the City have their own Data Protection Officer. These Data Protection Officers work together at a unit for data protection at the City.

The administrative unit responsible for the CIM pilot is the Urban Transport Authority which is governed by the Traffic Committee. A description of how the Urban Transport Authority work in terms of GDPR is described on [8] Homepage of GOT "How the Urban Transport Authority handles personal information". The Data Protection Officer for the Urban Transport Authority is Johanna Brunzell Begby. She has participated in the GDPR compliance analysis for the IRIS CIM pilot below.

8.1.2. GDPR compliance per IRIS demonstration measure

Table 22: GDPR compliance per IRIS demonstration measure

Demonstrator	In a nutshell	
#1 City Information Model pilot	Data controller:	Data controller is the Traffic Committee. They are aware of their responsibilities to ensure that EU and national data legislation regarding GDPR is followed. Correct handling is ensured through routines at Urban Transport Authority, and the Traffic Committee are not specifically informed of each project such as the IRIS project.

Demonstrator	In a nutshell	
	Personal Data:	For the CIM pilot project the only personal data collected and stored is related to the management of the development. Names and or contact information to professionals doing a contracted job for UTA, could exist in documents in the platform. The CIM pilot project will investigate how to set the requirements so that names and contact information will be disclosed from documents when they are not necessary. No other personal data will be stored in the platform and names will not be searchable.
	High risk involved:	The City of Gothenburg does not find any high risks for the CIM pilot in the IRIS project. The risks have been evaluated according to the criteria for risk assessment of the Swedish Data Protection Agency. See [9] Homepage of Swedish Data Protection Agency "Criteria for risk assessment"
	DPIA:	N/A
	Informed Consent Procedure	N/A
#2 EnergyCloud	Data controller:	Metry employees are the data controllers and will make sure appropriate access control is in place and will further ensure to follow EU -and national data legislation regarding GDPR.
	Personal Data:	Any personal data collected in the EnergyCloud demonstrator will be processed lawfully, safely and properly in accordance with the provisions of the Data Protection Regulation (EU) 2016/679 and other applicable laws to safe guard compliance with GDPR.
	High risk involved:	There is no high risk involved for EnergyCloud in the IRIS project as the data collected is non-personal, automated building- and energy data. Also, the data should only be made available to those who are authorised
	DPIA:	N/A
	Informed Consent Procedure	N/A

8.1.3. Energy Cloud

The implementation of the Energy Cloud demonstrator will include appropriate measure to secure that data protection is handled in accordance with the provisions of the Data Protection Regulation (EU) 2016/679 and other applicable laws to safe guard compliance with GDPR.

Any personal data collected in the Energy Cloud demonstrator will be processed lawfully, safely and properly.

For the Energy Cloud demonstrator, we only foresee the following needs to handle personal data:

- The personal data of employees at Akademiska Hus responsible for providing and managing access to data sources used for collection of data for the demonstrator. This could be data such as name, social security number, e-mail, phone number
- Contact info to representatives of contributing third party real estate companies and in particular employees responsible for providing and managing access to data sources used for collection of data for the demonstrator. This could be data such as name, e-mail, phone number
- Contact info to representatives of contributing third party energy service providers and external app developers in their professional role when accessing data collected in the demonstrator. This could be data such as name, e-mail, phone number.

8.2. Ethical aspects

8.2.1. City Information Model pilot

All research done in the CIM pilot will be in full compliance with the ethical principles and guidelines of the Horizon2020 and European and National legislation.

Data collection done for the CIM demonstration are

- Non-personal City Data collected through input from projects
- Non-personal Automated data from the City Innovation Platform
- Feedback from external app developers in their professional role

Thus, no human research participants are involved in the data collection that will be done in the CIM project. The feedback from external app developers will be collected in meetings where they might be requested to fill in an investigation form in their professional role.

In terms of taking measures to prevent malevolent, criminal or terrorist abuse, some of the data collected for the CIM could be data that should not be made available openly. The data collected in CIM needs to be classified and some data should only be made available to those who are authorised. Access control and security for the CIM pilot is handled using the containers called Wilma, Keyrock and Authzforce, configured on the City Innovation Platform.

