

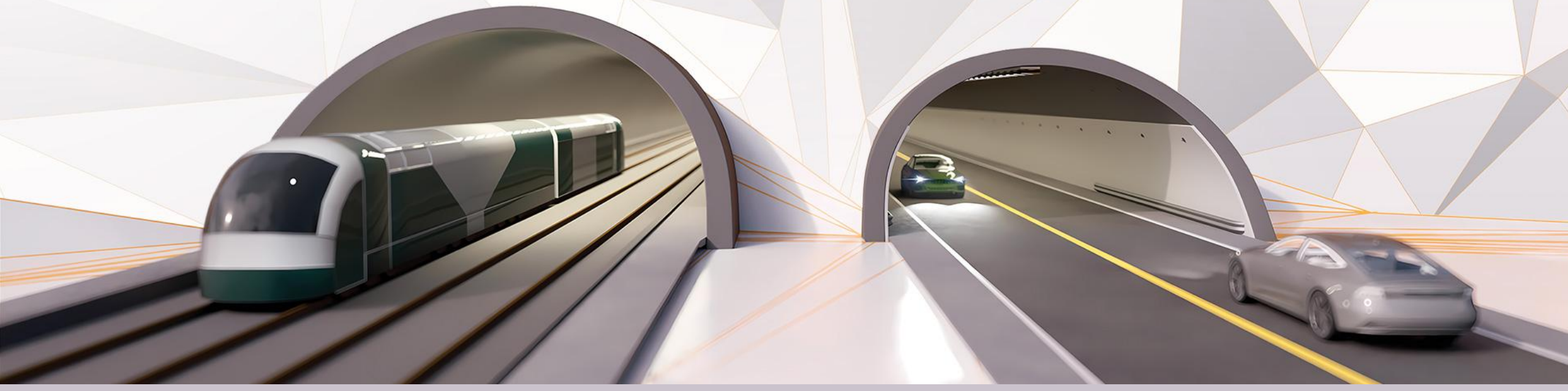


Statens vegvesen

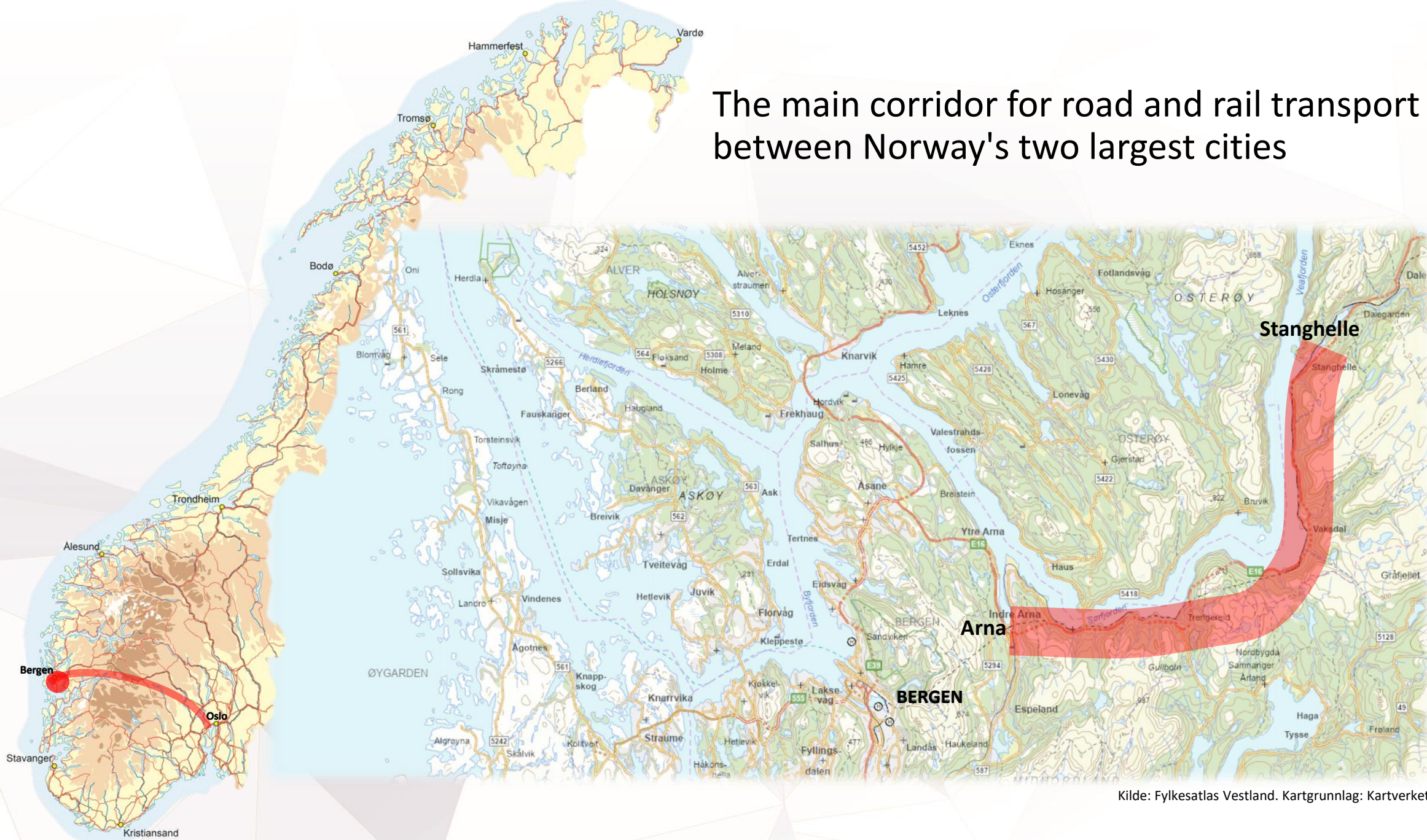
BANE NOR

The joint project Arna-Stanghelle

Road and railway



The main corridor for road and rail transport between Norway's two largest cities



