HERRENKNECHT

Pioneering Underground Technologies

22 NOV ITA TUNNELING AWARDS, MUMBAI

GENERAL INTRODUCTION
LARGE DIA REFERENCE PROJECTS

HERRENKNECHT
Tunnelling Systems

THE MANAGEMENT OF THE HERRENKNECHT GROUP

Dipl.-Wi.-Ing. Michael Sprang
Vice Chairman of the Board of Management and CFO

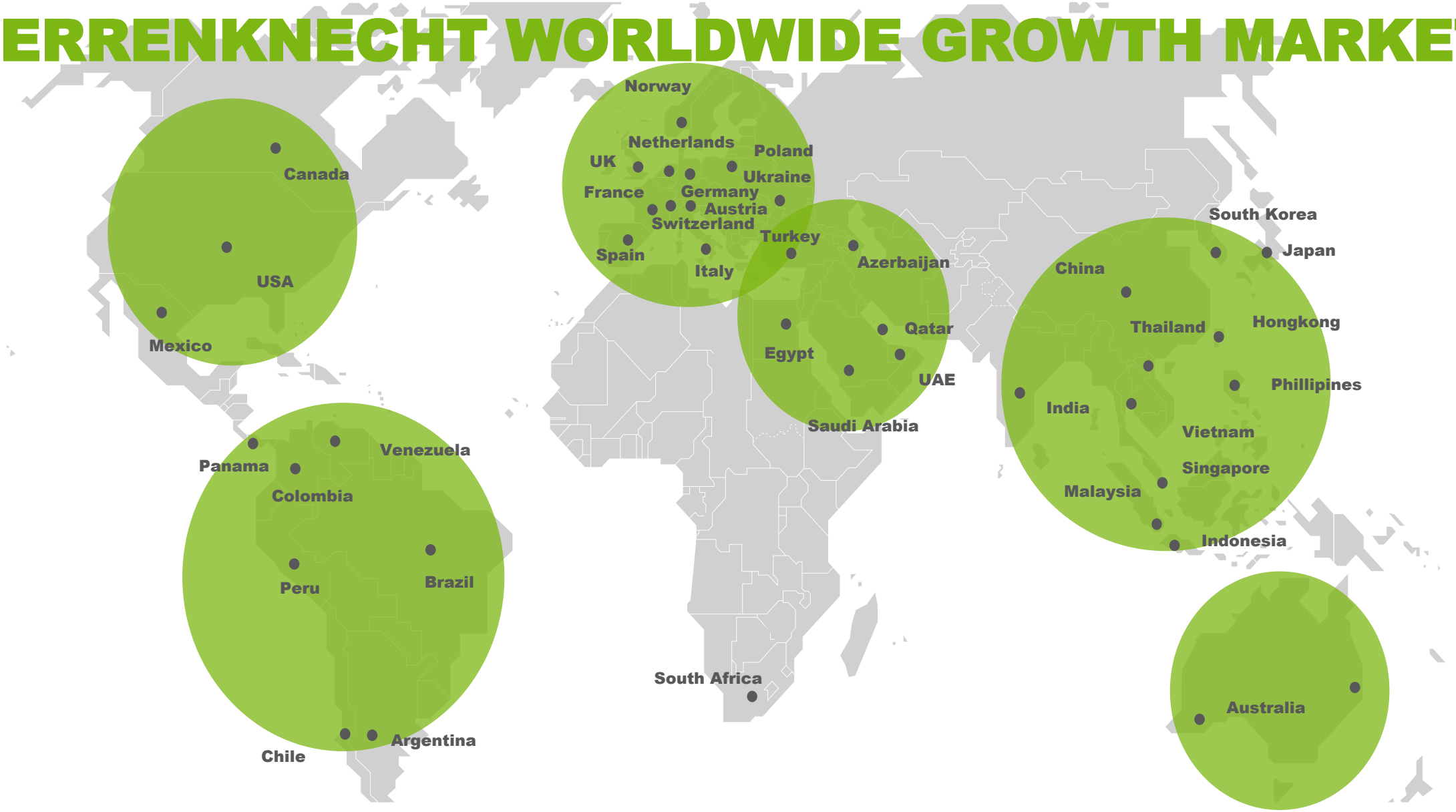
Dipl.-Ing. (FH) Ulrich Schaffhauser
Member of the Board of Management

Dipl.-Ing (FH) Martin-Devid Herrenknecht
Member of the Board of Management

PIONEERING UNDERGROUND TECHNOLOGIES

HERRENKNECHT
Tunnelling Systems

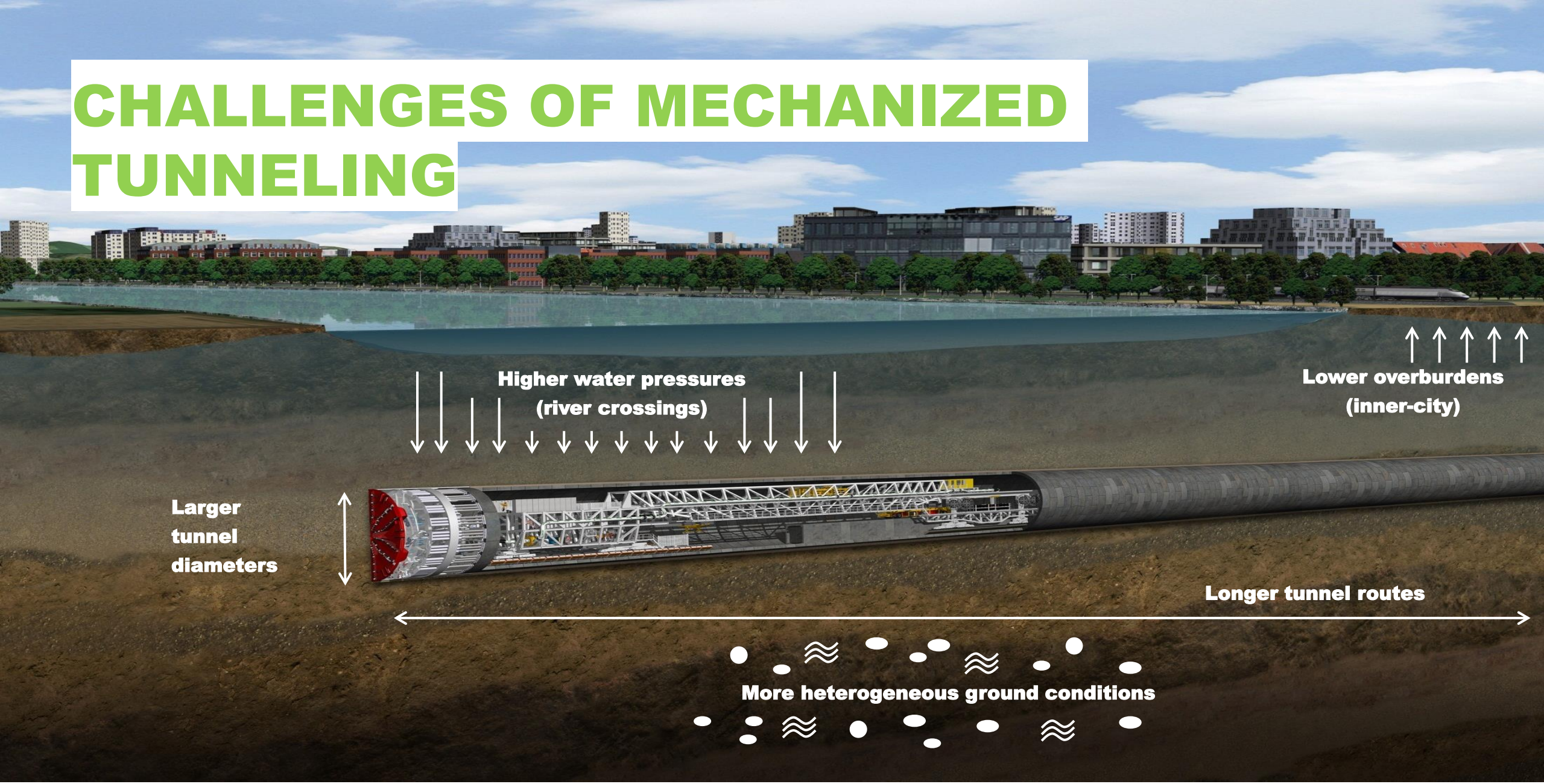
HERRENKNECHT WORLDWIDE GROWTH MARKET



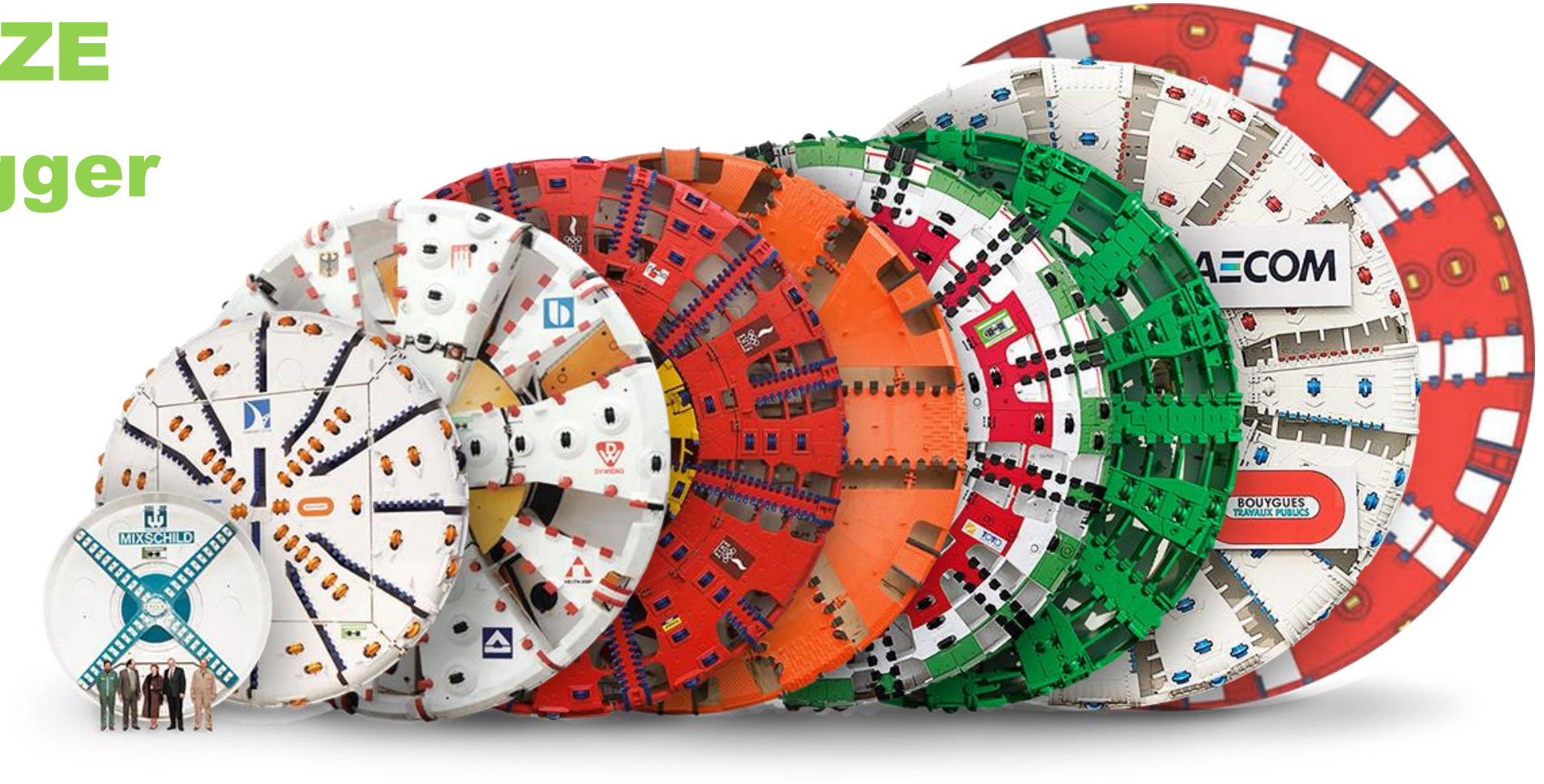
PIONEERING UNDERGROUND TECHNOLOGIES

HERRENKNECHT
Tunnelling Systems

CHALLENGES OF MECHANIZED TUNNELING



SUPERSIZE
Going bigger
STEP
BY
STEP



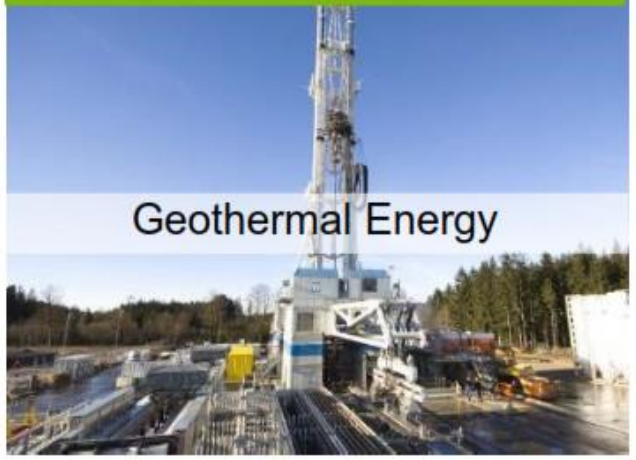
1985	1996	1997	2006	2006	2010	2016	2013	Konzept
HERA	**Sydney**	**Hamburg**	**Madrid**	**Shanghai**	**Sparvo**	**Santa Lucia**	**Hongkong**	**St. Petersburg**
5.95 m	10.70 m	14.20 m	15.20 m	15.43 m	15.62 m	15.87 m	17.6 m	19.25 m

