

HYDROPOWER TUNNELLING

Underground Solutions Provider

CREG TBM

China:
China Railway Engineering Equipment Group Co., Ltd.
E-mail: info_intl@crectbm.com
Tel: +86 0371 6581 5987
Address: No.99, 6th Avenue National Economic & Technical Development Zone 450016 Zhengzhou, Henan Province People's Republic of China

Southeast Asia:
China Railway Engineering Equipment Group Co., Ltd.
Singapore Branch
E-mail: info_singapore@crectbm.com
Tel: +65 6747 8091
Address: 1004 Toa Payoh North, #06-15/16/17, Singapore 318995

Korea:
CREG Co., Ltd. South Korea Branch
E-mail: info_korea@crectbm.com
Tel: +82 010-2156-8662
Address: No.1521, Building B, Terra-tower, 651, Songpa-gu, Seoul, Republic of Korea

Europe & South & North Americans:
CREG TBM Germany GmbH
E-mail: info@creg-germany.com
Tel: +49 211 52288900
Address: CREG TBM Germany GmbH Willstätterstraße 15 40549 Düsseldorf Germany

Italy:
China Railway Engineering Equipment Group Co.Ltd
Italy Branch
Email: creg.italy@legalmail.it
Address: Viale Giuseppe Mazzini 55, 00195 Roma

Oceania:
CREGA Australia Office
Email: info@crega.com.au
Tel: +612 9698 0018
Address: Unit 1, 118 Bourke Road Alexandria NSW 2015 Australia

Make Tunnelling Safer,
Better and Faster

Underground Solutions Provider

In the development of water resources in rivers, the construction of hydropower tunnelling can effectively utilize the height difference of the terrain, maximize the conversion of the potential energy of water into electrical energy, optimize the allocation of water resources, stabilize the water supply flow, reduce the damage to the surface environment and minimize the interference with the river ecology.

As an equipment manufacturer that best understands construction and a comprehensive service provider that is most proficient in manufacturing, China Railway Engineering Equipment Group Co., Ltd. adheres to a customer-centered concept and is committed to providing customers with all-round comprehensive solutions. With the help of tunnel boring machines of different diameters, it can make tunnel construction under various geological conditions safer, better and faster.

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CREG's innovative compact TBM has negotiated 30 m radius curve at drainage tunnel of Wendeng Pumped Storage Power Project.

Cover photo:
Large scale machinery helps mankind to exploit water resources for renewable energy more efficiently.

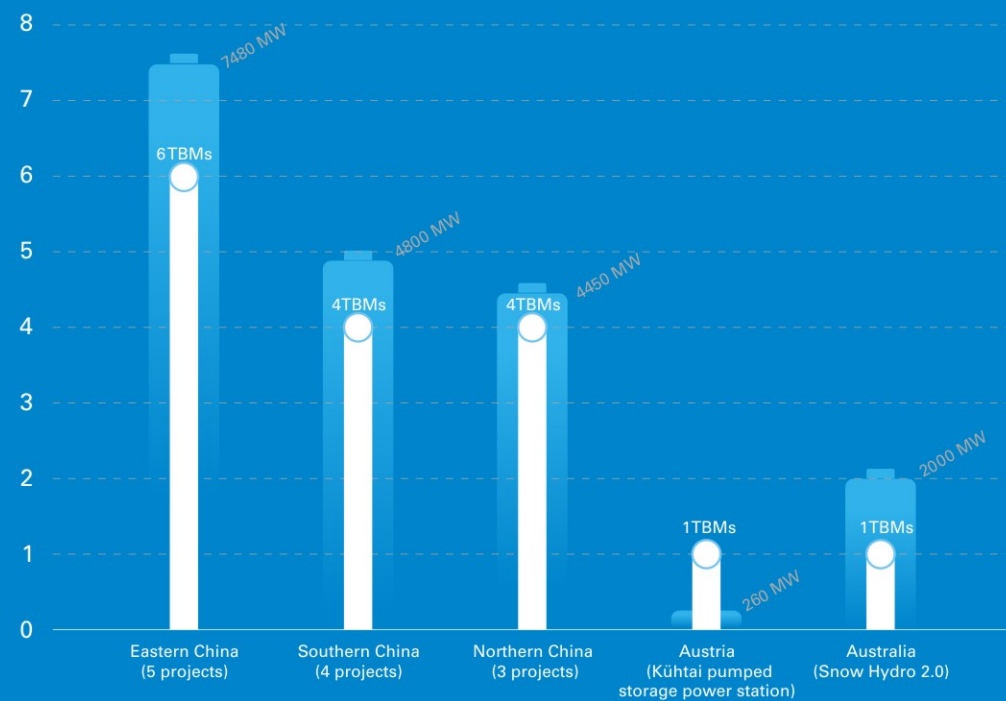
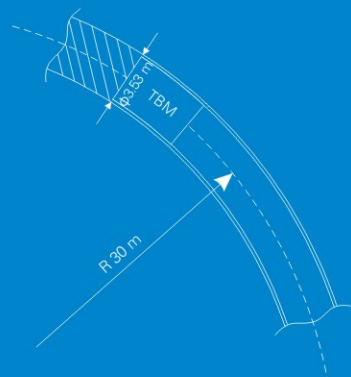
As small as

30m

turning radius CREG TBMs with diameter ranging from 3.5 to 11.09 meters have been put in construction of tunnels for hydropower plants with a total capacity of more than

20,390 MW

at home and abroad, contributing to producing green and renewable energy worldwide.



