

## NEXT CYCLE OF TRUSTED TECHNOLOGY

# PIONEERS ON THE STEEP SLOPE

Snowy 2.0 is the next chapter in the Snowy Scheme's history. It is a nation-building renewable energy project that will provide on-demand energy and large-scale storage for many generations to come. Here, experienced miners rely on innovative engineering from Herrenknecht to master extraordinary challenges.

AUTHOR: Bradley L. Garrett



## PROJECT DATA

### Contractor:

Future Generation, a joint venture between Webuild S.p.A. and Clough Projects Australia Pty Ltd.

### Client:

Snowy Hydro Ltd.

### Application:

Hydropower

**Geology:** Siltstone, sandstone, shale, laminates, quartzites, tuff, chert; meta-basalt, amphibiolite, schist, meta-sandstone, conglomerate, gabbro, meta-dolerite; granite, dacite, lava, agglomerate, limestone.

### Total tunnelling length:

21,170 m

## MACHINE DATA

### 1x Single Shield

S-1220A ("Kirsten")

Diameter: 11,010 mm

Cutterhead power: 4,900 kW

### 1x Multi-mode TBM Single/Mix

S-1221A ("Florence")

Diameter: 11,010 mm

Cutterhead power: 4,900 kW

At the Lobs Hole construction site in the Snowy Mountains of Australia, workers in high-visibility coveralls and well-worn hardhats have been teeming for months around a cradle perched at the portal of the main access tunnel into Australia's largest-ever hydroelectric project. This site, one of three and full-time home to dozens of workers, is part of a multi-year project that will eventually link the Tantangara and Talbingo reservoirs through 27 kilometers of subterranean tunnels via a pumped-hydro power station 800 meters below the Earth's surface.

The Snowy 2.0 project is making engineering history with a pressure shaft that is driven up at a gradient angle that is being realized for the first time in the world with this large diameter. By the time it is completed, the material legacy left behind will already be both a monument to ingenuity and a national historical treasure of multi-national infrastructural engineering.

The project owned by Snowy Hydro Limited was given the seal of approval by the Australian Prime Minister – Scott Morrison – at the tail end of 2021 quite literally: he put his signature on the side of the Herrenknecht tunnel boring machine (TBM) "Kirsten" and proclaimed in a press conference that: "This is what reducing emissions looks like. You have to build things like this to make that happen."

Often referred to as the "Australian Alps", the Snowy Mountains are a rugged range of variegated volcanic geology that stretches across the border from New South Wales to Victoria. These mountains encompass the tallest peak on the continent – Kosciuszko – protected inside the country's most well-loved national park. Complementing this natural beauty, the area also has a meaningful legacy stemming from it being the location for Australia's first hydroelectric plant, conceived and constructed just after



Lifting TBM "Kirsten" tailskin with 5,050 mm length and 94 tonnes weight. The 11,000 mm diameter of the tunnels is equivalent to a three-story building.

World War II. Today, as the world is inexorably developing more and more renewable energy sources, 70 years of history carved into the rock of the Snowy Mountains tell a story about perseverance, a story which will now be expanded to include the work that the Herrenknecht TBMs "Kirsten" and "Florence" will accomplish over the next few years, along with another machine and thousands of boots-on-the-ground. This collective endeavor will eventually produce an additional 2,000 megawatts of hydroelectric power, providing clean electricity for millions of Australians.



**// With TBM tunnels and the power station caverns over 800 meters deep, this is the longest and deepest underground project I have ever worked on. //**

**Damon Miller,**  
Snowy 2.0 Engineering Manager,  
Snowy Hydro Ltd.

It was 1949 when ground was broken on the first Snowy Scheme project, which produced the first major pumped-hydro plant built in Australia. The Snowy Scheme has been steadily producing 4,100 gigawatt-hours of renewable electricity each year since its completion in 1974. The initial project took 100,000 workers 25 years to complete. In stark contrast, Snowy 2.0 will be completed in just seven years by a workforce of 4,000 people, with the first power scheduled to come online in 2025 and project completion targeted for 2026. The largest single change that allows for this accelerated timeline is the fact the majority of Snowy 2.0 will be constructed not by drilling and blasting, but rather by mechanized tunnelling.

