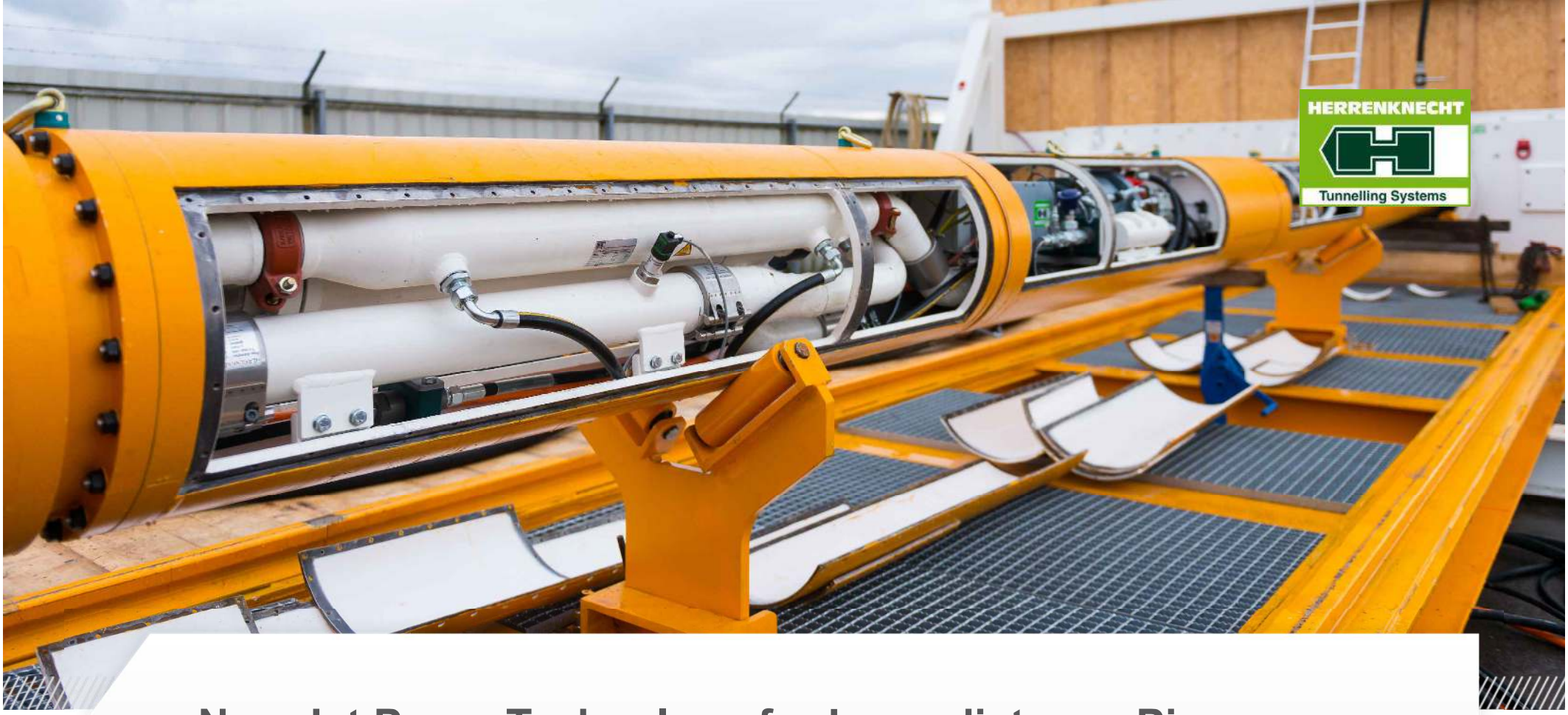


New Jet Pump Technology for Long-distance Pipe Jacking and HDD Crossings in Highly Permeable Soil.

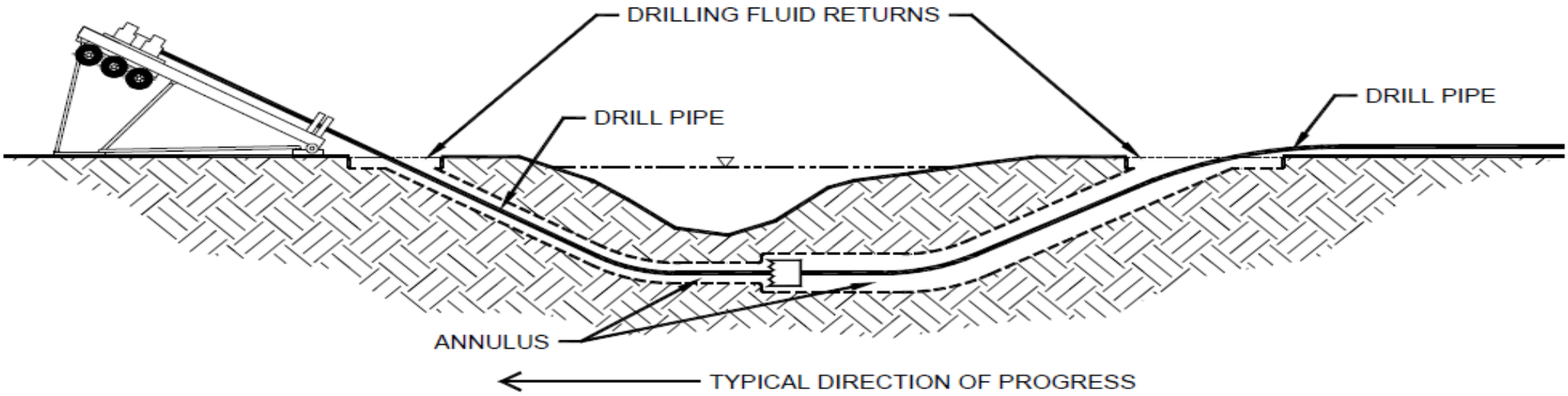
Dr. Gerhard Lang, Herrenknecht AG.

Fort Worth, January 2019

HDD limitations in permeable soils.

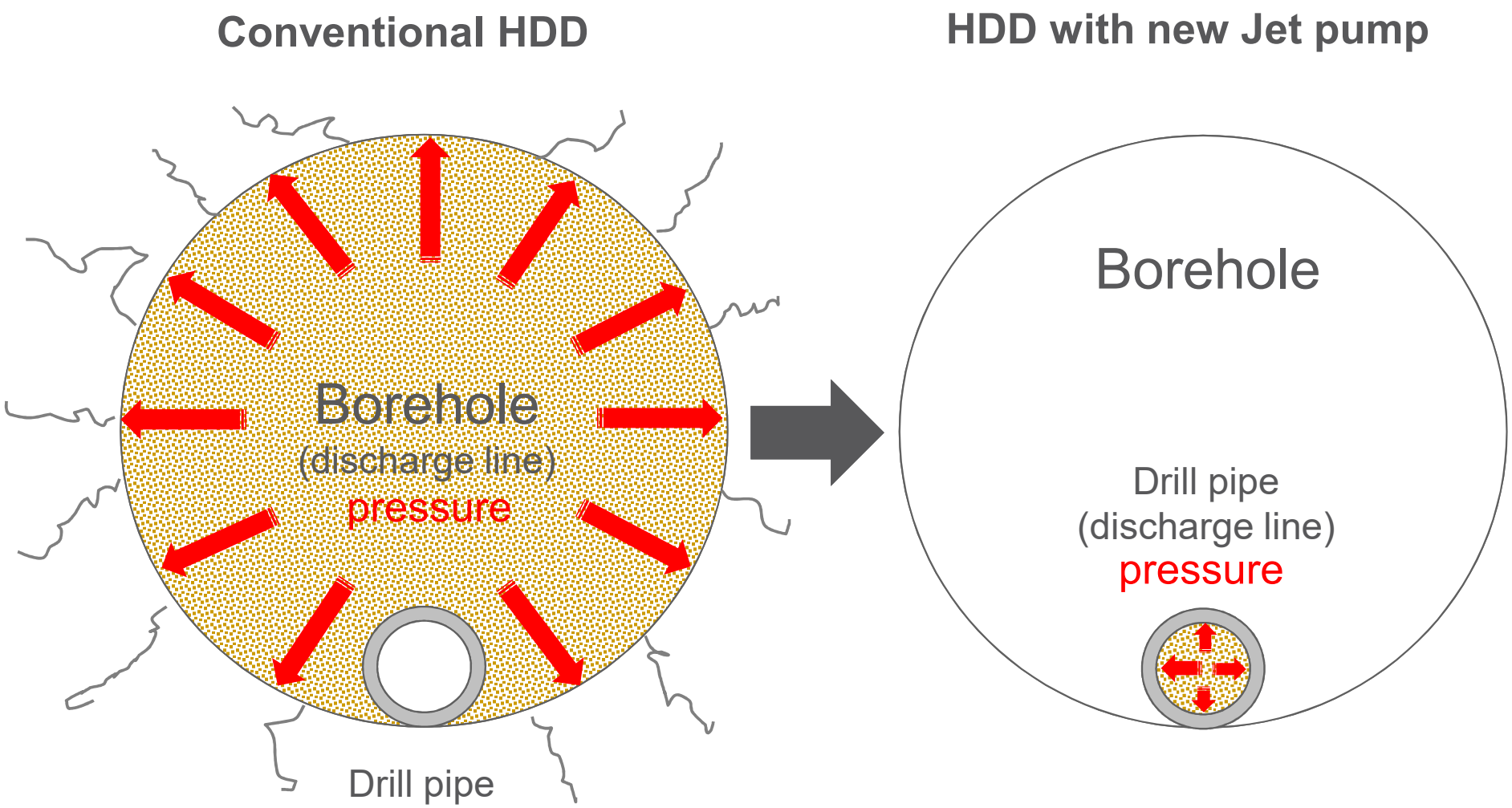
Conventional HDD.

