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Converting an idle coal mine into a renewable energy complex

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Abstract

Working collaboratively with our client Montem Resources and other professional services firms, we have established a technically and financially viable project to convert an idle coal mine into a renewable energy complex.

Tent Mountain is in the Canadian province of Alberta, and the open pit coal mine at the mountain ceased operations in 1983. Montem Resources was looking to recommence operations; however, the mining restart project has been met with significant permitting issues.

The challenge from Montem was to find a way to create a strong economically, sustainably, and sociably accepted project that would attract investment and utilise the unique features of the Tent Mountain site and location.

The resulting conversion project is named the Tent Mountain Renewable Energy Complex ('TM-REX') and includes a 320 MW pumped hydro energy storage facility, a 100 MW green hydrogen production electrolyser, and a 100 MW wind farm offsite (originally considered onsite).

The large-scale pumped hydro energy storage and green hydrogen of TM-REX help address climate change and support energy transition adoption and societal changes. Additionally, and importantly, the project captures the opportunity to promote Indigenous participation.

The TM-REX leverages Montem Resources' existing mining assets, notably the intact historical 'Upper Reservoir' near the top of Tent Mountain some 300 m above the valley floor below, along with access to requisite infrastructure, including major rail lines, high-voltage power lines, natural gas pipelines, and the interprovincial highway.

The addition of large-scale energy storage for the pumped hydro is important to enable further investment by private companies in additional wind and solar power generation in Alberta. As a result, the pumped hydro asset will act as a catalyst for further investment in Alberta and for continued decarbonisation of the electricity grid.

As a first of its kind in Alberta, the hydrogen portion of the project will lead the way in building partnerships and demonstrate the viability of green hydrogen projects to public and private stakeholders. The displacement of fossil fuels with hydrogen will significantly reduce emissions. The proposed full-scale, 100 MW facility will produce enough hydrogen to displace approximately 50 million litres of diesel, reducing approximately 200,000 t of CO_2 emissions each year, as well as bringing new jobs to the region.

Indigenous participation is another key facet of the project, and while onsite wind production was reviewed and remains possible, it was determined that offsite higher efficient wind resources that could leverage Indigenous group project development goals are the optimal opportunity to pursue.

The result is the early stages of a compelling and transformational project for both Montem Resources and the Tent Mountain site from an idle coal mine to a renewable energy complex.

Keywords: *conversion, renewables, hydrogen, transition, green*

1 Introduction

In 1983, open cut coal mining operations were suspended at the Tent Mountain mine, located in Alberta, Canada, in an area called Crowsnest Pass.

Montem Resources ('Montem'), an Australian mining company, purchased the mine assets in 2016 and has since conducted several drilling campaigns and undertaken environmental monitoring with the intent to restart metallurgical coal mining operations.

In early 2020, Montem completed a definitive feasibility study, which indicated a mine life of more than 14 years. In 2019, Montem had preliminarily explored the concept of a pumped hydro energy storage ('PHES') project at Tent Mountain, as part of the end of mine life plan.

The location of the Tent Mountain mine and the layout of existing historical operations are provided in Figure 1. This image also shows the location in relation to the major highway and railway to the north.