OUR FIELDS OF EXPERTISE

Traffic Tunnels

Mining

Exploration

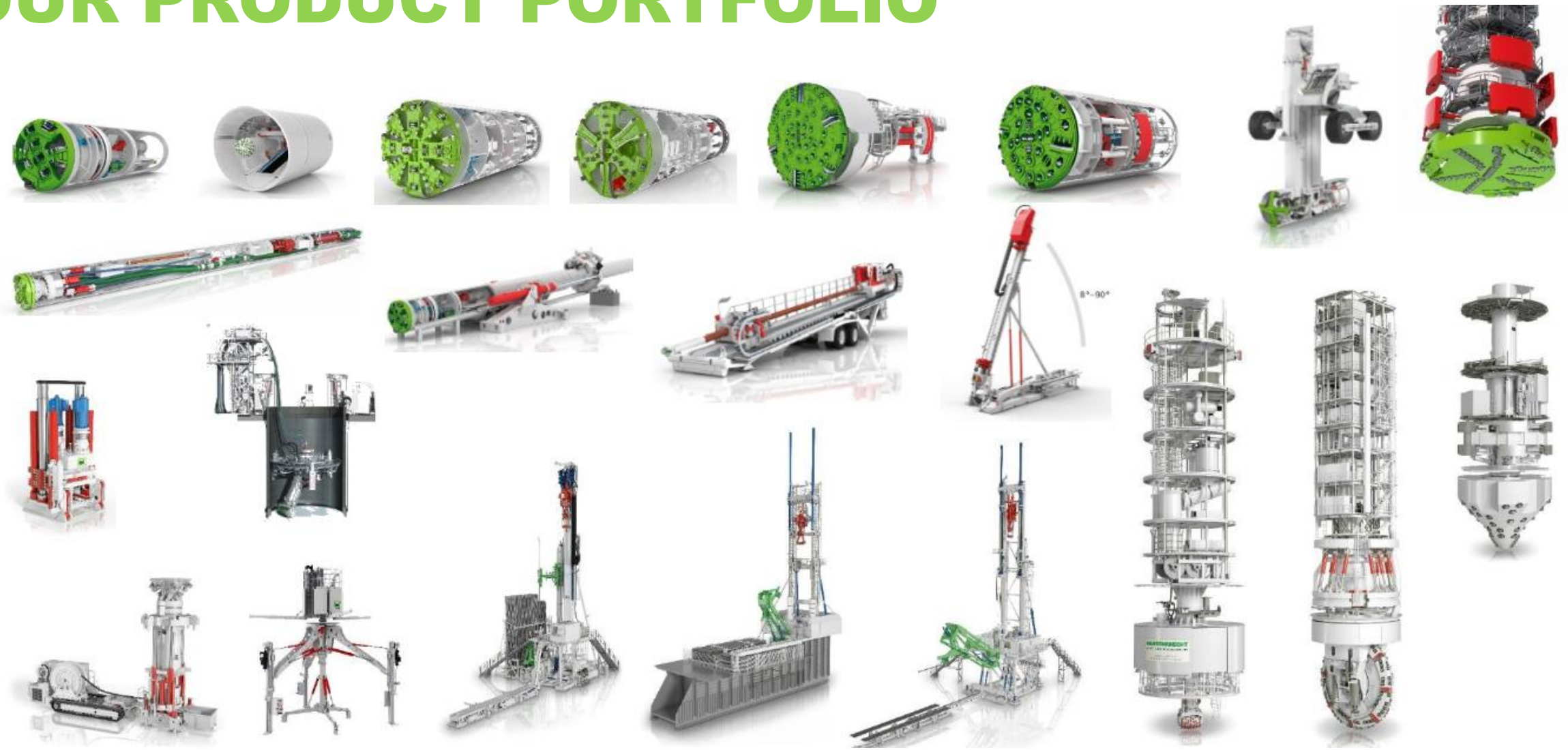


Utility Tunnels

Pipelines

Shafts & Foundations

OUR PRODUCT PORTFOLIO



THE PERFECT TECHNOLOGY FOR YOUR CHALLENGE – ADDITIONAL EQUIPMENT

Navigation and monitoring

Process data management

Seismic and geological exploration

Segment production systems

Combisegments®

Rock support equipment

Tunnel shutter

Pipe Thruster

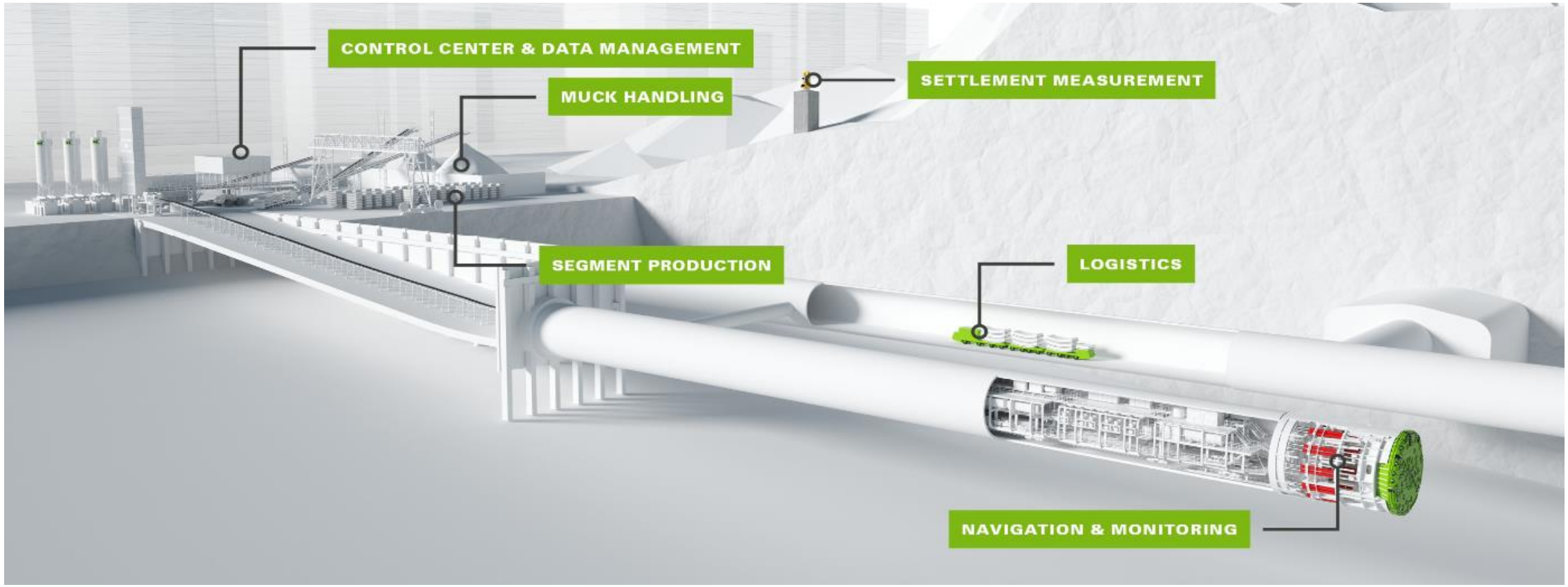
Excavation tools

Multi-service vehicles (MSV)

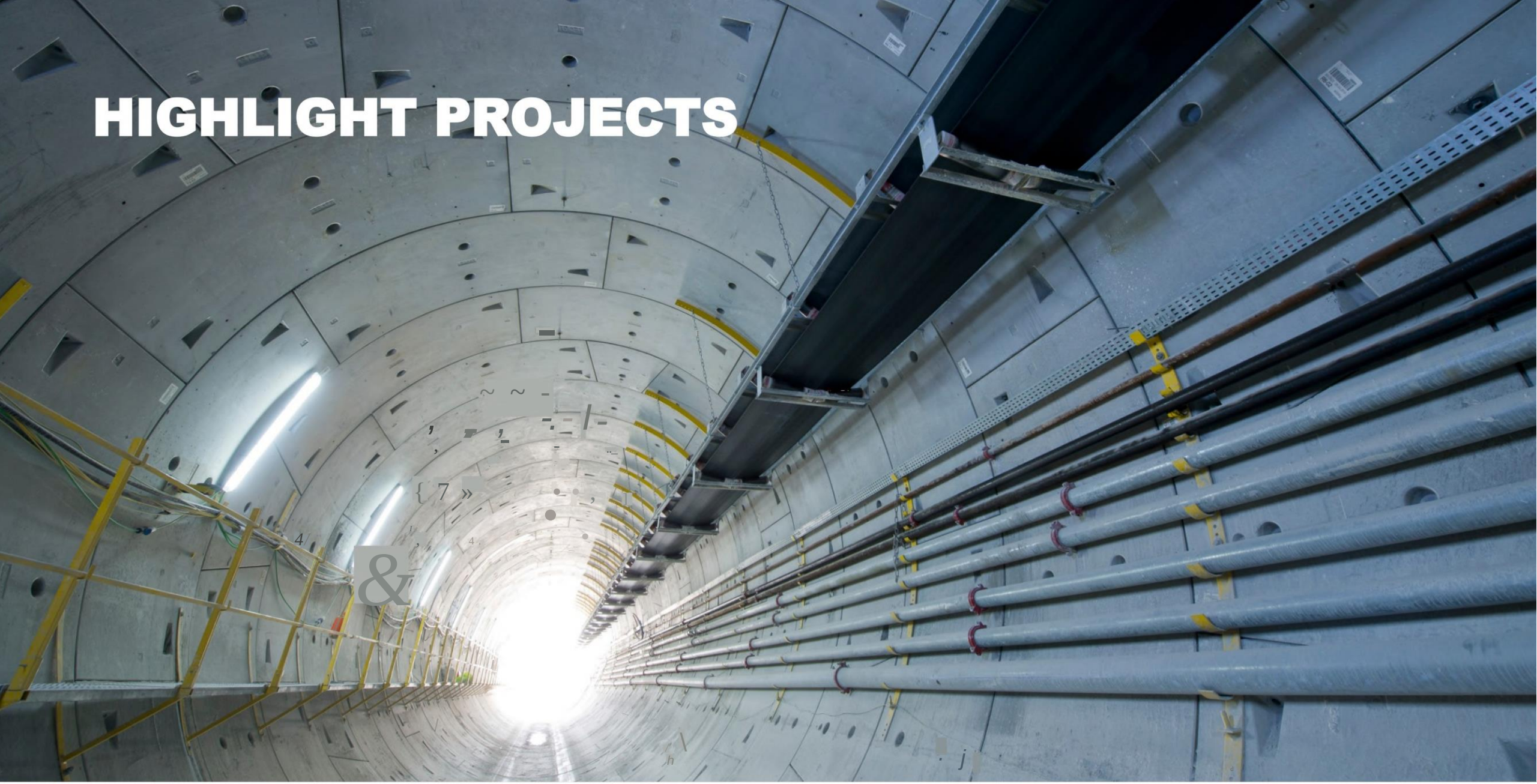
8–60 inches

THE FULL RANGE OF COMPETENCIES IN TUNNELLING

STRONGER TOGETHER



HIGHLIGHT PROJECTS



Final Breakthrough of Herrenknecht‘s Biggest EPB Shield

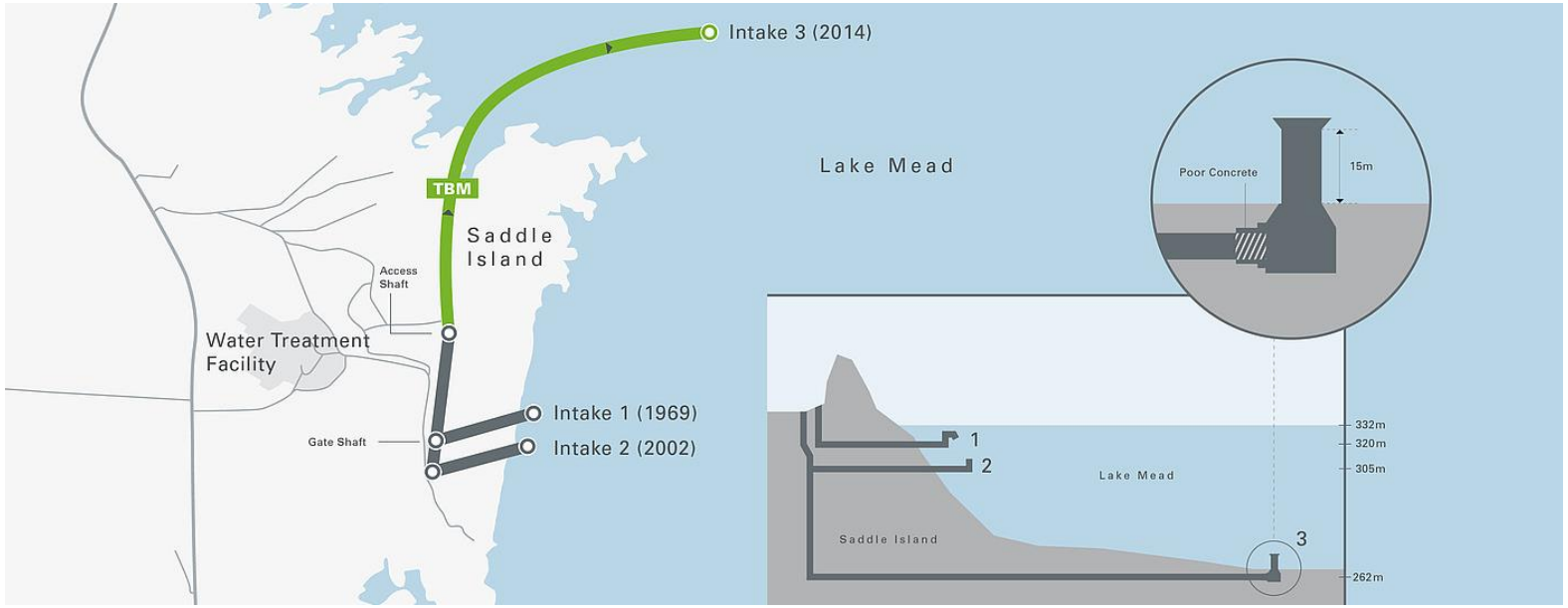
S-574 Galleria Sparvo, Ø 15.55 m & S-900 Santa Lucia, Ø 15.87m

- Peak performance of up to 24 meters / day and 126 meters / week
- Tunnelling of 4.9 km completed after only two years in August 2013
- S-900 St. Lucia: 7.5-km-long traffic tunnel – Europe’s biggest EPB Shield.

