D5.1 Case study involving an urban area with a transportation node, as well as the sub-urban areas, the semi-periphery and rural areas connected to this transportation node

Status	…
Authors	Alan Berger, Karl Otto Ellefsen, Espen Aukrust Hauglin (AHO)
Work Package	WP 5 – Developing green transport- and spatial planning strategies incorporating autonomous vehicles
Task	D5.1 Case study of a Norwegian urban area
Dissemination Level	PAV group team use
Issue Date	09 September 2021

Table of Contents

A STUDY OF POSSIBLE ADAPTIONS AND SPATIAL IMPACTS OF AV TECHNOLOGIES IN THE MUNICIPALITY OF SKI, OSLO METROPOLITAN AREA

Future urbanism: Planning for Autonomous Vehicles (PAV).
Institute of Urbanism and Landscape
Oslo School of Architecture and Design

The Elective Course Future urbanism: Planning for Autonomous Vehicles is a part of ongoing invention and research processes concerning automatic vehicles (AV). New hybrid transport systems will in the years to come influence settlement structure, habitat and urban design. The course links to the networks of the European research project PAV (Planning for autonomous vehicles) investigating challenges related to urban planning and design, and its possible spatial impacts.

Teachers

Assistant professor Espen Aukrust Hauglin (coordinator) Professor Alan Berger, MIT
Professor Karl Otto Ellefsen, AHO

Students

Deheng Kong, Oscar Frank, Johannes Hecker, Noah von Stietencron, Philipp Wadehn

The course is linked to the work on autonomous vehicles conducted by Ruter, the public transport authority for the Oslo metropolitan area.

Ruter experts

Ola Skar, Director of transportation and land-use planning,
Lars Gunnar Lundestad, Project manager

Ruter has been working with different pilot-projects to test out the use of self-driving vehicles. In 2021 a major pilot-project is localized to Ski in Nordre Follo Municipality, linking the Hebekk area – a low density housing-area – to Ski station. The intention of the pilot is to gain empirical data in order to answer technical and functional questions. Ruter tests out “the most proven technology in the marked”, in the Ski pilot adapted to standard Toyota mini-buses, Toyota Proace, with technology from Sensible 4.

The pilot in Ski is especially intended to create new knowledge on:

- Higher speed – stabile, seamless operation within a 50 km per hour zone (with existing traffic.)
- Weather conditions – ability to tackle Nordic weather conditions in all parts of the year. Snow is a particular challenge.
- On-demand functionality – development of systems for handling on-demand.
- Autonomous, non-manned operation.

The "Ski Learning Goals", defined and elaborated by Ruter

Presented by Lars Gunnar Lundestad
https://ahocloud.box.com/s/8r01hjkxv3o1jt14wti3p3pqgxn6k2cb

Stable, seamless operation in 50-zone

- Behaviour and perceived safety in higher speed
- Traffic cooperation in normal traffic conditions.

Validation of Oslo mobility study

- Ride sharing in smaller vehicles
- Integration with high-capacity transport network

Integration with infrastructure

- V2X communication with infrastructure (e.g. automatic gate)
- V2X integration with temporary traffic lights (e.g. during construction work)

Dynamic routing

- Dynamic routing based on customer needs
- Point to point mobility
- Dynamic routing based on roadworks and construction.

Fleet of different vehicles

- Potential for POC-test with vehicles of various size and types
- Test of Kiss & Drive in relation to public transport HUB's

Regulating departure times and management for holding areas

Unmanned operation

- Potential for operator outside vehicle

AHO study – APPROACH

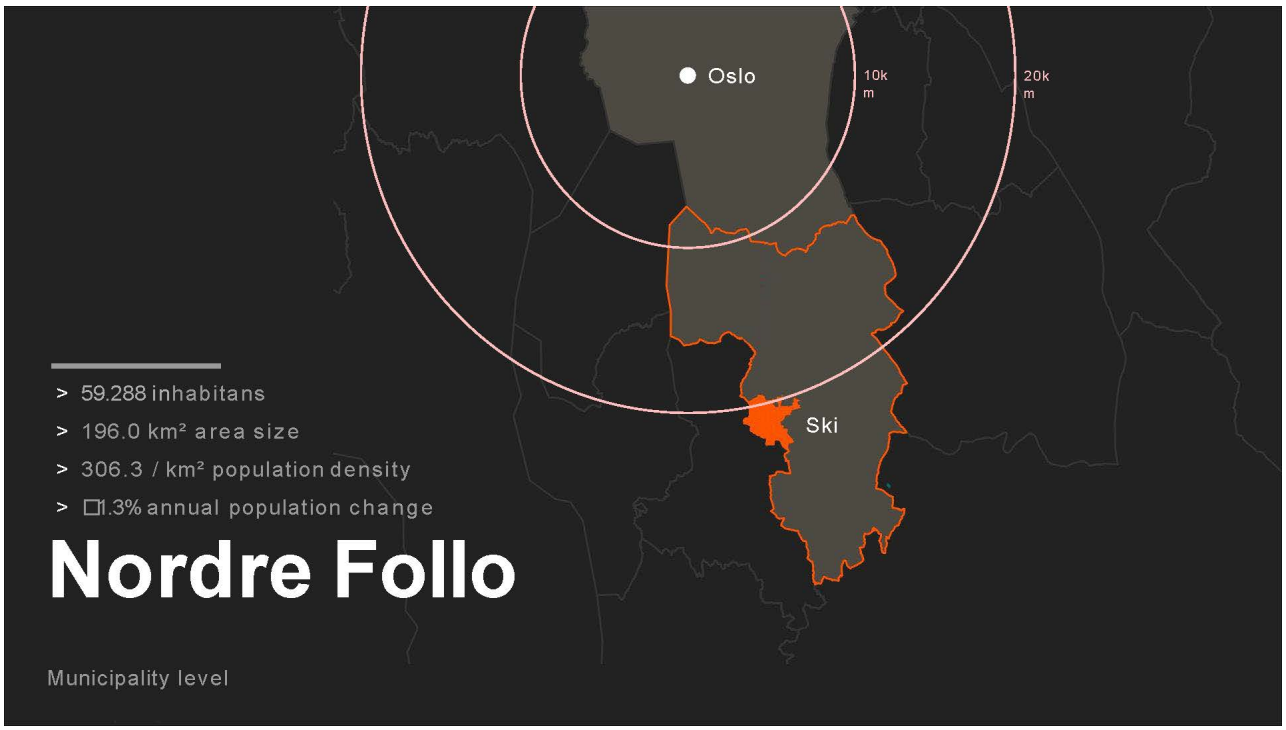
- In this study, the Ski pilot is discussed as a possible model for a new local transportation system in the municipality of Nordre Follo. The settlement pattern of the municipality is rather typical for the peri-urban parts of the metropolitan area, therefore the study has a general relevance.
- Referring to the literature list being developed as part of the AHO-project by Alan Berger (MIT), the possible future for the adaption of AV technology – options/potentials/consequences – are rather open. The AHO study is limited to a discussion of adaptions in the near future:
- A system of AV lines supporting the area, based on a time-schedule (mini-buses).
- These lines operating On-demand.
- A possible future where AV is fully adapted to a revised
- Road-system and may "go everywhere" is not taken into account in this preliminary study.

The AHO study is divided into two parts:

Discussing the model for AV used in the pilot, and testing it out for adaption on four levels:

- The Municipality of Nordre Follo
- Ski town
- The Hebekk area
- Ski station area.

Discussing the potentials for adaption and transformation in the Hebekk area, created by an alternative AV transportation system.



The municipality of Nordre Follo

The municipality of Nordre Follo in Viken County is located south of Oslo and borders the Oslo-fjord (Bunnefjorden) to the west and Østmarka (a protected forested recreational area) and the municipality of Enebakk to the east and southeast. The administrative centre is the town of Ski. With a distance of about 20 kilometers, the town may – after completion of a new tunnel (2022) – be reached in about 15–20 minutes by train from Oslo Central station.

Nordre Follo hosts a population of 59.288 inhabitants. The density is relatively low and accounts for 306,3 inhabitants per square kilometer due to abundant green-structure and low-density housing typology, single-family housing accounting for around 70 percent of the total. With regard to the subject of the study, one might note that there are 15,845 residential buildings within the municipality, and almost as many garage buildings (13,387). With a population of around 60,000 inhabitants, it may be assumed that each family has at least one car at its disposal.

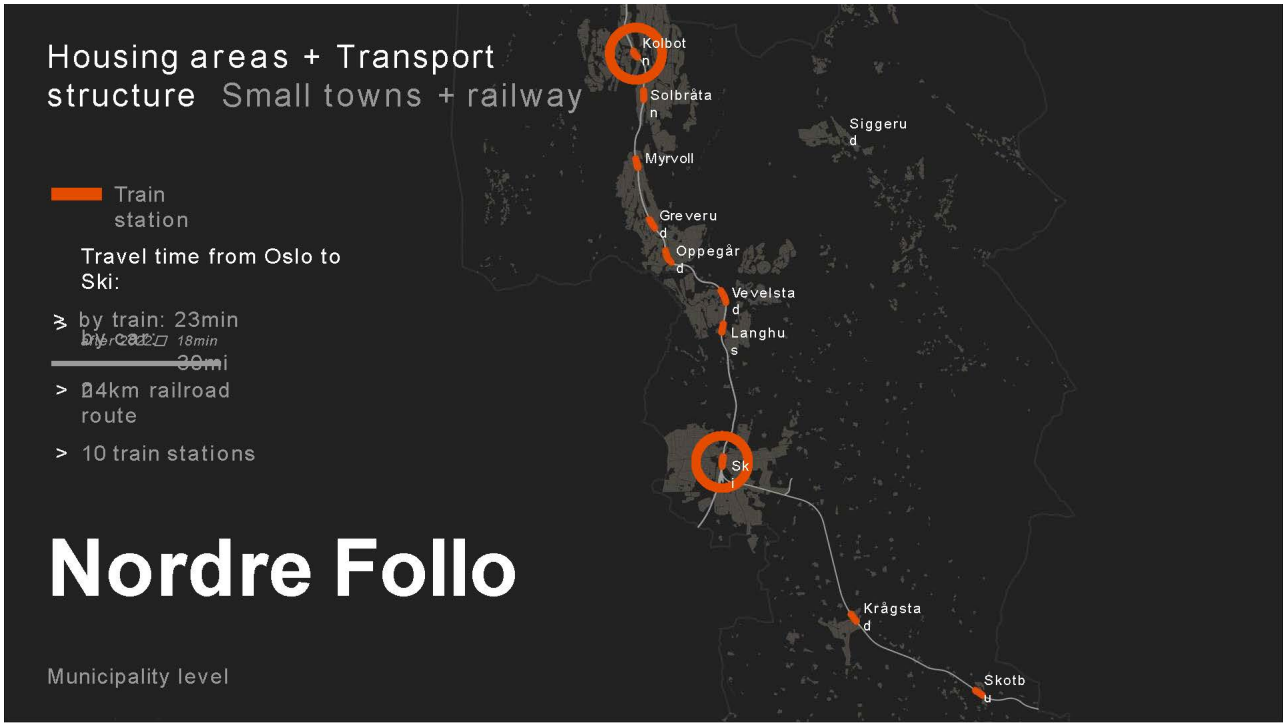
The main traffic artery of Nordre Follo is the railroad line Østfoldbanen, leading from Oslo to Ski and further to Sweden. The most populated settlements in the municipality are located along this line, as is the situation with Kolbotn and Ski. At Ski the railroad is divided into two lines, one via Krågstad to Skotbu (Inner Østfold line) and one serving the cities along the coast.