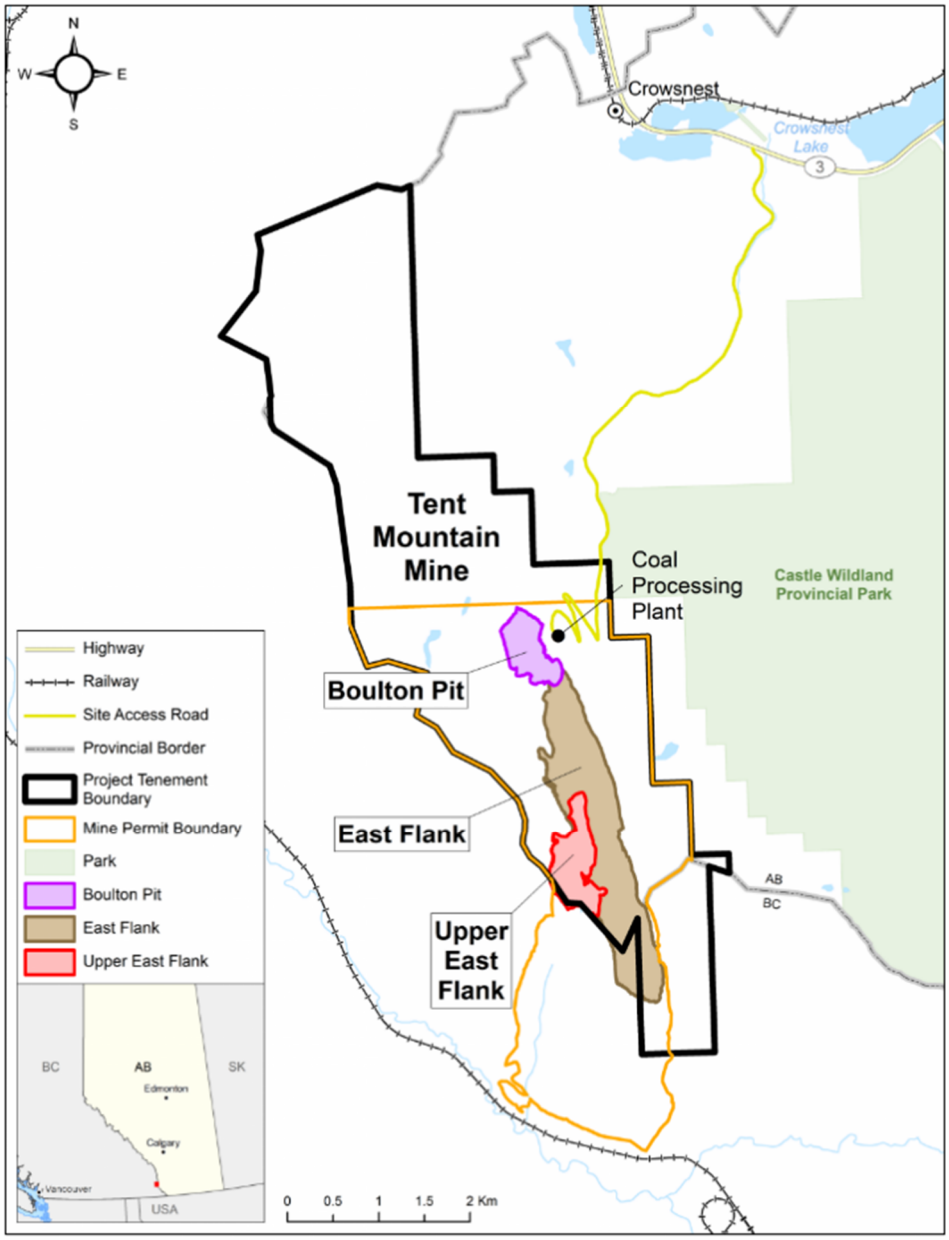

Figure 1 Location and layout of the Tent Mountain mine site, nearby Crowsnest Pass, Alberta, Canada (image courtesy of Montem)

Despite Montem moving the mining restart project forward within the provincial framework at the time, the proposed restart has been ordered to undergo a federal impact assessment before it can operate per Fletcher (2021).

The federal review process can take many years, with some examples taking over five years and with no guarantee of success. As a result, Montem sought to study alternatives for the Tent Mountain asset that they owned.

To commence an opportunity identification process, Montem engaged multiple professional services firms to look at their unique issue and work collaboratively together to form a technically and financially viable solution.

2 Transformation opportunity identification

There are three main ways in which Montem looked to identify the opportunity and move the opportunity forward with the greatest chance of success. These ways were to create diverse skill sets and knowledge to look at the issue in different ways, undertake a logical project assessment process, and establish a steering committee of key advisors to move the project forwards.

GHD, as a global engineering firm with the requisite experience, was engaged to look at enhancing the PHES preliminary financial returns if it were to be deployed in isolation; this included looking broadly at renewable energy and alternative or clean fuel opportunities that might be possible and driving the opportunity identification process in a collaborative fashion.

Other firms were tasked with further detailing the PHES return on investment, risks and opportunities, and defining what PHES project development would entail, while others were engaged specifically around the matters of regulatory and permitting requirements, and the important Indigenous aspects of a development.

Through the bringing together of different groups and initial divergent thinking, this project is a transformation that is an example of what is possible when multiple diverse skill sets and thinking are brought together to solve a compelling issue.

The steps that resulted in the TM-REX opportunity were:

1. Framing the issue and brainstorming options. This included reviewing the location, unique features and topography of the site, renewable energy options, such as wind and solar on- or offsite, as well as transportation options for products such as fuel. This brainstorming exercise led to a prioritisation of green hydrogen in concert with the PHES.
2. Value chain and opportunity definition, including alternatives. This step laid out all the building blocks for the value chain of green hydrogen, and included alternatives for renewable energy generation, sizing of the facility, water sources, storage requirements, transportation means and end users (or customers) for the hydrogen fuel.
3. Commercial development and exploratory discussions. After the creation of an extensive list, we prioritised those customers that may have a need for hydrogen fuel and undertook discussions to ensure alignment with a future project that may produce a needed diesel substitute.
4. High-level viability assessment through financial analysis and carbon credit fundamentals. In understanding the cost at a high level initially, and the financial drivers for the project, this created the understanding of areas for further exploration and understanding in later stages, and into feasibility.
5. Understanding risks and constraints and interconnectedness. These included the requirements for the project, such as water and clean electricity, customers and transportation. It also illustrated the need to further understand the potential benefits and risks of the interconnection between the PHES and the hydrogen facility and the renewable energy source.

6. Development roadmap for TM-REX. In considering how this might be developed and de-risking as many elements as possible, including commencing with a pilot-scale hydrogen facility and collaborating closely with Indigenous communities.

Once TM-REX was established as a project under development, Montem formed a steering committee led by the previous chair of the Alberta Electric System Operator, which included subject matter experts from across each of the project elements. This has ensured that the project is aligned and moves forward in an efficient manner.

