



**New developments and applications of Direct Pipe® & E-Power Pipe®.**

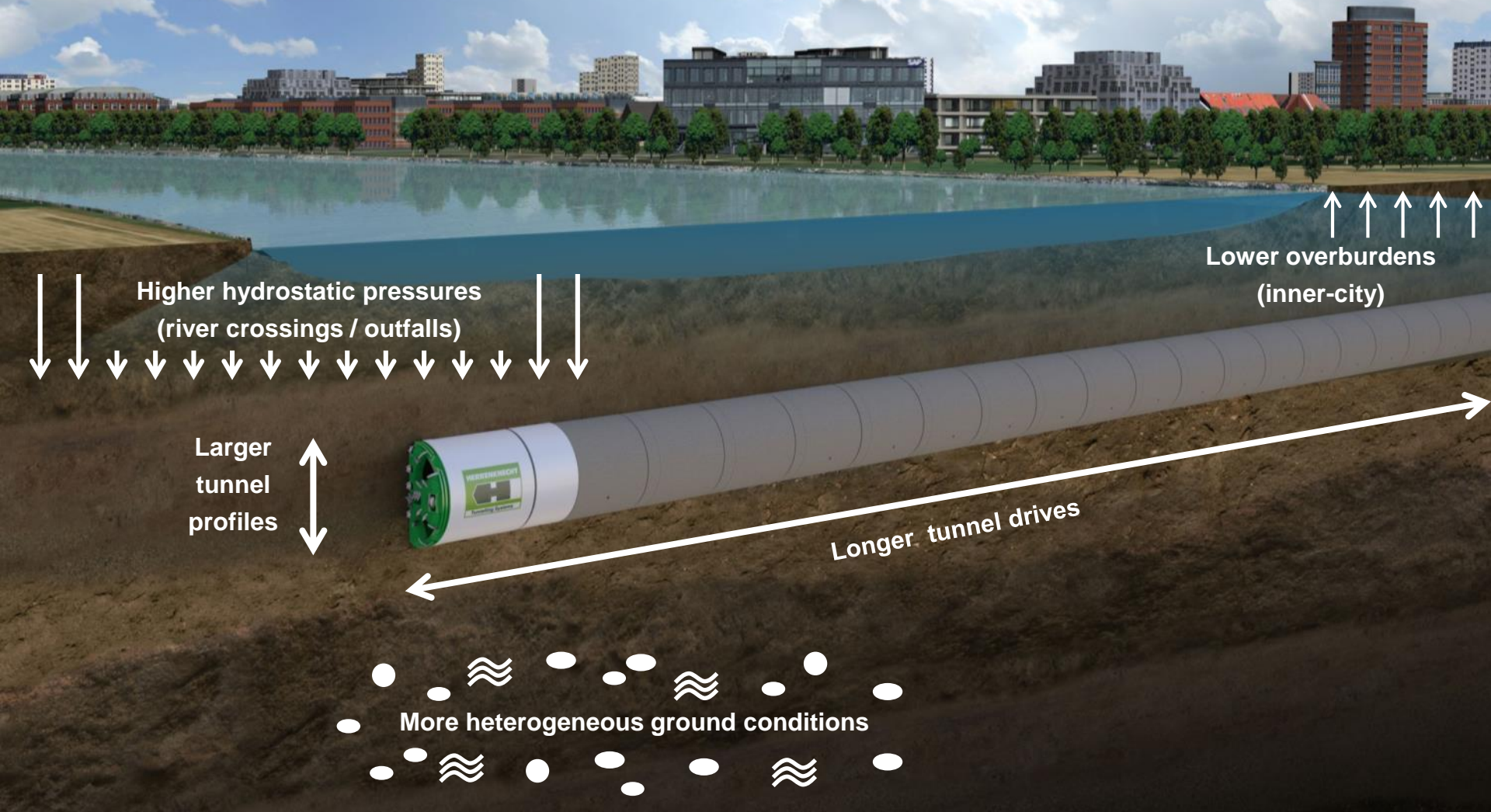
**No-dig infra yearly gathering, Thursday 28th of March 2019**