A total of 10 stations on the 24-kilometer-long railroad line constitute the traffic hubs of the municipality. Starting from these points, the presentation maps the residential areas at walking-distances of 500 and 1000 meters. For the population, a distance radius of more than 1000 meters often means the need for their own car or an available bus connection. Districts that fall into this category are both more rural settlements, such as Siggerud with 969 inhabitants, and urban districts with a longer distance to the station, such as Kontra with 824 inhabitants.

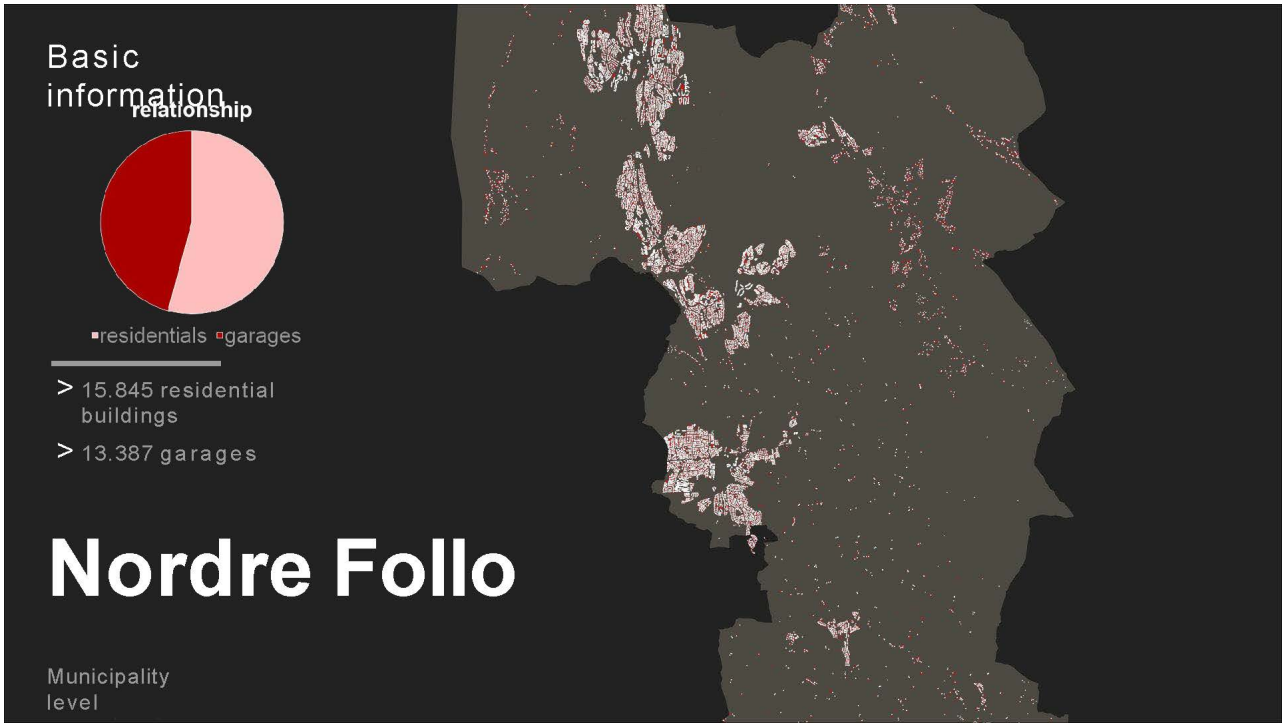
The presentation then marks the transformation areas planned by the municipality. Some are localized at relatively short distances from train-stops (Myrvoll, Vevelstad, Langhus and Ski). Areas around the municipalities of Vevelstad and Langhus are also localized within a radius of 1000m from the transportation hub. Outlying transformation areas with a distance of more than one kilometer are found east of Ski, northeast of Vevelstad and in the northwest of the municipality.

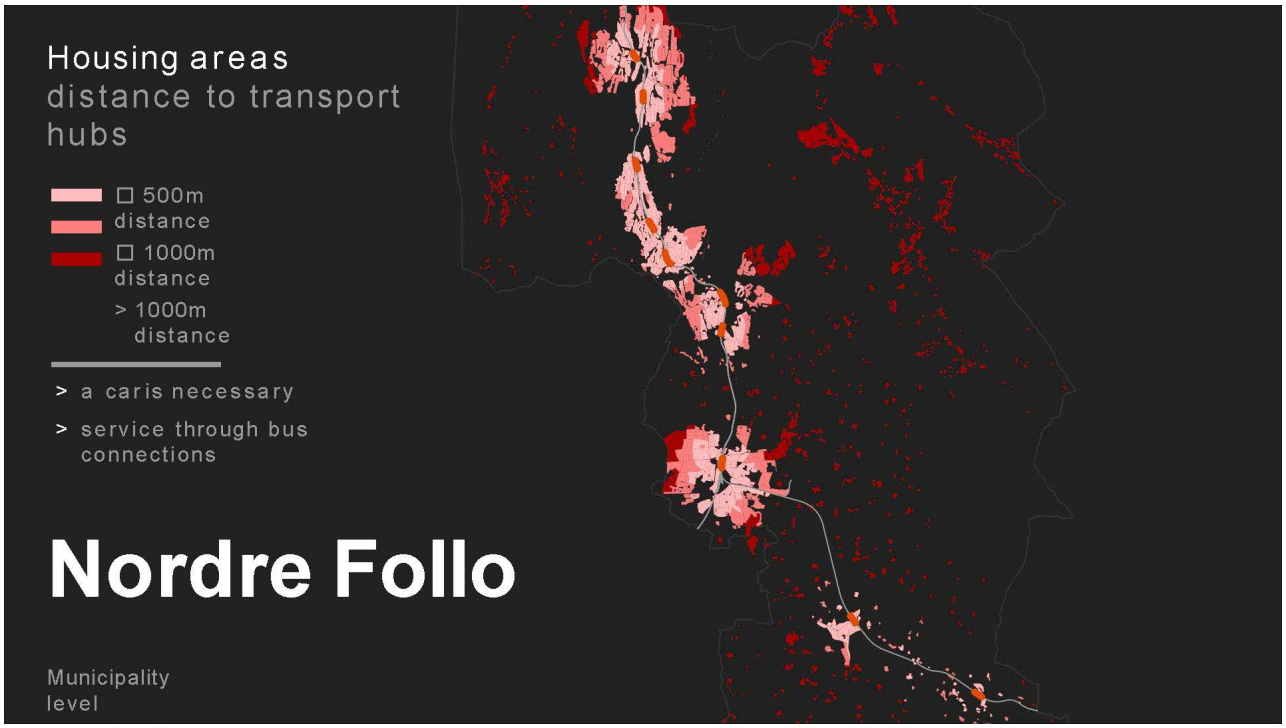
The following pages of the presentation map the specific transformation areas and the housing areas previously discussed. Both types of areas are presented graphically at a distance from the traffic junction of less than 1000m and at a distance from the traffic junction of more than 1000m.

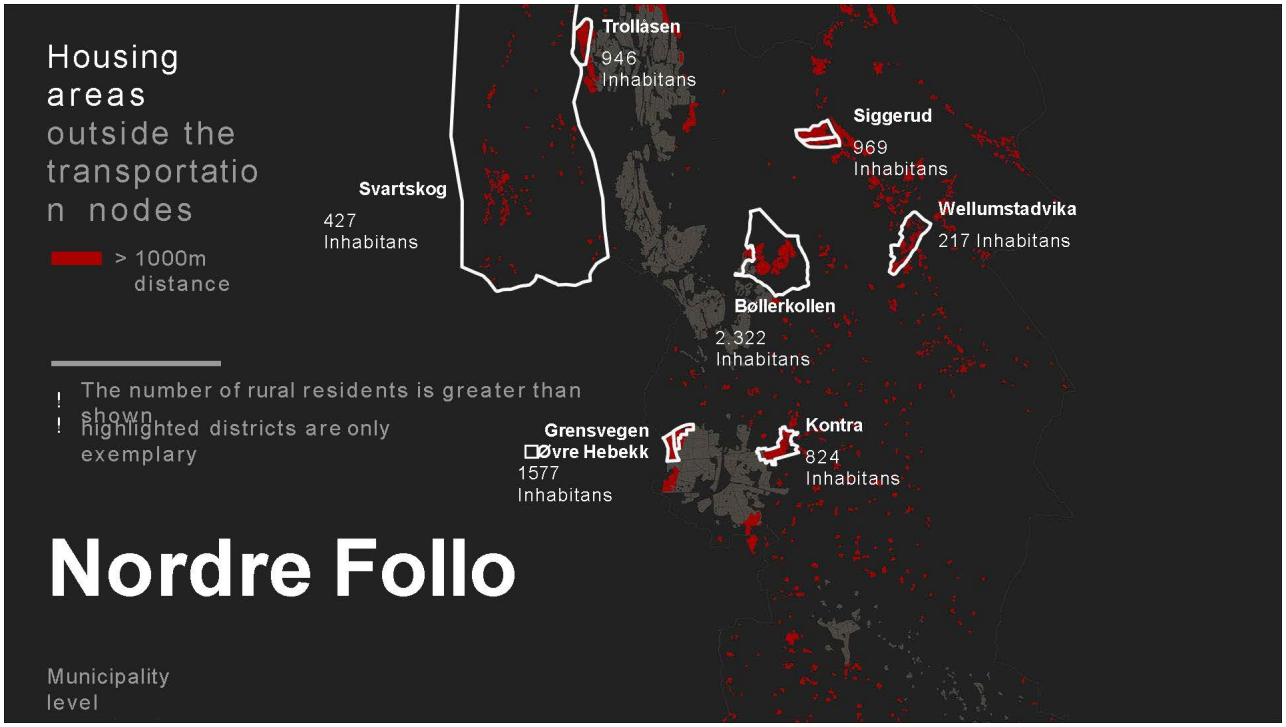
Finally, the last page of the first section of our presentation maps all the residential and transformational areas of the municipality. Graphically highlighted are development areas that – with existing infrastructure, existing user groups, and large-scale transformation areas provided by the municipality – offer very good potential for AV transportation.