World record for Las Vegas: Lake Mead Intake No. 3

Mechanized tunnelling under high pressure

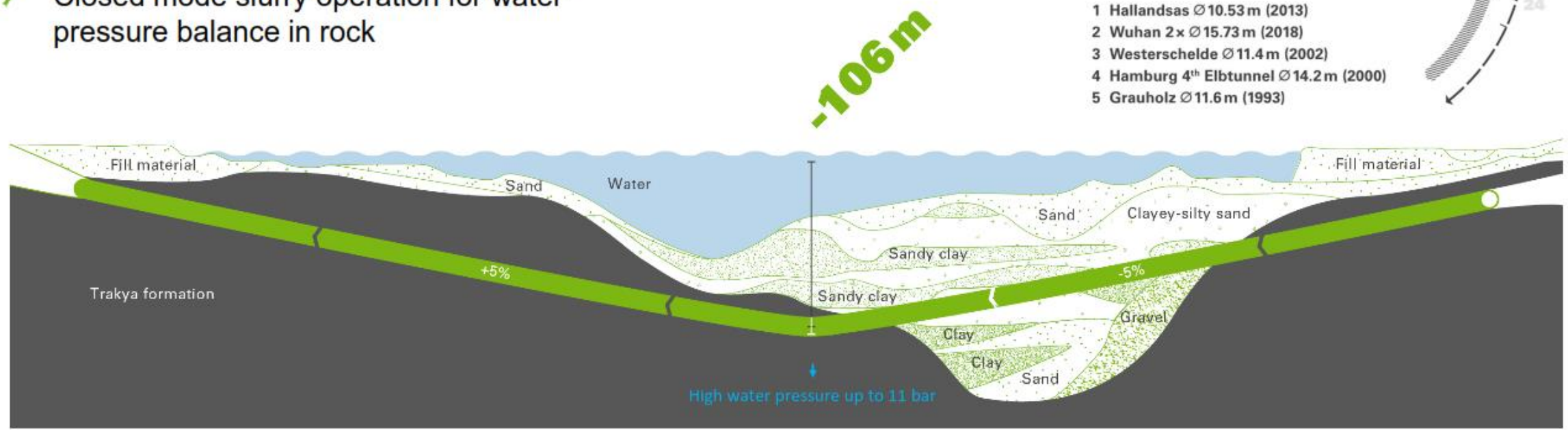
- Groundwater pressures of up to 15 bar
- S-502 Multi-Mode-TBM, Ø 7,180 mm
- Tunnelling from December 2011 - December 2014
- One of the most challenging tunnelling projects of all time



EURASIATUNNEL

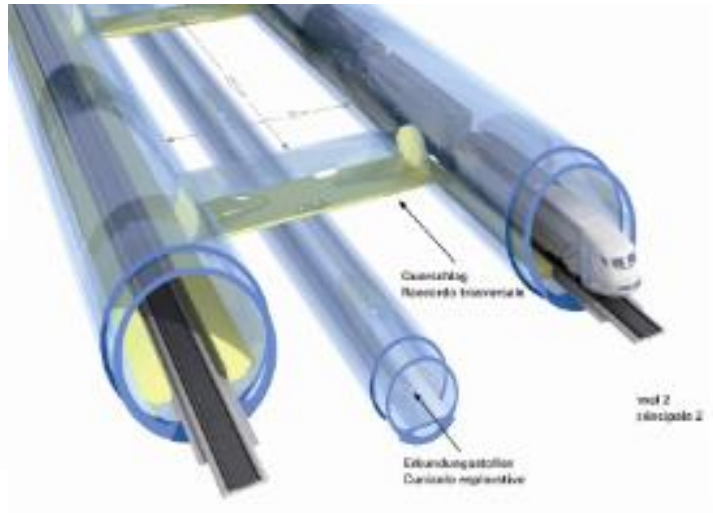
Connecting continents in Istanbul

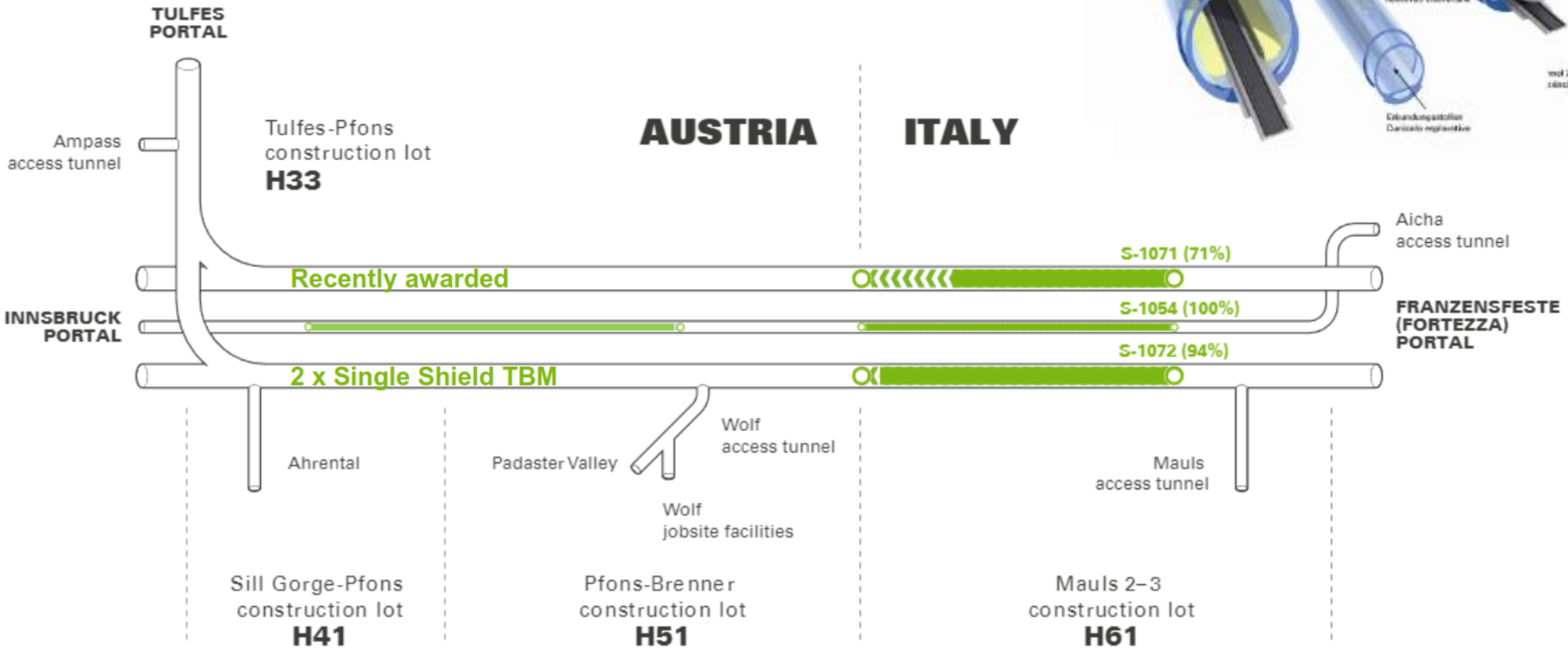
- Mixshield S-762 (Ø 13.66 m)
- Route runs up to 106 meters below sea level through heterogeneous geology and solid rock
- Closed mode slurry operation for water pressure balance in rock



Brenner Base Tunnel

The longest underground railway connection in the world

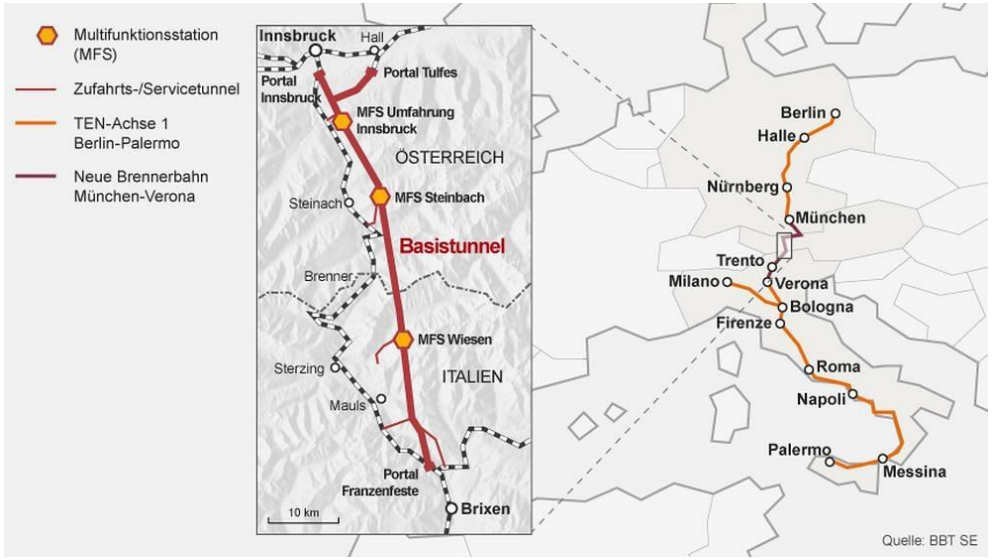




Brenner Base Tunnel

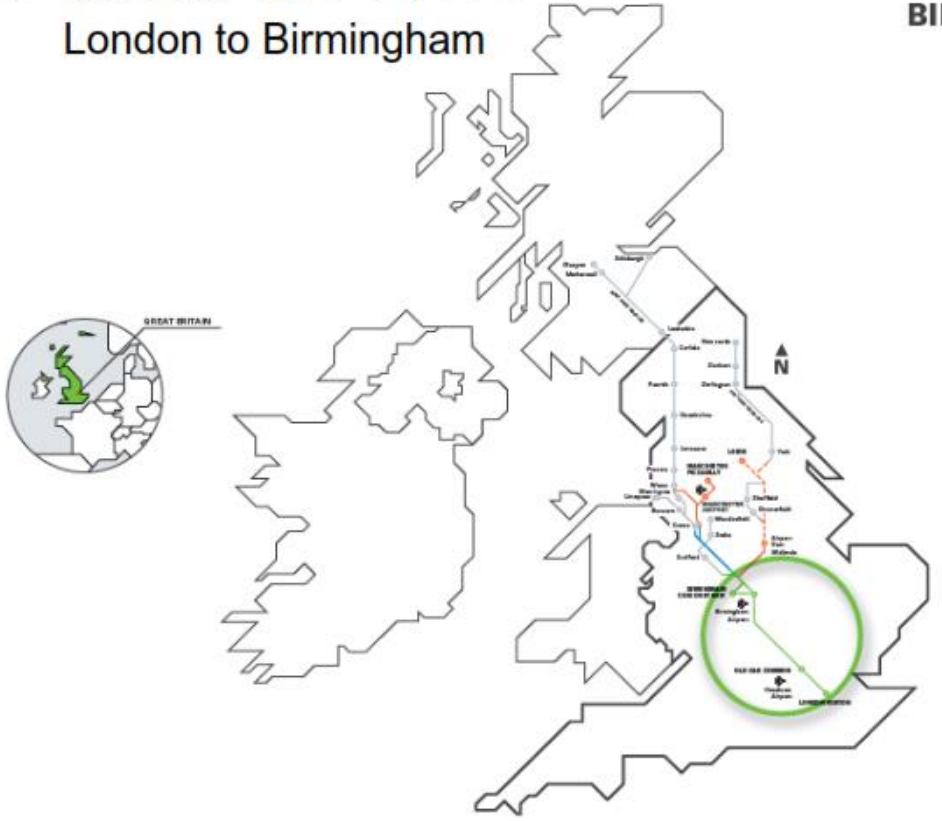
The longest underground railway connection in the world

- Gripper TBM at tunnelling since September 2015 for the 15 km long exploratory tunnel Tulfes-Pfons
- Current tunnelling status: more than 10 km advanced
- South: 3x Double Shield TBM sold for lot “Mauls”
- North: 2x Single Shield TBM for lt “Pfons”



HIGH SPEED 2

London to Birmingham



88.5KM RAILWAY TUNNEL

HS2 CONSTRUCTION FACTS

- Destinations served by HS2
- HS2 Phase 1
- HS2 Phase 2a
- HS2 Phase 2b
- Eastern leg scrapped
- HS2 services on existing network

Status as per September 2022. Subject to changes.

BIRMINGHAM

Birmingham Curzon Street

Birmingham Airport

BROMFORD TUNNEL

2× 5.7 km

1× Variable Density TBM:
S-1290A
Ø 8,600 mm
Ready to bore:
Spring 2023

4x VARIABLE DENSITY TBM

LONG ITCHINGTON WOOD TUNNEL

2× 1.5 km

1× Variable Density TBM:
S-1249A "Dorothy"
Ø 9,860 mm
Ready to bore:
October 26, 2021

CHILTERN TUNNEL

2× 16 km

2× Variable Density TBM:
S-1205 "Florence" S-1206 "Cecilia"
Ø 10,240 mm
Ready to bore S-1205:
May 7, 2021
Ready to bore S-1206:
July 2, 2021

ATLAS ROAD LOGISTICS TUNNEL

850 m

1× EPB Shield:
S-1311A
Ø 7,090 mm
Ready to bore:
Early 2023

EUSTON TUNNEL

2× 7.2 km

2× EPB Shield:
S-1366A, S-1367A
Ø 9,500 mm
Ready to bore:
Spring 2024

NORTHOLT TUNNEL WEST

2× 7.9 km

2× EPB Shield:
S-1274A, S-1275A
Ø 9,920 mm
Ready to bore S-1274A:
September 9, 2022
Ready to bore S-1275A:
Autumn 2022

7x EPB SHIELD

NORTHOLT TUNNEL EAST

2× 5.5 km

2× EPB Shield:
S-1332A, S-1333A
Ø 9,090 mm
Ready to bore S-1332A:
Summer, 2023
Ready to bore S-1333A:
Autumn 2023

LONDON

Heathrow Airport

PIONEERING UNDERGROUND TECHNOLOGIES

HERRENKNECHT Tunnelling Systems

TUEN MUN – CHEK LAP KOK LINK

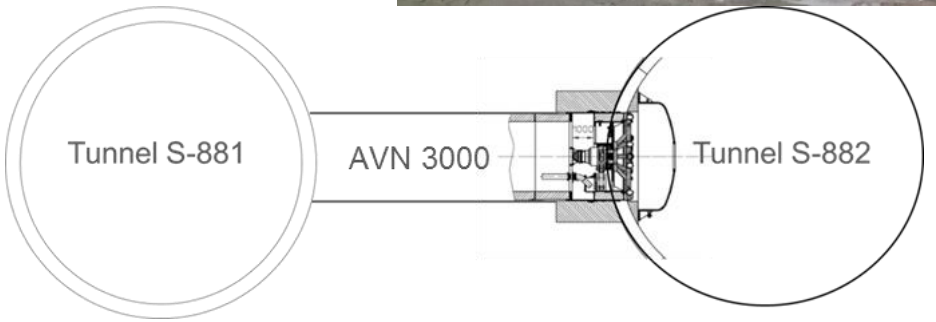
The world‘s biggest TBM

- S-880, Mixshield,
  bore diameter 17,630 mm
- Breakthrough at vantilating
  shaft by November 2015
- 2 parallel road tunnel for every
  2 roadways
- Important road axis in region
  Hongkong in connection to the
  airport

