Denne artikel er publiceret i det elektroniske tidsskrift
Artikler fra Trafikdage på Aalborg Universitet
(Proceedings from the Annual Transport Conference at Aalborg University)
ISSN 1603-9696
www.trafikdage.dk/artikelarkiv

Bæredygtig mobilitet i København med udgangspunkt i ITS / Sustainable mobility in Copenhagen enabled by ITS

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Abstrakt

As with many growing cities in the World, Copenhagen has to cope with a growing population and corresponding growing traffic demand. What is the Copenhagen way to deal with the challenges in urban mobility that comes with this growth? The first answer is concretized in a clear political goal (CO2 neutral in 2025). The second answer is formulated in a new political vision titled Community Copenhagen. The vision is an open invitation to all who use the city to build on 'a living and vibrant city', 'a city with edge' and 'a responsible city' together. The new political vision asks for a new take on multimodal traffic management that interacts directly with citizens and strengthens green mobility, thereby paving the path for sustainable mobility in daily life in Copenhagen – basically been a Smart City. This paper elaborates on the intelligent traffic solutions that enable sustainable mobility in Copenhagen.

This is an edited and updated version of a paper presented at the ITS European Congress with the title: ”Intelligent Traffic Solutions for sustainable urban mobility in Copenhagen”.

A sustainable and smart city asks for sustainable and smart mobility

In the region of Copenhagen (Greater Copenhagen area) live about 1,3 million people. Copenhagen covers a relatively small area of more or less 74 km2 and, as such, is characterized by a rather high population and building density. Yet, at the moment the population of the city grows with 1,000 people every month. This growth is in line with today’s urbanization seen all over the world.

The city has launched a successive vision for the Copenhagen Community that looks to the horizon of 2025 to ensure that Copenhagen keeps its place among the cities in the world with the highest quality of life, and remains to be known in the world for its climate and environmental initiatives, being the world's best cycling city and so on and so forth. The new vision is an open invitation to all who use the city (i.e. citizens, commuters from surrounding municipalities, companies, associations, business partners and so on) to build on 'a living and vibrant city', 'a city with edge' and 'a responsible city' together. After all, building together

on such a city gives the city more pulse, and it's more satisfying to be in a city, you yourself are helping to create.

Copenhagen's definition of sustainable mobility

As a stimulus for the ecological ambitions, the City of Copenhagen has imposed itself a clear policy objective: 'become carbon neutral by 2025' and beyond 2025. This goal forms the backbone in the Copenhagen Climate plan 2025, which was publicized in 2012 and remains a key stone in the new policy vision. Copenhagen will become CO2 neutral in 2025 by: (i) reducing power consumption, (ii) energy production from renewable resources, such as wind and water, (iii) decreasing municipal CO2 emissions and (iv) increasing green mobility, i.e. cycling, using public transport and shifting to electric vehicles.

An ambition like this asks for political choices and in the perspective of green mobility, a new generation of intelligent traffic solutions. The political choices come down to considerations on which modality will be rewarded with the highest priority on various traffic corridors in the city. The resulting choices have been captured in the traffic management plan, which is a specification of the climate plan for urban mobility.

Next in line is a new generation of intelligent traffic solutions. For this the City organized a Public-Private Innovation from November 2013 to April 2014. Together with 15 Danish and European companies, and two knowledge institutions a set of new solutions were defined and tested on their feasibility. These solutions fit nicely into each other and together provide a new take on multimodal traffic management that interacts directly with citizens and strengthens green mobility, thereby paving the path for sustainable mobility.

This new take on multimodal traffic management is now being implemented via a set of intelligent traffic solutions that will be operational over summer and early autumn of 2017. To exemplify this approach and the corresponding intelligent traffic solutions, we will look upon mobility from different heights, starting with a bird's eye view on the city.

Utilize the (urban) road network to the max

Taking a bird's eye view on a city we see a city region with socio-economic centers that are interlinked via a diversity of infrastructures. Roads for motorists and cyclists, public transport and telecommunication networks. From this height we see traffic and transport flows as if they were the blood stream through the city region body. The metaphorical blood stream that enables citizens and visitors to meet each other, socialize or do business, in fact do all the things that come with a rich social (well-being) and economic (prosperity) life. From time to time both traffic and transport flows might hamper, due to temporary (local) oversaturation, all sorts of incidents, bad weather conditions or road construction works on various place in the road network. This asks for coordinated network wide traffic management.