Kilde: Fylkesatlas Vestland. Kartgrunnlag: Kartverket

Rockfall- and landslide- prone corridor

- over 300 slide incidents since 1991

Accident-prone road

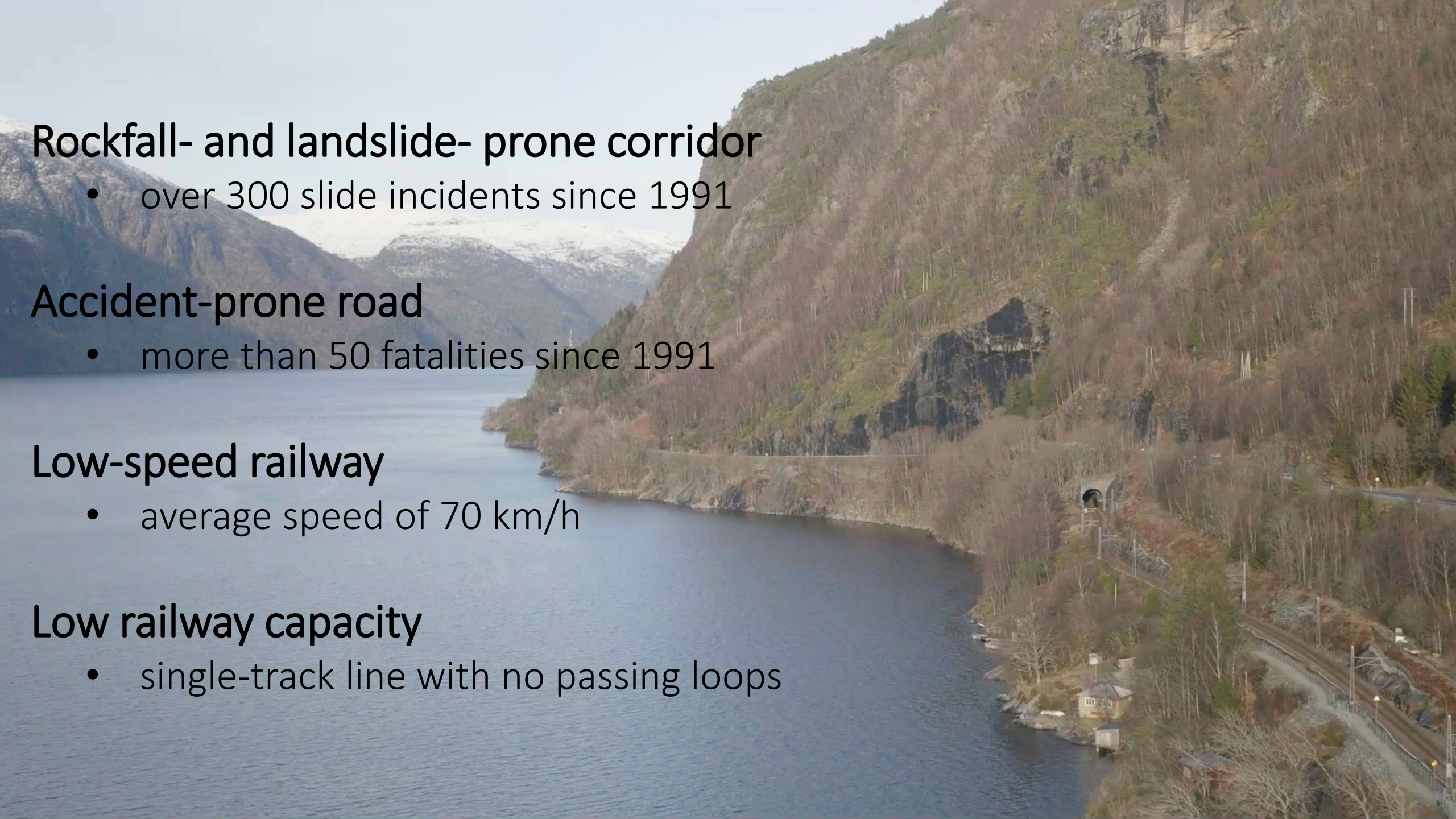
- more than 50 fatalities since 1991

Low-speed railway

- average speed of 70 km/h

Low railway capacity

- single-track line with no passing loops



Fellesprosjektet Arna-Stanghelle

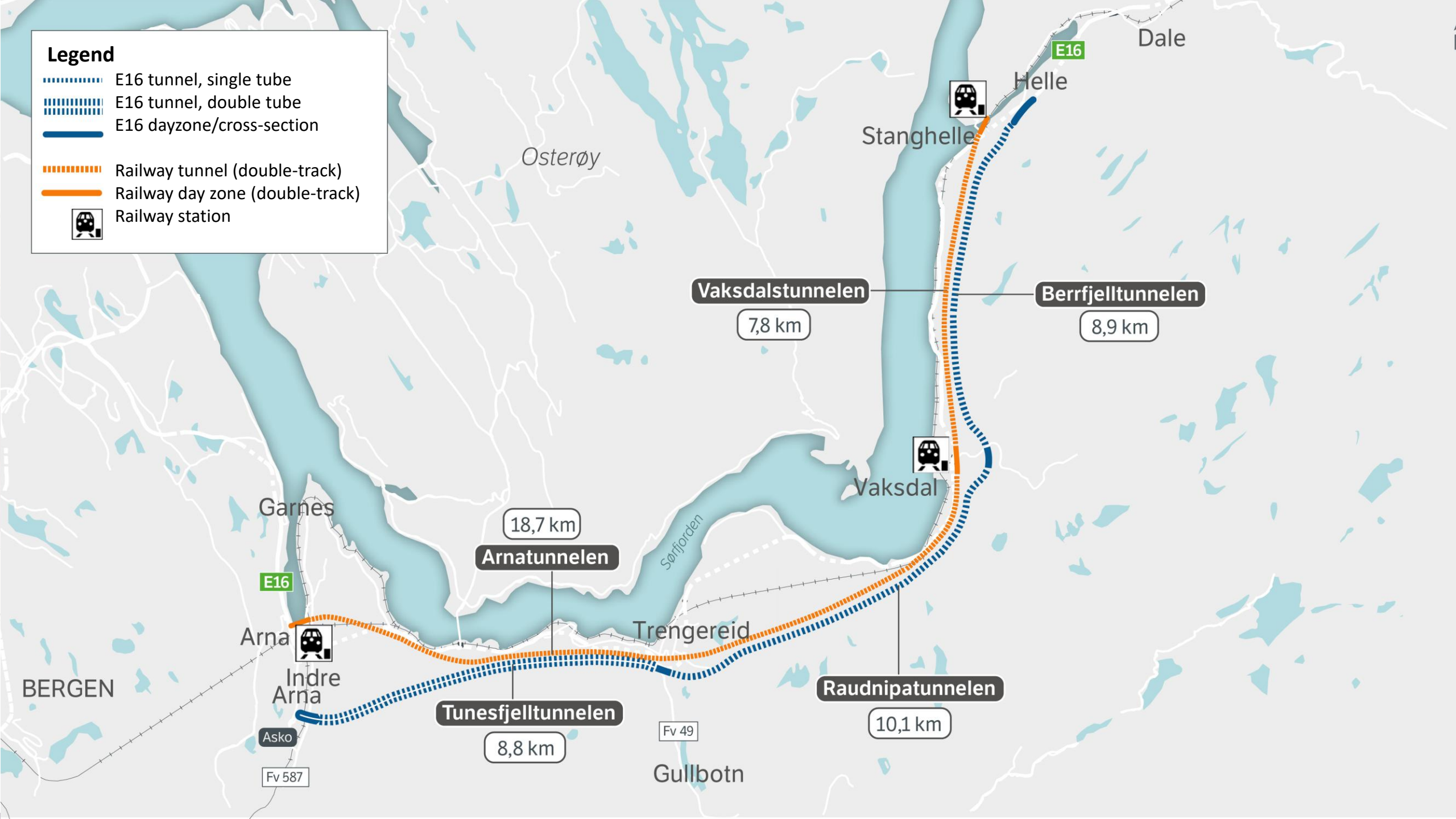
BANE NOR

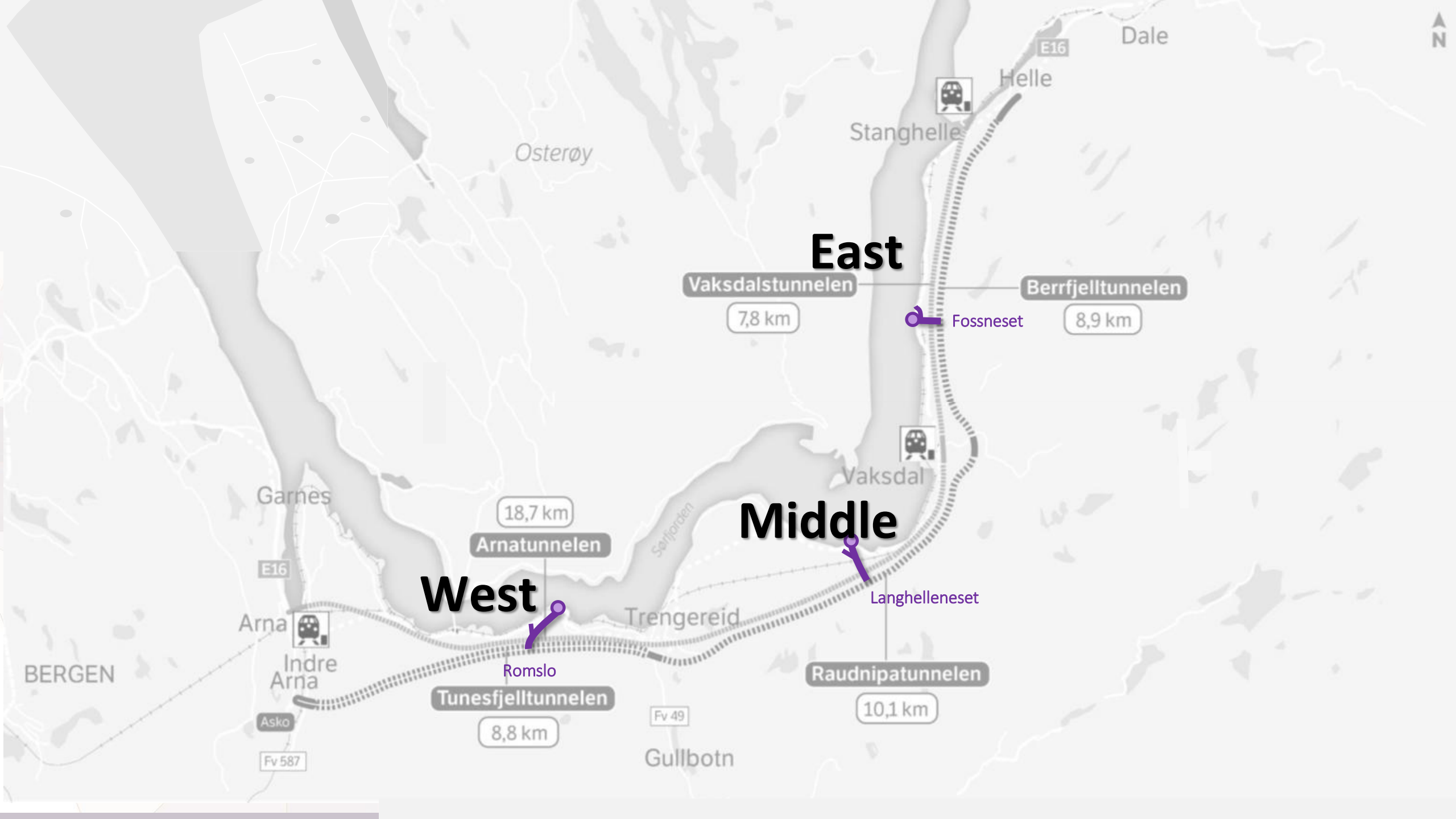


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Legend

-  E16 tunnel, single tube
-  E16 tunnel, double tube
-  E16 dayzone/cross-section
-  Railway tunnel (double-track)