Hongkong: Tuen Mun – Chek Lap Kok Link (TM-CLKL)

Cross passages with 2x AVN3000

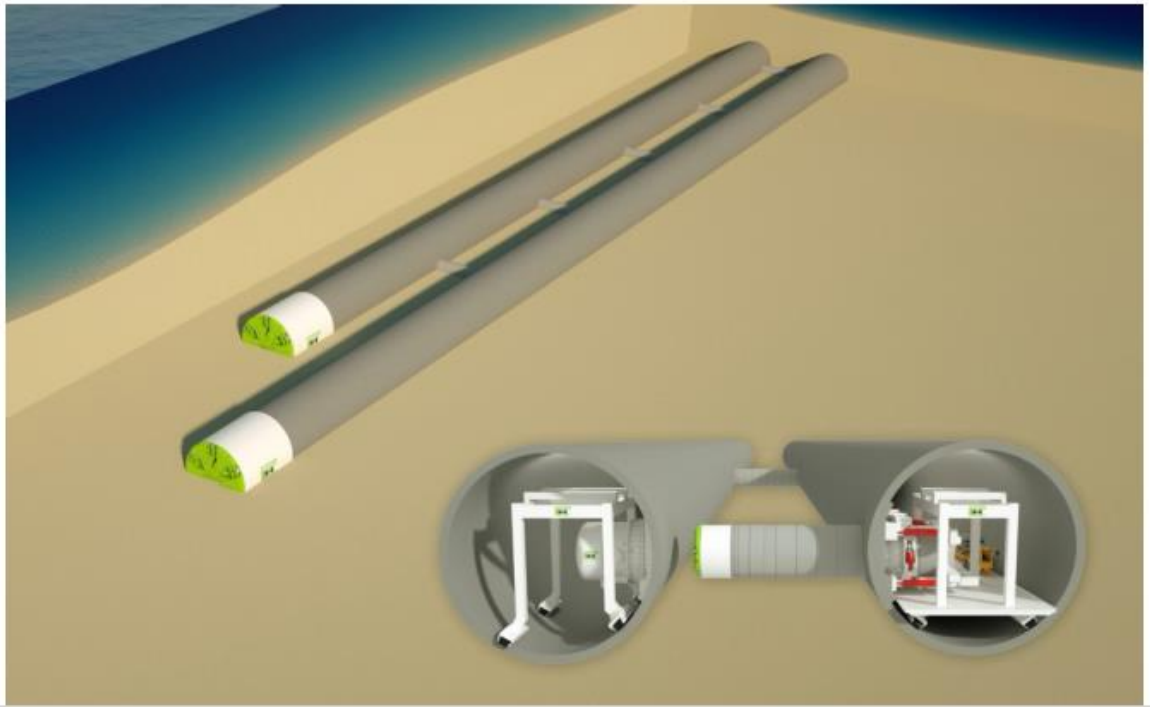
- 44 cross passages in total
- First breakthrough: March 31st, 2016
- Tunnel length: approx. 10 – 12 m
- Max. confinement pressure: 5.5 bar



CROSS PASSAGES

44x drilling lengths of 10-15m

- 2x AVN3000
- Surrounding pressure up to 5.5 bar
- Logistics in large tunnel can take place in parallel
- First usage of TBM technology for cross passages under groundwater



SNOWY 2.0

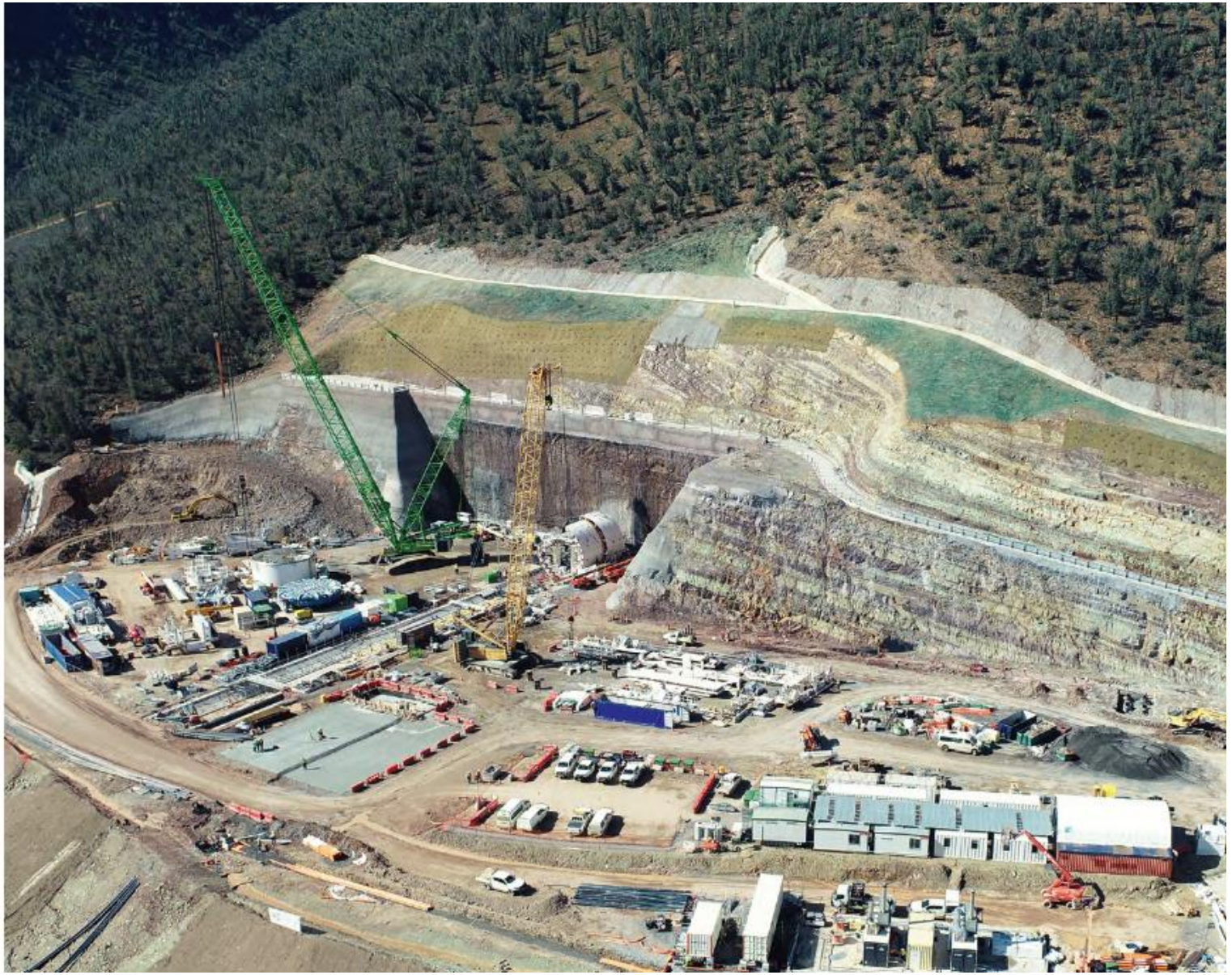
Pioneers on the steep slope

- **Single Shield TBM “Kirsten“**
  - Ø 11,010mm
  - Tunnelling length 6,471m
  - Record gradient of up to 25° / 42%
- **Multi-mode TBM “Florence”**
  - Ø 11,010mm
  - Tunnelling length 15,332m

Snowy 2.0 will produce an additional

2,000 MEGAWATTS

of hydroelectric power, providing
clean electricity for millions of Australians.



Talbingo Reservoir

Tailrace Tunnel

Main Access Tunnel

Surge Shaft

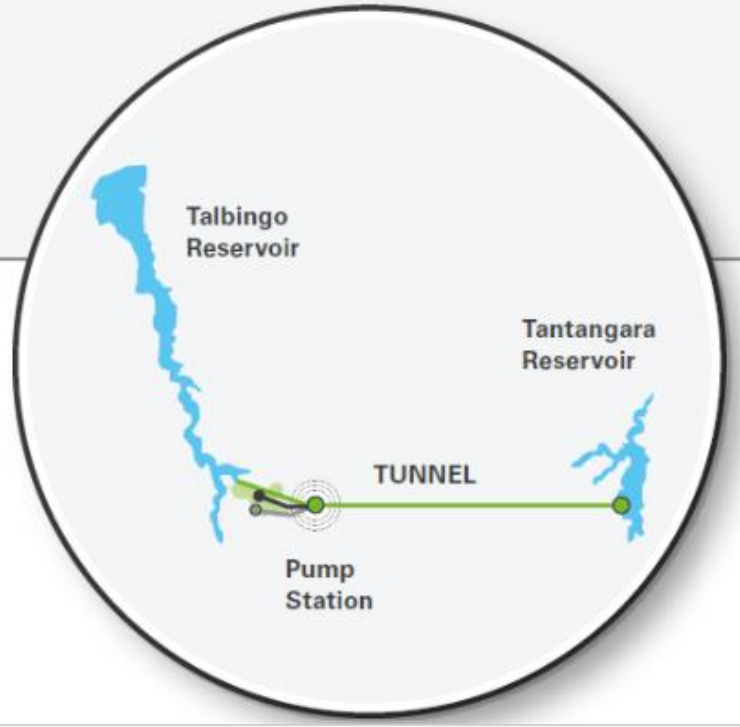
Headrace Tunnel

Tantangara Reservoir

Inclined Pressure Shaft

Emergency Cable Ventilation Tunnel

SNOWY 2.0



TUNNELLING LENGTH

6,471 m — TBM "Kirsten"

15,332 m — TBM "Florence"

TBM "Kirsten" will bore the inclined pressure shaft at a slope of approx.

25.17°

a feat never before accomplished in this diameter range

PIONEERING UNDERGROUND TECHNOLOGIES

HERRENKNECHT Tunnelling Systems

DTSS SINGAPORE

A superhighway for sewage treatment

MAIN COLLECTORS

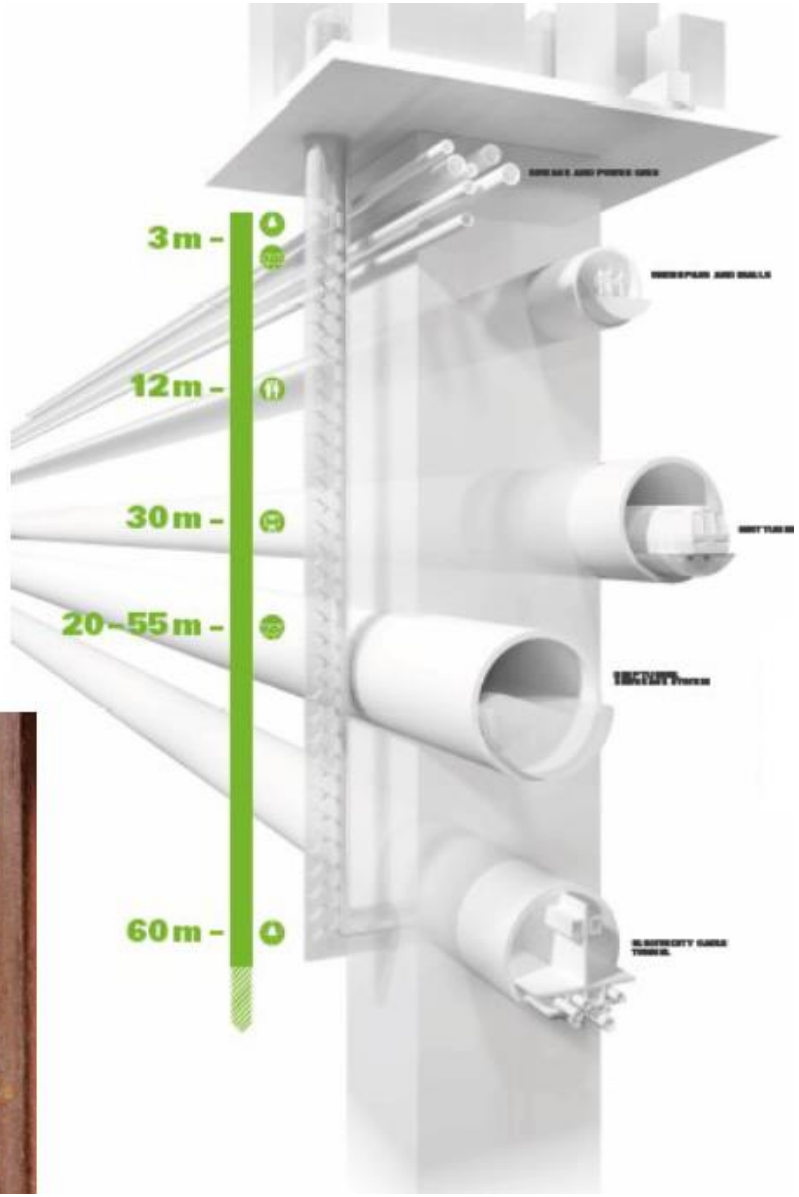
- 19x TBMs, Segmental Lining | ID 3.5 – 6.6 m (45km tunnel)
- Designed for pressures up to 8 bar and up to 150m curve radius

LINK SEWERS

- 17x TBMs, Pipe Jacking | ID 300 – 3000 mm (33km tunnel)

SHAFTS

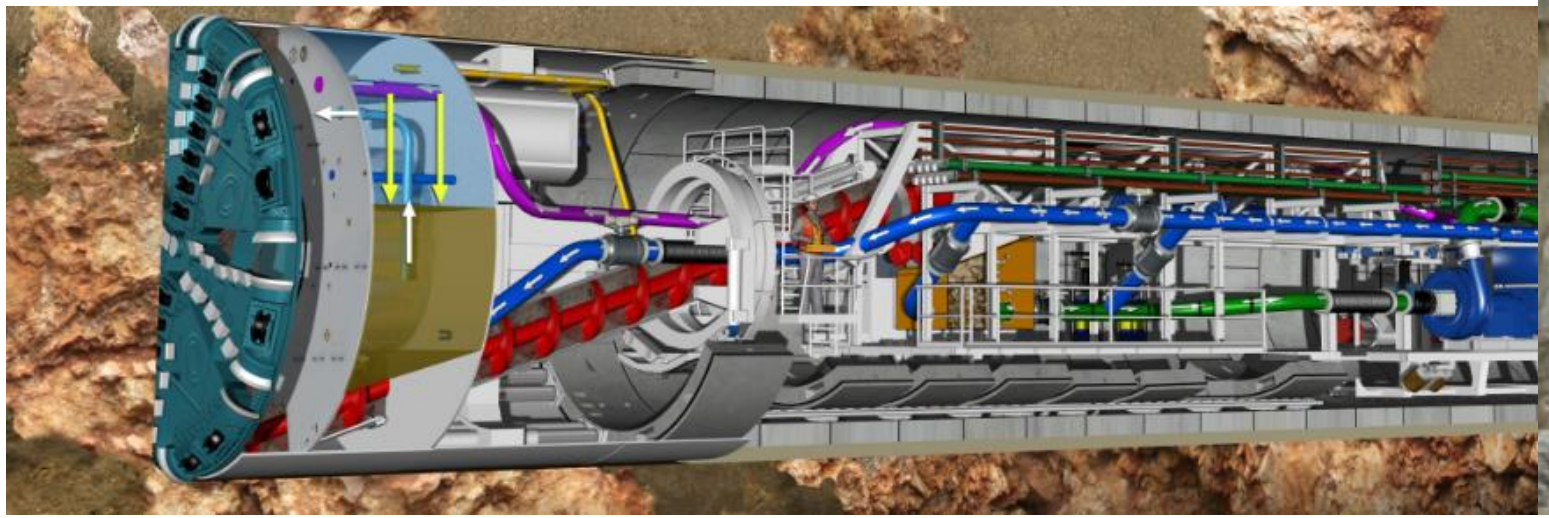
- 1 x VSM12000 for shaft sinking up to 56m deep



A World‘s First in Mechanized Tunnelling.