Coordinated network wide traffic management starts with proper information to road users and guidance of traffic flows. In case of temporary oversaturation, it comes with rerouting of traffic and buffering of traffic on those places where a traffic jam or a waiting queue causes the least harm to the quality of traffic on regional/overall level. All in all to provide citizens and visitors of the city with the freedom to move and visit places, without causing a serious drop down on road network performance the moments that too many citizens and visitors chose to travel at the same time.

Utilizing the (urban) road network to the max comes with two intelligent traffic solutions in Copenhagen, i.e. a Sensor Network and a City Traffic Management System (CTMS).

Sensor Network

The first step is to monitor the status of the road network and the traffic conditions. For the road network data from the existing system such as the winter system, environmental system, and drawbridge status sensors will be used, as well as manual input from traffic operators. For the traffic conditions we will start with a layer of GPS-based real-time traffic information for motorcars, busses and to some degree cyclists.

This provides traffic operators with an overview of speeds and travel times as realized that that very moment on the road network in Copenhagen. On top of that we will use a set of radar sensors to measure on essential locations volumes and speeds of cyclists, motorcars and heavy traffic.

City Traffic Management System

Traffic conditions on the network should not only be monitored, but should also be evaluated in relation to political decided service goals as defined with the city's traffic management strategy. These service goals are translated into a reference map, which present the intended state of the traffic in a specific period of time, in case of a specific event or of road construction works et cetera. By evaluating the current and foreseen traffic conditions on the road network with respect to the traffic management strategy and aspired quality of traffic, well-founded decisions can be made about the traffic services that need to be activated. For this the Traffic services include:

- tuning (increasing or decreasing) the inflow from specific road segments;
- tuning (increasing or decreasing) the outflow from specific road segments;
- enhancing the throughput over corridors;
- spreading traffic across alternative routes, and thereby across the road network (by diverting and guiding traffic);
- homogenizing cycling and driving speeds over arterials.

The stepping stones in realizing the CTMS and sensor network are depicted in figure 1.

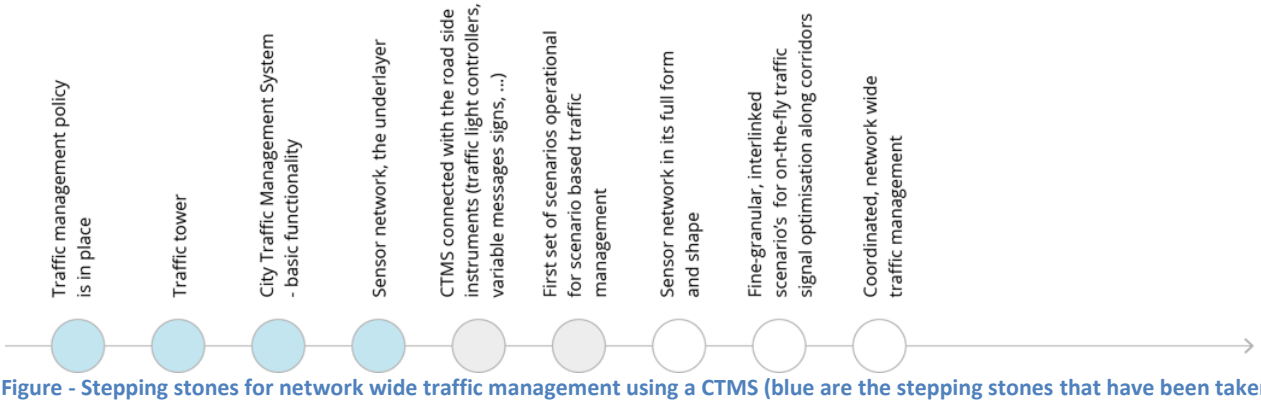

Figure - Stepping stones for network wide traffic management using a CTMS (blue are the stepping stones that have been taken. The white stepping stones will be taken summer and autumn 2017)

Optimize traffic flows along corridors

If we descend from our bird's eye view, we see an urban network consisting of avenues that divide the city in large areas or districts and we see streets crisscrossing those districts. On a daily basis citizens and visitors of the city use the avenues to move from one area to another mostly using a bicycle, public transport or motorcar.

The quality of the resulting traffic flow can be expressed in travel times and in both objective and perceived traffic safety. And it is exactly what the City of Copenhagen has done in the traffic management plan.