It has been important for Montem, with a core competence in mining, to have the right level of technical expertise and direction on a novel project such as this.

3 The Tent Mountain Renewable Energy Complex

The resulting TM-REX development has the following major scope elements: high-voltage grid connection infrastructure, the 320 MW PHES, the 100 MW hydrogen electrolyser with water supply and loadout, and the 100 MW offsite wind farm. Montem's current schematic and project information is available online (https://montem-resources.com/projects/tent-mountain-renewable-energy-complex/).

With approximately 300 m of head between the upper and lower reservoir, the PHES is anticipated to have 320 MW capacity. This storage capacity is being called for by the Alberta government as being required for grid stability, particularly as more intermittent renewables are added to the provincial power supply. Adding this storage also enables investors to develop more renewables in the province.

The PHES utilises an existing mining pit called the 'Upper Reservoir' in Figure 2, which shows the general layout and elements of the PHES. This Upper Reservoir is presently filled with water and collects rain and snow melt throughout the year. A Lower Reservoir would be constructed with a modest dam structure and utilise the existing natural terrain. A powerhouse and surface penstock would complete the required infrastructure.

Figure 2 Overlay rendering of the PHES configuration and elements at Tent Mountain (image courtesy of Montem)

The power market is fully deregulated in Alberta, per the Alberta Electric System Operator (2016), and thus independent power producers can sell power within the grid structure at a price they negotiate under power

purchase agreements or at the market equilibrium price. The PHES would essentially pump water from the Lower to Upper Reservoir when power prices were low and sell power when prices were high, as well as being a backstop in the auxiliary market, which would also be expected to obtain high prices.

Wind power would be the renewable energy supply for the complex – both the PHES and the hydrogen electrolyser. The offsite wind farm is being developed by the Piikani Nations, an Indigenous group in the region. The project concept is to develop the 100 MW wind farm near Pincher Creek, which is within 60 km of Tent Mountain and is an area with the most deployed wind capacity in Alberta.

'Green' hydrogen is a zero-emission fuel when it is created using renewable energy. The other feedstock required is fresh water, for which there are several sustainable options in the area. Electrolysers work by splitting water into hydrogen gas and oxygen gas. The hydrogen is then stored at pressure and transported to an end user. For this project, there were a few opportunities identified, the most promising of which are mining haul trucks at other operations and hydrogen locomotives (both which would directly substitute diesel as a fuel) and natural gas blending opportunities.

The full-scale, 100 MW hydrogen production facility will produce around 14,000 tpa of hydrogen. This would be enough to displace approximately 50 million litres of diesel from large highway trucks, or the equivalent of approximately 200,000 t of CO_2 emissions each year.

The TM-REX development displays a number of key positive attributes, as described in Table 1.

Table 1 Attributes of the Tent Mountain Renewable Energy Complex

Attribute	Description
Utilises leading-edge renewable technology	Using wind farms and water-based electrolysers as a business change enabler to produce zero-emission fuel and power. The 100 MW electrolyser, if in operation today, would be the largest green hydrogen facility globally.
Has a very high societal and environmental impact	In new green jobs creation in the region, and through reducing transport emissions significantly and pivoting from coal mining to renewable fuels.
Involves Indigenous communities completely	Through partnerships for wind farm development and broader participation and joint ownership opportunities.
Creates a new business for Montem and a viable use for this idle asset	To pivot from coal mining to green power and fuels as part of their corporate portfolio. Further, there is a new and differentiated opportunity for investors to partake in a unique opportunity.
Clean fuel supply of hydrogen as a substitute for diesel	Providing green hydrogen production in this region is the first of its kind and has the potential to aid decarbonisation of multiple industries such as heavy-haul transport and other regional coal mining operations.
Providing grid stabilising energy storage	Pumped hydro energy storage firms the grid and allows additional renewable energy projects to be added.
A first of its kind in North America	Incorporating renewables with pumped hydro and green hydrogen production has not been undertaken in North America.
Commercial potential is broad and large	Both for hydrogen sales and off-takers and for the pumped-hydropower system to the grid.
Will be an iconic green energy legacy project	Supporting the energy transition well into the future of low carbon energy.

There are several areas of the TM-REX development that are being developed concurrently, including addressing identified uncertainties, such as ensuring sustainable water supply, timing of the grid connection process, geotechnical investigations, and offsite wind farm development.

As of May 2022, the development was moving through pre-feasibility studies to understand these uncertainties and refine the project cost basis, all with the intent of making the project a reality.

4 Conclusion

The TM-REX is a novel approach to reimagining and then physically repurposing an idle coal mine. It takes advantage of natural topography and previously disturbed areas, and market and political support for both green hydrogen and a grid stabilising energy storage system.

The TM-REX development is one that achieves many objectives across Indigenous, social, political, environmental, and energy transition elements and is financially viable. All-in-all, it will leave a positive legacy.

It is a compelling transformation that is an example of what is possible when multiple diverse technical and commercial skills and thinking are brought together to solve a complex problem.

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