Variable density technology for Kuala Lumpur.

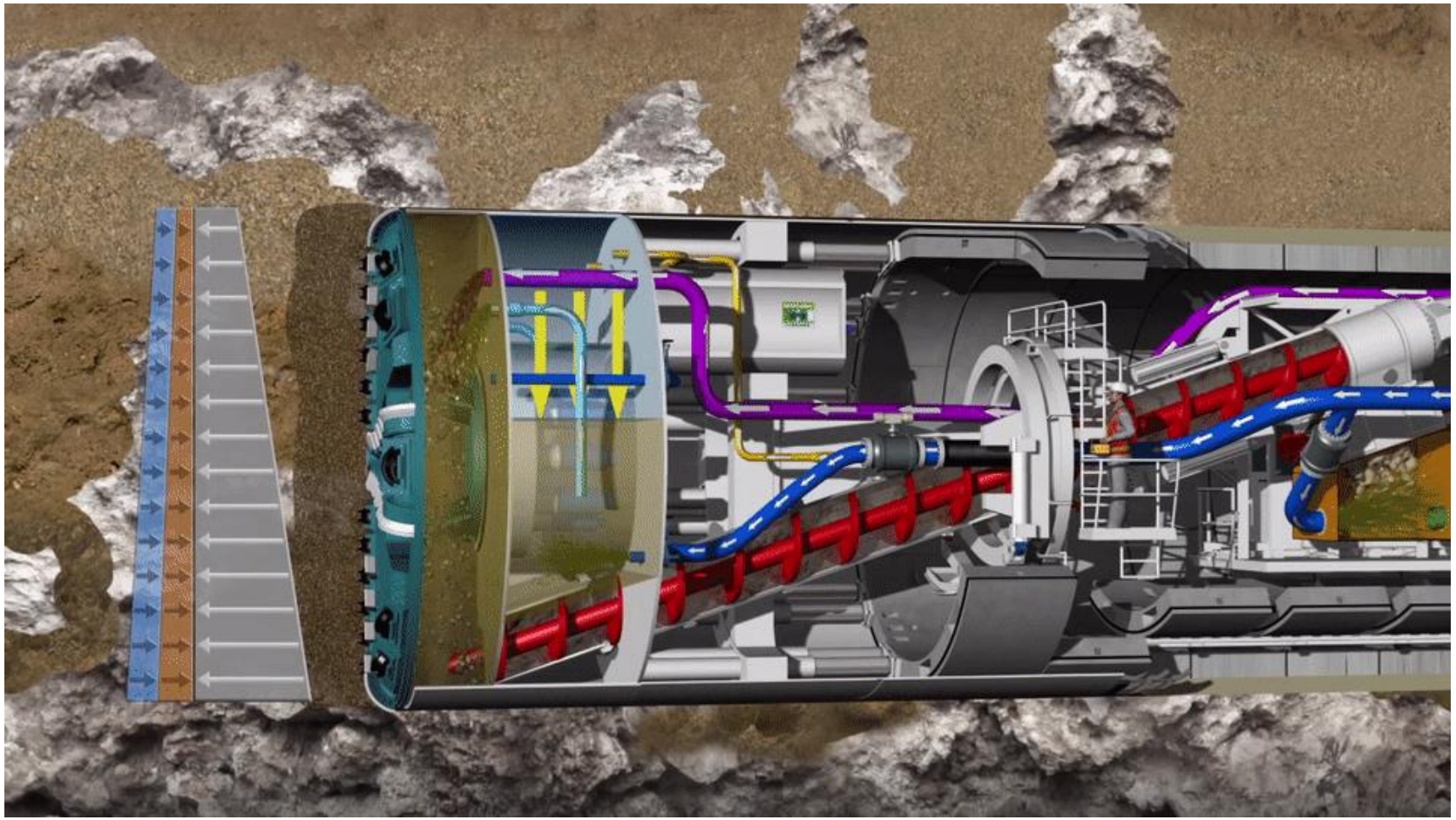
- Klang Valley MRT Project
- 9.8 km tunnel
- 6 x Variable Density TBM, Ø 6,620 mm
- Combination of EPB Shield and Mixshield
- Variation of density of suspension possible



A Machine for (Almost) all subsoils

Variable Density TBM: combination of Mixshield and EPB Shield

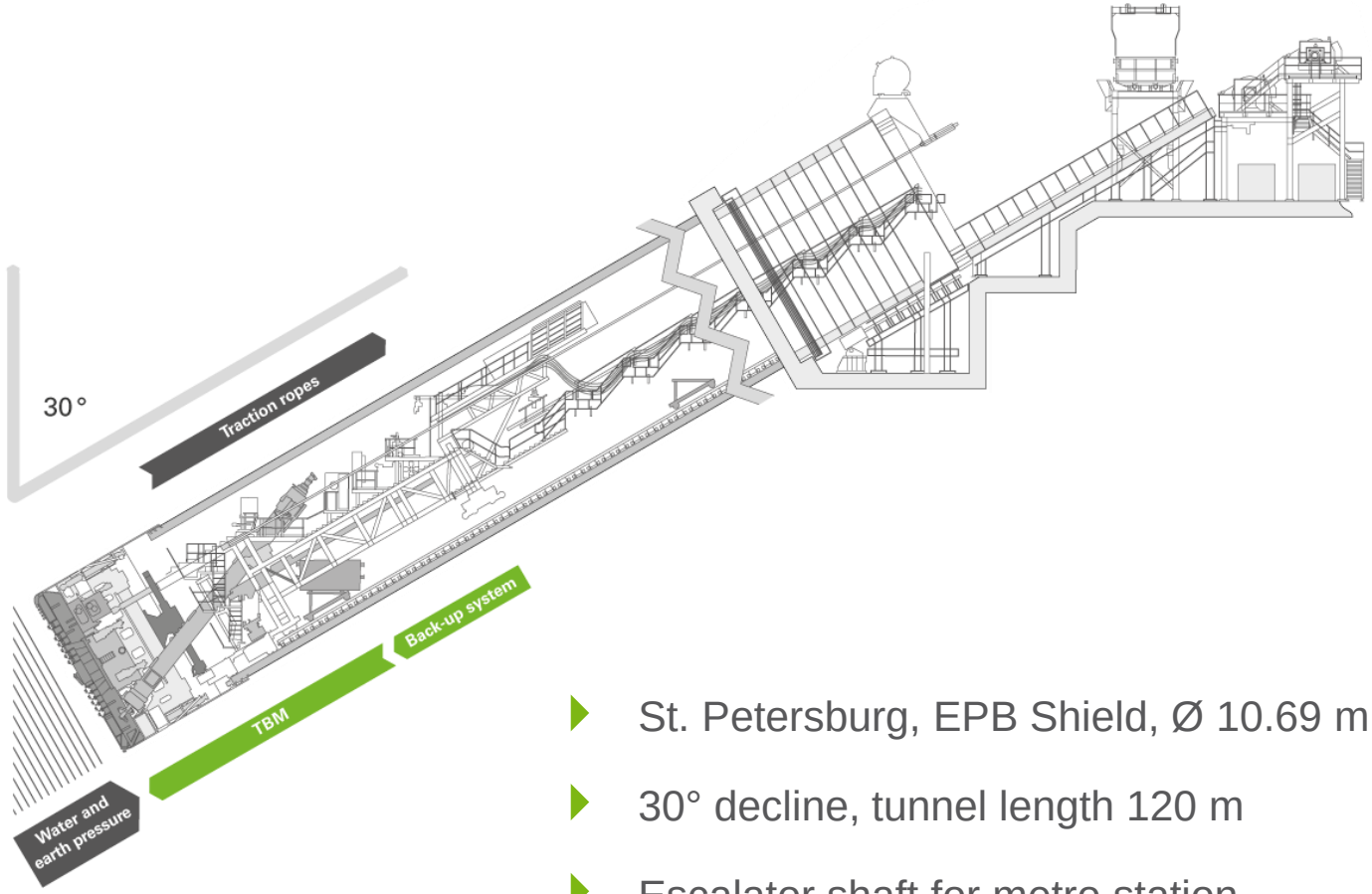
with 4 operation modes



Tailor-Made Solutions for Special Challenges.

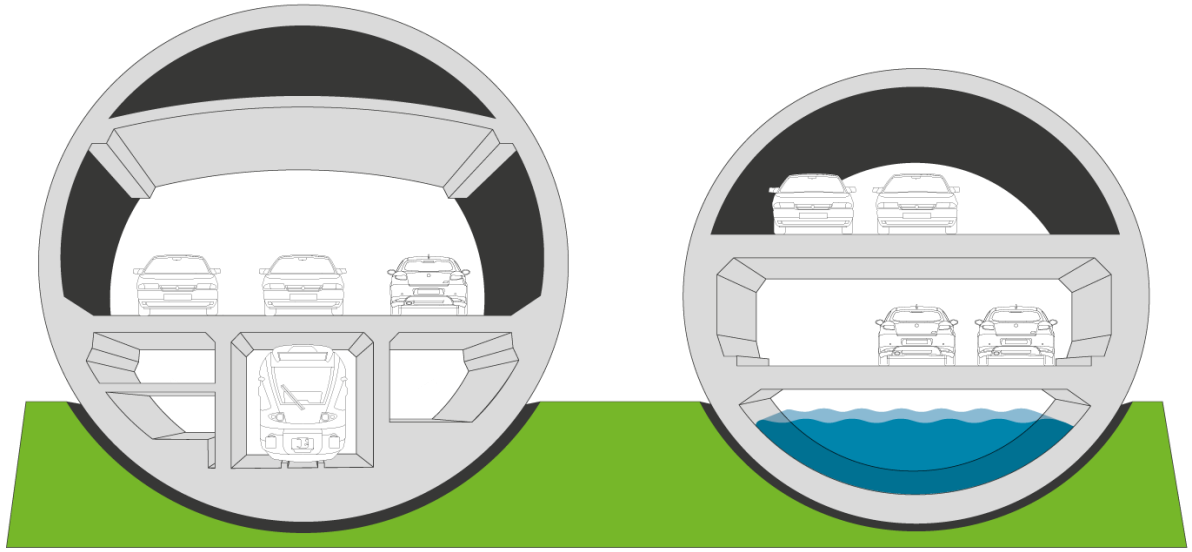
Declined and inclined tunnels.

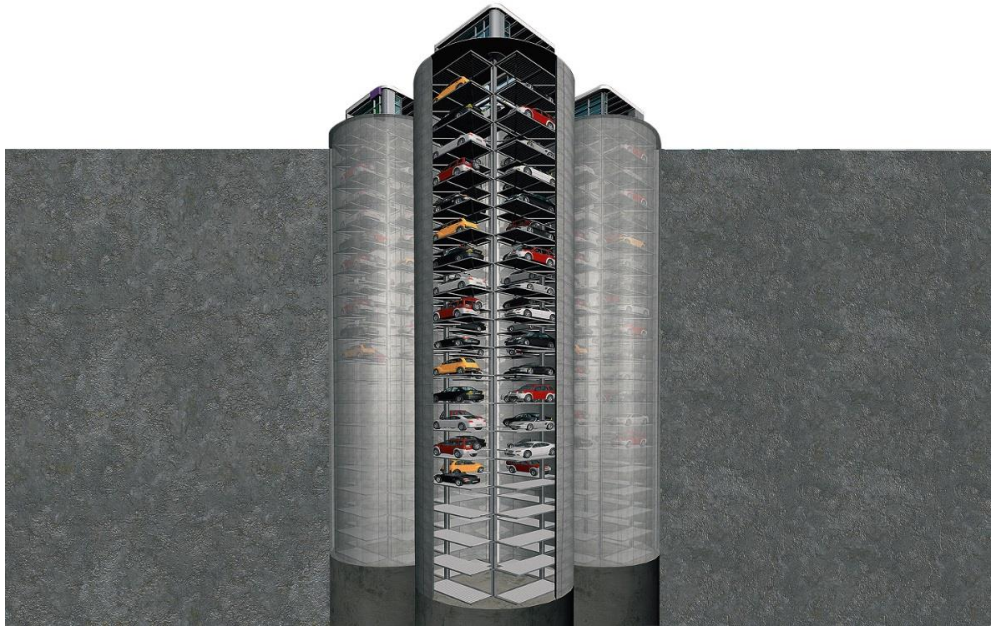
- Limmern, Gripper TBM, Ø 5.20 m
- 40° incline, tunnel length 2 x 1,023 m
- Shafts for pumped-storage power plant



- St. Petersburg, EPB Shield, Ø 10.69 m
- 30° decline, tunnel length 120 m
- Escalator shaft for metro station

INNOVATION AT SPECIFIC APPLICATION FIELDS





- Combined tunnel application with double or multiple use

- Automatised, urban parking solutions to improve the traffic situation
- Construction of the shafts with vertical shaft sinking machine (VSM)

SHAFT SINKING FOR U-PARK®

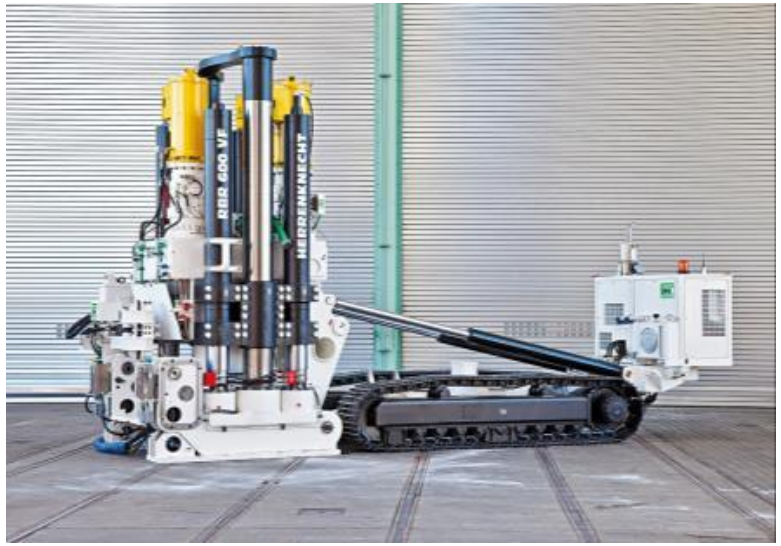
World premiere in Nanjing

- Vertical Shaft Sinking Machine VSM12000 (Ø 12,800mm)
- 2x 66m deep shafts for 100 parking lots on 25 levels each

Raise Boring Rig RBR.

