triangulum

DEMONSTRATE·DISSEMINATE·REPLICATE

INTEGRATED SOLUTIONS FOR SMART CITIES

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 646578

Budget

· 29 Million € overall budget
· 25 Million € funding from the European Union (Horizon 2020)

Participating Countries

Czech Republic, Germany, the Netherlands, Norway, Spain and United Kingdom

Duration

02/2015 – 01/2020

Project Description

Triangulum is one of 12 European Smart Cities and Communities Lighthouse Projects (SCC1) – a group that encompasses 12 members with more than 80 cities involved. As one of the first three projects, Triangulum is demonstrating solutions and first-of-a-kind innovative actions focusing on mobility, energy and ICT in its three Lighthouse Cities Manchester (UK), Eindhoven (NL) and Stavanger (NO) and disseminating and replicating them in its three Follower Cities Leipzig (D), Prague (CZ) and Sabadell (ES) as well as its Observer City Tianjin (CN).

By 2018, the majority of implementation projects has been completed and the monitoring and impact assessment is now being carried out using data stored at the central Cloud Data Hub. Triangulum exhibits 29 solution modules and 69 use cases addressing individual challenges and requirements of its Lighthouse Cities and involved stakeholders. Some of the most influential case studies per Lighthouse City are presented in this brochure.

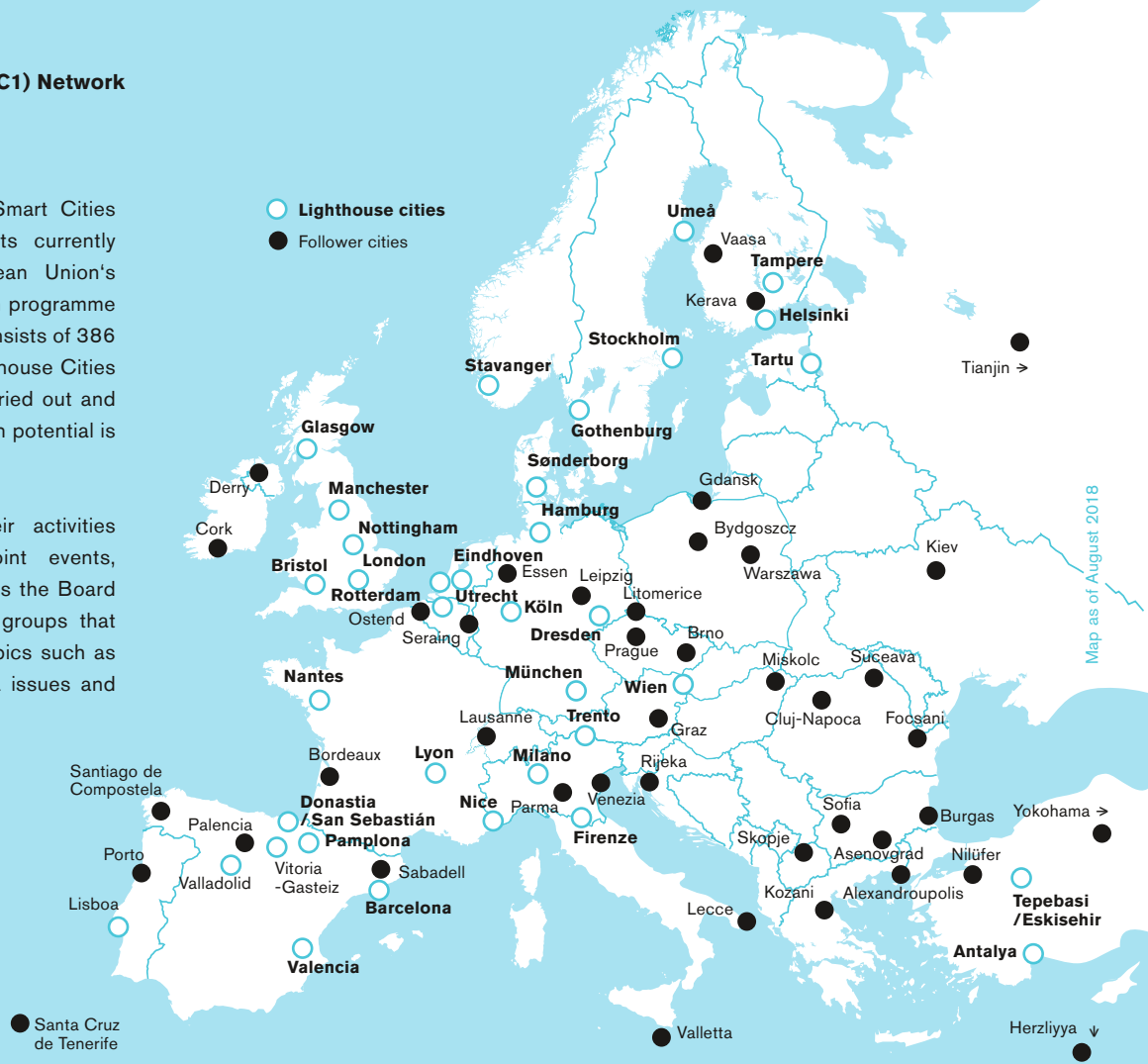
Triangulum is a significant accelerator generating new Smart City projects (>50 Million €) as well as three spin-offs, driving and contributing to the joint SCC1 collaboration.