Acceptable and predictable travel times can be obtained by spreading the road users over the avenues to prevent local oversaturation by using the City Traffic Management System. By optimizing the traffic signals along the avenues the waiting time at controlled intersections is shortened. As such, cyclists, public transport bus passengers and motorist can be provided with service goals. Service goals that give cyclists and public transport a competitive edge over the motorcar in the city.

Optimizing traffic flows along corridors comes with the intelligent traffic solution of traffic signal optimization.

Traffic signal optimization

To achieve the political decided service goals as defined in the traffic management plan and to reduce the CO2 emissions traffic signals along a selected set of corridors will be optimized. It is a multi-modal optimization for bicycles, buses, pedestrians and motor cars. In this way citizens are stimulated in a positive manner by intelligent traffic solutions to cycle, walk or use public transport. In delivering this service, we will take into account variations in the traffic flow caused by circumstances such as current and foreseen traffic volumes, road geometry and capacity, incidents and events.

The stepping stones in realizing traffic signal optimization are depicted in figure 2.

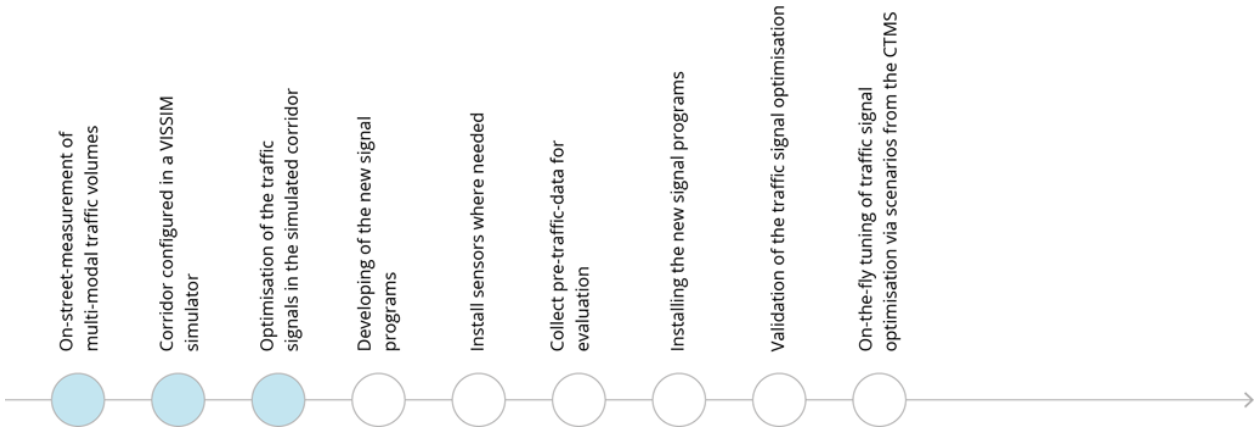

Figure - Stepping stones for traffic signal optimization (blue are the stepping stones that have been taken. The white stepping stones will be taken summer and early autumn 2017)

Facilitating and giving information to travelers on the avenues and streets

If we descend to the individual avenues, we see citizens passing by walking, cycling or using public transport or another motorized vehicle. It is on this level that Copenhagen can interact directly with its citizens while they are travelling.

Citizens that want to travel in a safe and smooth manner. Road traffic safety can be safeguarded by proper road geometry/design and by preventing dense clusters of road users. For the last, road users can be made aware of other, less crowded routes with tailored information. Commercial traffic information services in combination with route navigation already provide this sort of information for motorized traffic. Information that can be enhanced by bringing in the traffic management actions initiated by the traffic manager.

For cyclists this is different. The number and penetration rate of commercial services aimed at cyclists is still limited. Given the importance of cyclists for cities - cycling is a really green transport mode which comes with a limited claim on the urban road space – Copenhagen chooses to inform cyclists itself. After all, an enhanced road safety for vulnerable road users makes it more attractive for citizens to take the bike instead of a car. The intelligent traffic solution for this is an information services for cyclists using dedicated *variable message signs*.

Safety and traffic flow can be improved by concentrating specific road user groups such as trucks, busses and coaches on large avenues. This prevents them to use the smaller streets where they have to share the road space with vulnerable road users. The level of comfort for heavy vehicle drivers on these avenues can be enhanced drastically by providing dynamic speed advices in combination with traffic signal optimization. Heavy vehicle drivers (and of course passenger car drivers) can adjust their speed to the traffic control

cycles and as such arrive at the intersection when the traffic light shows green, thereby consuming less fuel. The pay back is that these instruments cause less stop&go traffic and thus less emissions of noxious gasses in the city. Inverse to this idea, other avenues and streets can be made more attractive to cyclists by providing dynamic speed advices to cyclists, so they can save energy and perceive a better air quality. The intelligent traffic solution for this is named *ecoDriving*.