Rapid, systematic and secure shaft construction.

- Precise construction of shafts in rock to 2,000 meters in depth
- High flexibility even under space constraints due to compact design
- Safer, less personnel-intensive and more cost-effective compared to conventional shaft sinking
- Several projects successfully completed



Herrenknecht India Pvt. Ltd.

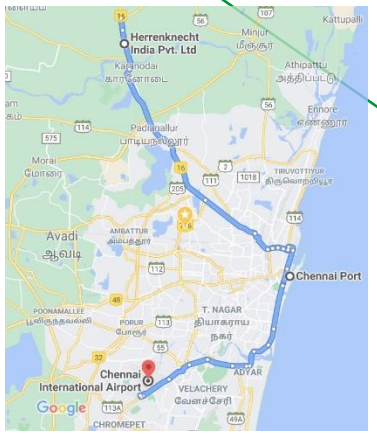
Chennai, Tamilnadu, INDIA

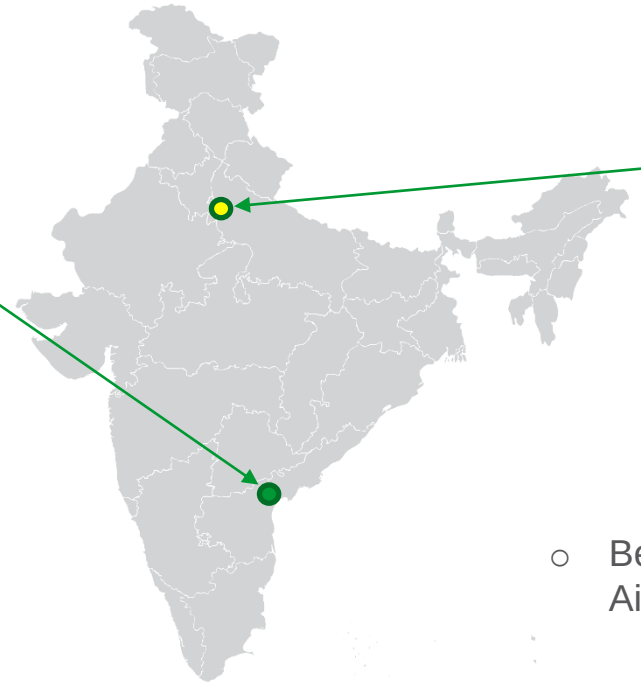
November 22, 2023

Herrenknecht India – Locations

Head Office & Factory

(Chennai)

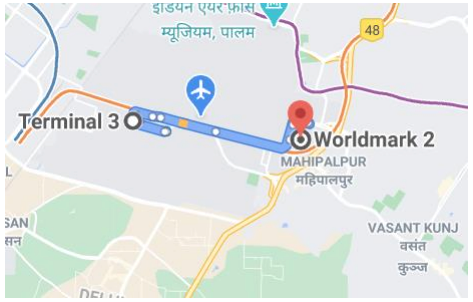




- 35 km from Chennai Port
- 50 km from Chennai International Airport

Sales & Marketing Office

(New Delhi)



- Besides New Delhi International Airport

Herrenknecht India – Head Office & Factory (Chennai)

Established in 2007, Herrenknecht India – the 100 % subsidiary of Herrenknecht AG; dealing in end-to-end mechanized tunnelling solutions, has been playing a key role in the development of urban infrastructure and transportation projects across India.

STRENGTHEN THE LOCAL MANUFACTURING IN INDIA.

To cope with rapid growth of Indian TBM market.

- There is a **rapid growth in infrastructure construction** projects in India
  - Railway, Road, Metro, Hydropower, Water and Sewage
  - 20x Tier 2 & 3 cities are planning to launch rail transit projects
  - 10x High-Speed Corridors in planning
  - Approx. over 100x TBM required for various infrastructure projects in the next 5 years, plus engineering support specialists, spare parts, etc.
- **“Made in India**“ is supported by the government in full force, with some projects specifying local content.
- Herrenknecht AG decides to **strengthen the local manufacturing** of TBM to cope with the growth of the TBM market and government policy. During 2021/2022, Herrenknecht India Pvt. Ltd has expanded its production capacity to **10 TBMs/year**, with enhanced localization.

GREATER THAN 200 km

TUNNELS COMPLETED WITH MORE THAN 75 TBMS

ONGOING PROJECTS

Bangalore Metro Phase - II (2021)
S-1259, S-1260, S-1264, S-839, S-840
OD : 6,600mm 6,640mm
TBM : Mixshield / EPB Shield
Contractor : AFCONS Infrastructure Limited
ITD Cementation India Pvt Ltd

Chennai Metro Phase - II
S-1326A, S-1327A, S-1328A, S-1329A, S-1330A, S-1331A
OD : 6,900 mm
TBM : EPB Shield
Contractor : L&T Constructions
Tata Projects

09 Sleemanabad Irrigation Tunnel (2013)
S-843
OD : 10,080mm
TBM : EPB Shield
Contractor : SEW-Patel JV

10 Tapovan Vishnugad (2018)
S 400
OD : 6,425mm
TBM : Double Shield
Contractor : SELI JV

11 Pakal Dul HPP
S-1293A, S-1294A
OD : 8,330mm
TBM : Double Shield
Contractor : L&T Construction

12 RVNL
S-1309A, S-1310A
OD : 9,050mm
TBM : Single Shield
Contractor : L&T Construction

COMPLETED PROJECTS

1. Delhi Metro(2000-2015)
S-195 , S-197 , S-198, S-417 , S-412, S-445, S-446, S 447, S 448, S 495, S 496, S 557, S 723, S 724, S-780, S-781, S-803, S-804, S-835, S-840, S-883, S-893, S-837
OD : 6,450mm - 6,880mm
TBM : EPB Shields
Contractors : Italian Thai Development PCL ;
FEMO – Pratibha JV
OFC – GIDI JV
Pratibha – CREG JV
Continental Engineering Corporation
Metro Tunnelling Group
Larsen & Toubro
HCC – Samsung JV
Alpine Mayreder – HCC – Samsung JV
HCC
IMCC JV

2. Ahmedabad Metro (2018 - 2019)
S-1134
OD : 6,600mm
TBM : EPB Shield
Contractors : AFCONS

3. Mumbai Metro (2017 - 2020)
S-1073, S-1074, S-1075
OD : 6,600mm
TBM: EPB Shield
Contractor : CEC ITD Cem TPL JV

4. Bangalore Metro Phase- I (2012 - 2015)
S-725, S-726
OD : 6,400mm
TBM : EPB Shield
Contractor : Gammon India Projects

5. Chennai Metro (2011 - 2017)
S-701, S-702, S-703, S-704, S-710, S-711, S-717, S-718
OD : 6,690mm
TBM : EPB Shield
Contractors : Gammon – Mosmatrestroy JV
AFCONS – Transtonnelstroy JV

6. Kolkata Metro (2010 - 2021)
S-615, S-616, S-639, S-640
OD : 6,350mm
TBM : EPB Shields
Contractors : Italian-Thai Development Public Co. Ltd
AFCONS Infrastructure Limited

7. Mumbai Water Supply Stage IV (2012 - 2013)
S 825
OD : 6,230mm
TBM : Gripper TBM
Contractors : SOMA Enterprise Ltd

8. Veligonda Irrigation Project (2008 - 2021)
S- 370
OD : 7800mm
TBM : Double Shield
Contractor : Megha Engineering Ltd

TBM Assembly Workshop

This massive workshop can be used to Rebuild 06 metro-size TBMs simultaneously with a production capacity of 10-12 TBMs annually.

Cutter Disc Production

Our well trained & skilled professionals, strictly maintaining the Herrenknecht standards, carry out complex processes like brazing & welding.

- 14“ ; 17“ ; 19“ ; Narrow disc, pressure compensated disc
- Soft ground Tools
- Cutting knifes & Buckets with tungsten carbide
- Export to different jobsites in Asia

Refurbishment of Used Disc Cutters

- Cost saving only to replace worn-out cutter parts
- Shorter lead time

Warehouse Facilities

For storage of Cutting Tools, Spare Parts & Process Technology Stores.

Domestic Orders manufactured at HAI – EPB Shields, Dia: 6,600 mm

Bangalore Metro Phase II: S-1264

Bangalore Metro Phase II: S-839B & S-840B

1st Make in INDIA TBM (almost 60% local content) – S-1326A

EPB Shields, Dia: 6,600 mm

SUSTAINABILITY IN TUNNELING

HERRENKNECHT ALL AROUND

Tunnelling Solutions & Services.

TBM-STAFF

CUTTER-TOOLS

SITE-SUPPORT

REMANUFACTURING

SPARE- AND
WEAR PARTS

REBUILD optimized our CO_2 – FOOTPRINT

Sustainability

Greenhouse gas declaration of Herrenknecht AG, verified by TÜV SÜD

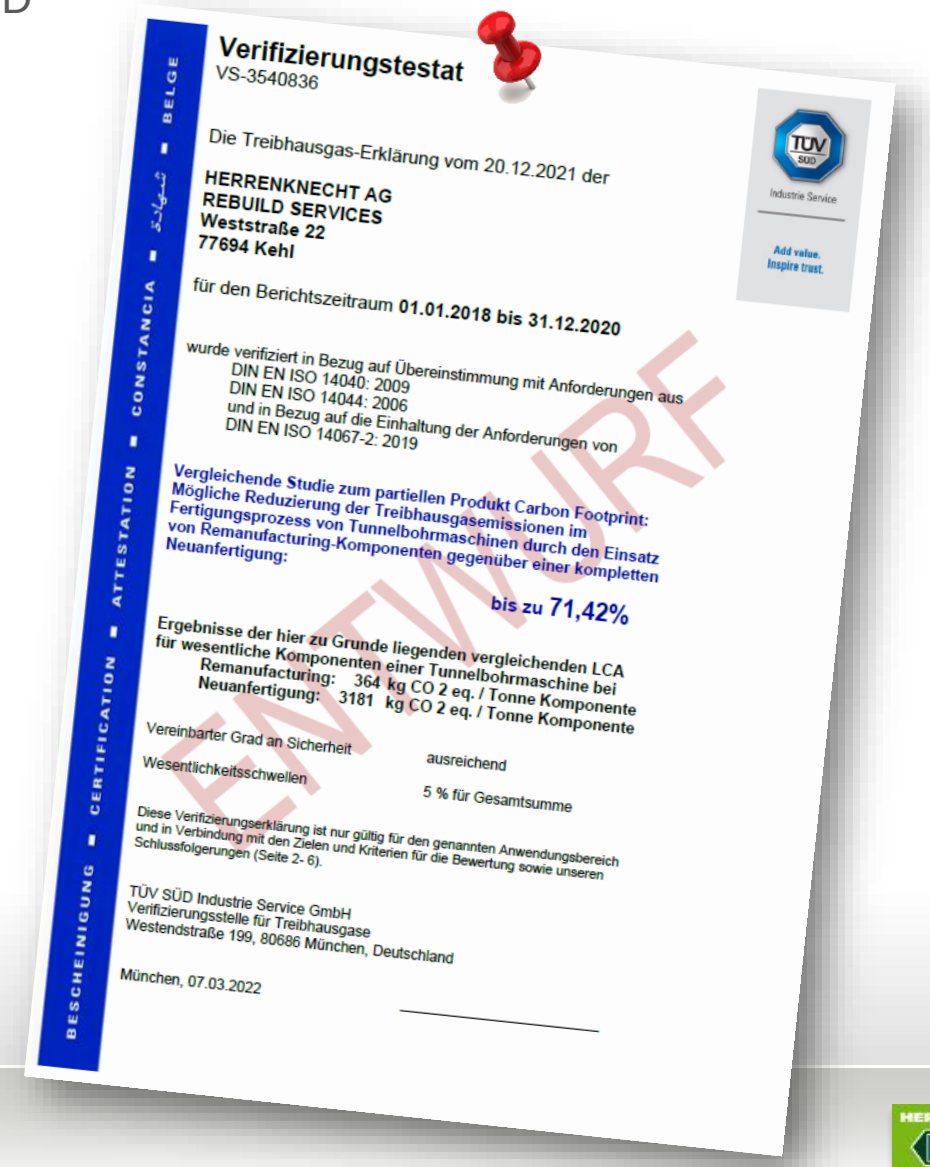
Core statement for the reduction of greenhouse gases through the use of „REMANUFACTURED“ components:

- „On Average, the REMANUFACTURING-Process saves per ton of components

71,42%

of emissions, compared to a new product.

⇨ This corresponds to a saving of 2.937,42 kg CO_2 eq. per ton component



BESCHEINIGUNG ■ CERTIFICATION ■ ATTESTATION ■ CONSTANCIA ■ شهادة ■ BELGE

Verifizierungstestat
VS-3540836

TÜV SÜD Industrie Service
Add value. Inspire trust.

