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HORDALAND
FYLKESKOMMUNE

Teknisk Forprosjekt

Trolleybus Extension to Laksevåg

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Revision History

Revision	Date	Summary of Change
01D	07/03/2017	First draft
02D	21/03/2017	Revision based on HFK, Skyss and BBAS comments
03D	07/04/2017	Final Issue

Document Verification

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Contents

1 Scope

The scope of this report is to describe and discuss the current technological options for the extension of the trolley bus system in Bergen and to confirm the viability of the proposed project. This report will also make a recommendation of the preferred option for this project. The focus of this report is limited to the development of the infrastructure.

2 Conclusion

The conclusion of the report is that the installation of a continuous OCS system (traditional trolleybus system) or a system using In Motion Charging (partial OCS) are both possible on the proposed route.

It is the recommendation of this report that the expansion of the trolleybus system in Bergen should be the In Motion charging system. The In Motion charging system allows a hybrid trolley and battery bus to charge a battery while in operation and connected to the overhead system. This enables the bus to operate on battery, for certain defined sections of the line, where OCS is not installed and by that avoid challenging construction areas like Sydnestunnel.

To achieve this solution, a traditional OCS system from Carl Konows gate to Lyngbø in Laksevåg is proposed to power and charge the hybrid trolley bus with the remainder of the route serviced by a battery supply. This solution will install approximately 4.5 km of overhead line and 3 substations intended to meet a 5 minute headway for the route. The infrastructure cost of this proposal including installation of the lighting system is estimated to be 71.5 M NOK.

This solution, which is in operation in other European cities today, will meet the availability requirements of the proposed expansion. This solution will present the least project and economic risk, presents the lowest construction costs, provides the least impact on the city during the construction stage and utilizes the available infrastructure best. This solution will give possibilities in the future for expansion or additional routes.

Future opportunities of this expansion will be investigated in the design stage as part of this project. This will be the inclusion of multiple electric car charging points at the proposed substations and electrical cross connection with the Bybanen.

3 References

1. "LINJE 2+ FREMKOMMELIGHET", Rambøll, 8/12/2014
2. "Forlængelsesmuligheder for trolleybussen i Bergen", COWI, 19/5/2014
3. "MULIGHETSSTUDIE: UTVIKLING AV ELEKTRISKE BUSSER I BERGEN», Norconsult, August 2014
4. "Aktuelle Technologien fur Batteriebuss" presentation, Dr. Adolf Muller-Hellmann, 05/09/2016
5. Sak om forlenging og oppgradering av trolleylinja i Bergen, HFK letter 16.11.2016
6. "Teknisk vurdering og efaring", Norconsult, 01/02/2017
7. "Energy saving potential of a battery assisted Fleet of trolley buses" Andreas Ritter.

4 Project Description

In 2014, Hordaland Fylkeskommune employed a number of consultancies to evaluate the current trolleybus system and to propose possibilities for extension. The focus of this exercise was to evaluate if the extension of the trolley bus system would be beneficial to Bergen and to contribute to the traffic management plan for the city in line with bymiljøavtale targets. These reports concluded and recommended the following:

- That the system should be maintained and remain in operation (linje no.2).
- The current route cannot be serviced using current technology for battery only buses.
- Based on passenger dispersion and population density, it is recommended that the trolleybus system is extended, to service areas expected to experience continuous population and commercial growth.
- The routes seen as most beneficial and worthy of first analysis for extension are to extend the trolleybus system from Birkelundstoppen to Nesttun and from Sentrum to Laksevåg

To develop further these studies HFK have requested a Teknisk Forprosjekt to evaluate the possibility of extending the current no. 2 line approximately a 5.5 km to Laksevåg, whilst incorporating of the existing infrastructure.

The selection of the route through Sydnestunnel is based on the consultancy reports using demography, traffic flow and commercial development as the criteria. Skyss regard this route as the optimum route for the local residents as an alternative route through Nøstet is perceived to be too slow due to current traffic flows and frequent traffic jams

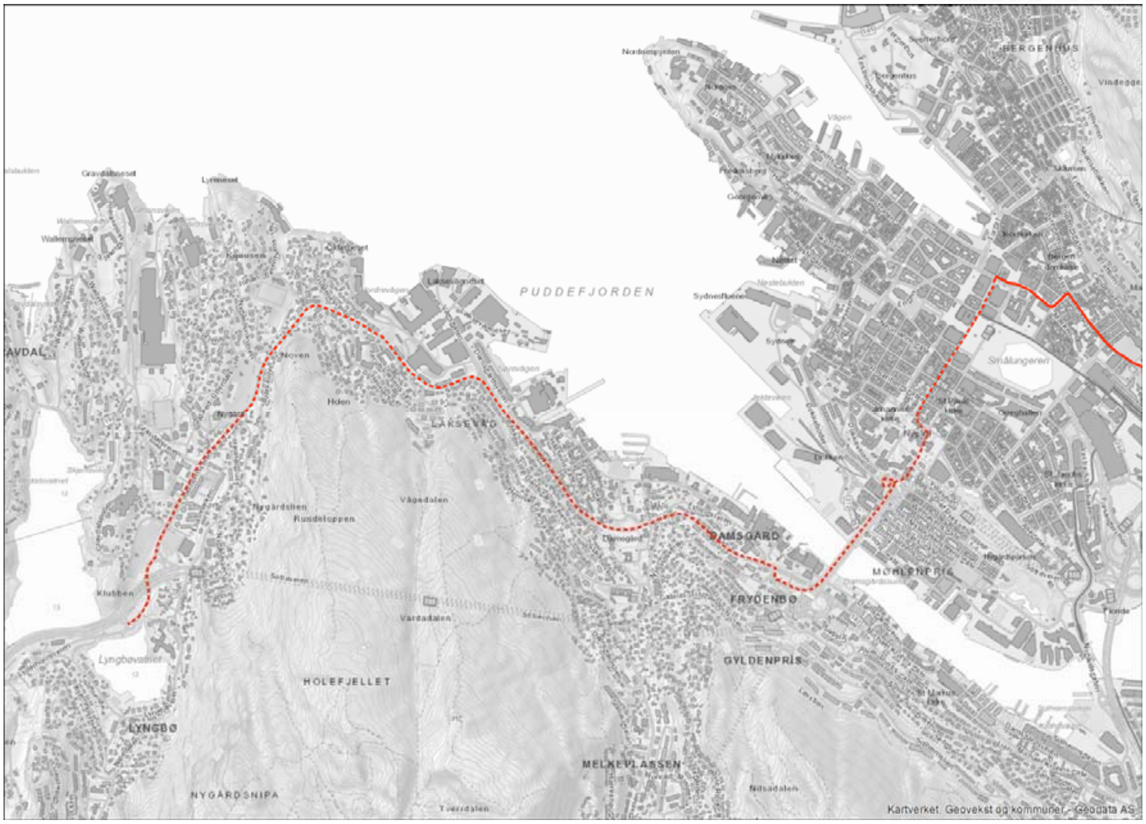


Figure 1 - proposed route

4.1 Project structure

This project is under the control of HFK. The project assessment and Teknisk Forprosjekt is the responsibility of Bybanen Utbygging under the instruction of HFK. Details of the works required and costing for lineside infrastructure will be evaluated in this report. The focus, coordination and direction of the project has been guided in project coordination meetings, which involve all stakeholders and managed by Hordaland Fylkeskommune.

Eigedomsavdelinga in HFK have begun an investigation into the current buildings at Mannsverk to assess suitability for expansion. Evaluation of the condition and access to the bus stops along the proposed new route will be investigated by AsplanViak in a separate study. Procurement of new assets to service any extension is under the control of Skyss in coordination with any proposed new infrastructure requirements. All steps will be taken in coordination with BBAS, who are the current maintainer of the existing trolley bus system.

Exploratory meetings have been held with Bergen Kommune to discuss the possible land acquisitions or planning permission required for the overhead line system and the placing of substation to supply power to the network. A start up meeting has been held with BKK regarding system supply and network availability on the proposed routes. SVV have been contacted regarding the existing road lighting infrastructure along the route as this is expected to be incorporated into any new poles installed.

5 Current concept on existing infrastructure

5.1 Trolley Buses

The current bus used on the system is a trolleybus utilizing an electric motor, supported by a small diesel-electric Auxiliary Power Unit for emergencies. To make use of the constant electric power the trolleybus uses current collector poles to connect to the overhead line system (OCS), this power is then used to meet the power requirements of the electric motor. It should be noted that all trolleybuses use a combination of constant power supply and a secondary system. This allows the trolleybus to make maneuvers whilst not connected to the constant power supply (OCS), to either move around broken down buses or to move through sections which are without power, during a substation trip for example.

5.2 Substations

The Substations currently in operation were put into service in 1950's. These substations were refurbished in the through 1970 to the 1980's to modernize the equipment. The installed power system supplies a trolleybus system, which runs at 10-minute headway in peak time and 20-minute headway off peak. Previously this system achieved a 2-minute headway in peak times with buses that would require a lower power than the modern equivalents.