Make Tunnelling Safer, Faster and Better



Hydropower Tunnel Construction

Leading technology and expertise worldwide guarantee safety and efficiency of tunnel construction

Various types of CREG TBM facilitate the construction of hydropower tunnels worldwide. In these projects, more than 60 kilometers of hydropower tunnel around the world have employed the innovative tunnel boring technology of CREG. Based on solid professional knowledge and rich experience, CREG works closely with customers to develop tailor-made technical solutions to overcome all challenges and build robust tunnel structures while maximizing the safety of personnel and the environment as well as controlling budgets and schedules.

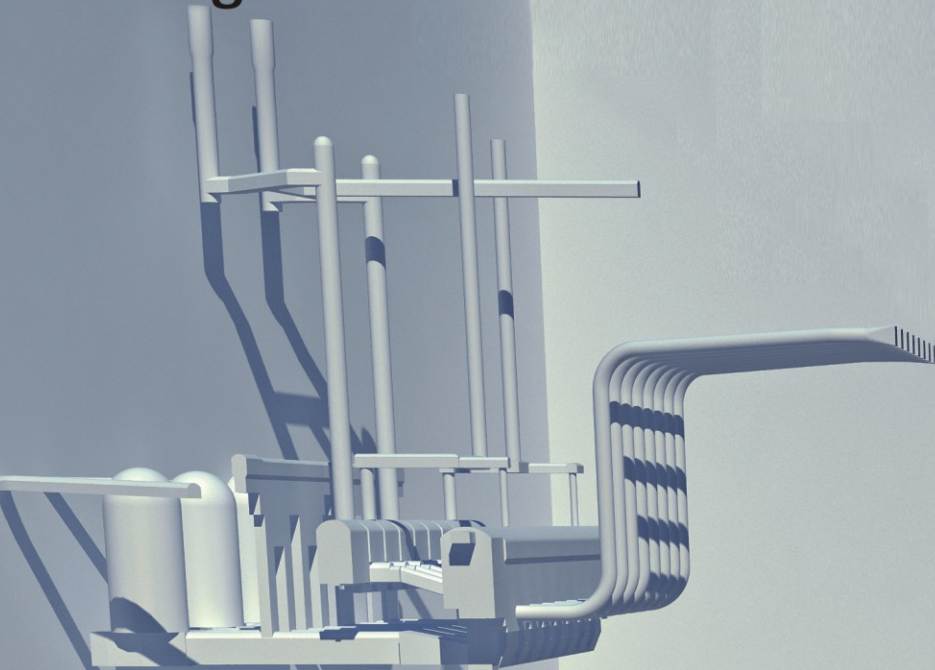
As the world's largest supplier of tunnel boring machines, CREG provides customers with products and services of the highest standards of technology and quality, combined with fast and comprehensive service. CREG pays special attention to teamwork and works hand in hand with all parties involved throughout the project.

CREG has completed more than 1,200 projects around the world in the fields of metro, road, railway, utility, hydropower and mines. CREG's tunnel boring technology is adaptable to all types of tunnels, pipelines, shafts in all geological conditions, with diameters ranging from 1 meter to 16 meters. Advanced technologies from CREG are used to build new infrastructure and help improve people's lives.

Make Tunnelling Safer, Faster and Better

HYDROPOWER TUNNELLING

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Double Shield TBM

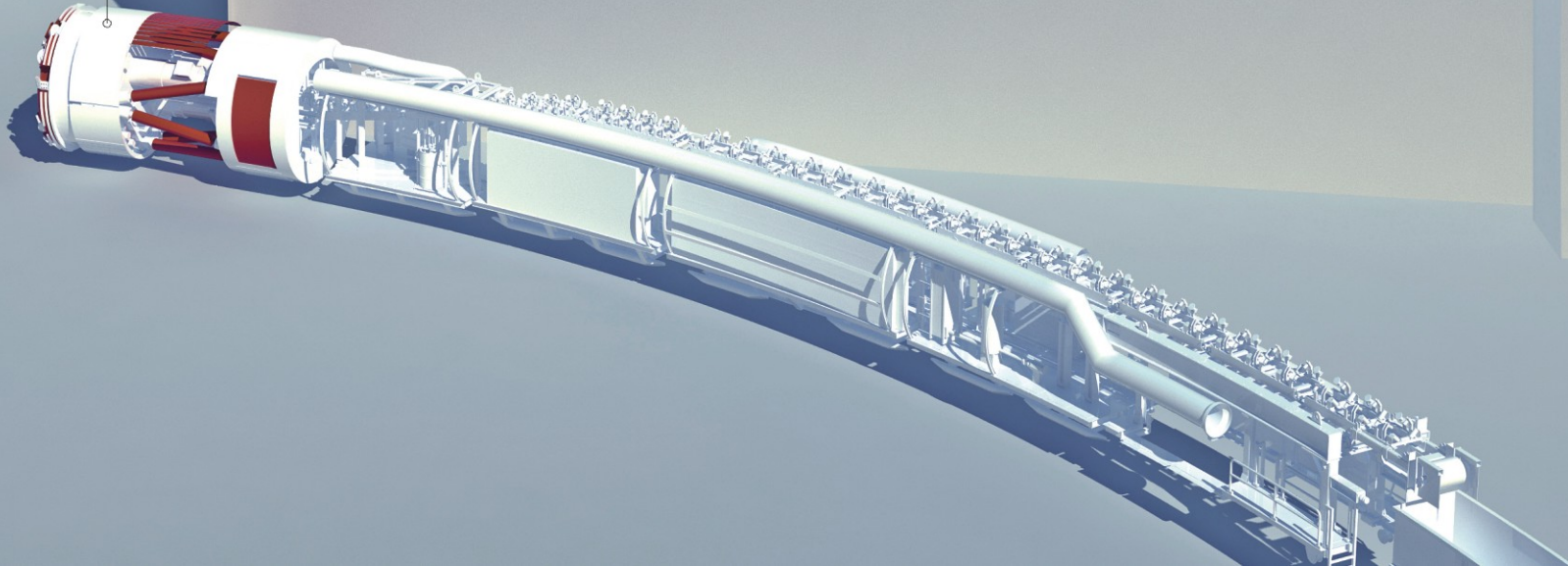
Application Scenario:

- Water diversion tunnel
- Drainage tunnel

Vertical Shaft Sinking Machine (VSM)

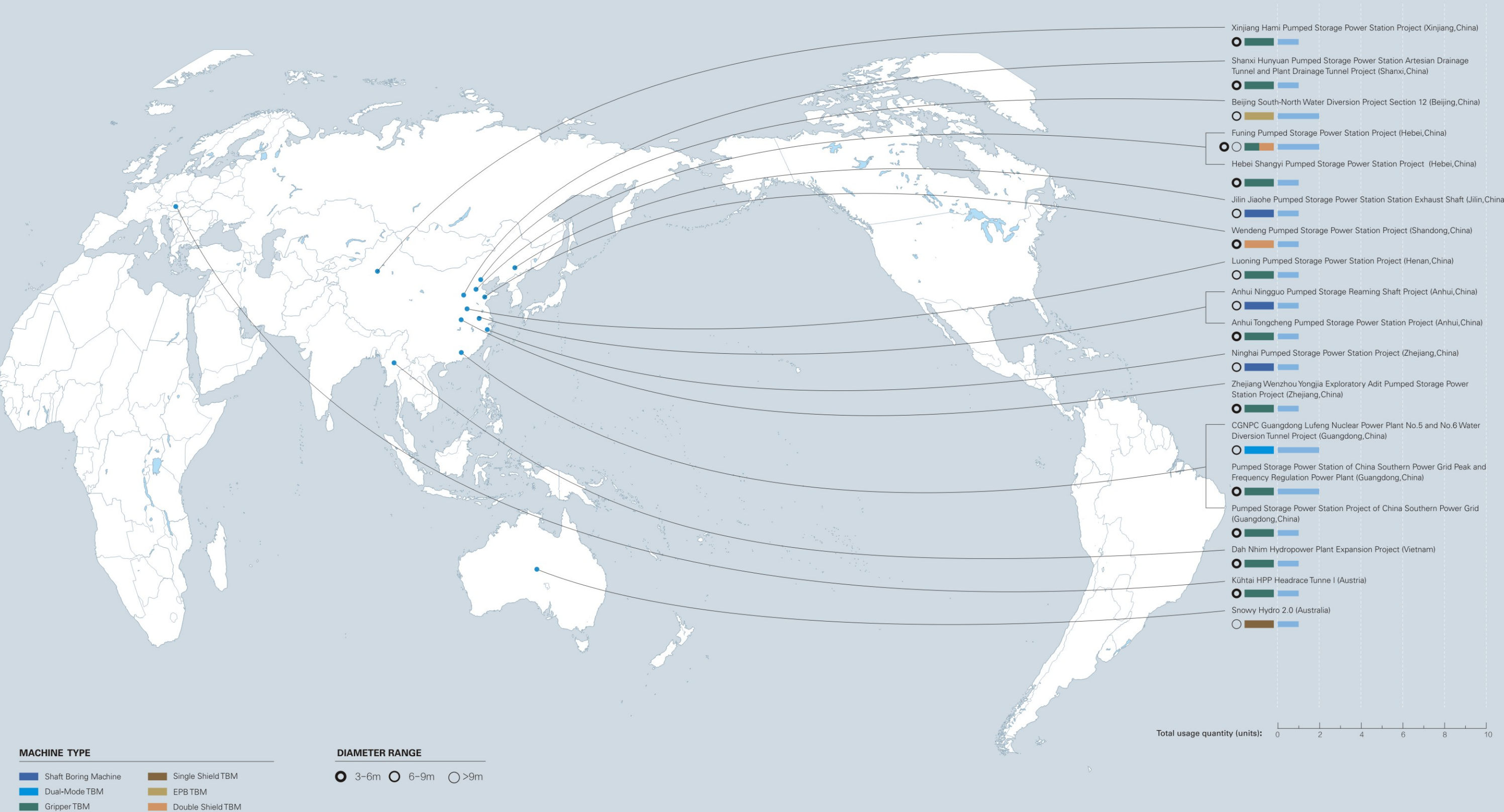
Application Scenario:

- Ventilation shaft
- Rescue shaft



GLOBAL VISION

To provide high-quality products for the world
Underground engineering equipments and services



Ninghai Pumped Storage Power Project

Introduction of TBM method to vertical shaft construction

Application of the concept of tunnel excavation to vertical shaft construction, realizing the mechanized, intelligent and factorial construction of large blind vertical shaft projects.

Project Information

- › Tunnelling length: 198m
- › Geology: Tuff
- › Contractor: Sinohydro Bureau 12 Co., Ltd.

TBM Parameter

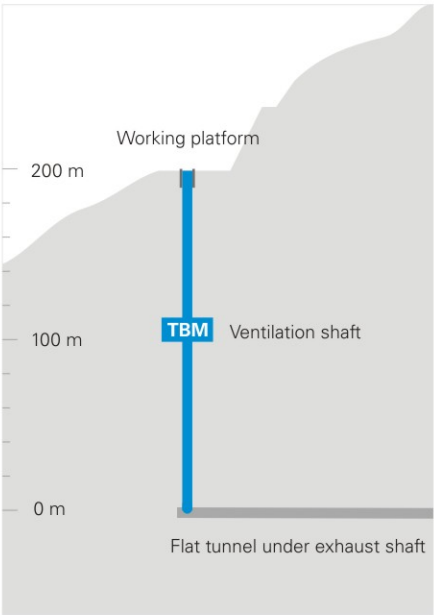
- › TBM type: Shaft Boring Machine (SBM)
- › TBM S/N: CREC 599
- › Boring Dia.: 7.83 m
- › Main drive power: 1,500 kW
- › Best performance: 4.82m per day

Project Characteristics

- › It faces the difficulty of upward muck discharge in blind shaft.
- › It's the first application of TBM concept to vertical shaft construction in China.
- › Advanced technologies help to save labor cost while enhancing tunnelling efficiency.