During the dark hours at night reduction of CO2 emissions by lowering the luminance levels of the street lighting is at odds with road safety for vulnerable road users. The intelligent traffic solution for this is *Intelligent Street Lighting*.

Now, let us have a closer look at the three intelligent traffic solutions that aim at facilitating, and informing and guiding travellers on the avenues and streets.

Variable message signs for cyclists

The variable message sign (VMS) for cyclists is an important element in stimulating green mobility given that it supports Copenhagen's growing cyclist community's awareness of the impact of biking. The VMS will enhance the everyday experience of bike commuters, thus becoming a very strong communicative element on the streets of Copenhagen, one which offers an opportunity for citizens to contribute to furthering the objectives of the city and at the same time improving their own experience. A well-designed VMS can produce this simple win-win. Together with the CTMS the VMS will form a flexible platform that reaches out to the biking community and help Copenhagen reach it's green objectives.

In line with the sustainability premises of Copenhagen as dedicated VMS for cyclist has been co-designed with representatives of the Danish Cyclists' Federation, following cradle-to-cradle principles, compliant to the Danish regulations for traffic signs and compliant to the design principles of the city architects.
The stepping stones in realizing the VMS and corresponding information service for cyclists are depicted in figure 3.

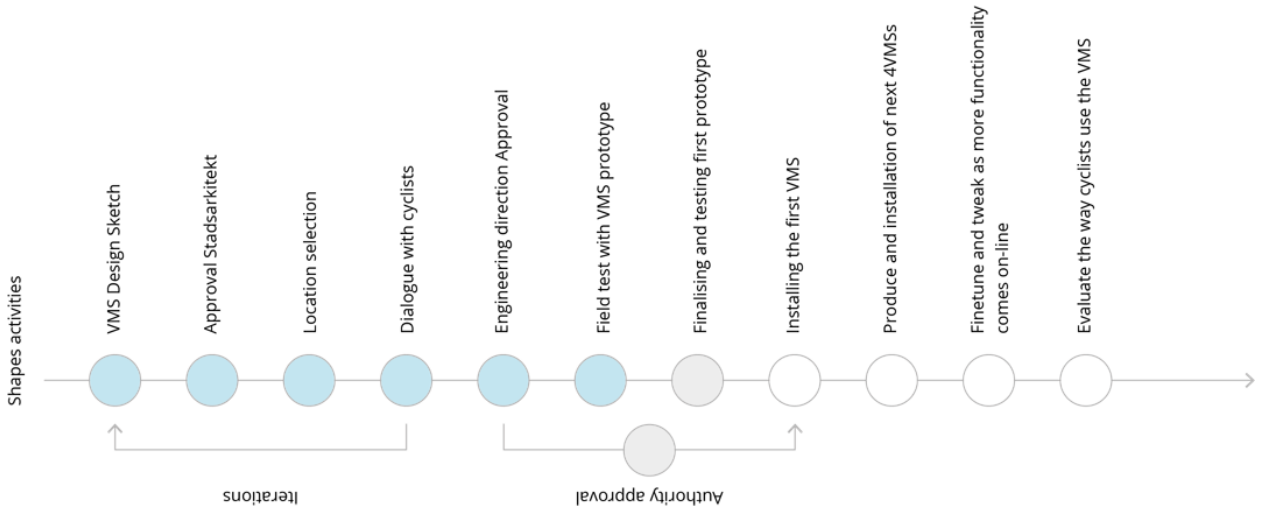

Figure - Stepping stones for VMS for cyclists (blue are the stepping stones that have been taken. The white stepping stones will be taken summer and early autumn 2017)

EcoDriving

EcoDriving is a cooperative service that is implemented in two ways: a regular (i.e. ITS-G5 based) service and a cloud based (i.e. cellular 3G/4G based) service. By receiving information on when traffic signals change, drivers (and cyclists) can adjust their speed, thereby avoiding the need to stop and accelerate.

Regular ecoDriving will be implemented on two corridors on the secondary ring road in Copenhagen. Together with the already equipped COMPASS4D and Folehavn corridors, regular ecoDriving will be

operational on half of the secondary ring road round of Copenhagen. With the ambition for the future to cover the full secondary ring road.

