ISSUE 01

Stantec

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ENERGY & RESOURCES ADVISOR

THE ENERGY REMIX

What is the future of the energy market?

STANTEC era

ENERGY & RESOURCES ADVISOR

THOUGHTS, TRENDS AND INNOVATION FROM THE STANTEC ENERGY & RESOURCES GROUP.

The Stantec Energy & Resources Advisor tackles the most pressing issues facing the market. From design to distribution, research to implementation, the publication draws on expertise across multiple disciplines to provide perspective on our evolving energy and resources industry.

IN THIS ISSUE: In our inaugural issue, we look at the causes of the changing energy mix and the strengths and weaknesses of various renewable energy sources – offshore wind, solar, hydropower, and pumped storage – are investigated. We question the role of established industries like oil and mining and address where they fit in this altered landscape. And we ask ourselves – what is the future of energy?

IN THIS ISSUE:

THE ENERGY REMIX

WHAT IS THE FUTURE OF ENERGY?

AN ENERGY REMIX

Old and new stakeholders are redefining how we power, live and move about our planet

BY KIRK MORRISON

THE INDUSTRIAL REVOLUTION TRANSITIONED

the world into an urban society. Innovations in manufacturing, agriculture, mining, and energy production increased the standard of living for the general public. The lives of everyday citizens were forever changed.

Today's society is experiencing another revolution ushered in by an energy remix. Our sources of energy are changing, and demand is increasing globally. Electricity generated from renewable sources is increasingly being used as the primary source of energy, and hydrocarbons are transitioning from being a primary source of energy to an industrial raw material.

This remix is bringing about vast changes in how we power, live and move about our planet.

WHILE THE PUSH FOR CLEAN ELECTRIFICATION IS MOVING FORWARD IT IS BEING FACED WITH THE STARK REALITY OF INCREASED ENERGY DEMANDS, GRID INSTABILITY, AND A LACK OF ENERGY STORAGE.

AS POPULATION GROWTH EXPANDS A NEED FOR MORE ENERGY WILL ALSO CONTINUE TO GROW

What is the Energy Remix?

In its simplest terms, the **Energy Remix** is a move from the historical practice of burning hydrocarbons as a primary source of energy to using electricity sourced from renewables. The remix is not a simple transition though but rather a gradual shift. Challenges posed by geography and increased energy demands will make hydrocarbons essential throughout the transition to renewables and after.

Each community's current energy mix varies according to the resources available – either as its own natural resources or what it can import, choices over what it exploits, standard of living and level of overall development. The energy produced is consumed by everything from transportation to domestic needs to business and commerce.

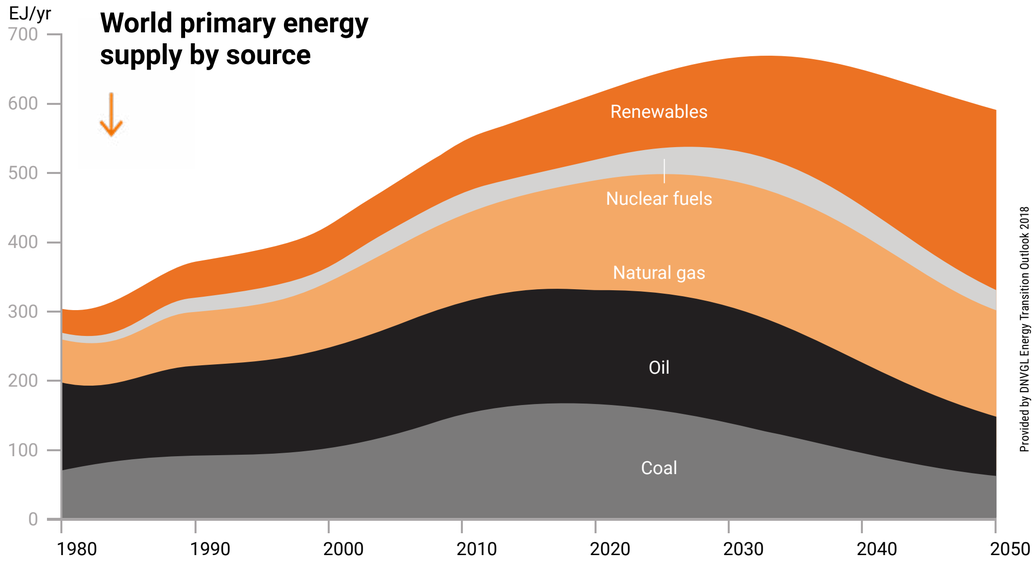
Consumption demands are changing though. The transport industry will consume less hydrocarbons as more electric vehicles enter the market and the use of public transit increases. Planes and ships are using low-emission fuels and becoming more efficient. Buildings and facilities are being designed to be net-zero or net-positive energy, and smart cities around the world are incorporating energy performance enhancing technologies.

The embrace of electrification and demand for more renewable energy sources is revealing some power sources weaknesses. Intermittent sources, like wind and solar, are unable to meet sudden unbalances in the electricity grid. To address concerns of grid reliability, a large investment in energy storage is needed. This is being addressed by continuous improvement in battery technology and renewed interest in pumped storage.

Global energy demand is shifting and growing

In the developed world, emphasis is being placed on energy efficiency and reducing consumption. This is being driven by demands for cost-savings and the desire to reduce emissions.

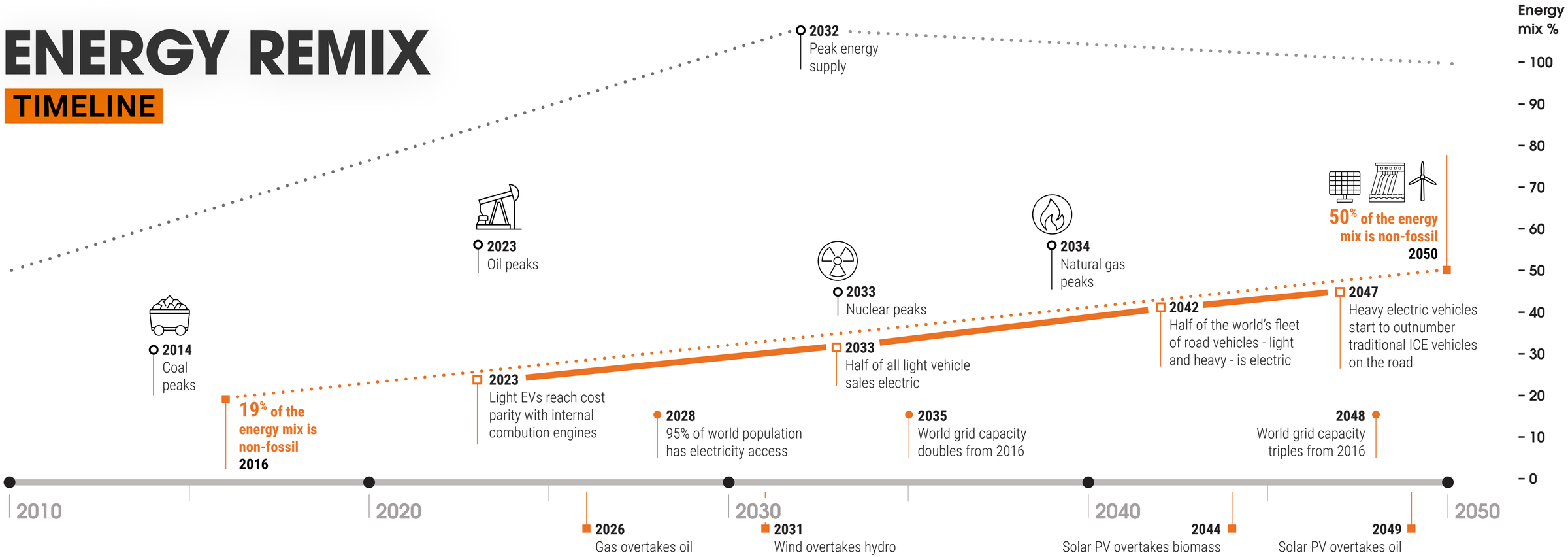
Yet according to the U.S. Energy Information Administration, energy consumption globally is expected to grow by 28% by 2040. This demand will be coming from the developing world.