Project Background

The full-face excavation mechanical synchronous mucking system has higher efficiency and lower energy consumption compared with traditional mucking methods such as the slurry and vacuum ones, and has successfully solved the international problem of synchronous construction of excavation and mucking. The pioneering shaft remote control system, has improved the safety and comfort of shaft construction.



The SBM has bored 4.82 m per day, much more efficient than the traditional method.



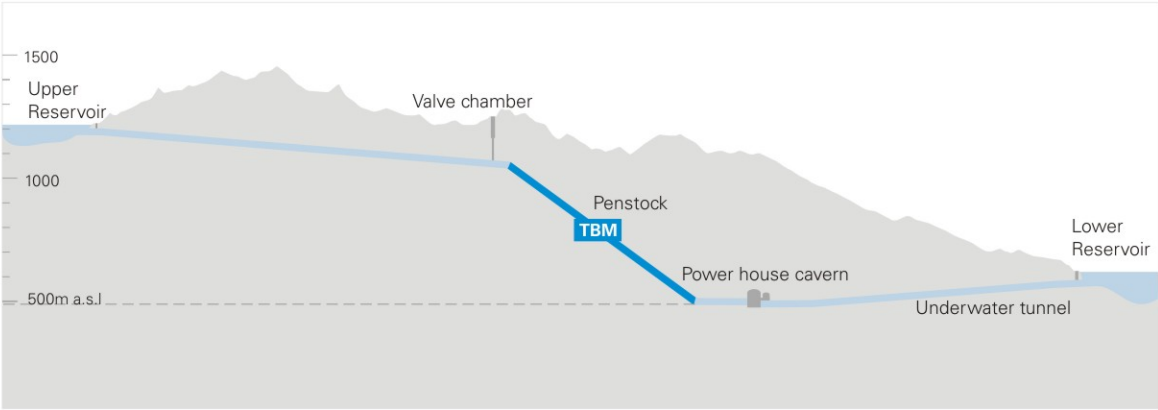
The SBM has completed 198 m deep tunnel and achieved breakthrough.

Luoning Pumped Storage Power Project

Challenging unprecedented 39°upward tunnelling

This project takes the lead in optimizing the upper inclined shaft for water diversion, the middle adit and the lower inclined shaft into a first-level inclined shaft plan, thus creating a new model for the construction of shafts in pumped storage power stations in China.

Project Information	Project Characteristics
› Tunnelling length: 1,800 m › Geology: Moderately weathered granite, fault fracture zone › Contractor: Sinohydro Bureau 6 Co., Ltd.	› Tunneling in large gradient - 38.742° upward › Dual anti-rolling-back system › Special muck chute for safe and efficient muck transfer. › Limited space for TBM assembly at job site.
TBM Parameter	Project Background
› TBM type: Inclined Shaft TBM › TBM S/N: CREC 1158 › Boring Dia.: 7.23 m › Main drive power: 2,800 kW › FAT date: August, 2022 › Best performance: 22.75 m per day, 332 m per month	The breakthrough of the inclined shaft for the water diversion of the pumped storage power station has refreshed a new record for the mechanized construction in the field of pumped storage power station construction in China, and witnessed the birth of a new model for the fully mechanized cross-section excavation of inclined shafts in China.



Vertical section of Luoning Pumped Storage Power Project



The project has created a new method of construction of pumped storage power station.



Large gradient has posed numerous difficulties to TBM tunneling.

Snowy Hydro 2.0

TBM serves the renewable energy project in Australia

Snowy Hydro 2.0 is a trans-regional water transfer project in Australia. In view of the engineering characteristics of the project, such as large excavation diameter, large overburden, high rock strength, fractured soft rock and downhill tunneling, CREG has adopted targeted designs, including heavy-duty hard rock cutterhead, shield body

anti-torsion devices and anti-slope drainage systems, enabling it to quickly deal with unfavorable geological conditions in advance. Meanwhile, the TBM is designed in accordance with CE standards and Australian standards in aspects such as safety protection, escape channels, fluid, electrical and hydraulic systems.

Project Information

- › Tunnelling length: 8,600 m
- › Geology:siltstone, sandstone, pyroclastic, conglomerate, sedimentary rock
- › Contractor: Future Generation JV

Project Characteristics

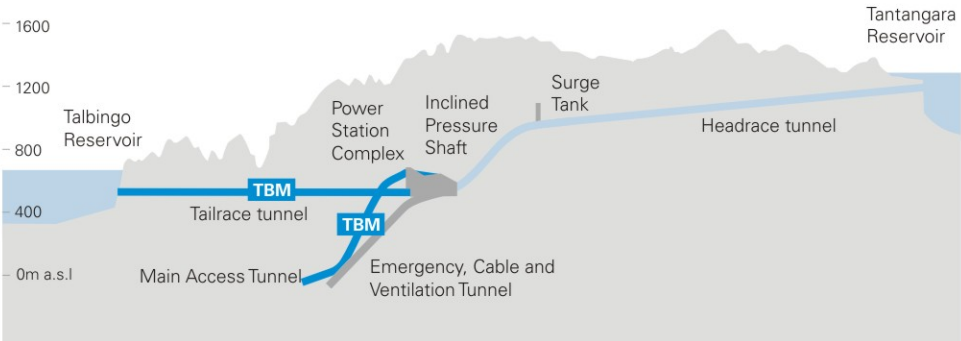
- › The burial depth of the tunnel reaches 723 m.
- › Downhill tunnelling has posed challenges to TBM design.
- › The overall TBM design meets CE standard and Australian standard.