NoDig Infra Konference og Årsmøde 2019 Gl. Avernæs, Sydfyn

Lutz zur Linde



# Trends in Pipe Jacking.

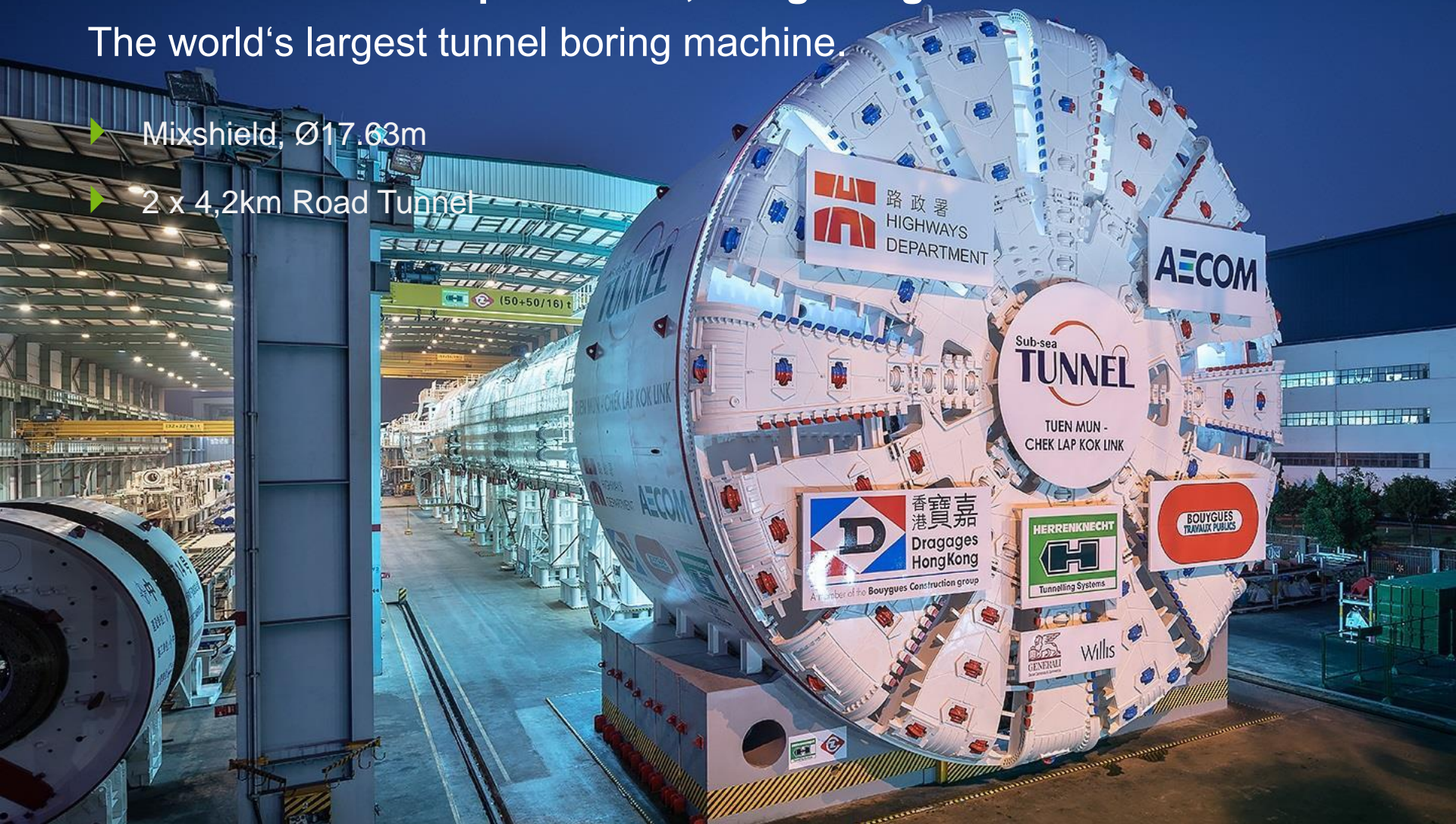




# Tuen Mun – Chek Lap Kok Link, Hong Kong.

The world's largest tunnel boring machine.

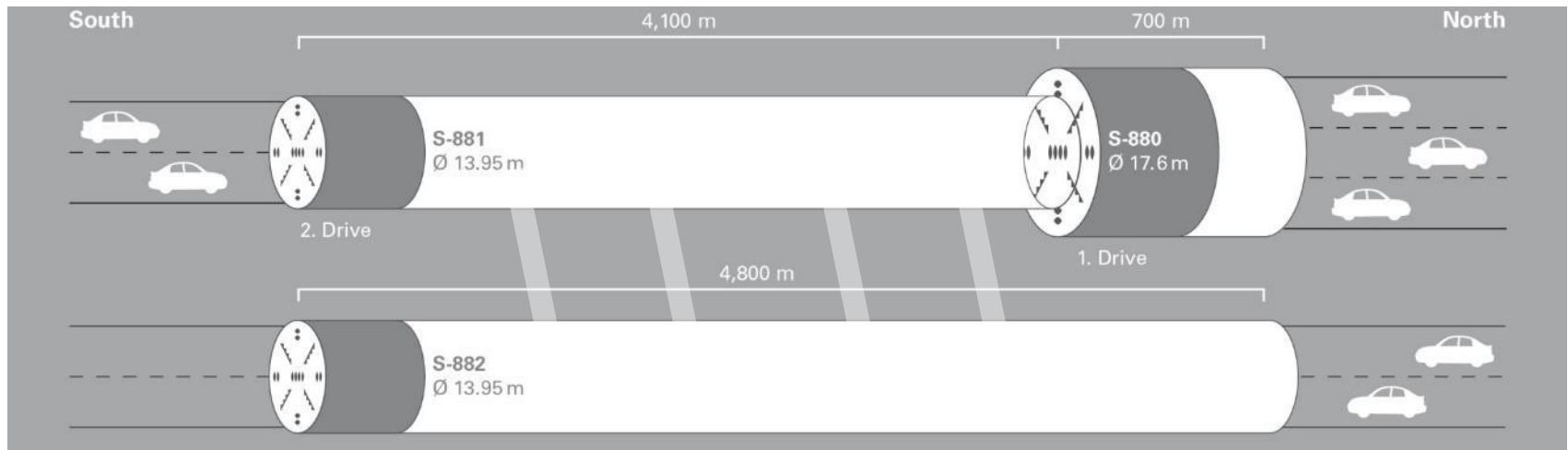
- ▶ Mixshield, Ø17.63m
- ▶ 2 x 4.2km Road Tunnel



# Tuen Mun - Chek Lap Kok Link.

## Herrenknecht technology involved.

- ▶ **2 road tunnels** (Traffic Tunnelling)
  - ▶ **3 x Mixshields** supplied by Herrenknecht
    - ▶ S-880 Ø 17.6m, world's largest TBM
    - ▶ S-881 Ø 14m
    - ▶ S-882 Ø 14m
- ▶ **46 cross passages** built by Mini-TBM
  - ▶ **2 x AVN 3000** with special equipment



**Herrenknecht. Pioneering Underground Technologies**



Dragages - Bouygues Joint Venture 寶嘉 - 布依格聯營

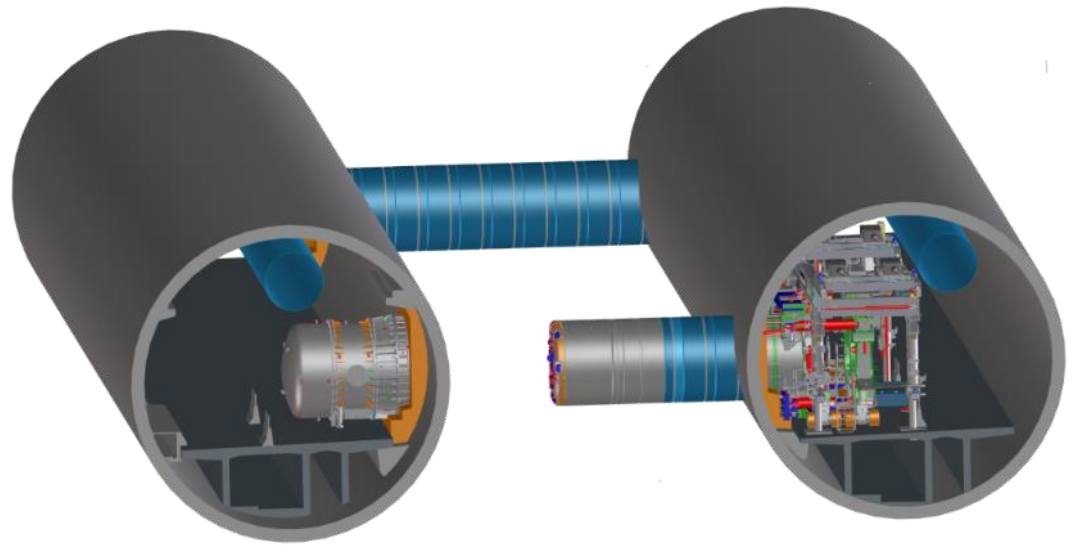




# Tuen Mun - Chek Lap Kok Link.

## Cross passage technology.

- ▶ M-2001M + M-2003M, 2 x AVN 3000, OD 3605
- ▶ 46 Cross passages built by Mini-TBM
- ▶ Length of cross passages: up to 13m
- ▶ Max. confinement pressure: **5,5 bar**
- ▶ Geology: sand, silt, clay, gravel, granite