The developing world is increasing energy demands in order to improve standards of living. This will be met by both new energy sources and products derived from hydrocarbons.

ENERGY REMIX

TIMELINE



Electricity is replacing hydrocarbons as the primary source of energy

This push to electrification will require a massive investment in energy production. New generation projects are expected to be mostly renewables (hydro, wind and solar) both in North America and beyond.

While these projects will continue to be developed at the traditional utility scale, increased activity in microgrids are expected as well. It is expected that distributed generation will be located on all types of industrial, commercial, institutional and residential facilities. The major driver for renewable generation has historically been a response to climate change.

However, costs for developing renewable projects have reduced, and continue to do so, and hence they are competing economically with fossil fuel generation. This trend is expected to continue.

Legend

- Energy peaks
- Transportation
- Energy transitions
- Energy milestones

What does this mean for hydrocarbons

BP's annual energy outlook report predicts that natural gas and renewable energy sources — including wind, solar, geothermal, biomass and biofuels — will account for 85% of the world's energy growth by 2040. Despite this focus on renewable energy, natural gas will account for nearly 30% of the primary energy source. Oil, despite decreases would still account for nearly 30% as well.

In summary: hydrocarbons aren't going anywhere. They will continue to serve an important fuel source during the remix. Long-term, they will be used to create the products that the world demands.

Hydrocarbons are the basis for the products, including plastics, that are feeding the global economy. Responding to the increasing demands for these products while ensuring sustainable life cycle management of them, will require significant innovation and investment.

New uses for hydrocarbons in products are emerging. For example, opportunities from research in Alberta on the alternative uses for bitumen, the oil found in that region, is remarkable. This oil could be used to create the cars we drive, the roads we drive on, or the energy storage solution we need.

Another Industrial Revolution

The first industrial revolution was powered largely by coal. It changed manufacturing and was a major economic driver. The energy remix has the potential to do that as well.

GEIDCO, an organization dedicated to promoting sustainable development of energy, estimates that the cost to electrify the globe using renewable sources, make us more energy efficient, and restore carbons to an industrial raw material will be in the $50 trillion range.

If managed properly, the energy remix could be the next economic driver to improving standards of living and reducing poverty throughout the world. ›

KIRK MORRISON

EXECUTIVE VICE PRESIDENT, ENERGY & RESOURCES

As the leader of Stantec's Energy & Resources businesses, Kirk manages the Oil & Gas, Mining, Hydropower, and Power business lines. Over the past 30 years, he has progressed from the design, construction, and management of a variety of projects – oil and gas, infrastructure, and environmental – to his current role, which involves strategic planning and management responsibilities across the energy and resources industry.

LEARN MORE ABOUT OIL & GAS

LEARN MORE ABOUT POWER

OFFSHORE WIND ENERGY

THE GREEN FUTURE OF ELECTRICITY GENERATION

BY KEN FITZGERALD AND KENNY ROGERS

MASSACHUSETTS IS TAPPING INTO THE OCEAN WINDS FOR ENERGY

Last August, the state of Massachusetts passed legislation setting a target of 3.2 gigawatts of offshore wind power generation by 2035, enough to power 1.6 million homes.

In December of 2018, the U.S. federal government's Bureau of Ocean Energy Management (BOEM) held an auction to lease 390,000 acres of waters off the coast of Martha's Vineyard and Nantucket Island in Massachusetts. The areas were earmarked for offshore wind farms as part of the most ambitious renewable energy project the American northeast has ever seen.

After two days of bidding, a trio of winners emerged. Combined, these companies smashed records with $405 million (U.S.) in bids. The previous highest-grossing lease sale, for an area off the coast of New York, was just $42.5 million (U.S.).

"I'm just going to say at this point, wow," said Walter Cruikshank, acting director of the BOEM, about the auction. "We are truly blown away by this result."

The growing momentum of offshore wind power is, in large part, due to compelling economics. Developers, legislators, utilities and communities are taking note of the plummeting cost of offshore wind

projects in the other parts of the world, including the U.K. and Nordic countries, where it has thrived as a source of renewable energy. According to analysts, costs of United States offshore wind projects have fallen 75% since 2014.

It's expected that hundreds of billions of dollars will be invested in offshore wind farms in the northeast over the next decade because of federal and state incentives. Most states in the region are far along with regulations to support development and to guarantee a market once projects are built. Federal permits are in place around the U.S., including the Gulf of Mexico and the Great Lakes, but demand is greatest in the northeast because of the large coastal population and relatively shallow waters (which make construction easier). Platforms can be mounted on the sea floor along the northeast coast, while floating platforms are needed on the west coast, where the ocean is much deeper. And because ocean winds are a lot steadier than those inland, the electricity supply from offshore turbines is more consistent.

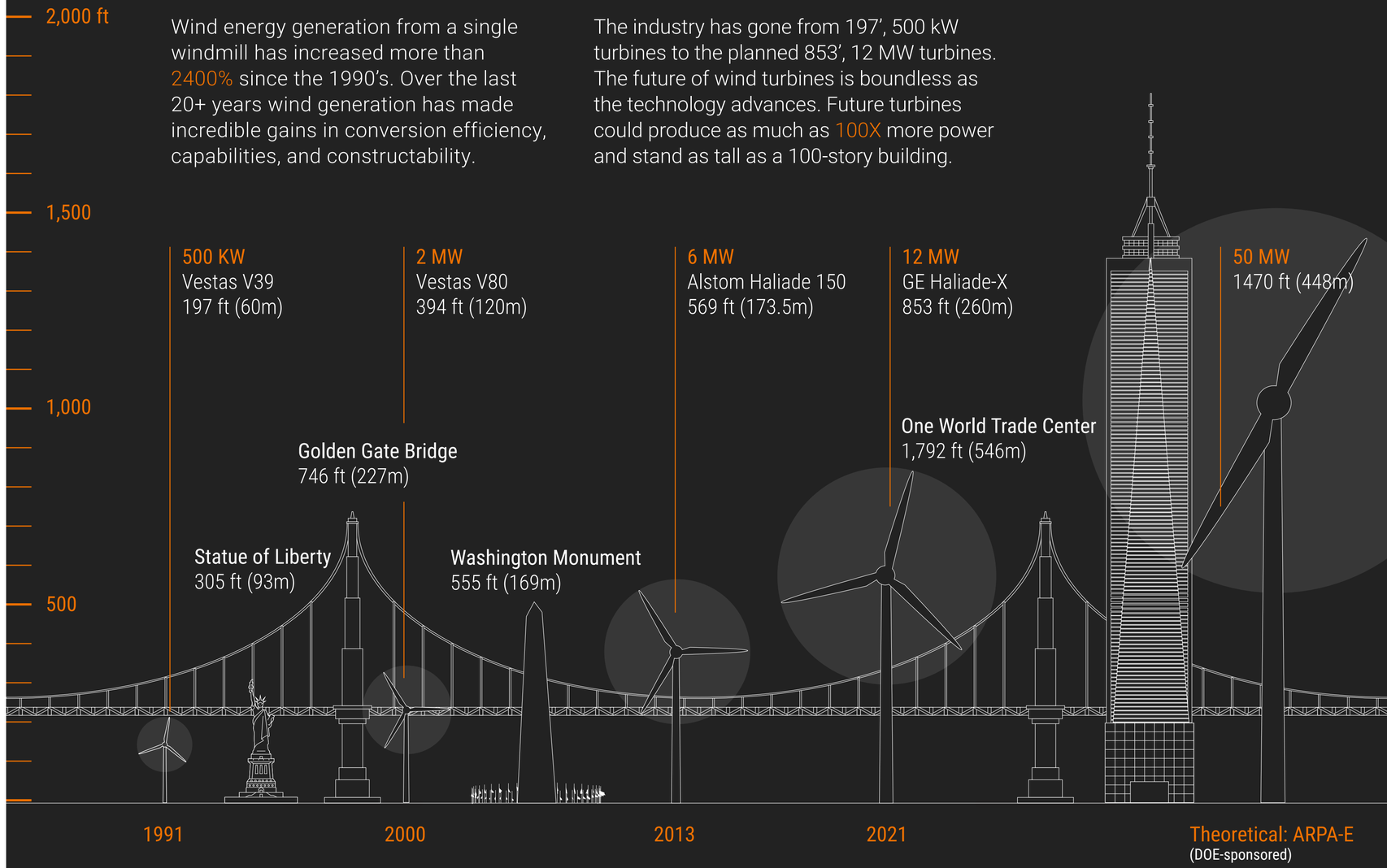
Massachusetts is a mighty player in the offshore wind market. Last August, the state passed legislation setting a target of 3.2 gigawatts of offshore wind power generation by 2035, enough to power 1.6 million homes—a doubling of an already ambitious 1.6 gigawatt goal set in 2016. The offshore wind plan is a part of larger goal Massachusetts has set for itself to reduce its dependence on fossil-based energy sources and lower carbon emissions by 80% by 2050.