TBM Parameter

- › TBM type: Single Shield TBM
- › TBM S/N: CREC 783
- › Boring Dia.: 11.09 m
- › Main drive power: 4,900 kW
- › FAT date: July,2020
- › Best performance: 26 m per day, 424 m per month.

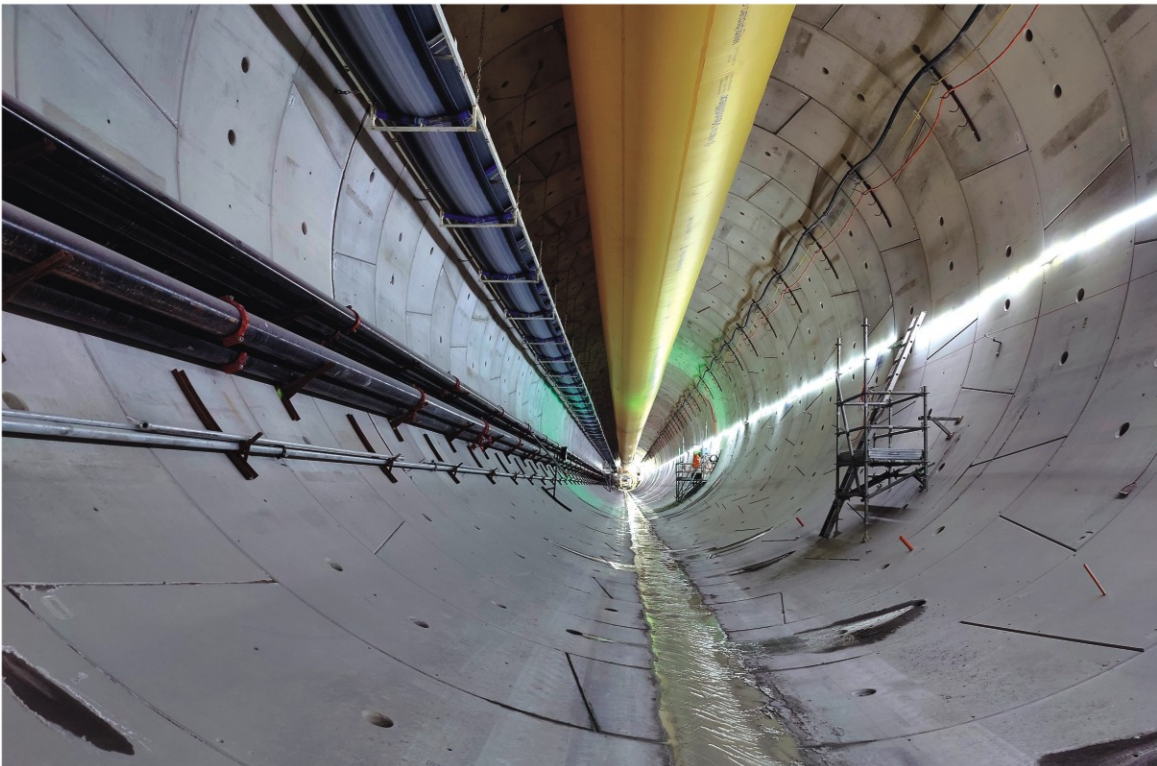
Project Background

As one of the large-scale inter-basin and trans-regional water transfer projects in the world, the main purpose of the project is to transfer water from the eastern region to the arid areas in the western region for irrigation and power generation. Once completed, it will increase the power generation capacity of the existing Snowy Hydro by 50% and add 2,000 megawatts of renewable energy supply to the Australian electricity market.



Vertical section of Snowy Hydro 2.0

The launching of the TBM
CREC-783 in Australia



The TBM is now boring the second section.

Wendeng Pumped Storage Power Project

Innovative compact TBM has solved difficulty of constructing small curve tunnels.

The drainage gallery project of the Wendeng Pumped Storage Power Station is faced with several difficulties, such as a small excavation diameter, high rock strength, good integrity of the surrounding rock and ultra-small turning radius. All these pose challenges to the efficient rock-breaking, reliability and overall adaptability of TBM. Based on the characteristics of the project, CREG has

customized the 37-meter-long hard rock TBM with an excavation diameter of 3.53 meters. Its volume is only about 80% that of a conventional TBM, and its turning radius is 30 meters, which is one-tenth of that of a conventional TBM. This has maximized its flexibility and maneuverability.

Project Information

- › Tunnelling length: 2,307 m
- › Geology: Slightly werthered granite
- › Contractor: China Railway 14th Bureau Co., Ltd.

Project Characteristics

- › The TBM's turning radius is 30 meters, which is 1/10 of that of a conventional TBM.
- › Small excavation diameter (3.53m)
- › High rock strength.

TBM Parameter

- › TBM type: Double Shield TBM
- › TBM S/N: CREG 776
- › Boring Dia.: 3.53 m
- › Main drive power: 900 kW
- › FAT date: September. 2019
- › Best performance: 20.55 m per day, 480 m per month.

Project Background

The full-face hard rock TBM construction method has been introduced into the construction of pumped storage power stations. It is of great significance for promoting the high-quality development of China's TBM industry and the intelligent construction of pumped storage power stations.