Herrenknecht. Pioneering Underground Technologies



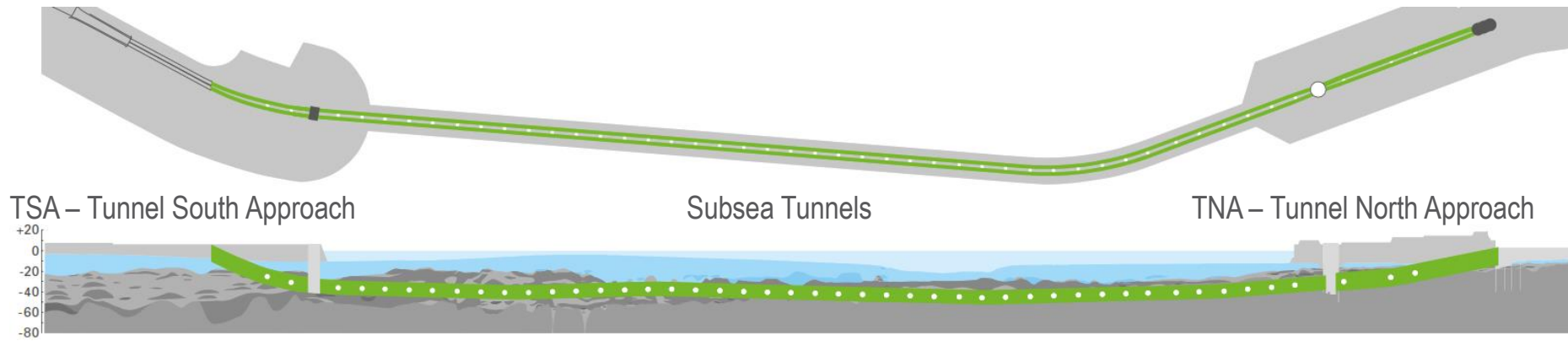
Dragages - Bouygues Joint Venture 寶嘉 - 布依格聯營



# Tuen Mun - Chek Lap Kok Link.

Cross passage technology.

- ▶ **46 CPs finished** by Mini-TBM
- ▶ **Performance: Ø 20 days per CP**
  - ▶ Advance cycle: including assembly, advance, disassembly and transport in tunnel



Herrenknecht. Pioneering Underground Technologies



Dragages - Bouygues Joint Venture 寶嘉 - 布依格聯營



# Curved Pipe Jacking.

## Rainwater collector.

- ▶ M-1909M, AVN2000, OD2425
- ▶ Location: Livry-Gargan, France
- ▶ Bassin du Rouailler - Rainwater collector
- ▶ Drive length: 412m
- ▶ **Curve drive: radius = 110m**
- ▶ Total tunnel length: 620m
- ▶ Geology: clay
- ▶ Contractor: Bessac, Sade





# Inclined Pipe Jacking.

Uphill pipe jacked sewage tunnel Bad Liebenzell, Germany.

- ▶ M-576M, AVN1200, OD1505.
- ▶ Tunnel length: 126m
- ▶ **Slope: up to 52%**
- ▶ Geology: cohesive ground, boulders, claystone, sandstone, quartzite





# Long-distance Pipe Jacking.

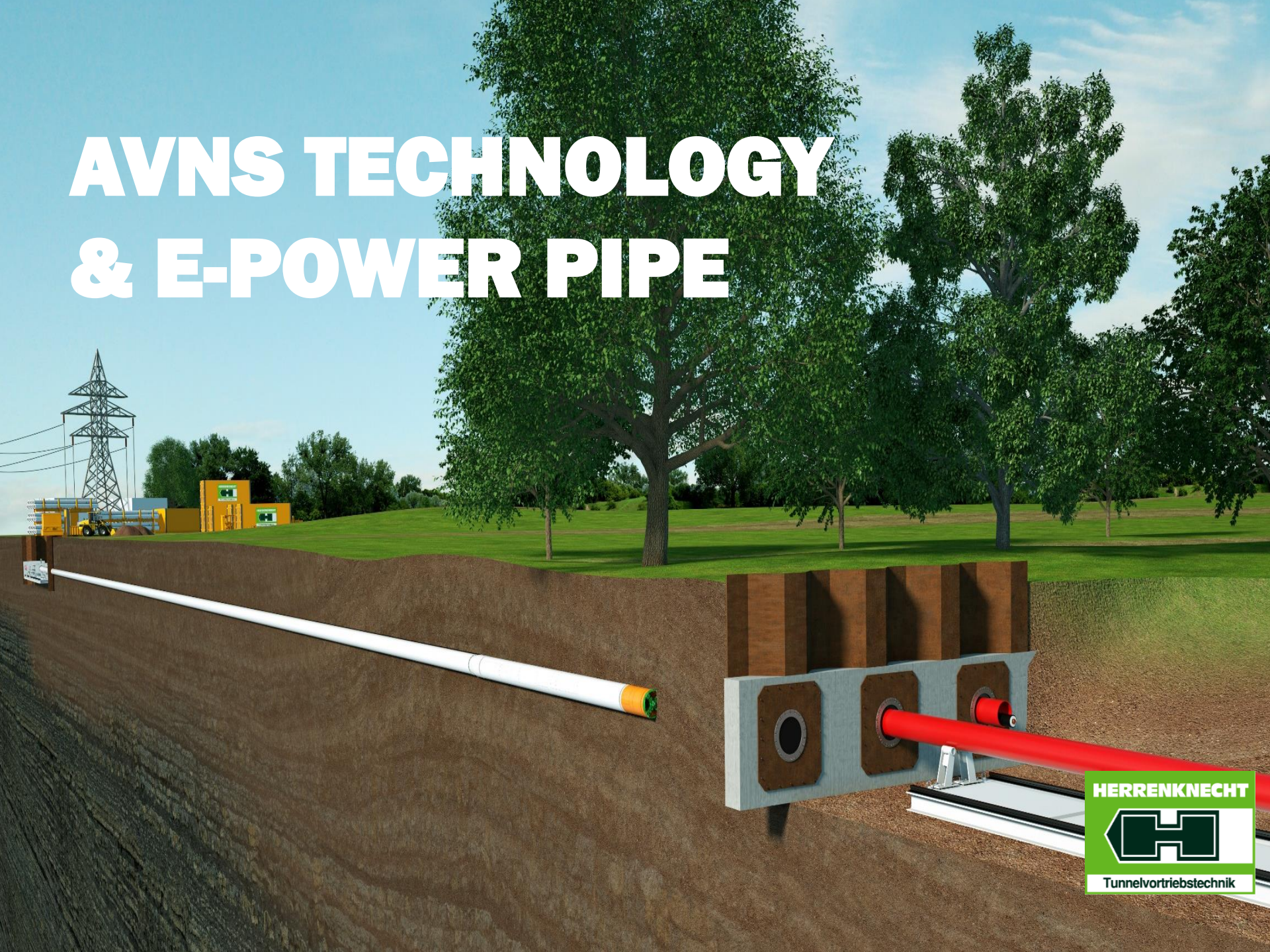
## Altamira Landfall, Sur de Texas – Tuxpan Pipeline.