One of the wining bids of the historic lease was Vineyard Wind LLC, a joint venture of two European entities, Avangrid Renewables and Copenhagen Infrastructure Partners. This new bid is in addition to Vineyard Wind's current $2-billion

Wind Turbines: Past and Present

Wind energy generation from a single windmill has increased more than 2400% since the 1990's. Over the last 20+ years wind generation has made incredible gains in conversion efficiency, capabilities, and constructability.

The industry has gone from 197', 500 kW turbines to the planned 853', 12 MW turbines. The future of wind turbines is boundless as the technology advances. Future turbines could produce as much as 100X more power and stand as tall as a 100-story building.



project, creating an 800-megawatt, 84-turbine offshore wind farm to be located 15 miles south of Martha's Vineyard and Nantucket Island. It is due to come on-line in two phases, in 2021 and 2022, and is expected to generate 10 gigawatts of electrical power, enough to serve five million people. When finished, it will be the country's largest offshore wind installation.

The project not only demonstrates the potential of offshore wind power but how far its acceptance has come. Last November, the International Energy Agency (IEA) published its annual World Energy Outlook, a 661-page report that projected massive changes in global energy markets. Among them is the rise of wind and solar energy for electricity, even in jurisdictions that have traditionally resisted clean energy.

On the other hand, the project has bipartisan support from lawmakers, communities and environmentalists, and is being hailed for bringing thousands of jobs to the area and projections that it will save Massachusetts residents approximately $1.4 billion (U.S.) in energy costs over 20 years. On the Federal level, the Trump administration has made offshore wind a key component of its balanced energy strategy, opening hundreds of thousands of acres throughout the east coast and California for lease auction and offshore wind development. This federal, state and local partnership ensures public understanding, acceptance and appreciation of the value of offshore wind projects of this scale. All told, the Massachusetts project will require consultation and approval from more than 30 federal, state and local agencies, including the Army Corps of Engineers, National Marine Fisheries Service and conservation commissions, and depends on further consultation with the area's Native American tribal authorities.

Getting the Vineyard Wind project off the ground—and into the water—also involves collaboration across highly specialized disciplines, including platform and turbine construction, civil engineering, geotechnical consulting, directional drilling and environmental consulting. (Stantec is involved in several of these roles.) Cables will carry electricity from the offshore wind farm to Cape Cod. The cables will be routed through an undersea conduit about 300 meters offshore and then land at an exit point in a beachfront parking lot in the community of Barnstable, Massachusetts. From there, electricity will travel through a new, 5.5-mile underground duct bank routed through the community until it reaches a new substation where it interfaces with the local utility system.

The Vineyard Wind project and the ambitious goals of Massachusetts's are merely the tip of the iceberg. Development may now be in the northeastern U.S., but it is working its way down the eastern seaboard and will soon be found in the western seaboard, including California. As it expands it is important for communities to have all the stakeholders at the table from the beginning. From your environmental scientists, to community development, to civil and electrical engineers, all must work together to deliver an effective and efficient project. Our green energy future is dependent on all players working together to deliver these important projects. ›

KEN FITZGERALD

SENIOR PRINCIPAL, POWER

Ken is a key member of Stantec's power team, and he works on a variety of complex projects. He has over 30 years of experience in the power industry, including engineering, design, and construction of combined cycle, coal, oil, natural gas, and wood-fired power generating facilities, as well as power plant emission control and repowering projects.

KENNY ROGERS

VICE PRESIDENT, POWER

Kenny oversees all Stantec's power business opportunities and projects, and with over 40 years of power experience, he's well suited for the task. He focuses on the executive management and project management of combustion turbine projects, including combined cycle, simple cycle, biomass, and waste-to-energy generation.

LEARN MORE
ABOUT WIND POWER

The **Perfect** Battery

Pumped Storage hydropower is the proven reliable, clean and sustainable answer to energy storage

BY PAUL BLASZCZYK

Rocky Mountain Pump Storage Project
Rome, Georgia

In the search for reliable renewable energy options, pumped storage hydropower projects may be the solution, but regulations hinder development.

Around the world, governments at the national, regional, and local level are setting aggressive renewable energy goals. The state of California has a goal of 100% electrical power from renewable energy sources by 2045. New York City is working to reduce their carbon emissions by 80% by 2050. Australia set a renewable energy target of 33,000 GW of renewable electricity by 2020.

To achieve these targets, many are choosing intermittent renewable resources, like wind and solar. The upside is they are quick to install and have low initial cost, but the wind doesn't always blow and the sun doesn't always shine when energy is in demand. Energy storage has become a critical partner to wind and solar, especially as renewable energy targets aggressively expand.

Tesla co-founder Elon Musk recently dominated the energy-storage conversation with talk of lithium-ion batteries. The technology headlines are captivating and Musk brings a celebrity-like following to the discussion. More recently, a large, long standing turbine generator equipment supplier entered the discussion by unveiling a battery-based modular energy storage for AC or DC coupled systems. There is no doubt that battery technology is advancing rapidly, and while it is getting much of the attention, new battery technology accounts

for only a small fraction of the global available energy storage. Also, the environmental and social impacts of the full life-cycle of batteries must be considered, from the mining of copper, aluminum, and lithium and their transport to factories, to the eventual disposal of these materials at the end of their useful life.

The biggest battery

In the US, one technology accounts for 95% of the energy storage capacity—pumped storage hydropower. Traditionally, pumped storage hydropower pumps water to a higher elevation when energy prices are low, which can then be released back through the reversible turbines as needed to meet energy demand. It is a utility scale battery with virtually immediate response time. Even better, when linked to intermittent energy resources such as wind or solar, it can store the renewable energy produced and provide it at peak demand times when intermittent renewables are not generating.

A great example of this is the 1,095-MW Rocky Mountain Pumped Storage project in Georgia. This project was completed in 1995 and is providing reliable energy to the Georgia and broader Southeastern power grid. By pumping water up to a reservoir when other sources are generating and demand is low, this plant can store nearly 7,000 MW hours that can be used as when needed.

