Possible future TBM road tunnels

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Norwegian Public Roads Administration
Norway – facts

Population: 5 051 275 inhabitants as of 1 January 2013
Inhabitants per sq. km. land area: 16
Population growth rate (2011): 1.3 per cent

Norway has the lowest population density in Europe after Iceland. However, almost 80 per cent of the population live in urban areas, where the population density is 1 595 per sq. km.

Area (mainland): 323 802 sq. km.
Longest straight-line distance (mainland): 1 752 km
Length of coastline (mainland): 25 148 km

Harsh climatic conditions, poor soil quality and difficult terrain mean that a large part of the country is unsuitable for settlement or agriculture.

Mainland topography

- Built-up area: 1.4 per cent
- Agriculture: 3.2 per cent
- Marsh/wetland: 5.8 per cent
- Freshwater and glaciers: 7.0 per cent
- Forest: 38.2 per cent
- Mountain and mountain plateau: 44.4 per cent

Transport infrastructure (2013)

- Public roads, total: 93 822 km
- National roads: 10 540 km
- County roads: 44 312
- Local roads: 38 970

- Total number of road tunnels: More than 1 000
- Railway network, total: 4 237 km
- Electrified: 2 844 km
- Double track: 245 km
- Airports with scheduled flights: 52
- Seaports with connection to the national transport grid: 32
- Fishing ports: 700
More than 1100 Road-tunnels in Norway
Road toll projects

- City Projects
- Single Projects
- Toll collection on ferries
- AutoPASS tolling
- Open Road Tolling
Upcoming PPP-projects

E10/rv 85 Tjelsund - Gullesfjordbotn - Langvassbukt
81 km new two lane highway
approx. 300 mill. EUR

Rv 3/rv 25 Ommangsvollen - Grundset/
Basthjørnet
7 km new two/three lane highway
and 10 km 4-lane motorway
Investment approx. 450 mill. Euro

Rv 555 Sotrasambandet
16 km new 4-lane motorway
including a major bridge
Investment approx. 850 mill. Euro
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads*</td>
<td>19,148</td>
<td>20,936</td>
<td>31,155</td>
</tr>
<tr>
<td></td>
<td>(EUR 2,394)</td>
<td>(EUR 2,617)</td>
<td>(EUR 3,894)</td>
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<tr>
<td>Railways</td>
<td>9,872</td>
<td>11,275</td>
<td>16,781</td>
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<tr>
<td></td>
<td>(EUR 1,234)</td>
<td>(EUR 1,409)</td>
<td>(EUR 2,098)</td>
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<td>Ports/harbours and navigation</td>
<td>1,108</td>
<td>1,251</td>
<td>1,940</td>
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<tr>
<td></td>
<td>(EUR 139)</td>
<td>(EUR 156)</td>
<td>(EUR 243)</td>
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<tr>
<td>Total</td>
<td>30,128</td>
<td>33,462</td>
<td>49,876</td>
</tr>
<tr>
<td></td>
<td>(EUR 3,766)</td>
<td>(EUR 4,183)</td>
<td>(EUR 6,235)</td>
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</tbody>
</table>
The Government’s ambition is to link Western Norway through an upgraded and ferry-free E39.

The Government’s basic assumption is that planning will be aimed at completing the projects within a twenty-year period.

In addition to the investment in E39, Southern Norway will see a major upgrade of several sections of the main roads, such as E6, E16, E18 and E134.

During the period, E18 extending from the Swedish border to Kristiansand, will be converted into a four-lane highway between Oslo and Langangen in Telemark, while significant work will be carried out south of Langangen.
E6 through Sør- and Nord-Trøndelag will be significantly upgraded.

The Government will also give priority to modernization and electrification of the Trønder and Meråker lines during the period.

In Northern Norway, the connecting projects on E6 in Helgeland will provide good road standards south of Saltfjellet.

The Government’s commitment to E10 will improve the road connection for both Vesterålen and Lofoten.

In Nordland and Troms, improvements will be made on key mountain passes. With the completion of E6 west of Alta, E6 will generally have a good standard in Finnmark. Development of E105 will improve the connection between Kirkenes and Russia.

An important maritime transport project is the Stad Ship Tunnel, a fairway project that will reduce the risk of accidents and improve navigation along the coast. It will be feasible to start the project at the end of the planning period.
In its guidelines to the Norwegian Public Roads Administration, the Ministry of Transport and Communication advises the agency to make use of cost-benefit analyses when prioritising projects.

The expectation is that such analyses will contribute to improve economic efficiency of the government’s resources.

However, previous studies suggest that cost-benefit analyses are not particularly important for politicians in their decisions, selecting which projects to be included in the National Transport Plan.

In order to find out whether the Norwegian Public Roads Administration incorporate cost-benefit analyses in their selection procedures of road projects, we focus on the process prior to direct involvement of politicians.