-  Railway day zone (double-track)
-  Railway station





East

Vaksdalstunnelen

7,8 km

Berrfjelltunnelen

8,9 km



Fossneset

Middle



Vaksdal



Langhelleneset

Raudnipatunnelen

10,1 km

West



Romslo

Tunesfjelltunnelen

8,8 km

Arnatunnelen

18,7 km

BERGEN



Arna

Indre Arna

Asko

Fv 587

Fv 49

Gullbotn

Trengereid

Sølfjorden

Osterøy

Stanghelle



Helle

E16

Dale

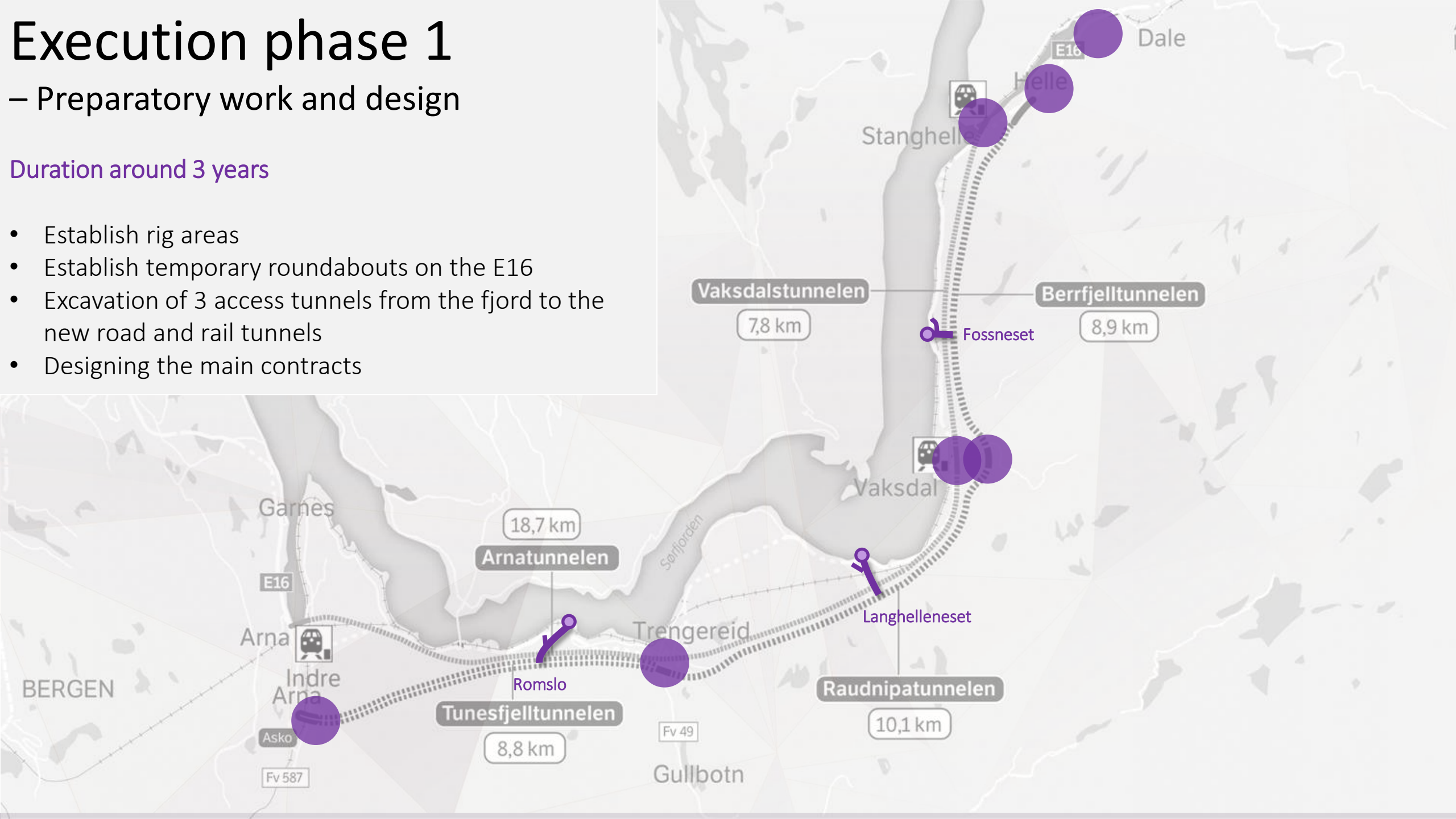


Execution phase 1

– Preparatory work and design

Duration around 3 years

- Establish rig areas
- Establish temporary roundabouts on the E16
- Excavation of 3 access tunnels from the fjord to the new road and rail tunnels
- Designing the main contracts

