RUGGEDISED
Designing smart, resilient cities for all

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Executive summary

Umeå municipality is part of the smart city project RUGGEDISED. By implementing several Smart Solutions, RUGGEDISED will facilitate a unified “smart district” in Umea, which is underpinned by planned regeneration and new developments, existing smart city capabilities and committed public and private sector investments. The main goal for the Smart Solution “Energy optimised electric BRT-station” (Bus Rapid Transit) as described in this report is to reduce heat and energy loss during the boarding procedures, save energy and reduce CO^2 emissions in the city of Umeå by making public transport more effficient and more attractive.

This new type of bus station has been developed and located in the smart city of Umeå. The design of the bus station will as a whole promote and increase the use of public transport and thereby contribute to the goal of reducing CO^2 emissions in the city. The design will also contribute to reduced boarding time and thus reduce energy loss from open doors in the electric buses as well as create a nice waiting environment for travellers.

Umeå municipality has the goal to reduce the city´s carbon dioxide emissons as at least 65 % of all travels shall use sustainable transport modes by 2022. The bus station contributes to that goal by giving public transport a modern and futuristic touch and giving passengers waiting for the bus a space to relax. More efficient boarding, made possible by the audio-visual system is good not only for the electric buses but also for the economy of the public transport system.

The feedback from the passengers on the first day of service was very positive, mainly pointing out the comfortable and smart design as well as the functionality and coziness of the new type of bus station.

The bus station is in service in Umeå municipality’s public transport system and connected to their real-time system. The station is connected to Umeå municipalities fibre net and electrical net.

Another goal with this project is that the final design has to be possible to replicate, either as a full concept or in-part e.g. the design of the innovative pods and the meditative light- and soundscape connected to the realtime GPS-system.

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1 Introduction

1.1 Background

Umeå kommun is a part in the smart city project RUGGEDISED. The overall goal for the project is to reduce CO^2 emissions in the city of Umeå.

In order to encourage the use of public transport, and thereby reduce CO^2 emissions in the city, a new type of bus station has been developed and located in the smart city of Umeå. The design of the bus station will as a whole promote and increase the use of public transport and thereby contribute to the goal of reducing carbon dioxide emissions in the city.

The bus station has been designed for easy replication in various weather, wind and climate conditions in Europe. It is fully adapted to mechanical snowploughing. It is also designed for all types of buses regardless of the positioning of doors and numbers of doors in the vehicle. The bus stop can be placed and secured to the ground with different ground conditions.

The area where the bus needs to pass and stop, has two different landowners (Region Västerbotten & Akademiska Hus) and another owner of the road (Umeå municipality). Those three partners formed early in the project a solid projectgroup where any problems or tasks were solved swift and easily. A good cooperation between landowners is important for the replication part.

1.2 Purpose

The purpose of this solution is to develop, design and build a climate smart bus station, where the main goal is to encourage public transport and thereby reduce CO2 emissions in the city.

Another purpose is to handle the heat loss every time the electric buses stops to let people in and out. The new station will be designed to contribute to reduced boarding time and thus reduce energy loss from open doors. The project also includes smart ticketing, smart shelters and a new way of thinking to create a nice waiting environment for travellers, to transform the expericene of waiting for the bus to a moment that gives the travellers an opportunity to “rest and reflect” before heading for a new place and new activities.

2 Methodology

The project for the Climate smart bus station was procured by Umeå kommun as a design-and-build contract. RISE Interactive, together with Rombout Frieling Lab, got the contract to design and build the bus station. The budget was 3,8 million swedish crones.

2.1 General description

The new climate smart bus station is expected with its innovative design - where technology, people and the environment interact with each other to reduce the city´s environmental impact and its carbon dioxide emission - to act as a symbol for the Smart University District. The bus stop is served by both electric and fossil fuel buses.

With its futuristic and unique design, the bus station establishes public transport as a modern mode of transport in the smart city. The design can potentially give passengers the opportunity to ‘rest and reflect’ while waiting for the bus. The unique sound- and lightsystem and the separation of waiting- and boardingzones contributes to reduced boarding time, which together with smart ticketing systems with smartphones minimize the heat

and energy loss from open doors and a reduction in CO2 emissions. The large wooden roof combined with the hanging pods inside the station gives passengers shelter from wind, rain and snow and there is therefore no need for any additional heating system or insulation structure.