Smart Cities and Communities (SCC1) Network

Triangulum is one of 12 European Smart Cities and Communities Lighthouse projects currently receiving funding within the European Union's Horizon 2020 Research and Innovation programme (overall 309 Million €). The network consists of 386 international project partners, 36 Lighthouse Cities where demonstration activities are carried out and 42 Follower Cities where the replication potential is being tested.

The projects regularly promote their activities and share their experience at joint events, exhibitions and other activities. Besides the Board of Coordinators, there are four task groups that meet regularly to work on common topics such as replication, business models, big data issues and dissemination and communication.

Furthermore, the projects are co-operating with the Smart Cities Information System (SCIS) and the European Innovation Partnership on Smart Cities and Communities (EIP-SCC).



STAVANGER
CASE STUDY
ENERGY

Central Energy Plant (CEP)

Stavanger has installed a renewable energy plant for three of its municipal administration buildings. This Central Energy Plant (CEP) heats and cools the buildings using energy generated from the city's waste and rain water from a large sewer tunnel underground. 100 m of the tunnel is equipped with 108 drain heat exchangers.

Benefits

- Reduction of fossil fuel usage, GHG and CO_2 emissions.
- Increase of the share of renewables.
- Improvement of air quality.

Main Challenge

Piping connection (access to installation point) from sewage plant to building through rocky terrain was difficult.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
04 2015 – 12 2016	12 2015 – 08 2016	06 2016 – 04 2017	07 2017

Heat exchangers in the sewage
Photo: Ernst Olsen, Stavanger Kommune

STAVANGER
CASE STUDY
ICT

Cloud Data Hub

The University of Stavanger has developed a Cloud Data Hub for gathering and analysing data from all 23 partners of the Triangulum project. A data analytics toolkit will enable others to analyse Triangulum as well as own data for Smart City purposes.

Benefits

- Improved regional services thanks to public data analysis.
- Solutions and/or technology developed within Triangulum can be easily replicated by others.

Main Challenge

Providing public data and providing privacy/ownership of data has to be balanced.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
02 2015	05 2015 – 07 2015	08 2015 – 10 2017	11 2017

Cloud Data Hub within data centre
Photo: University of Stavanger

STAVANGER
CASE STUDY
MOBILITY

Electric Battery Buses

Rogaland county council ordered three electric buses from Ebusco (the Netherlands). The buses, operated by the regional public transport company Kolumbus, have been running in the Nord-Jæren regional district since February 2017 and have performed well. To find an attractive look for the buses, a design contest was held in which three regional high schools participated. The overall goal of Rogaland county is to have a fossil-free fleet by 2025.

Benefits

- Field trial of new technology.
- Multi-organisational cooperation and participation.
- Collection of empirical values about CO_2 reduction possibilities.