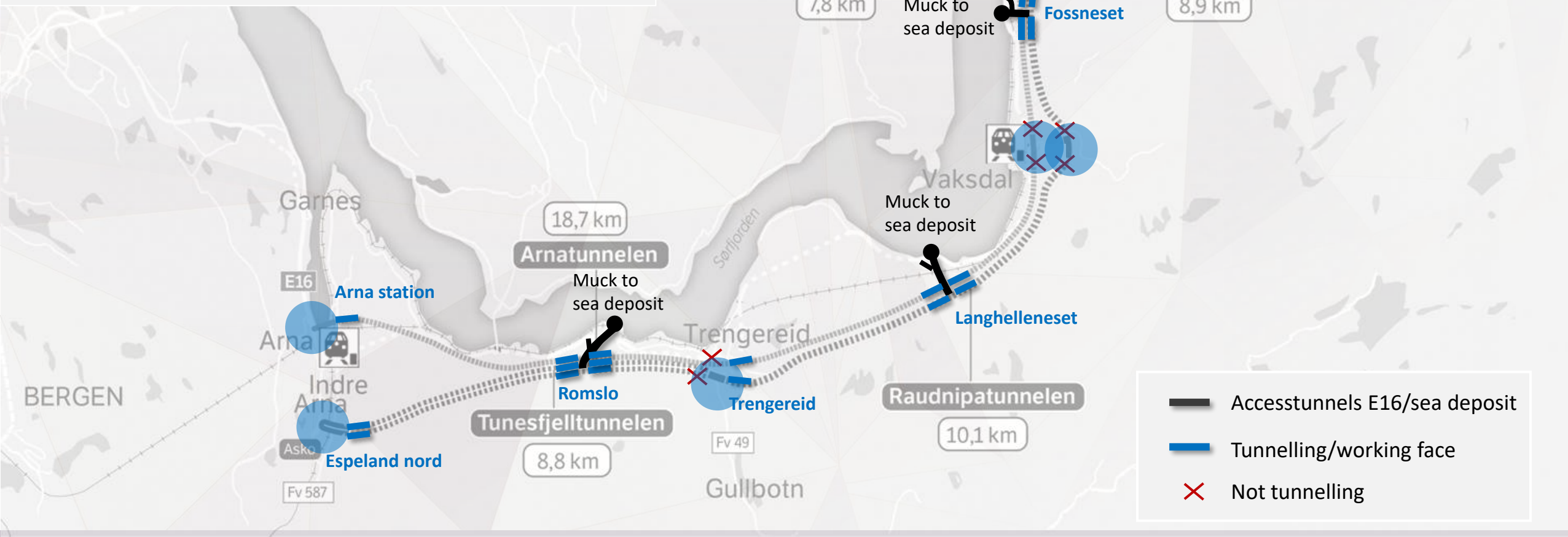


Execution phase 2

- Tunneling and civil works

Duration 5-6 years

- Tunnelling west, central and east part
- Civil works in Arnadalen, Arna station, Trengereid, Vaksdal, Tolåsen, Stanghelle and Helle

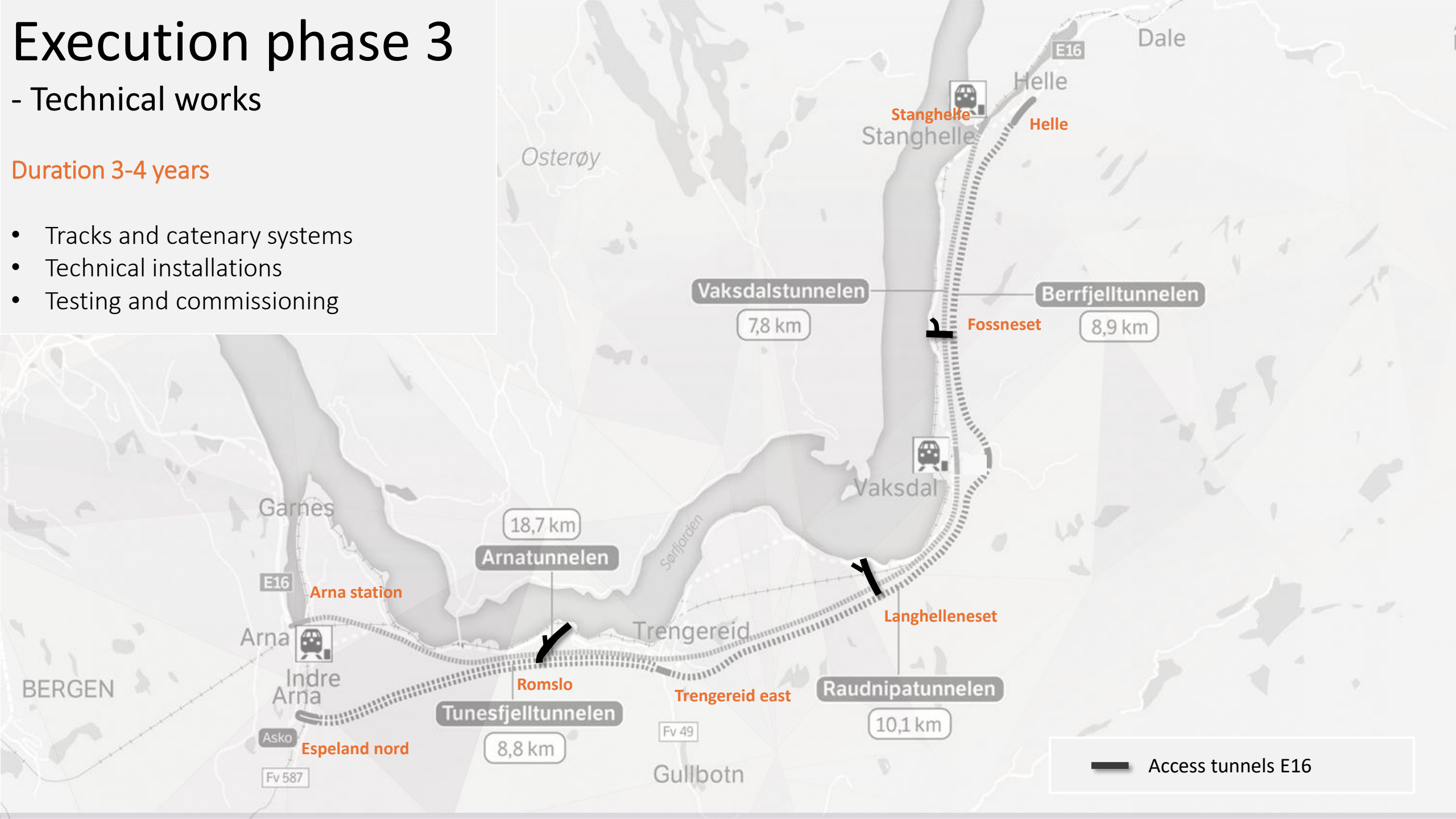


Execution phase 3

- Technical works

Duration 3-4 years

- Tracks and catenary systems
- Technical installations
- Testing and commissioning