The new bus station is largely made out of locally grown and produced timber. The little electrical power needed is provided by Umeå Energi, the local energy company. The designers also paid attention to maintenance: a snowplough can drive through the station and directly clear it from snow, as the pods move away automatically - making the station safe and comfortable. “Unlike the traditional bus stations, there is no more need to send out a team of people with shovels to dig after a snow fall’, says Dag Brändström, operation and maintenance engineer at Umeå municipality.

The climate smart bus station is implemented and in service.

Picture 1. Climate smart bus station

2.2 Main innovations for the climate smart bus station

- Hanging pods to create a micro-climate for the passengers, which can be turned in any direction by the wind or by choice from the traveller. The pods are placed in such a way so that the bus station, if necessary, can be ploughed with a snowplough. The pods hanging from a giant timber roof, automatically turn in position that allow travellers to lean against them, out of cold wind. “They provide support yet also allows people to keep moving their body”, the designers explain. The pods moreover cater for various social situations: looking at each other, keeping others out of the wind. The beauty is that the pods provide comfort and warmth without consuming any power.

- The meditative light- and soundscape connected to the real-time GPS-system for the buses. The GPS-system updates data every five seconds. Each bus route has its own colour and sound, and data, busnumber and minutes to arrivel, for the incoming buses are additionally displayed on a screen in the bus routes’ own separate colours. The light and sound makes the station more accessible for citizens with a visual impairment or hearing loss. Children who cannot read can learn the colour and sound of their bus.

- A separation of the waiting- and boarding zone to promote faster boarding, made possible by the light- and soundscape

Picture 2. Circular displays give accurate information about buses arriving

Picture 3. The pods always turn in such a position the they keep passengers out of the wind

Picture 4. Every bus line has its own distinct, meditative spectra of sound and light

Picture 5. The smart bus station senses when a bus is on approach

2.3 Description of the design process

The design process started with a thorough field research, together with students of the Umeå Institute of Design. The design team recorded many travellers describing the waiting expericence as boring, wasteful and (during winter) unpleasant. They observed travellers waiting inside their front doors, until they saw the bus appearing through the window – and then run mad for it.

The first design suggestions were all about an enclosed space with heating to meet the challenge of the heat and energy loss during the boarding procedures. But early in the project it came clear that an enclosed space was not possible because of the fact that the station was served by both electrical and fossil fuel buses, and

that the different bustypes had the doors located in different places. Observations of travellers leaning rather than sitting, and statements from travellers indicating their love for being outside articulated the design challenge: how to make waiting outside comfortable in a variety of weather conditions and at the same time save energy for the electrical buses?

Picture 6. Present design of bus shelters in Umeå

This challenge formed a clear contrast with the bus stop as it was: Like at most ordinary bus stops, travellers typically stand on a windy and icy platform, having a peak on the road about every 10 seconds while looking down at their mobile phones. Although seats and shelters are provided, hardly anybody uses these. The priority is to take the bus, and for that it is necessary to be continuously on the lookout for your bus. If you sit down, others block your view. And when you stand inside the shelter, you cannot see the traffic information display. The passengers therefore often waited outside to get a clear wiew of the arriving buses. The seats are often cladded with snow and ice, and snow and ice somtetimes build up inside the shelters, as the snowplough cannot go inside these. Finally do people like to have ample personal space – which is difficult to achieve with multiple people in a shelter of only approximately 3x1 meters.

Picture 7. Design workshop

The basic solutions to the different challenges became pods, to create a microclimate to give shelter and support, hanging from a giant timber roof, and a meditative and beautiful light- and soudscape to remove the need to continuously be on the lookout for the bus in order to create a faster boarding zone and give the passengers time to relax and reflect in the waiting zone while waiting for the bus.