- Principle HDD arrangement of the borehole and drill string
- Return flow through borehole
  - either to Rig side or to Pipe side



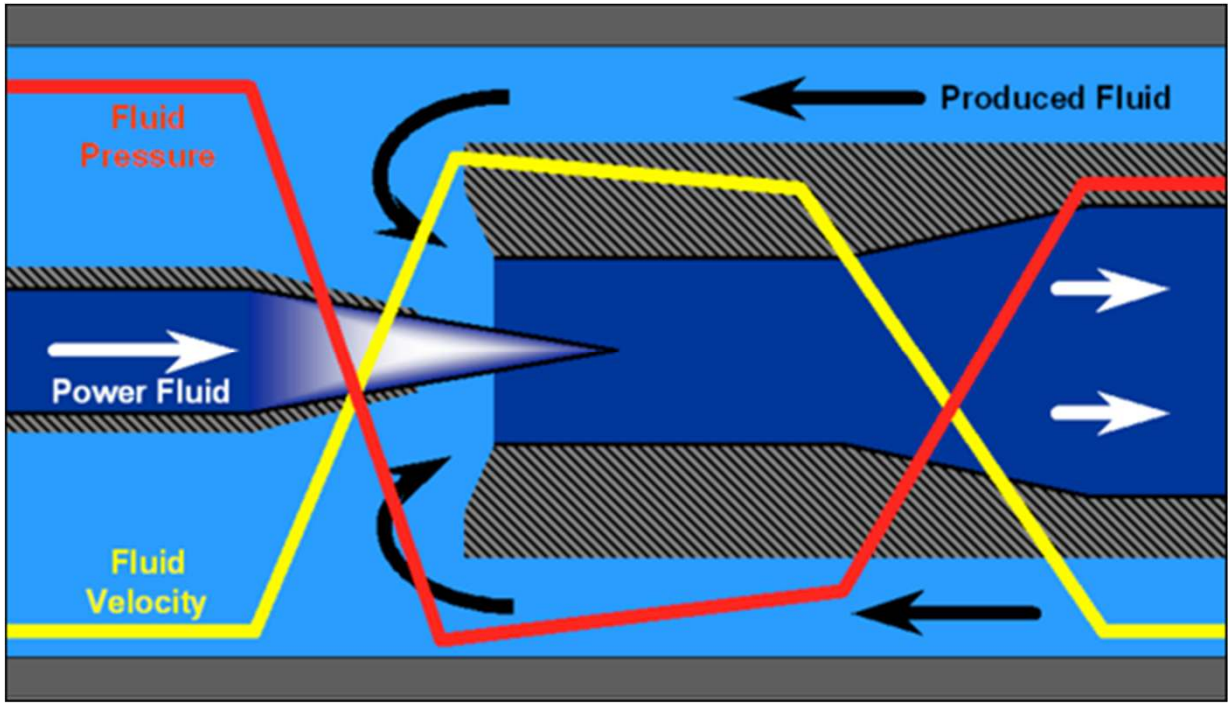
HDD limitations in permeable soils.

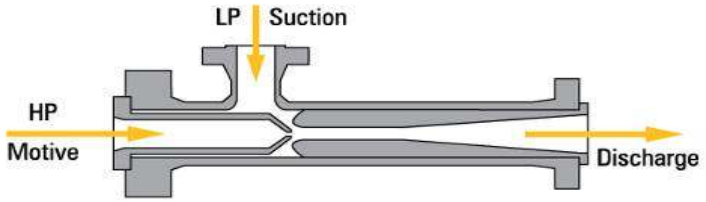
Conventional HDD vs. HDD with Jet Pump technology.



Jet Pump for HDD.

Principle of the system.





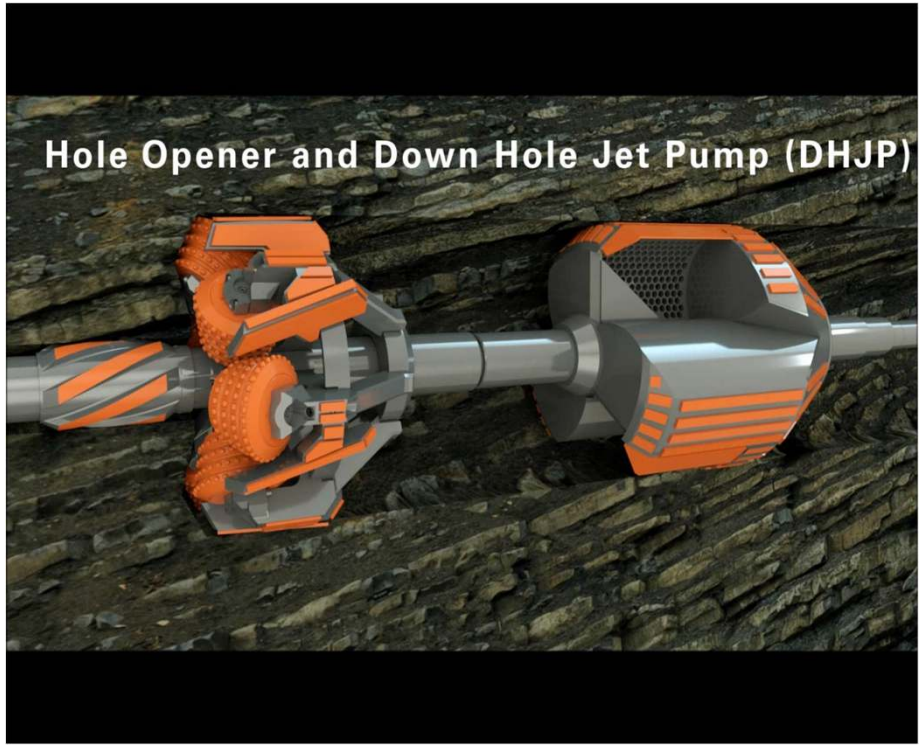
Nozzle:
v = 100 m/s (328 ft/s)
p = 50 bar (725 psi)

Mixing chamber

Diffuser:
v = 3,5 m/s (11,5 ft/s)
p = 20 bar (290 psi)

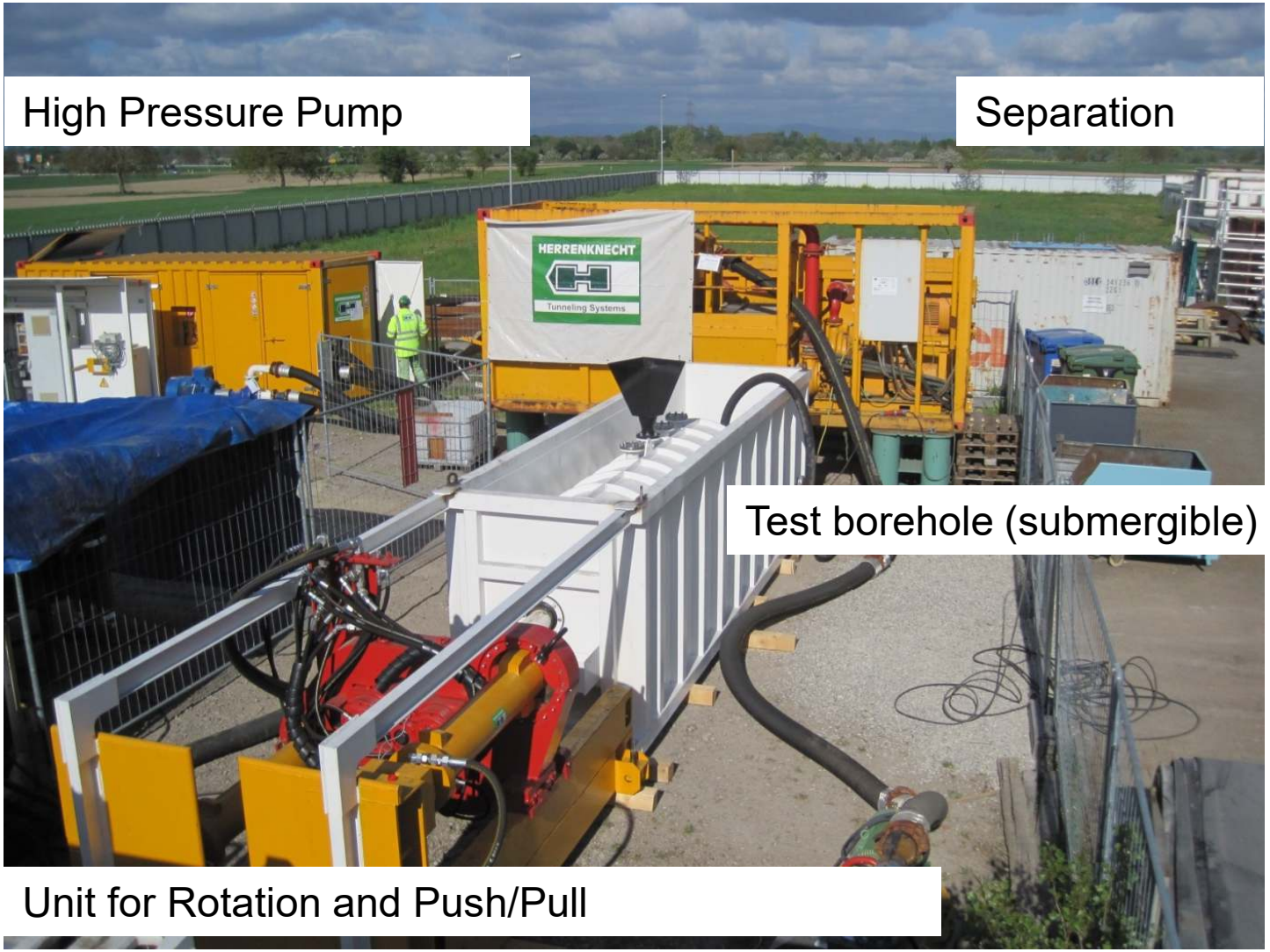
Jet Pump for HDD.