Targets for the joint project Arna – Stanghelle



- No fatalities or serious injuries



- No serious damage to the environment and the surrounding area



- NOK 42 billion



- 55% reduction in greenhouse gas emissions



- 12-14 year construction-period

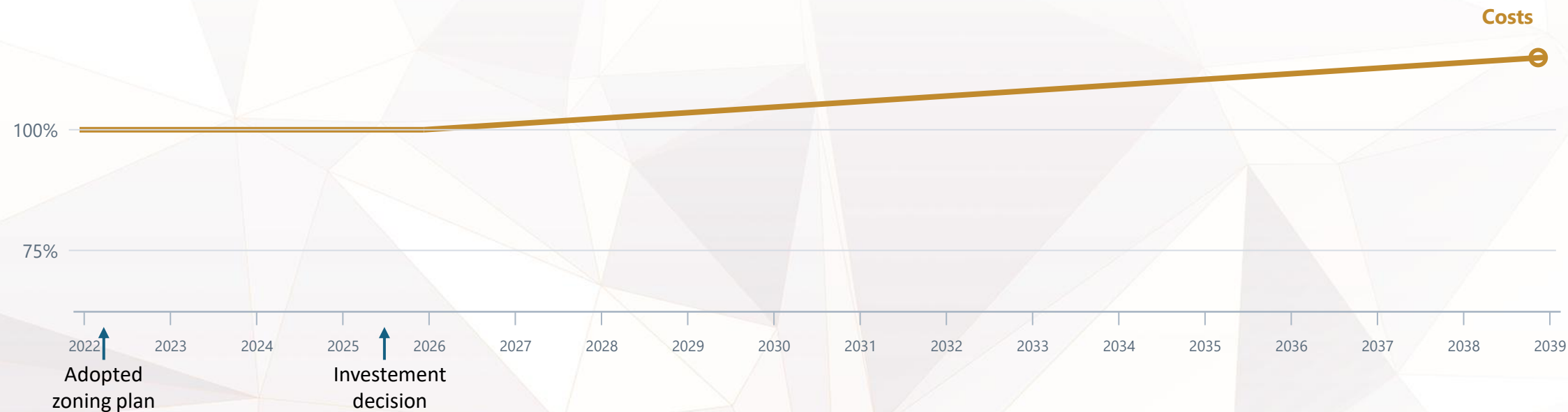


- Challenge the regulations if lower costs/greenhouse gas emissions



• 42 billion NOK cost frame

- Iron law of megaprojects



Project execution phases

1 Design/engineering and preparatory works

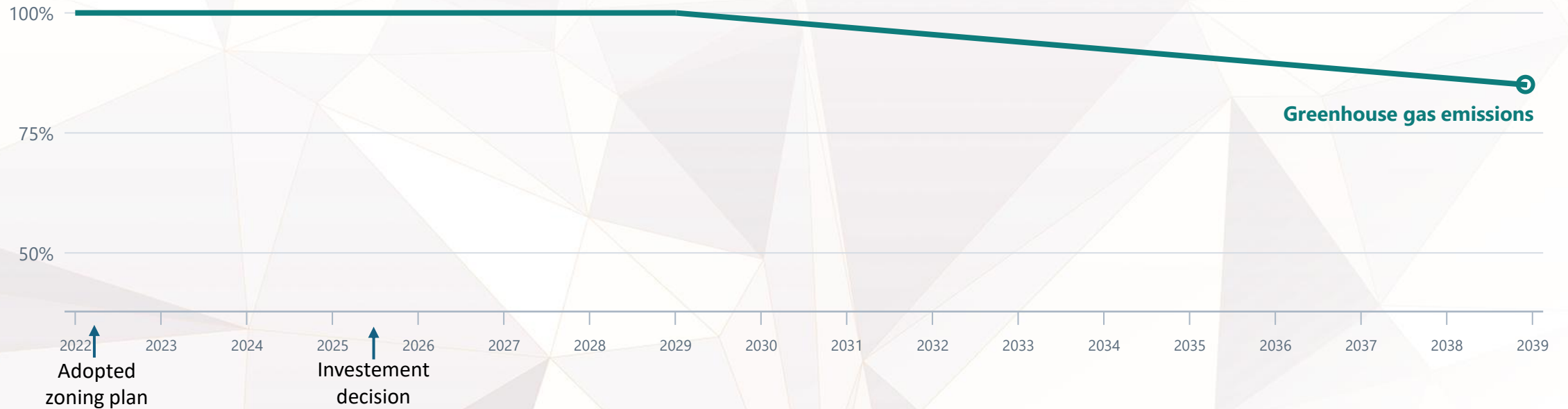
2 Tunnelling and civil works

3 Technical works



- 55% reduction in greenhouse gas emissions compared with the zoning plan

- Anticipated reduction



Project execution phases

1 Design/engineering and preparatory works

2 Tunnelling and civil works

3 Technical works

Standardisation

Predictable, but limited

- Proven designs
- Predictable costs
- Defined scope
- Low uncertainty

VS

Innovation

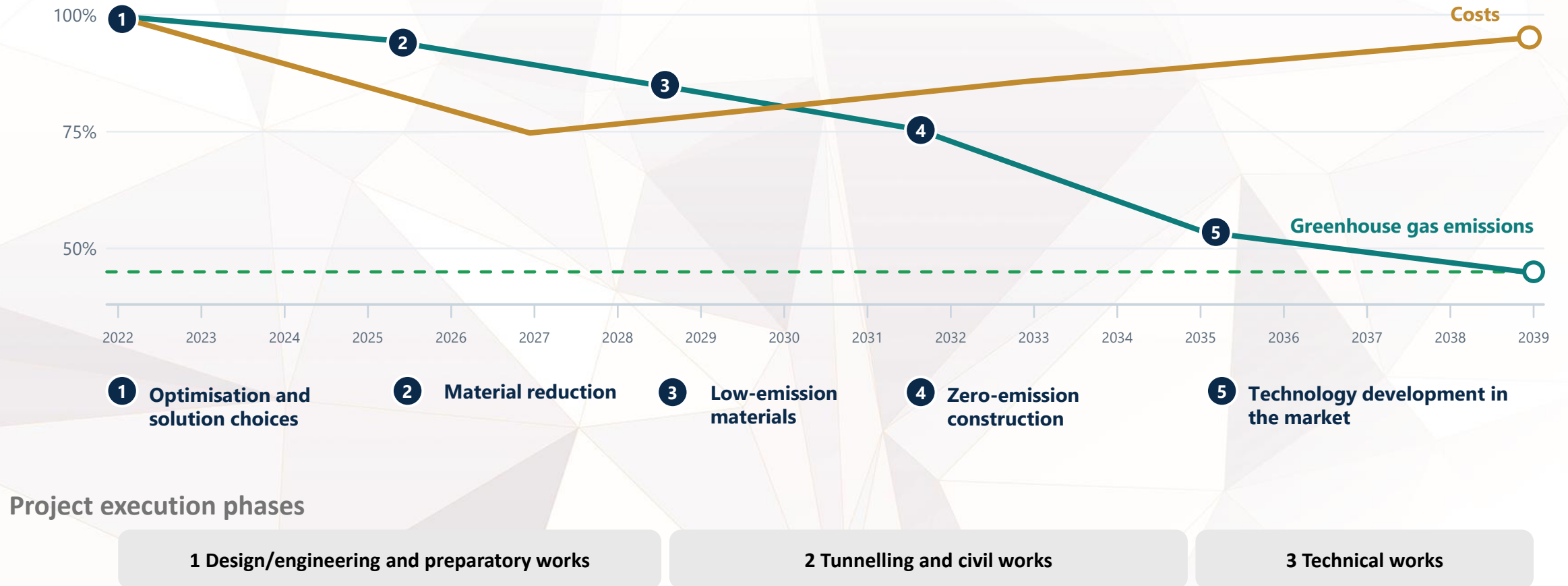
Necessary, but uncertain

- Unproven designs
- Uncertain costs
- Evolving scope
- New opportunities

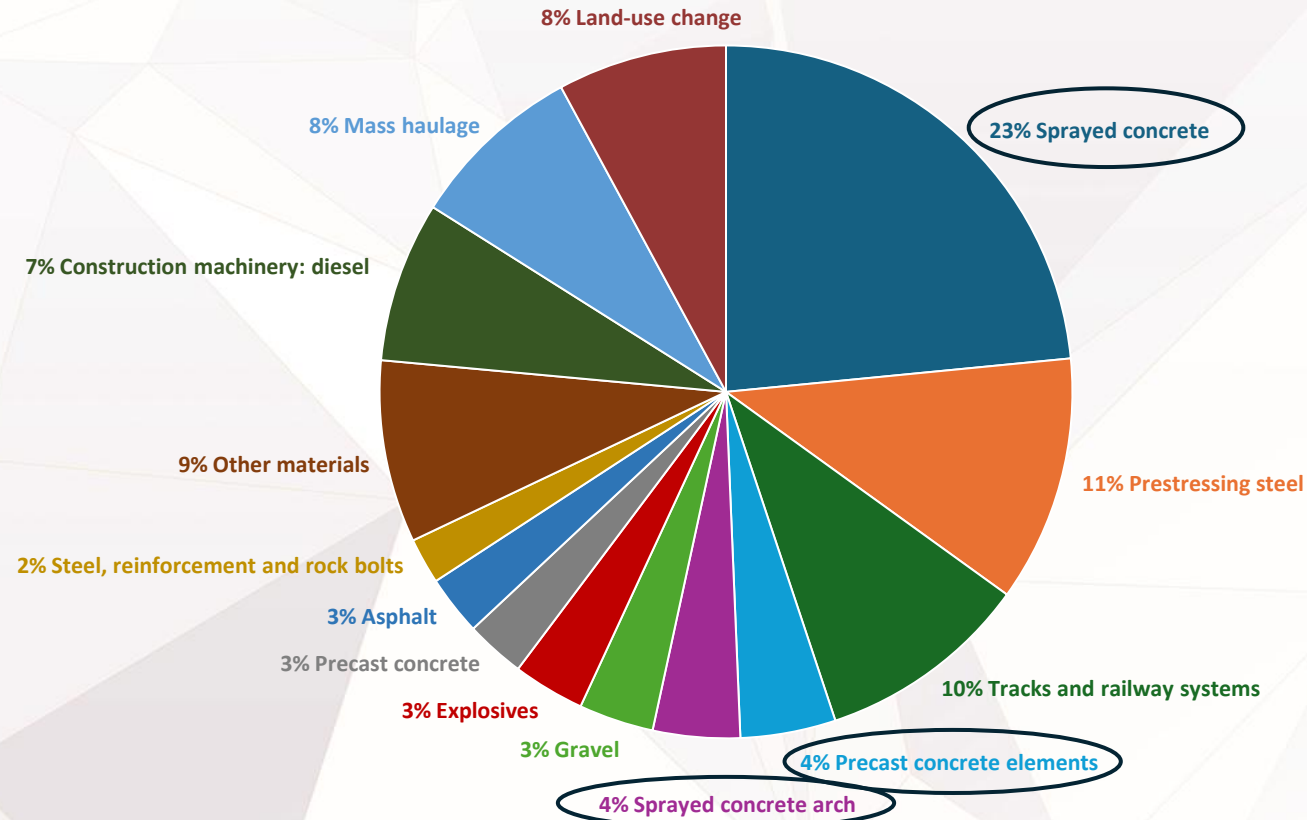
By embracing innovation within limited areas of the project, we aim to capture the greatest gains from innovation while retaining the predictability of standardisation.