Cloud based ecoDriving will be implemented not only on the ring but on all relevant corridors for cyclists and passenger cars. Therefore the RSMP communication protocol for road side equipment will be upgraded to RSMP++ so time-to-green and time-to-red information can be retrieved by the CTMS from the TLCs and used within the cloud based ecoDriving for generation dynamic speed advices.

The stepping stones in realizing ecoDriving are depicted in figure 4.

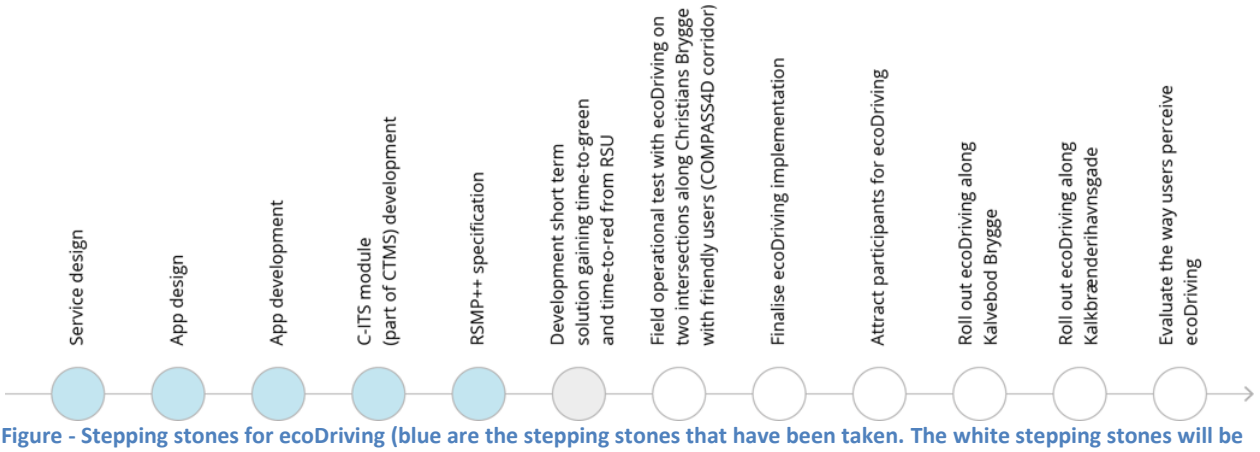

Figure - Stepping stones for ecoDriving (blue are the stepping stones that have been taken. The white stepping stones will be taken summer and autumn 2017)

Intelligent Street Lighting

Dedicated sensors will be installed at a first set of five intersections in order to detect approaching cyclists and pedestrians. Once detected the City Traffic Management System (CTMS) adjusts the luminance levels gradually. Once the detected cyclists and pedestrians have passed the intersection, the CTMS brings the luminance levels back to their original level, again gradually.

The stepping stones in realizing intelligent street lighting are depicted in figure 5.

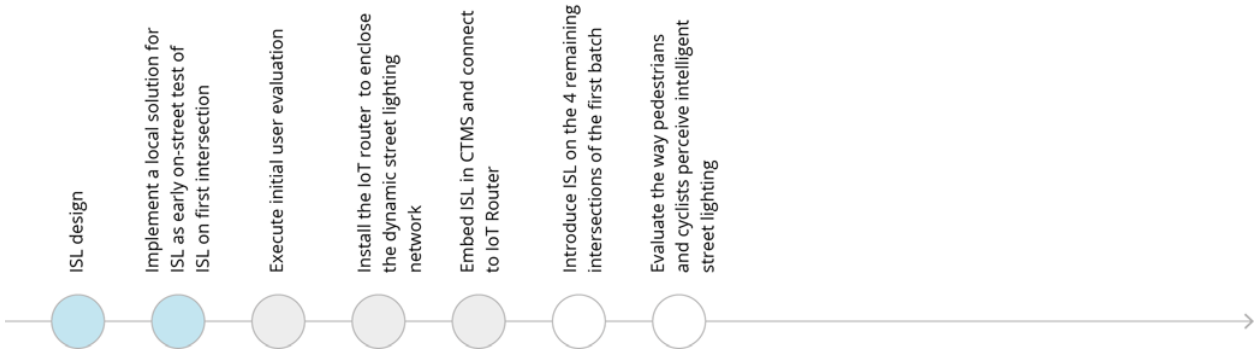

Figure - Stepping stones for intelligent street lighting (blue are the stepping stones that have been taken. The white stepping stones will be taken late summer 2017)