Die Treibhausgas-Erklärung vom 20.12.2021 der

HERRENKNECHT AG
REBUILD SERVICES
Weststraße 22
77694 Kehl

für den Berichtszeitraum **01.01.2018 bis 31.12.2020**

wurde verifiziert in Bezug auf Übereinstimmung mit Anforderungen aus
DIN EN ISO 14040: 2009
DIN EN ISO 14044: 2006
und in Bezug auf die Einhaltung der Anforderungen von
DIN EN ISO 14067-2: 2019

Vergleichende Studie zum partiellen Produkt Carbon Footprint: Mögliche Reduzierung der Treibhausgasemissionen im Fertigungsprozess von Tunnelbohrmaschinen durch den Einsatz von Remanufacturing-Komponenten gegenüber einer kompletten Neuanfertigung:

bis zu 71,42%

Ergebnisse der hier zu Grunde liegenden vergleichenden LCA für wesentliche Komponenten einer Tunnelbohrmaschine bei
Remanufacturing: 364 kg CO 2 eq. / Tonne Komponente
Neuanfertigung: 3181 kg CO 2 eq. / Tonne Komponente

Vereinbarter Grad an Sicherheit — ausreichend
Wesentlichkeitsschwellen — 5 % für Gesamtsumme

Diese Verifizierungserklärung ist nur gültig für den genannten Anwendungsbereich und in Verbindung mit den Zielen und Kriterien für die Bewertung sowie unseren Schlussfolgerungen (Seite 2- 6).

TÜV SÜD Industrie Service GmbH
Verifizierungsstelle für Treibhausgase
Westendstraße 199, 80686 München, Deutschland

München, 07.03.2022

ENTWURF

- **Reference: MASTER-These - Remanufacturing as a part of circular economy| 07/2021**

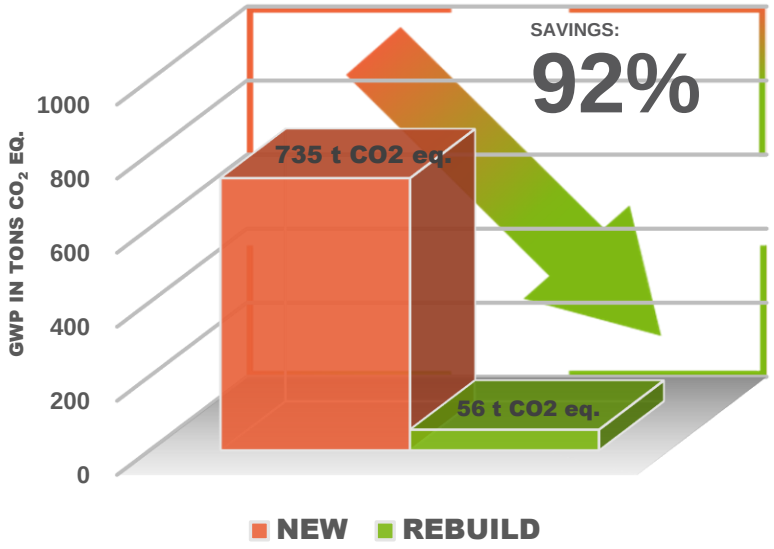
Comparative life cycle assessment (LCA / GWP) between remanufacturing and new production of 132 main components of a TBM

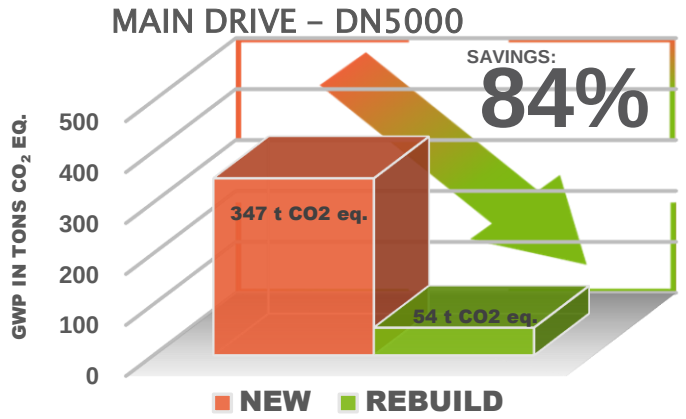
HERRENKNECHT | CO2 FOOTPRINT

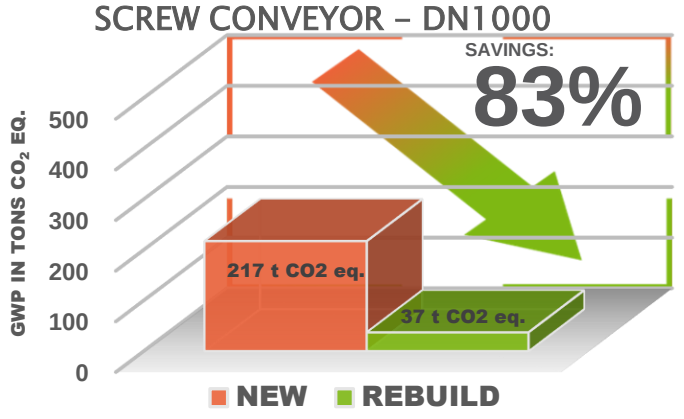
Sustainability

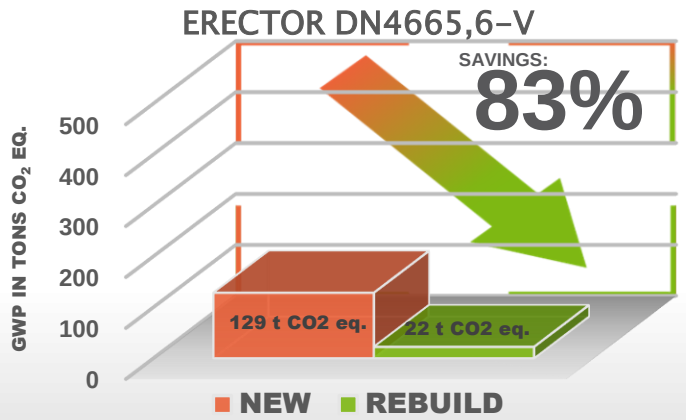
Reduction of greenhouse gases by using „REMANUFACTURED“ components

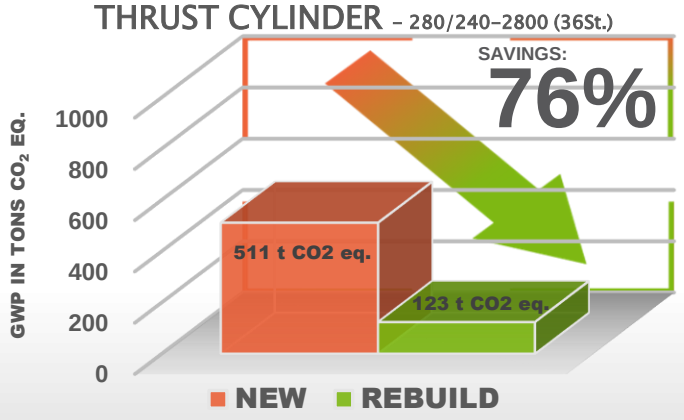
› Core assemblies of a ø9830mm EPB-TBM









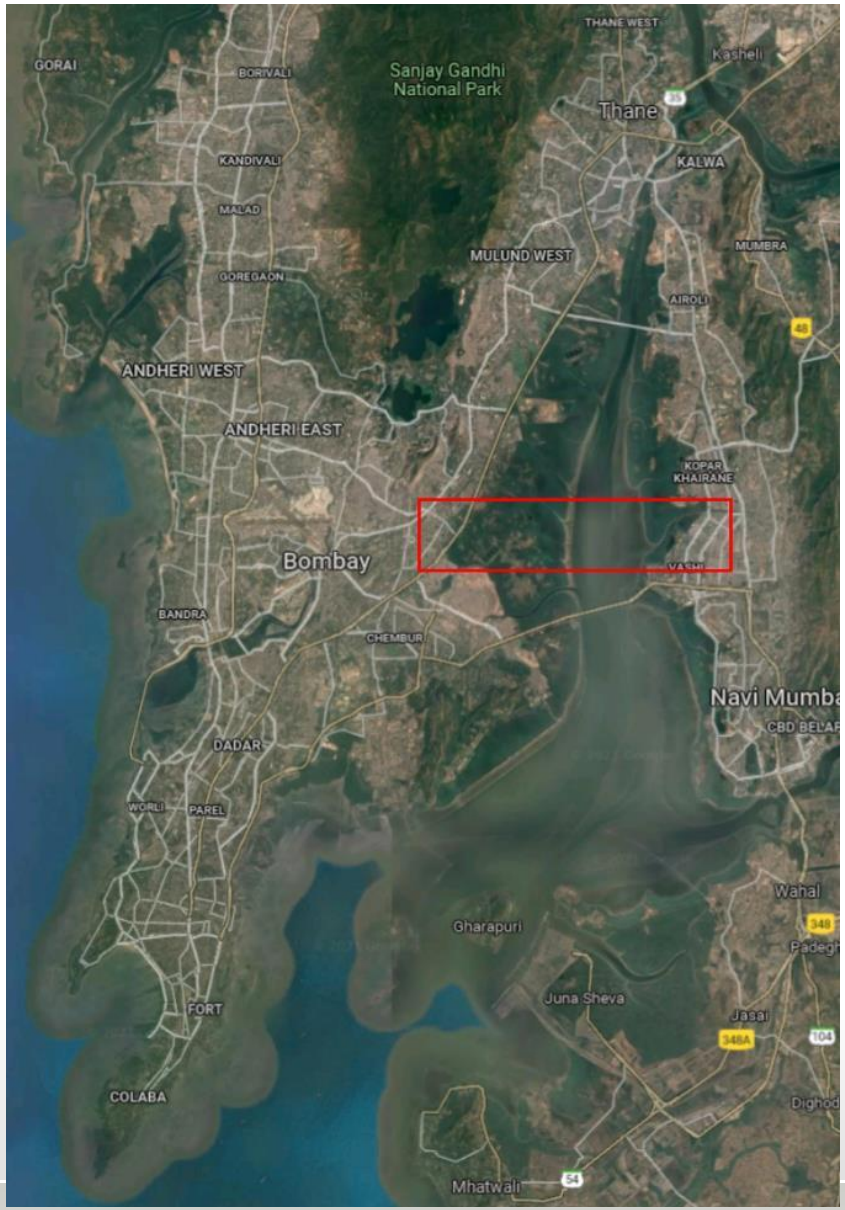


Global **W**arming **P**otential

ON GOING PROJECTS

HSR | C-2 Package

- **Project Owner**
  - NATIONAL HIGH SPEED RAIL CORPORATION LIMITED
- **Location**
  - Bandra Kurla Complex, Mumbai, India
- **Tender Scope**
  - TBM tunnel, total 15.42 km, 3 x TBM's
  - NATM tunnel, total 4.96 km
  - Shafts 2 & 3, Main Tunnel Portal, Adit Portal and Equipment Rooms
- **Segmental Lining**
  - 12,100 ID x 13,100 OD x 2,000 mm long
  - 9 + 1 configuration

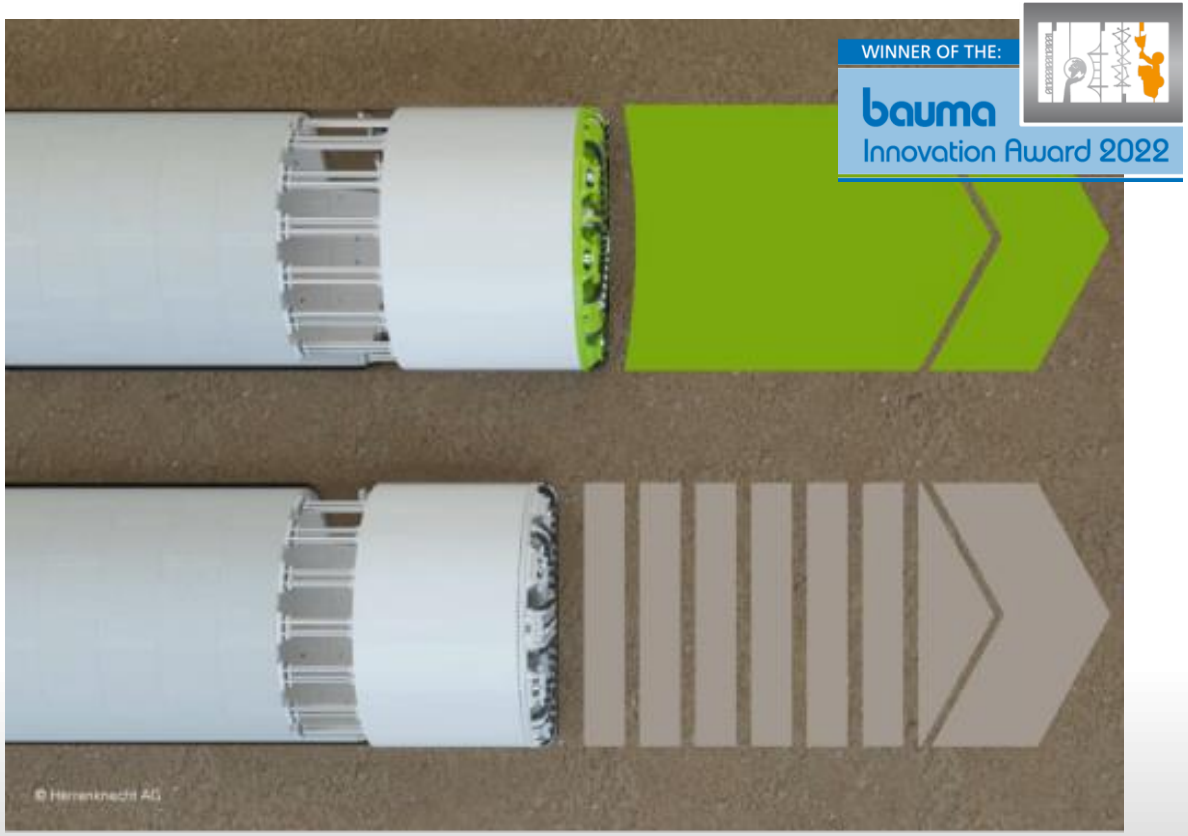


INNOVARTIVE CONCEPTS IN PREMIERE USE

HIGH SPEED 2.