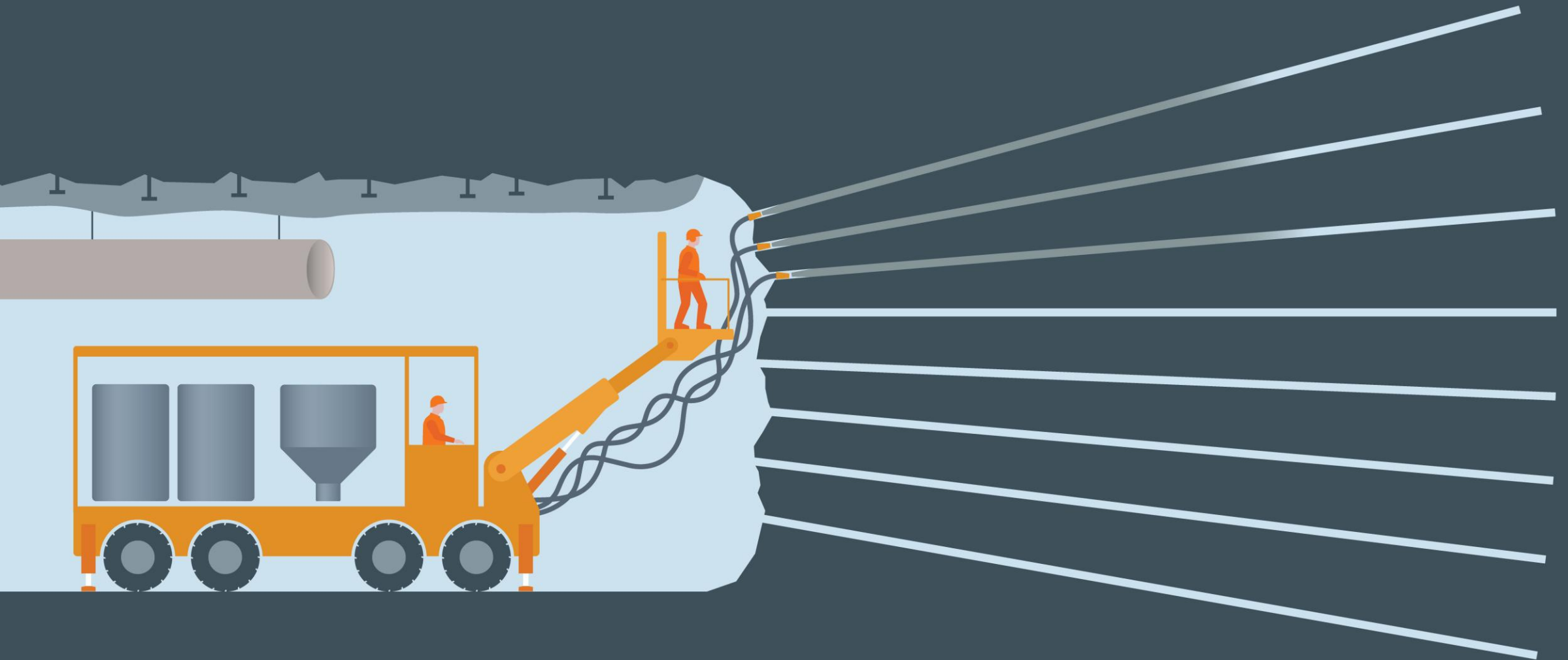
- Challenge the regulations if lower costs/greenhouse gas emissions