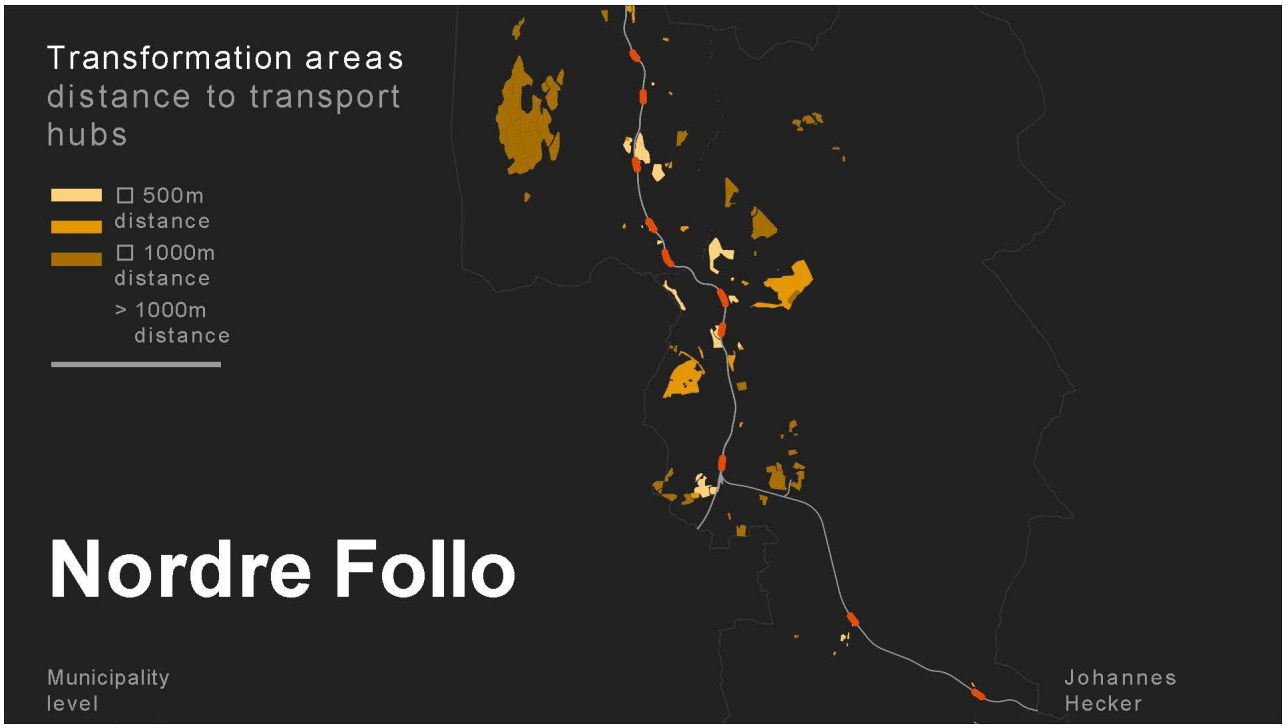

Housing areas + Transport structure Small towns + railway
Train station
Travel time from Oslo to Ski:
> by train: 23min
> 24km railroad route
> 10 train stations
Nordre Follo
Municipality level
Kolbotn
Solbråtan
Myrvoll
Siggerud
Greverud
Oppegård
Vevelstad
Langhus
Ski
Krågstad
Skotbu

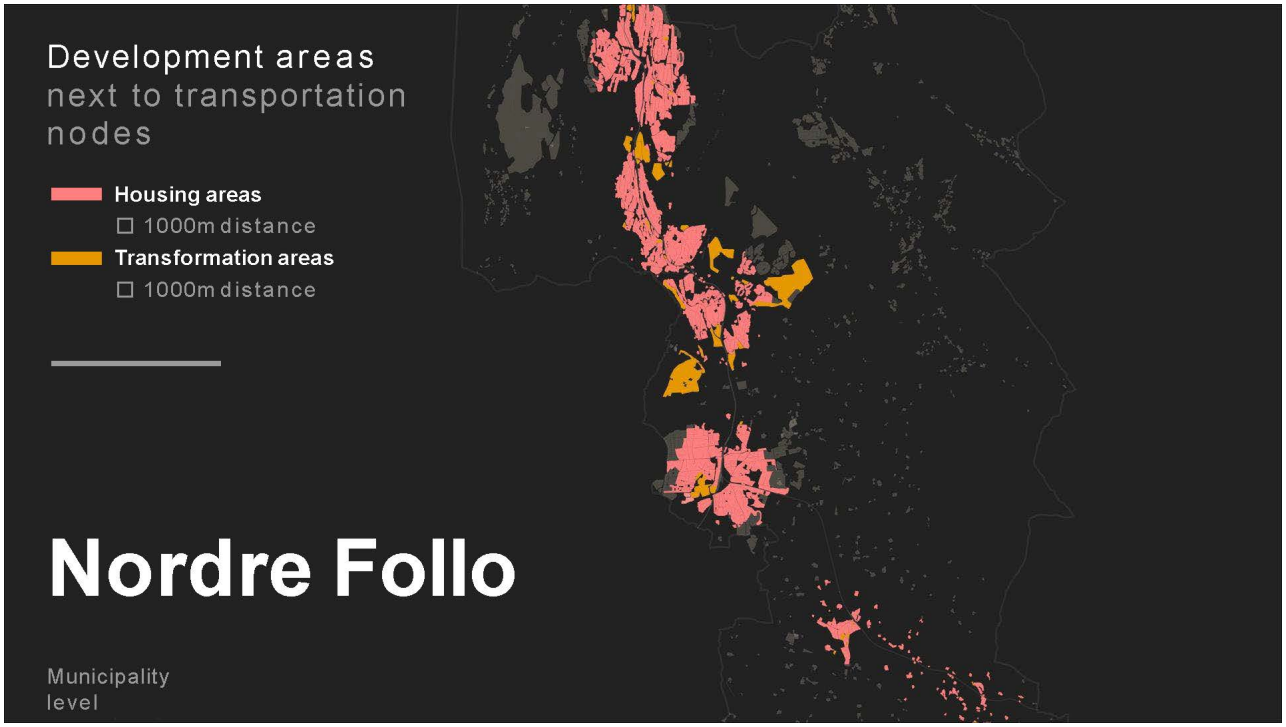

Settlements
house types
single family
row houses
apartements
others
> 10.841 single family houses
> 4.195 row houses
> 304 apartement buildings
> 505 others
Nordre Follo
Municipality level

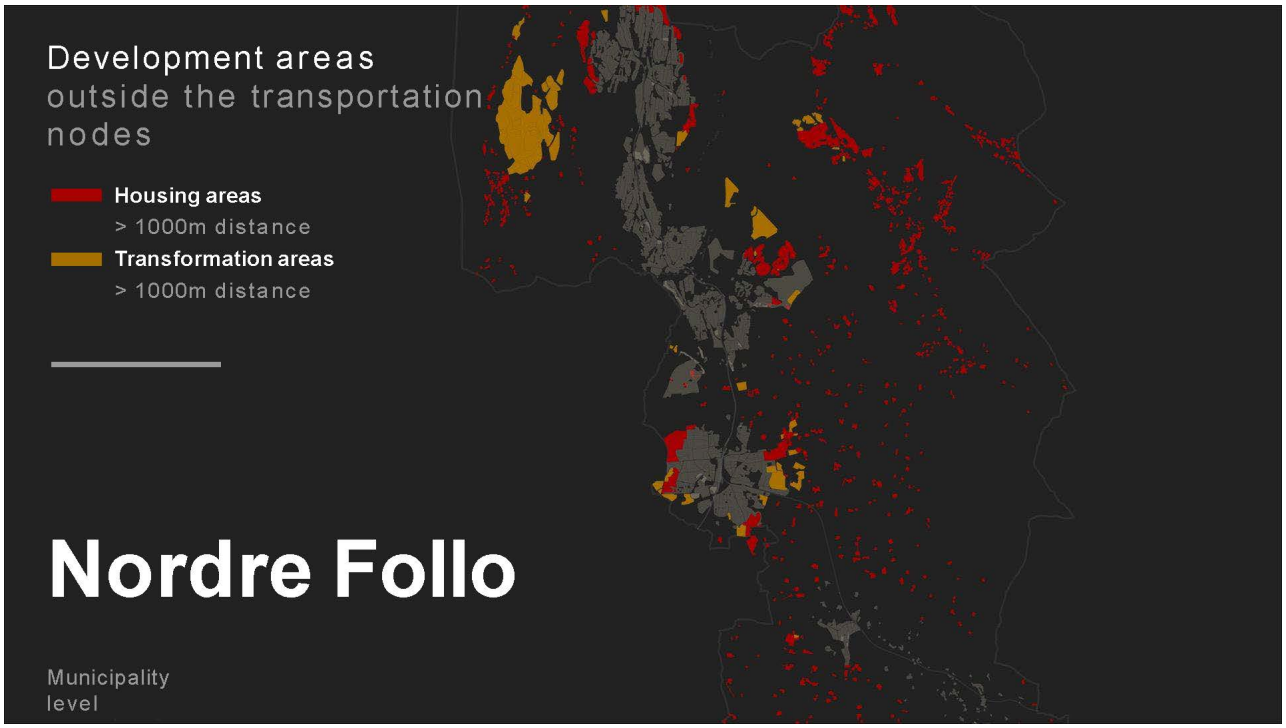

Basic information
relationship
residentials
garages
> 15.845 residential buildings
> 13.387 garages
Nordre Follo
Municipality level