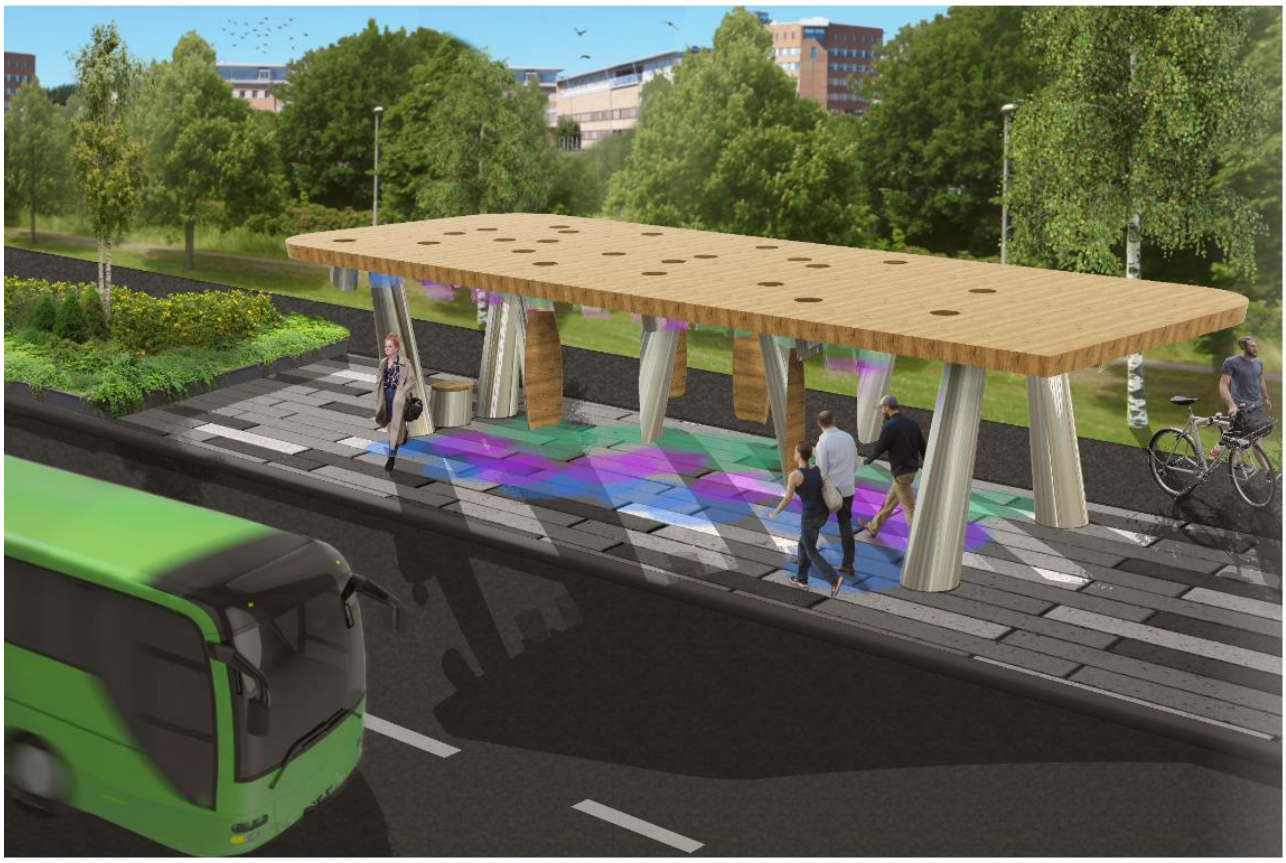


Illustration 1. Final design

2.4 Description of the building process

When the design of the climatesmart bus-station was completed, the process for the building permission and the planning for the necessary rebuilding of the bus street and the nearby bicycle lane started. In beginning of 2019 the complex technical drawings for the roof were completed together with the constructions-drawings for the ground works including electric and digital installations and the programming of the light- and soundscape. The roof had to be built indoors by a local contractor who is specialized on building large and complex structures in wood. June 2019 the groundwork started on sight.