New: drill pipe used as discharge line.



Herrenknecht Testing Facility.

Jet Pump tests.



Herrenknecht Testing Facility.

Jet Pump tests.

- 1000m (3280 ft) of discharge line circuit

Jet Pump for HDD.

Reference Project: Malmö Harbor Channel Crossing.

- H-165, HK150C Crawler Rig
- Location: Malmö, Sweden
- Project: District Heating Pipeline
- Drilling length: 850ft. (263m)
- Pipeline: 40“ HDPE casing pipe with inner steel pipeline for heat transport
- Geology: hard limestone, flintstones
- Contractor: BAB Rörtryckning AB

Jet Pump for HDD.

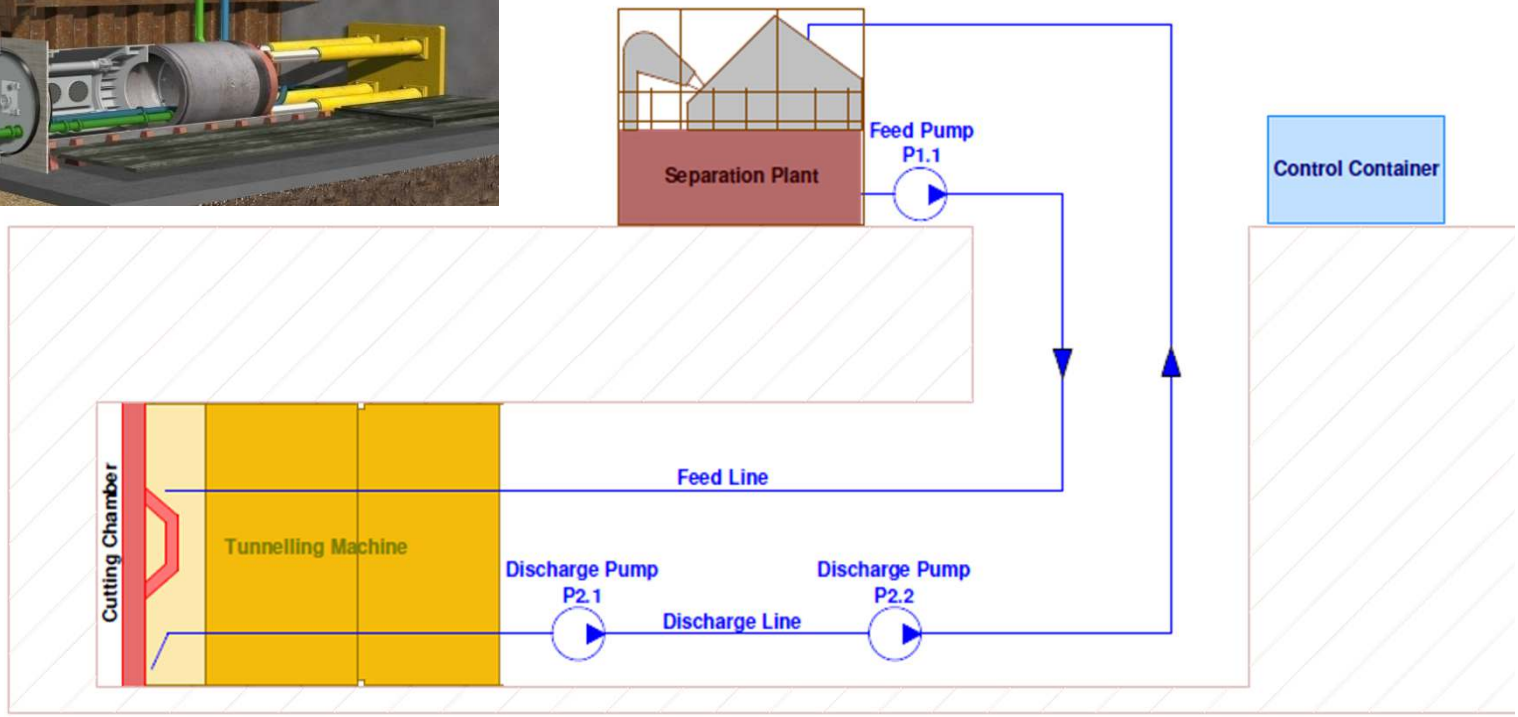
Benefits overview.

- Minimum frac-out risk during reaming
- Possibility to use a simple and cost saving mud program
- 98% clean borehole
- Immediate formation feedback on the separation plant (1000m = 3280ft = 7 min)
- Transportation of larger cutting sizes
- full-face reaming possible
- Works with non or partially filled boreholes
- Defined return flow direction

- Flow amounts (in & out the borehole) can be simply monitored and logged
- Direct connection of the mud flow to the recycling unit (No mud pit pump necessary)

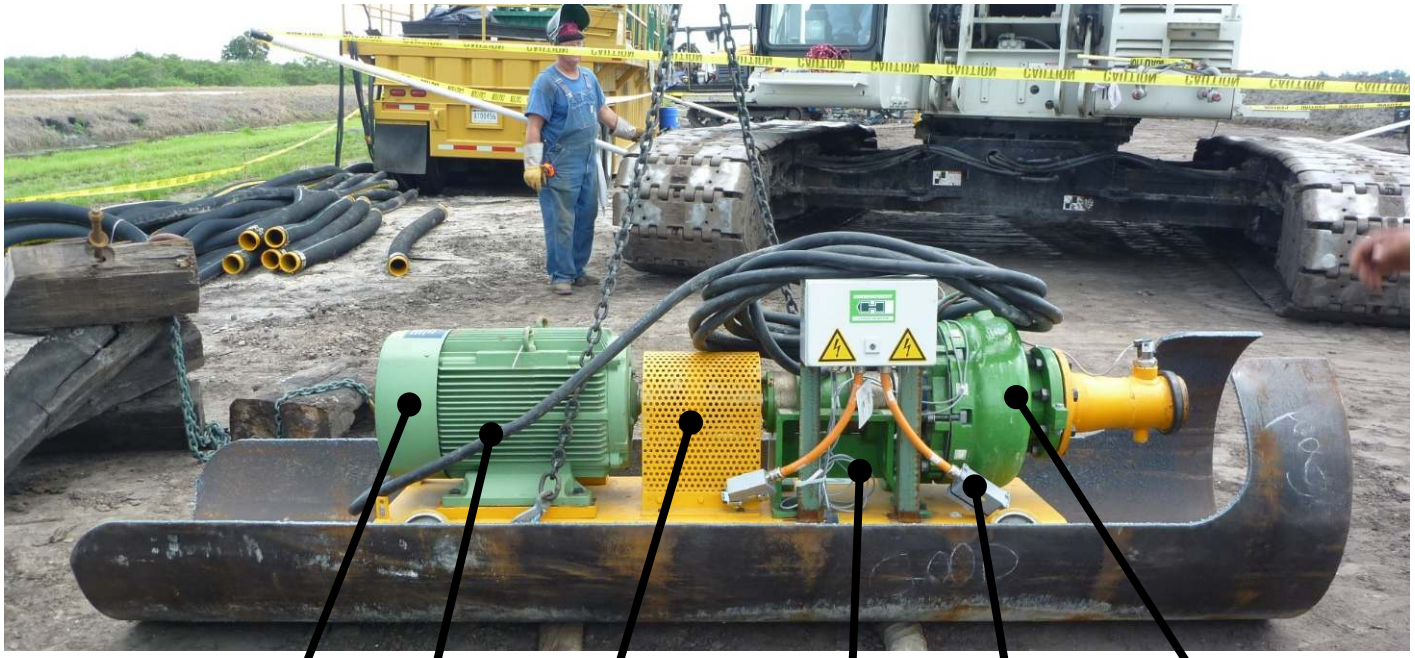
Jet Pump for Pipe Jacking.