- ▶ M-1275M, AVND2000, OD3200 (Pipe ID 2600)
- ▶ Location: Altamira, Mexico
- ▶ Tunnel length: **2,246m Sea Outfall**
- ▶ Geology: sand, silt, clay
- ▶ Best daily performance: 25.5 m





# AVNS TECHNOLOGY & E-POWER PIPE



**HERRENKNECHT**



Tunnelvortriebstechnik



# Long-distance Pipe Jacking for small diameters.

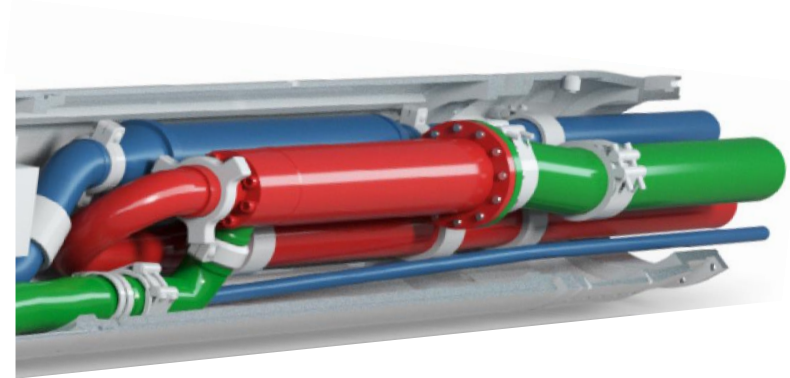
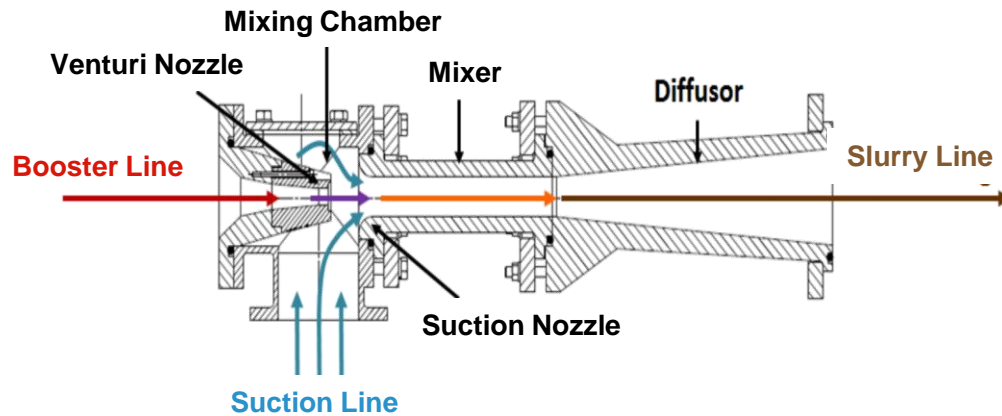
**EPOWER PIPE**

- ▶ Development of **AVNS** microtunnelling machine (for ID 400 – 1200)
- ▶ **Drive length: 1,000m – 1,500m**
- ▶ Special requirement for **underground cable installation**
  - ▶ Depth/ low coverage: 1,5m to 4m, constant
  - ▶ High precision: constant distance between lines 1m – 2m



# Direct Pipe®. Small Diameter Trenchless Technology.

## Newly-developed Jet Pump.



**Booster Line – High Pressure**

**Booster Line – High Flow Speed**

**Suction Side – Low Pressure**

**Mixing of Boost Flow & Suction Stream**

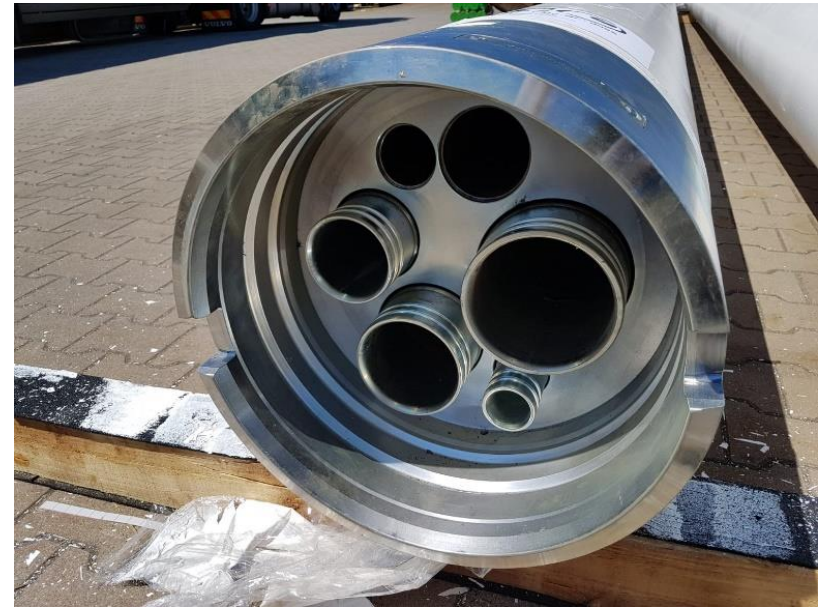
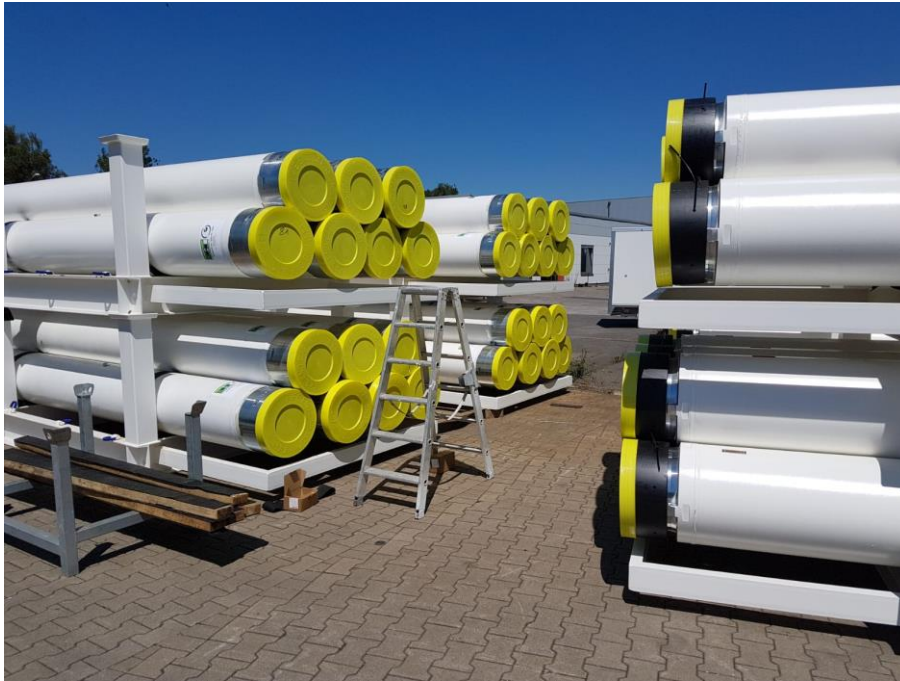
**Build-Up of Slurry Pressure**