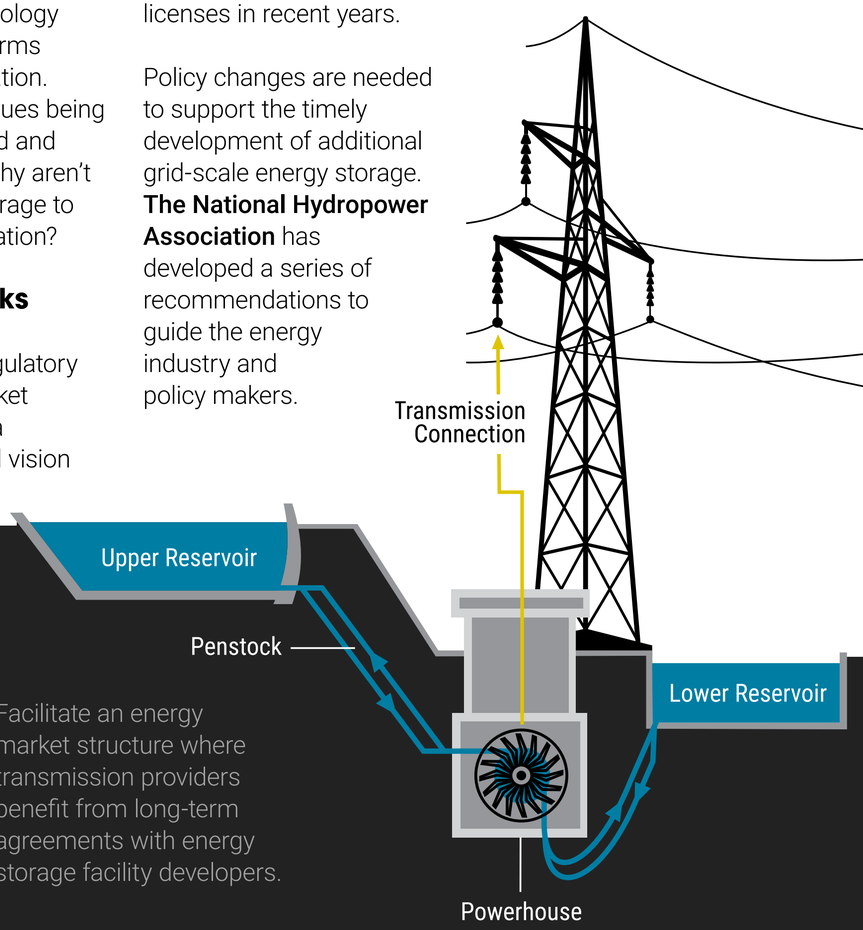
ONE PUMPED STORAGE PROJECT IS MORE THAN 50 TIMES GREATER (YES 50!) THAN THE ELECTRICITY STORAGE OF THE LARGEST CONSTRUCTED BATTERY FARM.

There is a place for all renewable energy resources—and energy storage technologies—in our collective generation toolbox. Pumped storage is a proven grid-scale, energy-storage technology that can help increase all forms of renewable energy generation. So, if the energy storage issues being discussed today have a tried and true economical solution, why aren't we using more pumped storage to help grow renewable generation?

Regulatory roadblocks

It is because the current regulatory framework and energy market structure in the US require a long-term commitment and vision for these projects to be built. The Federal Energy Regulatory Commission (FERC) has issued only a small handful of pumped-storage facility licenses in recent years.

Policy changes are needed to support the timely development of additional grid-scale energy storage. **The National Hydropower Association** has developed a series of recommendations to guide the energy industry and policy makers.



A FEW OF THE NHA'S KEY POLICY RECOMMENDATIONS INCLUDE:

Create market products that allow flexible energy storage resources to provide services that help meet electric grid requirements.

Level the policy playing field for pumped storage hydropower with other storage technologies to encourage the development and deployment of all energy storage resources.

Establish an alternative, streamlined licensing process for low-impact pumped storage hydropower, such as off-channel or closed-loop projects.

Improve integration of federal and state agencies into the early-stage licensing processes for pumped storage hydropower.

Facilitate an energy market structure where transmission providers benefit from long-term agreements with energy storage facility developers.

Around the world, pumped storage is recognized as the battery of choice.

The sites and opportunities are there

We've partnered with our clients to navigate the complex regulatory system in the US. Several of them received their FERC licenses within the past several years, however, construction remains years away. This is despite the fact in 2015, the US Department of Energy issued its Hydropower Vision Report in which it set an ambitious goal of 35.5 GW of pumped storage be available on the US grid by 2050. That is the equivalent of 30 Rocky Mountain Pumped Storage projects.

Greenfield development of pumped storage projects is not the only way to add storage. Stantec is partnering with several owners of pumped storage projects in North America to plan and implement the refurbishment and upgrade programs at their facilities. While these provide incremental increases at the plants, the combined upgrades are chipping away at the overall energy storage need.

Around the world, pumped storage is recognized as the battery of choice. In southern Australia alone, 185 potential sites have been identified and pumped storage projects are under development in China, Israel, Japan, and the United Kingdom—just to name a few. The locations are available, but the incentives are lacking, and the roadblocks remain.

Proven technology with potential

We all appreciate the need for clean, renewable, economical power generation, but few realize the important role that energy storage plays in allowing more renewable generation to be built and to still be able to meet the reliability and timing demands of electricity consumers. Even fewer realize that there is an existing, proven technology—pumped storage hydropower—with a lot more development potential to meet our energy storage needs and help grow our renewable generation portfolio.

For communities around the globe to realize their renewable energy goals pumped storage must be a part of their energy plan. Governments and regulatory bodies must implement practical policy and market changes to make energy storage—especially pumped storage hydropower—faster and less cumbersome to build. Future generations and our planet will thank us. ›

PAUL
BLASZCZYK

VICE PRESIDENT, WATERPOWER & DAMS

Paul helps our team and clients create effective strategies that make hydropower, dam, and other projects successful. With nearly 25 years of experience in the planning, design and rehabilitation of major hydroelectric plants, Paul considers himself fortunate to lead a multidisciplinary staff that specializes in engineering and consulting services for the dams, hydropower, and navigation sectors.

LEARN MORE
ABOUT PUMPED STORAGE

SOLAR & THE OIL INDUSTRY

5 reasons solar energy is sweeping the oil and gas industry

BY JOSE WALSH DUARTE

SOLAR ENERGY HAS THE POTENTIAL TO **LOWER** THE COST OF PROCESSING OUR RESOURCES

There's no better example of the green-power revolution than solar energy. We use it to power our cars, buildings and to charge our phones. It's the primary source of electricity used to power space missions. It also has the potential to help oil and gas companies process their resources.

Oil refining involves gas and water separation and oil distillation at massive volumes. It's an expensive and energy-intensive process, and companies are looking for ways to make it cheaper and cleaner. Solar is proving to be an answer to the industry's needs.

1

Solar is inexpensive. The cost of solar energy has plummeted to the point where electricity from solar PV is being produced for two to five cents per kilowatt hour, compared to 15 cents per kilowatt hour for fossil fuel power generation. That is a very long way from solar's infancy in the 1950s, when the cost of a solar cell was nearly $1,800 (U.S.) a watt which would have been equivalent to producing electricity for $661 per kilowatt hour today.

That's because the technology has improved and become much more affordable to produce on a commercial scale. Some main contributing factors consist of creating higher efficiency solar cells through research and development, market-stimulating policies and building larger solar plants. Many governments are working to meet their greenhouse gas emissions targets and as a result they are also pushing the industry to reduce costs.

Today a utility scale solar plant will pay for itself within five years and have an operating lifetime of more than 30 years. Operation and maintenance costs are low as well. Operating costs amount to just 2 to 3 per cent of the plant's annual revenue.