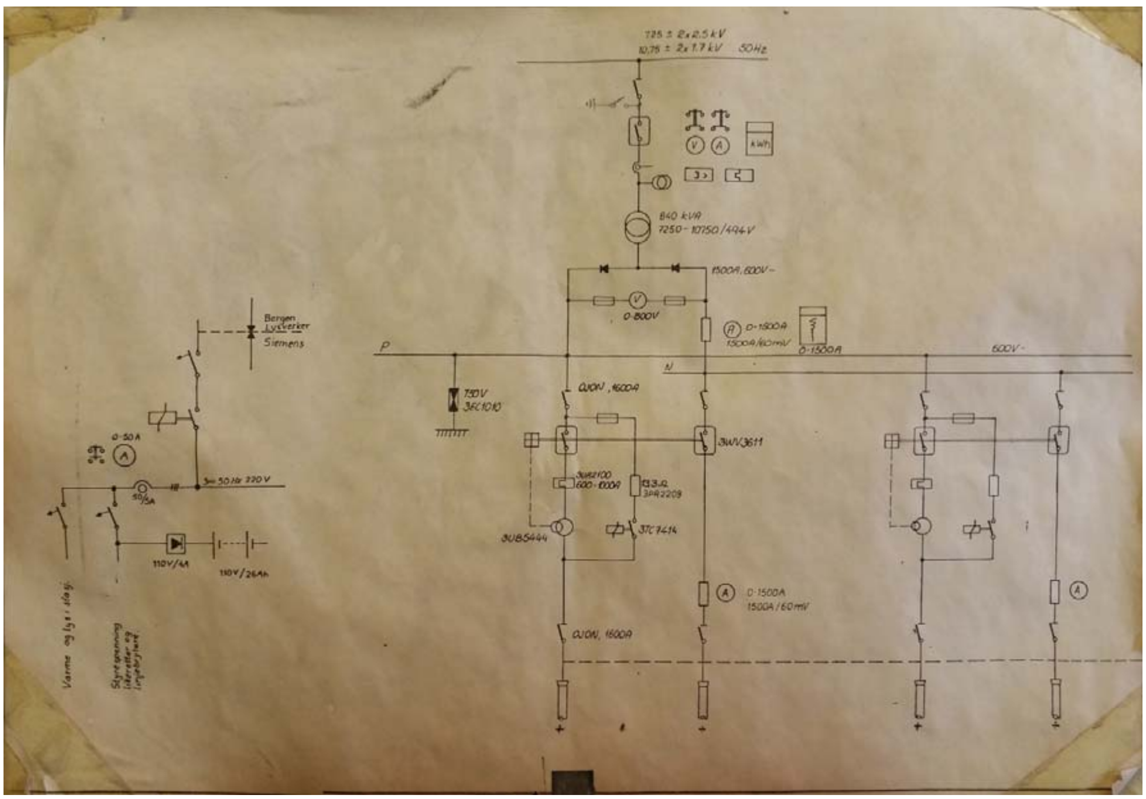


Figure 2 - existing system single line drawing

The system is supplied by BKK at 11 KV AC. This requires substations to be installed to convert this voltage from 11 kV AC to 600 V DC. Typically, these substations are spaced at a distance of 2 km to each other due to voltage levels and the resistance of the supply system, i.e. transmission losses inside the system. The existing substation are below 1 MVA maximum import capacity.

The arrangement as seen in figure 2 is to use an incoming 11 kV circuit board directly supplied from BKK to feed the traction unit. The traction unit then supplies the line through DC circuit breakers. The overhead line system is energized by connecting the dc breakers directly from the substation to the adjacent overhead line or connecting at remote points, using long run of cables, known as parallel feeder cables. Both connections may be required due to system load, but this can only be confirmed through power system simulation.

On review of the internal set up and system architecture, we do not recommend deviating too much from the original concept. The only addition we recommend at this time is to include a "house" transformer. Currently all internal power supplies for heating, lighting, command and control of the substation are directly fed from the BKK 400 VAC network. By supplying this system from the 11 kV network it will provide a more stable and secure supply for the substation

We are not currently in a position to confirm the size of the substations with respect to power capacity. This is calculated in the detailed design stage using power simulation software. However a basic calculation using information from bus vendors tells us that the peak load of a trolleybus can be in the region of 260 A. Considering a 5-minute headway, average bus speed of 40 km/h and a potential spacing of 2 km per substation, we see that the MIC (maximum import capacity) of the substation will be below 1 MVA. This means that we do not today see a requirement to upgrade the existing substations based on the MIC, in addition this is in line with the available capacity from BKK for the proposed route. We note that this assumption is made using a basic calculation and is subject to detailed design and simulation for confirmation.

5.2.1 Scada Command and Control

The existing substations do not have the ability for remote control for closing the switches. They can only be controlled using GSM to open the system for safety purposes. In the event of a trip or opening it is required that a trained technician visits the site to reclose the breaker. This is inefficient and we propose that in any extension, a simple Supervisory Control And Data Acquisition system (SCADA system) is installed to allow remote control of substations for fast reclosing and return to operation. The Scada system can also be expanded to include security and fire system notification and other system if deemed necessary.

5.3 Overhead Conductor System (OCS)

The installed system uses a maximum 100 sq.mm positive and negative wire to supply power to the trolley bus. This wire is positioned using a combination of insulated clamps and fixations to prevent short circuits to the surrounding support system. The suspension system utilizes a combination of GRP (Glass Reinforced Plastic) cantilevers, parafil rope (an electrical insulated material) and stainless steel wires to hang the catenary wire from wall fixations and steel masts. Wall mounted cantilevers directly fixed to mountain/rock structures are used where possible.

The mast today is a mixture of solid and lattice type structure, which is fixed to a concrete foundation via steel bolts. The majority of the masts were installed in the 1950's. There is a program ongoing by BBAS to replace some of the masts, which have suspect structural integrity due to age and corrosion. At heavy force areas, for example at Mannsverk, a larger round pole is used to provide the system the required structural support.

Figure 3 -typical existing OCS pole

To allow for the electrical sectioning of the line, sectional insulators and pole mounted switches are installed so certain areas can be isolated on the line if required without having to switch off at the substation.

The overhead line system is free hanging in daylight in most areas except at Haukeland where it is in tunnel. The maintainer, due to constant faults on the system and the restriction on the running speed, changed this installation in the tunnel from the original design of a rigid system to a suspended wire system. For this reason, BBAS does not; in their experience recommend a rigid system in any areas on the proposed extension.

A signaling system is installed at Mannsverk to allow the buses to change lines without having to disconnect the current collectors. Currently this has been disabled due to continuous driver errors. This system is used in other trolleybus systems in Europe and should be considered to be put back into operation. This of course will require driver training which should be considered as a requirement of this project once complete.

6 System selection

For the extension of the system, a number of technologies are available to consider. We will describe the available technologies and state if we will bring these forward for further consideration.

6.1 Traditional Trolleybus System

This proposal is to extend the OCS system for the entire length of the new route. This system involves using buses, which are equivalent to the buses today, diesel hybrids, or using small battery systems for short maneuvers. The new infrastructure will involve a tie in at Småstrandgaten for the inbound and outbound line and the installation of the OCS system through Festplassen on the inbound and outbound side using a combination of wall fixations and poles.

A ceiling mounted system is proposed through Sydnestunnel. An OCS system will be run across Puddefjordsbroen using poles mounted on the side of the bridge and in the central divide. An OCS system will be run from Carl Konows gate to Laksevåg using combined OCS and lighting poles where possible and potentially rock mounted cantilevers near Laksevåg Sentrum. This will be discussed further as option 1.

6.2 In-Motion Charging Trolleybuses

This option is to use a trolleybus utilizing constant power supply electric motor and a larger battery arrangement for the secondary system. The function of this system is to run on constant power when available whilst simultaneously charge a battery system. When no OCS or power is available, the bus can run solely on battery power for a considerable length of time. Figures of 25 % of the total line length can be achieved on battery only, including internal heating and cooling of the passenger cabins. Longer distances are possible with standard solution. For this system, we would propose the lower and raising of the current collectors is controlled electronically from the drivers cabin, not manually as is the practice today, to coincide with stopping to collect/drop off passengers.

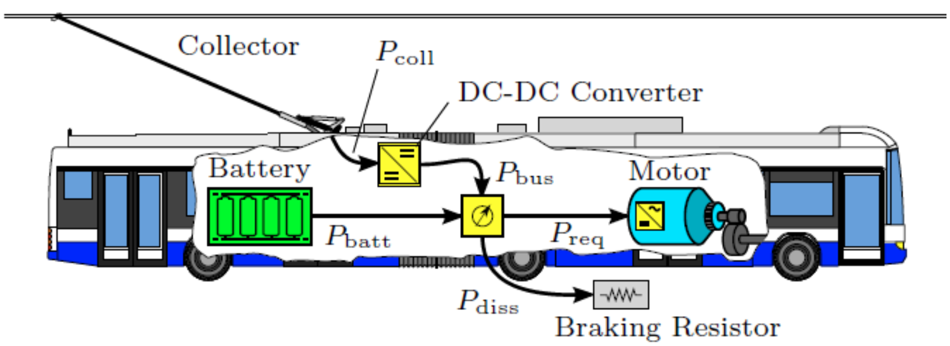


Figure 4 - example of in motion charging system, reference 1

In this option, there is no need to install the OCS system in the central part of the city, approximately 1 km. This would remove the need for an OCS system in the Festplassen, through Sydnestunnel and crossing Puddefjordsbroen. The remainder of the route will be installed as per option 1 beginning on Carl Konows gate. We have discussed this option with a number of bus manufacturers who have this system in operation in Europe and the distances proposed versus the available in motion charging time is easily achievable and well within the current performances of the buses and standard trolleybus battery systems.

With this design choice, the new generation of vehicles can regenerate and store breaking energy for future use independently of the grids absorption capacity. This is known as regenerative breaking which is the reusing of the breaking energy into traction energy and is a method of storing and reusing “free energy”. This option will be discussed further under Option 2.

6.3 Battery only Buses

This system uses batteries to store energy to propel the bus. The battery is charged by either:

- Charging overnight and/or end point charging,
- Pantograph charging at certain spots along the line by lowering a charge point or by raising a pantograph from the bus,
- Induction charging at stop locations.