The TBM has achieved excellent performance in its debut.



Schematic diagram of Wendeng Pumped Storage Power Project



The TBM has negotiated several continuous small curves.

Funing Pumped Storage Power Project

Two different TBMs contribute to renewable energy project construction in northern China.

Located in Qinhuangdao, Hebei Province, Funing Pumped Storage Power Station boasts a total installed capacity of 1,200 megawatts. In view of the difficult points of this project, such as intact surrounding rock, high compressive

strength, high quartz content and small turning radius, CREG has customized a large-diameter TBM with an ultra-small turning radius for this project, with a designed horizontal turning radius of 90 meters.

Project Information

- › Tunnelling length: 2,203.8 m
- › Geology: Moyite
- › Contractor: Sinohydro Bureau 11 Co., Ltd.

TBM Parameter

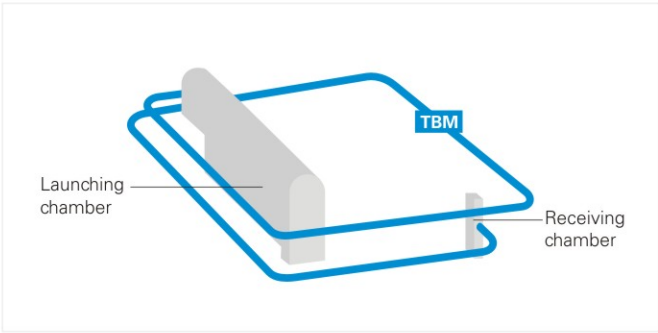
- › TBM type: Double Shield TBM
- › TBM S/N: CREG 972
- › Boring Dia.: 9.53 m
- › Main drive power: 900 kW
- › FAT date: June, 2021
- › Best performance: 21.6 m per day, 300 m per month.

Project Characteristics

- › The TBM design combines main machine structure of double shield TBM and support system of gripper TBM.
- › The TBM has achieved large diameter with small turning capacity of 90 m.
- › Advanced guidance system helps to achieve accurate guiding in small curve tunneling.

Project Background

After the project is completed, the power station will be connected to the power grids of Beijing, Tianjin and northern Hebei through 500-kilovolt lines, undertaking tasks such as peak shaving, valley filling, frequency modulation, phase modulation and emergency standby for accidents, providing a powerful guarantee for the safe and stable operation of the ultra-high voltage smart power grid. Meanwhile, it will effectively reduce the consumption of standard coal by thermal power in the regional power system, achieving energy conservation and emission reduction.

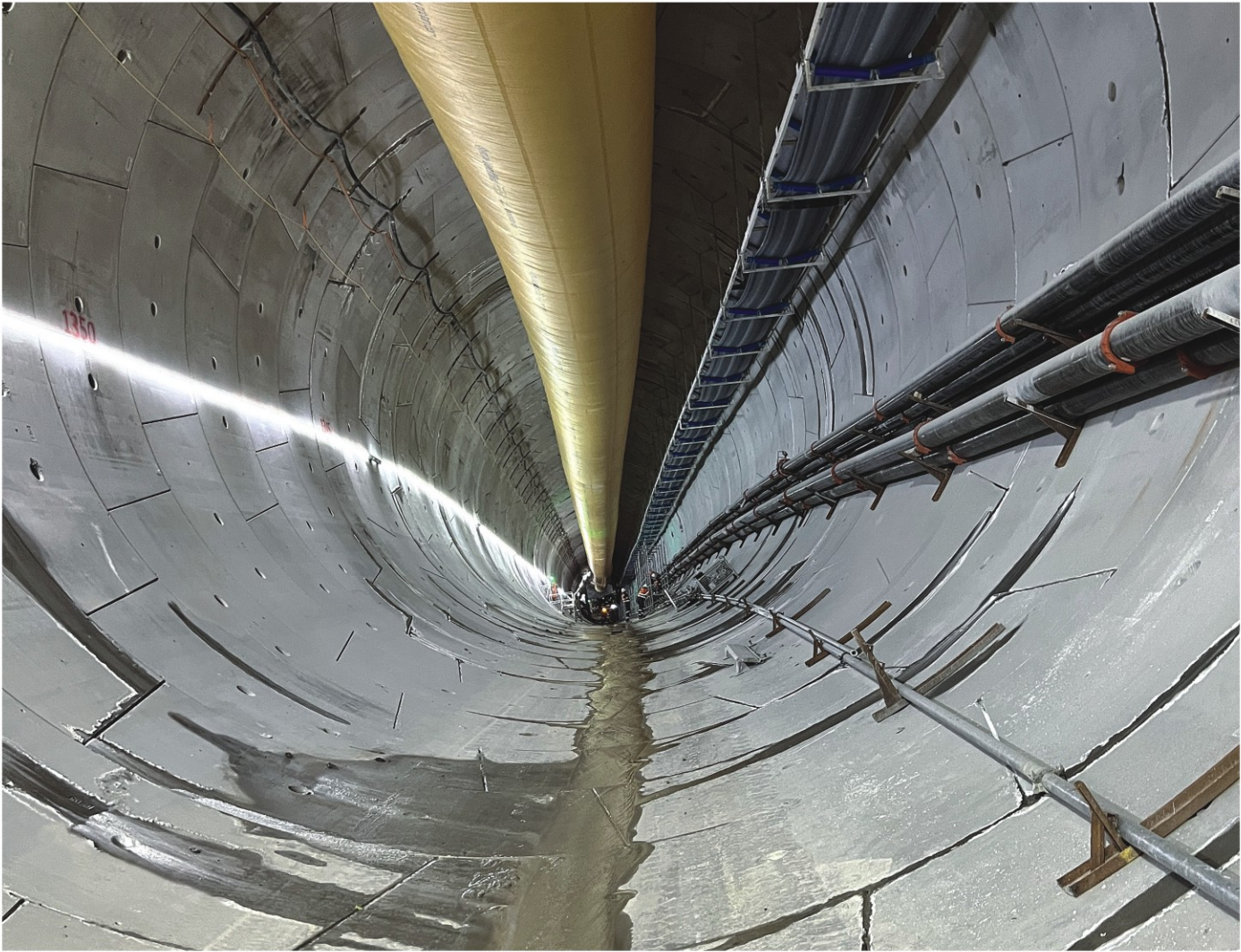


Schematic diagram of Funing Pumped Storage Power Project

The TBM has completed 2,203.8 m long tunnel drive with a maximum monthly advance rate of 300 m.