Main Challenge

Development of a solution for when the buses are not working.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
02 2015 – 09 2016	01 2016 – 04 2016	12 2015 – 12 2016	02 2017

Electric Battery Bus in Stavanger

Photo: Katelien van den Berge, Stavanger Kommune

MANCHESTER
CASE STUDY
ICT

Data Curation and Visualisation

The ICT element in Manchester is focused on two key areas:
1) project and wider city data curation, 2) visualisation and utilisation of the data. The data is hosted on the Manchester-I website (www.manchester-i.com). This gives an overview of data sources. The visualisation tools allow users to 'bring data to life' using virtual reality and augmented reality applications.
The project is also hosting innovation challenges for developers.

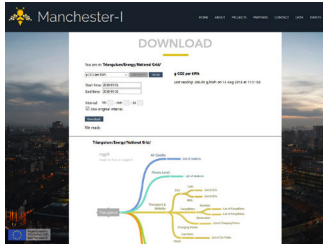
Benefits

- The data curation service enables users to create economic, social and environmental value from Triangulum data.
- The data can facilitate research projects at the university.
- Collaboration with other Smart City projects in Manchester e.g. CityVerve has resulted in a range of tools for data exploration.
- The University of Manchester stores energy consumption data from their buildings on the platform. It is working on behavioural change campaigns with 'dashboard' readouts for each building.

Main Challenge

It is important to be clear about the source and to specify the reuse rights for all data-sets.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
02 2016 – 12 2016	01 2016 – 06 2016	06 2017 – 12 2017	12 2017



Screenshot of the Manchester-I data platform
Photo: www.manchester-i.com

Walk through of University buildings, showing their energy consumption
Photo: University of Manchester

MANCHESTER
CASE STUDY
ENERGY

Manchester Art Gallery Building Optimisation

The Manchester Art Gallery is a suitable building for 'optimisation' measures that allow small improvements to make an impact. Therefore, a new Building Energy Management System (BEMS) has been installed. Optimisation measures have been applied to improve the operation of air handling units, and hot & chilled water systems.

Benefits

- Reduction of gas consumption by 24%, of electricity by 12% and of CO_2 by 15%. Resulting in an improvement of the energy rating from 'D' to 'C'.
- Significant financial savings.
- Interface of new BEMS allows visualisation of real time and historical operational data.

Main Challenge

The need to balance secure conditions for artefacts, alongside comfort for staff and visitors whilst optimising the building for energy and sustainability.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
04 2017	06 + 07 2017	07 2017 – 12 2017	01 2018

Sensor in Manchester Art Gallery
Photo: Siemens

Manchester Art Gallery
Photo: www.manchesterartgallery.org

MANCHESTER
CASE STUDY
MOBILITY

Electric-Assist Cargo Bike Hire

Four electric-assist cargo bikes for free use by local businesses and organisations around the Manchester Oxford Road Corridor. The bikes are available on a three-month loan. Bikes have been loaned to various local SMEs and partner university departments. They are used to make low carbon, convenient deliveries of parcels and food. Telematics have been installed to monitor journeys as well as the emission reductions achieved.

Benefits

- The bikes can replace a car or a van journey, are more convenient and save time in traffic-restricted areas (no vehicles except bicycles, buses and taxis between 06:00 – 21:00 on Oxford Road).
- Potential users are able to try before they buy.

Main Challenge

Moving from driving to cycling is a behaviour change that needs to be communicated well. Therefore, a "cycling champion" that promotes this change is key to support the introduction of cycling.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
02 2015 – 09 2015	09 2015 – 02 2016	02 + 03 2016	03 2016

Cargo bike decorated for a promotion event
Photo: Manchester Bike Hire

Pedal Assist Cargo Bike
Photo: Manchester Bike Hire

EINDHOVEN
CASE STUDY
ENERGY

Co-Creational Dwelling Renovations

A 3D-ICT tool has been developed to facilitate an interactive refurbishment process by allowing tenants to manage their energy consumption. The tool visualises chosen renovation measures and presents cost effects. It enables tenants to combine measures and to simultaneously start realising cuts on their energy costs. Unique to this project is that houses will be renovated individually according to the tenants' wishes.