Slurry circuit in Pipe Jacking.



Jet Pump for Pipe Jacking.

State-of-the-art centrifugal slurry pumps.



Discharge port

Electric motor

Power supply cable

Clutch

Seal package

Signal cable

Centrifugal pump

Feed port

Jet Pump for Pipe Jacking.

As alternative to centrifugal slurry pumps.

Jet Pump for Pipe Jacking.

Test project in Hannover, Germany.

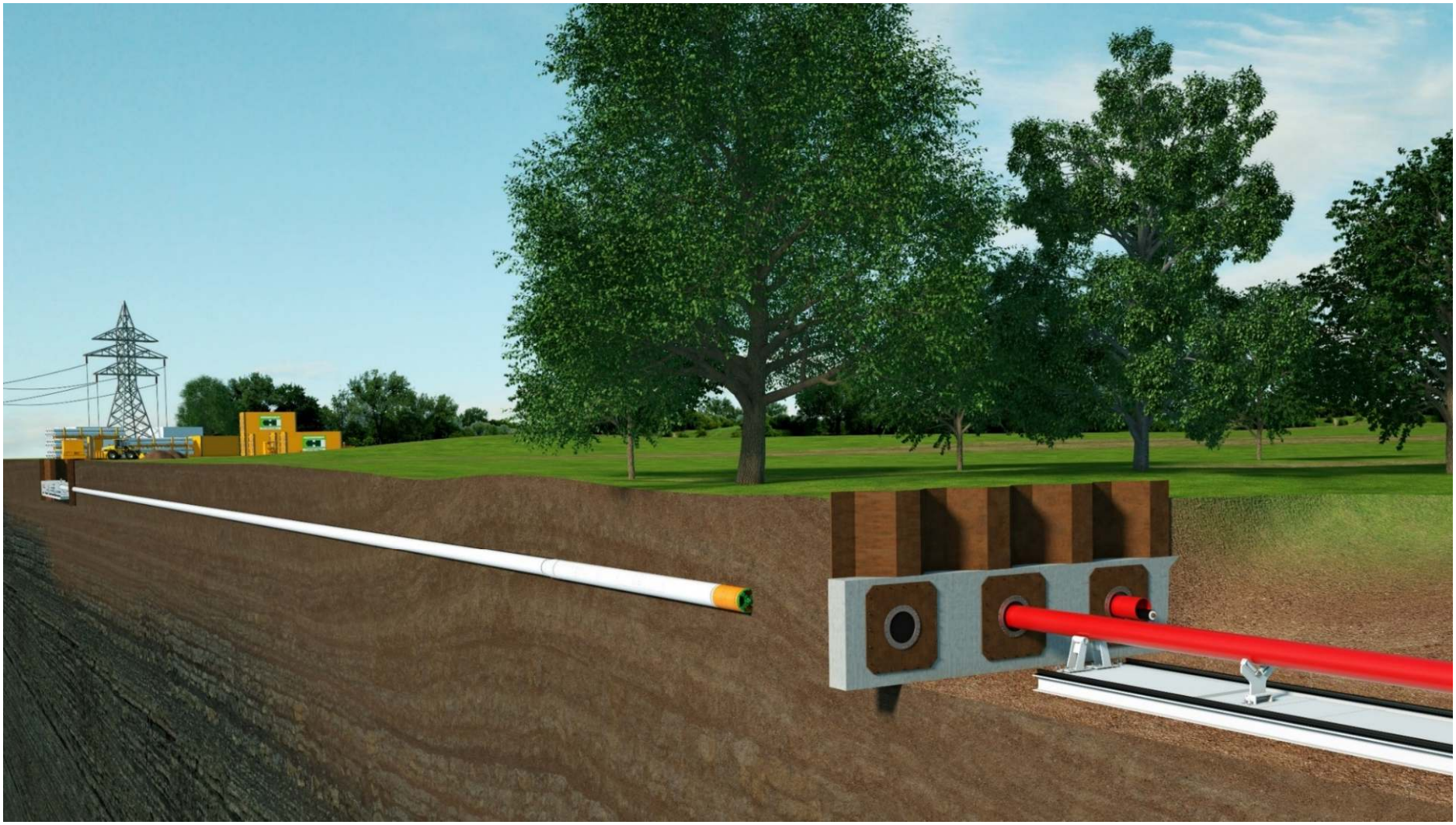
- Machine: AVN 700 with jet pump in machine can no. 3
- Drive length: 120m (394 ft),
- Installation depth: 4.5m (15 ft)
- Geology: Sand, Clay

Jet Pump for Pipe Jacking.

Test project with AVN 700 in Hannover, Germany.

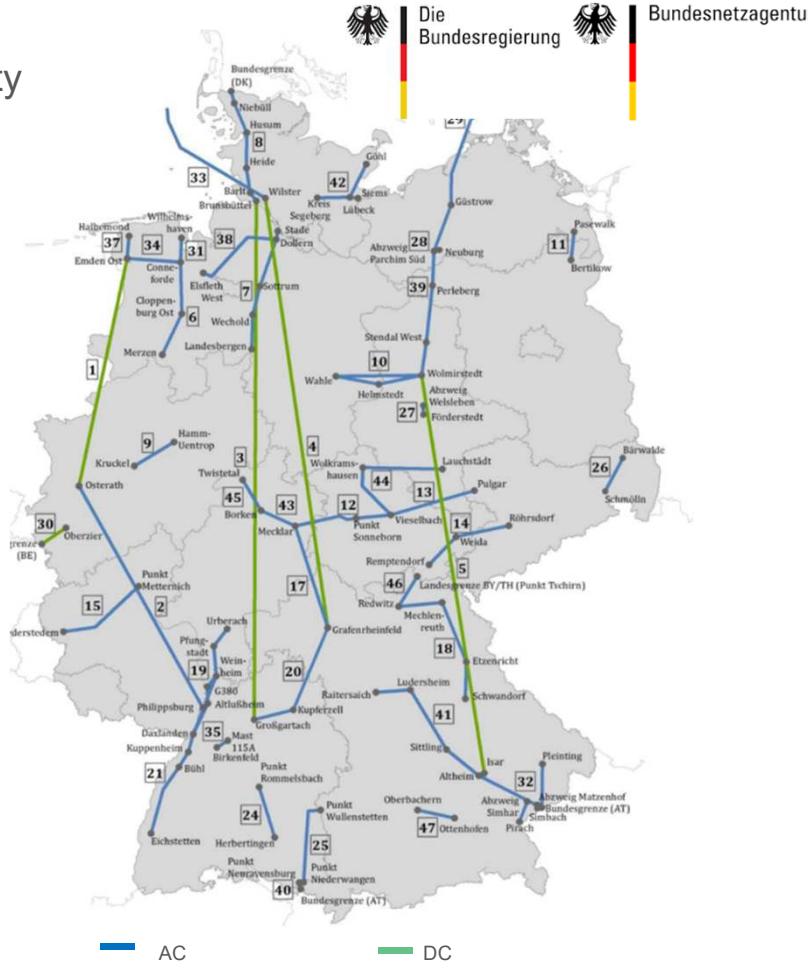
- Machine: AVN 700 with jet pump in machine can no. 3
- Geology: Clay with sand

EPOWER PIPE



High Voltage Power Grid in Germany.

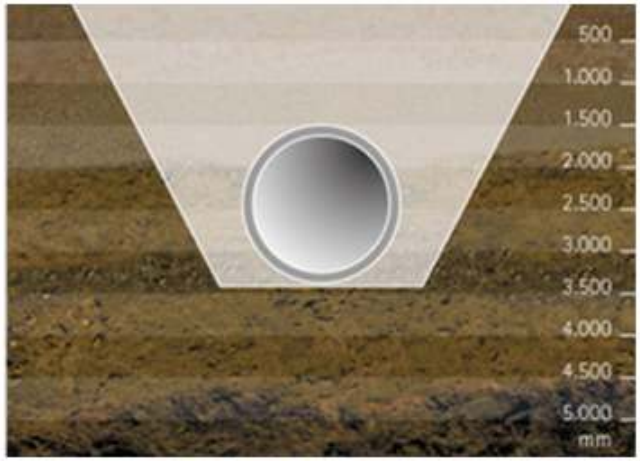
- Intention to replace nuclear power plants with renewable energy until 2025.
- Electrical power grid extension to connect the windfarms in the North Sea with the industry in the south. (underground cable priority for DC)
  - North – South connections (New DC lines) as underground cables
    - 1.500 to 2,250km (900 – 1,600 mi.)
  - Overhead lines use AC technology under special conditions (e.g. distance protected areas), underground lines favor DC.
  - Protests against overhead lines lead to trenchless technology.
  - **Commissioning of North-South connections in 2025 (formerly 2022)**



Underground cable installation.