8.2.2. Energy Cloud

All data collection and research in the Energy CloudEnergy Cloud demonstrator will be in full compliance with the ethical principles and guidelines of the Horizon2020 and European and National legislation.

Data collection done for the Energy CloudEnergy Cloud demonstrator will include

- Non-personal automated building- and energy data.
- Feedback and input from facility, building and energy managers and engineers in their professional role
- Feedback and input from external app and energy service developers in their professional role

Although the data collected in the Energy CloudEnergy Cloud demonstrator is not expected to be classified or would need special protection measures to prevent malevolent, criminal or terrorist abuse the data should only be made available to those who are authorised. Thus, appropriate access control and security mechanism will be specified and implemented.

9. Links to other work packages

9.1.1. City Information Model pilot

The CIM pilot has close connections to the following work packages:

WP4

The CIM pilot has a clear link to WP4. The CIM pilot use cases have given input on what CIP components are needed for Gothenburg. The CIM pilot will provide experience on implementing the parts of CIP that are relevant for the CIM pilot, the ones described in chapter 5.1.4.5. The CIM pilot have and will specifically be a frontrunner on the implementation of the saving mechanisms for 3D city data and GIS data and how this is connected to other CIP components e.g. the components for handling of security and authorization. The implementation of the test CIP needed for the demonstration is based on the deliverables from WP4, specifically D4.2 and D4.4.

The support needed from WP4 is the technical exchange of knowledge and experience on configuring and setting up the necessary CIP components.

WP8

This deliverable (D 7.6) should provide input to the replication roadmap to be created in WP8. The CIM pilot can be demonstrated on the mentor visits that WP 8 plan for and the CIM pilot could be replicated based on the technical specifications and implementation scripts to be created.

WP9

The selected KPIs to monitor for the CIM pilot have been identified in close cooperation with WP9. The evaluation planned for the CIM pilot and the measuring of the KPIs will provide input to WP9.

WP10

This deliverable (D 7.6) and the CIM pilot, when it is ready for demonstration, should provide input to communication activities and material in WP10.

WP11

This deliverable and the pilot to be demonstrated is valuable input to the WP 11 on the progress and status of the work and risks. It can be used to identify if the CIM pilot project is on the right track. Support needed from WP 11 is help in identifying, as early as possible, if the CIM pilot project needs to change or improve something in the wayof work or in intended demonstrations and deliveries.

WP12

The CIM pilot project will follow the ethics requirements specified by WP 12.

9.1.2. Energy Cloud demonstrator

The Energy Cloud demonstrator has close connections to the following work packages:

WP3

A main objective of the Energy Cloud is to demonstrate the value of applying a standardized approach when you collect, structure, store and share energy data across the real estate industry. This in order to increase the use of data to promote more efficient use of energy as well as increase the speed of replication of data driven innovative and smart digital energy services and applications. This is line with and connected to the objectives of WP3 to reduce the technical and financial risks in order to give confidence to investors for investing in large-scale replication of solutions developed and demonstrated in the IRIS project. In collaboration with WP3 we will therefore look into potential business models for the Energy Cloud that will promote replication in other EU cities with similar characteristics and how the implementation of standardized Energy Clouds in Europe will increase the speed of replication of smart data driven digital energy services across EU cities.

WP4

The Energy Cloud demonstrator will aggregate, structure, store and provide support for sharing building related energy data. A potential relevant channel for distribution and sharing of this data is through the CIP:s established across the IRIS lighthouse cities as part of WP4. For this reason, there is a particular interest in establishing a link between the Energy Cloud demonstrator and the City Information Model pilot in Gothenburg. A challenge identified in this process is however that the CIM-pilot in Gothenburg's focused on infrastructure and not building data. A dialogue is established between the two demonstrator projects with the objective to, if possible, also include some building data in the CIM-pilot that then could be integrated with an energy data feed from the Energy Cloud demonstrator.