Benefits

- Increased energy and resource efficiency.
- A 3D model of each dwelling enables the tenants to visualize and take thoughtful decisions about the renovation.
- A database of possible integrated solutions and measures matched to a specific type of housing and thus the creation of a live 3D BIM archive of housing stock to be used for future maintenance.

Main Challenge

Convincing other parties (building partners, suppliers, etc.) of the different (non-traditional) business case.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
2015	2016	04 2018 (invitations for renovation sent out)	After the renovation of every house

The tool presenting integrated solutions to the tenant
Photo: Woonconnect

Integrated roof solution (new triangular insulated roof in one piece with windows, PV-panels and chimney)
Photo: Woonbedrijf

EINDHOVEN
CASE STUDY
ICT

Smart Lighting Route

Co-creation sessions with residents and other stakeholders identified three upgrades for an existing popular footpath around two ponds. The smart lighting route "Living Lab Light" promotes sportive activities and leads to an improvement of the beautiful surroundings, which in turn leads to an increased feeling of safety, increased usage and thus health improvements. Therefore, a route of smart LED dimmable lights has been installed around the two ponds.

Benefits

- Residents interact during walking or running and thus get to know each other, enhancing social control.
- People are encouraged to move: the route includes four types of programs, from walking to running.

Main Challenge

Coordination with stakeholders and co-designing are time consuming activities.

PHASE 1 Planning	PHASE 2 Design	PHASE 3 Construction	PHASE 4 Launch
05 + 06 2016	07 2016 – 05 2017	05 2017 – 09 2017	10 2017

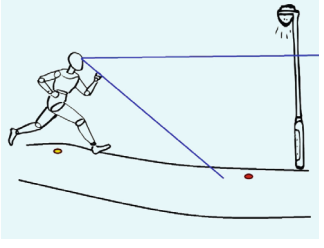


Illustration of lighting route
Photo: Het Energiebureau

Schoolchildren opening the lighting route
Photo: Jos Lammers

EINDHOVEN
CASE STUDY
MOBILITY

Smart Mobility at Strijp-S

At the Strijp-S terrain, old parking hardware systems of different vendors were in place. This made it difficult for visitors to navigate and locate empty parking spots close to their destined location. One goal of the Smart Mobility Strijp-S program was to present better and more precise parking management information to visitors that have been realised in the form of licence plate identification, (pre-) reserved parking, a guided parking route and detailed parking information.

Benefits

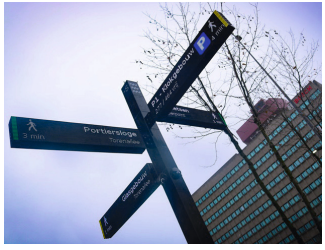
- Better and more accurate parking management information.
- Improved guidance and orientation in the area leads to more efficient trips and therefore less CO_2 emission.

Main Challenge

It is difficult to get people to change their daily parking routine. Intensive communication about the new services and related privacy policy issues is therefore very important.

PHASE 1 Planning	**PHASE 2** Design	**PHASE 3** Construction	**PHASE 4** Launch
07 2015 – 11 2015	11 2015 – 03 2016	05 2016 – 07 2017	10 2017

Dynamic parking management signpost at Strijp-S
Photo: VolkerWessels



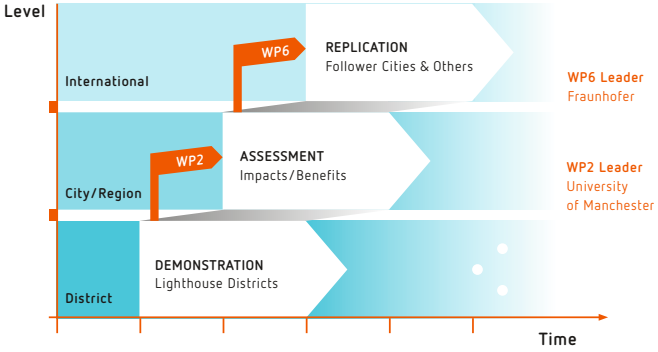
Wayfinder, a digital guidance platform
Photo: VolkerWessels