2.4.1 The building process in pictures

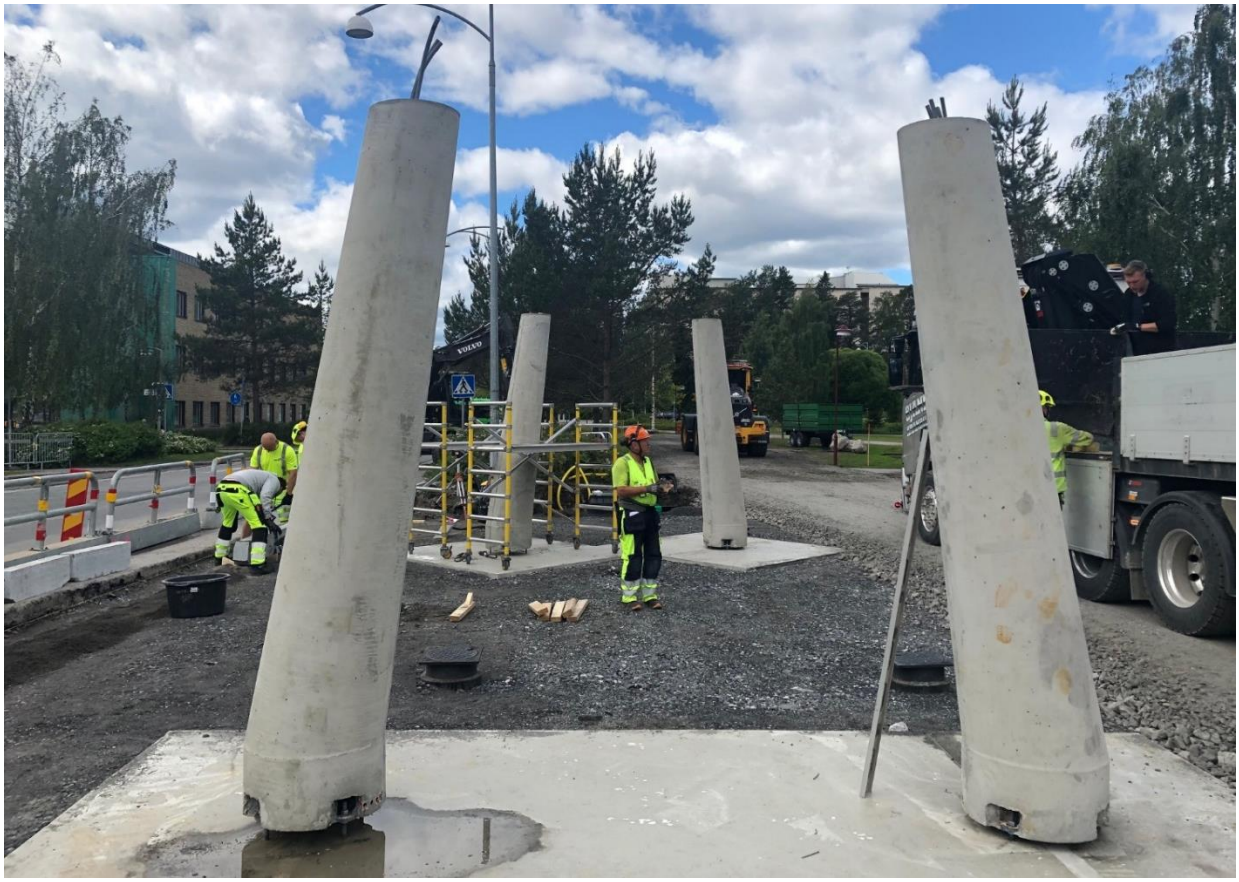
Picture 8. Drains with supervisory well are built

Picture 9. Non-woven cloth and drainage bed

Picture 10. Insulation of surface

Picture 11. Casting of pillar foundations

Picture 12. Mould grated and bearings packed



Picture 13. All pillars mounted

Picture 14. Tiling complete and wiring in pillars

Picture 15. The first plate is mounted

Picture 16. The top plate is mounted

Picture 17. The second top plate is mounted

Picture 18. Fitting of plates

Picture 19. Light inlet mounted

Picture 20. Programming of light- and soundscape

Picture 21. The climate smart bus station in service

3 Technical and operational information

3.1 Electronics

The displays, lighting and sound are all controlled from a central computer located in a black cabinet on the western side. The computer is linked to a router using UTP cable. It has a fixed ethernet IP address 192.168.1.200 and subnet 255.255.255.0

The router is linked to the access point using UTP cable. The router has IP address 192.168.1.100 and subnet 255.255.255.0. The router is linked to the displays using a UTP cable that directly connects to display 3 and from there to display 2 and 1.The router is also linked to the LANBox. The network is called TPLink (not the 5G one) and the password is 22118127

The LAN-Box is linked to the Philips Data Enabler Pro. The IP address of the LAN-box is 192.168.1.77
The Philips Data Enabler Pro is directly linked with all the luminaires in the roof.
The computer is linked to the Apart Amplifier using a standard 3.5mm > RCA jack cable.