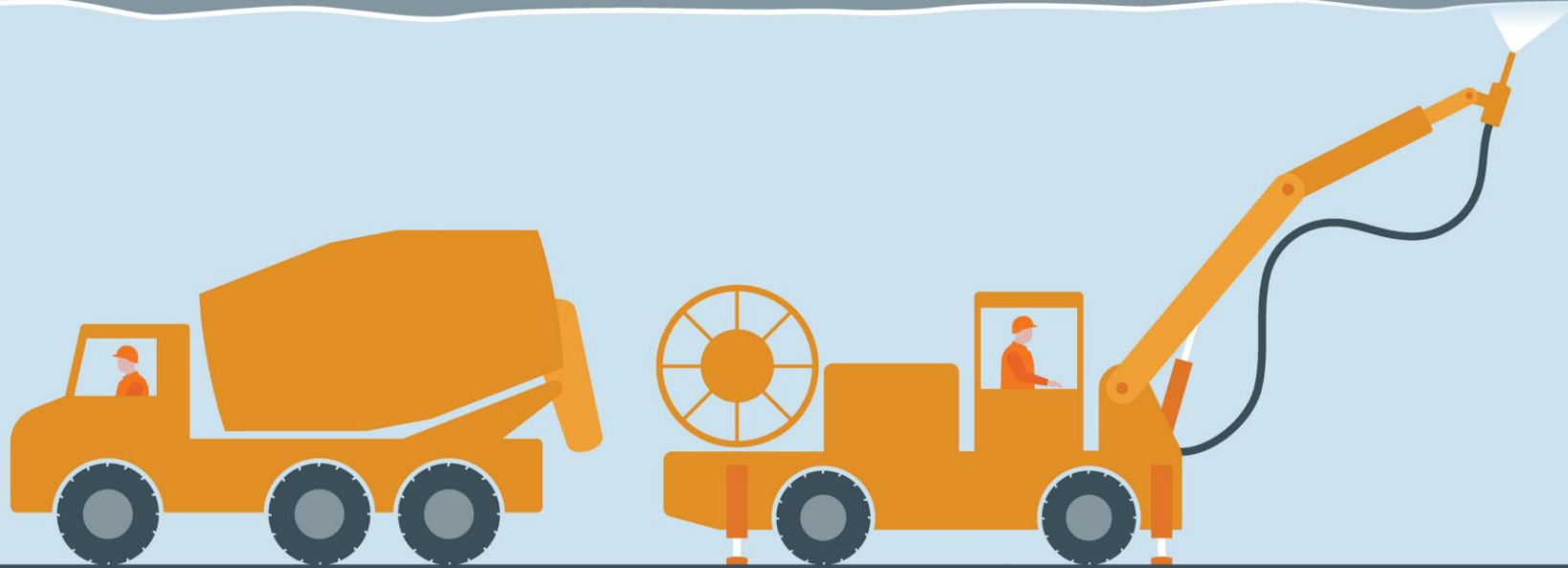
Greenhouse gas emission budget



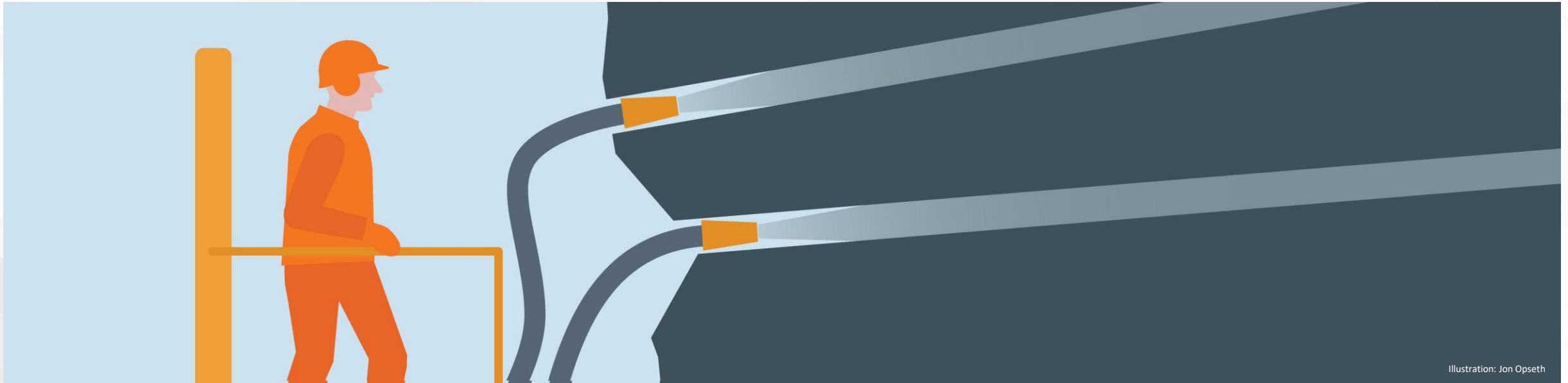
Grouting



Sprayed concrete



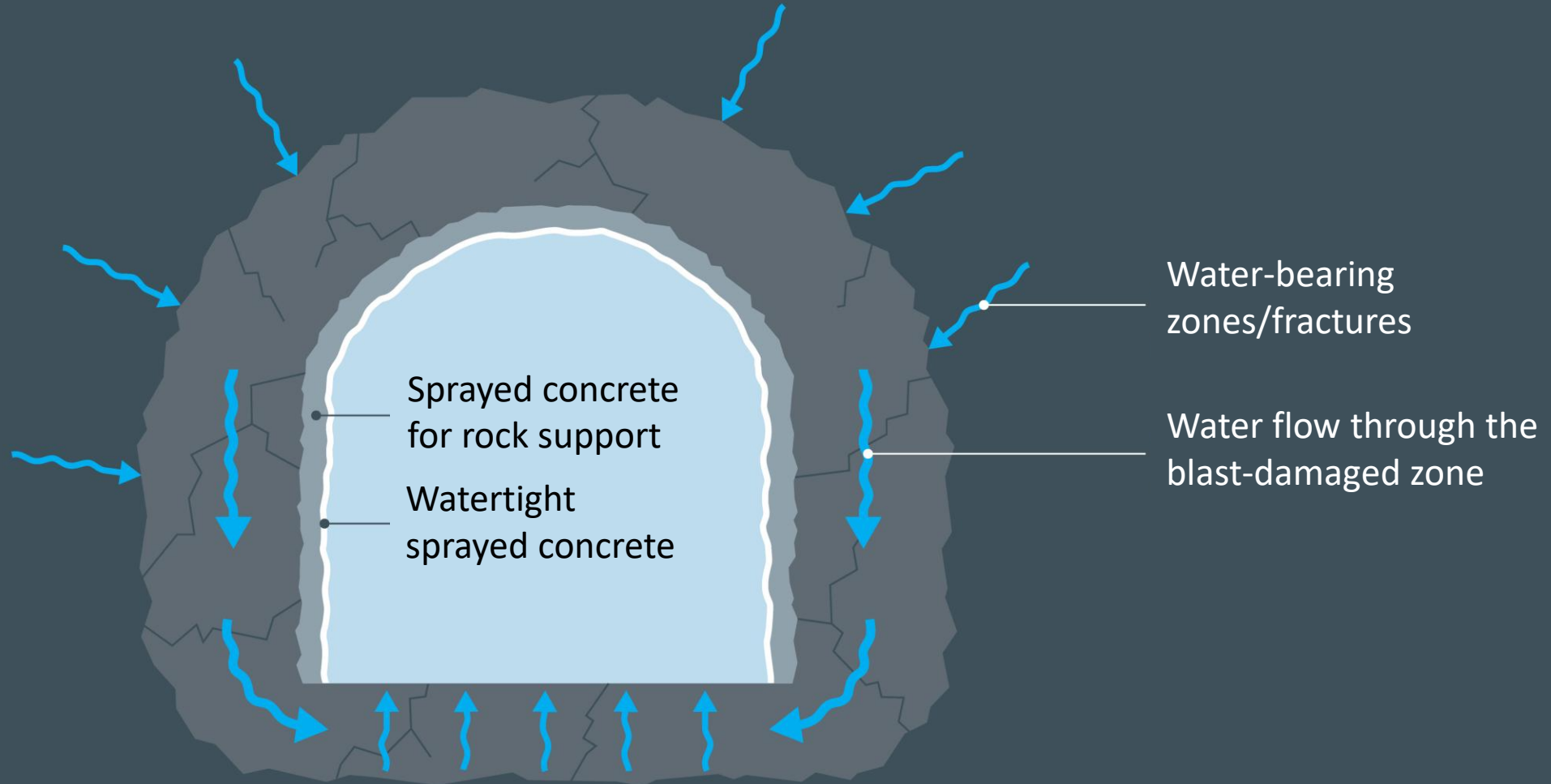
Alternative water and frost protection systems in tunnels



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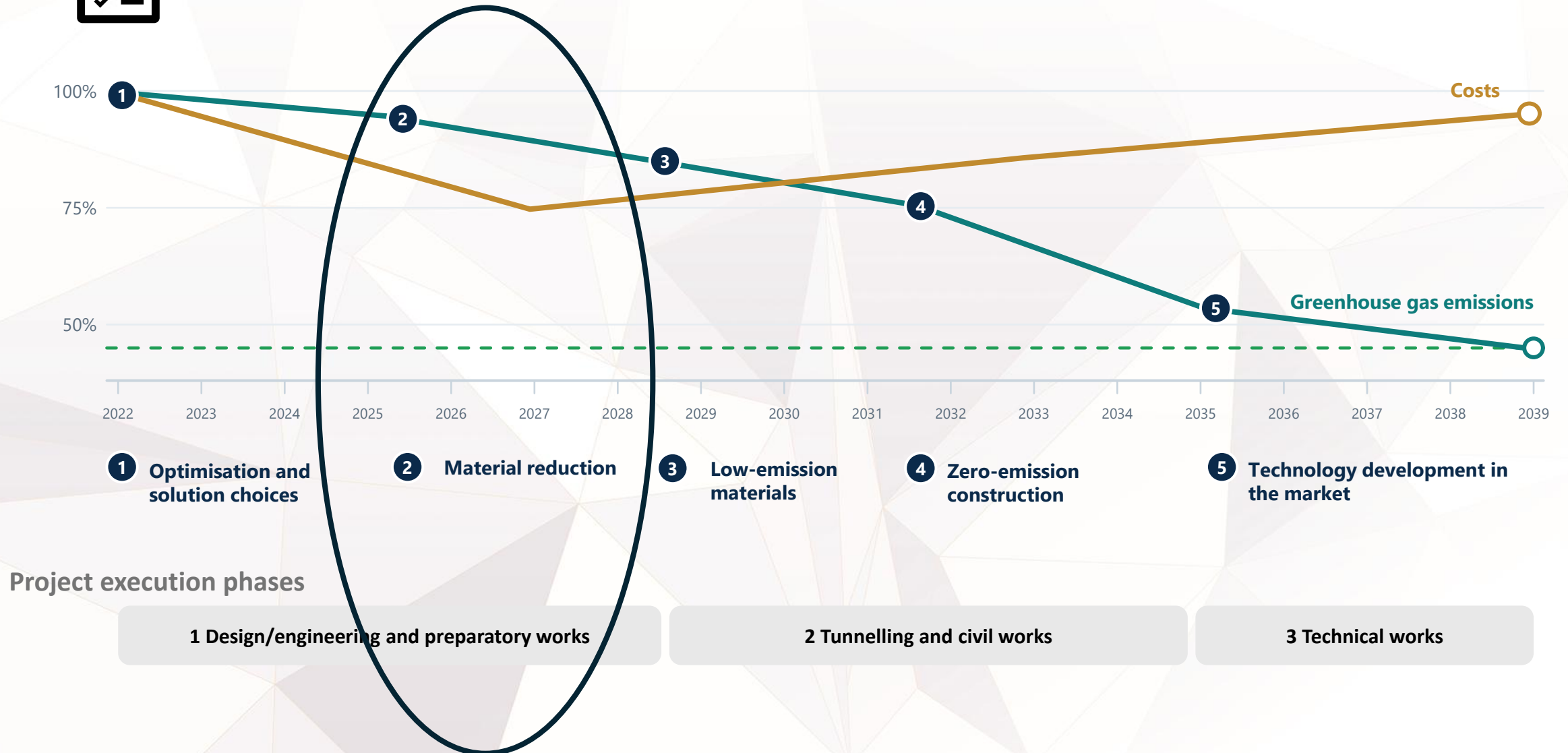
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Principle for water drainage through the blast-damaged zone and the invert in pre-grouted rock mass