From: www.ntnu.no/concept/
Key goals
The National Transport Plan contains four key objectives: (1) to improve accessibility in terms of reduced distance costs, (2) a ‘zero vision’ addressing road safety, (3) to limit greenhouse gas emissions and reduce environmental damage and (4) a ‘universally designed’ transport system (i.e. accessibility for all travellers, whether having a disability or not). The analyses of the ten road projects show that the two former goals are considered the most important.

To improve accessibility in terms of reduced distance costs is the most important justification for a road project. This goal includes a number of different conditions and differs between urban road projects and projects in the rural areas. In urban areas such accessibility is about reducing congestion and encouraging bicycling and walking, incorporating pedestrian and bicycle lanes into the projects. In rural areas such accessibility is primarily about improving the quality of roads, which for example lack the ‘yellow line’ or have unfortunate slope ratios and curvatures.
The second-most important argument for the need of a road project is **safety**. The informants highlight this issue in particular in geographical areas vulnerable to landslides and in districts with bad road quality, even though these roads do not necessarily have many fatal accidents.

Limiting **greenhouse gas emissions** is not considered vital. Informants point out the goal conflicts inherent in road building: while facilitating for increased traffic growth, on the one hand, the aim is to reduce such growth, on the other hand. Some informants argue that climate concerns should ideally have played a larger role in urban areas. Others believe that traffic would increase anyway. The informants describe the climate goal as an ‘additional’ dimension, i.e. climate concerns are incorporated only insofar as the urban road projects also improve the situation for bicyclists and pedestrians. They argue that even when for example bus lanes are not incorporated in new road projects, public transport also gains from such projects, as buses are normally in the same congested lanes as private cars. In rural areas reduction of greenhouse gas emissions is not considered important. The informants are more concerned with climate adaptation in rural areas.

Civil servants in the Norwegian Public Roads Administration consider the goal of **universal design** as a requirement that they seek to incorporate into the design of road projects, rather than as a target. Universal design is therefore not considered important in the selection of which projects that they propose to include in the National Transport Plan.

The informants perceive **non-monetised impacts** such as a landscape, local environment, outdoor recreation, culture and natural resources in the same way as universal design. Such aspects are important for project design, but are not considered important when selecting between different road projects in the proposal for the National Transport Plan.
National Transport Plan 2014–2023

Hundreds of Upcoming Projects

Maybe the TBM tunnels can like this?
Project with special priority

Coastal Highway E39

- 1,100 km – 7 ferry-connections
- Travel time 21 hours
- Ferry free within 20 years
- 7–8 hours reduced travel time
- Estimated investments 20,000 MEUR
- Activity mainly between the fjords during the first planning period (4 years)
- «Rogfast» will be started
Pipebridge crossing under Bjørnefjorden on E39 in western Norway
E39 Boknafjorden (ROGFAST)

• World’s longest subsea tunnel (25 km)
• Depth: −390 m
• 2 tubes
• Possible start 2018
The ROGFAST connection

E39 Rogfast is the name given to a possible crossing of Boknafjorden and Kvitsøyfjorden north of Stavanger in the southwestern part of Norway with a sub-sea road-tunnel. The tunnel starts in Harestad in Randaberg and ends at Arsvågen in Bokn. The tunnels length will be appx. 25.5 km. In addition to the main tunnel there will be an arm up to Kvitsøy with a length of appx. 4 km. E39 Rogfast will be the world's longest sub-sea road-tunnel. It will also be the deepest sub-sea road-tunnel in the world, the deepest point is appx 385 m beneath the sea level. E39 from Stavanger and further north is the main trunkway in the western part of Norway. E39 Rogfast will be a fast and ferryless connection between the two cities Stavanger and Haugesund, and it will also shorten down the travel time between Stavanger and Norways 2nd largest city, Bergen.

We have now started the planning of this project to see whether it is feasible, technical and financial, to develop it. When the plans are ready at the end of 2013 the project will be evaluated. If the results are positive it will be possible to start construction in appx. 2015.
BIDS IN NORWAY

Bid for highway opens the door to the lucrative Norwegian road construction market

Published: 24–11–2015 The bid to design and build four kilometres of highway in eastern Norway is a solid first step in entering the strategically important infrastructure market of Norway. If you have driven on holiday in Norway in recent years, you cannot help but have noticed the many road construction projects. You can hardly drive a few kilometres without encountering a new ongoing construction, an upgrade of existing roads, a new bridge or a new tunnel being built.

NIRAS has, in cooperation with Structor Lillehammer AS, won the bid for the design and construction of 4.1 kilometres of highway on Riksvej 4, from Roa to the municipality border at Gran, approximately 50 kilometres north of the Norwegian capital of Oslo. The project was on bid from the public road administration for the eastern region.

Strategically important order
The project is strategically important since NIRAS will be focusing on cementing the role of Scandinavian infrastructure advisor in the coming years.