**Underground cable construction.**  
Steel jacking pipes & coupling system.

**EPOWER PIPE**



E-Power Pipe®

**Animation.**

**EPOWER PIPE**



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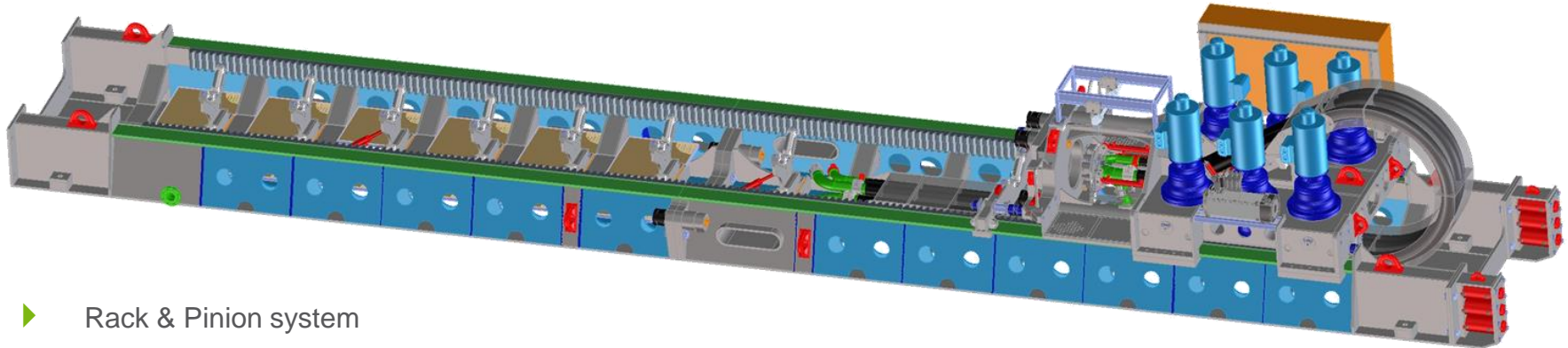
Herrenknecht. Pioneering Underground Technologies





## Underground cable construction. New E-PowerPipe® push & pull unit.

**EPOWER PIPE**



- ▶ Rack & Pinion system
- ▶ 6 electric drives, total. 66KW
- ▶ High performance in both directions: max. 5m/min
- ▶ Max. thrust & pull force: 340to

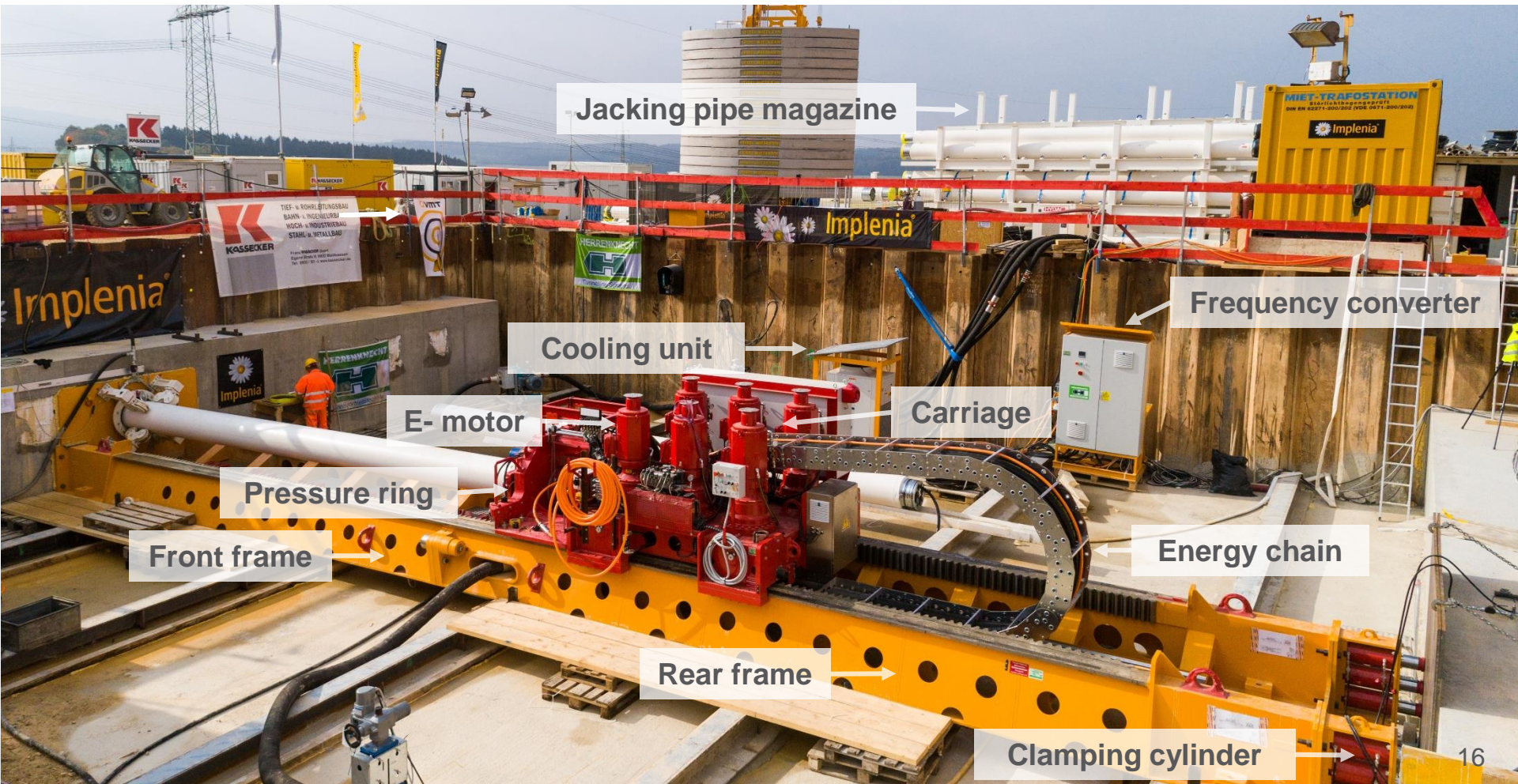
### Advantages:

- ▶ All couplings of lines and cables in one process step
  - ▶ Combination of **new push & pull unit and new steel pipes:**  
**Reduction coupling times 30min >>> 5 -10min !!!**



# E-Power Pipe®

## Rack and pinion jacking frame: Main parts





## Amprion Project in Bacharach: Key facts

- 





# E-Power Pipe®

## Project in Bacharach: Achievements

### Best daily performance m/day

[Pilot Bore]

144

127

108

Bore 1

Bore 2

Bore 3

### Average advance rate mm/min

[Pilot Bore]

175

151

95

Bore 1

Bore 2

Bore 3

### Days per drive

[in total: Pilot Bore and pull-in of casing]