Figure 5 - example of opportunity charging from fixed point connecting to the bus

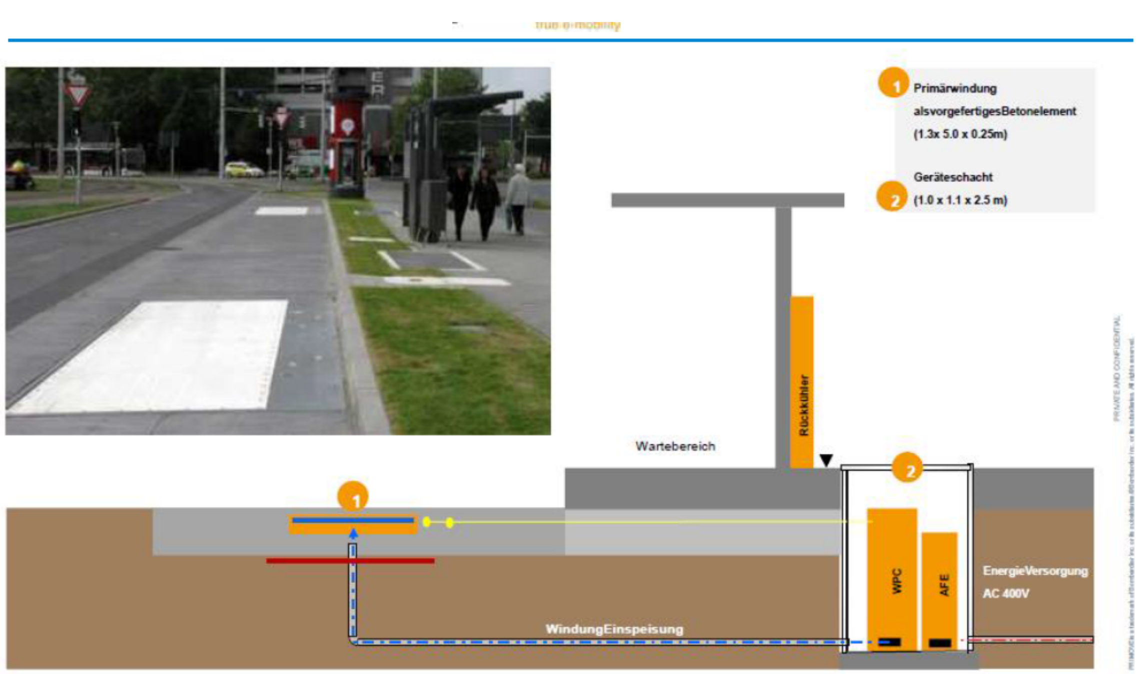


Figure 6 - example of opportunity charging by induction

As stated in the Norconsult report, endpoint charging does not meet the requirement for this project as the long steep climb from the city to Birkelundstoppen cannot currently be met with existing battery technology without reducing passenger number due to the total weight requirement of the bus.

It should be noted, that in Amsterdam end-point charging was investigated and rejected, as it cannot meet the city requirements without using extremely high-powered charging systems, which are currently not in commercial operation.

Opportunity charging is deemed as being too high risk and cost for the proposed extension. These solutions do not make use of the existing infrastructure, as it cannot be utilized to supply the opportunity pantograph charging or the induction charging system.

For these reason, we are not considering these technologies for further discussion as part of this project. These system may however be used for other routes in the future and are not discounted for future use as battery technology improves, but for this report it will not be discussed further.

6.4 Option 1 – Traditional Trolleybus System

6.4.1 Definition

This option is to interconnect the existing OCS system at Småstrandgaten and run a continuous OCS system to Laksevåg. This involves the installation of OCS poles and wall fixations to suspend the OCS wire above normal road traffic. Trolleybus vehicles that are in use today or trolleybuses with a small auxiliary battery system can operate this option.

6.4.2 Major Constraints

6.4.2.1 Sydnestunnel

Norconsult were tasked with performing a radar survey of the tunnel in 2014, refer to Appendix 1, and Appendix 2. This 3D survey showed that the minimum height of the tunnel is 3.9 meters with an average height of approx. 4.15 meters. We have engaged a number of bus manufacturers and OCS system designers and there is an identified risk of running the OCS wire through Sydnestunnelen, due to OCS electrical clearance height and minimum running height for the buses. This results in the possibility of having to lower the road in this area. We have estimated a 500 mm lowering of the road through the tunnel.

SVV were contacted to discuss similar works they had undertaken at Eidsvågtunellen to lower the road surface. They stated that the time take to lower the road of an 850 meters long straight tunnel with no utilities under the road surface took 3 months with a 24-hour work cycle. During this time, the tunnel was completely closed to all traffic.

Figure 7- Bergen program map showing water and drainage services running into sydnestunnel

In Sydnestunnel, we have identified drainage and water system under the road base. On the available survey maps electrical cables are not recorded so we cannot state if they are present or not but it is reasonable to assume the presence of BKK network cables in this area. These utilities will have to be diverted if they clash with the proposed road lowering.

Our initial estimate is that this tunnel will have to be closed for a period of 4-6 months to all road traffic if required to lower the road surface. This will have an obvious effect on road traffic in the city while it is closed. This tunnel also contains a shelter area for circa 5000 people using heavy steel gates for access. This internal gate system will have to be altered to allow the wire to run through the tunnel, which has not been discussed with the shelter manager as to what effect this action will have on the operation of this area.

6.4.2.2 Crossing the Bybanen

By running a continuous system interconnecting the existing system and the new system, we shall cross the Bybanen OCS system. This arrangement exists in other cities and products are available to perform such an arrangement. However, it is our opinion that this will lead to operational and maintenance constraints once both systems are in operation together and can provide a risk to both systems especially in the first year as operational procedures are developed.

6.4.2.3 Aesthetics and Construction in Festplassen

By running the wires through Festplassen there will be disruption to the current bus and pedestrian movement, in order to erect poles and erect the wires. Some of this work can be planned for night-time installation however this will be at a higher cost.

Once installed and commissioned there will be wires in the area of Festplassen. For such a prominent urban area in the centre of Bergen, this may be a high risk for the project even though Bergen has a history of trolleybus and trams in the city.

6.4.2.4 Road crossing at tunnel entrances

The transition from the road crossing at Christies gate/Olav Kyrres gate and Håkonsgaten is identified as a key constraint. From this point, the OCS system will need to transition from the road crossing height of 5.2 meters if this is used as the guide for the system height to the entry height of 3.9 meters in a distance of approximately 45 meters. This would give a gradient of approximately 2.88%.

The teknisk regelverk for tram systems states that the allowable gradient is 2.0% at 30 kph. There is currently no teknisk regelverk for the trolley bus but the tram version is used as a guide. This will need to be addressed in the design stage as such a sharp gradient will cause a greater up force on the system as it enters the tunnel and an increase in friction which may lead to higher maintenance costs over the lifecycle of the project. These costs will be in trolley bus pole connector carbon wear and OCS wire wear.

EN 50122-1 section 5.2.4. and repeated in the NEK 900 section 5.2.4 allows for a road crossing height of 4.7 meters for low voltage tram system (this is applicable for trolley bus). The normal designed height in Bergen for road crossing has been between 5 and 5.25 meters but this can be investigated further to get closer to the allowable height as per the EN/NEK standards. If allowed, this gives a gradient of 1.78%, allowing for a greater speed and a reduction of the friction between the systems. This would require consultation with SVV as well to ensure this does not restrict some vehicles from passing in this area.

6.4.3 Construction

The major construction in this option is the alteration works to Sydnestunnel and building construction for the substations. A combined total of 4-6 months is assumed in this case. Other civil construction is estimated to take about 5-6 months, this is construction of foundations for new poles and trench works for lighting systems. Electrical installation is estimated to take approximately 6 months; this includes installation and testing of the substations and erection of the OCS system.

6.5 Option 2 – In Motion charging

6.5.1 Definition

This option involves installing an overhead system from Carl Konows gate to Laksevåg only. The route between Festplassen and Carl Konows gate will be serviced by battery supply only which will be charged by running on the existing infrastructure. The new section to be installed will require the installation of OCS poles and wall fixations to suspend the OCS wire above normal road traffic.

In this solution, approximately 1 kilometer of the proposed 5.5 km length will have no overhead wire. This constitutes 18% of the new installation. However conceptually this is an extension of the existing system, therefore this will result in 1 km with no wire (battery drive only) on a 13.5 km line, approximately 8% of the total line with no wire.

6.5.2 Major constraints

6.5.2.1 Connecting and Disconnect the Current Collectors.

For this option to have the optimum availability, it is proposed that the action of lowering the current collectors to run on battery supply and raising the collectors to run on constant powered OCS and charge the battery system is conducted by the driver from the driver cabin while at bus stops. This system exists on the current fleet; but it is not used. For this system to operate in an efficient manner, the bus stops must be standardized so that the trolleybus can make the correct connection every time and minimize the occasions that a driver must leave the bus to conduct the process by hand. The standardization will be applied to all new stops to allow drivers to drive on and connect at the next stop should the connection point be missed. This can also be investigated for existing stops.

Lowering the collectors is not seen as an issue, as this process is in the complete control of one system only, the trolley bus. Raising the poles can be an issue if the bus is not correctly positioned and the collectors do not make contact with the wire. To assist this process a combination of plastic guiding systems are used, to guide the current collectors into position as they are released. These systems are mounted on the OCS at the bus stops for consistency and in the depot for parking on changing or maintenance lanes. Current collector heads can be magnetized to ensure that a good electrical connection is made when the poles are raised between the wire and poles. Additional material will have to be added to OCS wire to allow this connection to take place.

To assist in standardization and to provide on-site guides to driver to ensure that they position the bus in the correct position before engaging in the process, a proposal has been made to SVV to paint an "E BUS" sign on the road where the bus will stop to make connection. This is an early idea and other options are under investigation to provide better visual aids for drivers in addition to training.