The $\phi 9.53$ m is faced with 90 m radius curve along the tunnel alignment.



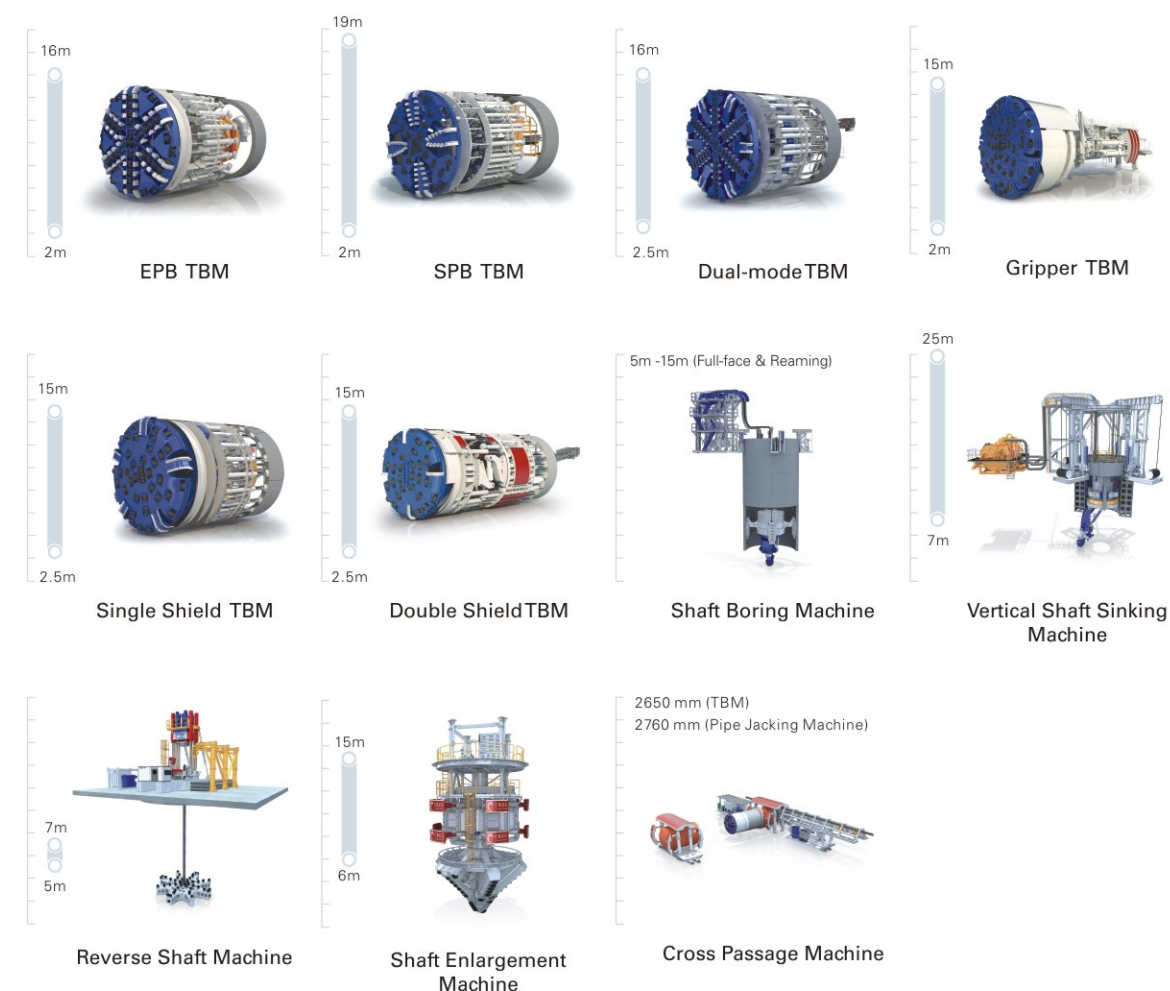
Product portfolio for hydropower tunnel

Tunneling technology suitable for various geological conditions and diameters

CREG is the only underground solutions provider that offers a comprehensive range of tunneling technologies suitable for various diameters and geological conditions. Furthermore, each CREG TBM or machine is specifically customised according to the geological, hydrological and

other parameters of the project. Consequently, our products are recognized for their durability, reliability and performance. We are dedicated to providing exceptional customer service, and we constantly strive to exceed customer expectations.

Product Portfolio



TBM Eileen Hudson is ready to bore the 8.6 km long tunnel at Snowy Hydro 2.0.

For more information of CREG, please refer to contacts at back cover.



CREG headquarters

CREG

Underground Solutions Provider

China Railway Engineering Equipment Group Co., Ltd. (referred to as "CREG") is a global underground solutions provider for a full spectrum of mechanized tunnelling technology and services. The company's headquarters is located in Zhengzhou, the capital city of Henan province. We bring together more than 4,500 employees including over 700 designers to design and manufacture TBMs and associated equipment. As the largest TBM supplier in the world, CREG boasts outstanding productivity,

performance, safety and geological adaptability, impressive R&D competence, a number of invention patents, as well as excellent after-sales service and support.