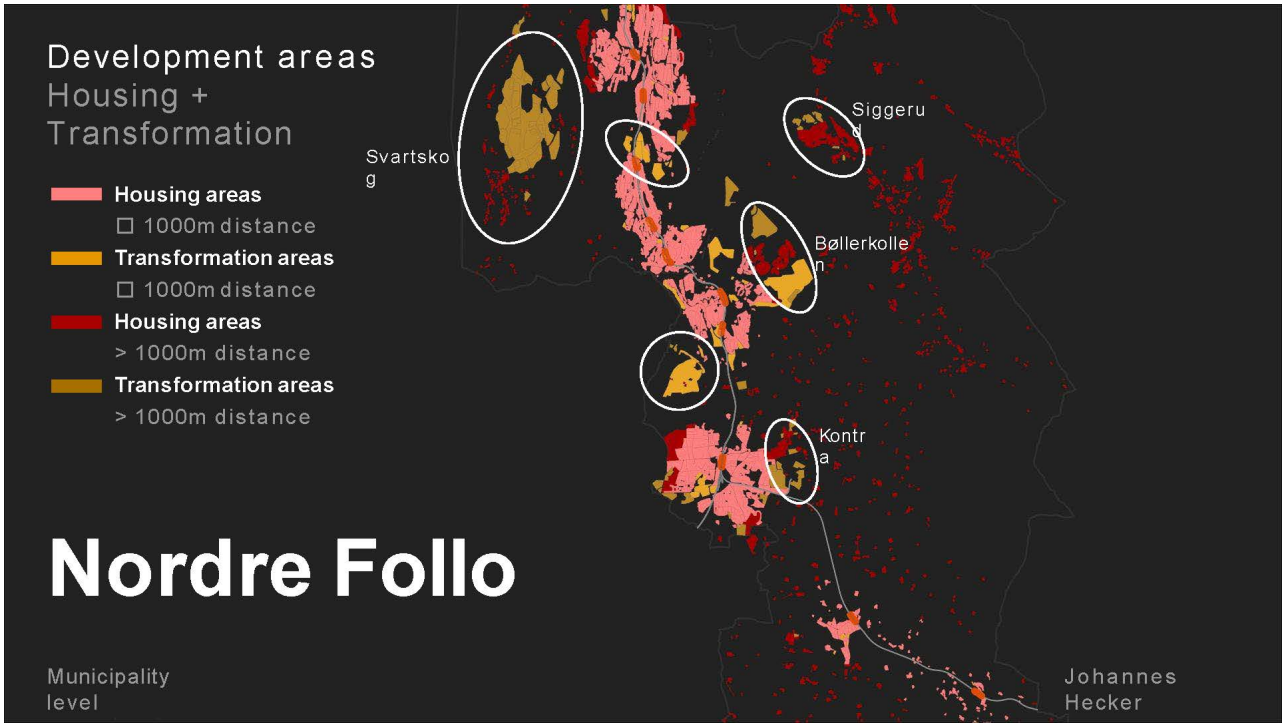

Housing areas
distance to transport hubs
500m distance
1000m distance
> 1000m distance
> a caris necessary
> service through bus connections
Nordre Follo
Municipality level


Housing areas outside the transportatio n nodes
> 1000m distance
Trollåsen
946 Inhabitans
Siggerud
969 Inhabitans
Svartskog
427 Inhabitans
Wellumstadvika
217 Inhabitans
Bøllerkollen
2.322 Inhabitans
The number of rural residents is greater than shown
highlighted districts are only exemplary
Grensvegen
Øvre Hebekk
1577 Inhabitans
Kontra
824 Inhabitans
Nordre Follo
Municipality level


Transformation areas distance to transport hubs
500m distance
1000m distance
> 1000m distance
Nordre Follo
Municipality level
Johannes Hecker


Development areas
next to transportation nodes
Housing areas
1000m distance
Transformation areas
1000m distance
Nordre Follo
Municipality level


Development areas
outside the transportation nodes
Housing areas
> 1000m distance
Transformation areas
> 1000m distance
Nordre Follo
Municipality level


Development areas
Housing +
Transformation
Housing areas
1000m distance
Transformation areas
1000m distance
Housing areas
> 1000m distance
Transformation areas
> 1000m distance
Svartskog
Siggerud
Bøllerkollen
Kontra
Nordre Follo
Municipality level
Johannes Hecker

The level of Place

The urban area of Ski is discussed as a localization for AV, based on the model of the Ruter Pilot. Areas are categorized according to their characteristics and their localization. A system of possible AV routes servicing the area is proposed. While the Ruter Pilot follows a loop, the proposed system is based on lines transecting the Ski urban area.

The area for micro mobility

The extent of the micro mobility area in the center of Ski will vary according to the main types of transportation used. It is important to take into account the impact of electric scooters, bikes and other vehicles. Even though the distance radiuses in the presentation are displayed as concentric circles around the train station, they do not necessarily represent real distances. Actual routes from the transportation hub to individual homes or other places differ from the linear distance based on the road layout. This has to be considered when actually defining the micro mobility area.

Established residential areas

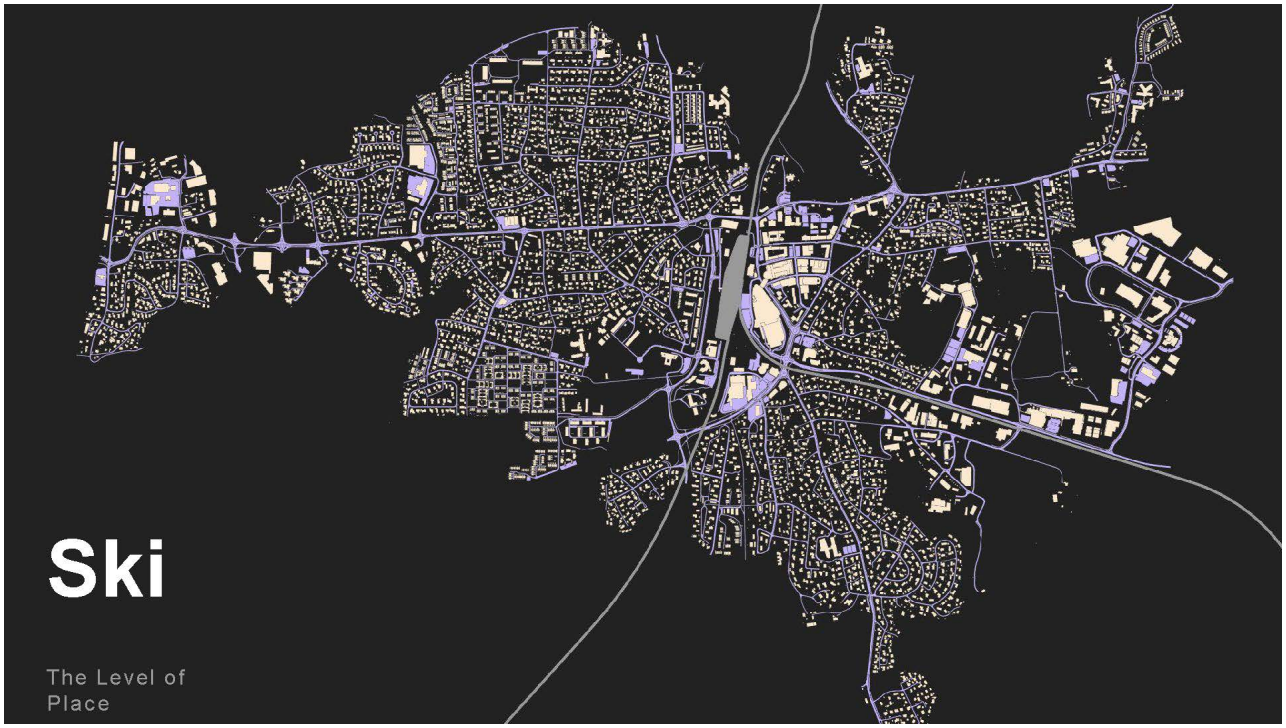
Ski is divided into two large residential areas, one to the West and one to the East of the train line. Each of these can be split up into two smaller areas. The current autonomous bus pilot drives along a loop line, having several stops on the border of the area that is to be served. Areas in the municipality with lower centrality

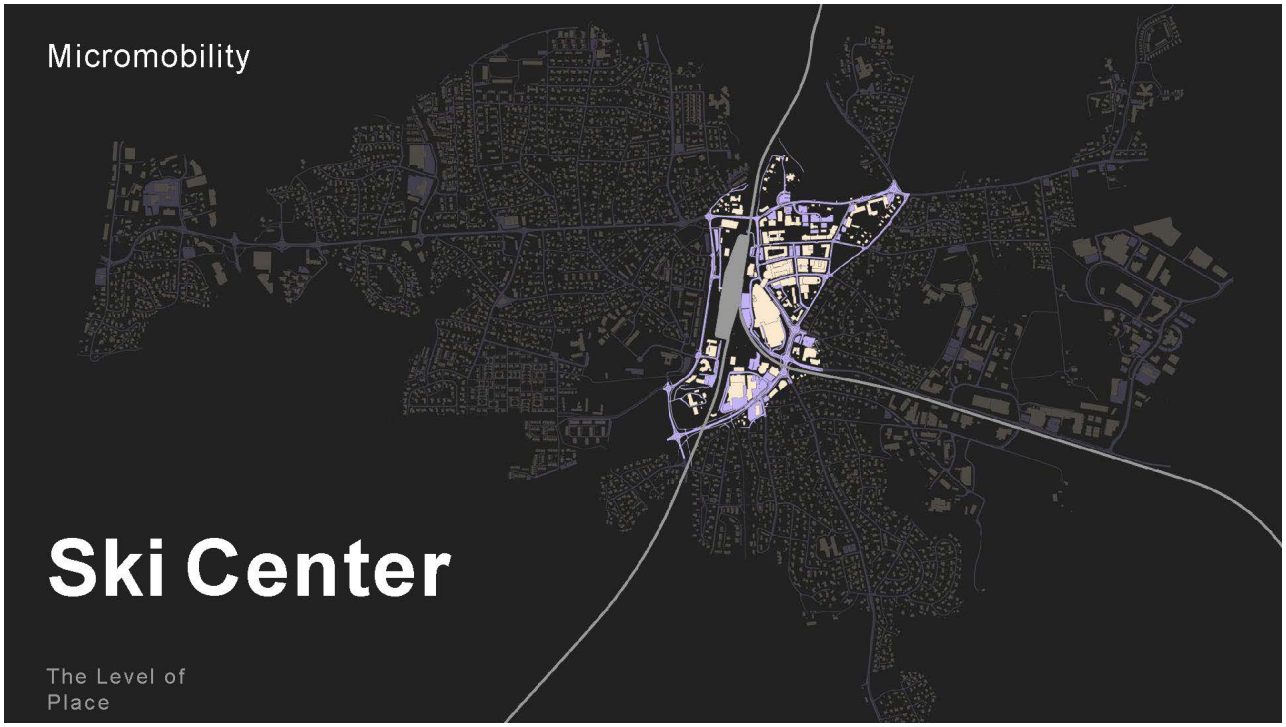
There are currently four smaller remote residential areas around Ski. One to the West next to the E18, one to the south in direction of Kråkstad and two north of Ski. The latter might at some point merge with the north-eastern residential area, but at present it is possible to clearly distinguish the four remote areas from the inner zone. It seems valuable to place future autonomous bus stops close to the four remote areas. Even without stops directly in the area, this could reduce the walking distance and serve parts of the remote areas. In the future these areas could benefit from on-demand autonomous vehicles that are not line based.