6.5.2.2 Procurement of Buses
It is expected that the total cost of the In Motion Charging bus will be greater than the traditional trolley buses but the operational costs of the In Motion Charging buses including maintenance is expected to be lower than traditional trolley buses based on information provided by other operators.

6.5.3 Construction
Civil construction is estimated to take about 5-6 months, this is construction of foundations for new poles and trench works for lighting systems. Electrical installation is estimated to take approximately 6 months; this includes installation and testing of the substations and erection of the OCS system.

6.5.4 Optimization of Battery Size
The sizing of the battery will be an element of the project that will be further developed in the detailed design stage. The optimization will focus on the range of battery only driving that we aim to achieve with the infrastructure we propose to install and considering existing infrastructure.

Certain constraints are included in this evaluation/simulation, such as:

- Limitations of battery size due to overall bus weight, including passengers,
- Available time for battery charging,
- Allowance of contingency in the event that an electrical section is not in operation due to maintenance or fault.
- Maximum headway and speed

This function is normally performed by trolley bus manufacturers through proprietary software and is modeled to give the optimum battery size for the system required and can be evaluated based on future requirements.

7 Bus manufacturers

7.1 Systems
Numerous vehicle providers were contacted to discuss the current options available in Bergen. All suppliers were traditional trolley but vendors so with regards option 1, classics trolley bus, this is not an issue. The main focus of meeting vendors was to understand the requirements of the In Motion charging system and to understand how it works in operation and if they have any first-hand experience from operators regarding faults with the system or proposed improvements. All companies contacted provided a positive repose to the system. In addition, they all recommended it as an option for Bergen as the system currently available could meet the proposed requirement of a 1 km section with no OCS.

It was noted that the use of Option 1 and option 2 presets a longer running day for the bus. In theory, except for maintenance and driver change over, the bus can be run for 24 hours. The other discounted options must be removed from service for a time for refueling or recharging.

7.2 Experience

NorConsult were instructed to perform a study based on the experience of other trolleybus systems from the perspective of the operator of the IN Motion system and the dropping and raising of the current collector system automatically. This report is included in Appendix 3. In summary, the system is successful in all cities that were interviewed, with no complaints regarding the system. The general response was that it provides added flexibility to the system and allowed the system to achieve a stable timetable. Failure rates for the disconnection and reconnection of the current collectors were lower than expected and where this rate is recorded, it is in the region of 1 failure in 2000 operations. These faults when they occur take approximately 30-60 seconds to rectify.

7.3 Load requirements and adaption to existing infrastructure

As stated in section 5.2, the assumed peak load of the current generation, either of trolleybuses using classic OCS systems or in motion charging systems does not exceed the maximum capacity of the existing infrastructure. This information allows us to present a substation design, which will follow the same principals as the existing system and does not mean the refurbishment of the old substations and OCS system based on technical requirements.

Note : battery only buses not considered in this review
Information source ZEEUS project and product manufacturer websites, emails and meetings

Manufacturer	Vehicle type	Passengers	Charging Type	In motion charging	Length	total Height inc. poles	Power Peak	battery energy
Carrosserie HESS AG	SwissTrolley BGT-N2D	147	Pantograph	Yes	18.74	3.47	240 kW	20 kWh
Carrosserie HESS AG	lighTram Trolley BGGT-N2D	221	Pantograph	Yes	24.72	3.47	320 kW	32 kWh
Solaris	trollino 12	83	In motion charging	Yes	12	3.49	280 kW/215kW	69 kWh
Solaris	Trollino 18/18.75	139	In motion charging	Yes	18/18.75	3.49	280kW/296kW	69 kWh
Vanhool	Exqui.city 18	131	Overhead catenary	Yes	18.6	3.3	120 kW	35 kWh
Vanhool	Exqui.city 24	149	Overhead	No	23.8	3.3	2x160 kW	20 kWh

8 Experience Visit

A study trip was organized by Norconsult to allow the involved parties in the project to visit other trolleybus systems that are currently operating Classic OCS systems and IMC system and to visit proposed systems to understand the operational issues with all systems.

8.1 Zurich

Zurich has an extensive trolleybus system operated by VBZ. The current system is approximately 55 kilometers using both traditional trolleybuses and IMC trolleybuses. The focus of the current public transport system and planned expansions is to employ proven and reliable technology that is compatible with their current fleet.

Currently VBZ are operating a number of routes on the network with IMC trolleybuses. The use of IMC is to allow route transition, to simplify complex tram and trolley bus junctions, to reduce construction constraints and to allow for easier expansion of the system. It is the experience of the operator that the activity of raising and lower the current collector poles at stops has a failure rate of approximately 1 in 1000 operations which they deem to be completely reliable and provides no operational constraint or negative impact on achieving the planned timetable.

Figure 8 - Zurich trolleybus

VBZ are currently planning further expansions of the trolleybus network using the IMC trolleybuses and installing sections of OCS, not a complete continuous line, to create a more flexible and efficient service. It is noted that Zurich have experienced lower operational costs using IMC buses in relation to battery only or diesel APU units. This is recorded as lower vehicle wear, less maintenance and higher lifetime of the buses. It is their experience that the lifetime of a trolley bus with diesel APU is 14 years versus 17 years for an IMC trolley bus.

The justification of expanding the system using IMC buses instead of traditional trolleybuses with diesel APU, battery only buses or opportunity charging in this is that in their experience IMC has been:

- The best performer, including hill performance,
- Not constrained by construction “bottlenecks”,
- Very few recorded failures,
- It is a proven technology in Zurich since 2015.

8.2 Lucerne

The Lucerne system is operated and maintained by VBL. Currently there is approximately 38 kilometers of installed traditional trolleybus line. VBL report that the system is preferred in their case as it is a traditional part of the city since its installation in the 1940’s. They report a very stable network due to high maintenance and high driver training. Today they are using both 12 and 18-meter trolley buses and are planning future expansions. These expansions are planned as traditional trolley bus however the IMC concept is under investigation.

Figure 9 - Lucerne R bus

8.3 Amsterdam

GVB are investigating options for the development of the bus network in Amsterdam under the Zero-emissions project. The goal of this project is create sustainable transport using zero emissions supply. The outcome is to have all transport inside the city of Amsterdam as zero emissions by 2030. This will be phased over the coming years and be a requirement for all cars, buses, trucks and ferries.

Through their investigations, they have found that battery only buses using overnight charging or end-point charging cannot currently meet their timetable requirement due to limited turnaround time. An investigation into all other available electric and hydrogen bus technologies has shown that the best technology in this situation is the use of IMC trolley buses. Through their research and lifetime cost modelling, they present the benefits of IMC trolleybuses over other technologies as:

- IMC trolleybuses are a trusted technology,
- The direct power supply aspect of the technology provides better engine operation over other technologies
- It is considered the cheapest infrastructure option,
- It provides the cheapest total cost of ownership option in their calculations,
- IMC trolleybuses meets their timetable requirements.

The proposed project is to install OCS wire for approximately 30% of the route for direct powered driving and battery charging and then operate the remainder route driving on battery power. The proposal is at the edge of the current technology limits and is being investigated with industry partners to achieve this high capacity, high charging rate demand solution.

9 Estimation on number of substations and design philosophy

This assessment of the maximum import capacity will be subject to future simulation of the power system but we will provide an approximation to allow for grid planning and substation sizing.

An estimation has been made of the number of Substations required to provide power to the system. This estimation is based on the following principals. The substations should typically be spaced between 1.5 – 2.5 km’s apart based on requirements of the power system and to achieve the requirements of an N-1 design where the system can operate with the loss of an individual substation.

Evaluation of the existing system shows that there is approximately 8 km of installed system with 4 Substations. Using this as a guideline, the following will be required for a continuous OCS system, pending a power simulation for complete confirmation.

Option 1 &2 - Laksevåg	3 additional Substation

This assessment is made on the assumption that the achievable headway should be approximately 5 minutes. This however remains undefined and should be confirmed as a key requirement if the project is approved to continue.

The basic principles of the old substation are applicable and the new Substation will mimic the old type with new equipment. On review, we do not see a need to produce a new design for these Substations, as the principal will be the same.

10 Placement and planning of substations

10.1 Building area and design

The general footprint of the current Substation is a 3 m x 4 meter building. They require an 11 kV and 400 Vac connections from BKK, which is in an adjoining building in the substation. This is estimated to be an additional 3 x 4 meters onto the overall footprint. This provides a final max estimated footprint of 6 x 4 meters not considering access area (maintenance vehicle parking) outside of the building. Areas will be required to be found to accommodate these new Substations, which are line adjacent and close to the BKK 11 kV network to reduce civil works for cable connections

The first option for the design and appearance of the building will be to base the appearance on the stage 2 and 3 design for the Bybanen and further give the appearance of coordination for the transports system of Bergen. This will be reevaluated in the detailed design stage.

Factors such as the promotion of Green Energy by the fact that this is an electric supplied system with the concept of zero emissions can be taken into consideration through signage around the building.

Figure 10 - example of possible substation appearance. Kokstadflaten substation Bybanen BT3

The second option is to provide a containerized solution, which is constructed in factory and delivered to site for minimum installation. These units are built to client requirements and are constructed, tested and commissioned in factory. Once complete they are delivered and installed on site with greatly reduced construction time. The unit is delivered in a container; however, an external façade can be created around the unit once installed to help integrate it into the surrounding environment. It is assumed that this unit can provide a cost saving to the project but exact figures are not available at this time.

Figure 11- example of containerized substation

10.2 Reguleringsplan

Initial meetings have been held with Bergen Kommune to evaluate the area for the location of the substations. The following locations were discussed (refer to fig 10 -13) with Bergen Kommune in line with current planning for the areas and the best locations for the substation.

