SUSTAINABLE GRID EXPANSION: TRENCHLESS INSTALLATION TECHNOLOGIES FOR UNDERGROUND CABLES

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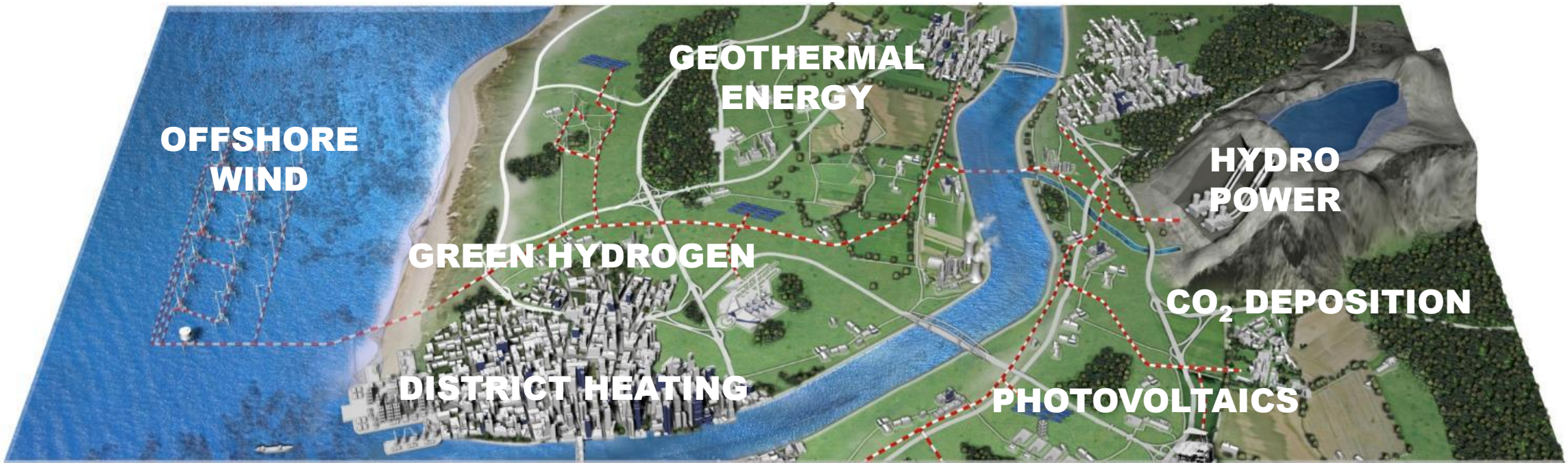
HERRENKNECHT
Tunnelling Systems

INCREASE IN RENEWABLE ENERGIES

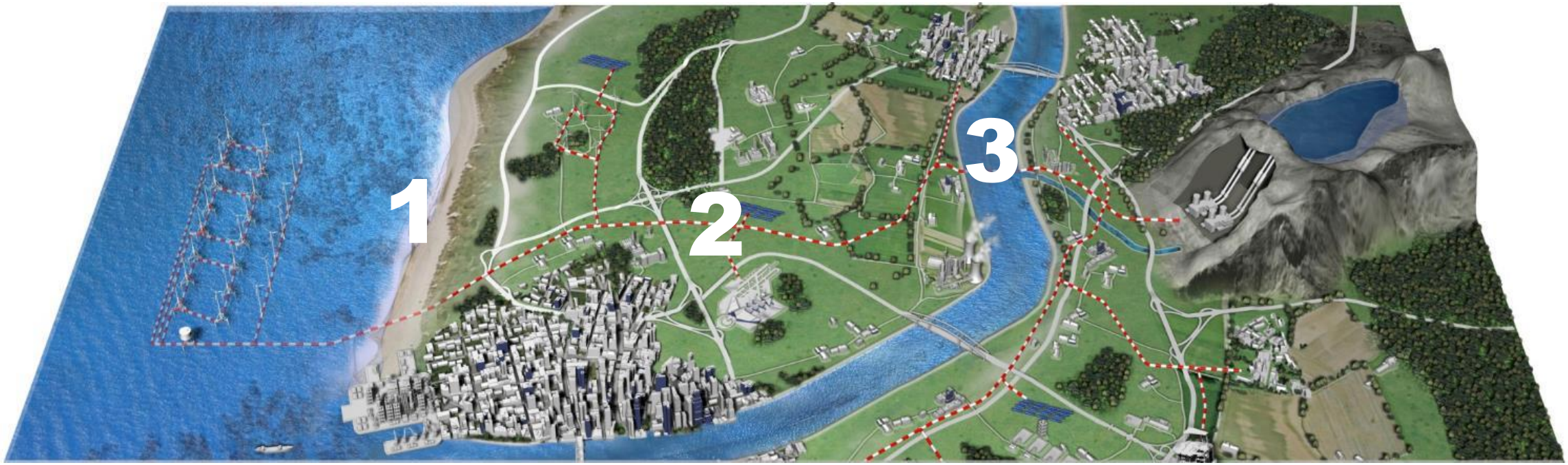
Main energy sources for sustainable energy transition



TRANSMISSION GRID EXPANSION REQUIRED

SUSTAINABLE POWER GRID EXPANSION

Challenges for landfalls, crossings and cross-country installations



1 Offshore-Onshore Connections / Landfalls

2 Cross-country installations with minimum disruption

3 Crossing of obstacles, e.g. waterways and traffic routes

SUSTAINABLE POWER GRID EXPANSION

For secure grids and energy supply.

Underground cable installation

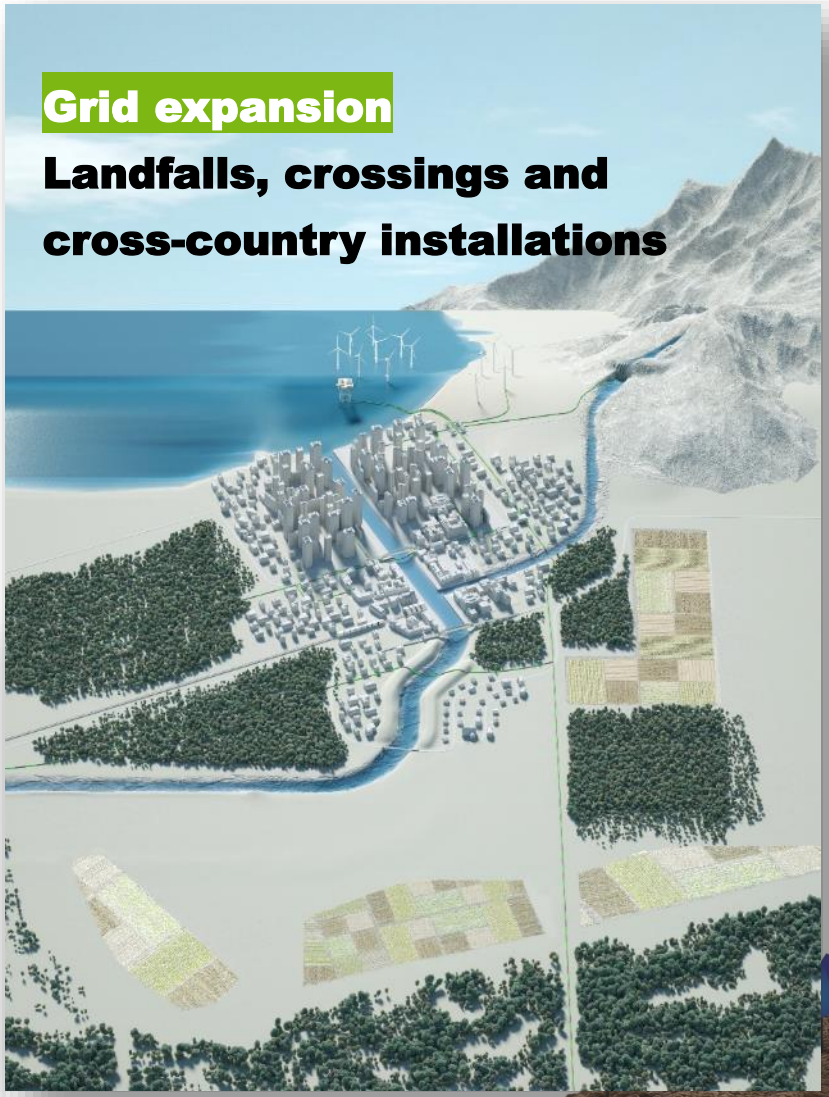
- Protection against damage from inclement weather (wind, ice storms, heat…) >>> reduction of maintenance costs
- Assure high grid availability
- Modernization and expansion of the power grids