Installation methods.

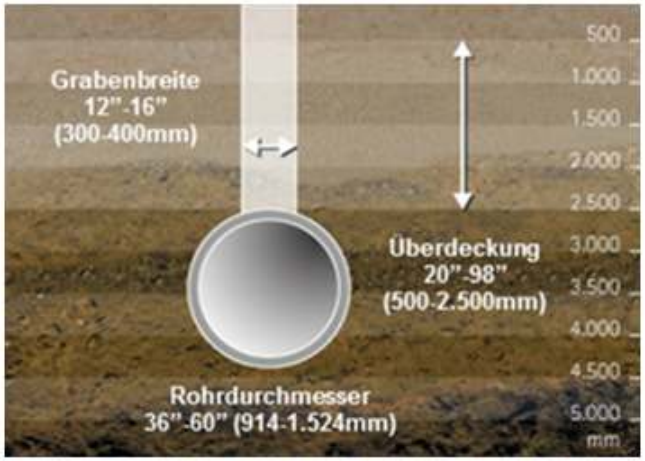
Open Trench



Application

Shallow installation
mostly soft ground
Rural area

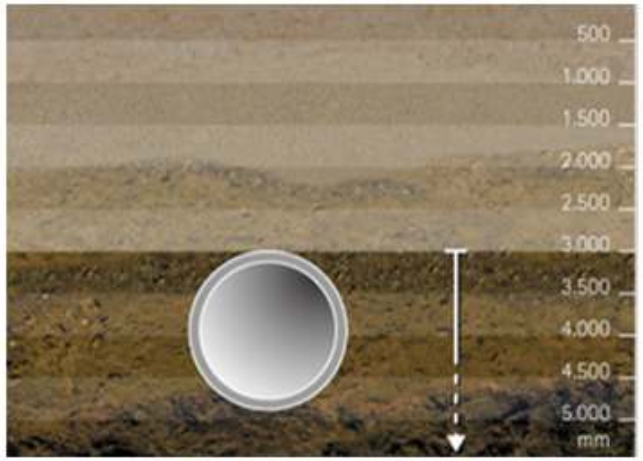
Semi-Trenchless



Application

Shallow installtion
Soft & mixed ground
Rural/less populated area

Trenchless



Application

Deep installation
All ground conditions
Urban area/ river crossings

Conventional Open Cut installation method.

Example Project Raesfeld.

Conventional Open Cut installation method.

Not possible for crossing of waterways and protected areas

Conventional Open Cut installation method.

Not possible for crossing of waterways and protected areas

Example Project Raesfeld

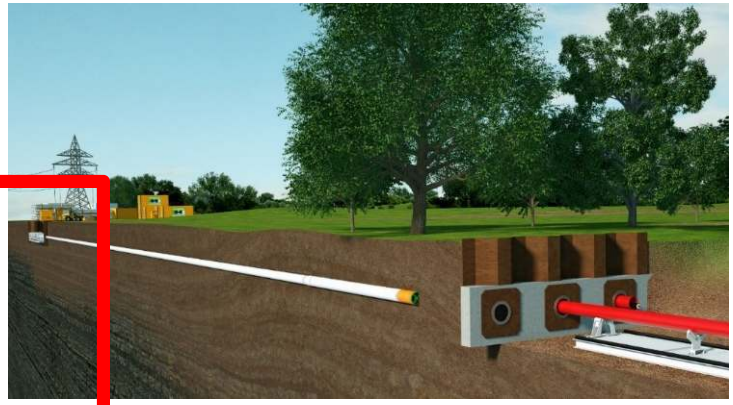
High Voltage Power Cable Installation.

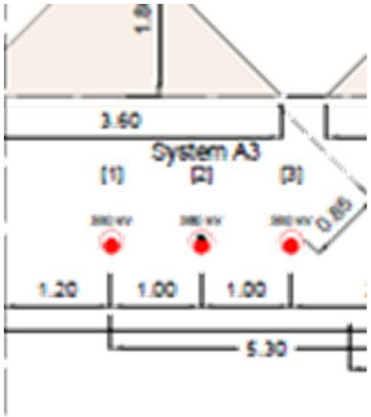
by Transition System Operator (TSO).

- Limited job site, construction roads, preparation area
- No heavy equipment between launch and reception point
- Steerable installation of casing pipes for AC & DC lines

Length:	3,300ft – 4.000ft
Depth:	5ft m to 13ft, constant
Diameter casing:	ca. DN10” – 16” (250-400mm)
Casing material :	plastic, non-conductive, e.g. PEHD
Distance between lines:	3ft constant

- Available on market: since 2017





Comparison trenchless installation methods.

Limitations.

POWER PIPE

		SEPARATE INSTALLATION 250 mm ~500mm / 20“			CASING TUNNELS Ø 1,500 mm			CASING TUNNEL Ø 3,000 mm		
Technology:	Ø in mm	Shallow	Accuracy	Length > 1,000 m	Shallow	Accuracy	Length > 1,000 m	Shallow	Accuracy	Length > 1,000 m
› Pipe Jacking	250-4,000	■	■		■	■	■	■	■	■
› Segmental Lining	2,300-4,000							■	■	■
› HDD	250-1,500			■			■			
› Direct Pipe®	700-1,500				■	■	■			
› Pipe Express®	900-1,500				■	■	■			

Jet Pump for Pipe Jacking.

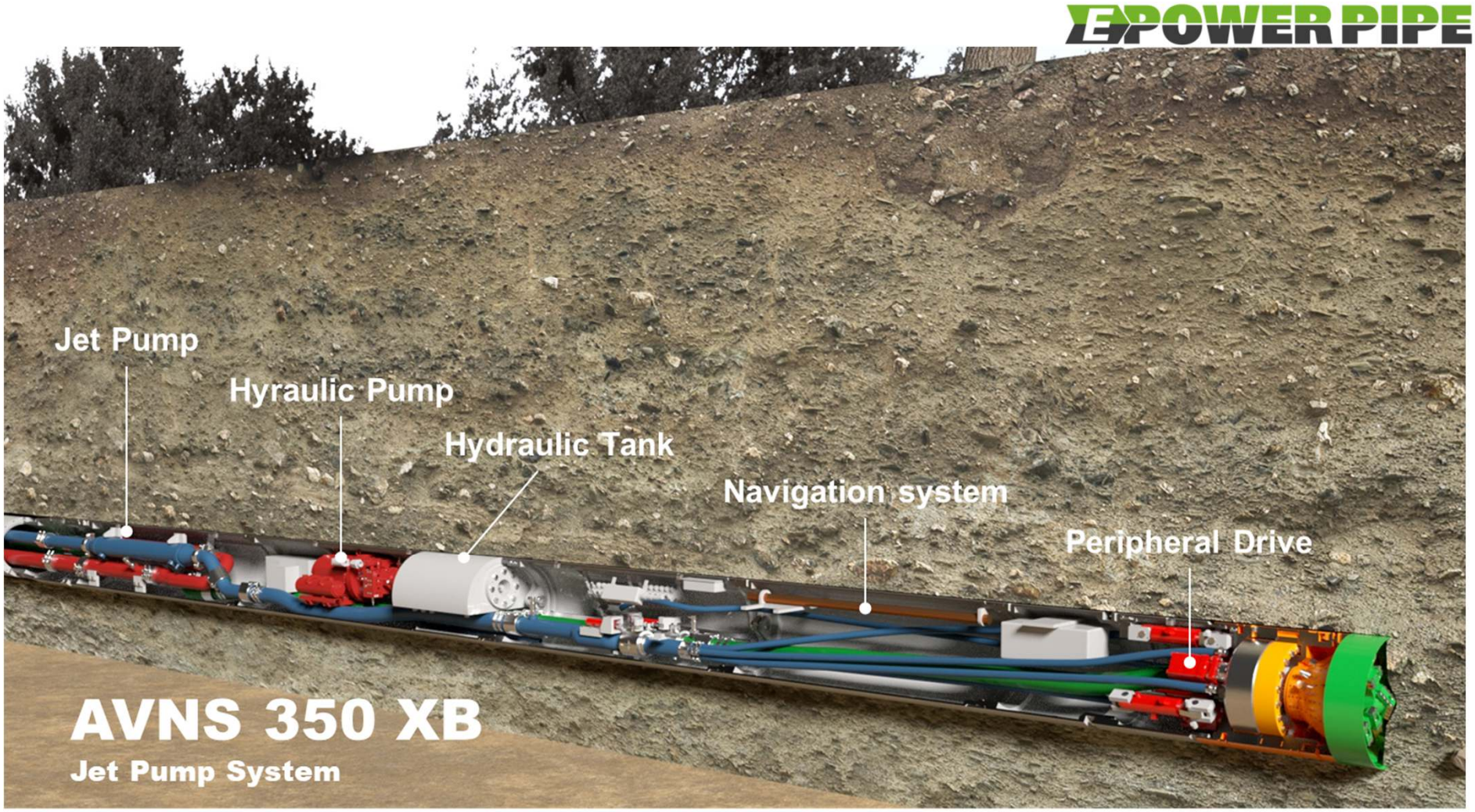
AVNS technology used in E-Power Pipe®.