This meeting was followed up with a preliminary planning meeting (forhåndskonference) with Bergen Kommune. It was confirmed that all proposed locations are in breach of current zoning plans, both in terms of purpose and in terms of distance from the road. The report of this planning meeting is included in Appendix 4. In order to use these locations, the project will require a dispensation from SVV to use the areas. A pre-conference will be established with SVV to progress the issue in parallel to the project design stage. It is noted that the process for a dispensation takes 4 months to complete.

10.3 Grid supply

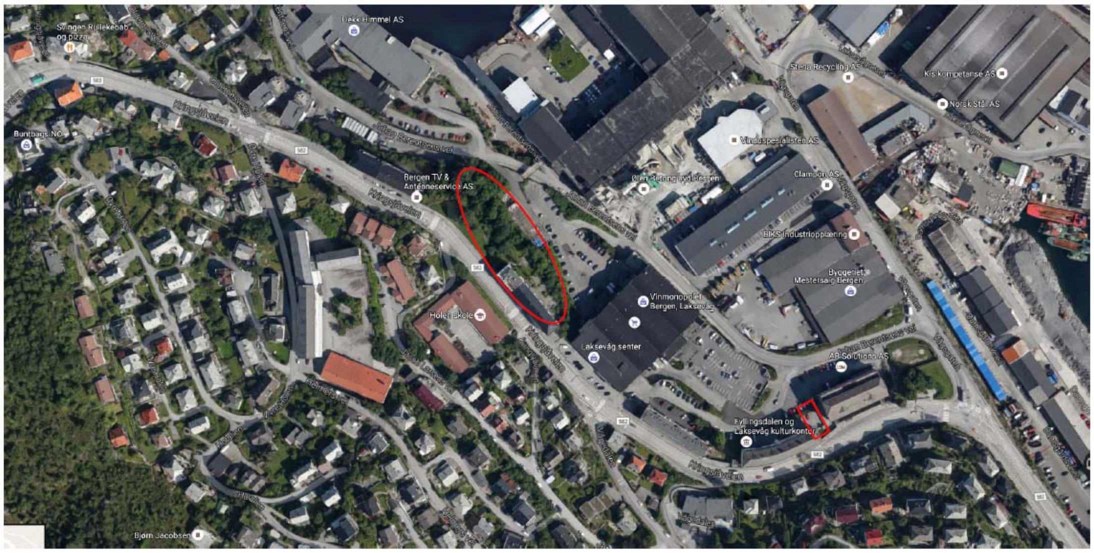
BKK have assessed the following locations and have stated that based on their initial assessment of load and the current capacity on the electric circuits in the area that the areas are possible. This is pending further detailed engineering assessment however for the initial assessment the locations can be supplied by BKK at 11 kV with minimum disruption to roads for rerouting of cables and will not require additional large infrastructure installment by BKK.

Location 1 *- Under bridge on Carl Konows Gate, direction towards Danmarks plass. Checked with BKK. Suitable network connections in the area at 11 kV

Figure 12 - location option 1

Option 2 Damsgårdveien (down the slip road). 11 kV connection in the area

Figure 13 - location option 2



Option 3 Kringsjåveien, BKK confirm 11 kV connection available

Option 4 Johan Berentsens vei – area not defined but many available sites. BKK confirm 11 kV connection available

Figure 14 - location option 3 and 4

Option 5 Lyderhornsveien area under pedestrian bridge. BKK confirm 11 kV connection available.

Figure 15 - location option 5

11 OCS system design

The concept for the OCS design will be to install wall fixations and wall/rock mounted cantilevers where possible. When pole installation is required, the emphasis will be to replace existing poles with new poles to reduce the impact on the pedestrian walkways.

The OCS support system will be a combination of OCS poles, combined OCS and lighting poles and wall fixations in line with the current system. The standard OCS pole can be of the type used today. Recent refurbishment and improvements to the trolley bus system in Bergen have replaced the old Lattice and square poles with round poles. This pole allows for multidirectional forces as it has the same structural strength in all directions and provides a more aesthetically pleasing appearance.

Figure 16 - new type round pole

A new concept pole can be considered for the project and become a standard for any further developments of the trolley bus. This will be the most visible part of the project and should be selected with care. A singular design should be selected for all new poles and replacement poles to allow for a uniform installation and lessen the visual impact. As there is no tension (weight sets) on the system we can progress the design in the manner. Currently there is no singular design concept for lighting poles in the Bergen area and a pole is selected for each individual construction. This is an area where we see that the system can be standardized. An example of a "traditional" pole under consideration in another project in figure 15

Figure 17 - traditional pole with light fixing arrangement

The "Nordic" concept for infrastructure installation (clean, simple, creative, efficient, and stylish) might be captured better in a more futuristic style arrangement. In figure 16, we can see an artist's impression of a more futuristic style of combined trolley bus and lighting pole.

Figure 18 - pole in keeping with the Nordic approach

The previous practice to combine OCS and lighting system has been to connect a luminaire and light head to an existing pole using brackets and supports. In this project, we propose that this pole is a single construction in which the lighting system is integrated into the pole and will give the appearance of a single structure. All cabling for the lighting will be contained inside the pole with an access panel on the pole to allow for cut out fuses as required by NEK 400. Types of lighting and intensity will be as required by the road department standard.

Wall fixations and cantilevers will be installed on buildings in areas where this is possible. In Festplassen, there are historic wall fixations, which may be used after analysis to confirm they are still fit for purpose. The suspended OCS system will be installed as required and be of the same material type as the existing system.

12 Civil construction aspects

After inspection of the existing system installed in the area, we state that the current street light masts cannot be used to support the OCS system. From our investigation, the structural strength of the pole cannot be confirmed as being able to support the forces of the OCS system and the existing foundations cannot confirmed as strong enough for the new purpose.

This provides 2 options for a foundation.

1. Complete construction of new foundation involving digging to remove old, excavating a new area for the foundation, installation of structural steel and concrete pouring.
2. No dig solution using drilling to create a foundation in the same area of the old one. This is under investigation if it can be applied to the size of foundation we will require.

In addition, the poles identified to be removed currently support the street lighting. This will have to be reinstalled on the OCS poles. SVV have stated that the installed cabling and control cabinets cannot be reused for this purpose. This is due to age and installation method. In this case, it will be required to re-cable the lighting system in the area. This will involve combined OCS and lighting poles (ref section 12) and new trenches for the cable system, required for the entire length of the line. In initial assessments, this trench will mostly be located in the pedestrian pathway however road crossings are unavoidable. This will require intensive traffic management and a considerable amount of night works.

The technical responsibility for the reinstallation of the road lighting can be captured under this project however the commercial responsibility should be subject to agreement between SVV and HFK.

13 Economic assessment

13.1 Option 1 – Traditional Trolleybus System

Estimation of the delivery or the power system for this project including OCS system and substations is 65 MNOK. This estimation considers 3 substations, which is an increase in the early assessment, however on detailed analysis we see a reduced cost for the building and equipment.

We cannot conclude at this time if there is a requirement to alter the tunnel or not. For this reason, a cost of 21.5 MNOK must be considered.

This project considers that the existing lighting system will be integrated into the OCS system. The estimated cost of this action is 12.7 MNOK.

This gives a total estimated cost of 99 MNOK.

The cost estimation is within the range of +/- 10% with the expectation of the cost associated with the tunnel alteration. The costs will be realised over the following estimate time scale.

- 2017 2 MNOK – design and procurement
- 2018 25 MNOK – civil costs and production
- 2019 50 MNOK – civil and electrical construction
- 2020 22 MNOK - completion of electrical installation and commissioning

13.2 Option 2 – In Motion Charging

Estimation of the delivery or the power system for this project including OCS system and substations is 59 MNOK. This estimation considers 3 substations, which is an increase in the early assessment, however on detailed analysis we see a reduced cost for the building and equipment.

For this option, we can conclude that tunnel civil works are not required.

This project considers that the existing lighting system will be integrated into the OCS system. The estimated cost of this action is 12.7 MNOK.

This gives a total estimated cost of 71.5 MNOK.

The cost estimation is within the range of +/- 10%. The costs will be realised over the following estimate time scale

- 2017 2 MNOK – design and procurement
- 2018 25 MNOK – civil costs and production
- 2019 44.5 MNOK –electrical installation and commissioning[OHHD1]

13.3 Economic Comparison of Option 1 and 2

Option 1 is estimated to be the more expensive option and require the longer construction time due to the civil works required in Sydnestunnel. Other impacts that are not calculable are the economic impact for Bergen city when the tunnel is closed for construction time as the civil construction works cannot be limited to night-time works only with day-time driving allowed. This will require bus diversions and increased traffic in Nygårds tunnel and through Nordnes.

Year	Option 1 - Classic OCS	Cost	Option 2 - IMC	Cost
2017	Design and procurement	2 MNOK	Design and procurement	2 MNOK
2018	Civil costs and production	25 MNOK	Civil costs and production	25 MNOK
2019	Civil and electrical construction	50 MNOK	Completion of electrical installation and commissioning	44.5 MNOK
2020	Completion of electrical installation and commissioning	22 MNOK		
	SUM	99 MNOK	Sum	71.5 MNOK

14 Future Opportunities

14.1 Cross connection with Bybanen substations

As both the Bybanen and the trolley bus system are 750 Vdc system and are currently maintained by the same company, the prospect of combining substations should be explored. In this case, a single substation could be built to supply both systems. This would only require 1 additional traction unit (1 transformer, 1 rectifier and 1 or 2 dc breakers) inside the building to facilitate power supply to the trolley bus system. At the moment, the systems are independent but this option is already under investigation at Haukeland for stage 4 of the Bybanen and should be considered in any expansion of both systems outside the current planned routes.