Example California

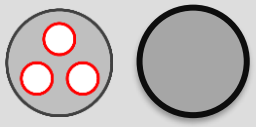
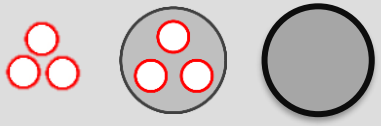
- **10,000 miles** of power lines to be laid **underground** to prevent wildfire risk caused by overhead lines
- Client: Pacific Gas and Electric Co. (PG&E)

Grid expansion

Landfalls, crossings and cross-country installations

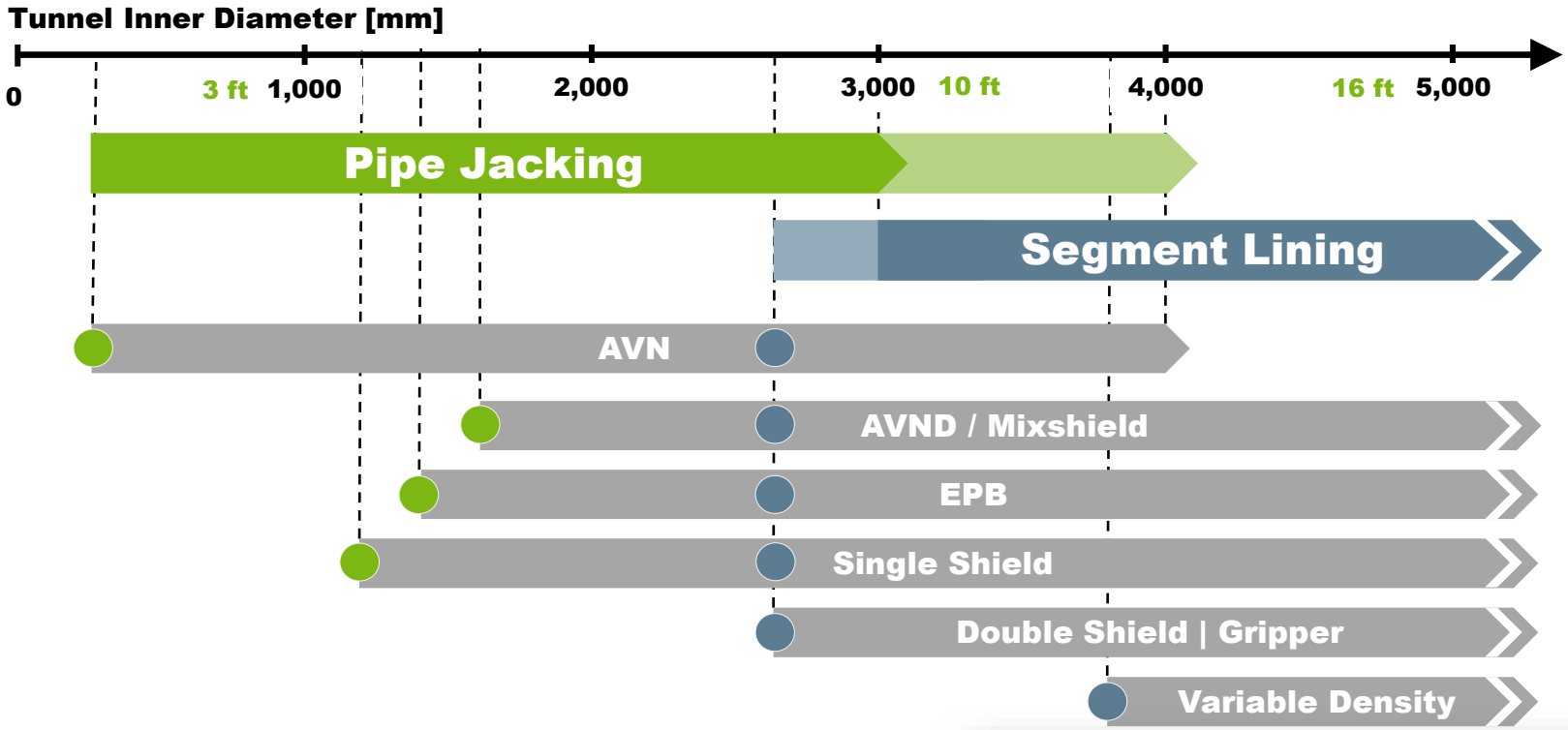


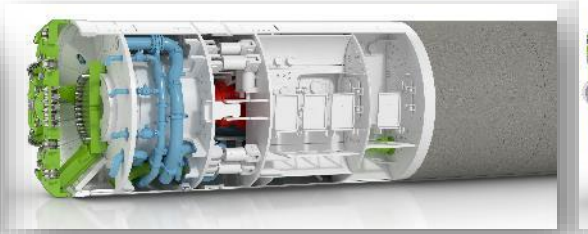
TRENCHLESS SOLUTIONS FOR SUSTAINABLE POWER GRID EXPANSION

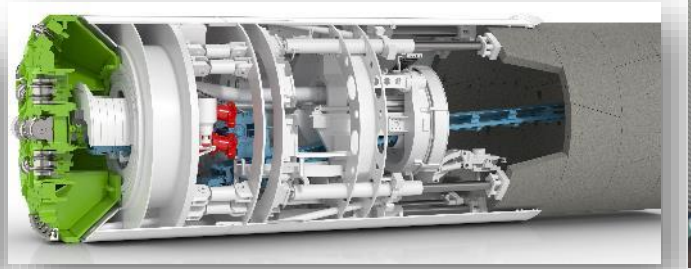
	Tunnelling	Direct Pipe®	E-Power Pipe®	HDD
Installation of **cable / casing**				
	Indirect Cables in tunnel	**one-step** steel casing	**two-stage** HDPE single casings or bundle, steel casing	**multi-stage** Cable bundle or steel casing
Diameter	**> 10“** Ø tunnel (ID)	**24“ – 60“**	**10“ – 28“** < 36“ with backreaming	**10“ – 60“**
Max. installation length	**33,000 ft**	**6,500 ft**	**6,500 ft**	**16,400 ft**

*The information in this table is intended as an initial guideline; the parameters may vary depending on the project.