Utilizing the Urban Space by the moment

When we descent even further we find ourselves in the streets within a district. Streets that should be the places where see people live, hang around and meet each other and where children play. However, motorized traffic has turned streets from time to time in thoroughfares that segregate both sides of the street like a river thereby segregating residents. Residents have to stay on the sidewalk for safety reasons and valuable urban space is claimed by parked cars. However, the same citizens want to have the right to

possess a car, park that car in the neighborhood and use the streets to find their way to the avenues and vice versa.

How can we give back the streets to the residents on those moments that count for outdoor living and playing? Parking lots for cars, for instance, can be turned into an extension of the sidewalks where children can play, shopkeepers can exhibit their goods and bars and restaurants can offer people a nice terrace. Streets can be changed from thoroughfares into residential areas during parts of the day, where children can play and people can hang out. When used as thoroughfare, street space can be shared between cyclist and motorized traffic dynamically depending on the volumes of cyclists and the priority the city wants to give to cyclists.

Utilizing the Urban Space by the moment comes with a cluster of intelligent traffic solutions, which all focus on a dynamic use of urban space.

Dynamic use of urban space

The first concept aims at a dynamic usage of parking space, which is an interesting concept for urban spaces where the number of cars parked there is much lower at certain times of the day, the week or the year than at others. Here a solution is piloted in which parking spaces change function for outdoor seating for cafes and restaurants, for example, or for bicycle parking.

The second concept is a dynamic usage of street space, which is an interesting concept for urban spaces where the distribution of different types of traffic changes over the day, creating bottlenecks and dangerous situations (for instance for). Here solutions will be piloted that change the function of traffic lanes, for example by turning part of a bicycle path into a sidewalk during a period of time during the day, to prevent pedestrians to pull out onto the bicycle path. In the same way part of the regular “path” for motorized traffic can be turned into an widened cycling path dynamically.

The stepping stones in realizing the dynamic urban space solutions are depicted in figure 6.

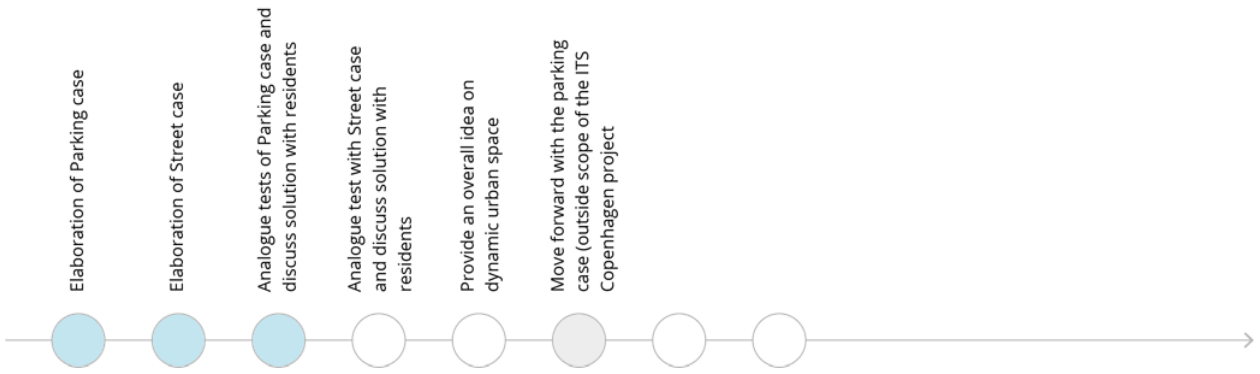

Figure - Stepping stones for dynamic urban space (blue are the stepping stones that have been taken. The white stepping stones will be taken during 2017)

Next steps

Sustainable mobility in Copenhagen is a journey that only just has started. The beauty of the journey is that it is anchored in political ambitions of a steady growing region and that every intelligent traffic solution is challenged in its design and added value. Challenged from a human perspective, such that the solutions are designed to create value for the citizens in Copenhagen. Challenged form a sustainability perspective, such that each solution is designed in a way that it can be scaled up once proven to be successful and appreciated. And challenged for openness, so new solutions and private contributions can be added that support the city’s vision to be CO2 neutral in 2025 and beyond.