To achieve this unification of the system the system voltage will have to be standardized. Currently the Bybanen operates at nominal voltage of 750 Vdc. The Trolleybus operates at 600 Vdc. From investigation with other systems and manufacturers, there is no reason for this difference in voltage level and we have discovered that the existing equipment and trolleybuses may be compatible with both voltage levels.

14.2 Single DC ring

Another concept under investigation in other systems in Europe is to combine trolley bus, battery bus and tram systems into a single dc ring. This concept allows for interconnection of system and provides for networks stability. This concept would be applicable in the future and would be subject to separate investigation but the concept deserves mentioning at this time.

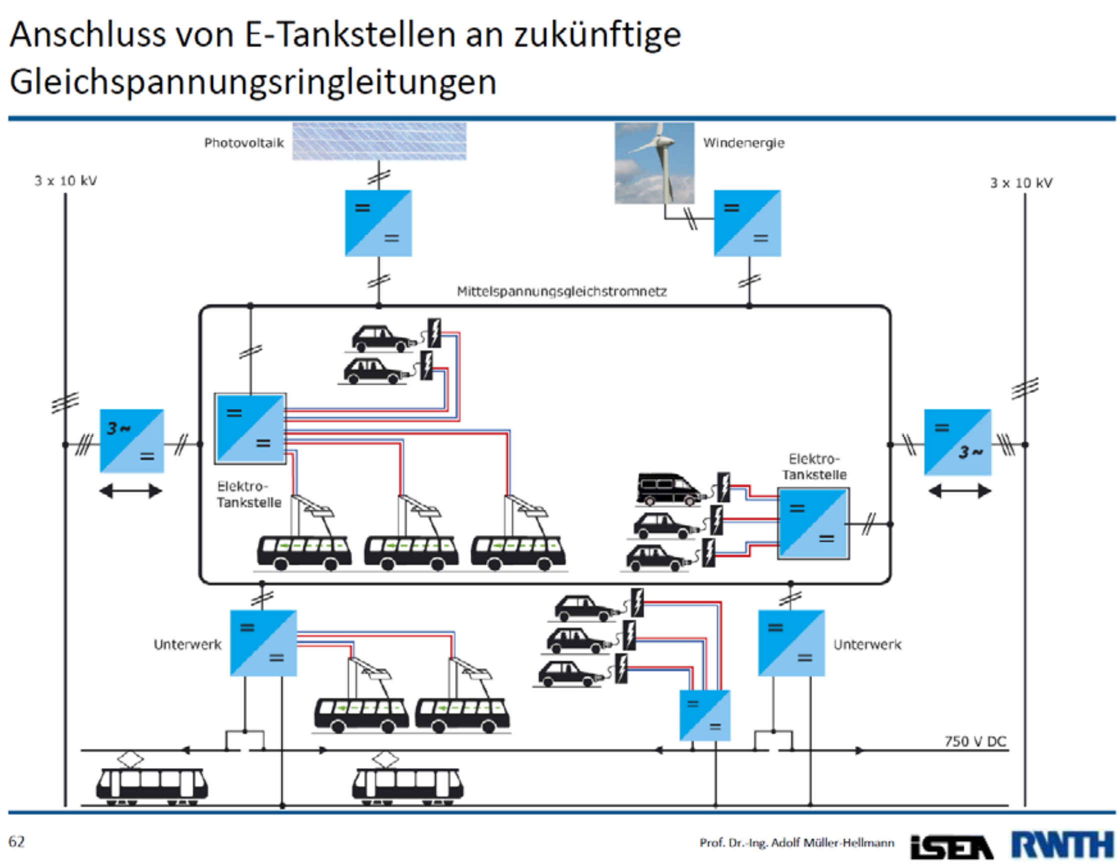


Figure 19 - example of an integrated dc network allowing for different dc powered transport infrastructure

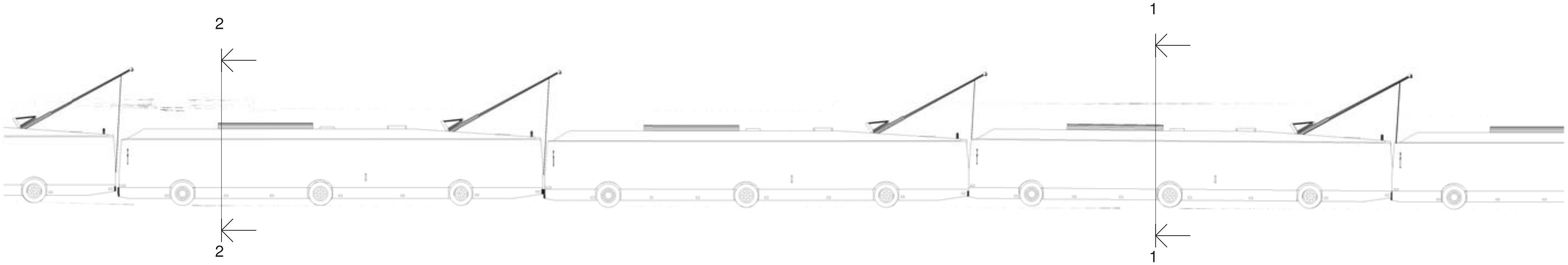
14.3 Electric Car Charging Points

New and existing infrastructure should be considered as points of supply for "Green Energy" for transport. This should not be limited to supplying the bus or tram infrastructure only but provide connection to car charging points. This will not greatly increase the load on the substation and allow for multiple car charging points to be established in proximity to the substations in areas where it is advantageous e.g. Laksevåg Sentrum. This concept can also be applied to existing Bybanen and Trolleybus substations e.g. Skjold TSS, has a car park adjacent to it.

This concept will be developed further in the design stage but it is important to note that this is seen currently as a benefit of the project, not part of the project. In addition, any retrospective works on existing substation should be taken as a separate project.

Appendix

1. SYDNESTUNNELEN INNMÅLTE TVERSNITT NORDVESTRE INNKJØRSEL OVERSIKTSLAN-5136160- Z-001
2. SYDNESTUNNELEN INNMÅLTE TVERSNITT NORDVESTRE INNKJØRSEL OVERSIKTSLAN-5136160- Z-002
3. Teknisk vurdering og efaring: Påsporing av trolleystenger til Kontaktledningsanlegg, Norconsult, 01/02/2017
4. Forhåndskonference med Bergen Kommune, 08/03/2017



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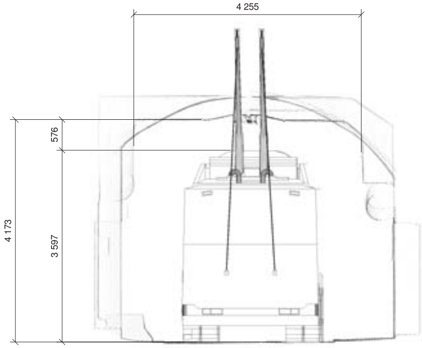

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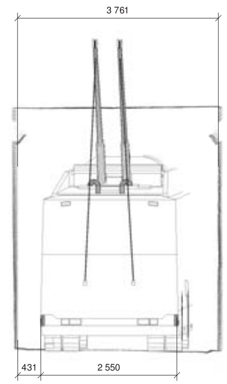

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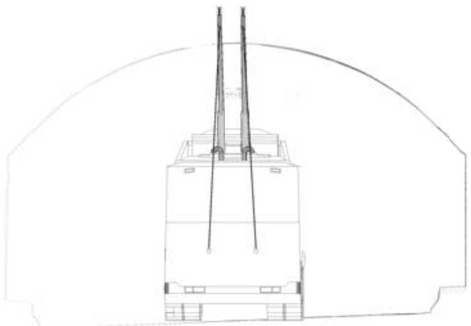

Snitt 3-3
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Oversiktskart
1 : 2000

Tegningsnummer Z-001 | Revisjon B1

Revisjon	Dato	Beskrivelse	Tegnet	Kontrollert	Godkjent
1	2014-05-05	For informasjon / kommentar hos eksterne parter	JS	BST	

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Målestokk (gjelder for A1 format): As indicated

SYDNESTUNNELEN
INNMÅLTE TVERSNITT
NORDVESTRE INNKJØRSEL
OVERSIKTSLAN

Norconsult

Oppdragsnummer	Tegningsnummer	Revisjon
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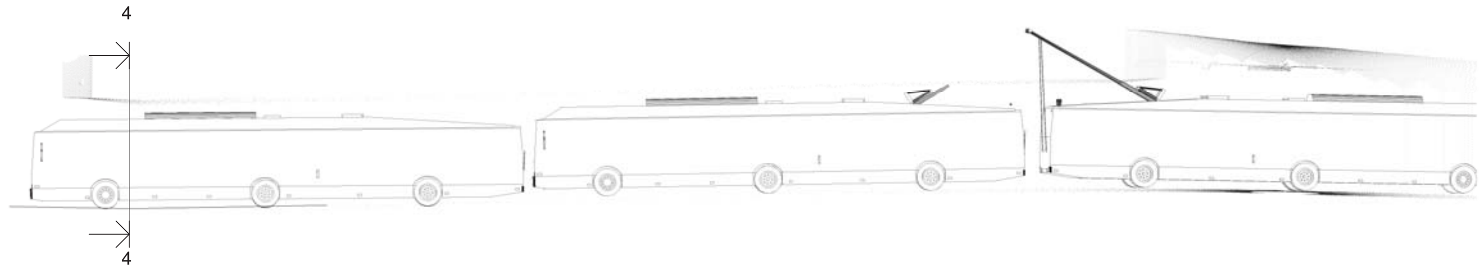