SMALL-DIAMETER TUNNELLING MACHINE RANGE



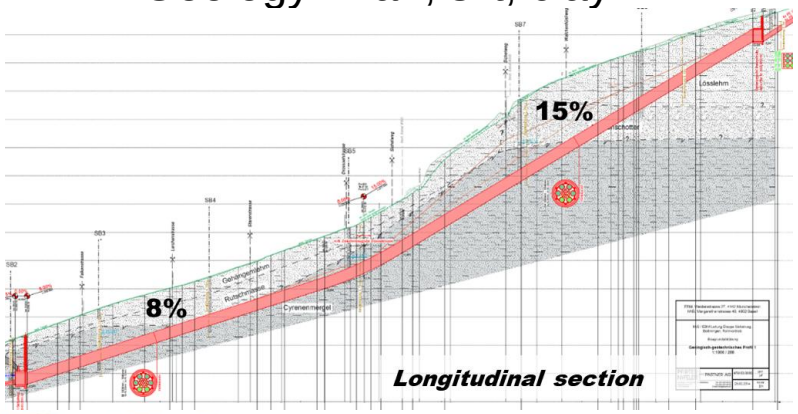




CABLE TUNNEL 50/150KV, BASEL, SWITZERLAND

Microtunnel for underground cable installation

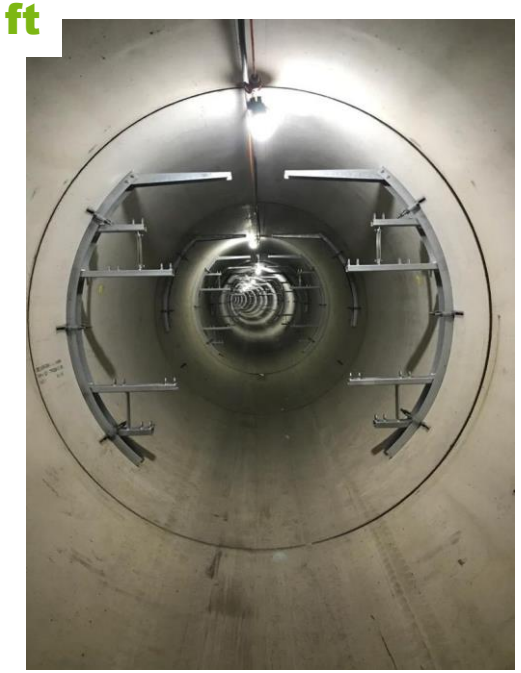
- AVND1600, OD 1960
- Tunnel Length: 521m **1,700 ft**
- Slope: **8% - 15%**
- Curve drive: 3-dimensional,
  - r min = 150m 500 ft
- Altitude difference: **60 m** 200 ft
- Geology: marl, silt, clay



CABLE TUNNEL LEGDEN

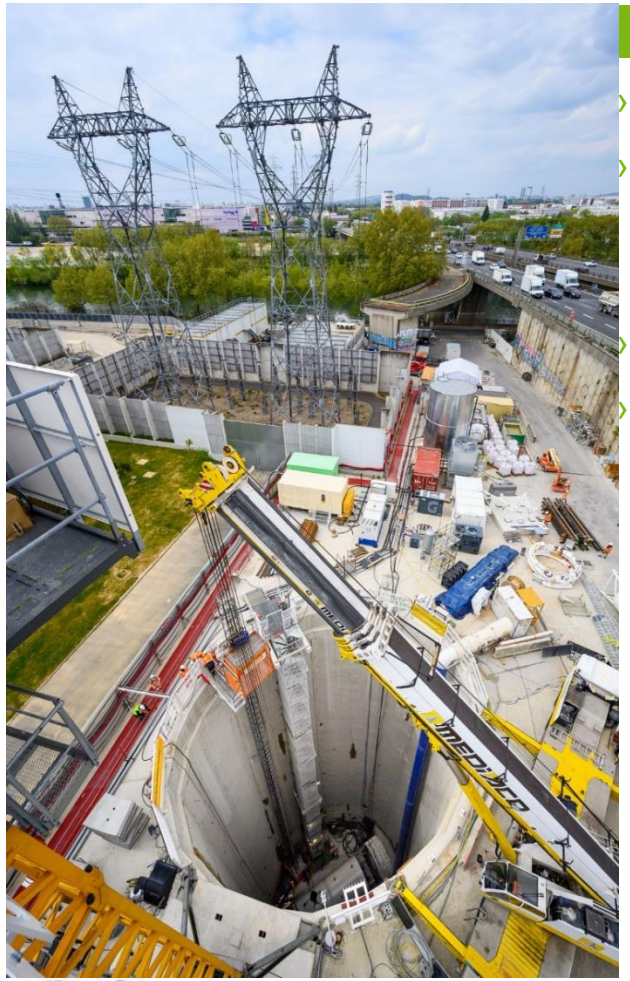
Amprion Cable Tunnel, Legden, Germany

- AVND 2500 with extension kit, **OD 3600 mm** **~12 ft**
- Pipe Jacking tunnel for 380 kV high-voltage transmission line
- Subsequent installation of 12 underground cables in tunnel
- Tunnel length: 813 + **1,297 m** **4,260 ft**
- Installation depth: 13 m



EUROPE´S CABLE TUNNELS WITH SEGMENT LINING

Large tunnel solution for deep installations, in inner-city conditions with restricted space above and underground.



Paris, France

~12 ft

- AVND3100AH, OD 3850 mm
- Relocation of 4 x 225 kV overhead lines underground for Olympic Games 2024
- Tunnel length: 2,404 m 7,900 ft
- Min. curve radius: 300 m

Berlin, Germany

- AVND3000AH, OD 3820 mm
- 380 kV cable diagonal for grid reinforcement
- Tunnel length: 6,701m 22,000 ft
- Min. curve radius: 300 m

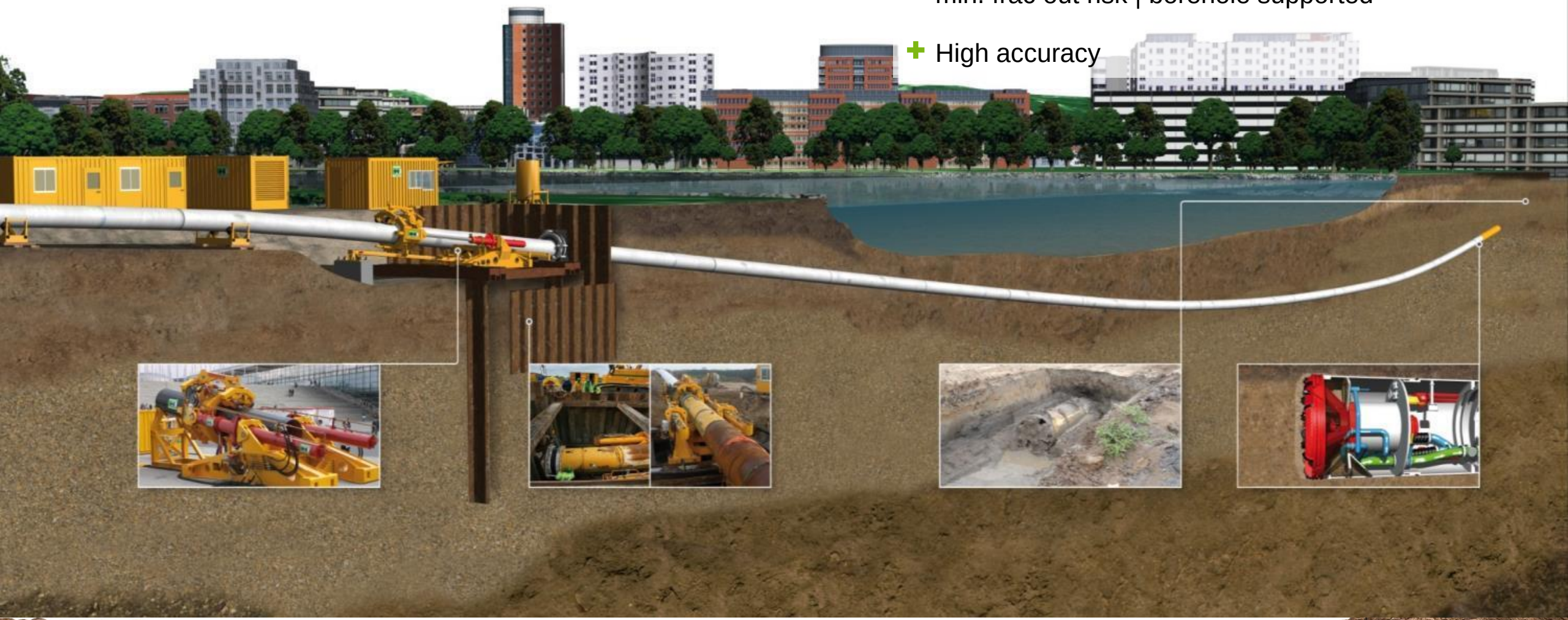
London, UK

- 3 x EPB 3000 AH, OD 3580 mm
- Casing for electricity transmission cables
- Tunnel length: 26,479m, 4 drives, max. 11,090 m
- Min. curve radius: 250m 36,000 ft