WP8

The Energy Cloud demonstrator will provide input to the replication roadmap to be created in WP8. The Energy Cloud can also be demonstrated on the mentor visits that is planned by and organized in WP 8 and will also provide an opportunity for data driven energy applications and services developed in other demonstrators in WP7 as well as WP5 and WP6 to be more easily replicated and tested in Goteborg. The Energy Cloud demonstrator will also be easily replicated to the other lighthouse and follower cities based on the technical specifications and business model defined in the demonstrator.

WP9

The selected KPIs for the Energy Cloud demonstrator has been identified in close cooperation with WP9. The evaluation planned for the Energy Cloud demonstrator and the monitoring of the KPIs will provide input to WP9.

WP10

The Energy Cloud demonstrator will provide input to communication activities and material in WP10.

WP11

The Energy Cloud demonstrator project will have a close dialogue and interaction with WP11 to ensure efficient management and implementation of the project as well coordination with other demonstrators and work packages. Interaction with WP11 has been particularly valuable in the re-boot of the Energy Cloud demonstrator project including the set-up of a new project consortium and updated project plan.

WP12

The Energy Cloud demonstrator project will follow the ethics requirements specified by WP 12.

10. Conclusions and next steps

10.1. City Information Model pilot

The City of Gothenburg is just in the starting phase of building a digital twin of the City. The IRIS CIM pilot is one stepping-stone towards the goal. The core in the IRIS CIM pilot is to implement a structured way of collecting and storing BIM data from projects so that this data can be made accessible together with other necessary City data for project management and planning and for visualization for citizens. The CIM data should be provided through APIs. To test the usability of the APIs and demonstrate how they could be used, two demonstration tools will be built. The tools are built to illustrate the two defined use cases: "Visualize your city" and "Kick start your project".

The first phase of the project has identified that there are several benefits of requesting and collecting BIM as a city, but the work in terms of collecting BIM data in the city and in other municipalities in Sweden is immature and it is harder than expected to get hold of BIM data from the City of Gothenburg. Uncertainties also remains about how to handle different level of secrecy of the information in the BIM data. One challenge we have is to decide what data to save and what data to discard. To save all data can be challenging for the personnel that needs to manage it.

The CIM pilot is closely related to the City Innovation Platform, and the pilot is designed in such a way that it is dependent on the components of the City Innovation Platform. Thus, a test version of the City Innovation Platform needs to be built to start implementing the CIM pilot. Close cooperation with the work done in WP 4 have been necessary and will continuously be necessary. The City of Gothenburg have no obligations to implement the CIP and might decide not to. This will affect the way ahead for the CIM pilot components and how they can be used and implemented in a larger perspective.

The CIM pilot is planned to be ready for demonstration by the end of 2019. In 2021 the City of Gothenburg plan for an innovation challenge, if the uncertainties regarding what data can be shared is solved. The purpose of an innovation challenge is to attract external app developers to develop applications on the new available data. Also, this is a way to connect to application developers and get feedback on the APIs and the usability of the data.

The plan is that the CIM pilot will be evaluated after the Innovation Challenge. Depending on the results of the evaluation the Urban Transport Authority will decide how to proceed with the CIM pilot.

10.2. Energy Cloud

The Energy Cloud demonstrator project has gone through a re-boot process due to withdrawal from the initial project partner Chalmers University of Technology. The project is now back on track with a new balanced and motivated stakeholder consortium and have clearly defined objectives in line with the overall IRIS objectives as well as the original objectives for the Energy Cloud demonstrator. In fact, due to the introduction of the real estate company Akademiska Hus into the stakeholder consortium, the focus of the demonstrator has become even more relevant for IRIS from a replication point of view. The project also has an updated project plan including an updated timeline that indicates a 12-month delay. It´s however expected that the project demonstrator still will be implemented and evaluated within the time boundaries of the IRIS-project overall time plan.