The Norwegian market is particularly important since the public road administration is investing more than 25 billion Norwegian kroner (20 billion Danish kroner) in expanding and maintaining infrastructure.
Ringeriksbanen and E16 Oslo–Hønefoss
The Hardangervidda tunnel(s)
E134 over Haukeli, arm via Odda mot Bergen

<table>
<thead>
<tr>
<th>Rute</th>
<th>Utbygd E134 arm Bergen ÅDT 2050</th>
<th>Differanse uf. ref.alt</th>
<th>Prosent</th>
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</thead>
<tbody>
<tr>
<td>E16 Filefjell</td>
<td>1270</td>
<td>-90</td>
<td>-7 %</td>
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<td>Rv 52 Hemsedal</td>
<td>1360</td>
<td>-30</td>
<td>-2 %</td>
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<td>Rv 7 Hardangervidda</td>
<td>870</td>
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<td>-80 %</td>
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<tr>
<td>E134 Haukeli</td>
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<td>+320 %</td>
</tr>
<tr>
<td>E39 Bjornafjorden</td>
<td>12300</td>
<td>-900</td>
<td>-7 %</td>
</tr>
<tr>
<td>E39 Rogfast</td>
<td>13100</td>
<td>+400</td>
<td>+3 %</td>
</tr>
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</table>

Investeringskostnad: 37 mrd. kr
Neddiskontert nytte: 70 mrd. kr
Nettonytte: +26 mrd. kr
Reisetidsreduksjon: 3 timer, 5 min.
Ny reisetid til Bergen: 5 timer
**E16 Arna - Voss**

- A journey between Arna and Voss – to day 70 minutes and with the new project: 46 minutes by car and 24 minutes by train.
- The proposal involves four fields path from Arna to Romslo, then new Two–Lane Road with median barriers on to Voss.
- Eight road tunnel.
- The track will double throughout.
- Stops are: Arna, Vaksdal, Stanghelle, Dale Bolstad and Voss.
- Here, too, there are many tunnels, with escapes opportunity road tunnel.
- The remedies will also cut travel time by train between Washington and Oregon down to 4.5 hours.

What we still do not know when construction will begin.

- Here are the options that were scrapped.
- Getting wanted fulfilled: New road for Christmas

Costing 33 billion NOK
Rv. 23 Oslofjordforbindelsen - construction phase 2

New tube in Oslofjordtunnelen, 4–lane road Vassum – Måna.

Project cost NOK 2.8 billion

Smaller consulting assignment 2015/16, agreement reached on construction plan contract

Potential invitations to tender in 2016
Project information

The Regional Directors’ presentations national information meeting January 2013:

www.vegvesen.no -> Entreprenør -> Bransjekontakt 2013

Information about projects and tenders:

www.vegvesen.no\vegprosjekter

http://www.vegvesen.no/Fag/Veg+og+gate/Prosjektering+og+bygging/Utbyggingsprosjekter/Prosjektportalen
"We will at the end of 1987 have full profile bored well 7.5 km road tunnel in Bergen. The experience is positive when it? Regards technical matters and progress. Regarding the pure plant costs is concluded something more conditional. The result after full profile boring is a tube of generally remarkable smooth fine walls. But it is regrettable that parts of the profile must be destroyed by enlarging that profile with D&B. The profile should have been large enough from start – for –Road application. In the future we have to use a TBM with large enough radius to cover the requirement for a two–lane road without ripping with D&B. Full face boring become an interesting alternative by even more road projects in Norway, particularly in densely populated areas."

Arild Hegrenæs, Project Manager on the Fløyfjell tunnels, Norwegian Public Roads Administration
CONCLUSION I

• Many possible projects for TBM in Norway
• The Owners have to show the interest for TBMs
• The Contractors have start using TBMs
• It is important to know the Norwegian way of doing tunnels
• The Consultants are to recommend use of TBM
• The Industry / the producers of TBMS ought to be more eager and honest about when and where to use TBMs
• The investigations has to be more thoroughly
• Learn from lessons learned before
CONCLUSION II

- NPRA should show greater interest in building road tunnels with TBM.
- Many in NPRA is still negative and sceptical to TBM.
- It is time to reverse the general attitude that TBM is not suitable in the construction of road tunnels.
- The NPRA has not been good enough to acquaint themselves with what the construction of tunnel with TBM actually entails. and I call for a Road department taking greater initiative to collect knowledge from suppliers, contractors and builders who have built tunnels with TBM in other country.
- There are several current road tunnels in future plans in Norway.
- Why should not TBM be included in the assessment?
- But it is obviously that all necessary preinvestigations has to be done before the conclusion is made.
- We must see the opportunities
- The Norwegian Public Roads Administration – has they decided that TBM is not suitable for subsea tunnels?
- The question must be whether investigations undertaken previously been thorough enough to conclude that the TBM is a foreclosed method for subsea tunnels?
- Both the TBMs itself, experience, knowledge and expertise have evolved tremendously after Norway last built a road tunnel with TBM for more than 25 years ago.
- I think we have to be better at seeing the possibilities instead of being 100 percent dismissive!
Thank you for your kind attention!
3D Animation:
Coastal Highway Route E39

24/10/2014

Jane Bordal, Director, Norwegian Public Roads Administration