DIRECT PIPE® TECHNOLOGY

24“ up to 60“ steel pipeline installations

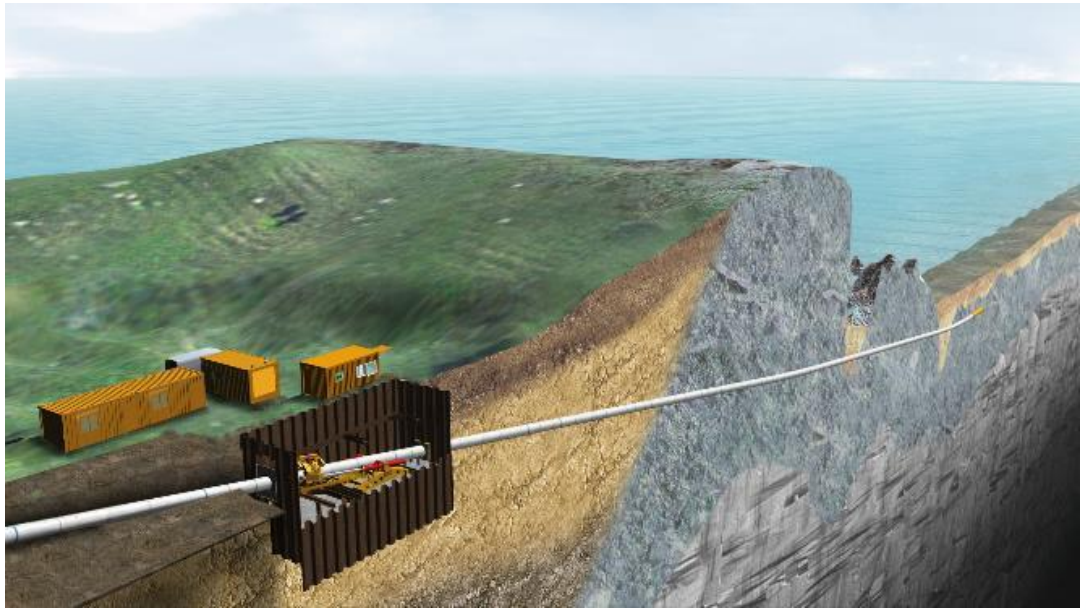
+ One-pass installation
+ min. frac out risk | borehole supported
+ High accuracy



EXPORT CABLE LANDFALL WITH DIRECT PIPE®

Beatrice Offshore Windfarm Landfall Project, Scotland.

- M-2130M, AVN 1000, 48“, H-336, HK750PT
- 48” Casing for 33kV Cable, 2x 440m | 1,450 ft.
- Geology: clay, sandstone, gravel, boulders
- Remote recovery module for offshore recovery of microtunnelling machine



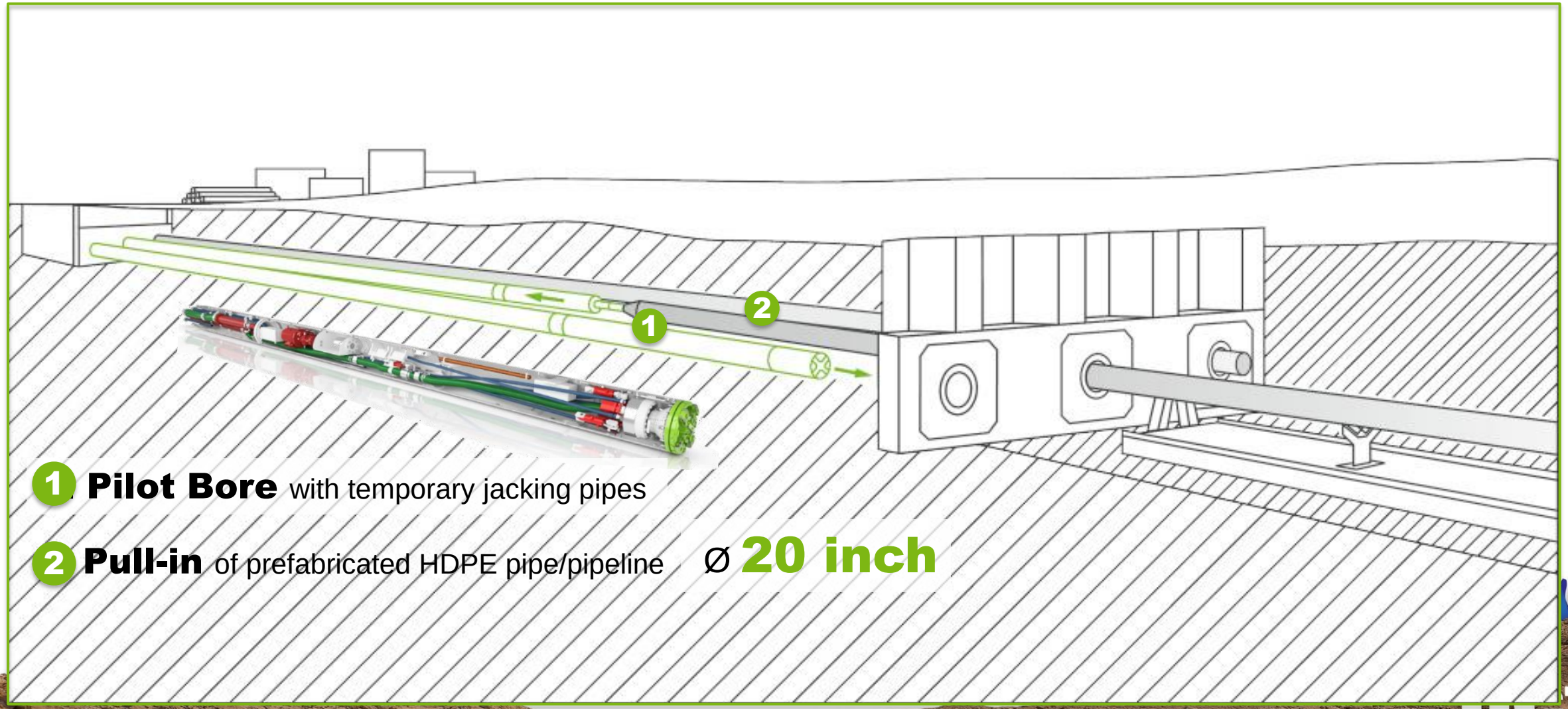
DIRECT PIPE® RECORD PROJECT

Longest reference project: World Record in New Zealand

- M-2170M, AVN1000 + Pipe Thruster HK750PT
- Location: Algies Bay, New Zealand
- Use of Pipeline: 48“ Casing Snells Algies Wastewater Pipe and Outfall Replacement, Shore approach with offshore recovery
- Drilling length: **2,021m WORLD RECORD | 7,000 ft.**
- Geology: mudstone, sandstone,
- Client: Watercare, Auckland
- Contractor: McConnell Dowell
- Performance:
  - Best daily performance: 42.5m 140 ft
  - Best weekly performance: 211m 700 ft
  - End position reached: July 28th, 2020