E-POWER PIPE

		SEPARATE INSTALLATION 500mm /20“			CASING TUNNELS Ø 1,500 mm			CASING TUNNEL Ø 3,000 mm		
Technology:	Ø in mm	Shallow	Accuracy	Length > 1,000 m	Shallow	Accuracy	Length > 1,000 m	Shallow	Accuracy	Length > 1,000 m
› Pipe Jacking	250-4,000	■	■		■	■	■	■	■	■
› Segmental Lining	2,300-4,000							■	■	■
› HDD	250-1,500			■			■			
› Direct Pipe®	700-1,500				■	■	■			
› Pipe Express®	900-1,500				■	■	■			
E-POWER PIPE	250-700	■	■	■						

Jet Pump for underground cable installations.

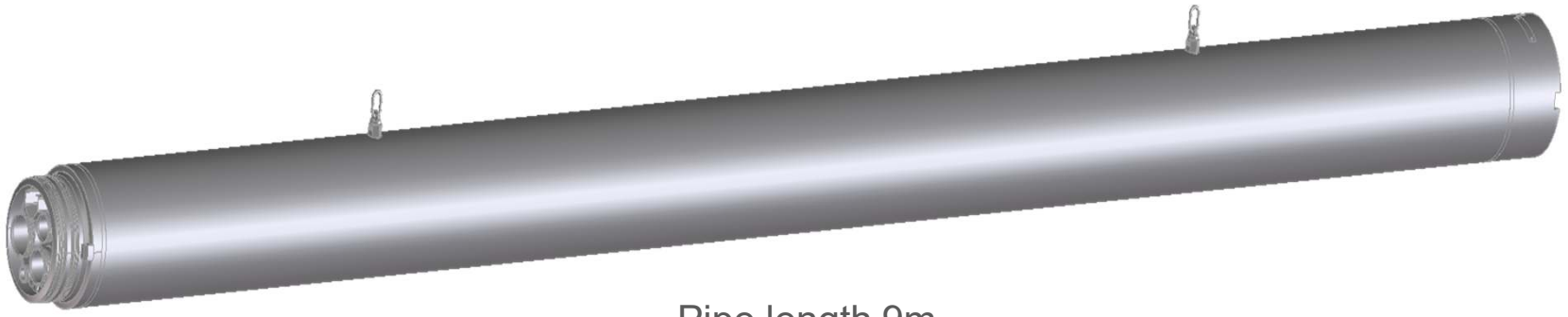
AVNS technology used in E-Power Pipe®.



POWER PIPE

New development E-PowerPipe®

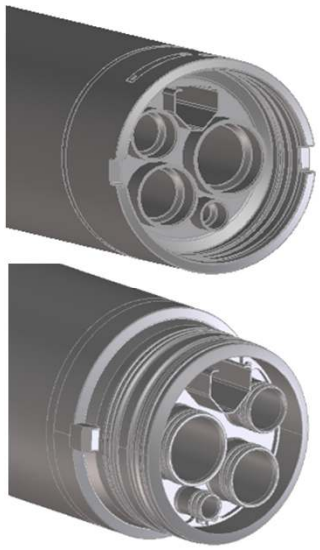
New steel jacking pipes.

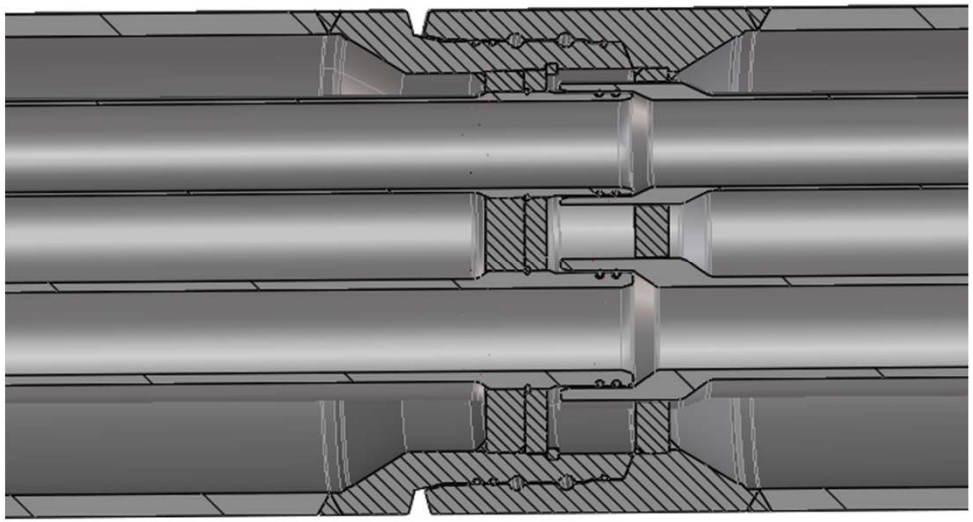


Pipe length 9m

Characteristics

- Smart coupling system
- All pipes and cables integrated
- Less couplings
- Life time

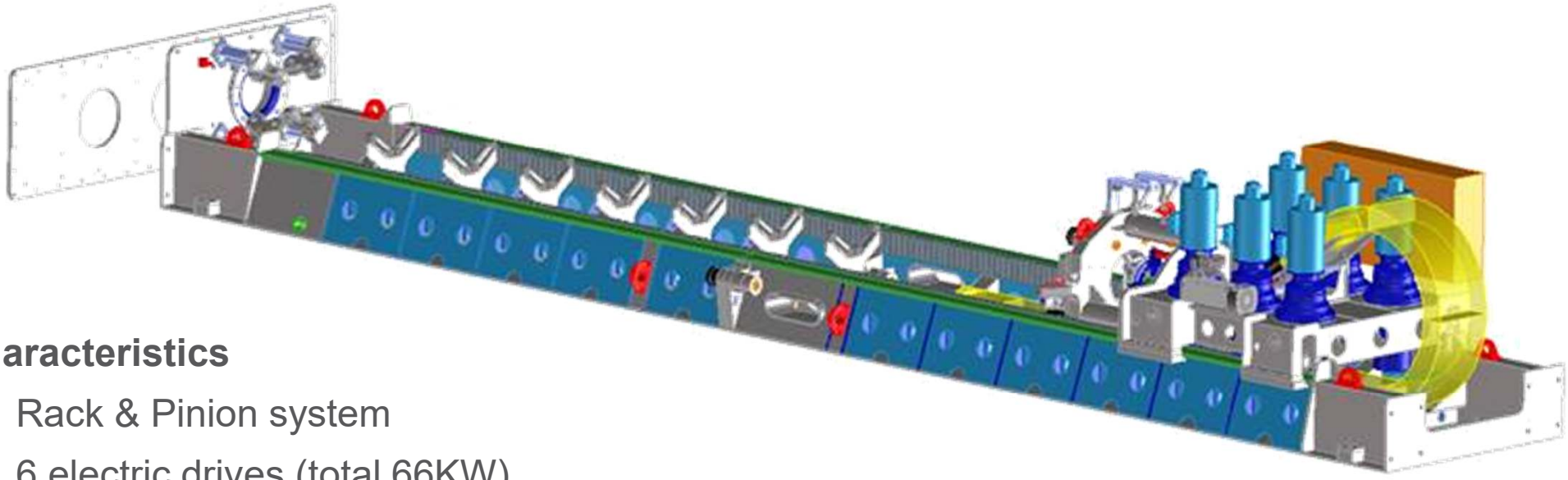




New development E-PowerPipe®

New jacking frame.