The original Snowy Scheme already delivers about a third of the renewable energy included in Australia's National Electricity Market, according to the Snowy 2.0 principal contractor Future Generation Joint Venture, a partnership between Australian construction company Clough and Webuild, the Italian group that is leading the project. The project is part of a multi-billion-dollar investment by Snowy Hydro



TBM "Kirsten" – named  
after a Wiradjuri astrophysicist – is

# 211 m long

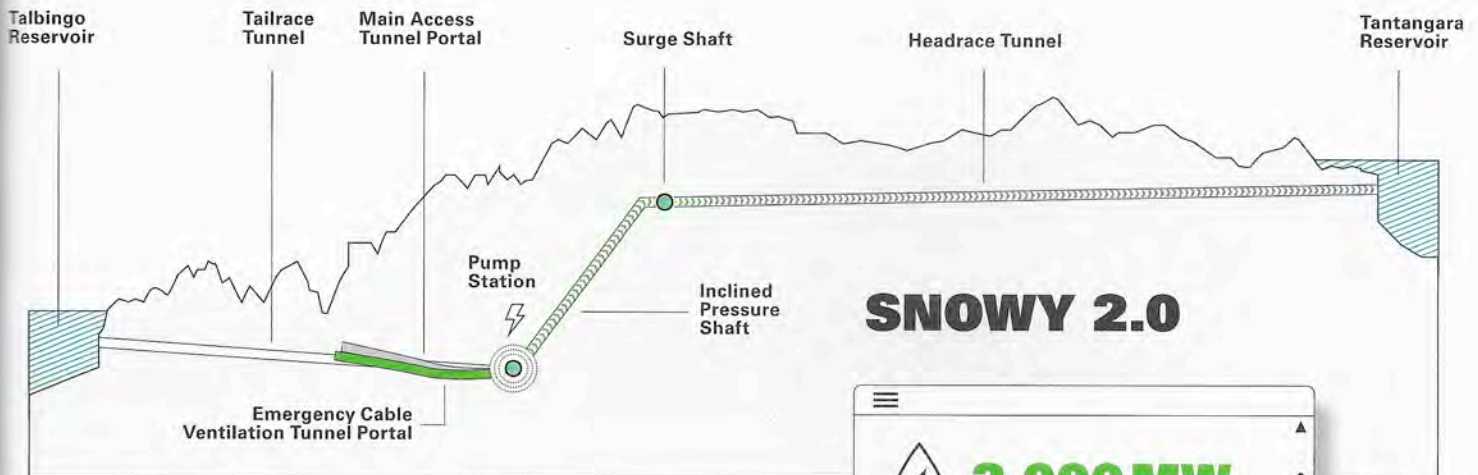
This is almost equivalent to the length of  
three Boeing 747s lined up in a row.

and the Australian government to securely manage the transition to renewables. Snowy 2.0 will underpin this transition to a low-carbon emissions future.

Of course, a venture of this magnitude is not without its complications. In fact, there were several challenges unique to this project that inspired Herrenknecht and Webuild engineers to come up with innovative solutions, some of which will undoubtedly be carried forward to future digs. As a result, the two tunnel boring machines Herrenknecht has built for the project each have unique attributes.

## It goes steep uphill

"Kirsten", or TBM #1 – named after a Wiradjuri astrophysicist – was launched on December 19, 2021. It will bore a 2.7 kilometer long Emergency Cable Ventilation Tunnel which will provide alternate access to the power station complex. At 211 meters long, "Kirsten" is one of the most complex and innovative ever built, and at 3,350 tonnes can accurately be described as a moving factory. With the boring of the Emergency Cable Ventilation Tunnel complete,



## SNOWY 2.0

### TUNNEL LENGTH

6,255 m – TBM "Kirsten"



14,915 m – TBM "Florence"



Tunnel alignment impression and tunnel lengths to be excavated by Herrenknecht TBMs.