IMPLEMENTATION AND REPLICATION

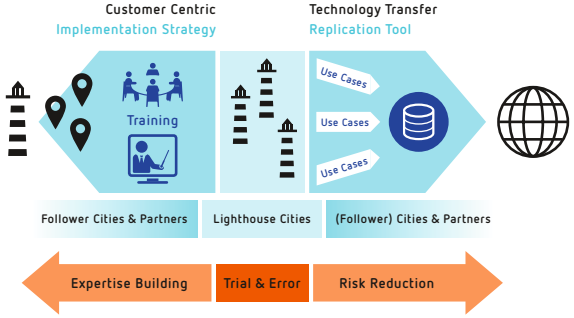
Within the Triangulum project, there is a work package dedicated to the measurement and the monitoring of the project results (WP2). A second work package is responsible for replication of these results, the expertise and experience to the three Follower Cities Leipzig, Prague and Sabadell and even beyond the project (WP6).

Three main objectives of the Smart City Framework:

- Streamline ICT integration of the three Lighthouse Cities to speed up planning and implementation.
- Design a replication framework and a decision-making tool for Smart City project development and implementation.
- Apply parts of this framework to accelerate the replication process in Follower Cities and beyond.



Three phases of Triangulum. Demonstration of applicability, assessment of Use Cases and then replication in the Follower Cities and others.
Graphics: Fraunhofer/A.Jung



A customer centric approach supporting the Implementation Strategies of Follower Cities and a technology transfer approach that allows replication by cities and other partners.
Graphics: Fraunhofer/A.Jung

REPLICATION STATUS OF FOLLOWER CITIES

The first cities that are following the performance of the Lighthouse Cities, and therefore test their replication potential, are Prague (CZ), Sabadell (ES) and Leipzig (D). Within a systematic approach, these cities are setting up their own Smart City Implementation Strategies, supported by scientific evaluation and conducted in close collaboration with the Lighthouse Cities.

This process will be supported by the *Smart City Framework.*

Follower City	**LEIPZIG**
Goal	Transform a historic residential and industrial area into a Smart City District by developing smart, innovative and feasible integrated solutions.
Planned implementations and expected results	▪ Safeguard mixed-use functionality for the future. ▪ Increase energy efficiency through intelligent energy balancing, aiming at an energy neutral or even energy positive district. ▪ Install Urban Data Platform in close cooperation with the public transport provider and the utilities. ▪ Pilot and establish advanced and emission free mobility offers. ▪ Establish stronger connections between local companies, bottom-up initiatives and the local start-up scene. ▪ Continue established participation format (Future Forum). ▪ Provide the necessary freedom to test out innovative solutions which can later be rolled out in the whole city.

PRAGUE

Enhance home care services through smart technologies and cross-sectoral cooperation in the pilot area of Prague 7 and update of Prague's 3D model.

- Create an integrated system of care support for senior citizens in their individual home environment to increase safety and wellbeing for seniors on the verge of self-sufficiency, exploration of the means for enhancing senior´s quality of life.
- Usage of e-mobility on city district level for social and health services.
- E-market place for services for seniors and data sharing between the care providers and other institutions.
- Update of Prague´s 3D model.

SABADELL

Evolve towards a green, social, transparent, participatory and innovative city based on social equality and small entrepreneurship.

- Digital horizontal platform for real-time data integration.
- Videoconference and other city visualisation technologies applied to municipal services.
- Renewal of the municipal fleet of vehicles with sustainability criteria.
- Innovative public lighting.
- Maker space in connection with the circular economy and digital platform for shared spaces and resources.
- Incentives for the last-mile delivery of goods.
- City beacons (interactive screens at the public space in crowded areas).
- Fostering green mobility to schools.
- Application of energy efficiency measures in the refurbishment of existing buildings.

Stavanger's technical partner Lyse works closely with Sabadell and Prague in order to introduce the video solution Blink as a replicaton effort positively impacting care services in the cities.

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