E-POWER PIPE® TECHNOLOGY

Two-step installation of HDPE protective pipe or small-diameter pipelines



1 **Pilot Bore** with temporary jacking pipes

2 **Pull-in** of prefabricated HDPE pipe/pipeline

Ø **20 inch**

E-POWER PIPE® TECHNOLOGY

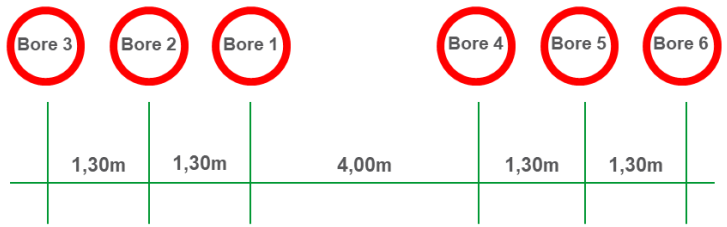
Two-step installation HDPE protective pipe or small-diameter pipelines

GENERAL APPLICATION FIELDS

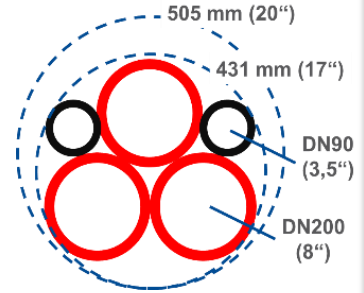
- Product pipe diameters **10” - 28”** (with backreaming up to 36”)
- Drive length up to **6,500 ft** (depending on ground conditions)
- Near surface installation possible (overburden **min. 5 ft)**
- Precise, parallel installation of lines possible (distance **min. 3 ft**)
- Grouting of annulus during pullback of product pipe

Small-diameter steel pipelines

HDPE protective pipe | single installation or bundle



Drilling diameter: 20 inch



Drilling diameter: 20 inch

PROJECT REFERENCES IN GERMANY

HDPE protective pipes for underground cables

1 Borken, TSO Amprion

- Sections 3 x 300 m, constant depth
- Geology: silt, sand, clay
- Feb-Mar 2017

2 Conneforde, TSO Tennet

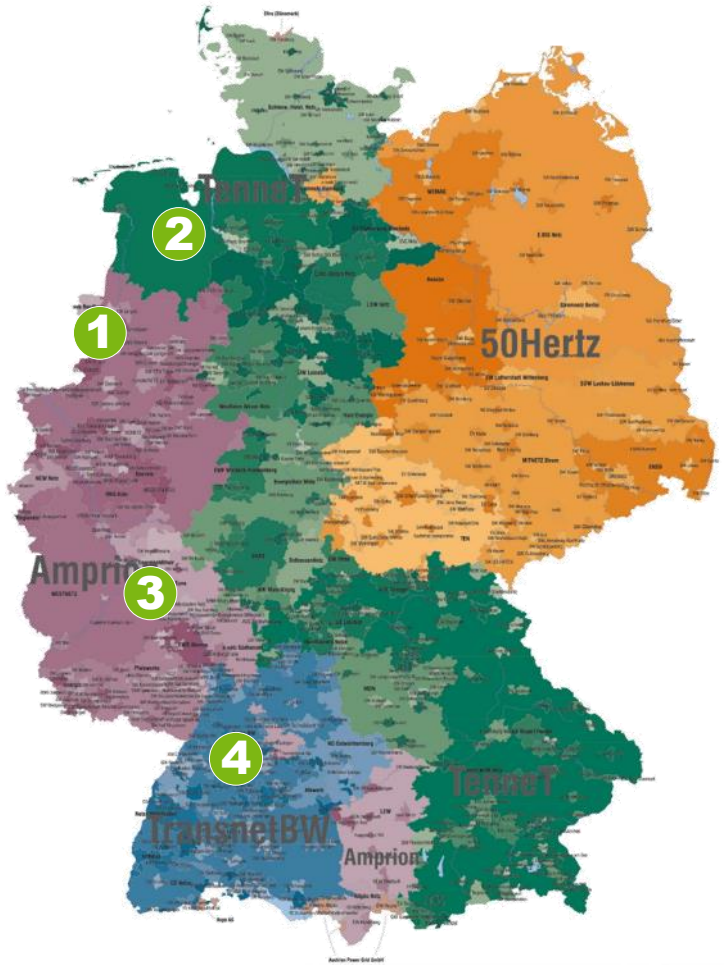
- Sections 6 x 300 m, S-curves r=500m
- Geology: silt, sand, clay, till, boulders
- Nov 2017 – Jan 2018

3 Bacharach, TSO Amprion

- Sections 6 x ~ 700 m, curves r=500m
- Geology: silt, sand, sticky clay, schist, quartzite boulders, iron ore
- Nov 2018 – Mar 2019