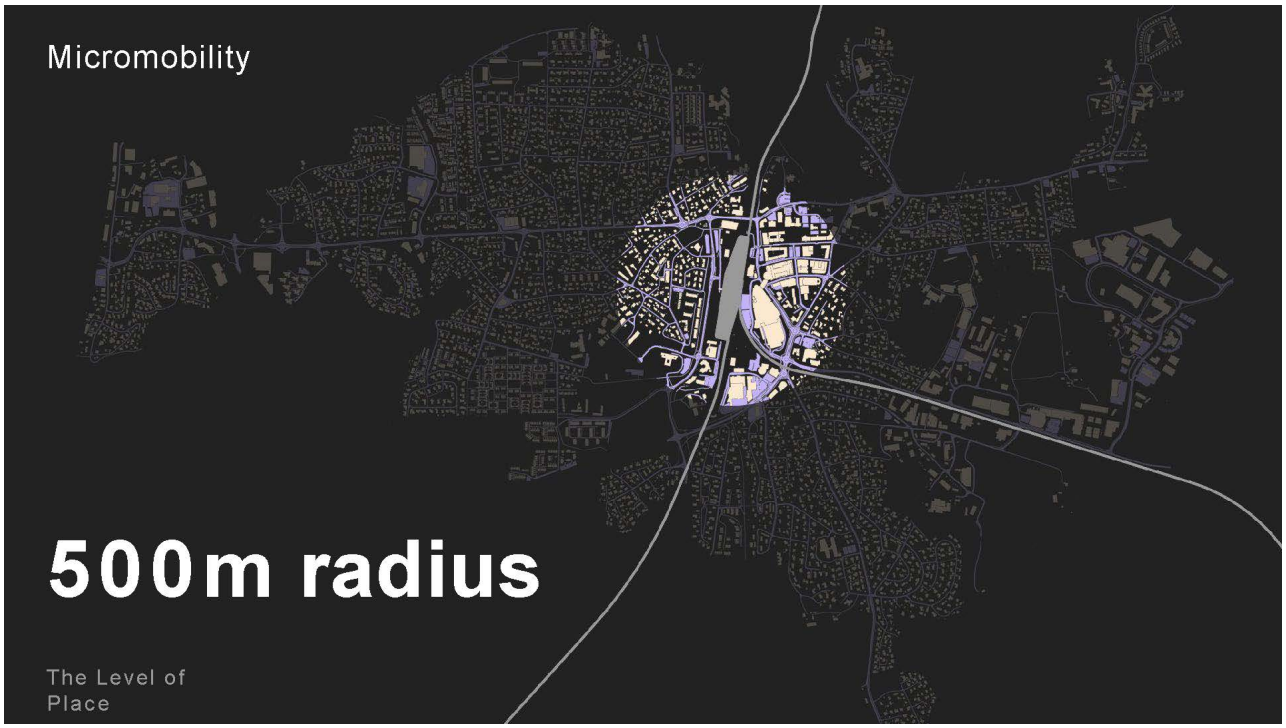
Development areas

The development areas – mainly the one south of the western residential area and one to the very east of Ski – hold great potential in terms of autonomous vehicle planning. To increase the benefits and impact of autonomous transportation it is necessary that Ruter is closely involved in the city planning processes as early as possible. Developments and findings from the pilot project must be continuously integrated into the planning process. Proposal for AV lines

The three proposed AV lines take the individually addressed aspects into account and apply the straight line concept. This is beneficial for public transport users as they do not have to travel unnecessary distances when living at an unfavourable end of the loop. One of the proposed lines covers the western part of Ski while a second one serves the East. A third line transect the urban area from the eastern to the western end. All three lines stop at the transportation hub in the center of Ski. The proposed lines have the potential to not only serve the development areas but also the four remote areas by stopping close by or entering them. Monodirectional AVs could make use of some the many roundabouts in Ski to turn around at the end of their routes.




Micromobility
Ski Center
The Level of Place


Micromobility
500m radius
The Level of Place

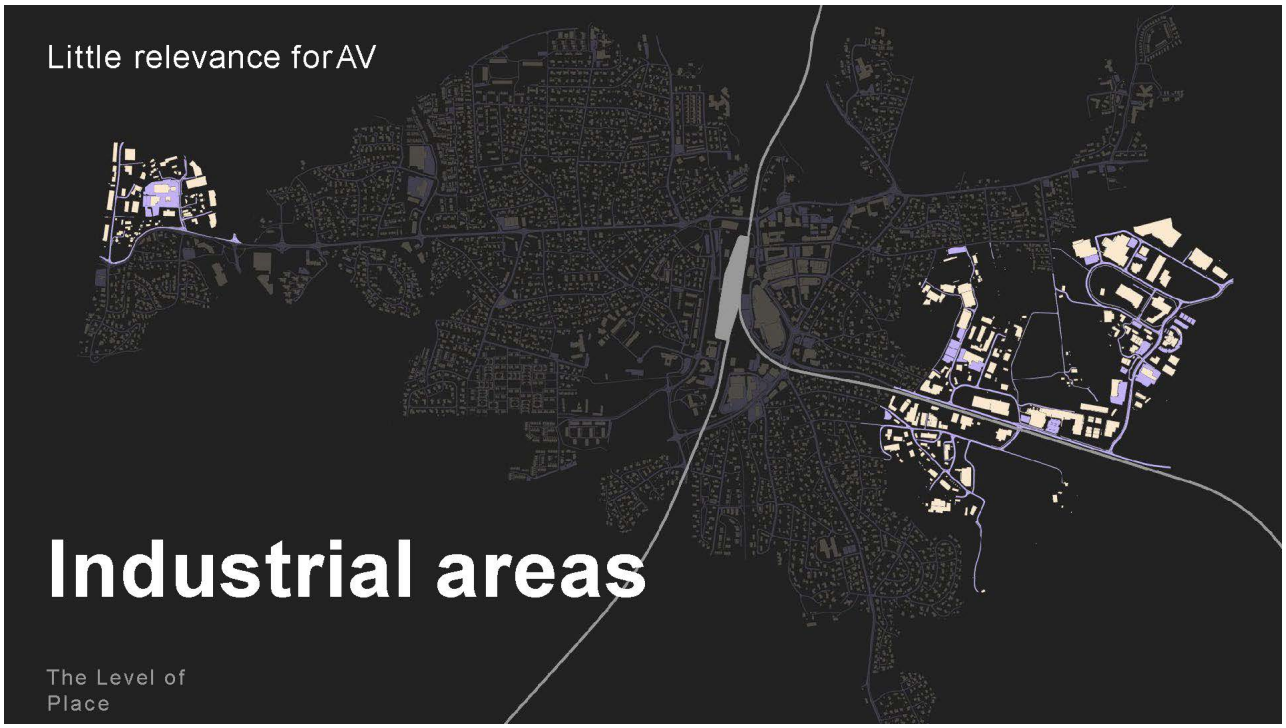

Micromobility
Extended
1000m radius
The Level of
Place


2000m radius
The Level of
Place


Adaption for AV
Residential areas
The Level of Place


Planning for AV
Remote residential areas
The Level of Place


Planning for AV
Development sites
The Level of Place


Little relevance for AV
Industrial areas
The Level of Place


Loop line concept
Current pilot
The Level of Place


Targeted area Ski, Hebekk
Pilot in Ski
Evaluating the pilot


Who should be served?
Single family houses
Row houses
Apartments
Garages
Others
» Single-family houses have at least one car per house
» Apartment buildings can have more cars per house
Housing types
Evaluating the pilot


Which distance is acceptable?
150 m
250 m
» Every meter to the stop makes it less attractive compared to the car
» Inner area fully covered
» Outer sections are not easily reached
Distances to AV stops
Evaluating the pilot


Bus lines cover outer areas Ski, Hebekk
525
Bus lines: 525, 520, 521
» Line 525 serves outer areas
» makes a big turn before coming back to the hub
» Southern parts of Hebekk need a nearby transport option
520/52
1
Bus lines
Evaluating the pilot


2. AV line complements the pilot
» Can substitute the bus line in this area
» Uses existing bus stops and added stops
2. AV Line
Evaluating the pilot


2. AV line covers all external areas
150 m
250 m
» Outer areas and the southern sections are served
Distances
Evaluating the pilot


Combination serves the entire area
150 m
250 m
» covers the whole area of Hebekk
» Outer areas have a straight link to the centrum
Distances
Evaluating the pilot


Can other destinations also be relevant?
150 m
250 m
» Make the AV service even more attractive
» Daily destinations ofthe Customers
» Examples: Hospitals, Schools, Grocery shop, Shopetc.
Additional Destinations
Evaluating the pilot