CREG has 16 production bases with an annual production of more than 300 TBMs. We have supplied TBMs ranging from ϕ 2m to ϕ 18m used in all kinds of ground conditions, including hard rock, soft soil and complex geology. Our products consist of Single/Double Shield Open-type TBM,

Gripper TBM, Earth Pressure Balance TBM, Rectangular TBM, Slurry TBM, Horseshoe-shaped EPB TBM, U-shaped Open-type TBM, Pipe Jacking Machine, Shaft Boring Machine, Reamer TBM and Inclined Shaft TBM. CREG is committed to every client as an efficient and reliable partner in the tunnel construction field. Until now, CREG has exported more than 140 TBMs to 34 countries and regions including Doha, Singapore, France, Italy, Australia, Lebanon, Poland, Denmark, South Korea and Austria etc.

With our extensive research and practical experience, CREG offers a series of auxiliary mechanized tunnelling equipment and service packages. In addition to various types of TBMs, CREG also designs and manufactures Shaft Boring Machines, Cutters, Rolling Stock, Roadheaders, Three-boom Drill Jumbos, and Wet Shotcrete Machines etc. We provide a full range of tunnelling equipment and all-around solutions.

Overseas Business and R&D institutions

- CREG TBM Germany GmbH
- China Railway Engineering Equipment Group Co., Ltd. Singapore Branch
- CREG Co., Ltd. South Korea Branch
- CREG Co., Ltd. Italy Branch
- カレグ・テクノロジー日本株式会社

Full Range Services

CREG also provides high value-added customized services, including design, consultancy, tunnelling service, maintenance, remanufacturing, mechanical & electrical installation, technical service, spare parts, etc. CREG establishes remote support system for delivered TBMs to facilitate CREG rendering quick troubleshooting and real-time monitoring during tunnelling.



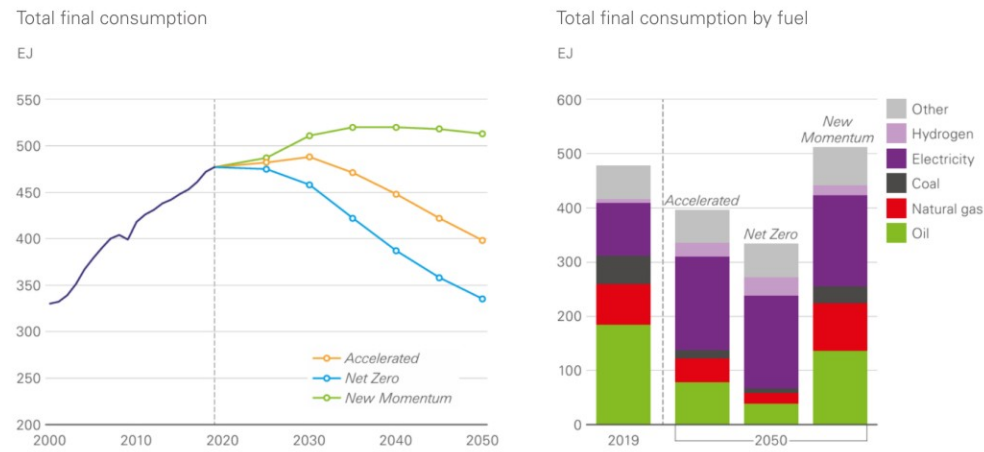
Site discussion



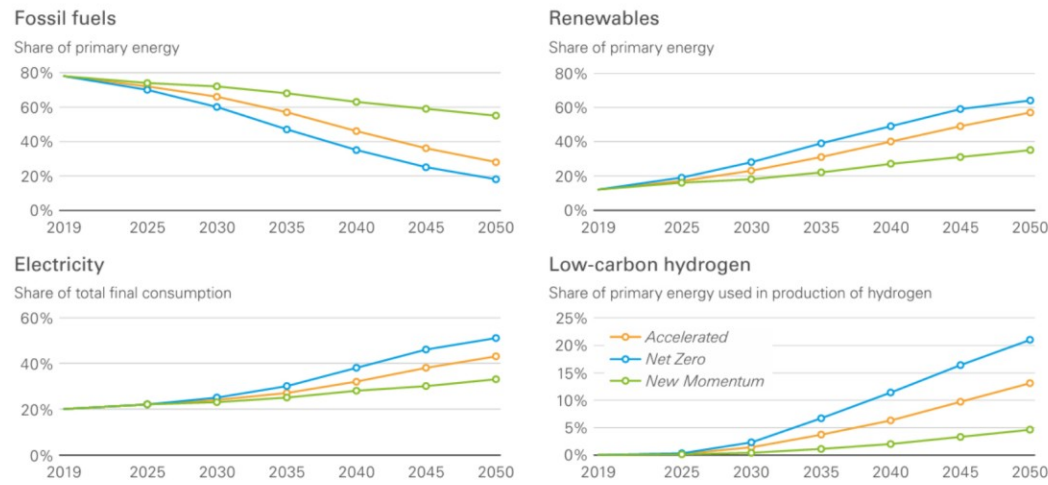
Trend

Infrastructure investment at current trends and need

Final energy demand peaks in all three scenarios as gains in energy efficiency accelerate



The future of global energy is dominated by four trends: declining role for hydrocarbons, rapid expansion in renewables, increasing electrification, and growing use of low-carbon hydrogen



Sources credit to: bp Energy Outlook 2023 edition

CREG has customized a compact TBM with a turning radius of 30 m for Wendeng Pumped Storage Power Station.