4 Grossgartach, TSO TransnetBW

- Sections 3 x 455 m, curves r_V=500m, r_H=788m
- Geology: clay
- Feb-Mar 2021

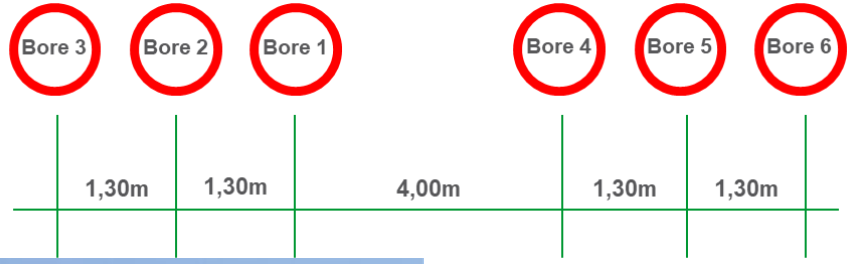


E-POWER PIPE® PROJECT BACHARACH

HDPE protective pipes for underground cables

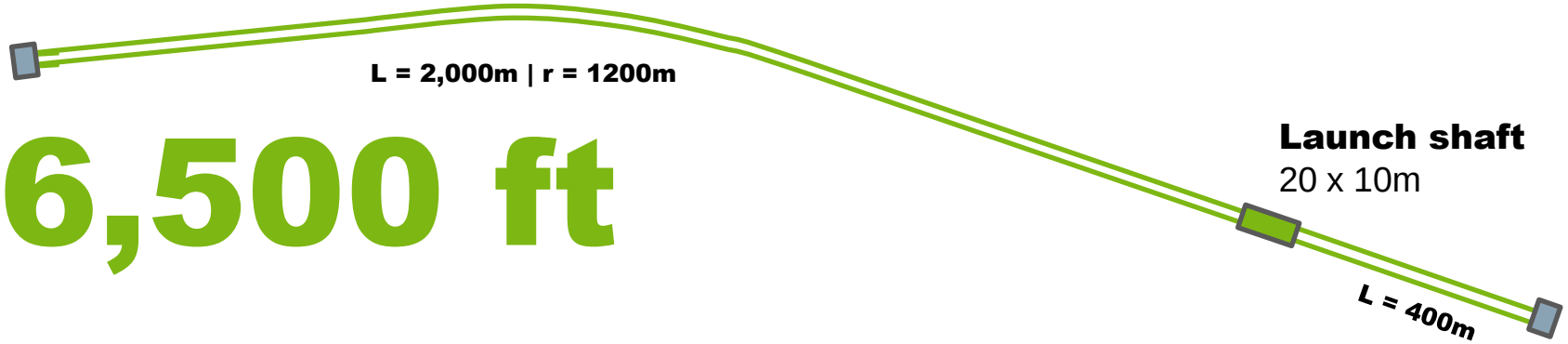
2,300 ft 1,600 ft

- Sections 6 x ~ 700 m, curves r=500m
- Average overburden: 2 m **6.5 ft**

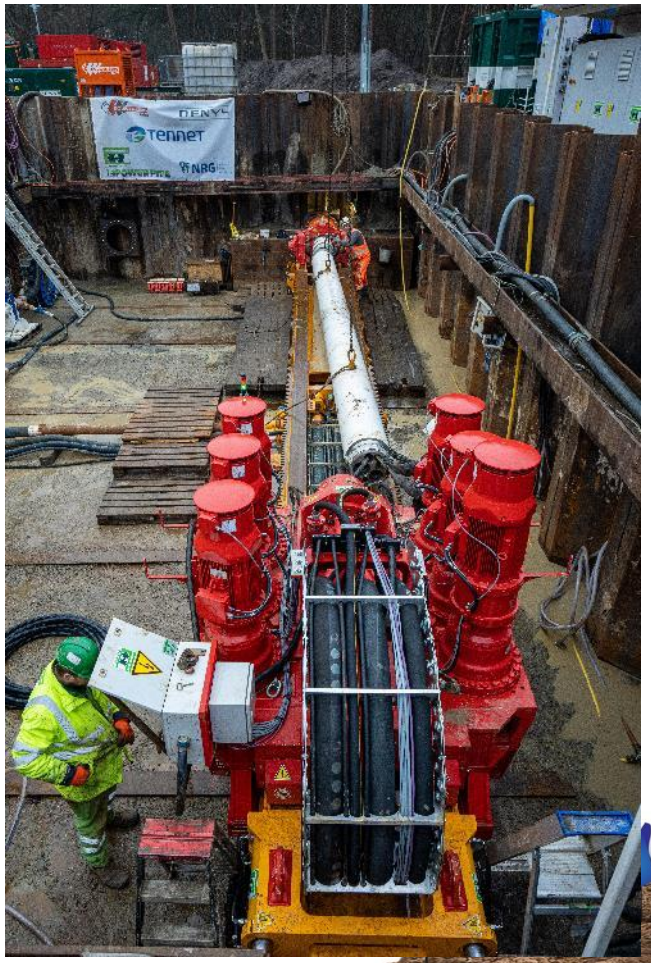


E-POWER PIPE® RECORD PROJECT (NL)

Latest cable project in the Netherlands



6,500 ft



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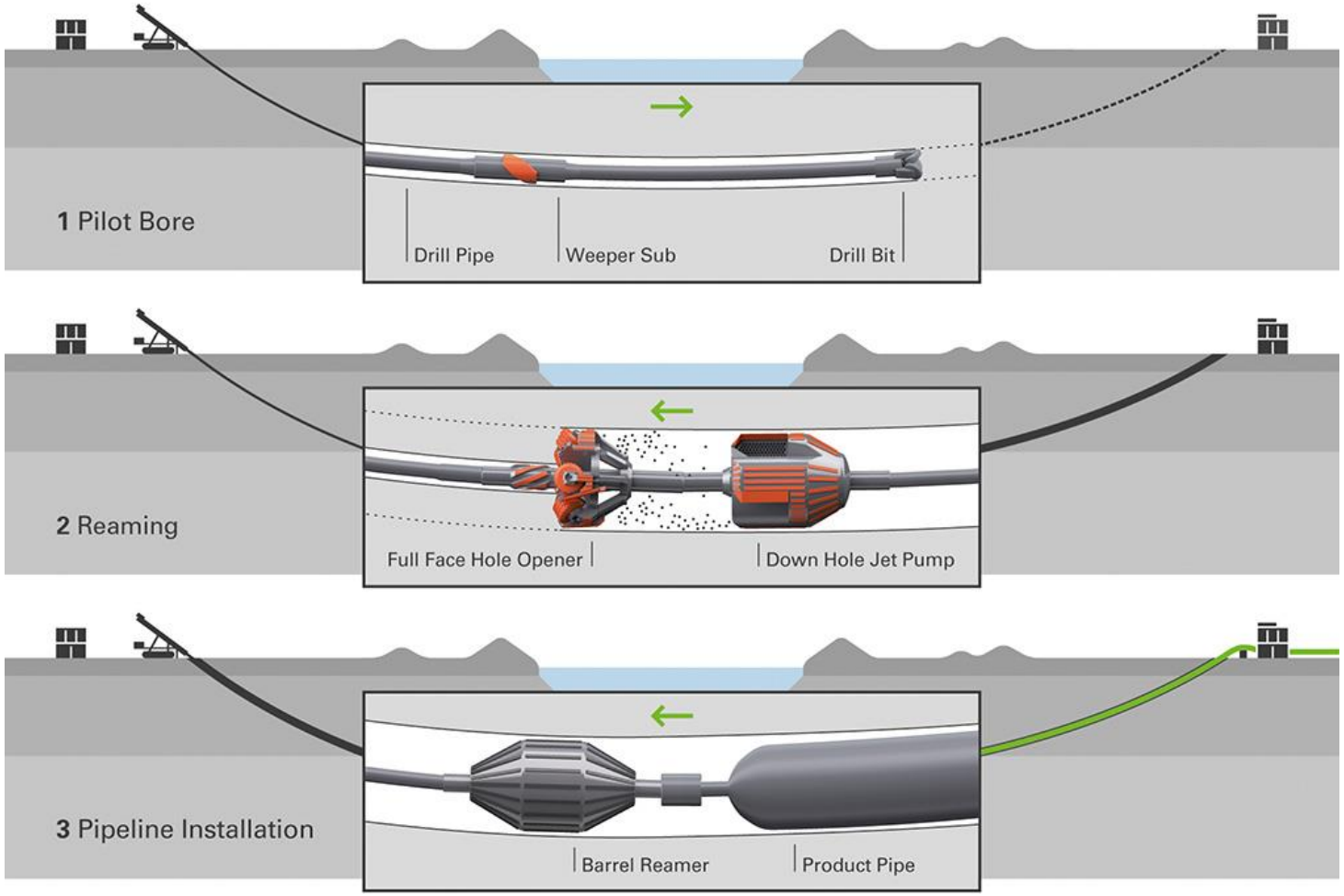
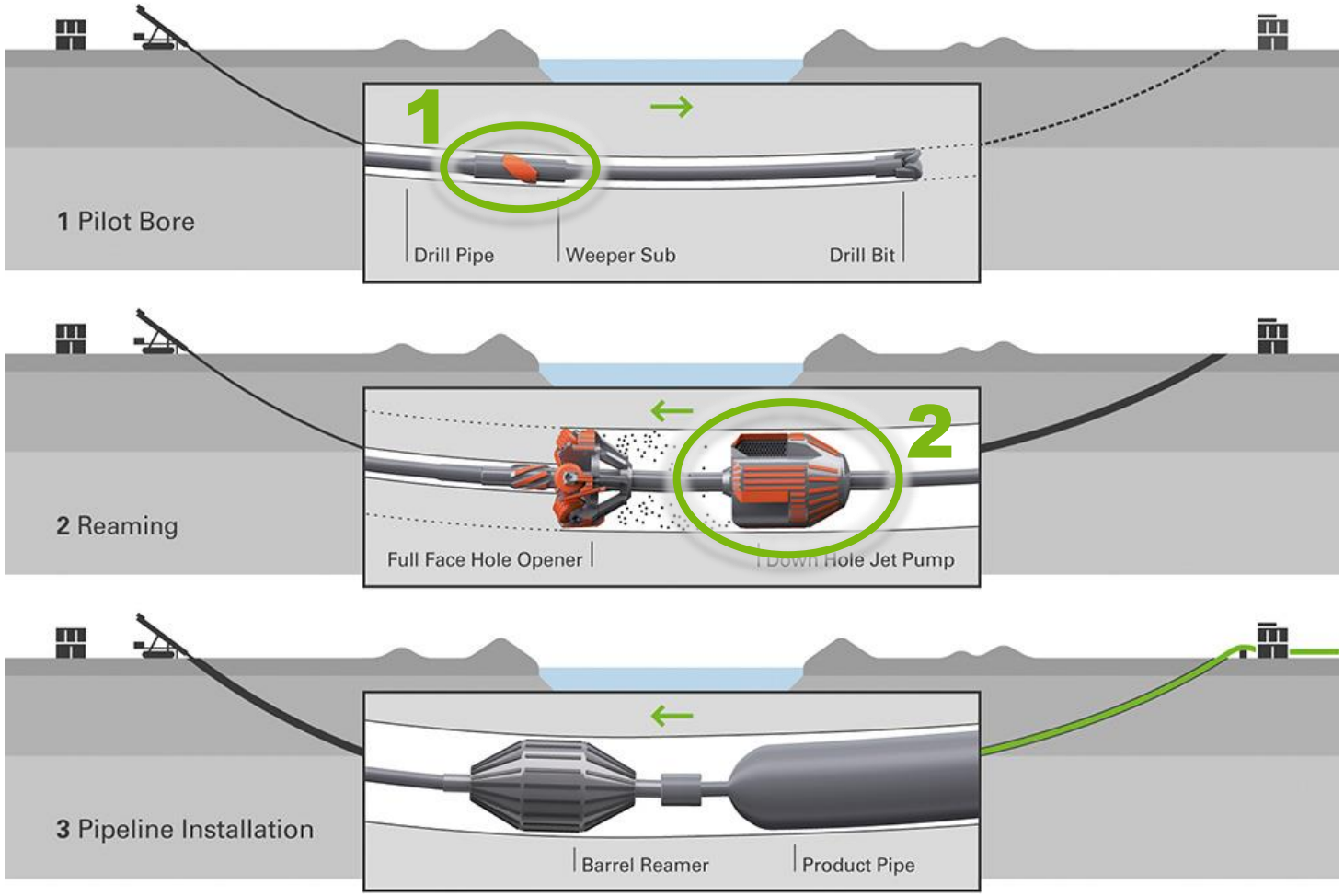
HDD Technology