Next step of the Energy Cloud project includes completion of a detailed specification of the demonstrator. This process will be concluded during Q4 2019 and trigger the start of the implementation phase as outlined in sub-task 7.6.2.4. The demonstrator implementation is expected to be completed at the end of Q2 2020 thus allow for a 12-month evaluation phase and 6-month sub-sequent replication phase within the overall time boundaries of the IRIS-project.

11. References

[2] Grant_Agreement-774199-IRIS-DEF

[3] BIM Alliance homepage
[4] BIM – digitalisering av byggnadsinformation i OFFENTLIGA FASTIGHETSORGANISATIONER
[5] Smart Built Environment homepage
[6] Handbook for the introduction of Building Information Modelling by the European Public Sector
[7] CoClass homepage
[8] Homepage of GOT "How the City of Gothenburg handles personal information"
[9] Homepage of GOT "How the Urban Transport Authority handles personal information"
[10] Homepage of Swedish Data Protection Agency "Criteria for risk assessment"
[11] Homepage of Metry AB
[12] Metry API
[13] Homepage of RealEstateCore
[14] Homepage of GOT "Open Data"
[15] FIWARE homepage
[16] CurateFX homepage
[17] Homepage of International Organization for Standardization (ISO)
[18] Homepage of Swedish Institute for Standards (SIS)

Annex 1: CIM pilot organization: Names, roles and responsibilities.

This annex and the tables below describe the current setup of persons, roles and main responsibilities of the persons in the CIM pilot project. The setup might vary over time, and for each phase of the project.

Table 23. Steering Committee

Name	Role and main responsibility in project	Organization
Maria Magnusson (Manager for the IT department)	Chairman and project owner. Budget and IT resources. Project results are in line with IT strategies	City of Gothenburg, Urban Transport Authority
Christer Niland (Manager for the department for large infrastructure projects)	Project result are in line with needs from large infrastructure projects	City of Gothenburg, Urban Transport Authority
Michael Ernfors (Manager from the department for asset management, GOT)	Project result are in line with needs from asset management	City of Gothenburg, Urban Transport Authority
Malin Andersson (Manager for the department for development and international relations)	Project result are innovative and internationally interesting	City of Gothenburg, Urban Transport Authority

Table 24. Project Management

Name	Role and main responsibility in project	Organization
Elin Dartfeldt (Digital strategist IT)	Assistant project owner GOT (until June 2019)	City of Gothenburg, Urban Transport Authority
Jonas Linderoth (Project manager IT)	Assistant project owner GOT (from June 2019 and onwards)	City of Gothenburg, Urban Transport Authority
Camilla Nordström (Project manager IT)	Subtask leader task 7.6, subtask 1. Project manager for the work done by the Urban Transport Authority in the pilot	City of Gothenburg, Urban Transport Authority
Mickael Rockström (Planning officer at the department for management of constructions)	Responsible for BIM data GOT (from September 2019 and onwards)	City of Gothenburg, Urban Transport Authority
Pär Hagberg	Project manager for the work done by Tyréns in the pilot	Tyréns

(Manager for the GIS and BIM department)		
Ellen Corneliusson (IT-coordinator)	Responsible for Innovation Challenge	City of Gothenburg, Urban Transport Authority

Table 25. Technical team Gothenburg

Name	Role and main responsibility in project	Organization
Tomas Jansson	Solution architect, GIS expert	Subcontractor for City of Gothenburg, Urban Transport Authority
Jonathan Stillbäck	Developer, FIWARE expert	Subcontractor for City of Gothenburg, Urban Transport Authority
Jonas Blixt	Server architect	City of Gothenburg, Intraservice

Table 26. Technical team Tyréns

Name	Role and main responsibility in project	Organization
David Wesström	BIM expert	Tyréns
Johan Larsson-Wallin	Developer, Geodata expert	Tyréns
Peter Alstorp	Developer, Geodata expert	Tyréns