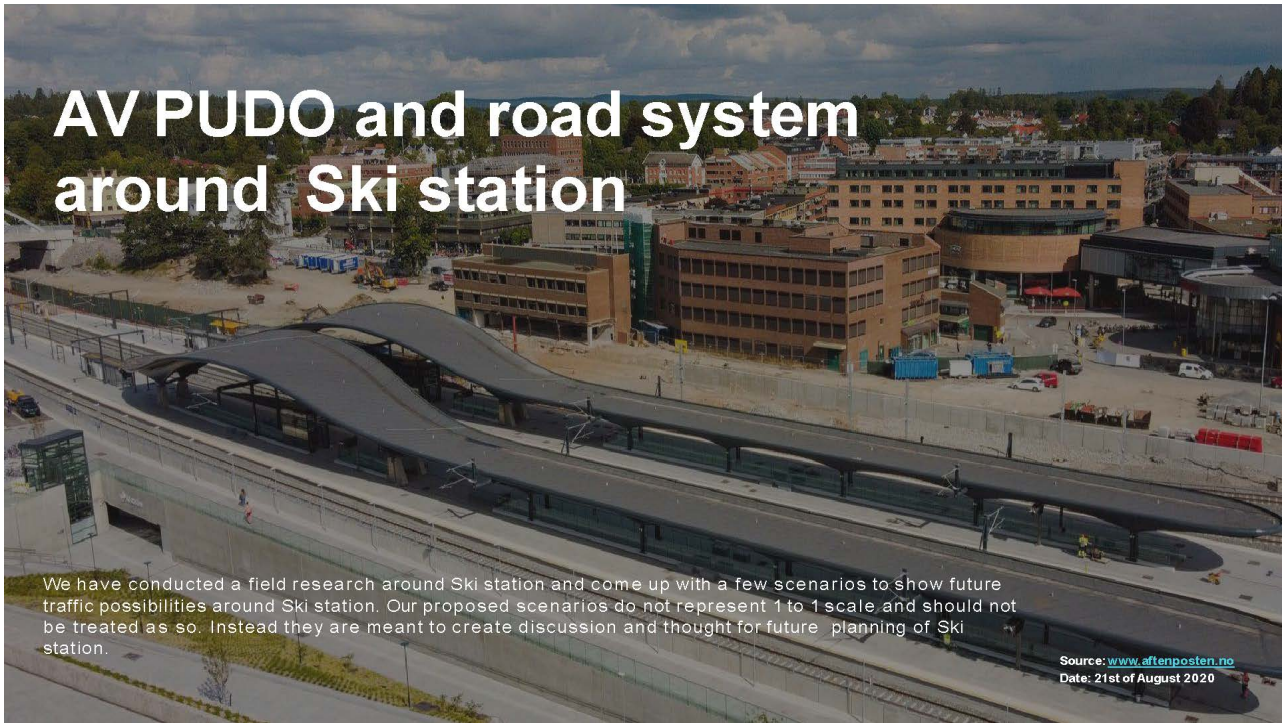

Straight line concept
Possible future line
The Level of Place

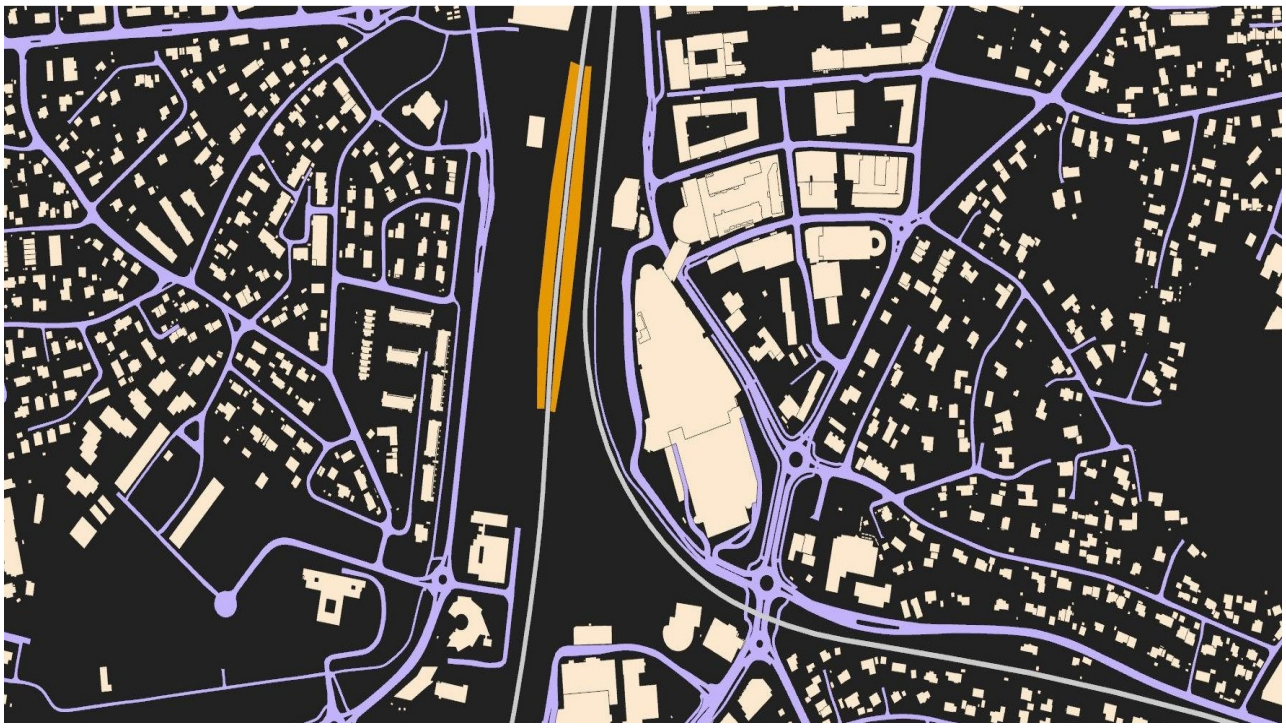

Straight line concept
Possible future lines
The Level of
Place


Straight line concept
Possible future lines
The Level of
Place


Serving development areas
Possible future lines
The Level of Place

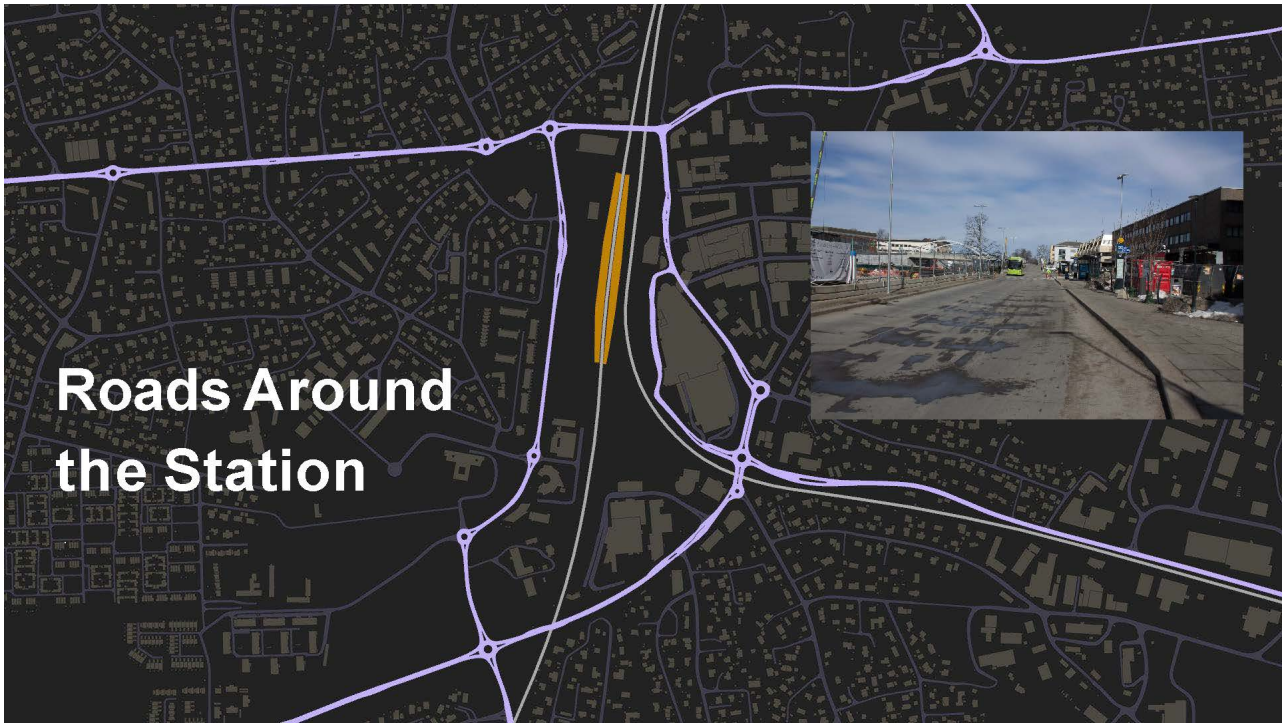

Serving remote areas
Possible future lines
The Level of Place

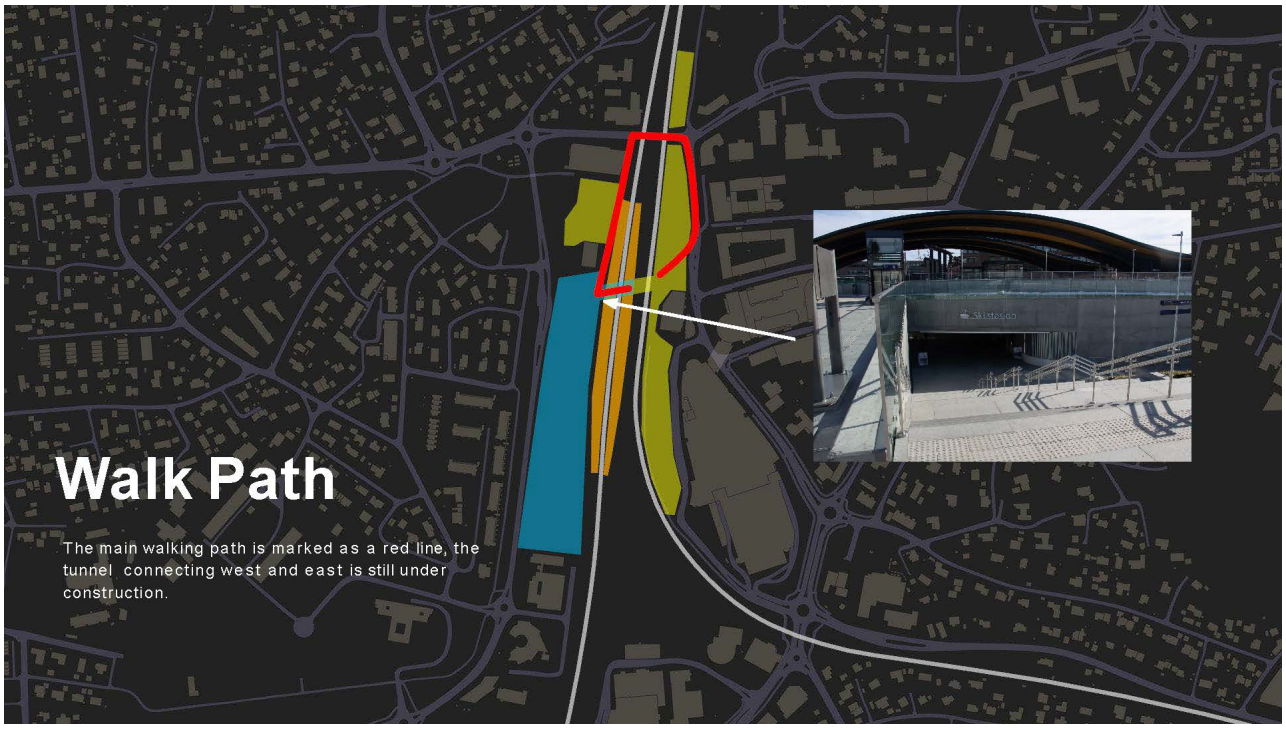

AV PUDO and road system around Ski station
We have conducted a field research around Ski station and come up with a few scenarios to show future traffic possibilities around Ski station. Our proposed scenarios do not represent 1 to 1 scale and should not be treated as so. Instead they are meant to create discussion and thought for future planning of Ski station.
Source: www.aftenposten.no
Date: 21st of August 2020