## 2,000 MW

The new plant's increase  
in generating capacity



## 500,000

Homes powered by Snowy  
2.0 hydropower generated  
electricity simultaneously



## 175 h

Number of hours it can  
generate without refilling  
the upper reservoir



At 211 m long, "Kirsten" is one of the longest tunnel boring machines in existence. This is almost equivalent to the length of three Boeing 747s lined up in a row. At 3,350 tonnes it can accurately be described as a moving factory.

Kirsten will then undertake a daunting mission, reversing to bore the inclined pressure shaft at a slope of approx. 47 %. This is a feat which has never been accomplished in mechanized tunnelling with such a large diameter. The cutterhead will be driven by a total of 14 motors with a nominal power of 350 kilowatts each. At the launching ceremony late last year, "Kirsten" was described by Scott Morrison as "the most complex TBM on Earth". At its maximum horizontal grade, the belt conveyor will be swapped for a screw conveyor and working platforms on the gantries will be

adjusted to accommodate the extreme angle of the bore on the incline shaft. This is the first such attempt of its type and will likely replace the need for drilling vertical pressure shafts on future projects, according to Fabrizio Lazzarin, Webuild Technical Director. Damon Miller, Engineering Manager at Snowy Hydro Limited, expressed similar excitement about the depth of the excavations, saying that "with TBM tunnels and the power station caverns over 800 metres deep, this is the longest and deepest underground project I have ever worked on."

## At the launching ceremony late last year, "Kirsten" was described by Prime Minister Scott Morrison as "the most complex TBM on Earth".

"Florence", which has been commissioned in March 2022, is a Multi-mode machine that will excavate the 14,915 meter headrace tunnel, punching through to meet "Kirsten" at the end of her drive. The particular challenge faced by "Florence" is that it will almost certainly encounter naturally occurring asbestos. Georg Schleer, the Snowy 2.0 Project Manager at Herrenknecht, explained that as a result of the asbestos, "we had to modify the TBM and our mode of transporting material out of the tunnel." Herrenknecht's unique solution to this is to offer a machine that can operate in dual mode. The single shield mode will be able to switch into slurry mode, in a closed system that can "encapsulate the airborne fibres within the slurry circuit for treatment at the surface".

### Safety and security play along

Through safety suits and a negative-pressure 5-chamber personnel lock, personnel is allowed

to enter and leave the contaminated area, and a 2-chamber material lock allows material to enter and leave the contaminated area. The diagrams of the operation look like an airlock in a spaceship. Or, in this case, we might say an earthship.

130,500 concrete segments will line the 27 kilometers of waterway tunnels, each 2 meters long. These are currently being produced in a factory in Cooma near the Snowy Hydro Limited headquarters. A steady stream of these segments is moving down the highway to be loaded onto the multi-service vehicles and finally installed by the TBM to line the tunnel, like shed snakeskin as Webuild's Lazzarin explained. There are three major benefits to a deep bore such as this: the segments will allow for extreme load and protect this critical infrastructure. The difficult topography on the surface does not present any challenges. The ability to deal with high pressure is key since the inclined shaft is being bored in lieu of a vertical pressure shaft. This means that water can