› Automation through robotics

› New continuous advance concept



Rishikesh Karnprayag Rail Link

2022-Today

- 2x SSH TBM’s (S-1309A & S-1310A) Completed SAT and started initial drive after driving thro cavern
- Group Brand Orders:
  - 4x MSV’s (TMS)
  - 11km Conveying System (H+E)
  - Grout Plant (HAG)

TBM Tunneling Progress in RVNL Rishikesh TBM 1 & TBM 2

Overview

> Performance-Dashboard

Status

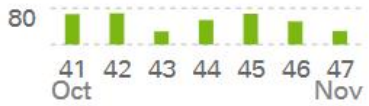
No production an hour

Progress

Advances: 1548; 2628.9 m of 10317 m: 25%

Advances per day

Advances per week (ISO 8601



Advances per month

Map

> Detailed map

Overview

> Performance-Dashboard

Status

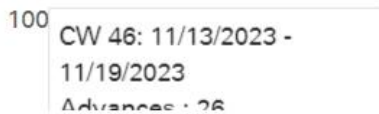
No production 3 hours

Progress

Advances: 2032; 3445.9 m of 10490 m: 33%

Advances per day

Advances per week (ISO 8601



Advances per month

Map

> Detailed map

Delhi METRO
22 PROJECTS
89 KILOMETERS

Delhi METRO 1, 2, 3 & 4

2002-Present

- The first successful tunnel drives on the Indian subcontinent by Herrenknecht EPB Shields started 2002.
- Total supply of 39 Nos Herrenknecht TBM's to DMRC
- 4xEPB's are being Re-built for Phase 4 (S-710C, S-1134D, S-711C & S-1264C). FAT of S-710C completed in Feb'23

Bangalore Metro Phase I & II

2017-Today

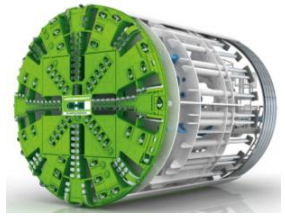
- In the Phase 2: 2x Mix-Shield and 3x EPBs are mining tunnels in Bengaluru starting March 2021.
- Out of 5xTBM's, 3xEPB's are rebuilt in India
- Present Status:
  - 1xEPB completed tunneling
  - 2xEPB's Completed 35%
  - 2x Mix-Shields Completed 55% & 65%

Pakal Dul HEP

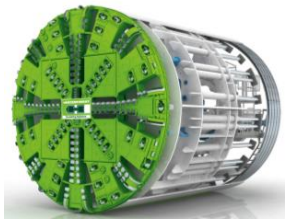
2022-Today

- 2x DSH TBM’s (S-1293 & S-1294) Completed commissioning
- RTB’s planned during CW8 & CW12 2023 respectively.
- Group Brand Orders:
  - 4x MSV (TMS)
  - 7.5 km Conveying System (H+E)

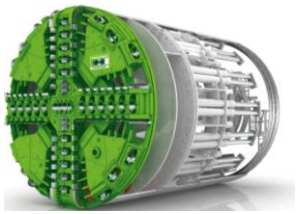
Large Projects Dia in India_ 2023-25



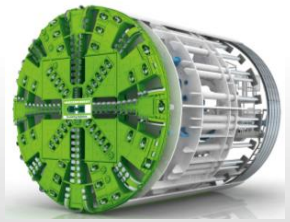
Mumbai Ahmedabad High Speed Rail, Package- C2, **Mumbai**, India, 3 x Mix shield



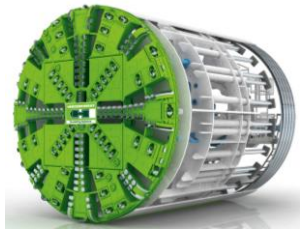
Thane-Borivali Tunnels (Package 1 & 2), **Mumbai**, India, 4x SS



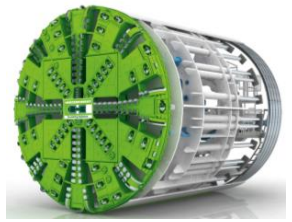
Goregaon Mulund Link Road, **Mumbai,** India, 2x EPB



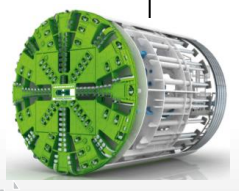
Coastal Freeway Tunnel, **Mumbai,** India, 2 TBM‘s



Versova-Dahisar Link Road, **Mumbai,** India, 2x TBM‘s



Dwarka Expressway Tunnel, New **Delhi,** India, 2x TBM‘s

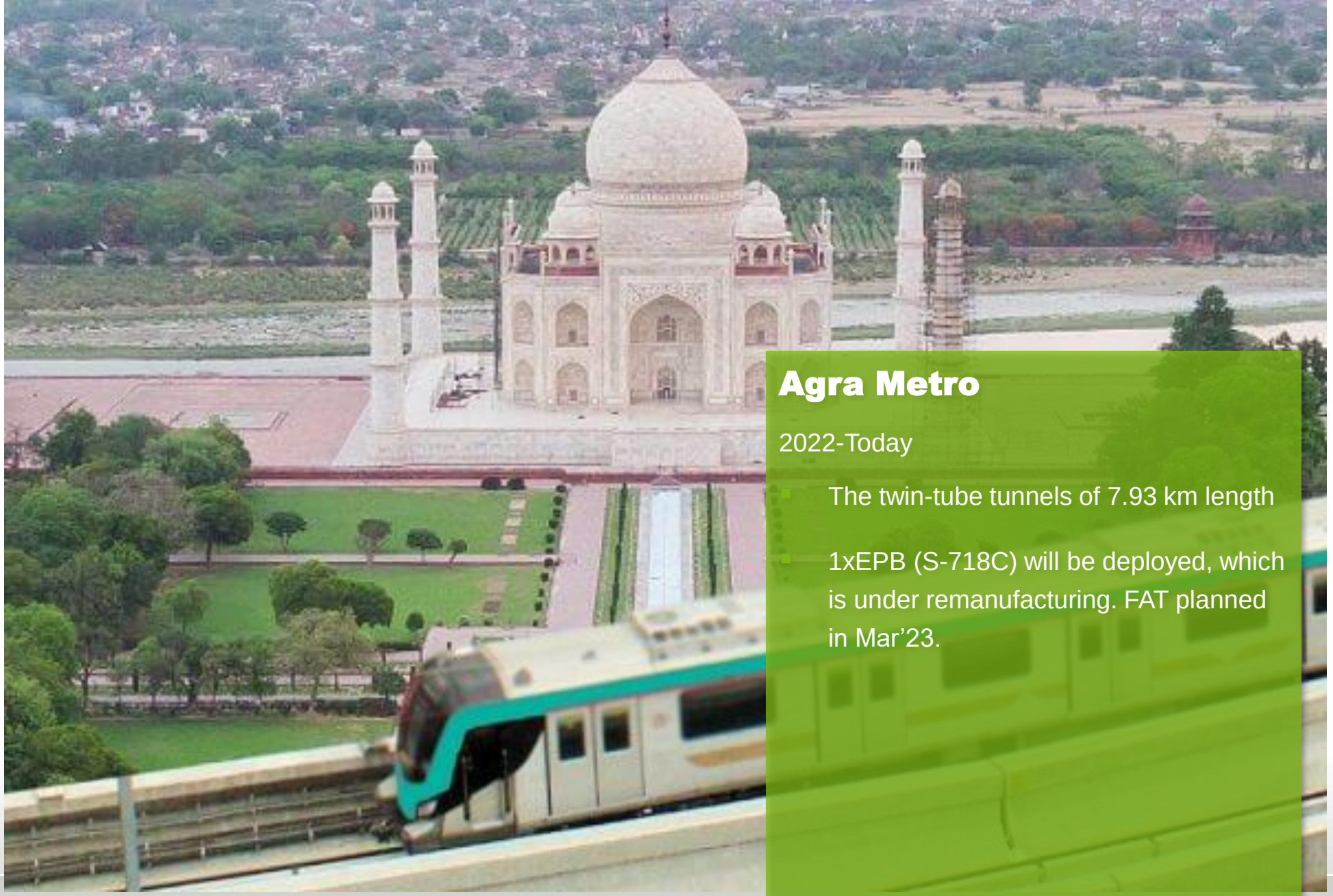


Silghat-Jumugurihat Brahmaputra Tunnels, Assam, India, 3 x TBM‘s

Chennai Metro Ph-I & Ph-II (C3 & C4)

2012-Today

- 100% UG works of Ph-I completed by 7x HK TBM's
- Ph-II Status:
  - C3: All 6xEPB's (S-1326, S-1327 S-1328, S-1329, S1330 & S1331) supplied out of HAI.
  - C4: 3xEPB's (S-1073B, S-1074B & S-1075B) from Mumbai metro Line 3 are being re-built in HAI & an additional EPB (S1352A) being imported. FAT of S-1073B completed & balance planned between Feb – Apr'23.



Agra Metro

2022-Today

- The twin-tube tunnels of 7.93 km length
- 1xEPB (S-718C) will be deployed, which is under remanufacturing. FAT planned in Mar’23.

Pula Subbaiah Veligonda project

- This Project comprises of Nallamala Sagar Reservoir which is being formed by constructing Dams across the three gaps namely Sunkesula, Gottipadia and Kakarla. It envisages to draw 43.50 TMC flood water of Krishna River from the foreshore of Srisailam Project Reservoir through Kollam Vagu (Upstream of Srisailam Reservoir) by twin Tunnels by gravity and thereafter, to impound in Nallamala Sagar Reservoir through a Feeder Canal.
- A large Herrenknecht Hard Rock Double Shield TBM (S-370) was deployed on this project near Kurnool which reached final breakthrough, marking near completion of Tunnel -I.

Application	Water
Geology	Rock Quartzite, slate, phyllite
Tunnelling length	18,000 m
Machine Data	1x Double Shield TBM Diameter: 7,900 mm Lining method: Segmental lining Cutterhead power: 2,800 kW Torque: 5,879 kNm

Sleemanabad Carrier Canal Tunnel Project

This Canal is part of the larger Bargi Diversion Project. It is an inter – Basin Project which will carry Narmada waters to Rewa and Satna district after crossing high ridges of Son-Tones Basin.

- The project constitutes construction of lined Tunnel (about 12 Km in length, about 10 m diameter) near Jabalpur district, Madhya Pradesh.
- Highly variable and quickly changing ground conditions were encountered due to which TBM parameters had to be optimized regularly.

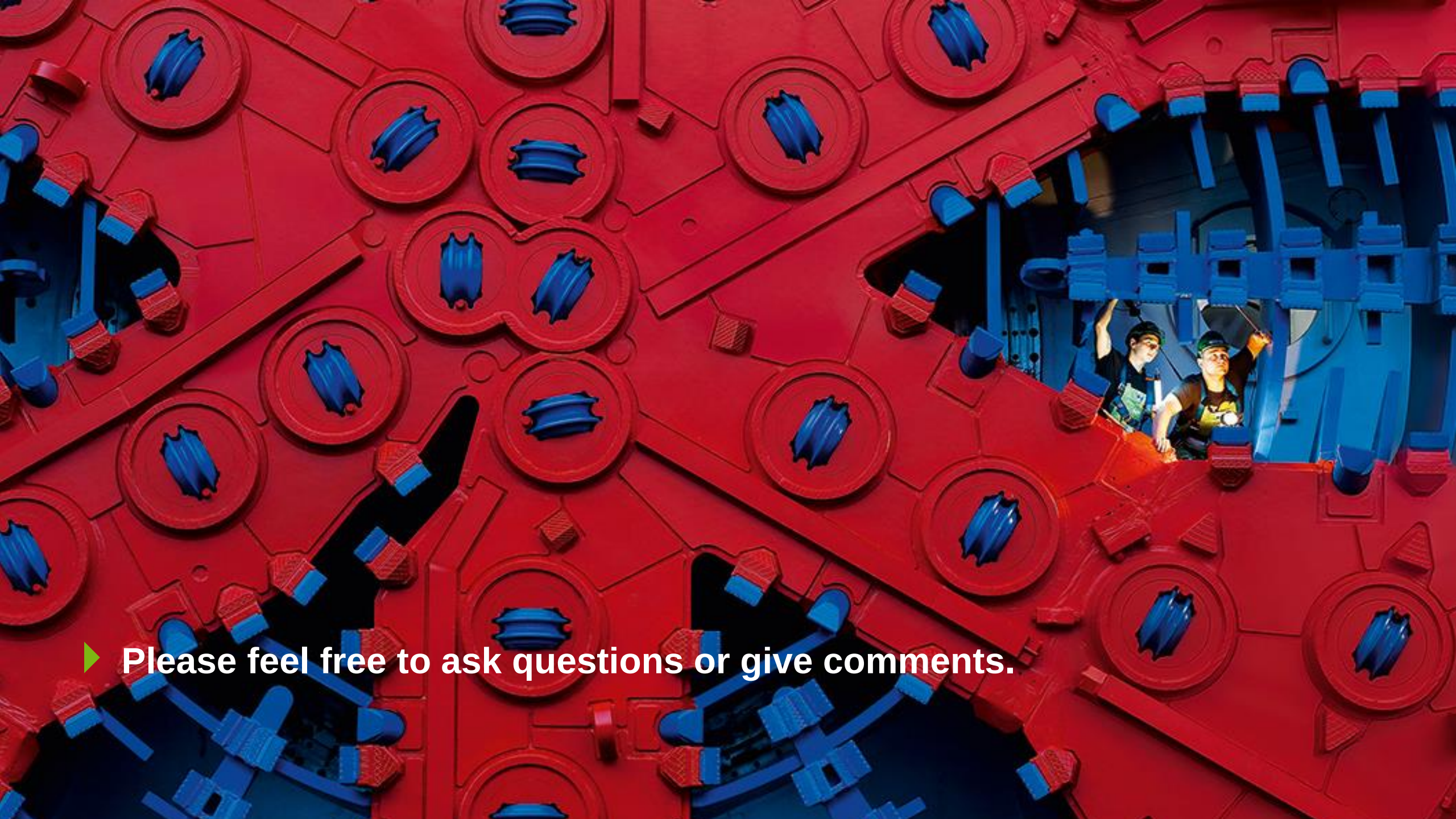
Application	Water
Geology	Rock and Marble interspersed with clay and gravel
Tunnelling length	6,251.2 m
Machine Data	1x EPB Shield TBM Diameter: 10,140 mm Lining method: Segmental lining Cutterhead power: 5,800 kW Torque: 22,616 kNm

VISIT US IN SCHWANAU

PIONEERING UNDERGROUND TECHNOLOGIES

HERRENKNECHT
Tunnelling Systems

Thank You



- Please feel free to ask questions or give comments.