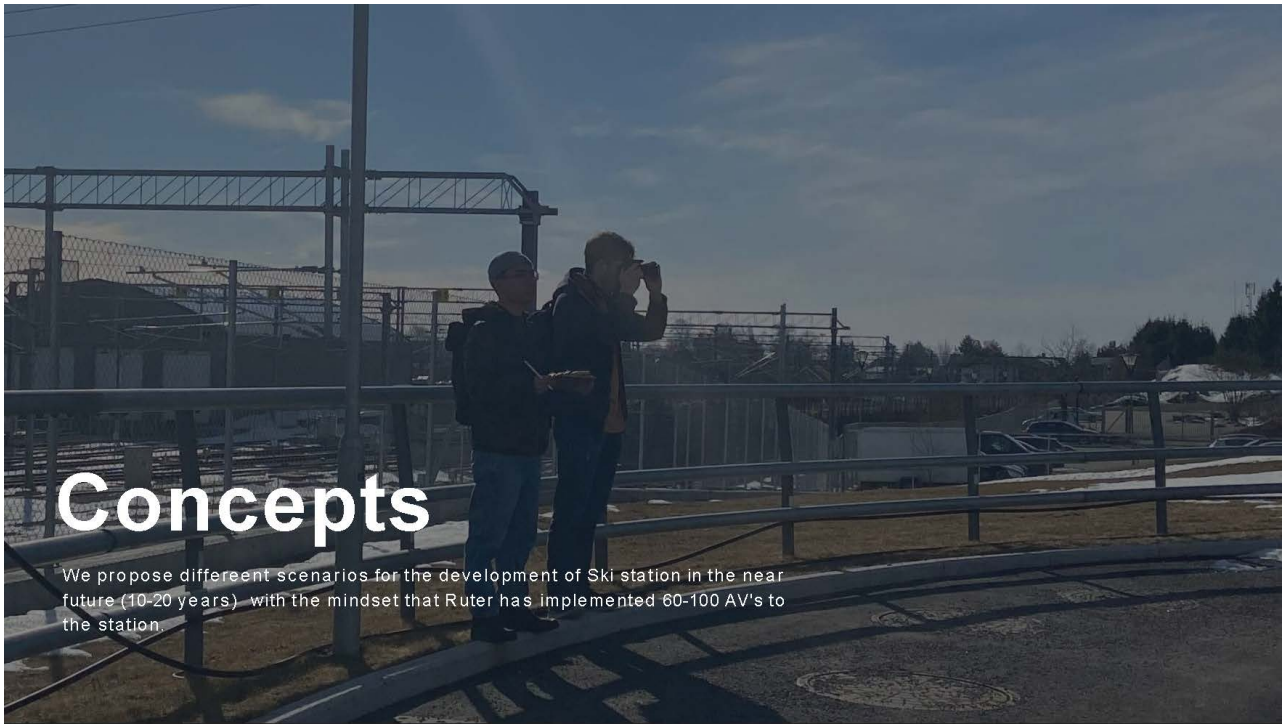



Current Situation
Bicycle and car parking
Ski station
Construction areas
Railroad


AV Pilot
The red point indicates the AV PUDO area for Ruter's current pilot project

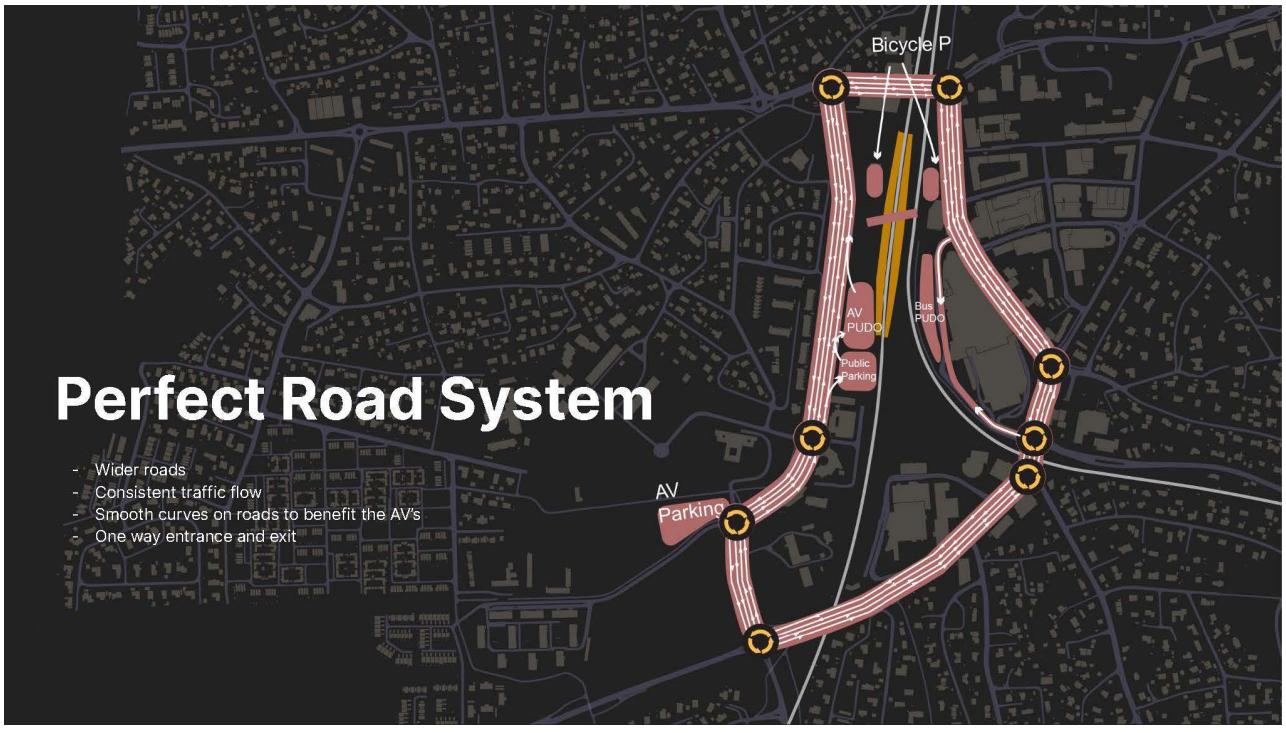

Roads Around
the Station


Walk Path
The main walking path is marked as a red line, the tunnel connecting west and east is still under construction.



Concepts

We propose differeent scenarios for the development of Ski station in the near future (10-20 years) with the mindset that Ruter has implemented 60-100 AV's to the station.



Perfect Road System

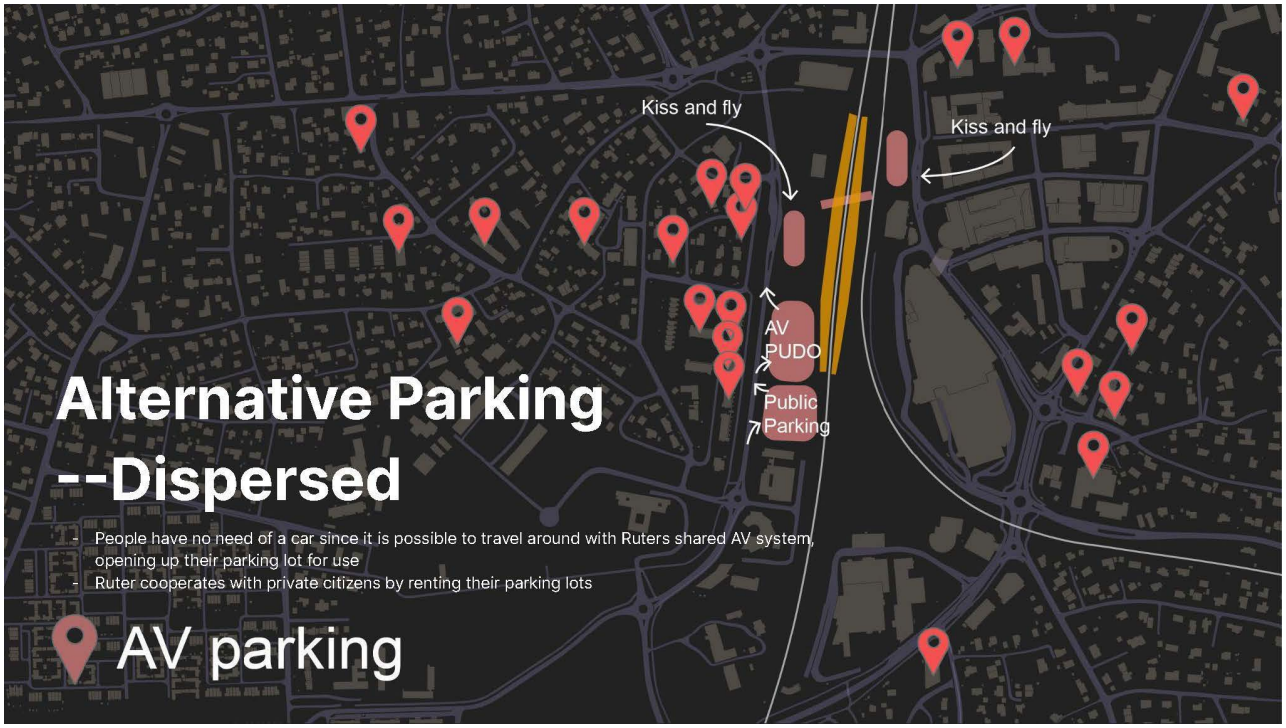
- Wider roads
- Consistent traffic flow
- Smooth curves on roads to benefit the AV's
- One way entrance and exit

Distribution of traffic

- Road on the west side has a total of 3 lanes which will benefit the one way entrance and exit zones.
- AV and Bus is gathered in one zone for user convenience and to avoid clutter on the east side.