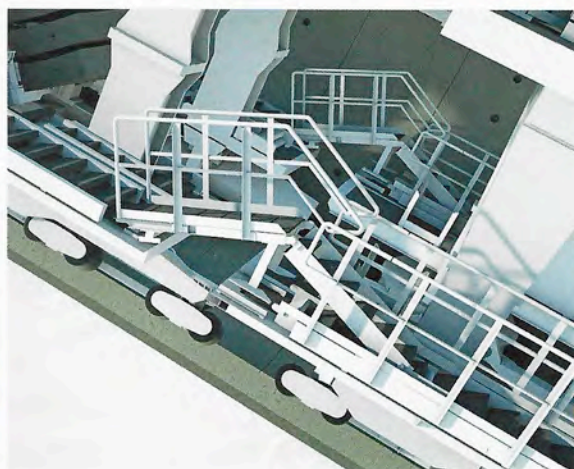
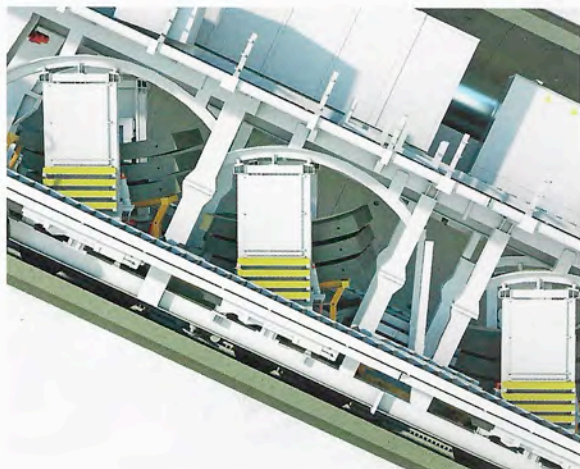
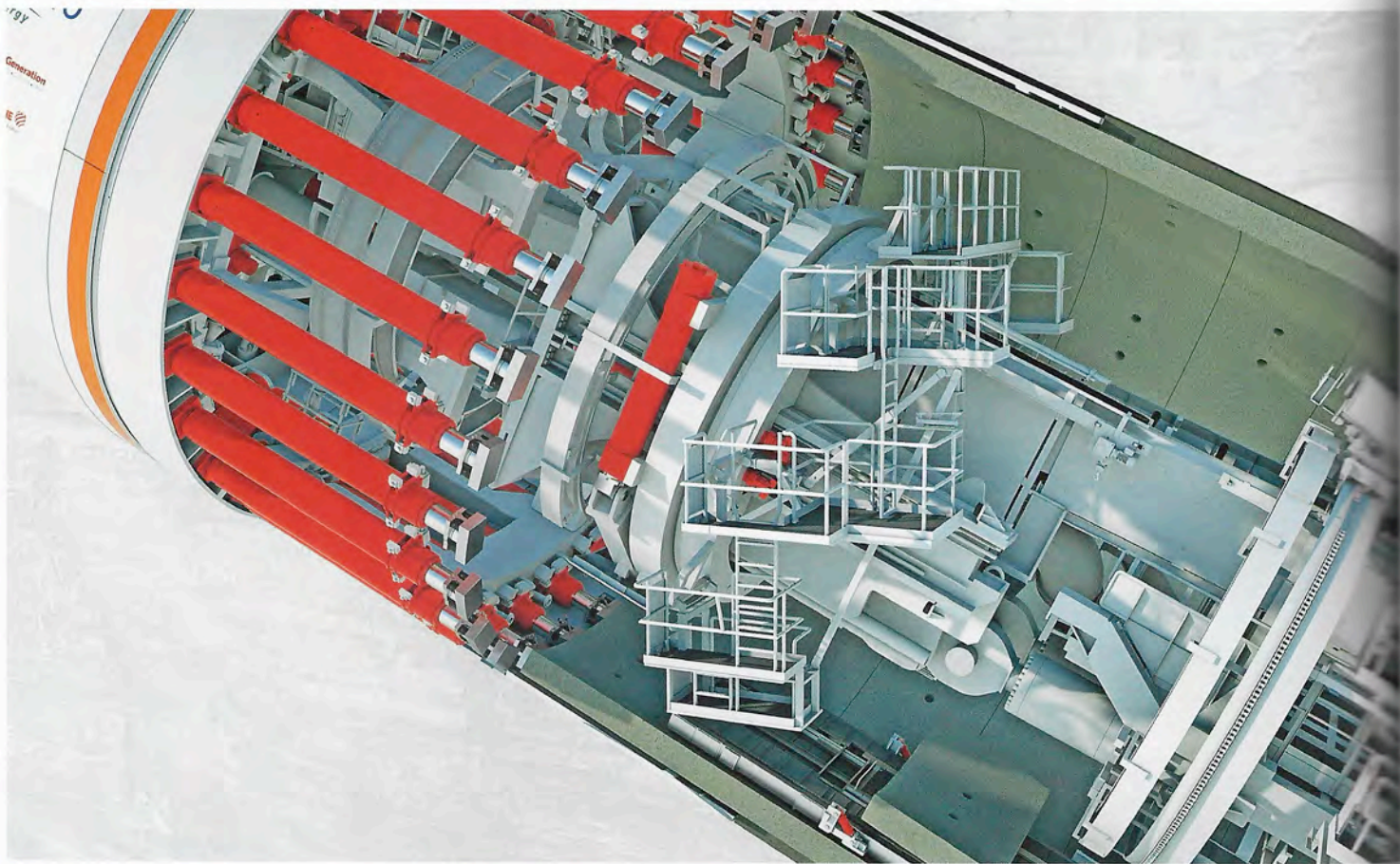
# -CO<sub>2</sub>