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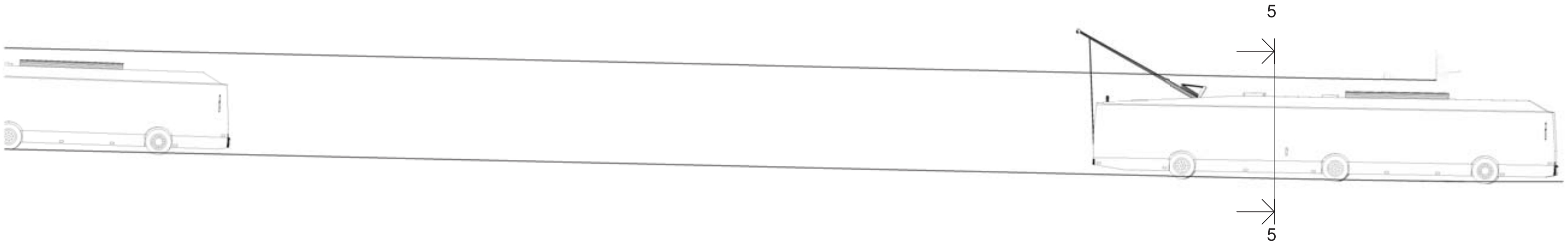

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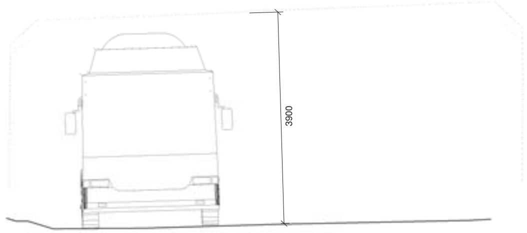

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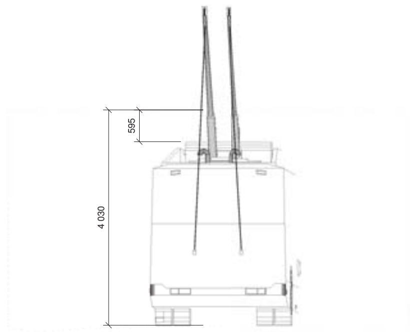

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Revisjon	Dato	Beskrivelse	Tegnet	Kontrollert	Godkjent
1	2014-05-05	For informasjon / kommentar hos eksterne parter	JS	BST	

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Oppdragsgiver
SKYSS

Målestokk (gjelder for A1 format)
As indicated

SYDNESTUNNELEN
INNMÅLTE TVERSNITT
INNKJØRSEL
OVERSIKTSPLAN

Norconsult

Oppdragsnummer	Tegningsnummer	Revisjon
5136160	Z-002	B1

Til:	Torbjørn Søderholm, Bybanen utbygging
Kopi:	Declan Rice (Bybanen utbygging), John Martin Jacobsen (Hordaland fylkeskommune)
Fra:	Thomas J. Potter
Dato	2017-02-01

Teknisk vurdering og erfaring: Påsporing av trolleystenger til kontaktledningsanlegg

Innledning

Hordaland fylkeskommune planlegger forlengelse av Bergens eneste trolleybusslinje, linje 2, mellom Strandkaien terminal og Birkelundstoppen.

Bybanen utbygging har fått i oppdrag å utarbeide et teknisk forprosjekt for forlengelsen.

Trolleybusslinje 2 ble først satt i drift i desember 1957 mellom Bergen sentrum og Fridalen og erstattet trikkedrift på samme strekning. Linjen er forlenget flere ganger fra åpningsdato fram til 80-tallet, og dagens endeholdeplass er nå ved Birkelundstoppen.

Dagens linje med en lengde på ca. 7 kilometer, driftes med 6 MAN/Neoplan-busser med elektrisk utrustning fra Vossloh-Kiepe. Bussene ble levert i 2003.

I 2014-2015 ble det besluttet at trolleybussdrift i Bergen skal opprettholdes. Hordaland fylkeskommune har kjøpt infrastrukturen for trolleybuss, og ansvar for vedlikehold av kontaktlednings-anlegg og strømforsyning er plassert hos Bybanen AS. Mulige utvidelser av systemet for å øke effektiviteten, har vært under vurdering siden 2015. Foreløpig er det besluttet at linjen skal fortsette gjennom Bergen sentrum over Puddefjordsbroen gjennom Laksevåg til Nyborg.

Teknisk løsning

Det er to alternative tekniske løsninger for forlengelse av linjen:

- Ren trolleybussdrift – 100% av strekning dekket av kontaktledningsanlegg
- Elektriskhybrid – Bruk av trolleybusser med batteripakker. Kontaktledningsanlegg benyttes på delstrekninger hvor batterier kan lades (såkalt *in-motion charging*).

Alternativ 1 representerer en kjent teknologisk løsning som er robust og pålitelig.

Med alternativ 2 er det nødvendig å koble til og fra kontaktledningsanlegg hvor det er overgang mellom strekninger med og uten KL-anlegg.

Den ene operasjonen – frakobling ved senkning av stengene – er relativ uproblematisk. Moderne trolleybusser er utstyrt med elektro-mekanisk system for senking av trolleystenger og stengene låses i posisjon ved hjelp av kroker på toppen av bussen. Operasjonen kan gjennomføres hvor som helst langs linjen og det er ikke nødvendig med ekstra utstyr.

Den andre operasjonen – heving og påsporing av trolleystangen – er mer komplisert. Her er det usikkerhet knytt til påkobling hvor bussen må stå på et bestemt plass (+/- 0,5 meter) og trolleystengene må heves ved hjelp av en plasthatt som styrer stengene inn på kjøretråd – se Figur 1.

I tilfelle påsporing ikke fungere som det skal, med automatisk heving av stengene, kan bussjåføren sett stengene på plass manuelt som vist i Figur 2. Her må det etableres regler som sikrer at påsporing kan gjennomføres i en trygg måte, spesielt med hensyn til øvrig trafikk i vegbanen.

Figur 1 – Automatisk påsporing med hjelp fra skjermer over KL-anlegg

Figur 2 - Manuell påsporing utført av bussjåfør ved eventuell feil.

Erfaring fra andre byer

Det er etablert kontakt med flere byer og fagmiljø for å prøve å kvantifisere hvor komplisert påsporing er.

Jeg har ikke funnet byer som har samlet statistikk over hvor ofte det er feil med påsporing. De fleste tilbakemelding er derfor basert på generelle oppfatninger og inntrykk. Feil med påsporing er ikke så stort avvik at driftsansvarlig vil merke det. Bussjåførene kan rydde opp i en feil situasjon med manuell påsporing av trolleystangene slik at feil ikke får store konsekvenser for driften.

I tabellen under det oppsummert noen av erfaringene som er samlet inn.

By	Kommentar
Esslingen, DE	Teknisk leder i Esslingen, Harald Boog, rapporterer at de opplever feil ca. en gang i måned eller mindre. I løpet av en måned er det ca. 2000 påsporing.
Zürich, CH	Zürich tror at feilraten er ca. 1 per 1000 påsporing (Hansjörg Feurer). De mener at systemet er meget stabilt og de øker antall strekninger uten KL-anlegg for å redusere kompliserte løsninger ved kryssing av trikkelinjer i sentrum. Bergen er oppfordret til å komme til Zürich for å se på driftssituasjon.
Landskrona, SE	De har et prøveprosjekt som startet i 2014 hvor busser kjører ca 10 kilometer på batteridrift og 4 kilometer under kontaktledninger. Risiko og usikkerhet knyttet til påsporing var ikke et tema under planlegging og har vist seg etterpå å være uproblematisk.
Amsterdam, NL	Amsterdam planlegger implementering av *in-motion charging*. Prosjektlederen i Amsterdam ser ikke påsporing som et problem eller utfordring. Prosjektteamet tar det som gitt at det er en teknisk robust løsning som kan implementeres i Amsterdam.
UITP, Brussels, BE	Arno Kerkof, sekretær for UITP Trolleybus Committee, har ikke hørt at det er stor usikkerhet knyttet til påsporingsrutiner.

Tiltak

Det er to tiltak som bør gjennomføres for å redusere risiko knyttet til påsporing.

- Operatøren må utvikle en god opplæringsplan for bussjåfører som skal kjøre trolleybusser.
- Utforming av holdeplasser for påsporing i rett linje med klar markering av stoppepunkt både med merking og stolper (for dager med snø) med riktig plassering.
- God vedlikehold av påsporingsutstyr (hatten).

Konklusjoner og anbefaling

Påsporingsutstyr og påsporingsrutiner for trolleybuss er vel utprøvd og i bruk i mange byer. Det er et pålitelig og robust system med lav feilrate.

Konsekvenser av en feil med påsporing er minimal. Bussjåfør må plassere stangen manuelt og eneste negativ konsekvenser er tapt tid. Det er lite sjanse for fysisk skade av hverken kontaktledningsanlegg eller stengene i slike feilsituasjoner.

Den største utfordringen er knyttet til opplæring av bussjåførene til å bli kompetente til å gjennomføre prosessen.

En kombinasjon av god opplæring av bussjåfører, godt vedlikehold av påsporingsutstyr og optimal utforming av holdeplassene som skal brukes for påsporing, vil sikre en akseptabelt nivå

Det er ingen grunn å velge bort alternativ med *in-motion charging* på grunn av usikkerhet knyttet til påsporingsprosessen.

0,9	2017-02-01	Utkast til oppdragsgiver for kommentarer	TJP	HPD	TJP
Versjon	**Dato**	**Beskrivelse**	**Utarbeidet**	**Fagkontrollert**	**Godkjent**

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REFERAT FRA FORHÅNDSKONFERANSE

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Tiltak: Likeretterbygg for trolley-buss til Laksevåg Tiltakshaver: Hordaland Fylkeskommune v/Bybanen utbygging.	Møtedato: 08.03.17

Deltakere (navn/firma):

Torbjørn Søderholm — Bybanen utbygging
Stein Jensen — " —
Declan Rice — " —

Karsten Høyheim — Plan og bygningsetat
Ronny Jakobsen — " —

Fakturamottaker (org.nr./navn/adr.):
-Hordaland Fylkeskommune v/Bybanen utbygging, Fjøsangerveien 50 C 5020 Bergen.