Table 27. Reference group: Design

Name	Role	Organization
Kristoffer Ekholm	Project Manager Design, Project Hisingsbron,	City of Gothenburg, Urban Transport Authority
Daniel Sjölund	Project Manager Design, Project Masthuggskajen	City of Gothenburg, Urban Transport Authority
Emir Halalkic	Gothenburg City Project Manager Design, Project Kville	City of Gothenburg, Urban Transport Authority
Nina Jornryd	BIM coordinator, Project Kville	Swedish Road Administration

Table 28. Reference group: Visualization

Name	Role	Organization
Eric Jeansson	Gothenburg city Geodata strategist	City of Gothenburg, City Planning Authority
Kim Lantto	Representative for citizens	City of Gothenburg, Consumer and Citizens services
Anders Johansson	Representative for citizens	City of Gothenburg, Consumer and Citizens services

Mikael Reidal	Communication strategist	City of Gothenburg, Urban Transport Authority

Table 29. Reference group: Information security

Name	Role	Organization
Hannah Nilsson	Archivist	City of Gothenburg, Urban Transport Authority
Lina Westberg	Archivist	City of Gothenburg, Urban Transport Authority

Table 30. Reference: Asset management, technical information

Name	Role	Organization
Marie Person	Planning officer at the department for technical management of assets	City of Gothenburg, Urban Transport Authority

Annex 2: CIM KPI parameters

A detailed description of the CIM pilot KPI parameters is given in Table 31 to Table 38 below.

Table 31 Description of parameter: Ratings on the Likert scale, of "Ease of use for end users", provided by users CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Ratings on the Likert scale, of "Ease of use for end users", provided by users [integer, Likert]
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	12
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer (Likert)
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	N/A
6	Meter *i.e. smart meter, survey, energy bill, etc.*	Surveys
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Twice, but from different users
10	Start of measurements	M32

	i.e. 1-1-2019, 0:00CET	
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner *i.e. the name of the company that will give access to data*	Gothenburg City
16	Comments *Further info*	

Table 32 Description of parameter: Total number of users that have provided a rating of "Ease of use for end users", CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Total number of users that have provided a rating of "Ease of use for end users" [integer]
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	12
4	Units of measurement	Integer

	i.e. kWh, Euro, etc.	
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	N/A
6	Meter *i.e. smart meter, survey, energy bill, etc.*	Manual count
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Twice
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M32
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner	Gothenburg City

	i.e. the name of the company that will give access to data	
16	Comments *Further info*	

Table 33 Description of parameter: Ratings on the Likert scale, of "Advantages for end-users", provided by users CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Ratings on the Likert scale, of "Advantages for end-users", provided by users [integer, Likert]
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	3
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer (Likert)
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	N/A
6	Meter *i.e. smart meter, survey, energy bill, etc.*	Surveys
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Twice, but from different users

10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M32
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner *i.e. the name of the company that will give access to data*	Gothenburg City
16	Comments *Further info*	

Table 34 Description of parameter: Total number of users that have provided a rating of "Advantages for end-users" CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Total number of users that have provided a rating of "Advantages for end-users" [integer]
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	3

4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	N/A
6	Meter *i.e. smart meter, survey, energy bill, etc.*	Manual count
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Twice
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M32
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool

Table 35 Description of parameter: Number of datasets that are DCAT compliant in CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Number of datasets that are DCAT compliant in CIM pilot
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	47
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0, No datasets exists
6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Once
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M45

11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner *i.e. the name of the company that will give access to data*	Gothenburg City
16	Comments *Further info*	

Table 36 Description of parameter: Total number of datasets in CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Total number of datasets in CIM pilot
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	47
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer

5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0, No datasets exists
6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Once
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M45
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner	Gothenburg City

	i.e. the name of the company that will give access to data	
16	Comments *Further info*	

Table 37 Description of parameter: Number of applications using the API in the CIM pilot

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Number of applications using the API in the CIM pilot
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number *KPI('s) that are related to the data*	29
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0, No API exists
6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Once

10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M45
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M46
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A
14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner *i.e. the name of the company that will give access to data*	Gothenburg City
16	Comments *Further info*	