Australian emissions will be reduced by 14.5 million tonnes of CO<sub>2</sub> per year by Snowy 2.0, the equivalent annual emissions from 3 million passenger cars per year.

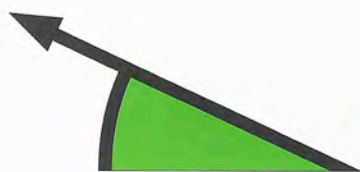
## ≈ 3 MILLION CARS



From left to right: Australian Energy Minister Angus Taylor, Prime Minister Scott Morrison, Snowy Hydro CEO Paul Broad and Webuild Executive Director Asia Pacific Marco Assorati at TBM "Kirsten" commissioning.



Working platforms on the gantries will tilt during the inclined pressure shaft excavation.



**approx. 47 %**

TBM "Kirsten" will bore the inclined pressure shaft at a slope of approx. 47 %, a feat never before accomplished in this diameter range.

be pumped uphill through the inclined pressure shaft to the upper reservoir at times of low demand and unleashed in a torrent of power through the surge shaft to the lower reservoir when the need for on-demand electricity is high. Both Sydney and Melbourne are going to benefit from the project, which is located mid-way between the metropolises. This means, in effect, that Kosciuszko, Australia's premier National Park, will now also be the site of Australia's largest renewable energy project.

### State of the art technology for a more sustainable future

According to Massimo Franceschi, Project Manager from Webuild, 27 probes will be deployed through the shields to explore and grout geological fracture lines and the TBMs themselves can be monitored from a smartphone. Without detracting from the ingenuity of the original scheme, which utilized Australia's first transistorized computer, it is clear we have come a long way from the 100,000-person crew drilling, blasting, and rock bolting the initial Snowy project. Now, state-of-the-art 3D modeling, visualizations, and innovations in tunnel boring technology are propelling us into the future.

## // Snowy 2.0 will underpin Australia's transition to a renewable energy future. //

Massimo Franceschi, Project Manager at Webuild

Massimo Franceschi summed it up perfectly: "Snowy 2.0 will underpin Australia's transition to a renewable energy future. Snowy 2.0 is the next chapter in the Snowy Scheme's history, and one which will chart the future deep hydroelectric projects to come, worldwide."

Hydropower was the first renewable energy source in the world. Tunnel boring advancements like those being implemented at Snowy 2.0 assure a bright future for hydro, turning water into electricity, like magic.

The Future Generation Joint Venture Team at TBM "Kirsten" commissioning. Snowy 2.0 will add 2,000 MW of on-demand energy generation to the Australian grid, enough to power three million homes.