E-POWER PIPE



Characteristics

- Rack & Pinion system
- 6 electric drives (total 66KW)

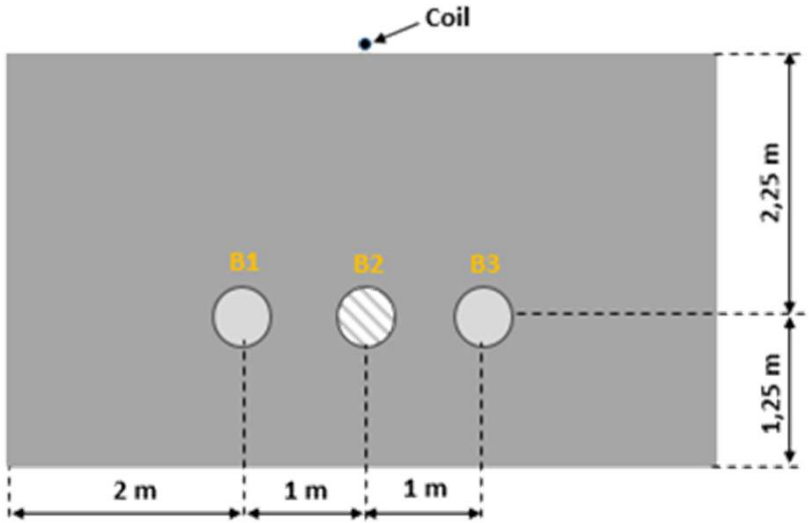
Advantages:

- Fast push and pull operation (max. 5m/min)
- Max. thrust and pull force 340to
- All coupling steps in one operation


POWER PIPE
Implenia
Implenia
KASSECKER

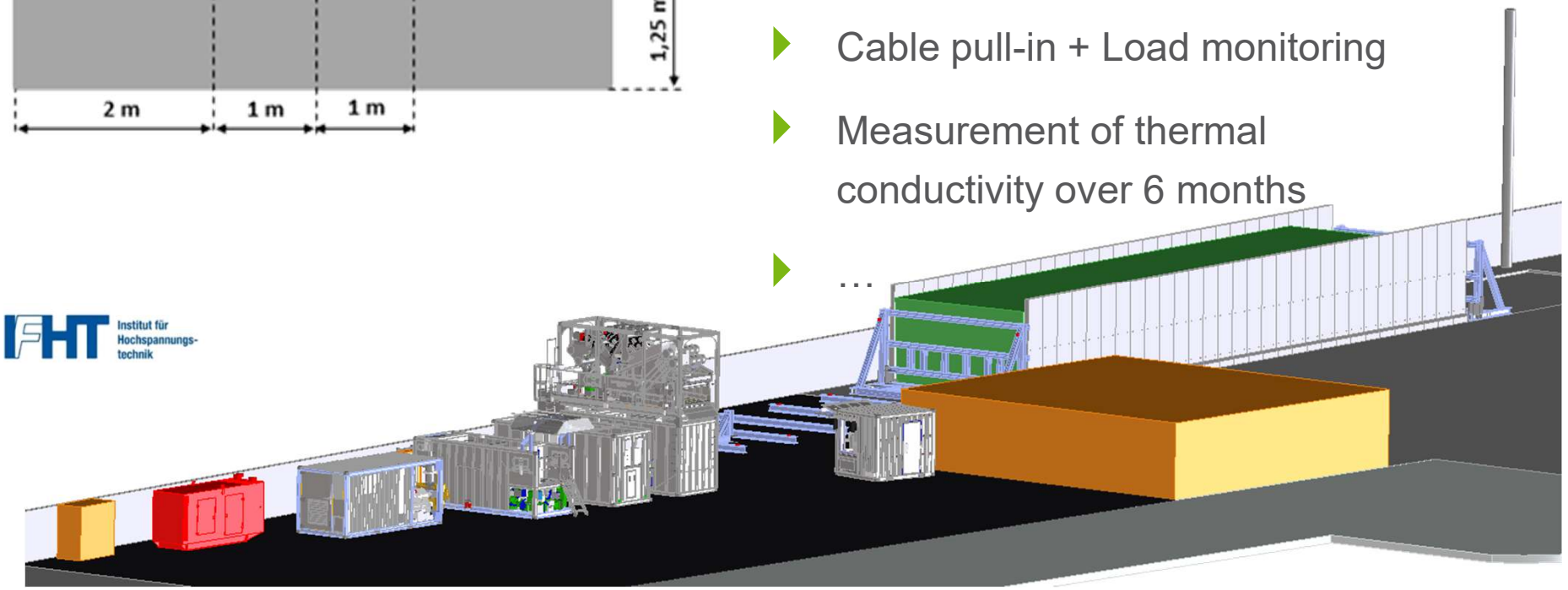
Tests in Schwanau Nov./ Dec. 2016.

Test plant.



Test criteria:

- 6 drives
- different soil composition, distance, depth
- Construction process
- Cable pull-in + Load monitoring
- Measurement of thermal conductivity over 6 months
- …



Tests in Schwanau Nov./ Dec. 2016.

Test plant.

EPOWER PIPE





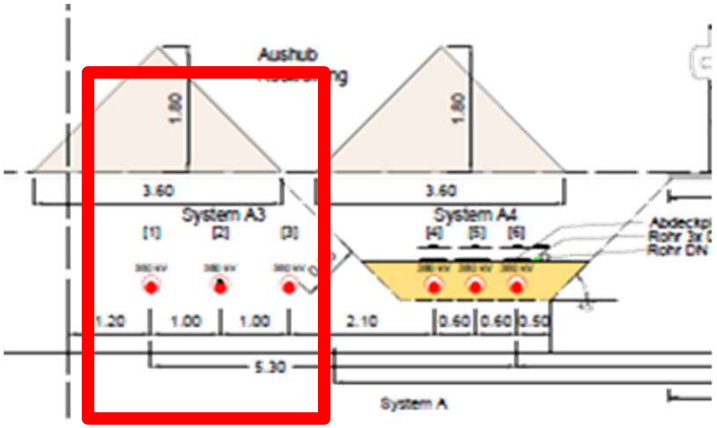


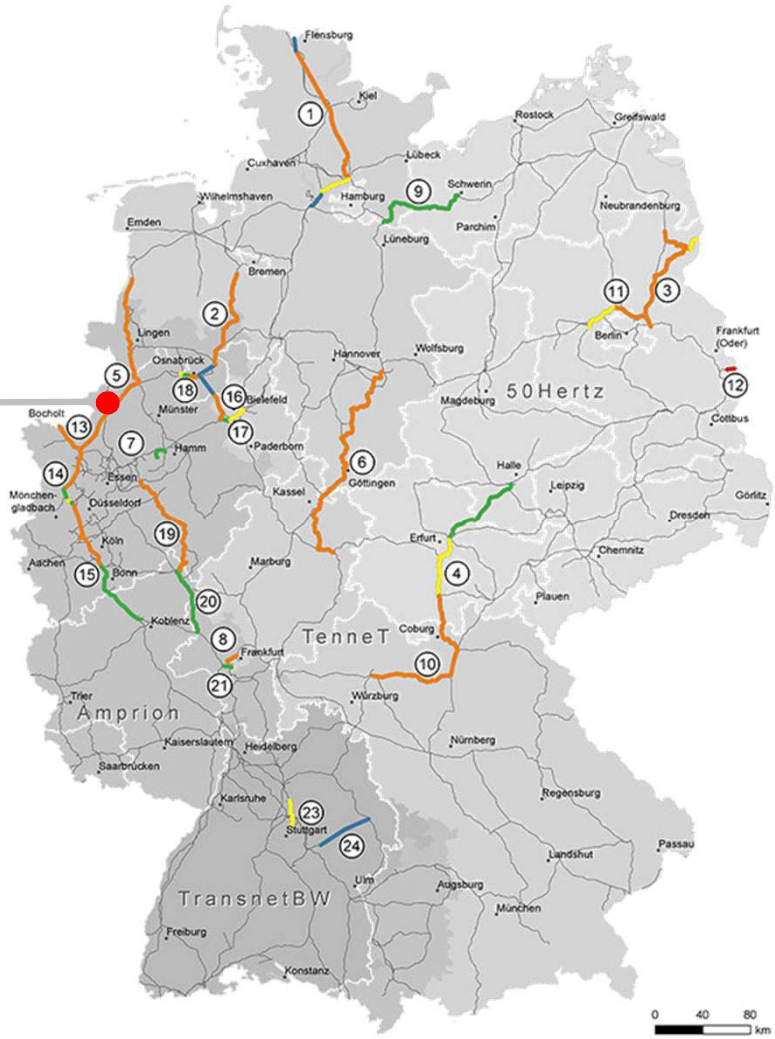

IFHT Institut für Hochspannungstechnik

Pilot project February/March 2017.

Amprion – Project Borken.

- 3 x 1,000ft (300 m)
- Mostly silt, sand, marl
- Constant depth of 3ft
- Spacing of approx. 30”





Federal Ministry of Economics and Technology

amprion

nicht im Genehmigungsverfahren | im Raumordungsverfahren | vor oder im Planfeststellungsverfahren
genehmigt oder im Bau | realisiert | Übertragungsnetz | ⑦ lfd. Nr. des Vorhabens

Pilot project February/March 2017.

Performance Data.

- Drive length: 300m (1,000 ft)
- Geology: sand, little gravel, fine sand / silt on second half of the drive
- Ø Performance: ~ 800mm/min (2.6ft/min)
- Max. Performance: > 1,200mm/min (4ft/min)
- Best daily performance: 126m (414ft)
- Pipe changing cycle: ~ 20min constant
- Jacking forces: mostly < 60to

Pilot project February/March 2017.

Jobsite Layout.