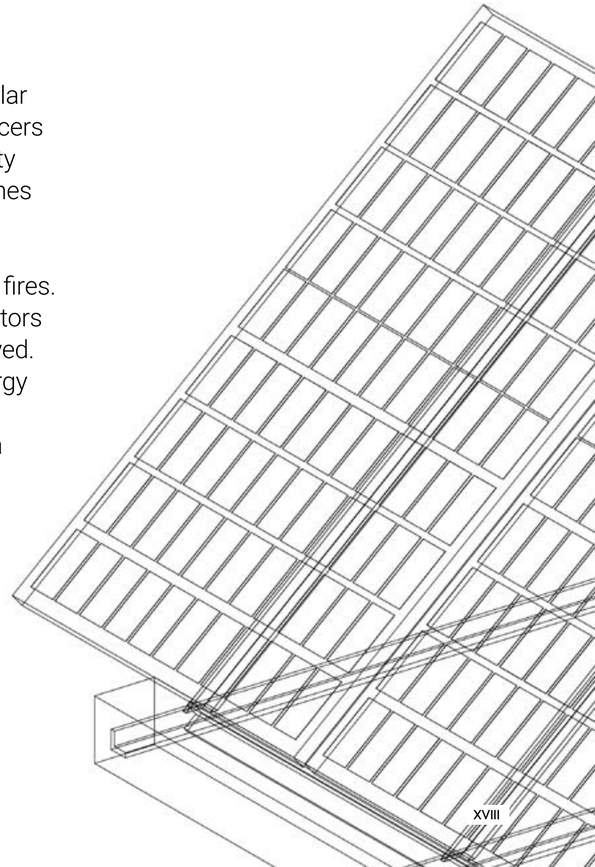
2

Solar is easy to install. In addition to the cost savings, solar plants are a fast solution for oil and gas producers. Building a solar plant only takes five to 12 months—compared to 2-3 years to build a plant that uses fossil fuels to generate electricity. Solar plants are scalable and have a quicker permitting process. Solar farms can be equipped with high-efficiency solar modules on single axis trackers, which follow the sun all day and increases energy production by 15 to 30 percent.

3

Solar is resilient. Installing a solar plant provides oil and gas producers an alternative source of electricity generation onsite. Distribution lines in remote locations sometimes breakdown due to equipment capacity limitations, storms and fires. Similarly, fuel delivery for generators in remote locations can be delayed. Solar PV can be paired with energy storage, allowing the solar plant to generate electricity 24/7 like a traditional power station.

We have another 5 billion years until the solar fuel runs out. The earth receives more energy from the sun in 22 days than we have coal, petroleum, and natural gas reserves on earth combined.



CALIFORNIA: RENEWABLES AND OIL & GAS INDUSTRY

A DELICATE BALANCE IN A GREEN STATE

California is often highlighted as the trailblazer in the green energy movement. The state has committed to being 60% renewable electricity by 2030. But California also has a huge oil and gas presence. The state has the third-largest reserves in the nation and are the U.S.'s 4th largest producer.

Companies working in the oil & gas industry in California must maintain a delicate balance. The California Resources Corporation, the largest oil and gas producer in California, has committed to reducing their carbon footprint while continuing to tap into this important and valuable resources. Their 10 large-scale solar projects are helping ensure that 30% of their energy is derived from renewables.

While the shift to new energy continues between now and 2030, the oil and gas industry must navigate the transformation while reducing their carbon footprint at existing facilities. The future of energy will be a mix of sources that are safe, clean, and productive. California is paving a path for the industry.

4

Solar is Portable. Oil and gas producers are also attracted to the portability of solar power. Many pumping stations are in remote locations and it is too expensive to build transmission and distribution lines. The nice thing about solar is how elegant it is—it's the only electricity source that doesn't require any moving parts. The solar modules are placed outside, sunlight gets absorbed by the solar cell material and electricity is generated.

5

Solar is Clean. And of course, solar power is a boon for a company's green footprint as well as its bottom line. A solar plant's energy payback time can be as little as two years. Unlike traditional energy sources, solar has no negative effects on air quality—it doesn't generate carbon monoxide or sulphur dioxide—and using it can earn carbon offset credits for oil and gas producers. Many big companies, including Shell, Total and BP, have already jumped on the bandwagon, installing solar arrays at their oil fields and diversifying their investments by installing renewable energy sources.

Just this year, California Resources Corporation (CRC) hired us to conduct a feasibility study and preliminary design of a 20-megawatt AC solar farm for their Kern Front Oil Field in the foothills of the Sierra Nevada mountains. CRC believes that renewable energy and oil and gas complement each other; nearly 30 percent of CRC's electricity comes from renewable sources.

A few months later, we held a lunch-and-learn for clients in Bakersfield, California—the most oil-productive county in the United States—which spurred even more interest. Major oil and gas companies are diversifying their energy assets and embracing these new technologies, and analysts in the sector are trumpeting this trend. One thing is certain – oil, gas and solar have a promising future together. ›

JOSE WALSH

SUB-SECTOR LEAD, SOLAR

Jose has been working in the solar photovoltaic (PV) industry for over 14 years. His experience includes the research and development of high-efficiency solar cells, as well as the implementation of over 100 projects and the installation of more than 1,300 megawatts. He's managed, optimized, and designed solar PV systems for remote communities in Ecuador and Kenya as well as residential, commercial, and utility-scale solar projects across the Americas and the Caribbean.

LEARN MORE ABOUT OIL & GAS | LEARN MORE ABOUT SOLAR

Is Mining a renewable energy industry?

Increasing synergies between mining and renewable energy will benefit both industries

BY BRIAN YATES AND JON TREEN

→

14 OF THE 19 METALS AND MATERIALS NEEDED TO BUILD SOLAR PANELS CAN BE FOUND BENEATH CANADIAN SOIL

The demand for solar panels, wind turbines, and battery technology has boomed as the world strives towards cleaner forms of energy. And, most of the material needed for those technologies is in the ground—it needs to be mined.

The mining and renewable energy sectors might not typically be considered allies. One industry is rooted in environmental concerns around climate change. The other, part of a long history of natural resource development, often finds itself at odds with the environmental movement. But now, it's clear that the two industries are reaching a moment that will mark the start of a mutually-beneficial relationship.

How? The two industries don't go hand-in-hand. Or do they?

The demand for solar panels, wind turbines, and battery technology has boomed as the world strives towards cleaner forms of energy. And, most of the material needed for those technologies is in the ground—it needs to be mined. In fact, 14 of the 19 metals and minerals needed to build solar panels can be found beneath Canadian soil (Clean Energy Canada 2017).

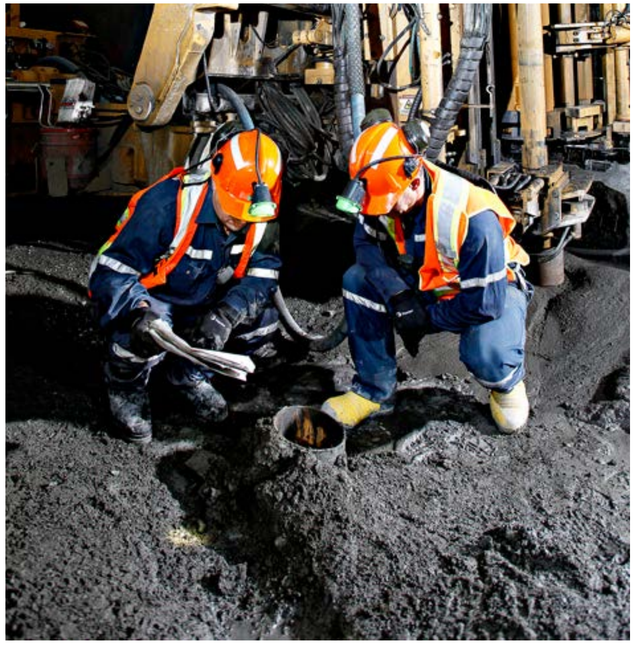
This inflection point creates an opportunity that could prove prosperous for both sectors, and the businesses and stakeholders affected by them. By working together, the renewable energy industry can access its much-needed metals and materials and diversify its client base, while the mining industry can realize the benefits related to reduced energy costs, improved environment performance, and an enhanced social license.