☐ Tiltakshaver opptrer på vegne av hjemmelshaver i henhold til fullmakt

Formålet med forhåndskonferanse etter plan- og bygningsloven (pbl) § 21-1 og byggesaksforskriften (SAK10) § 6-1, er å "*avklare tiltakets forutsetninger og rammene for videre saksbehandling*". Møtet skal bidra til at tiltakshaver får belyst aktuelle problemstillinger ved tiltaket og bli gjort kjent med relevante krav og forutsetninger. De avklaringene som blir gjort på forhåndskonferansen, er imidlertid ikke rettslig bindende og kan heller ikke påklages. Kommunen har ikke adgang til å gi noe forhåndstilsagn eller trekke andre konklusjoner om utfallet av byggesaken. Nabomerknader, uttalelser fra andre myndigheter, politiske vedtak og endrete rammebetingelser mv. kan føre til et annet resultat enn forventet i en konkret søknadsbehandling.
Referatet skal dokumentere de forutsetninger som er lagt til grunn, og danner grunnlag for videre behandling. Det gjøres oppmerksom på at referatet ikke kan gjengi i detalj alle tema som ble drøftet eller alle opplysninger som ble gitt.

Grunnlaget for møtet:

Bygningsmyndighetens opplysninger er basert på dokumentasjon mottatt før møtet og som er arkivert i saken. Det tas forbehold om betydning av eventuell dokumentasjon og nye opplysninger som fremlegges i møtet.

Beskrivelse, oversiktsbilder

Planstatus:

☒ I kommuneplanens arealdel (KPA2010) ligger eiendommen i formålsområde:

Bebyggelse og anlegg

☒ Kommunedelplan (KDP): Puddefjorden - Damsgårdssundet nr. 17330000 datert: 31.05.2010

Arealformål: Veganlegg

☒ Reguleringsplan nr./navn/vedtatt dato: 7490000, Vestre innfartsåre

Arealformål: Blandet formål Park.anlegg under bro. Kjøreveg, gang/sykkelveg/trafikkformål

☐ Eiendommen er ikke detaljregulert.

Pågående planarbeid:

☐ Det pågår ikke planarbeid på eiendommen/i området etter det bygningsmyndighetene kjenner til

☐ Det pågår følgende planarbeid på eiendommen/i området:

Viktige bestemmelser i gjeldende planer:

!	Tema/§§	Plan-avvik?	Merknader
	Plankrav *KPA pkt. 1*		
	Formål og tomteutnyttelse (BYA, TU, BRA, byggehøyder, byggegrenser etc.)	Ja	Formålsendring
	Utendørs oppholdsareal/MUA *KPA pkt. 10*		
	Kulturminner/kulturmiljø *KPA pkt. 12*		
	Trafikk- og flystøy *KPA pkt. 13*		
	Parkering *KPA pkt. 15*		
	Hensynssoner/restriksjonsområder (LNF, byfjellsgrense, strandsone, vassdrag, båndlegging, meldepliktsoner etc.) *KPA pkt. 25-27*		

Basert på mottatt dokumentasjon og opplysninger synes tiltaket å:

☐ være i samsvar med gjeldende plan(er), jf. pbl §§ 11-6 og 12-4.

☒ være avhengig av dispensasjon fra gjeldende plan(er), jf. pbl kap. 19.

☐ avvike så vidt mye fra gjeldende plan(er), at det må behandles som reguleringsendring/ny plan, jf. pbl kap. 12.

Deling:

☐ Tiltaket forutsetter deling/sammenføyning av eiendommen(e)

Viktige bestemmelser i plan- og bygningsloven og byggteknisk forskrift (TEK10)

(OBS: Oversikten er kun veiledende og ikke komplett for aktuell sak).

!	Pbl §§	TEK10 §§	Tema/krav/merknader	Avvik?
	27-1 27-2 27-3	Kap. 15	Vannforsyning og avløp. □ *Forhåndsuttalelse fra VA-etaten. Utslippstillatelse?* □ *Evt. private rettigheter?*	
	27-4		Atkomst/veirett. Avkjørsel. ☒ *Avkjørsel må godkjennes av Trafikketaten (kommunal vei) eller Statens vegvesen (fylkesvei og riksvei), jf. vegloven § 40.*	
	27-5		Fjernvarmeanlegg/tilknytningsplikt (jf. BKK Varme AS)	
	28-1 28-2	Kap. 7 Kap. 9	Byggegrunn, miljøforhold. Sikringstiltak. □ *Skredfarevurdering.* □ *Tiltaksplan forurensning. Miljøsaneringsbeskrivelse. Avfallsplan.*	
	28-7	Kap.8	Uteareal. □ *Kvalitet, universell utforming.* □ *Gangatkomst.*	
	29-1 29-2	8-3 Kap. 12	Utforming av tiltak. Visuelle kvaliteter. □ *Estetikk. Terrengtilpasning.* □ *Planløsning.*	
	1-1 29-3	Kap.8 Kap.12	Universell utforming/tilgjengelighet. □ *Heiskrav?*	
	29-4	8-3	Plassering av tiltak. Høyde. Avstander. □ *Terrengprofiler. Høyde bygning.* □ *Avstand til nabogrenser. Samtykke eller dispensasjon?* □ *Avstand til veg (vegloven §§ 29-30).*	
	29-5 29-6	Kap.12 Kap.13 Kap.14	Tekniske krav. Miljø og helse. □ *Romhøyder.* □ *Lys og utsyn.* □ *Bodareal.*	
	29-5	Kap. 11	Brannsikkerhet. □ *Rømningsveier.* □ *Uavhengig kontroll, jf. SAK10 kap 14.*	
	31-2		Tiltak på eksisterende byggverk	

Andre lover og forskrifter:

(listen er ikke uttømmende)

☒ Vegloven: *Avstand til midtlinje vei (15 m for kommunal vei og 50 m for fylkesvei og riksvei). Gjelder uregulert område eller når plan ikke viser byggegrense. Godkjenning avkjørsel.*

□ Kulturminneloven: *Fredete bygg og anlegg, automatisk fredet bygrunn, bygninger eldre enn 1850, mv.*

□ Arbeidsmiljøloven med forskrifter: *Utforming av arbeidslokaler. Godkjenning fra Arbeidstilsynet.*

□ Naturmangfoldloven: *Opplysningsplikt, konsekvensanalyse mv. Jf. TEK10 § 9-4.*

□

Andre forhold/bestemmelser som er drøftet på forhåndskonferansen:

- De andre plasseringer på Laksevåg: Overleveres planer etc for disse. Info for hver plassering er gitt i møtet.
- Gnr 153 Bnr. 74 Plasseringen krever disp. fra formålet/avstand.
- " 151 " 130 ——— " ——— ——— " ———
- " 146 " 9 ——— " ——— ——— " ———
- Anbefales møte/dialog med Statens Vegvesen/Bymiljøetaten (komm. vei)

Samordning mot andre myndigheter og etater (jf. pbl § 21-5 og SAK10 § 6-2):

Tiltakshaver/søker må i forbindelse med søknaden innhente uttalelse/samtykke fra:

- ☐ Arbeidstilsynet
- ☐ Riksantikvar
- ☐ BKK Varme
- ☐ Helsevernetaten
- ☐ Vann- og avløpsetaten
- ☐ Fylkeskonservator
- ☐ Havnevesenet
- ☐
- ☒ Trafikketaten (Kommunale veier)
- ☒ Statens vegvesen (Fylkesvei)
- ☐ Klima- og forurensn.dir.
- ☐

Bygningsmyndigheten må sannsynligvis sende saken på høring til:

- ☐ Fylkesmannen
- ☐ Riksantikvar
- ☐ Statens vegvesen
- ☐ RBA (tidl. TFBU)
- ☐ Avinor
- ☒ Hordaland Fylkeskommune
- ☐ Byantikvar
- ☒ Grønn Etat v/plassering i grønt
- ☐ Helsevernetaten
- ☒ Bymiljøetaten
- ☐ Fylkeskonservator
- ☐ Trafikketaten
- ☐ Brannvesen
- ☐ Forsvaret
- ☐

Ansvar og kontroll (jf. pbl kap. 23-24 og SAK10 kap. 10-14):

Krav til ansvarlige foretak, tiltaksklasser:

☐ Tiltaket vil kreve uavhengig kontroll (jf. pbl § 24-1 og SAK10 kap 14) av:

Krav til dokumentasjon i søknad:

Søknad om tillatelse til tiltak etter pbl § 20-1 og § 20-2 skal inneholde de opplysninger som er nødvendig for at kommunen skal kunne ta stilling til om tiltaket er i samsvar med bestemmelser gitt i eller i medhold av plan- og bygningsloven, jf. Forskrift om byggesak (SAK10) kap. 5.

Søknadsbehandling:

☐ Det er informert om aktuelle rammeforutsetninger og saksgangen etter plan- og bygningslov med forskrifter. Lovbestemt saksbehandlingstid er maksimalt 12 uker.

Ved dispensasjonssøknad fra planer er det ingen lovbestemt tidsfrist, men det antas å kunne behandle søknaden innen 3 + 1 måneder, utenom evt. politisk behandling.

I henhold til SAK10 § 6-1 skal referatet undertegnes av tiltakshaver og kommunens representant. De avklaringene som er gjort på forhåndskonferansen, og referatet, er ikke rettslig bindende og kan heller ikke påklages.

Etat for byggesak og private planer

dato: 08 / 03 2017

Referat godkjent og mottatt:

[signature]
Referent

[signature]
Tiltakshaver