- Challenge the regulations if lower costs/greenhouse gas emissions

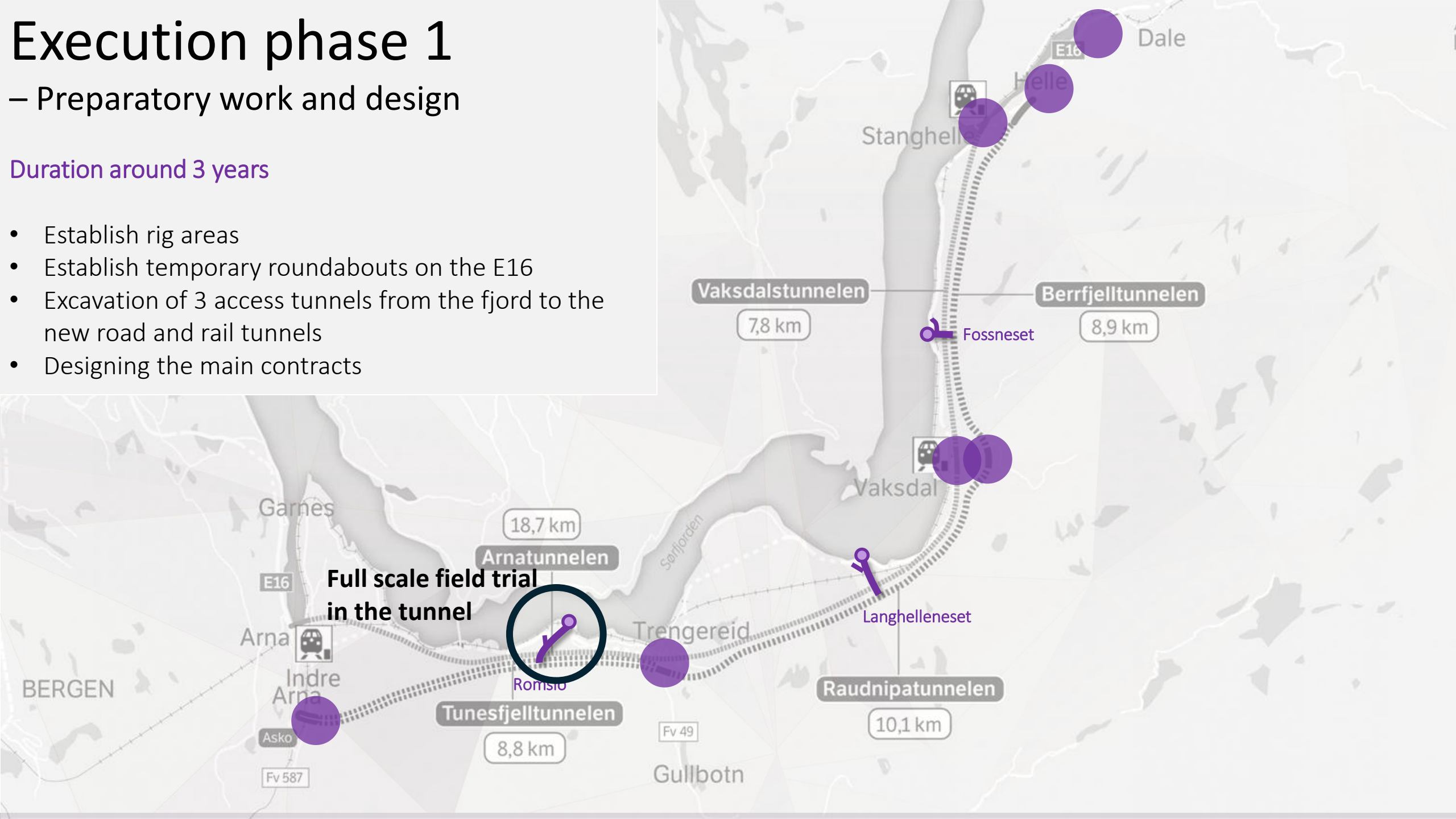


Execution phase 1

– Preparatory work and design

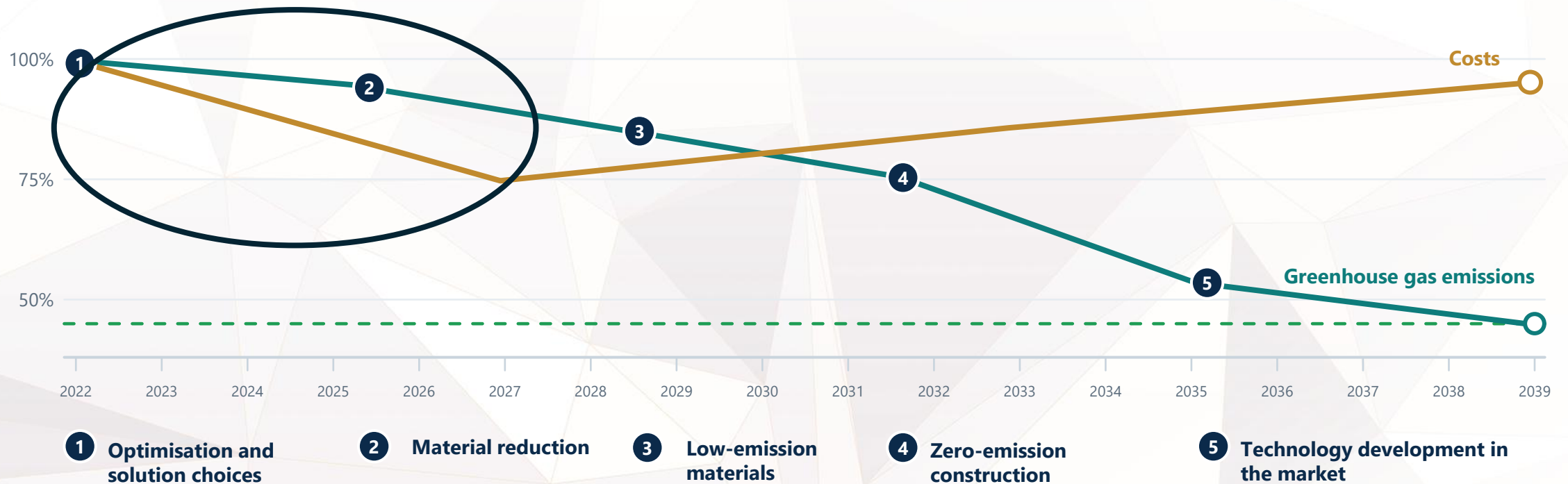
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- Challenge the regulations if lower costs/greenhouse gas emissions



Project execution phases

1 Design/engineering and preparatory works

2 Tunnelling and civil works

3 Technical works

Timing is everything

Early decisions set the cost

- Optimise as early as possible
- Early cost reduction builds the buffer against rising prices
- Design phase is where the leverage is

Innovate where it pays

Bounded, not boundless

- Target the biggest opportunities
- Small changes, large effects
- Full-scale field trial before rollout

Be honest on trade-offs

Priorities decide

- Cost prevails if goals conflict
- Reaching targets requires regulation change
- Transparency builds owner trust

Act early, innovate selectively – and be explicit about which goal wins



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Thank you for your attention!