37

12

17

Bore 1

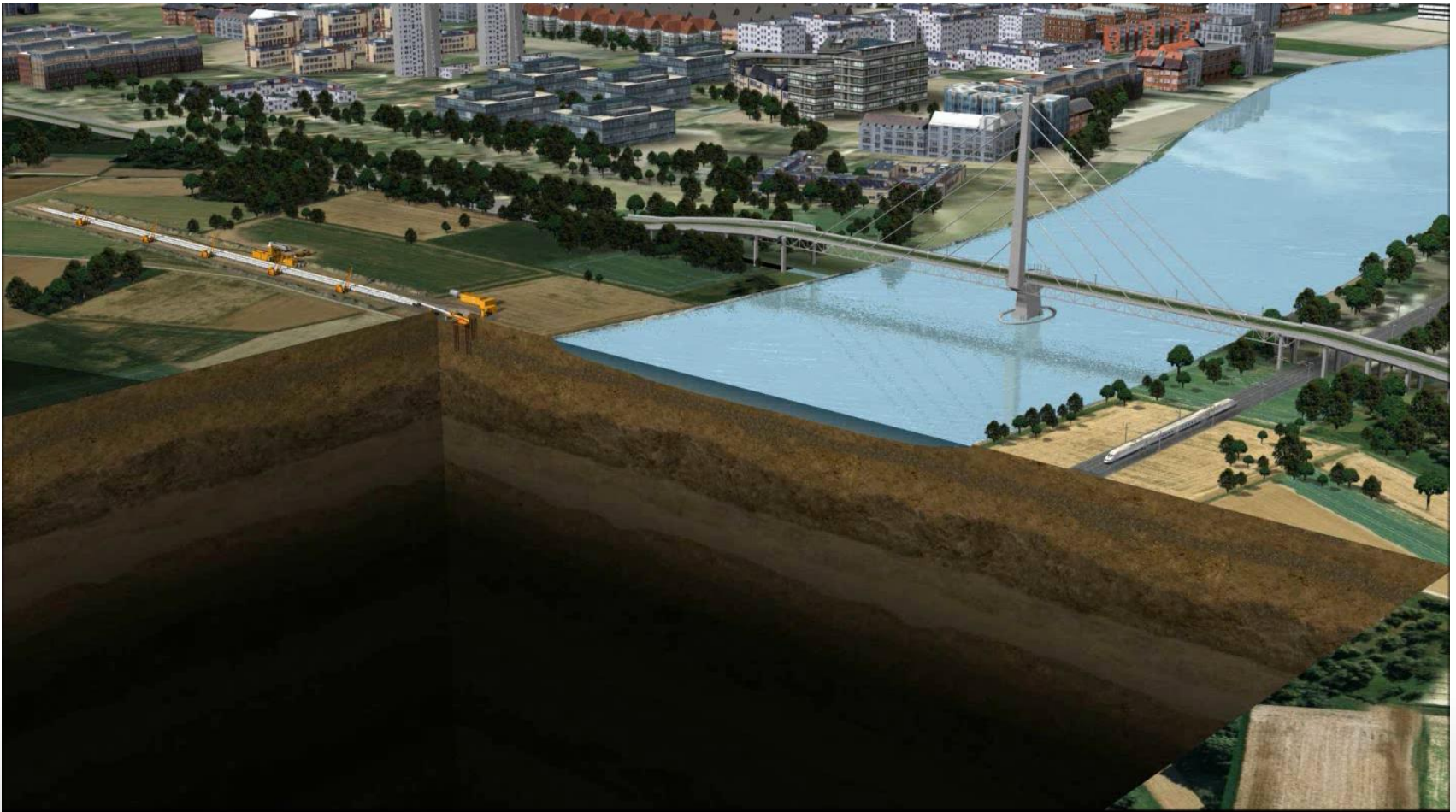
Bore 2

Bore 3



# Direct Pipe®. **Animation.**

Trenchless pipeline crossings and landfalls.



# Direct Pipe® Shore approach. Leviathan Gas Field, Israel.

## 32" Gas Pipeline with 56" Direct Pipe®.

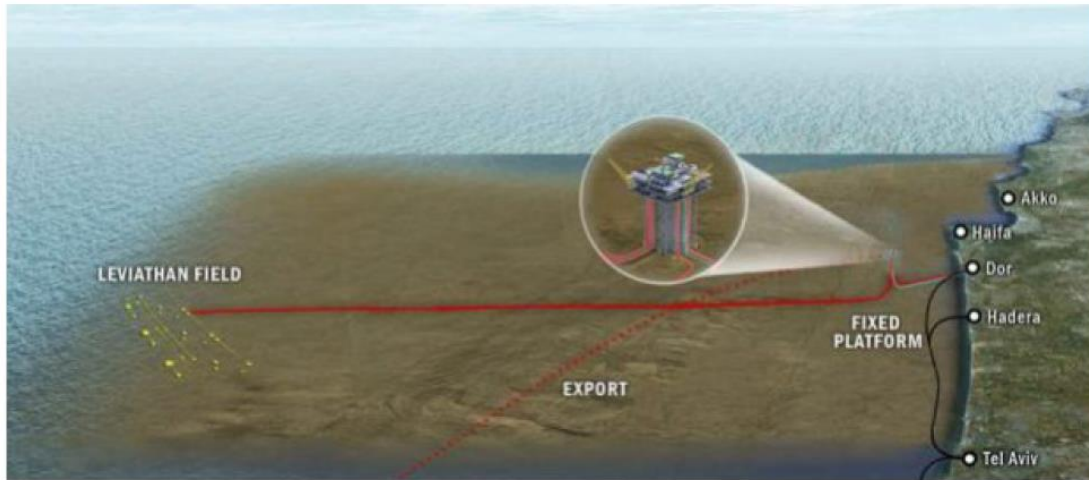
- ▶ M-2246M, AVN1200DP + 2 x HK750PT Pipe Thruster (one standby)
- ▶ Location: Dor, Israel
- ▶ Drilling length: 1,123m | 3,690ft
- ▶ Pipe section length: 60m
- ▶ Geology: sands, clays, Kurkar
- ▶ Client: Noble Energy
- ▶ Contractor: A. Hak Drillcon B.V.
- ▶ Best daily performance: 61,8m





# Direct Pipe® Shore approach. Leviathan Gas Field, Israel.

32" Gas Pipeline with 56" Direct Pipe®.



## Remote-controlled subsea recovery



# World Record Direct Pipe® Project.

48" Shore Approach with wet recovery.

- ▶ M-2170M, AVN1000DP + 1 x HK500PT & 1x HK750PT Pipe Thruster
- ▶ Use of Pipeline: Army Bay Wastewater Treatment Plant Outfall Replacement
- ▶ Location: Auckland, New Zealand
- ▶ **Drilling length: 1,930m World Record**
- ▶ Geology: sandstone, mudstone
- ▶ End position reached: August 02, 2018
- ▶ Client: Water Care
- ▶ Contractor: McConnell Dowell

## Performance:

- ▶ Best daily performance: 42.5m
- ▶ Best monthly performance: 210.7m





# Microtunnelling in hard rock.

New AVN800 | OD975.

- ▶ For rock with **high compressive strengths**: up to 200MPa
- ▶ High wear-resistance of **TCl cutter discs**
- ▶ Extended **drive length**: up to 200m
- ▶ **Torque equal** to current machine AVN800B (55kNm)
- ▶ Increased **rotation speed** of cutting head: up to **36rpm** @ 360l/min
- ▶ **Compact jacking frame** to achieve a small launch shaft of Ø 3,2m
- ▶ Operation by **standard control container C20** possible
- ▶ **Flushing ring**: fine rock particles to be kept away from annulus



# Microtunnelling in hard rock.

New AVN800 | OD975.