General



HDD | MINIMIZING FRAC-OUT RISK

Tooling concepts for HDD



1 WEEPER SUB

Reduces the risk of frac-outs significantly by gradually increasing the volume flow in the borehole. Less drilling fluid required at the drill bit.

TOOL DATA

- **Operation diameter:** 8 ½" – 12 ¼"
- **Adjustable jet volume:** 20 gpm – 105 gpm (75 l/min – 400 l/min)

2 DOWN HOLE JET PUMP

Installed directly behind the Full Face Hole Opener. Cleans the borehole and removes the cuttings directly inside the drill string.

TOOL DATA

- **Operation diameter:** 20" – 72"
- **Operation flow rate:** 475 gpm (1,800 l/min) at 65 bar

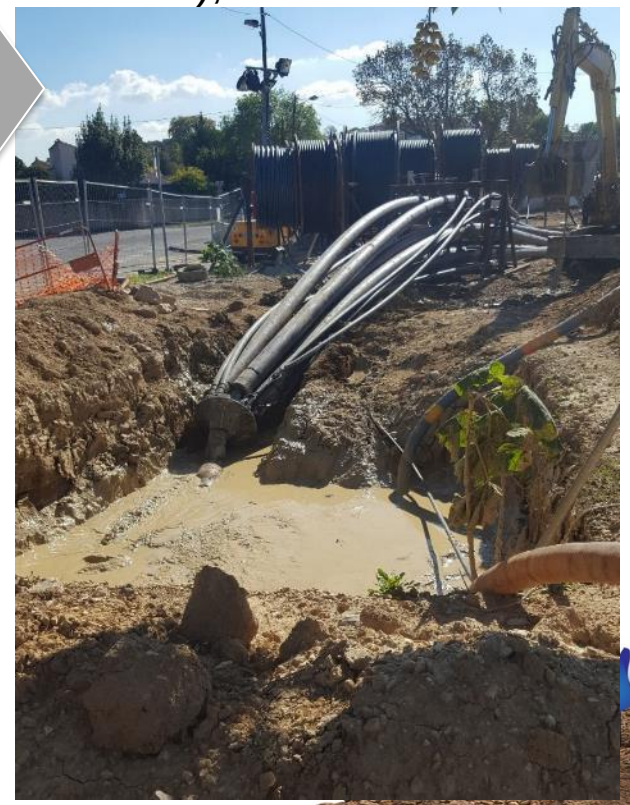
INSTALLATION OF CABLE BUNDLE WITH HDD

HK250T – 250to Trailer Rig in Denmark

- H-395, HK250T
- Crossing of Eastern Limfjord
- Installation length: **1,551 m | 5,100 ft.**
- Cutting diameter: 1,200 mm
- bundle 3xDN400 + 1xDN355 (HDPE)
- Geology: soft soil, dense chalk with flint

HK250T – 250to Trailer Rig in Marseille, France

- H-138, HK250T
- Crossing of streets, buildings, restricted space
- 16 lines to pull-in (Ø 63 – 225 mm), incl. 2 x 225kV lines
- Drilling length: 800m

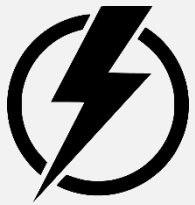


HDD RIG RANGE AND EQUIPMENT

HYBRID
HDD Rig
Electric-hydraulic

ALL-ELECTRIC
HDD Rig

Diesel generator
One source | independant | proven & robubst



Local grid
Quiet operation | low emissions | „plug and play“

- Separation plant
- Mud mixing unit
- Mud transfer tank
- Mud pit pump
- High pressure mud pump
- Breakout unit

HYBRID HDD RIG | HK80CK HYBRID

New rig concepts for greener operations.

- Compact crawler rig with electric engine
- Small footprint for jobsites in urban areas
- all components can be mounted directly on the rig
- Low in emissions and noise

HYBRID RIG HK80CK

Rig

- Installed power: 324 kW (434 hp)
- Power transmission: Rack & Pinion
- Drilling angle: 9°–21°
- Drill pipe length: 6,000 mm (20 ft)
- Pipe support system on mast: 2

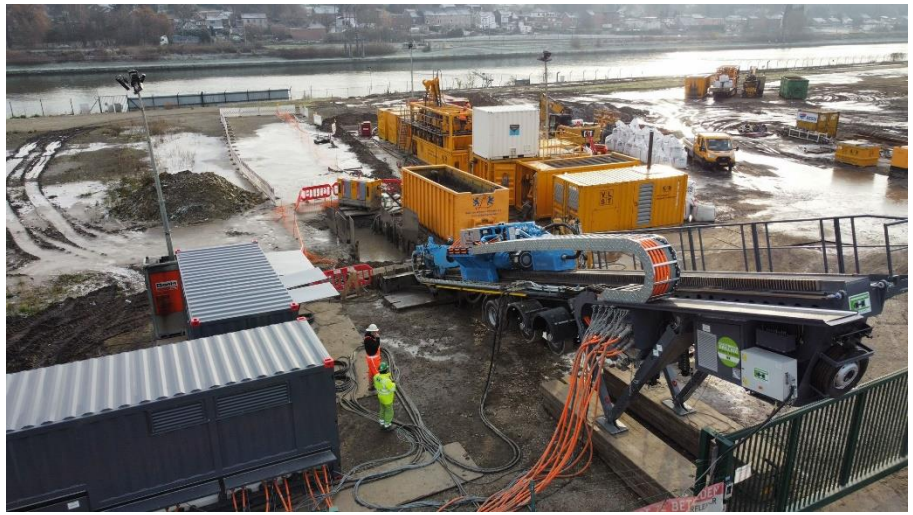
ALL-ELECTRIC HDD RIG | HK300TE

New rig concepts for greener operations.