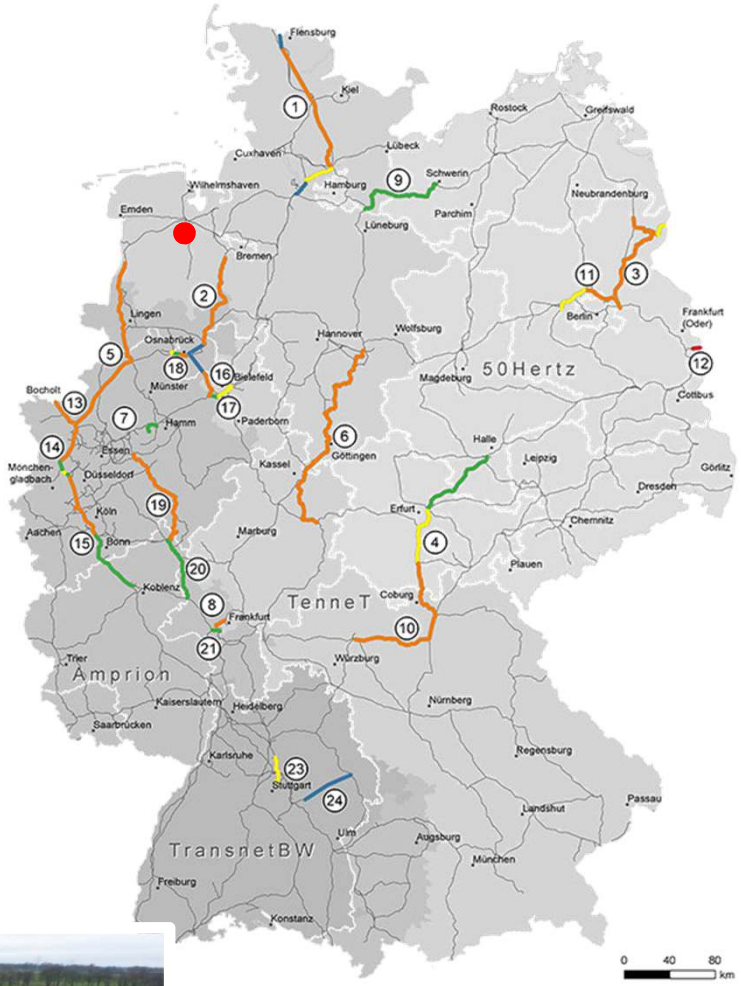
Pilot project February/March 2017.

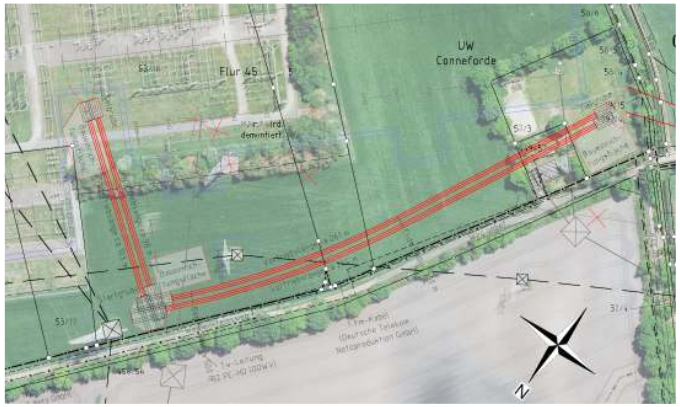
Jobsite Impressions.

New development E-PowerPipe®

Second project in Conneforde, Germany.

- 6 x 300m (1,000ft)
- Mostly silt, sand, marl, boulders
- Curved drive, radius 500m
- Constant depth of 1m (3ft)
- Spacing of approx. 1m





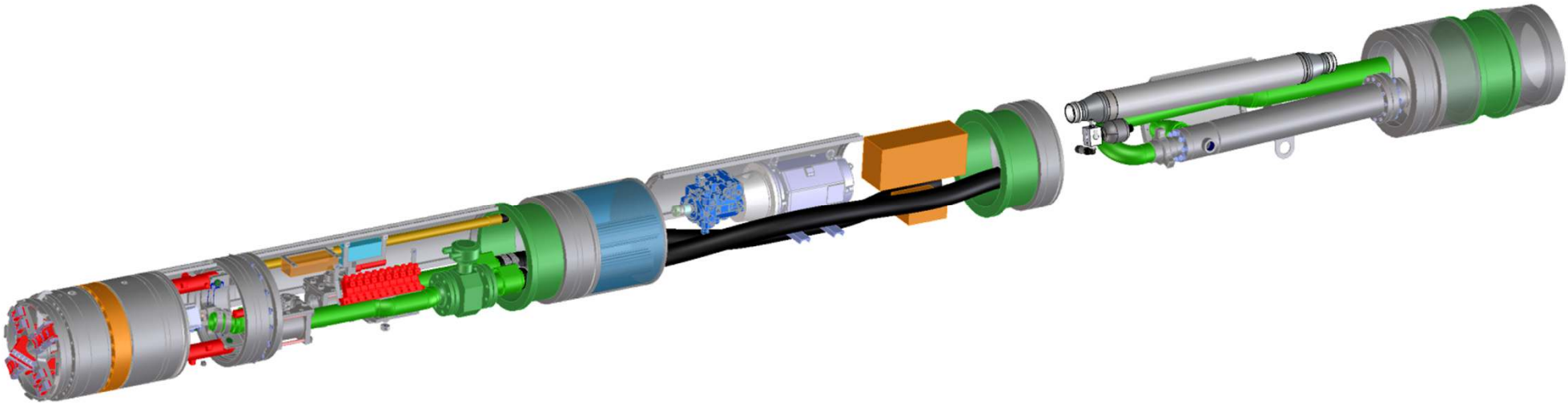
New development E-PowerPipe®

Second project in Conneforde, Germany, January 2018.

- Project: 6 x 270m (890ft) drives
- Installation depth: 2.5-4.5m (8-15ft),
- curve radius : r=500m (1,640ft)

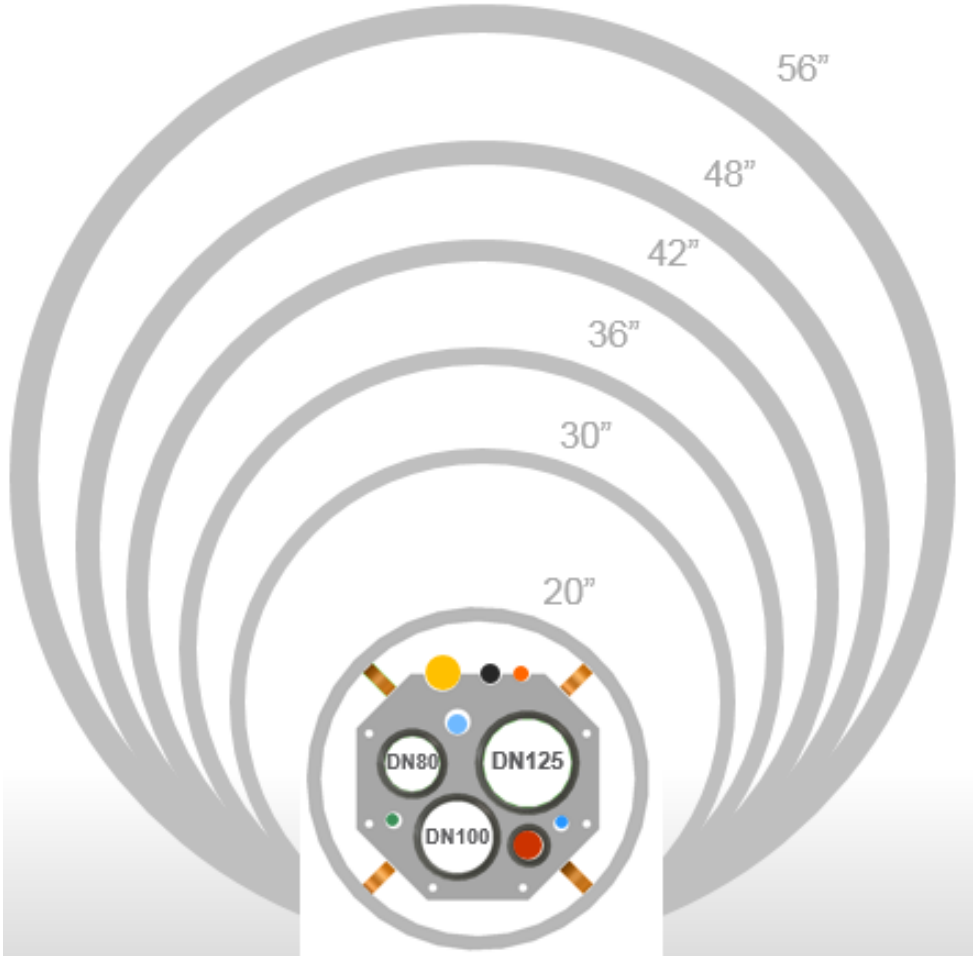
Conclusion | Outlook.

- Jet pump for **HDD**
  - Ideal for higly permeable soils.
  - Ideal for cleaning runs before the pipe pull in.
- Jet pump for small diameter **Pipe Jacking** (long distances)
  - **E-Power Pipe®** for shallow cable installations
  - New projects with long distances are already in line



Outlook for Jet Pump and Direct Pipe®

- Jet pump for **Direct Pipe®**
  - Beneficial for long distance crossings and small diameters <36




THINK
POSITIVE!
Together we build our future.
HERRENKNECHT
Tunnelling Systems