Mine energy considerations and the business case for a partnership

Although labor is the largest contributor to a mine's total operating costs, several factors can affect profitability, such as:

- Remote locations: access to fuel, transportation, security, and diesel price
- Reliability and quality of grid dependent energy
- Greenhouse gas emissions and carbon pricing
- Managing Environmental effects
- Acheiving Social license and creating value for communities and stakeholders

All of those aspects play a role in a mine's profitability. But the second highest cost after labor? Energy in all forms. Consider the power needed for lights, tools, and fuel stations at a mine. Think of all the computer technology, monitoring systems, and infrastructure used on a daily basis.



“Miners have the opportunity to drive down energy costs by up to 25% in existing operations and 50% in new mines through an effective energy management program, of which renewables are a major component. In addition to cost savings, the ability to reduce emissions and preserve the mine’s social license to operate increases the size of the prize even more,”

Deloitte, 2017

Integrating Renewables

The kilowatt/tonne (kWh/ton) of metal produced is becoming a key performance indicator within the mining business, and will only increase in importance in the near future. The more we can reduce the cost of power and use renewables the better off we will be as an industry and as a culture.

As the cost of capital and operating expenditures goes down, values related to avoiding fuel costs, stable power, and reduced CO_2 emissions start to increase.

An example at SunMine

To help illustrate some of these synergies—as well as the range of potential benefits related to investment in renewable energy—we can look to the example of SunMine in British Columbia.

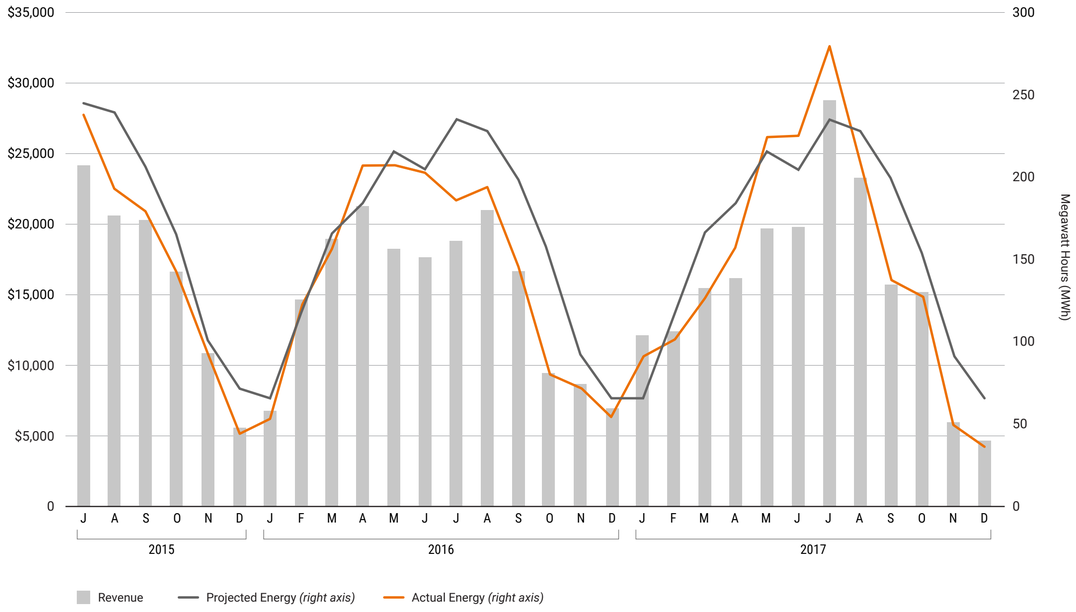
In 2001, the Sullivan Mine, located near Kimberly, closed after 90+ years of operation. The mine had primarily extracted lead, zinc, and iron. Since closing, the land has been undergoing a substantial decommissioning and reclamation process including the development of SunMine—British Columbia's largest solar project.

Built on the reclaimed mine site, SunMine begun commercial operation in 2015. With more than 4000 solar cells on 96 trackers, the project has the capacity to produce 1.05 megawatts (MW). That’s enough energy to power 200 homes with clean renewable energy! In fact, Sun Mine is the first solar project large enough to sell power to British Columbia’s energy provider, BC Hydro.

Teck Resources, Canada's largest diversified resource company, provided the reclaimed land as well as the site infrastructure. They also issued a $2 million contribution to get the project off the ground.

Check out the energy production in SunMine’s first few years of operation:

SunMine Generation Over 2.5 Years



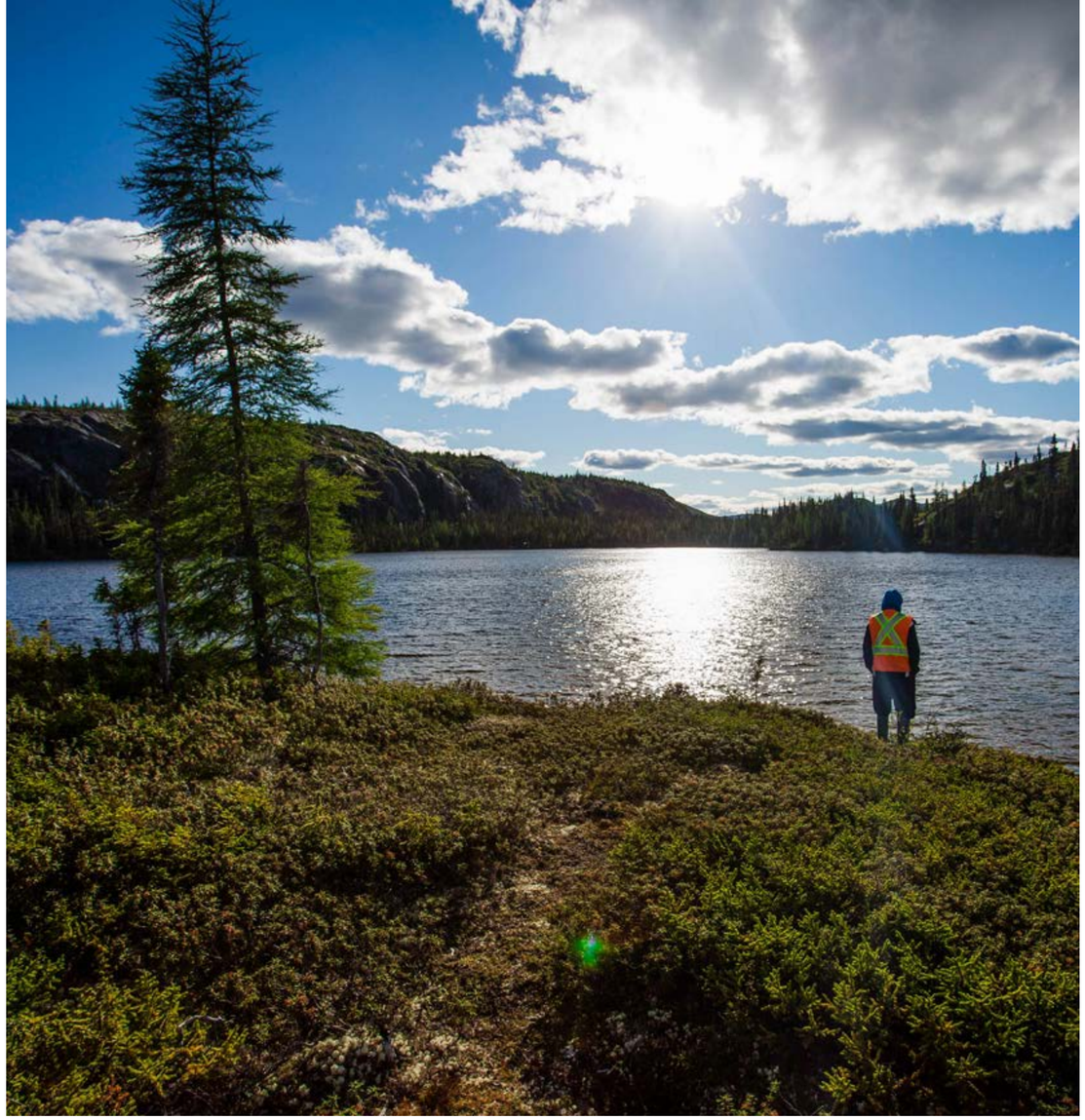
Sustainable benefits

Since going into operation, SunMine has realized its original business case with the delivery of clean power and an ongoing stream of revenue, underscoring the reliability of the technology. But, the sustainable benefits of SunMine go beyond just clean power. The site has been a successful example of how to pursue renewable energy by repurposing an industrial site, and it provides long term benefits for British Columbia.