	AVN800B <i>current</i>	AVN800B <i>Rock!</i>
Cutting head	7 x 2-ring disc	5 x TCI disc
Hydraulic pump	55 kW, 130 l/min	min. 90 kW, 260 l/min
Max. rotation speed	7.4 rpm	up to 36 rpm
Max. compressive strength	50 MPa	200 MPa
Max. drive length	100 m	200 m

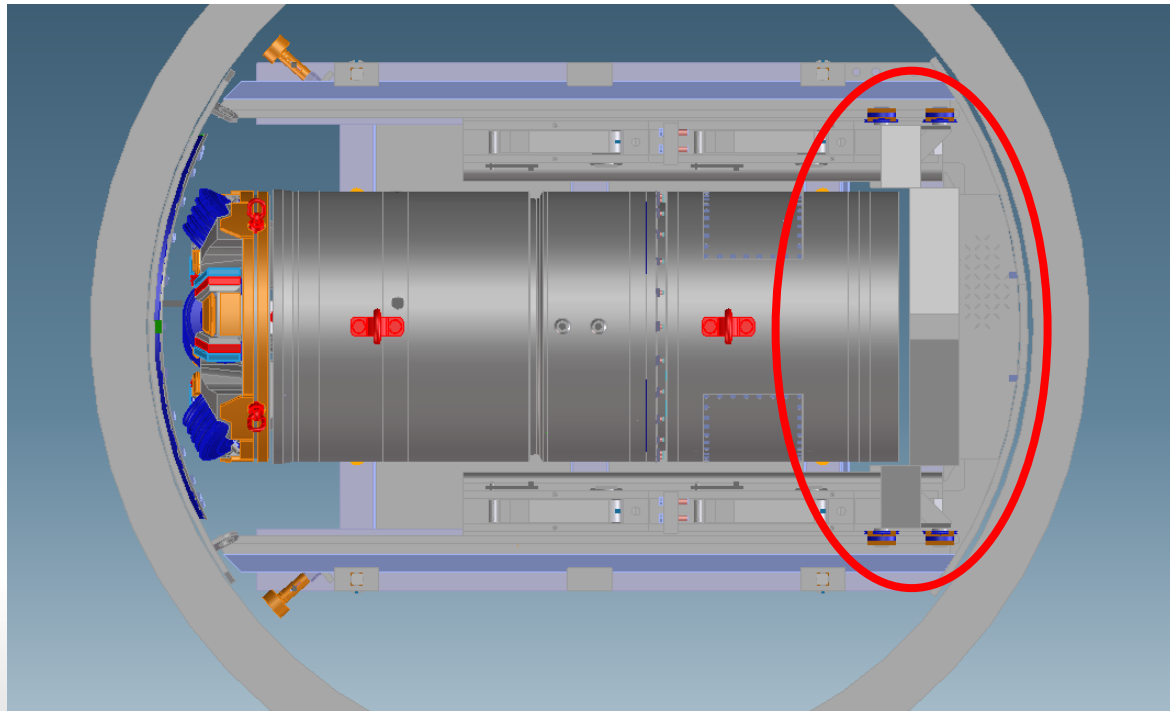




# Microtunnelling in hard rock.

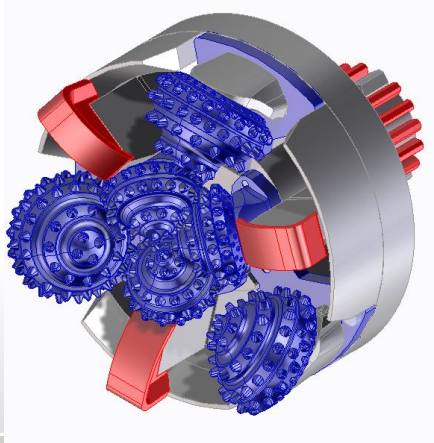
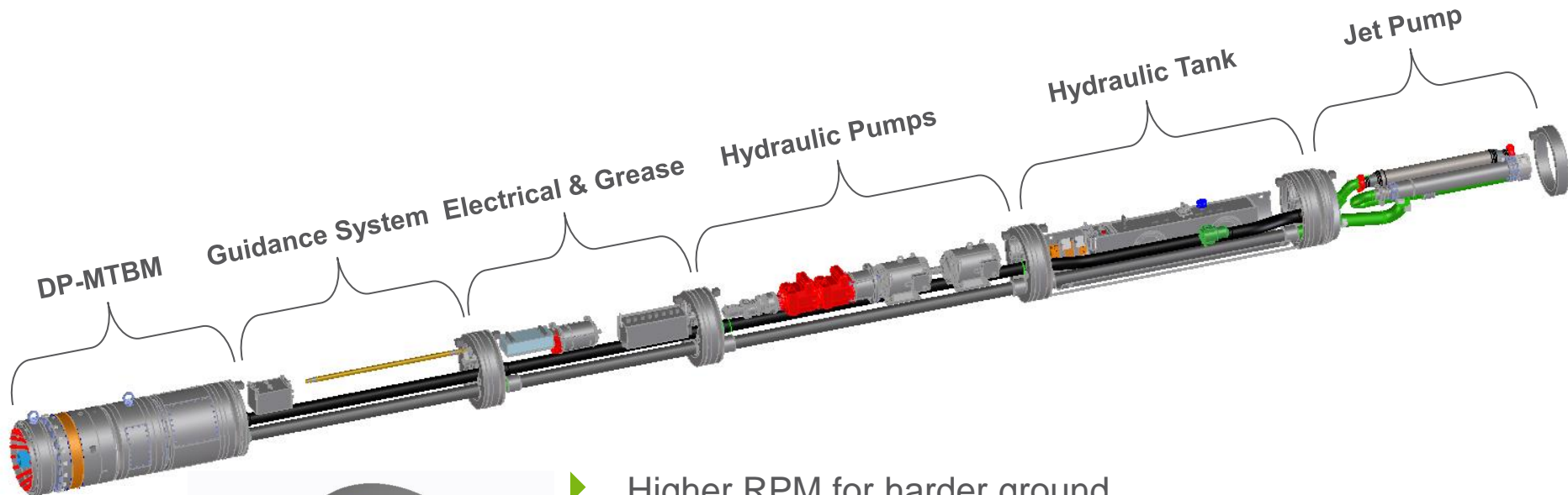
New AVN800 | OD975.

- ▶ Implementation of the requirements
  - ▶ Machine still fits in the small Ø3,2m round start shaft in combination with the compact jacking frame and adapted new thrust ring



# Direct Pipe®. Small Diameter Trenchless Technology.

New Design from 20" to 36" (up to 42" and 48").



- ▶ Higher RPM for harder ground  
→ rock capabilities 130-200 MPa (depends on diameter)
- ▶ Jet pump integration
- ▶ Combination of gyro & walkover guidance system
- ▶ Interchangeable power packs (for smaller diameters)



# Direct Pipe®. Trenchless Technology.

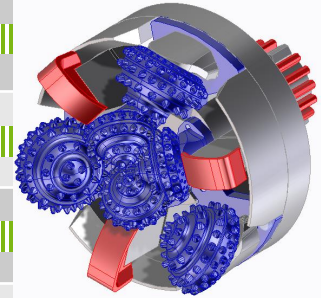
## Operating Range.