On the computer, a simple piece of software runs. As input, it receives real-time data about the location of the buses.

The control computer restarts every 24 hours, at 4:00am – the software also automatically restarts (and so the station turns off for a few minutes). The software on the control processor can be accessed remotely and serviced.

3.2 Snowploughing

The snowplough (type Wille 865 with siljum shovel as in picture) can drive through the station from east to west and push all snow to one of the sides. A requirement is that the pods are turned out of position (ie to the outside). In case of wind it is important to lock the pods into position. This can be done by using one locking key/stick per pod. The pod should be turned out of position, and then the locking holes in the rim above should align with a fixed holed. The stick should be pushed in and turned to keep hanging – and blocking the pod to move. This should only be done temporarily.

The ‘wings’ of the plough can be used to use maximum width. It should not drive through the westernmost pillars – as this is too narrow. But the shovel fits in between. After this the pods should be turned 180 degrees inwards (and locked if needed). The snow can then be removed from the sides by letting the plough drive in front and at the back of the station – and using the wing to push out any snow from where the pods were previously.

Picture 22. Snowplough test

3.3 Maintenance summary

For the pods the following maintenance is advised by Bruns.For more information see the pods manual.
This exhibit is a unique piece. There is often little experience with unique exhibits. The maintenance schedule is therefore a recommendation for the running-in period.

Weekly maintenance:
- Check the pod for outside damage and functionality. When damage is found then it is requested to address this immediately. Make sure the pod is completely dry when it is being repaired.
- Check the paint on the wood. If damaged repair and repaint (see part document “Double coat and Double coat UV”). Make sure the pod is completely dry when it is being repaired.

Yearly maintenance:
- Remove cover ring and clean the inside.
- Check the mechanism is running smoothly. If not: take of the pod and add grease.

3.4 Feedback from passengers

Feedback from passengers on the first day of service included: “Futuristic and aesthetic”, “exciting design”, “beautiful lights”, “surrounded by wonderful sounds”, “cosy leaning pods”, “fun”, “multiple senses”, “super with real-time notifications”, “it feels warmer in the pods than outside them”, “I don´t mind waiting for the next bus”, “awesome”.

The plan is to make a follow-up of how passengers experience the climate smart bus station. The exact date for the follow-up and how it is to be designed has not yet been determined. Because of the corona virus travel with public transport has dropped drastically.

4 Replication

The climate smart bus station has been designed for replication in the Northern Europe. It is fully adaped to mechanical snowploughing. It is also designed for all types of buses regardless of the positioning of doors or numbers of doors in the vehicle.

The climate smart bus station can be placed and secured to the ground with different ground conditions. It requires foundation with a large concrete plate that need to be properly anchored to withstand wind loads and more. The structure must always be adapted to the prevailing ground conditions.

The final design is possible to replicate, either as a full concept or in-part e.g. the design of the innovative pods or the meditative light- and soundscape connected to the realtime GPS-system. The climate smart bus station will not replace standard bus-stops in Umeå but after evaluation parts of the design may be used in other places.

5 Annex

For the electronics the following maintenance is advised:

1. Ensure that the monthly subscription with the serviceprovider for the real time system is kept in place, so that the control system keeps receiving realtime information on the location of the buses.

2. To setup the computer network:
Installed Windows 10sv 64bit (email: smartbusstop@outlook.com, user: smart, pass: Universum)

Installed Google Chrome

Disabled system sounds
Disabled windows update

Altered powersetting to never sleep

Changed BIOS settings to restart after power failure (hold F2 when booting)

Installed Teamviewer 14

- Start with Windows

- ID: 1 405 392 470

- pwd: universum

Installed Processing 3.5.3

- installed processing.sound

- installed ch.bildspur.artnet

- installed dmxP512 1.3

Compiled executable from Processing

- copied sounds folder from sketch to executable folder

Put shortcut to run program in shell:startup

Used netplwiz to set automatic login on startup

Scheduled daily reboot at 04:00 with taskschd.msc

Set a fixed IP address for ethernet
- IP: 192.168.1.200
- Subnet: 255.255.255.0
- Default gateway: 192.168.1.100
- Preferred DNS: 192.168.1.100

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