The application of renewable energy not only promotes clean power, it furthers knowledge within the industry through ongoing experience and innovation. Industry experts can apply new and expanded ideas throughout different regions, based on the experience of SunMine and other projects. It also allows for sustainable use of reclaimed land post mine closure.

Mining companies worldwide are starting to catch on. As of of this writing, the Rocky Mountain Institute's Renewable Resources at Mines tracker has identified more than 2 GW of wind and solar capacity installed at 57 sites worldwide. It's clear that the plummeting costs of wind and solar are competing with the environmental upside to propel mining companies to renewable energy solutions.

The most rewarding aspect of investing in renewable energy at mine sites? The long-term community investment. Adding renewable energy to a mine's portfolio builds a stronger social license—it shows we care about the neighboring communities. And at the end of day, that's what counts most. ›



JON
TREEN

SENIOR VICE PRESIDENT, MINING

Jon currently oversees Stantec's global mining team. A practiced speaker and advocate for mine safety and incident prevention through design, Jon has dedicated his career to improving mine operations all over the world — after all, mining is a global industry. He enjoys designing mines that wouldn't exist without an innovative and collaborative approach.

BRIAN
YATES

VICE PRESIDENT, REGIONAL LEADER – BRITISH COLUMBIA

Responsible for Stantec's overall business in British Columbia, Brian has spent his career leading large-scale environmental assessments and consultation efforts for a range of energy, ports, mining, and linear infrastructure clients. He has led numerous environmental assessments under the Canadian Environmental Assessment Act and BC Environmental Assessment Act. He has also implemented associated permitting and environmental management plans across Canada and Asia.

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WATER & SUN

Two is Better than One

The power of bringing hydropower and solar energy together.

BY MARK ALLEN

WE'RE MEETING THE GROWING DEMANDS OF OUR ENERGY-CONSCIOUS TIMES—AND BATTLING DROUGHT—BY COMBINING INNOVATIONS IN SOLAR WITH THE RELIABILITY AND STORAGE CAPABILITY OF HYDRO FACILITIES

Hydropower has reigned as one of the most established forms of renewable energy for decades. Hydropower facilities are now making large investments in their plants in order to meet a growing mandate to enhance their effectiveness in innovative ways. The industry is now asking: How can hydropower work with other forms of renewable energy to overcome the shortcomings faced by a single source of energy? One answer involves a cutting-edge approach that combines the increasingly attractive economics of solar power with the reliability and storage capability of hydropower.

Each industry has a weakness

On its own, any form of energy will have its limitations. Hydropower depends ultimately on rainfall, which is problematic given that many areas of the world are experiencing prolonged periods of change in rainfall levels—sometimes resulting in drought. When rainfall decreases, we see lowered reservoir levels and reduced power generation. This means during a drought, there is excess hydropower capacity because there isn't enough water to run the plant at full-speed. In extreme cases, a reservoir may even dry up, resulting in no power production and depriving a community of an important water storage asset.

Solar energy also has its challenges, including intermittent availability. Solar is dependent on the sun shining, meaning no power at night or reduced power during a cloudy day. Also because of lack of current energy storage options excess solar energy can not be stored in many locations.

Partnering to ensure consistent power

This is when a hybrid approach becomes an ideal option. Floating solar panels at existing hydropower facilities can provide the reliability needed by solar while reducing evaporation at hydropower facilities. With this approach, hydropower units operate at minimum or reduced output when the solar output is high, so that the hydropower units are mainly used to regulate power frequency. When the sun goes down or solar output is reduced by clouds, the hydropower units are ramped up (subject to the available water supply). In this way, each form of energy compensates for the other's limitations, and the combined system can more closely match energy demand.

We've completed a pilot project—with more coming in the near future—that adds 40-kilowatt floating photovoltaic panels to a hydro-plant basin in Italy. The approach enables even modestly-sized hydropower reservoirs to act as cost-effective energy storage facilities, all without reliance on batteries. And it's great for the grid: Pairing hydropower and solar is remarkably effective in that it allows us to keep a constant energy supply to the grid while not overtaxing it.

FLOATING SOLAR PANELS AT EXISTING HYDROPOWER FACILITIES CAN PROVIDE THE RELIABILITY NEEDED BY SOLAR WHILE REDUCING EVAPORATION AT HYDROPOWER FACILITIES.

Conserving water and mitigating drought

There are parts of the world currently suffering from major changes in rainfall – like California. Water storage is an ongoing issue for these communities. Existing hydropower

facilities are not only used as power sources but essential water storage and recreational facilities for the community. The use of floating solar panels can reduce evaporation of the reservoir while enhancing output from the panels due to the temperature-moderating effect of the water. Creating a combined hydro and solar facility may seem like a considerable investment. However, during drought, an existing hydropower facility has excess generating capacity, and this may be enough to support the addition of a substantial photovoltaic power station or solar park. Having both hydro and solar capabilities together in one power system can keep output at a high level while conserving water in the reservoir. The principal also applies when there is no water shortage, assuming that the hydropower units are not 100 per cent utilized 24/7. We call this concept "time-shifted energy storage." Time-shifted storage is the ability for a hydropower plant operate to decide when and how much water to run through the hydropower facility. By running less water while the sun is shining, they can ensure the community is getting the needed power through solar and the reservoir can refill.

This approach can reduce water consumption, increase the penetration of solar power in the energy picture, and enhance frequency regulation in power generation systems. Ultimately, the cost can be very attractive, particularly for existing hydro systems. Two is truly better than one with these renewable energy sources. ›

S. MARK ALLEN

VICE PRESIDENT, WATERPOWER & DAMS

Mark Allen manages domestic and international projects, specializing in renewable – particularly hydroelectric development. He has delivered renewable energy solutions at the first privately-developed hydropower facility in the history of Pakistan, as well as two small hydroelectric developments in Jamaica.

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Alberta's Oil Sands

What are the options for Alberta's oil sands in a low carbon future?