DP-MTBM  
"classic"

DP-MTBM  
"Jet Pump & Rock"

Pipeline Diameter	Direct Pipe® System	Drilling Distance <sup>1</sup>	Geology <sup>1</sup>					
			Clay	Sand < 2mm	Gravel <63mm	Cobbles <256mm	Boulders >256mm	Rock <100MPa
20"	AVN 400 DP	400 – 500 m 1,300 – 1,650 ft						
24"	AVN 500 DP	500 – 650 m 1,650 – 2,150 ft						
28"	AVN 600 DP	600 – 800 m 1,950 – 2,600 ft						
32"	AVN 700 DP	700 – 900 m 2,300 – 2,950 ft						
36"	AVN 800B DP	800 – 1,000 m 2,600 – 3,300 ft						
42"	AVN 800A DP	1,000 – 1,200 m 3,300 – 3,900 ft						
48"	AVN 1000 DP	1,500 – 2,000 m 4,900 – 6,550 ft						
56" – 60"	AVN 1200 DP	1,500 – 2,000 m 4,900 – 6,550 ft						



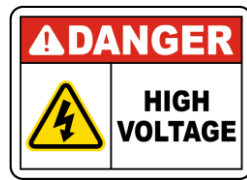
onshore only

onshore & offshore

<sup>1</sup> best case scenario – no distinction between DP-MTBM "classic" and DP-MTBM "Jet Pump & Rock"

# Horizontal Directional Drilling.

Complete HDD system is electrified – one power source



Separation Plant



Mud Mixing



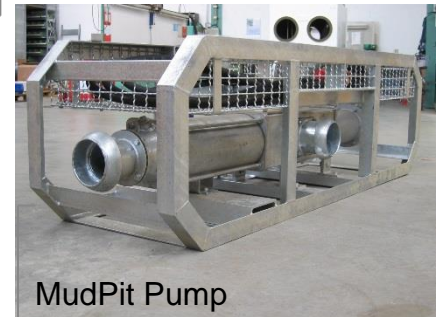
Mud Transfer Tank



HDD RIG



Break Out-Unit



MudPit Pump



Generators or – directly from the grid / STATNET



High Pressure Mud Pump



# Hybrid HDD Rig.

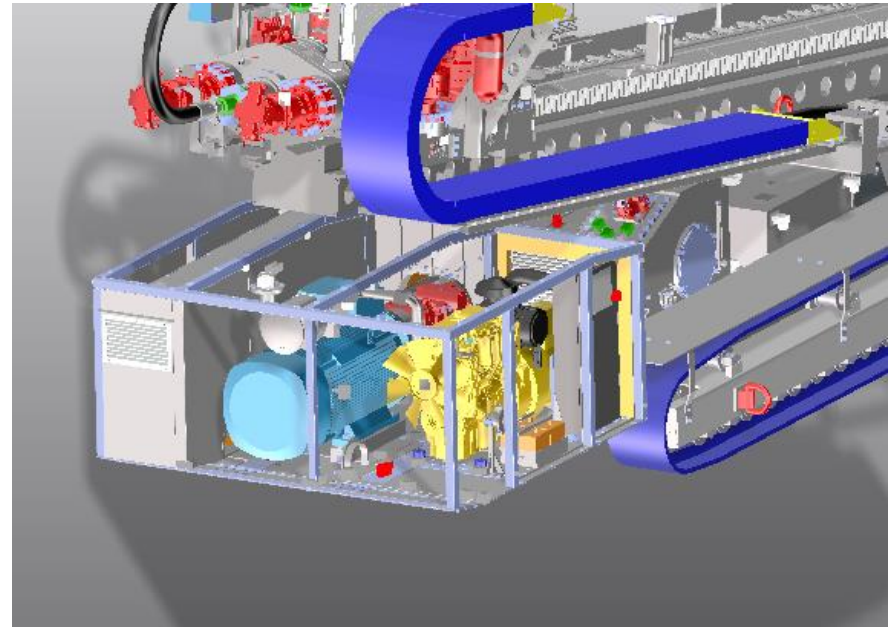
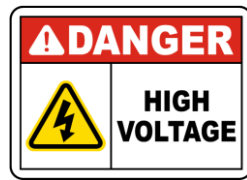
First use of Hybrid-Rig in France.

- ▶ H-348, HK80CK-Hybrid
- ▶ Developed for inner-city operation
- ▶ Quiet operation and minimal size ratio
- ▶ 250m River Crossing, nearby Paris, longtime client HDI



# Horizontal Directional Drilling.

HDD is getting electrified

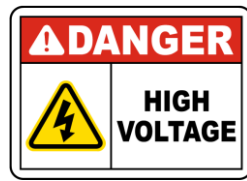


CAT 328 kW Engine → 250 kW E-Motor  
+ add. small Motor to move Rig

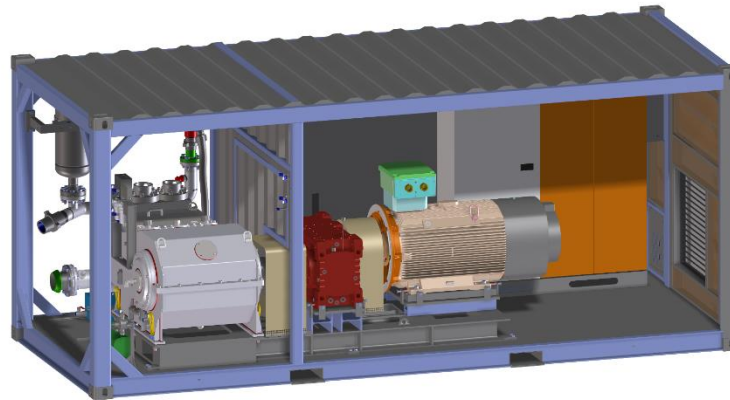


# Horizontal Directional Drilling.

HDD is getting electrified

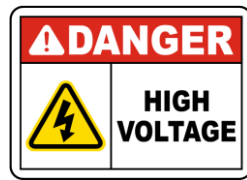


High Pressure  
Mud Pumps



# Horizontal Directional Drilling.

HDD is getting electrified



## Power Packs







## **PIONEERING UNDERGROUND TECHNOLOGIES**

▶ Thank you very much for your attention.



A 3D architectural rendering of an underground construction site. In the foreground, a large tunnel boring machine (TBM) cutterhead is visible, partially cut off by the left edge. The tunnel walls are reinforced with vertical steel ribs. A network of pipes and conduits runs horizontally across the middle ground. On the right, a large vertical shaft is being constructed, with a crane and other equipment visible at the top. The background shows a city skyline with various buildings, including residential houses and taller commercial structures, all rendered in a semi-transparent, light blue color. A large white circle on the left contains the text 'PIONEERING UNDERGROUND TOGETHER'.

**PIONEERING  
UNDERGROUND  
TOGETHER**

**THE FUTURE IS UNDERGROUND.**

Herrenknecht. Pioneering Underground Technologies