- Electric Motors directly on carriage
- High efficiency by elimination of hydraulic power losses
- Low in emissions and noise
- High availability: sensitive electronic parts located off the HDD Rig

ALL-ELECTRIC RIG HK300TE

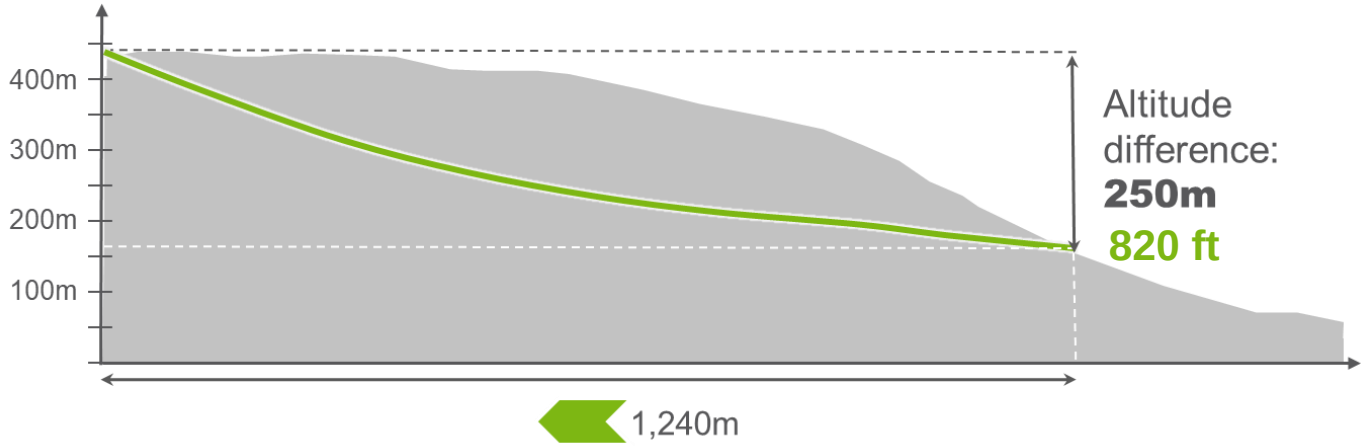
- Installed power: 550 kW (740 hp)
- Power transmission: Rack & Pinion
- Drilling angle: 8° - 15°
- Drill pipe length: 9.800 m (20 ft)
- Pipe support system on mast: 2
- Sound pressure level (L_{pA}): 72 dB(A)
- Sound power level (L_w): 104 dB(A)



APPLICATION OF HDD FOR RENEWABLES

Reinaa Hydro Electric Powerplant, Meraker, Norway.

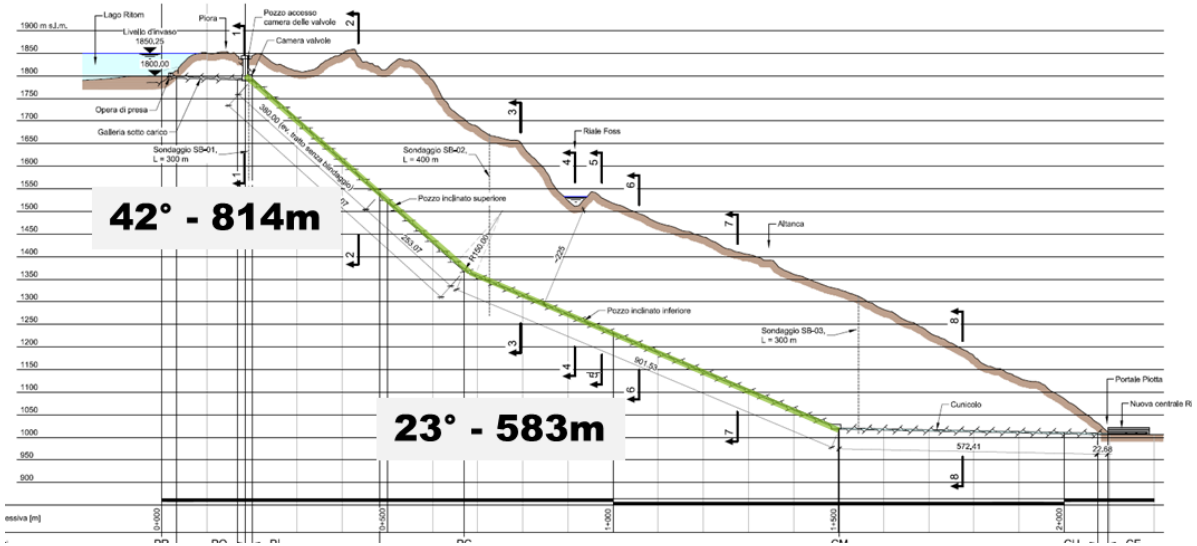
- H-332, HK250C
- Drilling length: 1,240m **4,000 ft**
- Water Pipeline Ø: 32“ / 813mm,
- max. 24° slope
- Drilling Ø: 978mm
- Geology: hard rock > 200 Mpa



APPLICATION OF TRENCHLESS & TUNNELLING FOR RENEWABLES

Hydropower Station Ritom, Switzerland

- M-2378M, Gripper TBM, OD 3230 mm
- Total tunnel length: 1,397 m
- Tunnell length: 1,397 m **4,600 ft**
- Slope: **23° / 42°**
- Geology: hard rock, up to 200 Mpa
- Min. curve radius: 150 m vertical



OFFSHORE FOUNDATION DRILLING

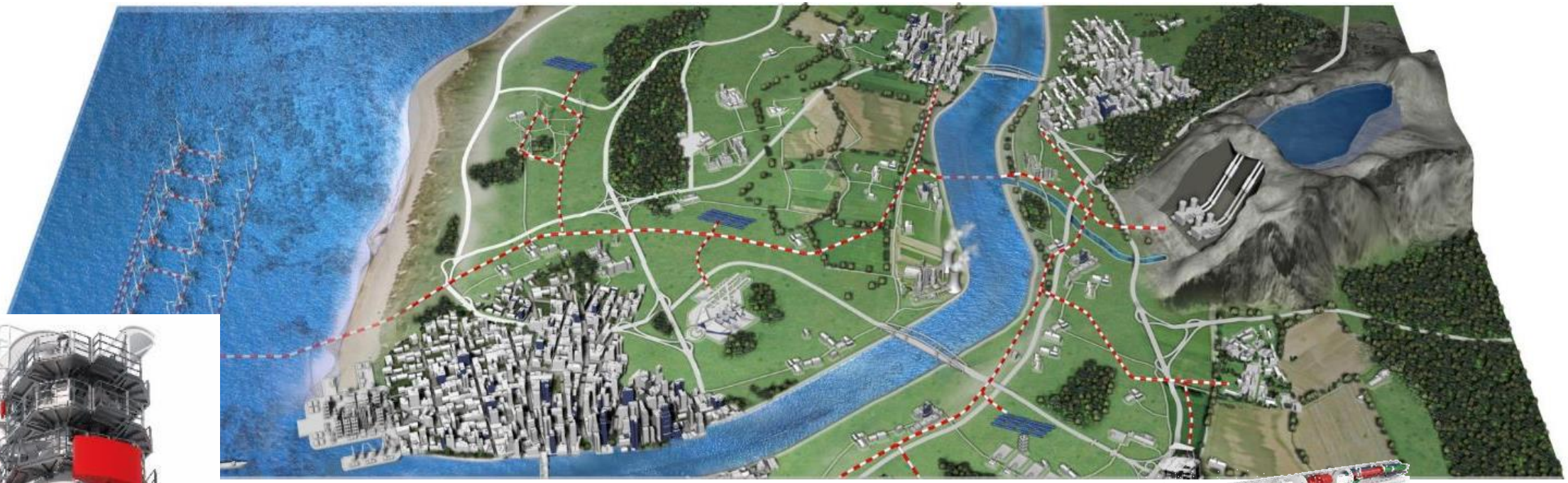
World premiere for wind farm St. Nazaire, France

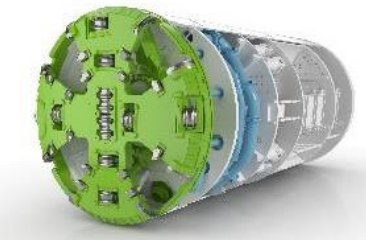
73 drilled monopiles

Ø 7.7 m

RENEWABLE ENERGIES AND POWER GRID EXPANSION

Technologies for sustainable energy transition





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