BY NATHAN ASHCROFT

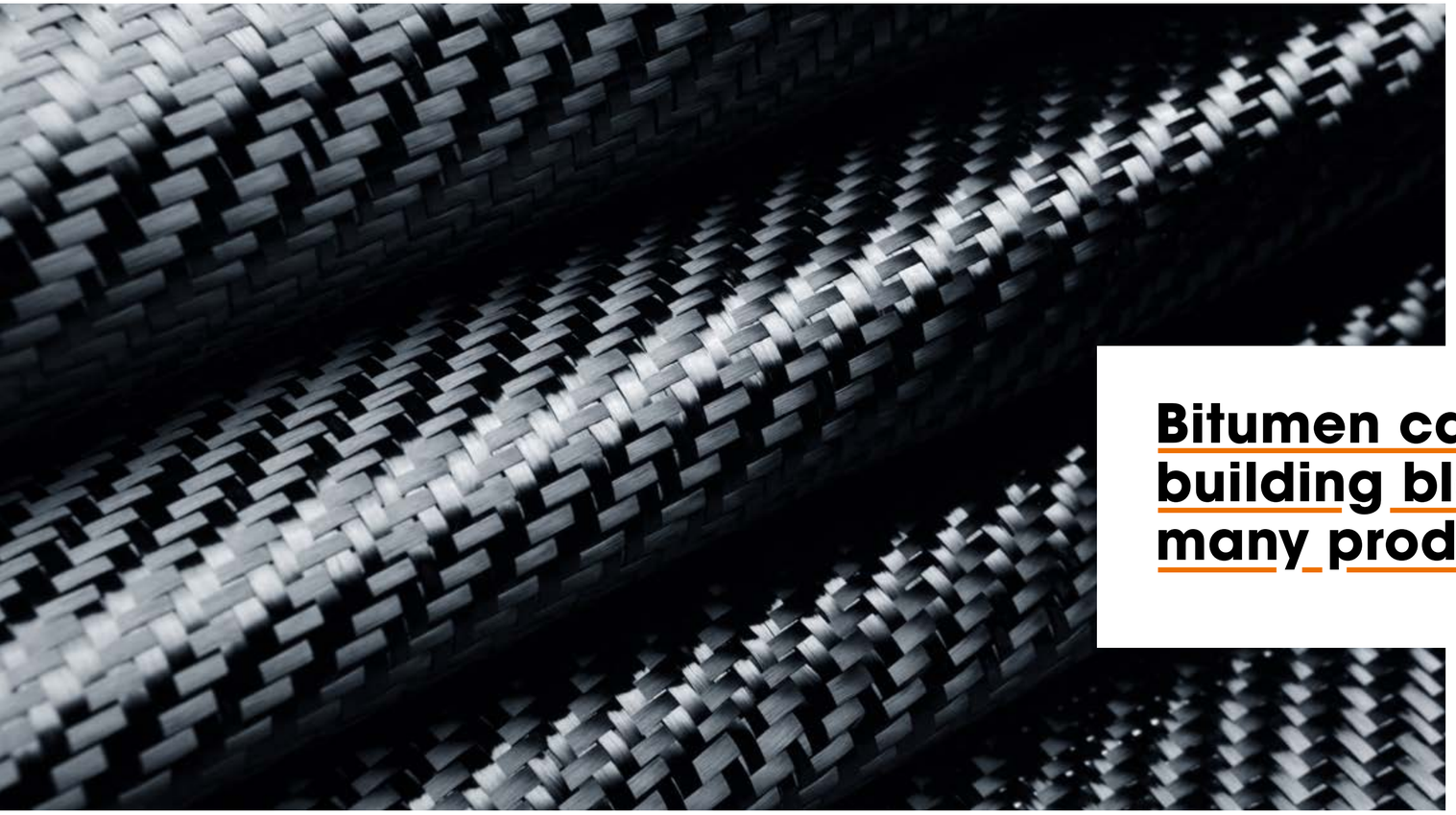
Our study for Alberta Innovates examines potential new markets for non-combustion products

Alberta's oil sands are the third-largest oil reserves in the world and their value as a source of combustible fuels has few parallels. But the long-term future of the oil sands is uncertain. Governments and industries are contemplating moving their energy sources away from oil. The Alberta oil sands are a unique resource though. They could change the way the world uses oil.

That's the intriguing, top-line conclusion of a detailed assessment conducted by Stantec and a team of leading industry partners, in support of Alberta Innovates' Bitumen Beyond Combustion (BBC) project. Bitumen is a thick, sticky mixture of hydrocarbons, with a uniquely high content of a complex molecular structure – asphaltenes.

Initiated in 2016, the BBC project's goal is to identify new and future markets for non-combustion products derived from bitumen. It also aims to reduce greenhouse gas emissions associated with the industry and convert troublesome "bottom of the barrel" bitumen components into valuable building blocks for other products. The study focused on the four product areas with the most potential, based on initial BBC research—carbon fiber, asphalt, vanadium flow batteries and polymers. We evaluated each on the basis of market potential and business case to 2030, current sources of supply, social acceptance, technology readiness and other factors.

It has strong potential to help diversify Alberta's economy and contribute to the long-term viability of the oil sands



Bitumen can be the building blocks for many products

Carbon fibers may be the future for many everyday products. It is an ultra-strong, ultra-light material used in aerospace, military, wind turbines and automotive applications. The present market, estimated at about $3 billion, is limited by the high cost of the raw material though.

Our study confirmed that the sticky, heavy, high-carbon asphaltenes that makes up about 20% of bitumen's content—and which are currently a waste product—can be processed to produce carbon fiber at a fraction of the current cost. A much lower price point opens the door to introducing carbon fiber into some huge global markets—replacing steel rebar with chopped carbon fiber in concrete, substituting it for steel in manufacturing and construction or integrating it with chip board, and other wood products.

The goal of the BBC project is to ensure any new investment will still use 100,000 barrels per day (bpd) of Alberta's bitumen. All the carbon fiber options exceed this significantly. For example, if carbon fiber replaced just 1% of the global steel market (1.6 billion tons a year), it would require approximately 500,000 bpd of asphaltenes—nearly the entire quantity being produced in Fort McMurray today.

Alberta Innovates has already committed to applied research that will move this potential option forward. Momentum is building.

Bitumen can be the roads we drive

Asphalt a global commodity used chiefly for roads and roofing. While the need for asphalt is global, its production is done locally. The reason: to remain workable, asphalt must be heated to a temperature of more than 150° C. Moving it by rail or ship is possible, but if the asphalt cools and hardens, it must be reheated in a slow, complicated, and expensive process before delivery.

In Alberta, bitumen is already used to make consistently high-quality asphalt, thanks to its relatively low amounts of impurities. These attributes make it a desirable product in the $50-billion global asphalt market—if the transportation challenge is overcome. To that end, our assessment determined that several technologies show promise in converting asphalt into sealed pucks, pellets or balls that can then be shipped in the same fashion as coal is today. Asphalt in this form would be immediately cost competitive and potentially be able to be shipped all around the globe, our report recommends further investigation of this opportunity.

Bitumen can be energy storage

We hear it all the time. Renewable energy sources like wind and solar power can't supersede traditional power sources until we solve the energy storage problem.

One of the solutions to this problem are rechargeable flow batteries made with Vanadium electrolyte. It also happens that oil sands bitumen contains significant quantities of vanadium, and when that bitumen is processed, it becomes highly concentrated in waste fly ash and coke.

The quantity of vanadium present is substantial, technologies are in place to extract vanadium from fly ash, and vanadium demand is expected to grow significantly by 2030, so the potential is there. However, our overall assessment is that this market may be tough to crack, as the extraction technology is not yet economical and existing vanadium sources may be better suited to fill the growing demand.

Polymers were included among the four products with the greatest potential because of the market's size—estimated to be nearly $1 trillion a year by 2030—and the fact that it is changing dramatically as efforts to control plastic pollution build and biodegradability of plastics enters a new era. However, our study found that the business case and competitive barriers limit any immediate opportunities for oil sands products. But with a sea change underway, it would be imprudent not to keep looking for opportunities.

In the period since Stantec first published the results of this report, it's become clear that bitumen's potential is capturing people's attention and imagination. And rightfully so. It has strong potential to help diversify Alberta's economy and contribute to the long-term viability of the oil sands. Our goals are ambitions, but our vision is strong. There is immense potential for Alberta. ›

NATHAN ASHCROFT

STRATEGIC BUSINESS DEVELOPER

Nathan works as a strategic business developer for Stantec's Oil & Gas team. This means he searches out big concepts and global changes and figures out how to adapt our business development strategy to align with a changing world. He's often involved in expanding services with existing clients or finding new ways to bring Stantec services to customers around the world.

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