Table 38 Description of parameter: Number of full purchased solutions from one single company used

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Number of full purchased solutions from one single company used
2	Measure Number *As it is stated in the measure tracker*	TT 4.1
3	KPI Number	44

	KPI('s) that are related to the data	
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0, No solutions exists
6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	Once
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	M40
11	End of measurements *i.e. 31-12-2020, 24:00CET*	M40
12	Expected availability *i.e. open data, public, confidential, no data available*	N/A
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	N/A

14	Data format *i.e. csv file, json…*	Manual Report in IRIS KPI tool
15	Data owner *i.e. the name of the company that will give access to data*	Gothenburg City
16	Comments *Further info*	

Annex 3. Energy Cloud KPI parameters

A detailed description of the CIM pilot KPI parameters is given in Table 39 to Table 41 below.

Table 39 Description of parameter "Number of datasets that are REC (RealEstateCore) compliant in Energy Cloud demonstrator" for measure 2

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Number of datasets that are REC (RealEstateCore) compliant
2	Measure Number *As it is stated in the measure tracker*	TT 4.2
3	KPI Number *KPI('s) that are related to the data*	47: Quality of Open Data
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0.There is no Energy Cloud demonstrator and there are no Datasets in the Energy Cloud pilot.
6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A

7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	unknown
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	Q1 2020
11	End of measurements *i.e. 31-12-2020, 24:00CET*	unknown
12	Expected availability *i.e. open data, public, confidential, no data available*	unknown
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	*online, but requires authentication*
14	Data format *i.e. csv file, json…*	Manual report at first

15	Data owner *i.e. the name of the company that will give access to data*	e.g. Chalmers Fastigheter, AH
16	Comments *Further info*	

Table 40 Description of parameter "Total number of datasets in Energy Cloud" for measure 2

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Total number of datasets in Energy Cloud
2	Measure Number *As it is stated in the measure tracker*	TT 4.2
3	KPI Number *KPI('s) that are related to the data*	47: Quality of Open Data
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0.There is no Energy Cloud demonstrator and therefore there are no applications using it.
6	Meter	N/A

	i.e. smart meter, survey, energy bill, etc.	
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	unknown
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	2020 Q1
11	End of measurements *i.e. 31-12-2020, 24:00CET*	Unknown
12	Expected availability *i.e. open data, public, confidential, no data available*	Unknown
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	*online, but requires authentication*

14	Data format *i.e. csv file, json…*	Manual report at first
15	Data owner *i.e. the name of the company that will give access to data*	e.g. Chalmers Fastigheter, AH
16	Comments *Further info*	

Table 41 Description of parameter "Number of applications using the REC compliant datasets in the Energy Cloud demonstrator" for measure 2

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	Number of applications using the REC compliant datasets in the Energy Cloud demonstrator
2	Measure Number *As it is stated in the measure tracker*	TT 4.2
3	KPI Number *KPI('s) that are related to the data*	29: Open data-based solutions
4	Units of measurement *i.e. kWh, Euro, etc.*	Integer
5	Baseline (of data variable) *e.g. relating to BaU or previous performance data*	0.There is no Energy Cloud demonstrator and therefore there are no applications using it.

6	Meter *i.e. smart meter, survey, energy bill, etc.*	N/A
7	Location of measurement *Where the measurements take place*	N/A
8	Data accuracy *How accurate is the measurement*	N/A
9	Collection interval *How often the data is recorded*	unknown
10	Start of measurements *i.e. 1-1-2019, 0:00CET*	2020 Q1
11	End of measurements *i.e. 31-12-2020, 24:00CET*	unknown
12	Expected availability *i.e. open data, public, confidential, no data available*	unknown
13	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires*	*online, but requires authentication*

	authentication, and, 3) offline	
14	Data format *i.e. csv file, json…*	Manual report at first
15	Data owner *i.e. the name of the company that will give access to data*	e.g. Chalmers Fastigheter, AH
16	Comments *Further info*	