Alternative Parking --Condensed

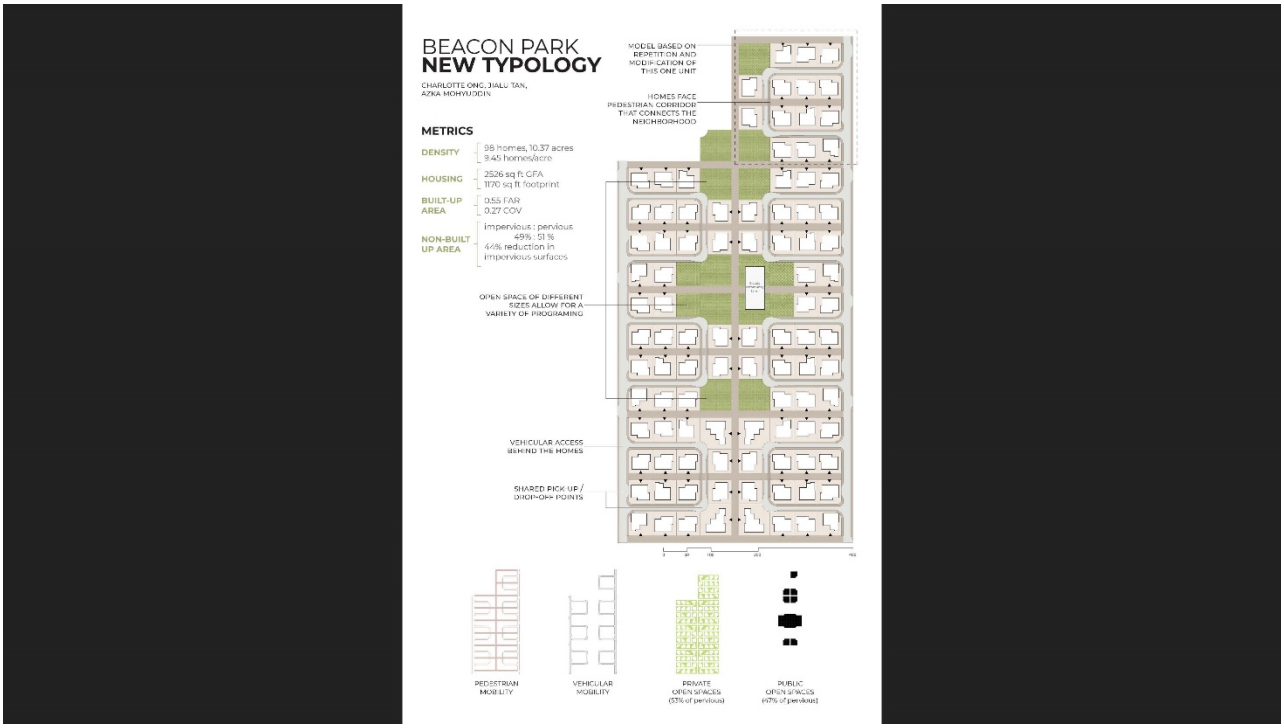
- AV parking is separated from station
- Large PUDO area
- multiple-story buildings for public and AV parking to utilize the space efficiently

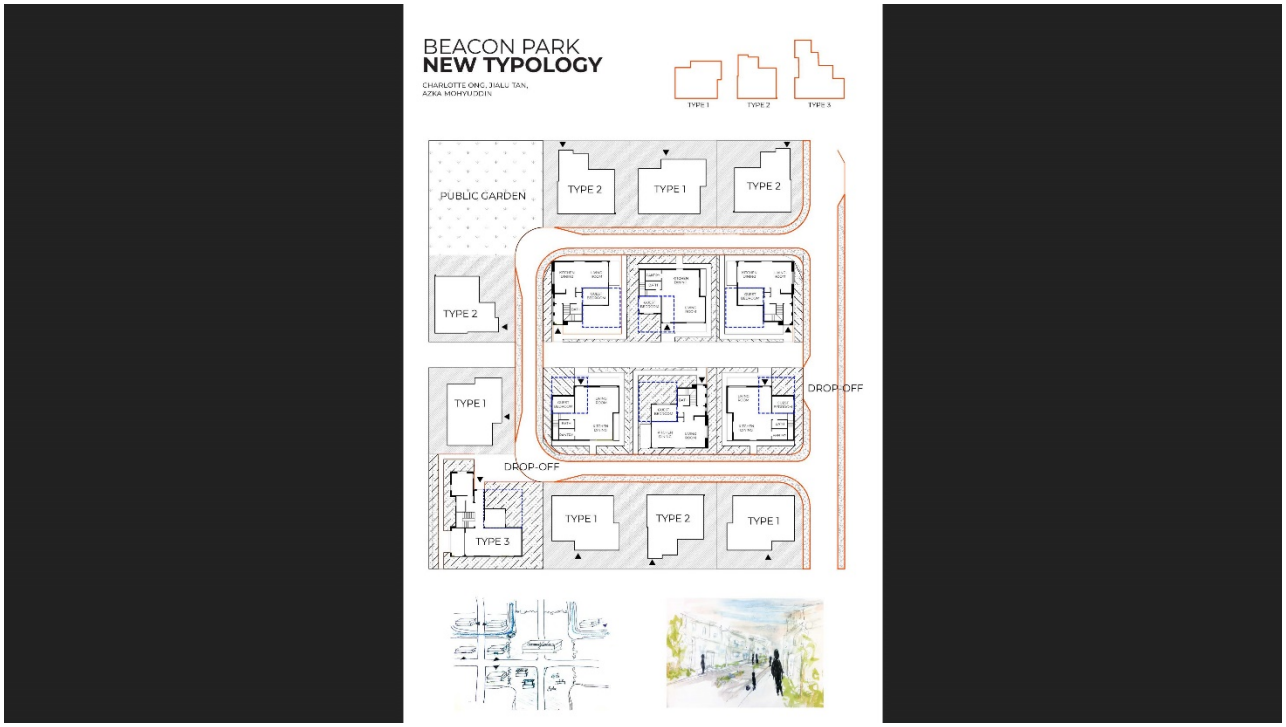

Kiss and fly
Kiss and fly
AV
PUDO
Public
Parking
Alternative Parking
--Dispersed
- People have no need of a car since it is possible to travel around with Ruters shared AV system, opening up their parking lot for use
- Ruter cooperates with private citizens by renting their parking lots
AV parking

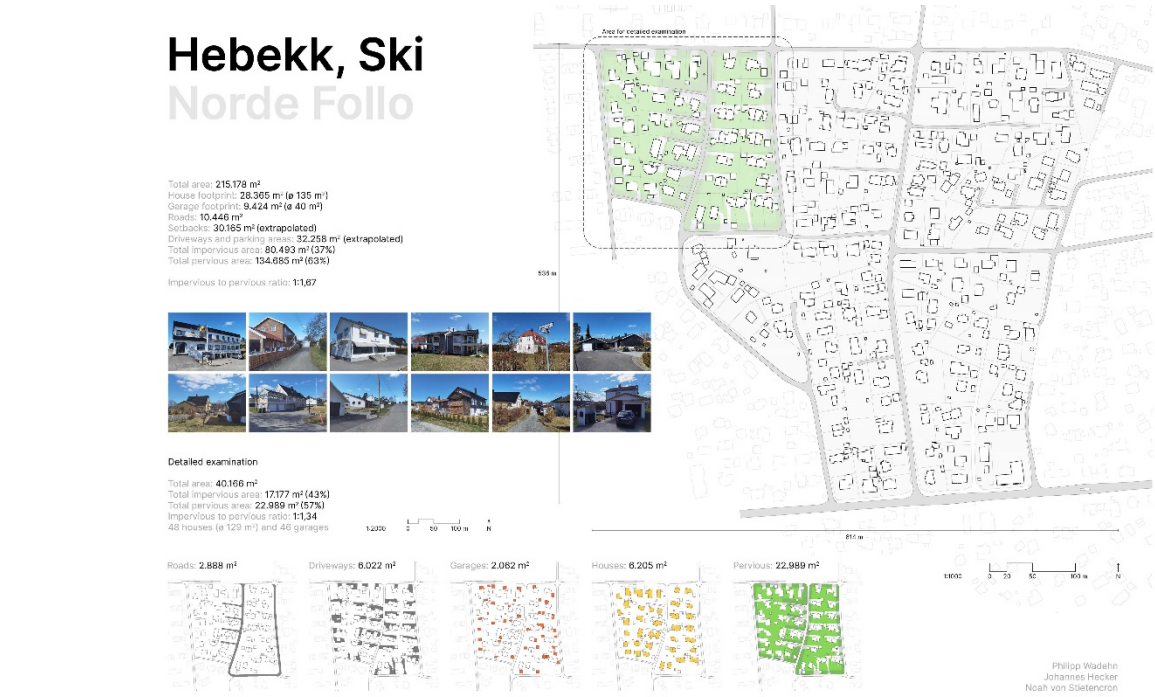
Potentials for Transformation

Parts of the area of Hebekk in Ski was studied in order investigate the potentials for revised use of areas, development of green structure and eventual densification

The first three illustrations shows comparable studies from the US (Alan Berger) and work as a model for discussing the future structure and morphology of Hebekk.







Interreg
North Sea Region
PAV
European Regional Development Fund
EUROPEAN UNION

Hebekk, Ski

Norde Follo

Current situation

Total area: 40.166 m²
Total impervious area: 17.177 m² (43%)
Total pervious area: 22.989 m² (57%)
Impervious to pervious ratio: 1:1,34
48 houses and 46 garages

Adaptation scenario

Total area: 40.166 m²
Total impervious area: 8.155 m² (20%)
Total pervious area: 32.011 m² (80%)
Impervious to pervious ratio: 1:3,92
48 houses

Greenfield scenario

Total area: 40.166 m²
Total impervious area: 8.271 m² (21%)
Total pervious area: 31.895 m² (79%)
Impervious to pervious ratio: 1:3,86
48 houses

Impervious areas
Pervious areas
Private space
Shared space

Philipp Wadehn
Johannes Hecker
Noah von Stietencron

Upper Hebekk

Total site area: 104327m²
Total Housing area: 19952m²
Total garage area: 4704m²
Road area: 9794m²
Pervious area: 60797m²
Impervious area: 43530m² (41,7% of total)
Pervious to impervious ratio: 1/1,39

In Norway there lives an average of 2,15 people per household*
The area consists of 323 houses, giving us an estimated population of almost 700 people.

Detailed examination

*https://www.ssb.no/en/statbank

Deheng Kong & Oscar Frank

Upper Myrsletta

During the first assignment we considered to work further with the left side of our our area for assignment 2, but after discussion and further consideration we decided to work with the northern part of our total area called Myrsletta. this section proposed more potential, to better understand the possibilities of AV.

Metrics

Total site area: 39661 m²
Impervious area: 15336 m² (38,6% of total area)
Pervious area: 24325 m²
Pervious to impervious ratio: 1/0.63

Examination

Road

Garage parking

Upper Myrsletta
New Typology

We propose to change the road system for AV of Myrsletta as seen on this page. The position of the houses are unchanged. The parking areas are gone and have freed up space to create public recreational areas to increase quality of life and amount of pervious area around Myrsletta.

Metrics

Total site area: 39661m2
Impervious area: 7424m2
18,7 % **impervious of total site area**
51,5% **decrease in current impervious area**

Examination

Road

Public Areas